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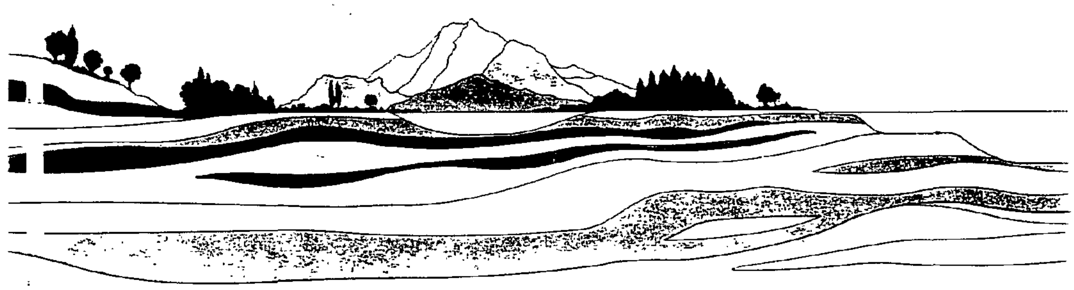
FINAL
ENVIRONMENTAL FIELD AUDIT FOR PRACTICES 1964-1990
PETROECUADOR-TEXACO CONSORTIUM
ORIENTE, ECUADOR

Prepared for:

Texaco Petroleum Company
150 Alhambra Circle
P. O. Box 343300
Coral Gables, Florida 33134

October 1992



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EXECUTIVE SUMMARY

In 1964, Texaco Petroleum Company (TEXPET) began petroleum exploration and production operations in Ecuador. From 1967 through 1990 TEXPET, as the consortium operator, conducted exploration and development production operation in the Oriente. Operations ultimately included 15 fields, 18 production facilities, 6 camps, 316 wells and transmission pipelines. According to the concession agreement operation of the Oriente fields was turned over to PETROAMAZONAS in June, 1990. Ownership was then transferred to PETROAMAZONAS in June, 1992. As part of a transfer agreement between TEXPET and its partner PETROAMAZONAS, a joint environmental audit of the consortium facilities was to be performed. Fugro-McClelland was contracted independently by TEXPET to perform a parallel audit. This report provides the summary of the findings of that parallel audit. The audit was based on applicable Ecuadorian laws and regulations and oil industry environmental practices for rainforest areas in effect from 1964 through 1990. A report titled *International Oilfield Practices (1964-1990) in Tropical Rain Forest Areas and Summary of Ecuadorian Laws and Regulations* was prepared under separate cover as part of the audit contract. This initial report provides the basis for the regulatory and practice evaluation contained herein.

A field audit of all the production facilities and camps, 50 percent of the wells and 28 miles of pipeline was conducted in April and May, 1992. The audit included; site condition documentation, produced water, stream and groundwater sampling, and analysis, crude oil and spill sampling and analysis, soil permeability and percolation testing, and noise measurement. A review of historical documents was also performed. Field observations described herein have been summarized in an effort to consolidate the large amount of data collected. A decision flow chart was used to evaluate TEXPET practices against Ecuadorian laws and regulations and industry practices for the time frame of 1964 through 1990. Practices which did not comply with the criteria and caused environmental impacts were identified for remediation measures or operational modification.

TEXPET's operation from 1964 through 1990 were in compliance with Ecuadorian laws and regulations and industry practices for seismic, exploratory drilling and many areas of development drilling/production operations. The average well site gravel pad area was 60,000 square feet (~1/2 hectare). Secondary growth existed around the perimeter of many drill sites, indicating natural revegetation was occurring. The audit identified hydrocarbon contamination requiring remediation at all production facilities and a majority of the drill sites. Seventy percent of the 158 drill sites audited had drilling or production pits. Approximately 50 percent of those pits contained

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crude oil in them. Various degrees of crude oil contamination existed on many of the well sites audited. Hydrocarbon contamination was also observed at the production facilities. The contamination was usually associated with equipment leaks or spills. Based on the field observations and the assumptions herein, approximately 50 percent of the drill pad and pit contamination and thirty percent of the hydrocarbon contamination at production facilities was attributed to TEXPET's operations from 1964 through 1990. The total volume of soil requiring remediation was estimated at 32,225 cubic yards (24,640 cubic meters). All produced water from the production facilities eventually discharged to creeks and streams except for one facility which used a percolation pit. None of the discharges were registered with the Ecuadorian Institute of Sanitary Works (IEOS) as required by the Regulations for the Prevention and Control of Environmental Pollution related to Water Resources (1989). Since the discharges were not registered, the IEOS did not establish sampling points and water quality standards to determine regulatory compliance. Facility modifications will be required at those facilities to bring the discharges into compliance with the current regulatory standards. Groundwater samples were collected from springs and water wells at nine locations. Analytical test showed no indication of contamination from production operations. Soil samples were collected for classification at each drill site, camp and production facility. The data indicated that a majority of the surficial soils in the concession area were clays and silty clays. Both laboratory permeability and field percolations tests confirmed that the soils have low infiltration rates. Pipeline installation and operation was consistent with industry practices. Only pipelines adjacent to the road were audited. A majority of those pipelines are located above ground. The average area cleared beyond the road was 20 feet, but the pipelines only occupies a portion of that space.

A preliminary remedial action plan was developed to remediate hydrocarbon contaminated soils, close out production pits and properly dispose of produced water. Since water quality standards were not established in 1989 for produced water discharges, it is impossible to determine if modification would have been required at that time. Therefore, the cost to modify the produced water discharges to current standards have been included in this report and the Environmental Management Plan. The estimated cost to perform the required modifications and remediation activities was approximately U.S. $8.5 million. The estimated cost for remediation, not including the produced water modifications was U.S. 5.5 million. These estimates include U.S. $2 million to conduct a comprehensive environmental assessment of all the consortium facilities and prepare a Remedial Action Plan. The Remedial Action Plan is necessary to develop a remedial approach and prepare an accurate cost estimate. Remedial action should be conducted following implementation of the Environmental Management Plan.

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SECTION 1

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1.0 BACKGROUND

1.1 TEXPET Operations in Ecuador (1964-1990)

With the signing of a Concession Agreement (March of 1964), Texaco Petroleum Company (TEXPET) began petroleum exploration and production operations in Ecuador. This agreement with the Ecuadorean government approved the transfer of concession rights to Texaco de Petroleos del Ecuador S.A. and Gulf Ecuatoriana de Petroleo S.A., with each company holding 50 percent participation interest in the concession (see Figure 1-1).

In 1973, the agreement was renegotiated and a new contract was signed between TEXPET, Ecuadorian Gulf Oil Company and the government of Ecuador. The Corporacion Estatal Petrolera Ecuatoriana (CEPE) purchased a 25 percent interest in the production assets in 1974 and Gulf's remaining shares in the operations in 1977. These purchases resulted in a majority holding (62.5 percent) by CEPE in the concession operations. On June 30, 1990, TEXPET relinquished control of the consortium's producing operations to PETROECUADOR. TEXPET relinquished its producing assets on June 6, 1992. At the time of this transfer the consortium assets to Petroecuador, including 15 production fields with a total of 316 wells (active and abandoned), 18 production stations, six base camps, and associated pipelines.

Seismic operations were initiated immediately following the signing of the concession agreement. These initial operations were concentrated in the northern region of the concession in the area of Lago Agrio. On February 16, 1967, TEXPET spudded the first exploration well in the area of Lago Agrio and which resulted in the discovery of commercially recoverable hydrocarbon resources. Exploration efforts continued through 1972 and resulted in the discovery of nine significant fields including (see Figure 1-2):

Field	Discovery Date
Lago Agrio	1967
Shushufindi	1968
Atacapi	1968
Parahuacu	1968
Sacha	1969
Aguarico	1969
Yuca	1970
Auca	1970
Cononaco	1972

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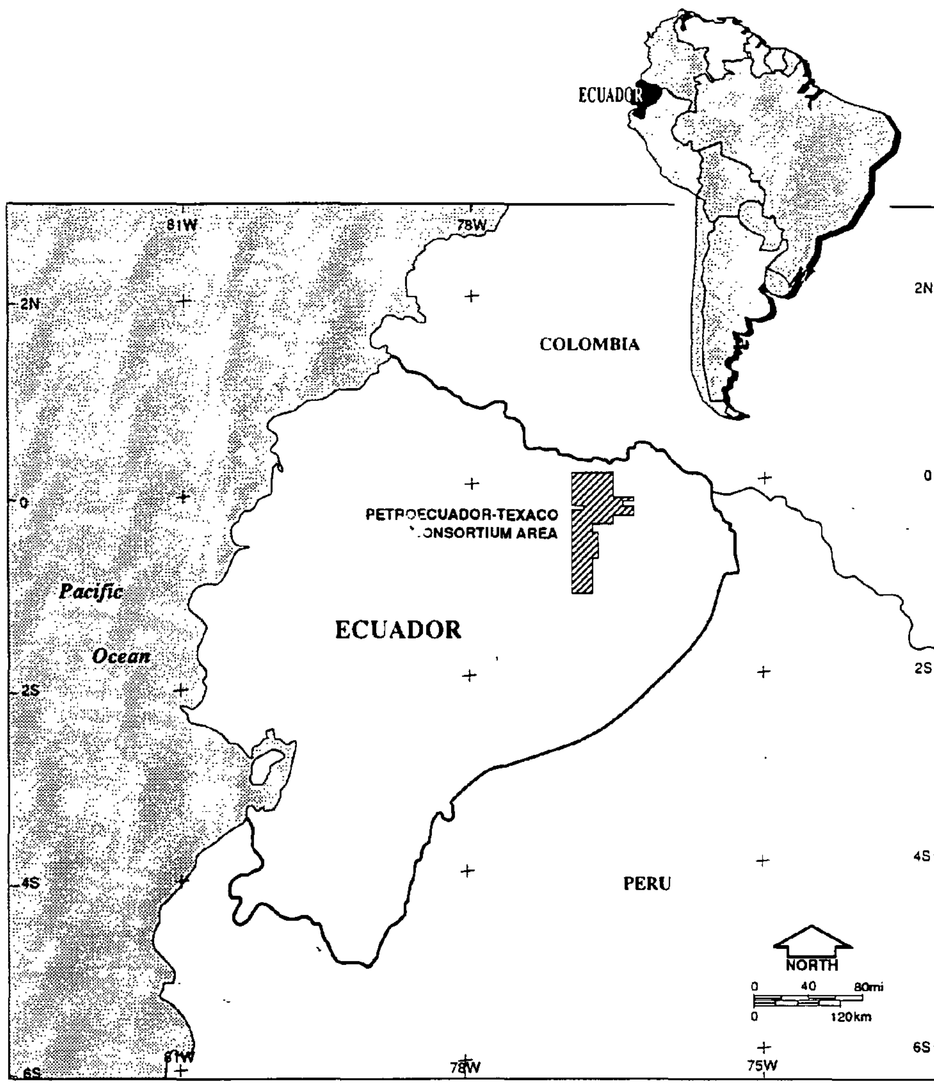

PROJECT LOCATION
Petroecuador-Texaco
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FIGURE 1-1

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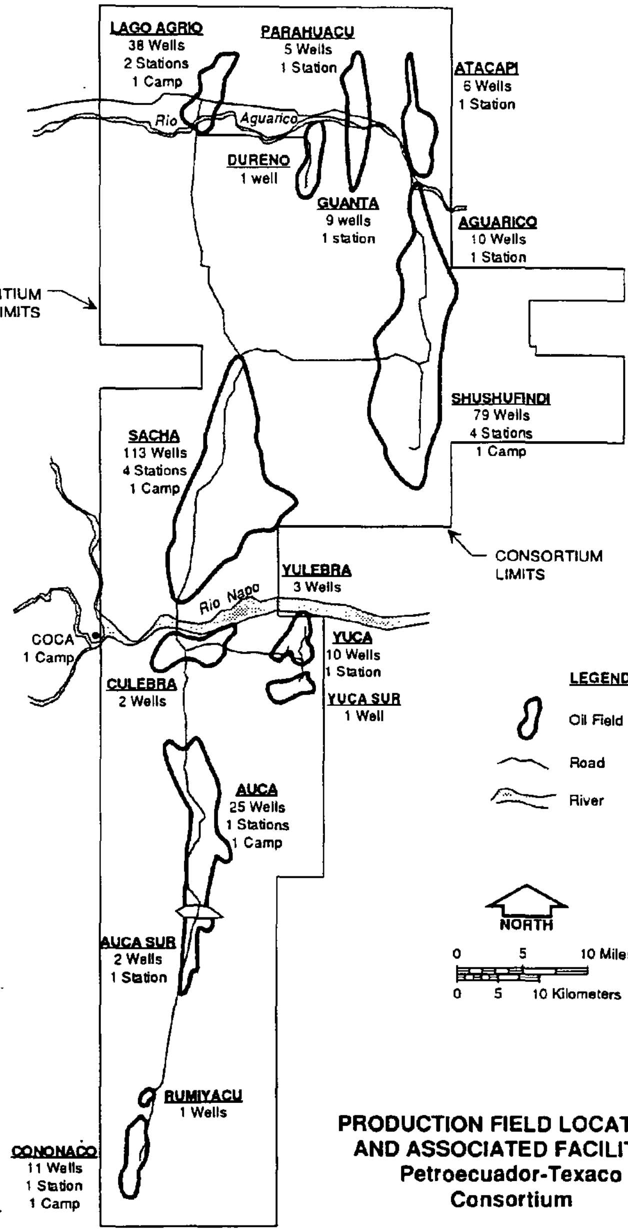

PRODUCTION FIELD LOCATIONS AND ASSOCIATED FACILITIES
Petroecuador-Texaco Consortium

FIGURE 1-2

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Development drilling was continued in the Lago Agrio, Shushufindi, and Sacha fields although a method of crude oil shipment out of the region was not available. To transport oil from the region Texaco undertook the design and construction of the Trans-Ecuadorean Pipeline. The 318-mile pipeline was completed in August 1972 at a cost of U.S. $150 million. The pipeline transports oil from Lago Agrio across the Andes Mountain Range with a maximum elevation of 13,000 feet, to a oil terminal at Esmeraldas on the Pacific coast. With this development Ecuador soon became the second largest exporter of oil in South America. Exploration and development activities continued with additional fields being discovered (See Figure 1-2):

Field	Discovery Date
Culebra	1973
Yuca Sur	1979
Yulebra	1980
Auca Sur	1981
Rumiyacu	1982
Guanta	1986

Water injection for enhanced recovery was initiated in the Shushufindi field in 1984 and Sacha in 1986.

1.2 TEXACO INDEPENDENT ENVIRONMENTAL AUDIT

1.2.1 Audit Background

In a Request for Proposal (RFP) the PETROECUADOR-TEXACO consortium solicited bids to conduct a environmental audit (Joint Environmental Audit) of the CEPE-Texaco, now PETROECUADOR-TEXACO, consortium oilfields in Ecuador that were operated by Texaco Petroleum Company until June 30, 1990. The Joint Environmental Audit scope of work includes: documentation of Ecuadorian laws and regulations, and "generally accepted" international oil practices in rainforest areas from 1964 to 1990; completion of an environmental audit of all camps and production facilities, 50 percent of the drill sites and 20 percent of the secondary pipelines; and preparation of a Environmental Audit Report (EAR) and Environmental Management Plan (EMP). To date, the completion of the joint environmental audit work and documentation are pending.

During the course of selection of the Joint Environmental Audit consultant, Texaco identified the need to ensure a balanced evaluation of their operations from 1964 to 1990. Texaco requested that Fugro-McClelland prepare a report that independently examined the Ecuadorian laws and regulations and "generally accepted"

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international oil industry practices in rainforest areas that were known to exist during this time frame.

Upon completion of the audit criteria document, *International Oilfield Practices (1964-1990) in Tropical Rain Forest Areas and Summary of Ecuadorian Laws and Regulations* (Fugro-McClelland, July, 1992), Texaco requested that Fugro-McClelland undertake a parallel audit of PETROECUADOR-TEXACO facilities. This parallel audit included the following level of effort:

- Audit six consortium base camps
- Audit 18 Production Stations
- Audit 50% of all Production Wells (316 wells)
- Audit 20% of all secondary pipeline (estimated at 30 miles)

This report provides the results of this parallel field audit effort.

1.2.2 Criteria Development

In order to develop criteria used to assess the performance of TEXPET consortium oilfields within Ecuador, Fugro-McClelland collected available information on operational practices occurring within the designated time frame (1964 to 1990). Information collected included both written and photographic documentation of oil and gas exploration, production, and development operations within rain forests worldwide. Literature sources included, but were not limited to, technical and professional publications, conference proceedings, technical manuals, field audit materials, and technical training manuals.

Once the available literature was obtained, it was used to develop assessment criteria and an overview of the oil practices that were used during the 1964 to 1990 time frame. Practices were traced backwards chronologically starting at 1990, noting any significant dates at which operational procedures had changed. At points where procedures changed, criteria applicable to practices occurring within that time period was developed. It was assumed that the literature publication date was reflective of the general time period in which a practice was in use. Where historical references to environmental practices or procedures could not be identified, it was assumed that the level of care to avoid environmental consequences corresponded to standard engineering practices in use at the time. In many instances, Texaco's operations were the first major oil and gas activity by a multinational company within a rainforest environment, and as such established the standards of operation for these areas.

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1.2.3 Field Audit

Fugro-McClelland was requested to conduct a field audit of 18 PETROAMAZONAS-TEXPET production facilities and 6 camps, 50 percent (159) of the drill/production pads and 20 percent (30 miles) of the secondary pipelines under the same scope of work as the Joint Audit Contract. It was agreed that 30 miles of pipeline would be audited, since the total length was unknown. Table 1-1 provides a listing of the production and camp facilities and drill sites that were audited. Figures 1-3 through 1-12 depict the locations of concession fields and facilities. The data collected is assumed to be representative of all the consortium facilities and operations.

Each location was observed by a team of auditors which included at least one geoenvironmental and natural resources specialist as well as an Ecuadorian representative familiar with oil and gas facilities in the region. One additional staff member was present to assist in observations, measurements, photographic documentation and field map preparation. While at the site, team members were required to complete audit forms. The geoenvironmental form outlined practices, such as waste disposal, and/or facility processes and equipment were to be examined. The natural resources form focused on the collection of information on biological aspects including soil type, vegetation characterization or any other indication of alterations to the natural setting that appeared to be the result of oil and gas operations.

In addition to the facility audit, a water sampling program was conducted. Samples of produced water pit discharge, stream samples, and groundwater were collected for analysis. . Field measurements including temperature, pH, dissolved oxygen, and turbidity were taken as part of the sampling program. Samples were delivered to the field laboratory at the Coca Base Camp for analysis. Chain of custody documentation was maintained throughout the sampling analysis process. Field percolation test were performed just outside the facility boundaries at two location in Sacha and Two in Shushufindi. Soil samples were also collected from produced water pit berms of those facilities for laboratory permeability test.

1.2.4 Audit Report and Management Plan

This audit information has been prepared to document TEXPET operating practices from 1964 through 1990. The report contains the summary of the field observations and sample collection and data analysis. Observations judged to be post 1990 are discussed in the text, but have been omitted from the report's conclusions. The field audit data was compared against the criteria for international oil field practices for rainforest areas which were in place from 1964 through 1990. If there

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were no criteria, it was considered that TEXPET's operations were in accordance with industry standard and in some instances were establishing the industry standard. If a criteria did exist, the documented practice or condition was evaluated against that criteria. If the criteria was met, environmental impacts or damages were not evaluated. If the criteria was not met, then the environmental impact and damage from the operation were assessed.

Following the evaluation of operations an estimate was prepared to assess the cost of remediation (if necessary) for those environmental impacts identified. A preliminary Remedial Action Plan was also developed which outlines potential mitigation options.

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Table 1-1. Production Field and Facilities Audited by Field Crews

Production Fields	Production Stations	Camps	Production Wells
Aguarico	1 station	No camp	5 wells
Atacapi	1 station	No camp	2 wells
Auca	1 station	camp	13 wells
Auca Sur	1 station	No camp	1 well
Coca	0 stations	camp	0 wells
Cononaco	1 station	camp	5 wells
Culebra	0 stations	No camp	1 well
Guanta	1 station	No camp	5 wells
Lago Agrio	2 stations	camp	19 wells
Parahuacu	1 station	No camp	3 wells
Rumiyacu	0 stations	No camp	0 wells
Sacha	4 stations	camp	57 wells
Shushufindi	4 stations	camp	42 wells
Yuca	1 station	No camp	4 wells
Yuca Sur	0 stations	No camp	1 well
Yulebra	0 stations	No camp	1 well
Total	18 stations	6 camps	159 wells

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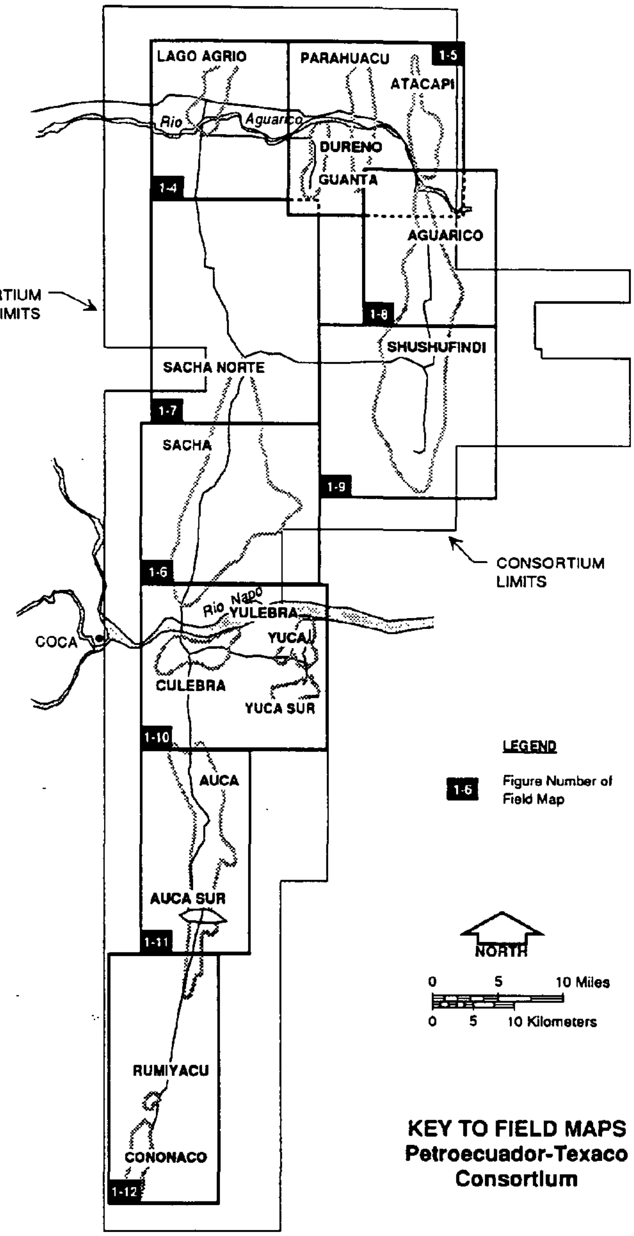

KEY TO FIELD MAPS
Petroecuador-Texaco Consortium

FIGURE 1-3

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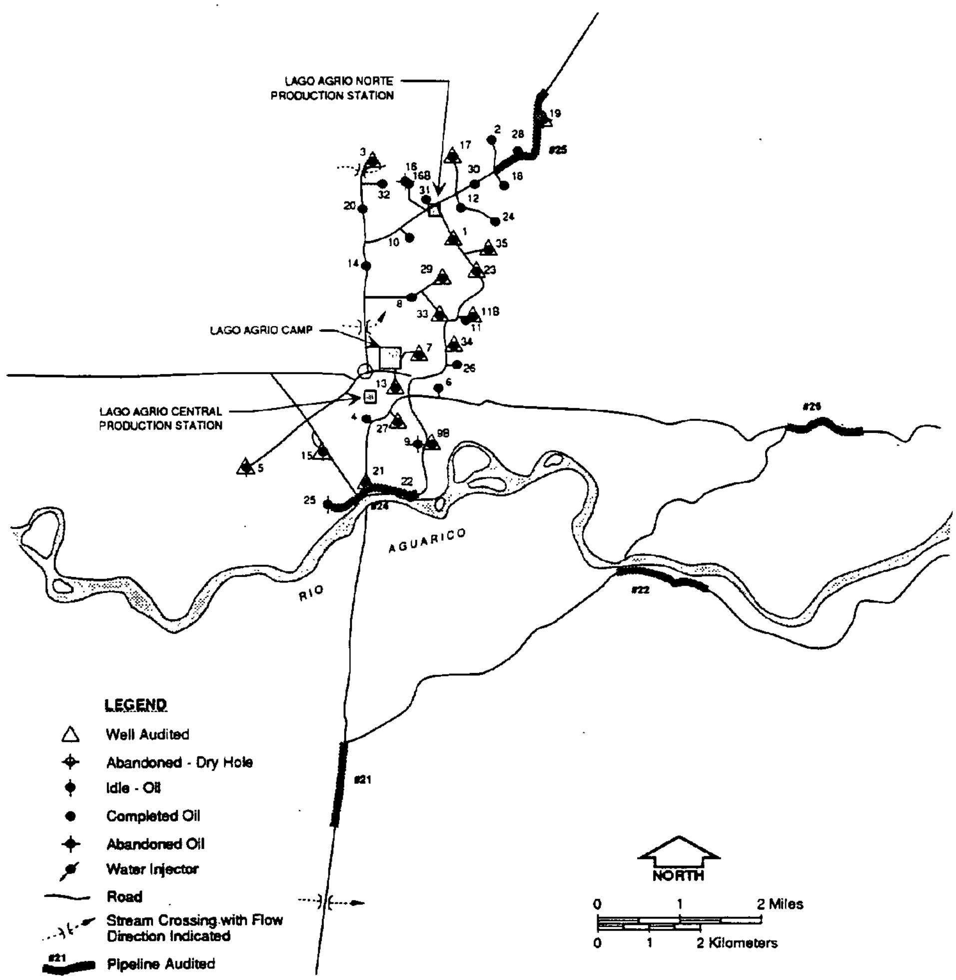

LAGO AGRIO FIELD
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FIGURE 1-4

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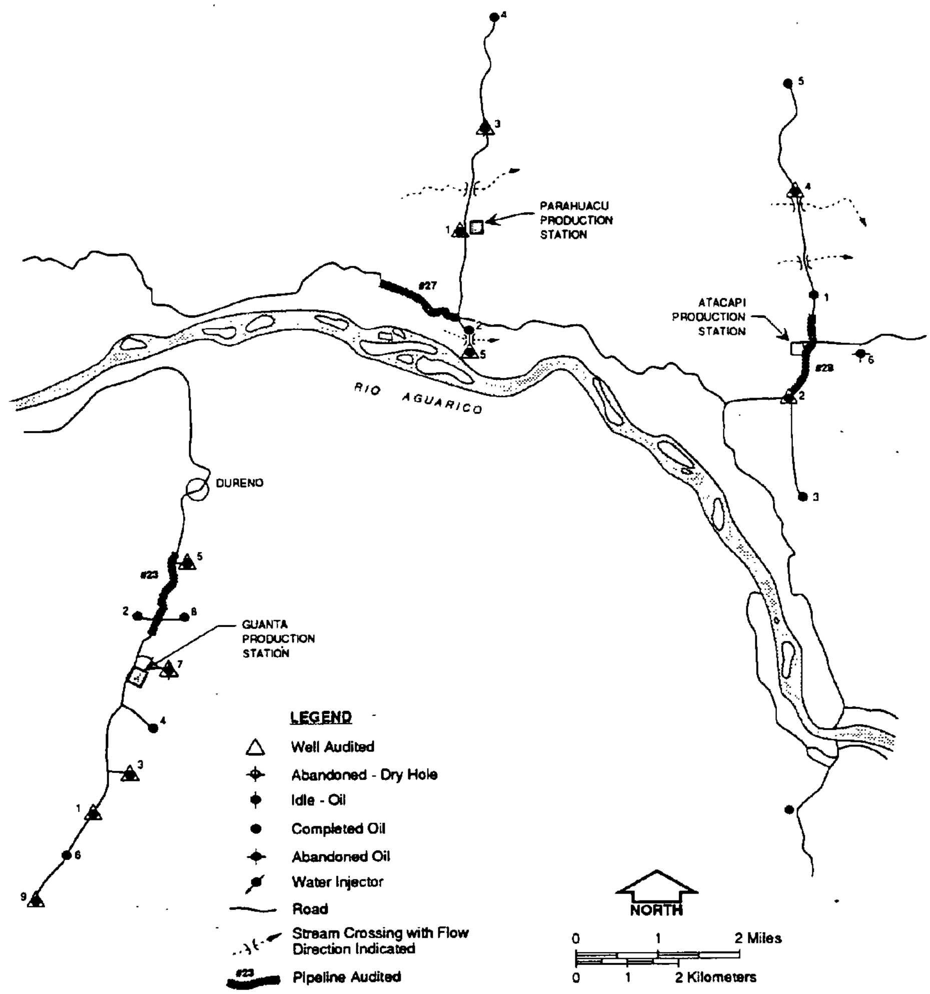

PARAHUACU/ATACAPI/GUANTA FIELDS
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FIGURE 1-5

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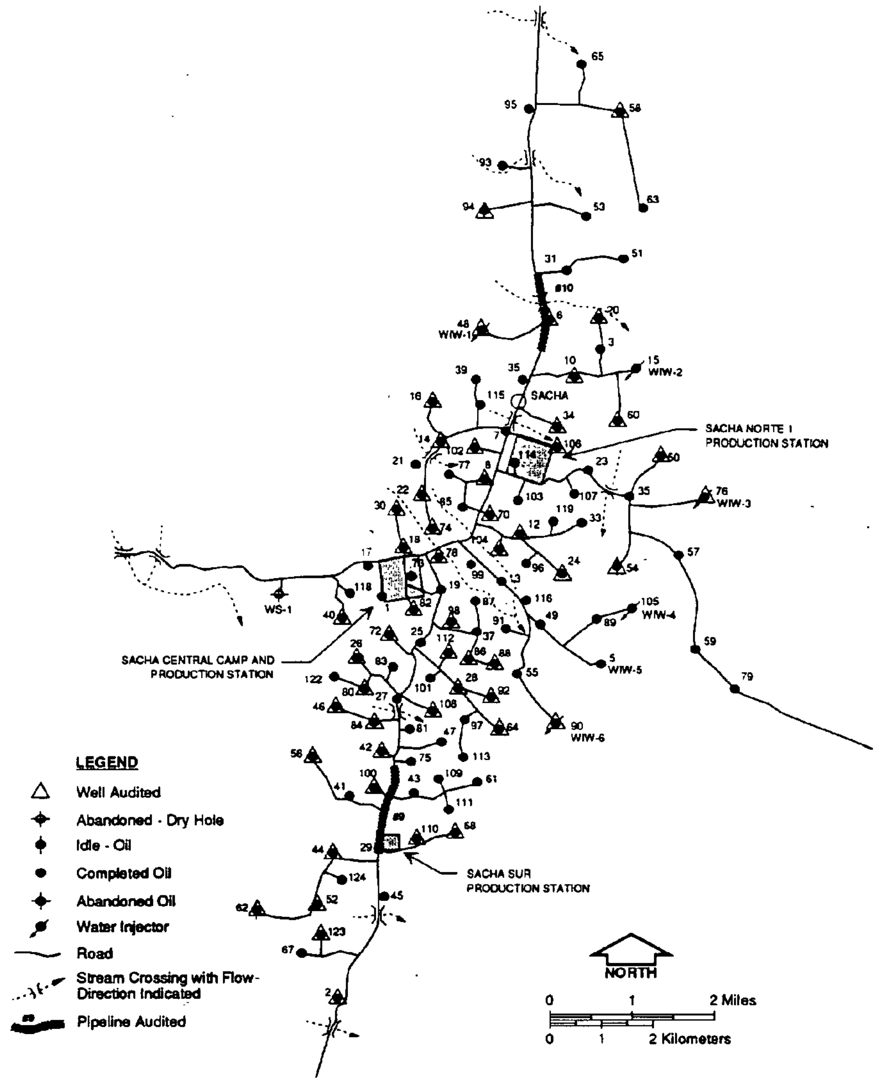

SACHA FIELD
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FIGURE 1-6

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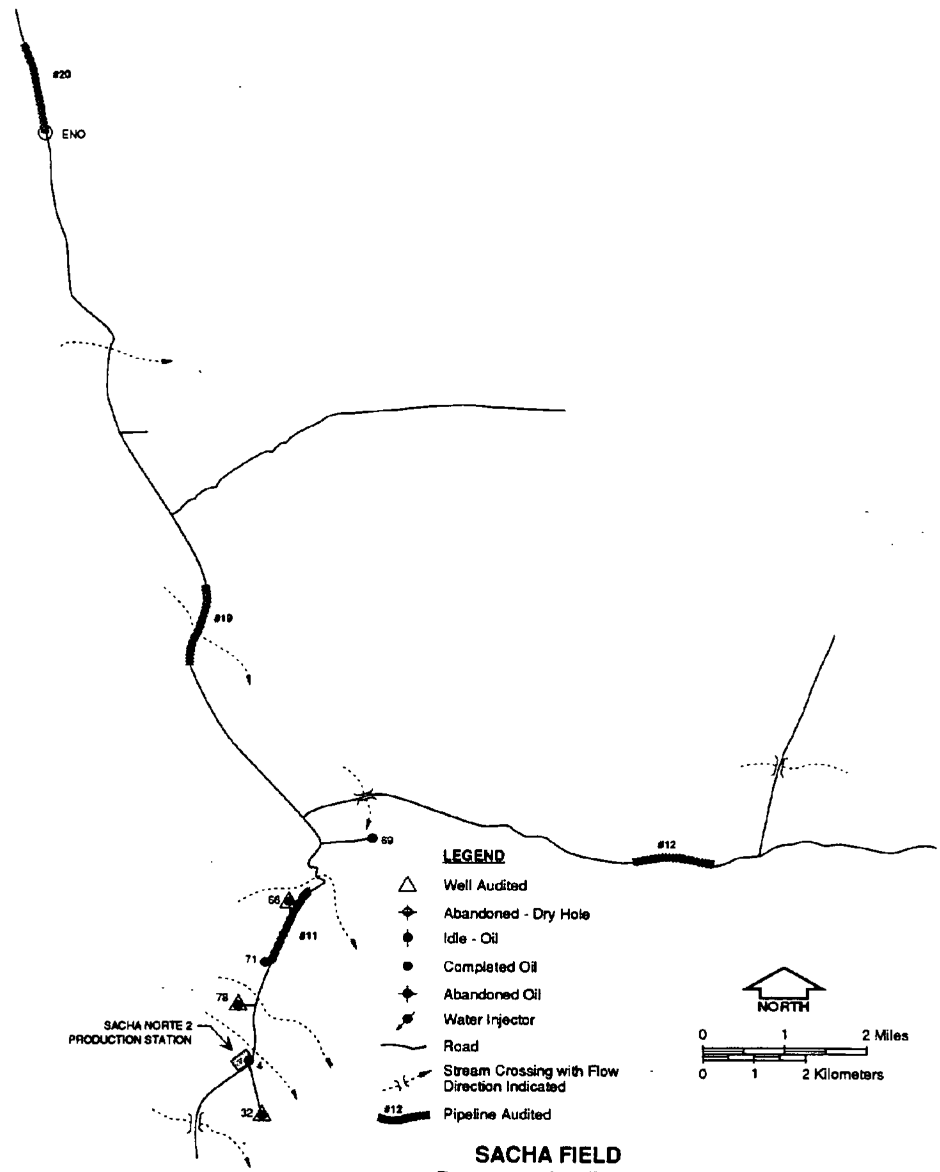

SACHA FIELD
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FIGURE 1-7

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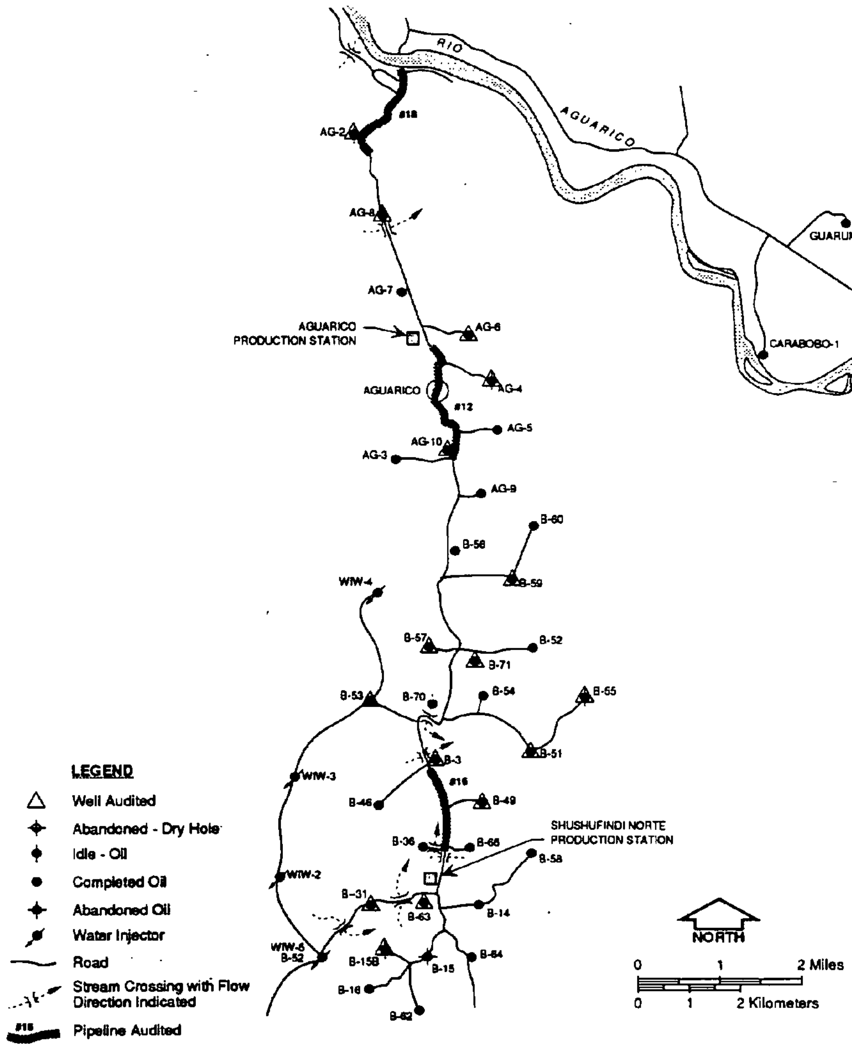

SHUSHUFINDI/AGUARICO FIELDS
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FIGURE 1-8

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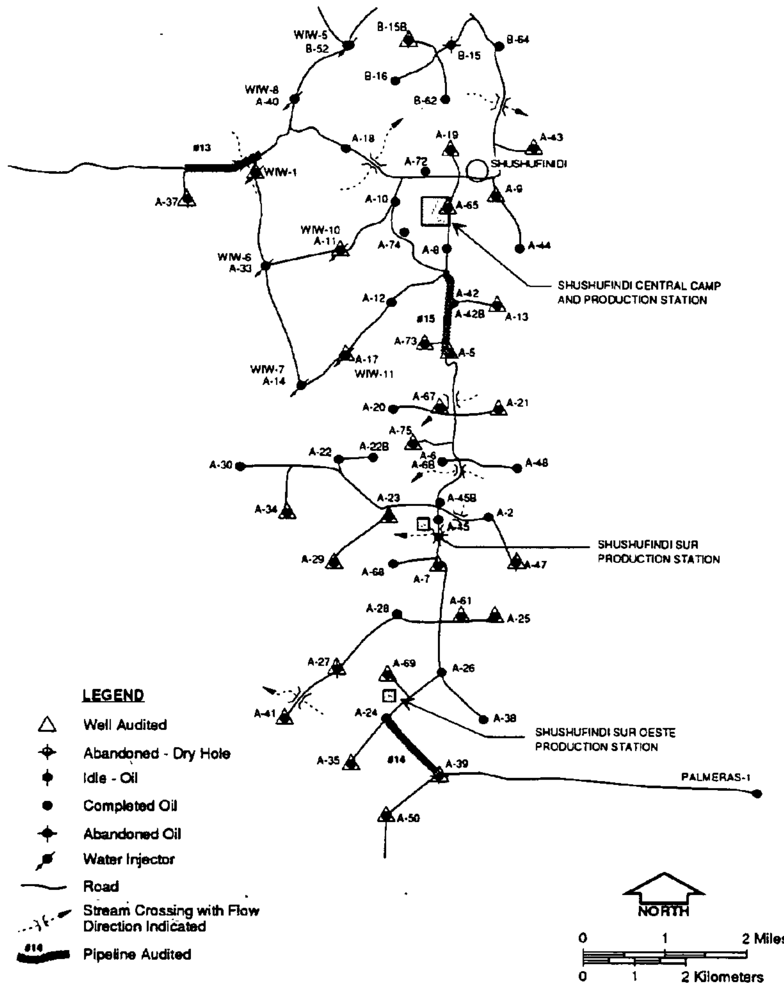

SHUSHUFINDI FIELD
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FIGURE 1-9

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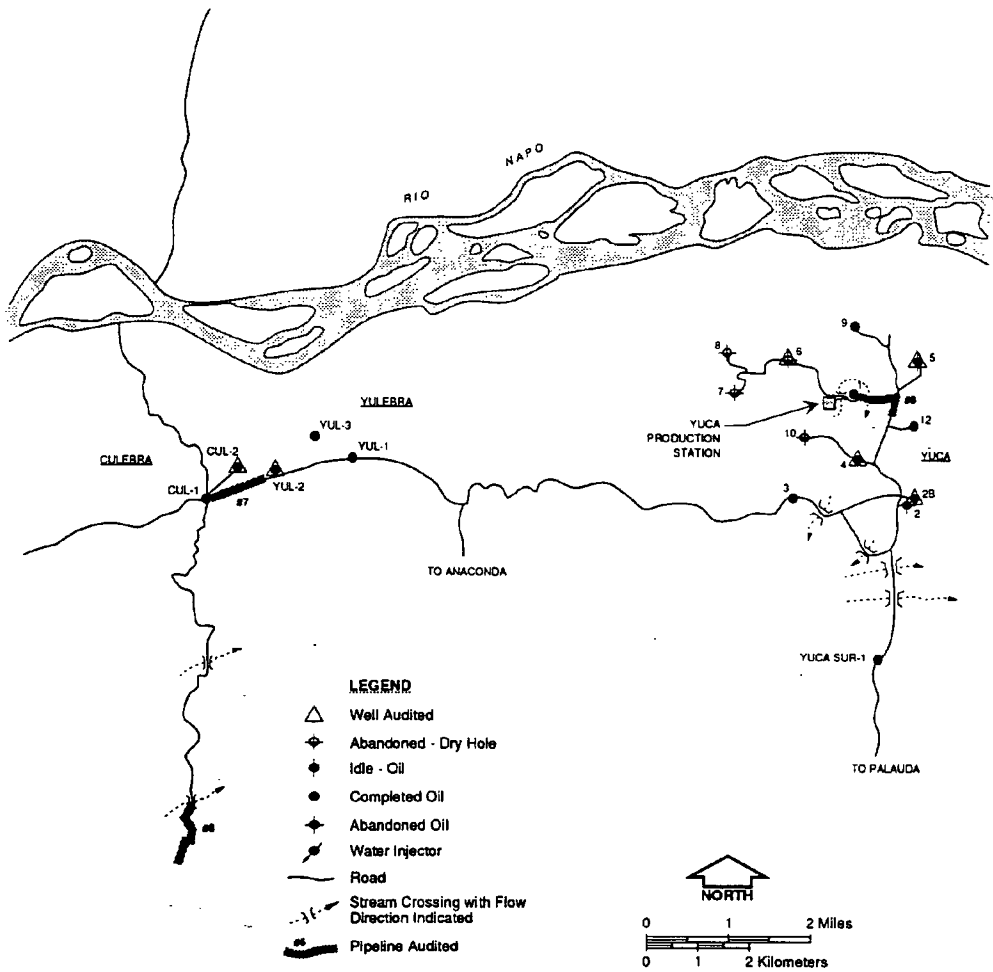

CULEBRA/YULEBRA/YUCA/YUCA SUR FIELDS
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FIGURE 1-10

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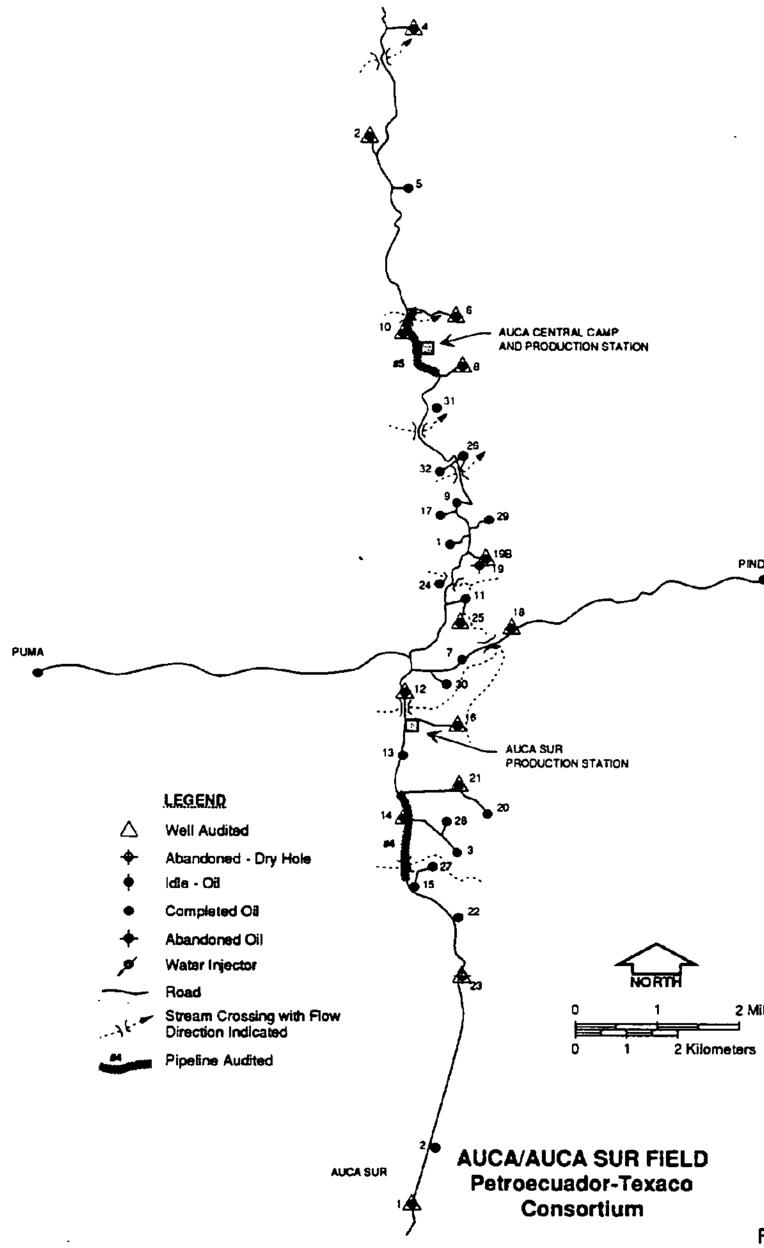

AUCA/AUCA SUR FIELD
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FIGURE 1-11

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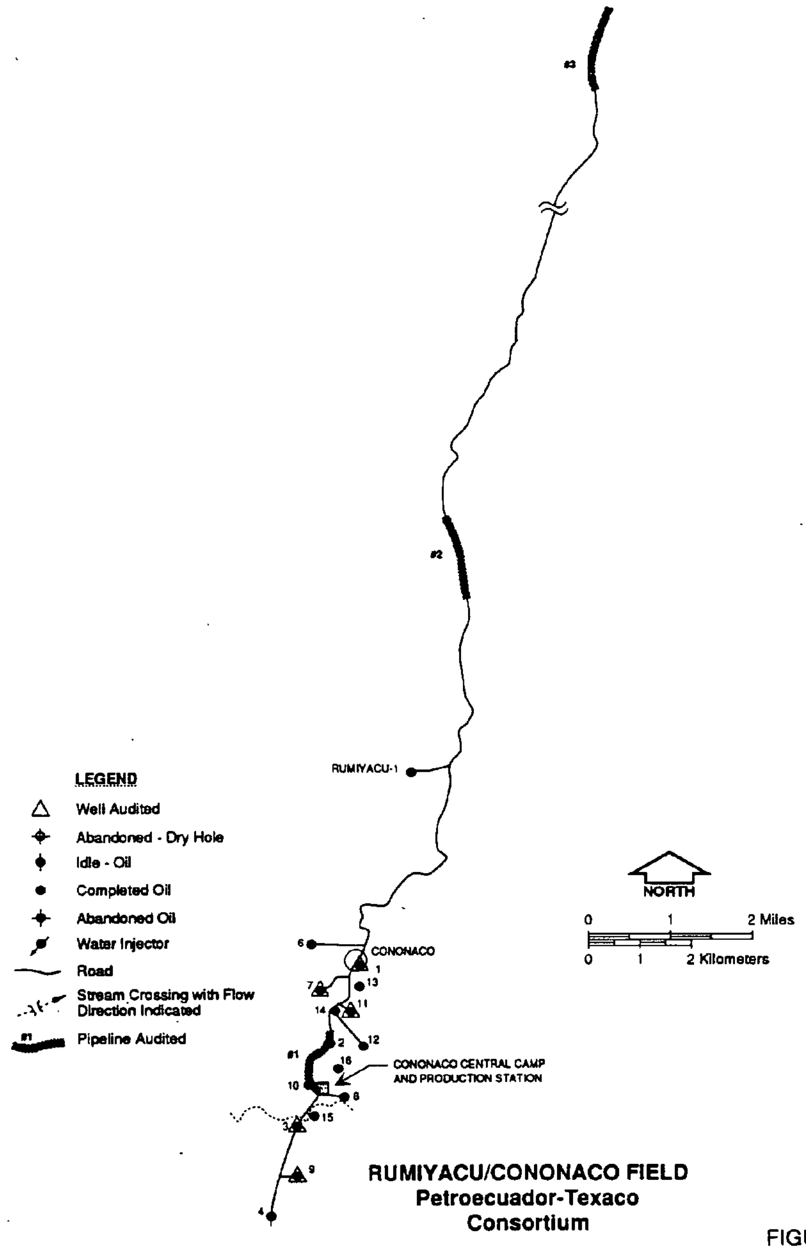

FIGURE 1-12

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SECTION 2

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2.0 INTRODUCTION

2.1 OIL FIELD PRACTICES

2.1.1 Seismic

In the search for hydrocarbon bearing formations, geological maps, aerial photographs and site surveys are prepared to identify major sedimentary basins. Once potential areas are identified, additional subsurface data must be acquired. This additional information is obtained using one of three principal survey methods: magnetic, gravimetric and seismic. Of these methods, the seismic survey (vibration and shot hole) is the most commonly used to delineate potential oil bearing geologic formations.

In remote, vegetated or topographical steep regions, shot holes is the most common technique employed. The shot hole method involves the detonation of small explosive charges placed in shallow (less than 30 meters) holes drilled below the surface. The detonation produces shock waves which are reflected to different degrees by the underlying rock strata. The resulting waves are recorded by geophones and displayed as stratigraphic layers on a map.

2.1.2 Exploration Drilling

Once a promising geological structure has been identified, the only way to confirm the presence of hydrocarbons, and the thickness and internal pressure of any reservoir, is to drill an exploratory well. It is important to emphasize that the location of a potential exploration site is based upon the underlying oil bearing geologic features. Therefore, site selection is inherently limited to specific areas. Normally clearing involves an area capable of supporting a portable drilling rig and associated facilities. Associated facilities normally include crew camps and assess roads and/or helicopter pads.

The time taken to drill a well depends on the depth of the oil bearing formation and geologic conditions. This may require one to two months. After the drilling and testing period, the rig is dismantled and moved to the next site. If the exploratory drilling is successful, a wellhead is installed. If commercial quantities of oil and gas are not found, the well is plugged and the site is abandoned.

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2.1.3 Development Drilling and Production

If a viable oil or gas field is discovered, existing well(s) may be placed in production. If the field is large enough, additional production wells will be drilled. When two or more wells are in production, a gathering system and central processing facility are constructed. The processing facility separates oil, gas, water, and other wastes and may include power generation, water treatment and injection and product shipping facilities. Facilities size vary based on function and total production.

Large facilities located away from developed regions require the establishment of a base camp to house oil field workers. For remote sites, service equipment and associated facilities are normally centralized at the production facility base camp. Routine operation at production facilities generally cause little disturbance. Facility expansion or modifications may occur as the field matures. Periodically, drill/workover operations on wells and maintenance activities on pipelines are required to maintain production. This work is usually limited in duration.

2.2 ENVIRONMENTAL SETTING

The environmental audit study area is located along the eastern slope of the Andes Mountain range, within the Amazon Region, Oriente District, of northeastern Ecuador (Figure 1-1). The area encompasses approximately 400,000 hectares (ha) within the provinces of Sucumbios and Napo.

The region is drained principally by the Rio Napo which flows southeast to its confluence with the Rio Maranon near Iquitos, Peru where it forms the Rio Amazonas. The major tributaries to the Rio Napo within the project area include the Rio Aguarico and Rio Coca. The elevation within the project area varies from approximately 1,000 feet at the westernmost sites to approximately 900 feet near Shushufindi and Aquarico (Instituto Del Militar, 1991).

Alluvial soils are the predominate soil type in the region between the Aguarico and Napo Rivers. The alluvial soils found along river banks and are comprised of recent deposits of volcanic ash. These deposits are in general, flat and may experience poor drainage and flooding. Outside of the alluvial valleys, the predominate soil type is the typical red, clayey soils of the Amazonian Basin. These soils are characterized by poor internal drainage and are susceptible to erosion in steeper areas (WBCS, 1979).

It is estimated approximately 9.3 million (M) ha of Amazonian lowland vegetation occurs within the political borders of Ecuador. Of that, approximately

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8.4M ha or 87 percent is forested (7.6M ha of terra firma forest and 800,000 ha of wetland forest), and the remaining area is principally cleared and/or cultivated lands (Eden, 1990). The project area is within the lowland forest of eastern Ecuador and is classified as *Tropical Moist Forest* and *Tropical Wet Forest* according to the Holdridge life zone system (Holdridge and Tosi, 1967). Vegetation is dominated by trees with a dense canopy layer about 100 feet above the ground, and is rich in vines and canopy plants (Balslev, 1988). Based on the classification system recommended by Prance (1979), most of the forest in this region is categorized as non-flooded (terra firma); however, floodplain forests (seasonal varzea) occur adjacent to the major rivers and tributaries.

Generalized cover type categories were used to describe the vegetation surrounding oil production facilities consistent with the method described by Duellman (1978). The cover type categories included the following:

- **Primary Forest.** Primary forests are mature forests characterized by nearly continuous canopy, stratified vegetation, and deep mulch layer. Canopy trees frequently exceed 100 feet in height and are often buttressed or have stillroots. Ground layer is weakly developed, but vines which grow in the canopy (epiphytes) are abundant. Primary rainforest maintains high species richness with relatively short-lived tree species (60 years).

- **Secondary Forest.** Secondary forests are successional series and partially cleared primary forest. The cutting of the large trees results in a secondary growth resembling that of intermediate successional stages of the primary forest.

- **Clearing.** Uncultivated clearings are usually man-made and characteristically support a variety of grasses. Clearings also include pasture and large commercial/ industrial areas associated with production facilities.

- **Cultivated Fields.** Any cleared areas bearing crops. Principal crops observed during field surveys included coffee, banana, yucca, coca, and maize. Often, cultivated fields contained residual stands of primary forest to provide overhead shading.

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- **Wetlands.** Wetlands were defined to include swamps, marshes, and wet meadows. Swamps were forest depressions/swales that were either permanently or periodically inundated. Marshes were also permanently or periodically flooded, but were dominated by non-woody vegetation.

- **Surface Waters.** Surface waters included ponds, lakes, streams, and rivers.

Primary Rainforest

In a study of the composition and structure of terra firma and floodplain forests near the Yasuni National Park, located approximately 160 miles east of Coca, Balslev et al. (1987) reported tree densities of 728 trees/ha in the terra firma rainforest and 417 trees/ha in the flooded forest. These data were comparable with other lowland rainforest studies. Species diversity was high with 228 and 149 species/ha in the terra firma and floodplain rainforest plots, respectively. The majority of the trees ranged from 50 to 100 feet (~15-30 meters) in height and 4 to 16 inches (~10-40 centimeters) in girth, however, one specimen exceeded 200 feet (~60 meters) in height, and over 3 feet (~1 meter) in diameter. The average life expectancy of a forest tree was estimated at 55.6 years.

Gentry (1987), in a study of wet forest species richness in the Upper Amazonian Basin, recorded diversity figures ranging from 102 to 300 species/ha, which exceeded species richness figures for Asian rainforests that were once considered the most diverse forests in the world. It is difficult to account for the high species diversity in the relatively uniform topographic and soil dependent (edaphic) environment represented by the lowland wet forest. Denslow (1980) noted that although rainforest species exhibit patterns associated with variation in topography or soil, species with non-random distributions often show no association with edaphic variation and the resultant overlap along soil gradients is high. Ewel (1980) postulated that timing, location, and dispersal are probably more influential in determining site-specific species composition than soil or topography. However, while species diversity is very high in the Amazon rainforest, endemism is typically low due to the lack of dispersal barriers (Balslev, 1988). Upper Amazonia rainforests have the highest diversity of butterflies, amphibians, reptiles, birds, and mammals in the world (Gentry 1987).

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Agriculture

Forsyth and Miyata (1984) have noted that although the oil development has not lead to extensive direct alteration of the rain forest habitat, construction of roads associated with oil field activities has caused changes in the landscape, principally because of settlement, agricultural, and logging. The road provided ready access to markets, and land that was once too difficult to settle became accessible and desirable.

Peck (1990) has described three perennial agricultural production systems practiced by the residents of the Upper Amazon region of Ecuador. These include "chacra" or swidden agriculture; coffee plantations; and cattle pastures.

The chacra is the traditional system used by the indigenous lowland Napo Quichuas and has sustained low-density settlement since before western contact. It is referred to as a "slash and mulch" system in which valuable trees and palms are preserved when the forest is first cleared. After the short-cycle crops have been harvested, the perennial species continue to produce. The remaining woody species are sources of regeneration thrc . jh residual saplings, sprouts from cut trees, germination of buried and/or wind-borne seeds, and direct seeding or transplantation. Chacra is never completely abandoned and proves a continual source of fruits, firewood, timber, and even game, and is tightly linked to the natural processes of forest succession.

Colonist production system evolved from the need to provide subsistence agriculture to the burgeoning population after colonization. The colonists adapted a degenerate form of the indigenous slash-and-mulch system for crops and pastures for cattle ranching. Two market-oriented perennial crop farming systems -- coffee plantations and cattle pastures -- have developed since the early 1970's and now are the dominate colonist production systems.

2.3 POTENTIAL ENVIRONMENTAL IMPACTS ASSOCIATED WITH OIL AND GAS OPERATIONS

Generally, the construction required for exploration and development of oil and gas result in environmental consequences which are unavoidable due to the nature of operations. Activities associated with oil and gas development can affect the physical, biological, as well as the socioeconomic environment. The phased approach to oil and gas exploration and development is conducive to minimizing environmental disturbance. The initial search for hydrocarbons is usually initiated with a non-intrusive study of geologic conditions and other available data. Based on the

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field and literature review a seismic survey may be conducted. Disturbances to the environment for seismic surveys include access; roads or helicopter, camp facility for survey team and equipment and survey line clearing. In promising area, exploratory wells are drilled. This usually requires the clearing of additional surface area for equipment access, drilling location and a larger base camp. Many oil and gas prospects never proceed beyond the exploration phase. If commercial quantities of oil and gas are discovered, development drill and production may occur. This will include the installation of drill sites, production facilities, pipelines and other associated equipment.

Within rainforest areas these activities, seismic, exploration and development may cause avoidable impacts. Those impacts for seismic and exploratory drilling operations may include erosion and soil and water contamination. Due to the heavy precipitation in the rainforest, unprotected soils, void of vegetation, may erode. Proper site preparation can minimize this problem. Soil and water contamination is also possible when fuel, drill mud, chemicals and other waste are accidently spilled. Spill prevention, control, and cleanup practices will reduce the potential for contamination. The unavoidable impacts such as tree and vegetation removal and soil disturbance for seismic and exploration activities are potentially short term due to the temporary nature of the work. It has been suggested that small areas, less than 0.5 to 1.0 ha will regenerate similar to natural forest gaps which occur through natural means (Eden, 1990). Larger areas may require additional time to recover, but regeneration will occur if the sites are left undisturbed. The potential avoidable impacts from development drilling and production are similar to that of seismic and exploration, except development operations continue for the life of the field, which may be several decades. Therefore, the possibility of soil erosion from road and facility maintenance and soil and water contamination by accidental spills also continues for that length of time. Again, proper site preparation and spill prevention, control and cleanup can minimize long term impacts. The unavoidable impact from development drilling and production have a long term effect on the rainforest environment. Land used for production operation must remain open and maintained. Therefore, these areas do not have the opportunity for restoration until abandonment occurs. Drilling and production operation also require more equipment which generate emissions and noise. These too can managed by proper design and operation to prevent environmental impacts.

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SECTION 3

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3.0 ENVIRONMENTAL AUDIT CRITERIA AND EVALUATION METHODS

3.1 AUDIT CRITERIA (1964-1990)

The following sections summarize the Ecuadorian laws and regulations and industry practices for specific issues associated with seismic surveys, exploration drilling, and development drilling/production for rainforest areas. Detailed criteria was developed through a literature search conducted by Fugro-McClelland and is contained in a report titled International Oilfield Practices (1964-1990) in Tropical Rain Forest Areas and Summary of Ecuadorian Laws and Regulations (Fugro-McClelland, July, 1992).

3.1.1 Seismic

During the time period from 1964 to 1971, there were no Ecuadorian laws or regulations pertaining to operational practices dealing with seismic activities: access and base camp; site selection, waste handling, or abandonment and restoration. An Environmental Impact Study (EIS) was first mandated in 1976 under the Ecuadorian Law of Prevention and Control of Environmental Pollution (Decree 374, 1976) for site selection. Under this law, environmental studies and mitigation measures for controlling potential impacts were required for industrial projects that could result in an alteration of the ecological system and air quality.

Ecuadorian laws adopted from 1971 through 1982 contained broad requirements pertaining to site preparation. The regulation required the protection of flora, fauna, and other natural resources and prevention of water, air, and land pollution. Additional site preparation regulations were adopted from 1982 through 1990 which required oil and gas facilities to operate according to generally accepted international environmental protection practices. These laws and regulations applied to both access and base camps.

Discharge requirements and Water quality standards were first enacted in the Regulation for Prevention and Control of Environmental Pollution to Water Resources (Decree No. 2144, 1989) were enacted. This regulation required discharges to be registered and required sampling to determine compliance with the established standards. These regulations are supported by the 1976 law which prohibits the discharge of waste and pollutants that were dangerous to the environment and human health. The 1989 regulations also contained the requirement for a spill prevention and control plan. Operators that explore, exploit, or store hydrocarbons were required to prepare and implement a plan.

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From 1964 to 1990, there were no documented industry practices pertaining to waste handling, spill prevention and response, and abandonment and restoration for access and base camp facilities. Industry practices for access preparation and site selection and preparation were identified beginning in 1973. These practices included locating base camps near rivers for access by heavy equipment and the clearing of land for roads, bridges, helipads, camps, etc.

Tables 3-1 and 3-2 provide a general summary of laws and regulations and industry practices that pertain to access and base camps associated with seismic surveys.

3.1.2 Exploration Drilling

Laws and Regulations discussed under Section 3.1 - Seismic are applicable to access and base camps associated with exploration drilling. These laws and regulations (Section 3.1) also apply to well site operational practices dealing with site selection, site preparation, waste handling (drill mud and cuttings), spill prevention and control, and abandonment and restoration.

Additional laws not previously introduced under Section 3.1, which apply to the disposal of natural gas from drilling/production operations, include the Concession Agreement (Decree No. 205-A, 1964), and modifications of this agreement through the Codification of Hydrocarbon Law (Decree No. 2967, 1978). In 1964 through 1971 these regulations required that non-usable gas be burned in appropriate burners. From 1971 to 1976 gases could not be vented without authorization from the Ministry of Hydrocarbon, and from 1976 to 1990 pollutants were prohibited from being discharged into the atmosphere if they were determined to cause environmental consequences.

From 1964 through 1990 site selection for exploratory drilling was based on the location of potential oil bearing geologic features. Site selection for access and base camps associated with drilling operations was dictated by ; located near roads or rivers (Hakim, 1973; Bleakley, 1983).

Industry practices relating to site preparation varied based on the mode of transportation selected. Exploration drilling operations were conducted using land, water, and air to transport personnel, equipment, and supplies into remote sites. The Sacha field discovery well was drilled in early 1969 by Texaco using a helirig (Rica, Jr. 1992). Preparation of well sites during the period between 1964 to 1990, included clearing and leveling sites to provide enough room for helipads, staging areas, base camps, auxiliary equipment, supplies, and a waste disposal pit. Generally, timber

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removed as part of the base camp and well site preparation was processed and used as location cover. From 1964 to 1990, drill mud and cuttings were deposed of in the reserve pits. There were no industry practices identified for spill prevention and control and site abandonment and restoration.

Tables 3-3 through 3-5 provide a general summary of Ecuadorian laws and regulations, and industry practices relating to access, base camps, and well sites associated with exploration drilling.

3.1.3 Development Drilling and Production

Ecuadorian laws and regulations that apply to base camps and access for development drilling and production are the same as those outlined in Section 3.1 - Seismic. These laws and regulations also apply to drilling and production operations; site selection, site preparation and waste handling (drill mud and cuttings, produced water, and hydrocarbons), spill contingency, and site abandonment and restoration.

Ecuadorian laws and regulation relating to natural gas associated with drilling and production were previously discussed in Section 3.1.2 (Exploration Drilling). From 1964 to 1990, these regulations included such measures as the burning of natural gas (1964 to 1971), and non-venting without prior authorization from the Ministry of Hydrocarbons (post 1971). In 1974, the Hydrocarbon Exploration and Exploitation Regulations (OR No. 530, 1974) mandated that drilling and production operations properly disposal of salt water, drilling mud, oil samples, and other elements that may cause damage to the flora and fauna.

From 1964 to 1990, there were no documented oil industry practices relating to access and base camp site selection, site preparation, waste handling, spill contingency plans, or site abandonment and restoration. In addition, no practices were documented pertaining to; drilling/production and pipeline site selection, waste handling, and spill prevention.

Between 1964 to 1990, drilling site preparation included the clearing and leveling of areas large enough to handle auxiliary equipment, supplies, and waste disposal pits. During this time frame, drill mud, cuttings, and other waste materials were disposed of in reserve pits.

Prior to 1990, production operations involved discharge of produced water into evaporation pits or other waste management methods including discharge into surface waters. Disposal of non-usable gas involved flaring or venting to the

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atmosphere (Wheeler, 1971; API, 1973; UNEP, 1987). Tank bottoms, emulsions, heavy hydrocarbons and crude oil contaminated soils were used for road oil, road mix or asphalt (Rudoffs, 1953; Perkins, 1990; API, 1989). Spill prevention and control practices from 1976 to 1990, included berms around storage tanks, berms or other alternate systems to contain spills.

From 1964 to 1990, site preparation for pipeline development included the removal of timber, underbrush, and rocks within a 50- to 70-foot wide right-of-way. These right-of-ways were restored through erosion control and revegetation (Petroleum Extension Service, 1966, Seager, 1988).

Tables 3-3 through 3-10 provides a general summary of Ecuadorian laws and regulations, and industry practices for development drilling/production activities.

3.2 FIELD EVALUATION METHODS

Walkover field surveys of the PETROECUADOR-TEXPET consortium drill sites and production facilities in the were conducted between April 8 and May 30, 1992 by Fugro McClelland staff scientists. Field teams consisted of at least four members, including one geologist, one biologist, one natural resources specialist and one Ecuadorian logistical coordinator. The teams completed detailed facility data sheets, prepared layout maps and took photographs to summarize the operational components and environmental characteristics of each site. Information recorded for the audit included:

- Maps and descriptions of well pads, production facilities, camp facilities, and pipelines
- Location and description of facility discharges as waste handling practices
- Locations and descriptions of apparent contamination (stained soil/vegetation, oily debris, sheen on water surfaces, etc.)
- Facility equipment; tanks, engines, pumps, and any modifications or additions
- Physical, biological, or cultural resource descriptions
- Descriptions of adjacent land uses

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- Condition and type of on site and adjacent vegetation
- Soil type of adjacent undisturbed areas as determined by the Munsell Color Charts
- Wildlife observations
- Locations of significant biological areas (wetlands, natural surface waters, roosting/nesting trees, etc.)

Produced water and the receiving waters (natural rivers, gullies or streams into which produced water is discharged) at each production station were sampled and analyzed for physical and chemical properties including temperature, pH, color, turbidity, hydrocarbon content, total alkalinity, hardness, dissolved oxygen, and suspended and dissolved solids. One produced water sample and three receiving water samples were collected (upstream of the discharge point, immediately downstream [mixing zone] of the discharge and approximately 100 meters downstream of the discharge). In areas where groundwater was accessible, samples were collected to determine regional base' . e water quality and to evaluate the potential for contamination. When groundwater contamination was observed, samples from the nearby production pits were taken for analysis, and the production pit structure (base and walls) was reviewed to identify obvious seepage or other potential pathways contamination. All produced water pits were checked to determine the extent of oil cover on the water.

3.3 IMPACT EVALUATION METHODS

Figure 3-1 provides a summary of the Impact Evaluation Method used in the preparation of this report. Following completion of the field audit, observations were compared against the audit criteria to determine facility operations compliance. If criteria were met, no impacts to the environment beyond those normally encountered with any industrial project were reported. If audit criteria were not met, an assessment of environmental damage was performed to determine what impact have occurred as a direct result of operations. Where impacts were identified mitigation measures were recommended (if necessary) to adequately restore the site.

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Fugro McClelland

**TEXACO ENVIRONMENTAL AUDIT
DECISION FLOW CHART
Petroecuador-Texaco
Consortium**

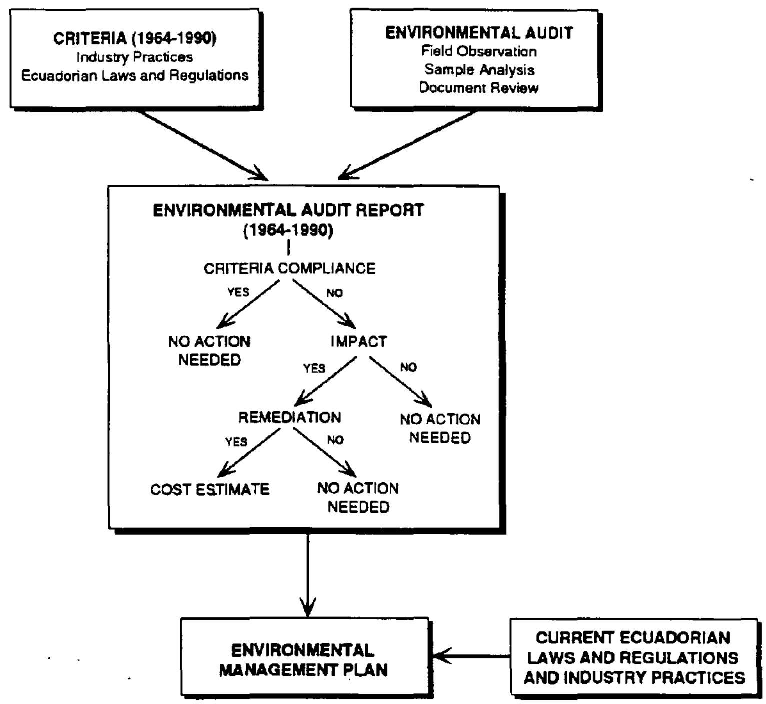

FIGURE 3-1

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Table 3-1. Seismic Surveys - Access Summary
International Oilfield Practices (1964-1990)
for Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures are required.	1964 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally accepted international practices.	1964 - 1973 No practices documented. 1973 - 1990 Cleared land by bulldozer or hand as necessary. Constructed helipads, roads, bridges and dams as required.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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**Table 3-2. Seismic Surveys - Base Camp Summary
International Oilfield Practices (1964-1990)
for Tropical Rainforest Areas**

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures are required.	1964 - 1973 No practices documented. 1973 - 1990 Establish base camps next to rivers for accessibility.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally accepted international practices.	1964 - 1973 No practices documented. 1973 - 1990 Cleared land by bulldozer or hand as necessary. Constructed helipads, roads, bridges and dams as required.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practices documented.
Spill Prevention and Response	1964 - 1989 No law or regulation. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-3. Exploratory Drilling - Access Summary
International Oilfield Practices (1964-1990)
For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures are required.	1971 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution 1982 - 1990 Operate according to generally acceptable international practices	1964 - 1969 No practice documented. 1969 - 1990 Use of land, water and air to transport personnel, equipment and supplies.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practice documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-4. Exploration Drilling - Base Camp Summary International Oilfield Practices (1964-1990) For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures are required.	1964 - 1973 No practices documented. 1973 - 1990 Base camps and staging areas are located at the closest road access or river landing.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally acceptable international practices.	1964 - 1983 No practices documented. 1983 - 1990 Boards and cut timber are used as a surface material for staging areas, camps and well sites.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practice documented.
Spill Prevention and Response	1964 - 1989 No law or regulation. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-5. Exploratory Drilling - Well Site Summary International Oilfield Practices (1964-1990) For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures required.	1964 - 1990 Based on the location of the potential oil bearing geologic feature.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution 1982 - 1990 Operate according to generally acceptable international practices	1964 - 1990 Well Site is cleared and leveled including enough room for auxiliary equipment, supplies and waste disposal pit. Timber from site clearance used as location cover.
Waste Handling	Drill Mud and Cuttings	
	1964 - 1974 No law or regulation. 1974 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 Drill Mud and Cuttings and other waste are disposed of in the reserve pit.

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Table 3-5. (Continued)

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Waste Handling (cont'd)	Natural Gas	
	1964 - 1971 Non-usable gas will be burned in appropriate burners. 1971 - 1976 Gas may not be vented or burnt without authorization from the Ministry of Hydrocarbons. 1976 - 1990 Prohibited to discharge pollutants to the atmosphere, if determined by the Ministry of Health to impair the environment or human health.	1964 - 1990 No practices documented.
Spill Prevention and Response	1964 - 1989 No law or regulation. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-6. Development Drilling/Production - Access Summary International Oilfield Practices (1964-1990) For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures are required.	1971 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally acceptable international practices.	1964 - 1990 No practice documented.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practice documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-7. Development Drilling/Production - Base Camp Summary
International Oilfield Practices (1964-1990)
For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures required.	1964 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally acceptable international practices.	1964 - 1990 No practices documented.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual water can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practices documented.
Spill Prevention and Response	1964 - 1989 No law or regulation. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-8. Development Drilling/Production - Drilling Summary International Oilfield Practices (1964-1990) For Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures required.	1964 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally accepted international practices.	1964 - 1990 Well Site is cleared and leveled including enough room for auxiliary equipment, supplies and waste disposal pits.
Waste Handling	Drill Mud and Cuttings	
	1964 - 1974 No law or regulation. 1974 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 Dispose of drill mud and cuttings and other waste in the reserve pit.

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Table 3-8. (Continued)

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Waste Handling (continued)	Natural Gas	
	1964 - 1971 Non-usable gas will be burned in appropriate burners. 1971 - 1976 Gas may not be vented into atmosphere or burnt without authorization from the Ministry of Hydrocarbon. 1976 - 1990 Prohibited to discharge pollutants to the atmosphere, if determined by the Ministry of Health to impair the environment or human health.	1964 - 1990 No practices documented.
Spill Prevention and Response	1964 - 1974 No law or regulation. 1974 - 1989 Prevent escape and waste of hydrocarbons to avoid loss, damage and pollution. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practices documented.

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Table 3-9. Development Drilling/Production - Production Summary International Oilfield Practices (1964-1990) for Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 - No law or regulation. 1976 - 1990 - Environmental impact and measure control are required.	1964 - 1990 - No practice documented.
Site Preparation	1964 - 1990 - No law or regulation.	1964 - 1990 - No practice documented.
Waste Handling	**Natural Gas**	
	1964 - 1971 - Non-usable gas will be burned in appropriate burners. 1971 - 1976 - Gas may not be vented into atmosphere or burnt without authorization from Ministry of Hydrocarbon. 1976 - 1990 - Prohibited to discharge pollutants to atmosphere, if determined by the Ministry of Health to impair the environment or human health.	1964 - 1990 - No practice documented.
	Produced Water	
	1964 - 1974 - No law or regulation. 1974 - 1989 - Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 - Residual waters can be discharged if they meet established standards. Registration with IEOS required.	1964 - 1990 - Residual waters were injected underground, placed in evaporation pits or managed in other ways including discharge to surface waters.

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Table 3-9. (Continued)

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Waste Handling (continued)	Hydrocarbons	
	1964 - 1974 No law or regulation 1974 - 1990 Prohibited to discharge pollutants that are dangerous to the environment and human health.	1964 - 1990 Tank bottoms, emulsions, heavy hydrocarbons and crude oil contaminated soils were used for road oil, road mix or asphalt.
Spill Prevention and Response	1964 - 1974 No law or regulation. 1974 - 1989 Prevent escape and waste of hydrocarbon to avoid loss, damage and pollution. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1976 No law or regulation. 1976 - 1990 Storage tanks should have dikes, berms or other alternate system to contain spills. Dikes and berms should have manual valves, or other manually operated equipment to remove retained fluids.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 No practice documented.

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Table 3-10. Development Drilling/Production - Pipeline Summary International Oilfield Practices (1964 - 1990) for Tropical Rainforest Areas

Operational Practice	Ecuadorian Law and Regulation	Industry Practice
Site Selection	1964 - 1976 No law or regulation. 1976 - 1990 Environmental impact study and control measures required.	1964 - 1990 No practices documented.
Site Preparation	1964 - 1971 No law or regulation. 1971 - 1982 Protect flora, fauna and other natural resources and prevent pollution. 1982 - 1990 Operate according to generally acceptable international practices.	1964 - 1990 Prepare right-of-way by removing timber, underbrush and rocks in an area 50 to 70 feet wide.
Waste Handling	1964 - 1976 No law or regulation. 1976 - 1989 Prohibited to discharge pollutants that are dangerous to the environment and human health. 1989 - 1990 Residual waters can be discharged if they meet the established standards. Registration with IEOS required.	1964 - 1990 No practices documented.
Spill Prevention and Response	1964 - 1989 No law or regulation. 1989 - 1990 Spill Prevention and Control Plan required.	1964 - 1990 No practices documented.
Site Abandonment and Restoration	1964 - 1990 No law or regulation.	1964 - 1990 Restore the right-of-way by erosion control and revegetation.

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SECTION 4

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4.0 SEISMIC OPERATIONS

4.1 HISTORICAL OPERATIONS OVERVIEW

Following the signing of the Concession Agreement in March of 1964 by Texaco Petroleum Company and the Ecuadorean government, Texaco initiated seismic exploration operations. These initial operations were concentrated in the northern region of the concession in the area of Lago Agrio. Lines were cut by ground crews in an irregular grid and were oriented in either a north-south or east-west direction (Texaco E&P Technology Dept., 1991). Additional seismic operations were conducted in the southern areas of the concession as exploration operations were underway in the northern areas.

4.2 IMPACT EVALUATION CRITERIA

Environmental Impact Studies (EIS's) were first mandated in 1976 under the Law on Prevention and Control of Environmental Pollution (Decree 374, 1976). Under this law, environmental studies and measures of controlling impacts were required for industrial projects that could result in an alteration of the ecological system and impact air quality. Ecuadorean regulations adopted in 1982 through 1990 required the hydrocarbon industry to operate according too generally accepted international practices with respect to preserving the environment. In addition, regulations in place from 1971 through 1982 provided broad requirements for protection of flora, fauna, and other natural resources and also required prevention of water, air, and land pollution. None of these regulations provided clear procedural guidelines or standards for implementation (see Tables 3-1 and 3-2).

Regulations for Prevention and Control of Environmental Pollution Relating to Water Resources (Decree No. 2144, 1989) establish specific discharge requirements for septic and industrial waste water. These regulations support the Law on Prevention and Control of Environmental Pollution (Decree 374, 1976) which prohibits discharge of pollutants dangerous to human health, flora, fauna, and properties into water or soil.

Before 1990, there were no industry practices documented that applied specifically to the location or siting of seismic lines, support facilities, or access routes. In addition no practices were identified for waste handling, spill contingency plans, or site abandonment and restoration (see Tables 3-1 and 3-2).

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Literature review indicated that from 1973 site preparation including clearing of airstrips, roads and seismic lines was conducted with either a bulldozer or by hand using chain saws. With either technique, large trees were cut. Bridges or dams were constructed to cross rivers, swamps and canyons (Godfrey and Tavella, 1973). Prior to 1990, camps were located next to rivers to facilitate access. This allowed for heavy equipment deliveries by barge. Personnel and some supplies were transported by helicopter and float plane (Godfrey and Tavella, 1973; Hakim, 1973; Criss, 1978) (see Tables 3-1 and 3-2).

4.3 FIELD OBSERVATIONS

Although not a formal part of the field audit of TEXPET operations in the Oriente, it was proposed that seismic lines would be noted if observed.

During the course of the field audit, no seismic lines were observed that could be related to TEXPET's operations within the consortium area. One recently cut line was observed adjacent to Auca 6 well pad. This line provided a good example of the type of vegetation clearing and ground surface disruption that can occur as a result of seismic line clearing, however, it was not clear if this line was associated with seismic operations.

4.4 CONCLUSIONS

Literature review of past laws, regulations, and industry practices provided few guidelines regarding standards under which to conduct seismic operations. Seismic operations are of short duration and generally result in localized short term impacts. In areas of rapid vegetation growth, such as tropical rainforest, seismic trails are quickly overgrown. Long term impacts associated with seismic operations are generally related to continued use of seismic trails and access roads by local inhabitants.

Field audit teams did not observe any areas exhibiting signs of previous seismic operations. These observations coincide with conclusions made from LANDSAT image interpretations. Such interpretation found that areas of deforestation in the Oriente did not follow the seismic grid pattern that Texaco used during seismic survey operations in the region (Texaco E&P Technology Dept., 1991).

Based on the conclusions of the Texaco LANDSAT analysis and direct field observations by audit teams, TEXPET's seismic operations were in compliance.

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SECTION 5

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5.0 EXPLORATORY DRILLING OPERATIONS

5.1 HISTORICAL OPERATIONS OVERVIEW

On February 16, 1967, Texaco spud the first exploration well in the area of Lago Agrio. With the successful completion of this well, an aggressive exploration drilling program was undertaken that continued through 1972 and resulted in the discovery of the large Lago Agrio, Sacha, and Shushufindi Fields. Addition exploration activities continued through 1986 with the completion of Guanta 1. Figure 5-1 provides an overview of the discovery dates for the PETROECUADOR-Texaco Consortium area and the approximate location of the first exploratory well within each field.

5.2 IMPACT EVALUATION CRITERIA

Environmental impact studies (EIS's) were first mandated in 1976 under the Law on Prevention and Control of Environmental Pollution (Decree 374, 1976). Under this law, environmental studies and measures of controlling impacts were required for industrial projects that could result in an alteration of the ecological system and impact air quality. Regulations adopted between 1982 and 1988 required the hydrocarbon industry to operate according to generally accepted international practices with respect to preserving the environment. Ecuadorian regulations from 1971 through 1982 provided broad requirements for protection of flora, fauna, and other natural resources and required prevention of water, air and land pollution. None of these regulations provided clear procedural guidelines or standards for implementation.

Regulations for Prevention and Control of Environmental Pollution Related to Water Resources (Decree No. 2144, 1989) establish specific discharge requirements for septic and industrial waste water. In addition, the Decree requires users that explore, extract, or store hydrocarbons to prepare and implement a contingency plan for spill prevention. These regulations are supported by previously mentioned Decree No. 374, 1976. The Hydrocarbon Exploration and Exploitation Regulations (OR No. 530, 1974) require proper disposal of salt water, drilling mud, oil samples, and other elements that may cause damage to the flora or fauna. Additional regulations have been developed to address disposal of natural gas produced from drilling/production operations. The requirements began with the Concession Agreement (Decree No. 205-A, 1964) and continued with various modifications through the Codification of Hydrocarbon Law (Decree No. 2967, Nov. 1978).

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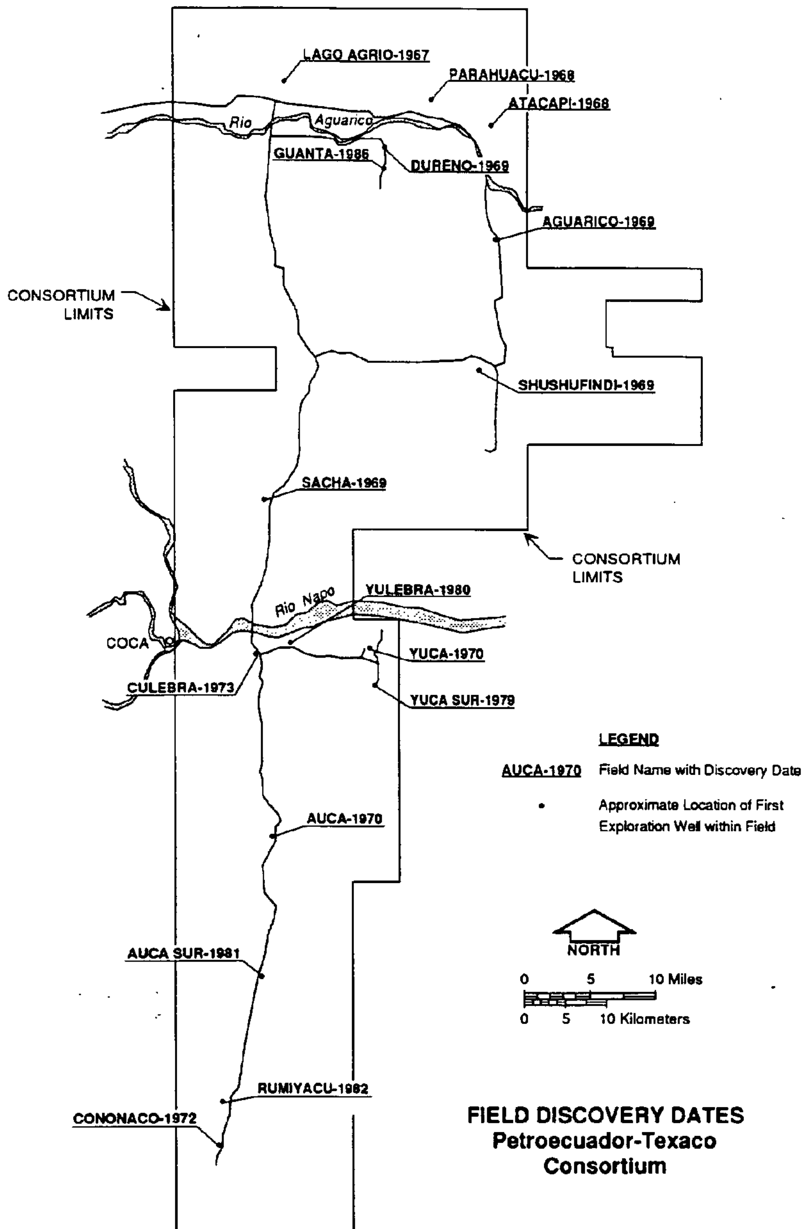

FIELD DISCOVERY DATES
Petroecuador-Texaco
Consortium

FIGURE 5-1

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Before 1990, there were no industry practices for well site selection. It is important to note that exploration activities were restricted to those areas of potential hydrocarbon bearing geologic features. During drilling activities, industry practices called for the disposal of drilling mud and cuttings, rig wash, excess cement, and other wastes in the reserve pit (McGhee, 1962, Petroleum Extension Service, 1970; SPE, 1975; Berger and Anderson, 1978; Sittig, 1978; Baker, 1979; API, 1989).

Industry practice for drill site preparation was a function of the equipment and support facilities required to drill and service the well. Typical equipment and facilities included the drilling rig, auxiliary equipment, crew quarters, reserve pits, and waste pits (McGhee, 1962; Petroleum Extension Service, 1970; Berger and Anderson, 1978; Baker, 1979). Specific clearing size was not identified, however, such clearing activity would be designed to meet the needs of the site, recognizing the cost of additional clearing activities. Initial site clearing to allow helicopter access has been performed using manual labor. Bull dozers were then lifted into the well location to complete the site configuration, dig cellars, and pits etc. (Bleakly, 1983). Two sources noted that the cleared area for a typical drill site and camp ranged from 4 to 5.4 acres with a cut tree flight path area of 6 to 24 acres respectively (Hakim, 1973; Bleakley, 1983). Timber from the site clearance was cut into boards for location cover (Oil and Gas Journal, 1974; Hakim, 1973).

Prior to 1989, no specific laws and regulations or industry standards were identified for spill prevention and control, or site abandonment and restoration procedures (see Table 3-3 through 3-5).

5.3 FIELD OBSERVATIONS

TEXPET exploration activities ended in the consortium area in 1986 with the completion of Guanta 1. Therefore, no formal audit was conducted for exploration operations. However, within the context of the overall field audit, exploratory wells now in production were audited (Table 5-1). There were no inherent differences between these sites verse that of a development drill site. Clearings for helicopter pads or camp locations were not apparent in close proximity to the exploratory well sites. Several of the well sites audited are now surrounded by development. The field observations do indicate that the reserve pits used for the disposal of muds and cuttings have been closed at all the sites with the possible exception of Guanta 1 drilled in 1986.

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5.4 CONCLUSIONS

A review of past Ecuadorian laws and regulations and industry practices provided few guidelines regarding standards under which to conduct exploration operations in rainforest environments. If exploration drilling did not identify recoverable quantities of hydrocarbons the site was abandoned. No standards were identified regarding the site restoration. If recoverable oil reserves were identified the well was prepared for production operations and a pipeline was constructed to transport the hydrocarbons from the site. Operating practices and potential impacts associated with exploration wells now under production are addressed in Chapter 6.0, Production Wells.

TEXPET's practices for site selection, site preparation were conducting according to Ecuadorian Laws and Regulations and industry practices. TEXPET was one of the first companies to use helirigs for exploratory drilling in tropical rainforest areas This minimized the need to construct extensive roads which substantially reduced environmental impact. Ten out of thirteen exploratory wells sites audited were drilled prior to the 1976 requirement for an EIS. EISs were not prepared for the exploratory drilling conducted in the consortium after 1976. The field audit was unable to identify environmental impacts which could be attributed to not preparing an EIS for exploratory drilling operations. Prior to 1990 no EISs were prepared for projects in Ecuador, except one located in a national parks. Based on the field audit, drilling muds and cuttings were placed in reserve pits according to industry practice. The last exploratory well (Guanta 1) was completed in 1986. Therefore the 1989 discharge regulation did not apply. The requirement for a spill prevention and control plan in the 1989 regulations are also not applicable for the exploratory wells drilled by TEXPET. Since all the exploratory wells audited were eventually placed on production, the field audit was not able to evaluate abandonment and restoration practices for exploration activities. The field audit did note that the reserve pit on all but one site had been closed, although the date of closure could not be determined. Therefore, TEXPET's practices for waste handling, spill prevention and control and abandonment and restoration were in conducted according to Ecuadorian law and regulation and industry practices.

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Table 5-1. Exploration Well Audit Summary

Well No	SPUD Date	Rig Release	Pad Size (ft^2)	Pit Size (ft)	Notes
			AGUARICO		
AG-2	6/17/70	8/15/70	43,750	50 x 80 50 x 50	
			AUCA		
AU-2	6/18/70	8/3/70	48,125	40 x 50	
			AUCA SUR		
AUS-1	11/30/80	1/18/81	120,000	50 x 50	Production Equipment at drill site
			CONONACO		
CO-1	10/28/72	12/15/72	37,500	-	
			GUANTA		
GU-1	12/16/85	2/11/86	112,500	150 x 75	
			LAGO AGRIO		
LA-1	2/16/67	4/8/67	90,000	-	First Successful well drilled in Oriente
LA-5	2/6/70	4/9/70	12,500	40 x 40 30 x 30	
			PARAHUACU		
PA-1	10/4/68	11/18/68	75,000	45 x 15	
			SACHA		
SA-2	7/4/69	8/31/69	26,900	30 x 20	
SA-4	3/14/70	6/12/70	N/A	-	Located in Sacha Norte 2 Production Facility
			SHUSHUFINDI		
SSF-1	12/4/68	1/13/69	72,500	45 x 45	
SSF-3	11/20/69	1/21/70	60,000	50 x 50	
			YUCA SUR		
YUS-1	11/18/79	12/24/79	100,000	40 x 40	

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SECTION 6

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6.0 DEVELOPMENT DRILLING AND PRODUCTION

6.1 HISTORICAL OPERATIONS OVERVIEW

Development drilling was initiated, soon after exploratory drilling stopped at Lago Agrio, Shushufindi/Aguarico, and Sacha fields. Approximately 70 percent of the wells in these fields were drilled by 1976 (Table 6-1). Drilling usually occurred on an established well spacing, and as the fields matured additional drilling (infill) was performed to increase the amount of recoverable oil. Drilling was also conducted to replace damaged wells or to install water injection wells. Although fields like Atacapi, Parahuacu, Cononaco, and Yuca were discovered in the late sixties and early seventies, development of those areas was delayed for almost 10 years. The most recent field to be placed into production was Guanta in 1986.

A review of the well files indicated that the fields audited were initially produced by natural flow. As the formation pressure declined, many of the TEXPET wells were produced by artificial lift. Methods of artificial lift included gaslift, and electric submersible and hydraulic pumps (Table 6-2). Periodically, workover and service operations were performed on most wells using a production rig or wireline unit. The operations included equipment repair and well treatment. Equipment repairs consisted of replacing the submersible or hydraulic pumps or conducting cementing and perforating programs. Well treatments consisted of fracturing, acidizing, and solvent treatment.

Formation fluids in a typical field included crude oil, formation water and natural gas. When formation fluids were brought to the surface, the three components were separated. This was done at the well site or at a central processing facility. Produced water was discharged into a pit or series of pits prior to discharge to the environment. Natural gas was used to fuel some of the production facilities equipment, as well as sold to PETROECUADOR gas plant. Natural gas not consumed in facility equipment was either vented to the atmosphere or flared. Crude oil was shipped via pipeline from the production facilities to the Trans-Ecuadorian pipeline pumping station in Lago Agrio.

Water injection for secondary recovery was initiated at Shushufindi in 1964 and Sacha in 1986. Water was pumped from local streams, cleaned and treated prior to injection.

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6.2 IMPACT EVALUATION CRITERIA

The criteria used to evaluated the potential impacts from TEXPET's operation are contained in the document *International Oilfield Practices (1964-1990) in Tropical Rain Forest Areas and Summary of Ecuadorian Laws and Regulations* (Fugro-McClelland, July, 1992). A summary of applicable Ecuadorian law and regulations and industry practices is provided in Tables 3-6 through 3-10.

6.2.1 Access

There were no industry practices for field development access, identified for the time period from 1964 through 1990. The Hydrocarbon Law (Decree No. 1459, 1971), Contract with Texaco-Gulf (Decree No. 925, 1973), and Hydrocarbon Exploration and Exploitation Regulations (OR No. 530) provided general requirements to protect the flora, fauna and other natural resources and to prevent pollution. The Law on Prevention and Control of Environmental Pollution (Decree No. 374, 1976) required environmental impact study (EIS) and control measure plans be prepared. This law also prohibited the discharge of pollutants that are dangerous to the environment and human health. The Reform to the Hydrocarbon Law (Decree No. 101, 1982) required petroleum operations to protect the environment according to the laws, regulations and international practices. The Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources (Decree No. 2144, 1989) established a discharge registration requirement and water quality standards. The criteria for development drilling/production access is summarized in Table 3-6.

6.2.2 Base Camp

From 1964 through 1990, there were no industry practices identified. The Ecuadorian law and regulations are the same as described in Section 6.2.1 with one exception. The 1989 Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources also required a spill prevention and control plan. The criteria for development drilling/production, base camp is summarized in Table 3-7.

6.2.3 Drilling

There was no industry practice for drill site selection. The Ecuadorian law and regulations are the same as described Section 6.2.1. The industry practice for drill site preparation involved clearing a site with enough room for equipment supplies and a waste disposal pit. The Ecuadorian laws and regulations are the same as described in Section 6.2.1. Waste handling was divided into drill muds and cuttings,

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and natural gas. The practice for drill mud and cuttings was to dispose of those wastes in the reserve pit. The Ecuadorian law and regulations are the same as in Section 6.2.1. There was no industry practice for the disposal of natural gas. However, the Concession Agreement (1964) required non-usable gas to be burned in appropriate burners. The Hydrocarbon Law (1971) states that gas may not be vented or burned without prior authorization. The Law on Prevention and Control of Environmental Pollution (1976) prohibits the discharge of pollutants to the atmosphere if they impair the environment or human health.

There was no industry practice for spill prevention and control. The 1974 Hydrocarbon Exploration and Exploitation Regulations require practices to prevent the escape and waste of hydrocarbons to prevent pollution. The 1989 Regulation for the Prevention and Control of Environmental Pollution Related to Water Resources also required a spill prevention and control plan. There were no industry practices or Ecuadorian laws or regulations pertaining to site abandonment and restoration. The criteria for development drilling/production, drilling is summarized in Table 3-8.

6.2.4 Production Operations

There were no industry practices identified for oil and gas production facility site selection. The Ecuadorian laws and regulations are the same as described in Section 6.2.1. There were also no industry practices or Ecuadorian laws and regulations for production facility site preparation. Waste handling involved natural gas, produced water and hydrocarbons. There was no industry practice for utilization or disposal of natural gas. The Ecuadorian laws and regulations are the same is described in Section 6.2.3. The industry practices for the disposal of produced water include underground injection, placing in evaporation pits or discharge into surface waters. These Ecuadorian laws and regulations are the same as described in Section 6.2.3.

Industry practice for storage tank spill prevention and control indicated that there should be dikes, berms or other spill control systems in place. The dikes and berms should also be constructed, so that retained fluids could be removed. The Ecuadorian laws and regulations are the same as described in Section 6.2.3. There were no industry practices or Ecuadorian law or regulations pertaining to site abandonment and restoration. The criteria for development drilling/production, production is summarized in Table 3-9.

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6.2.5 Pipeline

There was no industry practice for pipeline site selection. The Ecuadorian law and regulations are the same as described in Section 6.2.1. Industry practice for site preparation included the clearing of a right-of-way by removing timber, underbrush, and rock in an area 50 to 70 feet wide. The Ecuadorian law and regulations are the same as described in Section 6.2.2.

There was no industry practice for pipeline waste handling. The Ecuadorian laws and regulations are the same as described in Section 6.2.2. There was no industry practice for spill prevention and control. The Ecuadorian laws and regulations are the same as described in Section 6.2.2. The industry practices for site abandonment and restoration indicated the right-of-way should be restored with erosion control and revegetated. There were no Ecuadorian laws or regulations concerning this. The criteria for development drilling/production, pipeline is summarized in Table 3-10.

6.3 FIELD OBSERVATION

6.3.1 Access

The main access route for equipment and supplies into the Oriente is via the highway from Quito to Lago Agrio. From Lago Agrio the highway extends east and south. The eastern road continues beyond the Consortium boundary to the PETROPRODUCTION fields. The road south extends approximately 80 miles to the Cononaco field. There is one main spur highway on the southern route which provides access to the Shushufindi and Aguarico fields. The roads are heavily traveled by industrial and private vehicles. Consortium personnel who do not live in the surrounding communities are shuttled to the Orient by fix-wing aircraft from Quito to either the Lago Agrio or Coca base camp. They are then transported to the other facilities by Short Take Off and Landing aircraft (STOL) or by surface vehicle.

The roads over most of the Consortium area ranged from 25 to 30 feet wide. Roads were typically elevated 2-3 feet above adjacent drainage to facilitate water removal. Well access road conditions varied from newly constructed to heavily overgrown. Ponds/lakes were observed to have formed where road construction has prevented drainage. The presence of snags and dying trees were observed within the center of these ponded areas. Under natural forested wetland conditions, trees species occupying the margins and center of swamps would be tolerant of prolonged inundation. Along some roadways (e.g., Sacha 94), where colonization was limited, secondary growth has encroached into margin of the road. In other locations, drill

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pads could not be found because secondary growth had obscured the original access road (e.g., Atacapi 6 and Yuca 8).

Frequent maintenance is required on the highway between Lago Agrio and the other production facilities. Maintenance usually includes grading, application of crude oil and rolling the surface. Crude oil obtained from production tanks, and production or well site pits is applied directly on the road by a tank truck. The crude is then mixed into the road material by the grader and rolled. According to PETROAMAZONAS' personnel, crude oil from production tanks is currently used because it allows for better compaction. Application of crude oil to the road without grading and rolling was also observed. In addition, new road material may be brought in to fill depressions or damage from erosion or washouts. Impacts of road maintenance was generally confined to within a few feet of the roadway. Vegetation along roadways were routinely observed with hydrocarbon stains from oiling operations. In several areas, road widening operations were being conducted by PETROAMAZONAS.

The abundance and condition of vegetation directly adjacent to the road varied based on the level of human activity and road maintenance practices. Narrow bands of wetland vegetation, (sedges, etc.) were observed along and within roadside ditches where moist conditions prevailed. Vegetation beyond the immediate roadside also varied. The four major terrestrial cover types (e.g., primary forest, secondary forest, agricultural areas, and cleared/pasture) existed around most oil and gas operation areas. Bridges have been constructed to cross surface water systems (streams, rivers, etc.) and wetland habitats. The cover type adjacent to existing roadways was influenced by a number of factors, including age of the production facility (i.e., time period in which the facility was constructed), topography, and local traffic circulation patterns.

Developed areas such as Coca, Lago Agrio, Sacha and Shushufindi had larger percentages of cleared and/or occupied lands, while lands adjoining the Aguarico, Atacapi, Auca, Cononaco, Guanta, and Parahuacu retain larger proportions of primary forest.

6.3.2 Base Camps

<u>Site Selection</u>

Six camps were audited: Auca, Coca, Cononaco, Lago Agrio, Sacha, and Shushufindi. Five of the camps (Auca, Cononaco, Lago Agrio, Sacha, and

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Shushufindi) were located adjacent to or in close proximity to a central production facility. The camp at Coca is centrally located on the road between Sacha and Auca.

Site Preparation

All the camps except Cononaco have administration/operations office, sleeping quarters, a club house, a vehicle maintenance shop, fuel storage, and vehicle fueling areas, recreational facilities and an STOL airstrip. In addition, Lago Agrio, Sacha, and Shushufindi camps have medical facilities. The largest camp, Lago Agrio also has a gymnasium, greenhouse, body repair shop and drafting/reproduction facilities. Coca camp is used mainly for supply: equipment, pipe, and chemical storage. Recent modifications at Sacha include a new firestation, medical facility and sleeping quarters (still under construction).

In general, natural vegetation within the perimeter of the base camps was sparse due to the high level of development at the facilities. The base camps were characterized by structures and paved or gravel-surfaced areas interspersed with ornamental plantings composed of turf grass, flower beds, and trees and shrubs. However, limited areas of emergent and forested wetland areas were observed at Lago Agrio, Auca, Cononaco, Sacha Central, and Shushufindi Central. Vegetation immediately adjacent to base camps was highly variable, ranging from primary forest at Cononaco to highly developed areas (e.g., airport, refinery, and production facilities) at Lago Agrio. Most sites, however, were surrounded by agricultural lands and secondary forest.

Waste Handling

All camp facilities audited had one or more sanitary waste collection systems. These systems consisted of septic tanks, with some locations utilizing drain fields. The specific layout of these sanitary waste systems varied from site to site. The audit team was told that at the Auca camp sanitary waste discharges on the east side of the camp into a stream. Coca camp sanitary waste is collected and discharged via a drainage ditch into the Coca River. The Cononaco facility has a septic tank, but the point of discharge was unknown. The Lago Agrio camp sanitary waste passes through a septic tank/drainage field then into the Aguarico River. The numerous septic systems at Sacha and Shushufindi camp discharge waste into drainage ditches after passing through the septic tanks. Wastewater from laundry and cafeteria operations were piped into grease traps prior to discharge into the septic tank or drainage ditches. The exact configuration could not be determined at most facilities.

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Miscellaneous waste from the Base Camp operations are disposed of off site. This included food waste, general trash and ash from the incineration units at Lago Agrio Norte and Coca. The incinerator at Coca was not operational, so the trash was burned on the facility pad prior to disposal. Off site disposal included the use of well sites and various central collection areas. Trash was noted on many of the well sites audited and local waste collection sites were observed on the outskirts of Coca and Lago Agrio. The trash in these area is usually burned (if possible) then buried. A relatively new solid waste disposal facility has been constructed at Shushufindi camp. This facility contains several concrete cells for waste segregation and disposal. Once a cell has been filled, it is apparently covered and closed.

Four base camps; Auca, Lago Agrio, Sacha and Shushufindi, have vehicle maintenance areas. The facilities included buildings for vehicle repair and wash racks. All of the vehicle repair areas were constructed on concrete pads and had sumps for the collection of liquid waste. All the facilities used a mixture of JP-1 and diesel to remove the crude oil from vehicles. Sacha was the only facility which did not have any method of discharge collection from the wash rack.

Vehicle fueling stations exist at Auca, Coca, Sacha and Shushufindi. These stations consist of pump islands with dispensers and above ground fuel storage tanks. Refueling areas are surfaced with gravel. Consequently, any spills during refueling results in soil contamination. Contaminated soil was evident below all the fuel storage tanks fill ports.

Spill Prevention and Control

Spill prevention and control measures for base camps included berms around the fuel storage tanks and sumps at the vehicle maintenance shops. The fuel storage tanks at Auca, Coca, Sacha and Shushufindi were contained in berms. All the berms had drains, but the drains at Auca, Coca and Sacha did not have valves and the valve on the drain at Shushufindi was in the open position. Auca, Lago Agrio, and Shushufindi camps had sump systems for the vehicle maintenance areas. The sump at Auca drained into the produced water pit. Facility personnel reported that the hydrocarbons that collect in the sumps at Lago Agrio are collected by vacuum truck and put in one of the production pits. Fluids which pass through the sumps at Lago Agrio and Shushufindi discharge into open drainage ditches.

No significant losses of vegetation resulting from oil spills were observed at the base camps. However, isolated oil spills, either resulting in dead or stressed (e.g., oil-staining, leaf-wilt, chlorosis, etc.) vegetation, were observed at Sacha Central, Shushufindi Central, Coca, Lago Agrio, and Auca camps. Generally, spills were less

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than 1,000 square feet in size; however, Shushufindi and Auca had larger spills (7,500 sq. ft. and 1,500 sq. ft., respectively).

Site Abandonment and Restoration

The Yuca production facility at one time had a small camp. The structures of the camp have been removed, but the foundations still exist. Since the facility is currently operating, no other abandonment or restoration has occurred. There were no other indications of site abandonment and restoration.

6.3.3 Drilling

Site Selection

Well site selection was typically based on the geologic criteria. Wells were drilled at strategic locations in the oil bearing formation to maximize the removal of hydrocarbons. Specific well location may be determined based surface topography and environment. The audit did not provide any other information pertaining to site selection criteria that was used by TEXPET.

Site Preparation

The average well site gravel pad area was 60,000 square feet, or approximately ½ ha and varied from less than 20,000 square feet on Auca 19B to 180,000 square feet on Shushufindi 71 (Table 6-3). Site measurements were based on field estimates and do not include the area occupied by the reserve or production pits. Reserve and production pits varied in size from 10 by 10 feet, to 200 by 200 feet (Table 6-4). The pits were usually located in close proximity to the gravel pad. Soil samples were collected from the land adjacent to the well site for general description. The soil color was described using the Munsell Soil Color Charts (Munsell, 1990) and standard soil classification nomenclature (clay, silt, sand, etc.) determined for each sample. A summary of the field results is contained in Table 6-5. The predominate soil type was described as reddish clay to silty clay.

Table 6-6 shows the predominant land uses/vegetation types adjacent to the drill sites. Four categories of vegetation are identified in the table: primary forest, secondary forest, agricultural production, and cleared/pasture lands. Primary forest is characterized by pristine conditions, whereas secondary forest describes the successional stage of natural revegetation following disturbance (clearing of trees, fire, etc.) in primary forest areas. For purposes of analysis, areas adjacent to the pads were assigned to one of four directions or quartiles centered by the cardinal compass

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directions. For example, the eastern quartile included the area from approximately southeast to northeast, the north quartile encompassed an area from northwest to northeast, etc. Over 48 percent of the quartiles surrounding the drill sites were comprised of secondary forest, 31 percent were cleared lands, 19 percent were in agricultural production, and less than 2 percent were primary forest.

Vegetation on active drill sites generally consisted of low-growing grasses in the central (pad) portion, with a border of tall grasses, herbs and shrubs comprising the site perimeter. At sites which were surrounded by agriculture or cleared areas, the vegetation comprising the site perimeter generally consisted of an approximately 10-foot wide border of tall grasses and herbs. At sites with adjacent secondary forest growth, the borders were generally wider (approximately 15 to 20 feet wide) and represented gradual transition to secondary forest. These zones of vegetation were dominated by shrubs and secondary trees, with an herbaceous understory.

At many of the sites which were surrounded by upland vegetation, standing water or moist soils were observed in the pad areas. Under such conditions the occurrence of characteristic wetland species (umbrella sedges, etc.) was common. The density of these wetland populations varied with the amount of surface water/moisture present.

<u>Waste Handling</u>

Approximately 70 percent of the well sites audited had drilling or production pits (Table 6-4). At one well site in Atacapi five pits were observed. As previously indicated, pit sizes ranged from 10 feet by 10 feet, to as large as 200 feet by 200 feet at Sacha 123. Reserve pits, which are usually larger than 10,000 square feet, are used for the collection and disposal of drilling muds and cuttings. Upon well completion, the pit may be closed or used for production operations. A few well locations contained pits which were identified as natural depressions. Based on their close proximity to the well site, these depressions may be the result of reserve pit closure, but this could not be confirmed. Additional pits, less of less than 10,000 square feet were constructed for production test and workover operations.

Almost 50 percent of the pits audited were empty, or contained water. A majority of the remaining pits had 100 percent crude oil cover. The age of the crude oil in the pits was estimated by the audit team. The different grades were fresh (FS), slightly-degraded (SL-DEG), degraded (DEG) and heavily degraded (HV-DEG). The crude oil grade was typically distinguished by it's visual appearance and viscosity when disturbed. In general fresh crude from the consortium operations appeared shiny black and reflected light, while degraded crude was dull and did not reflect light.

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The fresh crude was also more fluid than the degraded crude which tended to adhere together when disturbed. Degraded or heavily degraded crudes were considered two years or older. Crude oil samples were collected from production facilities, selected production pits, and spills for fingerprint analysis. The analysis was conducted for comparison against field observations and to further assist in the crude oil age evaluation. The results of the fingerprint analysis are presented in Appendix A. The samples have been arranged in chronological order based on the relative carbon chain concentrations. Specific samples were collected to serve as markers of known date. Based on this information the remaining samples were given relative dates. Historical well information was also used to indicate when the crude oil may have been discharged.

Some of the pits contained siphons which allowed collected water to be released while retaining the crude oil. Contamination beyond the pits was observed at some areas. The contamination usually occurred as a result of pit overflow, berm failure or releases through the siphon. Depths of the pits could not be determined because the oil cover obscured the pit bottom. The thickness of oil covering the pits was not measured as part of this audit. Consequently, volumes of oil and water contained in these pits were not determined. Additional material including tree branches, trash and other debris were observed in the pits. The status of some pits could not be determined due to dense vegetation growth.

Vegetation was generally absent from the interior of production pits containing oil and/or water, although occasionally sparse stands of aquatic herbs were observed in pits containing mostly water. Vegetation around excavated pits consisted of an approximately 10-foot wide border of 4 to 5-foot tall grasses. A border of grasses was not observed where natural depressions were used as pits. Vegetation surrounding the grass borders varied in accordance with the vegetational composition of the adjacent area.

Varying degrees of crude oil contamination existed on a majority of the well sites audited. The contamination was typically located around the well heads, valves, sampling ports, and non-welded pipeline joints. The larger oil spills appear to have been the result of well maintenance and workover operations. Leaks from valves, sampling ports and other connections were usually minor. The areal extent of these spills on the well sites is provided in Table 6-4. Approximately 33 percent, 38 percent, and 29 percent of the well sites contained 0 to 1,000, 1,000 to 5,000, 5,000 and greater square feet of hydrocarbon contamination. Well sites Auca 8, Shushufindi 43 contained large areas of contamination. The contamination at Auca 8 is associated with production facility operations. A local resident reported that the contamination at Shushufindi 43 was from oil spreading operations. Where possible,

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the age of the crude oil contamination on the well sites was also recorded. Thirty of the well sites audited had chemical injection systems. Minor contamination was observed around the injection equipment at most of the those sites.

Approximately 80 percent of the well sites contained some domestic or industrial refuse, (pipe, thread protectors, oil filters, etc.). Well sites which had large accumulations included Sacha 40, Yuca 6 and Auca 6. The Sacha production facility personnel reported that well site Sacha 40 was used as a refuse disposal area. The site showed evidence of recent disposal activities. The waste accumulation at Yuca 6 was completely overgrown by vegetation and appeared to be predominantly domestic refuse. The trash at Auca 6 appeared to be from recent activities.

Four of the well sites audited, Sacha 36, Auca 8, Auca Sur 1, and Guanta 5 contained production equipment. Three of those facilities, Auca 8, Auca Sur 1, and Guanta 5 had separation equipment and produced water and natural gas discharges. The natural gas at Auca Sur 1 was being vented. The flares at Auca 8 and Guanta 5 were burning properly. Well site Sacha 36 contains a backup hydraulic lift system including two tanks and injection pumps.

Spill Prevention and Control

Oil spill prevention for well sites consists of siphons in the production pits. The siphons prevent the pits from over flowing while allowing collected water to be released. Oil spill control is accomplished by covering hydrocarbon contamination with sand. The sand adsorbs the oil and prevents it from flowing off site. Berms were not present around the production tanks at Auca 8, Auca Sur 1, Sacha 36, and Guanta 5. The hydraulic oil pumps at Sacha 36 were located on a concrete pad which had a sump that drained into the production pit. Auca 8 and Auca Sur 1 had a berm around the fuel tank, but the berm drains were not equipped with valves. Many of the other sites which had fuel tanks did not have berms.

Site Abandonment and Restoration

The well sites that had either been abandoned or shut-in for an extended period of time usually had production lines and other equipment removed from the location. Vegetation at the 10 abandoned sites (Table 6-7) was similar to that of the active sites, with grasses comprising the central portions, and tall grasses, herbs and shrubs forming a border around the site perimeters. At two of the abandoned sites where there was no evidence of imported soils, regeneration of tall grasses and herbs in the central pad areas was extensive. This suggests that the absence of imported soils may facilitate natural revegetation. The eight other abandoned sites containing

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imported soils in the over the pad areas. The density of grasses and herbs in the central portions of these sites varied, however this variation appears to be independent of the length of time the sites had been abandoned. Two of the abandoned sites, Yuca 6 and Lago Agrio 19 were relatively isolated from adjacent human disturbances, being completely surrounded by primary and secondary forest growth. At these sites the grasses in the central pad area were taller and comprised a smaller area, with the border vegetation encroaching toward the center.

The vegetation on abandoned areas was difficult to assess since the exact location of pits were unknown. In general, vegetation on recently abandoned pits (less than two years) consisted of bare soil or sparse grasses and herbs, while older abandoned pit surfaces usually contained a greater diversity of species characteristic of a later successional stage (shrubs, secondary trees, etc.). Based on existing pit size, Table 6-4 indicates that a majority of the reserve pits, larger than 10,000 square feet, have been closed. Natural depressions, some of which have been used as pits may be the result of previously abandoned reserve pits. These natural depression when left undisturbed contained vegetation representative of the surrounding plant community (secondary forest, wetland, etc.).

6.3.4 Production Operations

Site Selection

Eighteen production facilities were audited, Aguarico (1), Atacapi (1), Auca (2), Cononaco (1), Guanta (1), Lago Agrio (2), Parahuacu (1), Sacha (4), Shushufindi (4) and Yuca (1). In addition, an audit was performed on the Shushufindi Water Injection facility. All the production facilities are centrally located within the producing fields (Figures 1-3 through 1-12). Four of the facilities, Sacha Central, Sacha Norte 1, Sacha Norte 2, and Shushufindi Central, have a well site located within their boundaries.

Site Preparation

A summary of the equipment and facilities for each production site is shown in Table 6-8. In general, most of the production facilities contained storage tanks for crude oil and fuel, shipping pumps, produced water pits and natural gas flares. Selected facilities contained water treatment and injection pumps, hydraulic lift pumps, gas lift compressors, power generation turbines and chemical storage. The area occupied by production facilities ranged in size from 6 acres (2.5 ha.) to 125 acres (50 ha.).

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Vegetation surrounding the production facilities included primary forest, secondary forest, cleared/pasture areas, and agricultural areas occupied generally by subsistence farms. Vegetation at the production facilities was composed principally of low-growing grasses, sedges, and other herbaceous vegetation. The vegetated areas were sparse and comprised less than 30 percent of the total areal coverage. The remainder of the areas were exposed soil/gravel. Some sites also had small areas with turf grasses.

Most of the facilities have been constructed on generally level terrain. Therefore, construction of a drainage system to convey surface water runoff is normally required. Drainage is accomplished through a series of interconnecting earthen and concrete trenches. Natural drainage appeared to have been altered at several production facilities causing the impoundment of water and creation of wetlands above the channel constriction. Generally, this resulted from culverted road crossings; however, other causal factors observed included downed trees and berms. Storm water discharge usually enters the same body of water or drainage area as the produced water. In Aguarico, Atacapi, Auca, Auca Sur, Parahuacu, and Yuca the production facility has been constructed in a rolling natural topography. Erosion, which appeared to be the result of new construction, was observed at Aguarico and Atacapi. Minor erosion of pit walls at Auca Sur, Cononaco and Sacha Norte 1 and Shushufindi Central was noted. The pit wall at Auca Sur also contained stress cracks, indicating a possible wall failure.

<u>Waste Handling</u>

<u>Produced Water</u>

Produced fluids from individual wells are transported to the production stations by surface pipelines. At the facility the produced water is usually segregated in three stages; separator, wash tank, and surge tank. The separator removes a portion of the natural gas from the crude oil and produced water mixture. The mixture is then shipped to the wash tank where additional natural gas is released and gravity separation is used to segregate the oil and water. The water is then discharged to the produced water pit. The crude oil is shipped to the surge tank where additional water is removed. Water from the surge tank is also discharged into the produced water pit. The crude from the surge tank is then shipped to a central storage facility or into the pipeline.

The produced water which is directed into the produced water pits from the wash and surge tanks still contains residual hydrocarbons. The pits provide additional time for separation prior to water discharge. A single pit is used at Aguarico,

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Cononaco, and Yuca. The remaining facilities utilize two or more pits in series. Produced water is conveyed between pits through ditches or siphons. The intent of the multi-pit arrangement is to prevent the accidental escape of hydrocarbons into the environment. In theory, the primary pit would collect a majority of the oil carried over from the production tanks along with any crude which may be released during upset conditions. The subsequent pits would serve as back ups in case the primary pit volume is exceeded. Other pits were also identified, some of which had been previously used for produced water. These were now out of service.

Figures 6-1 through 6-7 provide schematic layouts of each facility's pit configurations at the time of the audit. The figures provide information regarding the pits estimated size, crude oil cover and discharge status. Four facilities were observed to have final stage pits (pit that discharges directly to a surface water feature) with little to no accumulation of hydrocarbons (less than 5 percent). These included Atacapi, Lago Agrio, Sacha Norte 2, and Shushufindi Norte. Nine facilities were observed to have final stage pits with a large accumulation of crude oil (greater than 95%). These included Aguarico, Guanta, Lago Agrio Norte, Parahuacu, Sacha Central, Sacha Norte 1, Sacha Sur, Shushufindi Central, and Yuca. Discharge pits at the remaining facilities had crude oil cover which ranged from 20 to 50 percent.

Vegetation was observed in and around produced water pits. Vegetation was generally confined to the pit crowns and outboard berm slopes and composed was of low-growing herbaceous species. Evidence of periodic mowing was observed at several locations. The inboard berm slopes were often denuded of vegetation or sparsely vegetated; however, in some pits, the vegetation encroached to within 1 foot of the oil/water surface. At Sacha Norte vegetation was observed at the oil water surface; however, the pit served as a secondary overflow and contained less oil. In most instances, vegetation growing on the inboard berm appeared stressed. In dry pits, vegetation was observed growing in the pit bottoms. Based on the lack of vegetation, the pits at Aguarico, Shushufindi Central and Norte appeared to have been constructed within the past two years.

Water samples were collected to evaluate selected water quality parameters for the produced water discharge and the receiving streams prior to and after discharge occurs. Samples generally were collected at the produced water outfall, receiving stream (mixing zone), and upstream, and downstream areas. Additional sampling points were selected based on site conditions. Some locations were not sampled because of problems with accessibility. Descriptions of sampling locations are provided in the water quality data sheets (Appendix B).

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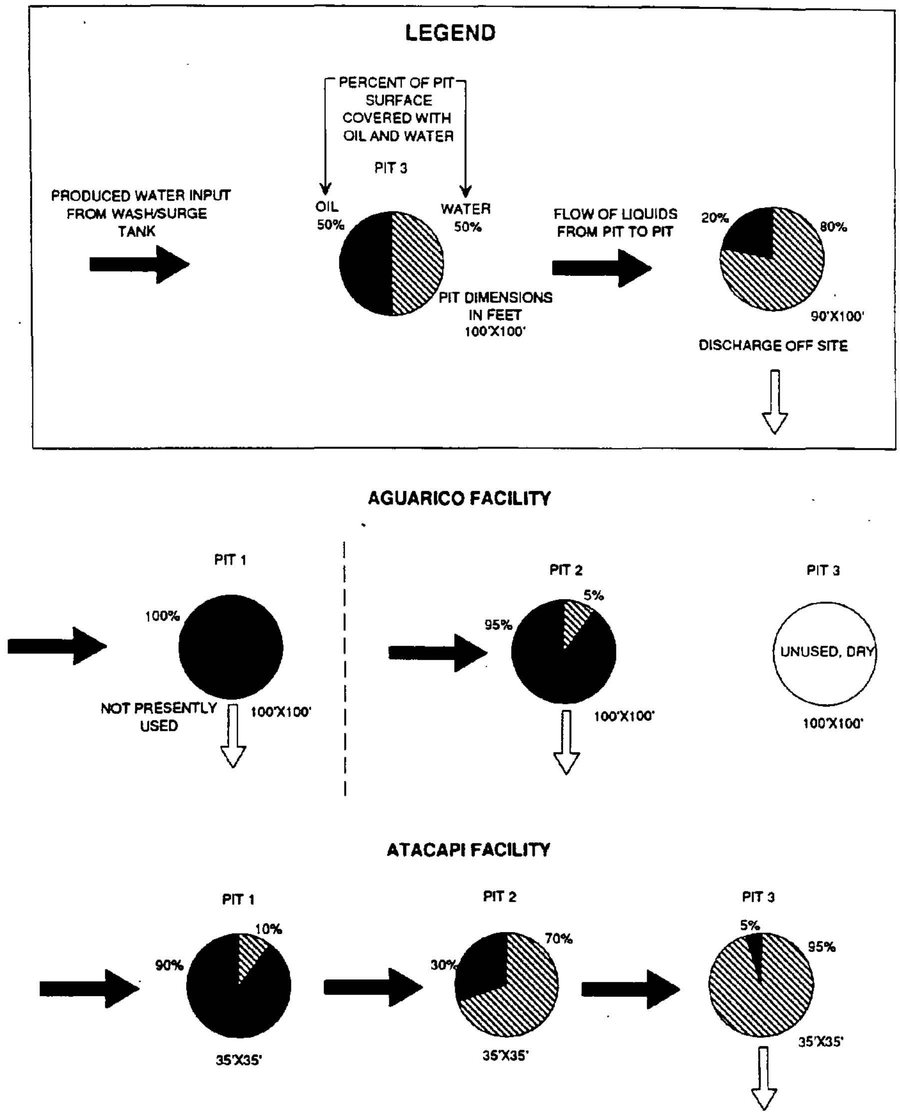

PRODUCED WATER FLOW
Petroecuador-Texaco Consortium

FIGURE 6-1

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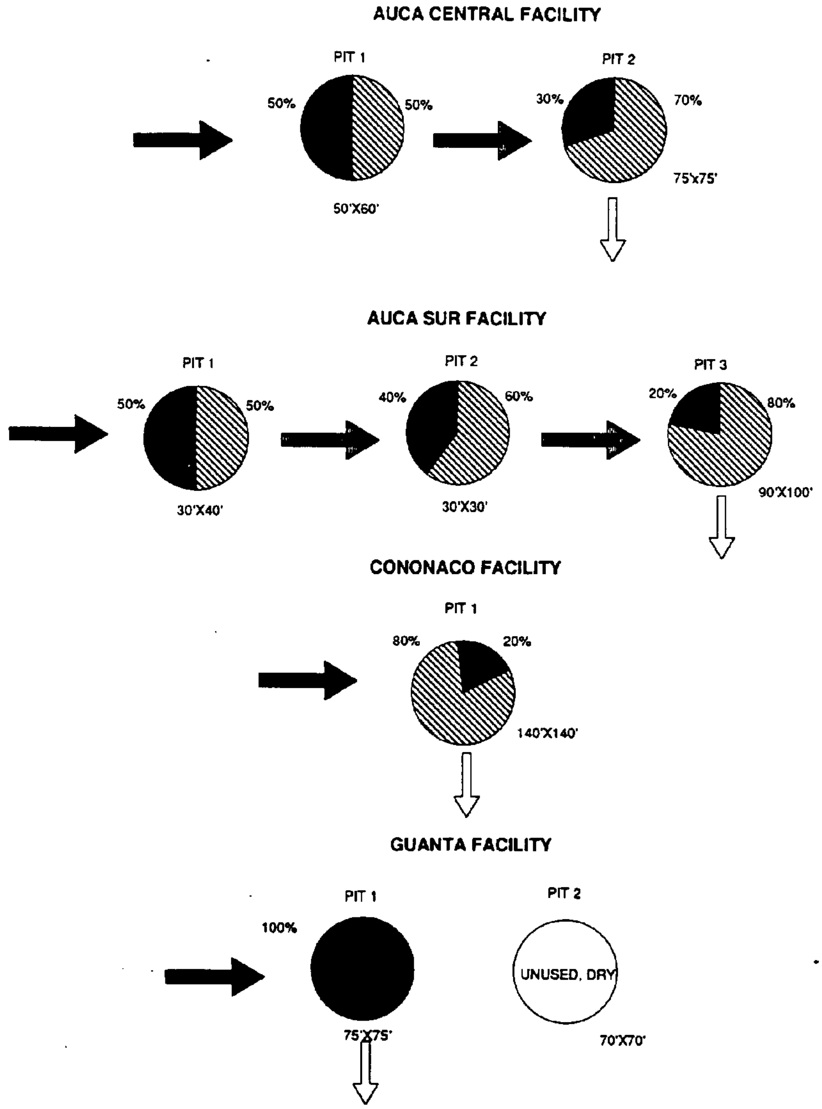

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FIGURE 6-2

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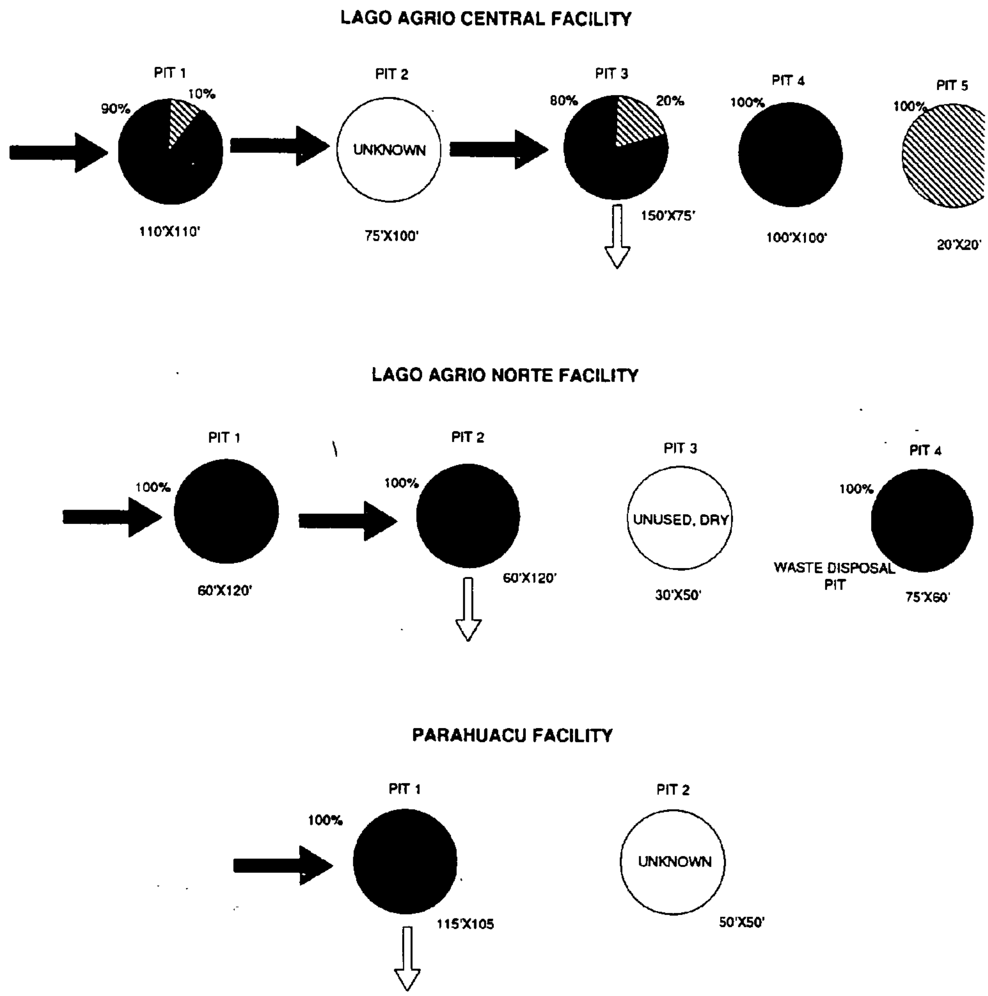

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FIGURE 6-3

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Fugro McClelland

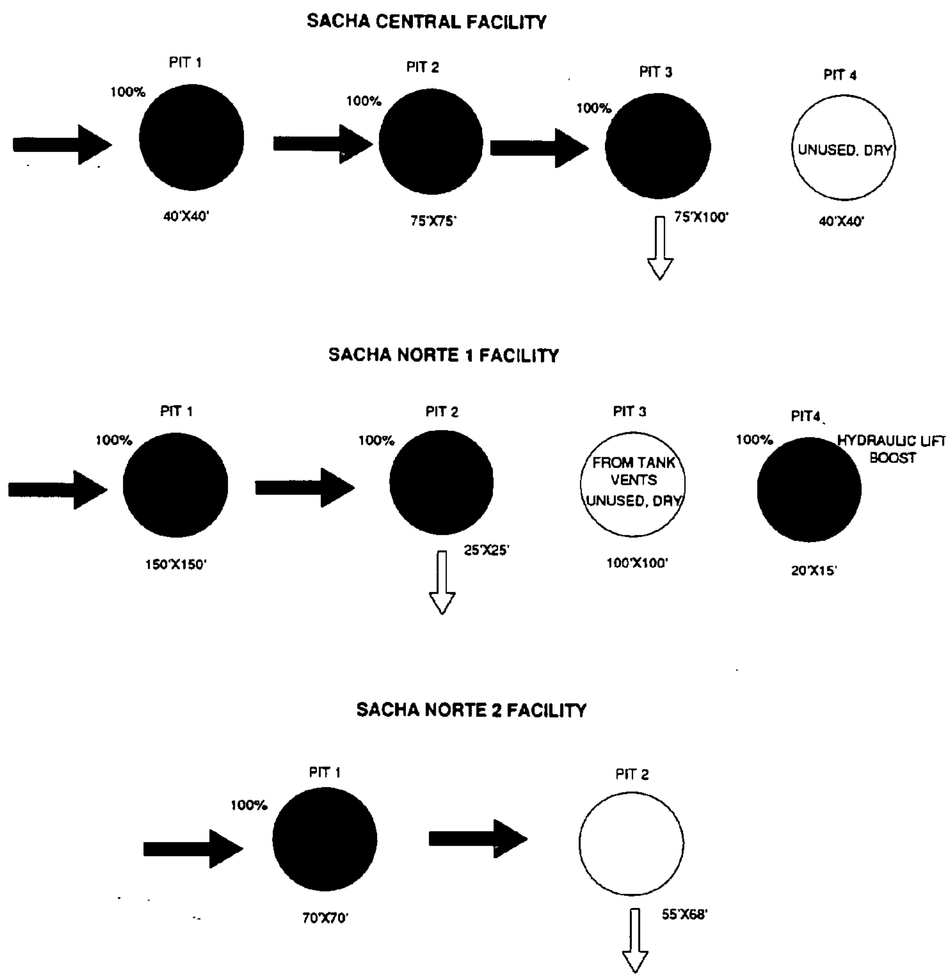

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FIGURE 6-4

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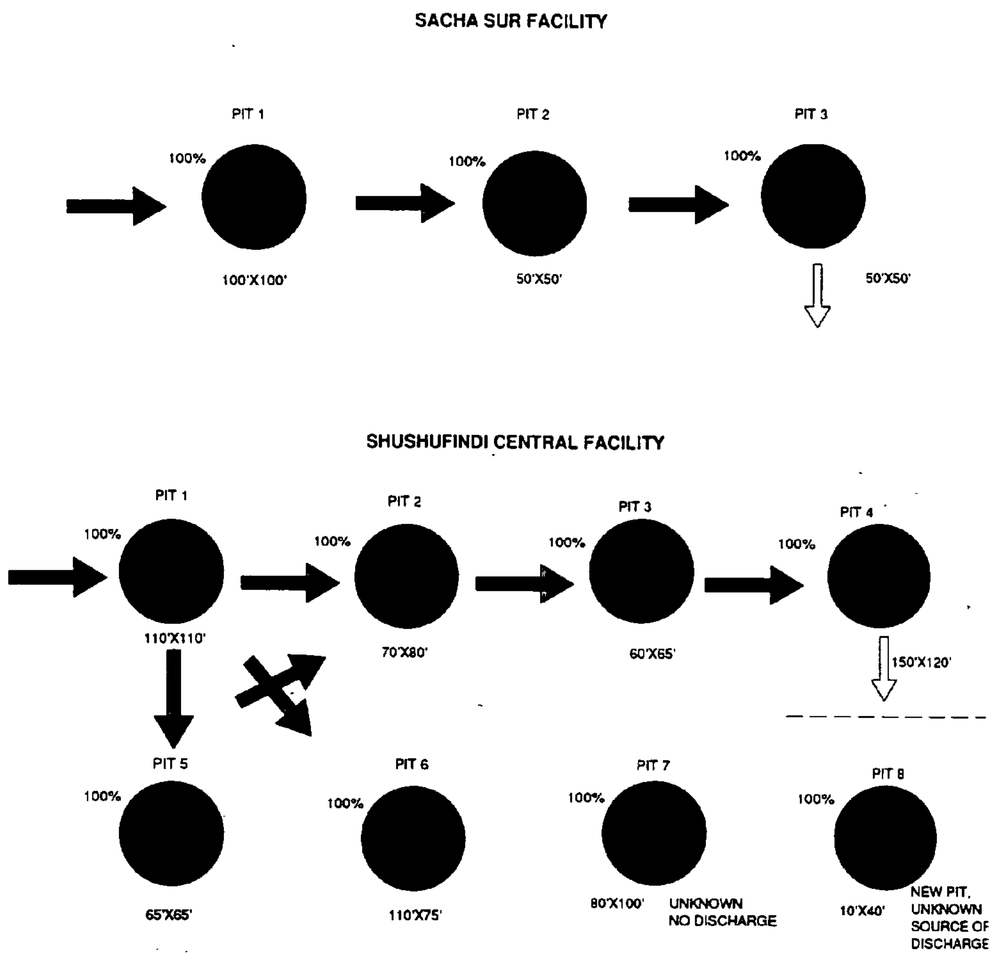

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FIGURE 6-5

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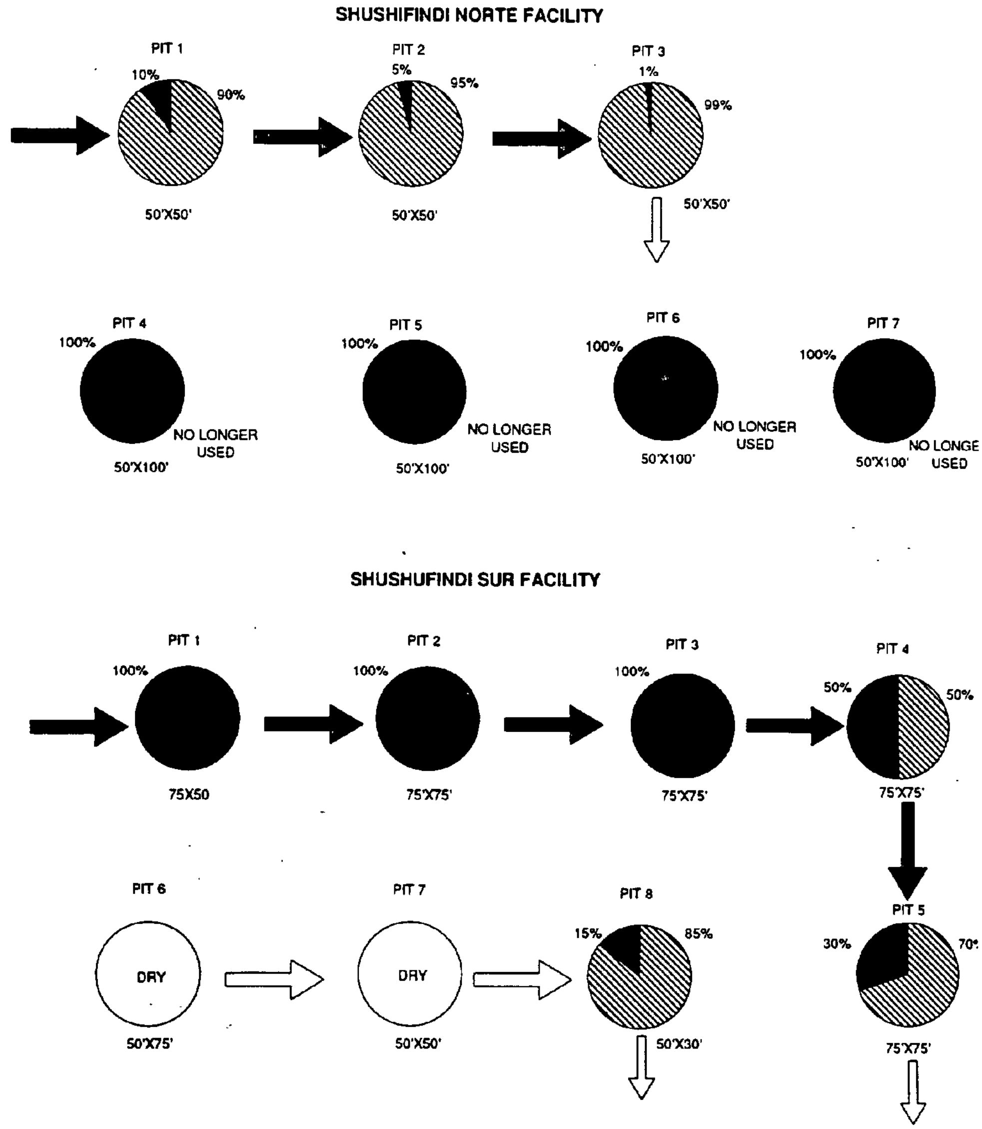

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FIGURE 6-6

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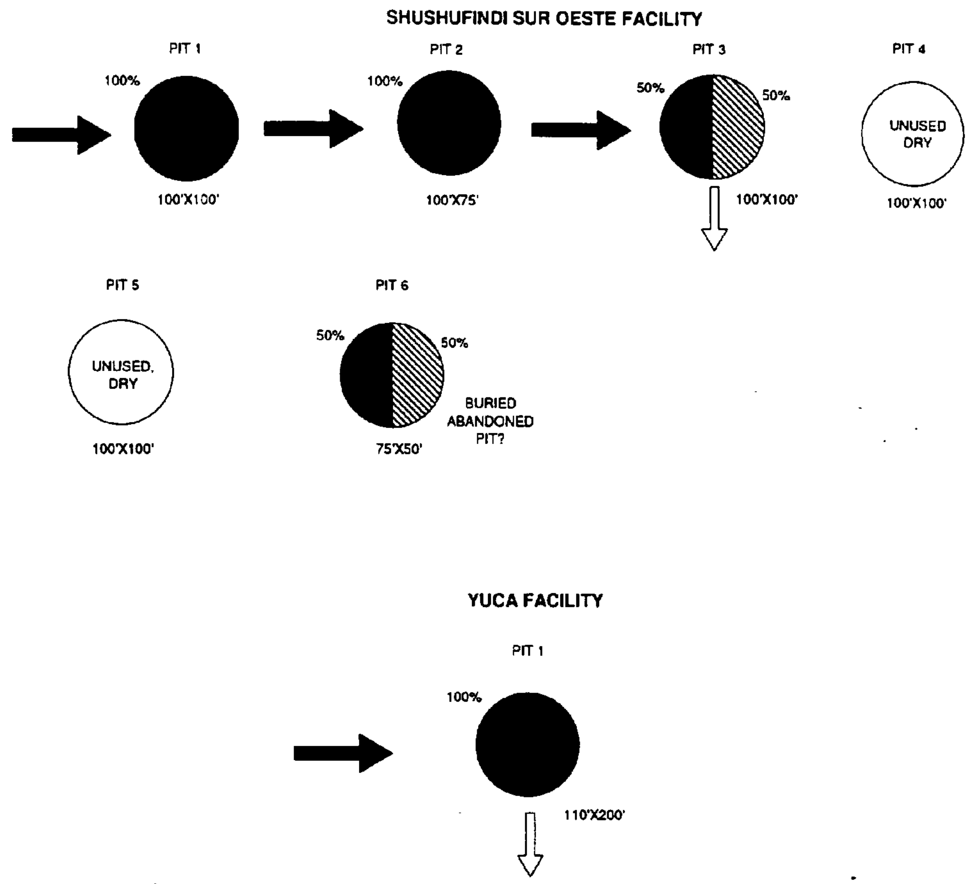
Fugro McClelland



PRODUCED WATER FLOW
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FIGURE 6-7

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The outfall sample was collected at the point of discharge prior to mixing with surface water. If the discharge pipe could not be accessed, the outfall sample was collected within the surface drainage as near to the discharge point as was reasonably accessible. The mixing zone sample was collected downstream of the outfall/surface drainage prior to the point where fluids converged with a natural body of water. The discharge in several cases traveled up to one kilometer prior to entering a stream. Upstream and downstream samples were generally collected at various distances from the mixing zone. To allow for the relocation of sampling points, locations with distinguishable landmarks, such as at bridge crossings were utilized. Field testing of the samples included pH, temperature, dissolved oxygen, and turbidity. A sufficient volume of sample was retained for analysis of 15 other parameters including chlorides and hydrocarbon content (Appendix B).

Ground water samples were also collected for analysis from natural springs and wells around Sacha Central, Sacha Sur, Shushufindi Central, Shushufindi Sur (Appendix B). The depth to ground water ranged from 6.5 to 10.5 feet around the Sacha Central, 6.5 feet to 7.0 feet around Shushufindi Central and 20 to 27 feet at Shushufindi Sur. Based on the field observations, ground water in the Sacha area appear to be associated with a sand strata which occurs below the surface soils. A sandstone bedrock outcrop is present at the Sacha Central production facility below the production tank berm wall. Bedrock was observed at several other locations around Sacha Central including at the bottom of two of the Sacha Central produced water pits. The direction of groundwater flow could not be determined since the surface elevation were unknown. Ground water seeps were also sampled near Lago Agrio and Sacha Sur. There was no evidence of contamination observed in any of the ground water samples collected.

Since ground water was present at three of the fields, an evaluation of soil permeability was conducted. The evaluation included four field percolation tests and laboratory permeability analysis of four pit berm soil samples. The field percolation tests were performed at the following locations:

- eastern edge of Sacha Central facility near the drainage ditch;
- southern edge of Sacha Sur facility near the drainage ditch;
- near the northwestern entrance to Shushufindi Central;
- adjacent to the percolation pit at Shushufindi Sur.

The percolation test procedure and results are contained in Appendix C. Soil infiltration rates ranged from 0.2 to 1 inch per hour. Laboratory permeability test were conducted on samples from the produced water pit berms at Sacha Central, Sacha Sur, Shushufindi Central and Shushufindi Sur. Permeabilities ranged from

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$2x10^{-3}$ centimeters per second at Sacha Central to $3x10^{-7}$ centimeters per second at Shushufindi Central and Sur. The laboratory results are also contained in Appendix C.

Evidence of petroleum releases beyond the final stage pit into a surface drainage feature were observed at Aguarico, Cononaco, Sacha Central, Sacha Norte, and Yuca. The drainage channels at Sacha Central and Yuca were heavily contaminated and contained free standing crude oil which was slightly degraded. In all instances hydrocarbon contamination was limited to the immediate vicinity of stream, discharge point or tributary. Organic material appeared to provide the anchoring substrate for hydrocarbon collection. Hydrocarbons in these areas did not appear to effect flora growth. Non-woody plants were observed growing directly in the hydrocarbon contaminated channels and stream areas.

A precipitation of an unidentified solid was observed at Atacapi, Aguarico, Shushufindi Norte, Shushufindi Central, Shushufindi Sur, and Shushufindi Sur Oeste. The precipitate was visually evident at the produced water discharge, and continued downstream for as much as 2/3 mile (1 kilometer). The discharge from the production pits was found to adversely impact vegetation at three production facilities Aguarico, Atacapi and Guanta. At Aguarico, a precipitate from the produced water discharge coated soil surfaces and the bottom of the stream channel. At Atacapi, production water and subsequent erosion was believed responsible for the dead trees and shrubs below a pit. At Guanta, production pit discharges were responsible for the dead and stress vegetation along the discharge stream below the pit. The precipitate also covered marshy areas at the other facilities, but it appeared to have little affect on the marsh species or plant growth and density.

Aquatic fauna was noted in several instances at the upstream sampling locations. Aquatic fauna included small fishes and surface invertebrates. In most facilities, aquatic fauna was also observed at the downstream sampling points. Exceptions to this were Aguarico, Sacha Central, Shushufindi Norte.

Minor impacts were observed at the produced water outfalls at Sacha Central and Sacha Sur. The flora in direct contact with the produced water discharge exhibited stress in the form of burnt leaf edges and discoloration of foliage due to increased temperature. Trees, shrubs and grasses growing immediately adjacent to the affected flora showed no indication of disformation or heat stress.

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Natural Gas

Natural gas separated from the crude oil is handled in four different ways; used as equipment fuel, converted to liquid natural gas, flared or vented. A portion of the gas produced at Aguarico, Sacha Central, Sacha Norte 1, Shushufindi Central, Shushufindi Norte, Shushufindi Sur and Lago Agrio Central and Largo Agrio Norte is used to fuel turbines for power generation, engines for gas compression and power oil, and to heat water circulated through the wash tanks. Natural gas is also collected in the Shushufindi area and compressed to make liquid petroleum gas (LPG).

Natural gas is released from the separators and wash and surge tank tower. This gas is piped directly to the flares. The flares normally consist of a vertical pipe about 10-15 feet high, with a terminal deflector plate. The flare pipe diameter is about 6 to 8 inches. Most of the flares were not located in bermed areas. Exceptions to this were Shushufindi Central and Sacha Sur. Sacha Sur had six flares, four of which were in operation. In numerous instances the flares were not ignited, so the gas was being vented. The flare at Shushufindi Sur Oeste was deformed and portions of the metal had been melted away. Other flares were missing the deflector plates. Natural gas and some hydrocarbons released from horizontal pipes at Shushufindi Central and Shushufindi Norte were also burning. Extreme surges in volume were observed along with occurrences of black smoke at Shushufindi Norte and Shushufindi Central. Black smoke was also seen at Shushufindi Sur Oeste flare. Soil below and adjacent to the flares was commonly scorched. At Sacha Norte 1, a release of crude oil from the flare contaminated the surrounding soil and vegetation.

Vents located on the top of the wash and surge tanks also released natural gas. The lines from the vents were usually located a safe distance away from the facility and the flare(s). Natural gas from these lines was discharged into the atmosphere without burning. In most cases, there was a flame arrestor which also served as a liquid knockout near the end of the vent line. Oil-soaked soil and free standing puddles of oil were common below the knockouts. Oil puddle size ranged from minor (5 square feet) to large (hundreds of square feet).

Hydrocarbons

Oil stained soil was noted at various locations within the production sites. Equipment used to transport, process or store crude oil, such as separators, shipping pumps, wash and surge tanks, fuel storage and produced water pits typically had oil stained soil near and below them. Oil sampling ports near the separators, pipe couplings, and pipe valves were common release points for crude oil. Oil collection sumps are located through out the facilities to collect drain runoff and some

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equipment releases. The sumps are typically connected into a central collection system and pumped back into the wash tank or released into drainage ditches. Most sumps checked contained free standing oil and oil stained soil around their perimeter.

Equipment associated with operations, such as injection and hydraulic oil pumps, turbines, and internal combustion engines commonly had oil stained soil around their concrete foundations or outside the gutter. Depending on the maintenance of the gutters, liquid would be contained within the gutters or spill over them. In most cases, hydrocarbon-stained soil was noted within about 10 feet around the foundation pad. At some sites, collection gutters drained into the surrounding soil. Others were captured and pumped into the site's sump system.

Chemicals were either used or stored at all the production facilities. These chemicals include: paraffin inhibitors, descalants, anticorrosants, deemulsifiers, and bacteria inhibitors. Small injection pumps feed the chemicals into oil lines near the separator tanks. Spills around the chemical storage tanks and injection pumps were common. In addition, drums were observed leaking and spill were evident around the chemical storage areas.

In general, spills of hydrocarbons and chemicals were not cleaned up. Instead, they were covered with a sand. This sand tends to cover the spills, thus reduce slip hazards and prevent tracking of oil around the plant. This practice of covering the oil spills makes it difficult to identify whether spills are recent or old. In places where spills are frequent, such as near separators, shipping pumps, oil storage tanks, and chemical injectors, overlapping patches of sand were observed. Recent spills which had not been covered were easily identified.

Noise

Ambient noise levels at the selected production facilities were monitored utilizing a Bruel & Kjaer Precision Integrating Sound Level Meter, Model 2222. Noise measurements yielded values which reflect the point source conditions at a specific time and location. However, it is expected that these levels are consistent with 24-hour noise levels since current oil and gas activities sites do not cease except during maintenance operations. The primary noise sources observed at the sites included flares, generators, compressors, turbines and internal combustion engines. Noise levels in the general proximity of the production sites are presented in Table 6-10, and are based on monitored results and standard noise alternation equations.

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Oil Spill Prevention and Control

Some oil spill prevention practices were apparent at production facilities. They include but not limited to tank berms, equipment pad drains and sumps and check valves in production lines. Some of the facilities, Aguarico, Shushufindi Sur Oeste, had emergency procedures posted near the facility entrance. The procedures require verification that the tank berm valves are closed and to notify the facility manager.

An oil spill prevention and control plan was not identified. The audit teams also did not observe any spill control or containment equipment (e.g., boom, absorbent pads). Field observations and conversations with facility personnel indicated that spill control and containment is usually accomplished using natural materials such as trees, straw and soil. Hydrocarbon spills that do not reach water are left in place and covered with sand or dirt. A vacuum truck was observed collecting crude oil from a spill at Sacha Norte 2.

Berms are present around all production facility crude oil tanks. A list of tank capacity, berm measurements and estimated capacity are shown in Table 6-9. Tank capacity was obtained from documentation and field observations. Tank berm measurements were taken in the field for a portion of the facilities. The remainder of the measurements were taken from the facility plans. Large (greater than 1000 gallons) fuel tanks also had berms, with the exception of three tanks at Shushufindi. Berm volume calculations were not performed for fuel storage areas. Most of the berms have drains in the dikes to release rain water. The drainage for 13 of 38 tank berms could not be determined or were not recorded. Three berms were identified which had open drain pipes. Thirteen berms had drains but the discharge was unknown or not visible. Nine berms had drains with valves, 4 of which were in the open position. Minor erosion was noted on some of the tank berms. None of these appeared to be sufficiently eroded to threaten the berms effectiveness in the event of a release.

Abandonment and Restoration

No abandoned production facilities were identified during the audit.

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6.3.5 Pipelines

Site Selection

Twenty-eight separate sections of secondary pipeline were examined (see Figures 1-3 through 1-12 for pipeline transect locations). All the pipelines audited were readily accessible from the road and were located in the road right-of-way. Auditing was conducted by walking one-mile (1.6 kilometer) sections of pipeline while recording field observations of pipeline condition and configuration and evidence of physical and environmental impacts. The transects were typically started at recognized locations such as road crossings, well sites, stream crossings, etc. Table 6-9 provides a summary of observations recorded during the pipeline audit.

Site Preparation

The number of pipelines observed in each transect varied considerably, ranging from zero over short distances to as many as 15 pipelines near Shushufindi Norte. In general the pipeline was located above ground supported by steel racks or concrete stands. The remaining pipeline either laid on the ground or was buried. The average number of pipelines observed over 28 transects was between 4 and 5. Even though the pipelines were adjacent to existing roads, heavy vegetation prohibited visual observations in many areas. The average road width along the pipeline transects was typically about 25 feet. Pipeline clearing widths (one side of road only) ranged from 7 feet to 35 feet with an average cleared width of about 20 feet. Clearing widths were recorded along an average cross section for each transect and represent one side of the road only. In most cases, the other side of the road had no pipelines or fewer pipelines and, thus, had a smaller cleared width. The average cleared width for each pipeline transect could be obtained by multiplying the average cleared width for that transect times two. Therefore, the average total cleared width of pipeline and roadway combined is about 65 feet (i.e., 20 ft x 2 for the pipeline plus 25 ft for the roadway).

Evidence of significant soil erosion was observed along 7 of the 28 pipeline transects. For transects in which soil erosion was reported, there was usually not more than one or two occurrences. Erosion was most prevalent along steep embankments in which vegetation had been cleared for pipeline construction. These areas of erosion extended up to 200 feet in length and a 20 feet in width. Stream crossings were observed along 25 of the 28 pipeline transects. The number of crossings within one mile transects ranged from 1 to 5. The average number of crossings per mile of pipeline audited was 1.5.

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Waste Handling

The integrity of the pipelines audited was generally fairly good. Minor to no evidence of corrosion was reported for 25 of the 28 pipeline transects. Minor to moderate pipeline corrosion was observed at transects No. 4 and No. 5, north of Auca Sur and north of Auca, respectively (Figure 1-11). Significant corrosion locally was observed at transect No. 28 at Atacapi. Eight of the 28 pipeline transects had patches on one or more pipelines. With the exception of transects No. 5 and No. 16, the number of patches reported were less than five. Twenty-five and nine patches were observed along pipeline transects No. 5 (north of Auca) and No. 16 (north of Shushufindi Norte), respectively.

Evidence of pipeline leaks were observed along 11 of the 28 transects. Several of these leaks were fairly minor in size, typically having occurred at valves. Ten of the spills identified along these four transects would be considered major (greater than a few hundred square feet in areal extent). However, three of these leaks were large in areal extent and appeared to be recent. These include:

- transect No. 5 — Significant soil contamination in five areas; two discharging to streams.
- transect No. 14 — 2,400 square feet of discolored soils near 1.4-km mark.
- transect No. 15 — Six spills ranging in area from a few hundred to several thousand square feet.

In addition to the pipeline audit, several spills associated with pipeline discharges were sampled for finger print analysis. These included three locations in Auca, one near Sacha Sur and one south of Aguarico. Four of the releases involved spills into surface water, three of which were major in extent. Cleanup efforts were apparent at two of the Auca spill sites.

Spill Prevention and Control

Spill prevention and control measured for pipelines included, block valves, and check valves. Pipeline leaks were typically repaired by installing patches. There was no indication of a pipeline monitoring program. Other than a vacuum truck, there was no equipment observed for containment and control of spills.

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Abandonment and Restoration

Only a few instances of pipeline abandonment were observed during the audit. Transect No. 18 contained a section of pipeline that appeared to have been removed as evidenced by the concrete block which still remained. Pipelines which had been cut or capped were also observed along two other pipeline sections. The operational status of each pipeline was not evaluated, therefore pipelines which may have been out of service, but not removed could not be determined.

6.4 CONCLUSIONS

6.4.1 Access

Since there were no specific industry practices or Ecuadorian laws and regulations for drilling and production operation access site selection, preparation, waste handling and site abandonment and restoration, TEXPET's practices from 1964 through 1990 were considered acceptable. The environmental audit was unable to identify any impacts from TEXPET's practices beyond those associated with normal industrial development.

The 1976 Ecuadorian law and regulation requires the preparation of an EIS and control measures. But, the document review and environmental audit were unable to identify any such studies prepared from 1976 though 1990, except for one for a project in the national park. An EIS, if required, would probably have been conducted at the beginning of a large development project. It is important to emphasize that a majority of TEXPET's development in the Oriente (consortium roadways, well access roads, production facilities and camps) were constructed prior to adoption and implementation of this law (Table 6-1).

TEXPET's practices for site preparation and waste handling were identified through historical document review. A Task Force Review dated February 4, 1975, evaluated road construction practices against the specification in Contract MC-E-352. The report recommended more direct supervision for highway and well access roads construction in Auca and Sacha. Contract MC-E-907 dated April 6, 1984 provides the specifications for highway construction and included a note which stated, "Crude contamination should be avoided in areas adjacent to the road, especially in sections near estuaries, rivers, etc." This information acknowledges TEXPET's intent to comply with the 1971-1989 regulation to protect flora, fauna and natural resources and prevent pollution.

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There are no industry practices on site abandonment and restoration for drilling/production access. Therefore, TEXPET's practices of leaving the access routes in place were considered acceptable.

6.4.2 Base Camp

Site Selection

With the exception of the 1976 requirement for an EIS and control measures, there were no industry practices or Ecuadorian laws and regulations that apply to base camp site selection from the period of 1964 through 1990. It is not possible to determine the environmental impacts, if any, which were a direct result of not preparing an EIS for work conducted after 1976. Other than the requirement for preparations of an EIS, TEXPET's base camp site selection practices were considered in compliance. From a historical prospective, the practice of facility consolidation can be seen in the Oriente where camp facilities are located within, adjacent, or in close proximity to production facilities.

Site Preparation

Construction of the base camps is believed to have resulted in the loss of primary rain forest; however, no definitive information was available concerning the pre-construction status of the camp sites. Secondary conversion of the lands outside of the base camps has largely resulted from agricultural production; however, in some areas, secondary forest is dominant. Continued operation and maintenance of the base camps supports the present mix of turf grasses and paved or gravel surfaces.

Since there were no specific industry practices or Ecuadorian laws and regulations for development drilling and production operation base camp site preparation, TEXPET's practices from the period 1964 through 1990 were considered in compliance. The Ecuadorian law and regulation does provide general requirements to protect flora, fauna and natural resources and prevent pollution. The environmental audit was unable to identify any avoidable impacts from TEXPET's base camp site preparation practices.

Waste Handling

The audit identified sanitary waste collection systems at all camps. Historical documentation reviewed included a report dated January 20, 1976, from Camp Dresser & McKee that evaluates the systems at Lago Agrio, Sacha and Shushufindi and provides recommendations for sewage disposal facility modification.

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A memorandum dated March 22, 1978 from the District Superintendent to all camps outlines the maintenance requirements for grease traps and septic tanks. This memorandum also indicated that waste removed from traps and tanks should be properly buried away from populated areas. Based on the assumption that the existing systems were designed and operated to prevent the discharge of pollutants dangerous to the environment and human health, TEXPET's base camp sanitary waste collection and treatment systems were in compliance with the Ecuadorian laws and regulations that were in effect from 1964 through 1989. Since sanitary waste discharge were not registered with the IEOS, compliance with the 1989 water quality standards could not be determined.

The audit observed that miscellaneous wastes from base camp operations were disposed of at off site locations. Since there were no Ecuadorian laws or regulations or industry practices, from 1964 through 1990, specific to domestic waste disposal, TEXPET's practices were considered in compliance. Historical documentation indicated that an incinerator was constructed at Lago Agrio prior to August, 1986. The audit also identified an incinerator at the Coca camp. The use of an incinerator for waste handling and treatment exceeded the regulatory requirements and industry practices.

All the vehicle maintenance areas except Sacha were constructed to prevent the discharge of hydrocarbons and other waste. If the sumps and drains were properly maintained, TEXPET's operations would have been in compliance with the Ecuadorian law and regulation from 1964 through 1990. The Sacha wash rack did not have a fluid collection system, therefore hydrocarbon contamination occurred in the surrounding area. The impacted area which would need to be remediated is approximately 1,500 square feet.

<u>Spill Prevention and Control</u>

See discussion under Section 6.4.4 Spill Prevention and Control. Based on the field observations and documentation, TEXPET operations were in compliance with the Ecuadorian law and regulation from 1964 though 1989 and industry practices for tank berm and berm drains. Compliance with the 1989 regulation for a Spill Prevention and Control Plan could not be assessed. Historical documentation identified TEXPET's efforts to prevent and control contamination from spills.

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Site Abandonment and Restoration

There are no industry practices that apply to site abandonment and restoration for development drilling and production base camps. Therefore, TEXPET's practices, for base camp abandonment and restoration were considered in compliance.

6.4.3 Drilling

Site Selection

With the exception of the 1976 requirement for an EIS and control measure, there were no industry practices or Ecuadorian laws or regulations for base camp site selection. It is not possible to determine the environmental impacts, if any, which were a direct result of not preparing an EIS for work conducted after 1976. Other than the requirement for preparation of an EIS, TEXPET's drill site selection practices were considered in compliance.

Site Preparation

Since there were no industry practices or Ecuadorian laws or regulations for development drilling, TEXPET's operations from 1964 through 1990 were considered in compliance. In fact, TEXPET's operation generally used less than 1/2 of the area allowed for drill sites under current regulations (2 hectares). Contract MC-E-907 dated April 6, 1984 contains a specification for well site construction. The total area occupied by well site based on that document is approximately 90,000 square feet or slightly less than 1 ha. This concurs with the field observations.

Waste Handling

TEXPET's practice of disposing of drill muds and cuttings in reserve pits is in accordance with standard industry practice from 1964 through 1990. In many cases the reserve pits were closed at the well sites audited. The 1974 through 1989 regulation prohibited the discharge of pollutants that are dangerous to the environment and human health. Historical documentation indicated that TEXPET's operations had been conscious of waste reduction since 1971 and proper handling of waste as early as 1972. A letter to Mr. J. H. Morre, dated January 14, 1971, discusses the transfer of drilling muds from location to location to reduce cost and mud pit construction. An internal memorandum dated, May 16, 1972, contains suggestions which indicate that reserve pits should not be used for well test, that small deep slush pit would be dug for well test, and that the slush pit should be filled in and the location graded once well testing was completed. In addition, numerous other documents were found which

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discussed, pit operation, inspection and closure. Based on this information and the results of the audit, TEXPET's operation were in compliance with the Ecuadorian law and regulation from 1974 though 1989. No records were found to document compliance with the 1989 regulations registration and discharge requirements. Not all reserve and production pits have been closed. The audit identified 56 pits which contained degraded or heavily degraded crude oil. If these pits will no longer be used, they should be closed in a manner consistent with the current regulations. The estimated volume of crude oil contamination at drill site pits attributed to TEXPET's operations from 1964 through 1990 is 2,000 cubic yards (Table 7-1).

Hydrocarbon contamination was identified at a majority of the well sites. According to the 1974 Ecuadorian law and regulation the discharge of pollutants that are dangerous to the environment and human health is prohibited. Based on regulatory requirements contamination which still exhibits the ability to release dangerous pollutants to the environment must be remediated. Well sites that contain heavily degraded crude oil in an asphaltic state may not require remediation. The estimated volume of all crude oil contamination at drill sites attributed to TEXPET's operation from 1964 through 1990 is 20,000 cubic yards (Table 7-1).

TEXPET's operation included the intentional burning of crude oil from spills and contained in pits. This operation usually created large amounts of black smoke and soot that can potentially impair the environment and human health. However, based on historical documents, permission to conduct pit burns was obtained from the appropriate authority. TEXPET's operation were therefore in compliance with the 1976 Ecuadorian law and regulation. The audit identified impacts to the surrounding vegetation caused by pit burning activities. The impacted vegetation was limited to the pit perimeter and regrowth appears to occur rapidly. Therefore, no further action is recommended.

Only two of the well sites audited had natural gas discharges. Permission from the Ministry of Energy and Mines to vent or burn natural gas, as required by the 1971 Ecuadorian law and regulation, could not be verified. The flares at Auca 8 and Guanta 5 appeared to burn without black smoke. The gas vent at Auca Sur 1 was recently installed. Therefore, TEXPET's operations were in compliance with the 1976 Ecuadorian law and regulation. Historical documentation also indicates that natural gas is burned at the well sites during well testing operations. This would be in compliance with the regulations provided that no black smoke was emitted. Based on known information, TEXPET's natural gas burning operations were in compliance with regulations in place.

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A minor amount of domestic and industrial refuse was observed on many well sites. According to the 1974 Ecuadorian law and regulation, unless the waste pose a threat to the environment or human health, there is no restriction on disposal practices. If the waste contains hydrocarbons, chemicals, or infectious waste it should be remediated by proper burial or incineration. The audit identified only minor impacts associated with trash disposal practices. The impact were usually the result of hydrocarbons in the waste.

Spill Prevention and Control

See discussion under Section 6.4.4 Spill Prevention and Control. Based on the field observations and documentation it would appear that TEXPET operations were in compliance with the Ecuadorian laws or regulations from 1964 though 1989. The production facilities at well sites Auca 8, Auca Sur 1, Sacha 36, and Guanta 5 were not in compliance with industry practices for tank berm and berm drains. To comply with industry practices, berms should be constructed to contain any possible releases. Compliance with the 1989 regulation for a Spill Prevention and Control Plan could not be assessed. Historical documentation identifies TEXPET's efforts to prevent and control contamination from spills.

Site Abandonment and Restoration

There are no industry practices that apply to site abandonment and restoration for development drilling and production operations. Therefore, TEXPET's practices for well site abandonment and restoration from 1964 though 1990 were considered in compliance. Natural revegetation of the area surrounding well site pads was documented in all areas not used for agricultural purposes. Based on observations of the vegetation within the central pad areas at abandoned sites, the presence of imported soils (cobble, gravel and silt) may delay, but does not preclude regeneration of secondary forest vegetation. However, it is likely that removal of imported soils (cobble, gravel and silt) would facilitate natural revegetation. Gravel and crude oil that had turned into asphalt usually inhibited vegetation (other than grasses) growth even after more than 10 years. The audit did not identify any impacts associated with leaving the gravel and asphaltic material in place.

6.4.4 Production Operations

Site Selection

With the exception of the 1976 requirement for an EIS and control measures, there were no industry practices or Ecuadorian laws or regulations for production

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facility site selection. It is not possible to determine the environmental impacts, if any, which were a direct result of not preparing an EIS for work conducted after 1976. Other than the requirement for an EIS, TEXPET's production facility site selection practices were considered acceptable. Facilities were located as necessary, in proximity to crude oil production areas.

Site Preparation

Since there were no specific industry practices or Ecuadorian laws or regulations for production facility site preparation, TEXPET's practices from 1964 through 1990 were considered in compliance.

Waste Handling

Produced Water

Results of the water quality testing of produce water, stream, and well sampling locations are provided in Appendix B. Results of field and laboratory testing are provided on individual data sheets for each facility sampled. Additionally, Appendix B contains summary tables for all groundwater and all upstream samples. The groundwater and upstream analytical data were intended to provide an approximation of natural conditions (i.e., average water quality values for groundwater and surface water not influenced by drilling and production operations).

The produced water from TEXPET's operations have historically been discharged into surface waters. This is consistent with industry practices in place from 1964 though 1990. Since there were no Ecuadorian laws or regulations from 1964 through 1974, TEXPET's practice was in compliance for that time period. From 1974 through 1989, the Ecuadorian law and regulation prohibited the discharge of pollutants that are dangerous to the environment and human health. In 1980, TEXPET conducted a sampling and analysis program to determine hydrocarbon concentration and to detect toxic substances in the waters downstream of production operations. The only area of concern identified in that report was the high levels of hydrocarbons and sulfates at Sacha Central. Therefore, except for the single documented instance of high hydrocarbon concentration, TEXPET's operations were in compliance with the Ecuadorian law and regulation for the period from 1974 through 1989.

Regulations for the Prevention and Control of Environmental Pollution Related to Water Resources (Decree No. 2144, 1989) required discharges to be registration with the IEOS. None of the produced water discharges were registered, therefore, the

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IEOS did not establish sampling points to determine compliance with the water quality standards. In order to evaluate the potential for environmental impacts from produced water discharges, the analytical results of samples collected during the audit were compared against the current 1992 water quality standards (Table 6-12). According to the current 1992 standards, concentrations beyond the mixing zone boundary cannot exceed 2,500 ppm chlorides, 15 ppm hydrocarbons, 1,200 ppm sulfates, and must not be outside of the range of 5.0 to 9.0 pH. Chloride concentrations beyond the mixing zone (downstream sample) ranged from a low of 65 ppm at Sacha Norte No. 1 to a high of 33,000 ppm at Atacapi. Hydrocarbon values varied from below the level of detection to 3.5 ppm; sulfate ranged from below the level of detection to 33 ppm; and pH ranged from a low of 3.75 at Atacapi to a high of 8.0 at Lago Agrio Norte. Based on the analytical results, chloride concentrations exceeded the 2,500 ppm downstream of the discharge at four of the facilities (Atacapi, Aguarico, Lago Agrio Norte, and Yuca) and was within 220 ppm of exceeding the criterion at Auca Sur. Shushufindi Sur which uses a percolation pit to dispose of produced water was also considered in exceedence of the standards. Atacapi was also in exceedence of the pH requirements. Modifications are therefore required on these discharges to bring them into compliance with the current 1992 water quality standards. It is not clear if these discharge modifications would have been required under the 1989 regulations.

A precipitate was observed on the surface, drainage ditches and receiving water at six production facilities. Heavy precipitation was present at Aguarico, Atacapi and Shushufindi Norte. All of these discharges have already been recommended for modifications. Minor precipitation was also observed at Lago Agrio Norte, Shushufindi Central, and Shushufindi Sur Oeste. The audit did not identify significant impacts from this discharge on marsh flora and fauna. Therefore, no action is required at these sites.

The water quality analysis and audit observations presented in this report are based on current conditions. The water quality beyond the mixing zone will vary according to the quantity of flow, both in the stream and from the produced water and the concentration of compounds in the produced water. A record of the total monthly volume of produced water from all facilities combined from May, 1972 through January, 1992 is provided in Figure 6-8. The average produced water from 1980 through July 1990 was 2.3 million barrels per month. From July, 1990 to January, 1992 the record indicates a large increase in total monthly production, peaking at about 3 million barrels per month. A 30 percent increase in produce water flow could substantially effect downstream water quality at a number of the facilities.

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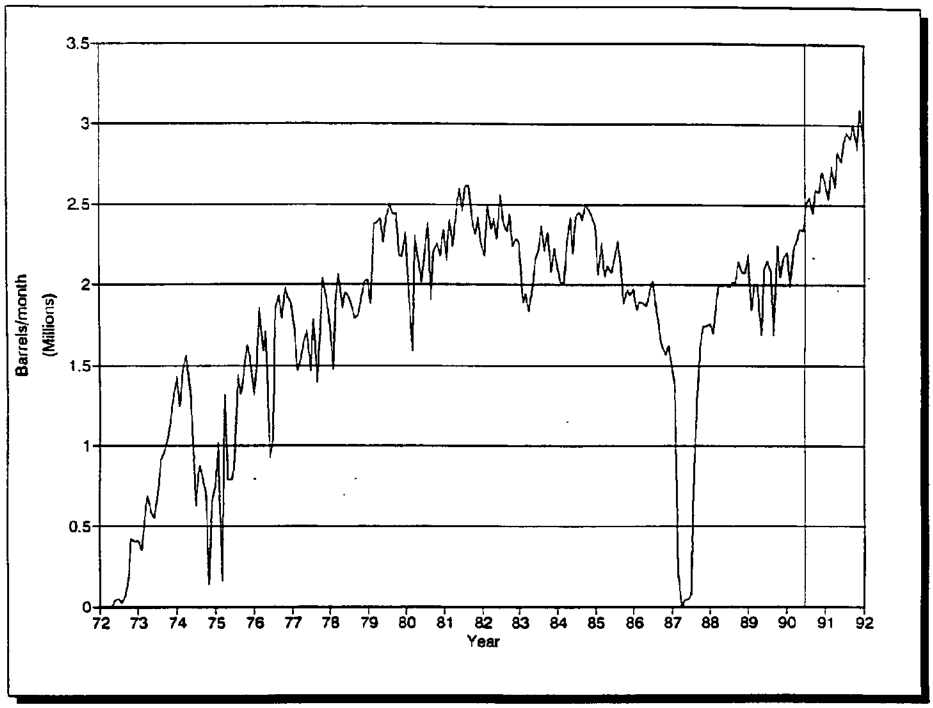

PRODUCED WATER RECORD
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FIGURE 6-8

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The presence of ground water at Sacha and Shushufindi is an issue, since all the produced water pits are constructed below grade. The audit identified the surface soils in the Sacha and Shushufindi as clay loam and loam respectively. A report on septic systems dated January 20, 1976, from Camp Dresser & McKee identified the soils at both sites as clay. The percolation test performed by Camp Dresser & McKee at Sacha recorded one inch of drop in 160 minutes (0.37 inches/hour) and no decrease in water level at Shushufindi. The percolation rate observed in the field test performed under this audit ranged from 0.2 inches per hour ($1.6x10^{-4}$ centimeters/second) at Sacha Central to 1 inch/hour ($6.8x10^{-4}$ centimeters/second) at Shushufindi Central. These data are relatively close given the possible variation in soil conditions and test methods. The laboratory permeability test of the pit berm samples ranged from $2x10^{-3}$ centimeters/second at Sacha Central to $3x10^{-7}$ centimeters/second at Shushufindi Central. The sample at Sacha Central was described as medium grained sand which may explain the higher permeability reading. In general, this information indicates that the ability for fluids to migrate from the surface pit into the groundwater is relatively low unless the produce water pit is in direct contact with the water bearing strata.

The chloride and pH concentrations of the groundwater ranged from 1.3 ppm to 8.1 ppm and 5.3 to 6.1, respectively. The concentrations of these compounds in groundwater at Sacha and Shushufindi were similar in composition. The fact that they are also similar to upstream samples, except for pH and dissolved oxygen, suggest that the two systems may be related in some fashion, i.e., surface water entering into the groundwater and visa versa. The conclusion that the soils in general have low permeability is supported by the facts that production has occurred in these fields for 20 years and the groundwater samples collected showed no indication of contamination.

Hydrocarbons

Hydrocarbon contamination was observed under separators, around sumps, equipment foundations and storage tanks. Chemical contamination was noted at drum storage areas, under bulk chemical tanks and around injection pumps. According to Ecuadorian laws and regulations the discharge of pollutants that are dangerous to the environment and human health is prohibited. Based on regulatory requirements contamination which still exhibits the ability to release dangerous pollutants to the environment must be remediated. Due to the use of spill sand around the storage tanks it was difficult to distinguish between recent or past (pre-1990) oil spills. In most cases the spill sand appeared to be recently applied as there was not vegetation growing on it. Base on this observation the estimated volume of

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hydrocarbon contamination around the waste, surge and production tanks was considered 50 percent (3,500 cubic yards) of the total calculated volume. Other spills around the production facilities could be categorized (FS, SL-DEG, DEG, HV-DEG) as previously discussed. The estimate volume of crude oil and chemical contaminate around the facility attributed to TEXPET's operations was 6,600 cubic yards. The total volume of contaminated soil at production facilities attributed to TEXPET's operations from 1964 through 1990 is 10,100 cubic yards (Table 7-1).

Natural Gas

Production facilities were not in operation until 1972, therefore the 1964 through 1971 Ecuadorian laws and regulations do not apply. According to the Hydrocarbon Law (Decree 1459, 1971) permission from the Ministry of Hydrocarbons was required to burn or vent natural gas. Compliance with this regulation could not be verified. According to the Law on Prevention and Control of Environmental Pollution (Decree No.374, 1976), the Ministry of Health was responsible for identifying discharges to the atmosphere that impaired the environment and human health. A search of historical documentation was unable to locate any reference to natural gas venting or flare operation. Based on this information, TEXPET's practice or burning and venting natural gas was in compliance with regulations in place at that time.

Oil Spill Prevention and Control

Prior to 1974 there were no industry practices or Ecuadorian laws and regulations governing spill prevention and control. However, documentation indicates the TEXPET had a spill response plan as early as 1972. A letter from James T. Moir to the Captain of the Balao Terminal, dated October 4, 1972, refers to Texaco's Trans-Ecuadorian Pipeline System, Oil Spill Response Plan. The first spill record was found at Sacha Central, dated July 28, 1973. Subsequent TEXPET correspondence from 1974, provides a list of oil spill response equipment and contacts. Pollution Control Instruction, Section V, covers "Preventive Steps to Be Taken Regularly" for all operating departments and locations within Texaco. Based on this information TEXPET's operations were in compliance with the 1974 regulations which required operators to prevent the escape and waste of hydrocarbons. The audit teams could not locate a spill response and control plan other than the 1972 document. Therefore, compliance with the 1989 regulation for a spill prevention and control plan could not be assessed. Memoranda to Consortium personnel, letters and other documents from 1975 through 1989 identify the importance of spill prevention and reporting.

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Based on documents dated, 1976 through 1990 industry practice suggested that storage tanks should have dikes, berms or other alternative system to contain tank spill. Table 6-11 shows that six of the 38 crude oil tank berms substantially lack the volume to contain the tank's capacity. The dimension of those facilities should be rechecked to verify this observation. Berms that are not in compliance with industry practices should be modified to the appropriate size.

Several of the tank berms do not have appropriate drains or the drains do not have valves. Production-Safety Report #4 dated June 5, 1974 indicates that tank basin drain lines were all being equipped with valves outside the berm at that time. A memorandum to refinery and production personnel dated April 15, 1975 indicates that berm drains must be equipped with outside valves and that the valves must be maintained in the closed position. Based on documentation, TEXPET operations were in compliance with the industry practices for tank berm drains.

Noise

Attenuation calculations from field measurements indicated that all the noise levels from production facility operation are below 75 decibels (dBs) within 380 feet (0.1 kilometer) from the source. In many cases, this is still within the facility boundary. There were no industry practices or Ecuadorian laws or regulations that applied to noise generated from production facility operations. Therefore, TEXPET's operations were in compliance.

Site Abandonment and Restoration

There were no industry practices or Ecuadorian laws and regulations for production facility abandonment and restoration. The audit did not identify any abandonment practices except for produced water pit closure. Contamination was observed at two production facilities. The closure appears to have occurred recently. Therefore, TEXPET's practices of production facility abandonment and restoration, if any, were in compliance.

6.4.5 Pipelines

Site Selection

With the exception of the 1976 requirement for an EIS and control measures, there were no industry practices or Ecuadorian laws or regulations for pipeline site selection. It is not possible to determine the environmental impacts, if any, which were a direct result of not preparing an EIS for work conducted after 1976. Other

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than the requirement for an EIS, TEXPET's site selection practices were considered in compliance.

Site Preparation

Very few specific industry practices or Ecuadorian laws and regulations pertaining to pipeline construction/ maintenance were established during the period from 1964 to 1990. Industry practices from 1964-1990 established pipeline clearing widths of about 50 to 70 feet. As reported in the field observations section, the average total cleared width, excluding the roadway, was reported to be about 40 feet. Therefore, TEXPET's practices of pipeline clearing widths were in compliance.

Waste Handling

There were no Ecuadorian laws or regulations specific for pipeline waste disposal. Regulations for the Prevention and Control of Environmental Pollution Related to Water Resources (Decree No. 2144, 1989) establishes water quality discharge standards for discharged fluids. Compliance with the 1989 regulations, could not be determined since waste fluid discharges for the time frame of 1964 though 1990 were not documented. Therefore, TEXPET's operations were considered in compliance. Historical spill reports indicate that pipeline spills were covered with soil, burnt or removed with a vacuum truck. No other records of pipeline waste disposal were identified.

Spill Prevention and Control

See discussion under Section 6.4.4, Spill Prevention and Control. Based on the field observations and documentation it would appear that TEXPET's operations were in compliance with the Ecuadorian laws and regulations in place from 1964 though 1989. Compliance with the 1989 regulation for a Spill Prevention and Control Plan could not be assessed. Historical documentation identifies TEXPET's efforts to prevent and control contamination from spills.

None of the spills observed during the 28 miles of pipeline audited could be clearly attributed to TEXPET's practices. The finger print analysis of two crude oil samples collected from other pipeline spills in the Auca area probably occurred during TEXPET's operations. A Spill Report in February, 1990, appears to be a record of the incident located at the intersection to wells Auca 20 and 21. The report indicates that cleanup efforts were undertaken and 45 barrels of the original 50 estimated spilled were recovered. The report also indicates the spill was cleaned up using sorbent pads. A spill located approximately 3.5 kilometers north of Auca Central was

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also older than 2 years based on fingerprint analysis. The probable spill report, dated February, 1990, for this release states that only 4-5 barrels of crude were discharged. The estimated volume of contamination from these two spills is 150 cubic yards.

Site Abandonment and Restoration

There were no Ecuadorian laws or regulations for pipeline abandonment and restoration from 1964-1990. Therefore, TEXPET's practices were considered in compliance. Industry practices recommend that site reclamation be conducted, but no specific requirements are identified. Pipeline removal was observed along Transect No. 18. This indicates TEXPET's operations were conducted in accordance with industry practices.

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Table 6-1. Drilling Activity Summary

Field	YEAR																									
	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
Aguarico			1	1			4	3						1												
Atacapi		1										2	2		1											
Auca				3				12	3			4	1*	1		1								2'	5'	2'
Auca Sur														1					1							
Cononaco						1											1	6	3						4'	1'
Culebra							1														1					
Dureno			1																							
Guanta																				4	5					
Lago Agrio	3	1		17	4		1			2*	1		1		1	3	1		1*	1	1					
Parahuacu		1										3	1													
Rumiyacu																1										
Sacha			3	1	30	14	20	7		8	2	1	2	5	4	2	3		1	4	3	3		3'	4'	4'
Shushufindi			2	2		16	20	12	7		4*				2*		4*		5*	3*		2		2'	5'	2'
Yuca				1									5*	3	1											
Yuca Sur													1													
Yulebra														1					1			1				
Total:	3	3	7	25	34	31	46	34	10	10	7	10	13	12	9	7	9	6	12	12	10	6	0	7	18	9

* Includes redrill of existing well(s)
' Sole risk drilled by PETROAMAZONAS
Note: Well Count through June 6, 1992

Fugro McClelland

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Table 6-2. Well Site History Summary

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
AGUARICO						
AG-2	07/17/70	---	01/13/90	---	SP	C 12/31/87 SI 05/16/90
AG-4	06/25/74	---	09/01/86	---	GL	SI 05/01/84 TAB 09/01/86
AG-6	03/02/74	---	01/30/82	---	---	SI 08/03/86
AG-8	08/29/73	---	07/07/84	---	SP GL	C 04/08/81 C 07/07/84 SI 10/24/83
AG-10	01/20/80	---	04/17/91	---	GL	C 08/29/84
ATACAPI						
AT-2	05/27/78	---	11/23/91	---	SP HL	C 04/16/90 C 11/23/91
AT-4	03/05/79	---	08/08/91	---	SP HL	C 02/06/84 C 07/03/91
AT-6	11/01/81	---	---	---	---	AB 11/25/81
AUCA						
AU-2	08/03/70					
AU-4	12/22/73	---	12/24/90	---	SP	C 04/12/86
AU-6	02/24/74	---	08/28/91	---	HL SP	C 11/10/86 C 12/21/85
AU-8	04/10/74	---	01/23/92	---	SP	C 11/25/84
AU-10	11/01/74	---	01/01/87	---	HL SP	C 01/01/87 C 08/23/85
AU-12	06/08/74	---	03/08/90	---	HL	C 05/04/79
AU-14	08/28/74	---	10/03/90	---	HL	C 04/03/79

AB Abandoned
C Converted
GL Gas Lift
HL Hydraulic Pump
INJ Injector
NF Natural Flow
SI Shut In
SP Submersible Pump
TAB Temporarily Abandoned

CONFIDENTIAL
PET 039712

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068459

CA1068459

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
AUCA (continued)						
AU-16	11/03/74	---	09/27/90	06/21/89	HL	---
AU-18	12/16/74	---	01/11/89	---	HL	---
AU-19	09/25/78	---	---	---	---	AB 09/25/78
AU-19B	03/20/79	---	06/29/91	---	HL	---
AU-21	02/23/75	---	10/22/90	---	HL	C 09/13/78
AU-23	08/21/78	---	---	---	---	AB 09/16/78
AU-25	07/31/90	09/18/90	None	---	---	---
AUCA SUR						
AUS-1	11/30/80	01/09/81	---	---	HL	C 01/09/81
AUS-2	06/15/85	07/14/85	03/04/92	---	---	---
CONONACO						
CO-1	10/26/72	---	09/30/84	---	NF	---
CO-3	02/15/84	---	None	---	NF	---
CO-5	Not Drilled					
CO-7	03/31/84	---	None	---	NF	---
CO-9	09/05/84	---	01/31/87	10/14/84	NF	---
CO-11	01/11/85	---	None	---	NF	---
CULEBRA						
CUL-2	08/17/87	---	05/22/91	---	SP	
GUANTA						
GU-1	12/16/85	02/11/86	11/27/88	11/17/89	SP	C 11/28/87
GU-3	09/19/86	10/10/86	10/14/90	---	SP	C 08/20/88

AB	Abandoned	INJ	Injector
C	Converted	NF	Natural Flow
GL	Gas Lift	SI	Shut In
HL	Hydraulic Pump	SP	Submersible Pump
		TAB	Temporarily Abandoned

CONFIDENTIAL
PET 039713

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068460

CA1068460

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
			GUANTA (continued)			
GU-5	01/06/87	02/10/87	None			
GU-7	03/20/87	04/27/87	09/22/90	03/26/91	SP	C 02/24/90 SI 06/12/91
GU-9	10/30/87	12/03/87	04/29/90			
			LAGO AGRIO			
LA-1	02/16/67	04/08/67	01/10/90	12/31/89	HL	C 01/14/74
LA-3	10/19/86	10/29/67	08/15/91	---	SP	C 12/14/81
LA-5	02/06/70	04/09/70	07/21/81	---	---	SI 11/25/75
LA-7	01/30/70	03/17/70	03/08/81	---	---	AB 08/02/81
LA-9B	02/22/76	06/21/76	02/13/88	06/20/88	SP	C 10/15/83 SI 06/18/88
LA-11B	04/13/76	06/10/76	11/15/91	10/08/90	SP	C 10/20/84
LA-13	08/07/70	09/09/70	11/28/91	02/03/91	SP HL	C 06/30/82 C 03/18/87
LA-15	07/09/70	08/05/70	03/21/91	03/19/88	SP	C 11/25/78 SI 03/21/91
LA-17	09/14/70	10/12/70	07/19/91	12/13/88	SP HL	C 02/27/83 C 06/14/86
LA-19	11/02/70	12/03/70	12/09/80	---	---	SI 12/01/73 AB 11/09/80
LA-21	10/16/70	11/15/70	01/30/91	08/31/90	SP HL	C 06/26/81 C 06/20/90
LA-23	01/10/71	02/25/71	07/24/91	03/15/90	SP	C 05/18/84
LA-25	02/03/71	03/02/71	07/20/85	08/13/84	SP	C 09/28/79 SI 08/28/84

AB Abandoned
C Converted
GL Gas Lift
HL Hydraulic Pump
INJ Injector
NF Natural Flow
SI Shut In
SP Submersible Pump
TAB Temporarily Abandoned

CONFIDENTIAL
PET 039714

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068461

CA1068461

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
LAGO AGRIO (continued)						
LA-27	07/15/77	09/03/77	07/16/91	10/02/90	SP	C 05/10/88
LA-29	---	09/29/81	02/14/91	02/03/91		
LA-31	02/15/82	03/17/82	09/26/90	05/18/83	SP	09/21/82 SI 12/13/86
LA-33	07/17/82	08/10/82	---	07/20/83		
LA-34	08/11/86	09/16/86	10/20/91	03/10/92	SP	C 08/27/87
LA-35	10/04/87	01/05/88	01/03/92	11/08/88		SI 10/30/88
PARAHUACU						
PA-1	10/04/68	09/18/68	10/10/91	01/23/92	SP	C 09/27/87
PA-3	07/24/78	09/01/78	02/03/86	01/06/86	SP	C 11/08/80 SI 01/11/86
PA-5	07/24/79	10/25/79	11/22/91	09/18/91	SP HL	C 11/17/83 C 09/12/86
SACHA						
SA-2	07/21/69	08/31/69	06/06/85	09/25/90	SP	C 08/03/79
SA-4	05/14/70	06/12/70	02/16/86	---	SP ---	C 03/11/81 AB 02/16/86
SA-6	04/23/71	05/17/71	02/22/91	---	SP HL	C 11/08/80 C 04/29/83
SA-8	03/19/71	03/27/72	01/13/83	---	HL	C 01/13/83
SA-10	05/23/71	04/12/72	09/18/90	11/25/86	HL	C 06/20/84
SA-12	04/28/71	06/03/71	11/02/86	05/21/91	HL	C 03/05/83
SA-14	05/27/71	06/29/71	09/06/90	11/02/91	HL	C 08/08/84
SA-16	06/23/71	07/17/71	04/04/91	08/29/91	HL	C 07/20/83
SA-18	07/09/71	08/14/71	04/14/91	08/29/91	HL	C 06/13/80

AB	Abandoned	INJ	Injector
C	Converted	NF	Natural Flow
GL	Gas Lift	SI	Shut In
HL	Hydraulic Pump	SP	Submersible Pump
		TAB	Temporarily Abandoned

CONFIDENTIAL
PET 039715

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068462

CA1068462

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
SACHA (continued)						
SA-20	07/02/71	07/26/71	09/19/91	05/03/92	HL	C 07/19/85
SA-22	08/25/71	03/14/72	03/06/92	11/10/87	HL	C 03/13/74
SA-24	09/17/71	10/12/71	11/17/86	01/18/86	HL	C 07/29/84
SA-26	11/11/71	04/20/72	05/25/90	07/06/85	HL	C 12/26/78
SA-28	12/08/71	04/13/72	08/26/90	04/24/86	HL	C 12/10/86
SA-30	10/12/71	04/04/72	07/09/90	07/18/89	HL	C 02/22/80
SA-32	12/15/71	05/11/72	10/21/91	10/22/91	SP	C 08/30/79
SA-34	12/04/71	02/27/72	04/22/87	09/17/87	HL	C 05/25/83
SA-36	12/28/71	03/24/72	06/29/91	05/21/90	HL	C 09/05/80
SA-38	02/05/72	06/16/72	3/21/89	08/19/89	SP	C 11/26/86
SA-40	02/06/72	03/03/72	06/14/89	---	HL	C 05/27/80
SA-42	03/14/72	04/26/72	07/09/89	02/18/90	HL	C 05/28/86
SA-44	04/05/72	06/10/72	02/12/92	05/27/90	SP	C 09/16/85
SA-46	06/16/72	08/15/72	12/10/91	07/30/91	HL	C 02/18/87
SA-48 (WIW-1)	06/17/72	08/07/72	06/02/86	11/11/85	HL INJ	C 09/16/80 C 06/02/86
SA-50	02/21/73	03/20/73	03/07/81	09/13/80	HL	C 09/16/80
SA-52	03/23/73	04/21/73	02/09/92	01/21/92	SP	C 12/11/79
SA-54	05/11/73	12/14/73	10/31/87	---	HL	C 07/14/80 SI 09/29/85
SA-56	05/19/73	06/22/73	12/17/90	07/16/86	SP	C 09/19/82
SA-58	05/27/73	10/31/73	04/25/91	10/31/89	SP	C 09/09/79
SA-60	07/01/73	09/03/73	12/10/89	02/15/86	HL	C 04/23/83
SA-62	09/17/73	11/01/73	05/17/91	---	---	SI 06/22/91

AB Abandoned
C Converted
GL Gas Lift
HL Hydraulic Pump
INJ Injector
NF Natural Flow
SI Shut In
SP Submersible Pump
TAB Temporarily Abandoned

CONFIDENTIAL
PET 039716

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378
CA1068463

CA1068463

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
SACHA (continued)						
SA-64	08/19/73	09/17/73	09/26/90	11/29/89	HL	C 06/23/80
SA-66	07/19/73	08/24/73	03/12/87	---	SP	C 04/18/81 AB 03/12/87
SA-68	11/29/73	01/08/74	11/22/90	---	HL	C 03/04/90
SA-70	01/17/74	02/12/74	04/28/90	01/16/90	HL	C 02/06/85
SA-72	03/18/74	04/26/74	01/14/89	1987	HL	C 03/06/79
SA-74	05/03/74	06/09/74	10/17/90	06/19/91	HL	C 05/23/83
SA-76 (WIW-3)	01/27/77	02/21/77	11/13/86	---	INJ	TAB 12/11/79 C 11/03/86
SA-78	07/07/76	08/26/76	12/28/91	04/19/92	HL	C 06/05/90
SA-80	08/01/76	09/09/76	01/25/90	11/20/91	HL	C 12/17/78
SA-82	09/21/76	---	07/25/88	09/05/91	HL	C 02/25/81
SA-84	12/08/76	12/25/76	08/18/91	---	HL	C 07/30/91
SA-86	10/31/79	12/21/79	03/29/87	09/15/91	HL	---
SA-88	07/03/80	07/23/80	04/29/91	---	HL	C 04/20/86
SA-90 (WIW-6)	06/08/79	---	09/19/86	11/18/85	HL INJ	C 06/09/80 C 09/19/86
SA-92	09/20/80	10/10/80	06/23/90	---	HL	C 09/23/85
SA-94	04/09/81	05/26/81	09/16/86	02/14/90	SP HL	C 08/30/82 C 09/16/86 SI 10/14/86
SA-96	08/03/81	08/25/81	10/20/86	01/19/91	HL	C 06/02/84
SA-98	12/07/81	01/10/82	10/11/88	1985	HL-	C 11/14/85
SA-100	03/07/83	04/01/83	02/17/92	---	HL	C 06/23/83
SA-102	04/05/83	04/29/83	08/12/90	04/29/92	HL	C 04/29/83
SA-104	02/14/86	04/02/86	08/11/91	04/15/92	HL	C 04/02/86

AB Abandoned
C Converted
GL Gas Lift
HL Hydraulic Pump
INJ Injector
NF Natural Flow
SI Shut In
SP Submersible Pump
TAB Temporarily Abandoned

CONFIDENTIAL
PET 039717

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068464

CA1068464

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
SACHA (continued)						
SA-106	04/21/86	06/14/86	None	04/02/91	HL	C 06/14/86
SA-108	06/05/87	06/30/87	None	---	HL	C 06/30/87
SA-110	10/01/87	---	08/22/90	---	HL	C 10/01/87
SA-112	05/19/88	04/13/88	None	---	HL	C 04/13/88
SA-123	10/23/91	12/01/91	---	---	---	---
SHUSHUFINDI						
SSF-1	12/04/68	01/11/69	06/14/83	12/01/90	GL	C 07/28/72
SSF-3	01/31/70	---	01/14/82	11/14/88	GL	C 11/10/80
SSF-5	02/12/72	---	11/02/91	---	GL SP	C 02/12/72 C 12/11/90
SSF-7	08/11/72	---	04/28/85	---	GL	C 08/11/72
SSF-9	05/26/72	---	11/15/84	03/20/92	GL	C 02/05/83
SSF-11 (WIW-10)	07/01/72	08/02/72	06/16/87	---	GL INJ	C 02/23/83 C 06/16/87
SSF-13	05/09/72	---	09/12/91	01/06/90	GL HL	C 01/25/75 C 09/12/91
SSF-15	07/19/72	---	04/07/89	09/17/91	GL	C 07/19/72 SI 05/27/90
SSF-17 (WIW-11)	08/12/72	---	06/23/87	---	GL INJ	C 08/12/72 C 06/23/87
SSF-19	03/06/73	---	02/15/79	---	GL	C 03/06/73
SSF-21	01/23/73	---	06/23/91	---	GL SP	C 01/23/73 C 01/22/91
SSF-23	10/20/72	---	05/09/87	10/22/87	GL	C 10/20/72

AB	Abandoned	INJ	Injector
C	Converted	NF	Natural Flow
GL	Gas Lift	SI	Shut In
HL	Hydraulic Pump	SP	Submersible Pump
		TAB	Temporarily Abandoned

CONFIDENTIAL
PET 039718

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068465

CA1068465

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
SHUSHUFINDI (continued)						
SSF-25	02/22/73	03/23/73	04/10/91	---	GL SP HL	C 02/22/73 C 03/09/88 C 04/10/91
SSF-27	06/25/73	---	03/15/90	---	GL SP	SI 09/10/91 C 06/25/73 C 12/07/85
SSF-29	04/28/72	---	07/19/91	---	GL SP	C 04/28/72 C 07/19/91
SSF-31	04/07/73	---	03/24/91	---	GL SP	C 04/07/73 C 01/08/90
SSF-33 (WIW-6)	07/08/73	---	10/31/84	---	GL INJ	C 07/08/73 C 10/31/84
SSF-34	05/27/73	---	09/22/83	---	GL	C 05/27/73 AB 09/22/83
SSF-35	05/26/74	---	11/22/90	---	GL SP	C 05/26/74 C 12/22/84
SSF-37	06/06/73	---	07/17/75	---	---	SI 07/17/75
SSF-39	05/09/74	---	06/24/87	---	GL	C 05/09/74 AB 06/24/87
SSF-41	09/11/73	---	11/28/91	06/09/91	GL SP	C 09/11/73 C 12/04/83
SSF-43	12/18/73	---	08/12/89	---	SP	C 08/28/85
SSF-45	11/17/73	---	03/22/86	05/08/92	GL	C 11/17/73 SI 03/22/86
SSF-47	04/24/74	---	06/05/87	---	GL	C 04/24/74 SI 03/22/86
SSF-49	03/23/74	---	10/06/91	---	GL SP	C 03/23/74 C 08/24/83
SSF-50	08/23/74	---	07/07/85	---	GL	C 08/19/77 SI 02/18/80

AB Abandoned
C Converted
GL Gas Lift
HL Hydraulic Pump
INJ Injector
NF Natural Flow
SI Shut In
SP Submersible Pump
TAB Temporarily Abandoned

CONFIDENTIAL
PET 039719

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068466

CA1068466

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
SHUSHUFINDI (continued)						
SSF-51	08/10/74	---	10/27/91	---	GL SP	C 08/10/74 C 12/31/80
SSF-53	05/04/75	---	04/20/92	---	SP	C 03/08/81
SSF-55	07/25/75	---	03/09/83	---	GL	C 07/25/75 SI 01/01/83
SSF-57	08/24/75	---	07/26/90	---	GL SP	C 08/24/75 C 05/06/83
SSF-59	11/05/75	---	05/01/91	---	GL SP	C 11/05/75 C 05/14/83
SSF-61	10/23/77	11/22/77	12/19/91	---	GL SP	C 11/22/77 C 10/17/91
SSF WIW-1	05/06/83	---	04/10/86	---	INJ	05/06/83
SSF WIW-3	06/30/83	---	---	02/15/86	INJ	06/30/83
SSF-63	06/28/85	08/18/85	None	08/25/90	GL	---
SSF-65	07/29/85	08/19/85	08/21/92	---	GL SP GL	C 08/19/85 C 07/22/90 C 08/19/92
SSF-67	06/21/86	---	08/05/86	11/01/91	GL	C 06/21/86
SSF-69	08/28/88	08/10/88	None	03/16/92	---	---
SSF-70	05/17/90	07/14/90	---	---	GL	---
SSF-71	11/23/90	01/09/91	None	---	GL	---
SSF-73	12/19/90	01/21/91	None	01/05/92	---	---
SSF-75	04/12/91	05/27/91	None	03/12/92	GL	---

AB	Abandoned	INJ	Injector
C	Converted	NF	Natural Flow
GL	Gas Lift	SI	Shut In
HL	Hydraulic Pump	SP	Submersible Pump
		TAB	Temporarily Abandoned

CONFIDENTIAL
PET 039720

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068467

CA1068467

Table 6-2. (Continued)

Well No.	SPUD Date	Completion Date	Last Workover	Last Treatment/ Wireline	Production Method	Remarks
YUCA						
YU-2B	06/16/79	07/25/79	08/30/91	06/13/89	SP	C 04/21/85
YU-4	09/06/79	10/02/79	10/13/91	01/10/90	SP	C 08/10/81
YU-5	10/10/79	11/08/79	08/30/86	---	SP	C 11/06/81 SI 08/30/86
YU-6	12/31/79	02/03/80	---	---	---	AB 02/03/80
YU-8				---	---	---
YULEBRA						
YUL-1	05/05/80	06/21/80	03/26/91	12/11/90	---	---
YUL-2	05/01/85	06/07/85	11/18/90	11/11/90	---	---

AB	Abandoned	INJ	Injector
C	Converted	NF	Natural Flow
GL	Gas Lift	SI	Shut In
HL	Hydraulic Pump	SP	Submersible Pump
		TAB	Temporarily Abandoned

CONFIDENTIAL
PET 039721

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068468

CA1068468

Table 6-3. Well Site Audit Summary

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
AGUARICO							
AG-2	43,750	1,000	None	---	1,000	No	---
AG-4	50,000	0	None	---	---	No	---
AG-6	90,000	100	Minor	---	100	No	---
AG-8	60,000	0	Minor	---	---	No	---
AG-10	75,000	100	None	100	---	Yes	Minor
ATACAPI							
AT-2	87,500	100	Minor	100	---	Yes	None
AT-4	56,250	0	Minor	---	---	Yes	Minor
AT-6	Site not located or too overgrown to identify						
AUCA							
AU-2	48,125	300	Minor	---	300	Yes	Minor
AU-4	70,000	2,300	Minor	1,150	1,150	No	---
AU-6	52,500	3,750	Moderate	3,750	---	No	---
AU-8	65,000	23,125†	Minor	12,500	10,625	No	---
AU-10	70,000	1,600	Minor	---	1,600	No	---
AU-12	50,000	2,500	None	2,500	---	No	---
AU-14	60,000	5,000	None	---	5,000	No	---
AU-16	60,000	1,850	Minor	---	1,850	No	---
AU-18	60,000	2,925	Minor	2,925	---	No	---
AU-19B	18,750	3,250†	Major	750	2,500	No	---
AU-21	67,500	375	None	---	375	No	---
AU-23	40,000	0	None	---	---	No	---
AU-25	60,000	1,800	None	1,800	---	No	---
AUCA SUR							
AUS-1	120,000	18,450	None	18,450	---	Yes	Minor

CONFIDENTIAL
PET 039722

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068469

CA1068469

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
CONONACO							
CO-1	37,500	3,750	Minor	3,750	---	No	---
CO-3	67,500	0	None	---	---	No	---
CO-5	Site not located or too overgrown to identify						
CO-7	110,000	400	None	---	---	No	---
CO-9	120,000	1,800	Minor	1,750	50	No	---
CO-11	70,000	300	None	---	---	No	---
CULEBRA							
CUL-2	73,125	400	None	---	---	No	---
GUANTA							
GU-1	112,500	0	None	---	---	Yes	Minor
GU-3	65,625	3,750	Minor	---	3,750	Yes	Minor
GU-5	52,500	8,000	Minor	8,000	---	Yes	None
GU-7	87,500	5,100	Minor	1,100	4,000	No	---
GU-9	70,000	11,525	None	11,250	275	Yes	None
LAGO AGRIO							
LA-1	90,000	200	None	---	---	No	---
LA-3	70,000	300	None	---	300	No	---
LA-4	40,000	0	None	---	---	No	---
LA-5	12,500	225	None	---	225	No	---
LA-7	---	0	None	---	---	No	---
LA-9	50,000	900	None	---	900	No	---
LA-11	60,000	0	None	---	---	No	---
LA-13	40,000	130	None	100	30	No	---
LA-15	31,225	825	None	---	825	No	---
LA-17	80,000	150	None	---	---	No	---
LA-19	50,000	0	Minor	---	---	No	---

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CA1068470

CA1068470

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
LAGO AGRIO (continued)							
LA-21	45,000	15,000	None	10,000	5,000	No	---
LA-23	75,000	10,000	None	---	10,000	No	---
LA-25	60,000	10,000	Minor	10,000	---	No	---
LA-29	45,000	1,700	None	---	---	No	---
LA-31	87,500	1,400	None	---	---	No	---
LA-33	60,000	200	None	---	---	No	---
LA-34	73,125	2,500	None	---	2,500	No	Minor
LA-35	65,000	1,000	None	---	---	No	---
PARAHUACU							
PA-1	75,000	300	None	100	200	Yes	None
PA-3	60,000	0	None	---	---	No	---
PA-5	50,000	300	Minor	200	100	No	---
SACHA							
SA-2	26,900	0	Minor	---	---	Yes	None
SA-4	---	150	None	---	150	No	---
SA-6	80,000	1,750	None	1,750	---	No	---
SA-8	52,500	625	None	---	625	No	---
SA-10	77,500	865	Minor	---	---	No	---
SA-12	61,250	1,200	None	---	---	No	---
SA-14	37,500	7,600	Minor	4,600	---	No	---
SA-16	45,000	7,000	Minor	---	---	No	---
SA-18	75,320	2,950	None	---	---	No	---
SA-20	62,500	9,500	None	9,500	---	No	---
SA-22	70,000	3,000	Minor	---	---	No	---
SA-24	47,500	3,125	None	100	3,025	No	---
SA-26	51,670	7,550	None	---	7,550	No	---
SA-28	52,500	1,550	None	50	1,500	No	---

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CA1068471

CA1068471

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
SACHA (continued)							
SA-30	75,320	2,530	None	---	---	No	---
SA-32	51,648	850	Minor	---	---	Yes	Minor
SA-34	60,000	1,125	Minor	---	---	No	---
SA-36	87,500	3,475	None	2,900	575	Yes	Minor
SA-38	64,560	1,500	None	---	---	No	---
SA-40	87,500	5,450	Minor	1,250	4,200	No	---
SA-42	54,986	3,600	None	---	3,600	No	---
SA-44	90,000	7,000	Minor	7,000	---	Yes	Minor
SA-46	57,566	10,150	Minor	1,750	8,400	No	---
SA-48 (WIW-1)	45,000	0	None	---	---	No	---
SA-50	46,250	3,725	Minor	2,175	1,600	No	---
SA-52	56,000	5,000	Minor	5,000	---	Yes	Minor
SA-54	37,675	1,200	Moderate	---	---	No	---
SA-56	84,375	400	None	---	---	No	---
SA-58	67,725	400	Minor	---	---	Yes	Minor
SA-60	62,500	875	Minor	---	---	No	---
SA-62	31,250	1,250	None	---	---	No	---
SA-64	61,250	7,000	None	400	6,600	No	---
SA-66	88,000	100	Minor	100	---	No	---
SA-68	93,750	5,000	None	1,000	4,000	No	---
SA-70	45,000	725	Minor	---	725	No	---
SA-72	90,300	100	None	100	---	No	---
SA-74	72,500	2,500	None	---	2,500	No	---
SA-76 WIW-3	90,000	0	None	---	---	No	---
SA-78	18,375	170	Minor	---	---	No	---
SA-80	34,357	9,400	Minor	400	9,000	No	---

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PET 039725

CONFIDENTIAL TREATMENT REQUESTED
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CA1068472

CA1068472

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
SACHA (continued)							
SA-82	12,360	3,235	Minor	3,235	---	No	---
SA-84	45,000	7,000	Minor	7,000	---	No	---
SA-86	67,000	4,500	None	---	4,500	No	---
SA-88	54,000	5,625	Minor	---	5,625	No	---
SA-90 WIW-6	52,500	1,200	None	---	1,200	No	---
SA-92	49,000	2,250	Minor	---	2,250	No	---
SA-94	45,000	9,000	Minor	---	9,000	No	---
SA-96	57,600	1,400	None	---	---	No	---
SA-98	93,600	450	Minor	---	---	No	---
SA-100	65,300	4,600	Minor	4,600	---	No	---
SA-102	56,875	6,600	Minor	330	6,270	No	---
SA-104	61,250	1,000	Minor	---	---	NN	---
SA-106	48,750	1,670	Minor	---	---	No	---
SA-108	70,000	1,300	None	---	---	No	---
SA-110	54,000	1,050	Minor	---	---	No	---
SA-112	21,000	9,000	None	---	9,000	No	---
SA-123	90,000	11,200	Minor	11,200	---	No	---
SHUSHUFINDI							
SSF-1	72,500	50	None	50	---	No	---
SSF H_2O Injector 1	90,000	530	Minor	---	---	No	---
SSF H_2O Injector 3	90,000	0	None	---	---	No	---
SSF-3	60,000	420	Minor	420	---	No	---
SSF-5	180,000	10,000	Minor	10,000	---	Yes	Minor
SSF-7	52,500	900	None	---	900	No	---
SSF-9	37,500	2,075	Minor	1,500	575	No	---

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CA1068473

CA1068473

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical Present	Chemical Contamination
SHUSHUFINDI (continued)							
SSF-11 WIW-10	80,000	600	Minor	---	---	No	---
SSF-13	133,200	2,400	Moderate	300	2,100	Yes	Minor
SSF-15	55,925	300	Moderate	300	---	No	---
SSF-17 WIW-11	37,500	0	Minor	---	---	No	---
SSF-19	87,000	350	Minor	350	---	No	---
SSF-21	94,100	450	Minor	---	450	No	---
SSF-23	54,250	350	Minor	200	150	No	---
SSF-25	40,200	820	Minor	---	---	No	---
SSF-27	83,800	2,500	Minor	600	1,900	No	---
SSF-29	75,000	2,650	Some	---	---	Yes	Minor
SSF-31	93,750	1,000	Minor	1,000	---	Yes	Minor
SSF-33 WIW-6	79,950	1,400	None	1,400	---	No	---
SSF-34	16,000	0	Minor	---	---	No	---
SSF-35	104,600	175	Minor	---	175	No	---
SSF-37	52,500	1,475	Minor	---	---	No	---
SSF-39	168,750	0	Minor	---	---	No	---
SSF-41	71,700	1,000	Minor	600	400	No	---
SSF-43	90,000	27,375	None	2,375	25,000	No	---
SSF-45	81,300	1,385	Minor	1,385	---	Yes	None
SSF-47	17,500	2,050	None	---	2,050	No	---
SSF-49	82,500	0	None	---	---	No	---
SSF-50	56,250	2,000	Minor	---	---	No	---
SSF-51	72,500	1,400	Minor	1,000	400	No	---
SSF-53	65,625	1,200	Minor	1,000	200	Yes	None
SSF-55	135,000	1,200	Minor	---	---	No	---
SSF-57	78,750	1,000	Minor	1,000	---	Yes	Minor

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CONFIDENTIAL TREATMENT REQUESTED
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CA1068474

CA1068474

Table 6-3. (Continued)

Well No.	Pad Size (ft²)	Contamination (ft²)	Refuse	FS SG-DEG (ft²)	DEG HV-DEG (ft²)	Chemical	
						Present	Contamination
SHUSHUFINDI (continued)							
SSF-59	52,300	600	Minor	---	600	Yes	Moderate
SSF-61	87,500	5,000	Minor	5,000	---	Yes	Minor
SSF-63	87,500	450	Minor	225	225	No	---
SSF-65	60,000	525	Minor	525	---	Yes	Minor
SSF-67	87,500	1,500	Minor	---	---	Yes	None
SSF-69	45,000	8,750†	Minor	8,750	---	Yes	Minor
SSF-71	180,000	3,625	Minor	3,625	---	No	---
SSF-73	116,775	2,000	Minor	---	2,000	Yes	None
SSF-75	115,500	1,000	Minor	---	---	No	---
YUCA							
YU-2B	135,000	3,875	None	3,200	675	Yes	Minor
YU-4	82,500	1,900	Minor	---	---	No	---
YU-5	61,250	300	None	---	300	No	---
YU-6	41,250	0	Minor	---	---	No	---
YU-8	Site not located or too overgrown to locate						
YUCA SUR							
YUS-1	100,000	200	Minor	200	---	Yes	Minor
YULEBRA							
YUL-2	80,000	3,500	Minor	3,500	---	Yes	None

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CA1068475

CA1068475

Table 6-4. Well Site Pit Summary

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
			AGUARICO		
AG-2	50 x 80 50 x 50	70 100	DEG DEG	January 1990	SI, May 1990 Pits recently burnt
AG-4	100 x 50	100	DEG	September 1986	SI, August 1984 Pit recently burnt
AG-6	No Pit	---	---	January 1982	Pits recently closed, seeping oil
AG-8	35 x 35 75 x 75	100 90	DEG DEG	July 1984	SI, October 1983
AG-10	75 x 175 40 x 40 60 x 80	100 100 30	SL DEG SL DEG HV DEG	April 1991	--- --- Contains water
			ATACAPI		
AT-2	60 x 250 50 x 50 50 x 50 25 x 30 30 x 100	30 30 30 100 0	SH SH SH SH ---	November 1991	--- Recently burnt Recently burnt --- Contains water
AT-4	80 x 80	100	SH	---	---
			AUCA		
AU-2	40 x 50	0	---	---	Contains water
AU-4	20 x 20	95	FS	---	Two pits recently closed
AU-6	50 x 50	100	DEG	---	---
AU-8	No Pit	---	---	---	---
AU-10	No Pit	---	---	---	---
AU-12	50 x 75	---	---	---	Pit recently closed, seeping oil

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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CA1068476

CA1068476

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
			AUCA (continued)		
AU-14	40 x 60 10 x 10	50 100	DEG FS	---	Pit recently excavated
AU-16	No Pit	---	---	---	---
AU-18	No Pit	---	---	---	---
AU-19	30 x 30 20 x 20 10 x 10	75 5 75	DEG SH SH	---	--- --- ---
AU-21	40 x 40	60	DEG	---	---
AU-23	50 x 50	0	---	---	Contains water Pit recently closed.
AU-25	300 x200	60	SL DEG	---	Pit recently burnt
			AUCA SUR		
AUS-1	50 x 50 30 x 30 20 x 20	60	DEG	---	Pit recently closed, seeping oil Two pits under construction (two oil production (100 x 100)
			CONONACO		
CO-1	40 x 35 20 X 30	100 Dry	FS ---	09/30/84	---
CO-3	50 x 50	0	---	None	Contains water
CO-5	---	---	---	---	Not drilled
CO-7	No Pit	---	---	None	---
CO-9	80 x 30 80 x 60	1 90	SH FS	01/31/87	Contains water
CO-11	No Pit	---	---	None	---
			CULEBRA		
CUL-2	100 x 100	20	DEG	05/22/91	Pit recently burnt

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039730

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CA1068477

CA1068477

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
GUANTA					
GU-1	150 x 75	100	DEG	October 1988	---
GU-3	75 x 75	100	FS	October 1990	---
GU-5	100 x 100 45 x 65	100 Dry	DEG ---	February 1987	--- ---
GU-7	120 x 180 21 x 33	100 100	FS FS	March 1991	Crude oil sample SI, June 1991
GU-9	80 x 80 15 x 45	100 90	FS FS	April 1990	---
LAGO AGRIO					
LA-1	No Pit	---	---	January 1990	---
LA-3	No Pit	---	---	August 1991	Pit recently closed, seeping oil
LA-4	No Pit	---	---	--- ---	---
LA-5	40 x 40 30 x 30	100 0	DEG	July 1981	Crude oil sample. Contains water
LA-7	No Pit	---	---	August 1981	---
LA-9	No Pit	---	---	February 1988	---
LA-11	30 x 30	80	DEG	November 1991	Pit recently closed
LA-13	No Pit	---	---	November 1991	---
LA-15	No Pit	---	---	---	---
LA-17	No Pit	---	---	July 1991	Pit recently closed, seeping oil
LA-19	30 x 30 40 x 60	0 0	--- ---	November 1980	Contains water Contains water

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039731

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CA1068478

CA1068478

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
LAGO AGRIO (continued)					
LA-21	40 x 40	0	---	January 1991	Contains water
LA-23	No Pit	---	---	July 1991	Pit recently closed
LA-25	No Pit	---	---	July 1985	---
LA-29	100 x 50	2	---	February 1991	---
LA-31	No Pit	---	---	September 1990	SI, December 1986
LA-33	No Pit	---	---	August 1982	---
LA-34	No Pit	---	---	October 1991	---
LA-35	No Pit	---	---	January 1992	SI, October 1988
PARAHUACU					
PA-1	45 x 15	100	SL DEG	October 1991	Pit recently closed
PA-3	80 x 125	100	DEG	February 1986	SI, January 1986
PA-5	35 x 35	100	FS	November 1991	Recently burnt
SACHA					
SA-2	30 x 20	90	DEG	June 1985	---
SA-4	No Pit	---	---	February 1986	AB, February 1986
SA-6	40 x 40	100	DEG	February 1991	---
SA-8	No Pit	---	---	January 1983	---
SA-10	30 x 40	100	DEG	September 1990	---
SA-12	50 x 50	100	FS	November 1986	---

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039732

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SDNY - 04 CIV 8378

CA1068479

CA1068479

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SACHA (continued)					
SA-14	66 x 66	100	SL DEG	September 1990	---
SA-16	No Pit	---	---	April 1991	---
SA-18	50 x 30	50	DEG	April 1991	---
SA-20	40 x 50 10 x 200	100 100	DEG FS	September 1991	--- ---
SA-22	50 x 50	100	FS/SL DEG	March 1992	---
SA-24	60 x 60	100	FS	November 1986	---
SA-26	No Pit	---	---	May 1990	---
SA-28	No Pit	---	---	August 1990	---
SA-30	30 x 30	50	HV DEG	July 1990	---
SA-32	No Pit	---	---	October 1991	---
SA-34	No Pit	---	---	April 1987	---
SA-36	50 x 50	---	FS/SL DEG	June 1991	---
SA-38	40 x 40 60 x 30	100 1	DEG SH	August 1989	--- ---
SA-40	No Pit	---	---	---	---
SA-42	30 x 50	95	SL DEG/DEG	July 1989	---
SA-44	60 x 100	100	DEG	February 1992	---
SA-46	30 x 90 30 x 30	Dry Dry	--- ---	December 1991	--- ---
SA-48 (WIW-1)	No Pit	---	---	June 1986	
SA-50	50 x 50 60 x 60	Dry 0	--- ---	March 1981	Small amount of water and degraded oil Contains water

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039733

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CA1068480

CA1068480

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SACHA (continued)					
SA-52	100 x 75 40 x 40	100 100	FS/SL DEG DEG	February 1992	--- Spill into swamp
SA-54	20 x 40 50 x 50	100 100	DEG DEG	October 1987	__ __
SA-56	No Pit	---	---	December 1990	---
SA-58	45 x 35 100 x 17	100 100	FS SL DEG	April 1991	--- Recently closed pit, seeping oil
SA-60	100 x 100 30 x 30	100 100	SL DEG/DEG HV DEG	December 1989	---
SA-62	No Pit	---	---	May 1991	---
SA-64	20 x 60	80	DEG	September 1990	---
SA-66	30 x 40	100	HV DEG	March 1986	---
SA-68	50 x 50	10	---	November 1990	Pit almost empty
SA-70	No Pit	---	FS	---	---
SA-72	120 x 60	---	DEG	January 1989	---
SA-74	130 x 150 40 x 40	100 100	SL DEG/DEG DEG	October 1990	--- ---
SA-76 (WIW-3)	120 x 275 50 x 30	0 1	--- ---	November 1986 ---	Water filled ---
SA-78	100 x 150 40 x 40	100 100	DEG SL DEG	December 1991	--- ---
SA-80	No Pit	---	---	August 1991	---
SA-82	50 x 50	0	---	July 1988	---

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039734

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068481

CA1068481

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SACHA (continued)					
SA-84	150 x 60	80	DEG	August 1991	---
SA-86	50 x 50	80	DEG	March 1987	---
SA-88	175 x 40	75	SL DEG	April 1991	---
SA-90 (WIW-6)	250 x 50 25 x 30	10 100	DEG SH	--- ---	--- ---
SA-92	No Pit	---	---	June 1990	---
SA-94	100 x 100 100 x 300 50 x 50 60 x 60	Dry 100 Dry 100	--- DEG --- DEG	September 1986	---
SA-96	150 x 50	100	HV DEG	August 1986	---
SA-98	220 x 50	80	DEG	October 1988	---
SA-100	150 x 30 30 x 50	90 90	FS DEG	February 1992	--- ---
SA-102	250 x 100	50	DEG	August 1990	---
SA-104	130 X 90	100	FS	August 1991	---
SA-106	262 x 60	75	HV DEG	None	---
SA-108	No Pit	---	---	None	---
SA-110	60 x 100	95	SL DEG	August 1990	---
SA-112	100 x 100	5	---	---	---
SA-123	200 x 200 200 x 70 200 x 70	5 1 1	SH SH SH	---	--- --- ---

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039735

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SDNY - 04 CIV 8378

CA1068482

CA1068482

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SHUSHUFINDI					
SSF-1	45 x 45	100	FS	---	---
(WIW-1)	No Pit	---	---	---	---
(WIW-3)	260 x 180	0	---	---	---
SSF-3	50 x 50	95	SL DEG	November 1988	---
SSF-5	No Pit	---	---	February 1991	---
SSF-7	80 x 50 60 x 60	50 30	DEG DEG	April 1985	--- ---
SSF-9	No Pit	---	---	November 1984	---
SSF-11 (WIW-10)	No Pit	---	---	June 1987	Pit recently closed
SSF-13	60 x 60 160 x 120	100 ---	--- ---	September 1991	--- ---
SSF-15A	40 x 60 75 x 75	0 100	--- SL DEG	April 1989	--- ---
SSF-17	90 x 50 45 x 15 120 x 100	30 100 0	DEG HV DEG ---	June 1987	--- --- ---
SSF-19	No Pit	---	---	February 1979	---
SSF-21	35 x 30	100	DEG	June 1991	---
SSF-23	40 x 30	100	SL DEG	May 1987	---
SSF-25	40 x 30 30 x 30	75 100	SL DEG DEG	April 1991	--- ---
SSF-27	40 x 30 40 x 30	80 20	DEG SH	March 1990	Pit recently closed, seeping fresh oil

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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PET 039736

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068483

CA1068483

Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SHUSHUFINDI (continued)					
SSF-29	55 x 30 60 x 30	100 30	SL DEG DEG	June 1991	--- ---
SSF-31	150 x 75 150 x 250	100 35	SL DEG DEG	May 1991	--- ---
SSF-33 (WIW-6)	No Pit	---	---	February 1984	Pit recently closed
SSF-34	100 x 200	1	SH	September 1983	AB, September 1983
SSF-35	No Pit	---	---	November 1990	Pit recently closed, seeping oil
SSF-37	No Pit	---	---	July 1975	---
SSF-39	100 x 150	0	---	June 1987	AB, June 1987
SSF-41	40 x 70 40 x 50	0 100	--- DEG	November 1991	--- ---
SSF-43	150 x 100	0	---	August 1989	---
SSF-43*	8 x 20 90 x 225	100 1	FL/SL DEG ---	---	--- ---
SSF-45	150 x 100	100	FS	March 1986	---
SSF-47	No Pit	---	---	June 1987	---
SSF-49	100 x 70 40 x 40	100 100	DEG FS/SL DEG	October 1991	--- ---
SSF-50	No Pit	---	---	June 1985	SI, February 1980
SSF-51	30 x 30 60 x 60	100 100	DEG DEG	---	--- ---
SSF-53	40 x 60	100	HV DEG	April 1992	---

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
SHUSHUFINDI (continued)					
SSF-55	No Pit	---	---	March 1983	SI, January 1, 1983 Pit recently closed
SSF-57	200 x 150 40 x 40	100 50	SL DEG DEG	June 1990	--- ---
SSF-59	50 x 40 80 x 60	100 95	FS FS	May 1991	--- ---
SSF-61	225 x 75 40 x 40	85 95	DEG FS	December 1991	--- ---
SSF-63	50 x 150 50 x 50	100 100	FS FS	August 1990	--- ---
SSF-65	No Pit	---	---	February 1992	---
SSF-67	145 x 80	95	FS	November 1991	---
SSF-69	80 X 200 20 x 30	0 100	--- FS	October 1989	---
SSF-71	200 x 120 175 x 100 175 x 40	50 0 0	SL DEG --- ---	January 1991	Date completed Contains water Contains water
SSF-73	175 x 100 90 x 65 82 x 56	100 95 50	--- --- FS	January 1991	Date completed
SSF-75	200 x 120 80 x 70 80 x 50	95 0 0	FS --- ---	May 1991	Date completed

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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Table 6-4. (Continued)

Well No.	Estimated Pit Dimensions (ft)	Percent Oil Cover	Oil Condition	Well Workover History	Remarks
YUCA					
YU-2	100 x 300 30 x 30	100 100	DEG DEG	---	--- ---
YU-4	30 x 50 30 x 30	50 100	--- DEG	---	--- ---
YU-5	50 x 60 50 x 70	100 ---	HV DEG HV DEG	---	--- ---
YU-6	No Pit	---	---	---	---
YUCA SUR					
YUS-1	40 x 40	100	HV DEG	---	---
YULEBRA					
YUL-2	15 x 60	100	SL DEG/DEG	---	---

AB	Abandoned	SH	Sheen
DEG	Degraded	SI	Shut In
FS	Fresh	SL DEG	Slightly Degraded
HV DEG	Heavily Degraded	---	None Noted

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Table 6-5. Munsell and Soil Type Summary

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
		AGUARICO		
AG-2	5YR	5/6	Clay/silt (friable)	
AG-4	5YR	5/6	Clay	
AG-6	7.5YR	4/6	Clay	
AG-8	5YR	4/6	Silt/clay	
AG-10	10YR	3/3	Clay	
		ATACAPI		
AT-2	5YR	4/4	Clay loam	
AT-4	5YR	5/8	Clayey loam	Petroleum staining to 8 inches
		AUCA		
AU-2	5YR	5/6	Clay	
AU-4	2.5YR	5/4	C`.	
AU-6	2.5YR	4/6	Clay	
AU-8	2.5YR 10YR	5/4 7/1	Clay Fine sand/silt	
AU-10	2.5YR	5/6	Clay	
AU-12	5YR	4/4	Silty clay with fine sand	
AU-14	2.5YR	5/4	Clay	
AU-16	5YR	6/2	Clay	
AU-18	2.5YR	5/4	Clay	
AU-19	5YR	5/6	Clay	
AU-21	2.5YR	4/4	Clay	
AU-23	5YR	5/4	Clay	
AU-25	5YR	4/4	Clay	
		AUCA SUR		
AUS-1	5YR	5/6	Clay	
		CONONACO		
CO-1	5YR	5/6	Clay	
CO-3	10YR	4/3	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
CONONACO (continued)				
CO-5	10YR	5/3	Clay with some silt/fine sand	
CO-7	2.5YR	4/6	Clay	
CO-9	5YR	6/4	Clay	
CO-11	2.5YR	5/6	Clay	
CULEBRA				
CU-2	7.5YR	4/6	Clay with bands of sands and gravels	
GUANTA				
GU-1	10YR	5/4	Clay	
GU-3	10YR	5/4	Clay loam	
GU-5	5YR	5/6	Sandy clay	
GU-7	10YR	4/3	Clay loam	
GU-9	10YR	3/4	Clay loam	
LAGO AGRIO				
LA-1	10YR	2/2	Sandy loam	
LA-3	10YR	3/3	Sandy loam	
LA-4	10YR	2/2	Loamy sand	
LA-5	10YR	4/4	Loam	
LA-7	10YR	3/3	Loam	
LA-9	10YR	5/6	Clay	
LA-11*	5YR	4/6	Clayey loam	* Re-audit
LA-13	10YR	2/2	Clay	
LA-15	10YR	4/4	Clay loam	
LA-17	10YR	3/3	Clay	
LA-19	10YR	4/4	Clay loam	
LA-21	2.5YR	4/6	Clay loam	
LA-23	10YR	3/2	Sand	
LA-25	5YR	5/6	Clay	
LA-29	10YR	3/3	Silty sand	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
		LAGO AGRIO (continued)		
LA-31	10YR	3/2	Clay with silt	
LA-33	7.5YR	3/4	Clay/slight silt	
LA-34	5YR	4/4	Clay loam	
LA-35	5YR with mottles 5YR	5/4 6/1	Clay	
		PARAHUACU		
PA-1	5YR	4/4	Clay loam	
PA-3	5YR	5/6	Clay loam	
PA-5	2.5YR	5/4	Clay loam	
		SACHA		
SA-2	5YR	3/2	Silt/clay	
SA-4	10YR	4/3	Loam	
SA-6	7.5YR	3/2	Clay	
SA-8	10YR	4/4	Clay loam	
SA-10	7.5YR	3/2	Loamy clay	
SA-12	10YR	3/4	Silt/clay	
SA-14	10YR	3/3	Sandy loam	
SA-16	7.5YR	3/2	Clay	
SA-18	7.5YR	3/2	Clay	
SA-20	10YR	3/4	Silty clay loam	
SA-22	7.5YR	3/2	Clay	
SA-24	10YR	3/3	Loamy clay	
SA-26	10YR	4/4	Clay/loam	
SA-28	7.5YR	5/4	Clay	
SA-30	No data		---	
SA-32	10YR	3/3	Loamy clay	
SA-34	10YR	3/3	Loam	
SA-36	10YR	5/4	Silty loam	
SA-38	10YR	3/2	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
SACHA (continued)				
SA-40	5YR	5/6	Clay	
SA-42	10YR	4/3	Loamy organic	
SA-44	No data		---	
SA-46	10YR	3/2	Loamy organic	
SA-48	10YR	4/4	Clayey loam	
SA-50	10YR	3/2	Clayey loam	
SA-52	10YR	4/4	Clay	
SA-54	7.5YR	3/2	Clay	
SA-56	No data		---	
SA-58	5YR	4/3	Clay	
SA-60	7.5YR	3/5	Loamy clay	
SA-62	10YR	3/3	Silty loam	
SA-64	5YR	5/3	Clay	
SA-66	10YR	3/2	Loamy clay	
SA-68	5YR	3/2	Silt/clay/organic	
SA-70	10YR	4/4	Clay loam	
SA-72	10YR	3/2	Clay	
SA-74	7.5YR	3/2	Clay	
SA-76	10YR	3/3	Clay/loam	
SA-78	7.5YR	3/2	Clay	
SA-80	10YR	3/3	Loamy organic	
SA-82	7.5YR	3/2	Loamy clay	
SA-84	10YR	3/3	Loamy organic	
SA-86	10YR	5/4	Clay	
SA-88	5YR	3/2	Loamy clay	
SA-90 WIW-6	7.5YR	3/2	Heavy silty clay	
SA-92	10YR	5/4	Clay	
SA-94	10YR	5/1	Silty clay loam	
SA-96	10YR 7.5YR	3/2 3/2	Fine silty clay Fine silty clay	16-inch depth

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
		SACHA (continued)		
SA-98	10YR	4/4	Clay	
SA-100	2.5YR	3/2	Silt/clay/organic	
SA-102	10YR	3/3	Clay	
SA-104	10YR	4/4	Clay/silt	
SA-106	10YR	5/3	Clay	
SA-108	5YR	5/6	Clay	
SA-110	5YR	3/2	Silt/clay/organic	
SA-112	2.5YR	5/8	Clay/some fine sand/silt	
SA-123	5YR	4/3	Clay	
		SHUSHUFINDI		
SSF-1	5YR	5/6	Clay	
SSF-1	7.5YR	3/2	Loam	Water Injector
SSF-3	7.5YR	3/4	Loamy clay	Water Injector
SSF-83	10YR	3/4	Clay	
SSF-5	2.5Y	4/2	Clay	
SSF-6	7.5YR	3/4	Clay	
SSF-7	10YR	4/3	Clay	
SSF-9	7.5YR	3/2	Loamy clay	
SSF-10	7.5YR	3/4	Loamy clay	Water Injector
SSF-13	2.5YR 7.5YR	5/6 8/0	Clay Silt	
SSF-15	5YR	5/6	Clay	
SSF-17	7.5YR	5/4	Clay	
SSF-19	5YR	5/8	Clay	
SSF-21	10YR	4/4	Clay	
SSF-23	7.5YR	3/4	Loamy clay	
SSF-25	10YR	3/4	Loamy clay	
SSF-27	10YR	3/2	Clay	
SSF-29	7.5YR	3/2	Loamy clay	
SSF-34	7.5YR	3/4	Loamy clay	

5 YR - Hue   5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
SHUSHUFINDI (continued)				
SSF-35	7.5YR	3/2	Loam	
SSF-37	7.5YR	5/6	Clay	
SSF-39	10YR	3/3	Loam	
SSF-41	10YR	3/3	Clay	
SSF-43	10YR	4/4	Loamy	
SSF-43*	10YR	4/4	Loam sand	* Re-audit
SSF-45	7.5YR	3/4	Loamy clay	
SSF-47	7.5YR	3/4	Loamy clay	
SSF-49	10YR	4/4	Clay	
SSF-50	7.5YR	3/2	Loamy clay	
SSF-51	7.5YR	3/4	Clay	
SSF-53	10YR	4/4	Clayey loam	
SSF-53	7.5YR	3/4	Loamy clay	
SSF-57	10YR	3/3	Clay	
SSF-59	5YR	5/6	Clay	
SSF-61	10YR	4/3	Clay	
SSF-63	10YR	5/6	Clay	
SSF-65	N/A		N/A	Within SSF Station
SSF-67	10YR	4/4	Clay	
SSF-69	10YR	3/3	Clay	
SSF-71	7.5YR	3/2	Loamy clay	
SSF-73	10YR	6/6	Clay	
SSF-75	10YR	4/4	Clay	
YUCA				
YU-2B	10YR	4/3	Loamy clay	
YU-4	7.5YR	4/6	Loamy clay	
YU-5	7.5YR	4/6	Loamy clay	
YU-6	10YR	5/4	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Well No.	Munsell Notation		Description	Remarks
	Hue	Color/Chroma		
YUCA SUR				
YUS-1	5YR	5/6	Loamy clay with some sand	
YULEBRA				
YUL-2	5YR	4/6	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Facility Name	Munsel Notation		Description	Remarks
	Hue	Color/Chroma		
PRODUCTION SITES				
Aguarico	7.5YR	4/6	Clay	
Atacapi	7.5YR	4/6	Clay/slight silt	
Auca Central	2.5YR	4/6	Clay	
Auca Sur	5YR	4/4	Clay	
Coca Pipeyard	10YR	3/4	Clay	
Cononaco	10YR	3/3	Clay	
Guanta	10YR	4/3	Clay/loam	
Lago Central	10YR 2.5YR	3/3 3/4	Sandy loam Clay	
Lago North	7.5HR	5/6	Clay/slight silt	
Parahuacu	5YR	4/4	Clay/loam	
Sacha Central	7.5YR	3/4	Clay loam	
Sacha Norte 1	10YR	3/3	Silty clay	
Sacha Norte 2	10YR	4/3	Loam	
Sacha Sur	10YR 2.5YR	4/2 3/4	Loamy clay	Matrix with mottles
SSF Central	10YR	3/4	Clay	
SSF H_2O Injection	7.5YR	4/6	Clay	
SSF Norte	7.5YR	3/2	Clay	
SSF Sur	10YR	3/4	Clay	
SSF Sur Oeste	10YR 7.5YR	3/4 3/2	Clay	
Yuca	5YR	5/6	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-5. (Continued)

Facility Name	Munsel Notation		Description	Remarks
	Hue	Color/Chroma		
BASE CAMPS				
Auca Dentra	2.5YR	4/6	Clay	
Coca	10YR	3/2	Clay	
Lago Agria	10YR	3/2	Sandy loam	
Sacha Central	10YR	3/6	Sandy loam	
SSF Central	7.5YR	3/2	Clay	

5 YR - Hue 5/6 - Color Chroma
Reference: Munsell Soil Color Chart
Note: Soil description based on general field observation

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Table 6-6. Predominant Land Uses, Adjacent to Well Sites

Well No.	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
AGUARICO				
AG-2	---	4	---	---
AG-4	---	4	---	---
AG-6	---	4	---	---
AG-8	---	4	---	---
AG-10	---	---	---	4
ATACAPI				
AT-2	---	3	1	---
AT-4	---	1	1	2
AUCA				
AU-2	---	---	1	3
AU-4	---	---	---	4
AU-6	---	4	---	---
AU-8	---	---	---	4
AU-10	---	---	---	4
AU-12	---	1	1	2
AU-14	---	---	---	4
AU-16	---	4	---	---
AU-18	---	4	---	---
AU-19	---	1	1	2
AU-21	---	4	---	---
AU-23	---	2	1	---
AU-25	---	1	1	2
AUCA SUR				
AUS-1	---	---	---	4
CONONACO				
CO-1	---	4	---	---
CO-3	---	---	---	4
CO-5	Site not located or too overgrown to identify			
CO-7	---	4	---	---

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-6. (Continued)

Well No.	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
		CONONACO (continued)		
CO-9	---	4	---	---
CO-11	---	4	---	---
		CULEBRA		
CUL-2	3	---	---	---
		GUANTA		
GU-1	---	3	1	---
GU-3	---	1	2	1
GU-5	---	2	---	2
GU-7	---	3	1	---
GU-9	---	1	3	---
		LAGO AGRIO		
LA-1	---	---	1	3
LA-3	---	4	---	---
LA-5	---	2	2	---
LA-7	---	1	---	2
LA-9	---	---	2	1
LA-11	---	---	4	---
LA-13	---	---	1	2
LA-15	---	---	---	4
LA-17	---	4	---	---
LA-19	---	---	4	---
LA-21	---	---	3	1
LA-23	---	---	1	3
LA-25	---	3	1	---
LA-27	---	2	1	1
LA-29	---	2	---	2
LA-31	---	2	---	1
LA-33	---	---	---	2
LA-34	---	---	---	4
LA-35	---	---	---	4

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-6. (Continued)

Well No..	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
		PARAHUACU		
PA-3	---	2	---	2
PA-5	---	---	4	---
		SACHA		
SA-2	---	---	2	---
SA-4	---	---	3	1
SA-6	---	3	1	---
SA-8	---	1	3	---
SA-10	---	2	---	2
SA-12	---	1	3	---
SA-14	---	---	4	---
SA-16	---	---	4	---
SA-18	---	---	3	1
SA-20	---	1	---	3
SA-22	---	1	3	---
SA-24	---	---	4	---
SA-26	---	4	---	---
SA-28	4	---	---	---
SA-30	---	---	4	---
SA-32	---	2	1	1
SA-34	---	---	1	3
SA-36	---	1	2	---
SA-38	---	---	4	---
SA-40	1	1	---	1
SA-42	---	4	---	---
SA-44	---	4	---	---
SA-46	---	2	1	1
SA-48	---	---	4	---
SA-50	---	1	3	---
SA-52	---	4	---	---
SA-54	---	2	2	---
SA-56	---	---	4	---
SA-58	---	3	1	---
SA-60	1	---	3	---
SA-62	---	4	---	---

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-6. (Continued)

Well No.	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
SACHA (continued)				
SA-64	---	4	---	---
SA-66	---	1	3	---
SA-68	---	2	2	---
SA-70	---	---	---	4
SA-72	---	1	3	---
SA-74	---	---	---	4
SA-76 WIW-3	---	---	4	---
SA-78	---	---	2	2
SA-80	---	1	---	---
SA-82	---	---	2	---
SA-84	---	4	---	---
SA-86	3	1	---	---
SA-88	---	4	---	---
SA-90 WIW-6	---	4	---	---
SA-92	---	4	---	---
SA-94	---	3	---	1
SA-96	---	4	---	---
SA-98	---	3	---	1
SA-100	---	4	---	---
SA-102	---	2	---	1
SA-104	---	2	---	2
SA-106	---	3	---	1
SA-108	---	4	---	---
SA-110	---	4	---	---
SA-112	---	4	---	---
SA-123	---	3	1	---
SHUSHUFINDI				
SSF-1	---	2	1	---
SSF-Inject 1	---	4	---	---
SSF-3	---	---	---	4

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-6. (Continued)

Well No.	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
SHUSHUFINDI (continued)				
SSF-Inject 3	---	1	2	1
SSF-5	---	1	---	3
SSF-7	---	---	---	4
SSF-9	---	1	1	2
SSF-11 WIW-10	---	---	4	---
SSF-13	---	---	---	4
SSF-15	---	4	---	---
SSF-17 WIW-11	---	1	---	3
SSF-19	---	---	---	4
SSF-21	---	4	---	---
SSF-23	---	3	1	---
SSF-25	---	4	---	---
SSF-27	---	---	---	4
SSF-29	---	4	---	---
SSF-31	---	4	---	---
SSF-33 WIW-6	---	---	4	---
SSF-34	---	4	---	---
SSF-35	---	---	4	---
SSF-37	---	4	---	---
SSF-39	---	1	---	1
SSF-41	---	---	3	1
SSF-43	---	---	1	3
SSF-45	---	2	1	1
SSF-47	---	4	---	---
SSF-49	---	2	1	1
SSF-50	---	2	---	2
SSF-51	---	3	1	---
SSF-53	---	4	---	---
SSF-55	---	---	3	1
SSF-57	---	---	1	3

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-6. (Continued)

Well No..	Primary Forest	Secondary Forest	Cultivated Land	Cleared Land
SHUSHUFINDI (continued)				
SSF-59	---	4	---	---
SSF-61	---	---	4	---
SSF-63	---	2	---	2
SSF-65	---	---	---	4
SSF-67	---	---	---	4
SSF-69	---	1	---	3
SSF-71	---	1	1	1
SSF-73	---	4	---	---
SSF-75	---	1	---	2
YUCA				
YU-2B	---	2	---	2
YU-4	2	---	---	2
YU-5	---	---	---	4
YU-6	4	---	---	---
YUCA SUR				
YUS-1	---	4	---	---
YULEBRA				
YUL-2	---	4	---	---
Total number of quartiles by cover type	18	278	148	173
Percent of total	3	45	24	20

Predominant land use immediately adjacent to individual drill/well sites was based on visual estimates. Each site typically had four sections or quartiles, located N,S,E,&W. Quartiles dominated by surface water or wetlands were not included in the estimate of land use.

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Table 6-7. Analysis of Natural Revegetation at Abandoned Well Site

Well No.	Date Abandoned	Closure Duration Years	Surrounding Cover Type	Present Drill Pad Size (ft)^2
AU-23*	09/78	13.5	Secondary Forest 50% Agricultural 50%	40,000
YU-6	02/80	12.5	Primary Forest 100%	41,250
LA-7	08/81	10.75	Secondary Forest 25% Agricultural 75%	Located at Lago Agrio Camp.
LA-19	11/80	11.5	Secondary Forest 100%	80,000
AT-6	11/81	10.5	Site not located or too overgrown to identify	
SSF-50	06/85	7.0	Secondary Forest 50% Agricultural 50%	56,250
SA-54	09/85	6.75	Secondary Forest 50% Agricultural 50%	37,675
SA-4	02/86	5.75	Located at Sacha Note 2 Production Facility	
SA-66	03/87	4.25	Secondary Forest 25% Agricultural 75%	86,000
SSF-34	06/87	4.0	Secondary Forest 50%	16,000
SSF-39	06/87	4.0	Secondary Forest 50% Agricultural 50%	168,750
YU-8	---	---	Site not located or too overgrown to identify	

* Community Center constructed on well site.

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Table 6-8. Production Facilities Audit Summary

Production Site Name	Crude Tanks	Chemical Storage	Flares	Fuel Storage	Gas Compressor	Heater Treater	Hydraulic Lift	Pits/ Lagoons	Power Generation	Septic Latrine	Shipping Pumps	Water Injection	Water Source
AGUARICO	X		X	X	X	X		X			X		
ATACAPI	X		X	X				X	X		X		
AUCA CENTRAL	X	X	X	X			X	X	X	X	X		
AUCA SUR	X		X	X			X	X	X		X		
CONONACO	X		X	X		X		X	X	X	X		
GUANTA	X		X					X			X		X
LAGO AGRIO CENTRAL	X	X	X	X		X		X	X		X		
LAGO AGRIO NORTE	X		X		X	X		X			X		X
PARAHUACU	X		X	X				X	X		X		X
SACHA CENTRAL	X	X	X	X		X	X	X	X	X	X		
SACHA NORTE 1	X	X	X	X		X	X	X	X	X	X	X	
SACHA NORTE 2	X		X	X		X		X			X		
SACHA SUR	X		X	X		X		X	X		X		
SHUSHUFINDI CENTRAL	X	X	X	X	X			X	X	X	X		
SHUSHUFINDI NORTE	X		X	X	X			X			X		
SHUSHUFINDI SUR	X		X	X	X			X		X	X		
SHUSHUFINDI SUR OESTE	X		X	X	X			X			X		
SHUSHUFINDI WATER INJECTION		X							X	X		X	
YUCA	X		X	X		X		X	X	X	X		X

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Table 6-9. Tank Berm Audit Summary

Facility	Tank	Tank Volume (Barrels)	Berm Area (ft^2)	Berm Height (ft)	Berm Volume (Barrels)
Aguarico	Wash	16,500	24,000	3	**12,535**
	Surge	12,500	30,102	4	20,963
Atacapi	Wash	1,000	4,805	5	4,183
	Surge	5,000	11,097	5	9,660
Auca Central	Wash	37,600	23,465	6	**24,512**
	Surge	28,600	25,564	6	**26,704**
	Crude	106,560	108,957	4	**75,878**
Auca Sur	Wash	50,300	30,434	6	**32,522**
	Surge	16,000	23,516	6	24,565
Cononaco	Wash	50,000	42,221	5	**36,752**
	Surge	24,600	30,381	5	26,445
Guanta	Wash	---	9,247	3.5	5,635
	Surge	---	9,292	3.5	5,662
Lago Central	Wash	14,700	24,306	5	21,158
	Surge	15,000	29,197	5	25,416
Lago Norte	Wash	24,600	44,558	3.5	27,151
	Surge	12,000	33,556	3.5	20,447
Parahuacu	Surge	5,010	9,042	4	6,297
	Crude	15,120	16,585	4	**11,550**
Sacha Central	Wash	72,500	133,300	3	**71,222**
	Surge	42,000	121,690	5	75,855
	Crude	150,000	196,940	5	157,838
Sacha Norte 1	Wash	105,000	162,000	5	144,261
	Surge	70,000	162,000	5	144,261
Sacha Norte 2	Wash	12,600	22,792	4	16,237
	Surge	12,000	22,792	4	16,237
Sacha Sur	Wash	20,000	26,400	4	**18,384**

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Table 6-9. (Continued)

Facility	Tank	Tank Volume (Barrels)	Berm Area (ft²)	Berm Height (ft)	Berm Volume (Barrels)
Shushufindi Central	Wash	28,800	45,208	3	**23,612**
	Surge	72,500	50,590	3	**26,423**
	Crude	100,000	153,278	4	106,742
Shushufindi Norte	Wash	37,500	70,000	4	49,868
	Surge	10,500	48,400	3	25,860
Shushufindi Sur	Wash	28,500	41,800	3	**22,334**
	Surge	22,300	38,000	3	27,063
Shushufindi Sur Oeste	Wash	8,300	35,000	3	18,701
	Surge		35,000	3	18,701
Yuca	Wash	24,600	54,600	5	43,759
	Surge	21,480	46,800	5	37,508

(Shaded Values)	Berm volume significantly less than tank volume.
Bolded Values	Berm volume less than tank volume.

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Table 6-10. Oil and Gas Operation Noise Levels

Site Location	Monitored Results		Distance to Noise Contour from Source (ft)*			
	Noise Measurement	Distance from Source (ft)	75dB	70dB	65dB	60dB
Aguarico	92.0 dB	50	354	629	1,119	1,991
Atacapi	80.6 dB	30	57	102	181	321
Auca Central	90.0 dB	50	281	500	889	1,581
Auca Sur	86.5 dB	50	226	401	713	1,268
Cononaco	79.2 dB	45	73	130	231	410
Guanta	95.0 dB	30	300	533	449	1,687
Lago Agrio Central	91.5 dB	15	100	178	317	564
Lago Agrio Norte	84.0 dB	20	56	100	178	317
Parahuacu	84.3 dB	20	58	104	185	328
Sacha Central	92.6dB	50	379	674	1,199	2,133
Sacha Norte 1	86.8 dB	60	195	346	615	1,094
Sacha Norte 2	69.9 dB	220	122	217	387	688
Sacha Sur	64.4 dB	50	15	26	47	83
Shushufindi Central	80.0 dB	100	178	316	562	1,000
Shushufindi Sur Oeste	87.6 dB	60	256	455	809	1,439
Yuca	80.3 dB	60	110	196	349	621

* Assumes an attenuation rate of 6.0 dB per doubling of distance.

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Table 6-11. Pipeline Audit Summary

Pipeline No.	Location	No. of Pipelines (both sides of road)	Patches	Valves	Leaks	Soil Erosion	Corrosion	Pipeline Configuration*	Exposed Soil (percent)	Cross Water	Cleared Area Width (ft)	Remarks
1	Cononaco	2 - 13	No	Yes	Yes	Yes (1)	Minor	4/1/95	5	Yes (2)	15	Valve leak observed at Cononaco facility
2	North of Cononacó	1 (E only)	No	Yes	Yes	No	None	20/10/70	1	Yes (3)	10	Leak observed at broken valve; soil excavated
3	South of Auca Sur	1 (E only)	No	No	No	No	None	30/10/90	10	Yes (2)	12	---
4	North of Auca Sur	6 - 9	Yes (3)	Yes	Yes	Yes (1)	Minor to Moderate	1/1/98	5	Yes (2)	10	Pipeline leak to drainage off of road; pipeline patched
5	North of Auca	~10	Yes (25)	Yes	Yes	Yes (2)	Minor - Mode.	5/5/90	5	Yes (2)	15	Significant soil contamination in five areas; two discharging to streams
6	South of Culebra	1(W only)	No	No	No	No	None	0/0/100	1	Yes (1)	7	---
7	East of Culebra	1 - 2	No	Yes	Yes	No	None	1/1/98	<5	Yes (1)	20	One leak at valve at Culebra #2
8	East of Yuca	2 - 4	No	No	No	Yes (1)	Minor	5/5/90	60	Yes (2)	20	Stream contaminated with crude oil; not from pipeline
9	North of Sacha Sur	8 - 13	Yes (3)	Yes	Yes	No	Minor	20/60/20	<1	Yes (1)	30	Leaks observed at three well road intersections. Portion of pipeline covered with vegetation
10	North of Sacha Norte #1	6 - 8	No	Yes	No	No	None	10/0/90 (36") 5/95/0 (other)	0	Yes (2)	25	Dense vegetation observed over 50 percent of pipeline
11	North of Sacha Norte #2	2	No	No	No	No	None	5/0/95 (36") 5/95/90 (6")	<5	No	25	Pipelines on west side only
12	West of Sushufindi Central	1 (S only)	No	No	No	No	None	10/0/90	35	Yes (1)	---	Disturbed/cleared areas resulting from road widening
13	Sushufindi	1 - 3	No	No	No	No	None	20/20/60	<1	Yes (4)	8	---
14	South of Sushufindi Sur Oeste	0 - 7	No	Yes	Yes	No	None	0/0/100	<2	Yes (1)	16	2,400 square feet of discolored soils near 1.4 km mark

Note: Clearing width measured from edge of road along typical section of pipeline.
* Percent buried/on ground/elevated.

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Table 6-11. (Continued)

Pipeline No.	Location	No. of Pipelines (both sides of road)	Patches	Valves	Leaks	Soil Erosion	Corrosion	Pipeline Configuration*	Exposed Soil (percent)	Cross Water	Cleared Area Width (ft)	Remarks
15	South of Sushufindi Central	10 - 12	Yes (1)	Yes	Yes	Yes	None	1/0/99	50	Yes (1)	30	Six spills ranging in area from a few hundred to several thousand square feet
16	North of Sushufindi Norte	11 - 15	Yes (9)	Yes	No	No	Minor	1/0/99	<1	Yes	35	All pipelines on west side
17	South of Aguarico	13 - 14	Yes (4)	Yes	Yes	Yes (1)	Minor	3/2/95	3	Yes (2)	18	2,400-square foot spill near patched portion of pipeline; appears fresh
18	North of Aguarico	2	No	No	No	No	None	5/10/85	<5	Yes	16	Portion of pipeline removed
19	South of Eno	2 - 5	Yes	Yes	Yes (1)	No	None	1/1/98	2	No	25	Small spill (65 square feet) at patched location
20	South of Eno	0 - 3	No	Yes	No	No	None	1/1/98	5	Yes	30	Portion of pipeline covered with vegetation
21	South of Lago	1	Yes (2)	No	No	No	None	1/0/99	<5	No	30	Portions of pipeline covered with vegetation
22	Southeast of Lago	2	No	Yes	No	No	Minor	10/70/20	<5	Yes	20	---
23	North of Guanta	2 - 7	No	Yes	No	No	Minor	1/10/89	5	Yes	15	---
24	South of Lago	2 - 3	No	Yes	No	No	Minor	50/30/20	<5	Yes	15	---
25	Lago Agrio	1 - 2	No	No	No	No	None	1/2/97	<5	Yes	25	Oily sheen in water at 1.1-km; no obvious pipe leak
26	Parahuacu	4	No	No	No	No	Minor	1/19/80	5	Yes	20	---
27	Parahuacu	4	No	No	No	No	Minor	1/1/98	5	Yes (5)	20	Possible leak at 1.5-km; oily sheen observed on water
28	Atacapi	4	No	Yes	Yes (2)	Yes (1)	Significant locally	1/5/94	5	Yes	25	Recent spills near Atacapi #2 and near production station

Note: Clearing width measured from edge of road along typical section of pipeline.
* Percent buried/on ground/elevated.

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Table 6-12. Permissible Discharges Limits for Fluids and Formation Waters

Parameters	Stated In	Unit of Measurement	Maximum Permitted Amount
pH	pH	--	5-9
Temperature*	°C	°C	--
Floating material	--	--	None
Hydrocarbons and slags	--	mg/l	< 15
Total dissolved solids	STS	mg/l	< 2,500
Chlorides	CL	mg/l	< 2,500
Sulfates	Sulfates	mg/l	< 1,200
Solids in suspension	SS	mg/l	Removal > 80% load or < 40
Sedimentary solids	--	mg/l	< 40
Chemical demand of oxygen	DQO	mg/l	< 80
Cadmium	Cd	mg/l	< 0.1
Zinc	Zn	mg/l	< 0.5
Copper	Cu	mg/l	< 3.0
Chromium	Cr	mg/l	< 0.5
Phenols	Phenols	mg/l	< 0.15
Fluorides	Fluorides	mg/l	< 5.0
Mercury	Hg	mg/l	< 0.01
Nickel	Ni	mg/l	< 2.0
Lead	Pb	mg/l	< 0.5
Vanadium	V	mg/l	< 1.0

* The temperature limits will be set by the Ecuadorian Institute of Sanitary (IEOS) keeping in mind the flow from the receiving body, dilution area and environmental temperature of the area where the effluent is going to be discharged.

Reference: Table 2 - Permissible Discharge Limits for Fluids and Formation Water, Environmental Regulations for Hydrocarbon activity in Ecuador, Resolution No. 621, 1992.

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SECTION 7

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7.0 REMEDIAL ACTION

TEXPET's practices from 1964 through 1990 were evaluated utilizing the decision flow chart in Figure 3-1. Practices which complied with or exceeded the established Ecuadorian laws and regulations and industry criteria do not require any further action. Those practices which did not comply with the criteria were further assessed to determine if an environmental impacts had occurred. If no impacts were observed during the field audit further action was not recommended. Practices which caused environmental impacts were then assessed to determine what action would be appropriate to remediate the impact.

A Remedial Action Plan is a major part of the overall remediation process. A properly designed Remedial Action Plan will take into consideration factors such as logistics, equipment and labor availability, etc, to identify the appropriate remediation technologies for the work that needs to be accomplished. The Plan will also provide a detailed cost estimate for that work. The Remedial Action Plan presented in this section is considered preliminary. The environmental audit performed covered a portion of the facilities in the consortium. In order to prepare a detailed Remedial Action Plan and cost estimate, a comprehensive environmental assessment of all the consortium facilities must be performed. The comprehensive environmental assessment would include: a site visit to the remaining well sites, sampling and analysis of at selected well sites and all production facilities to determine contamination characterization and volume, documentation of pit conditions; depth, water/oil content, a detailed analysis of surface and ground water parameters; flow rates and depths and possibly small scale remediation tests.

The remedial action recommended by the comprehensive environmental assessment should be performed following implementation of the EMP. The EMP provides the practices and operating procedures required to bring the consortium operation into compliance with the existing Ecuadorian laws and regulations and industry practices. The EMP should also minimize further environmental impacts.

7.1 SUMMARY OF IMPACTS

Several areas were identified during the environmental audit that, pursuant to Ecuadorian laws and regulations in effect from 1964 through 1990, will require either changes in operational procedures and/or site restoration/remediation. These areas included:

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- Clean up of spills associated with base camp activities
- Proper closure of pits at well sites
- Cleanup of spills associated with well site activities
- Cleanup of spills associated with production facilities.
- Remediation or correction of produced water discharge
- Cleanup of spills from pipeline leaks.

<u>Hydrocarbon Contamination</u>

Estimates of the volume of contaminated soil were made for the drill pads, production pits, tank berms, and miscellaneous spills at production facilities, camps and pipelines. Only contamination identified as degraded and heavily degraded have been attributed to TEXPET's operations. This is based on field observation and crude oil fingerprint analysis results. The volumes of soil requiring remediation was estimated as follows:

1) Well Site Pads - Spill size and age were noted during the field audit. (Table 6-3). Based on the data collected, 50 percent of the contamination was judged to be older than two years indicating that it was the result of TEXPET's operations prior to 1990. The remaining 50 percent appeared recent, within the past two years, which would be attributed to PETROAMAZONAS' operations from 1990 to 1992. To provide an estimate of contamination volume it was assumed that one foot of soil would need to be excavated to remediate site contamination.

2) Well Site Pits - In addition to removal of all fluids within the pits, it is recommended that some additional soils around the perimeter of the pits be remediated prior to backfilling and final closure. It has been assumed that all pits with greater than 50 percent oil cover (Table 6-4) will require some limited soil remediation. The volume of contaminated soil at these sites has been estimated to be one half foot deep by two feet vertical by the perimeter length. This calculation assumes that only the rim of the pit is affected by oil. Only pits which contained crude oil judged to be degraded or heavily degraded were attributed to TEXPET's operations. The estimate does not include the remediation of objects in the pit that may be oiled, or oil that may have sunk to the bottom of the pit. Remediation of this these material may

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also be necessary. Oil that has been released from the pits and resulted in site contamination would also need to be remediated. It has been estimated that one foot of soil would need to be excavated to remediate site contamination.

3) Tank Berms - The majority of the tank berms audited showed some signs of previous and recent spills. However, because many of these spills have been covered with sand to contain the spills and reduce spreading, it is difficult to quantify the extent of contamination requiring cleanup. To approximate the volume of contamination in these areas, it has been estimated that 10 percent of the total berm area is contaminated and that 1 foot of soil would need to be remediated. It has been estimated that 50 percent of this contamination has resulted from TEXPET's operations from 1964 through 1990 and that 50 percent has resulted from PETROAMAZONAS' operations from 1990 through 1992. This estimate is conservative and is based on the field observation that the spill sand in many of the tank berm areas appeared to be recent due to the absence of vegetation cover.

4) Miscellaneous spills at production facilities - Spill which occurred around equipment, sumps and pits, etc. were also estimated at each production facility. Miscellaneous spills were classified as previously discussed (FS, SL DEG, DEG, HV DEG). Spills which were judged as degraded or heavily degraded were attributed to TEXPET's operations from 1964 to 1990. In addition, spills fresh or degraded which were the result of improper equipment design were considered the responsibility of TEXPET. Oil spill areas were assumed to be 1 foot deep.

The total volume of soil requiring remediation at the drill pads audited was estimated to be 20,000 cubic yards. Since only about half of the drill sites were audited, the total estimated volume of contaminated soil at all 316 drill sites is estimated to be 40,000 cubic yards. As previous discussed, approximately one-half or 20,000 cubic yards would be attributed to TEXPET's operations prior to 1990.

Closure of production pits will require that all fluids be removed from the pits and that the pits be backfilled, compacted, and revegetated to restore the area to natural conditions. Oil within the pits will need to be skimmed initially to avoid smearing of oil during fluid removal. If the remaining water in the pits meet the established water quality standards (Table 6-12), then the water can be discharged to a surface body of water. Care should be taken to avoid erosion or increased sedimentation during discharge. If water in the pits do not meet the established water

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quality objectives, then it must be treated prior to discharge. Oil and oily water removed from the pits would need to be treated or could possibly be recycled (road construction, etc.). The total volume of contaminated soil from production pits audited is estimated to be 1,000 cubic yards. This figure represents about 550 cubic yards of soil from excavation of the pit perimeters and about 450 cubic yards of soil from spills extending beyond the pits. Similarly, since only half of the production pits were audited, the total volume of contaminated soil from the pits is estimated to be 2,000 cubic yards.

The total volume of contaminated soil from the tank berms is estimated to be 7,000 cubic yards. This is based on total area within berms of 1,900,000 ft^2 by 1 foot deep by 10 percent of total berm area. Therefore, 50 percent, 3,500 cubic yards would be attributed to TEXPET's operations from 1964 to 1990. Miscellaneous spills at the production facilities are estimated to be 30,100 cubic yards, of which 6,600 cubic yards are the result of TEXPET operations prior to 1990. Two spills from pipeline leaks were also attributed to TEXPET. The amount of soil requiring remediation was 125 cubic yards.

The total volume of soil rec. ring remediation from drill pads, production pits, tank berms, and miscellaneous spills is estimated at 32,225 cubic yards (Table 7-1).

Table 7-1. Estimated Volume of Soil Requiring Remediation

Area Affected	Soil Volume in Cubic Yards (Cubic Meters)	
	Estimated Total Volume	Pre-1990 Volume
Well Site Pads	40,000 (30,580)	20,000 (15,290)
Well Site Pits	11,600 (8,870)	2,000 (1,530)
Tank Berms	7,000 (5,350)	3,500 (2,675)
Miscellaneous Spills	30,100 (23,015)	6,600 (5,045)
Pipelines	20,000 (15,290)	125 (95)
Total Estimate:	109,700 (83,150)	32,225 (24,635)

Produced Water

According to the 1989 regulations, produced water discharges should have been registered with the IEOS. Following discharge characterization, the IEOS would have established a sampling point to determine compliance with established water quality standards. Compliance with the 1989 regulations could not be determined

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since the discharges were not registered as required. Analysis of samples collected downstream of the produced water discharge of six facilities during the audit either exceeded or was close to the water quality standards for chlorides, 2500 ppm (Table 6-12) in the current 1992 regulations. Also one facility discharges high salinity produced water into a percolation pit which could be impacting the fresh water aquifer in the area. Therefore, the produced water discharge at seven production facilities will require modifications. It is not clear, if discharge modifications would have been required under the 1989 regulations. Therefore, the cost for discharge modifications have been included in this report and the EMP.

7.2 REMEDIATION ALTERNATIVES

7.2.1 Hydrocarbon Contaminated Soils

A number of remediation technologies have been developed for the treatment of petroleum contaminated soils. Provided herein is a discussion of the technologies available for remediating soil contamination and their applicability to conditions within the Oriente. The following elements are addressed in this feasibility study/corrective action plan:

- A screening of the available corrective action alternatives based on technical, environmental, public health, and cost criteria.
- A brief description of the corrective action alternatives that will be considered for implementation.
- A brief analysis of the contemplated corrective action alternatives and associated costs.

Screening of Corrective Action Technologies. Several remedial technologies are available for cleaning up soil contamination. Some of these technologies can be eliminated from consideration because 1) the limitations of the technology make the alternative impractical, 2) the relative costs are too high to be considered, 3) the technology is in the research and development stage and has not proven itself as a practical remediation tool, 4) site considerations preclude the consideration of the technology, or 5) the technology possesses environmental or public health concerns. Below is a list of technologies eliminated from consideration with a discussion of reasons.

Passive In-situ Remediation (No Action). The environmental conditions in the Oriente area are conducive to bioremediation, high temperatures and

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sufficient moisture. But, a no action option has been ruled out for sites determined to have significant levels of contamination because the time required for remediation to occur (through natural degradation) may be considerable. During such time, the environmental and human health risks of exposure are difficult to control. Passive in-situ bioremediation remediation may be a viable alternative for small volumes or areas which have low levels of contamination.

Leaching/Soil Flushing. In-situ leaching/soil flushing is a technology in which in-place soils are flushed with water mixed with surfactant (anionic, cationic, or non-ionic) to leach contaminants into the groundwater. The groundwater is extracted downgradient through a collection system for treatment or disposal. This technology is in the research and development phase and is not commonly practiced. The cost of recycling groundwater extracted is considered to be high. This method is not being considered because the technology is not readily available and the costs for recycling would be too high.

Vitrification. The process of vitrification utilizes a high voltage electric current to vitrify contaminated soils. Electricity is applied to the contaminated soil and the heat generated volatilizes some of the petroleum contaminants for capture and treatment. The contaminants remaining in place are converted into a durable glass and crystalline form by melting the soil with the electrical energy. This technology can be applied to hydrocarbon contaminated soil; however, it is in its infancy. Because it is an undeveloped technology, costs are difficult to predict and can be prohibitively high. For these reasons, vitrification has been eliminated from consideration for the project.

Soil Vapor Extraction/Emissions Treatment. Soil vapor extraction and emissions treatment is an in-situ technology by which volatile contaminants are extracted using a vacuum source and the emissions treated by adsorption, combustion, or condensation. Soil vapor extraction has proven to be successful in remediating the volatile contaminants of gasoline. However, this technology is not applicable to heavier hydrocarbons such as crude oil and is, therefore, eliminated from consideration.

Excavation and Off-Site Disposal. This alternative considers excavation of soil followed by off-site disposal. Excavation and disposal is a practicable technology for sites located in relative close proximity to landfills or other

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approved disposal facilities. There are no such facilities within the Oriente and, therefore, this option will not be considered.

Isolation/Containment Barriers. Isolation/ containment is a process by which the contaminated soil is separated from the surrounding environment. Separation of the contaminated soil from uncontaminated soil can be accomplished by installing containment devices such as surface caps, cutoff walls, grout curtains, and slurry walls. The technology is used to isolate the contamination and prevent its migration and further contamination of the surrounding environment. The contamination becomes immobilized within the containment facility. This technology is most applicable to sites where contamination is isolated or if it would be difficult to remediate using other methods. Because remediation of the facilities in the Oriente may involve hundreds of separate sites, this technology would be cost prohibitive.

Thermal Treatment. Incineration involves removal of the soil from the subsurface for off-site or on-site incineration. Because there are no incineration facilities currently operating within the Oriente, a transportable unit would need to be brought in. Thermal treatment or incineration of the contaminated soil after excavation is being eliminated from consideration because the process is currently more expensive than more viable alternatives.

Asphalt Incorporation or Solidification. Asphalt incorporation and solidification are technologies that require excavation and offsite treatment. Following excavation, the soil is transported to an asphalt batching plant for incorporation into road materials for fixation, or solidification in a chemical fixative rendering it unleachable. There are no asphalt plants or solidification facilities currently operating in the Oriente. Therefore soil would either need to be transported considerable distances or one or more of these facilities would need to be constructed in the Oriente. As such, these technologies are considered to be cost prohibitive.

<u>Corrective Action Alternatives</u>

With some of the remedial technologies eliminated from consideration, the discussion will focus on those corrective action alternatives that will be considered. The following discussion is a description of the corrective action alternatives that would be applicable to this project. The following technologies do not have obvious practical limitations and the relative costs to use the technology are reasonable. The technologies described below are currently being used to remediate petroleum

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contamination, and the equipment and material requirements do not have significant limitations. The site considerations are amenable to the use of the following technologies and there are no major environmental or public health concerns associated with using these technologies.

Land Treatment (Enhanced Biodegradation)

Land treatment (or enhanced biodegradation) involves removal of contaminated soils and spreading to enhance naturally-occurring processes. These naturally occurring processes include volatilization, aeration, biodegradation, and photolysis. Soil is typically excavated and transported to a bermed containment device. Although frequently lined to prevent contaminant migration, this may not be required for clayey type soils observed at the drilling/production facilities within the Oriente. Soil is normally placed in a single two to three foot vertical lift. Fertilizer containing nitrogen and phosphorous compounds is periodically added and the soil is tilled to help promote hydrocarbon degradation by aerating the material, thus adding oxygen. Factors that influence the effectiveness of land treatment include the types of soil microorganisms, topography, soil moisture and texture, temperature, soil pH, nutrients, precipitation, hydraulic loading, and aeration/oxygen addition. Pilot studies are required to evaluate the optimal stockpile treatment cell conditions.

Costs associated with this remedial option include the costs of constructing the treatment pads and purchase of equipment, such as tractors and rototillers, and operation and maintenance costs. The costs for each individual (large-scale) operation is estimated to be U.S.$150,000. Operation and maintenance costs are generally about U.S.$30 per cubic yard of soil and include material transportation and application, cultivation and site operations, and soil analysis. Costs would increase somewhat if treatment cells were required to be lined because site soils were not sufficiently low in permeability to impede vertical migration of contaminants. These costs are gross estimations and do not include a detailed cost analysis. Because very little, if any, remedial technology has been applied within the Oriente, these costs must be considered estimates only.

Augmented Biodegradation

Biodegradation through augmented techniques involves the additional of specialized bacteria that degrade specific petroleum hydrocarbon types (gasoline, diesel fuel, crude oil, etc.). Microorganisms are manufactured by specialty contractors. The hydrocarbon contaminants are degraded to carbon dioxide and water. Biodegradation can be either in-situ or ex-situ. In-situ techniques involve more

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complex operations and often require groundwater controls and monitoring which greatly increase the costs of operation.

Ex-situ biodegradation is similar to land treatment in that soil is excavated and transported to a bermed treatment area. In addition to adding bacterial nutrients, however, the soil is periodically inoculated with microorganisms to further enhance the degradation processes. The soil is kept moist (optimum conditions for the bacteria degrading petroleum) and the soil is tilled or some other method used to expose the bacteria to oxygen. Because the microorganisms are aerobic, the key to increasing the rate of bioremediation is the availability of oxygen. Over time, bacteria consume and degrade the hydrocarbons and carbon dioxide and water are generated from the hydrocarbons.

The costs for biological treatment include completion of pilot studies, construction of the biotreatment system, operation and maintenance, and confirmation sampling. The cost for augmented bioremediation would be fairly similar to those for land treatment (enhanced bioremediation). The additional costs of using micro-organisms are often offset by a reduced cleanup schedule.

Recommended Corrective Action Alternative

Either land treatment (enhanced biodegradation) or augmented biodegradation are technically feasible remediation methods. These alternatives are experiencing widespread use in remediating hydrocarbon contaminated soil worldwide. Additionally there are no adverse environmental impacts that cannot be mitigated, and there are no adverse public health threats that cannot be mitigated if this technology is implemented. The high seasonal temperatures and rainfall amounts within the Oriente should increase the effectiveness of biodegradation as a remedial tool.

Based on the estimated volume of soil requiring remediation, it is anticipated that at least four strategically located main treatment areas would need to be established. The abundance of open and level land at production facilities would make these areas ideal locations for treatment cells. Treatment cells could be established at Sacha, Shushufindi, Auca, and Lago Agrio. Although some sites may be conducive to in-situ treatment of soils, it is expected that most of the contaminated soils would be excavated and transported to the primary treatment cells. This would result in a relatively high labor intensive effort initially, but would reduce the long-term costs associated with treating the soil (cultivation, nutrient and/or microorganism application). Ex-situ treatment would also allow for final site restoration (grading and revegetation) to proceed and thus expedite final site closure. The minimum time

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required to bioremediate soils is expected to be about 6 to 9 months. The entire remediation project may require 3 to 5 years to complete.

7.2.2 Produced Water

There are several alternatives for the treatment and disposal of produced water. Provided herein is a discussion of the technologies available for the disposal or reuse of produced water.

Subsurface or Underground Injection - Underground injection is an acceptable practice for the disposal of produced water provided the water is isolated from drinking water sources. Produced water is injected into the hydrocarbon bering formation to enhance oil recover (waterflood) or it may be injected into subsurface formations which contain saline waters. In order to utilize underground injection an existing must be available or new well be drilled in close proximity to the produced water source. It also requires a high pressure pump to inject the fluids into the subsurface formation.

Discharge to Water - The discharge of produced water to surface streams and rivers is an acceptable method of produced water disposal provided there is sufficient dilution to meet the established water quality standards. In some cased the discharge must be transported via pipe to a water course capable of assimilating the produced water volume and chemical levels.

Discharge to Land - The use of percolation pits, evaporation or land spreading is an acceptable method for produced water disposal provided the chemical constituents do not effect the soils, surface water or ground waters. This method is not considered feasible due to the high salinity of the produced water.

Other Methods - Methods such as; chemical fixation, desalination, etc are cost prohibitive given the large volume of produced water and the number of facilities which require modifications.

Based on the alternative presented, discharge to surface waters and underground injection are the only viable and cost effective methods of produced water disposal. A cost comparison must be performed to evaluate the appropriate alternative for each facility. The two key elements in determining the best method will be the location of the nearest creek or stream which can handle the discharge and the location of existing wells which could be converted for injection/disposal. The cost to transport produced water to an available stream will vary depending on the

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length of pipe required. Pipeline purchase and installation cost was estimated at U.S.$30/ft. The pump and pad required for fluid transfer was estimated at U.S.$10,000. The estimated cost for underground injection includes: purchase and installation of injection pump, tanks and pipeline from the facility to the injection well and equipment installation and workover operations for the injection well. Pipeline purchase and installation cost for injection wells was estimated at U.S.$45/ft. Injection pump, tank and other associated equipment cost was estimated at U.S. 175,000. Engineering, equipment, drilling, logging and perforation services was estimated at U.S.$200,000.

7.3 REMEDIAL COST ESTIMATES

The remediation cost estimate (Table 7-2) is based on the assumption that the facilities and well sites audited are representative of all the consortium operations. In order to prepare a proper remedial action plan and detailed cost estimate all the consortium will need to be audited.

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Table 7-2. Remediation Cost Estimate

	ESTIMATED COST U.S. $M
Remedial Action Plan	
Perform Comprehensive Environmental Assessment Conduct Sampling Select Remedial Action Method(s) Prepare Detailed Remediation Cost Estimate	2,000
Bioremediation Facility	
Design and Construct Facilities at Auca, Lago Agrio, Sacha, and Shushufindi	200
Equipment for Facility - Dump Trucks, Tractors, and Soil Disks	540
Subtotal	740
Well Sites Pits	
Pit Fluid Removal - 120 pits $2M/Pit	240
Soil Excavation - 120 pits $1M/Pit	120
Contaminated Soil Treatment - 2,000 cu.yds. $30/cu.yd.	60
Fill and Level Pits - 120 pits $2.5M/Pit	300
Subtotal	720
Well Site Pads	
Contaminated Soil Treatment - 20,000 cu.yds. $30/cu.yd.	600
Production Facility/Base Camp	
Contaminated Soil Treatment - 10,100 cu.yds. $30/cu.yd.	303
Produced Water Discharge Modification	
Aguarico (Convert to Underground Injection)	525
Atacapi (Convert to Underground Injection)	555
Auca Sur (Extend Outfall)	310
Lago Agrio Norte (Extend Outfall)	205
Shushufindi Sur (Extend Outfall)	110
Shushufindi Sur Oeste (Extend Outfall)	85
Yuca (Convert to Underground Injection)	665
Subtotal	*2,455

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Table 7-2. (Continued)

	ESTIMATED COST U.S. $M
Remediation/Restoration Verification	
Monitoring: 5 years - $50M/yr	250
Total	7,068
Contingency 20%	1,414
Total with Contingency	8,482

*Note: All or a portion of the cost to modify the produced water discharges may be covered under the Environmental Management Plan. The estimated cost for remediation, not including the produced water modifications is U.S.$5.5 million.

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SECTION 8

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8.0 LIMITATIONS

This document has been prepared for Texaco Petroleum Company, Coral Gables, Florida, as required under Work Order 1 of the Basic Ordering Agreement signed March 1992. In performing our professional services, we have applied present scientific and engineering judgement and used a level of effort consistent with the standard of practice measured on the date of this document and in the locale of the project. Fugro-McClelland makes no warranty, expressed or implied.

The Ecuadorian law and regulations, guidelines and practices summarized in this document have been developed based on the review of existing information pertaining to international oilfield practices (Seismic Surveys, Exploratory Drilling and Development Drilling/Production Operations) in tropical rainforest areas, from 1964 through 1990, and Ecuadorian Law and Regulation. Only Ecuadorian laws and regulations relevant to seismic surveys, exploratory drilling and development drilling/production operations were included in this report.

Many of the documents used in this report were originally written in Spanish and required translation. Pertinent sections have been translated internally and not by a certified translator. As such, Fugro-McClelland is not responsible for any misinterpretation or omissions that may have resulted from document translation. The original laws and regulations (Spanish) are included as Appendix D in the report titled *International Oilfield Practices (1964-1990) in Tropical Rain Forest Areas and Summary of Ecuadorian Laws and Regulations* (Fugro-McClelland, July, 1992).It is also important to recognize that the industry practices are based on numerous publications written by others. Fugro-McClelland cannot be responsible for the biases or possible inaccuracies of studies or reports that are referenced in this document.

The conclusions in this report have been developed based on documented industry practices and Ecuadorian laws and regulations from 1964-1990, field audit observations, soil and water sampling and analysis, and a historical document review. The field audit observations and analytical results are limited to the conditions that existed at each site or sampling point at the time the work was performed. It should be recognized that contamination can vary within a given site, and that contamination can go undetected in any limited investigation. Fugro-McClelland is not responsible for any conditions which may have gone undetected or which arise at any subsequent time.

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SECTION 9

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APPENDIX A

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APPENDIX A

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Rocky Mountain
Analytical Laboratory

Enseco
A Corning Company

August 24, 1992

Mr. Roy D. Roberts
Fugro-McClelland West, Inc.
5855 Olivas Park Drive
Ventura, CA 93003

Dear Mr. Roberts:

Please find enclosed the revised Introduction and Summary page along with a revised text for RMAL project 023538. I have also enclosed the chromatogram from the reanalysis of the Lago Angrio Pit #'s. Additionally, we reanalyzed the SFF #73 Pit, and the original results were confirmed.

We apologize for any inconvenience.

Best regards,

Mike Hoffman
Team Leader
UST Team

MH/cla
enclosures

RMAL #023538

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Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303 421-6611 Fax: 303 431-7171

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Enseco
A Corning Company

Introduction and Summary

This report summarizes the results from the analyses of 31 crude oil samples submitted to our laboratory on June 4, 1992. As requested, analyses were performed by GC/FID to generate a "fingerprint" that could be used to assess the relative age of each sample. Based on our assessment of the GC-FID fingerprints, the samples are ordered, in increasing age, as follows:

Group One:	Surge Tank Pump @ SFF Central Pump Parahuacu Facility Pump Lago Augrio Central
Group Two:	Surge Tank @ Aguarico Facility Auca SUR #1 & #2 Pump Shipping Pumps Central Sacha
Group Three:	Creek S of Aguarico #10 Spill N of Auca #15/S of Rio Tiputini Spill 100' north of Sacha Sur Facility Spill at Sacha 20
Group Four:	Guanta #7 Pit SFF #45B Pit Spill @ Auca #25 Spill @ Sacha 52 Pit Sacha 84 Pit
Group Five:	Aguarico #2 Pit Spill N of Auca Central Discharge Sacha 28 Sacha 116 Pit Sacha 78 Pit
Group Six:	Spill @ Road to Well #21 Spill @ SFF 53 SFF Central/Petro Ind. Comp. SFF #61 Pit
Group Seven:	Parahuacu #3 Pit SFF #73 Pit Sacha 74 Pit
Group Eight:	Aguarico #10 Pit Spill @ Parahuacu #2 Auca Sur #1 Pit Lago Augrio Pit #5

More detailed discussions follow.

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Group One

These three samples represent a relatively unweathered crude, with n-alkanes from C_8 to C_{36}. A key aspect of these samples is the even distribution from C_8 to C_{17}.

Group Two

These three samples are very similar to the group one samples, but show a slight evaporative loss in the C_8 to C_{10} range.

Group Three

These four samples are virtually identical to the Group One samples from C_{14} and above, but show extensive evaporative loss in the C_8 to C_{13} range.

Group Four

These five samples are showing evaporative losses through C_{16}.

Group Five

These five samples show evaporative losses through C_{16} and degradation of the higher n-alkanes through C_{30}.

Group Six

These four samples are showing extensive degradation (>50%) of the n-alkanes from C_{14} to C_{36}, along with evaporative losses up to the C_{14} to C_{17} range.

Group Seven

These three samples show significant losses of the n-alkanes through C_{16} with extensive degradation (>50%) of the n-alkanes in the C_{16} to C_{36} range.

Group Eight

These four samples show virtually complete losses of the n-alkanes (>90%) and detection of pristane and phytane. These three samples show little resemblance to the reference crudes.

The samples were received under Chain of Custody as shown in the enclosed attachment. Copies of the chromatograms are also enclosed.

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Analytical Procedure

A one gram aliquot of each sample was diluted to 10.0 mL in methylene chloride. This solution was analyzed by capillary column GC-FID under the following conditions:

Column: Restek RTx-5
30m, 0.25 mm ID, 0.25 um film

Calibration Standard: C_8 to C_{36} n-alkanes plus pristane and phytane

Internal Standard: 5-a-androstane

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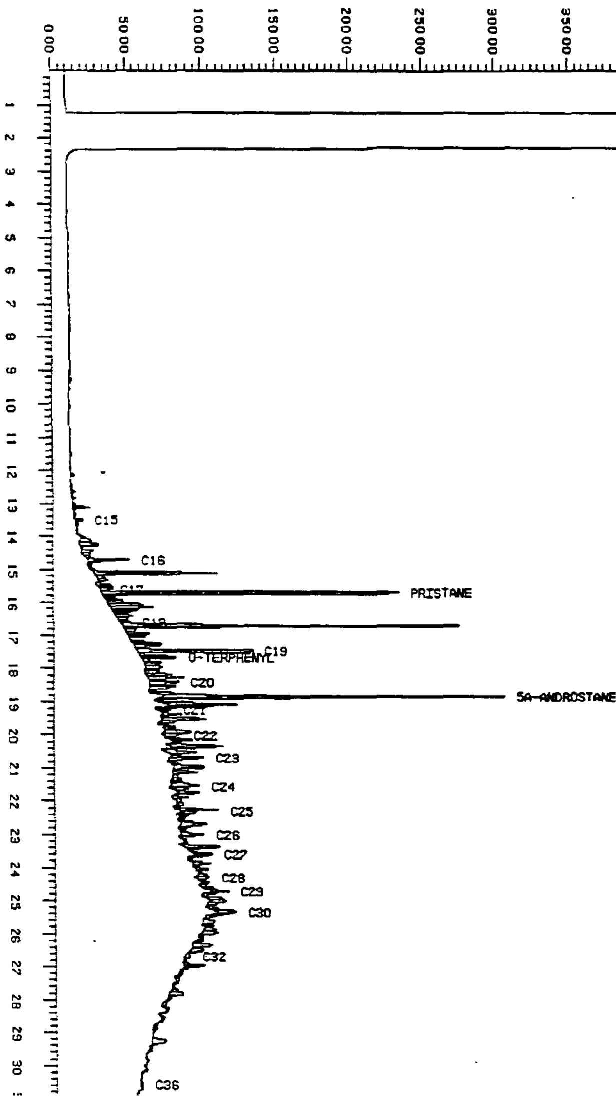
RMAL Chromatography System on DENCR2

[FID08_2] 24 O13AUG92,12,1

23538-21 AMT=1.0G PDIL=5%.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 14-AUG-1992 at 00:08
Reported on 24-AUG-1992 at 11:31
Box 1 (of 1)



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Rocky Mountain
Analytical Laboratory

Enseco

July 29, 1992

Mr. Roy D. Roberts
Fugro-McClelland West, Inc.
5855 Olivas Park Drive
Ventura, CA 93003

Dear Mr. Roberts:

Enclosed is the report for 31 samples received at Enseco-Rocky Mountain Analytical Laboratory on June 4, 1992.

Please call if you have any questions.

Sincerely,

Mike Hoffman

Mike Hoffman
Team Leader
UST Team

MH/cla
Enclosures

RMAL #23538, 23180

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Enseco Incorporated

Analytical Results

For

Fugro-McClelland Inc.

Enseco

RMAL Project:
23180
23538

July 29, 1992

Prepared By:

Jerry L. Parr
Director,
Petroleum Industry

Reviewed By:

Mike Hoffman
Team Leader,
UST Team

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Introduction and Summary

This report summarizes the results from the analyses of 31 crude oil samples submitted to our laboratory on June 4, 1992. As requested, analyses were performed by GC/FID to generate a "fingerprint" that could be used to assess the relative age of each sample. Based on our assessment of the GC-FID fingerprints, the samples are ordered, in increasing age, as follows:

Group One:
- Lago Augrio Pit #5
- Surge Tank Pump @ SFF Central
- Pump Parahuacu Facility
- Pump Lago Augrio Central

Group Two:
- Surge Tank @ Aguarico Facility
- Auca SUR #1 & #2 Pump
- Shipping Pumps Central Sacha

Group Three:
- Creek S of Aguarico #10
- Spill N of Auca #15/S of Rio Tiputini
- Spill 100' north of Sacha Sur Facility
- Spill at Sacha 20

Group Four:
- Guanta #7 Pit
- SFF #45B Pit
- Spill @ Auca #25
- Spill @ Sacha 52 Pit
- Sacha 84 Pit

Group Five:
- Aguarico #2 Pit
- Spill N of Auca Central
- Discharge Sacha 28
- Sacha 116 Pit
- Sacha 78 Pit

Group Six:
- Spill @ Road to Well #21
- Spill @ SFF 53
- SFF Central/Petro Ind. Comp.
- SFF #61 Pit

Group Seven:
- Parahuacu #3 Pit
- SFF #73 Pit
- Sacha 74 Pit

Group Eight:
- Aguarico #10 Pit
- Spill @ Parahuacu #2
- Auca Sur #1 Pit

More detailed discussions follow.

CONFIDENTIAL
PET 039792

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SDNY - 04 CIV 8378

CA1068539

Group One

These four samples represent a relatively unweathered crude, with n-alkanes from C_8 to C_{36}. A key aspect of these samples is the even distribution from C_8 to C_{17}.

Group Two

These three samples are very similar to the group one samples, but show a slight evaporative loss in the C_8 to C_{10} range.

Group Three

These four samples are virtually identical to the Group One samples from C_{14} and above, but show extensive evaporative loss in the C_8 to C_{13} range.

Group Four

These five samples are showing evaporative losses through C_{16}.

Group Five

These five samples show evaporative losses through C_{16} and degradation of the higher n-alkanes through C_{30}.

Group Six

These four samples are showing extensive degradation (>50%) of the n-alkanes from C_{14} to C_{36}, along with evaporative losses up to the C_{14} to C_{17} range.

Group Seven

These three samples show significant losses of the n-alkanes through C_{16} with extensive degradation (>50%) of the n-alkanes in the C_{16} to C_{36} range.

Group Eight

These three samples show virtually complete losses of the n-alkanes (>90%) and detection of pristane and phytane. These three samples show little resemblance to the reference crudes.

The samples were received under Chain of Custody as shown in the enclosed attachment. Copies of the chromatograms are also enclosed.

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PET 039793

CA1068540

Analytical Procedure

A one gram aliquot of each sample was diluted to 10.0 mL in methylene chloride. This solution was analyzed by capillary column GC-FID under the following conditions:

Column: Restek RTx-5
30m, 0.25 mm ID, 0.25 um film

Calibration Standard: C_8 to C_{36} n-alkanes plus pristane and phytane

Internal Standard: 5-a-androstane

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PET 039794

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068541

SAMPLE DESCRIPTION INFORMATION
for
Fugro-McClelland West, Inc.

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
023180-0001-SA	SACHA 52 PIT	WASTE	27 MAY 92	08:00	04 JUN 92
023180-0002-SA	SPILL-100' N. OF SACHA FAC.	WASTE	27 MAY 92	08:35	04 JUN 92
023180-0003-SA	SACHA 84 PIT	WASTE	27 MAY 92	09:15	04 JUN 92
023180-0004-SA	DISCHARGE SACHA 28(PIT AREA)	WASTE	27 MAY 92	09:50	04 JUN 92
023180-0005-SA	SACHA 116 PIT	WASTE	27 MAY 92	10:50	04 JUN 92
023180-0006-SA	SPILL AT SACHA 20	WASTE	27 MAY 92	12:00	04 JUN 92
023180-0007-SA	SACHA 74 PIT	WASTE	27 MAY 92	15:00	04 JUN 92
023180-0008-SA	SHIPPING PUMPS CENTRAL SACHA	WASTE	27 MAY 92	16:00	04 JUN 92
023180-0009-SA	SACHA 78 PIT	WASTE	27 MAY 92	17:00	04 JUN 92

CONFIDENTIAL
PET 039795

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068542

CA1068542

SAMPLE DESCRIPTION INFORMATION
for
Fugro-McClelland West, Inc.

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
023538-0001-SA	AUCA SUR #1&#2 PUMP	WASTE	25 MAY 92	12:00	04 JUN 92
023538-0002-SA	SPILL @ROAD TO WELL #21	WASTE	25 MAY 92	13:40	04 JUN 92
023538-0003-SA	AUCA SUR #1 PIT	WASTE	25 MAY 92	14:30	04 JUN 92
023538-0004-SA	SPILL N OF AUCA #15/S OF RIO	WASTE	25 MAY 92	15:15	04 JUN 92
023538-0005-SA	SPILL @AUCA #25	WASTE	25 MAY 92	15:55	04 JUN 92
023538-0006-SA	SPILL N OF AUCA CENTRAL	WASTE	25 MAY 92	17:00	04 JUN 92
023538-0007-SA	AGUARICO #2 PIT	WASTE	26 MAY 92	10:30	04 JUN 92
023538-0008-SA	SURGETANK @AGUARICO FACILITY	WASTE	26 MAY 92	11:00	04 JUN 92
023538-0009-SA	AGUARICO #10 PIT	WASTE	26 MAY 92	11:20	04 JUN 92
023538-0010-SA	@CREEK S OF AGUARICO #10	WASTE	26 MAY 92	11:30	04 JUN 92
023538-0011-SA	SPILL @SFF53	WASTE	26 MAY 92	12:00	04 JUN 92
023538-0012-SA	@SFF CENTRAL/PETROIND. COMP.	WASTE	26 MAY 92	13:20	04 JUN 92
023538-0013-SA	SFF #61 PIT	WASTE	26 MAY 92	13:40	04 JUN 92
023538-0014-SA	SFF #45B PIT	WASTE	26 MAY 92	14:00	04 JUN 92
023538-0015-SA	SFF #73 PIT	WASTE	26 MAY 92	14:20	04 JUN 92
023538-0016-SA	SURGETANK PUMP @SFF CENTRAL	WASTE	26 MAY 92	14:40	04 JUN 92
023538-0017-SA	PUMP LAGO AUGRIO CENTRAL	WASTE	30 MAY 92	08:35	04 JUN 92
023538-0018-SA	PARAHUACU #3 PIT	WASTE	30 MAY 92	11:20	04 JUN 92
023538-0019-SA	SPILL @PARAHUACU #2	WASTE	30 MAY 92	11:50	04 JUN 92
023538-0020-SA	PUMP PARAHUACU FACILITY	WASTE	30 MAY 92	12:10	04 JUN 92
023538-0021-SA	LAGO AUGRIO #5 PIT	WASTE	30 MAY 92	16:00	04 JUN 92
023538-0022-SA	GUANTA #7 PIT	WASTE	30 MAY 92	14:20	04 JUN 92

CONFIDENTIAL
PET 039796

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068543

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

Enseco
A Corning Company

Rocky Mountain Analytical Laboratory
4955 Yarrow Street
Arvada, CO 80002
303/421-6611 FAX: 303/431-7171

CHAIN OF CUSTODY

ENSECO CLIENT: FUGRO - McCLELLAND
PROJECT: TEXACO - ENVIRONMENTAL AUDIT
SAMPLING COMPANY: FUGRO - McCLELLAND
SAMPLING SITE: ECUADOR - ORIENTE
TEAM LEADER: ROY D. ROBERTS

SAMPLE SAFE™ CONDITIONS

PACKED BY:
SEAL NUMBER:
SEAL INTACT UPON RECEIPT BY SAMPLING COMPANY:
CONDITION OF CONTENTS:
SEALED FOR SHIPPING BY:
INITIAL CONTENTS TEMP: °C
SEAL NUMBER:
SAMPLING STATUS: ☐ Done ☐ Continuing Until
SEAL INTACT UPON RECEIPT BY LAB: ☒ Yes ☐ No
CONTENTS TEMPERATURE UPON RECEIPT BY LAB: 24.4 °C

23538

	DATE	TIME	SAMPLE ID/DESCRIPTION	SAMPLE TYPE	# CONTAINERS	ANALYSIS PARAMETERS	REMARKS
-01	5/25/92	1200	CRUDE OIL F/ AUCA SUR #1 #2 PUMP	CRUDE OIL	1 40ml VOA	FINGERPRINT	HOLD ALL SAMPLES
-02	5/25/92	1340	CRUDE OIL F/SPILL @ ROAD TO WELL #21	CRUDE OIL	1 40ml VOA	"	FOR POSSIBLE FURTHER ANALYSIS
-03	5/25/92	1430	CRUDE OIL F/ AUCA SUR #1 PIT	CRUDE OIL	1 40ml VOA	"	
-04	5/25/92	1515	CRUDE OIL F/ SPILL N. OF ROAD AUCA #15 & S. OF RIO TIPUTINI	CRUDE OIL	40ml VOA	"	
-05	5/25/92	1555	CRUDE OIL F/SPILL @ AUCA #25	CRUDE OIL	1 40ml VOA	"	
-06	5/25/92	1700	CRUDE OIL F/SPILL N. OF AUCA CENTRAL (3.5 KM APPROX)	SOIL w/ CRUDE OIL	1 2oz	"	
-07	5/26/92	1030	CRUDE OIL F/ AGUARICO #2 PIT	CRUDE OIL	1 40ml VOA	"	
-08	5/26/92	1100	CRUDE OIL F/ SURGE TANK @ AGUARICO PRODUCTION FACILITY	CRUDE OIL	1 40ml VOA	"	
-09	5/26/92	1120	CRUDE OIL F/ AGUARICO #10 PIT	CRUDE OIL	1 40ml VOA	"	
-10	5/26/92	1130	CRUDE OIL F SPILL @ CREEK ~200' S. AGUARICO #10	CRUDE OIL	1 40ml VOA	"	

CUSTODY TRANSFERS PRIOR TO SHIPPING

RELINQUISHED BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME
Roy D. Roberts			

SHIPPING DETAILS

DELIVERED TO SHIPPER BY: Roy D. Roberts
METHOD OF SHIPMENT: DHL
AIRBILL NUMBER: 538643114
RECEIVED FOR LAB: RMAL
SIGNED: [signature]
DATE/TIME: 6/4/92 11:20
ENSECO PROJECT NUMBER: 23538

ENS 1131

CONFIDENTIAL
PET 039797

White - CLIENT Pink - LAB

CA1068544
CA1068544

CONFIDENTIAL TREATMENT REQUESTED
ONY - 04 CIV 8378

CHAIN OF COUSTODY

SAMPLE SAFE™ CC... IONS

ENSECO CLIENT	Fugro- McClelland
PROJECT	Texaco - Environmental Audit
SAMPLING COMPANY	Fugro- McClelland
SAMPLING SITE	Ecuador - Oriente
TEAM LEADER	Roy D. Roberts

PACKED BY	
SEAL NUMBER	
SEAL INTACT UPON RECEIPT BY SAMPLING COMPANY	
CONDITION OF CONTENTS	
SEALED FOR SHIPPING BY	
INITIAL CONTENTS TEMP	°C
SEAL NUMBER	
SAMPLING STATUS	☐ Done ☐ Continuing Until
SEAL INTACT UPON RECEIPT BY LAB	☒ Yes ☐ No
CONTENTS TEMPERATURE UPON RECEIPT BY LAB	24.4 °C

	DATE	TIME	SAMPLE ID/DESCRIPTION	SAMPLE TYPE	# CONTAINERS	ANALYSIS PARAMETERS	REMARKS
11	5/26/92 ~~1200~~	1200	CRUDE OIL F/SPILL @ SFF 53	Soil	1 2oz	FINGERPRINT	Hold All Samples
12	5/26/92	1320	CRUDE OIL F/SPILL @ SFF CENTRAL BY PETROINDUSTRIAL'S COMPRESSOR	Soil	1 2oz	"	FOR POSSIBLE FURTHER ANALYSIS
13	5/26/92	1340	CRUDE OIL F/SFF #61 PIT	Crude Oil	1 40ml VOA	"	
14	5/26/92	1400	CRUDE OIL F/SFF #45B PIT	Crude Oil	40ml VOA	"	
15	5/26/92	1420	CRUDE OIL F/SFF #73 PIT	Crude Oil	40ml VOA	"	
16	5/26/92	1440	CRUDE OIL F SURGE TANK SHIPPING	Crude Oil	40ml VOA	"	
23180	~~5/27/92~~		PUMP @ SFF CENTRAL				
01	5/27/92	0800	CRUDE OIL F/SACHA 52 PIT	Crude Oil	1 40ml VOA	"	ANALYZE SAMPLES F/
02	5/27/92	0835	CRUDE OIL F/SPILL ~100' N. OF SACHA SUR. FACILITY	Crude Oil	2 40ml VOA	"	SACHA FIRST.
03	5/27/92	0915	CRUDE OIL F/SACHA 84 PIT	Crude Oil	2 40ml VOA	"	

CUSTODY TRANSFERS PRIOR TO SHIPPING

RELINQUISHED BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME
Roy D. Roberts			

SHIPPING DETAILS

DELIVERED TO SHIPPER BY	Roy D. Roberts
METHOD OF SHIPMENT	DHL
AIRBILL NUMBER	538643114
RECEIVED FOR LAB	RMW
SIGNED	[signature]
DATE/TIME	6/4/92
ENSECO PROJECT NUMBER	23538

085-113

White - CLIENT Pink - LAB

CONFIDENTIAL
PET 039798

CA1068545

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

Enseco
A Corning Company

Rocky Mountain Analytical Laboratory
4955 Yarrow Street
Arvada, CO 80002
303/421-6611 FAX: 303/431-7171

CHAIN OF CUSTODY

ENSECO CLIENT: FUGRO - McCLELLAND
PROJECT: TEXACO - ENVIRONMENTAL AUDIT
SAMPLING COMPANY: FUGRO - McCLELLAND
SAMPLING SITE: ECUADOR ORIENTE
TEAM LEADER: ROY D. ROBERTS

SAMPLE SAFE™ CONDITIONS

PACKED BY:
SEAL NUMBER:
SEAL INTACT UPON RECEIPT BY SAMPLING COMPANY:
CONDITION OF CONTENTS:
SEALED FOR SHIPPING BY:
INITIAL CONTENTS TEMP: °C
SEAL NUMBER:
SAMPLING STATUS: ☐ Done ☐ Continuing Until
SEAL INTACT UPON RECEIPT BY LAB: ☒ Yes ☐ No
CONTENTS TEMPERATURE UPON RECEIPT BY LAB: 24.4 °C

23540

	DATE	TIME	SAMPLE ID/DESCRIPTION	SAMPLE TYPE	# CONTAINERS	ANALYSIS PARAMETERS	REMARKS
04	5/27/92	0950	CRUDE OIL F/DISCHARGE SACHA 28 (PIT AREA)	CRUDE OIL	2 40ml VOA	FINGERPRINT	HOLD ALL SAMPLES
05	5/27/92	1050	CRUDE OIL F/SACHA 116 PIT	CRUDE OIL	2 40ml VOA	"	FOR POSSIBLE
06	5/27/92	1200	CRUDE OIL F/SPILL @ SACHA 20	CRUDE OIL	2 40ml VOA	"	FURTHER ANALYSIS
07	5/27/92	1500	CRUDE OIL F/SACHA 74 PIT	CRUDE OIL	2 40ml VOA	"	
08	5/27/92	1600	CRUDE OIL F/SHIPPING PUMPS CENTRAL SACHA	CRUDE OIL	2 2 oz	"	
09	5/27/90	1700	CRUDE OIL F/SACHA 78 PIT	CRUDE OIL	2 40ml VOA	"	
23533 17	5/30/90	0835	CRUDE OIL F/SHIPPING PUMP LAGO AGRIO CENTRAL	CRUDE OIL	2 40ml VOA	"	
18	5/30/90	1120	CRUDE OIL F/PARAHUACU #3 PIT	CRUDE OIL	1 40ml VOA	"	
19	5/30/90	1150	CRUDE OIL F/SPILL @ PARAHUACU #2	CRUDE OIL	1 40ml VOA	"	
20	5/30/90	1210	CRUDE OIL F/SHIPPING PUMPS PARAHUACU FACILITY	CRUDE OIL	1 40ml VOA	"	

CUSTODY TRANSFERS PRIOR TO SHIPPING

RELINQUISHED BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME
Roy D. Roberts			

SHIPPING DETAILS

DELIVERED TO SHIPPER BY: Roy D. Roberts
METHOD OF SHIPMENT: DHL
AIRBILL NUMBER: 5386473114
RECEIVED FOR LAB: RHM
SIGNED: [illegible]
DATE/TIME: 6/4/92 11:00
ENSECO PROJECT NUMBER: 23538

ENS-1133 White - CLIENT Pink - LAB

CONFIDENTIAL
PET 039799
CA1068546
CA1068546

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

Enseco
A Corning Company
Arvada, CO 80002
303/421-6611 FAX: 303/431-7171

CHAIN OF CUSTODY

ENSECO CLIENT: FUGRO-McCLELLAND
PROJECT: TEXACO-ENVIRONMENTAL AUDIT
SAMPLING COMPANY: FUGRO-McCLELLAND
SAMPLING SITE: ECUADOR-ORIENTE
TEAM LEADER: ROY D. ROBERTS

SAMPLE SAFE™ CONDITIONS

PACKED BY:
SEAL NUMBER:
SEAL INTACT UPON RECEIPT BY SAMPLING COMPANY:
CONDITION OF CONTENTS:
SEALED FOR SHIPPING BY:
INITIAL CONTENTS TEMP. °C
SEAL NUMBER:
SAMPLING STATUS: ☐ Done ☐ Continuing Until
SEAL INTACT UPON RECEIPT BY LAB: ☒ Yes ☐ No
CONTENTS TEMPERATURE UPON RECEIPT BY LAB: 24.4 °C

	DATE	TIME	SAMPLE ID/DESCRIPTION	SAMPLE TYPE	# CONTAINERS	ANALYSIS PARAMETERS	REMARKS
21	5/30/92	1600	CRUDE OIL F/LAGO AUGRIO #5 PIT	CRUDE OIL	40ml VOA	FINGERPRINT	HOLD ALL SAMPLES
22	5/30/92	1420	CRUDE OIL F/GUANTA #7 PIT	CRUDE OIL	40ml VOA	"	FOR POSSIBLE
							FURTHER ANALYSIS

CUSTODY TRANSFERS PRIOR TO SHIPPING

RELINQUISHED BY (SIGNED)	RECEIVED BY (SIGNED)	DATE	TIME
Roy D. Roberts			

SHIPPING DETAILS

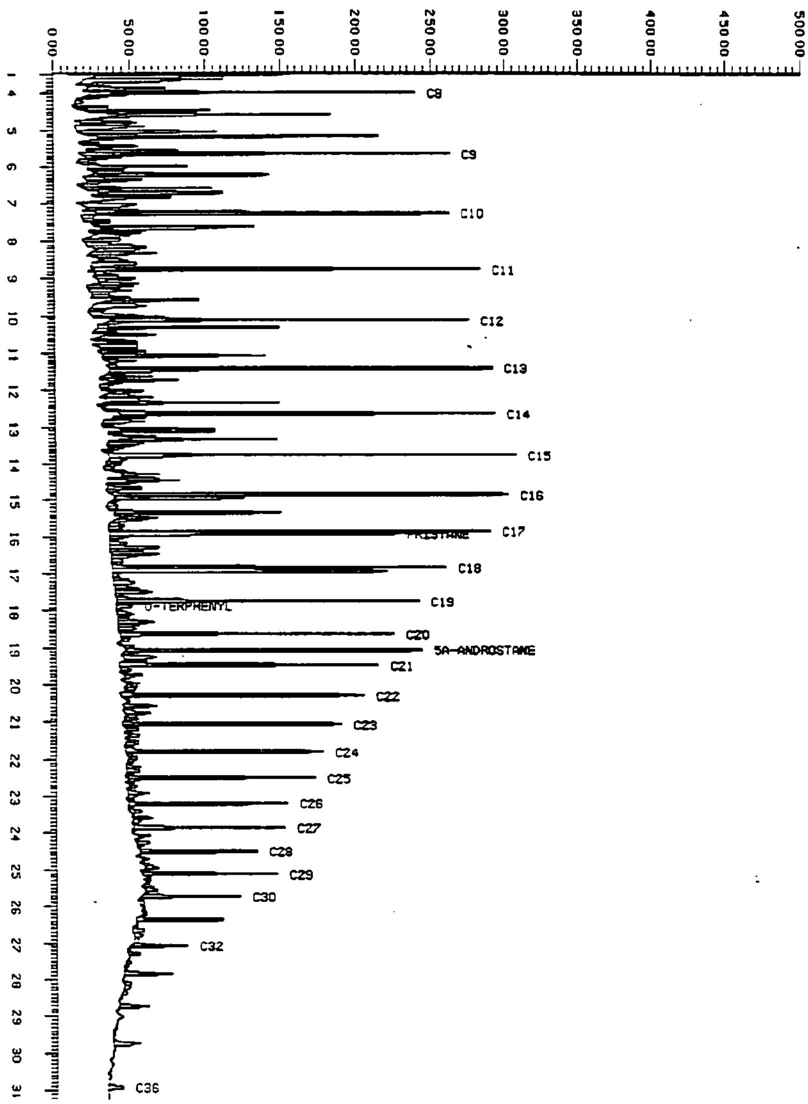
DELIVERED TO SHIPPER BY: Roy D. Roberts
METHOD OF SHIPMENT: DHL
AIRBILL NUMBER: 5386431114
RECEIVED FOR LAB: PMAZ
SIGNED: [signature]
DATE/TIME: 6/4/92 11:00
ENSECO PROJECT NUMBER: 23538

CONFIDENTIAL
PET 039800
CA1068547
CA1068547

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,9,1

23538-16 AMT=1.03G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 17:46
Reported on 28-JUL-1992 at 08:38
Box 1 (of 1)



CRUDE OIL F/SURGE TANK SHIPPING PUMP @ SFF CENTRAL

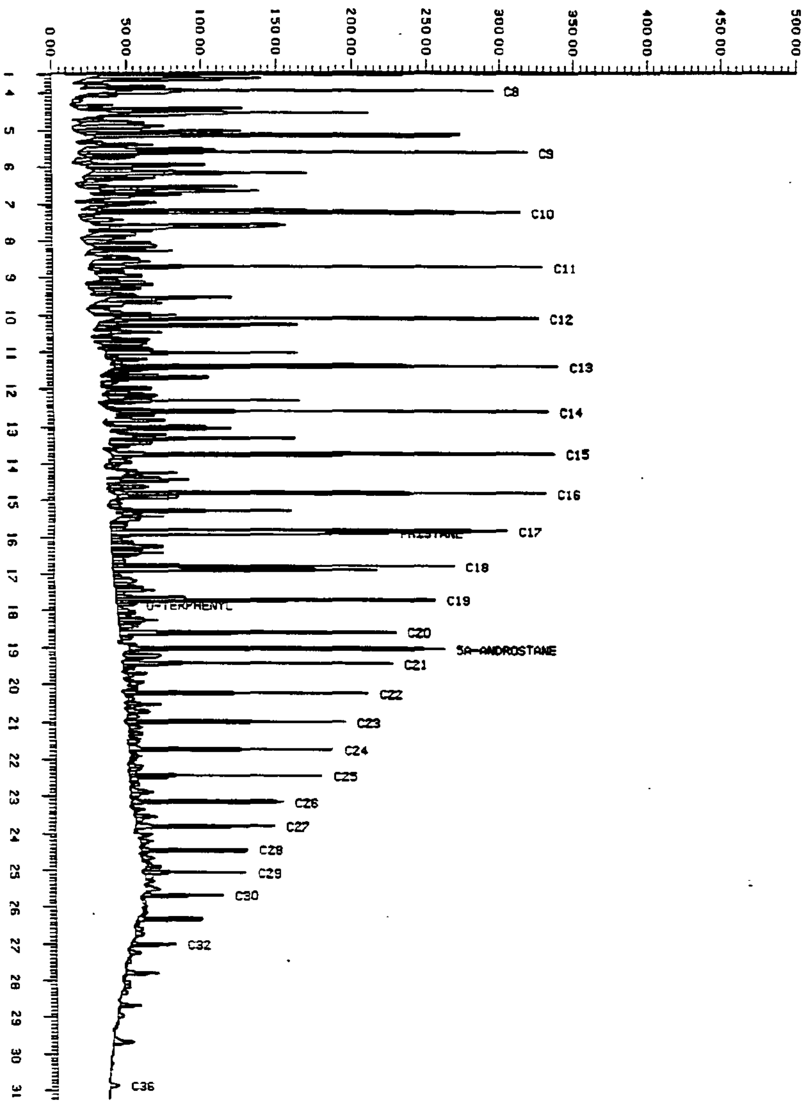
CONFIDENTIAL
PET 039801

CA1068548

RMAL Chromatography System on DENCR2

{FID06_4} 24 003JUL92,13,1

23538-20 AMT=1.03G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 21:05
Reported on 28-JUL-1992 at 08:40
Box 1 (of 1)



CRUDE OIL F/SHIPPING PUMPS PARAHUACU FACILITY

CONFIDENTIAL
PET 039802

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

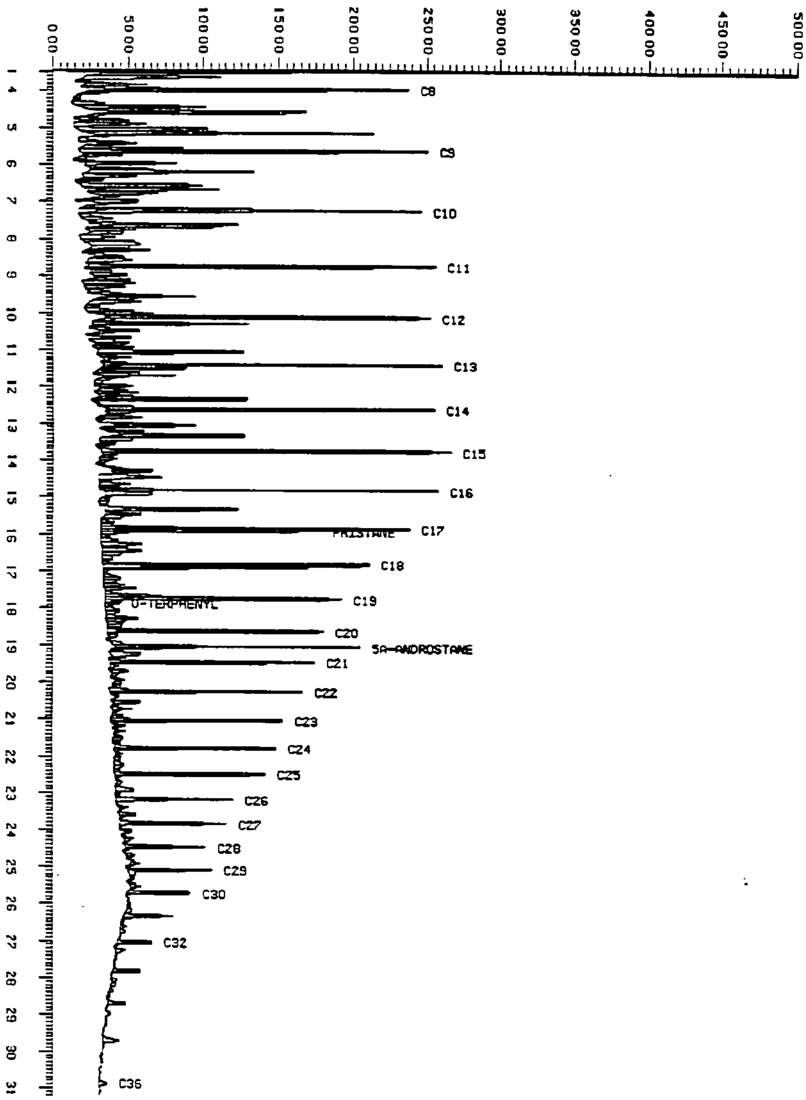
CA1068549

CA1068549

RMAL Chromatography System on DENCR2

[FID06_4] 24 C03JUL92,14,1

23538-21 AMT=1.01G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 21:54
Reported on 28-JUL-1992 at 08:41
Box 1 (of 1)



CRUDE OIL F/LAGO AUGRIO #5 PIT

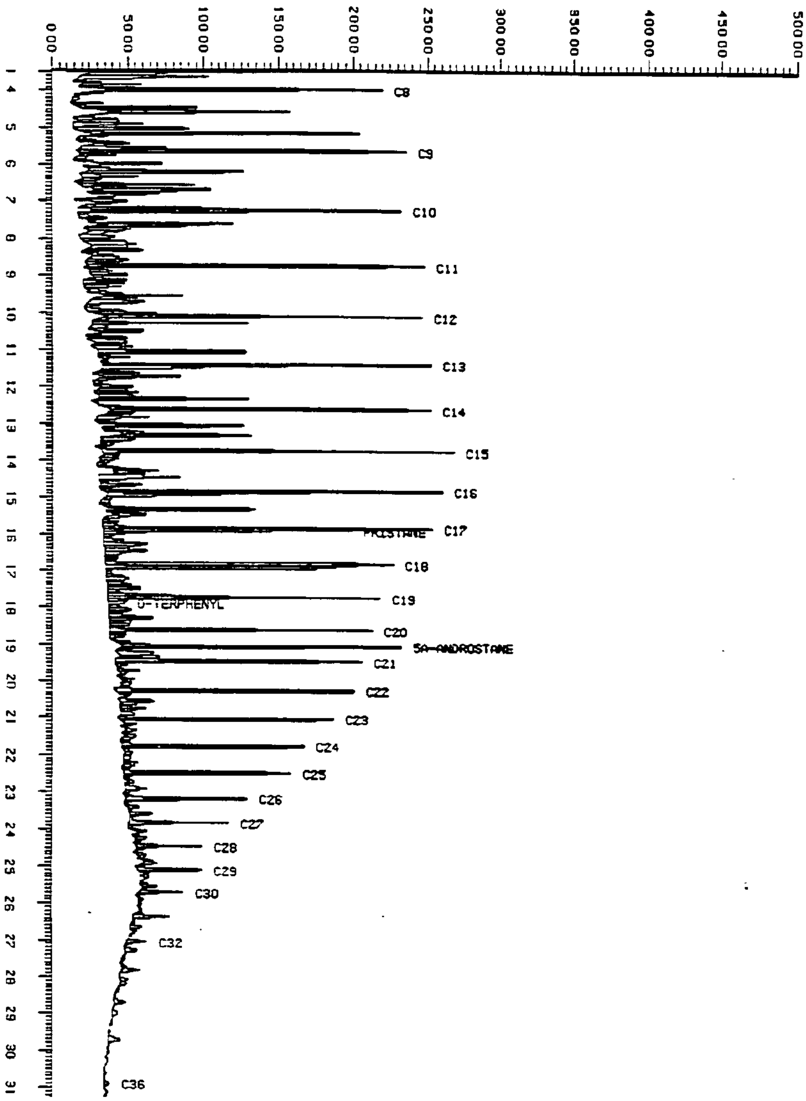
CONFIDENTIAL
PET 039803

CA1068550

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,10,1

23538-17 AMT=1.02G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 18:36
Reported on 28-JUL-1992 at 08:38
Box 1 (of 1)



CRUDE OIL F/SHIPPING PUMP LAGO AUGRIO CENTRAL

CONFIDENTIAL
PET 039804

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

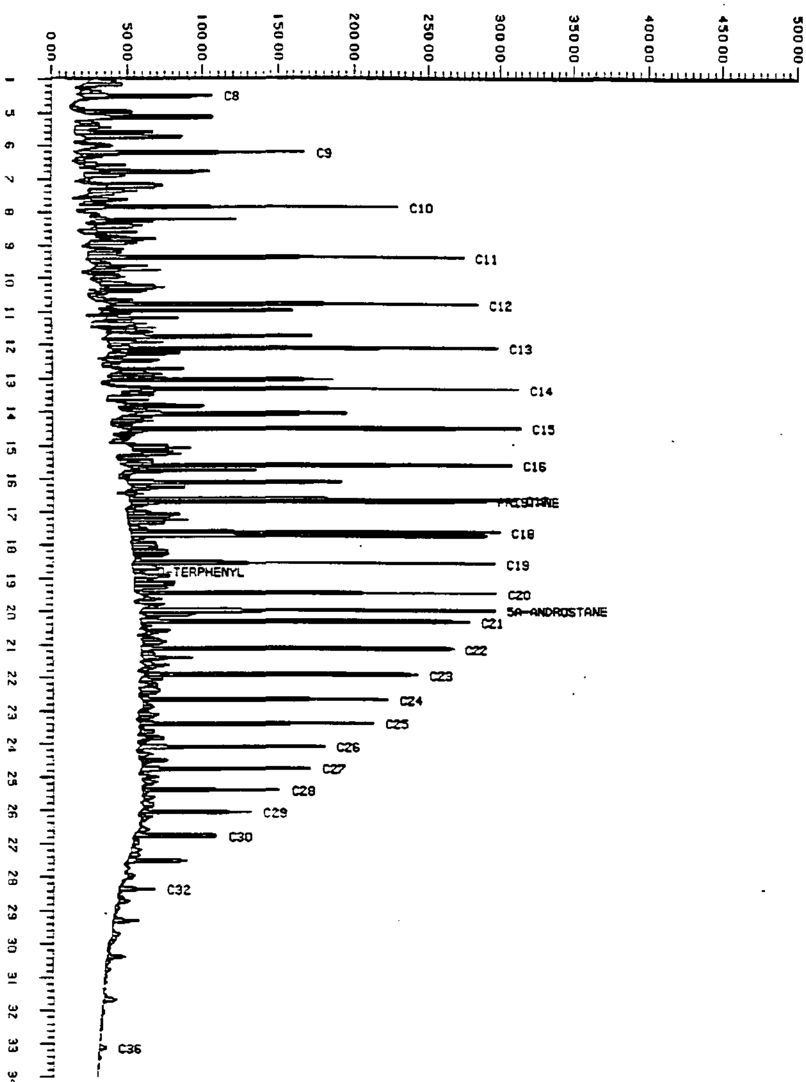
CA1068551

CA1068551

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,5,1

23538-01 AMT=1.01G PDIL= 5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 14:26
Reported on 28-JUL-1992 at 08:53
Box 1 (of 1)



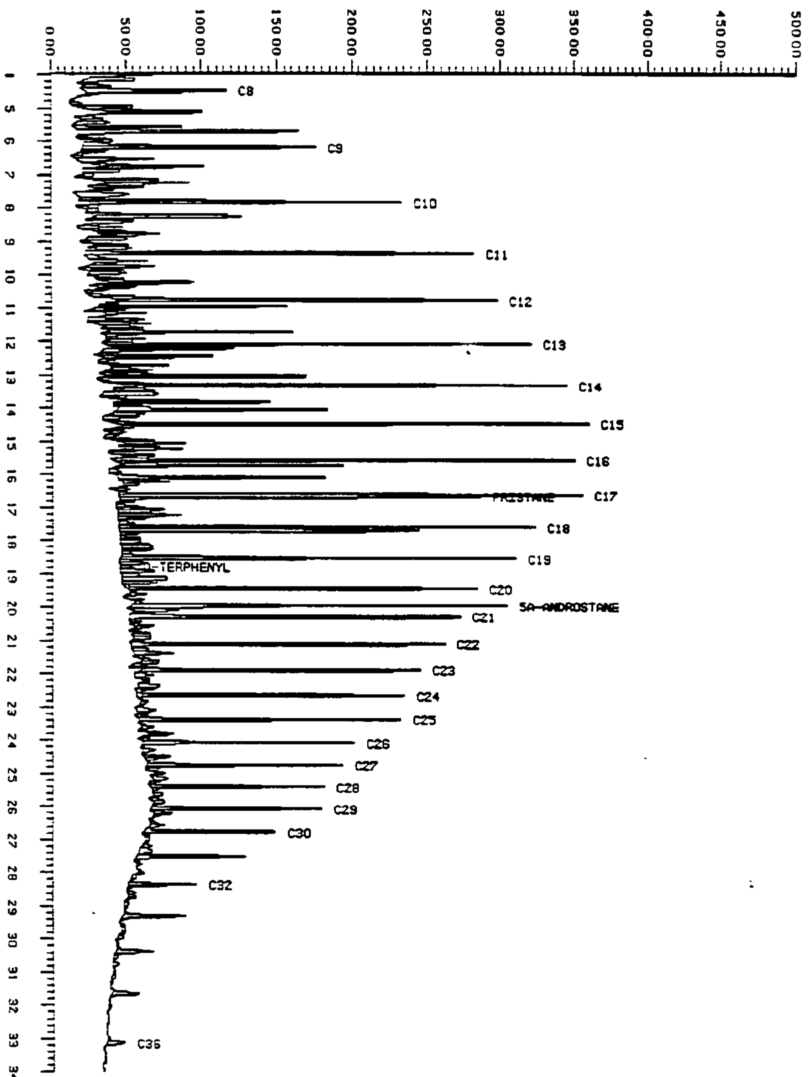
CRUDE OIL F/AUCA SUR #1 & #2 PUMP

CONFIDENTIAL
PET 039805

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,12,1

23538-08 AMT=1.01G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 20:16
Reported on 28-JUL-1992 at 08:56
Box 1 (of 1)



CRUDE OIL F/SURGE TANK @ AGUARICO PRODUCTION FACILITY

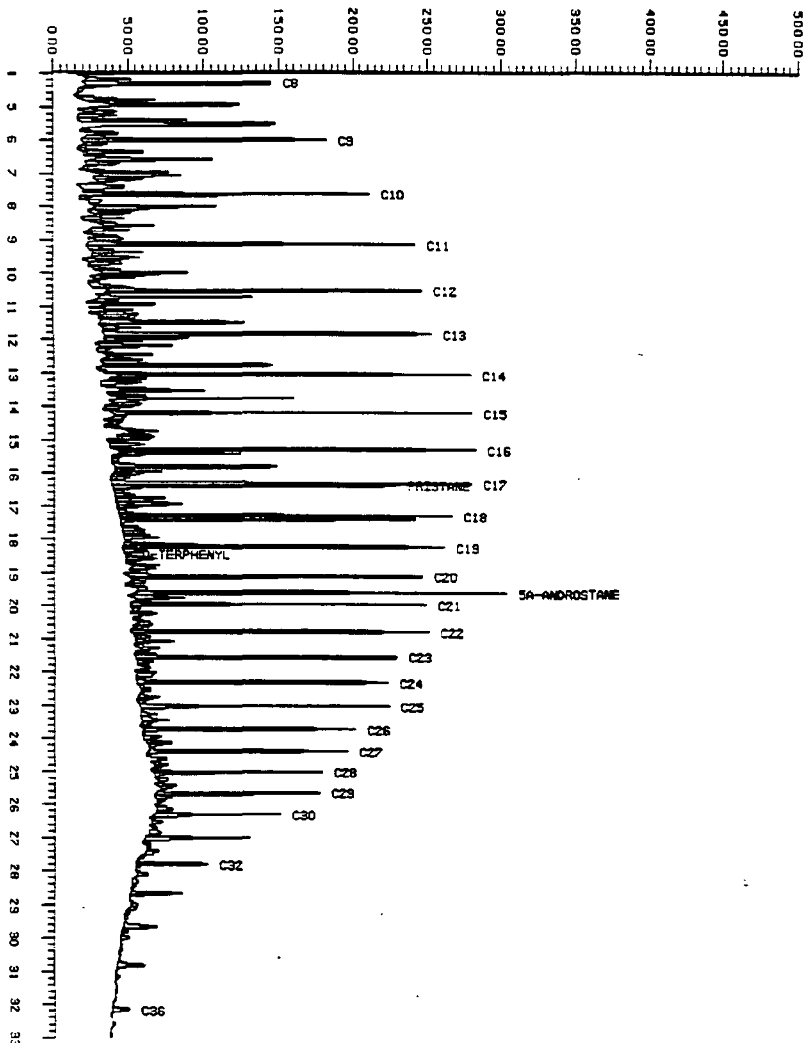
CONFIDENTIAL
PET 039806

CA1068553

RMAL Chromatography System on DENCR2

[FID06_2] 24 016JUN92,15,1

23180-08 PDIL=5% AMT=1.0G.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 12:24
Reported on 28-JUL-1992 at 09:08
Box 1 (of 1)



CRUDE OIL F/SHIPPING PUMPS CENTRAL SACHA

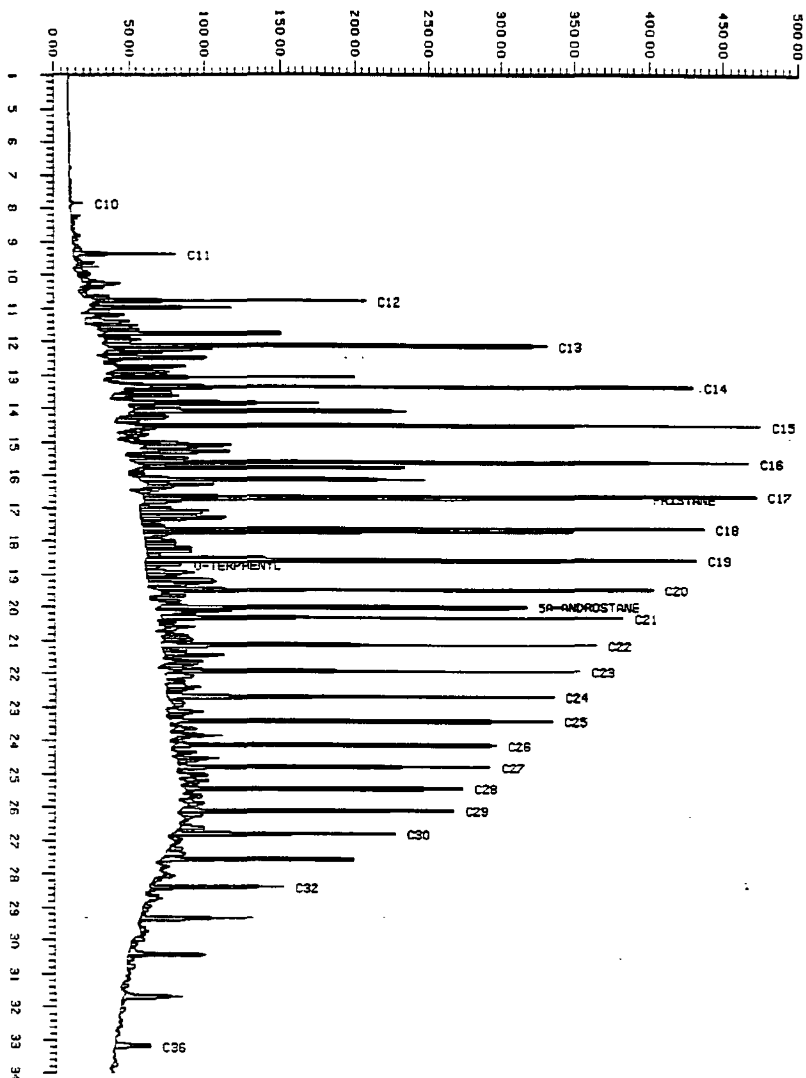
CONFIDENTIAL
PET 039807

CA1068554

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,14,1

23538-10 AMT=1.00G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 21:54
Reported on 28-JUL-1992 at 08:57
Box 1 (of 1)



CRUDE OIL F/SPILL @ CREEK 200' S. AGUARICO #10

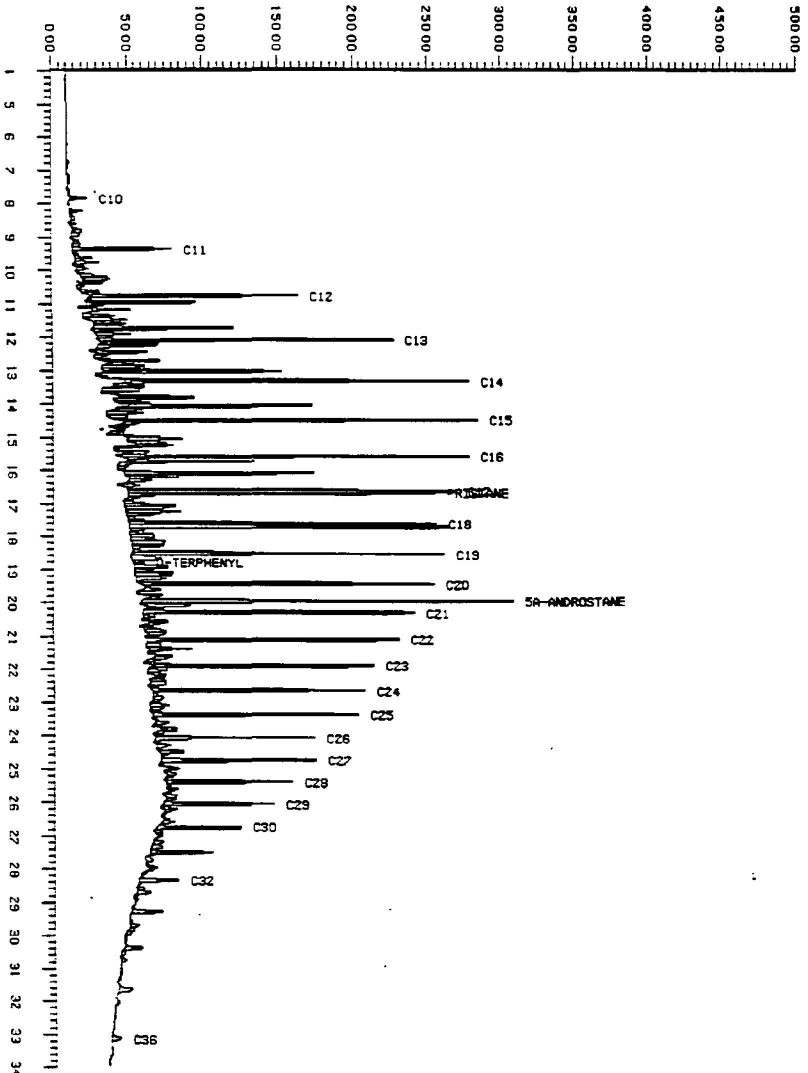
CONFIDENTIAL
PET 039808

CA1068555

RMAL Chromatography System on DENCR2

{FID06_4} 23 003JUL92,8,1

23538-04 AMT=1.02G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 16:56
Reported on 28-JUL-1992 at 08:54
Box 1 (of 1)



CRUDE OIL F/SPILL N. OF ROAD AUCA #15 & S. OF RIO TIPUTINI

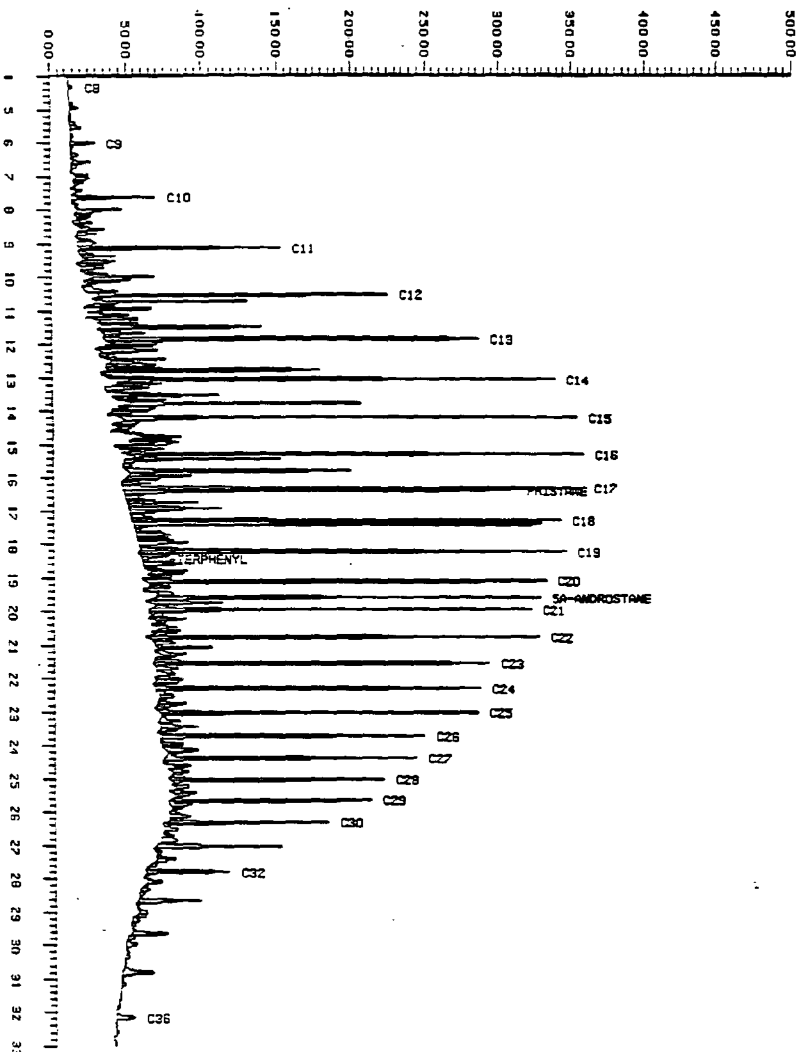
CONFIDENTIAL
PET 039809

CA1068556

RMAL Chromatography System on DENCR2

[FID06_2] 24 C16JUN92,9,1

23180-02 PDIL=5% AMT=1.0G.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 07:30
Reported on 28-JUL-1992 at 09:06
Box 1 (of 1)



CRUDE OIL F/SPILL 100' N. OF SACHA SUR FACILITY

CONFIDENTIAL
PET 039810

CA1068557

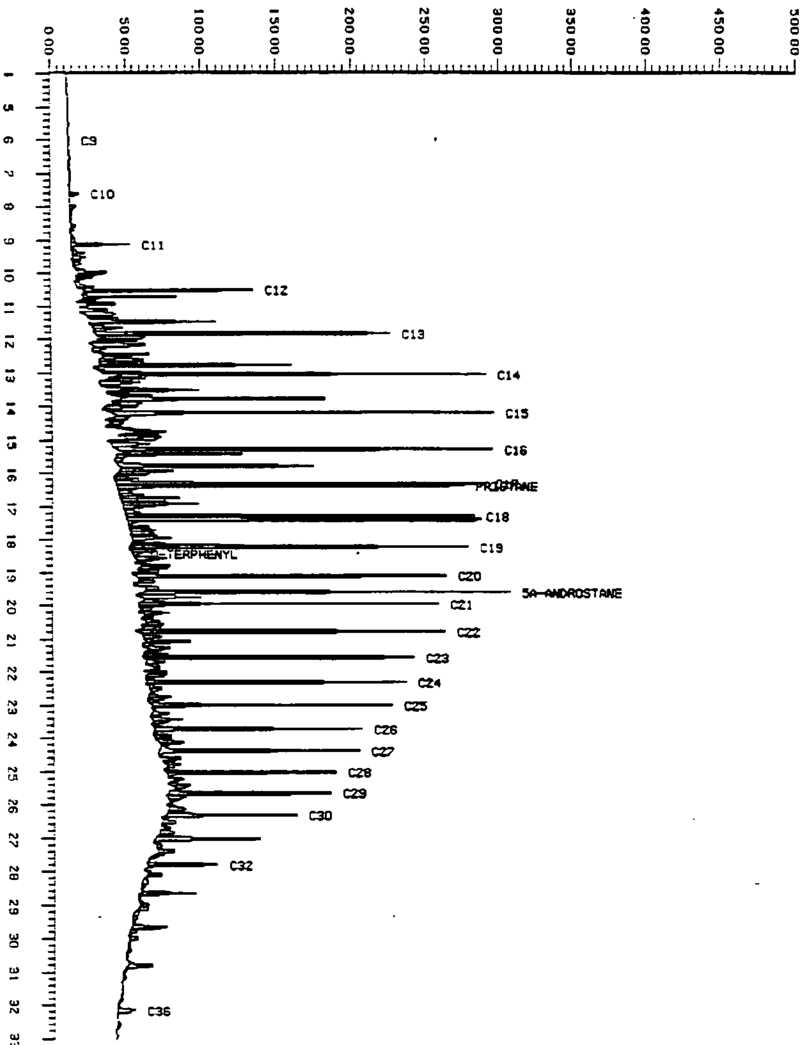
CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068557

RMAL Chromatography System on DENCR2

[FID06_2] 24 O16JUN92,13,1

23180-06 PDIL=5% AMT=1.0G.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 10:45
Reported on 28-JUL-1992 at 09:07
Box 1 (of 1)



CRUDE OIL F/SPILL @ SACHA 20

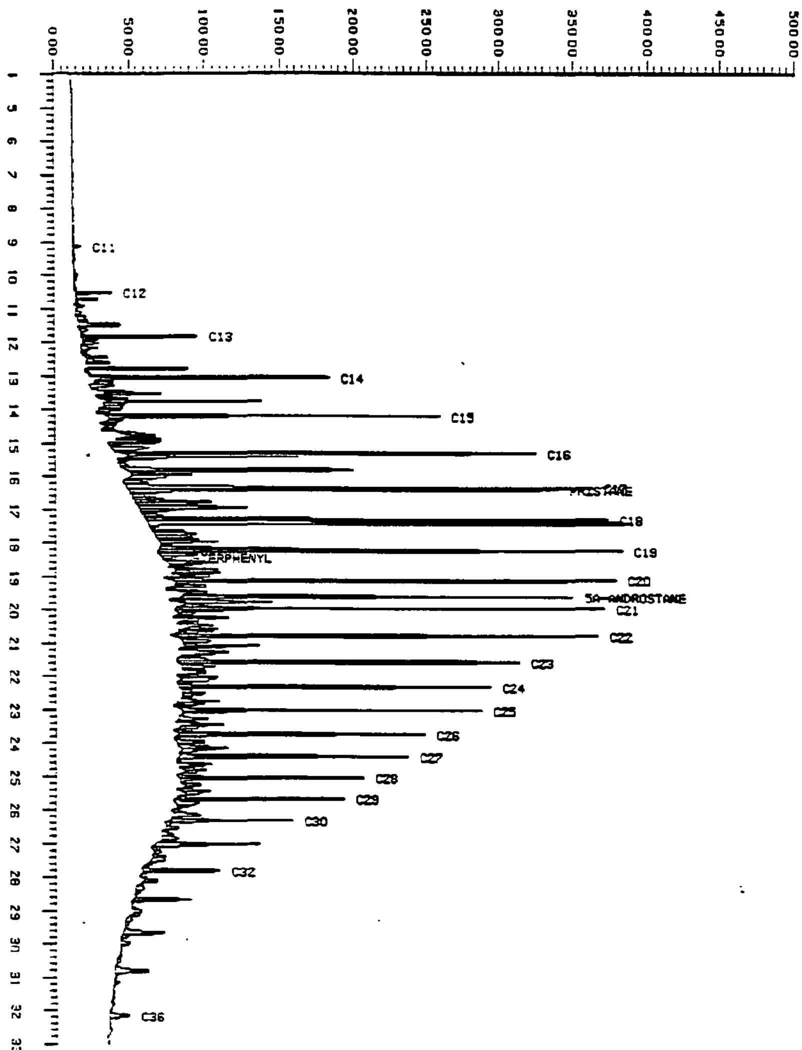
CONFIDENTIAL
PET 039811

CA1068558

RMAL Chromatography System on DENCR2

{FID06_2} 24 016JUN92,8,1

23180-01 PDIL=5% AMT=1.0G. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 06:41
Reported on 28-JUL-1992 at 09:06
Box 1 (of 1)



CRUDE OIL F/SACHA 52 PIT

CONFIDENTIAL
PET 039812

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

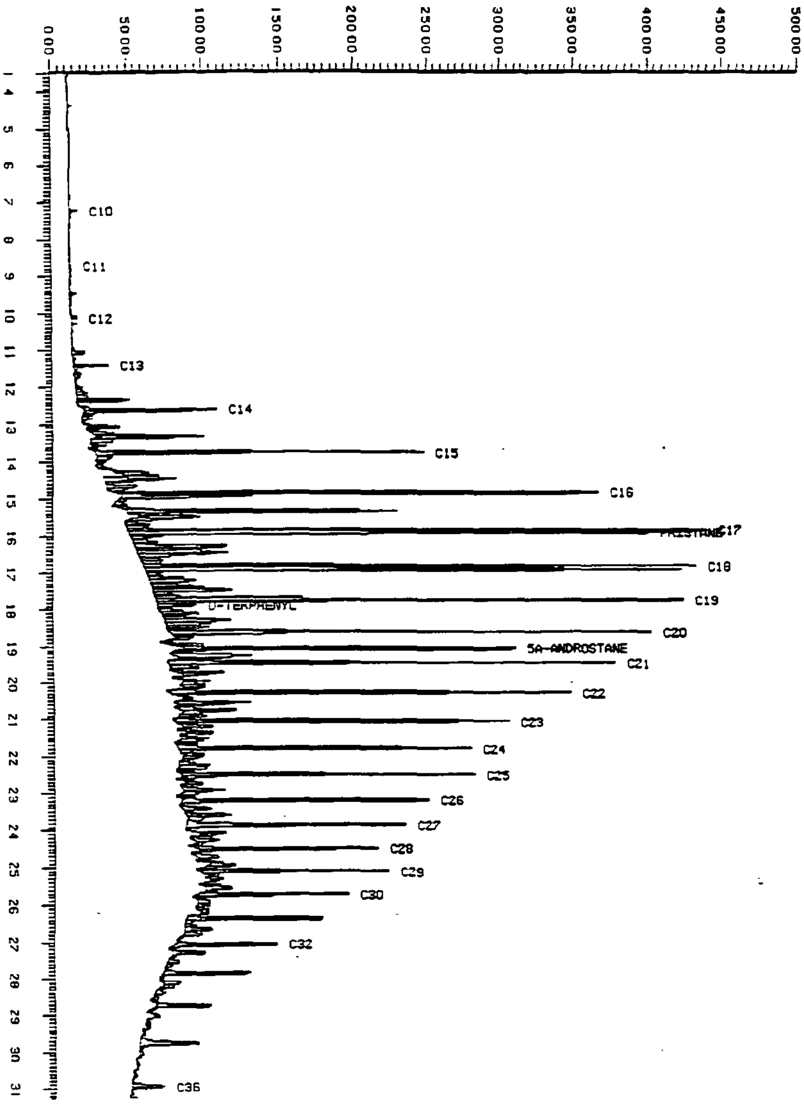
CA1068559

CA1068559

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,7,1

.3538-14 AMT=1.04G PDIL=5% EV=10ML. Amount : 1.000.
:ESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
.cquired on 3-JUL-1992 at 16:06
:eported on 28-JUL-1992 at 08:37
:ox 1 (of 1)



CRUDE OIL F/SFF #45B PIT

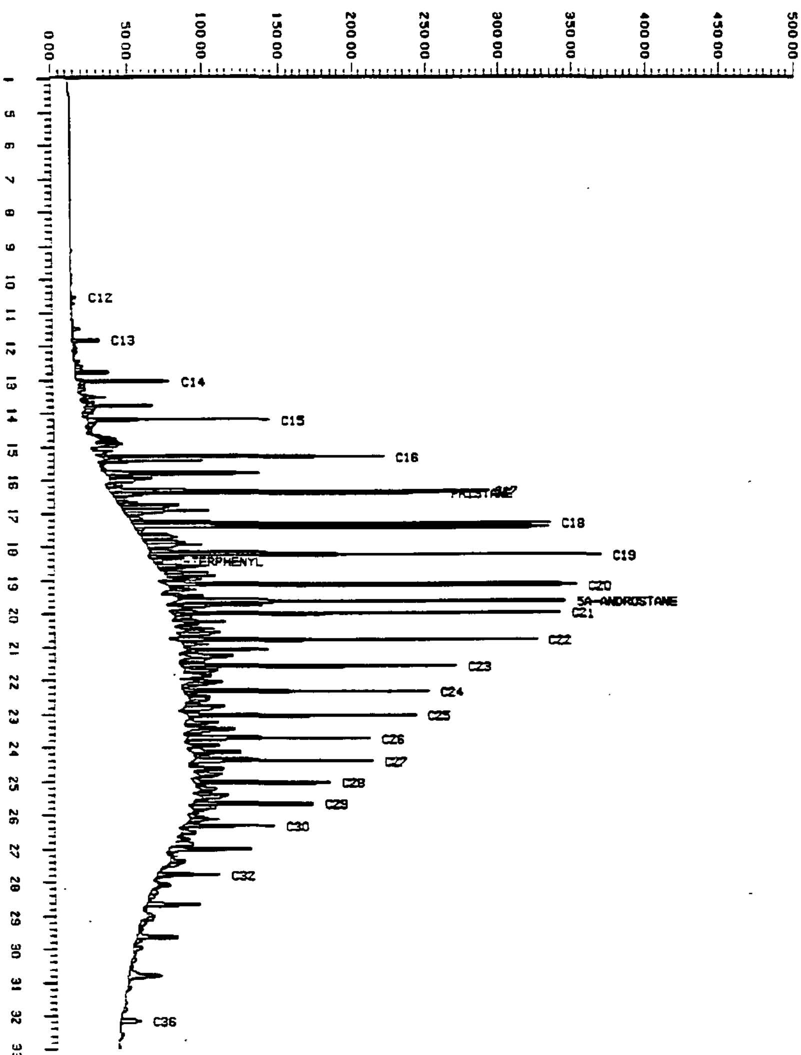
CONFIDENTIAL
PET 039813

CA1068560

RMAL Chromatography System on DENCR2

(FID06_2) 24 O16JUN92,10,1

23180-03 PDIL=5% AMT=1.0G.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 08:19
Reported on 28-JUL-1992 at 09:06
Box 1 (of 1)



CRUDE OIL F/SACHA 84 PIT

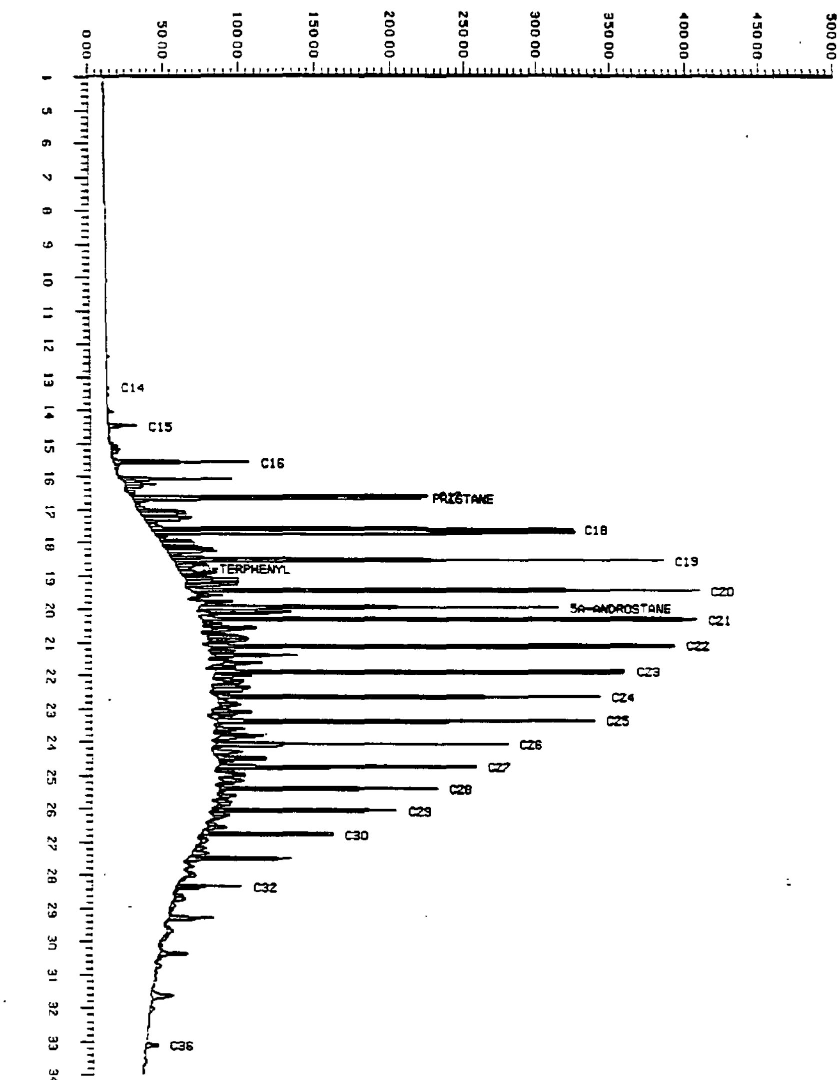
CONFIDENTIAL
PET 039814

CA1068561

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,9,1

23538-05 AMT=1.03G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 17:46
Reported on 28-JUL-1992 at 08:54
Box 1 (of 1)



CRUDE OIL F/SPILL @ AUCA #25

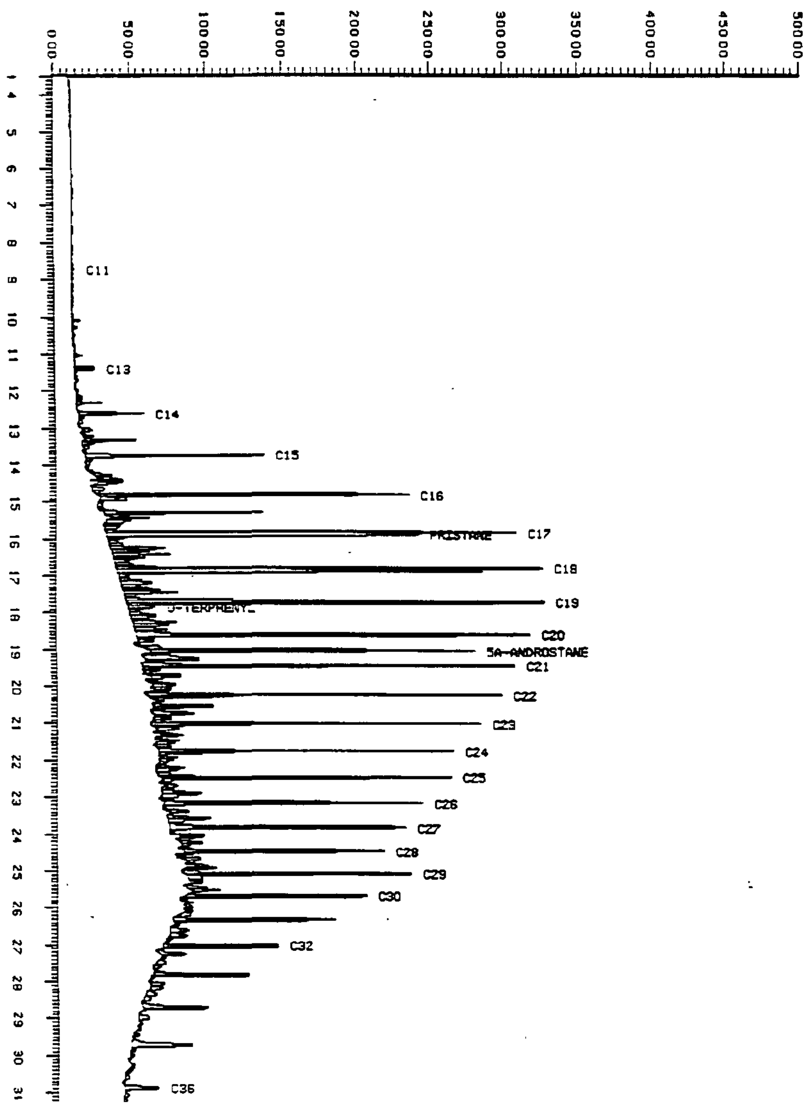
CONFIDENTIAL
PET 039815

CA1068562

RMAL Chromatography System on DENCR2

[FID07_1] 24 009JUL92,16,1

23538-22 AMT=1.02G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 9-JUL-1992 at 20:26
Reported on 28-JUL-1992 at 08:45
Box 1 (cf 1)



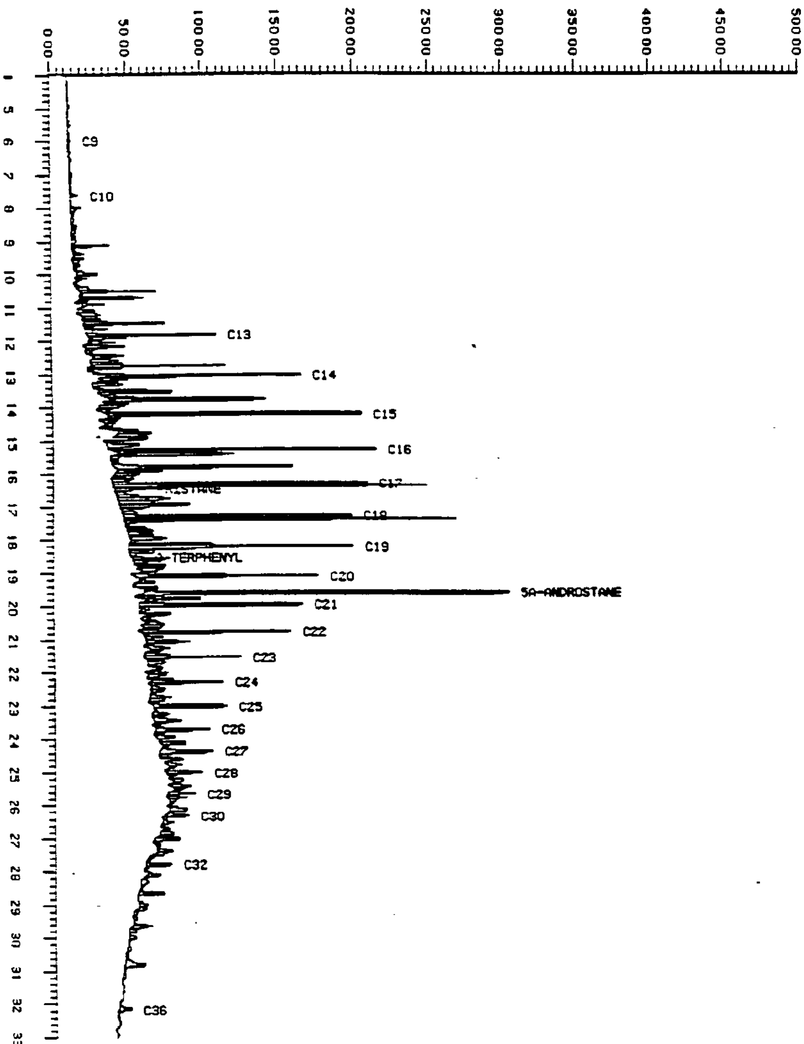
CRUDE OIL F/GUANTA #7 PIT

CONFIDENTIAL
PET 039816

RMAL Chromatography System on DENCR2

[FID06_2] 24 016JUN92,11,1

23180-04 PDIL=5% AMT=1.0G. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 09:08
Reported on 28-JUL-1992 at 09:07
Box 1 (of 1)



CRUDE OIL F/DISCHARGE SACHA 28
(PIT AREA)

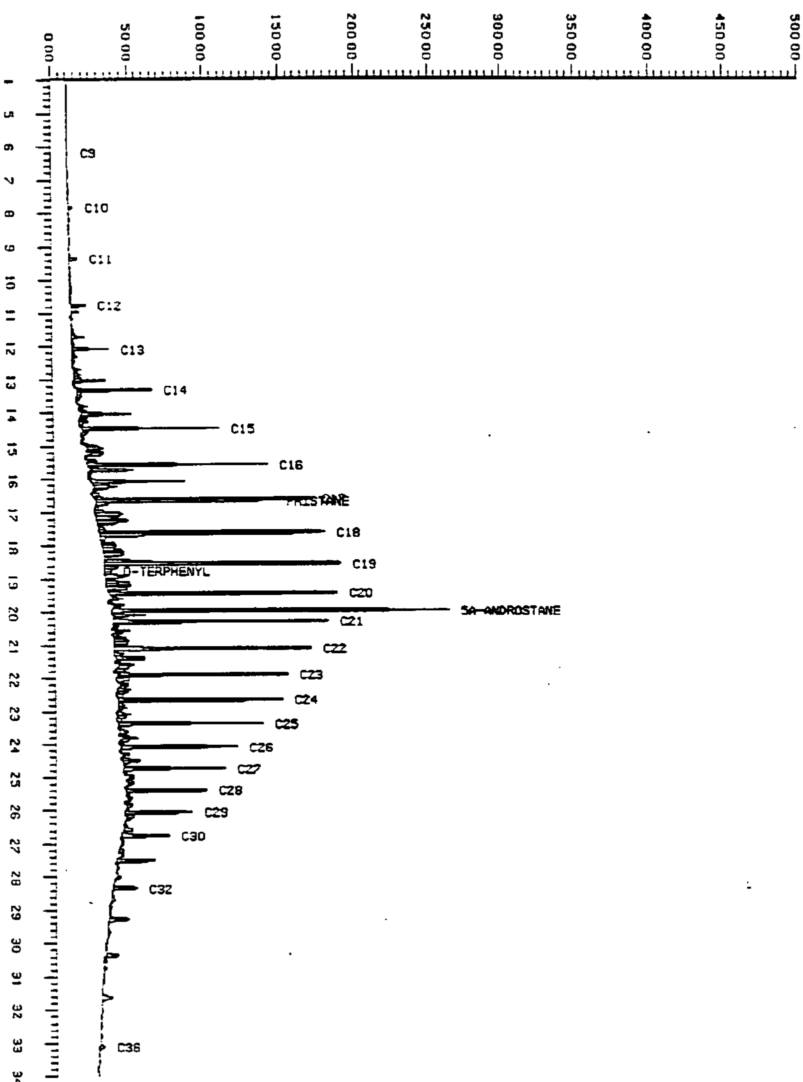
CONFIDENTIAL
PET 039817

CA1068564

RMAL Chromatography System on DENCR2

{FID06_4} 23 003JUL92,10,1

23538-06 AMT=1.02G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 18:36
Reported on 28-JUL-1992 at 08:55
Box 1 (of 1)



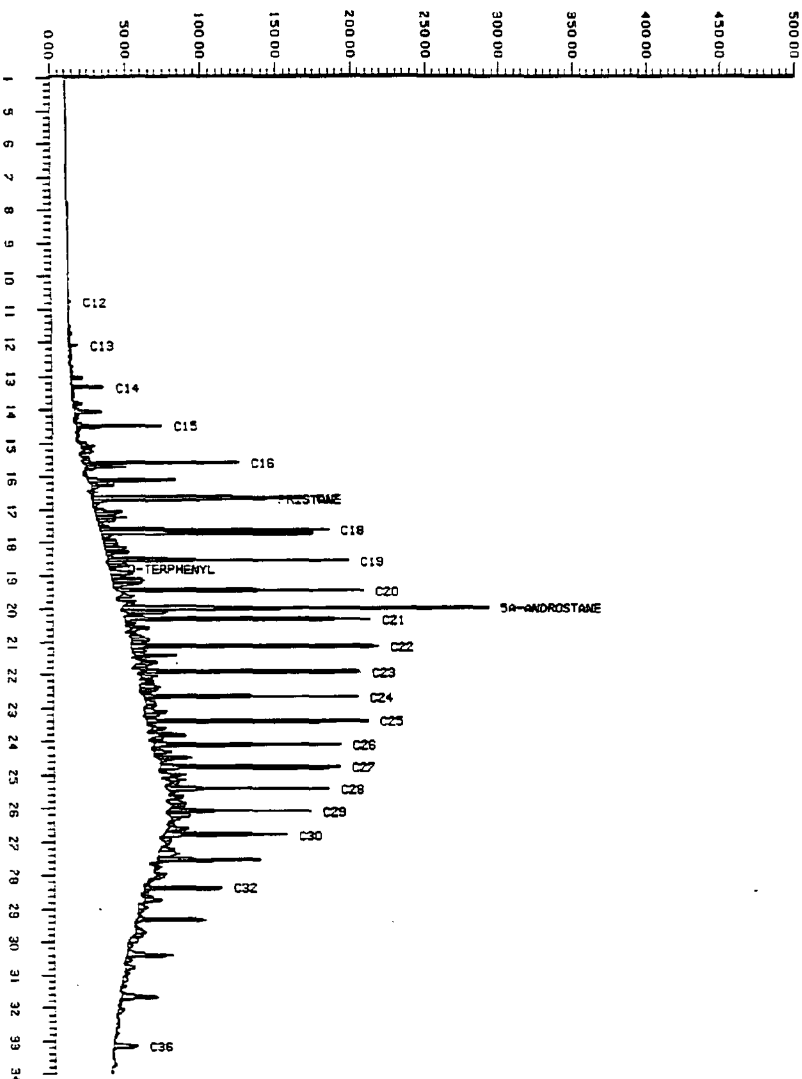
CRUDE OIL F/SPILL N. OF AUCA CENTRAL (3.5 KM APPROX.)

CONFIDENTIAL
PET 039818

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,11,1

23538-07 AMT=1.06G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 19:26
Reported on 28-JUL-1992 at 08:55
Box 1 (of 1)



CRUDE OIL F/AGUARICO #2 PIT

CONFIDENTIAL
PET 039819

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

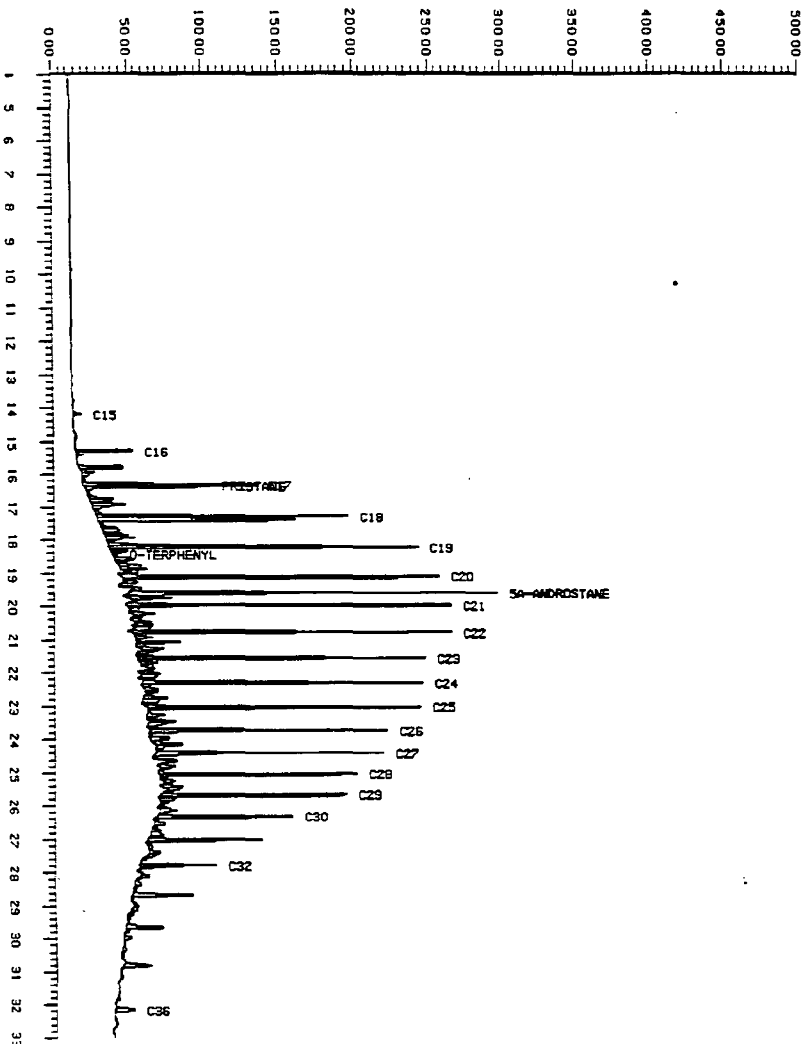
CA1068566

CA1068566

RMAL Chromatography System on DENCR2

[FID06_2] 24 O16JUN92,12,1

23180-05 PDIL=5% AMT=1.0G. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 09:57
Reported on 28-JUL-1992 at 09:07
Box 1 (of 1)



CRUDE OIL F/SACHA 116 PIT

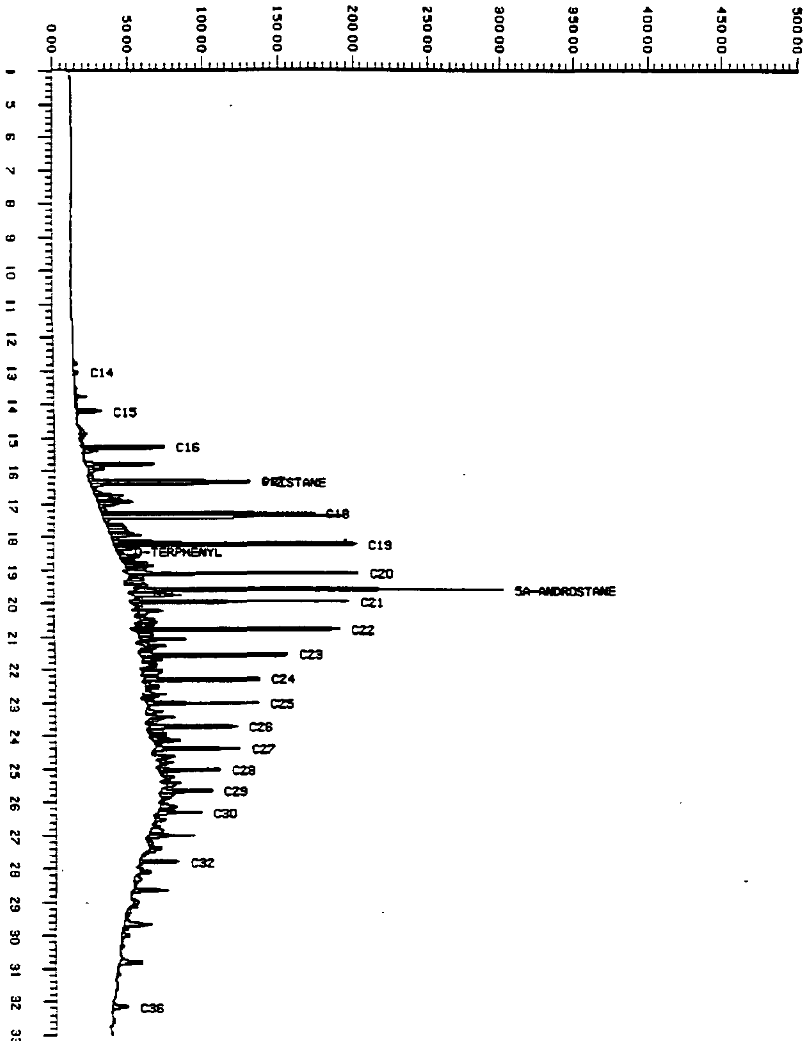
CONFIDENTIAL
PET 039820

CA1068567

RMAL Chromatography System on DENCR2

[FID06_2] 24 016JUN92,16,1

23180-09 PDIL=5% AMT=1.0G. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 13:14
Reported on 28-JUL-1992 at 09:09
Box 1 (of 1)



CRUDE OIL F/SACHA 78 PIT

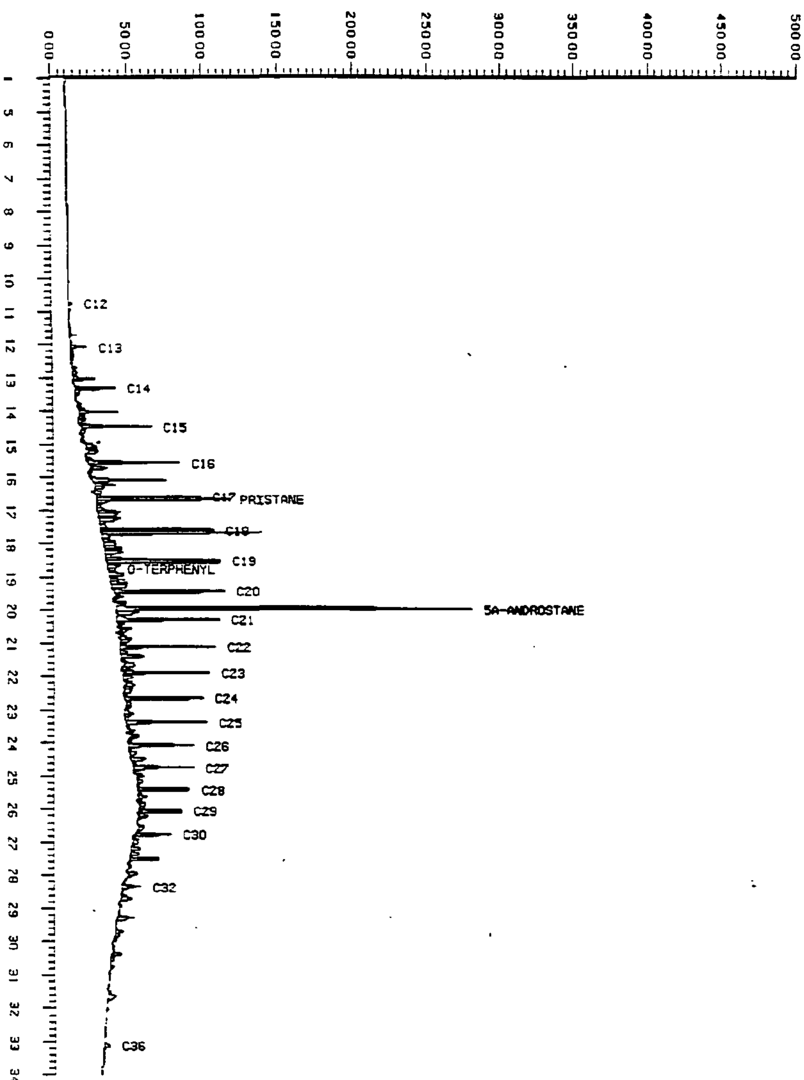
CONFIDENTIAL
PET 039821

CA1068568

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,6,1

23538-02 AMT=1.00G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 15:16
Reported on 28-JUL-1992 at 08:53
Box 1 (of 1)



CRUDE OIL F/SPILL @ ROAD TO WELL #21

CONFIDENTIAL
PET 039822

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

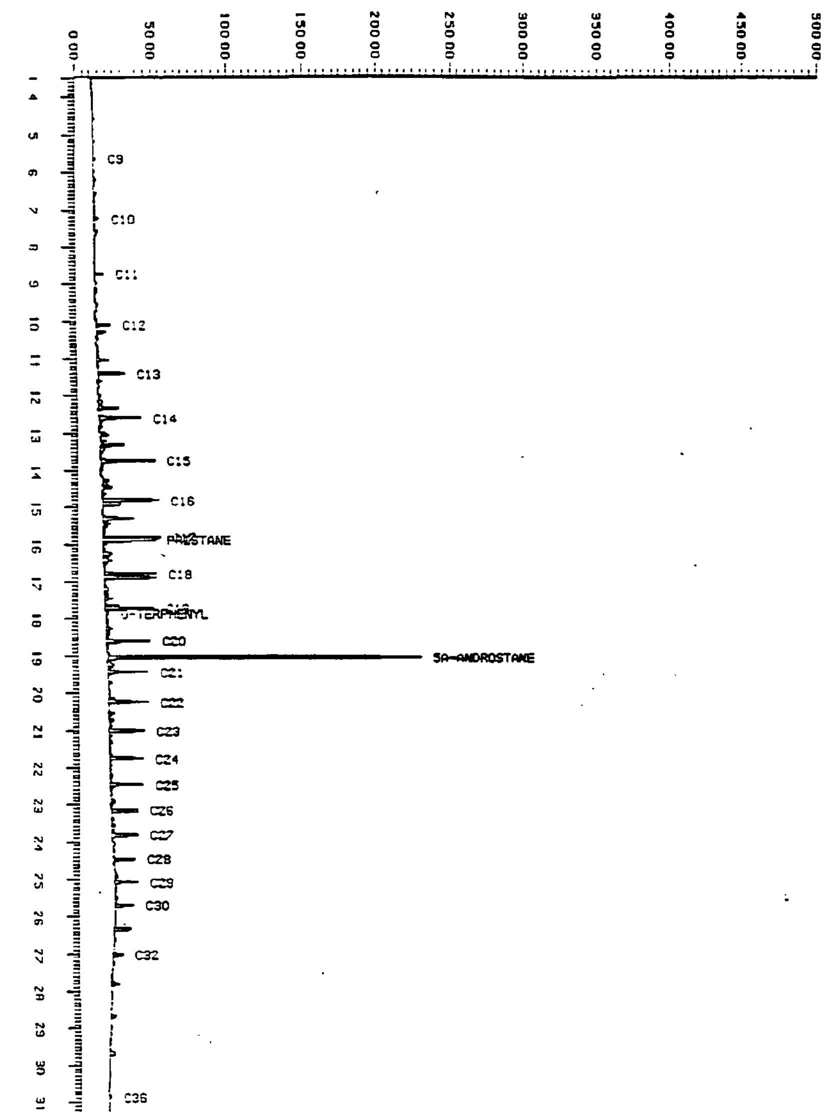
CA1068569

CA1068569

RMAL Chromatography System on DENCR2

{FID07_1} 24 009JUL92,14,1

23538-11 AMT=1.01G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 9-JUL-1992 at 18:45
Reported on 28-JUL-1992 at 08:44
Box 1 (of 1)



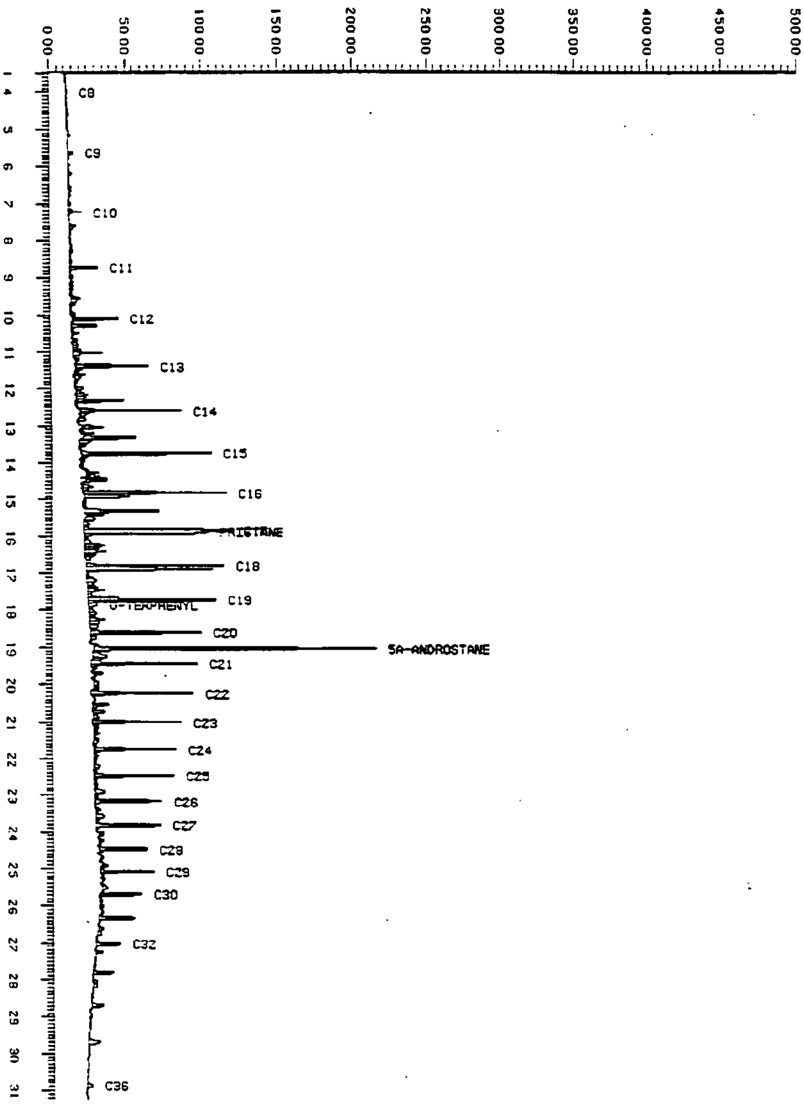
CRUDE OIL F/SPILL @ SFF 53

CONFIDENTIAL
PET 039823

RMAL Chromatography System on DENCR2

{FID06_4} 24 003JUL92,5,1

23538-12 AMT=1.04G PDIL=5% EV=10ML.   Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 14:26
Reported on 28-JUL-1992 at 08:36
Box 1 (of 1)



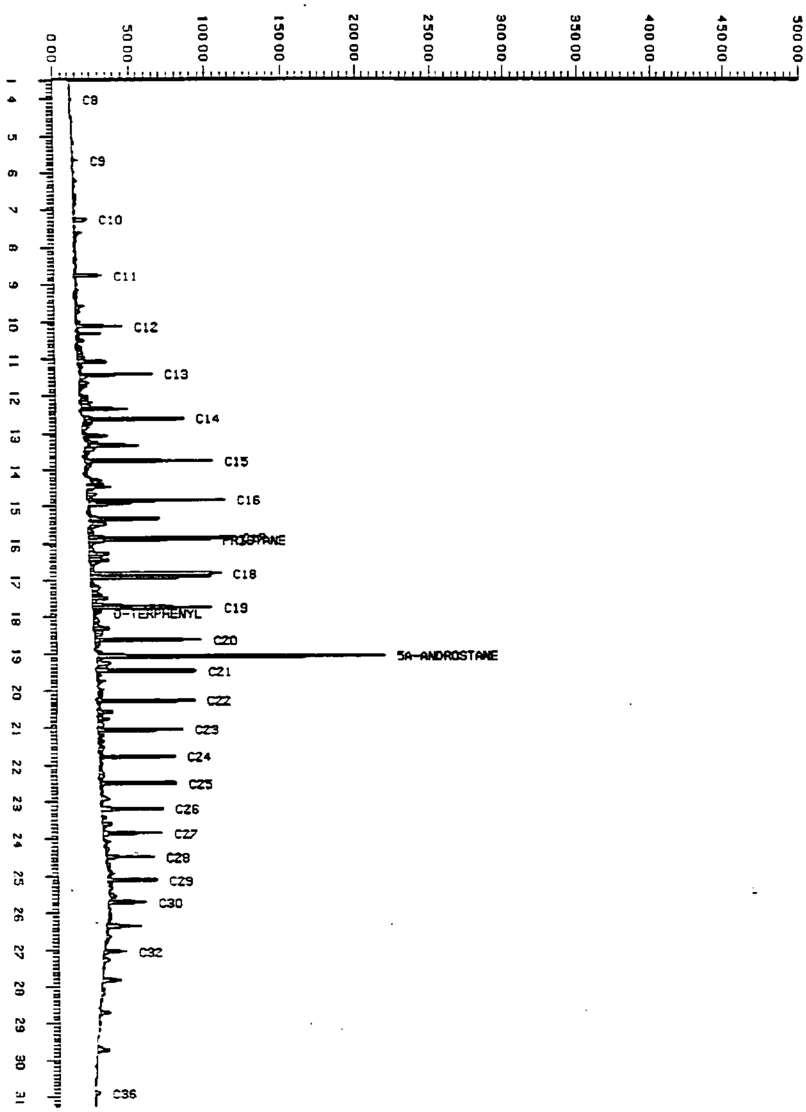
CRUDE OIL F/SPILL @ SFF CENTRAL BY PETROINDUSTRIAL'S COMPRESSOR

CONFIDENTIAL
PET 039824

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,6,1

23538-13 AMT=1.06G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 15:16
Reported on 28-JUL-1992 at 08:36
Box 1 (of 1)



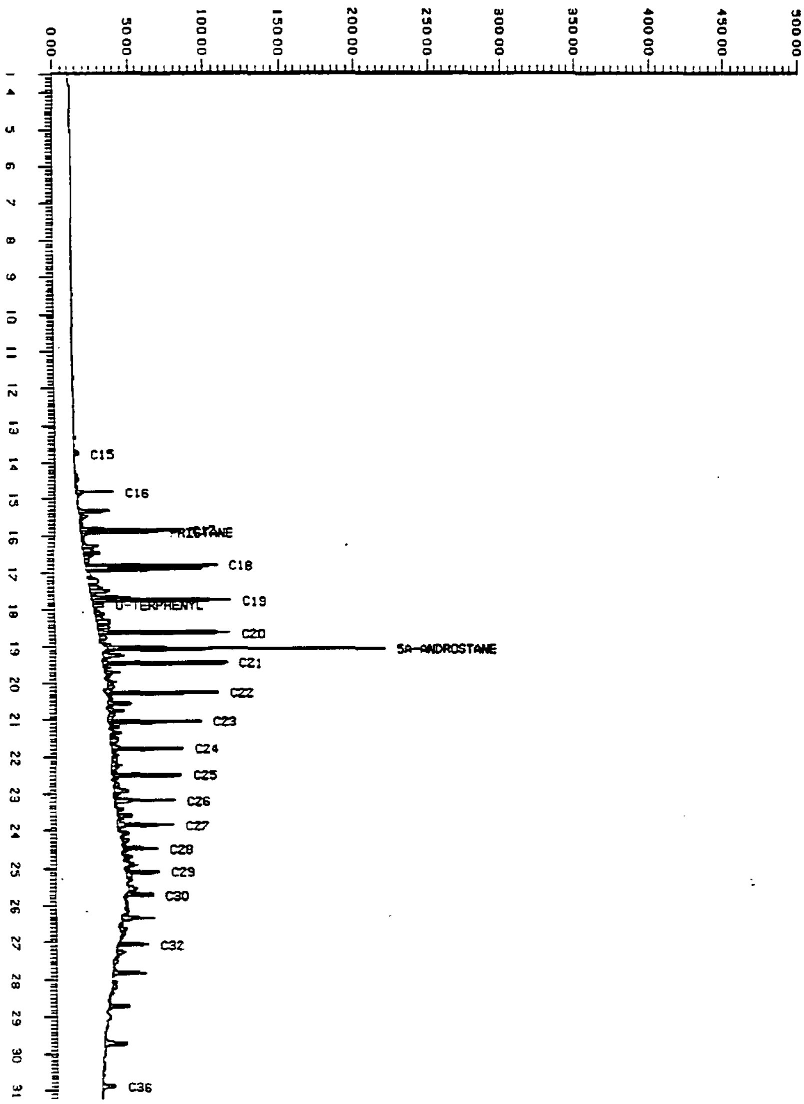
CRUDE OIL F/SFF #61 PIT

CONFIDENTIAL
PET 039825

RMAL Chromatography System on DENCR2

{FID06_4} 24 O03JUL92,11,1

23538-18 AMT=1.01G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 19:26
Reported on 28-JUL-1992 at 08:39
Box 1 (of 1)



CRUDE OIL F/PARAHUACU #3 PIT

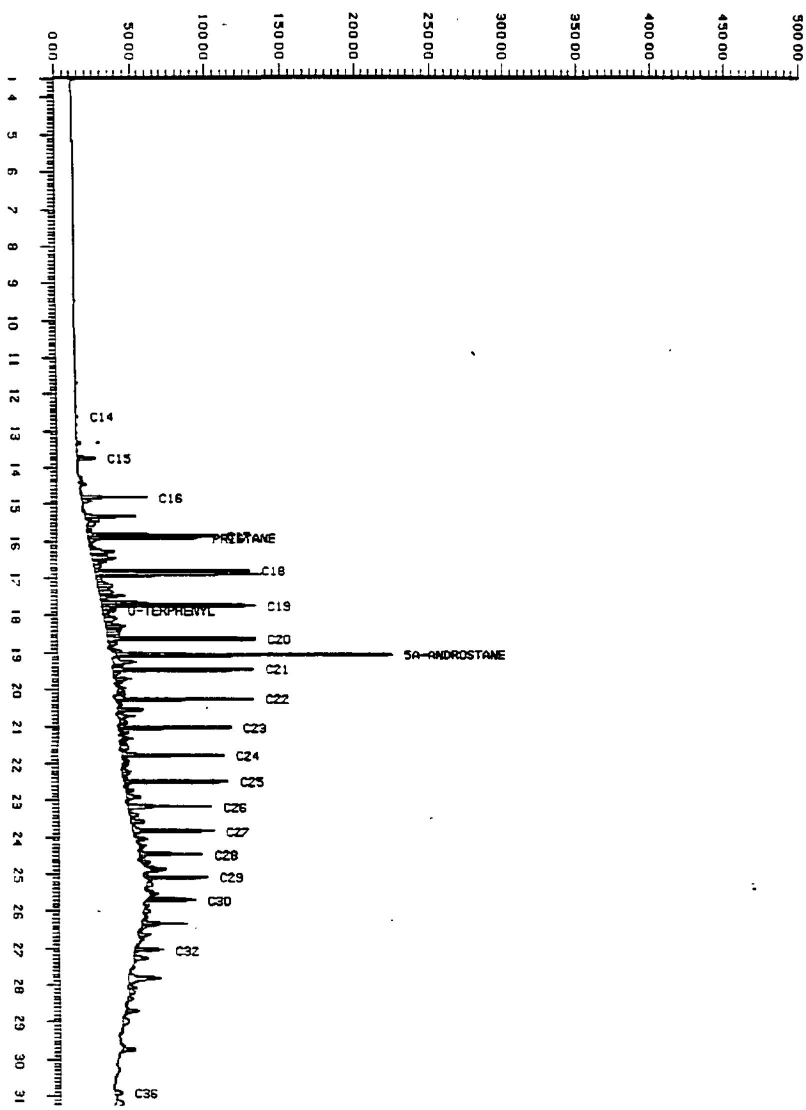
CONFIDENTIAL
PET 039826

CA1068573

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,8,1

23538-15 AMT=1.02G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 16:56
Reported on 28-JUL-1992 at 08:37
Box 1 (of 1)



CRUDE OIL F/SFF #73 PIT

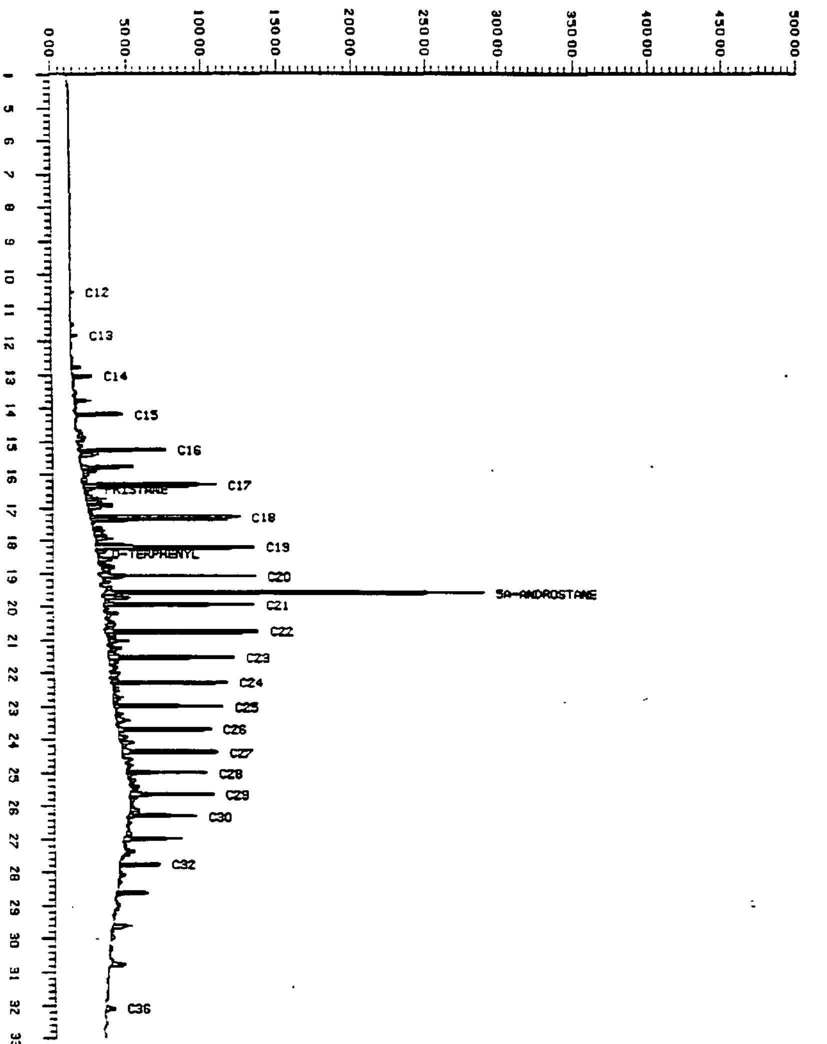
CONFIDENTIAL
PET 039827

CA1068574

RMAL Chromatography System on DENCR2

[FID06_2] 24 O16JUN92,14,1

23180-07 PDIL=5% AMT=1.0G. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 17-JUN-1992 at 11:34
Reported on 28-JUL-1992 at 09:08
Box 1 (of 1)



CRUDE OIL F/SACHA 74 PIT

CONFIDENTIAL
PET 039828

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

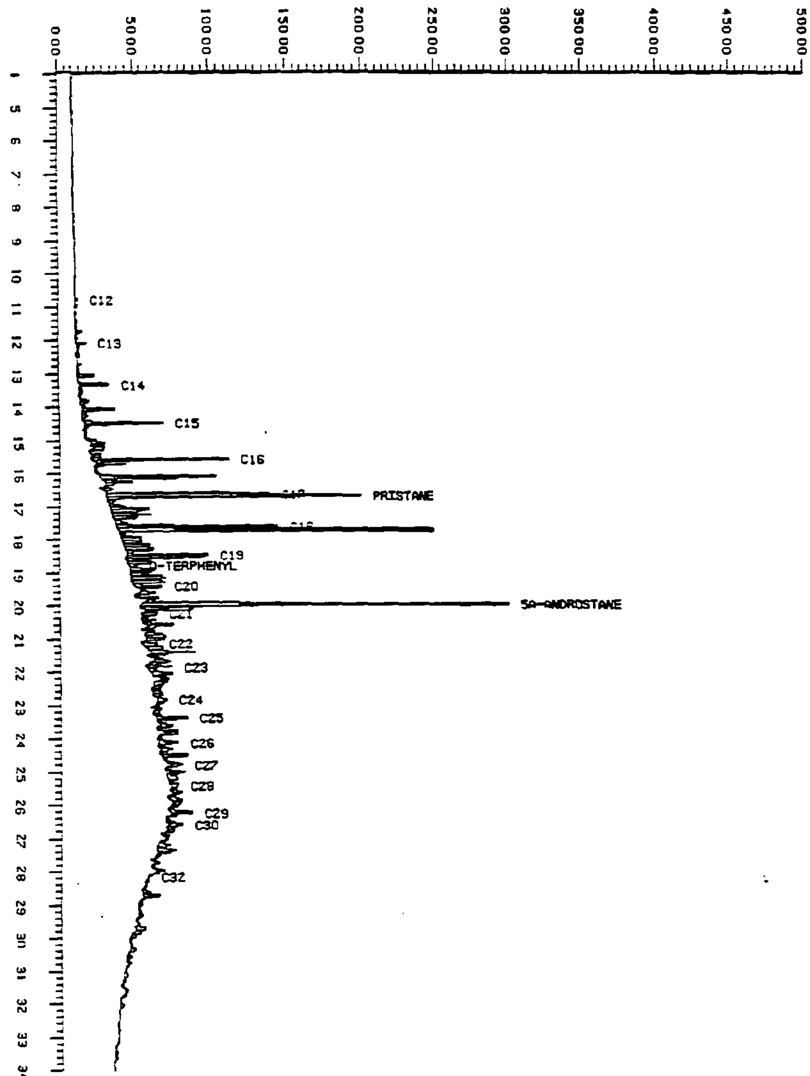
CA1068575

CA1068575

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,13,1

3538-09 AMT=1.08G PDIL=5% EV=10ML. Amount : 1.000.
ESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
cquired on 3-JUL-1992 at 21:05
eported on 28-JUL-1992 at 08:56
ox 1 (of 1)



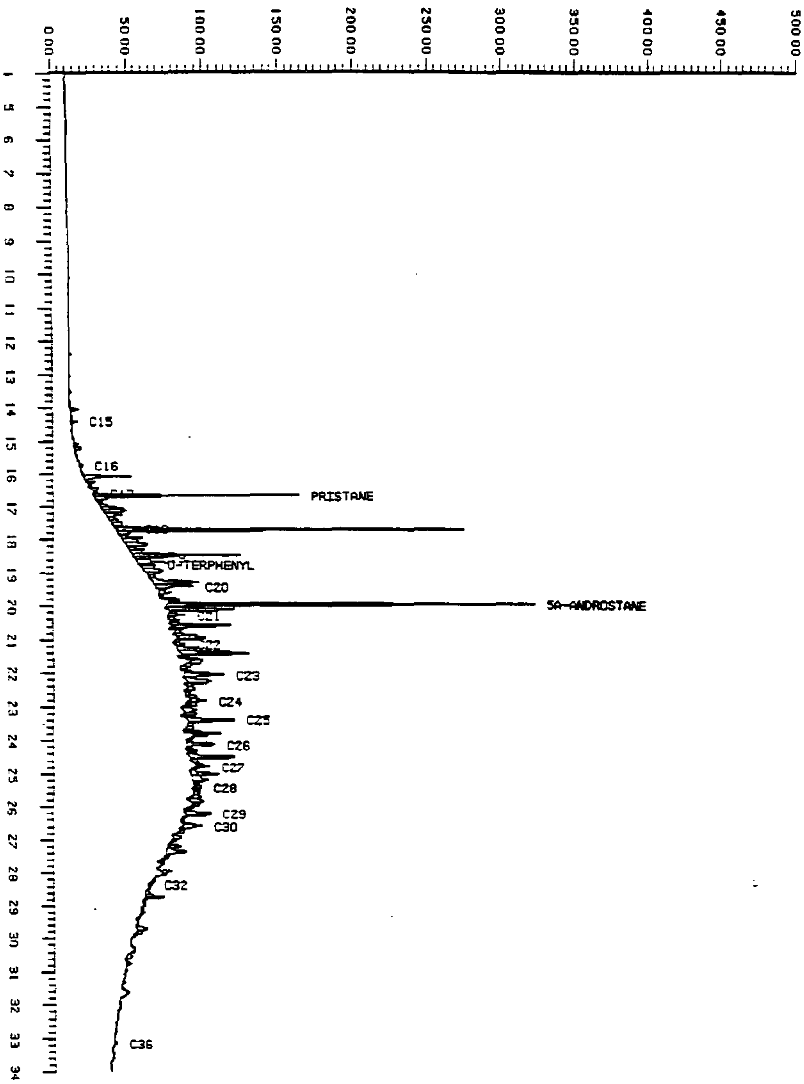
CRUDE OIL F/AGUARICO #10 PIT

CONFIDENTIAL
PET 039829

RMAL Chromatography System on DENCR2

[FID06_4] 23 003JUL92,7,1

23538-03 AMT=1.01G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 16:06
Reported on 28-JUL-1992 at 08:53
Box 1 (of 1)



CRUDE OIL F/AUCA SUR #1 PIT

CONFIDENTIAL
PET 039830

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

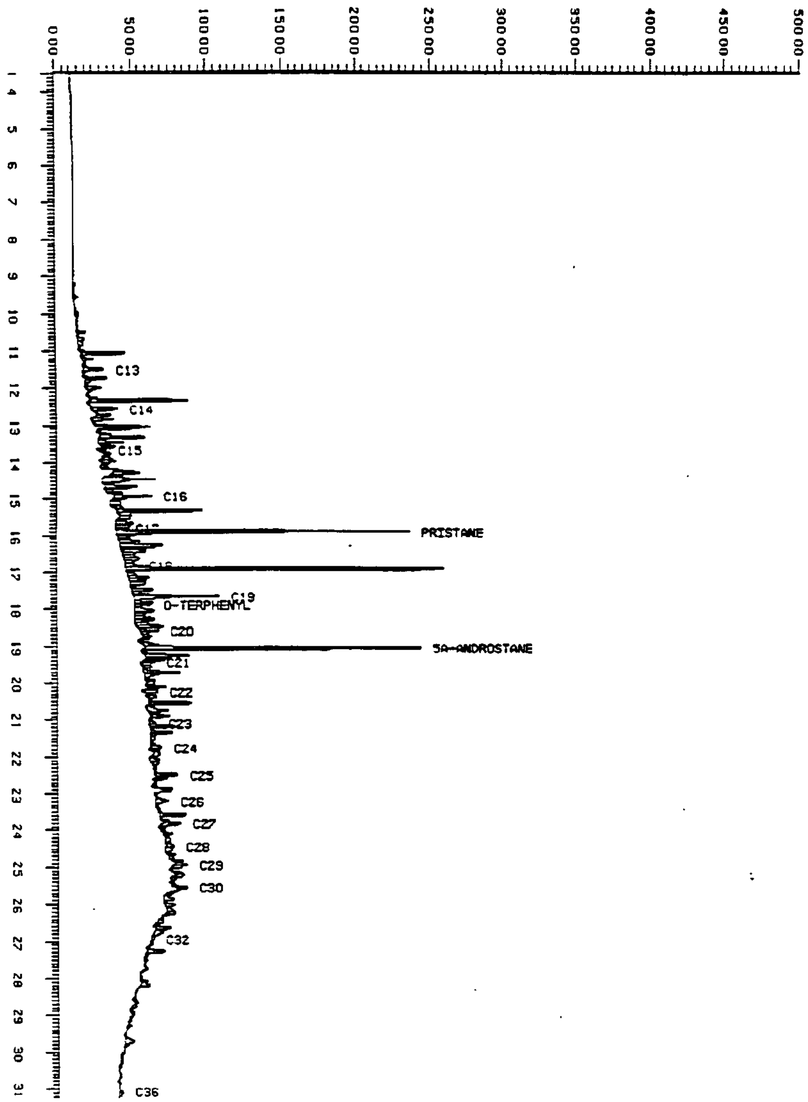
CA1068577

CA1068577

RMAL Chromatography System on DENCR2

[FID06_4] 24 003JUL92,12,1

23538-19 AMT=1.05G PDIL=5% EV=10ML. Amount : 1.000.
RESTEK RTx-5, 0.25mm ID, 0.25um film, 30m length
Acquired on 3-JUL-1992 at 20:16
Reported on 28-JUL-1992 at 08:39
Box 1 (of 1)



CRUDE OIL F/SPILL @ PARAHUACU #2

CONFIDENTIAL
PET 039831

APPENDIX B

CONFIDENTIAL
PET 039832

CA1068579

APPENDIX B

F92-0886

CONFIDENTIAL
PET 039833

CA1068580

TABLE B-1: WATER QUALITY DATA - AGUARICO

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	6.4	7.1	7	6.8
Temperature DEG C	29.8	29.1	26.8	26
Dissolved Oxygen	1.9	3.5	6.7	3.1
Turbidity NTU	14.5	14.2	11	10
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	794	263	32	70
Chlorides ppm Cl	47150	24900	4	3770
Sulphates ppm SO4	133	47	ND	13
Total alkalinity	651	216	26	57
Total Hardness	12139	5918	43	881
Hardness Carbonated	651	216	26	57
Hardness non carbonate	11488	5702	17	824
Calcium ppm Ca	3861	1892	5	281
Magnesium ppm Mg	604	289	7	44
Iron ppm Fe	7.5	0.2	1	0.4
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	134	75	ND	26
Hydrocarbons ppm	2.7	0.4	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; approximately 250 meters from outfall
Sample 3 - upstream; approximately 30 meters upstream of mixing zone
Sample 4 - downstream; approximately 150 meters from mixing zone; downstream of bridge/culvert

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

CONFIDENTIAL
PET 039834

CA1068581

TABLE B-2: WATER QUALITY DATA - ATACAPI

SAMPLE NUMBER	1	2	3	4	10
FIELD MEASUREMENTS					
pH Units	6.1	4.2	5.8	3.75	6.1
Temperature DEG C	29.9	31	25.1	27.8	34.3
Dissolved Oxygen	0.9	4.5	5.5	4.6	0.8
Turbidity NTU	16.3	103.6	7.4	8.2	14.8
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	223	32	11	11	223
Chlorides ppm Cl	104200	81800	1.6	33000	103800
Sulphates ppm SO4	36	29	ND	21	36
Total alkalinity	183	26	9	9	183
Total Hardness	32760	23400	7	10530	31980
Hardness Carbonated	183	26	7	9	183
Hardness non carbonate	32577	23374	ND	10521	31797
Calcium ppm Ca	10686	7917	1	3374	11193
Magnesium ppm Mg	1469	877	1	509	971
Iron ppm Fe	8.8	13.5	1.1	1	6.5
Manganese ppm Mn	ND	ND	ND	ND	ND
Suspended Solids ppm	248	150	ND	58	220
Hydrocarbons ppm	ND	ND	ND	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; bottom of ridge
Sample 3 - upstream; 350 meters from Atacapi gate entrance
Sample 4 - downstream
Sample 10 - duplicate outfall

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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PET 039835

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068582

TABLE B-3: WATER QUALITY DATA - AUCA CENTRAL

SAMPLE NUMBER	1	2	3	4	5
FIELD MEASUREMENTS					
pH Units	6.8	6.7	6.2	6.9	6.7
Temperature DEG C	34.2	28	27.8	28.5	33.4
Dissolved Oxygen	2.3	8.5	6.1	5.5	2.3
Turbidity NTU	13.8	11.7	20.3	10.9	11.9
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	319	32	19	38	303
Chlorides ppm Cl	7800	525	3	519	8260
Sulphates ppm SO4	24	12	ND	14	24
Total alkalinity	262	26	15	31	249
Total Hardness	897	90	16	59	897
Hardness Carbonated	262	26	16	31	249
Hardness non carbonate	635	64	ND	28	648
Calcium ppm Ca	296	27	3	20	281
Magnesium ppm Mg	38	6	2	2	47
Iron ppm Fe	1.5	0.2	0.9	0.6	1.4
Manganese ppm Mn	ND	0.8	ND	ND	ND
Suspended Solids ppm	24	ND	14	ND	31
Hydrocarbons ppm	2.5	ND	ND	ND	3

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; 150 meters from edge of facility
Sample 3 - upstream; outside of camp, across from large pond
Sample 4 - downstream; upgradient of well #6
Sample 5 - outfall; second sample

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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PET 039836

CONFIDENTIAL TREATMENT REQUESTED
SDNY - 04 CIV 8378

CA1068583

TABLE B-4: WATER QUALITY DATA - AUCA SUR

SAMPLE NUMBER	1	2	3	4	5
FIELD MEASUREMENTS					
pH Units	7	6.8	6.5	6.8	7
Temperature DEG C	38.3	27.2	26	26.9	71
Dissolved Oxygen	3.6	4.2	4.4	4.5	0.8
Turbidity NTU	7.2	10.5	5.6	6.6	2.9
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	472	81	27	75	413
Chlorides ppm Cl	21200	2290	2	2280	7340
Sulphates ppm SO4	3	ND	ND	ND	54
Total alkalinity	387	66	22	62	339
Total Hardness	2594	332	23	293	956
Hardness Carbonated	387	66	23	62	339
Hardness non carbonate	2207	266	ND	231	617
Calcium ppm Ca	811	78	12	90	289
Magnesium ppm Mg	138	33	ND	17	57
Iron ppm Fe	1.2	0.6	1.7	0.6	1.7
Manganese ppm Mn	ND	ND	ND	ND	ND
Suspended Solids ppm	54	14	ND	15	15
Hydrocarbons ppm	2.5	3.5	ND	3.5	3.4

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone
Sample 3 - upstream; small dammed pond
Sample 4 - downstrean; 100 meters from outfall
Sample 5 - discharge point of well Auca Sur #1

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

CONFIDENTIAL
PET 039837

CA1068584

TABLE B-5: WATER QUALITY DATA - CONONACO

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	7.2	7.3	7.1	6.9
Temperature DEG C	49.3	42.4	26.7	29.1
Dissolved Oxygen	3.3	2	3.2	2.9
Turbidity NTU	9.5	6.7	8.2	6.2
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	274	239	78	156
Chlorides ppm Cl	365	270	2	130
Sulphates ppm SO4	13	10	ND	ND
Total alkalinity	224	196	64	128
Total Hardness	137	156	60	55
Hardness Carbonated	137	156	60	55
Hardness non carbonate	ND	ND	ND	ND
Calcium ppm Ca	25	21	12	12
Magnesium ppm Mg	18	25	8	6
Iron ppm Fe	0.4	0.7	0.9	1.5
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	ND	ND	ND	77
Hydrocarbons ppm	1.3	3.5	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; marshy area
Sample 3 - upstream; approximately 150 meters, near abandoned farm house
Sample 4 - downstream; approximately 300 meters; large swampy area near roa

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

CA1068585

TABLE B-6: WATER QUALITY DATA - LAGO CENTRAL

SAMPLE NUMBER	4	5	6	7	14
FIELD MEASUREMENTS					
pH Units	6.4	6.2	6.2	6.5	6.4
Temperature DEG C	25.9	26.9	28.1	27.2	25.5
Dissolved Oxygen	3.6	4.3	1.1	3.8	3.5
Turbidity NTU	5.8	25.7	19.5	24.7	5.5
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	70	121	129	191	67
Chlorides ppm Cl	30	10	10	565	28
Sulphates ppm SO4	ND	ND	ND	ND	ND
Total alkalinity	57	99	106	156	55
Total Hardness	46	81	167	262	46
Hardness Carbonated	46	81	106	156	46
Hardness non carbonate	ND	ND	61	106	ND
Calcium ppm Ca	12	21	22	89	14
Magnesium ppm Mg	6	7	27	9	2
Iron ppm Fe	0.7	3.1	3.1	0.3	0.5
Manganese ppm Mn	ND	1.7	1.3	1.7	ND
Suspended Solids ppm	ND	10	17	19	ND
Hydrocarbons ppm	1.7	ND	ND	ND	1.6

Sample Locations

Sample 4 - downstream; 200 to 300 meters from discharge point
Sample 5 - municipal wastestream (upstream); near culvert/road
Sample 6 - municipal/production mixing zone; mixing zone within pit #3
Sample 7 - discharge downstream of mixing zone; discharge through rock retaining wall
Sample 14 - duplicate of sample #4

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068586

TABLE B-7: WATER QUALITY DATA - LAGO NORTE

SAMPLE NUMBER	1	2	3	4	20
FIELD MEASUREMENTS					
pH Units	7	8.1	7.3	8	4.8
Temperature DEG C	38.8	30.1	25.8	29	28.3
Dissolved Oxygen	2.1	2.4	4.6	1.7	3.2
Turbidity NTU	54.6	23.7	8.6	8.8	13.5
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	1275	859	54	698	11
Chlorides ppm Cl	6380	4220	9	3610	7
Sulphates ppm SO4	115	64	ND	ND	ND
Total alkalinity	1045	704	44	572	9
Total Hardness	2506	1658	33	1365	3
Hardness Carbonated	1045	704	33	572	3
Hardness non carbonate	1461	954	ND	793	ND
Calcium ppm Ca	940	612	6	499	2
Magnesium ppm Mg	38	31	4	28	ND
Iron ppm Fe	0.5	0.5	1.6	0.2	0.1
Manganese ppm Mn	ND	1	1.1	ND	ND
Suspended Solids ppm	43	20	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; pasture area
Sample 3 - upstream; approximately 100 meters south of and 70 meters east of well #10
Sample 4 - downstream; approximately 70 meters west of road, next to bridge
Sample 20 - spring location

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068587

TABLE B-8: WATER QUALITY DATA - PARAHUACU

SAMPLE NUMBER	3	4
FIELD MEASUREMENTS		
pH Units	5	5.5
Temperature DEG C	24.8	25.3
Dissolved Oxygen	2.5	3.9
Turbidity NTU	1.8	4.4
LABORATORY ANALYSIS		
Color APHA		
Carbonates	ND	ND
Bicarbonates	8	11
Chlorides ppm Cl	1.5	24
Sulphates ppm SO4	ND	ND
Total alkalinity	7	9
Total Hardness	7	16
Hardness Carbonated	7	9
Hardness non carbonate	ND	7
Calcium ppm Ca	2	5
Magnesium ppm Mg	ND	1
Iron ppm Fe	0.5	0.9
Manganese ppm Mn	ND	ND
Suspended Solids ppm	ND	ND
Hydrocarbons ppm	ND	ND

Sample Locations

Sample 3 - upstream; adjacent road, approximately 300 meters from well #10
Sample 4 - downstream; approximately 100 meters due east of pit

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068588

TABLE B-9: WATER QUALITY DATA - SACHA CENTRAL (SURFACE WATER)

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	6.8	7.5	7.3	7.7
Temperature DEG C	33.2	27.8	25.6	27.8
Dissolved Oxygen	0.3	5.2	6.2	4.5
Turbidity NTU	39.4	12.6	12.9	12.9
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	373	132	46	121
Chlorides ppm Cl	4105	950	3	813
Sulphates ppm SO4	10	4	ND	4
Total alkalinity	306	108	37	99
Total Hardness	926	380	44	250
Hardness Carbonated	306	108	44	99
Hardness non carbonate	620	272	ND	151
Calcium ppm Ca	320	78	8	74
Magnesium ppm Mg	31	45	6	16
Iron ppm Fe	2	0.3	0.6	0.5
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	45	11	ND	11
Hydrocarbons ppm	27.2	6.7	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; approximately 200 meters southeast of facility
Sample 3 - upstream; approximately 100 meters from mixing zone
Sample 4 - downstream; approximately 100 meters from mixing zone

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068589

TABLE B-10: WATER QUALITY DATA - SACHA CENTRAL (WELLS)

SAMPLE NUMBER	20	21	22	23
FIELD MEASUREMENTS				
pH Units	6	6	6	6.1
Temperature DEG C	26.3	25	26.7	26.1
Dissolved Oxygen	4.3	5.9	4.3	4.5
Turbidity NTU	4.1	7.2	2.5	5.5
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	27	16	38	27
Chlorides ppm Cl	1.9	1.3	1.5	3.2
Sulphates ppm SO4	ND	ND	ND	ND
Total alkalinity	22	13	31	22
Total Hardness	31	21	33	33
Hardness Carbonated	22	13	33	22
Hardness non carbonate	9	8	ND	11
Calcium ppm Ca	5	4	5	6
Magnesium ppm Mg	4	3	5	4
Iron ppm Fe	ND	ND	ND	ND
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	ND	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND

Sample Locations

Sample 20 - water well near rear gate (SE side of facility)
Sample 21 - water well at NE side of facility
Sample 22 - water well at N side of facility
Sample 23 - water well at W side of facility

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-11: WATER QUALITY DATA - SACHA NORTE NO. 1

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	7.1	7.2	7.3	7.4
Temperature DEG C	45.5	25	25	25
Dissolved Oxygen	3.8	0.6	5.4	5.3
Turbidity NTU	20.8	11	5.02	4.6
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	483	279	70	81
Chlorides ppm Cl	2520	1275	1.7	65
Sulphates ppm SO4	18	ND	ND	ND
Total alkalinity	396	229	57	66
Total Hardness	780	488	41	51
Hardness Carbonated	396	229	41	51
Hardness non carbonate	384	259	ND	ND
Calcium ppm Ca	257	133	11	15
Magnesium ppm Mg	33	38	3	3
Iron ppm Fe	1.8	1.2	0.6	0.6
Manganese ppm Mn	ND	0.4	ND	ND
Suspended Solids ppm	10	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; 100 meters downstream from discharge
Sample 3 - upstream; 5 meters from mixing zone
Sample 4 - downstream; 10 meters from mixing zone

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-12: WATER QUALITY DATA - SACHA NORTE NO. 2

SAMPLE NUMBER	1	2	3	4	5
FIELD MEASUREMENTS					
pH Units	6.8	7.3	7.3	7.2	7.4
Temperature DEG C	34	32.9	25.3	39	26.4
Dissolved Oxygen	1.3	3.2	6.3	3	6.6
Turbidity NTU	9.5	12.4	5.2	45.6	8.9
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	930	676	81	574	54
Chlorides ppm Cl	1400	1410	1.3	1320	2
Sulphates ppm SO4	37	28	ND	26	ND
Total alkalinity	763	554	66	471	44
Total Hardness	956	780	51	729	35
Hardness Carbonated	763	554	51	471	35
Hardness non carbonate	193	226	ND	258	ND
Calcium ppm Ca	343	273	11	250	7
Magnesium ppm Mg	24	24	6	25	4
Iron ppm Fe	0.5	0.6	1.1	1.8	0.3
Manganese ppm Mn	ND	ND	ND	0.9	ND
Suspended Solids ppm	ND	ND	ND	10	21
Hydrocarbons ppm	3.2	0.5	ND	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; approx. 100 meters from discharge
Sample 3 - upstream; at bridge southwest of facility
Sample 4 - downstream; 50 meters from mixing zone
Sample 5 - downstream at bridge for main road

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-13: WATER QUALITY DATA - SACHA SUR

SAMPLE NUMBER	1	3	4	5
FIELD MEASUREMENTS				
pH Units	6.5	7.2	7.1	6
Temperature DEG C	46	28.6	28	26
Dissolved Oxygen	1.7	0.7	0.6	5.2
Turbidity NTU	43.8	12.5	4.2	3.2
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	313	225	201	35
Chlorides ppm Cl	1120	758	688	1.8
Sulphates ppm SO4	ND	ND	ND	ND
Total alkalinity	257	185	165	29
Total Hardness	390	244	218	16
Hardness Carbonated	257	185	165	16
Hardness non carbonate	133	59	53	ND
Calcium ppm Ca	140	86	74	6
Magnesium ppm Mg	9	7	8	ND
Iron ppm Fe	2.6	0.6	0.3	ND
Manganese ppm Mn	0.4	ND	1.2	ND
Suspended Solids ppm	12	ND	ND	ND
Hydrocarbons ppm	19	1.2	ND	ND

Sample Locations

Sample 1 - outfall
Sample 3 - downstream; approx. 700 m south of facility; 100 m upstream of spring
Sample 4 - downstream; approx. 900 m south of facility; 100 m downstream of spring
Sample 5 - spring; approximately 800 m south of facility

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068593

TABLE B-14: SHUSHUFINDI CENTRAL (SURFACE WATER)

SAMPLE NUMBER	1	3	4
FIELD MEASUREMENTS			
pH Units	7.4	6.7	6.9
Temperature DEG C	32.8	25.2	26.5
Dissolved Oxygen	1	0.4	1.8
Turbidity NTU	-	-	-
LABORATORY ANALYSIS			
Color APHA			
Carbonates	ND	ND	ND
Bicarbonates	870	89	72
Chlorides ppm Cl	26200	177	1520
Sulphates ppm SO4	80	ND	ND
Total alkalinity	713	73	59
Total Hardness	5460	138	332
Hardness Carbonated	713	73	59
Hardness non carbonate	4747	65	273
Calcium ppm Ca	1568	35	110
Magnesium ppm Mg	374	12	14
Iron ppm Fe	1.7	2.1	1.7
Manganese ppm Mn	ND	ND	1.3
Suspended Solids ppm	38	ND	ND
Hydrocarbons ppm	5.3	ND	ND

Sample Locations

Sample 1 - outfall
Sample 3 - upstream; approximately 100 meters from outfall at pipeline crossing
Sample 4 - downstream; approximately 500 meters from outfall at bridge; petroleum spill observed 100 meters upstream of this sampling point

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-15: WATER QUALITY DATA - SHUSHUFINDI CENTRAL (SPRING AND WELLS)

SAMPLE NUMBER	20	21	22	23
FIELD MEASUREMENTS				
pH Units	5.5	5.6	5.3	5.6
Temperature DEG C	26.4	27	25.5	25
Dissolved Oxygen	2.2	3	3.5	5
Turbidity NTU	0.47	3.7	3.3	2.2
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	19	24	13	16
Chlorides ppm Cl	1.2	4.6	8.2	2.3
Sulphates ppm SO4	ND	ND	ND	ND
Total alkalinity	15	20	11	13
Total Hardness	16	37	31	18
Hardness Carbonated	16	20	11	13
Hardness non carbonate	ND	17	20	5
Calcium ppm Ca	4	7	5	3
Magnesium ppm Mg	1	5	4	3
Iron ppm Fe	ND	ND	ND	ND
Manganese ppm Mn	0.8	ND	ND	ND
Suspended Solids ppm	ND	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND

Sample Locations

Sample 20 - spring sample south of station; 15 meters from well 74 marker on road
Sample 21 - well adjacent to main station gate
Sample 22 - well near firehouse and dispensary
Sample 23 - well ENE of facility within town of Shushufindi

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-16: WATER QUALITY DATA - SHUSHUFINDI NORTE

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	7.1	6.9	6.8	6.7
Temperature DEG C	43.5	25.4	25.4	26.1
Dissolved Oxygen	1.3	5.5	5.3	5.1
Turbidity NTU	59.8	6.1	7.3	6.4
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	948	32	19	24
Chlorides ppm Cl	24400	540	2	292
Sulphates ppm SO4	105	ND	ND	ND
Total alkalinity	777	26	15	20
Total Hardness	4914	176	23	74
Hardness Carbonated	777	26	15	20
Hardness non carbonate	4137	150	8	54
Calcium ppm Ca	1560	31	3	21
Magnesium ppm Mg	246	24	4	5
Iron ppm Fe	0.9	0.7	0.8	0.8
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	72	ND	ND	ND
Hydrocarbons ppm	3.2	ND	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; bottom of 25 foot gulley
Sample 3 - upstream; south of station, adjacent bridge
Sample 4 - downstream; 200 meters near bridge

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068596

TABLE B-17: WATER QUALITY DATA - SHUSHUFINDI SUR

SAMPLE NUMBER	1	2	3	4
FIELD MEASUREMENTS				
pH Units	6.8	6.6	6.1	6.8
Temperature DEG C	36.6	25	25.5	25
Dissolved Oxygen	0.2	0.5	5	4.5
Turbidity NTU	15	89	2.5	6.4
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	770	666	67	40
Chlorides ppm Cl	33000	33250	5	3
Sulphates ppm SO4	63	37	ND	ND
Total alkalinity	631	546	55	33
Total Hardness	6026	5811	18	18
Hardness Carbonated	631	546	18	18
Hardness non carbonate	5395	5265	ND	ND
Calcium ppm Mn	1966	1841	5	4
Magnesium ppm Mg	270	294	1	2
Iron ppm Fe	7.3	7.1	ND	0.7
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	72	63	ND	ND
Hydrocarbons ppm	6.5	3.5	ND	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; percolation pit at end of ditch, 1.2 km from facility
Sample 3 - water well 300 meters west of drainage ditch
Sample 4 - stream northwest of facility, near bridge at well SSF-23

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068597

TABLE B-18: WATER QUALITY DATA - SHUSHUFINDI SUR OESTE

SAMPLE NUMBER	1	2	4
FIELD MEASUREMENTS			
pH Units	6.9	7.1	7.2
Temperature DEG C	35.9	33.8	25.7
Dissolved Oxygen	0.3	0.4	3.6
Turbidity NTU	8.8	19.6	7.3
LABORATORY ANALYSIS			
Color APHA			
Carbonates	ND	ND	ND
Bicarbonates	816	843	64
Chlorides ppm Cl	37550	39250	2
Sulphates ppm SO4	ND	ND	ND
Total alkalinity	669	691	53
Total Hardness	7371	7332	27
Hardness Carbonated	669	691	27
Hardness non carbonate	6702	6641	ND
Calcium ppm Ca	2340	2321	9
Magnesium ppm Mg	370	372	1
Iron ppm Fe	1.2	1.4	0.5
Manganese ppm Mn	ND	ND	ND
Suspended Solids ppm	78	98	ND
Hydrocarbons ppm	3.4	2.6	ND

Sample Locations

Sample 1 - outfall
Sample 2 - mixing zone; swampy area approximately 200 meters from outfall
Sample 4 - downstream; approximately 600 meters from main gate at bridge along road

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068598

TABLE B-19: WATER QUALITY DATA - YUCA

SAMPLE NUMBER	1	5	6	10
FIELD MEASUREMENTS				
pH Units	6.4	7.1	7	6.4
Temperature DEG C	40.3	23.8	24	40.3
Dissolved Oxygen	4	6.3	5.4	4
Turbidity NTU	10.7	56.7	10.8	10.7
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	505	177	97	505
Chlorides ppm Cl	45700	15150	8050	45500
Sulphates ppm SO4	50	16	15	49
Total alkalinity	414	145	79	414
Total Hardness	7020	2350	1326	7020
Hardness Carbonated	414	145	79	414
Hardness non carbonate	6606	2205	1247	6606
Calcium ppm Ca	2246	741	433	2309
Magnesium ppm Mg	341	121	59	303
Iron ppm Fe	11.4	0.1	0.4	11.2
Manganese ppm Mn	ND	ND	ND	ND
Suspended Solids ppm	77	25	64	88
Hydrocarbons ppm	2.9	ND	ND	2.6

Sample Locations

Sample 1 - outfall
Sample 5 - downstream; 1st bridge east of facility
Sample 6 - downstream; 2nd bridge east of facility
Sample 10 - duplicate of sample #1

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068599

TABLE B-20: WATER QUALITY DATA - WATER WELLS

SAMPLE NUMBER	SACHA CENTRAL SMPL 20	SACHA CENTRAL SMPL 21	SACHA CENTRAL SMPL 22	SACHA CENTRAL SMPL 23	SHUSHUF SUR SMPL 3
FIELD MEASUREMENTS					
pH Units	6	6	6	6.1	6.1
Temperature DEG C	26.3	25	26.7	26.1	25.5
Dissolved Oxygen	4.3	5.9	4.3	4.5	5
Turbidity NTU	4.1	7.2	2.5	5.5	2.5
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	27	16	38	27	67
Chlorides ppm Cl	1.9	1.3	1.5	3.2	5
Sulphates ppm SO4	ND	ND	ND	ND	ND
Total alkalinity	22	13	31	22	55
Total Hardness	31	21	33	33	18
Hardness Carbonated	22	13	33	22	18
Hardness non carbonate	9	8	ND	11	ND
Calcium ppm Ca	5	4	5	6	5
Magnesium ppm Mg	4	3	5	4	1
Iron ppm Fe	ND	ND	ND	ND	ND
Manganese ppm Mn	ND	ND	ND	ND	ND
Suspended Solids ppm	ND	ND	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND	ND

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068600

TABLE B-20 (CONTINUED): WATER QUALITY DATA - WATER WELLS

SAMPLE NUMBER	SHUSHUF CENTRAL SMPL 20	SHUSHUF CENTRAL SMPL 21	SHUSHUF CENTRAL SMPL 22	SHUSHUF CENTRAL SMPL 23	AVERAGE (9 WELLS)
FIELD MEASUREMENTS					
pH Units	5.5	5.6	5.3	5.6	5.8
Temperature DEG C	26.4	27	25.5	25	25.9
Dissolved Oxygen	2.2	3	3.5	5	4.2
Turbidity NTU	0.47	3.7	3.3	2.2	3.5
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	19	24	13	16	27.4
Chlorides ppm Cl	1.2	4.6	8.2	2.3	3.2
Sulphates ppm SO4	ND	ND	ND	ND	ND
Total alkalinity	15	20	11	13	22.4
Total Hardness	16	37	31	18	26.4
Hardness Carbonated	16	20	11	13	18.7
Hardness non carbonate	ND	17	20	5	7.8
Calcium ppm Ca	4	7	5	3	4.9
Magnesium ppm Mg	1	5	4	3	3.3
Iron ppm Fe	ND	ND	ND	ND	ND
Manganese ppm Mn	0.8	ND	ND	ND	0.1
Suspended Solids ppm	ND	ND	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND	ND

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068601

TABLE B-21: WATER QUALITY DATA - UPSTREAM SAMPLES

SAMPLE NUMBER	AGUARICO SMPL 3	ATACAPI SMPL 3	AUCA CENTRAL SMPL3	AUCA SUR SMPL3	CONON SMPL 3
FIELD MEASUREMENTS					
pH Units	7	5.8	6.2	6.5	7.1
Temperature DEG C	26.8	25.1	27.8	26	26.7
Dissolved Oxygen	6.7	5.5	6.1	4.4	3.2
Turbidity NTU	11	7.4	20.3	5.6	8.2
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	32	11	19	27	78
Chlorides ppm Cl	4	1.6	3	2	2
Sulphates ppm SO4	ND	ND	ND	ND	ND
Total alkalinity	26	9	15	22	64
Total Hardness	43	7	16	23	60
Hardness Carbonated	26	7	16	23	60
Hardness non carbonate	17	ND	ND	ND	ND
Calcium ppm Ca	5	1	3	12	12
Magnesium ppm Mg	7	1	2	ND	8
Iron ppm Fe	1	1.1	0.9	1.7	0.9
Manganese ppm Mn	ND	ND	ND	ND	ND
Suspended Solids ppm	ND	ND	14	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND	ND

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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CA1068602

TABLE B-21 (CONTINUED): WATER QUALITY DATA - UPSTREAM SAMPLES

SAMPLE NUMBER	LAGO NORTE SMPL 3	PARAH SMPL 3	SACHA NORTE 1 SMPL3	SACHA NORTE 2 SMPL3	SACHA CENTRAL SMPL 3
FIELD MEASUREMENTS					
pH Units	7.3	5	7.3	7.3	7.3
Temperature DEG C	25.8	24.8	25	25.3	25.6
Dissolved Oxygen	4.6	2.5	5.4	6.3	6.2
Turbidity NTU	8.6	1.8	5.02	5.2	12.9
LABORATORY ANALYSIS					
Color APHA					
Carbonates	ND	ND	ND	ND	ND
Bicarbonates	54	8	70	81	46
Chlorides ppm Cl	9	1.5	1.7	1.3	3
Sulphates ppm SO4	ND	ND	ND	ND	ND
Total alkalinity	44	7	57	66	37
Total Hardness	33	7	41	51	44
Hardness Carbonated	33	7	41	51	44
Hardness non carbonate	ND	ND	ND	ND	ND
Calcium ppm Ca	6	2	11	11	8
Magnesium ppm Mg	4	ND	3	6	6
Iron ppm Fe	1.6	0.4	0.6	1.1	0.6
Manganese ppm Mn	1	ND	ND	ND	ND
Suspended Solids ppm	ND	ND	ND	ND	ND
Hydrocarbons ppm	ND	ND	ND	ND	ND

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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TABLE B-21 (CONTINUED): WATER QUALITY DATA - UPSTREAM SAMPLES

SAMPLE NUMBER	SHUSHUF SUR SMPL 4	SHUSHUF CENTRAL SMPL 3	SHUSHUF NORTE SMPL3	AVERAGE (13 SMPLS)
FIELD MEASUREMENTS				
pH Units	6.8	6.7	6.8	6.7
Temperature DEG C	25	25.2	25.4	25.7
Dissolved Oxygen	4.5	0.4	5.3	4.7
Turbidity NTU	6.4	—	7.3	8.3
LABORATORY ANALYSIS				
Color APHA				
Carbonates	ND	ND	ND	ND
Bicarbonates	40	89	19	44.2
Chlorides ppm Cl	3	177	2	16.2
Sulphates ppm SO4	ND	ND	ND	ND
Total alkalinity	33	73	15	36
Total Hardness	18	138	23	38.8
Hardness Carbonated	18	73	15	31.8
Hardness non carbonate	ND	65	8	6.9
Calcium ppm Ca	4	35	3	8.7
Magnesium ppm Mg	2	12	4	4.2
Iron ppm Fe	0.8	2.1	0.8	1
Manganese ppm Mn	ND	ND	ND	0.1
Suspended Solids ppm	ND	ND	ND	1.1
Hydrocarbons ppm	ND	ND	ND	ND

Notes

1. Values are given in ppm (mg/l) unless otherwise noted.
2. ND = not detected.

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APPENDIX C

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CA1068605

APPENDIX C

F92-0685

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TEXACO ECUADOR
ENVIRONMENTAL AUDIT
FIELD PERCOLATION TEST PROCEDURE

June 1992

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No generally accepted method is applicable to all field conditions or problems in spite of all the studies that have been made of the measurement of infiltration rate. Infiltration tests involving large-pond or large-diameter-ring(s) are the best for determining accurate infiltration data but are usually not feasible because of economic considerations. A method utilizing a single-ring-infiltrometer is probably the most versatile of the available methods; such a method is described in detail to provide a simple standard that can be used.

Field Percolation Test Procedure

1. A typical infiltrometer ring would consist of a 12- to 24-inch-diameter 20-inch-high cylinder. The infiltrometer ring should be driven 6 to 8 inches into the soil. Where the infiltration rate for a shallow subsurface layer is desired, a pit should be excavated to the desired depth before the ring is installed. An infiltration ring is driven by means of a driving cap (½-inch-thick plate), which has been centered on the ring and on the edge of which has been placed a heavy wood block. Blows of the heavy sledge on the block should be of medium force to prevent undue fracturing of the soil surface. The wood block should be moved around the edge of the driving cap every one or two blows, so the cylinder will penetrate the soil surface uniformly, without the tilting back and forth that results in a disturbance of the soil.

2. After the driving is completed and the ring is level, the disturbed soil adjacent to the ring on the inside should be tamped firm by means of the metal tamp. If the soil is disturbed more than 1/8-inch from the wall of its ring, an attempt should be made to reset the infiltrometer ring with less disturbance of the surface.

3. A staff gage should be installed on the infiltrometer ring to assist the investigator visually in maintaining a given water level (head). A minimum water level of 1-inch and a maximum of 6 inches is usually maintained.

4. To dissipate the force of the applied water and to prevent disturbance of the soil, the soil surface within the infiltrometer rings should be covered with a splash guard (pieces of burlap or rubber sheet). The initial amount of water poured into the ring need not be measured, but any water added to maintain the desired depth of water, after the start of the timing interval, should be recorded.

5. The water level should be maintained as near the desired depth as possible. For average materials the amount of water used should be recorded at intervals

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of 15 minutes for the first hour, 30 minutes for the second hour, and 60 minutes during the remainder of a period of at least 6 hours. Permeable materials may require more frequent early readings. A longer test may be desirable if the soil has a low permeability.

6. The volume of water used during each measured time interval should be converted into depth of water per unit of time (inches per hour or centimeters per hour) see Table 1 - Data for Single-Ring Infiltrometers.

Table 1. Data for Single-Ring Infiltrometers

Diameter of Ring (inches)	Area of Ring (square inch)	Area of Ring (square centimeter)	Volume of Water in ml Providing 1-inch depth	Multiply Volume of Water Used in ml by (A) or (B) to Obtain Depth of Water	
				(A) Inches	(B) Centimeters
12	113.1	729.7	1,854	5.39×10^{-4}	13.70×10^{-4}
18	254.5	1,642.0	4,176	2.39×10^{-4}	6.09×10^{-4}
24	452.4	2,918.9	7,415	1.35×10^{-4}	3.43×10^{-4}

7. All test data, as well as the infiltration rates calculated during the progress of the test, are recorded in a record book or on a report form (see attached figure). The data are plotted also on the cross-sectioned part of the report form.

PERCOLATION TESTING

Field percolation testing was conducted at both the Sacha and Sushifindi facilities using the established procedure. The field tests were conducted in the vicinity of production facilities at the following locations which were considered undisturbed with no fill:

- Sacha Central - Back of facility, between drainage and PetroProduction station.
- Sacha Sur - South side of facility, across road.
- Sushifindi Central - Adjacent main gate, outside of facility.

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- Sushifindi Sur - Outside of fence, near percolation pit.

Prior to conducting each test, the upper 6 inches of soil was cleared of vegetation, roots, etc.. The 20-inch high (PVC) standpipe was driven into the soil approximately 6 to 8 inches. Presoaking of the test cylinder was conducted 24 hours prior to initiating the test. Testing was performed for a minimum of 6 hours during which time the volume of water added was recorded at regular intervals. The results are summarized in Table A-1.

PERMEABILITY TESTING

Soil samples were collected for laboratory permeability testing within the bermed soil of the water production pits at the same four production facilities (Sacha Central, Sacha Sur, Sushifindi Central, and Sushifindi Sur). The samples were collected along the norther perimeter of the final stage pit at each facility. Permeability tests were performed using ASTM test method 5084. The results are summarized in Table A-1.

Table A-1. Percolation and Permeability Results

Site	Field Permeability (cm/sec)	Laboratory Permeability (cm/sec)
Sacha Central	1.6×10^{-4}	1.7×10^{-3}
Sacha Sur	5.3×10^{-4}	4.9×10^{-5}
Sushifindi Central	6.8×10^{-4}	3.3×10^{-7}
Sushifindi Sur	2.8×10^{-4}	3.7×10^{-7}

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INFILTRATION TEST

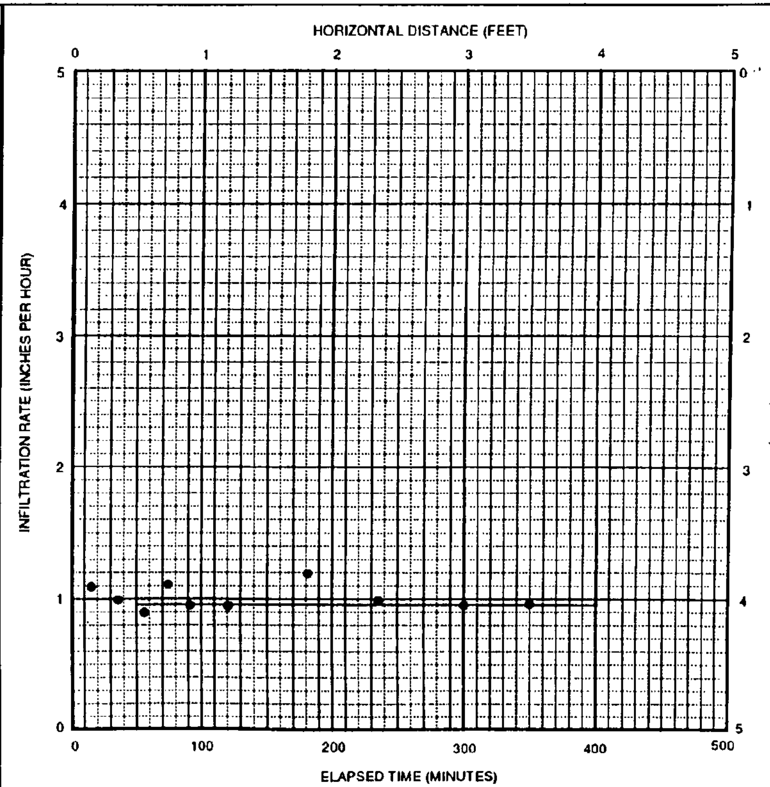
Fugro McClelland

JOB #: 9241-0684 JOB NAME: TEXACO-EQUADOR BY:
LOCATION: ADDRESS: DATE:

TEST BY: ALFONSO CARRERA METHOD: SINGLE RING INFILTROMETER (APPROXIMATELY 12-INCH DIAMETER)

DATE: 10-07-92 LOCATION: SHUSHUFINDI CENTRAL OBSERVATION: SUNNY INSIDE PIPE DIAMETER = 11.85 INCHES

ELAPSED TIME (MIN.)	QUANTITY OF WATER (ML)	INFILTRATION (IN/HR)
15	490	1.084
30	444	0.982
45	400	0.885
60	498	1.102
90	877	0.970
120	870	0.962
180	2172	1.201
240	1863	1.030
300	1776	0.982
360	1738	0.961



SOIL PROFILE DESCRIPTION

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INFILTRATION TEST

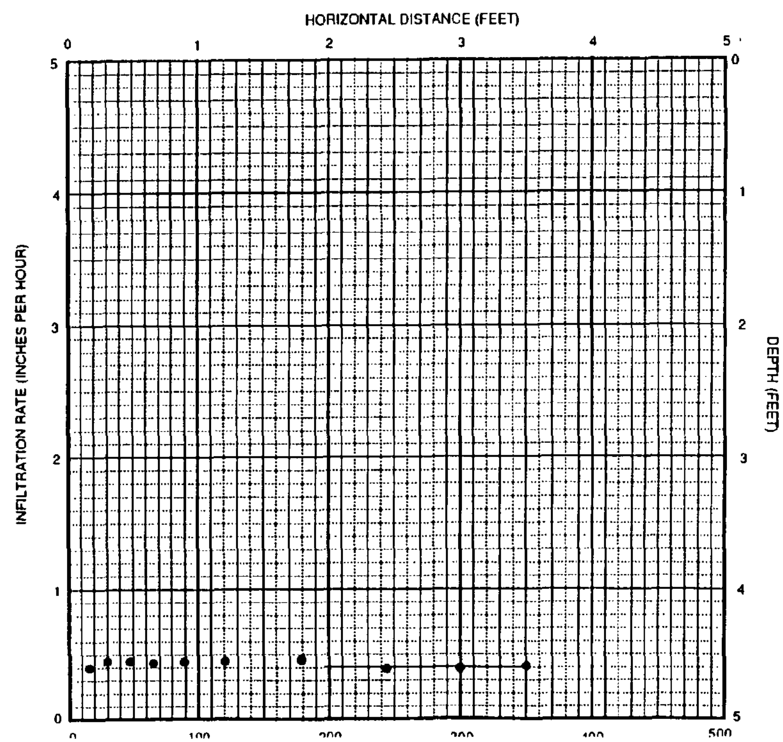
Fugro McClelland

JOB #: 9241-0684 JOB NAME: TEXACO-EQUADOR BY:
LOCATION: ADDRESS: DATE:

TEST BY: ALFONSO CARRERA METHOD: SINGLE RING INFILTROMETER (APPROXIMATELY 12-INCH DIAMETER)

DATE: 9-07-92 LOCATION: SHUSHUFINDI SUR OBSERVATION: CLOUDY INSIDE PIPE DIAMETER = 11.85 INCHES

ELAPSED TIME (MIN.)	QUANTITY OF WATER (ML)	INFILTRATION (IN/HR)
15	`188	0.416
30	194	0.429
45	199	0.440
60	198	0.438
90	378	0.418
120	375	0.414
180	798	0.441
240	700	0.387
300	688	0.380
360	700	0.387



SOIL PROFILE DESCRIPTION

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INFILTRATION TEST

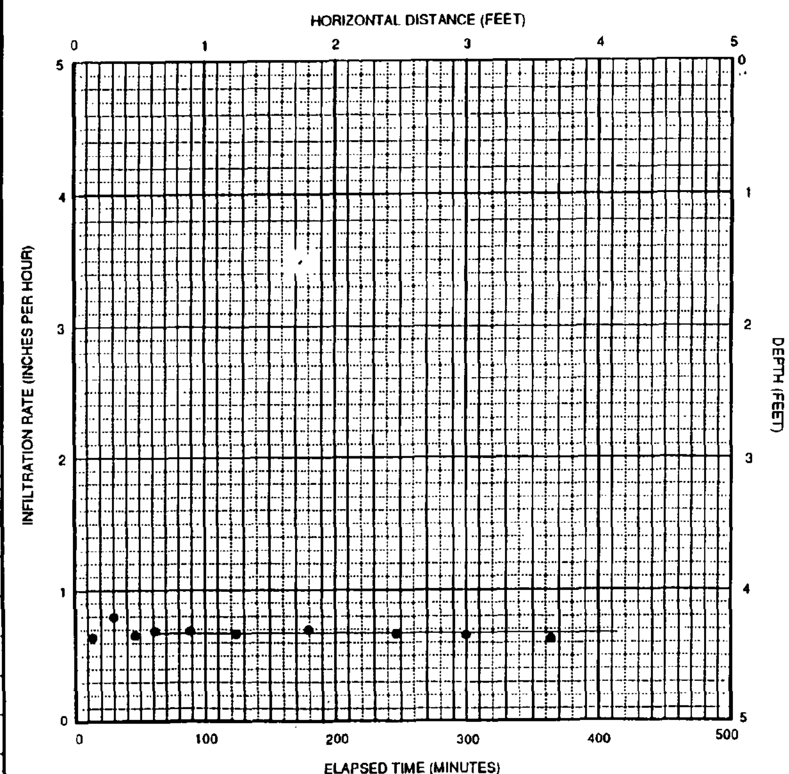
FUGRO McClelland

JOB #: 9241-0684 JOB NAME: TEXACO-EQUADOR BY:
LOCATION: ADDRESS: DATE:

TEST BY: ALFONSO CARRERA METHOD: SINGLE RING INFILTROMETER (APPROXIMATELY 12-INCH DIAMETER)

DATE: 8-07-92 LOCATION: SACHA SUR OBSERVATION: CLOUDY INSIDE PIPE DIAMETER = 11.85 INCHES

ELAPSED TIME (MIN.)	QUANTITY OF WATER (ML)	INFILTRATION (IN/HR)
15	298	0.659
30	375	0.829
45	332	0.734
60	364	0.805
90	729	0.806
120	641	0.709
180	1426	0.788
240	1382	0.764
300	1199	0.663
360	1284	0.710



SOIL PROFILE DESCRIPTION

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PET 039866

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INFILTRATION TEST

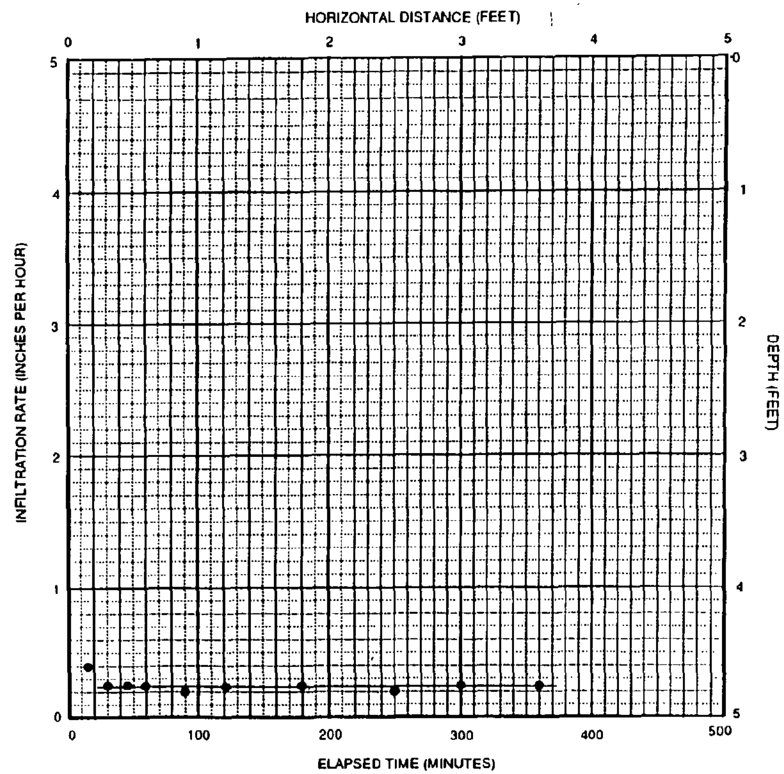
Fugro McClelland

JOB #: 9241-0684 JOB NAME: TEXACO-EQUADOR BY:
LOCATION: ADDRESS: DATE:

TEST BY: ALFONSO CARRERA METHOD: SINGLE RING INFILTROMETER (APPROXIMATELY 12-INCH DIAMETER)

DATE: 7-07-92 LOCATION: SACHA CENTRAL OBSERVATION: SUNNY INSIDE PIPE DIAMETER = 11.85 INCHES

ELAPSED TIME (MIN.)	QUANTITY OF WATER (ML)	INFILTRATION (IN/HR)
15	193	0.427
30	112	0.248
45	97	0.215
60	124	0.274
90	167	0.185
120	213	0.236
180	398	0.220
240	315	0.174
300	390	0.215
360	400	0.221



SOIL PROFILE DESCRIPTION

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PET 039867

CA1068614

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PERMEABILITY TEST

FALLING HEAD RISING TAILWATER

JOB No.: 684	JOB NAME: TEXACO-ECUADOR	Date: 07/06/92	
BORING No.: A .	MATERIAL DESCRIPTION: MODERATE BROWN SILTY CLAY	Page: _ of _ 1	1
SAMPLE No: SHUSHIFINDI SUR	SAMPLE DEPTH (ft): N/A	PERMEAMETER No.: 1	
BURETTE DIAMETER (cm): 1 128	AREA, a (cm ^ 2): 1.00	SPECIFIC GRAVITY: 2.65	

SPECIMEN INFORMATION

INITIAL MOISTURE CONTENT AND DENSITY						FINAL MOISTURE CONTENT		
REMOLDED SAMPLE			UNDISTURBED SAMPLE					
Maximum Dry Unit Weight (pcf):			Wet Weight of Sample (g):		134.7	Final Wet Sample Weight (g):		136 8
Soil Moisture Content (%):			Moisture Sample Tare No:		114	Moisture Sample Tare No.:		FOC
Desired Relative Compaction (%):			Wet Weight of Moisture Sample & Tare (g):		33.4	Wet Weight of Moisture Sample & Tare (g):		136 8
			Dry Weight of Moisture Sample & Tare (g):		24	Dry Weight of Moisture Sample & Tare (g):		76.9
			Tare Weight of Moisture Sample (g):		11 8	Tare Weight of Moisture Sample (g):		0
Initial Diameter, D (in)(cm):			Initial Diameter, D (in)(cm):	1 92		Final Diameter, D (in)(cm):	1.92	
Initial Samp. Ht., L (in)(cm):			Initial Samp. Ht., L (in)(cm):	1 87		Final Samp. Ht., L (in)(cm):	1.87	
Initial Samp.Area, A (in)(cm):	0	0	Initial Samp.Area, A (in)(cm):	2 89529179	18 6792645	Final Samp Area, A (in)(cm):	2.89529179	18 6792645
Initial Samp. Vol. (cu-in)(cc):	0	0	Initial Samp Vol. (cu-in)(cc):	5.41419565	88.7227706	Final Samp Vol. (cu-in)(cc):	5.41419565	88 7227706
Initial Sample Moist Soil Weight (g):		0.000	Initial Sample Moisture Content (%):		77.049	Final Moisture Content (%):		77 893
Initial Sample Saturation (%):		ERR	Initial Sample Saturation (%):		97.74	Final Saturation (%):		100.40
Initial Sample Dry Unit Weight (pcf):		0 00	Initial Sample Dry Unit Weight (pcf):		53.53	Final Sample Dry Unit Weight (pcf):		54.11

B-VALUE CHECK

Initial Pore Pressure (psi):	90	Final Pore Pressure (psi):	99.7	Delta Pore Pressure (psi):	9.70
Initial Cell Pressure (psi):	93.2	Final Cell Pressure (psi):	103.2	Delta Cell Pressure (psi):	10 00
		B-value:	0.970	(should be greater than 0.95)	

PERMEABILITY DATA

Note: cm H2O = 70.338 * (psi)

$$Kt = \frac{aL}{2A(t1-to)} [Ln (ho / h1)]$$

K=Permeability (cm/sec) L=Length of Sample (cm) ho=Initial Head (cm)

a=Area of Burette (cm2) to=Initial Time (sec) h1=Head at t1 (cm)

A=Area of Sample (cm2) t1=Time at h1 (sec)

Date	Hour	Temp. (C)	Elapsed Time (sec)	Applied Press.Dif. (psi)	Top. Bur. Reading (cm)	Bot. Bur. Reading (cm)	Burette Difference (cm)	Delta T (t1-to) (sec)	h (cm)	Kt (cm/sec)	K20 (cm/sec)
07/08/92	8.55	20	0	1	21.900	2.000	19 900	0	90 278		
07/08/92	9.08	20	780	1	21.800	2.100	19.700	780	90.078	3.61E-07	3.63E-07
07/08/92	9:22	20	1620	1	21.700	2.200	19.500	840	89.878	3 36E-07	3.38E-07
07/08/92	9:37	20	2520	1	21.600	2.300	19 300	900	89.678	3.14E-07	3.16E-07
07/08/92	9:51	20	3360	1	21.500	2.400	19.100	840	89.478	3.36E-07	3.39E-07
07/08/92	10.08	20	4260	1	21 400	2.500	18 900	900	89 278	3 16E-07	3 17E-07
07/08/92	10:21	20	5160	1	21.300	2.600	18 700	900	89 078	3.17E-07	3.18E-07
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK

Tested by:	Date:	Computed by:	Date:	Average Result: 3 23E-07

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CA1068615

PERMEABILITY TEST

FALLING HEAD RISING TAILWATER

JOB No.: 584	JOB NAME: TEXACO-ECUADOR	Date:	07/08/92
BORING No.: A -	MATERIAL DESCRIPTION: DK GREYISH BROWN MEDIUM GRAINED SAND	Page: _ of _	1 / 1
SAMPLE No.: SASHA CENTRAL	SAMPLE DEPTH (ft): N/A	PERMEAMETER No.:	1
BURETTE DIAMETER (cm): 1.128	AREA, a (cm ^ 2): 1.00	SPECIFIC GRAVITY:	2.65

SPECIMEN INFORMATION

INITIAL MOISTURE CONTENT AND DENSITY							FINAL MOISTURE CONTENT		
REMOLDED SAMPLE			UNDISTURBED SAMPLE						
Maximum Dry Unit Weight (pcf):			Wet Weight of Sample (g):		174.5		Final Wet Sample Weight (g).		192.3
Soil Moisture Content (%):			Moisture Sample Tare No.:		114		Moisture Sample Tare No..		MCN
Desired Relative Compaction (%).			Wet Weight of Moisture Sample & Tare (g):		51		Wet Weight of Moisture Sample & Tare (g):		192.3
			Dry Weight of Moisture Sample & Tare (g):		41.4		Dry Weight of Moisture Sample & Tare (g):		130.4
			Tare Weight of Moisture Sample (g):		11.8		Tare Weight of Moisture Sample (g):		0
Initial Diameter, D (in)(cm):			Initial Diameter, D (in)(cm):	1.92			Final Diameter, D (in)(cm):	1.92	
Initial Samp. Ht., L (in)(cm):			Initial Samp. Ht., L (in)(cm):	2.48			Final Samp. Ht., L (in)(cm):	2.48	
Initial Samp.Area, A (in)(cm):	0	0	Initial Samp.Area, A (in)(cm):	2.89529179	18.6792645		Final Samp.Area, A (in)(cm):	2.89529179	18.6792645
Initial Samp. Vol. (cu-in)(cc):	0	0	Initial Samp. Vol. (cu-in)(cc):	7.1224178	116.715516		Final Samp. Vol. (cu-in)(cc):	7.1224178	116.715516
Initial Sample Moist Soil Weight (g):		0.000	Initial Sample Moisture Content (%):		32.432		Final Moisture Content (%):		47.469
Initial Sample Saturation (%):		ERR	Initial Sample Saturation (%):		63.84		Final Saturation (%):		91.78
Initial Sample Dry Unit Weight (pcf):		0.00	Initial Sample Dry Unit Weight (pcf):		70.48		Final Sample Dry Unit Weight (pcf):		69.75

B-VALUE CHECK

Initial Pore Pressure (psi):	30	Final Pore Pressure (psi):	34.9	Delta Pore Pressure (psi).	4.90
Initial Cell Pressure (psi):	33	Final Cell Pressure (psi):	38	Delta Cell Pressure (psi):	5.00
		B-value:	0.980	(should be greater than 0.95)	

PERMEABILITY DATA

Note: cm H2O = 70.338 * (psi)

$$Kt = \frac{aL}{2A(t1-to)} [Ln (ho / h1)]$$

K = Permeability (cm/sec) L = Length of Sample (cm) ho = Initial Head (cm)
a = Area of Burette (cm2) to = Initial Time (sec) h1 = Head at t1 (cm)
A = Area of Sample (cm2) t1 = Time at h1 (sec)

Date	Hour	Temp. (C)	Elapsed Time (sec)	Applied Press.Dif. (psi)	Top. Bur. Reading (cm)	Bot. Bur. Reading (cm)	Burette Difference (cm)	Delta T (t1-to) (sec)	h (cm)	Kt (cm/sec)	K20 (cm/sec)
07/08/92	13:00.00	20	0	0	25.000	0.000	25.000	0	25		
07/08/92	13.00:10	20	10	0	24.000	1.000	23.000	10	23	1.39E-03	1.40E-03
07/08/92	13 00 20	20	20	0	23.000	2.000	21.000	10	21	1.52E-03	1.53E-03
07/08/92	13 00 30	20	30	0	22.000	3.000	19.000	10	19	1.67E-03	1.68E-03
07/08/92	13.00.40	20	40	0	21.000	4.000	17.000	10	17	1.86E-03	1.87E-03
07/08/92	13:00.50	20	50	0	20.000	5.000	15.000	10	15	2.09E-03	2.10E-03
		20	0	0			0.000	0	0	BLANK	BLANK
		20	0	0			0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	* BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
Tested by: TOM G		Date:	07/08/92	Computed by TOM G		Date:	07/08/92	Average Result:			1.72E-03

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CA1068616

PERMEABILITY TEST
FALLING HEAD RISING TAILWATER

JOB No.: 684	JOB NAME: TEXACO-ECUADOR	Date:	07/12/92
BORING No.: A -	MATERIAL DESCRIPTION: BROWN SILTY CLAY	Page: _ of _	1 / 1
SAMPLE No.: SHUSHIFINDI CENTRAL	SAMPLE DEPTH (ft): N/A	PERMEAMETER No.:	1
BURETTE DIAMETER (cm): 1.128	AREA, a (cm ^ 2): 1.00	SPECIFIC GRAVITY:	2.65

SPECIMEN INFORMATION

INITIAL MOISTURE CONTENT AND DENSITY						FINAL MOISTURE CONTENT		
REMOLDED SAMPLE			UNDISTURBED SAMPLE					
Maximum Dry Unit Weight (pcf):			Wet Weight of Sample (g):		188.3	Final Wet Sample Weight (g):		194 8
Soil Moisture Content (%):			Moisture Sample Tare No.:		114	Moisture Sample Tare No:		B
Desired Relative Compaction (%):			Wet Weight of Moisture Sample & Tare (g):		40	Wet Weight of Moisture Sample & Tare (g):		194 8
			Dry Weight of Moisture Sample & Tare (g)		34 8	Dry Weight of Moisture Sample & Tare (g):		137.4
			Tare Weight of Moisture Sample (g):		11.8	Tare Weight of Moisture Sample (g):		0
Initial Diameter, D (in)(cm):			Initial Diameter, D (in)(cm):	1 92		Final Diameter, D (in)(cm):	1.92	
Initial Samp. Ht., L (in)(cm):			Initial Samp. Ht., L (in)(cm):	2.35		Final Samp. Ht., L (in)(cm):	2.35	
Initial Samp Area, A (in)(cm):	0	0	Initial Samp.Area, A (in)(cm):	2.89529179	18 6792645	Final Samp Area, A (in)(cm):	2.89529179	18 6792645
Initial Samp. Vol. (cu-in)(cc):	0	0	Initial Samp. Vol (cu-in)(cc):	6.80393571	111.49653	Final Samp. Vol. (cu-in)(cc):	6.80393571	111.49653
Initial Sample Moist Soil Weight (g):		0 000	Initial Sample Moisture Content (%):		22.609	Final Moisture Content (%):		41 630
Initial Sample Saturation (%):		ERR	Initial Sample Saturation (%):		63 49	Final Saturation (%):		95 98
Initial Sample Dry Unit Weight (pcf):		0.00	Initial Sample Dry Unit Weight (pcf):		85 08	Final Sample Dry Unit Weight (pcf):		78 93

B-VALUE CHECK

Initial Pore Pressure (psi):	80	Final Pore Pressure (psi):	89 7	Delta Pore Pressure (psi):	9.70
Initial Cell Pressure (psi):	83	Final Cell Pressure (psi):	93	Delta Cell Pressure (psi):	10 00
		B-value. 0.970	(should be greater than 0.95)		

PERMEABILITY DATA

Note: cm H2O = 70.338 * (psi)

$$Kt = \frac{aL}{2A(t1-to)} [Ln (ho / h1)]$$

K=Permeability (cm/sec) L=Length of Sample (cm) ho=Initial Head (cm)
a=Area of Burette (cm2) to=Initial Time (sec) h1=Head at t1 (cm)
A=Area of Sample (cm2) t1=Time at h1 (sec)

Date	Hour	Temp. (C)	Elapsed Time (sec)	Applied Press.Dif. (psi)	Top. Bur. Reading (cm)	Bot. Bur. Reading (cm)	Burette Difference (cm)	Delta T (t1-to) (sec)	h (cm)	Kt (cm/sec)	K20 (cm/sec)
07/14/92	11:15	20	0	2	22.000	2.000	20.000	0	160 756		
07/14/92	11 21	20	360	2	21.900	2.100	19 800	360	160.556	5.52E-07	5.55E-07
07/14/92	11:35	20	1200	2	21.700	2 300	19 400	840	160.156	4.74E-07	4 76E-07
07/14/92	11:44	20	1740	2	21 600	2 400	19 200	540	159.956	3 69E-07	3.71E-07
07/14/92	11:53	20	2280	2	21.500	2.500	19 000	540	159.756	3.70E-07	3 72E-07
07/14/92	12:02	20	2820	2	21 400	2 600	18 800	540	159.556	3.70E-07	3.72E-07
07/14/92	12:20	20	3900	2	21 200	2.800	18 400	1080	159.156	3.71E-07	3 73E-07
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
Tested by:		Date:		Computed by:		Date:		Average Result:			3.72E-07

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PERMEABILITY TEST
FALLING HEAD RISING TAILWATER

JOB No.: 684	JOB NAME: TEXACO-ECUADOR		Date:	07/12/92
BORING No.: A -	MATERIAL DESCRIPTION: MODERATE TELLOWISH BROWN SANDY CLAY		Page: _ of _	1 / 1
SAMPLE No.: SASHA SUR	SAMPLE DEPTH (ft): N/A		PERMEAMETER No.:	1
BURETTE DIAMETER (cm): 1 128	AREA, a (cm ^ 2): 1 00		SPECIFIC GRAVITY:	2.65

SPECIMEN INFORMATION

INITIAL MOISTURE CONTENT AND DENSITY							FINAL MOISTURE CONTENT		
REMOLDED SAMPLE			UNDISTURBED SAMPLE						
Maximum Dry Unit Weight (pcf):			Wet Weight of Sample (g):		155 4		Final Wet Sample Weight (g):		182.3
Soil Moisture Content (%):			Moisture Sample Tare No.:		114		Moisture Sample Tare No.:		
Desired Relative Compaction (%):			Wet Weight of Moisture Sample & Tare (g):		35 4		Wet Weight of Moisture Sample & Tare (g):		182.3
			Dry Weight of Moisture Sample & Tare (g):		28.7		Dry Weight of Moisture Sample & Tare (g):		90
			Tare Weight of Moisture Sample (g):		11.8		Tare Weight of Moisture Sample (g):		
Initial Diameter, D (in)(cm):			Initial Diameter, D (in)(cm):	1 92			Final Diameter, D (in)(cm):	1 92	
Initial Samp. Ht., L (in)(cm):			Initial Samp. Ht., L (in)(cm):	2.3			Final Samp. Ht., L (in)(cm):	2.3	
Initial Samp.Area, A (in)(cm):	0	0	Initial Samp.Area, A (in)(cm):	2.89529179	18 6792645		Final Samp.Area, A (in)(cm):	2 89529179	18 6792645
Initial Samp. Vol. (cu-in)(cc):	0	0 .	Initial Samp. Vol (cu-in)(cc):	6 65917112	109 124263		Final Samp. Vol. (cu-in)(cc):	6 65917112	109.124263
Initial Sample Moist Soil Weight (g):		0 000	Initial Sample Moisture Content (%):		39 645		Final Moisture Content (%):		80 333
Initial Sample Saturation (%):		ERR	Initial Sample Saturation (%):		65 77		Final Saturation (%):		96 26
Initial Sample Dry Unit Weight (pcf):		0.00	Initial Sample Dry Unit Weight (pcf):		63 66		Final Sample Dry Unit Weight (pcf):		51.49

B-VALUE CHECK

Initial Pore Pressure (psi):	89.6	Final Pore Pressure (psi):	99.1	Delta Pore Pressure (psi):	9 50
Initial Cell Pressure (psi):	93.6	Final Cell Pressure (psi):	103.6	Delta Cell Pressure (psi):	10 00
		B-value:	0.950	(should be greater than 0 95)	

PERMEABILITY DATA

Note: cm H2O = 70.338 * (psi)

$$Kt = \frac{aL}{2A(t1-to)} [Ln (ho / h1)]$$

K=Permeability (cm/sec) | L=Length of Sample (cm) | ho=Initial Head (cm)
a=Area of Burette (cm2) | to=Initial Time (sec) | h1=Head at t1 (cm)
A=Area of Sample (cm2) | t1=Time at h1 (sec)

Date	Hour	Temp. (C)	Elapsed Time (sec)	Applied Press Dif. (psi)	Top. Bur. Reading (cm)	Bot. Bur. Reading (cm)	Burette Difference (cm)	Delta T (t1-to) (sec)	h (cm)	Kt (cm/sec)	K20 (cm/sec)
07/13/92	13:55	20	0	0 5	24 000	1.000	23.000	0	58.189		
07/13/92	13:55:30	20	30	0.5	23.600	1.200	22 400	30	57.589	5.40E-05	5 42E-05
07/13/92	13:56	20	60	0 5	23.300	1.500	21.800	30	56.989	5 46E-05	5 48E-05
07/13/92	13:56:30	20	90	0 5	23.100	1.700	21.400	30	56.589	. 3.67E-05	3 69E-05
07/13/92	13:57	20	120	0.5	22.800	2 000	20.800	30	55 989	5 55E-05	5 58E-05
07/13/92	13:58	20	180	0.5	22.300	2.500	19 800	60	54 989	4 69E-05	4 72E-05
07/13/92	13:59	20	240	0.5	21.800	3.000	18 800	60	53.989	4 78E-05	4 80E-05
07/13/92	14 00	20	300	0.5	21.300	3 500	17.800	60	52.989	4 87E-05	4 89E-05
07/13/92	14:01	20	360	0.5	20.800	4 000	16.800	60	51.989	4 96E-05	4 99E-05
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0.000	0	0	BLANK	BLANK
		20	0				0 000	0	0	BLANK	BLANK
Tested by: tom g		Date:		Computed by tom g		Date:	07/14/92	Average Result:			4.85E-05

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CA1068618