ENVIRONMENTAL REPORT FOR PLATFORM EUREKA

SAN PEDRO BAY
OFFSHORE SOUTHERN CALIFORNIA
FEDERAL OCS LEASES P-0300 AND P-0301
BETA FIELD

SHELL CALIFORNIA PRODUCTION INC.
OPERATOR

Prepared By:

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January 1984

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NOTE

Effective June 1, 1982, Shell Oil Company (Shell) transferred its oil and gas production operations in California to Shell California Production Inc. (SCPI). SCPI is owned through a subsidiary relationship by Shell.

All titles, agreements, permits, applications, drawings, references, reports, etc. originally bearing the name Shell Oil Company and which relate to this project have been transferred to SCPI. Where appropriate and reasonable, the text and other printed materials have been revised to reflect the establishment of SCPI as owner and operator of Shell's facilities and interest in the Beta Field Unit and related onshore activities. Some changes, however, may not have been made through infeasibility or oversight. All reviewers and users of this and associated documents are hereby advised of the establishment and interest of SCPI as it relates to Shell's Beta Field activities.

The application materials submitted to Minerals Management Service for the development of Platform Eureka in SCPI's Beta Field is provided in two separately-bound volumes. Volume I is the Development and Production Plan which contains a detailed description of the proposed project. Volume II is the Environmental Report and contains a summary of Volume I plus a detailed assessment of the project's environmental impacts.

INTRODUCTION

Development of the Beta Field includes two drilling platforms, Ellen and Eureka, and one production platform, Elly, for Leases P-0300 and and a drilling and production platform, Edith, for Lease P-0296. An EIR/EA which addressed Ellen and Elly and referred to the eventual development of Eureka was submitted in December 1978. Subsequently, an Environmental Report for Platform Edith was submitted in November 1980.

Platform Eureka is the subject of this Environmental Report. The document provides the necessary detail on environmental issues for Platform Eureka that was not available or completely defined when the original EIR/EA was prepared.

Platform Eureka is located in the NW/4, SW/4, Lease P-0301, in approximately 700 feet (213 m) of water depth. Installation of Platform Eureka with sea floor pipelines and power cables to Platform Elly will provide for complete development of the Beta Reservoir underlying Leases P-0300 and P-0301, and initial exploration of P-0306 on approximately 15-acre (6 ha) well spacing.

The Platform Eureka project includes:

1) Design, fabrication and installation of a drilling platform jacket and deck in 700 feet (213 m) of water, including facilities for primary separation, well testing and crew quartering. The drilling platform is designed for the drilling of up to 60 wells including disposal wells.

2) Modification and installation of one API-type drilling rig, relocated from existing drilling Platform Ellen to proposed drilling Platform Eureka.

3) Installation of a 12-inch subsea oil pipeline, a 6-inch subsea wet gas pipeline, a 10-inch subsea injection water pipeline, and two 35 kV subsea electrical power cables between drilling Platform Eureka and existing Platform Elly.

4) Design, construction and installation of additional generator capacity on existing production Platform Elly.

The Beta Field Unitization Agreement and the Participating Area has been approved, with an effective date of April 15, 1983. SCPI is the unit operator for the four leases in the Beta Unit (P-0296, P-0300, P-0301, and P-0306), and operates Platforms Ellen and Elly on Lease P-0300. SCPI will also be the operator of Platform Eureka on Lease P-0301. Chevron U.S.A. is the designated agent in the operation of Lease P-0296, and operates Platform Edith on that lease for itself and partners Union

Oil (46.429 percent), Minoco et al. (5.313 percent), and Pacific Federal Ventures (0.938 percent). SCPI's partners in Leases P-0300 and P-0301 are Hamilton Brothers (4.5 percent), Aminoil USA, Inc. (16.5 percent), Petro-Lewis, Inc. (17 percent), and Santa Fe Energy (12 percent). SCPI holds 50 percent interest in these leases. Lease P-0306 is held 100 percent by Chevron U.S.A.

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1.1 PROJECT NAME

Environmental Report for Platform Eureka.

1.2 AREA NAME

San Pedro Bay.

1.3 BLOCK NUMBER AND FIELD

Field	Leases	Tract	Block
Beta	P-0300, P-0301	No. 35-261, 262	No. 33N-37W, 36W

1.4 LESSEE AND/OR OPERATOR

Shell California Production Inc. (SCPI) is the operator for lease P-0301 and thus will operate Platform Eureka. SCPI's co-lessees in leases P-0301 and P-0300 are Hamilton Brothers (4.5 percent), Aminoil USA, Inc. (16.5 percent), Petro-Lewis, Inc. (17 percent), and Sante Fe Energy (12 percent). SCPI holds 50 percent interest in the leases.

1.5 PLATFORM/UNIT NAME

Platform Eureka/Beta Unit.

1.6 PREPARATION DATE OF ENVIRONMENTAL REPORT

January 1984.

1.7 ADDRESS FOR INQUIRIES:

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1.8 PREVIOUS RELATED ENVIRONMENTAL REPORTS, ENVIRONMENTAL ASSESSMENTS, AND/OR ENVIRONMENTAL IMPACT STATEMENTS

1. EIR/EA, Shell OCS Beta Unit Development, dated December 1, 1978, and Finalizing Addendum, dated February 21, 1979; prepared by the California State Lands Commission, the Port of Long Beach and the U.S. Geological Survey.
2. Environmental Report for Proposed Platform Edith, San Pedro Bay, November 24, 1980; Chevron U.S.A. Inc.
3. Draft Environmental Impact Report, Platform Edith Project: Platform Edith, Natural Gas Pipeline to Platform Eva, Crude Oil Pipeline

to Platform Elly, Power Cable to Shore, October 1982; prepared by California State Lands Commission.

4. EA for Exploration Plan of Lease 488, Gulf Oil Company, November 1983; Minerals Management Service, Pacific OCS Region.
5. EA for Exploration Plan of Lease 366, Chevron USA, October 1983; Minerals Management Service, Pacific OCS Region.
6. Final Environmental Impact Statements for Lease Sales 35, 48, and 68.
7. Draft Environmental Impact Statement for Southern California OCS Lease Offering, February 1984.

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DESCRIPTION OF THE PROPOSED ACTION

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DESCRIPTION OF THE PROPOSED ACTION

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SECTION 2
DESCRIPTION OF THE PROPOSED ACTION

2.1 LESSEE AND OPERATOR

Lessee: Shell California Production Inc.; Hamilton Brothers; Aminoil USA, Inc.; Petro-Lewis, Inc.; and Santa Fe Energy.

Operator: Shell California Production Inc.

2.2 LEASE NUMBER AND LOCATION

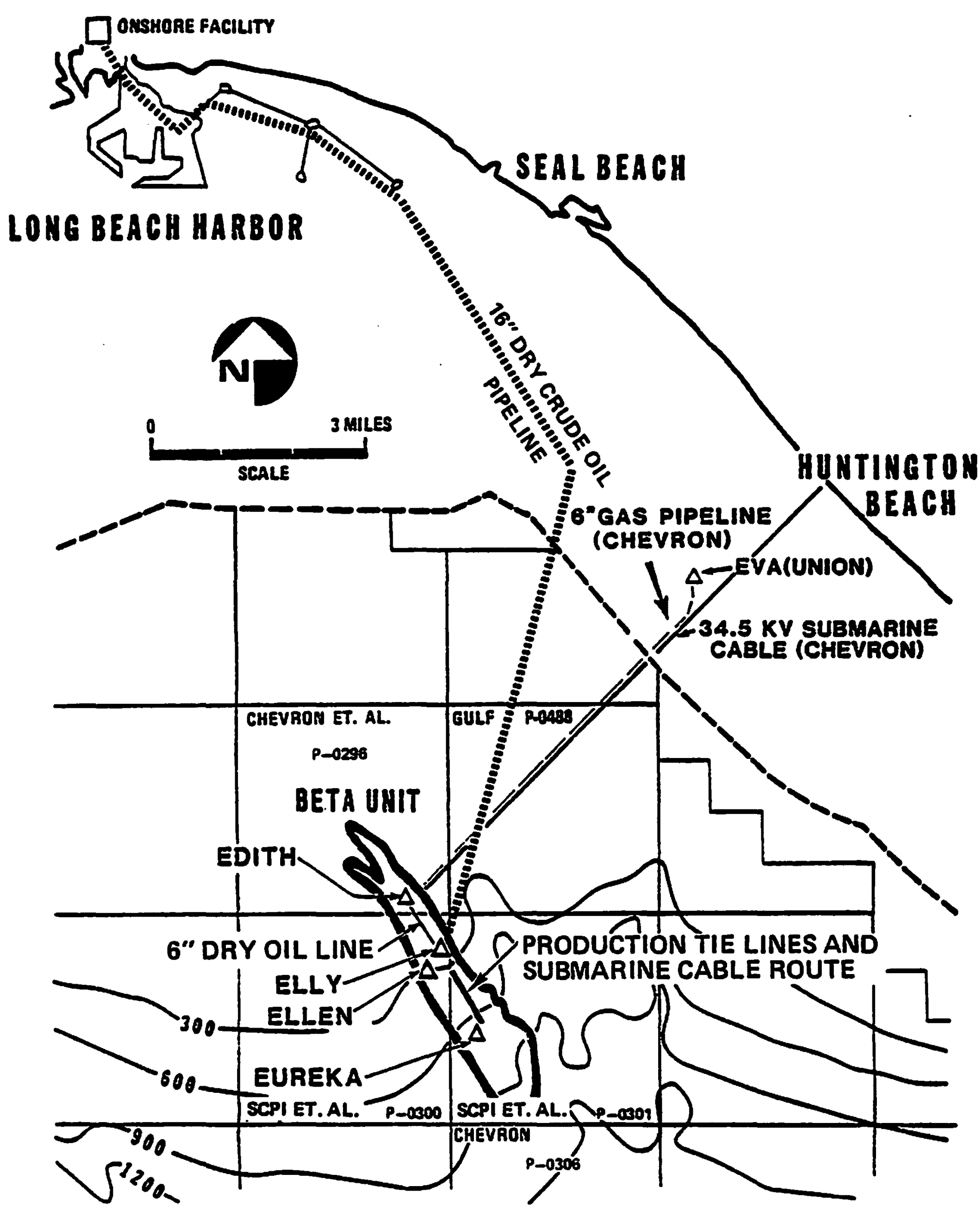
Platform Eureka would be located on lease P-0301 and connected via 3 pipelines and 2 power cables to Platform Elly on lease P-0300. Platform Ellen is immediately adjacent to Platform Elly on lease P-0300. The relative positions of these facilities are shown on Figure 2.2-1. The Loran C coordinates for the three platforms and the corners of the two leases follow.

LORAN C COORDINATES

	X	Y
Platforms		
Eureka	28201.55	40943.45
Ellen	28201.00	40949.99
Elly	28201.13	40949.99
P-0301		
NE corner	28209.60	40934.60
SE corner	28207.40	40926.50
SW corner	28199.99	40941.50
NW corner	28202.30	40949.40
P-0300		
SW corner	28192.20	40956.90
NW corner	28194.90	40964.20

2.3 PROJECT OBJECTIVES

The overall objectives as stated in the original EIR/EA for development of the Beta Unit (SLC et al., 1978) have not changed, and the installation and subsequent operation of proposed Platform Eureka is in furtherance of these objectives.



Beta Field Location and Facilities

FIGURE 2.2-1

Shell California Production Inc. (SCPI) and its partners (Hamilton Brothers, Aminoil USA, Petro-Lewis, and Santa Fe Energy) propose to continue expeditious development and production from reservoirs underlying OCS Leases P-0300 and P-0301 in accordance with directions from the U.S. Department of the Interior, Assistant Secretary for Energy and Minerals (Department of Interior, 1977). Such expeditious development is in keeping with justification for the original investments in SCPI's Beta Unit facilities. That justification included monies for excess processing and pipeline capacities to handle production from proposed Platform Eureka.

It is the objective of the lessees of leases P-0300 and P-0301 to develop, recover, process, and market the recoverable crude resources from these leases within the framework of their existing facilities and distribution systems, and the dictates of supply/demand functions. Through the sale of such petroleum products, lessees will provide the public with necessary goods, for which lessees expect to derive economic benefit in terms of return on investment.

2.4 DESCRIPTION AND LOCATION OF EXISTING AND/OR PROPOSED PLATFORMS AND FACILITIES

2.4.1 Existing Platforms and Facilities

Figure 2.2-1 presents a regional map showing the location of existing and proposed facilities. Section 2.2 provides Loran-C coordinates for location of the platforms and leases. As shown, three platforms are presently installed and operating in the Beta Field; two, Ellen and Elly, are operated by SCPI for itself and partners. Platform Ellen is an 80-slot, eight-legged drilling platform with two drilling rigs installed in 265 feet (81 m) of water on Lease P-0300. Platform Elly is a 12-legged production platform installed in 255 feet (78 m) of water, also on Lease P-0300. Production from Ellen is processed on Elly and pumped ashore via a 16-inch (41 cm) crude oil pipeline.

A third platform in the Beta Field has been installed on Lease P-0296. Chevron and partners' Platform Edith is a 12-legged 70-slot drilling and production platform, located in 161 feet (49 m) of water. Clean oil from Edith is shipped via a 6-inch (15 cm) pipeline to SCPI's Platform Elly where it is comingled with production from Platform Ellen. Following approval and installation, crude from proposed Platform Eureka will be processed on Elly with that from Ellen and comingled with clean oil from Platform Edith. All crude oil from the Beta Field will be pumped to shore facilities in Long Beach Harbor from Elly via the existing 16-inch (41 cm) crude pipeline. Details of Platform Edith are set forth in Chevron's Platform Edith Environmental Report (Chevron, 1980) and in the Draft Environmental Report for the Platform Edith Project (SLC, 1982).

2.4.2 Proposed Platform Eureka

SCPI's proposed Platform Eureka is the only proposed platform not yet installed in the Beta Field. Eureka will be a 60-slot, eight-legged drilling platform installed in 700 feet (213 m) of water on Lease P-0301. The structure will be secured to the bottom by 24 skirt piles situated near the four corners of the jacket. The platform will have two deck levels each measuring approximately 170 feet by 200 feet (52 m by 61 m).

A single drilling rig will be transferred from Ellen for use on Eureka and produced crude oil and gas pipelines will transport these fluids to Platform Elly for processing. Primary gas separation will occur on Eureka. A subsea pipeline will transfer injection water from injection pumps on Elly to the Eureka injection wells. Two power cables will transmit platform power from generators on Elly to Eureka. A simplified process flow diagram for the platform is provided in Figure 2.4-1.

2.4.2.1 Platform Construction

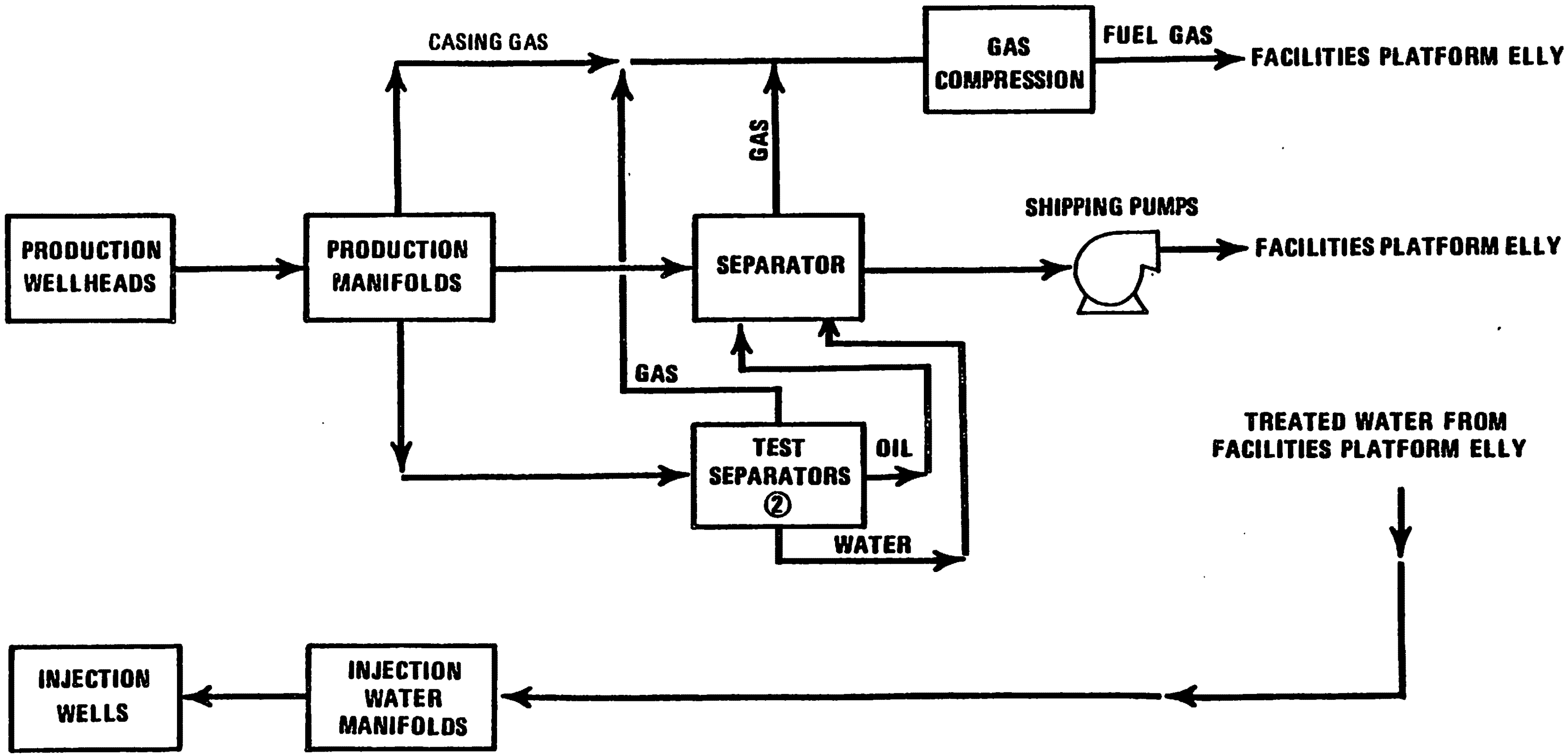
A self-propelled crane ship will be mobilized to the Beta Field to install Platform Eureka and set or relocate various equipment components on Platforms Ellen, Elly and Eureka. The crane ship will be equipped with a 1600 short ton lift (1451 metric tons) capacity crane, anchoring system and accommodations for approximately 200 construction personnel. The entire installation phase is scheduled to be completed in approximately 80 days.

The crane ship will initially set up adjacent to Platform Ellen to remove one of the two drilling rigs. The drilling rig components will be loaded onto a cargo barge and transported to shore where modifications will be made to adapt the rig for Platform Eureka's use.

After the drilling rig is offloaded, several new packages will be installed on Platform Ellen. A Piperack Package and Skid Adapter Panel will be installed to allow one drilling rig to service all the platform wells. A Beam Package with recreation building will also be installed on the upper deck in an area vacated by one of the previously removed rig packages.

After making all the Platform Ellen lifts, the crane ship will move to Platform Elly and set Generator Station No. 2. Generator Station No. 2, weighing approximately 850 tons (771 metric tons), will be transported on a cargo barge from the fabrication site in Southern California.

The next phase of the construction program involves installation of Platform Eureka. The Eureka jacket, weighing aproximately 21,800 tons (19,773 metric



Simplified Process Flow—Eureka Platform Production Facilities.

FIGURE 2.4-1

WESTEC Services, Inc.

tons), will be transported on a launch barge from the fabrication site in Northern California to the Beta Field. After launching the jacket from the barge, approximately three tugboats will be attached to the jacket to maneuver the structure to the final installation site. The jacket will then be lowered to the seafloor by controlled flooding of the jacket legs and buoyancy tanks.

The 24 skirt piles, weighing approximately 5000 tons (4500 metric tons), will be transported to the installation site on a cargo barge from the fabrication site on the Gulf Coast. The skirt piles are 60-inch (152.4-cm) diameter with single section lengths of 315-400 feet (96-122 m). The skirt piles will be stabbed into guides on the jacket by the crane ship and driven with above water steam hammers to a penetration of 225-320 feet (69-98 m) below the seafloor. When the piles are driven to final penetration, they will be grouted to the jacket to permanently affix the structure to the seafloor.

The 60 strings of offshore installed structural casing, weighing approximately 3050 tons (2700 metric tons), will be transported to the installation site on a cargo barge from the fabrication site in Northern California. The structural casings are 24-inch (61 cm) diameter and will be driven with the crane ship approximately 200 feet (61 m) below the seafloor.

After the above work is completed, the deck sections will be installed. The deck, weighing approximately 4000 tons (3600 metric tons), will be transported on a cargo barge in four sections from the fabrication site on the Gulf Coast. Each deck section will be lifted and set onto the legs of the jacket.

The drilling rig previously offloaded from Platform Ellen will be set on the Eureka deck. Several new modules, which includes a Piperack, Derrick Skid Base, Cement Tanks, Flare Boom and Living Quarters, will also be set on the Eureka deck.

A mooring system consisting of an anchor with chain running up to a crown buoy will be installed southeast of Platform Eureka to allow supply boats to hold station during loading/unloading of drilling supplies. This system will be installed upon completion of the platform installation phase.

Hook-Up is the interconnection of structure, piping, wiring, instrumentation, and equipment which (1) cross the splices between the deck sections; (2) connect field installed equipment modules together and to the deck; and (3) connect the jacket (subsea portion of platform) to the deck. This construction phase will begin immediately after the installation phase ends. The work on Elly involves connecting the new generator station module. The work on Ellen involves connecting the new pipe rack, skid adapter panel and beam package modules. The work on Eureka involves connecting the four deck sections, the quarters building module, the Rig 2 modules, and the jacket.

2.4.2.2 Drilling Equipment

Eureka will have slots for a maximum of 60 wells. One API platform-type drilling rig and associated crew and services will be required to drill the wells presently planned. The rig will be taken from Platform Ellen, modified on shore, and installed on Eureka. One rig will remain on Ellen.

The Eureka drilling rig will consist of the following units: pump package, engine package, derrick skid base, derrick substructure, pipe rack package and derrick. The substructure will house the following main drilling equipment.

a. Drawworks - 2000 hp (2028 metric hp) electrically powered.
b. Rotary Table - 1000 hp (1014 metric hp) independently electrically powered.
c. Hook, Traveling Block and Crown Block 350+ ton (317+ metric ton) load rated capacity.
d. Drill Pipe - 5 inch (12.7 cm), 19.50#, Grade G-105.

The platform-type derrick, 147 feet (44.8 m) high with 1,400,000 pound (635,029 kg) API gross nominal capacity will be on top of the substructure.

The substructure will be supported on a skid base, which will rest on two elevated deck skid beams. The skid base will be equipped with a hydraulic jacking system to transport it along the platform deck beams. The substructure will be transported across the skid base by the same type jacking system.

The rig will be equipped with two 1000 hp (1014 metric hp) mud pumps, a mud slugging tank, three active mud tanks, a reserve mud tank, and a gel tank. In addition, a completion fluid system will be provided. The completion fluid will be used for all underreaming or perforating through the pay interval, for gravel packing operations and for well workovers.

A low solids, gas free mud will be maintained using shale shakers, desanders, desilters and a degasser. A cuttings wash system will handle any oil contaminated cuttings for disposal. Cuttings that cannot be adequately cleaned will be diverted to the waste cuttings bin to be hauled ashore for appropriate disposal.

Mud volumes will be closely monitored using a pit volume totalizer system, an incremental flowrate indicator, and a precision fill-up measurement system. These warning systems will have visual and audible alarm signals at the driller's console. A bulk material handling system will be provided for barite. Other mud and completion fluid additives (chemicals, lost circulation material, gravel, etc.) will be palletized.

The drilling rig moved from Ellen will be powered by three 800 kW generators, housed in its engine package. The facility's power system will also serve as a backup power source for essential services.

Two diesel powered cementing units and four 1000 cubic feet (28 cubic m) bulk storage tanks will be provided for well cementing operations. One of the cementing units, when combined with a blender, will be used for gravel packing operations.

2.4.2.3 Equipment and General Layout

Platform Eureka will be provided with all necessary equipment for safe off-shore drilling. Drilling facilities were described in Section 2.4.2.2. Oil, water and gas processing will occur for the most part on Platform Elly. Primary gas separation and well testing equipment will, however, be installed on Eureka. Additional equipment will include safety and monitoring systems as well as living facilities for personnel. The general layout for each level of the platform is shown on Figures 2.4-2, 2.4-3, and 2.4-4.

2.4.3 Proposed Pipelines and Cables

2.4.3.1 Pipeline/Cable Specifications and Location

There will be three pipelines and two power cables connecting Platform Eureka to Elly. The three pipelines are for produced water and crude oil, injection water, and natural gas. The pipelines and cable routes are shown on Figure 2.4-5. Pipeline and cable specifications are as follows:

Pipeline Specifications

a. Products to be transported:
   - 12.75-inch (32.3-cm) OD line - produced water and crude oil
   - 10.75-inch (27.3-cm) OD line - injection water
   - 6.625-inch (16.8-cm) OD line - wet natural gas

b. Size, weight and grade of the pipes:
   - 12.75-inch (32.3-cm) OD x 0.625-inch (1.58-cm) WT, 80.93 lb/feet, AP15LX-Grade X-42 SMLS Pipe
   - 10.75-inch (27.3-cm) OD x 0.594-inch (1.5-cm) WT, 64.43 lb/feet, AP15LX-Grade X-42 SMLS Pipe
   - 6.625-inch (16.8-cm) OD x 0.375-inch (0.95 cm) WT, 25.03 lb/feet, AP15LX-Grade X-42 SMLS Pipe

c. Length of lines (J-tube to J-tube):
   - 12.75-inch (32.3-cm) OD line - 8220 feet (2506 m)

SECTION 1

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on lease OCS-P0488, which is immediately north of P-0301 where Eureka is proposed (see Figure 2.2-1). Drilling could start in the first quarter of 1984.

A third pending action is an exploration drilling plan for Chevron USA, Inc. on Lease OCS P-0366. Five wells are to be drilled by drillship, possibly starting in the first quarter of 1984. The lease is adjacent to the south of Lease P-0306 (Figure 2.2-1).

charge from the facility will comply with OCS Order No. 7. The measures which will be taken include reporting of drilling mud components, disposal of excess mud and drill cuttings under EPA permitting procedures, curbs, gutters, and drains to collect all contaminated deck drainage (also regulated by the U.S. Coast Guard), containers and similar solid waste material transported ashore for disposal, personnel instruction, training and drills, pollution inspection and reports, oil spill contingency plan on file, pollution control equipment, and materials maintained on board the vessel or standby boat.

6. Per OCS Order No. 8, SCPI will obtain design verification for all platform facilities through a MMS-approved third party Certified Verification Agent.
7. The design of the pipeline will be in accordance with the provisions of OCS Order No. 9, which includes approved high-low pressure monitoring and shut-in equipment.
8. OCS Order No. 10, Twin Core Holes, does not apply to this project.
9. SCPI will comply with OCS Order No. 11. This includes proposing a maximum efficient rate from the reservoir(s) encountered during the drilling program within 45 days of first production from that reservoir. The operator will provide maximum production rate information as required and follow the testing and completion procedures outlined.
10. The operator will mark documents available for public inspection per OCS Order No. 12.

In addition to the above, SCPI will obtain U.S. Army Corps of Engineers' approval of the platform pipelines and cables location.

2.13 NEARBY PENDING ACTIONS

Platform Eureka is the third of three platforms originally planned to be constructed by SCPI for development of their leases in the Beta Unit. One nearby pending action that the applicant is aware of is in regard to EPA establishing an ocean disposal site for drilling muds and cuttings. The site would be utilized for disposal by THUMS Long Beach Company for drilling activity at four islands in Long Beach Harbor. The proposed location is about 17 nautical miles west of Platforms Elly and Ellen. The proposed EPA rule was announced in the December 8, 1983 Federal Register.

A second pending action involves the drilling of five exploration wells by Gulf Oil Exploration and Production Company. These wells are to be drilled by jack-up rig further reduced by adherence to the mitigation measures set forth above.

e. Produced water will be discharged in accordance with the EPA NPDES permit.

2.12 <u>COMPLIANCE WITH OCS ORDERS AND REGULATIONS</u>

Submittal of this Environmental Report and the accompanying Development and Production Plan for Platform Eureka complies with the regulations in 30 CFR 250.34, OCS Order 2, and NTL 80-2 "Minimum Requirements for Environmental Reports," dated March 20, 1980. Other measures in compliance with these regulations include:

1. Certification of Consistency with California's Coastal Management Plan.

2. The platform will be marked in accordance with OCS Order No. 1, Paragraph 1. Measures to comply with OCS Order No. 2 include filing of applications for permits to drill (also follows NTL 80-2), submittal of evidence of fitness of drilling unit with operational limitations and anticipated conditions, including safety, firefighting, and pollution equipment, completion and submittal of a Shallow Geological Hazard Survey and Report (conforms in detail with NTL 80-2). The following activities will conform to MMS requirements: well casing and cementing program including testing; directional surveys; blowout preventers, testing programs and drills; mud program and monitoring; and supervision, surveillance and training of drilling personnel. A Critical Operations and Curtailment Plan is included in the Oil Spill Contingency Plan for the Beta Unit including Platform Eureka submitted to the MMS concurrently with this Environmental Report.

3. Each well will be plugged and abandoned in compliance with OCS Order No. 3.

4. OCS Order No. 4, Determination of Well Producibility, requires all production tests to be witnessed by an authorized representative of the MMS. To comply with this order, the MMS office will be notified as required. In complying with OCS Order No. 5, SCPI shall install and operate the Best Available Safety Technology aboard the platform.

5. The wellhead completions performed on Platform Eureka will meet the requirements of OCS Order No. 6. Solid and liquid disposal and dis-

The proposed project is not expected to result in seafloor subsidence. Sections 3.1 and 4.1 of this report provide a detailed discussion of the geologic characteristics of the site and any potential for subsidence to occur.

When not being injected in the planned waterflood program treated produced water from Eureka will be discharged at existing Platform Elly along with that from existing Platform Ellen. The water treatment and discharge system has been designed to comply with EPA discharge permit requirements.

FINDING: The proposed activities are consistent with the referenced policies for the following reasons:

a. All of the geological data available from former studies and the geophysical survey for Platform Eureka have been extensively evaluated by SCPI in order to determine the safest, most effective platform structure design. Design, fabrication, and installation will all be performed in accordance with the latest edition of OCS Order No. 8. Prior to the approval of the proposed platform, the detailed shallow hazards and geophysical survey report will be reviewed according to the MMS Verification Program to ensure that the development is performed safely.

b. OCS Order No. 2 regulating casing and mud programs and implementation of the best available safety technology minimize the risk of a blowout resulting from communication between a higher presure strata and a lower pressure strata. In addition, SCPI has extensive experience drilling and operating in the offshore environment. If experience dictates, steps in addition to those required by the MMS will be taken to insure the safety of the personnel and protection against a major oil spill.

c. The existing 16-inch (40.6cm) clean oil pipeline will serve as a common facility for other producing platforms in the Beta Field, and the existing onshore metering and pumping station facilities will accommodate crude from all existing and proposed facilities in the unit, resulting in a consolidation of facilities.

d. The proposed platform will be located sufficiently clear of the northbound shipping land of the designated VTSS. The platform will be sited in accordance with the requirements of the U.S. Army Corps of Engineers and the U.S. Coast Guard. Potential hazards to navigation are

ASSESSMENT: The proposed platform will be located in the most suitable site in terms of the least impact on the environment and greatest advantage for oil production. The proposed location of Platform Eureka is very critical to maximize oil recoveries and at the same time avoid mechanical problems in drilling, completing and producing highly deviated wells. After careful consideration, it was decided that the optimum platform location was at Lambert Coordinates X=1,431,380 Y=513,460 within lease OCS P-0301. A platform at this location will maximize oil recoveries from the Beta Field South Sliver oil accumulation. Also, potential reserves underlying Chevron lease OCS P-0306 can be evaluated from this location and Chevron has rights to 1 of the 60 slots on Eureka for this purpose. Platform Eureka is projected to be the third in a series of three SCPI platforms associated with the Beta Field. Development planning for this field has resulted in consolidation of production processing facilities and crude oil pipelines to shore. One platform, SCPI's existing Platform Elly, is designed to handle crude production from both existing SCPI drilling Platform Ellen and proposed drilling Platform Eureka. In addition, clean oil from Chevron's Platform Edith on OCS Lease P-0296 will be comingled with all of SCPI's clean crude and transported to the existing onshore distribution facility at Long Beach via the existing 16-inch (40.6-cm) pipeline.

The use of subsea completions has been determined to be an infeasible alternative for the placement of Platform Eureka. The use of subsea completions would not serve to eliminate visual impacts because a drilling vessel would be required onsite during the 7-year drilling phase and frequently during the production phase to accomplish well workovers and testing. The introduction of additional seafloor obstructions over a relatively large area would pose a greater impact to commercial fisherman than that resulting from the proposed platform. There is also more environmental risk associated with the use of subsea completions because they are not as accessible to control or service in case of a malfunction. This is particularly true of deep water locations. In the case of the proposed project, artificial lift will be required to extract the resource, thus reducing the potential for using subsea completions and increasing the frequency of well servicing operations.

The proposed surface location for Platform Eureka is within the Gulf of Santa Catalina Traffic Separation Scheme; however, it is clear of both the Northbound (inbound) and Southbound (outbound) and their respective buffer zones, with some 1400 feet (427 m) being the point of nearest proximity to a traffic lane. Navigation aids and high visibility paint color schemes will be incorporated and maintained as required by the U.S. Coast Guard.

Section 30262, OIL AND GAS DEVELOPMENT

Oil and gas development shall be permitted in accordance with Section 30260, if the following conditions are met:

a. The development is performed safely and consistently with the geologic condition of the well site.

b. New or expanded facilities related to such development are consolidated, to the maximum extent feasible and legally permissible, unless consolidation will have adverse environmental consequences and will not significantly reduce the number of producing wells, support facilities, or sites required to produce the reservoir economically and with minimal environmental impacts.

c. Environmentally safe and feasible subsea completions are used when drilling platforms or islands would substantially degrade coastal visual qualities unless use of such structures will result in substantially less environmental risk.

d. Platforms or islands will not be sited where a substantial vessel traffic hazard might result from the facility or related operations, determined in consultation with the USCG and the Army Corps of Engineers.

e. Such development will not cause or contribute to subsidence hazards unless it is determined that adequate measures will be undertaken to prevent damage from such subsidence.

f. With respect to new facilities, all oil field brines are reinjected into oil-producing zones unless the Division of Oil and Gas of the Department of Conservation determines to do so would adversely affect production of the reservoirs and unless injection into other subsurface zones will reduce environmental risks. Exceptions to reinjection will be granted consistent with the Ocean Waters Discharge Plan of the State Water Resources Control Board and where adequate provision is made for the elimination of petroleum odors and water quality problems. Where appropriate, monitoring programs to record land surface and nearshore ocean floor movements shall be initiated in locations of new large-scale fluid extraction on land or near shore operations begin and shall continue until surface conditions have been stabilized. Costs of monitoring and mitigation programs shall be borne by liquid and gas extraction operators.

6. Energy consumption will be minimized during the proposed activities by use of recycled waste heat, produced gas, and highly fuel efficient turbines for power generation.

7. The Huntington and Newport Beach areas provide a number of recreational opportunities which attract tourism to the region. Project activities will occur at a sufficient distance from the beaches to preclude any adverse impacts during normal activities. Recreational resources along the coastline will not be significantly disrupted as a result of project construction activities and no long-term effects on recreational opportunities are expected.

Section 20360, LOCATING INDUSTRIAL DEVELOPMENT

> Coastal dependent industrial facilities shall be encouraged to locate or expand within existing sites and shall be permitted reasonable long-term growth where consistent with this division. However, where new or expanded coastal-dependent industrial facilities cannot feasibly be accommodated consistent with other policies of this division, they may nonetheless be permitted in accordance with this section and Section 30261 and 30262 if: (1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible."

ASSESSMENT: All components of the proposed project are coastal dependent, requiring locations on or adjacent to the ocean to be able to function. The proposed platform site is located in an existing field currently being developed and offshore oil and gas extraction and production facilities in the area are thus not an uncommon use.

FINDING: Because domestic production of oil is considered to be in the national interest and is important to the State and local economy, the implementation of the proposed project is in the public's interest.

SCPI's incorporation of development standards and other mitigation measures as part of the proposed project effectively mitigates potentially adverse environmental effects to the maximum extent possible.

technologies including low NO_x diesel engines, cogeneration, fugitive emissions program, smokeless flare burner and a hydrocarbon vapor recovery system for the minimization of hydrocarbon and nitrogen oxide emissions to the atmosphere.

Energy consumption will be minimized during the proposed activities by the use of recycled waste heat from the turbine generators for oil treatment and utilization of produced gas generated from the platform to help supply normal operating fuel requirements for both Platform Eureka and the existing Platform Elly processing facilities. The project itself represents a net production of energy.

As discussed in Section 4.5.2 of this report, project activities will not constitute a major impact to transportation systems in the area or create a substantial increase in vehicle trips per day. The proposed project activities will not disrupt or affect any special communities or neighborhoods.

FINDING: The proposed project is consistent with the goals and intent of the above policy for the following reasons:

1. Based on the known submarine geology and earthquake recurrence intervals, the structure will be designed in accordance with the latest edition of OCS Order No. 8 for the most severe loads that might occur during launch and installation, and during operations, to safely withstand the potential earthquake ground shaking identified for the seismic region. Complete details on site conditions, design criteria, platform analyses, fabrication and installation will be provided as part of the Verification Documentation required for OCS Order No. 8.
2. The platform site and structure will remain stable, even under maximum credible earthquake conditions. The design will also incorporate the ability of the platform to withstand extreme oceanographic conditions.
3. OCS Order No. 2 and implementation of best available safety technology minimize the risk of blowout resulting from communication between a higher pressure strata and a lower pressure strata.
4. The proposed pipelines will be designed to minimize the risk of damage from geologic hazards and to ensure their structural integrity.
5. The proposed activities will comply with MMS-established regulations, 30 CFR Part 250, concerning air emissions from offshore oil and gas operations.

FINDING: The proposed project will not adversely effect or interfere with views of the ocean or coastal areas. The offshore platform will appear diminutive in scale from shoreline viewing locations and generally will not be visible. The project is considered to be in conformance with Section 30251.

Section 30253, HAZARD AND ENERGY CONSERVATION CRITERIA

New development shall:
1) Minimize risks to life and property in areas of high geologic, flood and fire hazard.
2) Assure stability and structural integrity, and neither create nor contribute significantly to erosion, geologic instability, or destruction of the site or surrounding area in or any way require the construction of protective devices that would substantially alter natural land forms along bluffs and cliffs.
3) Be consistent with requirements imposed by an air pollution control district or the State Air Resources Control Board as to each particular development.
4) Minimize energy consumption and vehicle miles traveled.
5) Where appropriate, protect special communities and neighborhoods which, because of their unique characteristics are popular visitor destination points for recreational uses.

ASSESSMENT: Ground shaking will occur in the vicinity of the platform and along the pipeline route whenever earthquakes of sufficient magnitude occur within a significant range. Although the project is located within the Palos Verdes fault zone, the platform site is well removed from any active fault traces. The proposed pipelines will cross two fault traces, but will be designed to withstand any seismic movement expected along these faults. Further discussion of geological hazards is presented in Section 4.1.2.

Although the offshore emissions will exceed the MMS exemption level as provided in 30 CFR 250.57, they are totally offset onshore by reductions at Shell Oil's Wilmington refinery, Aminoil's operations at Huntington Beach, and SCPI facilities in Ventura, and Yorba Linda.

The proposed project will comply with all Clean Air Act and DOI requirements and applicable local air quality control regulations and will receive all necessary permits and approvals prior to operation. The project will incorporate several control

Studies by MESA[2], Inc., "Deep Water Beta Platform Site Evaluation" (1979) and "Beta Pipeline Route Evaluation" (1980) revealed no cultural resources in the project area. A more recent cultural resource survey of the project area by MESA[2] (1984c) revealed a feature of undetermined cultural significance approximately 5000 feet (1524 m) south of the proposed Platform Eureka site in a water depth of 825 feet (251 m). No other features found in the project area were concluded to be of cultural significance. As described in the Platform Eureka DPP, all proposed construction and operation activities will avoid the above noted feature of undetermined significance.

FINDING: The proposed activities are considered consistent with the stated policy since no significant or potentially significant resources will be disturbed.

Section 30251, COASTAL VISUAL RESOURCES AND SPECIAL COMMUNITIES

> The scenic and visual qualities of coastal areas shall be considered and protected as resource of public importance. Permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas. New development in highly scenic areas such as those designated in the California Coastline Preservation and Recreation Plan prepared by the Department of Parks and Recreation and by local government shall be subordinate to the character of its setting.
>
> New development shall, where appropriate, protect special communities and neighborhoods which, because of their unique characteristics, are popular visitor destination points for recreation uses.

ASSESSMENT: The installation of Platform Eureka and associated offshore construction activities are potentially visible from nearshore roadways, and by beach users along the Huntington Harbour, Huntington Beach, and Newport Beach area shoreline.

The platform appearance would not be unique on the horizon line due to the presence of other structures in the immediate area; however, the additional visual intrusion is of minor significance because of the platform's 9 mile (16 km) distance from shore and frequent fog and haze limitations on visibility.

ASSESSMENT: The proposed continuation of development in the offshore Beta Field from Platform Eureka will not occur within or reasonably near any identified environmentally sensitive habitat areas.

The proposed activities would impact environmentally sensitive areas in the unlikely event of a major oil spill occurring and reaching the shoreline. The impacts of an oil spill on sensitive biological communities in these areas are discussed in Section 4.6.4 of this report. The SCPI Beta Unit Oil Spill Contingency Plan defines the sensitive ecological areas within possible oil spill paths (determined from trajectory data) and delineates procedures to protect these areas from contamination.

Normal operation of seafloor pipelines would not impact sensitive habitat areas. Should an accidental spill occur, intertidal habitats and several public beaches could be adversely affected. The Oil Spill Contingency Plan includes particular reference to these areas to mitigate or prevent spill impacts.

FINDING: The proposed activities will be conducted so that adverse environmental impacts on important habitat areas will be avoided. The proposed project is consistent with this policy because normal project activities will not significantly impact any environmentally sensitive habitat areas in the general vicinity, and the impact of an oil spill or blowout would be mitigated by observing the requirements of OCS Order No. 7, requiring that immediate action be taken to minimize the impact on marine resources.

Section 30244, PROTECTION OF ARCHAEOLOGICAL AND PALEONTOLOGICAL RESOURCES

Where development would adversely impact archaeological or paleontological resources as identified by the State Preservation Officer, reasonable mitigation measures shall be required.

ASSESSMENT: Notice to Lessees (NTL) 77-3, "Minimum Cultural Survey Requirements, OCS Exploratory Drilling," requires that a cultural resource survey be conducted prior to approval of OCS drilling operations in less than 394 feet (120 m) of water. Platform Eureka will be located in approximately 700 feet (213 m) of water, and therefore could be considered exempt from this requirement. The pipeline and cable route, however, pass through areas where the water is less than 260 feet (79 m) deep.

FINDING: The proposed activities are consistent with the policy to protect against oil spills because: 1) all possible protective measures will be taken to prevent accidental spills; and 2) in the unlikely event that an oil spill does occur, all available means will be implemented to mitigate its impacts and to ensure that it does not adversely impact the marine resources of the area.

Section 30234, COMMERCIAL FISHING AND RECREATIONAL BOATING FACILITIES

> Facilities serving the commercial fishing and recreational boating industries shall be protected and, where feasible, upgraded. Existing commercial fishing and recreational boating harbor space shall not be reduced unless the demand for those facilities no longer exists or adequate substitute space has been provided. Proposed, recreational boating facilities shall, where feasible, be designed and located in such a fashion as not to interfere with the needs of the commercial fishing industry.

ASSESSMENT: The construction and production phases of the proposed project involve vessel movements within established commercial areas of the San Pedro Bay/ Long Beach Region. The proposed project is not expected to reduce commercial fishing or recreational boating harbor space at any such facilities within the proposed project area.

FINDING: The proposed project will not compete with commercial or recreational vessels for available dock space or ancillary facilities and is therefore consistent with the policy stated above.

Section 30240, ENVIRONMENTALLY SENSITIVE HABITAT AREAS

> Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on such resources shall be allowed within such areas.
>
> Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade such areas, and shall be compatible with the continuance of such habitat areas.

government agencies and the deployment of clean-up personnel and equipment. Cleanup equipment on Platform Eureka has been designed for spills of less than 400 gallons (1514 l). Larger spills would be controlled as outlined in Section 2.9 of this report (Description of Containment and Cleanup Activities). SCPI is a member of Clean Coastal Waters (CCW) which is an oil spill cooperative responsible for containment and cleanup operations in the San Pedro Bay area. CCW cleanup vessels have response times ranging from 45 minutes to 2-1/2 hours. SCPI is also a participant in Clean Seas, an oil spill cooperative in the Santa Barbara area.

The curbs fitted in to the platform decks and the drainage system will provide protection against any small oil spillage that might occur on the platform. To protect against the occurrence of a blowout, Platform Eureka will be fully equipped with blowout preventor (BOP) equipment, as specified in the OCS Order No. 2, and will observe safe drilling practices in compliance with all applicable OCS orders and MMS regulations.

To protect against the occurrence of an oil spill due to pipeline or vessel rupture, SCPI will equip the platform with the best available safety technology as required in OCS Order No. 5 and OCS Order No. 9.
required in OCS Order No. 5 and OCS Order No. 9.

Fuel transportation and fuel transfer operations are controlled by the MMS anti-pollution regulations (33 CFR 154 and 33 CFR 156). The contractor supplying diesel fuel to the platform will be required to comply with these regulations.

The pipeline from the Platform Eureka to existing Platform Elly will be protected from over-pressure by means of a pressure switch set to shut down the pumps when a predetermined pressure is exceeded. The crude field gathering pipeline is metered as described in Section 2.4.6 to detect leaks and limit the amount of oil spilled in the event of a leak. Large leaks (i.e., pipeline rupture) will be detected by a low pressure sensor on the pipeline exit from the platform. In the event that this sensor detects an abnormally low pressure caused by a pipeline break, all oil shipping pumps will be automatically stopped.

The procedures for preventing and reacting to oil spills are described in detail in the SCPI Beta Field Oil Spill Contingency Plan; proposed Platform Eureka is included. The oil spill containment procedures and equipment identified therein provide the maximum feasible mitigation of oil spill risks. SCPI's emphasis on the rapid identification and protection of sensitive coastal areas in its spill contingency plan will help reduce potential impacts should a spill occur.

4. The effects of drill cuttings disposal are limited to: 1) localized smothering of less mobile elements of the benthic epifauna and infauna at the base of the drilling platforms and on the lower portions of the structures, and attendant reduction of available food to animals at higher trophic levels; 2) a temporary increase in water turbidity and consequent reduction of light for plant photosynthesis; and 3) possible interference of recolonization in the cuttings mound if textural differences exist between the deposit and adjacent natural sediments. The discharge of drilling muds at the platform site will not affect marine resources and productivity within coastal State waters.

5. The produced water, separated from the crude oil, will be sent to water treatment facilities for oil removal at existing Platform Elly facilities. The produced water cleanup facility allows the produced water to be reinjected as currently planned or, if conditions require, to be discharged to the ocean. Treatment prior to injection or disposal will consist of a skim tank for removal of oil and suspended solids by gravity separation. The water will then be passed through a flotation cell to remove suspended oil. The clean water will then either be injected in the planned waterflood program or discharged to the ocean. The oil concentration in any discharged water will meet EPA-issued NPDES requirements.

Section 30232, PROTECTION AGAINST SPILLS

> Protection against the spillage of crude oil, gas, petroleum products, or hazardous substances shall be provided in relation to any development or transportaion of such materials. Effective containment and cleanup facilities and procedures shall be provided for accidental spills that do occur.

ASSESSMENT: The proposed project would increase the potential for oil spills occurring in offshore State and Federal waters. Oil spills could be generated by Platform Eureka, offshore intrafield pipelines and transport vessels. Protection against the spillage of oil has been incorporated into the project design.

The 1983 Beta Unit Facilities Oil Spill Contingency Plan outlines the proposed immediate and post-spill response procedures. These procedures include notification of

A discussion of the impacts of oil-free mud and cuttings disposal is included in Section 4.6 of this Environmental Report. In summary, there is much documentation that supports the fact that most water-based drilling muds (the type planned for this project) are relatively nontoxic to marine organisms. The discharges from Platform Eureka will not result in any long-term adverse impacts to the biological productivity of communities within the area of discharge or nearby vicinity, with the exception of the burial of benthic organisms in the immediate area of discharge; however, the area subject to burial should experience only short-term impacts. In addition, the 700-foot (213 m) water depth at the proposed site will act as a mitigating factor.

The release of drilling muds and cuttings will produce a displacement of sediment and localized turbidity in the vicinity of the platform. The sediment effects are physical in nature, as only "clean" cuttings and drilling muds are to be dumped into the surrounding waters. Both epifaunal and infaunal benthic communities will be locally affected to some degree. Reduced water clarity associated with mud discharges is expected to have little, if any, impact on phytoplankton productivity because these discharges would be localized and occur below the eutrophic zone. The normal functions and interactions of local benthic communities will be temporarily disturbed by the deposition of sediments from drilling and construction. However, the disposal of mud and cuttings has no significant impact on pelagic fauna.

There is no evidence that cetaceans, pinnipeds, or seabirds are adversely impacted by routine drilling or production operations, especially where the drilling site is miles from the areas where these animals are concentrated.

FINDING: The proposed activities are consistent with the enumerated policies for the following reasons:

1. Compliance with MMS regulations (particularly OCS Order No. 7, prohibiting ocean dumping of muds containing toxic compounds), and EPA NPDES permit requirements.
2. Installation of the power cables and pipelines will have a short-term, insignificant impact upon localized flora, fauna, and bottom-dwelling biota, thereby preserving the overall marine resources in the project area.
3. The platform, cables, and pipelines will provide additional habitat for fish and other marine organisms, therby enhancing the marine environment.

the EPA NPDES permit conditions. These discharges could result in temporary, localized turbidity and water quality changes, and are expected to have negligible adverse effects. All discharge points on the Outer Continental Shelf are located significantly further than 1000 m seaward of the State 3-mile boundary and will not directly affect the water quality or biological productivity of the State's waters.

Treated produced water discharged at the Platform Elly site will create a minor, localized impact in the vicinity of the discharge point by increasing the concentration of such constituents as salinity, suspended solids and turbidity, trace oil and grease, and trace metals. Any concentration of materials above normal background levels will be diluted rapidly by waves and currents. The discharge will be in accordance with NPDES permit requirements established by the federal EPA. Such discharges, in fact, already occur at Platform Elly as a result of production from existing Platform Ellen. In addition, the planned well injection program will mitigate this discharge.

All solid wastes generated aboard the platform, with the exception of oil-free drill cuttings, drilling muds and sanitary wastes, will be collected and disposed of at appropriate onshore facilities in accordance with EPA, state, and local disposal permit conditions.

Oil-contaminated solids, spent oil, solvents, etc. will be containerized, transported onshore and disposed of in an appropriate disposal site or as specified in the local disposal permit. Produced water, along with any other drainage water containing oil, will be processed in a flotation unit on the platform to remove free oil and suspended solids such that it will meet federal permit requirements (72 ppm maximum oil and grease concentration) prior to discharge to the ocean. Deck drainage from rainfall runoff and washdowns will be processed in either flotation units or gravity separation units such that it will comply with NPDES permit requirements prior to discharge to the ocean.

The EPA and the MMS strictly regulate discharges into the marine environment, including the discharge of drilling muds and cuttings. The ocean disposal of oil-contaminated waste is prohibited. The proposed well locations are significantly further than 1000 m from State waters. According to a policy established by the California Coastal Commission in 1980, discharges of drilling muds and cuttings from operations conducted more than 1000 m from the State's 3 mile boundary do not affect the coastal zone.

reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural streams. (Section 30321)

ASSESSMENT: Offshore construction activities would be sufficiently removed from designated Areas of Special Biological Significance surrounding the San Pedro Bay area, marine sanctuaries, rocky intertidal areas, and significant estuarine habitats. Installation of the platform will occur within the region of the seasonal cetacean migration path. The principal installation and operational activities that may affect marine resources in the vicinity of the platform site are summarized below.

Installation of the platform and offshore pipeline and power cables will increase suspended solids in the general area of installation. This condition is temporary and will occur intermittently over an approximate span of eight months, involving the following activities:

- Installation of platform pilings
- Relocation of work barge anchors
- Placement of subsea pipelines and power cables and lay barge anchor drag

Localized turbidity would have short-term minor effects upon flora, fauna and bottom-dwelling biota. The water depth and currents in the project area ensure maximum dilution and rapid settling of the suspended plume.

Long-term localized changes in bottom habitat where the platform structure is placed will have a moderate biological impact, creating additional habitat and a localized increase in the number of fish and other marine organisms present. The presence of platform structures results in increased fish production and this effect is considered to be beneficial.

Possible commercial fishing equipment losses associated with anchor drag mound problems or industrial debris will be effectively mitigated by SCPI's commitment to utilize pipelines with a minimum of surface obstructions and its commitment to reimburse for equipment losses resulting from their facilities. SCPI will inform local commercial fishermen of the schedule and locations of installation activities. Locations will be identified on a bathymetric chart using Loran-C coordinates to assist fishermen in identifying the area.

All associated discharges from platform operations, such as hydrostatic test water, treated sanitary and domestic wastes, etc., are subject to and will comply with

Management Plan policies, as set forth in the California Coastal Act, are hereinafter stated and evaluated in relationship to the proposed activities.

Section 30211, PUBLIC ACCESS

> Development shall not interfere with the public's right of access to the sea where acquired through use or legislative authorization, including, but not limited to, the use of dry sand and rocky coastal beaches to the first line of terrestrial vegetation.

ASSESSMENT: The construction and drilling phases of the project will contribute increased vehicle and truck traffic in the coastal area associated with personnel and equipment transport. In addition, the offshore pipelines will require temporary onshore storage prior to installation.

FINDING: The proposed project would not provide new public access nor will it interfere with existing access. The increased traffic associated with the proposed project would not represent a new use of the coastal area. The proposed project is consistent with Section 30211 because the construction effects will be of limited duration and will not preclude or hinder public access.

Sections 30230 and 30231, PROTECTION OF THE MARINE ENVIRONMENT

> Marine resources shall be maintained, enhanced, and where feasible, restored. Special protection shall be given to areas and species of special biological or economical significance. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters and what will maintain healthy populations of all species of marine organisms adequate for long-term commercial, recreational, scientific, and educational purposes. (Section 30230)

> The biological productivity and the quality of coastal waters, streams, wetlands, estuaries, and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface waterflow, encouraging waste water

Table 2.10-4

TRACE CONTAMINANTS IN CALIFORNIA
OFFSHORE PRODUCED WATER

Contaminant	Concentration Range, mg/l
Arsenic	0.001 - 0.08
Cadmium	0.02 - 0.18
Chromium (total)	0.02 - 0.04
Copper	0.05 - 0.116
Lead	0.0 - 0.028
Mercury	0.0005 - 0.002
Nickel	0.100 - 0.290
Silver	0.005 - 0.03
Zinc	0.05 - 3.2
Cyanide	0.0 - 0.004
Phenolic Compounds	0.35 - 2.10

Source: BLM (1979)

initially developed from proposed Platform Eureka, insufficient produced water will be available and water from source wells will be used as injection water. The injection water is treated to remove oil and entrained solids. On occasion, it may be necessary to discharge injection water due to operational problems or injection system overpressure. When this occurs, discharge rates will be approximately 4000 bbl/day, and the discharge point will be 177 feet (54 m) below the sea surface at existing Platform Elly.

Contaminants in produced water include dissolved solids (21,700-40,400 mg/l), suspended solids (30-75 mg/l) and oil and grease (56-359 mg/l). Trace metals, cyanide and phenolic compounds may also be present, as shown in Table 2.10-4. Suspended solids and oil and grease are removed in the treatment process to levels authorized by the NPDES discharge permit.

i. Fire System Test Water

MMS requirements include weekly testing of the firewater system. Both pumps on proposed Platform Eureka will be tested. Since seawater is used in the firewater system, no contaminants will be introduced. Any testwater falling on potentially contaminated deck areas will be handled as described in the appropriate paragraphs above.

2.10.3.2 Marine Sources, Composition, Discharge Rates for Liquids

Marine sources of liquid discharges will be limited to crew and supply boat activities. These vessels have only one such discharge - once-through non-contact cooling water - and the sole pollutant is thermal. Vessel discharges of this sort are universal and accepted since the discharge rate is small and the discharge is immediately diluted.

2.10.3.3 Onshore Sources, Composition, Discharge Rates for Liquids

Onshore discharges to a publicly-owned treatment system occur only at the existing onshore facilities - offices, crude oil metering and pumping station, crew and supply boat areas. No increase in discharge rate or composition is expected from these sources as a result of this project.

2.11 CERTIFICATION OF COASTAL ZONE CONSISTENCY

The proposed installation and operation activities of Platform Eureka on lease OCS-P-0301 as outlined in this report are consistent with the policies of the California Coastal Management Program (CMP). The proposed activities will be conducted in such a way to ensure continued conformance with the CMP. All of the SCPI Beta Unit facilities have been consolidated to ensure minimum impact on the environment while producing a valuable energy source. Each of the applicable California Coastal Zone

Table 2.10-3

BETA
GENERIC MUD SYSTEM

Mud Component	Usage (lbs/bbl)
Bentonite	130
Sodium Carbonate	11.9
Sodium Hydroxide	16.3
Clay (Sepiolite)	16.2
Barite	432.9
Polyanionic Cellulosic Polymer	8.4
Sodium Bicarbonate	0.8
Clay (Magnesium Montmorillonite)	4.2
Chrome-Free Lignosulfonate	14.9
Tributyl Phosphate	0.8
Sodium Hexametaphosphate	0.2

Table 2.10-2

EPA GENERIC MUD SYSTEMS

1. Potassium/Polymer Mud

Components	lbs/bbl
KCL	5-50
Starch	2-12
Cellulose Polymer	0.25-5
XC Polymer	0.25-2
Drilled Solids	20.100
Caustic	0.5-3
Barite	0.450
Seawater or Freshwater	As needed

2. Seawater/Lignosulfonate Mud

Components	lbs/bbl
Attapulgite or Bentonite	10-50
Lignosulfonate	2-15
Lignite	1-10
Caustic	1-5
Barite	25-450
Drilled Solids	20-100
Soda Ash/Sodium Bicarbonate	0-2
Cellulose Polymer	0.25-5
Seawater	As needed

3. Lime Mud

Components	lbs/bbl
Lime	2-20
Bentonite	10-50
Lignosulfonate	2-15
Lignite	0-10
Barite	25-180
Caustic	1-5
Drilled Solids	20-100
Soda Ash/Sodium Bicarbonate	0-2
Freshwater or Seawater	As needed

4. Non-dispersed Mud

Components	lbs/bbl
Bentonite	5-15
Acrylic Polymer	0.5-2
Barite	25-180
Drilled Solids	20-70
Freshwater or Seawater	As needed

5. Spud Mud (slugged intermittently with seawater)

Components	lbs/bbl
Attapulgite or Bentonite	10-50
Lime	0.5-1
Soda Ash/Sodium Bicarbonate	0-2
Caustic	0-2
Barite	0-50
Seawater	As needed

6. Seawater/Freshwater Gel Mud

Components	lbs/bbl
Attapulgite or Bentonite	10-50
Caustic	0.5-3
Drilled Solids	20-100
Barite	0-50
Soda Ash/Sodium Bicarbonate	0-2
Lime	0-20
Seawater or Freshwater	As needed

7. Lightly Treated Lignosulfonate Freshwater/Seawater Mud

Components	lbs/bbl
Bentonite	10-50
Barite	0-180
Caustic	1-3
Lignosulfonate	2-6
Lignite	0-4
Cellulose Polymer	0-2
Drilled Solids	20-100
Soda Ash/Sodium Bicarbonate	0-2
Lime	0-2
Seawater to Freshwater Ratio	1:1 appx.

8. Lignosulfonate Freshwater Mud

Components	lbs/bbl
Bentonite	10-50
Barite	0-450
Caustic	2-5
Lignosulfonate	4-15
Lignite	2-10
Drilled Solids	20-100
Cellulose Polymer	0-2
Soda Ash/Sodium Bicarbonate	0-2
Lime	0-2
Freshwater	As needed

As mentioned above, drilling mud formulations change with depth and down-hole conditions. In general, such changes can be anticipated and mud formulations for the entire well can be planned. SCPI intends to use muds that have been classified as generic by the EPA, either in the original General NPDES Discharge Permit for Offshore Southern California (Permit Number CA 0110526) or which have since been classified as generic under the provisions of that permit, which requires that bioassay be conducted on candidate muds. The mud presently being used on SCPI's Platform Ellen has been classified as generic under this provision, as have muds proposed by several other operators. A list of the original generic muds authorized by the General NPDES Permit is presented in Table 2.10-2. The Beta mud recently classified by EPA as generic is shown in Table 2.10-3. Only oil-free drilling muds authorized by EPA for overboard discharge under either an individual or a General NPDES Discharge Permit covering Eureka will be released from the platform. Oil contaminated muds or other muds not authorized for overboard discharge will be collected in containers and properly disposed onshore.

f. Excess Cement Slurry

Excess cement slurry from cementing operations is discharged up to three times for each well drilled. Volumes can vary but generally are less than 21 m^3 (27.7 cubic yards) per well. Discharge occurs over a relatively short period of time (less than 1 hour) and joins the large once-through non-contact cooling water discharge flow, entering the ocean 121 feet (37 m) below the surface. Composition is well cement mixed with seawater.

g. Filter Backwash Water

Periodic backwashing of injection water filters is necessary to remove particles plugging the beds. Source water is used for this operation and the backwash is returned to the ocean at 110 feet (34 m) below the surface at existing Platform Elly. The system is designed such that in the future either treated produced water or source water can be used for backwash. Contaminants are predominantly inert solids entrained in the produced water being processed for injection. Discharge rate when backwashing is approximately 2 to 30 bbl/day, maximum. This operation occurs on Platform Elly; rates will be the same, but frequency will increase due to processing of produced water from Platform Eureka.

h. Treated Produced Water

Current plans call for produced water to be reinjected to maintain reservoir pressure, prevent subsidence, and enhance oil recovery. As the field is pass through grease traps before entering the treatment systems. Grease thus collected will be taken ashore for disposal by a renderer or in an appropriate waste disposal facility.

e. Oil-Free Mud and Cuttings

During drilling operations, cuttings will be separated from the mud system by shale shakers. Desanders and desilters will remove cutting particles too small to be separated by the shale shakers. The cuttings will then be discharged beneath the platform at a depth of 200 feet (61 m) below the surface. Since cuttings are composed of largely insoluble formation rock particles, unacceptable concentrations of pollutants are not expected. Discharge rates are estimated at about 300-400 cubic feet (8.5-11.3 cubic meters) per day, dependent on the depth of the hole and the achievable penetration rate. As potential hydrocarbon-bearing strata are approached and drilled, particular attention is devoted to oil in the mud return. Cuttings which are oil-contaminated are segregated and stored for transport ashore and ultimate disposal in a Class I or II-1 disposal site.

Drilling mud is discharged in several ways. Some naturally adheres to drill cuttings and is discharged with them. In addition, as drilling depth increases or down-hole conditions change, mud formulations must be adjusted to meet drilling requirements. On occasion, mud pit volumes are such that a bulk discharge must be made to accommodate the formulation change. Finally, upon completion of the well, the entire mud system must be reformulated. Although some mud may be reused, most if not all the previously-used mud must be disposed in a bulk discharge. Table 2.10-1 provides information on the volume and duration of drilling mud discharges. The estimated net volume of excess treated drilling mud to be discharged is 900 bbls/well.

Table 2.10-1

DRILLING MUD DISCHARGES

Type of Discharge	Frequency	Duration	Rate
With Cuttings	Continuous during drilling	24 hr/day	less than 1 bbl/hr
Pit Volume Change	3-4 times/well	1 hr	50-100 bbl/hr
End of Well	1 time/well	2 hr	600 bbl/hr

a. Once-Through Non-Contact Cooling Water

Cool seawater is drawn from a depth of 125 feet (38 m) beneath the platform and distributed to heat exchanging equipment for cooling. There is no process contact and the warmed seawater is returned to the ocean at a depth of 121 feet (37 m) without treatment. Temperature increases should not exceed 20°F. Equipment served by this system includes the drilling rig power generators, rig brake cooling, drilling rig rotary table, shipping and mud pumps, and air conditioning chillers. Discharge rates will range between 72,000 barrels/day and a maximum of 90,000 barrels/day, averaging 81,000 barrels/day.

b. Treated Water Drainage

Oil-contaminated water from numerous drains, sumps, relief devices, rig washdown areas, etc. will be routed to a collection and treatment system. Oil and other floating or settleable materials will be removed and the treated water will be routed to an emergency sump. This sump will remove any oil overflowing from treatment system before the water is discharged through a pipe 195 feet (59 m) below the ocean surface. Discharge rates will be highly variable, but should range from 350 barrels/day when not drilling to a maximum of 7200 bbl/day when drilling, averaging about 3600 bbl/day. (Rainwater is not included.) Potential contaminants include hydrocarbons and dust and dirt from rig washdowns. Contaminant levels should be well within the limits authorized by the NPDES Permit covering the proposed platform. Oily residue separated from the wastewater will be retained in waste tanks for transport to shore and disposed of at an approved Class II-I onshore site or will be combined with crude for recovery.

c. Oil Free Drainage

Uncontaminated rainwater from the heliport deck will be discharged untreated through a discharge pipe 15 feet (4.6 m) above the ocean surface. Volume will normally be zero. A 1-inch rainfall in would yield a 100-barrel discharge from the heliport drain.

d. Treated Sanitary and Domestic Wastes

Sanitary wastes will be treated in an approved package sewage treatment system meeting EPA requirements, including residual chlorine. Flow rates, based on a 45 gpd requirement per person for 80 persons, will average about 85 bbl/day. Domestic wastes (i.e., water from showers, sinks and galley) will be treated in the same system and discharged 40 feet (12.2 m) below the ocean surface. Based on an average of 100 gallons/person/day, domestic waste flow will be 190 bbl/day. Galley wastes will waste to be disposed of from both offshore and related onshore operations is estimated to be 60-70 tons/month.

2.10.2.2 Marine Sources, Composition, Generation Rates for Solid Waste

Solid wastes from crew and supply boats will be minimal during both installation and operational phases and will consist largely of paper trash, a few metal and fiber empty containers and galley wastes. These will be segregated and containerized as required for disposal by commercial handlers.

2.10.2.3 Onshore Sources, Composition, Generation Rates for Solid Waste

Office paper, and shipping wastes and miscellaneous trash from the storage staging area will be primary contributors to onshore-generated solid wastes. Once the installation phase is complete, generation rates will diminish significantly, particularly from the storage/staging area. As mentioned in paragraph 2.10.2.1 above, operations phase solid wastes from both onshore and offshore facilities will total about 60-70 tons per month. Commercial haulers will transport these wastes to appropriate waste disposal facilities on shore.

2.10.3 Liquid Discharges

There are three principal categories of liquid discharge sources associated with the proposed project: platform discharges, marine (vessel) discharges, and onshore discharges. Any platform wastes that might be considered harmful to the environment will be disposed of in an acceptable manner. All liquid platform wastes will be covered in the SCPI NPDES permit application to the EPA. SCPI's discharge practices will be consistent with the NPDES permit requirements and OCS Order No. 7, Pacific Region.

2.10.3.1 Platforms Sources, Composition, Discharge Rates for Liquids

Sources of liquid discharges from proposed Platform Eureka include the following:

- Once-through non-contact cooling water
- Treated water drainage
- Oil-free drainage
- Treated sanitary and domestic wastes
- Oil-free mud and cuttings
- Excess cement slurry
- Filter backwash water (discharged at Platform Elly)
- Treated produced water (at Platform Elly when discharge occurs)
- Fire system test water

Discussion of these sources is presented in the paragraphs below.

2.10 EMISSIONS AND DISCHARGES

The following subsections address emissions, discharges and generation rates of gaseous, liquid and solid materials anticipated to result from proposed Platform Eureka. Where appropriate, the treatment, storage, transporting and disposal of these wastes are also discussed.

2.10.1 Gaseous Emissions

Gaseous pollutant emissions originate primarily from combustion sources (diesel engines, gas or diesel fixed generators, marine and crane engines, platform flare) and hydrocarbon vapors (tank and sump vents, drains, processing equipment relief devices, pipe fittings). Information on the nature and quantity of emissions and the characteristics and operating frequency of significant emission sources associated with the platform is provided in Section 4.3. Existing air quality is documented in Section 3.3.

2.10.2 Solid Waste Generation

During the construction phase, the primary solid wastes generated are construction material wastes and the usual wastes associated with office and quartering facilities such as trash and sanitary wastes. Once operations commence, the contribution of construction material wastes will end, and generation of solid waste will be limited to maintenance material and platform trash and garbage. Further discussion of these wastes is offered in the following subsections. The probable onshore disposal sites and the project's contribution to these landfills is discussed in Section 4 of the Environmental Report.

2.10.2.1 Platform Sources, Composition, Generation Rates for Solid Waste

During the installation phase, virtually all platform solid waste will consist of scrap construction materials and common paper wastes. Some garbage will also be generated. All wastes will be segregated and containerized for transport to sanitary landfills or other appropriate waste disposal facilities on shore. Where significant quantities of recoverable materials are generated, such as metals, these will be separated for shipment to scrap metal dealers. Generation rates for these wastes are highly variable, and estimates of construction period platform solid wastes have not been made.

Solid waste generated during the operational phase of the project will consist of paper and galley wastes, empty metal and fiber containers, scrap maintenance materials, and spent oils and solvents. Domestic solid waste generated by the platform crew would total an estimated 112 lbs/day or 1.7 tons/month. Total solid acific Strike Team, which is based in San Francisco. The strike team is staffed with trained personnel and supplied with sophisticated containment and removal equipment. They can provide direct assistance in major emergencies, as well as furnish consultation and equipment on request for less serious spills. However, basic implementation of the NCP rests on the regional concept: each of the Standard Federal Regions (EPA, HUD, and HEW regions) is directed by the NCP to develop a Regional Contingency Plan establishing a Regional Response Team (RRT) with overall responsibility for coordinating spill response within the region.

The governing plan for the southern California coastal region is the Region IX Multi-Agency Oil and Hazardous Materials Pollution Contingency Plan, Subregional plan for Zone One, Southern California, dated December 1971. Zone One is contained within the 11th Coast Guard District, whose coastal boundaries are the northern limit of Santa Barbara County and the Mexican border. The Commandant of the 11th Coast Guard District serves as the on-scene coordinator (OSC) for all spills, and as such, is the key federal official onsite. It is the OSC, together with other federal, state, and local agency representatives, who coordinates cleanup efforts and, if necessary, actually directs those efforts when the spiller's response is judged inadequate. As such, the 11th Coast Guard District has a very detailed containment plan, which provides policy and direction for spill containment within the SCPI Beta project area.

2.9.6 Hydrogen Sulfide Contingency Plan

Experience to date with Beta Field crude has confirmed that encountering unacceptable levels of hydrogen sulfide (H_2S) is highly unlikely. In continuation of the current understanding with MMS, SCPI will implement a hydrogen sulfide contingency plan, 1) should operations or experience on any SCPI Beta Field platform indicate that such a plan is needed, or 2) should it become necessary to use sulfate bearing water for injection. Should H_2S occur during flooding, the producing wells and injection system would be monitored closely, with corrective or protective steps being developed as necessary. MMS will be kept informed of the condition and any programs developed to minimize the effects of H_2S.

2.9.7 Critical Operations and Curtailment Plans

Certain operations and conditions require established plans to preclude development of emergency situations. The Eureka Platform will be covered under the existing Critical Operations and Curtailment Plans for SCPI Platforms Ellen and Elly, and will be subject to the same operating procedures, drills and safety meeting requirements.

spills by various state agencies, and (2) furnishes a procedure for keeping local governments and the public informed regarding a spill and its probable effects. The state plan creates a State Agency Coordinator, with responsibility for directing on-scene operations of all state agencies engaged in combating a pollution incident. The state plan also establishes a support team to provide technical advisory and supervisory advise in response to an actual spill.

While the state plan provides direction in a spill situation, it does encourage local agencies to prepare plans to handle the specific needs of individual localities. However, based on discussions with local officials and with the possible exceptions of the Port of Los Angeles, cities of Laguna Beach and Huntington each, and Orange County, little effort has been expended by local governments in this region to establish local plans.

2.9.5.2 Federal

The national legal and administrative framework for oil spill response procedures is provided by the Federal Water Pollution Control Act of 1970 (PL 92-500), as amended. PL 92-500 established that the spiller would be liable for cleanup costs and all penalties, the only defenses being acts of God, acts of war, negligence on the part of the U.S. Government, or acts or omissions on the part of third parties. This act required the formation of a new contingency plan and delegated responsibility for its development to the Council on Environmental Quality. Pursuant to Section 311(c)(2) of the Act, a National Oil and Hazardous Substances Pollution Contingency Plan (NCP) was established in 1973, amended in 1975, and further amended in 1982 (47 CFR 31180 et seq.).

The NCP provides for: (1) assignment of cleanup responsibilities to various federal agencies in coordination with state and local entities; (2) establishment of a national center for coordination and direction of operations; and (3) establishment of strike and task forces to carry out the plan. The body with overall responsibility for implementation of the plan is the National Response Team (NRT), composed of representatives of several cognizant government agencies such as the Departments of Defense, Interior, Commerce and Transportation, and the Environmental Protection Agency; the U.S. Coast Guard is responsible for coastal waters and the Great Lakes and for ports and harbors. The Minerals Management Service is responsible for measures to abate the source of pollution from offshore wells.

The U.S. Coast Guard has established three national strike teams to provide this protection. The Southern California coastal area is the responsibility of the

Table 2.9-1

INVENTORY OF OIL SPILL PREVENTION, CONTAINMENT AND RETRIEVAL EQUIPMENT ABOARD SCPI BETA PLATFORMS

1. All blowout prevention equipment listed in Final OCS Order No. 2, Drilling Procedure, effective May 1, 1976, U.S. Geological Survey.

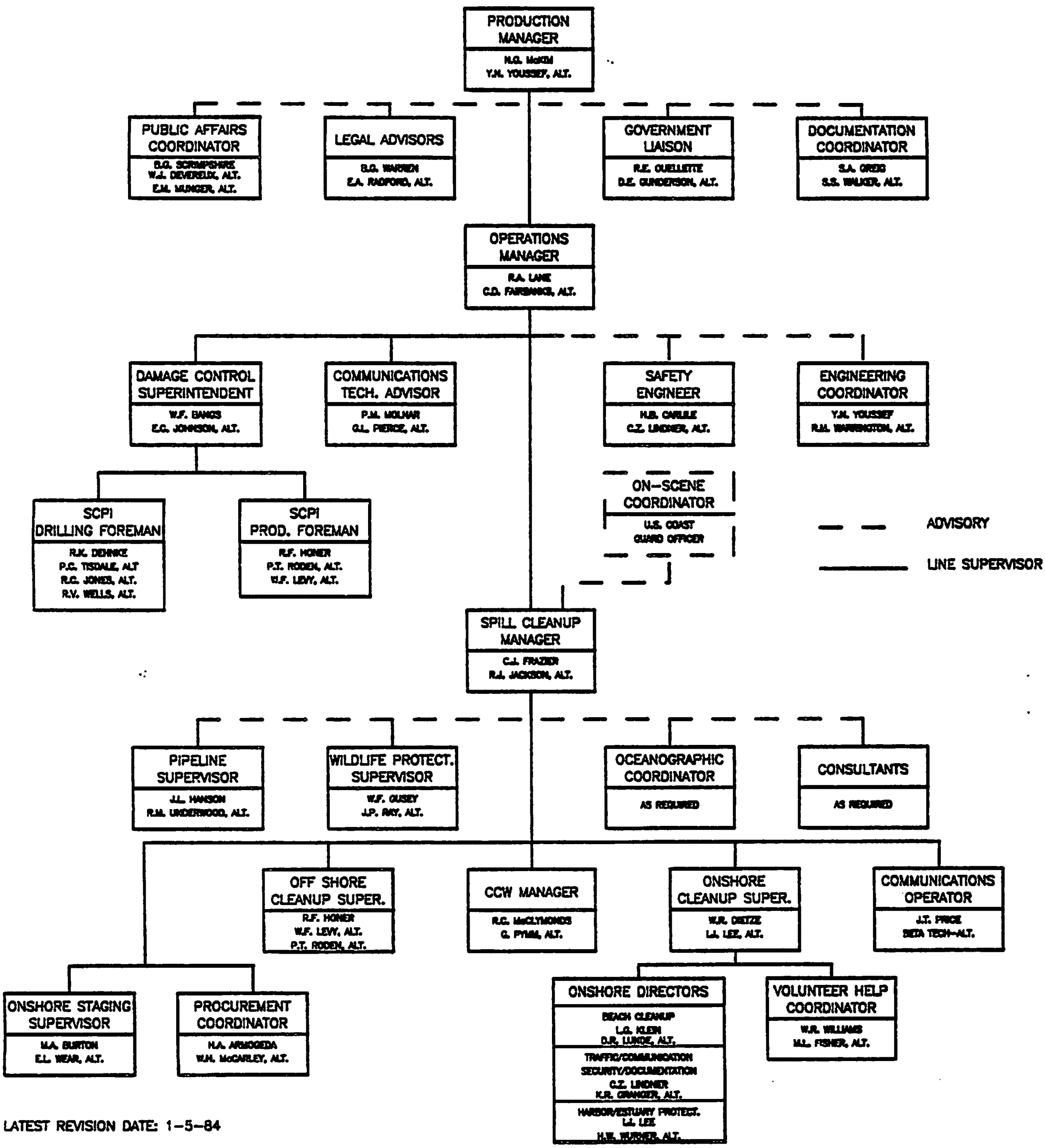
2. Curbs, gutters, drains, and drip plans will be placed to collect contaminants from the deck areas and prevent them from discharging into ocean waters.

3. Miscellaneous quantities of sorbent pads, sorbent booms, and dispersants.

4. Communications equipment.

5. A fast deployment containment boom, 1600 feet (488 m) long on an electric-hydraulic reel. (This boom is stored on Platform Elly and is available for rapid deployment to other Beta Platforms.)

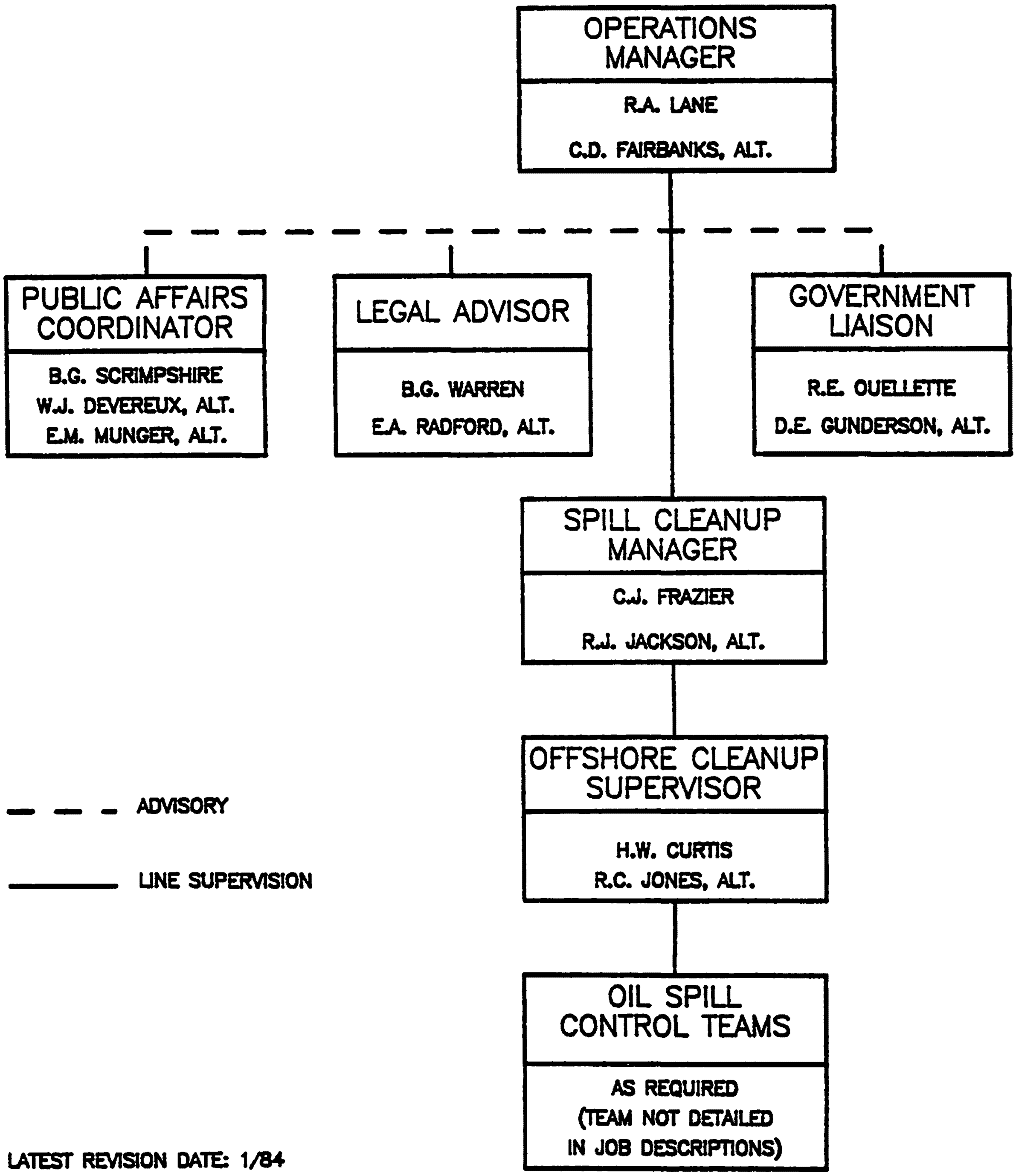
In addition, a dedicated vessel and three fast response boats are berthed in Long Beach. The response craft can be on the scene within 1 hour; the larger vessel can arrive within 2-1/2 hours.



Oil Spill Contingency Organization Chart Beta Unit Complex

FIGURE 2.9-2

Shell California Production Inc.
WEST COAST PRODUCTION DIVISION



Small Spill Organization Chart Beta Unit Complex

FIGURE 2.9-1

relations and dissemination of information, protection and cleanup activities ashore, wildlife and environmental concerns, legal affairs, the employment of non-company personnel as required, and monitoring and assessment. The Plan calls for in-company training of personnel and familiarization with equipment and materials to be used.

2.9.3 Personnel and Cleanup Activities

Personnel presently assigned to oil spill response activities are shown in Figures 2.9-1 and 2.9-2. As can be seen, personnel are assigned by function and alternates are provided. Contact telephone numbers (home and office) are provided in the Plan manual, as are detailed job descriptions of their response and cleanup activity duties.

2.9.4 Equipment and Response Times

On-board equipment is listed in Table 2.9-1. Equipment available from CCW is shown in Appendix A of Volume I, Platform Eureka Development and Production Plan.

Response time for very small spills (less than 10 gallons [38 l]) is 15 to 30 minutes, since the equipment required is on the Beta platforms. For larger spills, up to 400 gallons (1514 l), containment can be rapid (less than 1 hour) using onboard equipment but clean up with an oil skimming device will take longer to initiate (1-2 hours) since the device must be brought from shore.

For large spills involving CCW equipment, response time will be somewhat longer. Raider boats with booms and skimmer can be dispatched from Berth 59, Long Beach Harbor, and should take less than 1 hour to arrive on-scene and commence boom deployment. The larger response vessel, "Clean Waters I," can depart her berth and arrive on-scene within 2-1/2 hours. CCW equipment is located aboard the various response craft or is stored in readily available locations ashore for immediate transfer to response vessels.

2.9.5 Other Oil Spill Contingency Plans

CCW has its own Oil Spill Contingency Plan for use in responding to calls from member companies. In addition, both the State of California and the federal government have established oil spill contingency plans in accordance with their respective governmental regulations.

2.9.5.1 State of California

State response to pollution incidents is governed by the State of California Oil Spill Contingency Plan of March 1977, developed in accordance with California Government Code 8574.1. This Plan (1) provides for a coordinated response to oil small spill the plan provides that personnel safety should be assured, the flow of pollutant stopped, and equipment for containment and clean-up deployed. A very small spill about 10 gallons (38 l) or less would result in loading sorbents and sorbent boom on the crew boat, containing the slick with the sorbent boom, and using sorbent pads on the surface of the slick until the visible spill is cleaned up. For larger spills (up to 400 gallons [1514 l]), a larger boom would be lowered from the reel on Platform Ella and loaded onto the crew supply boat for deployment. A Walosep (W-3) oil skimming device would be utilized in the boomed area. The oil skimmer would be brought by fast response boat. Sorbents would be used to capture small amounts of oil that may escape the boom. Sorbents would also be utilized to clean up remaining oil when the oil skimming device is no longer effective. Oil and oil soaked sorbents will be disposed of onshore in an approved disposal site.

2.9.2 Large Spill Plan

In the case of large spills (greater than 400 gallons [1514 l]), it is anticipated that assistance will be required from shore. Platform personnel using on-board equipment will initiate constraint procedures pending arrival of assistance. SCPI's site foreman will initiate control measures and notify SCPI's superintendent. Appropriate governmental agencies will be notified, and the onshore assistance groups will be contacted as needed or required.

SCPI belongs to the CCW cooperative. This organization will provide a large portion of the equipment which would be required to contain a large spill. This equipment is stored at the CCW storage yard in the Port of Long Beach, on CCW response vessels, in trailers for ready transport, and on Santa Catalina Island. The SCPI Oil Spill Contingency Plan provides a listing of CCW equipment and its location. This information has also been included as Appendix A of Volume I, Development and Production Plan. The Oil Spill Contingency Plan also provides listings of commercial firms within the Los Angeles-Long Beach Harbor area who can provide additional equipment or manpower as required. The Plan indicates that containment efforts will be supervised by SCPI in-field supervisors and corporate management. Management support and technical advice will be provided by CCW.

Job descriptions are provided for SCPI personnel who might be required in an oil spill emergency. Job responsibilities are listed for personnel on levels ranging from company management to working supervisors. Tasks envisioned are detailed in job descriptions, and they include management, notification, immediate and longer-term responses and actions, liaison with government agencies on all levels, public and media

14-days-on and 7-days-off schedule. A one-third change of the 90-person rotating crew will occur each 7 days.

Once hook-up and rig-up operations are completed and development drilling and production commences, approximately 76 SCPI and 30 contractor employees will be assigned. This level will continue throughout the drilling phase, then begin to decline near the end of the decade. Since drilling personnel now employed on Ellen will be moved to Eureka, the only additions to current employment should be 11 people in the production organization and 36 contractors (catering, well-servicing, and 6 miscellaneous). This level should continue throughout the producing life of the project.

SCPI currently employs 11 people onshore. This number should not increase.

2.8 USE OF NEW OR UNUSUAL TECHNOLOGY

No new or unusual technology is anticipated for Platform Eureka.

2.9 USE OF THE OIL SPILL CONTINGENCY PLAN

The SCPI Beta Unit Complex Oil Spill Contingency Plan provides detailed response for each of two spill categories, small (less than 400 gallons [1514 l]) and large. This Plan, recently revised for Platform Eureka, is reviewed at least annually to ensure that it reflects current information. It has been submitted to the Minerals Management Service under separate cover.

The purpose of the Plan is to direct SCPI personnel in their response to an oil spill emergency. The Plan provides for the use of the containment and cleanup capabilities of Clean Coastal Waters (CCW) and Clean Seas Incorporated. In addition to SCPI's plan, each of these cooperatives have their own contingency plan for dealing with spills.

2.9.1 Small Spill Plan

Small spills of less than 400 gallons (1514 l) will be handled by platform personnel and materials/equipment stored aboard the platforms. SCPI's site foreman will initiate control measures and notify SCPI's superintendent. Appropriate governmental agencies will be notified, and the onshore assistance groups will be contacted as needed or required. The Plan provides job descriptions for various key individuals. Platform staff receive training on spill containment procedures, and are drilled to provide required readiness.

The small spill plan designates an operations manager, spill cleanup manager, offshore cleanup supervisor, and oil spill control team (in descending order of authority). The operations manager has three staff positions in an advisory role including a public affairs coordinator, legal advisor, and government liaison. In the event of a production phase will span some 7 years, commencing in mid-1985, followed by production for an estimated additional 25 years.

2.6 PROPOSED TRAVEL MODES FOR MOVING SUPPLIES AND PERSONNEL

Personnel providing onshore and offshore services and support for proposed Platform Eureka will arrive at work locations, boat launch areas or helicopter areas via personal or public land transportation. As described in Section 2.4.4, the crewboat launch at Pier G in Long Beach Harbor, the supply boat facilities at the Seventh Street terminal (between berths 58 and 59), and the helicopter facilities at Long Beach Airport are the main staging areas onshore. The municipal access routes are via the Pacific Coast Highway, Long Beach Freeway, Harbor Freeway, Ocean Boulevard/Seaside Avenue or Anaheim Street.* Personnel working or providing services offshore will utilize either crewboat or helicopter transportation to reach the platform.

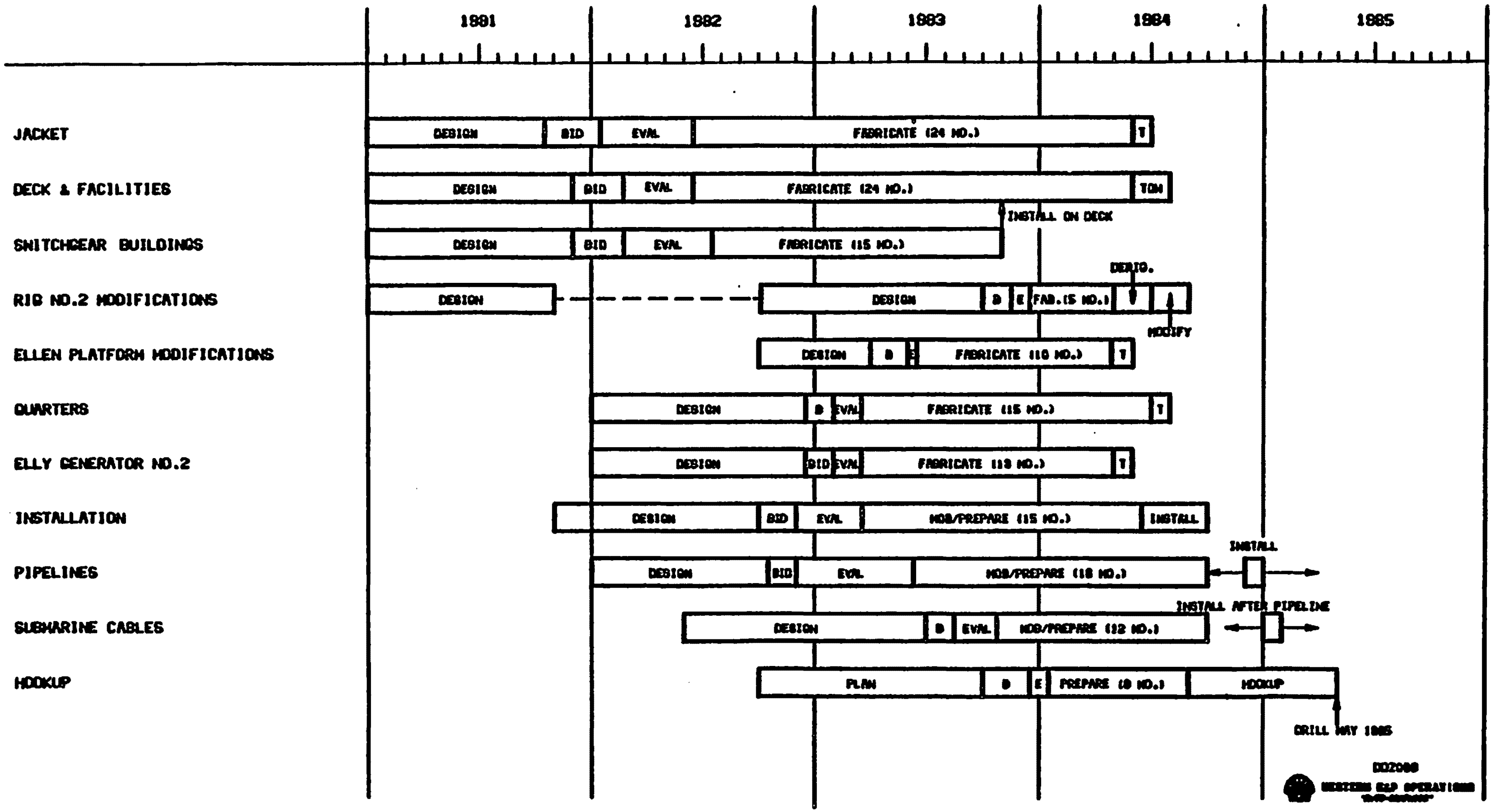
Supplies are delivered to onshore facilities via truck; those scheduled for delivery offshore are then transported to the platform via supply boat. About seven deliveries per day of supplies via truck to the onshore facilities are expected during operations. Delivery of these supplies offshore will take place on supply boats currently servicing Platforms Elly and Ellen. A 50 percent net increase in supply boat traffic is expected.

Crewboats and supply boats will utilize an established route between the onshore facilities and the platform. The route will be the same as that currently used by these vessels in reaching Platforms Ellen and Elly. From the respective berthing facilities within Long Beach Harbor, crewboats and supply boats will enter Long Beach Channel and proceed to the breakwater. Once outside of the breakwater, vessels will proceed directly toward Platforms Ellen and Elly. The compass course in the outbound direction is 162° true, while the inbound heading is 342° true. The compass headings between the harbor and Platforms Ellen, Elly and Eureka will vary by $\pm 2°$, since the three platforms are not quite in a direct line. Between Platforms Ellen/Elly and Eureka, crewboats and supply boats will follow a compass course of 152° true (to Eureka) and 332° true (to Ellen/Elly).

2.7 PERSONNEL REQUIRED

About 150 construction workers will be needed for platform installation. Of these, 60 will remain at the work site at all times, and the remainder will work on a

*During construction approximately 125 workers will be offshore, with a 1/3 crew change every 7 days. Each of 3 crews typically works 14 days on and 7 days off. Crewboats typically leave at three scheduled times during the day. For operations, about 24 personnel will be on the platform and they will rotate on a 7 days on, 7 days off schedule.



Platform Eureka Development Schedule

FIGURE 2.5-1

WESTEC Services, Inc.

to provide early notice of potentially hazardous situations; they frequently initiate appropriate automatic functions to prevent damage to personnel and/or equipment.

Other monitoring systems and procedures on proposed Platform Eureka are designed to avoid undesirable environmental incidents. Among these are the following:

- Discharge Monitoring - Discharge sampling schedules, stations and procedures to ensure compliance with environmental permits, such as the NPDES discharge permit.
- Pipeline Monitoring - Pressure monitoring (PSH and PSL) of crude and gas field gathering pipelines to detect possible fluid loss.
- Mud Monitoring - Mud pit volume will automatically be monitored to warn of potential presence of oil or gas in the mud return.

No meterological monitoring facilities are planned for Eureka. However, a monitoring station was recently installed on the Platform Elly exercise room roof. This station will transmit wind direction and velocity data to the National Weather Service for processing and dissemination to appropriate users.

Environmental studies by industry, governmental agencies, or academic institutions and involving proposed Platform Eureka are not contemplated at this time. Environmental data collected in compliance with various permits is frequently used by all of these entities in continuing studies of the environmental impacts of oil and gas drilling and producing operations; data from Eureka will be no exception. SCPI has frequently participated in many studies, contributing technical assistance, data and funds for projects which are designed to ensure meaningful and useful results. Such participation will continue, with each such study being evaluated on its individual merits.

2.4.7 Resource Recovery from Platform Eureka

Production from Platform Ellen is projected to peak at 11,400 barrels per day in 1985, while production from Platform Eureka will reach its anticipated maximum of 10,400 barrels per day in 1992. Maximum production from SCPI's Beta facilities should peak in 1991 at about 17,200 barrels per day. Of the total anticipated yield from both platforms, Eureka is expected to provide some 55 percent.

2.5 APPROXIMATE TIME FRAMES FOR DEVELOPMENT

Figure 2.5-1 depicts project timing for proposed Platform Eureka installation and hookup. Three separate phases are included in the life of this proposed platform: construction and installation; development drilling and production; and platform abandonment. These phases will cover some 35 years. The development drilling and

Quantity		Description
Ellen and Elly (Cont.)	Eureka	
8	4	Dual Ventilated FA-250 Lanterns with 120 volt AC, 500 watt lamp with mounting stand to operate as a master and standby system. Flash characteristic is 0.04 seconds ON, 0.6 seconds OFF, 7000 effective candelas; 120 VAC, 60 Hz power source required.
1	0	HALS 15, 15 Mile Derrick Light. Dual ventilated FA-250 lantern with mounting stand and both lanterns operating simultaneously, 15,000 effective candelas. Flash characteristic 1 second ON, 2 seconds OFF; 220 VAC, 60 Hz, power source required.

The fog signals have a 2-mile (3.2-km) minimum range and are directional and synchronized. All lights will flash in unison. All navigational components are connected to the emergency standby generator buss.

2.4.5.3 Emergency Shutdown System (ESD) and Automatic Shut-in of Wells

All wells, including those artificially lifted, will be initially equipped with surface controlled surface and subsurface safety devices. The subsurface devices will be installed in the well below the mudline and held open by the application (from the deck of the platform) of hydraulic pressure. The surface devices will be mounted on the wellhead and held open by the application of pneumatic pressure. Any accidental or deliberate bleeding off of either pressure will cause these devices to close and thereby stop any flow from the well from below the device.

The pneumatic system controlling these and other safety shut-in devices on the platform equipment is located throughout the platform. Monitors of critical functions and manual bleed-off valves at ESD stations will cause the system control pressure to bleed off if an abnormal condition is detected. Accidental breaking of the system piping will also cause the system to bleed off and shut in the wells.

2.4.5.4 Escape Equipment

Escape systems (life rafts and three enclosed boats), life jackets and ring buoys will be provided on the platform.

2.4.6 Proposed Operations and Environmental Monitoring Systems

Among the monitoring systems to be installed on Eureka are several which are normally considered as a part of safety systems. These include gas detectors, smoke detectors, excess heat detectors, fluid level monitors, etc. These are designed

- Crew boat launch at Pier G in Long Beach Harbor.
- Supply boat facilities at 7th Street Terminal.
- Helicopter facilities at Long Beach Airport (Air Logistics).
- Office space at Pier G in Long Beach Harbor.
- Crude oil distribution facility just north of Ocean Boulevard one-quarter mile west of the Ocean Boulevard Bridge in Long Beach.

2.4.5 Proposed Safety Systems on Platform Eureka

Eureka's safety systems include blowout preventers, pressure relief and vent systems, emergency electrical power, platform emergency shutdown systems, firewater and halon fire suppression equipment, navigation aids for collision prevention, and personnel safety and escape equipment. Details for some of these systems follow.

2.4.5.1 Fire Suppression System

The design of the fire suppression system will include the following:

a. A looped fire water system with two fire water pumps. These pumps will be separated so that the likelihood of damage to more than one is reduced.

b. Dry chemical extinguishers.

c. Fire hose stations with AFFF (aqueous film forming foam) capability.

d. Deluge system around the diesel storage tank, well clean-up tank, separators, treaters and pipeline pumps.

2.4.5.2 Navigation Aids

Navigation aids for Platforms Ellen, Elly, and Eureka are designed in accordance with U.S. Coast Guard Class 1 criteria. The system includes the following components:

Quantity: Ellen and Elly	Quantity: Eureka	Description
2	2	CG-1000 Fog Signal inverter with remote control switch and two ELG-500/02 emitters. Blast characteristic is 2 seconds ON and 18 seconds OFF; 120/240 VAC 60 Hz power source required.
1	1	SF-4000 Light Controller and Monitor with photocell; 120 VAC 60 Hz power source required.

The 6-inch (15-cm) and 10-inch (25-cm) pipelines at Platform Elly will be installed in J-tubes, whereas the 12-inch (30-cm) pipeline will be attached to a preinstalled clamped riser. Because of the orientation of Platform Elly with respect to the 6-inch (15-cm) and 10-inch (25-cm) pipelines, short sections of riser pipe will be pulled through their appropriate J-tube and left on bottom. A spoolpiece connection will be made between each riser section and the appropriate pipeline utilizing the remaining half of the ball connector. A spoolpiece will also be used to connect the 12-inch (30-cm) pipeline to the clamped riser at Platform Elly. A saturation diving spread aboard the lay barge will be utilized during the spoolpiece hookup phase of the work.

After all three lines have been installed, a sizing plate will be run through each line to confirm that the lines have been laid without damage. Hydrotesting the lines to at least 1.25 times the maximum design working pressure for 8 hours will complete the work.

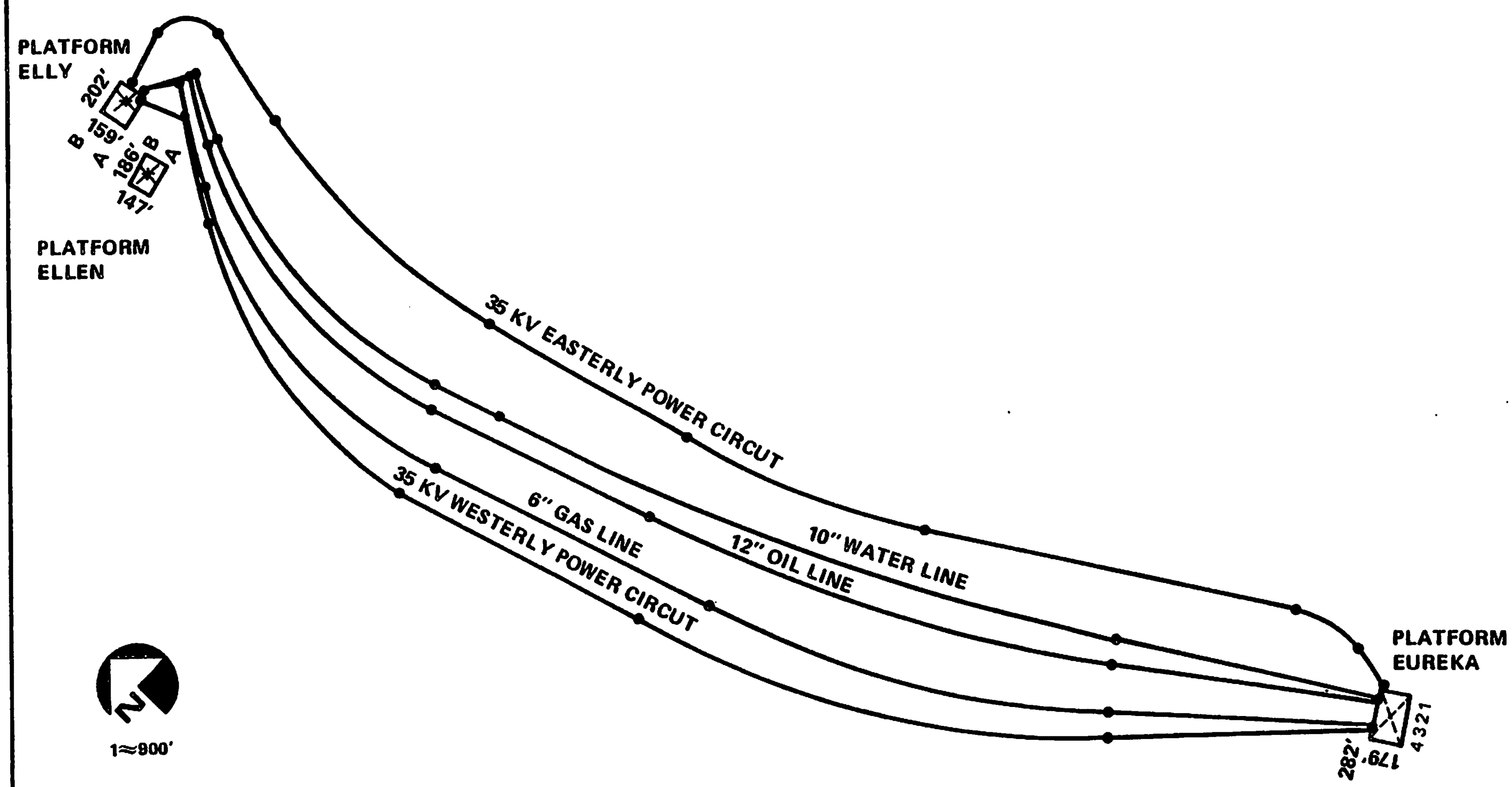
Submarine Cable Installation

The Beta Intrafield 35 kV submarine power cables will be installed using a cable laying barge after the pipeline work is completed. A barge will be outfitted with thrusters, anchor winches, linear cable gripping machine, cable handling frame and tub, cable ramp and all other necessary pieces of equipment prior to loading out the cable.

The barge will be towed to location and set in a four point moor at Platform Eureka. The first cable circuit will be pulled through a J-tube with adequate length pulled onto the platform to reach the cable termination location. A tug will then pull the barge along the cable route after releasing it from the mooring system. Thrusters aboard the barge will keep the cable on the predetermined route. Upon reaching Platform Elly, the barge will be set in a moored configuration. The end of the cable will be held at the stern of the barge in a gripping device. A predetermined length of cable will be fed through the linear gripping machine and laid on the deck of the barge where a pull head will be attached. A winch on Platform Elly will then begin to pull the cable off the end of the barge and through a J-tube on Elly. When the cable on the deck has been fed over the stern, the gripping device at the barge stern will be released and the cable slack gradually lowered to the seafloor as the J-tube pull continues. Adequate cable will be pulled onto the platform to reach the termination location.

2.4.4 Onshore Facilities

Proposed Platform Eureka will not require any onshore support systems beyond those already serving existing Platforms Ellen and Elly. Eureka project will utilize the following existing facilities:



Beta Intrafield Pipelines and Cables

FIGURE 2.4-5

WESTEC Services, Inc.

- 10.75-inch (27.3-cm) OD line - 8156 feet (2487 m)
- 6.625-inch OD (16.8-cm) line - 8439 feet (2573 m)

d. Description of Protective Coating - 14 mils of thin film thermo-setting epoxy.

e. Type of corrosion protection:

- 12.75-inch (32.3-cm) OD line - 150# aluminum anodes spaced 550 feet (167 m) apart
- 10.75-inch (27.3-cm) OD line - 125# aluminum anodes spaced 550 feet (167 m) apart
- 6.625-inch (16.8-cm) OD line - 75# aluminum anodes spaced 550 feet (167 m) apart

f. Design working pressure and capacity:

- 12.75-inch (32.3-cm) OD line - 700 psi at 19,600 bpd
- 10.75-inch (27.3-cm) OD line - 1500 psi at 110,000 bpd
- 6.625-inch (16.8-cm) OD line - 60 psi at 3 MMSCFD

g. Maximum design working pressure and capacity:

- 12.75-inch (32.3-cm) OD line - 1440 psi at 24,500 bpd
- 10.75-inch (27.3-cm) OD line - 2200 psi at 180,000 bpd
- 6.625-inch (16.8-cm) OD line - 200 psi at 12.3 MMSCFD (based on velocity)

Cable Specifications

a. Cable description - 35 kV, 3 conductor No. 1/OAWG, EPR insulated, armored submarine power cable with 3 instrumentation quads

b. Size and weight of cables - 4.500-inch (11.43-cm) OD, 9 lb/foot in seawater, 15 lb/foot in air

c. Length of circuits (J-tube to J-tube):

- Easterly circuit - 8515 feet (2596 m)
- Westerly circuit - 8485 feet (2587 m)

2.4.3.2 Pipeline and Cable Installation

The Beta Intrafield Pipelines will be installed by the lay barge method after completing the Platform Eureka installation phase. A pipelay barge equipped with tensioners, stringer, weld stations and anchor winches will be mobilized for the pipeline installation. Each riser pipe at Eureka will be pulled through a J-tube conduit and terminated prior to moving towards Elly. Upon arrival at Elly, the pipe will be laid on bottom with one-half of a misaligning ball connector attached to it.

SECTION 3

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SECTION 3
DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 GEOLOGY

Geologic elements of the environment that could affect or be affected by the proposed project are described below. Included are descriptions of regional and site-specific physiography, stratigraphy and geologic structure, soils, geologic hazards, and groundwater resources.

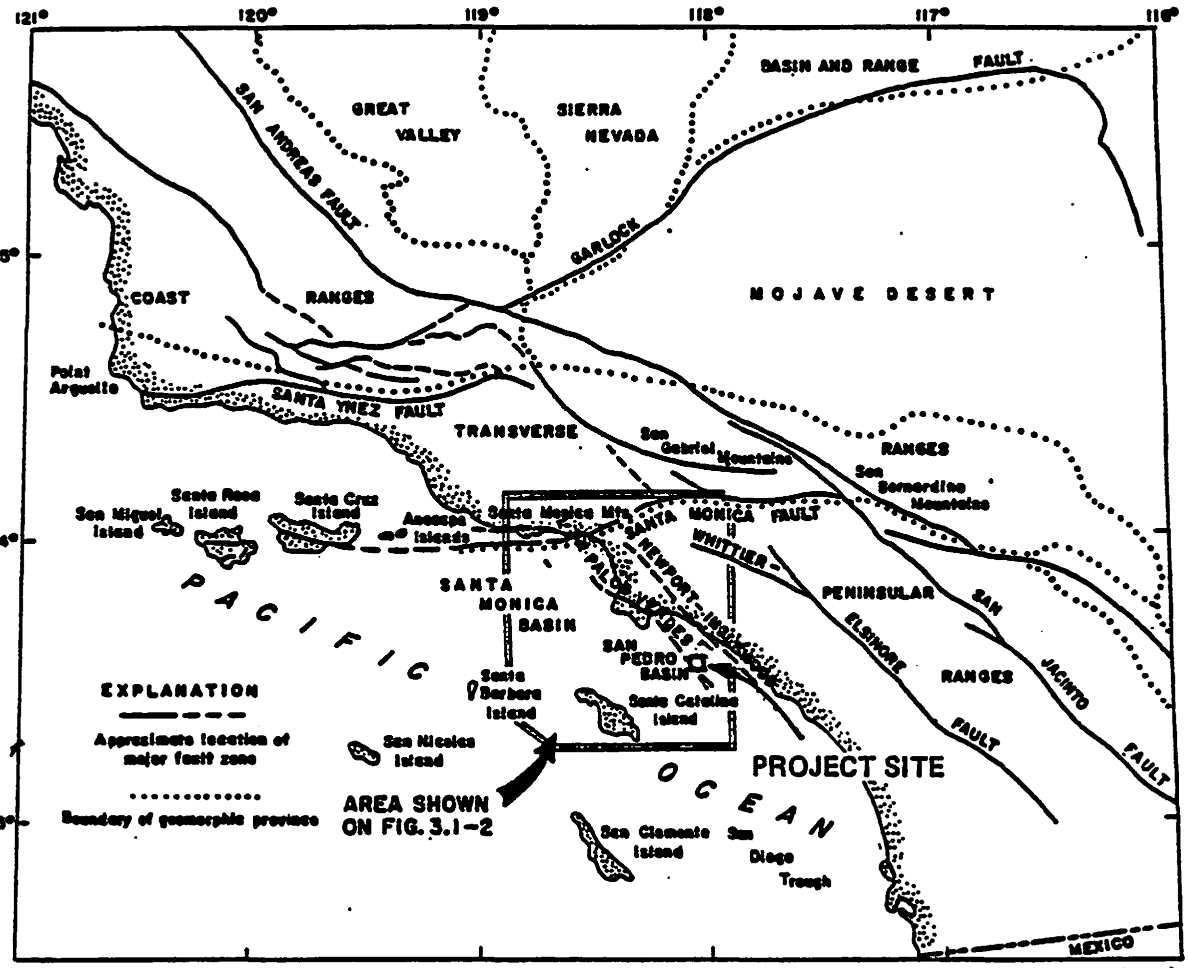
Data related to the regional and local geotechnical aspects of the project area are readily available from several sources. The most useful of these are the original "Shell OCS Beta Unit Development EIR/EA" (SLC et al., 1978), and geotechnical and hazards surveys of the proposed Platform Eureka site and intrafield pipeline routes prepared by Marine Environmental Science Associates in 1979 and 1980 and updated and refined in 1984 ($MESA^2$ 1979, 1980, 1984a,b). These data sources, along with several other recent, pertinent publications, as cited in the following text, have been drawn on in preparation of this environmental analysis.

3.1.1 Physiography

3.1.1.1 Regional Physiography

The Platform Eureka project area is located in the San Pedro basin, a submerged portion of the Peninsular Ranges physiographic province (see Figures 3.1-1 and 3.1-2). Onshore, this province is characterized by elongate, northwest trending ridges and mountain ranges separated by sediment-filled structural basins. The submerged portion of the province, termed the Southern California Continental Borderland, is an irregular complex of basins, shelves, banks, islands, and submarine canyons.

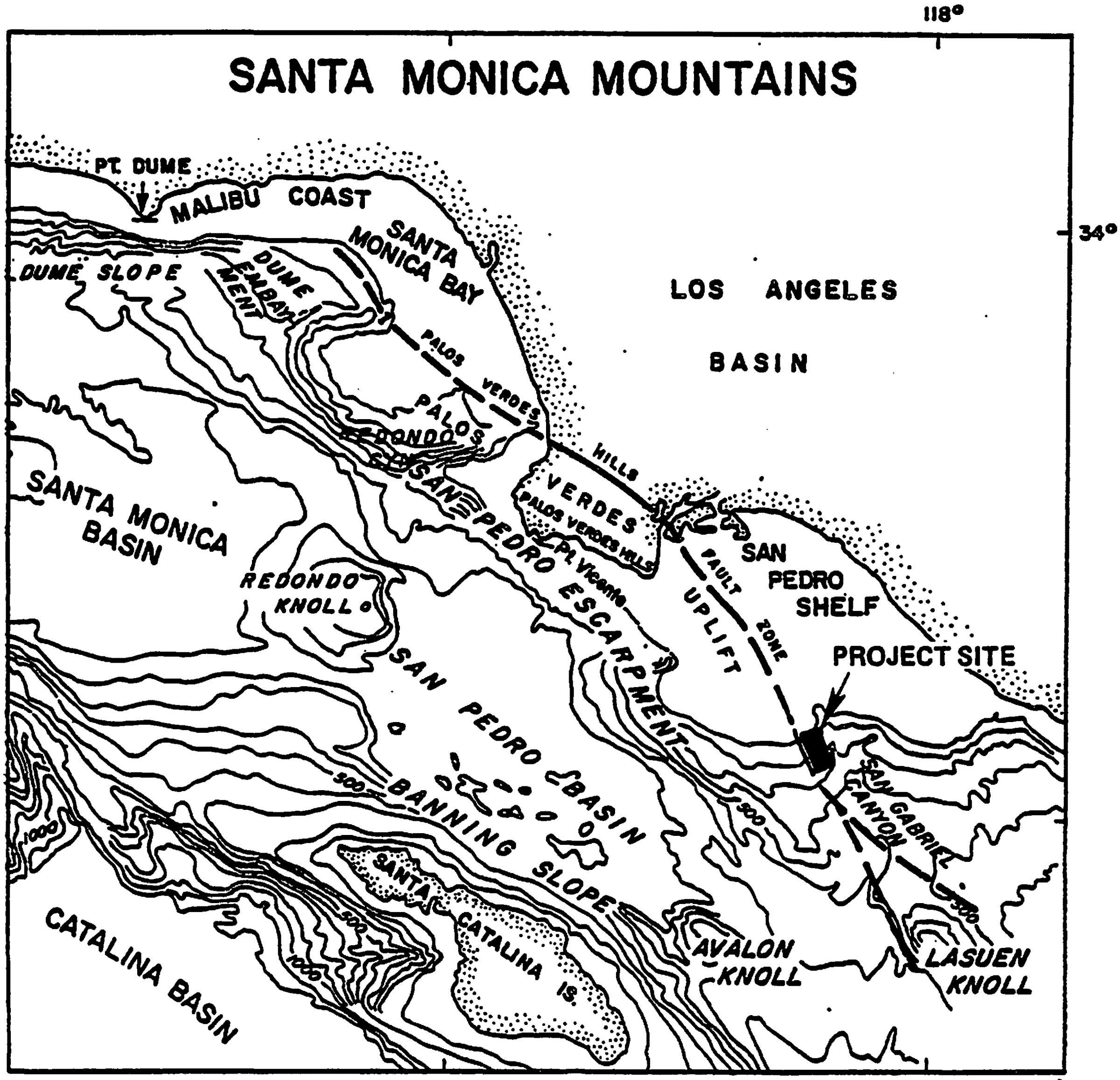
As shown on Figure 3.1-2, the proposed Platform Eureka development is located at the southeast corner of the San Pedro shelf on the San Pedro slope or escarpment. It lies adjacent to and partially astride the Palos Verdes fault zone between the outer shelf (250 foot (76 m) isobath) and the mid-slope (750 foot (229 m) isobath). To the northwest, the project area is bounded by a low ridge which is a surficial expression of the Palos Verdes fault zone and uplift, and to the southeast it is cut by the inactive San Gabriel submarine canyon. Additional information regarding regional physiographic features are available in Section 3.1.1.1 (pages 63-66) of the "Shell OCS Beta Unit Development EIR/EA" (SLC et al., 1978, Vol. I).



MODIFIED FROM YERKES ET AL. (1965)

Geomorphic Provinces and Major Fault Zones in Southern California

FIGURE 3.1-1



MODIFIED FROM JUNGER AND WAGNER (1977)

BATHYMETRIC CONTOUR INTERVAL: 100 METERS

Bathymetry and Major Structural Features in the Offshore Site Region

FIGURE 3.1-2

3.1.1.2 Project Area Physiography

a. Bathymetry

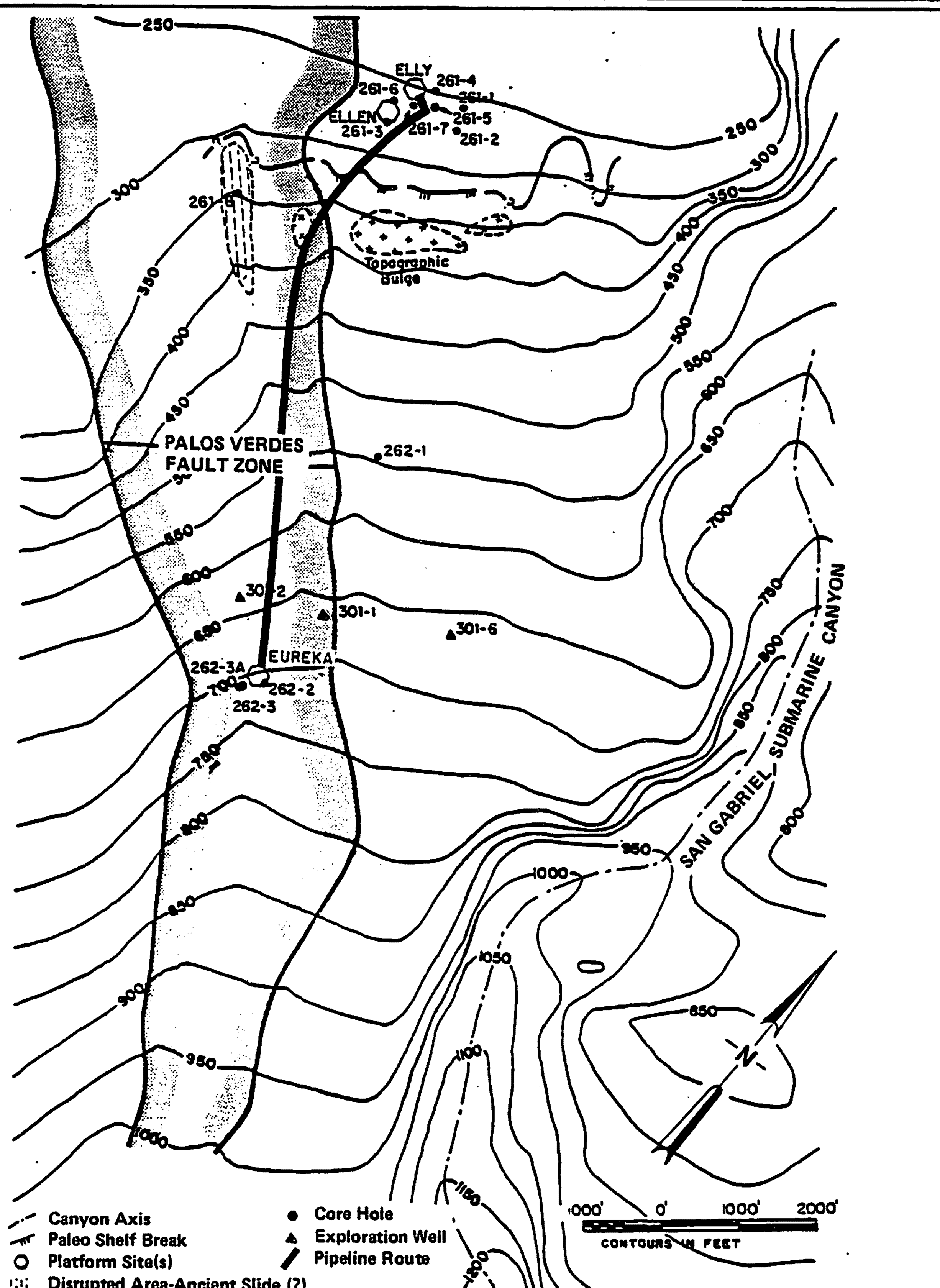
Figure 3.1-3 is a map illustrating general bathymetric features in the project area from the proposed Platform Eureka site to Platform Elly. As shown, the Platform Eureka site is located on the upper slope of the San Pedro basin at a water depth of 700 feet (213 m). In this area the seafloor slopes evenly to the southeast at a gradient of approximately 5 percent (3° from the horizontal). The proposed pipeline routes to Platform Elly ascend the upper slope along gradients of 5 to 11 percent (3 to 6°) to Platform Elly, which is located on the southerly edge of the San Pedro shelf at a water depth of 260 feet (79 m) on a slope of about 3.6 percent (2°). The inactive San Gabriel submarine canyon, with wall heights of 200 to 250 feet (61-76 m), lies approximately 5000 feet (1524 m) east of the proposed Platform Eureka site (Figure 3.1-3).

b. Surficial Features

Figure 3.1-4 provides a more detailed picture of bathymetry as well as seafloor surface features in the project area. As shown, two slope gullies which originate near the shelf break in water depths of 300 to 325 feet (91-99 m) and die out east of the Platform Eureka site at depths of 725 to 750 feet (221-229 m), are important bathymetric features in the area. The gullies lie along the eastern edge of the Palos Verdes fault (Figure 3.1-3), and were apparently incised along the flank of this uplifted zone. Typically, the gullies are both broad (500 to 700 feet (152 to 213 m)) and shallow (10 to 15 feet (3 to 5 m) deep). The near absence of modern sediment along the gullies indicates they are active erosional features (MESA[2], 1984b).

A subtle change in slope angle immediately below the shelf break south of Platform Elly and east of the proposed pipeline route is due to a topographic bulge in this area (Figure 3.1-3). This bulge overlies a zone of disturbed bedding where early Holocene/late Pleistocene strata are distorted and upbowed. As a result, later Holocene sediments are thin to absent over this trend. Generally discontinuous and inconsistent reflectors or bedding seen on subbottom profiles from the area indicate this topographic bulge may be a zone of creep (MESA[2], 1977).

Figure 3.1-5 shows the pattern of upper Holocene and modern sediment erosion related to the aforementioned slope gully system in the western portion of the study area. Other surficial features in the area (Figure 3.1-5) are largely man-made, such as anchor and chain drags related to past exploratory drilling operations.



SOURCE: MESA[2] (1984b)

General Bathymetric Setting of Project Area

FIGURE 3.1-3

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general, the surficial soils consist of medium to very fine grained sand (or coarse silt) near the shelf break, becoming increasingly silty and clay-rich down the shelf (Mesa[2], 1984a,b).

3.1.3 Geologic Hazards

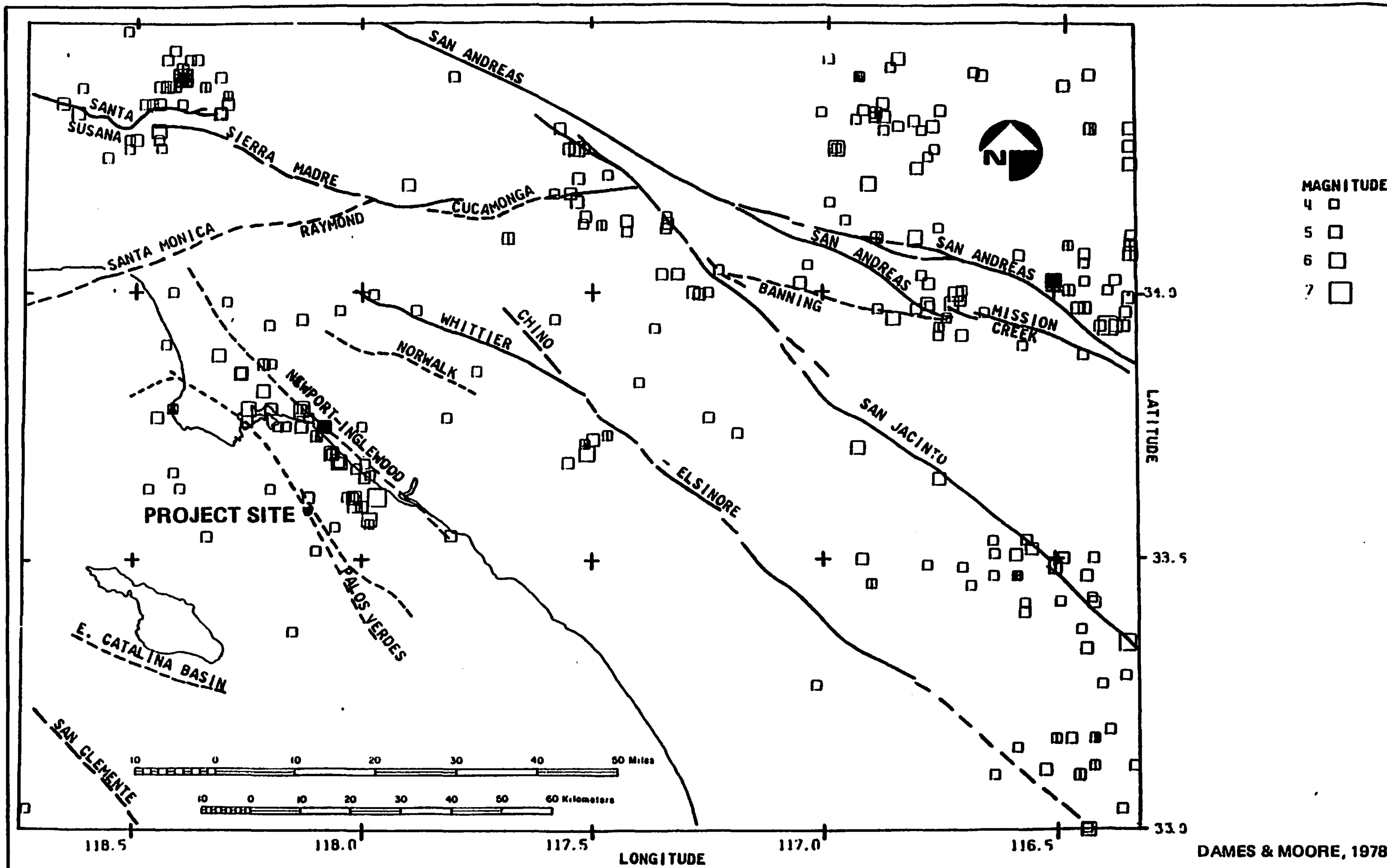
3.1.3.1 Seismic Groundshaking

Figure 3.1-7 shows the location and general magnitude of all earthquakes of Richter magnitude (M) 4.0 or greater in southern California from 1930 through 1977. Also shown on the figure are the region's major faults, which form the dominant structured elements in southern California. The San Andreas fault is the major tectonic feature in the region, extending a distance of over 684 miles (1100 km). The San Jacinto fault branches from the San Andreas, whereas other major faults within the system (i.e., the Newport-Inglewood) either die out in a series of smaller splay faults or are terminated on the north by east-west-trending faults along the southern front of the Transverse Ranges.

Much of the regional seismicity shown by the distribution of epicenters in Figure 3.1-7 can be correlated with zones of faulting. Of the principal faults shown, the San Jacinto has had the highest historic seismicity, although all are considered capable of generating large magnitude earthquakes. The concentration of epicenters in the vicinity of the Newport-Inglewood fault primarily represent the M6.3 main shock and numerous aftershocks of the 1933 Long Beach earthquake.

Four epicenters in the immediate Platform Eureka site area are shown in Figure 3.1-7. These represent earthquakes that occurred on January 20, 1934 (M4.5), January 15, 1937 (M4.0), November 1, 1940 (M4.0), and March 20, 1934 (M4.0). Due to an uncertainity of about 5 km in the location of these epicenters, their correlation with the Palos Verdes fault is suspected but not confirmed. In any event, the project area does not appear to be unique in southern California as having experienced unusually high or low levels of seismicity.

The Newport-Inglewood and Palos Verdes faults, located approximately 10 miles (16 km) from and adjacent to, respectively, the Platform Eureka site, are considered to be of greatest seismic significance to the proposed project. Due to its potential to produce a great earthquake (M8.0), resulting in large, long-period ground motions at the project site, the San Andreas fault is also considered to be of significance. The structural and seismic characteristics of these faults are described in detail in Section 3.1.2.3 and 3.1.2.4 (pages 111-117) of the original Shell Beta Unit Development EIR/EA (SLC et al., 1978, Vol. I), and a recent analysis of seismicity of the Palos



DAMES & MOORE, 1978

Earthquakes of Magnitude 4.0 and Greater in the Southern California Region (1930-1978)

FIGURE 3.1-7

Verdes fault is contained in Fisher et al. (1983). Based on these characteristics and expected maximum earthquake magnitudes, source-site distance/attenuation relationships, and project site soil conditions, peak seismic groundshaking in the Platform Eureka area can be predicted. Table 3.1-3 shows the range of maximum groundshaking (in terms of peak horizontal accelerations) that can be reasonably expected at the proposed project site.

Table 3.1-3

ANTICIPATED SEISMIC GROUNDSHAKING
IN PLATFORM EUREKA PROJECT AREA

Causative Fault	Earthquake Magnitude	Closest Approach of Fault to Platform Eureka site (km)	Peak Horizontal Accelerations (g)	
			Rock	Mudline
Palos Verdes	6.5-7.0	0.15	0.5-0.7	0.25-0.4
Newport-Inglewood	6.5-7.0	15.0	0.2-0.5	0.15-0.3
San Andreas	8.5+	71.5	0.10	0.10

Source: SLC et al. (1978, Vol. I, p. 117)

3.1.3.2 Surface Fault Rupture

Known faults extending to or near the sea floor in the project area are relatively well defined (see Figure 3.1-6). As summarized in Section 3.1.2.2b and discussed in detail in MESA[2] (1979, 1980, 1984a,b), four of these faults -- F-2, F-3, F-4 and F-7 -- are considered active and, hence, capable of surface rupture. Faults F-2 and F-7 are of no direct concern to the proposed project; however, the proposed pipeline route crosses faults F-3 and F-4. The Platform Eureka site itself is removed from any zone of active faulting.

3.1.3.3 Soil Liquefaction

Soil liquefaction occurs when saturated, loose to moderately dense sand or silty sand materials lose their shear strength because of increased pore-water pressure during relatively long-duraction dynamic loading. Soils in the project area, with the exception of some very thin surficial materials and thin sandy interbeds, are typically silty clays or clayey silts. This clay fraction acts to provide a cohesive property to the soils; hence, liquefaction is not expected to be a significant hazard.

3.1.3.4 Induced Seismicity

Seismic events induced by the subsurface injection of fluids have been reported several places in the world [for example, at the Rocky Mountain Arsenal near Denver (Evans, 1966; Healy et al., 1968); at the Rangely Oilfield, Colorado (Rayleigh, 1976); at Matsushiro, Japan (Ohtake, 1974); and in the Attica-Dale area, New York (Fletcher and Sykes, 1977)]. In each case, significant increases in subsurface pore pressure was found to be the triggering mechanism.

Production of hydrocarbons from Platform Eureka will be accompanied by a fluid injection program to maintain reservoir pressure. However, injection pressures are not expected to substantially exceed current in situ pore pressures, and no induced seismicity hazards are forseen.

3.1.3.5 Subsidence

Both induced subsidence and natural or tectonic subsidence are of potential concern. Induced subsidence can be caused by a number of activities: groundwater withdrawal, oil and gas withdrawal, hydrocompaction, and oxidation of peat deposits (Alfors et al., 1973). In the case of oil and gas withdrawal there are a number of contributing factors, but the main factor is a reduction of pore-fluid pressure which allows the overburden to compact the fluid-depleted reservoir rock. As described above, a reservoir pressure maintenance program will accompany production from the proposed platform. Induced subsidence, thus, should not be a problem.

$MESA^2$ (1979, 1984a, 1984b) estimates a subsidence rate of 1 to 2 feet (0.3 to 0.6 m) per 100 years in the proposed platform vicinity. This subsidence is apparently associated with tectonic stresses acting along and within the Palos Verdes fault zone. Special design features will be included in the construction and operation of Platform Eureka to accommodate this expected subsidence.

3.1.3.6 Slope Stability

Slopes in the project vicinity are considered to be stable ($MESA^2$, 1979, 1980, 1984a,b). Within the project area minor slumping was found only within the slope gullies, and there is no evidence of such slumping near the pipeline crossings. It appears that a reasonably high degree of cohesion and consolidation exists in the Holocene units underlying the seafloor in the area.

As shown on Figure 3.1-3, a suspected submarine slide is located approximately 5000 feet (1524 m) upslope of the Platform Eureka site. This slide shows no evidence of reactivation nor of recent movement.

3.1.3.7 Erosion/Deposition

Bottom photographs, box and dart cores, and surficial anchor-drag marks observed on side-scan sonar records all indicate that a relatively thin veneer of modern sediments covers the erosional surface in the project area. The presence of this modern sedimentary blanket suggests that, except along the slope gullies, active flows or erosional processes are not a design hazard ($MESA^2$, 1984a,b).

3.1.3.8 Hydrocarbon Seeps

Hydrocarbon seeps are defined by the USGS (1982) as geologic hazards if they are associated with rock outcrops, steeply-dipping beds, or faults. A gas seep is found in the project area near the proposed pipeline alignment at the 425 foot (130 m) isobath ($MESA^2$, 1980). No seeps were found in the vicinity of the platform site.

The mapped seep is not associated with rock outcrops, dipping strata or active faults, and is therefore not felt to represent a significant hazard.

3.1.4 Groundwater Resources

No significant fresh water aquifers are found below 1200 feet (366 m) in the Beta Field (Chevron USA, 1980). At shallower depths, electric logs and drill cuttings indicate the sediments are primarily tight clayey sites and silty clays, with occasional thin interbeds of fine silty sand. Such sediments form poor aquifers and contain little groundwater due to the absence of significant porosity.

3.2 CLIMATOLOGY AND METEOROLOGY

The primary year-round factor governing weather patterns in Southern California is the location of the semi-permanent Eastern Pacific high pressure cell. The central pressure of this cell, the pressure along the coast, and the pressure in the deserts to the southeast also participate in determining the large scale weather patterns throughout most of the year. Other meteorological features which can affect Southern California's weather are: (1) Santa Anas, (2) fronts and storms, (3) upper air troughs and ridges, and (4) Catalina Eddies.

Large-scale circulation and winds along the Southern California coast are largely affected by the strength of the pressure gradient between the Pacific high pressure cell located to the west and the relative positions of the thermal low to the east. During the summer months, the thermal low is well developed, and the Pacific High, although farther west than in winter, is at its strongest. This results in a larger pressure difference between the thermal low and the Pacific High. The position and strength of the high pressure cell in summer effectively steer storms to the north and weaken them. The strength of the Pacific High determines the degree of subsidence and results in creating subsidence inversions at about 2000 feet (600 m) above sea level. The relatively cold water that flows southward along the coast allows the formation of coastal fogs and low clouds during the night and early morning hours.

Due to terrain effects, land-sea temperature differences, and the location of the Pacific High, small-scale circulations can differ significantly from regional patterns. Areas near the coast are subject to a varied diurnal reversal which features daytime onshore and nighttime offshore winds. This sea-land circulation is often relatively shallow, resulting in funneling of winds through coastal valleys and canyons.

The typical shallowness of the marine layer near the coast is caused, in large part, by temperature inversions which are present in all seasons, but are stronger and more common in summer and fall. Three basic types of inversions occur in Southern California: (1) marine inversion, caused by cooling of low-level air passing over the cool ocean surface; (2) radiation inversion, caused by nighttime cooling during generally cloudless conditions; and (3) subsidence inversion, a result of the large-scale descent of air in the Pacific High.

During inversion conditions, vertical air movement is inhibited, resulting in confinement of low-level parcels to valleys and coastal plains. Severe or persistent inversions, combined with light winds, can result in heavy buildups of atmospheric pollutants in Southern California.

Upper level troughs and ridges play a significant role in determining the height and intensity of the persistent subsidence temperature inversion and thus play a dominant role in determining the vertical extent through which pollutants can be dispersed.

When the upper-level circulation is anti-cyclonic (i.e., a high pressure ridge) the subsidence inversion is low and vertical motions are limited. Conversely, with the approach of an upper trough, the height of the inversion increases and the depth through which pollutants are mixed increases.

Additional synoptic regimes which can exert significant effects upon the study area are Santa Ana conditions and so-called Catalina Eddies. Santa Anas occur when there is a surface high with a cold core over the Great Basin, and lower pressures along the coast. These conditions result in strong downslope northeasterly winds over most of Southern California. Santa Ana conditions are most common during the fall and winter months, often preceding the passage of a mid-latitude frontal system.

As the name implies, the Catalina Eddy forms in the vicinity of Catalina Island during the warm season. The predominant flow over the ocean is cyclonic (counter-clockwise). These small scale cyclonic circulations are caused by orographic effects on the coastal mountain range in the vicinity of Point Conception. At Point Conception the coastline and mountain range turn sharply and become oriented on an east-west axis. A northwesterly flow is recurved in the lee of the mountains. The recurvature causes south-westerly to southerly winds locally instead of northwesterly, as would normally occur. The eddy has its greatest effects on air flow over the water; the extent of its effectiveness depends on the size of the eddy and the direction and speed of its flow. Occasionally the eddy is very intense and covers a large area. When this occurs, the marine layer deepens rapidly, forcing the inversion upward and permitting greater vertical mixing.

Precipitation in the study region falls chiefly in the winter months. The major portion occurs between November and April, and is usually associated with mid-latitude cyclonic storms. Summer thunderstorms form from moisture advected to the area from either the Gulf of Mexico or the waters off Baja California. These storms rarely track over the coastal waters. Tropical storms in the warm part of the year may, on very rare occasions, provide extensive rainfall.

The prevailing winds in the vicinity of the SCPI Beta platforms are a complex pattern created by the variability of the coastal topography and offshore islands. Detailed descriptions and graphics of the wind patterns are found in the original Shell Beta Development Plan, pages 121 through 135.

3.3 AIR QUALITY

3.3.1 Introduction

The air quality in any region is determined by a combination of factors: rate and quantity of pollutant emissions, meterology (wind speed and stability), and solar radiation. Solar radiation is a major factor in the incidence of photochemical smog. Wind patterns modified by topographic characteristics can affect air pollution potential. Air quality can vary considerably in spite of constant levels of pollutant emissions. Atmospheric conditions are the major factors that determine the short-term changes in air quality. Long-term changes result from variations in total pollutant emissions.

The South Coast Air Basin has a high potential for air pollution because of its geographic location between the sea and the mountain ranges, its low average wind speeds, intense solar radiation, and the trapping effect of pollutants resulting from frequent, strong, temperature inversion. The coastline area of the South Coast Air Basin has very good air quality. The pollutant concentrations seldom exceed any existing air quality standards. The only time that air quality along the coastline is not good is during some of the periods of offshore wind flow. Offshore wind flow can occur for prolonged periods during Santa Ana wind conditions, at night during times when the drainage wind is stronger that the normal westerly wind gradient, or during periods of rain. Obviously, during rain conditions air quality is still good.

Another condition that limits the downwind concentrations of pollutants is the deposition and retention of a pollutant on a surface. In this case, the pollutants could be absorbed by the ocean surface.

The geographical relationship of the SCPI Platform Eureka project to the South Coast Air Basin and various monitoring stations is shown in Figure 3.3-1. The proposed project is closest to the shoreline in the Huntington Beach area. The air quality monitoring station that is considered to be most representative of the coastal area adjacent to the project is in Costa Mesa. Current air quality concentrations at specific locations in the vicinity of the proposed project are presented in the following sections.

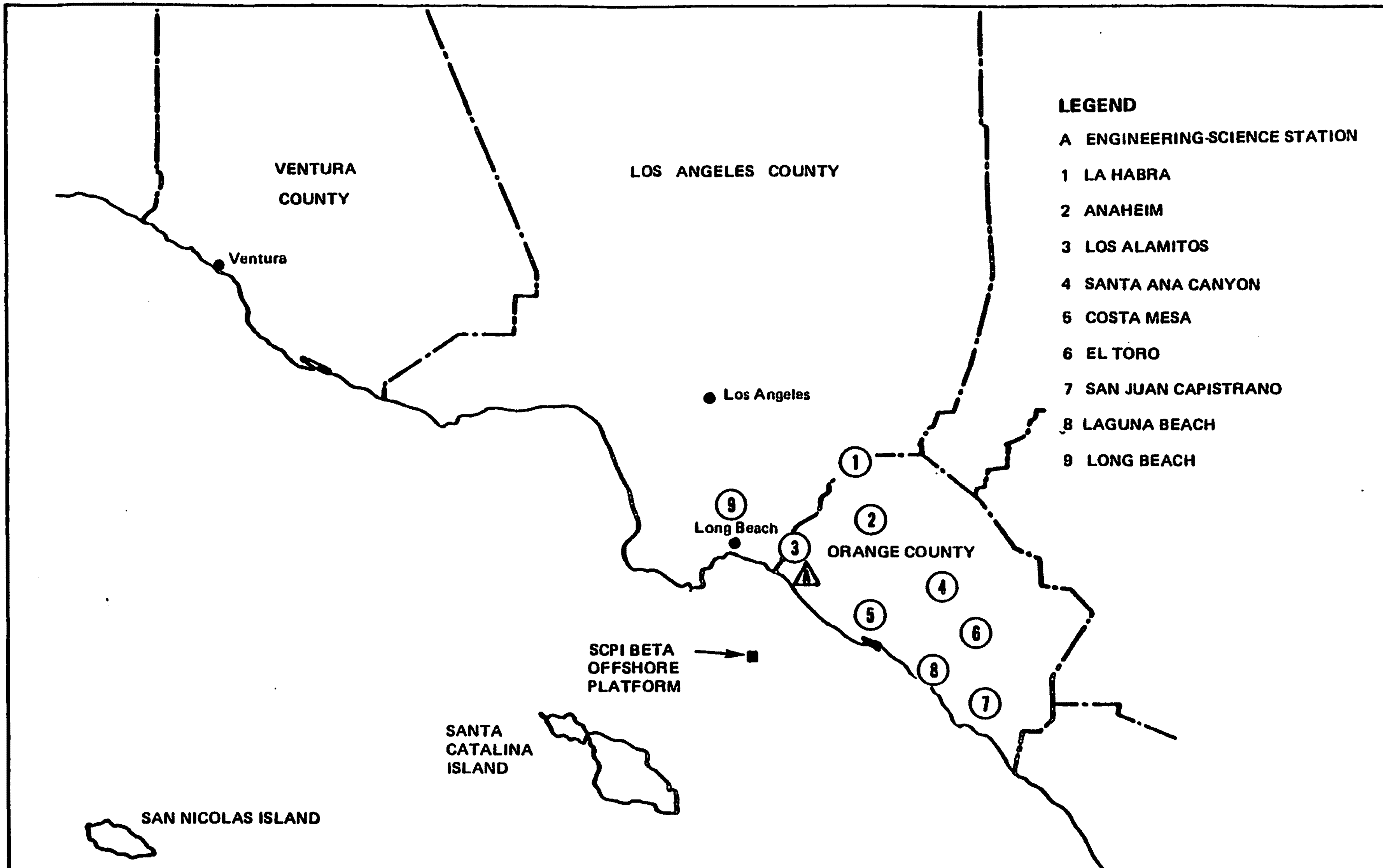
3.3.2 Costa Mesa

Based on the number of days per year that state air standards are met or exceeded, the air quality of Costa Mesa is generally very good. Costa Mesa has had relatively few days with contaminants reaching high concentrations. The Costa Mesa air quality monitoring station is located about 3.2 miles (5.1 km) inland from the coast. The location of this station with respect to the project is shown in Figure 3.3-1.

The Costa Mesa site is typical of locations in the coastal areas of the South Coast Air Basin. Most of the year the air quality is good. Air quality generally improves with nearness to the coastline because of the prevailing air flow off the ocean.

The number of days the California air quality standards were equaled or exceeded at the Costa Mesa site in 1981 and 1982 is shown in Table 3.3-1. Even though Costa Mesa exceeded the standard for oxidant 25 days out of the year in 1982, the maximum concentration of oxidant was only 0.18 ppm. The typical inland station in the South Coast Air Basin reached a maximum of 0.32 ppm and exceeded the California standard 79 days or more during the year. There were no exceedances of the SO_2 standard in 1982 at any of the monitoring sites in the South Coast Air Basin. Costa Mesa did not exceed the NO_2 (1-hour) standard during 1982.

All stations within the South Coast Air Basin exceeded the particulate matter (TSP) standards during 1982. Total suspended particulates, however, were not monitored at the Costa Mesa site.



Air Monitoring Stations in Site Vicinity

FIGURE 3.3-1

Table 3.3-1

NUMBER OF DAYS CALIFORNIA AIR QUALITY STANDARDS EQUALLED OR EXCEEDED AT COSTA MESA IN 1981 AND 1982

Air Contaminant	State Air Quality Standard (averaging time)	Number of Days Exceeding Standard 1981	1982
Ozone (O_3)	0.10 ppm (1-hour)	28	25
Carbon Monoxide (CO)	10.00 ppm (12 hours - 1981) 9.10 ppm (8 hours - 1982)	1	5
Nitrogen Dioxide (NO_2)	0.25 ppm (1-hour)	2	0
Sulfur Dioxide (SO_2)	0.05 ppm (24 hours)	0	0
Total Suspended Particulates (TSP)	Not measured in 1981 and 1982	--	--

Source: California Air Resources Board, "California Air Quality Data," 1981 and 1982 Annual Summary.

3.3.3 South Coast Air Quality Management District

3.3.3.1 Ambient Conditions

The air quality of the South Coast Air Basin (SCAB) has been generally improving over the past decade. Even with the improvement, on a majority of the days during the year the state ambient air quality standards are exceeded. As would be expected, most of the days of high contaminant levels are experienced at the inland monitoring stations. The number of days that the state standards are equaled or exceeded in the SCAB are shown in Table 3.3-2.

3.3.3.2 Existing Emissions

The Beta project location is southwest of the Huntington Beach area. The South Coast Air Quality Management District summarizes emission inventory data for the entire district and for each county of the district. The last full year of data that have been summarized are for 1979. The emission inventories for the entire District and Orange County for carbon monoxide, sulfur dioxide, nitrogen oxide, particulate matter, and organic gases are presented in Tables 3.3-3 and 3.3-4.

Table 3.3-2

NUMBER OF DAYS CALIFORNIA AIR QUALITY STANDARDS EQUALLED OR EXCEEDED AT SOUTH COAST AIR BASIN IN 1981 AND 1982

Air Contaminant	State Air Quality Standard (averaging time)	Number of Days Exceeding Standard 1981	Number of Days Exceeding Standard 1982
Ozone (O_3)	0.10 ppm (1-hour)	233	198
Carbon Monoxide (CO)[1]	10.00 ppm (12 hours)	50	
	9.10 ppm (8 hours)		72
	40.00 ppm (1 hour)	not exceeded	
	20.00 ppm (1 hour)		11
Nitrogen Dioxide (NO_2)	0.25 ppm (1-hour)	38	0
Sulfur Dioxide (SO_2)	0.50 ppm (1-hour)	not exceeded	
	0.05 ppm (24 hours)	not exceeded	
Particulate Matter	60.00 $\mu g/m^3$ (annual)	365	314
	100.00 $\mu g/m^3$ (24 hours)		

[1]The standard for carbon monoxide changed from 1981 to 1982. In 1981, the 12-hour standard was 10.00 ppm and the 1-hour standard was 40.00 ppm. In 1982, the standard was changed to an 8-hour standard of 9.10 ppm and a 1-hour standard of 20.00 ppm.

Source: California Air Resources Board, "California Air Quality Data," 1981 and 1982 Annual Summary.

Table 3.3-3

EMISSION INVENTORY FOR SOUTH COAST AIR BASIN IN 1979[1]

(tons/year)[2]

Contaminant	Stationary Source Source	Mobile Source	Totals
Total Organic Gases[3]	1,274,748	334,566	1,609,314
Reactive Organic Gases[4]	248,200	311,345	559,545
TSP	190,495	33,250	223,745
NO_x	148,190	305,505	453,695
SO_2	73,255	26,755	100,010
CO	215,350	2,576,900	2,792,250

[1] Last year that has been summarized.

[2] Source: Draft Air Quality Management Plan, 1982 Revision, Appendix 4-A, July 1982, South Coast Air Quality Management District.

[3] Total Organic Gases is a collective term for all gaseous chemical compounds containing the element carbon, but excluding: carbon monoxide, carbon dioxide, carbonic acid, carbonates, and metallic carbides.

[4] Reactive Organic Gases is a collective term for all organic gases except the following which are considered non-reactive:

methane
methylene chloride
methyl chloroform
trichlorotrifluoroethane
trichlorofluoroethane
dichlorodifluoromethane
chlorodifluoromethane
trifluoromethane
dichlorotetrafluorethane
chloropentafluoroethane

Table 3.3-4

EMISSION INVENTORY FOR SOUTH ORANGE COUNTY IN 1979[1]

(tons/year)[2]

Contaminant	Stationary Source Source	Mobile Source	Totals
Total Organic Gases[3]	225,756	66,408	292,164
Reactive Organic Gases[4]	45,618	61,732	107,350
TSP	24,794	6,563	31,357
NO_x	17,578	59,462	77,040
SO_2	5,176	4,354	9,530
CO	5,336	512,179	517,515

[1]Last year that has been summarized.

[2]Source: Draft Air Quality Management Plan, 1982 Revision, Appendix 4-A, July 1982, South Coast Air Quality Management District.

[3]Total Organic Gases is a collective term for all gaseous chemical compounds containing the element carbon, but excluding: carbon monoxide, carbon dioxide, carbonic acid, carbonates, and metallic carbides.

[4]Reactive Organic Gases is a collective term for all organic gases except the following which are considered non-reactive:

- methane
- methylene chloride
- methyl chloroform
- trichlorotrifluoroethane
- trichlorofluoroethane
- dichlorodifluoromethane
- chlorodifluoromethane
- trifluoromethane
- dichlorotetrafluorethane
- chloropentafluoroethane

3.3.3.3 Rules and Regulations

On October 8, 1976, the New Source Review Rule (Rule 213) was adopted by the California Air Resources Board for the South Coast Air Quality Management District (SCAQMD). However, the 1977 Amendments to the Federal Clean Air Act made Rule 213 inadequate in enforcing the New Source Review requirements. As a result, a more appropriate and extensive New Source Review procedure was adopted on October 5, 1979; this procedure is known as Regulation 13. Regulation 13 was subsequently revised and amended on March 7 and July 11, 1980, and on September 10 and December 3, 1982.

The Regulation not only calls for compliance by industry with the statutory requirements of the Clean Air Act, but also with all applicable SCAQMD rules. The Regulation applies throughout the SCAQMD's four-county area of jurisdiction including Los Angeles, Orange, Riverside, and San Bernardino Counties.

Specific requirements embodied within the Regulation include:

- emission increases greater than 550 pounds (249 km) per day of carbon monoxide, 150 pounds (68 km) per day of particulate matter and sulfur dioxide, 100 pounds (45 km) per day of nitrogen oxides, 75 pounds (34 km) per day of reactive organic gases, and 3 pounds (1.4 km) per day of lead components must be offset so as to result in a net air quality benefit within the region;
- emissions from a new source or modification must not interfere with a schedule of reasonable further progress as determined by the Executive Officer;
- emissions from new sources or modifications must be the lowest level achievable; and
- air quality modeling must be used to ensure that the quality of the air in the immediate area will not be adversely impacted as a result of the new source or modification.

The Executive Officer may exempt from Regulation 13 any new or modified stationary source employing Best Available Control Technology (BACT) which:

- converts from gaseous fuels to liquid fuels because of a shortage;
- is portable;
- is air pollution control equipment used solely to reduce the issuance of air contaminants;
- is a relocation of an existing stationary source within a distance of 5 miles (8 km);
- is exclusively used as emergency stand-by equipment for non-utility electrical power generation; or
- is a permit unit replacing a functionally identical permit unit.

The Executive Officer may also exempt any new or modified stationary source employing BACT from the offset requirement of Regulation 13 which:

- is used exclusively for providing essential public services;
- is a cogeneration or other energy-related project using fossil fuels (but excluding power plants or refineries); and
- uses innovative control technology.

3.3.3.4 Projected Air Quality Trends

The existing air quality maximum concentrations for oxidant and particulate matter for the SCAB are still above the limit set by the state standard. The necessary reductions to meet federal and state standards are presented in Tables 3.3-5 and 3.3-6.

At the present time, the South Coast Air Basin, including Orange County, has been designated as an attainment area for SO_2; this designation is not expected to change by 1987. Between 1982 and 1987, Orange County and Los Angeles County are projected to have CO concentrations which are from 31 to 51 percent in excess of the standards. By 1987, the NO_2 standard will be 57 percent in excess of the state standard, and 20 percent in excess of the federal standard for the South Coast Air Basin. Total hydrocarbons for the South Coast Air Basin are projected to exceed the standards in 1987 by 34 to 65 percent. The estimated annual emissions of reactive organic gases (ROG), oxides of nitrogen (NO_x), sulfure dioxide (SO_2) and carbon monoxide (CO) are presented in Figure 3.3-2. This figure shows the downward trend in the total emission rate.

3.3.4 Federal and State Standards and Regulations

Air pollutant emissions from onshore and offshore sources would occur as a result of construction, drilling and production operations. Construction and drilling emissions would be of short duration, while those for production would occur throughout the life of the project. Gaseous emissions associated with the proposed project consist of carbon monoxide (CO), volatile organic compounds (VOC), nitrogen oxides (NO_x), sulfur compounds treated as sulfur dioxide (SO_2), lead (Pb) and total suspended particulates (TSP). In addition to the above, fugitive hydrocarbon emissions originate from miscellaneous leaks at valves, pumps, and flanges.

The relevant regulations which must be satisfied prior to obtaining construction approval for the proposed development are the Department of the Interior (DOI) Outer Continental Shelf (OCS) air regulations (30 CFR 250), the Environmental Protection Agency (EPA) Prevention of Significant Deterioration (PSD) regulations

Table 3.3-5

EMISSION REDUCTIONS NEEDED IN 1982 TO MEET FEDERAL AND STATE STANDARDS IN THE SOUTH COAST AIR BASIN (tons/day)

Pollutant	Standard	1974 Emissions	Allowable Emissions	1982 Projected Emissions	Emission Reductions Needed in 1982	Percent Reduction From 1982 Emissions
THC	Federal O_3 and NO_2		578		581	50
	Federal O_3 and State NO_2		305		854	74
		1,620		1,159		
NO_x	Federal		804		455	36
	State	1,322		1,259		
SO_x	Federal		425		---	---
	State		147		246	63
		400		393		
CO	Federal		2,495		2,561	51
	State		2,786		2,270	45
		9,037		5,056		
TSP	Federal		202		266	57
	State		116		352	75
		457		468		

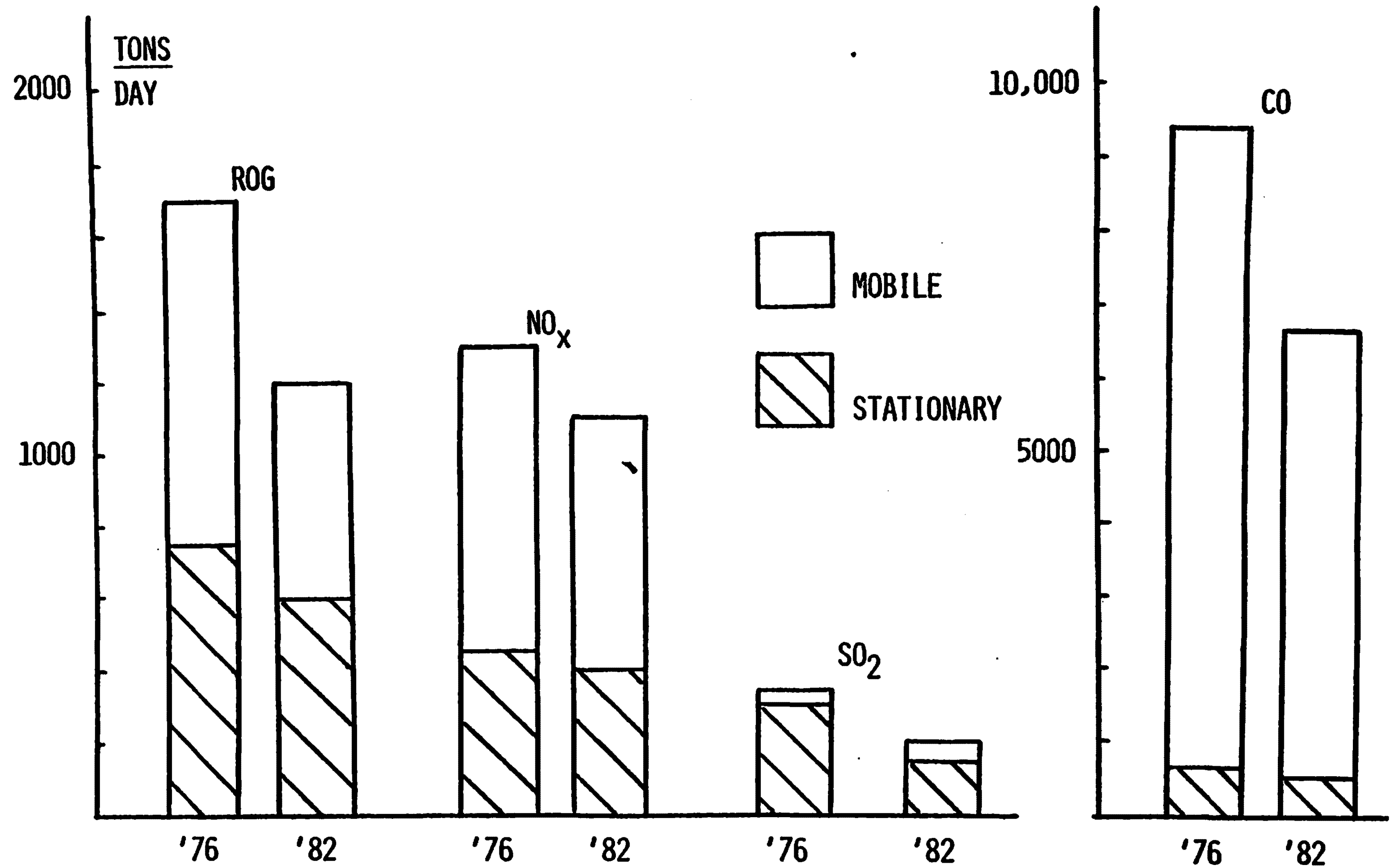
Source: Draft Air Quality Management Plan, Southern California Association of Governments and the South Coast Air Quality Management District.

Table 3.3-6

EMISSION REDUCTIONS NEEDED
IN 1987 TO MEET FEDERAL AND STATE STANDARDS
IN THE SOUTH COAST AIR BASIN
(Tons/Day)

Pollutant	Standard	1974 Emissions	Allowable Emissions	1987 Projected Emissions	Emission Reductions Needed in 1987	Percent Reduction From 1987 Projected Emissions
THC	Federal O_3 and NO_3	1,620	578	878	300	34
	Federal O_3 and State NO_3		305		573	65
NO_x	Federal	1,322	804	1,011	207	20
	State		431		580	57
SO_x	Federal	400	425	423	—	—
	State		147		276	65
CO	Federal	9,037	2,495	4,061	1,566	39
	State		2,786		1,275	31
TSP	Federal	457	202	501	299	60
	State		116		385	77

Source: Draft Air Quality Management Plan, Southern California Association of Governments and the South Coast Air Quality Management District.



REFERENCE: South Coast Air Quality Management District, "A Progress Report—1977-1983", April 1983.

South Coast Air Basin Emissions 1976-1982

FIGURE 3.3-2

(40 CFR 52), and California Ambient Air Quality Standards (CAAQS), and South Coast Air Quality Management District (SCAQMD) emission offset requirements.

The DOI regulations apply to any temporary or permanent OCS facility that emits air pollutants which significantly affect onshore air quality. A facility is assumed to not significantly affect onshore air quality if its emissions are below the following emission exemption levels.

Pollutant	Exemption Level (tons per year)
TSP	33.3 D
NO_x	33.3 D
VOC	33.3 D
SO_2	33.3 D
CO	$3400\ D^{2/3}$

Where D = The distance from the proposed facility to the closest onshore area (statute miles).

The concentrations of pollutants that this exemption level corresponds is directly related to the significance level EPA applies to Class II areas under the Prevention of Significant Deterioration Regulations. These limitations are designed to prevent an area designated as attaining the primary pollutant standards from degrading to any significant degree.

A temporary or permanent facility is subject to these regulations if its emissions on a yearly basis are greater than the calculated exemption level for each pollutant. If less than the exemption level the facility will not adversely impact air quality and therefore is exempt from further air quality review. If a facility's SO_2 NO_x, TSP, Pb and CO emissions exceed DOI exemption levels, further analysis is required. This further analysis involves calculating the onshore air quality concentrations resulting from the facility operations and comparing them to DOI air quality significance levels. This calculation must be completed using a DOI-approved air quality dispersion model.

VOC emissions are reviewed differently since DOI assumes that emitted VOC will react photochemically in the atmosphere and form ozone. Air quality modeling cannot be used to calculate VOC effects on ambient ozone levels because DOI has not approved any photochemical models. For this reason, VOC emission from a facility which is not exempt based on DOI exemption levels for VOC are automatically considered to significantly affect onshore air quality.

As part of the federal Prevention of Significant Deterioration (PSD) program, the EPA has provided specific quantifications as to the incremental level of pollution that would be considered as contributing to an existing violation of National Ambient Air Quality Standards (NAAQS). This is applicable when a major source is to be located in a "clean" area (locality in which primary and secondary standards are being met); however, the source might impact an area that does exceed a NAAQS some distance away, as in the case with the proposed project. The applicable standards are presented in Table 3.3-7.

These standards were set in an effort to protect the public health, and six pollutants are now covered by existing NAAQS. These six pollutants are lead (Pb), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), suspended particulate matter (TSP), and ozone (O_3).

The California Ambient Air Quality Standards (CAAQS) also apply to the pollutants covered by the national standard. In addition to these, the California standards include five more contaminants. These are sulfates, vinyl chloride, hydrogen sulfide, ethylene, and visibility-reducing particles. In the event that the federal and state standards are not the same, the more strigent rule is to be followed.

On December 21, 1976, EPA issued an Interpretive Ruling addressing the issue of whether and to what extent NAAQS established under the Clean Air Act may restrict or prohibit construction of major new or expanded stationary pollution sources. At the heart of this Interpretative Ruling is the offset or trade-off policy, whereby new sources could be allowed in non-attainment areas if the new or expanded source owner could insure emissions from existing sources in the area could be reduced an equal or greater amount than the new or expanded sources could emit. The Ruling requires that emission reductions from the trade-off sources, when combined with the new source emissions, result in a "net air quality benefit in the affected area." The SCAQMD has incorporated these offset requirements into their new source review rules. Formal approval by the EPA has not been received.

The new source review rules include provisions for new sources locating in attainment areas. For "major" new sources, there are four requirements to be met in order to be granted a PSD permit. These are: demonstrations of Best Available Control Technology; review of existing ambient air quality; future compliance with ambient standards and PSD increments; and, effects on air quality related values (such as soils, vegetation, visibility and growth).

Table 3.3-7

NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS), CALIFORNIA AMBIENT AIR QUALITY STANDARDS (CAAQS) AND FEDERAL PREVENTION OF SIGNIFICANT DETERIORATION (PSD) -- SIGNIFICANCE LEVELS

Pollutant	Regulations[a]	Maximum Concentration μg/m³	Averaging Time
Sulfur Dioxide	N	80	Annual
	N	365	24-hour
	N	1,300**	3-hour
	C	130*	24-hour
	C	1,300	1-hour
	P	1	Annual
	P	5	24-hour
	P	25	3-hour
Particulate Matter	N	75	Annual
	N	260 (150)**	24-hour
	C	60	Annual
	C	100	24-hour
	P	1	Annual
	P	5	24-hour
Nitrogen Dioxide	N	100	Annual
	C	470	1-hour
	P	1	Annual
Carbon Monoxide	N	10,000	8-hour
	N	40,000	1-hour
	C	10,000	12-hour
	C	46,000	1-hour
	P	500	8-hour
	P	2,000	1-hour
Ozone	N	235	1-hour
Oxidant	C	200	1-hour
Lead	N	1.5	Calendar Quarter
	C	1.5	30-day
Vinyl Chloride	C	26	24-hour
Hydrogen Sulfide	C	42	1-hour
Sulfates	C	25	24-hour

* At locations where the state standard for oxidant and/or suspended particulate matter are violated.
** Secondary Standard.
(a) N=NAAQS, C=CAAQS, P=PSD

3.4 . OCEANOGRAPHY AND WATER QUALITY

The SCPI Beta project study area lies within a much larger area referred to as the Southern California Bight (Figure 3.4-1). Most areas of the Bight are influenced by a common oceanic current pattern which affects local oceanographic conditions. The Bight area is bounded by the eastern edge of the California current and includes the open embayment extending from Point Conception to Cabo Colnett in Baja California, Mexico. Oceanographic conditions within the Bight are highly variable as a result of locally induced current and water circulation patterns influenced by natural and artificial structures.

Estimates indicate that water moving around the Channel Islands within the Southern California Bight is replaced about three to four times per year (Jones, 1971). Inshore waters are estimated to turnover at a rate of no greater than once per year (Fay, 1971) and represents a somewhat closed physical and chemical system. The low turnover rate is of importance in understanding the factors contributing to marine productivity and the effects that man's activities can have on this ecosystem.

In 1978, Brown and Caldwell conducted a physio-chemical oceanographic field survey to gather site-specific data for the proposed SCPI Beta development and to provide verification of the existing data base (SLC et al., 1978).

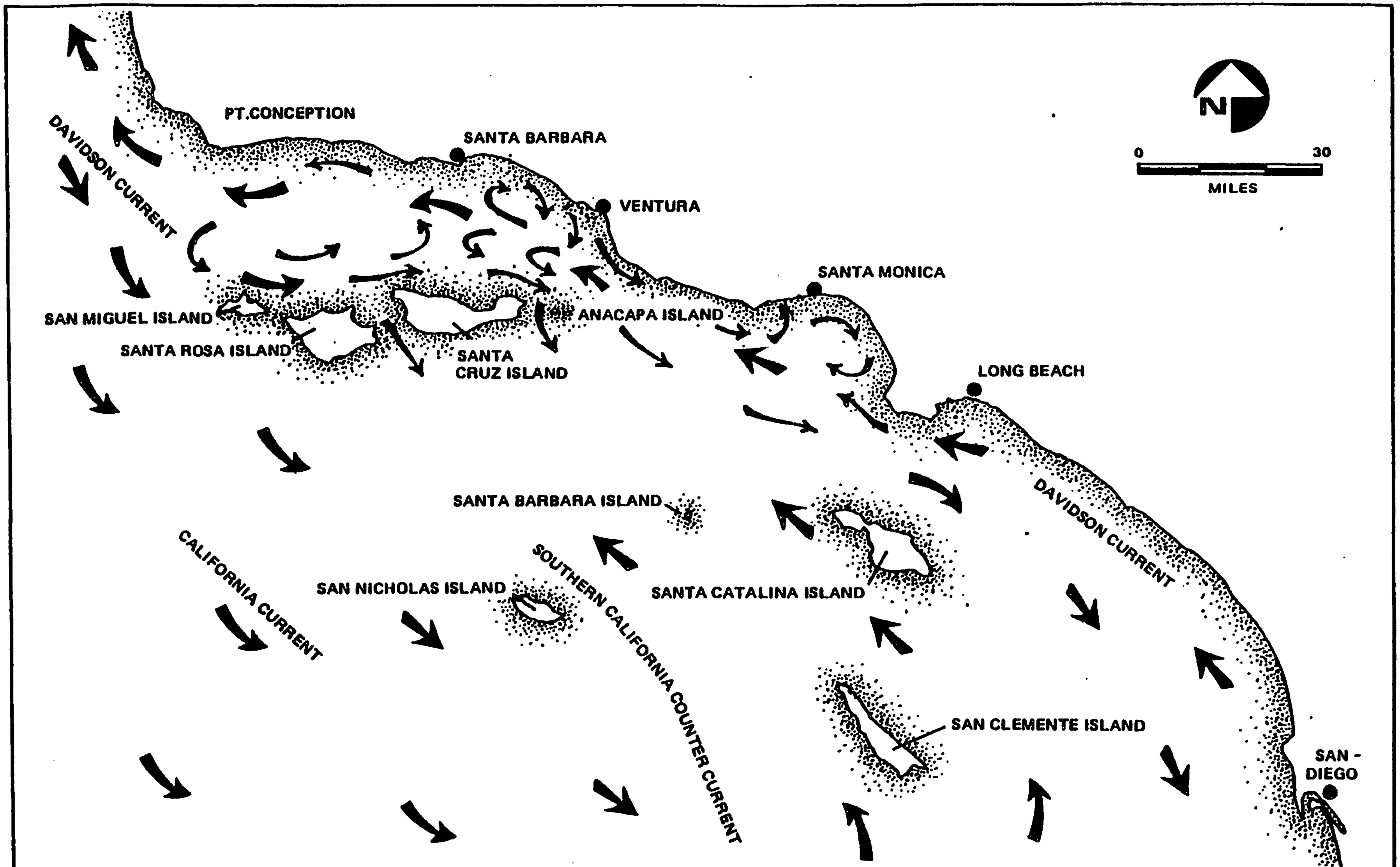
The scope of work included a single comprehensive examination of representative physical and chemical oceanographic parameters within the study area. Parameters examined included physical measurements of currents, temperature, salinity, density, hydrogen ion concentration, dissolved oxygen, transmissivity, and solar irradiance, as well as receiving water and sediment chemical analyses for nutrients, grease and oil, trace metals, organic content, and coliform organisms.

The results of that study indicated that all parameters measured in the area of the proposed platforms were within normal limits for nearshore oceanic waters within the Southern California Bight, including chemical analyses as well as physical measurements.

The development of Platform Eureka and the interconnecting pipelines and cables requires a review of the previous documents and an updating of studies and publications obtained since 1978. The following sections includes this review and updating.

3.4.1 Currents

The project site is located in the San Pedro Channel and is generally considered to be in an area of complex coastal currents. The currents are complex because



Surface Circulation Within the Southern California Bight

FIGURE 3.4-1

local water movements are the result of the action and interaction of a number of small-to-oceanic-scale forces along the rough fluid boundary formed by the Pacific Coast east of Point Conception. The overall pattern of circulation within the Southern California Bight is primarily a result of the interaction of the California Current system with locally generated wind-drift currents and tidal currents.

The two major currents within the Southern Californa Bight are the California Current and the Southern California Countercurrent. The California Current is part of the general clockwise pattern of surface water circulation in the northern Pacific ocean. The current flows southeast along the California coast. Within the Southern California Bight, the California Current lies outside of the 5000-foot (1524 m) depth contour. Offshore of northern Baja California, the main portion of the California Current turns landward and divides into two branches. One branch continues southward, while the other branch, the Southern California Countercurrent, turns northward and flows through the Channel Islands inshore of the California Current. Major currents are shown in Figure 3.4-1.

East of the Southern California Countercurrent, the current again turns southeast, forming an eddy which flows along the coast. This flow is associated with the dynamic topography established under the influence of winds along the coast and consequently seaward movement of surface water. The Southern California Eddy, a nearly permanent feature of the flow pattern, is seasonal in character. The Eddy is usually well developed in summer and autumn and weak (and occasionally absent) in winter and spring. Average seasonal variations of surface currents in the California Bight are summarized in Table 3.4-1, however, data pertaining to the small scale, horizontal eddy structures, which are important in describing lateral mixing as well as in determining the residence time of a parcel of water in the Bight, have not been reported in the literature.

Circulation in coastal waters is dominated to a large extent by prevailing wind patterns (Hickey, 1979; Williams et al., 1980) Considerable variability exists on various time and spatial scales driven by the variations in the wind forcing as well as the inherent variability of the flow itself (Bernstein et al., 1977, Owen, 1980).

Table 3.4-1

SUMMARY OF SURFACE CURRENT MEASUREMENTS
WITHIN THE STUDY AREA

	Season			
Parameter	Winter	Spring	Summer	Fall
Maximum Speed	0.8 knot	1.3 knot	1.0 knot	0.8 knot
Average Speed	0.2 knot	0.4 knot	0.3 knot	0.2 knot
Minimum Speed	0.1 knot	0.2 knot	0.1 knot	0.1 knot
Direction(s)	SE & NW	E & NW	E & NW	SE & NW
Type:	Drogue and Current Meter	Drogue and Current Meter	Drogue and Current Meter	Drogue and Current Meter

Source: Oceanographic Services, Inc., 1978.

The year-round presence of the California Current, transporting sub-arctic water masses toward the Equator is the dominant feature. The California Undercurrent, present at a depth of 150 m along the shelf slope is also a significant element of the current system.

In a recent study of currents in the Los Angeles Area (Hendricks, 1980) current speeds at a depth of 41 m on the nearshore shelf northeast of the project site were measured. At this depth median current speeds are approximately 10.7 cm/sec with net flows being 2-5 cm/sec. Net flow is in an upcoast direction (274° magnetic north). Flow in marine canyons was measured off Santa Monica with normal net flow being down canyon. At the head of the Santa Monica canyon, currents were highly variable and were influenced by a variety of sources including tides.

The proposed platform is located adjacent to a minor marine canyon and it is assumed that the net flow on the bottom in the general vicinity of the platform would be in the 2-5 cm/sec range. The majority of the canyon flow in the Hendricks' study was southerly to southwesterly at a depth of 168-384 m. However, at one location off Santa Monica Bay at 472 m, flow was measured at 0.2 cm/sec (280°) northwesterly.

An analysis of CalCOFI data on the driving forces affecting the California currents (NOAA, 1980) indicate that these forces are complex and that observed short-term patterns may not hold over longer time scales.

In summary, the currents in this area of the proposed pipeline and platform are complex and difficult to interpret. Seasonal variation of surface currents, undercurrents and the effect of winds combine to create a variable current picture especially in light of the depth of the platform. Bottom currents will likely go in a opposite direction to surface and near surface currents.

3.4.2 Tides

The tide within the San Pedro Channel, like that occurring everywhere along the Pacific Coast of North America, is classified as mixed, because there are both diurnal and semidiurnal tidal components with periods of approximately 12.5 and 25.0 hours. Semidiurnal tides are characterized by two unequal high tides and two unequal low tides occurring with one complete tidal period.

Extreme tides occur twice annually, once in June or July and again in December or January. These extreme tides, termed the solstices, are caused by the increased effect of the sun on the diurnal tide as the declination of the sun reaches its two annual maxima. All along the Pacific Coast, the summer solstice tides reach lower low tidal levels in the predawn hours and higher high tidal levels in early evening, while winter solstice tides reach their lowest levels in midafternoon and their highest levels after dawn.

The tide along the southern California coast varies in range from less than 1 foot (0.3 m) during a "vanishing tide" (when the difference between the lower high water and higher low water becomes so small that the two tides merge) to slightly more than 6.5 feet (2 m). This does not take into account storm tides, which may raise the sea level higher and which are unpredictably distributed. The period of the tide varies from about 10 to 14 hours. The most common tidal range is between 4 and 4.5 feet (1.2 and 1.4 m). The tide wave which accompanies this rise and fall is progressive and approaches the coast from the southeast. Any tidal currents generated by flooding tides flow toward the northwest. Ebbing currents flow toward southeast. Current measurements along the Southern California Shelf, however, have always shown characteristic diurnal patterns more closely related to the wind cycles than to the tide (Hancock, 1965).

3.4.3 Sea State

3.4.3.1 Waves

Ocean waves are primarily the result of wind and storms. Less frequently, waves are generated by geologic activity such as earthquakes, volcanic activity, and submarine landslides. Tidal action produces another form of wave. Waves which grow in height under the influence of wind are referred to as wind waves or seas, and the area over which they are generated is termed the fetch. Once the wind waves move out of the fetch area and continue on without additional energy input, they are referred to as swell. In southern California, wind waves are predominantly from the northwest (prevailing winds), and swells may occur from any seaward direction. Wave height and direction may be the result of several different wave trains moving through the area.

Sea surface waves range in length from fractions of an inch (capillary waves) to hundreds of miles (tides and tsunamis). Most of the wave energy transmitted on the sea surface appears in the form of wind-generated waves with periods ranging from approximately 5 to 15 seconds.

Propagation of surface waves over water of depth less than about one-fourth the wavelength is inhibited by the friction or wave-breaking effects caused by the waves moving over or breaking onto the bottom. According to the State Water Quality Control board (Allan Hancock, 1965), nearly all of the southern California Coast is protected, to some degree, from swells generated outside the coastal area by the offshore islands. Certain portions of the coast are exposed to essentially unlimited fetches from the west and south, but no location is exposed to swell from all possible seaward directions. The project site lies in an area that is protected from incoming surface wave energy in all but westerly and southeasterly directions. Local wave generation is also limited because the surrounding topography reduces the length of wind fetch.

Along the coast from Long Beach to Newport Beach, most significant swells arrive from 260° to 280° and from 160° to 190° True. Even in areas which are exposed to long fetches, swells with periods greater than 10 seconds are altered, at least in direction, by refraction over banks and around the offshore islands.

The protection offered by offshore islands (especially Catalina) is generally so complete that significant waves over the shelf are mainly formed in the local area. The restricted fetches allow only the development of low waves with short wave lengths and periods. Larger waves (to 6 or 8 feet (1.8-2.4 m)) are formed during frontal crossings, but again with short wave lengths and periods due to the limited fetch. It is only when gale winds of greater than 35 knots (64.8 km/hr) blow from the west that high waves are formed in the local region and travel over the shelf. These are most common in the San Pedro Channel where waves as high as 25 feet (7.6 m) have occurred (SLC et al., 1978).

During the 1983 winter storms, the primary direction of wave flow was from the south and southeast. Waves in excess of 12 to 15 feet were observed (Scripps Institute of Oceanography, NORPAC Data Center). South facing coastlines experienced shorebreak in the range of 15-20 feet and were extensively damaged.

An estimation of extreme wave height and directional spectral shape for the San Pedro Basin and the Eureka site was prepared by Reece (1980). That document reviewed previous studies on wave heights and reassessed the hindcast using a new modeling program (GAPS - Gulf of Alaska Pilot Study). That model reproduced wave systems from 14 storm periods selected from historic storm populations of the north Pacific as potentially the generators of the largest waves off the lower California Coast.

The hindcast data were compared to measured wave heights at Tanner Bank in 1977. Taking the sheltering effect of offshore islands into affect, the hindcast wave heights were extrapolated to 100-year return intervals. The 14 storms generated a mean peak wave period of 13.9 seconds and an average wave period of 10.5 seconds. An average of 6806 waves were generated during the storm peak (n = 14 storms).

The wave height and period values listed below are recommended by Reece (1980) for use in design for San Pedro Bay. They have been estimated taking island sheltering into effect. For the 100-year return interval $(H_s)_{max}$ is the maximum significant wave height during a single storm, H_{max} is the maximum wave height during a single storm, T_{max} is the period associated with H_{max}, and T_P is the location of the spectral peak. Recommended values are:

$$(H_s)_{Max} = 22.6 \text{ feet}$$

$$H_{max} = 43.0 \text{ feet}$$

$$T_P = 12.8 \text{ seconds}$$

$$T_{max} = 11.5 \text{ seconds}$$

3.4.3.2 Tsunamis

Tsunamis are surface gravity waves generated primarily by submarine earthquakes or volcanic eruptions. They are a finite series of waves that travel in a concentric pattern from the source of disturbance. Generally they are long-period waves (from 5 minutes to several hours), low in height (a few feet or less) and may travel at speeds well over 400 knots (740 km/hr). On the open sea or in deep water, they usually go unnoticed by ships and platforms. However, as the wave moves to shallow water, it is modified by coastal and bottom configurations and increases in height and shortens in length eventually breaking against the coast. The damage associated with tsunamis often occurs in the form of rapidly rising water levels or bores rather than breaking waves.

Use of the term "tidal wave" to denote the seismic wave is misleading because of the allusion to astronomical tide, which is a surface gravity wave of a larger wavelength. Though the longer and higher astronomically driven tide waves possess far more energy and inundate larger areas of land than do tsunamis, they are not as destructive. Tides may flood an area regularly and predictably, while tsunamis occur rarely and without warning.

According to the Coast Pilot #7 (1968), the coast of California is not generally subject to waves of the magnitude which strike the Hawaiian Islands and other Pacific areas, although widespread damage to shipping and to waterfront areas occurs occasionally. For example, much of the damage to the Los Angeles area from the 1960 Chilean tsunamis was caused by rapid currents and the swift rise and fall of the water level, which broke mooring lines and set docks and ships adrift. Tsunamis are not considered a hazard to the proposed platform as it will be located in a water depth of 700 feet.

3.4.3.3 Upwelling

A cyclonic eddy sandwiched between the shore and the southward flowing California current characterizes the circulation in the Southern California Bight. The California Current in the project area abounds in mesoscale eddy activity including large scale meanders and energetic jet-like flows (Bernstein et al., 1977, Blumberg et al., 1983). The various capes in the region are areas of intense upwelling and jet-like offshore flows.

Upwelling is a major factor influencing the ecology of the Southern California Bight. Northwesterly winds blow nearly parallel to the southern California coast in the spring, and river surface waters offshore, causing bottom waters with low temperature, low dissolved oxygen, and high plant nutrient content to be carried inshore and to the surface.

3.4.4 Regional Longshore Sediment Transport

Longshore sediment transport is a result of net movement of water parallel to the coastline. It is a function of nearshore currents, and wind-generated waves and generally occurs in or adjacent to the surf zone. Normally this process is a relatively smooth phenomenon, however in areas of high shoreline irregularity (harbor mouths, breakwaters, and uneven coastlines) the process is disrupted. The result is an irregular distribution of sand on area beaches, significant losses or gains adjacent to impinging structures and often permanent losses of sand material diverted into offshore canyons.

No nearshore project components are considered above current levels and longshore sediment transport should not be considered a significant environmental element for this impact analysis.

3.4.5 Salinity, Temperature, and Oxygen

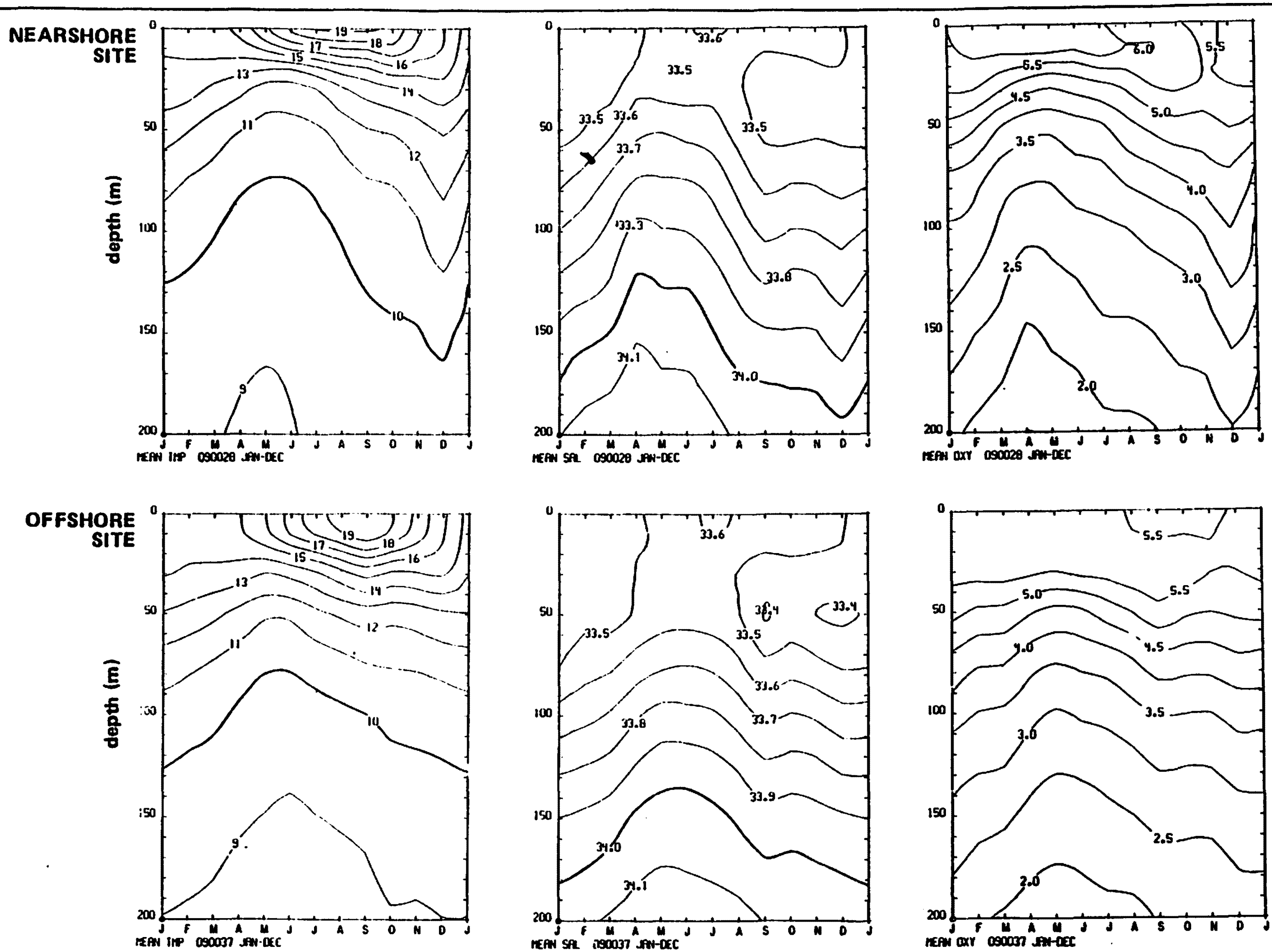
3.4.5.1 Temperature

The temperature of the seawater in the vicinity of the project site is controlled by the advective processes that move water into the area and by solar warming and evaporative processes. Temperature is of major importance as a seawater characteristic influencing density, biological productivity, and the dispersion properties of the water mass. An area of rapid temperature change (0.1°C per meter) is referred to as a thermocline. Thermoclines are created by increases in surface water temperature, thus decreasing surface density. A strong thermocline results in vertical stratification that may inhibit natural physico-chemical and biological vertical exchange, and may also affect dispersion and settling of suspended materials.

During the summer months (July, August, and September), inshore waters are generally warm, and a well defined thermocline exists. In late summer, colder northern water carried by the California Current is moved inshore via the Southern California Countercurrent. Part of the current flows north toward Point Conception, and the remainder reverses direction and moves southward along the coast. The surface waters become cooler due to wind-induced mixing with colder deeper waters, and the thermocline gradually disappears. During the winter, storms maintain this mixing. In the spring, an upwelling of colder subsurface water occurs. This colder water also chills the air over the water surface creating fog during the months of April, May, and June. Summer heat then gradually warms the inshore waters to complete the cycle.

Stratification of water along the southern California mainland shelf is principally the result of temperature differences with depth. In summer the temperature change from surface to 200 feet (60 m) may be 15° to 20°F (8° to 11°C). Summer thermoclines are generally observed between 30 and 50 feet (9 to 15 m) and may show a temperature decrease as much as 5° to 8°F (3° to 4°C). In winter the temperature difference from surface to 200 feet (60 m) may be as small as 1 to 2F (0.6 to 1.2C). Upwelling tends to decrease the depth of the thermocline.

Figure 3.4-2 shows long-term temperature profiles for a nearshore and offshore CalCOFI grid location adjacent to the project area for data taken from 1950 to



Annual Mean Temperature, Salinity and Oxygen Levels at Two CalCOFI Grid Locations Near the Project Site (1950-1965) (Eber, 1977)

FIGURE 3.4-2

WESTEC Services, Inc.

1965. It is not expected that sea temperatures will vary from these figures. Short-term anomalies such as the thermal incursion occurring along the southern California coast at the present time are infrequent phenomena and should not be considered to have long-term impacts on the aquatic system.

3.4.5.2 Salinity

Salinity, as a measure of the concentration of dissolved salts in seawater, is relatively constant throughout the open ocean. However, it can vary in coastal waters, primarily because of the inputs of freshwater from land or because of upwelling (SCCRWP, 1973). Salinity typically increases with depth, although generally remaining uniform in the open ocean, with concentrations varying between 33.4 and 34 ppt (Eber, 1977). Water in the site area is often isohaline below a depth of 50 feet (15 m) with the effects of dilution and evaporation detectable only in the surface 50 feet (15 m). During summer, a salinity inversion develops near the surface due to evaporation, however, the density stratification is usually sufficient to preserve water column stability, and the increase is only slight. The average annual salinity for two CalCOFI grid sites in the project area is shown in Figure 3.4-2.

3.4.5.3 Oxygen

Dissolved Oxygen. The Southern California Coastal Water Research Project (SCCWRP, 1975) reports that surface waters are usually saturated or supersaturated with dissolved oxygen on the mainland shelf with the highest concentrations occurring during the summer months when oxygen saturation may reach as high as 140 percent of saturation. Coastal water concentrations of dissolved oxygen are more variable than those offshore, reaching as high as 10 to 14 mg/l. Highest concentrations are characteristic of nutrient-rich water which maintain phytoplankton populations releasing oxygen during photosynthesis. Dissolved oxygen may be depleted by respiration from marine organisms and chemical and/or biochemical oxygen demand.

Concentrations of dissolved oxygen are a function of photosynthetic processes, respiration, atmospheric exchange of gases, ocean temperature, salinity, currents, density, and wind-mixing. There is little horizontal variation of dissolved oxygen but there are large vertical variations. Dissolved oxygen concentrations are greatest in spring and summer because of photosynthesis; they also vary with depth because photosynthesis occurs mainly in the upper strata of the ocean. Concentrations generally decrease with depth; however, values below 200 feet (60 m) of depth usually do not fall below 4 mg/l in shelf waters, which is about 50 percent of saturation and adequate to support marine life.

Data from long-term oceanographic studies conducted under the auspices of CalCOFI shows a somewhat different picture (Figure 3.4-2). Oxygen levels drop rapidly below 100 m, to below 2.0 ppm dissolved oxygen. Organisms living in the deeper waters have adapted physiologically to the interactive effects of temperature, pressure, oxygen and salinity and live quite satisfactorily.

3.4.6 Water Quality Parameters

A number of physical and chemical characteristics are used to define the term water quality. Three of these characteristics: temperature, salinity and oxygen, have been discussed previously.

3.4.6.1 Transparency/Turbidity

Light is a major factor in the growth of phytoplankton and the growth and reproduction of attached marine plants. It is also affects the diurnal vertical migration of zooplankton and some fishes. The transparency of water, which determines the depth to which light will penetrate, is of concern in considering many biological processes.

Turbidity, the reduction of water transparency created by the presence of suspended solids, is most commonly measured as the percent transmittance (%T) of white light through 1 m of water. Naturally occurring contributors to turbidity offshore include high plankton concentrations (usually in surface waters), fine particles of suspended sediments from storm water and river runoff, or resuspended bottom material from wave action and upwelling.

Transparency is lower in the spring than in the fall, particularly in the vicinity of the alluvial land plains along the coastline south of San Pedro. A band of low transparency water within a mile or so of the beach is characteristic of the southern California Coast (Allan Hancock Foundation, 1965). There are two main rivers (San Gabriel and Santa Ana) which drain into the coastal area south of Long Beach Harbor. These rivers supply the majority of suspended particles from storm water runoff and provide the principle inputs which contribute to reduced transparency along the coast.

Visual transparency along the coast for all seasons varies from an average of less than 20 feet (6 m) to greater than 50 feet (6 m) are characteristic of localities off allivual plains, while transparencies between 20 (6 m) and 40 feet (12 m) are typical of rocky shores (Allan Hancock, 1965). The amount of turbidity in the water column influences marine plant productivity by limiting the amount of light penetration. Heavy amounts of suspended particles can inhibit visual feeding animals, obstruct filter feeders, or damage the gills of fishes (Kinne, 1970).

3.4.6.2 Nutrients

Nutrients may be defined as the substances that are needed for marine life to reproduce and grow. Nutrients are considered to be one of the most important limiting factors in primary production (Hutchinson, 1957). They are assimilated from seawater through the autotrophs and transferred along the food web to heterotrophic organisms. In this section the most important nutrients, nitrogen and phosphorus, will be discussed. Silica, which is an important nutrient to diatoms, will also be discussed due to the fact that diatoms comprise much of the phytoplankton community along the Southern California Bight.

The primary sources of these nutrients are upwelling of nutrient rich deep waters, aductions, and discharges from land sources (rivers, rainwater runoff, industrial and domestic wastewaters). The primary process depleting the concentration of nutrients in the surface waters is uptake by phytoplankton. Other processes depleting nutrient concentrations are advection to other areas and mixing with nutrient depleted water masses. Low concentrations of nutrients are normally found in surface waters except in local source areas (BLM, 1975).

Nitrogen and phosphorus represent the two elements generally found to be limiting in natural ecosystems; however, nitrogen is considered to be the more important of the two. In the open ocean, it has been commonly observed that total nitrogen and total phosphorus are found in a relatively constant ratio of about 15 atoms of nitrogen to 1 atom of phosphorus (Redfield, 1958). This relationship is not nearly so constant in coastal waters, which are affected by higher rates of organic production and are subject to influences from land-based nutrient sources. Ryther and Dunstan (1971) suggest that since phosphate is normally present in concentrations twice that of nitrogen in the coastal marine environment, nitrogen must be the critical limiting factor.

Phosphorus exists in a great number of forms, the most prevalent of which is the phosphate group ($PO_4^{=}$). The slightly soluble inorganic phosphorus of the earth's crust is a relatively unlimited reservoir which slowly leaches into aquatic systems through the weathering of rock. These soluble orthophosphates are quickly assimilated by phytoplankton and transformed into particulate organic phosphorus. Dissolved inorganic phosphorus compounds are released into solution by excretion or decomposition and are transformed into particulate organic phosphorus, or, through degradation, are converted back into inorganic orthosphosphates. As in nitrogenous forms, some of the organic products result in refractory compounds, unavailable for biological use, and become part of the sediments.

In the Southern California Bight, average nitrate and phosphate concentrations in the surface water, 0 to 50 feet (0-15 m) are always low (NO_3 = < 5 μg/l; PO_4 - 4P = < 0.5 μg/l). From a depth of 50 to approximately 330 feet (15-100 m) concentrations increase rather rapidly (NO_3 - N = 8 - 12 μg/l and PO_4 - P = 1 - 2 μg/l). Below 330 feet (100 m) of depth, the concentrations increse steadily, but at slower rates than near the surface. Below 740 feet (225 m) of depth, nitrate concentrations are consistently greater than 20 μg/l and phosphate greater than 2 μg/l.

Nutrient concentrations in the surface waters vary with season near the coast due to spring upwelling and runoff from storms. Concentrations of both nitrate and phosphate are higher during the spring than in other seasons. This seasonal change is less evident farther from shore and is not evident below 330 feet (100 m) of depth. Concentrations measured at equal depths throughout the Bight are usually similar, which indicate that the horizontal distribution of nutrients is fairly uniform. Some differences are expected in the surface water due to local differences in runoff and upwelling characteristics. The depth at which concentrations of at least 30 μg/l NO_3 - N are continually available apears to be 1000 feet (300 m) or more. The distribution of both phosphate and nitrate concentrations were observed to be the same (Oceanographic Services, Inc., 1978).

Silica concentrations are relatively uniform in surface waters, with low values occurring in the fall and winter. The differences in concentrations between surface waters and waters at 300 feet (90 m) of depth appear to be the greatest during April, May, and June, when the upwelling of deep water is greatest. Silica concentrations at the surface range from approximately 200 μg/l to 800 μg/l. Mean silica concentrations show fairly consistent patterns, increasing with depth. Silica concentrations at 300 feet (90 m) range from 800 μg/l to 2250 μg/l (SCCWRP, 1973).

3.4.6.3 Trace Metals

Trace metals (such as cadmium, copper, zinc, mercury, and lead) are normal constitutents of sea water and sedimentary material. In the Southern California Bight, trace metals within the water column and sediments are derived from natural sources (weathering of pre-existing rock material) and man-induced sources. The movement of trace metals from source area to depositional site is complex, and involves many interrelated physical, chemical, and biological processes (Dames and Moore, 1978).

Metals can exist in the waters in ionic form, associated with particulates, organically bound, or as chemical complexes. Chemical and biological processes shift the equilibria between these states. Total trace metal concentrations and the state of trace material in coastal waters can be expected to vary significantly from those in offshore waters. Similarly, concentrations in surface waters and in deep ocean waters differ significantly. Other factors, such as heavy rains, storm runoff to coastal waters, upwelling of subsurface water, or changes in plankton population can also alter metals concentration.

The levels of metals in the waters of the Southern California Bight, even in the vicinity of river discharges and wastewater outfalls, are within ranges reported for seawater in various areas around the world (SCCWRP, 1975). Trace metal concentrations measured in southern California Bight Studies (BLM, 1975) are presented in Tables 3.4-2 and 3.4-3.

Table 3.4-2

TRACE METAL CONCENTRATIONS
IN SEAWATER WITHIN THE STUDY AREA

Trace Metal	Concentration (μg/l)
Cobalt	0.1 - 0.2
Copper	1.6 - 9.0
Iron	1.9 - 44.3
Mercury	0.03
Nickel	0.4 - 2.5
Lead	0.4 - 18.2
Zinc	1.1 - 41.2

Source: BLM, 1975

Trace metal concentrations are important to marine life; at low concentrations they are essential to plant productivity, while at high concentrations, they can be inhibitory or toxic.

Core samples collected by Dames and Moore (1975) close to the proposed Beta Project pipeline route were analyzed for mercury, the concentrations of pollutants in the samples analyzed were below the maximum allowable concentration required by the EPA for the dredging and replacement of material in the pipeline trenches. Trace

Table 3.4-3

TRACE METAL CONCENTRATIONS (ppm) IN SEDIMENTS FOR SAN PEDRO SHELF AND BASIN

Sample Number	Depth (fathoms)	Arsenic	Cadmium	Chromium	Copper	Iron	Mercury	Nickel	Lead	Zinc
				San Pedro Shelf (upper 2 inches of sediment)						
1	20	6.82	3.57	48.16	17.08	16,640	0.160	37.59	61.29	75.74
2	<20	14.10	2.00	46.07	26.99	22,890	0.258	37.23	39.55	---
3	<20	---	---	---	---	---	---	---	---	80.03
4	100	1.12	2.77	35.96	14.64	17,270	0.210	41.82	52.70	41.82
5	<20	1.65	1.83	42.62	21.75	19,570	0.128	26.09	41.32	73.06
6	<20	1.84	2.24	30.51	9.63	15,130	0.106	20.03	44.00	36.11
7	75	1.26	1.92	34.63	13.68	24,800	0.040	25.65	48.31	51.30
8	<20	2.19	1.57	31.75	10.51	15,130	0.043	20.22	31.98	43.22
9	<20	1.25	1.91	23.72	9.18	14,160	0.035	19.14	24.37	35.88
10	30	1.26	2.28	27.23	13.82	18,430	0.072	33.51	56.56	55.72
11	150	3.21	2.41	58.80	14.39	35,050	0.106	25.37	48.68	41.54
				San Pedro Basin (upper 2 inches of sediment)						
12	350	6.63	2.68	62.37	28.07	34,740	0.134	53.02	46.78	96.48
13	>450	5.04	3.24	57.55	33.81	39,280	0.117	61.15	50.36	87.77
14	>450	6.53	2.52	37.74	25.66	35,080	0.179	55.34	55.20	110.40
15	>450	6.24	3.09	70.06	34.66	33,190	0.183	67.10	51.62	94.40
16	350	6.84	3.50	42.55	29.04	28,040	0.186	55.07	42.55	82.61
17	425	5.20	2.90	55.86	30.47	31,920	0.256	50.78	47.15	92.85
18	400	4.36	3.44	50.39	29.64	29,230	0.207	68.18	47.43	96.67
19	375	3.14	3.00	57.81	37.54	35,510	0.244	60.06	56.31	93.85

metal concentrations in surface sediments are presented in Table 3.4-3. This data was originally presented in the Shell Beta EIR (SLC et al., 1978).

3.4.7 Summary

Oceanographic and water quality conditions at the project site is typical of the ocean waters throughout the Southern California Bight. Though fluctuations in various parameters are observed over time, they are within the general levels of tolerance for marine organisms. Short-term thermal incursions ("El Nino") are relatively infrequent events in time and should not create a long-term effect.

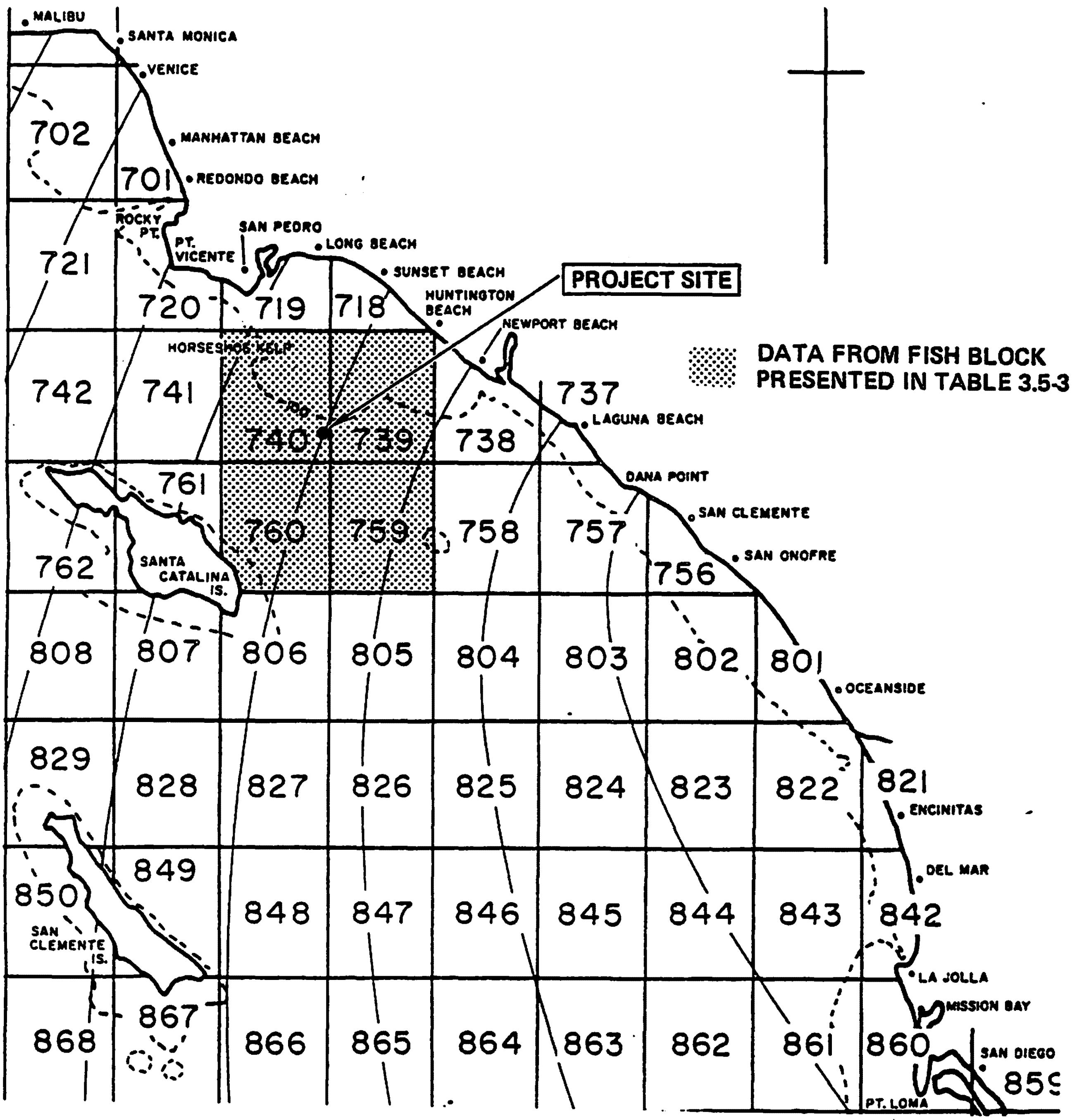
3.5 OTHER USES OF THE PROJECT AREA

3.5.1 Commercial and Sport Fisheries

As pointed out by Horn (1974), almost all of the commercial and sport fishes landed in southern California are either pelagic species that are taken by a variety of methods or inshore predatory species that are taken by selective hook-and-line fishing. In contrast to central and northern California, where bottom trawling accounts for much of the fish landed, only an insignificant fraction of the total commercial catch in southern California is taken by trawling. In Fish and Game District 19 (Santa Barbara-Ventura County line to the Mexican border), the possession of trawl nets is governed by terms of a permit issued by the California Department of Fish and Game.

The SCPI Beta project lies within California Department of Fish and Game Fish Blocks 739 and 740 (Figure 3.5-1). The historical commercial catch in pounds and sport catch in number of individuals landed for the two fish blocks is given in Tables 3.5-1 and 3.5-2, respectively. The data show that since 1964, 10 pelagic species taken from Fish Blocks 739 and 740 were important in terms of total weight, of which 4 appear to have contributed most of the commercial catch from these blocks. These were in ranked order of pounds captured: northern anchovy, jack mackerel, Pacific bonito, and Pacific mackerel. Although substantial differences in pounds landed exist between the two blocks, the species composition of the commercial catch was very comparable. The total commercial catch in Blocks 739 and 740 was 22,841 metric tons, which amounted to approximately 13 percent of the total southern California commercial catch, and nearly the entire catch was composed of 21,556 metric tons of northern anchovy (SLC et al., 1978).

According to Allen and Voglin (1977), northern anchovy, Pacific sardine (Sardinops sagax), Pacific mackerel, and jack mackerel accounted for over 80 percent of the total pelagic wetfish fishery catch per year in southern California since 1930. The 1975 commercial catch for fish blocks encompassing the entire Southern California



California Department of Fish and Game Designated Fish Blocks

FIGURE 3.5-1

Table 3.5-1

COMMERCIAL CATCH FISH BLOCKS 739 AND 740 (1964-1975)
(POUNDS LANDED) (SLC et al., 1978)

	Fish Block 739	Fish Block 740
1964	6,595,292	547,177
1965	2,667,124	159,629
1966	12,744,386	7,919,878
1967	5,224,562	9,498,742
1968	720,410	2,982,855
1969	13,760,795	5,418,524
1970	35,713,603	22,693,019
1971	10,657,642	6,082,456
1972	15,650,120	10,653,619
1973	35,682,996	26,161,501
1974	23,615,954	6,197,018
1975	18,248,044	41,984,336
Total	181,580,928	140,298,744
Mean	15,131,744	11,691,562

Most Abundant Taxa

Block 739		Block 740	
Anchovy	109,691,488	Jack mackerel	22,083,534
Jack mackerel	2,701,557	Anchovy	17,224,459
Rock crab	1,550,289	Pacific bonito	3,730,367
Pacific bonito	1,408,070	Pacific mackerel	3,518,118
Pacific mackerel	579,533	Squid	1,068,705
Total	116,119,401		47,625,183
% of total	(64%)		(34%)

Table 3.5-2

SPORT CATCH FISH BLOCKS 739 AND 740 (NUMBER OF INDIVIDUALS)
(SLC et al., 1978)

	Fish Block 739	Anglers	Angler Hours	Fish Block 740	Anglers	Angler Hours
1964	167,582	29,641	1,062,349	11,023	18,533	641,362
1965	131,789	25,791	1,067,838	158,670	24,445	929,424
1966	98,998	19,267	731,436	201,349	37,080	1,395,104
1967	65,207	12,027	527,687	109,639	28,315	1,034,983
1968	85,801	12,502	48,614	158,851	28,240	108,715
1969	106,397	15,503	67,306	150,406	25,645	99,546
1970	119,288	18,517	73,033	102,916	21,533	72,665
1971	81,777	11,046	46,129	156,102	24,469	83,285
1972	159,071	16,541	66,767	147,843	19,146	75,597
1973	186,357	26,336	99,667	184,216	25,722	97,778
1974	149,670	19,203	62,394	191,906	19,198	72,432
1975	87,765	8,642	30,743	211,498	22,999	86,271
Total	1,439,702	215,016	3,883,963	1,886,412	295,325	4,697,162
Mean		17,918	323,663		24,610	391,430

FIVE MOST ABUNDANT TAXA

Block 739		Block 740	
Rockfish	501,315	Rockfish	806,188
Rock bass	323,426	Pacific bonito	311,410
Pacific bonito	184,777	Rock bass	198,398
California barracuda	137,390	California barracuda	116,732
Sandbass	97,713	Pacific mackerel	109,001
Total	1,244,621		1,641,729
% of total	86%		87%

Bight was 178,040 metric tons, with anchovies accounting for approximately 77 percent, or 137,268 metric tons. The commercial fish catch data from the Beta Unit EIR (SLC et al., 1978) is presented in Table 3.5-1.

More recent data has been provided by the California Department of Fish and Game data processing group in Long Beach (Eric Knagg, personal communication). Complete fisheries data is available to 1977 and for 1981. The 1977 and 1981 data are presented in Table 3.5-3 for fish blocks 739, 740, 759 and 760.

Commercial fishing in the general vicinity of the proposed platform is limited. The primary commercial fishery is a purse seine fishery for anchovy and Pacific mackerel. Purse seining is generally a night time activity and occurs in the vicinity of the proposed platform during the spring (Mr. Bozanich, personal communication). The catch data supports this as a moderate fishery, with 5-10 percent of the total Pacific mackeral catch being taken in the San Pedro Channel especially at depths to 300 feet.

The other fishery is a drift gill net fishery for shark and swordfish. Mr. Bedford (California Department of Fish and Game, personal communication) stated that little activity of that type occurred in the project area. The majority of the active gill netting action was in the Santa Barbara Channel and west of Santa Catalina.

3.5.2 Shipping

Marine navigation in the vicinity of the project is regulated by the Gulf of Santa Catalina Traffic Separation Scheme. Traffic Separation Schemes (TSSs) have been developed by the Inter-Governmental Maritime Consultative Organization (IMCO) to improve the safety of marine navigation in areas of coverging traffic. The Gulf of Santa Catalina TSS was developed to regulate the vicinity of Long Beach Harbor.

Traffic Separation Schemes are comprised of opposing lanes of marine traffic. The lanes are separated by a separation zone, and two buffer zones running parallel to each other. Temporary structures may be located in the separation or buffer zones but not in the traffic lanes. Permanent structures may be located only within the separation zone.

Like Platforms Ellen and Elly, Platform Eureka would be located within the Gulf of Santa Catalina TSS separation zone as shown on Figures 3.5-2 and 3.5-3. The platform would be situated 1/2 mile (0.8 km) west of the northbound traffic lane and 1.8 miles (2.9 km) east of the southbound traffic lane.

The Eleventh Coast Guard District Marine Safety Office conducted a survey of commercial traffic generated by the Ports of Long Beach and Los Angeles. The

Table 3.5-3

COMMERCIAL FISH CATCH, 1977 AND 1981
(Blocks 739, 740, 759 and 760)

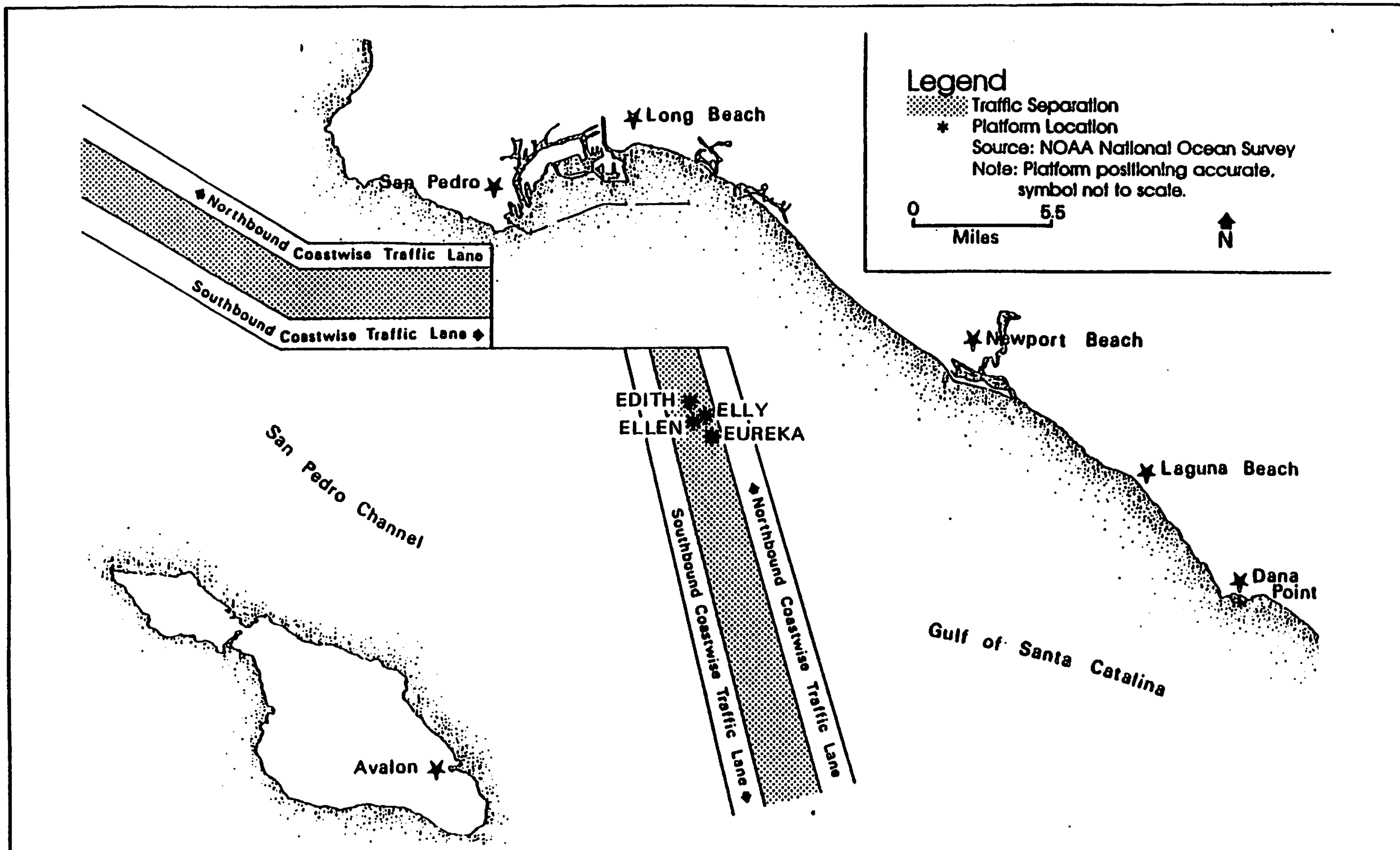
Common Name	ID #	Fish Block 739 1977	739 1981	740 1977	740 1981	759 1977	759 1981	760 1977	760 1981
Abalone, green	(703)	--	--	--	--	—	25	504	50
Abalone, pink	(704)	--	--	--	--	—	52	—	25
Abalone, red	(702)	--	--	--	—	—	—	—	94
Anchovy, Pacific	(110)	4,594,600	1,592,397	13,802,160	2,397,500	7,616,000	1,832,000	2,584,500	456,000
Barracuda, California	(130)	1,906	7,272	3,383	160	12,240	25	20	—
Bass, giant sea	(280)	—	—	—	13	—	—	—	15
Bonito, Pacific	(3)	21,712	16,069	83,226	17,785	68,988	7,556	5	307,570
Butterfish, Pacific	(80)	727	740	623	—	1,002	—	—	4,155
Crab, King	(804)	--	—	—	—	45	—	—	--
Crab, Rock	(801)	101,749	11,342	—	52	202	—	—	60
Crab, Spider	(803)	43	—	—	—	—	—	—	--
Croaker, white	(435)	1,518	13,227	8,658	512	—	—	150	10
Fish, unspec.	(999)	37	—	—	110	—	—	—	238
Flying fish	(445)	—	4,258	—	—	—	—	—	--
Halfmoon	(478)	—	—	—	--	—	—	--	16
Halibut, California	(222)	61	1,995	4,155	492	193	509	—	5,105
Lingcod	(195)	--	—	40	9	—	—	—	—
Lobster, California Spiny	(820)	1,061	9	287	—	—	—	—	216
Mackeral, Jack	(55)	2,743,635	303,116	9,506,539	1,145,525	679,440	296,874	1,334,263	410,255
Mackeral, Pacific	(51)	98,202	1,073,134	1,201,340	3,340,537	40,956	172,691	25,456	646,715
Mackeral, unspec.	(50)	—	--	--	55	—	8,300	—	—
Opah	(467)	—	—	—	—	—	—	—	517
Opaleye	(475)	—	—	—	—	—	—	14	—
Rockfish, bocaccio	(253)	—	—	772	—	652	138	—	400
Rockfish, cowcod	(254)	—	—	482	—	75	—	—	—
Rockfish, unspec.	(250)	61	647	2,448	3,651	4,733	2,140	255	4,848
Rockfish, vermillion	(249)	—	—	—	—	51	—	—	—
Rockfish, yelloweye	(265)	—	—	—	—	--	828	—	291
Sablefish	(190)	—	—	—	10	—	—	—	—
Sanddab	(225)	—	—	--	—	—	—	--	375
Sardine, Pacific	(100)	—	1,896	—	681	—	—	—	454
Scorpionfish, spotted	(260)	823	628	245	17,025	20	—	—	95
Seabass, white	(400)	1,687	76	2,739	147	937	—	77	22
Shark, blue	(167)	—	—	—	213	45,096	—	3,160	33,359
Shark, bonito	(151)	—	394	—	298	672	2,072	—	7,234

Table 3.5-3

COMMERCIAL FISH CATCH, 1977 AND 1981
(Blocks 739, 740, 759 and 760)
(Continued)

Common Name	ID #	Fish Block 739 1977	739 1981	740 1977	740 1981	759 1977	759 1981	760 1977	760 1981
Shark, common thresher	(155)	2,224	—	82	1,659	27,136	2,372	301	36,671
Shark, leopard	(153)	—	—	32	—	—	—	36	18
Shark, Pacific angel	(165)	—	—	--	--	—	—	—	4,507
Shark, spiny dogfish	(152)	—	—	3,536	2	—	—	--	—
Shark, soupfin	(159)	—	18	33	92	411	312	100	335
Shark, unspec.	(150)	1,906	739	3,012	65	14,515	365	4,396	3,503
Sheephead	(145)	—	12	37	26	—	—	—	60
Silversides	(189)	—	—	2,000	—	—	—	—	—
Skate, unspec.	(175)	—	180	—	—	—	—	—	—
Smelt, true	(180)	—	205	—	—	—	—	—	—
Smelt, whitebait	(185)	—	635	—	—	—	—	—	—
Snail, sea	(732)	5,298	—	—	—	—	—	—	—
Sole, English	(206)	—	—	20	—	—	—	—	—
Sole, unspec.	(200)	10	—	7	—	—	—	—	—
Squid, market	(711)	90,350	817,500	969,575	46,500	48,950	—	1,725,100	4,747,200
Surfperch, black	(552)	—	—	—	3,790	—	—	—	—
Surfperch, unspec.	(550)	350	—	—	40	—	—	—	—
Swordfish	(91)	519	669	98	594	3,185	10,518	13,261	59,569
Tuna, albacore	(5)	—	—	—	—	—	—	—	1,286
Tuna, bluefin	(4)	—	—	—	4,137	415	262	18	—
Tuna, yellowfin	(1)	—	—	—	—	—	1,035	—	—
Urchin, sea	(752)	—	—	940	2,170	—	—	—	1,075
Yellowtail	(40)	148	—	575	—	388	-	149	—

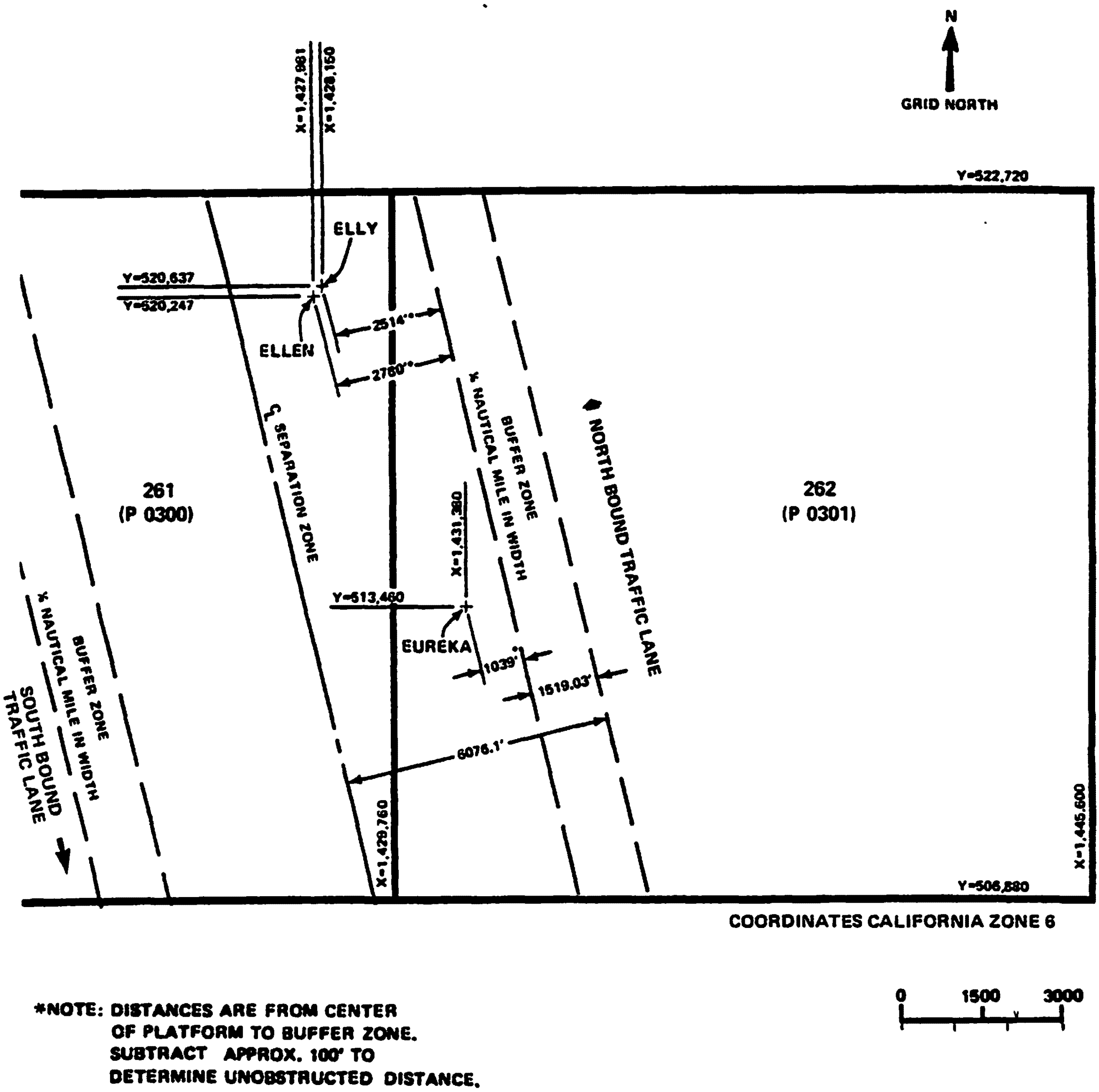
Data from Fisheries Statistics Section, California Department of Fish and Game.



SOURCE: SLC etal., 1978

Traffic Separation Schemes

FIGURE 3.5-2



Location of Beta Unit Platforms/Traffic Separation Scheme

FIGURE 3.5-3

survey found that 27 percent of outbound and 35 percent of inbound traffic utilize the Gulf of Santa Catalina (SLC et al., 1978). Therefore, based on the present average of 18 outbound and 18 inbound ships per day (Onstad, 1984), an average of 4.9 southbound and 6.3 northbound ships utilize the Gulf of Santa Catalina on any given day.

Ships navigating within the Gulf of Santa Catalina are normally headed to or from the Ports of Long Beach and Los Angeles, San Diego, Mexico or the Panama Canal. Ships traveling to and from such other locations as the Orient do not generally enter the Gulf of Santa Catalina.

Other factors affect marine safety in the vicinity of the platform site. These factors are thoroughly discussed in Section 3.6.3.3 of the Shell OCS Unit Development EIR/EA (SLC et al., 1978). These factors include the location of the Long Beach Electronics Test Area, the location of lighted buoys and fixed navigation aids, and the availability of Loran A-C radio coverage.

3.5.3 Recreation

The recreational resources of the Long Beach area represent an important component of the Southern California environment and economy. From Long Beach south to the San Diego County line there are over 42 miles (67 km) of shoreline which support numerous offshore and onshore recreational activities. The principal offshore activities are sportfishing and recreational boating. Onshore recreational activities center primarily around public beaches.

3.5.3.1 Offshore Recreation

Due to its mild weather, proximity to the ocean and substantial population, the State of California supports one of the largest recreational boating fleets in the world. Los Angeles and Orange Counties contain roughly 30 percent or 130,000 of the State's registered pleasure boats; 18,000 of which are located in the Long Beach to San Clemente region. As of November 1981, Newport Bay had the largest number of public and private berthings in this region (6491), followed by the Long Beach Harbor/ Alamitos Bay area (5796), Huntington Harbour (2656), Dana Point (2450), and Anaheim Bay (548). Four thousand additional berths were proposed for development in these areas in 1981. Accurate records are not available for the number of recreational boat users in the vicinity of the proposed platform.

Sportfishing is a major recreational activity in the San Pedro Basin. The sport fishing catch for Blocks 739 and 740 was dominated by five species: rockfish (Sebastes sp.), rock bass (Paralabrax sp.), Pacific bonito (Sarda chiliensis), Pacific mackerel (Scomber japonicus), and California barracuda (Sphyraena argentea).

Together, they accounted for over 85 percent of the total sport fishing catch (Table 3.5-2).

The major area of sportfishing is the northeast corner of Block 740 near Horsehose Kelp. This shallow, rocky, kelpbed is a major attraction for party boats from Long Beach, San Pedro and Huntington Beach. The majority of the designated sportfishing catch comes from this area. Other sportfishing areas include the fishing barges off Seal Beach, ocean piers and warm water outfalls from power plants (Figure 3.5-4).

Significant sportfish include yellowtail (Seriola dorsalis), albacore (Thunnus alalunga) and California halibut (Paralichthys californicus). Yellowtail and albacore generally are caught offshore, although the recent thermal incursion has brought them in closer to shore for the past year. Sportfishing areas and species taken are shown in Figure 3.5-4 (Gusey, 1982).

3.5.3.2 Onshore Recreation

The majority of onshore recreational activities in the vicinity of Long Beach center around public and private beaches. A listing of the visitorship of 12 major public beaches in the area is provided in Table 3.5-4. Over 44 million visitors patronized these major beaches in 1981, primarily during the months of May-September. A substantial number of these visitors travelled to these beaches from inland areas, thereby contributing to the tourist industry of the coastal region.

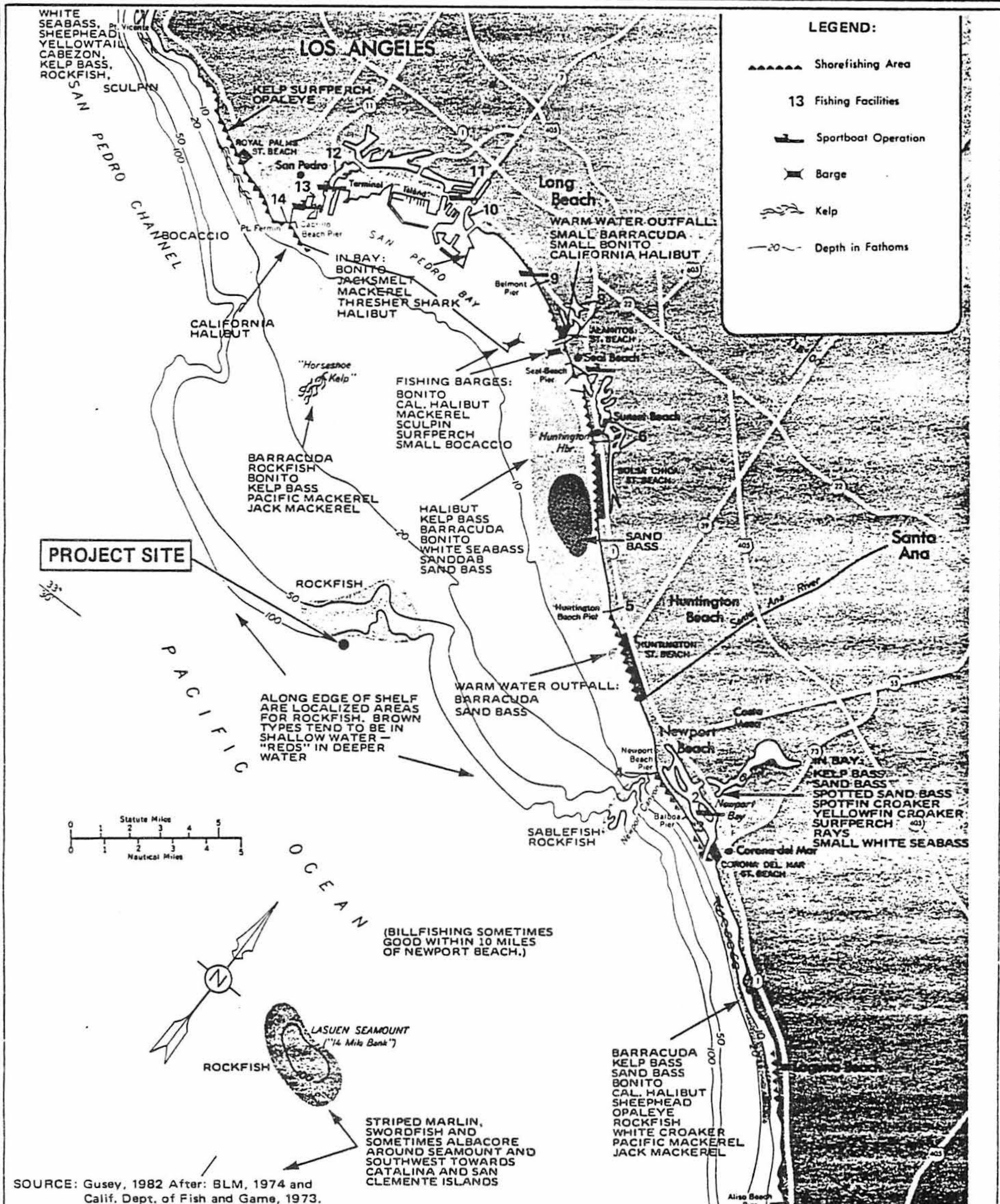
3.5.4 Kelp Harvesting

All significant kelp beds in California are under the jurisdiction of the California Department of Fish and Game. Each bed is numbered and a map of the southern California beds is shown in Figure 3.5-5.

The project site (Platform Eureka) and the proposed pipeline route from Platform Elly to Platform Eureka are in a water depth greater than 60 m and no kelp esources are within that corridor. The nearest designated kelp bed areas are Beds 10, 11, and 12. A recent discussion with Kelco (D. Glantz, personal communication) provided background information on these beds. At the present time no significant kelp resources are in these bed areas. This appears to be the result of the recent thermal incursion and long-term water quality problems. No harvesting activities have been carried out in these areas for several years.

3.5.5 Existing Pipelines and Cables

There are no pipelines or cables on or in the immediate vicinity of the project site other than those associated with the Beta Unit. These were depicted in Figure 2.2-1.



SOURCE: Gusey, 1982 After: BLM, 1974 and Calif. Dept. of Fish and Game, 1973.

Sportfishing in the San Pedro Area

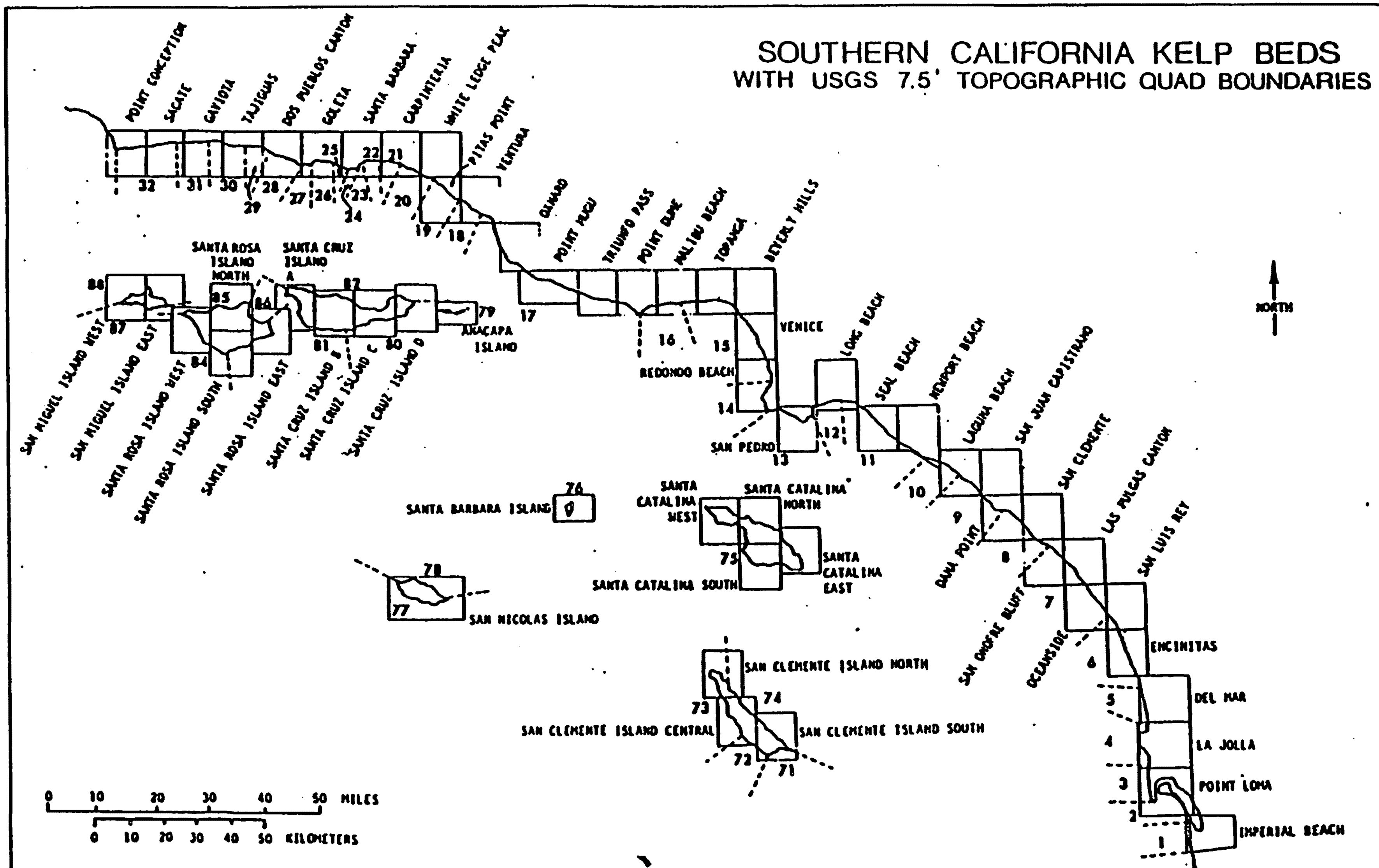
FIGURE 3.5-4

Table 3.5-4

ESTIMATED NUMBER OF ANNUAL VISITORS TO MAJOR PUBLIC BEACHES IN 1981

Beach	Visitors
Long Beach	12,000,000
Seal Beach	1,283,700
Sunset Beach	893,000
Bolsa Chica State Beach	4,400,300
Huntington Beach-City	4,522,500
Huntington State Beach	2,529,600
Newport Beach, including Corona Del Mar State Beach	11,500,000
Crystal Cove State Beach (Irvine Properties)	500,000
Laguna Beach	3,097,000
Doheny State Beach	731,100
San Clemente-City	2,500,000
San Clemente State Beach	625,800
TOTAL	44,583,000

Source: Dorsey, 1982; Gentib, 1982; Jacobsen, 1982; Klosterman, 1982; Moore, 1982; Norton, 1982; Terry, 1982.



Southern California Shore Line Map Showing the Numbers and Locations of the Kelp Beds Including the USGS 7.5' Topographic Map Names and Boundaries

FIGURE 3.5-5

WESTEC Services, Inc.

3.5.6 Other Mineral Resources

There are no other mineral resources in the vicinity of proposed Platform Eureka known to be commercially extractable.

3.5.7 Ocean Dumping

At the present time the Corps of Engineers and the Environmental Protection Agency have one authorized disposal site in the general area of the project site. This is LA2 located at 33°37'06"N, 118°17'24"W. It is located in a sloping shelf area approximately 11 nautical miles northwest of the platform location. A prohibited dumping area is located 5.5 miles northwest of Platforms Ellen and Elly and 6.5 miles northwest of Platform Eureka at the north end of the San Pedro ship channel separation zone. In addition, EPA has recently (December 8, 1983 Federal Register) proposed to designate a disposal site for drilling muds and cuttings from the four islands in Long Beach Harbor of THUMS Long Beach Company. The proposed location is about 17 nautical miles west of Platforms Ellen and Elly at 33°34'30"N, 118°27'30"W.

3.5.8 Military Use

Due to the location of the proposed platform within the separation zone for marine traffic the project vicinity is not within a military use area.

3.5.9 Cultural Resources

A cultural resource assessment has been completed covering the proposed Beta intrafield pipeline route, Eureka Platform site and adjacent areas which could be affected by project construction or operation activities ($MESA^2$, 1984c). The assessment has been prepared pursuant to Executive Order No. 11593, Protection and Enhancement of the Cultural Environment dated May 13, 1971, which directs that necessary measures be taken to preserve all Federally-owned sites, structures, and objects of historical, architectural or archaeological significance. Requirements of the executive order (further defined by United States Minerals Management Service, NTL 77-3, March 1, 1977) stipulate that the Oil and Gas Supervisor determine whether the project area would include sites or objects of possible cultural significance and notify lessees of the need to conduct a cultural resource investigation via a high resolution geophysical survey. Because the project area is in the vicinity of shipping lanes and at least two shipwrecks have been recorded near the platform site, a geophysical survey has been conducted.

A number of features of possible cultural origin were found in the survey area, and are believed to be primarily debris from recent oil exploration and production activities or modern maritime operations. One feature of undertermined significance (referenced as Feature A in the cultural resource report and identified by side-scan sonar) exists approximately 5000 feet (1524 m) southerly of the Platform Eureka site in a water depth of 825 feet (251 m) (see location on Figure 3.1-6). This feature consists of five major linear and possibly cylindrical elements, each a maximum of 135 feet (41 m) in length and over 7 feet (2.1 m) high.

3.6 MARINE BIOLOGY

3.6.1 Intertidal Community

Intertidal organisms must contend with a rigorous and changing environment which often limits their distribution to distinct zones. Physical factors (temperature, salinity, humidity, wave shock, etc.) must be tolerated as well as the effects of inter-specific competition and predation. Despite the relative harshness of the environment, intertidal communities tend to be stable in time and space.

Five recent studies have been completed on intertidal marine communities in the vicinity of the Shell Beta project. These studies have reported on the biological communities present on rocky, sandy, or muddy substrates.

Long Beach Harbor Consultants (1976) sampled nine intertidal stations located either within or outside Long Beach Harbor (Table 3.6-1). A total of 55 species represented by 96,168 individuals were enumerated in the quantitative portion of the study. The greatest mean number of species was present at outer breakwater of San Pedro Harbor in contrast to the harbor shoreline stations where the mean number of species was much lower. The mean number of species was also shown to decrease with distance above Mean Lower Low Water (MLLW). The mean number of individuals showed the same relationship to height above MLLW, decreasing from a high of 37 individuals at 1 foot (0.3 m) above MLLW to 5 individuals at 5 feet (1.5 m) above MLLW.

Fourteen dominant species were identified in the study and their mean abundance at each station also noted. Three barnacle taxa Chthamalus ssp., Balanus glandula, Tetraclita squamosa rubescens) were among the top four taxa in abundance. Chthamalus ssp. was the single most abundant species when considering all stations and all levels above MLLW. The sea anemone, Anthopleura elegantissima, was the second most abundant species overall.

Straughan and Patterson (1975) and Straughan (1975) conducted studies of sandy beaches at Inner Cabrillo Beach, Outer Cabrillo Beach, and Long Beach. They found that Inner Cabrillo was the richest in species (22) and numbers of individuals (920). Outer Cabrillo contributed fewer species (16) and fewer (248) individuals. The Long Beach sampling station was particularly depauperate, contributing only 9 species and 40 individuals.

Table 3.6-1

FOURTEEN DOMINANT SPECIES AND THEIR RELATIVE ABUNDANCE AMONG STATIONS AND LEVELS
(From Long Beach Harbor Consultants, 1976)

Rank	Scientific Name	Station 11A	13A	23	22A	22B	57A	57B	65A	65B
1	*Chthamalus* spp.	15.8	48.8	61.6	43.6	41.8	6.4	49.0	45.2	21.6
2	*Anthopleura elegantissima*	11.4	7.6	0.0	34.2	27.4	83.6	54.4	42.6	44.4
3	*Balanus glandula*	62.8	22.4	24.2	11.2	28.4	1.0	10.2	0.4	7.6
4	*Tetraclita squamosa rubescens*	0.8	5.2	39.6	6.6	11.2	11.6	18.2	44.2	12.4
5	Phaeophyta, unid.	0.0	5.2	30.6	6.2	0.2	35.0	0.8	69.8	5.2
6	*Ulva* sp.	42.8	0.0	0.0	4.0	6.8	8.6	4.8	0.4	6.2
7	Chlorophyta, unid.	0.0	0.0	34.2	9.4	1.2	0.0	0.0	26.2	0.2
8	*Corallina* sp.	0.0	2.0	0.2	8.4	10.0	16.6	2.0	2.2	24.4
9	*Collisella scabra*	1.8	7.6	5.0	9.4	5.6	1.2	6.4	5.8	7.4
10	*Prionitis lanceolata*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0
11	*Collisella digitalis*	6.0	0.2	2.8	0.4	6.2	0.0	2.2	0.0	2.6
12	*Rhodoglossum affine*	0.0	0.0	0.0	1.8	10.8	1.2	3.0	0.0	1.6
13	*Mytilus edulis*	10.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	5.8
14	*Pisaster ochraceus*	0.0	0.0	1.2	0.2	0.4	0.2	1.0	0.8	2.0

Rank	Scientific Name	Level 1	2	3	4	5	Grand Mean
1	*Chthamalus* spp.	15.77	23.88	41.55	70.00	34.22	37.08
2	*Anthopleura elegantissima*	61.33	54.44	33.22	4.11	0.00	30.62
3	*Balanus glandula*	5.88	13.11	42.66	30.33	1.44	18.68
4	*Tetraclita squamosa rubescens*	28.77	32.11	14.66	6.11	1.55	16.64
5	Phaeophyta, unid.	40.88	28.44	6.66	5.33	0.77	16.41
6	*Ulva* sp.	15.00	13.77	12.00	0.10	0.00	8.17
7	Chlorophyta, unid.	23.55	2.44	12.00	0.00	1.55	7.90
8	*Corallina* sp.	24.66	10.66	1.22	0.00	0.00	7.31
9	*Collisella scabra*	3.00	7.55	9.00	5.88	2.44	5.57
10	*Prionitis lanceolata*	21.11	0.00	0.00	0.00	0.00	4.22
11	*Collisella digitalis*	0.00	0.55	4.88	4.55	1.33	2.26
12	*Rhodoglossum affine*	8.33	1.66	0.22	0.00	0.00	2.04
13	*Mytilus edulis*	9.00	0.10	0.10	0.00	0.00	4.84
14	*Pisaster ochraceus*	1.33	1.88	0.00	0.00	0.00	0.64

During the sampling period from March 1973 to July 1974 (Straughan, 1975), the sand crab, Emerita analoga, was the numerical dominant of the sampled fauna at Outer Cabrillo. It was collected during all 9 samples and ranged from a low of 2 individuals in September 1973 to a high of 60 individuals in May 1973. Besides Emerita analoga, only the polychaete, Nephtys ferruginea, and the spiny sand crab, Blepharipeda occidehtalis, were present in more than half the samples.

Inner Cabrillo samples contained 19 polychaete species, 5 crustacean species, and 1 molluscan species (Straughan, 1975). The polychaetes, Magelona pitelkai, Nerinides acuta, and Dispio sp., and the snail, Olivella biplicata, were the four most abundant species in the combined sampling period.

Long Beach samples yielded six polychaete species, two crustaceans, and one molluscan species (Straughan, 1975). Abundances were very low for virtually all species during every sampling period. The polychaete, Nerinides acuta, contributed eight specimens in the July 1973 sample, a high for any sampling period.

All three beaches revealed very little invertebrate fauna in the upper intertidal and supra-intertidal areas (Straughan and Patterson, 1975). The authors suggested that frequent beach maintenance activities may have accounted for the depauperate condition of the fauna.

Intertidal surveys of the oil islands (Grissom, White, Chaffee, and Freeman) were conducted for the Downtown Marina Environmental Impact Report (Southern California Ocean Studies Consortium, 1977). A list of all taxa identified in these surveys is included in Vol III, Beta Unit (SLC et al., 1978).

The barnacles, Chthamalus fissus and Balanus glandula, were numerically dominant in the high and middle intertidal zones. Pachygrapsus crassipes, the shore crab, was abundant at all stations in the middle intertidal. Low intertidal stations yielded more species and greater abundances for many species than the middle or high intertidal zones. Abundant groups or species in this zone were the sea anemone, Anthopleura elegantissima, nemertaens, nematodes, and polychaetes (especially Capitella capitata, Eupomatus gracilis, Polydora limicola, Tharyx ssp., and Typosyllis fasciata). Barnacles remained abundant although in smaller numbers than in the middle and upper tidal zones. Such crustaceans as the isopod, Ianiropsis tridens, the amphipod, Elasmopus rapax, and the shore crab, P. crassipes, were abundant. The limpets, Collisella digitalis and C. scabra, the mussel, Mytilus edulis, the sea urchin, Strongylocentrotus purpuratus, and the sea star, Pisaster ochraceous, were common or abundant in most samples. The marine algae were plentifully represented by Ulva sp., Egregia sp., Gelidium sp., and Gigartina sp. in the low intertidal.

Ten intertidal stations within Long Beach Harbor were sampled (Environmental Quality Analysts and Marine Biological Consultants, Inc., 1977) at quarterly intervals from February 1974 to November 1976. The intertidal was sampled from MLLW to +4 feet (1.2 m). During the sampling period, almost 116,000 organisms representing 95 taxa were analyzed and evaluated. Mean density of the intertidal community showed a general increase from Inner to Outer Harbor. Highest values for mean densities were recorded at +1 and +2 tidal levels. Table 3.6-2 shows the species abundance data for the EQA-MBC study based upon seasonal measurements.

3.6.2 Biofouling Community

The biofouling community is the marine counterpart of terrestrial weeds, which are plants growing where they are not desired. Fouling organisms are those plants and animals which are normally attached to rock or other natural substratum, but which can also colonize man-made substrates as well. The presence of structures such as docks, pilings, and floats increases the available habitat for the biofouling community. The composition of the community is dependent upon the ability of individual species to successfully compete for space, light, and other limiting factors (Connell, 1972; Dayton, 1975).

In comparison to harbor areas, offshore platform structure are exposed to different physical, chemical, and biological conditions; consequently, the animals adapting to these factors are different and the composition of offshore biofouling communites differs significantly from inshore harbor areas. Offshore structures promote communities resembling those of rocky shores, attracting suspension feeders, herbivores, carnivores, and other feeding types that require a hard substrate for attachment or crevices for refuge, e.g., *Mytilus californianus* communities (Kanter, 1977, 1978).

Two distinct biofouling communities are associated with offshore structures. One is a littoral community existing near and at the surface of the support structures; the other is a sub-tidal community that is associated with the foundations of the structure (SCCWRP, 1976).

The littoral biofouling communities found on the pilings of offshore structures resemble those of rocky intertidal habitats, where species such as *Mytilus californianus* prevail over *M. edulis*. Other genera common to this habitat include *Hiatella*, *Caprella*, *Balanus*, and *Styela* (Kanter, 1977).

The subtidal biofouling communities resemble those of rocky shore subtidal communites and support several species of *Pisaster*, *Stronglocentrotus*, *Anthopleura*,

Table 3.6-2

TEN MOST ABUNDANT SPECIES IN 1976 WITH QUARTERLY MEAN DENSITY PER REPLICATE
(From Environmental Quality Analysis, Inc. and Marine Biological Consultants, Inc., 1977)

Rank	Species	Mean Number/ Replicate	Species	Mean Number/ Replicate
	February		May	
1	Balanus glandula	6.03	Balanus glandula	6.43
2	Chlorophyta, unid.	3.16	Mytilus edulis	3.31
3	Mytilus edulis	2.77	Chthamalus sp..	3.20
4	Ulva sp.	2.12	Gelidium pusillum	1.80
5	Chthamalus sp.	2.07	Chlorophyta, unid.	1.58
6	Balanus amphitrite	1.92	Balanus amphitrite	1.34
7	Gelidium pusillum	1.88	Ulva spp.	1.19
8	Cladophora sp.	0.55	Enteromorpha sp.	1.04
9	Tetraclita squamosa rubescens	0.54	Cladophora sp.	0.91
10	Collisella scabra	0.45	Ectocarpus sp.	0.55
	August		November	
1	Balanus glandula	4.65	Mytilus edulis	4.21
2	Mytilus edulis	3.15	Balanus glandula	3.06
3	Gelidium pusillum	2.45	Chthamalus sp.	1.96
4	Chthamalus spp.	2.09	Gelidium pusillum	1.67
5	Spirorbinae, unid.	1.78	Enteromorpha sp.	1.05
6	Balanus amphitrite	0.83	Chlorophyta, unid.	0.84
7	Phaeophyta, unid.	0.66	Balanus amphitrite	0.60
8	Cladophora sp.	0.45	Collisella scabra	0.41
9	Tetraclita squamosa rubescens	0.43	Holoporella brunnea	0.35
10	Ulva spp.	0.42	Spirorbinae, unid.	0.33

and several tubicolous polychaetes (U.S. Corps of Engineers, 1976). Table 3.6-3 contains a list of representative species populating littoral and subtidal offshore biofouling communities.

Turner (1969) and later SCCWRP (1976) both confirmed an increase in diversity and numbers of pelagic and demersal fishes near offshore structures and other artificial reefs as well as an overall increase in productivity of the areas which was attributed to successful formation and growth of biofouling communities associated with these areas.

3.6.3 Benthic Community

Several comprehensive studies (Hartman, 1955 and 1966; Jones, 1969; Science Applications, Inc., 1978) have described the species composition and faunal communites of the Southern California borderland. The San Pedro Shelf, including Los Angeles and Long Beach Harbors, was the site of sampling stations for the Hartman (1955 and 1966), Jones (1969), Long Beach Harbor Consultants (1976) and SAI Benchmark reports (SAI, 1978). Hartman (1955 and 1966) and Jones (1969) investigated samples taken during the 1950s and early 1960s in the proximity of the Shell Beta Platform site or near the proposed pipeline connecting it to the mainland. Recent and relevant work was reported in the benthic macrofaunal section of the Southern California Baseline Study Final Report (SAI, 1978) where a High Density Sampling Area (HDSA) offshore of Huntington Beach, Newport Beach, and Laguna Beach is noted (Station 825, at 237 m in depth).

The San Pedro Shelf is in an area of considerable sedimentary, hydrographic, and physiographic complexity. This physical heterogeneity has given rise to high faunal diversities, complex distributional patterns, and a variety of community assemblages.

Hartman (1955 and 1966) analyzed samples from 267 stations located at 2-mile (3.2 km) intervals on a grid covering the San Pedro Channel region. These samples were obtained by means of an orange peel grab sampler or by a Campbell grab. She noted that faunal diversity was so high in the San Pedro Channnel region that large scale faunal communities could not be identified. She found that the number of species and species abundance was highest in nearshore shelf regions such as the San Pedro Shelf, and that the fewest species and numbers of individuals were sampled in deep basins offshore. Progressive replacement by different species of the same genus with depth was noted. As expected, biomass was typically higher in the shallower stations.

Hartman (1966) described the San Pedro Shelf as a diversified and complex fauna, changing from one location to the next, based upon sediments, locations, and

Table 3.6-3

REPRESENTATIVE ORGANISMS OF
OFFSHORE BIOFOULING COMMUNITIES

Littoral Communities

Sea Anemones
- *Anthopleura elegantissima*
- *Corynactis californica*
- *Metridium senile*

Tube anemones
- *Ceriantharia* sp.

Gorgonians
- *Lophogorgia chilensis*
- *Muricea* sp.

Sea pens
- *Acanthoptilum* sp.
- *Stylatula elongata*

Mussels
- *Mytilus californicus*

Subtidal Communities

Starfishes
- *Astropectin verrilli*
- *Luidia foliolata*
- *Patiria miniata*
- *Pisaster giganteus*
- *P. ochraceus*

Sea urchins
- *Strongylocentrotus franciscanus*
- *S. purpuratus*

Source: Wolfson et al. (1979)

other physical factors. She found that most species had distinct depth preferences and some species tended to aggregate in predictable community assemblages.

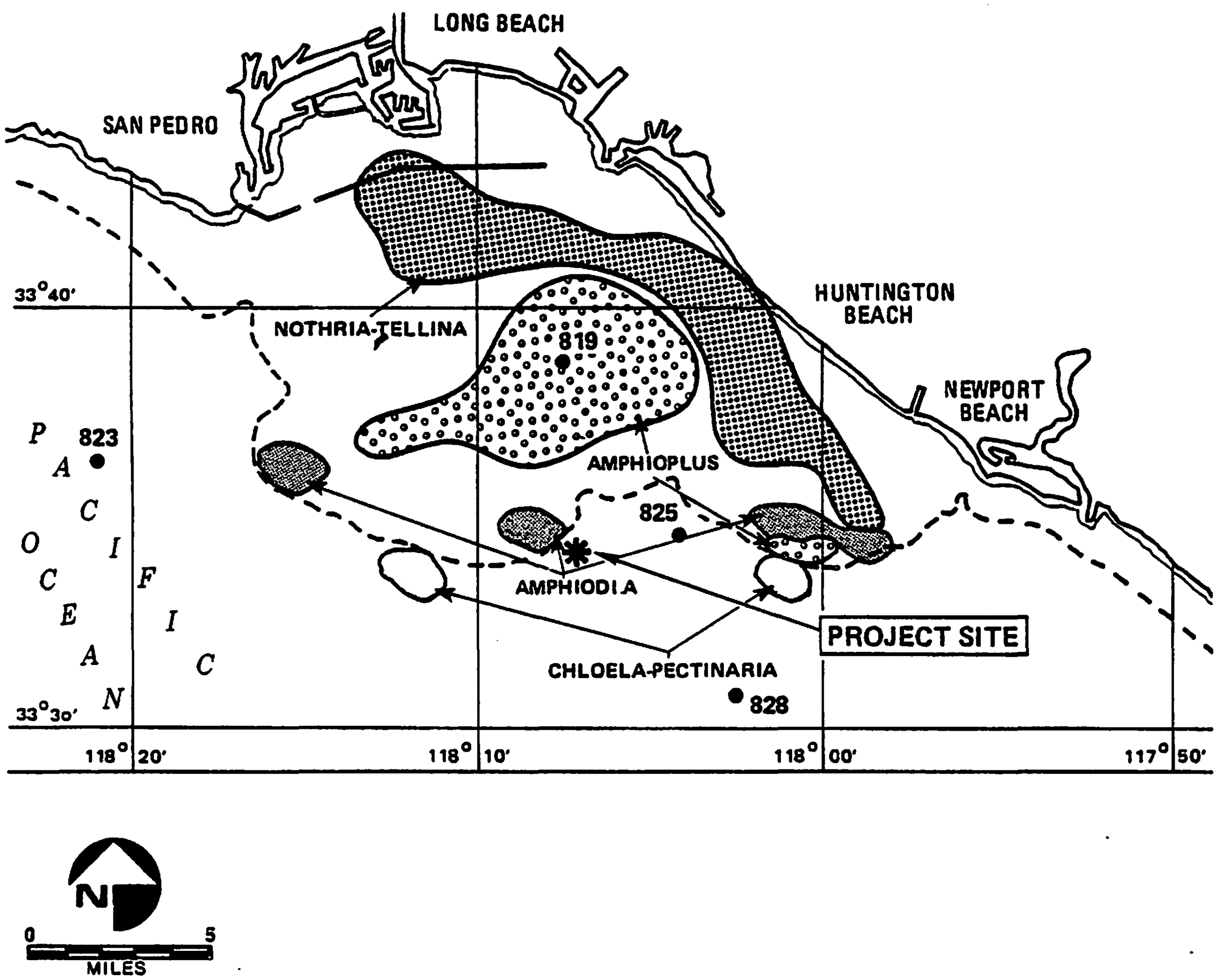
Jones (1969) analyzed some of the same stations on the San Pedro Shelf sampled by Hartman. His principal objective was to characterize faunal assemblages along the Southern California mainland shelf. In his analysis, he made use of (1) a subjective approach in examining the data and (2) a computer program which determined the number of occurrences of a given species and the number of joint occurrences of different species. The program computed an index of affinity for each species pair, offering a method of grouping species into possible faunal assemblages.

Subjective mapping of benthic macrofaunal assemblages for the San Pedro Shelf is given in Figure 3.6-1. Jones named each assemblage for its numerically dominant species or co-dominant species. One such dominant is the ophiuroid, *Amphiodia urtica*, which was characterized by Barnard and Ziesenhenne (1961) as the most abundant and widely distributed species on the coastal shelves of Southern California. On the San Pedro Shelf, three patches of the *Amphiodia* association were mapped (Figure 3.6-1) by Jones (1969), each located along the 50 fathom (91.5 m) isobath. One patch was located near the San Gabriel Submarine Canyon at the site of Platforms Elly and Ellen.

Three other faunal association occur on the San Pedro Shelf (*Chloeia-Pectinaria*, *Nothria-Tellina*, and *Amphioplus*). The most prominent inshore association is the *Nothria-Tellina* association, made up of species in the polychaete genus, *Nothria*, and the pelecypod genus, *Tellina*. This association is present for approximately 16 miles (25.8 km) from the Long Beach Harbor breakwater to a point west of the Newport Beach Marine Canyon. The oil pipeline will cross approximately 2 miles (3.2 km) of this association.

The *Amphioplus* association (Figure 3.6-1) is the second most prominent association on the San Pedro Shelf. It is located seaward of the *Nothria-Tellina* association and concentrated in the area of the proposed pipeline. Approximately 7 miles (11.3 km) of seabed occupied by the *Amphioplus* association was crossed by the existing pipeline. Small concentrations of the *Chloeia-Pectinaria* association were mapped in the deeper water of the San Pedro slope in two localities. This association is characterized by the polychaetes, *Chloeia pinnata* and *Pectinaria californiensis*.

Jones (1969) also applied recurrent groups analysis to the macrofaunal benthic data. Seven species groups were enumerated (Table 3.6-4) from an analysis of species occurrence patterns, or on the basis of species population size. Jones mapped



Source: Jones, 1969; SAI, 1978

Distribution of Benthic Macrofaunal Associations in San Pedro Bay and Location of Baseline Sampling Sites

FIGURE 3.6-1

Table 3.6-4

THE RECURRENT GROUPS OF THE MAINLAND SHELF BASED ON THE ANALYSIS OF 1966 SAMPLE SET I.A. = 0.650 (From JONES, 1969)

Recurrent Group	Occurrence	Affinities	Recurrent Groups	Occurrence	Affinities
GROUP I:			GROUP II:		
Prionospio pinnata (P)	159	29	nemertean unknown (O)	150	20
Pholoe glabra	124	28	Prionospio malmgreni (P)	148	17
Amphiodia urtica (E)	153	26	Amphipholis squamata (E)	136	13
Pectinaria californiensis (P)	131	26	tanaid unknown (C)	105	13
Gnathia crenulatifrons (C)	92	18	ostracod unknown (C)	109	10
Paraonis gracilis (P)	108	15	Tharyx tesselata (P)	105	7
Axinoosida serricata (M)	92	14	Associated with Group II:		
Terebellides stroemi (P)	103	14	Ampelisca cristata (C)	89	2
Glycera capitata (P)	94	13	Glottidia albida (O)	91	2
Ampelisca brevisimulata (C)	101	13	Goniada brunnea (P)	114	7
Associated with Group I:			Haploscoloplos elongatus (P)	105	5
Aricidea suecica (P)	84	1	Laonice cirrata (P)	96	3
Axiothella rubrocincta (P)	87	1	Lumbrineris cruzensis (P)	92	3
Paraphoxus robustus (C)	73	1	Spiophanes missionensis (P)	107	7
Chloeia pinnata (P)	64	1	Sthenelanella uniformis (P)	84	2
Ampelisca cristata (C)	89	2	Nephtys sp. (P)	90	2
Glottidia albida (O)	91	2	Haliophasma geminata (C)	93	9
Goniada brunnea (P)	114	7	GROUP III:		
Haploscoloplos elongatus	105	5	Heterophoxus oculatus (C)	97	17
Laonice cirrata (P)	96	3	Paraphoxus similis (C)	76	12
Lumbrineris cruzensis (P)	92	3	Paraphoxus bicuspidatus (C)	77	6
Spiophanes missionensis (P)	107	7	Ampelisca pacifica (C)	76	12
Sthenelanella uniformis (P)	84	2	Associated with Group III:		
Nephtys sp. (P)	90	2	Haliophasma geminata (C)	93	9
Haliophasma geminata (C)	93	9	Metaphoxus frequens (C)	73	7
Metaphoxus frequens (C)	73	7	Nicippe tumida (C)	50	2
Nephtys ferruginea (P)	77	5	Nemocardium centifilosum (M)	53	1
			Eudorella A (C)	63	2
			Nephtys ferruginea (P)	77	5
			GROUP IV:		
			Cossura candida (P)	91	6
			Sternaspis fossor (P)	95	10
			GROUP V:		
			Aricidea lopezi (P)	80	3
			nematode unknown (O)	91	4
			Associated with Group V:		
			Mediomastus californiensis (P)	65	1
			GROUP VI:		
			Diastylidae unknown (C)	70	4
			Ampelisca pugetica (C)	69	6
			GROUP VII:		
			brown ostracod (C)	46	1
			rectangular ostracod (C)	34	1

the location of these designated groups on the San Pedro Shelf (Figure 3.6-1) and attempted to correlate their presence to sediment type

Along the southern California coastline, recurrent groups II and V tend to be found in shallower areas (Jones, 1969), while groups I, III, IV, and VI are generally found in deeper water. On the San Pedro Shelf, however, the typical pattern of recurrent group distribution does not apply. Groups are distributed widely across the Shelf with the exception of Groups I and III, which are located exclusively in deeper water (Figure 3.6-1).

The Allan Hancock Foundation extensively sampled the near shore benthic environment from Point Conception to the Mexican border (State Water Quality Control Board, 1965). Several sampling sites were in the vicinity of Platforms Elly and Ellen and the existing pipeline corridor. A short synopsis of two relevant stations follows:

- SWQCB 5745-58 - This station is the closest to the existing SCPI platforms of any known benthic sampling station. It is located approximately two-thirds of a mile (1 km) southwest from the platforms at a depth of 45 fathoms (82.4 m) in fine green sand. The ophiuroid, Amphiodia urtica, and the polychaete, Lumbrineris cruzensis, were numericals co-dominants with 98 individuals collected. Echinoderms represented only 9.1 percent of all specimens collected, but constituted 80 percent of the wet weight of the specimens.

- SWQCB 5746-58 - Located one and one-third miles (2.1 km) south of the platform site in 80 fathoms (146.4 m), the sample was taken in light green foraminiferan sand. The most abundant single species was Onuphis nebulosa, a polychaete worm. Polychaetes were the most numerous group, representing 52 percent of the total number of specimens. This site is near the proposed Platform Eureka site and on the proposed pipeline corridor route.

These sites and the dominate fauna are consistent with other samples taken at corresponding depth and substrate in the Southern California Bight.

Box core samples were taken along the southeastern boundary of the San Pedro Shelf as part the Bureau of Land Management's Outer Continental Shelf Survey (SAI, 1978). The benthic macrofaunal section reported the presence of shallow water, shelf, and deep water faunal associations in the High Density Sampling Areas (HDSA) selected along the southern California coast.

The shallow-water shelf fauna was characterized as an area of high population densities and species richness. The ophiuroid, Amphioda urtica, was the best indicator of this fauna, occurring in densities of between 270/m^2 in the Huntington Beach

HDSA and 770/m^2 in the Laguna Beach HDSA. It was collected at all stations except shallow sandy bottom stations unfavorable to the species. Dominant microcrustaceans were amphipods, particularly ampeliscids, phoxocephalids, and oedicerotids. The pelecypods, Axinopsida serricata, Paramya sp. A, Mysella tumida, and Parvilucina tenuisculpta, were the numerically dominant mollusks. Polychaetes were particularly well represented and very diverse. Deeper shelf stations yielded high population densities for the ice cream cone worm, Pectinaria californiensis. Other abundant infaunal components were the echiuroid Listriolobus pelodes, various phoronids, the brachiopod Gottida albida, and burrowing anemones.

Samples taken during the Southern California Baseline Study at shelf, slope and basin stations show that density and species richness decrease from the shelf to the basin. Station 825 (231 m) is near the proposed platform location and had an average density of 756 specimens per m^2 and a diversity of 23 species per sample (see Figure 3.6-1 for the locations of sampling station locations). Standing crop also decreased downslope with Station 825 having a relatively high mean value of 223 grams/m^2. Table 3.6-5 illustrates the relationship between shelf, slope and basin for these characters.

The dominant species at Station 825 was the polychaete Maldane sarsi (30 percent of total). Myriochele gracilis (5 percent), Pectinaria californieusis (4 percent) and Axinopsida serricata (4.5 percent) were the next group of dominant species. A total of 17 species made up 65 percent of the total species found at Station 825 (SAI, 1978).

Benthic associations in the project area (slope stations 825, 827) appeared to be less aggregated than the shelf stations but showed a higher level of aggregations than basin stations (generally randomly distributed).

The benthic fauna in the vicinity of the proposed platform is composed of a variety of feeding and mobility types. Ten percent were motile carnivores, 8 percent sessile filter feeders, 3 percent motile filter feeders, 3 percent sessile surface detritovores, 20 percent motile surface detritovores, 45 percent sessile subsurface detritovores, 9 percent motile subsurface detritovores, and 2 percent were motile grazers or herbivores. A total of 80 percent were detritovores with the majority of those being sessile. Maldane sarsi (a sessile subsurface detritovore) abundance levels are evidence of that fact (SAI, 1978).

The project site has a relatively rich benthic invertebrate fauna. The species represent a community dependent upon a soft bottom sediment and an abundance

Table 3.6-5

COMPARISON OF SHELF, SLOPE AND BASIN STATIONS
FOR BENTHIC INFAUNA IN THE PROJECT AREA

Station	Station #	Depth (m)	Mean Density (#/m^2)	Richness (Species/Sample)	Standing Crop (g/m^2)
Shelf	819	20	4310 (2960-5472)	82 (65-94)	173 (99-454)
Upper Slope	825	237	756	23	223 (42-445)
Lower Slope	828	539	362	14	16
Basin	823	875	92	3 (1-7)	6 (2-14)

NOTE: Where range data is available, it is presented in ( ).
Data summarized from Southern California Baseline Study (SAI, 1978).
Project site is adjacent to Station 825.

of detrital material. The moderate density and richness measurements are intermediate between the shelf and basin levels. The high level of standing crop may be indicative of an abundance of larger species feeding in a rich detrital deposition area. It is not clear from the SAI study what factors may have influenced the level of the standing crop.

3.6.4 Planktonic Community

The Southern California Bight is characterized by a diverse assemblage of oceanic phytoplankton not usually found in large numbers in any given sample. A small percentage of the Bight borders island or mainland coastline, and the phytoplankton found in these area are more numerous and less diverse than those found in the more oceanic areas. Studies by the State of California (1965) recorded 60 species of diatoms and 11 dinoflagellates in samples taken at 769 stations throughout the Bight. *Chaetoceros* was the most abundant diatom species sampled and *Prorocentrum micans* the most abundant dinoflagellate. Allen (1939) reported large differences in species composition and abundance in each of 20 years of sampling of phytoplankton in La Jolla and Point Hueneme. No 2 years were alike, although major trends were apparent. Variations in species composition may be due to temperature differences (Balech, 1960). Phytoplankton abundances expressed as displacement volumes were reported by the Southern California Coastal Water Research Project (SCCWRP, 1973). They reported displacement volumes of 1.38-1.85 ml/L at 18 stations along the coast, indicating fairly homogeneous distributions in that area. Chlorophyll *a* concentrations, an indicator of plankton biomass, ranged from 18-101 mg/m^2. The water column from the surface to 150 m was integrated below each square meter of sea surface. Slightly lower results (20-30 mg/m^2) were reported by Owen (1974) for the California Cooperative Oceanic Fishery Investigations (CalCOFI).

Fager and McGowan (1963) reported heterogeneous zooplankton assemblages in the California area. Fleminger (1967) reported over 190 species of copepods in the Southern California Bight area. Samples from CalCOFI (Thrailkill, 1969) indicated that yearly zooplankton variations were similar to those for phytoplankton.

Larval fishes are very abundant in the Southern California Bight area due to the large amount of coastline available for inshore spawning both on the mainland and around the numerous islands. The most abundant larvae is that of the northern anchovy, *Engraulis mordax* (Messersmith et al., 1969). Kramer and Ahlstrom (1968) reported abundances of *E. mordax* exceeding 10/m^3. Other important ichthyoplankton include larvae of the white croaker, the California hake, and members of the atherinid family (topsmelt, jacksmelt, and grunion).

Plankton samples taken in the existing pipeline corridor (1 mile (1.6 km) on each side of the proposed pipeline) exhibited lower abundances of phytoplankton than stations to the west (SWQCB, 1965). Concentrations of diatoms at the surface ranged from 500-5000/L (SWQCB stations 5745, 5953, 5952, 5951). Major species collected included Chaetoceros ssp. and Nitzschia sp. Other species exhibiting occasionally high abundances included Leptocylindrus danicus and Nitzschia closterium. Diatom abundances were greatest at the surface. Mean concentrations at 25 feet (7.6 m) and 50 feet (5.3 m) were similar; however, concentrations at 50 feet (15.3 m) were more variable, and often exceeded those at 25 feet (7.6 m). Concentrations of dinoflagellates were occasionally high, especially 3 miles (4.8 km) south of the entrance to Anaheim Bay, and one-fourth mile (0.4 km) from the proposed pipeline. Abundances as high as 9300/1 were recorded. The dominant dinoflagellate was Prorocentrum micans, while an unidentified euglenid displayed occasionally high values (SLC, 1978).

The method used to collect phytoplankton by SWQCB (1965) was a Nansen reversing water bottle, which was inadequate for collection of zooplankton. Ichthyoplankton eggs and larvae were also rarely captured due to their low abundances. In a study of the distribution of Engraulis mordax eggs and larvae at stations near the corridor, Kramer and Ahlstrom (1968) reported abundances commonly within the 0.1-1/m^3 (SLC, 1978).

It is not expected that significant changes in the planktonic community has occurred in the South California Bight since the Shell Beta Unit EIR was prepared (SLC et al., 1978). For additional information, the reader is referred to the plankton Section 3.5.1.3 (SLC, 1978 p. 221, Vol II).

3.6.5 Fishes

The fish communities of San Pedro Bay and the Southern California Bight in general were well discussed in the Beta Unit EIR (SLC et al., 1978). The primary data base for that review were the Southern California Coastal Water Research Project document (SCCWRP, 1973) and the Southern California Ocean Studies Consortium Report (SCOSC, 1974). The first is a report on a 3-year investigation into the ecology of the Southern California Bight by the Southern California Coastal Water Research Project (SCCWRP, 1973), in which the emphasis was on the shallow-water demersal fishes of the mainland and island shelves. The second is a literature review by the Southern California Ocean Studies Consortium (SCOSC, 1974), which presents a summary of knowledge of the southern California coastal zone and offshore areas. The chapter on fishes summarizes the information compiled by SCCWRP (1973) on the shallow-water fish populations, and presents a discussion of knowledge of fishes from deep-sea basins in a comparable format. It includes a section on pelagic fishes, and an updating of the SCCWRP report on fish abnormalities and environmental stresses.

3.6.5.1 Faunal Association

Convergence of North Pacific Central Water with Pacific Subarctic Water and Equatorial Pacific Water endows the waters offshore of southern California with the characteristics of a transitional zone between northern cold-temperature waters and southern warm-temperature, sub-tropical waters (Lavenberg and Ebeling, 1967). Consequent latitudinal temperature gradients are reflected in the distribution of the fish fauna of the eastern Pacific, which SCCWRP (1973) categorized into three major faunal groups according to temperature regions. They are the cold water fauna of the Alaskan-Vancouveran Regions, the temperate fauna of the Californian Region, and the tropical fauna of the Panamic Region. Because of varying degrees of affinity with faunas to the north and south, the Californian Region can be further divided in Montereyan and San Diegan subregions. The fish fauna of the San Pedro Channel which is a major concern to the SCPI Beta project, belong to the warm water, temperate fauna of the San Diegan subdivision of the California Region.

3.6.5.2 Species Distribution and Regional Abundance

Horn (1974) stated that 87 percent (481) of the 554 species of marine fishes reported by Miller and Lea (1972) to occur along the California coast are found in southern California waters, which encompasses the coastal reach between Point Conception and the Mexican border. Furthermore, since Miller and Lea included only a part of the deep-sea fauna, the total number of species in the Southern California Bight exceeds 481. The number of species and number of families of principally coastal marine fishes are listed for southern, central, and northern California in Table 3.6-6.

The list provided in Table 3.6-7 names the 10 most speciose fish families occurring offshore of southern California. The presence of a relatively large number of species, however, is not necessarily indicative of the ecological importance of that family to the ichthyofauna of the region. Other families with far fewer species often constitute much more consistent elements of the fauna because of the numerical abundance of one or more of their species. Among the most important of the families inhabiting nearshore waters are the Clupeidae, Engraulididae, Atherinidae, Serranidae, Scianidae, Bothidae, Pleuronectidae and Cynoglossidae.

The compilation of data on the nearshore fish fauna in the SCCWRP (1973a) report was based on the results of 330 otter trawl samples from 119 stations

Table 3.6-6

NUMBER OF SPECIES AND FAMILIES OF PRINCIPALLY COASTAL FISHES IN SOUTHERN, CENTRAL, AND NORTHERN CALIFORNIA[1]

Region	Species	Families
Southern California (Mexican border to Point Conception)	481	129
Central California (Point Conception to San Francisco)	396	118
Northern California (San Francisco to Oregon border)	333	102

Table 3.6-7

TEN MOST SPECIOSE FAMILIES OF FISHES OCCURRING IN SOUTHERN CALIFORNIA[1]

Family	Common Name	Number of Species
Scorpaenidae	scorpionfishes/rockfishes	55
Cottidae	sculpins	34
Embiotocidae	surfperches	18
Pleuronectidae	righteye founders	18
Myctophidae	lanternfishes	16
Scombridae	mackerels and tunas	14
Carangidae	jacks and pompanos	13
Gobiidae	gobies	13
Clinidae	clinids	12
Carcharhinidae	requiem sharks	12

[1]Data from Miller and Lea (1972) except Myctophidae from Ebeling, et al. (1970).

located throughout the Southern California Bight. The frequency of occurrence of the 20 most common species from that 1969-1972 sampling period are presented in Table 3.6-8 for San Pedro Bay. Dover sole dominated the trawl sampling, followed by California tonguefish, horny-headed turbot, English sole, and speckled sandabs. The flatfish domination of the sampling was not unexpected in light of the bottom substrate and low gradient topography.

The data were examined by a recurrent group analysis as detailed by Fager (1957, 1963) and Fager and Longhurst (1968) to identify species that tend to be associated with each other in the trawl catches, and which, therefore, may be considered as samples from operational communities. About 20 percent of the 121 nearshore demersal species captured during the 1969-72 trawling surveys appeared together in statistically significant groupings. Five major groups and six associated individual species emerged from the analysis (Figure 3.6-2). The first named species in each of the group is the dominant member. The geographical distribution of these recurrent groups is shown in Figure 3.6-3.

SCCWRP (1973) acknowledged that the groups may or may not represent complete fish communities since the data were collected by daytime trawling, excluding nighttime trawl sampling, and the use of additional methods such as longline fishing, purse seining, fish trapping, and in situ photography. The last technique, used in a later study (SCCWRP, 1973), revealed that at least two species, sablefish (Anopoploma fimbria) and spiny dogfish (Squalus acanthias) were more abundant that the trawl catches indicated, and that, conversely, many of the more commonly trawl-caught species such as sculpins, combfish, small flatfishes, and several species of rockfishes and croakers were not observed in the films.

Nevertheless, recurrent group analysis did identify groups that appears in the trawl catches in sufficient frequencies so that their mutual appearance was statistically significant. It was assumed that this was a consequence of an association in nature resulting from preference for, and selection of, similar environmental conditions. It is interesting to note that all of the recurrent groups are flatfish-dominated groups in the project area and along the proposed pipeline route.

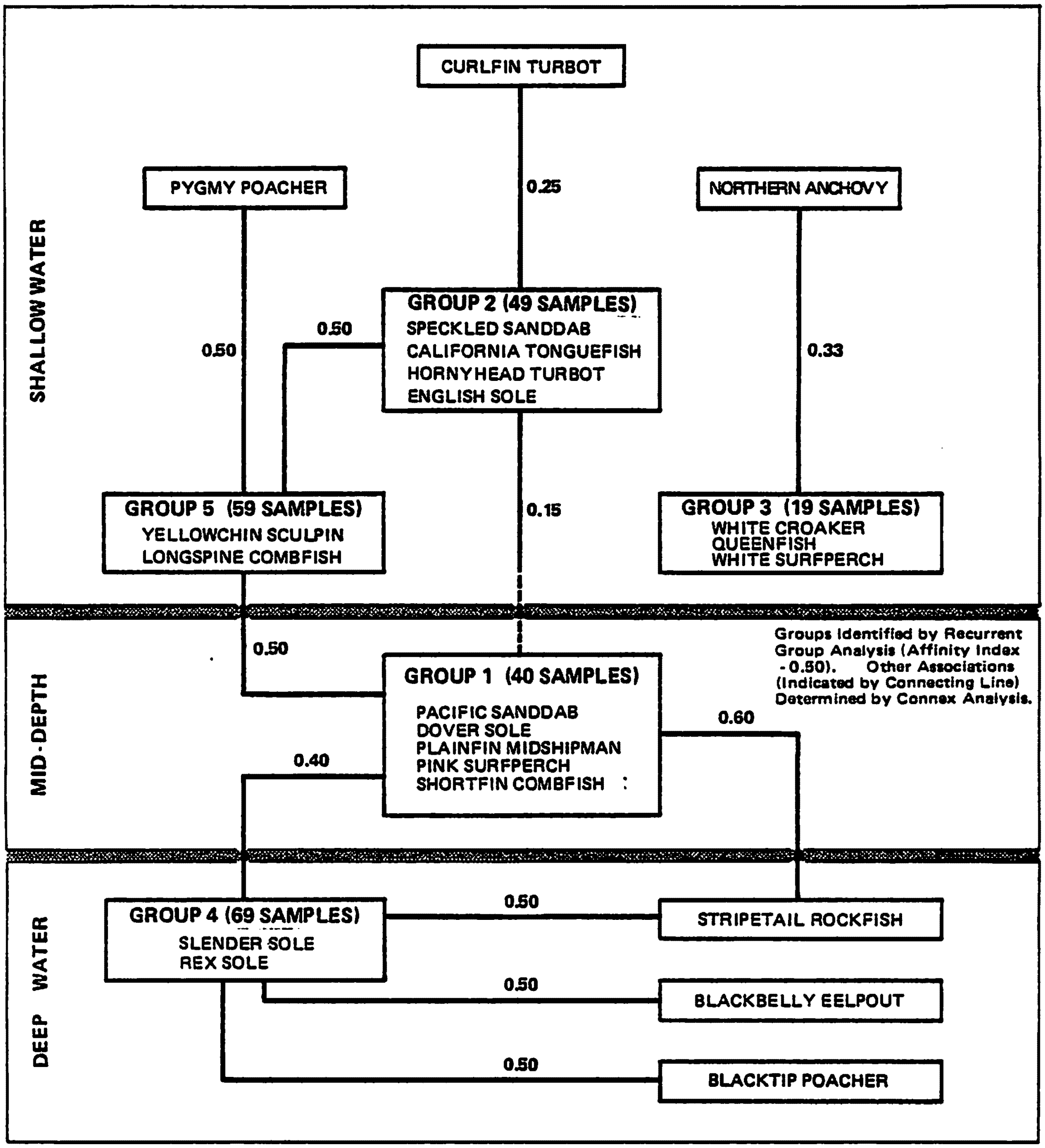
An extensive review of the recurrent analysis of fishes from the nearshore and midwater zones is presented in the Beta Unit EIR (SLC et al., 1978, refer: Section 3.5.1.4, page 224).

Table 3.6-8

FREQUENCY OF OCCURRENCE (Percent) OF THE 20 MOST COMMON SPECIES IN SAMPLES FROM THE 1969-72 TRAWLING SURVEYS OF SOUTHERN CALIFORNIA COASTAL WATERS (From SCCWRP, 1973)

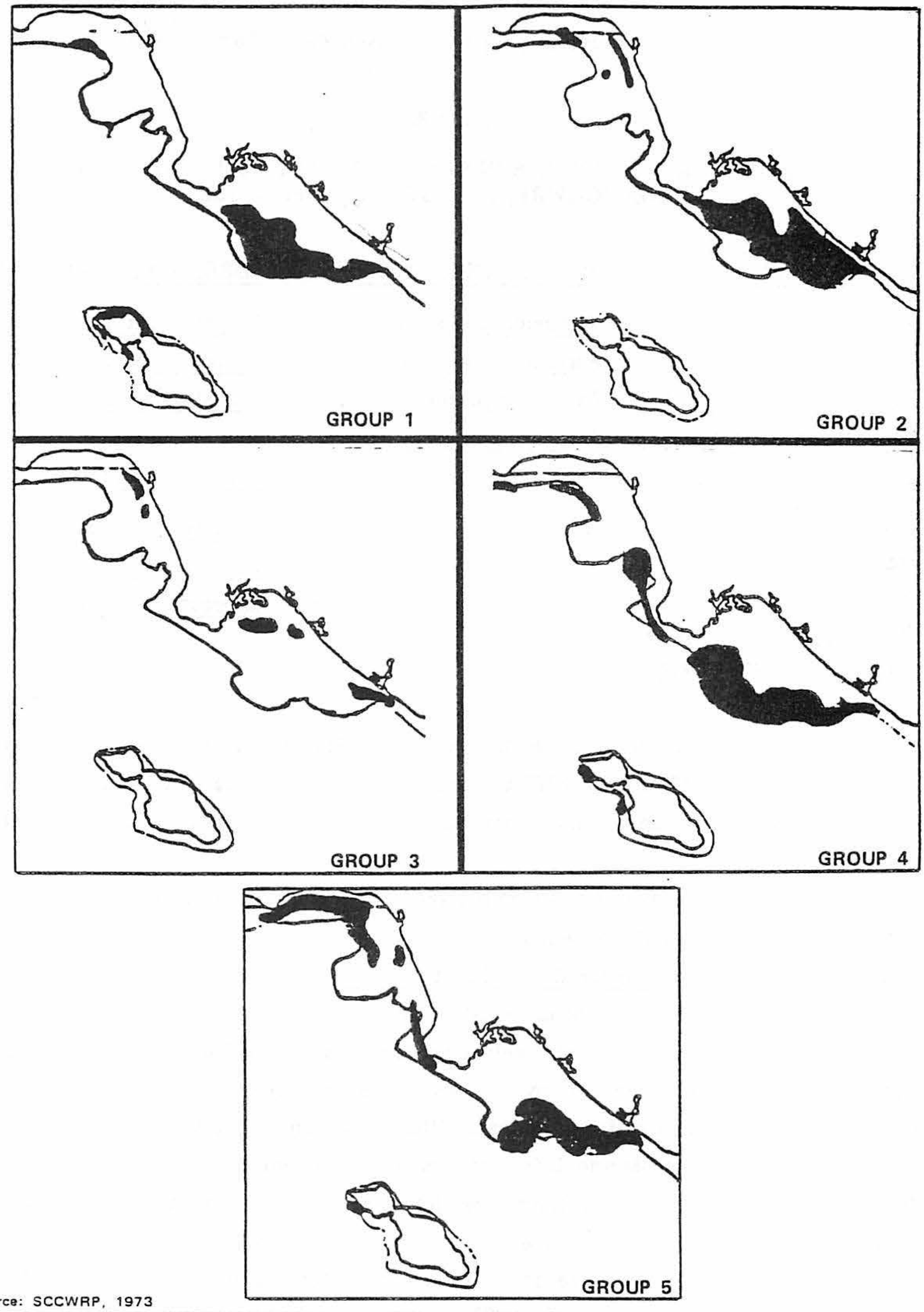
Rank	Species	% Occurrence in San Pedro area
1	Dover Sole	73
2	California tonguefish	64
3	Hornyhead turbot	61
4	English sole	56
5	Speckled sanddab	55
6	Pacific sanddab	53
7	Plainfin midshipman	52
8	Pink seaperch	48
9	Yellowchin sculpin	41
10	Shortspine combfish	41
11	Rex sole	41
12	Slender sole	38
13	Stripetail rockfish	36
14	Bigmouth sole	35
15	Shiner perch	33
16	Halfbanded rockfish	33
17	Longspine combfish	31
18	White croaker	30
19	California scorpionfish	19
20	Curlfin turbot	12

Number of Hauls = 132



Species Associations of Nearshore Demersal Fishes

FIGURE 3.6-2



Source: SCCWRP, 1973

Distribution of Recurrent Nearshore Demersal Fishes

FIGURE 3.6-3

A list of characteristic species in San Pedro Bay by depth ranges is presented in Table 3.6-9.

Table 3.6-9

CHARACTERISTIC SPECIES IN SAN PEDRO BAY BY DEPTH RANGES
(after SCCWRP, 1973, STEPHENS et al. 1973)

SHALLOW WATER (10-30 m)	MID-DEPTH (80-200 m)	DEEP WATER (200-400 m)
Genyonemus lineatus	Citharichtyhy sordidus	Glyptocephalus zachirus
Seriphus politus	Porichthys notatus	Lyopsetta exilis
Cymatogaster aggregata	Zalembus rosaceus	Sebastolobus alascanus
Phanerodon furcatus	Sebastes diploproa	
Icelinus quadriseriatus		INTERMEDIATE (100-200 m)
Zaniolepis latipinnis		Sebastes saxicola
Symphurus atricauda		Zaniolepis frenata
Parophrys vetulus		Microstomus pacificus
Pleuronichthys verticalis		
Citharichthys stigmaeus		

SCCWRP summarized the results of 317 trawls at 148 stations at depths ranging from 10 to 627 m from 1977 to 1982 (Moore, et al., 1982). A list of the 25 most frequently occurring epibenthic organisms taken in this survey are presented in Table 3.6-10.

The species composition has not changed significantly since 1972 and flatfish still dominate the bottom fauna.

3.6.6 Sensitive or Unique Marine Environments

The southern California coast is physically and ecologically variable. Some areas such as wetlands and relatively undisturbed intertidal/subtidal habitats are of significant ecological value. Many of these sites have been identified as biologically sensitive areas in the California Coastal Plan (California Coastal Commission, 1975). Some are identified as Marine Life Refuges or Ecological Reserves by the California Department of Fish and Game (Smith and Johnson, 1974) or as Areas of Special Biological Significance (ASBS) by the State Water Resources Control Board (1976a,b,c).

Biologically sensitive areas within the potential influence zone of Platform Eureka and the pipeline corridor from Platform Elly to Eureka are:

Table 3.6-10

THE MOST FREQUENTLY OCCURRING EPIBENTHIC ORGANISMS
IN TAXONOMIC ORDER IN CENTRAL SOUTHERN CALIFORNIA WATERS
AT 148 STATIONS AND 317 TEN-MINUTE TRAWLS

Fish (25 of 200)		Invertebrates (25 of 500)	
Porichthys notatus	Plainfin midshipman	Acanthoptilum gracile	Sea pen
Lycodopsis pacifica	Blackbelly eelput	Filigella mitsukurii	Sea whip
Zalembius rosaceus	Pink seaperch	Stylatula elongata	Sea pen
Lepidogobius lepidus	Bay goby	Cerebratulus sp.	Ribbon worm
Scorpaena guttata	California scorpionfish	Calinaticina oldroydii	Moon snail
Sebastes dali	Calico rockfish	Nassarius spp.	Dog welk
S. diploproa	Splitnose rockfish	Polinices draconis	Moon snail
S. rosenblatti	Greenblotched rockfish	Acanthodoris brunnea	Nudibranch
S. saxicola	Stripetail rockfish	Pleurobranchaea californica	Nudribranch
Sebastolobus alascanus	Shortspine thornyhead	Octopus spp.	Octopus
Zaniolepis frenata	Shortspine combfish	Scalpellum californicum	Barnacle
Z. latipinnis	Longspine combfish	Cragnon spp.	Shrimp
Chitonotus pugetensis	Roughback sculpin	Sicyonia ingentis	Shrimp
Icelinus quadriseriatus	Yellowchin sculpin	Spirontocaris spp.	Shrimp
Odontopyxis trispinosa	Pygmy poacher	Paguristes spp.	Hermit crab
Xeneretmus latifrons	Blacktip poacher	Mursia gaudichaudii	Hermit crab
Citharichthys sordidus	Pacific sanddab	Pyromaia tuberculata	Crab
C. stigmaeus	Speckled sanddab	Astropecten verrilli	Starfish
Hippoglossina stomata	Bigmouth sole	Luidia folioata	Starfish
Glyptocephalus zachirus	Rex sole	Allocentrotus fragilis	Sea urchin
Lyopsetta exilis	Slender sole	Brisaster latifrons	Sea urchin
Microstomus pacificus	Dover sole	Brisopsis pacificus	Sea urchin
Parophrys vetulus	English sole	Lytechinus anamesus	Sea urchin
Pleuronichthys verticalis	Hornyhead turbot	Ophiura lutkeni	Brittle star
Symphurus atricauda	California tonguefish	Parastichopus californicus	Sea cucumber

(Moore, et al. 1982)

1. Anaheim Bay
2. Seal Beach National Wildlife Refuge
3. Bolsa Bay and Bolsa Chica Ecological Reserve
4. Santa Ana River mouth/associated wetland
5. Newport Bay (primarily Upper Bay)
6. Newport Beach Marine Life Refuge (ASBS)
7. Irvine Coast Marine Life Refuge (ASBS)
8. Laguna Beach Marine Reserve and the Heisler Park Ecological Reserve
9. Santa Catalina Island

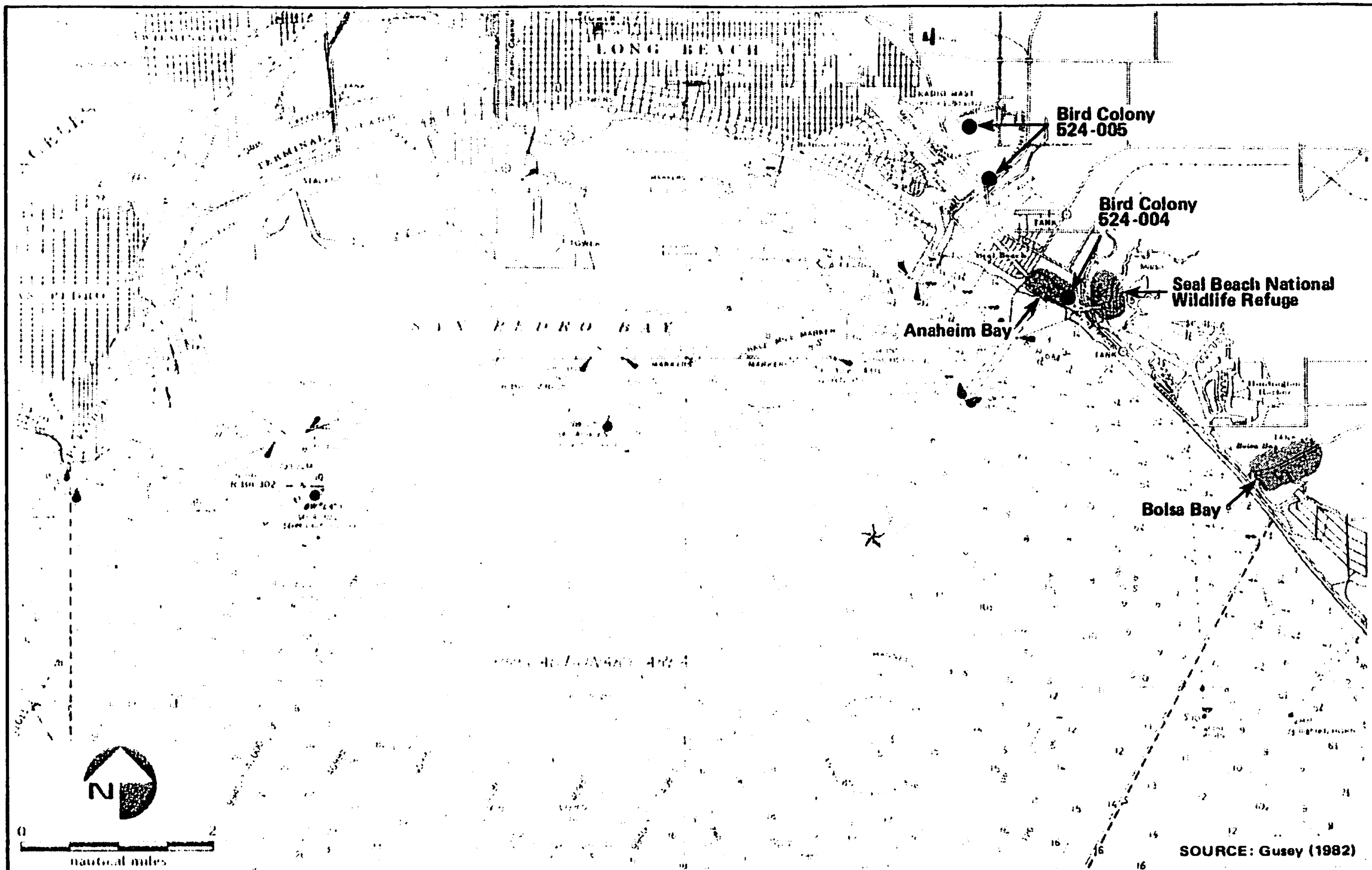
The Anaheim Bay-Huntington Harbour-Bolsa Bay area incorporates bay waters, tidal channels, mudflats and saltmarsh. The Seal Beach National Wildlife Refuge has over 700 acres of saltmarsh and tidal channels. Bolsa Chica wetlands now contain 563 acres and have been designated by the state as an ecological preserve. Efforts are underway to reflood sections of the marsh and improve or restore wetland habitat. These wetland and refuge areas are significant avian habitats, including habitat for the Snowy Plover and the state and federally listed endangered Least Tern, and Light-Footed Clapper Rail (Figures 3.6-4 and 3.6-5).

The mouth of the Santa Ana River is a disturbed area. Historically, wetlands at the mouth and along the floodplain provided substantial areas of wildlife habitat. Some small, isolated wetlands still exist, and the Least Tern has been known to feed in small ponds along the river floodplain.

Newport Bay can be divided into upper and lower portions. The lower portion is heavily developed for marinas, waterfront housing and commercial development. Upper Newport Bay includes about 800 acres of open water, 525 acres of mudflats, 125 acres of marsh and 120 acres of sheltered habitat. This area is heavily used by overwintering and migrating birds. Speth (1969) calculated that during the period from September to mid-March the area supports 3.25 million birds, including the Light-Footed Clapper Rail and the Least Tern.

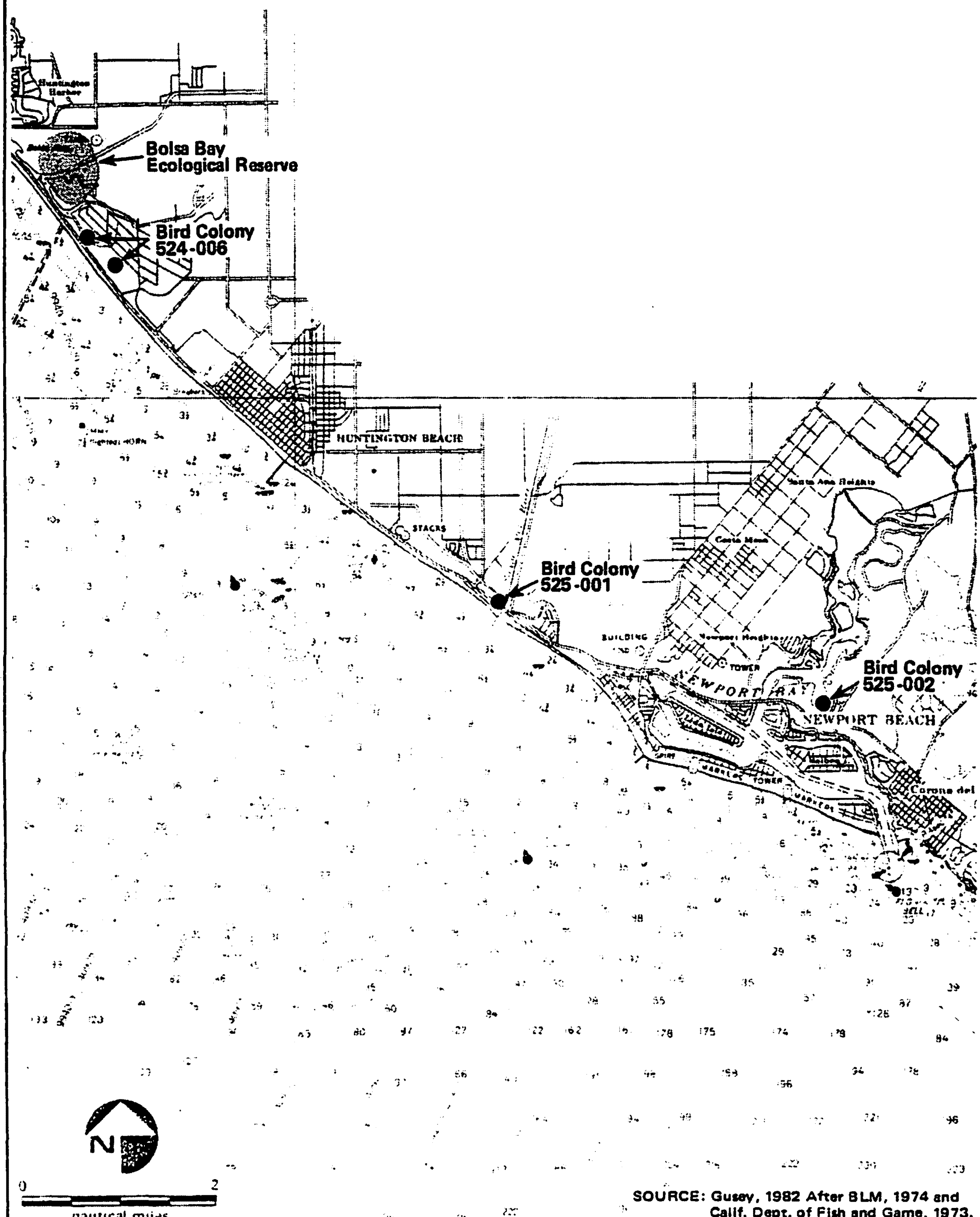
The California State Water Quality Control Board (SWQCB) designated a number of coastal areas as Areas of Special Biological Significance (ASBS) (SWQCB, 1976). Three of these areas are within the general region of proposed Platform Eureka.

The Newport Beach Marine Life Refuge (State Water Resource Control Board, 1979a) is 0.68 miles long (1.1 km) and extends seaward 1000 feet (Figure 3.6-6). The intertidal zone is comprised nearly equally of rocky headlands and sand beaches.



Sensitive Marine Habitats- Long Beach to Bolsa Bay

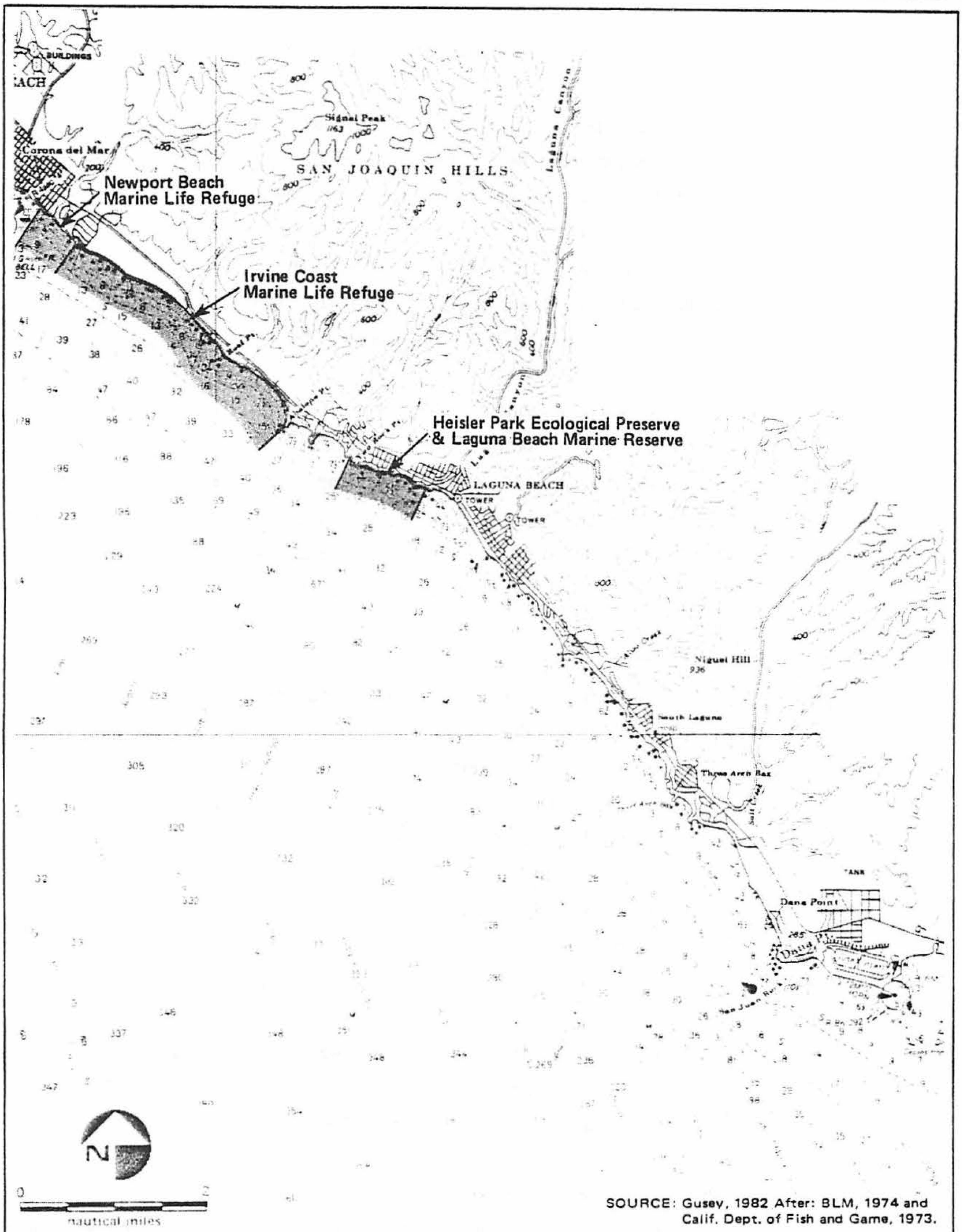
FIGURE 3.6-4



SOURCE: Gusey, 1982 After BLM, 1974 and Calif. Dept. of Fish and Game, 1973.

Sensitive Marine Habitats- Bolsa Bay to Newport

FIGURE 3.6-5



SOURCE: Gusey, 1982 After: BLM, 1974 and Calif. Dept. of Fish and Game, 1973.

Sensitive Marine Habitats- Newport to Laguna Beach

FIGURE 3.6-6

Offshore areas are rocky reefs to 50-foot depth interspersed with coarse sand and muddy substrates.

Irvine Coast Marine Life Refuge (SWQCB, 1979b) is considered one of the most biologically healthy regions on the Southern California coast (Figure 3.6-6). It is a mixture of sand bottom habitats and rocky reef areas, although it is dominated by sand habitats both intertidally and subtidally.

The Heisler Park Ecological Preserve (SWQCB, 1979c) is the third ASBS area. It is located near Laguna Beach (Figure 3.6-6) and is dominated by intertidal rocky areas and rocky reefs to 20 m. Below 20 m is sand bottom habitat dominating to the edge of the reserve.

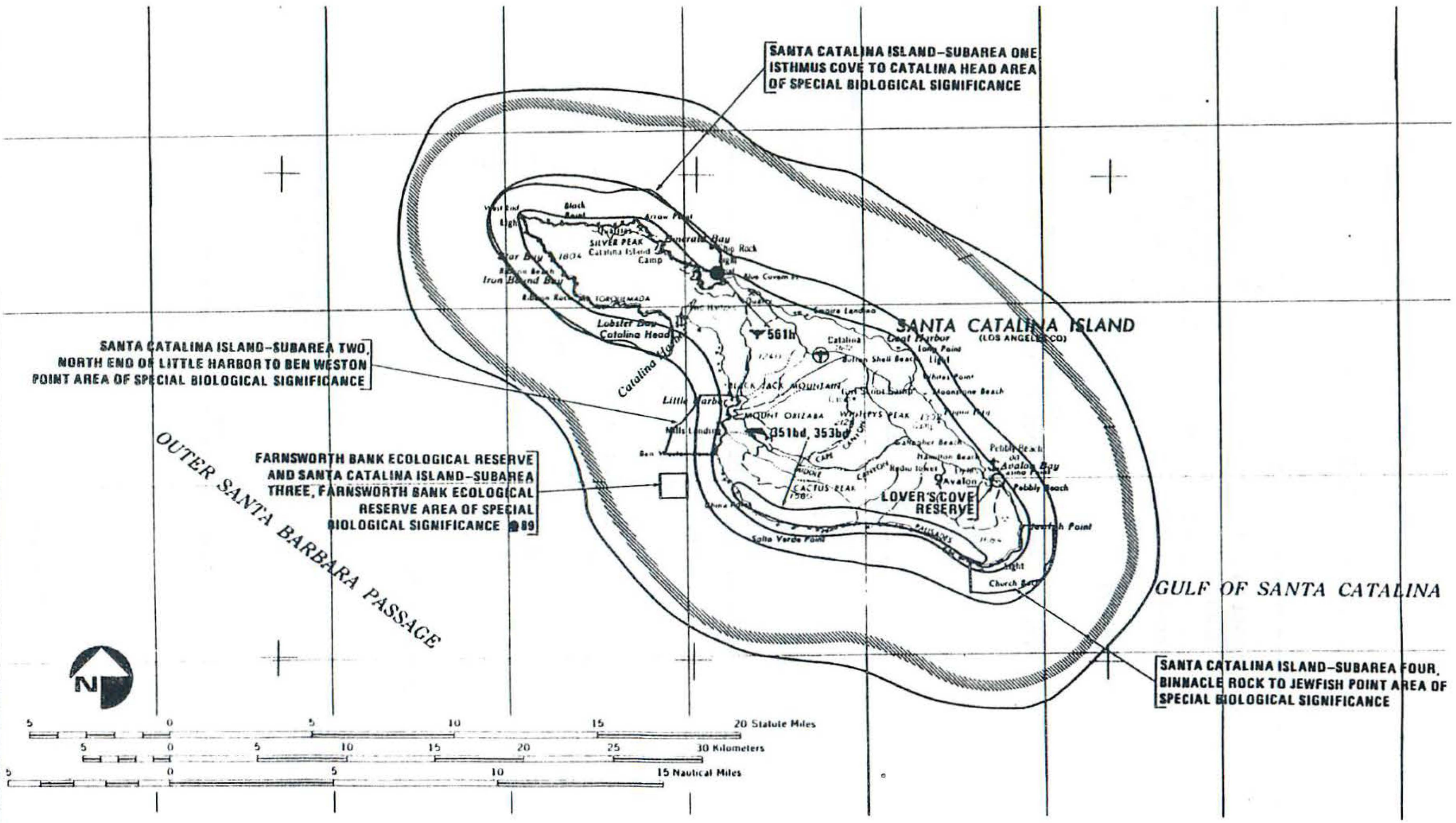
Santa Catalina Island is considered an area of special biological significance although it is not included in the Channel Islands National Park. The coastline of the island provides a variety of marine environemnts from protected coves and kelp beds to rocky outer coasts. It is extensively utilized by recreational visitors and sportfishermen (MMS, 1983). Figure 3.6-7 shows the sensitive biological areas around the periphery of Santa Catalina Island (data from U.S. Fish and Wildlife Service, Pacific Coast Ecological Inventory).

3.6.7 Avian Resources

More than 400 species of birds have been recorded from the Southern California coast and Channel Islands. The Channel Islands, in particular, are one of the richest areas in the United States for marine birds. This is based on both numbers and species diversity. Seabird concentrations occur on the islands themselves (which provide nesting habitat for more than 60 of Southern California's breeding seabirds) as well as in the productive waters around the islands. The total complex of marine birds includes 64 nesting species, year-round visitors, summer visitors, winter visitors, transients, and strays (see Table 3.6-11). Because of their mobility and migratory habits, probably all of these seabird species appear at some time near the Channel Islands and adjacent mainland.

The Brown Pelican is the only breeding seabird on the Channel Islands which is listed as endangered. Other endangered birds of the mainland are the Light-Footed Clapper Rail, Belding's Savannah Sparrow, Peregrine Falcon, Southern Bald Eagle, and Least Tern.

Although distribution and movement vary between species and seasons, seabirds tend to concentrate over areas of high bottom relief including ridges, island shelves, and plateaus. During the summer, for example, the Brown Pelican, Western



SOURCE: Pacific Coast Ecological Inventory
Long Beach, California, 1981

Santa Catalina Island Sensitive Biological Areas

FIGURE 3.6-7

WESTEC Services, Inc.

Table 3.6-11

THE MARINE AVIFAUNA OF THE SOUTHERN CALIFORNIA BIGHT

1. Nesting Species

Ashy Storm-Petrel (Channel Islands)	Pigeon Guillemot (Channel Islands)
Brown Pelican (Channel Islands)	Xantus' Murrelet (Channel Islands)
Double-Crested Cormorant (Channel Islands)	Cassin's Auklet (Channel Islands)
Brandt's Cormorant (Channel Islands)	Least Terns (mainland only)
Pelagic Cormorant (Channel Islands)	Caspian Terns (mainland only)
Western Gull (Channel Islands)	Elegant Terns (mainland only)

2. Year-Round Visitors

(do not breed on the Islands but can be expected any time of the year)

California Gull	Forster's Tern	Royal Tern
Ring-Billed Gull	Black Storm-Petrel	Black-Footed Albatross

3. Summer Visitors

Least Storm-Petrel	Craver's Murrelet	Pink-Footed Shearwater
Red-Billed Tropic-Bird	Leach's Storm Petrel	Sooty Shearwater

4. Winter Visitors

Heermann's Gull	Black Storm-Petrel	Glaucous-Winged Gull
Northern Fulmar	Manx Shearwater	Herring Gull
Common Loon	Fork-Tailed Storm Petrel	Common Murre
Arctic Loon	White-Winged Scoter	Thayer's Gull
Red-Throated Loon	Surf Scoter	Mew Gull
Horned Grebe	Red-Breasted Merganser	Bonaparte's Gull
Eared Grebe	Red Phalarope	Black-Legged Kittiwake
Western Grebe	Pomarine Jaegar	Rhinoceros Auklet

5. Transients

(pass through Southern California waters while migrating)

New Zealand Shearwater	Skuas
Brant	Sabine's Gull
Parasitic Jaeger	Common Tern
Long-Tailed Jaeger	Horned Puffin

6. Strays

Red-Necked Grebe	Laysan Albatross
Ancient Murrelet	Cape Petrel

Reference: University of California, Santa Cruz, 1978.

Gull, and Cassin's Auklet in the Bight are found in greatest numbers northwest of San Miguel Island, in the eastern end of Santa Barbara Channel, close inshore around all eight islands, and in waters overlying the northern Santa Rosa-Cortes Ridge and Santa Cruz Basin (Briggs et al., 1978). In general, marine birds tend to forage within 6 to 15 miles (10-24 km) of their colonies.

During the breeding season some species prefer to forage over the island shelves which may vary from 3 to 6 nautical miles in width. The birds found in the island breeding colonies may be most dependent on the waters around the Channel Islands.

Many of the offshore rocks within the Southern California coastal zone provide nesting and/or roosting sites for a variety of marine and shorebirds. These offshore rocks often provide relatively undisturbed marine and shorebird habitat close to heavily populated areas. Artificial jetties and breakwaters also attract various shorebirds and gulls, in addition to surfbirds, Black Turnstones, American Black Oystercatchers, and Wandering Tattlers. Endangered Brown Pelicans frequently forage in coastal waters, both off the open coast and in harbors.

The most significant marine and shorebird habitat found within the Southern California borderland are the coastal wetlands (marshes, sloughs, and bays), upon which large numbers of shorebirds, waterfowl, and other water-associated birds depend. In addition, these areas provide important feeding and resting areas for migratory species.

As noted previously, the wetland areas in the region of the proposed construction are generally of high value to avifauna, including a number of endangered species. Fluctuations in population levels are to be expected as birds migrate along the Pacific Flyway. Peak numbers of birds are expected in the fall and winter. Species such as the Brown Pelican and Double-Crested Cormorant occur year-round in the area, while others such as the Black Brant, Ashy Storm-Petrel, Sooty Shearwater and Canvasback are found seasonally (BLM, 1979).

The Southern California shoreline includes many miles of sandy beaches. During the summer, human use of the beaches substantially reduces their value as bird habitat. However, during the offseason, and at beaches which may be inaccessible, beach habitat provides feeding and nesting areas for many bird species. Shorebirds that use those beaches include the Long-billed Curlew, Semipalmated Plover, American Golden Plover, Black-bellied Plover, Snowy Plover, Whimbrel, Marbled Godwit, Sanderling, Western Sandpiper, and Least Sandpiper. The Least Tern, an endangered species, has altered its nesting habits and moved to less favorable sites because of heavy beach use. Many of the species mentioned here use beaches for feeding and resting during early morning and evening hours.

The cliffs and irregular topography of rocky shore areas provide extensive nesting and feeding habitat for birds. Some of the more common species associated with this habitat include the American Black Oystercatcher, Black Turnstone, Ruddy Turnstone, Spotted Sandpiper, Surfbird and Western Gull. A recent review by Gusey (1982) discussed the avifauna of the Southern California Bight in light of potential oil spills.

A list of U.S. Fish and Wildlife Service (USFWS) breeding colonies in the vicinity of Platform Eureka is presented in Table 3.6-12. Reference should be made to Figures 3.6-4 through 3.6-6 for specific colony locations.

3.6.8 Marine Mammals

Many species of cetaceans (whales, dolphins, and porpoises) are present year-round or seasonally along the coast of Southern California, including the Santa Barbara Channel. Most marine mammals are migratory, and seasonal fluctuations in both the number of species and populations of each species are normal. The common dolphin, Pacific white-sided dolphin and northern right whale dolphin are the most frequently observed marine mammals. The Pacific pilot whale, Pacific bottle-nose dolphin, and Dall's porpoise are less abundant and occur in about equal numbers (Leatherwood, et al., 1972).

Most smaller cetaceans travel in herds whose numbers may vary greatly from season to season. They also have far-ranging movement patterns that are governed mainly by the availability of food. The peak period of abundance for all cetaceans in the inshore waters off California occurs during winter and early spring, a period that coincides with the winter upwelling of rich nutrient water off Southern California. The upwelling concentrates spawning quid and anchovies, which serve as a primary food source for large schools of cetaceans. The number of cetaceans estimated to occur off Southern California during peak periods is shown in Table 3.6-13.

The cetaceans of the Southern California coast include the Mysticeti (baleen whales) and Odontoceti (toothed whales), of which the latter are by far the most abundant. Some are residents and others are transients where only incidental sightings have been recorded. Of the baleen whales, the Pacific right whale (Baleana glacialis) has been confirmed in Southern California waters. The five members of the fin or rorqual whale group including the little piked or minke whale, Balaenoptera acutorostrata; finback whale, B. physalus; humpback whale, Megaptera novenangliae are transients.

Table 3.6-12

MARINE BIRD BREEDING COLONIES[1] AND ESTIMATED ABUNDANCE IN THE SAN PEDRO BAY REGION

	Abundance
Anaheim Bay (524 004)	
Light-footed Clapper Rail	8
Least Tern	80-96
	104
San Gabriel River (524 005)	
Least Tern	24-30
Bolsa Chica Beach (524 006)	
Snowy Plover	20
Least Tern	40-52
	72
Huntington Beach (525 001)	
Least Tern	140-180
Newport Bay (525 002)	
Least Tern	4-10
Light-footed Clapper Rail	Probably breeding
	24
Bird rock (Santa Catalina) (524 010)	
Western Gull	52

[1]Colony numbers are in parentheses.

Data from Gusey (1982), after BLM, 1974, A summary of knowledge of the Southern California Coastal Zone and offshore areas, Vol. II; and California Department of Fish and Game, 1973, Coastal County Fish and Wildlife Resources and their utilization.

Table 3.6-13

MARINE MAMMALS OF THE SOUTHERN CALIFORNIA BIGHT
(Point Conception-Mexican Border)

Common Name	Genus/Species	Estimated Population
Pinnipeds	(Zalophus californianus)	40,000
California sea lion	(Eumetopias jubatus)	5-20
Northern fur seal	(Callorninus ursinus)	1,200
Guadalupe fur seal	(Arctocephalus townsendi)	1-5
Northern elephant seal	(Mirounga angustirostris)	16,600
Harbor seal	(Phoca vitulina)	1,400
Fissipeds		
Sea otter	(Enhydra lutris)	1-5
Cetaceans		
Bryde's whale	(Balaenopteraendeni)	—
Minke whale	(Balaenoptera acutorostrata)	60
Blue whale	(Balaenontera musculus)	7
Sei whale	(Balaenoptera borealis)	—
Finback whale	(Balaenoptera physalus)	23
Humpback whale	(Megaptera novaengliae)	6
Gray whale	(Eschrichtius robustus)	336
Common dolphin	(Delphinus delphis)	33,564
Pacific pilot whale	(Globicephala macrorhynoa)	4,333
Risso's porpoise	(Grampus griseus)	556
White-sided dolphin	(Lagenorhynchus obliiquidens)	10,007
Northern right whale dolphin	(Lissodelphis borealis)	1,848
Killer whale	(Orcinus orca)	122
Harbor porpoise	(Phocena phocoena)	0
Dall porpoise	(Phocenoides dalli)	647
False killer whale	(Pseudorca crassidens)	0
Long-beaked dolphin	(Stenella coeruleoalba)	0
Pacific bottlenose dolphin	(Tursiops gilli)	557
Sperm whale	(Physeter catadon)	0
Pygmy sperm whale	(Kogia breviceps)	0
Baird's beaked whale	(Berardius bairdii)	—
Ginko-toothed whale	(Mesopolodon ginkgodens)	—
Cuvier's beaked whale	(Ziphius cavirostris)	0
Pacific right whale	(Balaena glacialis)	0
Pacific spotted dolphin	(Stenella graffmani)	0
Rough-toothed dolphin	(Steno bredanensis)	0
Hubb's beaked whale	(Mesoplodon carlhubbsi)	0
Total Sighted		52,066

*Numbers for cetaceans indicate sightings from air and ship (Norris et al., 1975).

There are confirmed sightings only of the minke, sei, and finback. The only common Mysticete found in the area is the California gray whale, Eschrichtius robustus, which migrates annually from the summer feeding areas in the Bering Sea and Chukchi Sea to the breeding grounds in Scammon Lagoon, Baja California, Mexico. Seven species of whales are listed by the U.S. Fish and Wildlife Service as threatened (Table 3.6-14). The toothed whales, which include the porpoise and dolphin groups, include 15 species in these waters. Of these, ten are common to occasional (common dolphin, Delphinus delphis; Pacific pilot whale, Globicephala macrorhyncha; Pacific striped or white-sided dolphin, Lagenorhynchus obliquidens; northern right whale dolphin, Lissodelphis borealis; killer whale, Orcinus orca; harbor porpoise, Phocoena phocena; Dall's porpoise, Phocoenoides dalli; longbeaked dolphin, Stenella caeruleoalba; Pacific bottlenose dolphin, Tursiops gilli; pygmy sperm whale, Kogia breviceps) and five are uncommon to rare (false killer whale, Pseudorca crassidens, Pacific spotted dolphin, Stenella graffmani; sperm whale, Physeter catadon; Hubb's beaked whale, Mesoplodon carlhubbsi; and Cuvier's beaked whale, Ziphius cavirostris).

Table 3.6-14

WHALES IN SOUTHERN CALIFORNIA WATERS LISTED AS THREATENED
(U.S. Fish and Wildlife Service 1973)

Gray whale	(Eschrichtius robustus)
Blue whale	(Balaenoptera musculus)
Finback whale	(Baleaenoptera physalus)
Sei whale	(Balaenoptera borealis)
Humpback whale	(Megaptera novaeangliae)
Pacific right whale	(Balena glacialis)
Sperm whale	(Physeter catodon)

The 27 or more species of cetaceans reported from southern California waters appear to occur in 3 major groups. The inshore group consists of common dolphin, Pacific bottlenose dolphin, white-sided dolphin, Dall's porpoise, minke whale, gray whale, and pilot whale. The continental shelf group includes Risso's porpoise, right whale dolphin, various beaked whales, blue whale, sei, sperm, and humpback whales. The third or far-offshore group is normally found in the open ocean of the central Pacific gyre and includes species such as the false killer whale, pygmy killer whale, pygmy sperm whale, long-beaked dolphin, and rough-toothed porpoise. Within the Southern California Bight, aerial and shipboard sightings indicated the common dolphin, white-sided dolphin, and pilot whale as the three most commonly sighted species (Norris et al., 1975).

Southern California waters may function as the home range of the common dolphin, Pacific white-sided dolphin, and Pacific bottlenose dolphin. Pilot whales also occupy the area for feeding, and large concentrations have been sighted feeding on squid. The Pacific right whale, one of the rarest of the great whales, occasionally has been viewed in the Channel Islands area. The area may be important to the right whale as both habitat and foraging area but further research appears necessary to substantiate this assertion (Norris et al., 1975).

Gray whales migrate through the area twice each winter with estimated populations ranging as high as 10,000 to 12,000. Observations of gray whales with calves close to the islands indicate that the area is a significant route of returning calf migrations. Reference should be made to Gusey (1982) for an extensive review of the existing distribution and sighting literature as well as a review of species utilizing the Southern California Bight.

Although whales and dolphins are common and important transient inhabitants of the waters around the Channel Islands, the area is especially significant for seals and sea lions which require the island shelves and shoreline habitat for haulout and feeding purposes. The islands and surrounding waters are particularly important since major rookeries do not occur on the Southern California mainland coast.

It has been estimated that approximately 75,000 seals and sea lions occupy Southern California Bight waters. The unusually large populations of pinnipeds (as well as whales, dolphins, and seabirds) are indicative of the region's high productivity which can be traced to the oceanic upwelling of the region.

In general, the two most important pinniped concentration areas in the Bight are on the western tip of San Miguel Island around Point Bennett and on the southwestern side of San Nicolas Island. Santa Rosa, Santa Cruz, Anacapa, San Clemente and Santa Barbara Islands also provide 1) island-bred pups with their first aquatic habitat and feeding areas; 2) a source of refuge for hauled-out animals; and 3) a buffer area against the impacts of ocean development and use occurring greater distances from shore. No significant pinniped rookeries or haulout areas are in the immediate region of the proposed platform. Although none of the six pinniped species are listed as endangered or threatened under the Endangered Species Act of 1973, the National Marine

Fisheries Service intends to consider the Guadalupe fur seal for listing as an endangered species (NOAA, OCZM).

As mentioned previously, whales and dolphins tend to be more transient inhabitants of surrounding island waters. Because cetaceans cannot haul out on island shores, they tend to be less dependent than pinnipeds on habitats. The sea otter occasionally occupies waters around the northern Channel Islands. To date there have been only occasional sightings of a few individuals (probably transient males) off the islands of San Miguel and Anacapa. The sea otter rarely hauls out, and is limited to shallow coastal waters (less than about 120 feet (37 m)). It has not been observed in the southern Channel Islands. The sea otter is not expected to occur in the project area.

3.7 ONSHORE LAND USES

3.7.1 Facilities

The California Coastal Commission requires that Port Districts prepare Master Plans to designate appropriate coastal land uses within their jurisdiction. Other responsible agencies such as cities and counties are required to develop Local Coastal Programs (LCPs) instead of Port Master Plans.

Existing onshore SCPI facilities in the Port of Long Beach consist of a crew boat launch, office space, a supply boat marshalling yard and a crude oil distibution facility. Each of these operations is zoned PM, a City of Long Beach zone which permits manufacturing related facilities within the Port area. The approved Port of Long Beach Master Plan designates each SCPI site for water dependent industrial land uses (Buck, 1984). Since the onshore facilities relate to the production of offshore crude oil, they are consistent with applicable zoning and land use designations.

The crew boat launch facility and SCPI office spaces are located at Pier G in the Port of Long Beach. The supply boat marshalling yard is located at the 7th Street Terminal north of channel three, which is used for ship repair and servicing. SCPI's crude oil distribution facility is situated on a 1 acre site located within a street loop connecting the westbound lanes of Ocean Boulevard with the southbound lanes of the Long Beach Freeway. This distribution facility consists of a surge tank, distribution manifold and electric motor-driven pumps.

In addition to those facilities outlined above, SCPI utilizes helicopter and parking facilities at the Long Beach Airport.

3.7.2 Scenic/Visual Resources

SCPI onshore facilities in the Port of Long Beach consist of a marine transport terminal, a materials supply yard and a production distribution facility at the

7th Street Terminal and the crew boat launching ramp at Pier G. The supply yard can be viewed from the two adjacent lots, 7th Street, Piers One and Two, and from the California Ship Building and Drydock Company. The crude oil distribution facilty is located on a one acre site located within the street loop connecting the westbound lanes of Ocean Boulevard with the southbound lanes of the Long Beach Freeway. Onsite facilties consist of a surge tank, a distribution manifold and electric motor-driven pumps. Vantage points for the distribution facility are from the southbound lanes of the Long Beach Freeway traffic loop.

In terms of visual access to the activity areas described above, the entire Port area is visible from many of the taller buildings in downtown Long Beach. However, the crude oil distribution facility is more visible than the supply yard which is obscured by a line of sight obstruction.

The crew boat launching ramp at Pier G is only visible from areas immediately adjacent to it.

The offshore site designated for Platform Eureka is located about 1.5 miles (2.4 km) to existing Platforms Ellen, Elly and Edith and 7 1/2 miles (12 km) southwest of Platforms Eva and Emmy. Views of the platforms from Huntington Beach are quite variable. Platforms Eva and Emmy are located less than 2 miles offshore and are generally visible except under foggy conditions. Due to the effects of fog, haze, and smoke, Platforms Edith, Elly and Ellen, located about 8 miles (13 km) offshore Huntington Beach, are visible approximately 53 percent of the time. However, visibility is increased during the winter months.

3.8 SOCIOECONOMICS

3.8.1 Related Employment and Area Unemployment

The manufacturing, trade and services sectors in Los Angeles County accounted for approximately 2,500,000 jobs, or 71.5 percent of the total non-agricultural labor force in 1982 (California Employment Development Department, 1982). A substantial portion of the manufacturing category is associated with the electrical and transportation equipment industries. The trade category includes wholesale and retail trade while a major portion of the services category is associated with the tourism industry. Unemployment in Los Angeles County averaged 8.5 percent during the first 5 months of 1982. The statewide unemployment rate was 10.1 percent during the same time frame.

Major labor markets in Orange County correspond closely to those in Los Angeles County. The services, trade and manufacturing sectors (especially electrical equipment and machinery) accounted for 620,300 jobs or 72 percent of the total non-agricultural Orange County labor force in 1982. A fourth category, state and local government, contributed 106,500 jobs or 12 percent to the Orange County labor market in 1982. The County's unemployment averaged 6.1 percent during the first 5 months of 1982.

3.8.2 Location and Size of Related Population and Industry Centers

As of January 1, 1982 Los Angeles County had a total population of 7,699,650, approximately 31.5 percent of the total population of the State (California Department of Finance, 1982). The SCPI onshore support facilites are located in the City of Long Beach, County of Los Angeles. Long Beach accommodates 370,400 residents, 5 percent of Los Angeles County's total.

The current SCPI payroll includes an estimated $42,000 per month for the 11 onshore employees. The monthly payroll for offshore personnel (44 SCPI employees, 56 contractors) is approximately $658,000.

3.8.3 Existing Community Services

3.8.3.1 Fire Protection

In an emergency, the Long Beach Fire Department would provide fire protection and paramedic service to onshore facilities in the Port of Long Beach. Station #3, located at 1222 Daisy Avenue would respond to the facilities within 5 minutes.

3.8.3.2 Police Protection

Security at the onshore facilties in the Port of Long Beach is the reponsibility of SCPI security guards. However, in the event that onsite security guards were unable to handle a problem, the Harbor Police or the Long Beach Police Department would respond. These agencies have dual jurisdiction over the area. The Harbor Police would respond to SCPI facilities in approximately 4 minutes (Wilson, 1983). A response time for the Long Beach Police Department is not currently available (Shelly, 1983).

3.8.3.3 Health Care Facilities

As mentioned above, the Long Beach Fire Department would provide paramedic service to the onshore facilities in the Port of Long Beach. The closest hospital to the site is Saint Mary's hospital, a full service medical facility. Saint Mary's hospital currently supports 540 licensed beds, of which 55 percent are normally occupied. The hospital also includes a helipad and contacts with Med-Air for helicopter ambulance service.

Injured personnel could also be transferred to Long Beach Memorial Hospital. Long Beach Memorial Hospital contains 998 beds and maintains an occupancy rate of 69 percent (Lifschutz, 1983). Two Life Flight helicopter ambulances are stationed at Long Beach Memorial Hospital.

3.8.3.4 Water

The City of Long Beach supplies water to the onshore facilities in the Port of Long Beach (Tomason, 1983).

3.8.3.5 Energy

The Southern California Edison Company (SCE) provides gas and electricity to the onshore facilities in the Port of Long Beach.

3.8.3.6 Sewage Generation

Sewage collection and disposal is provided by the City of Long Beach.

3.8.3.7 Solid Waste

SCPI onshore facilities at the 7th Street Terminal currently generate wastes such as office paper, shipping waste and miscellaneous trash. These wastes are transported with containerized waste from existing platforms by commercial haulers to the Casmalia landfill in Santa Barbara County. The Casmalia landfill is a Class I landfill which accepts hazardous wastes such as oil contaminated solids, spent oil and solvents from drilling rigs. The Casmalia landfill accepts 12,000 cubic yards of waste annually and has a projected lifespan through the year 2060 (Chevron USA, 1983).

3.8.4 Public Opinion

Unlike many other California coastal cities, the Long Beach area has developed as an industrial presence on the California coastline. This presence is seen in the existing warehouses, pipelines, ships processing facilities, and on- and offshore drilling rigs. Local beaches and coastal areas are patronized despite their proximity to oil processing facilities. Residents and tourists have become accustomed to oil facilities. Therefore, development of additional facilities would not adversely affect the character of the Long Beach coastline. The public opinion regarding these facilities is not anticipated to be adverse.

In order to update measurements of public opinion towards proposed new offshore oil and gas development in California, Western Oil and Gas Association decided to conduct a poll of California voters. The firm of Tarrance and Associates was retained to conduct the survey, and a statewide probability sample of 1000 voters was interviewed during early September 1983. The survey data demonstrated that 56 percent of the population surveyed "favors" or "strongly favors" continued offshore development for oil and gas resources. One of the underlying reasons supporting offshore development is the public belief that the oceans and beaches can be protected at the same time oil and gas development is in progress. Energy development companies will have to demonstrate both the technology and a willingness to protect the environment if this public belief is to be maintained. The survey also indicated that the majority of the public would hold the federal government and the oil industry responsible for any future energy shortage (Tarrance and Associates, 1983).

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SECTION 4

ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND RECOMMENDED MITIGATION MEASURES

4.1 GEOLOGY

The following analysis of potential environmental impacts related to geotechnical factors has been divided into two categories. The first deals with impacts to the geologic or hydrologic environment that could potentially occur as a result of the proposed development and production operations. The second category includes potential impacts to the project from natural geologic hazards known to exist in the area. Measures to reduce or alleviate impacts identified in these two categories are described in Section 4.1.3.

4.1.1 Development and Production Operations

4.1.1.1 Bathymetry

The existing seafloor topography (bathymetry) on the San Pedro shelf and slope will be affected to a small degree by installation of the proposed project. The placement of Platform Eureka on the upper slope and the driving of main and skirt piles will result in only minor disturbances to the seafloor with no significant bathymetric impact. The pipelines and cables will be placed on the seafloor from Platform Eureka to Platform Elly, with similar minor topographic disturbance.

4.1.1.2 Induced Seismicity

Seismic events induced by oil and gas production operations have been reported in several locales. The high-pressure subsurface injection of fluids, which is believed to reduce frictional resistance along previously stressed fault planes, is one potential causative mechanism. A second potential cause is the creation of horizontal shear stresses due to land subsidence resulting from the withdrawal of large volumes of subsurface fluids.

The production plan for the SCPI Beta Field facilities includes water injection to maintain original reservoir fluid pressures. The injection of fluids at pressures significantly exceeding existing levels is not expected. In addition, as described below, significant subsidence of the ground surface due to large-scale oil and gas withdrawal is not expected to occur. Thus, the potential for the proposed operations to induce seismic events is low.

4.1.1.3 Subsidence

The production of oil and gas can result in a partial transfer of overburden load from the pore fluids to the reservoir rock. In some reservoirs this can lead to compaction of the rock and subsidence of overlying strata and the ground surface. As described above, a reservoir pressure maintenance program is included as a component of the proposed project. Induced subsidence of the ground surface is therefore considered to be unlikely.

Tectonic stresses along the Palos Verdes fault zone have apparently resulted in natural subsidence of the seafloor in the proposed platform area. MESA[2] (1984a) estimates a subsidence rate of 1 to 2 feet per 100 years. The platform and pipeline are designed to accommodate this rate.

4.1.2 Geologic Hazards

Natural geologic hazards considered potentially capable of adversely affecting the proposed Platform Eureka development and production area are discussed in detail in Section 3.1.3 and briefly summarized below. It is important to note that the alleviation of environmental impacts relative to these hazards can be achieved through either the siting of project facilities to avoid sensitive areas or proper geotechnical engineering design.

4.1.2.1 Seismic Groundshaking

Table 3.1-3 shows the range of maximum seismic groundshaking (in terms of peak horizontal rock and mudline accelerations) that can be reasonably expected at the project site. To assure the maintenance of structural and foundation stability, the platform and pipelines will be designed to withstand the short-term loads caused by expected seismic ground motions.

4.1.2.2 Surface Fault Rupture

The proposed pipeline alignments cross two fault traces considered active and capable of horizontal and vertical displacement at the seafloor (Faults F-3 and F-4 on Figure 3.1-6). According to information presented on page 23 in Section 4.1.2.1(5) of original Shell Beta Unit EIR/EA (SLC et al., 1978, Vol II), the proposed pipelines will be designed and constructed to withstand up to 3 feet of displacement without reaching pipe yield, while maximum displacement of faults in the area is expected to be 2 feet or less. It is thus likely that any fault movement that might occur will be less than could be tolerated by the pipelines, and no impact would be expected.

4.1.2.3 Slope Stability

A suspected submarine slide is located approximately 5000 feet (1524 m) upslope of the proposed Platform Eureka site, and may represent a potential hazard. However, this feature is interpreted to be an ancient or paleo-slide (MESA[2], 1984a, b), and shows no evidence of reactivation since the time of modern gully cutting in the area (some 300 years ago). The slide is therefore not considered to be detrimental to the proposed site.

4.1.3 Mitigation Measures

4.1.3.1 Development and Production Operations

Alteration of the existing seafloor to install Platform Eureka and the marine pipelines will constitute very minor bathymetry impacts, and no mitigation measures are considered necessary. The potential for significant impacts resulting from induced seismicity or subsidence was also found to be very low, and no specific mitigation measures are recommended.

4.1.3.2 Geologic Hazards

The mitigation of potential impacts resulting from natural geologic hazards in both the offshore and onshore regions takes two forms: avoidance and proper engineering design. The proposed platform site and pipeline route were carefully selected to avoid almost all the seafloor irregularities and problem areas identified during the earlier geohazards investigations. Potential hazards that could not be avoided through siting considerations principally include fault rupture, seismic groundshaking, and a potential slide upslope of the platform site. Mitigation of related impacts will be achieved through a series of geotechnical and structural engineering design studies that are required by local, state and federal regulatory agencies.

4.2 METEOROLOGY

There are no expected impacts of the project on meteorology. The indirect effects of adverse meteorologic conditions, such as high waves on the project, are discussed in Section 4.4. Meteorological conditions which effect air quality impacts are taken into account in Section 4.3.

4.3 AIR QUALITY IMPACTS

4.3.1 Project Emissions

Project emission calculations are based on the operation of all SCPI equipment in the Beta Field. The Beta Field equipment consists of Platforms Ellen and Elly currently operating and the construction and operation of the proposed Platform Eureka, as well as Chevron's Platform Edith.

4.3.2 Installation Phase Emissions

The installation emissions include only the emissions from the installation of the new Platform Eureka and not the current operating emissions from Ellen and Elly.

4.3.2.1 Offshore Emissions

The air pollutant emissions associated with the installation phase for the offshore facilities were calculated by collecting relevant data on the offshore activities and applying accepted emission factors for each particular activity. These figures are based on the best available data at this time and may not necessarily reflect the exact emissions that will occur at project start-up.

For the offshore installation and construction of Platform Eureka, it was anticipated that peak employment of approximately 250 individuals will be required as support staff. The major equipment involved includes a derrick barge, crew and supply boats, and tugs for moving and handling materials and personnel from the dock-side of the fabrication yard to the platform area. A small helicopter will probably be required to transport specialists, inspectors, and other officials to the work site.

The offshore emission rates are summarized in Table 4.3-1 and were obtained from emission factors and data given in Tables 4.3-2 through 4.3-5.

4.3.2.2 Onshore Emissions

The onshore emissions for the Platform Eureka during the construction phase are only caused by the vehicle traffic associated with employee transportation and supply truck deliveries. It is estimated that the average daily automobile traffic will be 10 round trips a day at 30 miles per trip. The supply trucks will make two deliveries a day throughout the installation phase with a round trip of 30 miles. Onshore emissions are included with the marine and air mobile sources in Tables 4.3-1, 4.3-4 and 4.3-5.

4.3.3 Operations Phase Emissions

4.3.3.1 Offshore Emissions - Platforms and Drilling Equipment

The primary pollutants which will be emitted by the offshore facilities are NO_x, HC, CO, particulate and SO_2. The major sources of these pollutants will be the electrical generation engines and water injection engines on Platform Elly, and the drilling rigs on Platform Ellen and the new Platform Eureka. Other potential sources of emissions include fugitive hydrocarbons associated with drilling and oil recovery operations, standby generators, and crew and supply boats.

Table 4.3-1

EUREKA PLATFORM ONSHORE AND OFFSHORE AVERAGE DAILY CONSTRUCTION AND INSTALLATION EMISSIONS

Activity	Activity Duration	Emissions (lb/day)				
		NO_x	HC	CO	TSP	SO_2
Staff Autos	5/1/84 to 5/1/85	1.6	0.9	8.1	0.2	0.1
Supply Trucks	5/1/84 to 5/1/85	2.7	0.3	1.7	0.3	0.4
Crew Boat	5/1/84 to 5/1/85	74.5	13.8	30.3	9.7	7.5
Tug Boats	5/15/84 to 8/3/84	871.7	38.0	201.2	---	87.2
Work Boats	5/15/84 to 8/3/84	445.0	82.4	181.3	57.7	44.5
Helicopters	5/1/84 to 5/1/85	4.6	4.2	45.6	2.0	1.4
Totals[1]	5/15/84 to 8/3/84	4,215.1	364.6	1,080.2	270.9	328.1
Total	5/1/84 to 5/14/84 and 8/4/84 to 5/1/85	120.7	26.1	100.9	17.0	13.1

[1]Includes derrick barge emissions from Table 4.3-3.

Table 4.3-2

EMISSION FACTORS FOR DERRICK BARGE

Pollutant	Emission Factor[1] (pounds/1000 gallon)
NO_x	469.0
HC	37.5
CO	102.0
Particulate	33.5
SO_2	31.2

[1] U.S. Environmental Protection Agency Compilation of Emission Factors, AP-42 Table 3.3.3-1 (1/75).

Table 4.3-3

EMISSION FROM DERRICK BARGE

Pollutant	Emissions[1] (pounds/day)
NO_x	2,814
HC	225
CO	612
Particulate	201
SO_2	187

[1] Based on diesel fuel consumption of 3900 gallons/day for the equipment and 2100 gallons/day for power generation from 5/15/84 to 8/3/84.

Table 4.3-4

EMISSION FACTORS FOR MOBILE SOURCES

Source	Rate	Pollutant				
		NO_x	HC	CO	TSP	SO_2
Staff Autos[1]	grams/mile	2.44	1.3	12.25	0.35	0.13
Supply Trucks[2]	grams/mile	20.59	2.11	13.14	1.96	2.73
Crew Boat[3]	pounds/gallon	0.27	0.05	0.11	0.035	0.027
Supply Boat[3]	pounds/gallon	0.27	0.05	0.11	0.035	0.027
Tug Boats[3]	pounds/gallon	0.39	0.017	0.09	N/A	0.039
Work Boats[3]	pounds/gallon	0.27	0.05	0.11	0.035	0.027
Helicopters[4]	pounds/LTO	0.57	0.52	5.70	0.25	0.18

[1]Composite Emission Factors (stablized at 45 mph); HC includes crankcase emissions Light Duty Passenger Vehicle, CARB 1979.

[2]Composite Emission Factors (stablized at 45 mph); Heavy Duty Diesel Trucks, CARB 1979.

[3]U.S. EPA Compilation of Emission Factors, AP-42 Table 3.2.3-3 (1/75).

[4]U.S. EPA Compilation of Emission Factors, AP-42 Table 3.2-1-3 (1/75).

Table 4.3-5

OPERATING FACTORS FOR MOBILE SOURCES DURING INSTALLATION OF EUREKA PLATFORM

Source	Activity	Rate Per Day
Staff Autos	10 trips per day with an average commute of 15 miles	300 miles
Supply Trucks	2 deliveries per day with an average trip of 15 miles	60 miles
Crew Boat	2 trips per day at 15 miles and 4.6 gallons per mile	276 gallons
Supply Boat	1 trip per day at 15 miles and 4.35 gallons per mile	130 gallons
Tug Boats	associated with derrick activity to handle material barges	2,100 gallons
	1 trip per day at 15 miles and 4.5 gallons per mile	135 gallons
Work Boats	associated with derrick activity	1,648 gallons
Helicopters	4 trips per day	8 LTO

a. Gas/Diesel Turbines for Electrical Generation and Water Injection

The Plan of Development for Platform Eureka calls for the installation of two new Mars Generators on Elly. The three existing Centaur Generators will become standby for the new Mars Generators. The Saturn turbines used for water injection are located on Platform Elly and no changes on the number of units are anticipated. The turbines are sized to handle the production of crude oil from Ellen and the new Platform Eureka. The turbines will be using both natural gas and diesel fuel. Table 4.3-6 shows the fuel consumption for the Mars and Saturn turbines by year and fuel type. These estimates are based on projected load data and horsepower requirements for the planned drilling and production operations starting in 1985 (Table 4.3-7).

It should be noted that the fuel consumption rate originally projected for SCPI's Beta Field Facilities is less than the fuel actually consumed. This difference is due to greater than anticipated horsepower requirements for both drilling of and (down hole) pumping from highly deviated wells.

The emission factors for the Mars turbines are indicated by load and fuel type in Table 4.3-8 and Figures 4.3-1 and 4.3-2. The total emissions from the Mars and Saturn engines are calculated in Table 4.3-9.

b. Caterpillar 398 Diesel Engines

Caterpillar diesel engines will be used on the drilling platforms to power the drilling rigs. Each rig will be equipped with three of these engines (including the standby), complete with separate circuit aftercoolers.

The drilling rig schedules include the use of only two drilling rigs at any one time. They will be used for drilling and completing wells. There are currently two drilling rigs on the Platform Ellen. One of these rigs will be moved to the new Platform Eureka. The remaining drilling rig on Ellen will be used primarily for well servicing after July 1, 1986. The drilling rig moved to Eureka will be on a drilling schedule until July 1, 1991, then on a well servicing schedule.

Well servicing will be at one-third drilling power and used only 12 hours per day. Based on previous experience by SCPI, it is estimated that 461 hp average power is required per drilling rig while performing all operations required to drill a well. SCPI also estimates that at least one engine would be running at all times while drilling. The operating engine would be running loaded 53 percent of the time and idling 47 percent of the time. Table 4.3-10 shows the distribution of the load factor for the 53 percent of the time the engine is operating.

Table 4.3-6

SCPI BETA PROJECT GAS/DIESEL TURBINE
FUEL CONSUMPTIONS

	Annual Fuel Consumption by Saturn Turbines		Annual Fuel Consumption by Mars Turbines		Total Annual Fuel Consumption	
Year	Diesel 10^3 gal/yr	Gas 10^6 scf/yr	Diesel 10^3 gal/yr	Gas 10^6 scf/yr	Diesel 10^3 gal/yr	Gas 10^6 scf/yr
1985	0	98.6	0	1,038.5	0	1,137.1
1986	0	102.2	0	1,051.2	0	1,153.4
1987	0	116.8	0	1,065.8	0	1,182.6
1988	0	135.1	0	1,087.7	0	1,222.8
1989	0	153.3	0	1,087.7	0	1,241.0
1990	0	167.9	0	1,087.7	0	1,255.6
1991	0	178.9	0	1,102.3	0	1,281.2
1992	0	193.5	0	1,109.6	0	1,303.1
1993	0	208.1	0	1,122.0	0	1,330.1
1994	0	215.4	3,321.7	657.0	3,321.7	872.4
1995	0	226.3	3,296.0	657.0	3,296.0	883.3
1996	0	233.6	3,265.3	657.0	3,265.3	890.6
1997	0	240.9	3,234.6	657.0	3,234.6	897.9
1998	352.6	200.8	3,219.3	657.0	3,571.9	839.5
1999	781.8	146.0	3,188.6	657.0	3,970.4	803.0
2000	1,042.4	116.8	3,158.0	657.0	4,200.4	773.8
2001	1,395.0	73.0	3,127.3	657.0	4,522.3	730.0
2002	1,686.3	36.5	3,112.0	657.0	4,798.3	693.5
2003	1,870.3	18.3	3,081.3	657.0	4,951.6	675.3
2004	2,070.0	0	3,204.0	638.8	5,274.0	638.8
2005	2,070.0	0	3,189.0	638.8	5,259.0	638.8

Source: Based on operation and production characteristics provided by SCPI, November 1983.

Table 4.3-7

SCHEDULE OF LOAD AND FUEL ASSIGNMENTS FOR THE MARS GAS/DIESEL ENGINES

Year	Mars Engines		
	Unit #1 (kW)	Unit #2 (kW)	Total (kW)
1985	4,083	4,083	8,166
1986	4,388	4,388	8,775
1987	4,508	4,508	9,015
1988	4,659	4,659	9,318
1989	4,685	4,685	9,370
1990	4,697	4,697	9,393
1991	4,775	4,775	9,549
1992	4,854	4,854	9,707
1993	4,935	4,935	9,870
1994	6,364	3,193*	9,557
1995	6,364	3,485*	9,894
1996	6,364	3,430*	9,974
1997	6,364	3,364*	9,728
1998	6,364	3,311*	9,675
1999	6,364	3,255*	9,619
2000	6,364	3,187*	9,551
2001	6,364	3,115*	9,479
2002	6,364	3,089*	9,453
2003	6,364	3,026*	9,390
2004	6,082	3,278*	9,360
2005	6,082	3,263*	9,345

*Indicates engine runs on diesel fuel instead of gas fuel.

Source: SCPI, November 1983.

Table 4.3-8

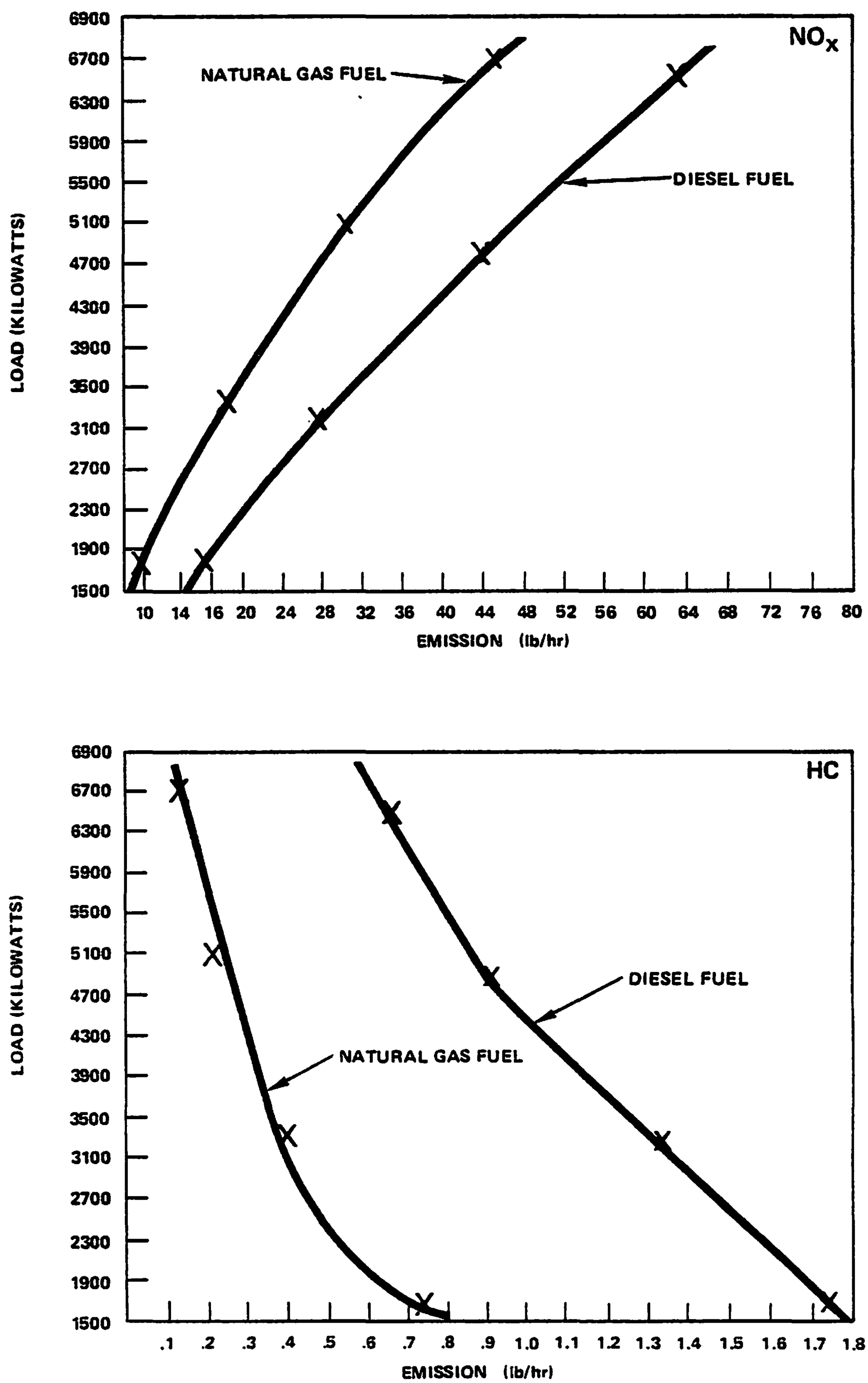
EMISSION FACTORS FOR MARS GAS/DIESEL ENGINES

Pollutant	For Diesel Fuel (load kW)			
	6508	4881	3254	1627
	Emission pounds/hour			
NO_x	62.97	44.55	28.38	15.68
HC	0.66	0.90	1.33	1.76
CO	0.90	0.65	0.42	0.24
SO_2[1]	8.38	6.99	5.59	4.23

Pollutant	For Gas Fuel (load kW)			
	6764	5073	3382	1691
	Emission pounds/hour			
NO_x	45.25	30.19	18.10	9.47
HC	0.14	0.22	0.38	0.73
CO	0.43	0.74	1.46	3.78
SO_2	0	0	0	0

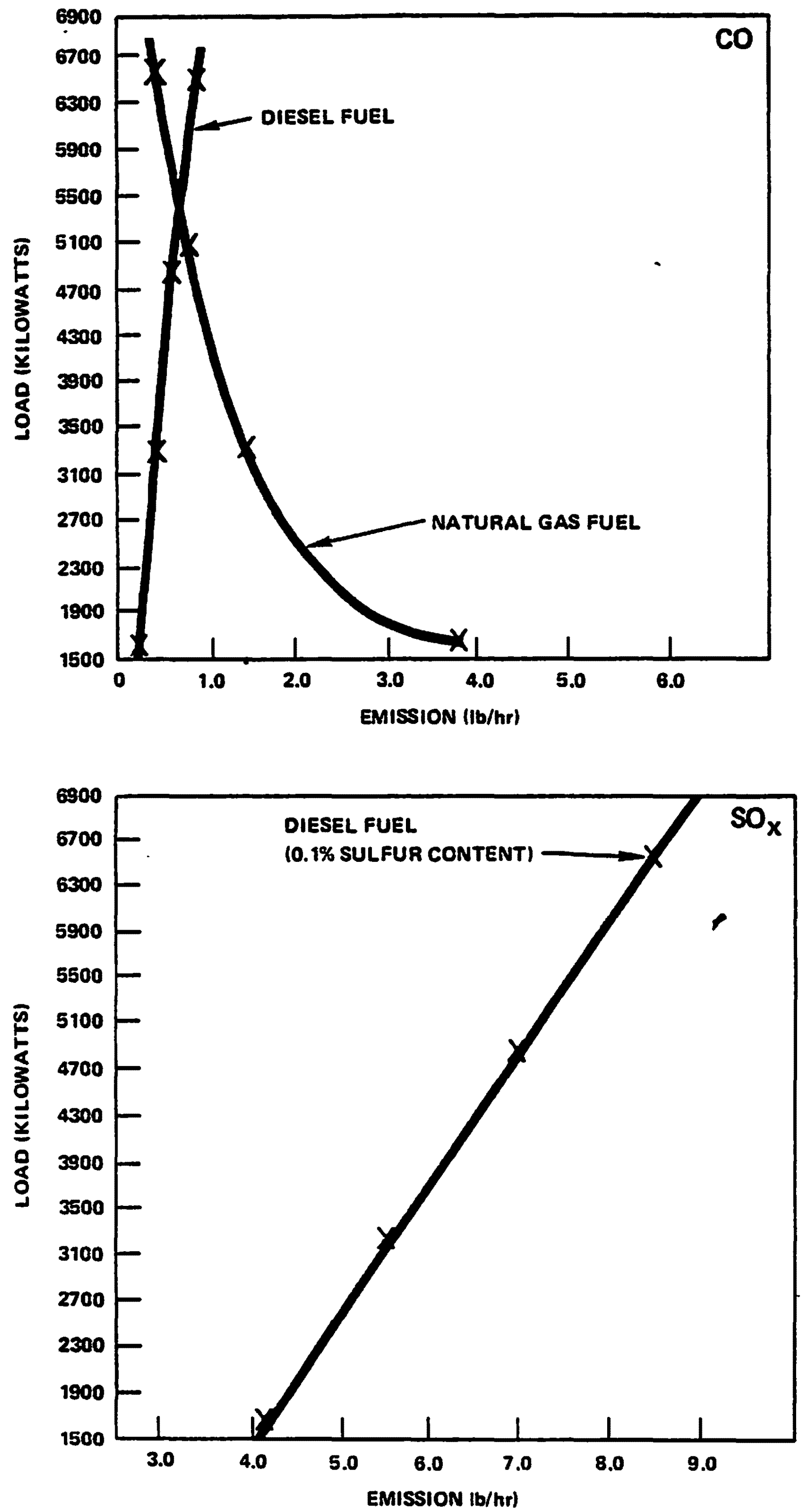
Source: Data supplied by Solar Turbines International, June 22, 1983.

[1]Emissions for 0.1 percent sulfur in fuel.



Mars Turbine Nitrogen Oxide and Hydrocarbon Emissions

FIGURE 4.3-1



Mars Turbine Carbon Monoxide and Sulfur Dioxide Emissions

FIGURE 4.3-2

Table 4.3-9

MARS[1] AND SATURN[2] TURBINE EMISSIONS

	NO_x tons/year			HC tons/year			CO tons/year			Particulate[3] tons/year			SO_2 tons/year		
Year	Mars	Saturn	Total	Mars	Saturn	Total	Mars	Saturn	Total	Mars[2]	Saturn	Total	Mars	Saturn	Total
1985	197.1	20.4	217.5	2.7	2.1	4.8	9.6	5.7	15.3	7.3	0.7	8.0	0	0	0
1986	219.0	21.1	240.1	2.5	2.1	4.6	8.8	5.9	14.7	7.4	0.7	8.1	0	0	0
1987	227.8	24.1	251.9	2.4	2.5	4.9	8.3	6.7	15.0	7.5	0.8	8.3	0	0	0
1988	236.5	27.9	264.4	2.4	2.8	5.2	7.9	7.8	15.7	7.6	0.9	8.5	0	0	0
1989	238.0	31.7	269.7	2.3	3.2	5.5	7.9	8.8	16.7	7.6	1.1	8.7	0	0	0
1990	240.9	34.7	275.6	2.3	3.5	5.8	7.4	9.7	17.1	7.6	1.2	8.8	0	0	0
1991	245.3	36.9	282.2	2.3	3.8	6.1	7.4	10.3	17.7	7.7	1.3	9.0	0	0	0
1992	249.7	40.0	289.7	2.2	4.1	6.3	7.4	11.1	18.5	7.8	1.4	9.2	0	0	0
1993	254.0	43.0	297.0	2.1	4.4	6.5	7.2	12.0	19.2	7.9	1.5	9.3	0	0	0
1994	300.0	44.5	344.5	6.6	4.5	11.1	4.0	12.4	16.4	12.9	1.5	14.4	24.8	0	24.8
1995	313.2	46.7	359.9	6.2	4.8	11.0	4.2	13.0	17.2	12.8	1.6	14.4	25.4	0	25.4
1996	308.8	48.2	357.0	6.3	4.9	11.2	4.1	13.4	17.5	12.8	1.6	14.4	25.2	0	25.2
1997	306.6	49.7	356.3	6.4	5.1	11.5	4.1	13.9	18.0	12.7	1.7	14.4	25.0	0	25.0
1998	304.4	53.4	357.7	6.4	5.2	11.6	4.1	14.2	18.3	12.6	2.3	14.9	25.8	2.5	28.3
1999	302.2	56.7	358.9	6.5	5.3	11.8	4.0	14.4	18.4	12.6	3.0	15.6	24.5	5.5	30.0
2000	300.0	59.5	359.5	6.6	5.4	12.0	4.0	14.7	18.7	12.5	3.4	15.9	24.1	7.3	31.4
2001	297.8	62.4	360.2	6.6	5.4	12.0	3.9	15.0	18.9	12.4	4.0	16.4	23.9	9.8	33.7
2002	295.6	64.7	360.3	6.7	5.5	12.2	3.9	15.1	19.0	12.4	4.5	16.9	23.9	11.8	35.7
2003	291.3	67.2	358.5	6.7	5.6	12.3	3.9	15.5	19.4	12.3	4.8	17.1	23.4	13.1	36.5
2004	293.5	70.2	363.7	6.5	5.8	12.3	4.2	16.0	20.2	12.5	5.2	17.7	24.7	14.5	39.2
2005	291.3	70.2	361.5	6.6	5.8	12.4	4.2	16.0	20.2	12.4	5.2	17.6	24.7	14.5	39.2

[1] Mars emissions based on Tables 4.3-7 and 4.3-8.

[2] Saturn emissions based on Table 4.3-6 and AP-42 Table 3.3.1-2.

[3] Mars particulate emissions based on AP-42 Table 3.3.1-2.

Table 4.3-10

LOAD FACTOR FOR CATERPILLAR D398 ENGINE WHEN USED FOR DRILLING[1]

Percent of Running Time[2]	Percent of Full Load[2]
30	100
15	75
30	50
25	25

[1]Source: Shell Oil Company, 1978.

[2]One diesel engine will be running loaded 53 percent of the time—these columns showing a distribution of the load time. The engine will be idling 47 percent of the time.

Table 4.3-11

EMISSION FACTORS FOR CATERPILLAR D398 DIESEL ENGINES[1]

Pollutant	Load Factor (%)				
	100	75	50	25	Idle
	Emission (pounds/hour)				
SO_2[2]	0.69	0.40	0.27	0.13	0.03
HC	0.11	0.10	0.12	0.29	0.88
CO	2.43	1.98	1.98	3.31	4.85
NO_x	8.45	5.16	3.64	1.75	0.15
Particulate	0.17	0.11	0.10	0.10	0.09

[1]Data supplied by Caterpillar Tractor Company, 1978.

[2]Emission factors based on use of 0.1 percent sulfur diesel fuel.

The emission data displayed in Table 4.3-11 are based on emission factors obtained from manufacturers' test data and include all operations phases that the Caterpillar engines would experience (i.e., tripping, drilling, waiting on cement, etc.).

c. Primary Operating Emissions Summary

Based on Tables 4.3-9 and 4.3-12, the highest NO_x, HC, SO_2 and particulate emissions will occur with the years 2004 and 2005, and the highest CO emissions will occur in the year 1985. The peak NO_x, HC, SO_2 and particulate emissions occurs because of the peak in electrical power usage and the diesel fuel usage for the Mars turbines. The peak of CO emissions is due to the operation of the Caterpillar diesel engines used during the drilling activities. The average annual emissions along with the worst case emissions from the electrical, water injection turbines and diesel drilling engines are indicated in Table 4.3-13. The total maximum discharge of emissions will occur in the year 1994.

4.3.3.2 Offshore Emissions - Other Sources

SCPI estimates that spillage of crude and lubricating oil on the platform will be extremely limited. This is based upon their experience with offshore operations and similar projects. A worst-case estimate of 100 barrels per year has been used in this analysis. Virtually all of this is expected to be recovered and transported ashore for disposal in approved onshore disposal facilities. The hydrocarbon emissions from a 100-barrel spill, assuming a 2 percent vaporization, is less than 668 pounds (303 kg) per year (Sivader and Mikolaj, 1973).

Preliminary estimates by SCPI for the early years of production show that 2 percent of the natural gas intended to be reinjected will probably be flared because of compressor malfunctions and irregular flow rates inherent in producing operations. This equates to a maximum of $31.5 \times 10^6 ft^3$/year ($8.9 \times 10^5 m^3$) of gas that will be flared. This quantity will be significantly reduced as gas production from the field diminishes and gas is not available for reinjection. SCPI has installed a smokeless flare with a liquid knock-out drum at Platform Elly; any collected oil is recycled. Platform Eureka will have a similar flare and liquids knockout for purges of the system. The gas burning rate of the flare will be $0.018 \times 10^6 ft^3$/day. Pollutant emissions from gas flaring operations are summarized in Table 4.3-14.

Well servicing may take place up to four times per year per well. These operations will release small quantities of methane and some nonmethane hydrocarbons (NMHC). A conservative estimate of NMHC released from each well is 200 pounds/year

Table 4.3-12

CATERPILLAR D398 DIESEL ENGINE EMISSIONS

Year	Emission (tons/year)				
	NO_x	HC	CO	Particulate	SO_2[1]
1985	19.3	2.0	26.4	2.0	1.5
1986	18.3	1.9	25.0	1.9	1.4
1986-1990	13.5	1.4	18.5	1.4	1.1
1991	8.6	0.9	11.8	0.9	0.7
1992-2005	3.8	0.4	5.2	0.4	0.3

[1]Based on sulfur content of diesel fuel at 0.1 percent sulfur.

Table 4.3-13

SCPI BETA PROJECT GAS/DIESEL TURBINE/ENGINE EMISSIONS

Pollutant	Annual Average Emissions (tons/year)	Worst-Case Emissions (tons/year)
NO_x	319.2	360.3
HC	9.1	12.4
CO	17.7	20.2
TSP	12.7	17.7
SO_2	17.8	39.2

Table 4.3-14

EMISSIONS FROM GAS FLARING

Pollutant	Emission Factor[1] (pounds/10^6 scf)	Emission (tons/year) Maintenance Purging	Malfunctions	Total
NO_x	100.0	<0.40	2.0	2.4
HC	8.0	<0.03	0.1	0.1
CO	20.0	<0.07	0.3	0.3
Particulate	5.0	<0.02	0.1	0.1
SO_2	0.6	<0.01	0.1	0.1

[1]U.S. Environmental Protection Agency Compilation of Emission Factors, AP-42, Table 1.4-1.

Table 4.3-15

OPERATIONS PHASE EMISSIONS FROM MOBILE SOURCES

Source	Operating Rate Per Day	Emissions (tons/year) NO_x	HC	CO	TSP	SO_2
Crew/Supply Boat	276 gallons	13.6	2.5	5.5	1.8	1.4
Work Boat	138 gallons	6.8	1.3	2.8	0.9	0.7
Helicopter	8 LTO	0.8	0.8	8.3	0.4	0.3
Supply Truck	30 miles	0.2	0.03	0.2	0.02	0.03
Staff Autos	90 miles	0.1	0.05	0.4	0.01	0.005
Total[1]		21.5	4.7	17.2	3.1	2.4
Total[2]		43.0	9.4	34.4	6.2	4.8

[1]For current Ellen and Elly platform operations.

[2]For total SCPI Beta Field operations (double current rate). This will be considered the maximum rate.

per well (90.7 kg/yr), or less than 12 tons per year (10.8 mt) with all 120 wells in production on both Platforms Ellen and Eureka.

Fugitive total hydrocarbon (THC) emissions will occur from inadvertent leaks that occur at valves, connections, seals, etc. A count of these components proposed for Platform Eureka was made and emission factors from "Fugitive Hydrocarbon Emissions From Petroleum Production Operation," prepared by the American Petroleum Institute, March 1980 applied to estimate these emissions. Total fugitive hydrocarbon emissions including methane and ethane were calculated to be 103.76 pounds per day (see Table 4.3-16).

An indirect air quality impact is emissions associated with the mobile sources used in support of platform activities. These mobile sources include the crew/supply boat, work boat, helicopter, supply truck and staff automobiles. The current operating rates for these activities in support of the Platforms Ellen and Elly are 19 crew/supply boat trips per week, 28 helicopter trips per weeks, and 21 automobile trips per week. These operating rates will decrease after the drilling phase on Platform Ellen is completed. With the addition of Eureka, the operating rates of the mobile units in the entire Beta Field would be expected to double; however, the crew/supply boat, work boat, and helicopter may call on both platforms on each trip, thereby reducing the number of trips. The current mobile emissions from Platforms Ellen and Elly, and future mobile emissions from the three platforms in the Beta Field are indicated in Table 4.3-15.

4.3.3.3 Onshore Emissions

One 10,000-barrel (1590 m^3) capacity crude oil surge tank was constructed in the Port of Long Beach for this project. SCPI installed a tank equipped with a double-seal floating roof which will meet or exceed SCAQMD requirements, as outlined in Rule 463, for floating roof tanks. Floating-roof tanks reduce evaporative storage losses by minimizing vapor spaces. The tank consists of a welded or riveted cylindrical steel wall, equipped with a deck or roof which is free to float on the surface of the stored liquid. The roof then rises and falls according to the depth of stored liquid. To ensure that the liquid surface is completely covered, the roof is equipped with a sliding seal which fits against the tank wall. Sliding seals are also provided at support columns and at all other points where tank appurtenances pass through the floating roof. Floating-roof tanks produce two types of hydrocarbon vapor emissions. A "standing" loss occurs when vapors escape from between the outer side of the sealing ring on the floating roof and the inner side of the tank wall. A "wetting" loss occurs when the

Table 4.3-16

PLATFORM FUGITIVE EMISSIONS

Process Component	Service	Emission Factor[1] (lb/day/component)	Number of Components	THC[2] Emissions (lb/day)
Valves Type				
Gate	gas	.212 E +00	184	39.01
Gate	oil	.284 E -02	6	0.02
Ball	gas	.134 E -01	159	2.13
Ball	oil	.164 E -03	121	0.02
Plug	gas	.581 E -01	240	13.94
Globe	gas	.243 E +00	18	4.37
Globe	oil	.309 E -02	20	0.06
Needle	gas	.401 E -01	431	17.28
Needle	oil	.482 E -03	201	0.10
Check	gas	.375 E -01	155	5.81
Check	oil	.444 E -03	34	0.02
Choke	gas	.375 E -01	60	2.25
Mult.	gas	.797 E -04	2	0.00
Relief	gas	.123 E -02	33	0.04
Relief	oil	.147 E -04	11	0.00
Connections				
Raised and Flatface	gas	.329 E -02	577	1.90
Raised and Flatface	oil	.781 E -04	543	0.04
Ring flanges	gas	.150 E -05	1,623	0.00
Union	gas	.297 E -01	120	3.56
Threaded	gas	.136 E -01	668	9.08
Threaded	oil	.330 E -03	353	0.12
Diaphrams (valve operator)	gas	.170 E +00	8	1.36
Sight Glass	gas	.241 E -02	34	0.08
Hatches (flat gasket)	gas	.104 E -01	11	0.11
	oil	.311 E -02	6	0.02
Seals				
Rotating shaft	oil	.427 E -03	13	0.01
Packings	oil	.111 E -03	13	0.00
Reciprocating rod	gas	.112 E +01	2	2.24
Packings	gas	.965 E -01	2	0.19
			Total (lb/day) =	103.76

[1]Emission factors from Volume 1, Fugitive Emissions from Petroleum Production Operations, March 1980, API.

[2]Total hydrocarbon emissions including methane and ethane.

floating roof moves toward the bottom of the tank during emptying. As the roof descends, a small quantity of crude oil is left on the walls of the tank, some of which evaporates when exposed to the atmosphere. According to the SCAQMD, a double seal system is accepted as "Best Available Control Technology" (BACT), and results in emission reductions of greater than 90 percent over unsealed tanks. This technique was used for the surge tank.

With the addition of Platform Eureka, no increase in emissions will occur from this source.

The following equation, from EPA AP-42, Supplement 12, Section 4.4.2.3.1, was utilized to calculate the standing storage losses from the 10,000 barrel surge tank.

$$L_S = K_S V^N P^* D M_V K_C E_F$$

where

L_S = Loss in lbs/yr

K_S = Seal factor = 0.2 (Metallic shoe seal with rim-mounted secondary seal)

V = Average wind speed at side = 6 mi/hr

N = Seal related wind speed exponent = 1.0

P^* = Vapor pressure function

$$= \frac{\frac{P}{P_A}}{(1 + (1 - \frac{P}{P_A})^{.5})^2}$$

where P = true vapor pressure

P_A = average atmospheric pressure

P = 1.1 psia at 65°F, P_A = 14.7 psi, P^* = 0.038

D = Tank diameter = 40 feet

M_V = Average vapor molecular weight = 71.5 lb/lb-mole at 113°F (Table 4.3-17)

K_C = Product factor = 0.4 (for crude oil)

E_F = Secondary seal factor = 1.0

Table 4.3-17

ESTIMATED COMPOSITION OF SCPI BETA CRUDE OIL VAPOR AT 113°F

Components	Percent By Weight (%)
Methane	0
Ethane	0.1
Propane	4.9
Isobutane	6.7
n-Butane	19.1
Isopentane	18.6
n-Pentane	18.5
2,2-Dimethylbutane	0.1
2,3-Dimethylbutane	1.0
2-Methylpentane	7.6
Cyclopentane	2.8
3-Methylpentane	5.9
n-Hexane	5.0
2,4-Dimethylpentane	0.1
Methylcyclopentane	6.9
$C^{+}6$	2.7

Therefore,

L_S = 52.2 lbs/year.

From EPA AP-42, Supplement 12, the withdrawal loss from external floating roof tanks can be estimated by the equation:

$$L_W = \frac{(0.943)\ Q\ C\ W_L}{D}$$

where

L_W = Withdrawal loss in lb/year

Q = Average throughput = 120,000 bbl/yr

C = SCPI Clingage factor = 0.0060 (light rust)

W_L = Average liquid density = 7.9 lb/gal at 65°F

D = Tank diameter = 40 feet

Therefore,

L_W = 134.1 lbs/year

The total standing storage and withdrawal losses are summarized in Table 4.3-18.

The platform-to-shore pipeline will be cleaned and serviced once per month using a device called a "pig". This process will release approximately 5 barrels (0.8 m^3) of crude oil into an open 20-barrel (3.2 m^3) "pig" catcher each time the pipeline is cleaned. Such operations will produce a negligible amount of fugitive hydrocarbons.

Woffinden (1976) measured fugitive heavy hydrocarbon leak rates of 0.34 lb (0.15 kg) per day from the 4000 barrel per day ARCO Elwood facility. In addition, he estimated that only 0.33 lb (0.16 kg) per day would be lost from a proposed 20,000 barrel per day facility. Thus, fugitive emissions from pumps, seals, and valves are anticipated to produce a negligible amount of hydrocarbons.

Emissions from additional onshore commercial electric power generation used to provide power to operate the pumps at the distribution facility are difficult to quantify due to the interconnected nature of the electrical generation network. However, the SCAQMD (1977) has addressed a method to estimate emissions due to the power requirement of the pumps. The power requirement is an additional 9600 kW-hours per day based on the demand of the onshore pumps (estimated to be 400 kW).

Table 4.3-18

ESTIMATED ONSHORE SURGE TANK LOSSES

	Emissions (pounds/year)
Standing Storage Losses	52.2
Withdrawl Losses	134.1
Total Annual Losses	186.3

Table 4.3-19

RELATED POWER PLANT EMISSIONS FACTORS
FOR BETA ONSHORE
ELECTRIC POWER REQUIREMENTS

Pollutant	Emission Factor (pounds/MW hour)
NO_x	2.5
SO_x	2.61
Particulate Matter	0.5
HC	0.2

Source: SCAQMD (1977).

Fuel burned is assumed to be 0.25 percent sulfur fuel oil. The emission factors for the power plant emissions are listed in Table 4.3-19.

The total annual emissions associated with all offshore and onshore operations of the SCPI Beta project are summarized in Table 4.3-20.

4.3.4 Impact Analysis Models

The platform will be located approximately 8.4 miles from the nearest landfall. The DOI regulation would therefore exempt from further impact analysis nitrogen oxides, sulfur oxides, volatile organic compound, or particulate matter which do not exceed 279.7 tons per year (8.4 miles x 33.3). The DOI exemption for carbon monoxide would be 14,060 tons per year ($3400 \times 8.4^{2/3}$). Nitrogen oxides at 410.1 tons per year was the only pollutant requiring dispension modeling.

A modified MTPER Gaussian dispersion model was used to predict the annual average nitrogen dioxide (principle project-generated pollutant) onshore impacts. This model is an approved U.S. Environmental Protection Agency (EPA) model which was modified to meet the Minerals Management Services requirements of reduced dispersion of pollutants which occurs over large bodies of water (see Appendix B). Since the closest land mass is approximately 13 km from Elly an array of receptor sites located on semi-circles ranging from 13 to 20 km was used. These semi-circles were located on an axis from northwest to southeast, which best approximates the coast land mass relative to Elly. The impacts at 540 sites were calculated (15 semi-circles from 13 to 20 km and 36 points per semi-circle, at 5° intervals). Nitrogen oxide emissions from both Mars turbines and the three Saturn turbines located on Elly as well as diesel auxillary engines located on Ellen and Eureka were used as a worst-case emission rate. All other pollutants are emitted at a much lesser rate ranging from 7 to 16 times lower than the nitrogen oxide emissions. The highest annual average predicted nitrogen oxide impact was 0.34 micrograms per cubic meter of atmosphere. This level is below the significance level of 1.0 microgram per cubic meter used by the U.S. EPA for the Prevention of Significant Deterioration (PSD) program. Therefore, the conclusion of the modeling study is that there will be no significant impact to the annual average nitrogen dioxide level on the shore area surrounding the Shell Beta field. The other pollutants would, likewise, have a lower impact rate than the nitrogen oxide values predicted by the model.

4.3.5 Mitigation of Impacts

The primary mitigation measure will be a nitrogen dioxide offset available from the Shell Wilmington Manufacturing Complex in Los Angeles County. These

Table 4.3-20

OPERATIONS PHASE EMISSION SUMMARY

Activity	Emissions (tons/year) (pounds/day) NO$_x$		HC		CO		Particulate		SO_2	
Production[1]	360.3	(1,974.2)	31.3	(171.7)	20.2	(110.7)	17.7	(97.0)	39.2	(214.8)
Platform[2]	319.2		23.0		17.7		12.7		17.8	
Gas Flaring	2.4	(13.0)	0.1	(0.5)	0.3	(1.6)	0.1	(0.6)	0.1	(0.5)
Well Servicing	—		12.0	(65.8)	—		—		—	
Platform Oil Spill	—		0.33	(1.8)	—		—		—	
Crew Boats and Helicopters	42.4	(232.0)	9.3	(51.0)	33.2	(182.0)	6.2	(34.0)	4.8	(26.0)
Staff Autos and Supply Truck	0.6	(3.3)	0.16	(0.9)	1.2	(6.6)	0.06	(0.3)	0.07	(0.4)
Onshore Tankage	—		0.1	(0.5)	—		—		—	
Onshore Electric Power Generation	4.4	(24.1)	0.3	(1.6)	—	—	0.9	(4.9)	4.6	(25.2)
Totals[1,3]	410.1	(2,247.1)	53.6	(293.8)	54.9	(300.8)	25.0	(136.8)	48.8	(267.2)
	369.0		45.3		52.4		20.0		27.4	

[1] Maximum yearly emissions per Table 4.3-9 and fugitive hydrocarbon emissions per Table 4.3-16.

[2] Average annual emissions.

[3] Second row of numbers represents average emission per Table 4.3-13 expressed in tons/year.

offsets are the result of emission reductions previously made by SCPI and documented by the South Coast Air Quality Management District (SCAQMD). A ratio of 1.5 pounds of nitrogen dioxide at Wilmington for each 1.0 pounds generated at the Beta Field due to the operation of Platform Eureka is required. This added amount of net reduction is required to show a net air quality improvement in the overall South Coast Air Basin.

The use of turbine engines for electricity generation results in a significant improvement in emissions compared to conventional diesel engines. Typically nitrogen dioxide emissions are 10 times lower from a turbine than a comparable diesel engine. Additional reduction of nitrogen dioxide emissions from turbine engines can be achieved with use of water injection which prevents the formation of nitrogen oxides. This has been investigated by SCPI and proven to be excessively expensive in this application to be considered as "Best Available Control Technology" for this facility (see Radian Corporation Report, August 1, 1983, Appendix B).

Inspection and maintenance of valves, flanges, and other fittings is a safety requirement on platforms. This will significantly reduce the amount of fugitive hydrocarbon escaping to the atmosphere.

4.4 OCEANOGRAPHY AND WATER QUALITY

4.4.1 Effect of Sea Conditions on the Proposed Project Activities

4.4.1.1 Impacts on Installation, Drilling and Production Operations

Oceanographic parameters in the project region are not expected to significantly impact the proposed construction of the platform or the interconnecting subsea pipeline. However, the San Pedro Channel can be exposed to waves generated by North Pacific storms, as well as the occasional southern Pacific swells. Construction activity involving the platform and pipeline may be restricted in rough weather. Any operation involving, ships, crews, supply boats and barges may have limited access to the platform during adverse weather conditions.

As a component of the Oil Spill and Emergency Contingency Plan, SCPI will submit a Critical Operations and Curtailment Plan for Platform Eureka. The intent of this plan will be to minimize as far as practicable the performance of certain critical drilling operations during periods when wind and/or sea state would seriously interfere with communications or transportation to the platform of any material needed in an emergency. Critical operations are defined as those operations where a significant spill potential exists.

Normal currents and tidal fluctuations in the San Pedro Channel should have no effect on drilling or production activities. Pipelines will be designed and constructed to resist recurring environmental loading resulting from steady-state and wave induced currents, mudslides and seismic activity.

4.4.1.2 Oil Spills

In the event of an oil spill from the platform or subsea pipeline during severe weather conditions, oil spill containment and cleanup operations would be severely impeded. Wind action will affect the rate of dispersal and movement of oil slicks on the surface, and will also generate localized short-period seas affecting the performance of spill response equipment. The deployment of containment booms and skimmers is seriously limited by waves in excess of 1.8 m (6 feet). Only the largest open ocean booms and skimmers can be used on these occasions and the safe deployment of the equipment is of concern. The implementation of the cleanup and control measures described in the Oil Spill and Emergency Contingency Plan will reduce the impacts on water quality should an accidental release of oil occur.

4.4.2 Effects of the Proposed Project on Physical Oceanography

Oceanographic parameters in the project region are not expected to be significantly impacted by the proposed project. The physical behavior of currents, tides and waves will not be affected by the platform or pipeline except in an extremely localized manner. The presence of the platform causes some minor turbulance in the immediate vicinity of the structure. This turbulence may contribute to the rapid dispersion of material emitted into the ocean and a localized redistribution of sediments. No distinguishable impacts will be detected away from the platform.

The discharge of drilling fluids, drill cuttings, treated sewage, deck drainage and domestic waste waters would have a negligible impact on local temperature, salinity and conductivity profiles. It is expected that nutrients and trace metals will be incrementally increased in the local marine environment. The primary sources of these materials are sewage effluent, deck drainage, and drilling fluid disposal.

The impact should be minor to negligible. Dilution of the discharged material of 5000:1 to 100,000:1 within 100 m (330 feet) of this discharge point have been reported for similar discharges (Ecomar, 1978).

4.4.3 Effects of the Proposed Project Activities on Water Quality

4.4.3.1 Introduction

The proposed project will impact water quality in the vicinity of the proposed platform during installation of the platform and subsea pipeline by the discharge of drilling mud and cuttings, by discharge of treated sewage, and by other normal operating activities discussed in Section 4.4.3.2. A diesel fuel spill from construction equipment, although unlikely, could potentially pose a water quality impact on offshore water and coastal streams and wetlands.

All of the wastes discharged from the platform will be in accordance with the effluent limitations and monitoring requirements set forth in either an individual or a General NPDES Discharge Permit, issued by Region IX of the EPA on February 18, 1982 and as amended on December 8, 1983. An NPDES permit sets limits on the type and amounts of substances that may be discharged to receiving waters and require that the discharge comply with the monitoring and reporting program described in the permit. Such discharges could contain traces of hydrocarbons (an average of 50 ppm). All other oil contaminated substances will be containerized and transported to shore for disposal at a state approved disposal site.

4.4.3.2 Platform Eureka

- Turbidity Impacts During Installation

The initial platform-jacket placement and erection, which will be completed approximately 4 weeks after initiation, is expected to have only a temporary impact on water quality at the platform site, and as such, will not be discussed in detail or considered potentially detrimental. The magnitude and extent of the short-term turbidity resulting from construction and assembly activities depends on the nature of the substrate, sediment grain size, prevailing current, and the nature and duration of the activity. Adverse impacts can result when bottom materials are resuspended and pollutants in the sediment are remobilized into the water column.

- Liquid and Solid Wastes During Installation Activities

Sanitary sewage generated during platform and subsea pipeline installation would be processed by U.S. Coast Guard-approved treatment units located on the work vessels. Treated effluents would be intermittently discharged to the ocean in accordance with EPA and Coast Guard requirements. These sanitary waste discharges would be rapidly dispersed by surface currents and waves, resulting in no detectable degradation of water quality within 5-10 m from the discharge point. Thus, ocean water quality would not be affected significantly.

Potable water requirements on the order of 6426 liters (1700 gallons) per day during platform installation and approximately 5677 liters (1500 gallons) per day during subsea pipeline installations would be met by desalinization units onboard the work vessel. The brine wastewater stream would be generated at a ratio of 6:1 (brine:potable water), with a discharge salinity of 40 parts per thousand. Upon discharge to the ocean, the brine would tend to sink because of its slightly higher density. Complete mixing and dispersion of the brine plumes is expected to occur within a distance of a few meters from each plume centerline. Thus, the effect of brine discharges at these levels on water quality during installation is expected to be of negligible significance.

In addition, the new platform would require approximately 775,900 to 946,000 l (200,000 to 250,000 gallons) of seawater for hydrostatic testing prior to the initiation of drilling. After use, hydrostatic test water would be discharged to the ocean in accordance with an NPDES permit.

Hydrostatic test water may include small quantities of oil and grease (used as a lubricant or coating) and trace metals. As a result, the concentrations of these materials in discharged test water may slightly exceed those normally found in seawater. However, test water concentrations of these materials are not expected to be significantly higher than concentrations in seawater; and the materials would be dispersed shortly after the test water is discharged. Thus, within hours after release of test water, there would be no detectable increase in these materials in receiving waters and no significant impact on ocean water quality.

All other liquid effluents will be collected in containers and shipped to shore. These effluent would be hauled by tank truck to an EPA approved disposal site.

- Liquid and Solid Effluent During Platform Operations

The liquid and solid effluents generated when the platform is fully complemented with personnel during platform operations are described in Section 2 of this report. In summary, these effluent are:

Effluent	Average Quantity
Drilling mud	900 bbl/well
Cuttings	6,000 ft^3/well
Completion fluid	600 bbl/well
Sanitary effluent	85 bbl/day
Domestic effluent	190 bbl/day
Produced water	4,000 bbl/day
Seawater distillation brine	50 gal/minute
Engine and pump room drainage[1] and washwater (deck drainage)	3,600 bbl/day
Filter backwash	2-30 bbl/day
Cement slurry	150 gal/day

[1] The quantities are an estimated average discharge. Daily quantities will vary primarily due to rainfall.

There is substantial documentation on the impacts of offshore mud and cuttings disposal summarized in the Symposium: Research on Environmental Fate and Effects of Drilling Fluids and Cuttings Volume I and II, 1980 (API, 1980). Chemical and physical properties of drilling mud and cuttings may locally degrade ocean water quality by the following ways:

1. Increase trace metal concentrations such as barite, cadmium, copper, lead and mercury;
2. High dissolved oxygen demand;
3. Raised temperature;
4. Increased light attenuation;
5. Reduced hydrogen ion concentration (elevated pH, sodium hydroxide); and
6. High concentrations of organic carbon, total nitrogen and phosphorous.

Each well drilled from Platform Eureka during its drilling program is expected to produce approximately 225 m^3 (6000 cubic feet) of drill cuttings. These cuttings will be thoroughly washed to remove (and recover) fines, drilling mud, and oil and grease, then periodically discharged to the ocean through a vertical pipe or cuttings chute whose terminus would be approximately 60 m (200 feet) below the ocean surface. A minor increase in local water column turbidity will result during periods of cuttings disposal, with no significant impact anticipated. All oil contaminated cuttings will be shipped to shore and trucked to an approved disposal site. Thus, oil contaminated cuttings disposal will not impact ocean water quality.

During drilling, clean water-based muds and completion fluid will periodically be discharged to the ocean at a discharge rate of 1500 bbl (total) per well. These quantitites of used drilling muds would be discharged into the ocean through the cuttings chute in accordance with a NPDES permit and in conformance with OCS Order No. 7. Any oil contaminated drilling mud will be collected and shipped to shore for disposal at an approved disposal site.

The dilution and dispersion of the drilling mud discharge plume depends on the rate and volume of discharge, depth of discharge, ocean current velocity, and suspended solids concentration. Studies on the dispersion of discharged drilling muds have shown that dilution occurs rapidly and that background concentration levels of the mud components are reached within short distances of the discharge point. Ayers et al. (1980) examined mud being released at a rate of 1000 bbl per hour, and found suspended solids and trace metal concentrations reaching background levels by 1000 m (3280 feet) from the discharge source. The discharged mud forms two plumes. The lower plume contains the bulk of the discharged material and descends quickly to the seafloor. As the lower plume descends, an upper near-surface plume is generated by the turbulent mixing of the lower plume with seawater. This upper plume is several meters thick and persists in the water column and gradually is dispersed by currents. Light transmittance and suspended solids concentration appear to be the only water quality parameters affected by the discharge. All other hydrographic variables remained unchanged from ambient conditions within the monitored interval of 40 to 1500 m (131 to 4920 feet). Results of these were reported in the proceedings of the symposium "Research on the Environmental Fate and Effects of Drilling Fluids and Cuttings" (API, January 1980), and suggest that because of rapid dilution, discharged muds do not result in significant effects on water quality. The available literature suggests that drilling mud from the proposed platform would not have significant or lasting effects on ocean water quality (refer to Section 4.6, Marine Biology, for a discussion on drilling mud and cuttings toxicity).

Cement slurry will be discharged to the ocean without further treatment. Estimates for excess cement slurry volumes are difficult to make but should not exceed 21 m^3 (27.4 cubic yards) per completed well. This will not be a continuous discharge and will take place when well casing is being cemented. This will have no adverse effect on water quality.

All sanitary and domestic wastes will be treated prior to release with a chlorine residual maintained at approximately 1 mg/l and thus will have a minimum impact on water quality. Treated wastewater from these sources will be discharged through a disposal caisson. Galley discharges will pass through grease traps before treatment and discharge. Due to the distance of the site from the shoreline and the dilution factors involved, no detrimental effects on water quality are anticipated.

All deck drainage will be routed to the sump system. Oily water and liquid hydrocarbons are pumped from the sump system back to the production treatment system for separation and treatment.

All decks will be solid steel plate and have a 15 cm (6 inch) high curb around the perimeter to prevent any runoff overflow into the ocean. Spray shields will be included where necessary to prevent liquid hydrocarbon spray from reaching the ocean. No significant impact on water quality from these discharges is anticipated.

Produced oil-free water resulting from the oil separation process on Platform Elly will be reinjected into the formation to reduce the potential for subsidence. Infrequent disposal of produced water may result during periods of injection well shutdown but the potential discharge would be done in accordance with EPA requirements. The volume of produced water will vary during the production phase. All oil and solids resulting from this treatment process will be pumped to a waste tank for disposal onshore.

- <u>Oil Spill Impacts on Water Quality</u>

Water quality may be degraded as a result of an accidental oil spill or oil leaks to the ocean. In the unlikely event of an oil spill, the nature and extent of impacts would depend on the type and volume of material released, the location of the release point, and the weather and sea conditions at the time of the spill. Shell California Production Inc. has developed an existing Oil Spill and Emergency Contingency Plan (summarized in Section 2.9) designed to assist SCPI in responding quickly and effectively to any oil spill. Implementation of the cleanup and control measures described in the plan will help to reduce impacts on water quality should an accidental release of oil occur.

The discharge of crude oil in an oil spill of moderate (240 barrels) magnitude should not significantly affect the quality of the surrounding waters based on observations of previous spills of comparable size (McAuliffe, 1976). If the water quality is affected, it would be generally of short duration.

The presence of a floating slick would pose a most important impact. In general, the fate of oil entering the marine environment is determined by various processes including evaporation, spreading on the surface, emulsification, adsorption onto particles, solution formation, oxidation, uptake by living organisms and settling and adsorption by bottom sediments. Crude oils which could be spilled can vary considerably in composition. In addition to hydrocarbons, crude oils contain small but significant quantities of chemicals containing nitrogen, sulfur, oxygen, and trace metals. An oil spill is of concern for water quality because of its effects on dissolved oxygen, odor, light transmission and in general the toxic nature of the oil.

The most toxic period for crude oil spilled into the ocean is within the first few days after an oil spill occurs. It is within this time period that volatile low molecular weight hydrocarbons are still present (BLM, 1979). After and during initial evaporation the nonvolatile oil acts as a source of pollution, adsorbs onto small particles, settles to the bottom and remains as a source of pollution, and depletes dissolved oxygen by oxidation of chemical or biological products. Toxicity tests performed on oil by EPA show that aromatics are the most toxic, napthenes and olefins are intermediate in toxicity, and straight paraffins, the least toxic hydrocarbons present (SLC et al., 1980). Other reports (Blumer et al., 1970) suggest that oil can concentrate other fat-soluble substances such as pesticides.

Slicks of moderate thickness may be expected to reduce light penetration, but reduction of light transmission is, at most, a transient situation because oil spills are moved and broken into patches by winds and currents (McAuliffe, 1976). Under normal sea conditions, only a small portion of a total spill area surface will be significantly affected since oil remaining on the water surface tends to develop into thicker rope-like configurations surrounded by a thin sheen.

While the presence of petroleum products from an oil spill in the water column will be temporary, longer-lasting effects could come from oil trapped in sediments and slowly released by weathering. However, as sediments in the project area already have a high oil content resulting from natural known oil seeps, oil added to the sediments by an oil spill would not cause significant impacts to water quality.

4.4.3.3 Subsea Pipelines and Cables

- Turbidity Impacts During Installation

The proposed subsea development calls for a 12.75 inch oil/water line, a 10.75 inch injection water line, a 6.625 inch natural gas line, and two 35-kV power cables to be installed from Platform Eureka to Platform Elly. The magnitude of turbidity resulting from pipeline installation will depend on the nature of the substrate, grain size of sediment, and prevailing currents. Installation activities will occur over a 2 month period. During this time transient modifications in the water quality will occur. Adverse impacts can result when bottom materials are resuspended and pollutants in the sediments are remobilized into the water column. Any detrimental conditions are expected to be of a temporary nature.

After the pipelines are installed, seawater will be used for hydrostatic testing of the pipelines and then discharged to the marine environment. Pipelines will be hydrostatically tested to 1.25 times the design working pressure for at least 24 hours. After testing, the discharge of the used test water into federal waters could introduce small amounts of iron and other metals into the receiving waters and increase turbidity. The discharge quality would be regulated by an NPDES permit issued by the EPA for discharge in federal waters. All test water would be rapidly dispersed and diluted shortly after discharge. Within hours after release, there would be no detectable increase in these materials in receiving waters and no significant impact on water quality.

Pipelines will be coated with thin film epoxy (an industry standard for submarine pipelines). Cathodic protection will be achieved through use of sacrificial alluminum anodes. The anodes will be spaced at 550 feet (168 m), and weigh 75, 100, and 125 lbs (34, 45, and 57 kg) for the 6, 10 and 12-inch pipelines, respectively.

- Pipeline Rupture

Oil spills from pipeline ruptures or breaks comprise a significant portion of the total volume of oil spills during offshore operations. A large portion of the volume of pipeline oil spilled results from anchor-dragging related incidents (BLM, 1975). Water quality impacts resulting from a pipeline rupture would be similar to those discussed in Section 4.4.3.2 (Platform-Oil Spills). However, depending on where the ruptures occurs, the severity of the impact can vary, especially in the case of marine life in intertidal areas (see Section 4.6, Marine Biology).

New safety regulations and the oil industry's determination to decrease the high volume of spillage per accident and to keep the frequency of recurrence low has led to the development of new techniques and equipment. Pipeline corrosion protection and automatic high/low pressure shutdowns have all helped to decrease spillage rates.

Proposed pipelines will be designed to resist predicted recurring environmental loads resulting from steady-state and wave induced currents, and from seismic activity. The magnitude and direction of loads will be determined through ocean data measurements and review of existing relevant data.

During production activities high and low pressure shutdown devices will monitor and automatically shut down the pipeline if changes in pressure (high or low) exceed preset limits. Pipelines coming onto and leaving the platform will have automatic shut-in valves operated in accordance with OCS Order No. 9.

4.4.4 Mitigation

No specific measures are recommended for environmental impacts generated by the construction of the pipeline and platform. The impacts generated will be generally of short duration and the added substrate will potentially enhance the marine environment in that location.

The primary impacts associated with the operation of the platform, well drilling activities and pipeline utilization will be generated by the disposal of drilling muds and cuttings and the potential of an oil spill.

SCPI has developed an Oil Spill Contingency Plan for dealing with potential spill events, including cleanup operations and reducing the level of operations during hazardous conditions. These measures are designed to reduce the probabilities, and to provide high level cleanup operations if they are needed. The plan is specifically oriented towards protection of sensitive resources. Protection and cleanup techniques specific to the varied habitats and environs are clearly delineated in the plan.

The physical impacts of cuttings deposition will result in the loss of some existing infauna near the platform. To reduce the extent of this burial and grain size alteration, the discharge pipe could be placed near the bottom and the cuttings will be deposited in a fairly small circle. However, this will also concentrate the drilling muds in one location, potentially increasing the toxic response. To minimize the varied impacts from this depositional process, the discharge pipe will be a minimum of 60 m (200 feet) below water level, which will minimize wind current effects on mud dispersal and allow cuttings to fall to the sea floor in a confined area near the platform.

4.4.5 Cumulative Impacts to Water Quality

This section considers the cumulative effects on water quality of the proposed action combined with all discharges occurring in the Beta Field. Included are discharges from SCPI's existing Platforms Ellen and Elly, and proposed Platform Eureka; and Chevron's existing Platform Edith. Since Eureka is the last platform to be installed in the Beta Unit, cumulative impacts on turbidity due to installations of subsea pipelines and the platform jacket will not occur. However, the combined effect of various platform operational discharges is included below.

4.4.5.1 Drilling Muds and Cuttings

Drilling operations on Platforms Eureka and Edith are expected to generate about 323 bbls/day of clean water-based muds and completion fluids for discharge (consisting of about 41 bbls/day from Eureka's one rig and 282 bbls/day from Edith's two rigs). Edith's drilling program will be completed within 2 years while Eureka's drilling program will take 3 years from initiation.

As indicated previously, available literature suggests that drilling muds do not result in significant or lasting effects on ocean water quality because they are rapidly dispersed and diluted. Due to the distance between Platforms Edith and Eureka, approximately 3620 m (11,880 feet), the drilling mud plumes from the two platforms will not combine to cause cumulative effects.

Discharges of cleaned drill cuttings are expected to amount to about 6 m^3 (212 cubic feet) per day from Platform Eureka and 15 m^3 (542 cubic feet) per day from

Platform Edith. Minor increases in local water column turbidity will result from individual discharges, however, there is sufficient distance between operations so that significant cumulative effects will not occur.

4.4.5.2 Other Liquid and Solid Discharges

Other kinds of wastes from all four platforms in the Beta Unit will occur on a daily basis. Sanitary and domestic wastes amounting to 692 bbls/day (29,050 gallons per day) will be discharged. These wastes will be treated in accordance with NPDES requirements and discharged from individual platforms. Due to the small quantity of discharge and the required treatment, significant cumulative impacts to water quality will not occur.

A substantial amount of washwater is used to clean the platform. Deck washing and drainage could amount to about 4000 bbls per day per platform. Ocean water is commonly used for this purpose and oil is removed from this washwater prior to discharge back to the ocean. Significant individual or cumulative effects will not occur from this operation.

The only other substantial discharge from operating platforms is the periodic discharge of produced waters. Produced waters will normally be reinjected into the producing zones, however, periodically as much as 4000 bbls per day per platform may be discharged during injection well shutdown. Oil and solids would be removed from the produced water prior to discharge, thus this intermittent disposal is not anticipated to result in cumulative effects.

4.5 OTHER OFFSHORE USES

4.5.1 Commercial and Sport Fisheries

Potential commercial fishing space will be lost at the platform location for the duration of the project construction and the life of the platform. In addition, temporary exclusion zones would be required at the pipeline location during construction. The area with availability of similar habitats within the vicinity of the proposed project suggests that the impact of the project on commercial fisheries would be long term but of minor significance.

Based upon the dominant species taken, the primary fishing gear are purse seines. Drifting gill nets are used for shark and swordfish. Purse seining should not be affected by the project, except to limit activity in that particular spot. Gill netting, using drifting gill nets, is not used extensively in the area due to the heavy marine traffic but is more commonly used outside the separation zones. Trawling is limited in the area but would be the type of activity most affected by the project.

Commercial fishermen have often voiced concern regarding the potential problems associated with platform placement and its effect on commercial fishing areas. Contact was made with the California Department of Fish and Game and the Fisheries Cooperative in Los Angeles. Information was provided regarding current fishing effort and types of gear utilized. Drift gill netting is not utilized in the project area and should not be affected by the development of Platform Eureka (D. Bedford, CDFG, personal communication). Mr. R. Klingbeil (CDFG, personal communication) commented that purse seining for mackeral and anchovies was carried out in the general area but that the proposed platform location is located over a bottom configuration that is not particularly attractive to these species.

A representative of the Fishermans Co-op (Mr. Bozanich, personal communication) commented that a moderate level of activity (purse seines) was carried out in the area of the platform during the spring. The primary species taken is Pacific mackeral. This fish is currently restricted to a total fishing of 22,000 tons and 5-10 percent of this total is taken in the project area. The nets are 40-50 fathom nets and are generally fished to the bottom. The depth of the proposed platform is in 116 fathoms and is not considered a dominant fishing area. One specific comment by Mr. Bozanich was that once the nets are in the water, the vessel is stationary. Currents in the area can be quite fast and fishermen must set their nets at a safe distance from a platform (1-1 1/2 miles). This distance is required to protect the nets and boats and is not a legislated zone.

Several studies (Allen and Moore, 1977; Wolfsen et al., 1979; Benech et al., 1980), have indicated that offshore oil platforms serve as attractants to many types of fish and may actually benefit sport and commercial fishing stocks in the immediate area. Observations of high densities of commercially harvestable shrimps and crabs in the cuttings mound under similar platforms, such as Exxon's Hondo A, indicate that these species are not directly harmed by the mud discharges, although the long term effects are still being studied.

Indirect effects of the project on commercial catches could also occur in the event of an oil spill. A major spill in the project area could limit commercial and sport fishing operations for anywhere from a few days to a couple of months, depending upon the extent of the spill. During the 1969 Santa Barbara spill, there was some reluctance of fishermen to foul boats and gear which caused a measurable short-term reduction in sport and commercial fishing activity.

Following the Santa Barbara spill, fish trawl surveys were performed and compared with pre-spill studies to determine the extent of the impact on marine fishes. There appeared to be no significant reduction in the abundance and diversity of fishes following the spill, and the larvae of common fishes were found to be plentiful and uncontaminated (Ebeling et al., 1971). Thus, indirect impacts to the fishing industry as a result of possible oil spill contamination to commercial taxa are anticipated to be insignificant.

4.5.1.1 Mitigation

Commercial fishing activity will be reduced in the area of the platform. However, the added substrate could potentially increase the availability of commercial species in the general area.

Shell California Production Inc. has conducted a geophysical survey that identified areas of anchor scarring. The locations can be provided to the U.S. Coast Guard and thus added to the Notice to Mariners. The pipeline is designed not to hang nets therefore no further mitigation appears necessary.

4.5.2 Shipping

As outlined in the Shell OCS Beta Unit Development EIR/EA, the installation of Platform Eureka in the Gulf of Santa Catalina increases the chances of a ship-to-structure collision. To determine the level of risk, the consequences of an accident must be understood, the parties who may suffer damage identified, and the probability of occurrence quantified. The consequences and parties affected were detailed in SLC et al. (1978). The probabilities of occurrence and subsequent risk assessment are summarized below.

4.5.2.1 Probability of Occurrence

Due to the short history of drilling offshore Southern California, ship-to-structure collision statistics for the Southern Californa Bight are not available. Therefore, in order to calculate the frequency with which a collision can be expected to occur, similar episodes in the Gulf of Mexico were observed. Research indicates that meteorological and physical conditions within the Gulf of Mexico are adequately similar to the Southern California Bight to allow a comparison.

Probability estimates of collision for ships transiting the Gulf of Santa Catalina TSS were formulated in the 1978 Shell OCS Beta Unit Development EIR/EA. Using such variables as structure and vessel size, a ramming per passage coefficient, and a causation probability estimate, it was determined that one ramming incident with a vessel over 500 gross tons can be expected to occur every 654 years for Platform

Eureka. The increase in ship traffic in the last 5 years is within the level assumed in SLC et al. (1978), and therefore the probability of collision calculated should reasonably reflect future risks.

The probability of small ship-to-structure collision incidents were also evaluated in the EIR/EA. Small vessels less than 500 tons were considered separately because they are not required to use the TSS. Using similar methodology, it was determined that one small ship collision can be expected to occur every 238 years.

4.5.2.2 Risk Estimates

The estimated annual and project lifetime risks associated with the proposed entire Beta unit development are shown in Table 4.5-1. This table was developed for the original EIR/EA (SLC et al., 1978).

4.5.2.3 Marine Traffic Mitigation

Due to the low probability of collision occurrence, Platform Eureka would not represent an adverse impact to marine safety within the Gulf of Santa Catalina. However, measures will be implemented to further reduce the chance of a ship-to-structure ramming episode. These measures include:

1. Installation of a U.S. Coast Guard approved lighting/navigation aid system on Platform Eureka
2. Utilization of colors and markings on Platform Eureka to ensure visibility from the TSS
3. Notification of installation activities to marine interests
4. Provision of a 500-meter safety zone around Platform Eureka

4.5.3 Boating and Recreation Impacts

The proposed development will not significantly alter recreational opportunities in the project vicinity. The installation of the platform and associated subsea cables and pipeline will temporarily preclude the use of that area for recreational purposes such as boating, fishing, and swimming. However, the impact will be of relatively short duration and no construction will occur on state or county recreational beaches (for impacts to onshore recreation, see Section 4.7; Land Use). The presence of an additional platform will not hinder recreational boating in the area and will in fact function as a navigational aid. The increase in crew and supply boat activity will, however, cause boating enthusiasts to exercise more caution in the navigation of their craft.

The primary impact on recreation would be from a potential oil spill. Large oil spills could cause short-term disruption to recreational opportunities resulting from

Table 4.5-1

SHELL BETA PROJECT OVERALL RISK ESTIMATE - MARINE TRAFFIC
(Source: SLC et al., 1978)

Consequence	Prime Party Affected	Annual Risk (Events/Year)	35 Year Project Risk (Events)
Major oil spill (10,000 bbl)	Public	8.1×10^{-4}	2.8×10^{-2}
All oil spills associated with marine traffic accidents	Public	12.5 (bbls oil/yr)	438 (bbls)
Vehicle Damage:			
Total loss of a major vessel	Vessel owner/operator	3.7×10^{-4}	1.3×10^{-2}
Major[(1)] damage to:	Vessel owner/operator		
Vessel (less than 500 gross tons)		2.5×10^{-4}	8.8×10^{-3}
Vessel (greater than 500 gross tons)		1.1×10^{-3}	3.8×10^{-2}
Any vessel		1.35×10^{-3}	4.7×10^{-2}
Minor[(2)] damage to:	Vessel owner/operator		
Vessel (less than 500 gross tons)		4.0×10^{-3}	1.4×10^{-1}
Vessel (greater than 500 gross tons)		3.2×10^{-3}	1.1×10^{-1}
Any vessel		7.2×10^{-3}	2.5×10^{-1}
Structure Damage:			
Total loss of structure	Structure owner/operator	6.9×10^{-4}	2.4×10^{-2}
Major damage to structure	Structure owner/operator	3.2×10^{-3}	1.1×10^{-1}
Minor damage	Structure owner/operator	5.1×10^{-3}	1.8×10^{-1}

(1) Major damage: economic loss of approximately $100,000 or greater, possible injury.

(2) Minor damage: economic loss of less than approximately $30,000.

the closure of affected beaches, harbors and marinas. Recreational use of an area would be impeded from the time oil covered the beaches until cleanup or replacement of the contaminated sand was completed. A major oil spill, though a remote possibility, could interfere with public enjoyment of the coastal beaches and might temporarily halt or restrict boating activities and water sports for reasons of public health and safety.

4.5.3.1 Mitigation Measures

Since normal operations of the proposed project would not generate any significant or long-term impacts to recreational facilities, no mitigation is deemed necessary. Prevention and cleanup of oil spill-related impacts is discussed in Section 2.9. It should be emphasized that it is the philosophy of the Oil Spill and Emergency Contingency Plan to prevent oil from reaching the beaches and harbors.

4.5.4 Kelp Harvesting

No kelp harvesting has been conducted in Beds 10, 11, and 12 for a number of years and the nearshore water quality, implicated in the elimination of the beds, is not expected to improve. Comments from biologists at Kelco (D. Glantz, per. comm.) lead to the assumption that kelp harvesting in these beds is unlikely in the near future and potentially they will never return to a harvestable level.

In the event that kelp does return to harvestable levels and an oil spill occurs, kelp harvesting could be affected. While oil does not adhere to the kelp itself, it could interfere with the actual harvesting operations by fouling the boat and mechanical equipment.

4.5.4.1 Mitigation

No impacts on kelp resources are expected except in the event of an oil spill. The Oil Spill Contingency Plan describes actions to be taken to conserve significant resource areas.

4.5.5 Existing Pipelines and Cables

No impacts are expected on existing pipelines and cables from development of Platform Eureka.

4.5.6 Other Mineral Resources

Development of Platform Eureka will not impact other extractable mineral resources in the project vicinity.

4.5.7 Ocean Dumping

No impacts are expected on this use from development of the platform and pipelines.

4.5.8 Military Uses

No impact to military operations are expected.

4.5.9 Cultural Resources

As described in the recently completed cultural resources report ($MESA^2$, 1984c), the only feature of potential cultural significance found in the project area is located 5000 feet (1524 m) south of the Platform Eureka site (see Figure 3.1-6).

4.5.9.1 Mitigation Measures

Until such time that the precise nature of the cultural feature south of Platform Eureka can be determined, it will be avoided by all activities related to the proposed project.

4.5.10 Cumulative Impacts to Other Offshore Uses

4.5.10.1 Commercial Fishing

The placement of Platform Eureka will be the final platform in the Beta field. It will be placed in 700+ feet of water and will have a moderate effect on commercial fishing. Safe distances must be maintained by fishermen and this results in some restriction of fishing capability around the platform. The shallow platforms are areas of commercial fishing conflicts due to the higher quality fishing in those areas. The cumulative impact of the placement of Platform Eureka will be to further restrict purse seining in the lower San Pedro Bay.

4.5.10.2 Cumulative Vessel Traffic Impacts

The crew and supply boat traffic from proposed Platform Eureka will increase the overall level of this type of vessel traffic servicing all platforms in the Beta Unit. Presently about 19 crew/supply boat trips per week are made to service existing Platforms Ellen and Elly. Additionally, up to 28 crew/supply boat trips per week are made to service Chevron's Platform Edith. Operations on Eureka may increase the number of crew/supply boat trips currently made to SCPI Beta platforms by up to 50 percent (28 trips per week). Cumulatively, Beta Unit crew/supply boat traffic will average 56 trips per week. This level of service is a conservative estimate and will substantially reduce as drilling operations on platforms phase out (within 3 years).

The increase in vessel traffic should not significantly affect other vessels operating in the VTSS since the crew/supply boat routes do not utilize the lanes for transit. However, the increase in crew/supply boat traffic will cause recreational boaters to exercise additional caution in navigating through the area.

4.6 MARINE BIOLOGY

4.6.1 General Analysis of the Biological Impacts

During the construction phase of the project potential impacts on the marine environment will result from the transportation of personnel and supplies to the construction site; placement of the physical platform system; drilling of wells; deposition of drilling muds and cuttings; and the laying of the marine pipeline.

In addition, there will be some impacts associated with the deposition of wastes generated by platform personnel including domestic sewage, desalinization brine, and potentially, water used in cleaning deck areas. Secondary treatment of sewage will occur aboard the platform prior to its discharge below the water surface. This disposal of treated sewage at sea will result in minor inputs of nutrients, but dilution should be rapidly accomplished by natural water movement. The discharge of produced water will occur at Platform Elly on an infrequent basis.

Installation of the platform will require the use of a moored construction barge. Mooring points will generally be spaced in a circle around the construction point. The anchors and anchor chains used to connect the barges to the mooring points would disturb or eliminate epifaunal and infaunal organisms at any point of bottom contact and lead to localized short-term increases in turbidity.

These localized turbidity increases could disrupt the feeding or breathing mechanisms of filter-feeding organisms in the area; however, the turbidity increases are expected to be rapidly dispersed by currents, with no measurable increases expected beyond the near vicinity of the disturbed areas. Recolonization of the disturbed areas by species from nearby populations is expected to occur shortly after the anchoring systems are removed from the site. Thus, these impacts would be highly localized, short-term, and of minor significance.

The placement of the platform would result in the elimination of organisms under the pilings. Although this is a long-term affect, this loss of habitat and organisms is insignificant since the benthic organisms found in the area of the platform are generally common in the project area and are not concentrated within the project area.

The deposition of drill cuttings and drilling muds may represent a significant source of impact on the marine organisms inhabiting the benthic communities of the deep San Pedro basin. The principal impacts of the deposition of drill cuttings and drilling muds are assumed to be physically similar to those of dredge spoils disposal including increased turbidity and the potential for burial of organisms. The presence of chemical agents such as barium, barite and chromium in many drilling muds adds a potential for bioaccumulation (BLM, 1979). Specific impacts associated with deposition of muds and cuttings are discussed in Section 4.6.4.

It is proposed that these waste muds and cuttings will be discharged at the platform, resulting in the deposition of approximately 600 barrels of drilling fluids and

900 barrels of mud and 350 cubic yards of cuttings per well. Cuttings will be allowed to settle by gravity to the ocean bottom and will be distributed by subsurface current movements according to their settling rates which are dependent upon particle size and density. Generally, organisms inhabiting the benthic environment near the platform will be subjected to the greatest impact due to discharge of drill cuttings and drilling muds, as a portion of the ocean floor will be buried. Increased turbidity of the water will occur over a broader area due to the addition of fine particles of mud and cuttings to the seawater. The particles causing this turbidity can clog the respiratory organs and feeding mechanisms of many of the marine animals inhabiting the benthic environment.

The installation of the pipelines and cables will result in the physical disturbance of benthic and epibenthic organisms along the proposed routes. This disturbance will be limited to the construction phase of the project. However, the area should be rapidly recolonized and the lines themselves will serve as attachment surfaces increasing epibiotic growth.

An associated beneficial impact from the development of the platform/wellhead/pipeline system is the additional structure being added to the offshore environment. The offshore area is a relatively low relief environment and wherever high relief occurs, increased levels of biological activity can be found. The addition of platform supports, wellheads and exposed pipelines can contribute substantially to the overall biological activity in the local area.

Clearly, the greatest potential impact from development of the platform and pipeline would be expected to result from an episodic (catastrophic) event such as a well blowout or pipeline rupture resulting in gas discharge or an oil spill. The proximity of the platform to shore makes the impact of an oil spill on the intertidal and shallow-water communities much more significant.

The Bureau of Land Management (1979), SLC (1978, 1982), and Woodward-Clyde (1982), have provided several reviews concerning the multitude of potential impacts resulting from an oil spill. The discharge of gas from a well blowout appears to exert the greatest impact on air quality, while spilled oil significantly alters water quality and can prove harmful to inhabitants of the aquatic environment. The Bureau of Land Management (1979) discusses the fate of spilled oil in the ocean and oil spill variables, based on oil content and physical and chemical aspects of the environment in which the spill has occurred. State Lands Commission et al. (1978) provides a summary of the effects of spilled oil on marine biotic communities.

The type of oil and its concentration appear to be the most important factors in determining the biological impact of an oil spill. Generally, oil spilled into ocean waters will change in physical and chemical makeup as it floats on the ocean surface, with the rate of change being markedly influenced by prevailing environmental conditions. Lighter and aromatic fractions of oil, which are of greater toxicity to organisms, are more rapidly lost than other oil fractions during weathering. Consequently, the longer the crude oil is at sea and the greater the intensity of the environmental factors (i.e., winds, waves and temperature), the greater will be the changes in the makeup of the oil (weathering) and the higher will be the loss of the more toxic, lighter and aromatic components.

The California State Lands Commission et al. (1978) reported on biotic effects of oil spills. In general, impacts are divided into lethal effects, sublethal effects and habitat alteration. Lethal effects include chemical toxicity from water soluble aromatic hydrocarbons such as napthalenes, toluene, and various benzene ring compounds. These low to medium molecular weight compounds are potentially the most deleterious components of crude oil. Crude oil exposed to environmental weathering rapidly loses these compounds to evaporation and dissolution.

Sublethal effects are harder to define but can include physiological effects, mutagenic effects, carcinogenic effects, mechanical coating, and tainting. The impact of crude oil deposition on marine substrates can alter the habitat in such a way as to limit settling of marine invertebrate larvae or restrict feeding areas. Beach coverage can kill or cause the dislocation of infaunal oganisms. The assimilative capacity of marine biotic communities has not been conclusively tested to determine the impacts of acute oil pollution events. The Bureau of Land Management (1979) also adds to the above list of generalizations that there is a lack of knowledge as to the effects of long-term low level (chronic) oil pollution on marine organisms.

The magnitude of oil spills can vary greatly and certainly exerts considerable influence over the extent of the potential environmental impacts. During construction or drilling phases, small-scale spills are most likely and the probability of a major spill much less. However, SLC et al. (1978) has suggested that with reference to impacts on the marine environment, small-scale or large-scale spills exert similar impacts on the environment, only with different magnitude. Consequently, generalized environmental impacts of a spill from the production drilling program can be predicted based on previous oil spill research, with the extent of the impact a function of the magnitude of the spill.

The Bureau of Land Management (1979) has summarized the effects of several major oil spills on the marine environment. The results reveal that the biological effects of an oil spill vary based upon several factors. A series of nine factors proposed by Straughan (1972) bear consideration when interpreting the effects of spilled oil. These include: (1) type of oil; (2) concentration reaching the biota; (3) physiography of the spill area; (4) weather conditions at the time of the spill; (5) biota living in the impacted habitats; (6) season at the time of the spill; (7) prior exposure of the biota to oil or other pollutants; (8) co-contamination of the impacted biota by other pollutants; and (9) use of treatment agents to clean up the spilled oil.

Generally, the most direct measurable impacts of the majority of oil spills have been on populations of marine birds (particularly pelagic birds) and shallow-water benthic organisms. Intertidal communities have been found to be most vulnerable, particularly the highly adapted upper shoreline forms such as barnacles, limpets and several species of algae.

With regard to the 1969 oil spill in the Santa Barbara Channel, Straughan (1972) indicated that several factors complicated the problem of determining the biological effects. These included: (1) the presence of natural oil seeps in the area and the influence of natural seepage on the ecology of the Santa Barbara Channel, and (2) the occurrence of unusually heavy rains during the spill period which lowered salinities, increased sedimentation, and possibly increased concentrations of pesticides in coastal waters. In light of these complications, Straughan (1972) summarized the results of the several investigations performed in the aftermath of the spill to indicate that damage to the biota was not widespread and that major effects included significant mortality in pelagic bird populations, populations of the intertidal barnacle <u>Chthalmus fissus</u>, the marine sea grass <u>Phyllospadix torrey</u>, and the marine alga <u>Hesperophycus harveyanus</u>. Sublethal effects included a reduction in breeding in <u>Pollicipes polymerus</u> in localized areas. A cautionary approach to these conclusions is advised however, as it has been strongly emphasized that because of the cumulative effects of environmental alteration in Southern California and a general lack of the proper kind of baseline information, the full short- and long-term impacts of the 1969 oil spills were perhaps impossible to determine.

4.6.2 Intertidal Communities

The construction of the platform and the planned drilling program are not expected to significantly impact the intertidal and biofouling communities. The discharge of wastes resulting from drilling operations and transportation activities should be of very limited volume and quickly diluted. The deposition of drill cuttings and drilling muds in the vicinity of the platform site is not anticipated to impact the intertidal communities. The most significant impact to the intertidal communities would be from a large-scale oil spill.

Generally, deposited crude oil may physically coat organisms, thereby smothering them, or produce toxins causing mortality and physiological stress. In the event of a major spill from the pipeline, much of the affected intertidal habitats would be damaged. As indicated by the Bureau of Land Management (1979), repopulation of the impacted habitats will commence once oil is cleared from the substrata and sexually reproducing populations are available to provide new colonizers. Most intertidal and subtidal invertebrates and plants had recovered and appeared viable in a 1972 survey by Strachan (1972).

A recent study by Woodward-Clyde Consultants for the County of Santa Barbara (County of Santa Barbara, 1984) experienced the relative sensitivities of various coastline habitats to an oil spill. Important elements in evaluating oil spill impacts are the potential vulnerability and sensitivity of biological resources to oil and the ability of the resource to recover from the effects of the oil. This evaluation led the establishment of three concern levels regarding biological resources.

- Primary Level of Concern
  - Major change expected in distribution, size, structure, and/or function of affected biotic resource (population, community, or habitat).
  - Recovery from these changes expected to require several years to decades.
- Secondary Level of Concern
  - Moderate change expected in distribution, size, structure and/or function of affected biotic resource (population, community, or habitat).
  - Recovery from these changes expected to require several years.
- Tertiary Level of Concern
  - No to minor change expected in distribution, size, structure, and/or function of affected biotic resources (population, community, or habitat).
  - Recovery from these changes expected to require several months to several years.

The levels of concern represent the potential effect to the impacted biotic resource if the resource contacts oil. It is possible (and even likely) that the anticipated magnitude and/or duration of impact which defines a level of concern will not materialize. For example, an oiled marsh may recover completely in a short time (one or two growing seasons) from a single oiling episode. However, there are also documented cases where the impact to a marsh is still visible after many years, representing a long-term impact. Considering the key role that marshes play in the functioning of estuarine systems, marshes are considered areas of primary concern because of the potential for a long-term impact to occur (County of Santa Barbara, 1984).

In response to being oiled, the biota of the intertidal zone may suffer immediate large mortalities as measured by body counts of individuals and, in the longer term, the recolonization of individuals may be slower than expected in the affected area. The sensitivity of the macrobiota in the intertidal zone varies with species and may show temporal and spatial variability, depending upon a number of factors such as:

- Type of oil spilled
- Amount of oil reaching the intertidal zone
- Weathered state of oil
- Life history stage of the species
- "Health" of the species
- Season
- Record of prior exposure

The literature indicates that the capacity of the intertidal macrobiota to recover to pre-spill conditions, or to conditions prevailing on nearby nonoiled shorelines, will generally not be diminished following a single crude oil spill, even though there were substantial mortalities of some species. Areas affected by an oil spill are expected to exhibit recolonization and recovery not unlike that which occurs continuously under natural conditions in the rocky intertidal. The time required for recovery may depend upon the size and location of the area affected and season in which impact occurs but the process would begin immediately, often before the last traces of oil are removed (County of Santa Barbara, 1984).

The oil spill trajectories for Platform Eureka (Dames and Moore, 1983) are presented in Appendix A and summarized by month in Table 4.6-1. The most significant intertidal areas along the San Pedro Bay coast are the beach areas from Newport Beach to Anaheim Bay. Oil spills offshore would contact land in these areas at nearly 100 percent probability during the period of April to September, with a mean contact

Table 4.6-1

OIL SPILL TRAJECTORY SUMMARY
PLATFORM EUREKA

Month	Probability of Land Contact	Principal Locale	Hours to Principal Locale
January	28.5	Long Beach	30
February	29	Long Beach	33
March	45.5	Huntington Beach	39
April	99	Newport Beach	46
May	100	Newport Beach	46
June	100	Newport Beach	46
July	100	Newport Beach	46
August	100	Huntington Beach	44
September	100	Huntington Beach	44
October	10	Long Beach/Anaheim Bay	53/38
November	28.5	Long Beach	53
December	23	Long Beach	53
	mean = 63.6%		mean = 44.4 hrs

The data presented is a summary of the oil spill trajectory modelling report prepared by Dames and Moore (1983). It is based upon 200 model trajectories per month and a spill volume of 10,000 bbls or less.

time of 46 hours. Onshore winds would drive an oil spill toward these beaches. From October to March a monthly trajectory is projected with the principal contact point being Long Beach/San Pedro Harbor. This area is dominated by rocky intertidal (natural and artificial). The probability of an oil spill contacting land in this zone as a yearly average is 63.6 percent with a mean contact time of 44 hours (assuming no intervention). The report in Appendix A should be reviewed to assess other assumptions of the modelling operation.

Shaw et al. (1981), Maynard et al. (1978) and Chan (1978) all examined the impacts associated with acute and chronic depositions of oil in the rocky intertidal zone. In general, oil and "tar balls" were deposited in the high intertidal or splash zone. The majority of the rocky intertidal species and biomass are lower in the intertidal zone and did not appear to be significantly affected either by accumulation petrogenic hydrocarbons or by habitat loss to oiling effects. Organisms in the splash zone were affected by bioaccumulation of hydrocarbons and loss of habitat. Chan (1978) observed extensive mortality of rocky shore crabs and echindoderms, seagrasses and some mangrove areas. She also observed that elevated temperatures on oil covered substrates exceeded upper lethal limits for many intertidal organisms.

These studies focus on rocky intertidal habitat with little data provided for beach habitat. The physical stranding of oil on beaches can create an extensive area of oil covered sands. Normally the oil will be driven to the high tide elevation and then stranded. This creates a rather narrow band of oiled sand in an area of reduced biological activity.

The use of oil dispersants is severely restricted in California waters and can only be used under specific circumstances (see Oil Spill Plan). Various oil dispersants have been tested and found to be largely detrimental to marine biota (reviewed in Greenwood, 1983). Emulsification of the oil tends to decrease droplet size and increase the deposition area, as well as increase the toxic effects observed in marine invertebrates.

The intertidal communities near the project area could be impacted from an oil spill due to the construction and operational activities of Platform Eureka and the marine pipeline. The degree of this impact would vary with the magnitude of the spill and the ability to contain the oil. The impact on the intertidal habitat would be generally limited to the highest intertidal habitat and should pose no long term degradation in the local populations.

4.6.3 Biofouling Communities

Watson (1971) and Woodin (1973) reported localized damage to marine algae, bivalves, barnacles, and worms from small amounts of diesel fuel. The damage resulted from ingestion of lethal toxins and suffocation. Colonization of denuded areas is expected and no long-term effects are predicted. The effects of a crude spill on the littoral biofouling community could be fatal to all or part of this community depending on the dose and time of exposure. Nicholson and Cimberg (1971) reported extensive mortalities to the barnacles Chthamalus and Balanus, the limpet genus Collisellia, and the mussel Mytilus, as a result of the 1969 Santa Barbara oil spill. Mortality was due to suffocation and not to ingestion of toxins; recolonization was slow compared to control sites. It is expected that recuperation of the littoral biofouling community following a small spill would be accelerated by weathering and dispersal of the crude oil by wave action at the platform site. The subtidal biofouling community is not expected to experience any adverse effects from a small spill of crude oil. This is predicted because any oil reaching this community will have gone through extensive weathering, dispersal, chemical, and microbial degradation prior to contact with the subtidal community. Nicholson and Cimberg (1971) report mortalities in intertidal species which are also common to fouling communities, when those species were exposed to heavy crude oil from the Santa Barbara spill. The biofouling community associated with the offshore platform would be impacted similarly by a spill; however, recruitment would begin as soon as water quality and substrate became suitable. Harbor and offshore biofouling communities are exposed to alternating periods of immersion and exposure, sudden infusions of freshwater, deviations in salinity, changes in temperature, and contaminants, including oil. Organisms accustomed to this type of habitat tend to be hardier and more resistent to sudden changes to their environment. After the Torrey Canyon disaster, Crapp (1971) demonstrated that several species of Chthamalus and Balanus were unaffected after being subjected to long-term coating by weathered Kuwait crude.

Coating of a substrate (such as the surface of a newly constructed offshore structure) with crude oil will affect settling and recruitment by fouling organisms. Other possible effects include mortalities of less-tolerant juvenile forms of these organisms, thus inhibiting recruitment. Depletion of food supply, especially marine algae, could affect distribution of limpets and other grazing populations associated with biofouling communities. Oil at sublethal concentrations may have adverse effects due to organisms having different tolerance levels with respect to recruitment. Hence, alteration in the relative species abundances in the population can occur. In addition, resistent species may flourish when populations of less-tolerant species decline and make available previously limited resources, e.g., primary substrate. Stainken (1975) and Neff (1975) demonstrated that several species of bivalves can magnify the concentration of petroleum hydrocarbons up to five times that of ambient concentrations, yet there seems to be no direct effect to the organisms. Latent effects nonetheless may occur and include mortalities and reduction of reproductive potentials of fish and other populations dependent upon the biofouling community as a food source.

4.6.4 Benthic Communities

Impacts associated with construction and placement of the platform on benthic communities include the effects of temporary anchoring devices, permanent support footings, and permanent wellheads. All of these actions will result in the disruption and/or destruction of limited areas of benthic habitat. Infaunal organisms at impact points will be lost.

The addition of the hard surfaces will increase the attachment surfaces available and there will be an increase in epibiotic attachment organisms. The resulting community provides a variety of structural habitats which should lead to an increase in higher trophic level organisms (fishes). The primary impact on benthic organisms in the area around the platform will be from the deposition of drilling muds and cuttings and from potential oil spills.

Crude oil spilled from the production platform would represent a potential hazard to subtidal benthic communities. Oil that reaches the shallow water epibenthic communities would likely result in damage to organisms. The extent of this impact would be difficult to predict, but epilithic algae and invertebrates appear to have been subjected to considerable damage in certain of the previous oil spills though Strachan (1972) found most populations had recovered and were viable 2 weeks after the Santa Barbara Spill of 1969. The impacts of oil deposition on deep water environments is currently being studied (Karinen, 1980). The Bureau of Land Management (1979) suggests that complete destruction would not be anticipated, but that certain populations of various sensitive species, particularly microcrustacean and shallow water endemics, may be eliminated or significantly reduced from the area impacted by oil.

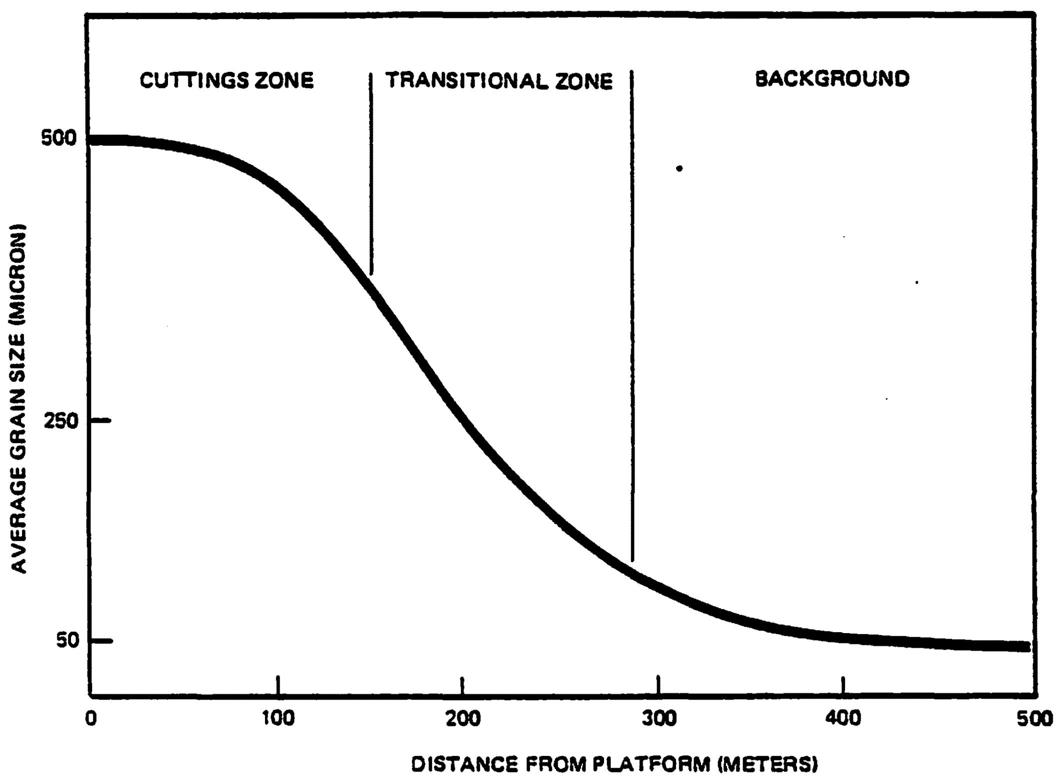
The localized impact of muds and cuttings has a much higher probability of causing impacts on benthic organisms. The impacts of the disposal of muds and cuttings can be divided as follows: A typical well will produce approximately 222 cubic yards (6000 cubic feet) of rock cuttings from a 5000 foot (2439 m) deep well. Nine hundred barrels of drilling muds and 600 barrels of completion fluids will be required per well to accommodate the drilling process. The drilling muds and cuttings will be cleaned to remove oil and, if the muds are to be reused, remove cutting fragments on a shaker screen.

The material will be discharged from a pipe approximately 200 feet (60 m) below the water surface, resulting in a material fall of 500 feet (152 m) to the bottom. Under normal circumstances cleaned cuttings will be discharged routinely, while drilling muds generally are stored then discharged once or twice during the drilling operation, usually when a change in mud components is required and at the end of the drilling cycle.

Due to their heavier weight, cuttings tend to settle to the bottom much more rapidly than drilling muds. Cutting particles generally range in size from 100 microns to 900 microns and are dominated by sharply angular, nonbiogenic particles. Deposition of this material onto a silty substrate will alter the average grain size, and potentially, the distribution of infaunal organisms. The current structure in the platform area is highly variable, especially in relation to depth, but the cuttings should fall within a 200 m (656 foot) radius of the discharge outlet. The estimate of 200 m is based upon the settling velocity of cutting particles and the general current structure in the region. This will result in a distribution of grain size near the platform resembling the generalized curves shown in Figure 4.6-1.

The effect of changes in grain size distribution on infauna and epifaunal species was well demonstrated in a paper by Wolfson et al. (1979). He concluded that most benthic species were not affected by the addition of cutting size particles, though several species in his study responded positively to the addition of cuttings. The bottom material at Wolfson's test site was basically sand. The substrate at the Platform Eureka site is fine silt and sand. The addition of larger grained cuttings may result in a decrease in the present infaunal species composition and the potential replacement by other infaunal species capable of dealing with larger grained substrates.

The dominant species in the project area are polychaetes. The majority are sessile filter feeders and detritovores. Most would be capable of feeding and maintaining normal activities under conditions of increased deposition from muds and cuttings. The material deposited naturally as detritus would generally exceed the deposition of muds and cuttings. Particulate levels deposited on the bottom would increase slightly with mud deposition but the effect would be limited to the area immediately adjacent to the platform.



Summarized From Wolfson et. al. (1979)

Generalized Distribution of Cutting Particles Around Discharge Location

FIGURE 4.6-1

In the event of significant grain size distribution changes in the area of the platform, some change in the invertebrate fauna would be expected. It is difficult to predict the result of the faunal replacement due to the lack of data on the microscale effects of grain size on invertebrates. The changes may be so subtle that sampling variability may mask any changes. The change in grain size should not significantly effect benthic invertebrates in the area around the platform.

At the present time, there are over 1000 trade name products available for drilling fluids formulation. To accomplish the various tasks required of drilling muds, the fluids must be carefully matched to the subsurface formations and drilling conditions encountered. The basic fluid is a water-based clay suspension with non-chrome lignosulfate added to control viscosity and fluid loss and barium sulfate added to increase fluid density.

Biological effects from the deposition of drilling muds can be induced by chemical contamination of the water column and the sediments, and by the physical act of burial of marine organisms by the deposited muds. The testing of chemical effects is conducted by use of bioassay. Acute as well as chronic effects can be tested. Table 4.6-2 presents a respresentative bioassay on drilling fluid components. This type of analysis does not answer the question regarding whole mud toxicity discharged into the marine environment since it only addresses the potential impacts of the various components. Other tests do, however, and are frequently required in conjunction with applying for or obtaining NPDES Discharge Permits for muds and cuttings discharges.

Table 4.6-2

REPRESENTATIVE BIOASSAYS ON DRILLING FLUID COMPONENTS
(Results expressed as 96-HR TL_m unless otherwise indicated)
(concentrations in parts per million)

Component	Concentration	Organism
barium sulfate (barite)	100,000	white shrimp
bentonite	10,000	rainbow trout
formaldehyde	28	salmon
lignite	24,500	sailfin molly
lignosulfonate, chrome	1,925	white shrimp
lignosulfonate, iron	7,800	white shrimp
polyacrylate, low molecular weight	3,500	white shrimp
sodium acid pyrophosphate	1,200	sailfin molly

Source: Ray, 1978

A recent whole mud bioassay was conducted by Marine Biological Consultants (1982) on Beta and Minerva Prospect drilling muds. A 96-hour static acute bioassay was conducted on liquid, suspended and solid phase components of the muds. The test results are summarized in Table 4.6-3.

Table 4.6-3

SUMMARY OF BETA PROJECT DRILLING MUD
(96 hr acute bioassay)

Phase	LC_{50}	Survival Percent	Species
Liquid	19,000 ppm	—	Acanthomysis sculpta
Suspended	4,200 ppm	—	Acanthomysis sculpta
Solid Test	—	97	Macoma nasuta
Solid Test	—	97	Macoma nasuta

Data summarized from Marine Biological Consultants (1982).

Recent field studies have been conducted by Shell (Southern California) and ARCO (Alaska) to determine the fate and potential effect of mud and cuttings discharges. Results have indicated several important facts which should influence the design of future bioassay tests. As cuttings are discharged, the material separates upon entering the water into two phases. First, the cuttings fall rapidly to the bottom due to their weight. Second, most of the mud that adheres to the cuttings (usually 1 to 5 percent by volume), is washed off and spreads horizontally to form the surface plume. Even under conditions of maximum discharge (750 bbl/hr), dilutions of 400 to 1000:1 are reached within several meters of the discharge point. Within 100 m (330 feet), maximum suspended solids content with the plume did not exceed 25 ppm. At distances of 1000 m (330 feet) downstream (current 0.2 knot) the plume had only descended to 26 m (86 feet) [discharged at 13 m (43 feet)]. This suggests that in most OCS areas, mud plumes will have reached background levels of suspended solids and heavy metals prior to reaching the bottom (Ray, 1978).

Recent regulations require "shunting" of mud and cuttings to within several meters of the bottom in some OCS areas. This practice, if anything, may greatly increase the potential for introducing toxic materials at high enough concentrations to have a local effect on bottom communities. It appears that discharge at depths from 30-60 m (100-200 feet) beneath the surface would mitigate most potential effects of the discharge. By doing so, adequate dilution will have occurred before the plume reaches the surface or the bottom. Rapid dilution of plume materials under most conditions indicates that downstream sedimentation effects on bottom communities should be minimal to nonexistant (Ray, 1978).

Chronic effects of drilling mud components are much more difficult to determine. Marine invertebrates have been shown to bioaccumulate heavy metals in their tissues. It has also been demonstrated that bioaccumulation does not occur at the same rate for all species, in fact wide variability in uptake is found within the same species.

Major components of concern in the drilling muds are normally barium sulfate and chrome and ferrochrome lignosulfonate. However, SCPI is not using a chrome or ferro chrome lignosulfonate in their drilling program. These metals have been shown to accumulate in sediments, especially barium. Several studies cited by Ray (1978) have shown elevated barium levels in the sediments up to 500 m (1641 feet) from a platform. Barium does not have a significant toxic effect on aquatic vertebrates and invertebrates, and apparently passes through the digestive tract. In a recent study Neff et al. (1978) concluded that bioaccumulation of heavy metals was highly species-dependent, and was usually influenced by a variety of physical environmental parameters (temperature, salinity, etc.). A most significant element of his study was the data showing how control animals were just as likely to accumulate metals as those tested in contaminated sediments, often demonstrating an inverse relationship. Iron was the only metal showing a dominating bioaccumulation potential and iron is generally considered nontoxic even at highly elevated levels.

The National Academy of Science (NAS, 1983) recently reviewed the impacts of drilling discharges in the marine environment. This extensive review of existing literature and discussions with academic, industry and regulatory personnel provide a "state of the art" document. In summary, the panel's review of existing information on the fates and effects of drilling fluids and cuttings on the OCS shows that the effects of individual discharges are quite limited in extent and are confined mainly to the benthic environment. These results suggest that the environmental risks of exploratory drilling discharges to most OCS communities are small. Discharges from oil and gas field development drilling introduce greater quantities of material into the marine environment over longer periods of time. Results of field studies suggest that the accumulation of materials from these longer-term inputs is less than additive and therefore the effects of exploratory drilling provide a reasonable model for projecting the effects of development drilling. Uncertainities regarding effects still exist for low energy depositional environments, which experience large inputs of drilling discharges over long periods of time.

To minimize effects, care needs to be exercised in the following:

- Discharges should be prevented from burying particularly sensitive benthic environments, especially hard substrate epibiota, which are not exposed to significant natural sediment flux.
- The use of more toxic additives, such as diesel fuel (No. 2 diesel oil), should be monitored or limited. Fluids that show significant toxicity should be analyzed chemically to determine their toxic components (NAS, 1983).

4.6.5 Planktonic Communities

Impacts to the planktonic communities due to the construction and operation of the platform should be highly localized. Very small and probably insignificant increases in nutrient levels near the drilling platform may occur due to the discharge of secondary treated sewage. This could elevate phytoplankton production slightly. Any increase in water turbidity in the photic zone due to the deposition of drill cuttings and drilling muds would reduce phytoplankton production.

Potential impacts on planktonic communities from an oil spill could range from lethal, for cases of high concentrations of spilled oil on surface waters, to various more subtle sublethal effects (SLC, 1974). The Bureau of Land Management (1979) suggests that for the phytoplankton, sublethal effects such as reduced photosynthetic and growth rate could result from exposure to low-level concentrations of oil, while for zooplankton, abnormal feeding and behavioral patterns from the uptake of hydrocarbons in food sources would be likely. However, Prouse et al. (1976) reported that at crude oil concentrations of less than 1 ppm, oceanic phytoplankton did not display growth characteristics significantly different from control species, and some phytoplankton was actually stimulated by small concentrations.

4.6.6 Fishes

Limited disturbance of the fish population near the platform is expected. Impacts are anticipated to be largely from the deposition of drill cuttings and drilling muds and the resultant increase in turbidity and the alteration of benthic habitats.

Demersal fishes are likely to be most affected, although fishes (particularly filter-feeding forms) that swim through the drilling area may be disturbed by the expected increase in suspended particles in the water. The pipeline will constitute a major structural addition to the bottom and contribute areas of refuge and additional feeding habitat and should not act as a barrier to fish movements.

Fishes can be susceptible to spilled oil as adults, juveniles, larvae, or in the egg stage of the life history, however little information is available on the effects of spilled oil on animals of the nekton other than fish. For the fishes, it would seem that the most vulnerable stages of the life history are the egg and larval stages. Certainly, these stages are the most sensitive of all stages in the life histories of most species. The State Lands Commission et al. (1978) has indicated that available studies on the effects of oil on fish eggs generally revealed reduced survival or resulted in an alteration of development patterns. The Bureau of Land Management (1979) has also indicated that perhaps the greatest impact on marine fishes would result from the use of chemical disbursing agents in treating the spill. Such agents have, in the past, produced toxic effects such as in the dispersal of the Torrey Canyon spill (Longwell, 1977). The State Lands Commission et al. (1978) has summarized the potential effects of an oil spill on marine fishes as resulting in some direct mortalities but has also noted that fishes should be able to recover their populations fairly rapidly.

The bioaccumulation potential of heavy metals in discharged drilling muds is not well known. However, the resuspension of deposited muds did not appear to be significant in a recent study (Trocine and Trefry, 1983) and it is possible that once material is deposited it remains.

Significant trophic level bioaccumulation has not been documented from drilling mud studies. However, accumulation of heavy metals and organic hydrocarbons has been documented for the San Pedro area as a result of the disposal of large volumes of wastewater into the area (SCCWRP, 1982).

The potential risk to aquatic organisms on a chronic basis is difficult to determine, but if the discharged material is disposed of at a depth of 60 m (200 feet), the impact zone should not be significant.

4.6.7 Sensitive or Unique Marine Environments

None of the marine refuges, Areas of Special Biological Significance (ASBS) or sensitive wetlands or bays should be affected by the construction and operation of the platform and interconnecting pipeline and cables. The deposition of drilling needs and cuttings during the drilling phase of the project will not affect the coastal sensitive resource areas.

In the event of a major oil spill from the platform or pipeline, particularly during the summer, a number of ASBS areas and wetlands could be adversely affected.

Primary points of contact include the:

- Laguna Beach Marine Life Reserve and Heisler Park Ecological Preserve
- Irvine Coast Marine Life Refuge
- Newport Beach Marine Life Refuge
- Newport Bay
- Bolsa Bay and Bolsa Chica Ecological Reserve.

The major areas to be affected in the event of an uncontrolled spill would be the intertidal areas along the mainland coast. The areas of special biological significance, especially in the south coast generally have sandy beach and rocky intertidal areas. The impacts on this type of environment has been discussed in Section 4.6.2.

Marshes can be seriously affected by oil spills due to the flatter topography, the relatively sensitivity of marsh plants to oiling and the concurrent ecological effects on resident birds, invertebrates and other biota. Upper Newport Bay and Anaheim/ Bolsa Chica Marshes represent significant wetland habitat which could be affected by an oil spill. In Upper Newport Bay several listed species of plants; Saltmarsh bird's beak (Federal and State-listed) and Laguna Beach dudleya (State listed) would be potentially affected in the event of an oil spill combined with a high tide. California least-tern, light-footed clapper rail, California black rail and Belding's savannah sparrow are all State and/or Federal-listed species and are found in the upper Newport Bay. Impacts on these birds could range from minimal to significant depending upon whether they actively encounter the oil spill (in feeding) or have their habitat affected by oiling.

Bolsa Chica and Anaheim Bay have similar conditons to Upper Newport and will be simiarly impacted. One factor that may minimize the potential for severe impact is the narrowness of the opening to these marsh areas. Oil spill measures such as booming the entire entrance could effectively limit the impact from an oil spill. The low probability of an oil spill occurring and the ability to protect sensitive wetland and bays should minimize potential impacts from an offshore spill.

The sensitive resource areas on and around Catalina Island could be affected by an oil spill, but the probability of contact is extremely low. Oil could contact the eastern shoreline during the winter months at a probability of 2-3 percent. Primary point of contact would be between White Point and Avalon Harbor. There are kelp beds in this area as well as rocky intertidal habitats. Impacts would be as described previously for rocky intertidal areas. Kelp does not appear to be significantly affected by oil spills (except for its ability to be harvested).

The time to landfall for an oilspill in the south San Pedro Bay beaches and reserves is 30-50 hours. Based upon the spill trajectory models (Appendix A), minimum times for spills to reach the shoreline (especially in the winter trajectories directed toward Long Beach and San Pedro) can be as low as 12 to 24 hours, although the contact probabilities at these locations are low (<1 percent).

No significant kelp bed areas should be affected by the proposed construction and operation of the platform and pipelines. Beds 10, 11, and 12 are generally non-significant beds with Bed 10 being approximately 0.1 square miles (64 acres) and Beds 11, and 12 being non-existent (SCE, 1981). Water quality deterioration has been implicated in the loss of these beds. The production Platform Eureka and the operation of the pipelines should have no effect on kelp resources in the potential contact areas.

4.6.8 Avian Resources

The construction and operation of the pipeline and platform should have no significant impact on marine birds. Increased noise and boat traffic should not affect the normal activity patterns, including feeding behavior of marine bird species. Migratory patterns should not be affected by the vertical structure of the platform.

The most significant impact on avian resources will be generated in the event of a catastrophic oil spill. Marine birds, particularly pelagic birds, have historically been severely affected by oil spills. Mortalities in bird populations typically result, as pointed out by SLC et al. (1978), from oil coating their plumage, and the toxic effects of ingesting oil. The Bureau of Land Management (1979) summarizes a wide variety of additional potential impacts on marine bird populations due to toxic and sublethal effects of oil spills. These include a depression in reproductive output. Perhaps the most obvious damage to birds occurs when individuals contact floating surface oil, thereby contaminating their feathers. This results in reduced buoyancy and an impairment of thermal insulation. The Bureau of Land Management (1979) and Nero and Associates (1983) report that the kinds of seabirds believed to be the most susceptible to contamination by oil are murres, guillemots, auklets, murrelets, puffins, cormorants, loons, grebes, and scoters. Other birds including shearwaters, fulmars, albatrosses, petrels, gulls, terns, shorebirds and some ducks and geese are also described to be vulnerable to contamination at sea, but less so than the diving birds. Many of these species of seabirds have been commonly reported in the offshore island region.

Consequently, in the unlikely event of a major oil spill, numerous incidents of bird mortality would be expected. For example, SLC et al. (1978) reports estimates of bird losses between Point Conception and the Ventura River due to the 1969 Santa Barbara oil spill to be 3686, based on an actual body count; birds that died at sea and were not recovered did not contribute to this estimate. An additional effect of oil on marine bird populations could occur through ecosystem contamination leading to the decrease of suitable food or alteration of critical feeding grounds. These impacts are poorly understood.

The impact of an oil spill on endangered bird populations wouild depend upon a variety of factors. Vulnerability and sensitivity of the species woiuld define the level of impact expected. The majority of the endangered birds occupy restricted habitats (Beldings savannah sparrows, Light-footed clapper rail, California black rail and California least tern). The impact on the specific habitat required by these species would vary. For example, if a large spill entered Upper Newport Bay on a high tide, areas of Salicornia could be covered with oil reducing reproductive success. Similar habitat alteration could be expected for the two rails. Impacts on the least tern would be primarily at the feeding areas of open water. If an oil slick covered the primary feeding areas, and birds tried to dive through the oil, it would be expected that some losses may occur.

The use of dispersants could have a significant impact on bird population via the potential bioaccumulation of petroleum hydrocarbons into avian food chains.

4.6.9 Marine Mammals

Construction of the pipeline and platform and the operation of the platform system should result in a limited impact on marine mammals. The increased level of noise from construction activities and boat traffic on marine mammals is not well documented, though it is speculated that the increased level of marine shipping traffic has reduced the effective communication ranges for many whale species. Although no generally accepted conclusions on the effects of noise generated by offshore oil development have been reached, whale migration through the Southern California Bight does not appear to have decreased since oil development began.

As discussed previously in Section 3.6.8, the southern sea otter (Enhydra lutris nereis) is not expected to be found in the area of the platform or pipeline, therefore no impact on this species from the construction and operation of the platform and pipeline is expected. Sea lions are often observed under and around existing platforms during drilling and discharge operations. Impacts on these marine mammals from the construction and operation of Platform Eureka are not expected to be significant. The increased levels of turbidity during drilling mud and cuttings disposal could have a temporary effect on feeding activity of some marine mammals using visual feeding, though this should not be significant.

Some of the species of marine mammals occurring in the Southern California Bight could be affected by an oil spill, although as noted by SLC et al. (1978), available information suggests that marine mammals often avoid areas covered by oil. Contact with floating oil can foul the fur of pinnipeds, as well as be ingested and inhaled. Fur seals depend upon their fur for insulation and when fur is contaminated by oil, insulation properties are impaired and buoyancy is decreased. Ingestion of oil by nursing pups from their mothers' teats, and coating of respiratory passages in pinnipeds and cetaceans, can also result from an oil spill and can lead to marine mammal mortalities (SLC et al., 1978). An oil spill near Platform Eureka could produce minor changes in the migratory routes of the California gray whale depending upon the magnitude of the spill. In summary, marine mammal populations in San Pedro Bay would likely suffer some impact from an oil spill, with a few expected mortalities of pinnipeds. Additional impacts of a spill on marine mammals, including the endangered gray whale, are difficult to predict, but should not be significant.

4.6.10 Mitigation

The construction and operation of the platform and pipeline will have some impact on the marine ecosystem as previously described.

The losses associated with platform placement, the laying of the pipelines and cables, and the anchor scars will reduce the benthic infauna at the contact locations. This loss should not be considered significant due to the relatively uniform infauna at the project location and the type of habitat affected.

The most significant negative impacts would be generated from catastrophic oil spills and potentially from the deposition of muds and cuttings.

Shell California Production Inc. has developed an Oil Spill Contingency Plan for dealing with potential catastrophic events, including cleanup operations and reducing the level of operations during hazardous conditions. These measures are designed to reduce the probability of an oil spill and to provide high level cleanup operations if they are needed. The plan is specifically oriented towards protection of sensitive resources. Protection and cleanup techniques specific to the varied habitats and environs are clearly delineated in the plan.

The physical impacts of cutting deposition will result in the loss of some existing infauna near the platform. To reduce the extent of this burial and grain size alteration, the discharge pipe could be placed near the bottom and the cuttings deposited in a fairly small circle. However, this will also concentrate the drilling muds in one location, potentially increasing any adverse response. To minimize the varied impacts from this depositional process, the discharge pipe will be a minimum of 60 m (200 feet) below water level, which will minimize wind current effects on mud dispersal and allow cuttings to fall to the sea floor in a confined area near the platform.

Long-term effects of drilling muds on the bioaccumulation of metals by marine fauna are not well known, but is not expected to be significant.

4.6.11 Cumulative Impacts on Marine Biology

Platform Eureka will be the last platform in the Beta Unit. The cumulative biological effects of the drilling, platform placement and waste discharges will add to the existing impacts generated by the other three platforms. At the present time no specific negative impacts have been noted on biota from the placement of the previous platforms. It is difficult to assess the potential cumulative impacts in light of all of the other, non-oil related impacts generated within the San Pedro Bay region.

There will be some additive impacts from the volume of drilling muds and cuttings deposited on the bottom, however the assimilation capacity of the benthics appears capable of adapting to this effect. There will be an increased potential for oil spills above the existing level, but with the implementation of the oil spill contingency plan impacts should be controlled.

4.7 ONSHORE LAND USES

4.7.1 Facilities

Development of Platform Eureka would not require additional onshore support systems. As outlined in the project description, crude oil produced on Platform Eureka would be transferred to Platform Elly for transport to shore through existing pipelines similar to Platform Ellen's procedure. The produced oil would then be delivered to the onshore distribution facility. The existing pipelines and distribution facility were designed with adequate capacity to process oil from each of the three platforms (Chevron's existing Platform Edith production is transported via this existing pipeline). Operation of Platform Eureka would also utilize the existing crew boat launch and supply boat yard. However, the frequency of use at each of these facilities may increase due to Platform Eureka. Additional helicopter operations may take place at the Long Beach Airport although no new facilities are planned. Facilities and staffing levels at the Pier G offices will remain at current levels as well.

No new onshore facilities are proposed as part of the Platform Eureka project. Therefore, since existing onshore facilities are consistent with applicable zoning and land use designations, the project would not represent an impact to onshore land uses.

4.7.1.1 Mitigation

No mitigation is required.

4.7.2 Scenic Visual Resources

Construction and implementation of Platform Eureka would not require the development of additonal onshore facilities. However, the use of existing facilities in the Port of Long Beach would increase during construction and installation of Platform Eureka. Additional materials and personnel will be required at the onset of Eureka. This would temporarily increase the industrial character of the area. However, due to the temporary nature of construction related activities and the low scenic value of existing onshore facilities, the increased use of the area would not represent a significant adverse impact. Since operation of Platform Eureka would not require additional onshore facilities or personnel, the project would not alter the visual character of existing facilities.

Platform Eureka would extend approximately 241 feet above mean high water level. As outlined in Shell OCS Beta Unit EIR, due to the platform's distance offshore and the effect of the curvature of the Earth, only a small portion of the viewshed would be occupied by the platform. Assuming a 180° horizontal view plane from Huntington Beach, the structure would occupy 0.28° or 0.15 percent of the view plane. Vertically, using a 90° plane, the platform would occupy 0.29° or 0.32 percent of the viewshed. This intrusion is felt to be minor, although visual resources are difficult to quantify and some individuals may consider any intrusion adverse. Regardless of the degree of intrusion, implementation of Platform Eureka would not introduce a new element to the area offshore Huntington Beach. The project site is located south-southeast of Platforms Edith, Elly and Ellen; additional platforms are located closer to the coast (SLC et al., 1978).

On a cumulative basis, Platform Eureka would represent a continuance of offshore development. However, Eureka represents the last platform to be developed in the Beta Unit oil field. No other developments are presently planned in the area. Therefore, development of Platform Eureka is not expected to induce the development of additional platforms in the immediate vicinity and would represent the final visual intrusion within the Beta Unit oil field.

It should also be noted that although the platform would be in operation for 30 years, it would eventually be disassembled and removed from the viewshed, following appropriate agency approvals. Therefore, Platform Eureka would not represent permanent visual presence.

4.7.2.1 Mitigation

The development of Platform Eureka would not represent an adverse impact to areal visual resources. Furthermore, existing onshore support facilities are expected to be capable of serving Platform Eureka, and no new facilities would be required. Therefore, since project implementation would not represent an adverse impact to scenic visual resources, no mitigation is necessary.

4.8 SOCIOECONOMIC IMPACTS

4.8.1 Effect on Local Employment, Population, Housing and Economics

4.8.1.1 Construction

The Platform Eureka jacket is currently being constructed at Kaiser Steel's facilities in Vallejo, California and is expected to loadout in May of 1984. The installation phase of Platform Eureka would encompass an 80-day period. The deck section, crew quarters, heliport and modified drill rig from Platform Ellen would then be installed on the jacket.

Onshore fabrication activities will take place in northern California and the Gulf Coast area. The employment requirement for the onshore fabrication of Platform Eureka facilities is estimated to be 900 man years with a peak employment of 630 persons. As shown on Table 4.8-1, 50 persons will be employed by SCPI during onshore fabrication activities while the remaining 580 will consist of contractor employees. Based on a construction multiplier of 3.6 (Fitz, 1983) 2268 secondary employment opportunities are expected to be generated by onshore fabrication of Platform Eureka. Secondary employment opportunities include service jobs generated by the project and induced employment generated by employee spending. Because onshore fabrication would take place outside of Los Angeles County, local labor would not be involved and fabrication activities would not represent an impact to County population or housing.

As shown in Table 4.8-1, offshore fabrication is expected to generate a total of 1150 jobs (250 direct jobs and 900 secondary employment opportunities). These jobs primarily will be situated within the L.A. Basin area. Because this is a relatively small number of jobs in comparison to the total available labor in the area, and because these positions are relatively short-term in nature, these jobs will likely be filled by local labor and would not stress local labor markets or induce in-migration.

Table 4.8-1

ESTIMATED PEAK LABOR REQUIREMENTS
PLATFORM EUREKA AND ONSHORE FACILITIES

	Direct		Secondary	Total
	SCPI	Contractor		
FABRICATION				
Onshore	50	580	2,268*	2,898
Offshore	70	180	900*	1,150
OPERATIONS				
Onshore	0	36	NA	0
Offshore	11	36	356**	403

*Based on a secondary employment factor of 3.6 for fabrication activities.
**Based on a secondary employment factor of 7.6 for operation/production activities.

4.8.1.2 Precommissioning and Operation

Installation of pipelines, submarine cables and a second generator on Platform Elly will take place during the 7-month precommissioning period from October 1984 to April 1985. Offshore employment within SCPI Beta Field facilities will reach its peak during this period when approximately 87 SCPI workers and approximately 66 contract personnel are employed. However, offshore activities will be composed of various shifts and specialized tasks, therefore, not all employees will be onsite at any one time. The majority of these employees will be transferred from Platforms Elly and Ellen, resulting in a net new employee requirement of 11 SCPI and 36 contract employees. Peak employment levels would continue throughout the drilling phase of the project. Based on a secondary employment factor of 7.6 secondary employees per direct employee, the net increase in employees would generate a need for 357 secondary employees. Due to the availability of qualified personnel and the high rate of unemployment in Los Angeles County (8.5 percent), the local labor pool is expected to satisfy the primary and secondary personnel requirements.

4.8.1.3 Employment Summary

Although the majority of the work force will be comprised of persons already engaged in similar activities, there is the potential for new employment opportunities to result from the proposed project, either through direct project employment or induced employment in the support and service sectors. Overall, project employment opportunities will represent a moderately beneficial impact to the Los Angeles County mining and construction industries.

As discussed in the preceding sections, no significant impacts to local population or housing conditions are anticipated due to the predominantly short-term duration of the various project phases and the use of construction forces already established locally.

4.8.2 Effects on Community Services

4.8.2.1 Fire Protection

Construction activities will temporarily increase the potential for fire at existing onshore facilities due to the increased presence of motorized vehicles, heavy construction equipment and the presence of flammable hydrocarbons. While there is a potential for fire hazards at the onsite processing facilities, prevention, detection and suppression of fires would be the responsibility of SCPI, and therefore not create significant increased demands on local fire-fighting entities. The oil metering and pumping facilities at Long Beach have been designed and constructed to incorporate necessary fire prevention and protection measures, thus reducing reliance upon the fire department during the critical early stages of a fire at or near the site. Continuous monitoring of fire sensors will be accomplished in addition to the provision of automatic fire-extinguishing equipment in the more critical areas.

During operation the availability of fire protection services at SCPI onshore facilities would not be affected by implementation of the Eureka platform. To date, the Long Beach fire department has not been called to existing onshore facilities. However, the department is capable of serving SCPI onshore facilities. Operation of Platform Eureka is not anticipated to significantly increase onshore manning or facility levels. Therefore, the platform would not create an increased need for fire protection services onshore.

Implementation of Eureka would generate a new potential for fires on the platform; therefore, fire suppression equipment has been incorporated in the project design. Fire suppression equipment would consist of a two-pump saltwater system with primary and backup electricity sources feeding AFFF hose reels. Certain enclosed areas of the platform, such as the rig switching room and paint locker, would also be equipped with a Dupont halon gaseous fire extinguishment system. In addition, numerous 30-lb hand portable and 350-lb wheeled dry chemical (Purple-K) extinguishers would be located at strategic locations on the platform. Each system would be regularly tested according to MMS regulations and will be capable of extinguishing potential fires on the drilling rig.

4.8.2.2 Police Protection

To date, police services have not been required at onshore facilities or on the existing platforms. The crew and supply terminals receive normal patrol service which will continue during implementation and operation of platform Eureka. An increased potential for theft and vandalism at SCPI onshore activities will occur during the contruction phase of the project due to an influx of temporary workers. However, SCPI security guards are anticipated to be capable of handling any problems onsite. Although their services are not anticipated to be required, the Harbor Police Department and the Long Beach Police Department are capable of providing back-up protection onsite.

Since security has not been a problem on existing offshore platforms, development of platform Eureka is not anticipated to generate a requirement for police protection. Therefore the proposed project would not represent an adverse impact to police protection services.

4.8.2.3 Medical Facilities

As outlined under Section 3.8.3, "Existing Community Services" Long Beach Fire Department paramedics would respond to injuries at onshore facilities in the Port of Long Beach. Injured personnel would be taken to St. Mary's Hospital or Long Beach Memorial Hospital. Both hospitals operate well below capacity (Riccardi, 1983; Lifschutz, 1983).

Injuries occurring on the platform would be handled in one of several ways. Minor injuries would be treated with Coast Guard approved first aid techniques. Moderately injured personnel would be transported to shore via crew boats or SCPI helicopter and then to one of the aforementioned Long Beach hospitals via private car or paramedic service. In severe cases, patients could be transported via Med-Air or Life Flight helicopter ambulance service.

It is estimated that three to four SCPI or contract employees per year would require some level of emergency medical care (SCPI, 1983). Adequate medical facilities are available to serve these employees, regardless of where the employees are located. Due to the availability of medical services and the low number of SCPI personnel requiring medical attention, the proposed project would not represent an significant impact to emergency medical facilities.

4.8.2.4 Water

Development of Platform Eureka would create a minor increased requirement for water from onshore facilities, associated primarily with the need for drilling water supplies. Potable water on the rig itself would be supplied through desalinization of saltwater, and no import of municipal water would be required. Implementation of Platform Eureka is not expected to represent a significant impact to municipal water supplies.

4.8.2.5 Energy

SCPI has estimated that onshore energy consumption would remain at the current level following implementation of Platform Eureka. One hundred percent of the Eureka's energy requirement would be generated by the combustion of natural gas on Platform Elly. Two separate underwater electrical lines will be available to transmit power from Platform Elly to Eureka. Therefore, since Platform Eureka would not generate need for additional domestic energy supplies, the project would not represent an adverse impact to energy resources.

4.8.2.6 Sewage Disposal

Sewage generation at onshore SCPI facilities is not anticipated to increase due to project implementation. As required by the NPDES Discharge Permit regulating Eureka, sewage generated on the platform will be processed through an EPA approved sewage treatment system prior to being discharged 40 feet (12 m) below the surface of the ocean. Based on an average of 145 gallons (549 l) per person per day, the additional 47 onboard personnel would generate 6815 gallons (25,795 l) of sewage per day. Slight increases in the amount of suspended solids, oxygen demand residual chlorine and nutrient levels near the ocean discharge point would result from the deposition of treated sewage. However, these residuals would be imperceptable at a distance of a few meters from the discharge point and would not act to degrade water quality. Since domestic wastes generated on platform Eureka would be disposed of offshore, no impacts to municipal sewage systems would result from project implementation.

4.8.2.7 Solid Waste

During construction, activities associated with Platform Eureka would generate increased loads of solid waste onshore. These would be transported with waste from permanent onshore facilities and from the existing SCPI Platforms to appropriate approved hazardous or non-hazardous solid waste disposal facilities. The increased loads of hazardous and non-hazardous solid waste generated by operation of Platform Eureka would be adequately handled at approved local landfills.

4.8.2.8 Mitigation

Other than adherence to the preventative safety measures, no additional mitigation measures are required.

SECTION 5
ALTERNATIVES TO THE PROPOSED ACTION

5.1 NO PROJECT

The "no project" alternative would result in avoidance of all impacts discussed in this Environmental Report. However, needed hydrocarbon resources would not be produced and the full resource potential of the Beta Field would not be realized. Additional imported crude would thus be required to meet domestic needs. Importation would result in negative environmental effects, adverse balance of payments at the federal level, and loss of royalties to the U.S. government and monetary loss to the State of California. SCPI and its partners would also suffer significant economic loss should the Beta Field not be produced to its full potential, and installed processing and pipeline transportation capacity, justified in anticipation of proposed Platform Eureka, would be underutilized, resulting in loss of capital and operating efficiencies.

The no-project alternative has already been considered at the Federal level in conjunction with decisions made concerning OCS Lease Sale No. 35 by the Bureau of Land Management. In accepting bids from Shell and others for leases in the Beta Field, this alternative was essentially rejected. Moreover, current Department of Interior policy is that oil and gas leases must be explored and developed within a reasonable time or the lessee faces the possibility of relinquishing the leases to the government. MMS further specifies that it has authority to not approve a Development and Production Plan if, for example, it is determined that serious harm or damage would result to fish and other aquatic life, or serious harm or damage to the human environment. Such possibilities have been thoroughly discussed in Section 4 and there is no basis for such a determination for this specific project. Consequently the no-project alternative does not appear justified.

5.2 DELAYED PROJECT

Delay of the Platform Eureka Project would result in increased project costs at the time the platform is ultimately installed. These increased costs would be mitigated to some unknown extent by the probability of concomitant increases in product value. Project delay would also result in the temporary sufferance of impacts discussed under the "no project" alternative, and would have an effect on SCPI's and partner's cash flow planning. Postponement could also result in loss of the lease through failure to meet lease stipulations regarding timely development of reserves.

Delay of the project would result in the same environmental impacts discussed in this report except at a future date. This is true unless future technological developments occur which reduce the risks of potential adverse impacts.

5.3 ALTERNATE LOCATION

As described in the original EIR/EA, alternate locations are infeasible from a geologic point of view. Further, due to the configuration of the field, no improvement in platform location relative to the Vessel Traffic Separation Scheme and shipping corridors would result. Finally, such relocation would not yield any beneficial effects regarding environmental impacts.

5.4 PROCESSING FACILITIES

Installing processing facilities on Platform Eureka could eliminate the need for the three pipelines to existing Platform Elly. While this would mitigate some potential negative concerns with regard to commercial fishing, it would require a larger platform occupying a larger area, and would be far more costly. In addition, at least one crude oil pipeline would still be required. Further, the processing facilities already installed on Platform Elly are designed to handle full production from Eureka. If processing facilities were installed on Eureka, those on Platform Elly would not be utilized to full capacity, resulting in inefficient operation and economic loss.

5.5 POWER GENERATION FACILITIES

Power generation facilities could be installed on Platform Eureka. The benefits and impacts are similar to those discussed above for processing facilities. In addition, negative environmental effects could result from inefficient fuel use due to equipment service factors (loss of generated energy per unit of fuel consumed), increased opportunity for spills during fueling operations, and increased potential for vessel/platform collisions.

5.6 ALTERNATIVE DRILLING FACILITIES

Use of other drilling/producing methods such as more than one platform, mobile oil drilling units, sub-sea completions, etc. are discussed in the original EIR/EA (SLC et al., 1978). The lack of environmental benefits and increased risks of spills and collisions described therein still hold true. The increased economic costs associated with multiple deepwater platforms would be severe.

5.7 ON LAND DISPOSAL OF DRILLING MUDS AND CUTTINGS

Proposed Platform Eureka will operate under either a General or an individual NPDES Discharge Permit. In either case, discharge of oil-free drilling muds and cuttings will be considered during the permit issuance process. Should such discharge be allowed, limited and temporary negative environmental impacts will result. These negative impacts will have been considered acceptable by the agency issuing the permit. Mitigation of these impacts will be accomplished on Platform Eureka through drilling mud recovery practices and use of muds classed as generic by the federal EPA (i.e., those having acceptable toxicity characteristics as demonstrated through laboratory bioassay testing).

Disposal of drilling muds and cuttings at onshore disposal sites is a potential alternative to overboard discharge. Although this alternative would eliminate those environmental impacts associated with onsite disposal, significant terrestrial and marine impacts would result.

5.7.1 Terrestrial Impacts

Disposal of drilling muds and cuttings is regulated under California law and requires the use of appropriate Class I and Class II-1 disposal sites. Use of such sites would result in consumption of valuable and limited space which, in the case of non-hazardous muds and cuttings, is contrary to the state's active program to minimize the number and size of these facilities. Beyond this consideration, a heavy air pollution burden would be created by the large number of trucks which would be required to transport these materials to the disposal location, with concomitant increases in heavy truck traffic, noise, road and highway congestion. An estimated 5 to 10 thousand barrels of drillings muds and/or 1500 barrels of cuttings per well would require transport. Using trucks with an average of 100 barrels, some 65 to over 100 trips would be required for each of the 60 wells scheduled for Platform Eureka. Between 1400 and 2400 cubic yards of disposal site space would be occupied for each well drilled. Assuming disposal would occur at the BKK site in West Covina (80 miles round trip), 5200 to 8000 miles would be traveled, again for each well. However, the BKK site will not be permitted to accept liquid wastes after May of 1984. Therefore, the Casmalia or Kettleman Hills disposal facilities would have to be used. The travel distances to these disposal sites will be far greater.

5.7.2 Marine Impacts

The use of vessels to transport mud and cuttings ashore will increase marine traffic in the project area and will require the availability of dock space with dockside truck access. Additional air pollutant emissions will result from the use of platform cranes, transport vessels, and unloading equipment at the pier.

5.7.3 Other Factors

Space, equipment and manpower considerations must also be evaluated for this alternative. For economic reasons platforms are designed with little free space. Thus, the storage facilities for muds and cuttings is at a premium and would at a minimum result in overcrowding an already crowded area. The manpower required to handle the loading of storage bins, transferring them to vessels and transport to shore is costly and the operation can increase the opportunity for accidents. Costs associated with land based disposal are large and are comprised of not only those included in the handling and transport of these wastes, but also fees charged by the disposal facility and by the State of California.

5.7.4 Conclusions

The alternative of onshore disposal of oil-free mud and cuttings is not considered viable. Despite the elimination of the environmental impacts of onsite marine disposal, the added economic and environmental effects of onshore disposal are considered excessive.

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APPENDIX A

OIL SPILL TRAJECTORY ANALYSIS
PLATFORM EUREKA
BETA FIELD

OIL SPILL TRAJECTORY ANALYSIS
PLATFORM EUREKA
BETA FIELD
FOR SHELL CALIFORNIA PRODUCTION INC.

Job No. 00216-269-15

AUGUST 16, 1983

Dames & Moore
MARINE SERVICES
LOS ANGELES, CALIFORNIA

OIL SPILL ASSESSMENT

1.0 INTRODUCTION

Shell California Production Inc. is proposing to construct a new production platform Eureka on lease OCS P-0301 adjacent to the existing platforms Ellen and Elly on lease OCS P-0300. To comply with the recently upgraded Minerals Management Service requirements for oil spill trajectory analysis submitted by POCS operators, Shell California Production Inc. contracted Dames & Moore to conduct such an analysis.

The trajectory analysis presented here is designed to predict the likely fate of oil spilled from any of the elements in the leases OCS P-0301 and OCS P-0300, given a spill occurs, by selecting a release site midpoint between the two production platforms. Considerations based on the accuracy of available wind and surface current data make this a realistic assumption. The risk of such a spill occurring is briefly addressed in the first section of the report.

2.0 OIL SPILL RISK

The probability of an oil spill related to offshore oil production occurring in California waters is statistically difficult to estimate due to the very low historical accident rates and the fact that existing data bases for U.S. waters do not generally differentiate between exploration and production operations. Since 1963 over 500 wells of both types have been drilled on the California OCS with the 1969 Santa Barbara oil spill the only significant accident. In addition, over 3000 wells have been drilled in state offshore waters with no significant accidents.

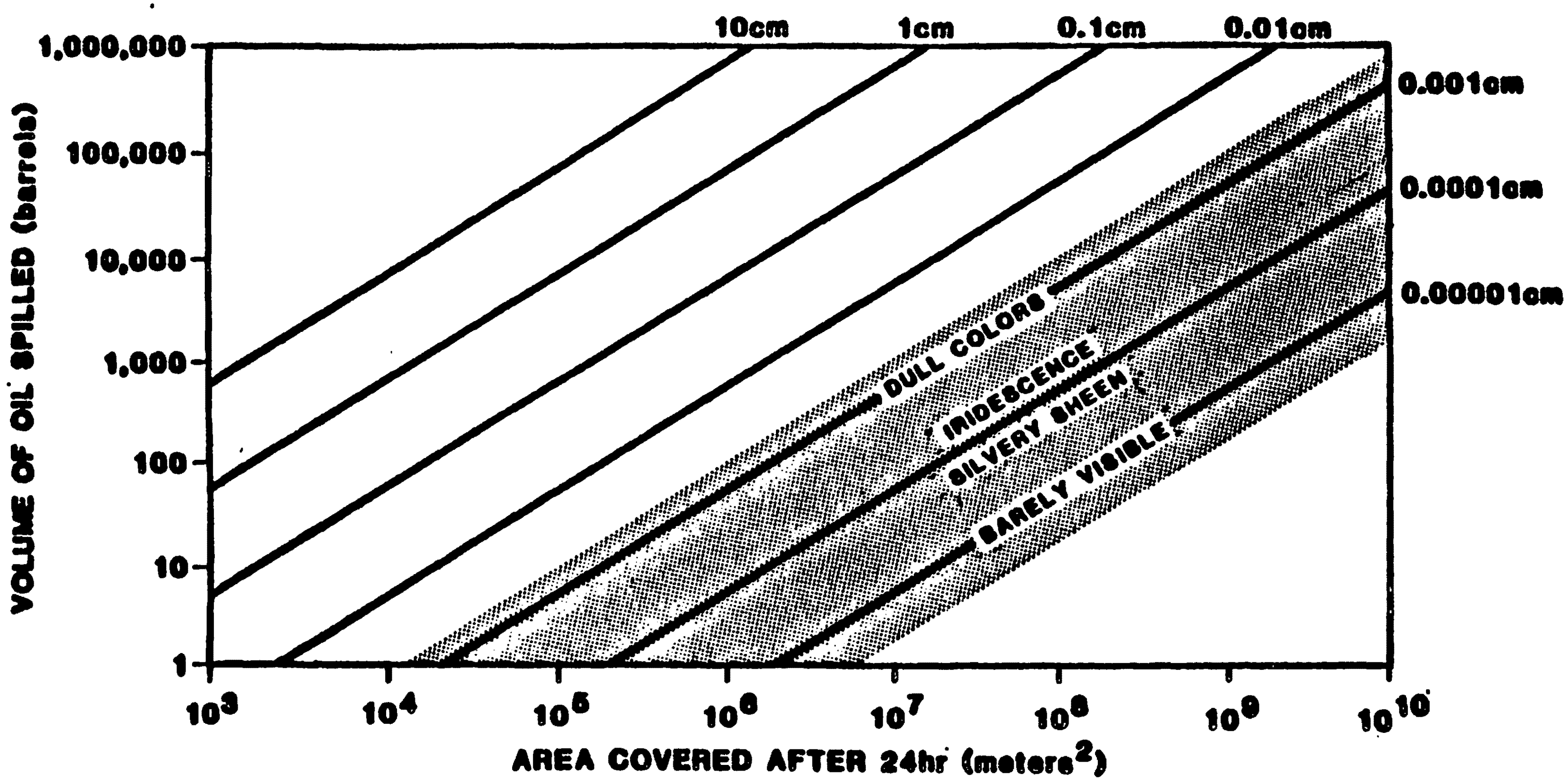
Possible spill size is equally difficult to estimate statistically. The potential size of a major incident is indeterminate. The most probable spills will be associated with vessel resupply and routine operations, and are anticipated to be within a few or tens of barrels in volume.

An important aspect of planning oil spill response actions is assessing the volume and potential movement of any spill. In the case of large spills that may affect shoreline areas, the early assessment of spill movement can provide the necessary time to take actions to protect sensitive areas. An accurate estimate of spill volume is necessary to help determine cleanup equipment requirements and to comply with federal oil spill reporting requirements. Spills of less than 6.3 bbl, which are controlled in the vicinity of the spill site, and spills of 6.3 bbl or greater have different reporting requirements.

2.1 ESTIMATION OF SPILL VOLUME

Several oil spill sources may be associated with OCS platform operations. Small diesel spills may result from normal platform operations during transfer between the supply boat and the platform. Although it would be an unlikely occurrence, a well blowout or pipeline rupture could be the source of a larger oil spill. In the event of a sizeable spill (one that is too large to contain near the platform) a rough estimate of the spill's total volume is desirable. Early in the response, total spill volume determines, in part, the equipment and manpower needed, the amount of oil that may reach shoreline sensitive areas, and the requirements of the disposal sites to be used. Because early estimates of spill size are important, onsite estimations are necessary.

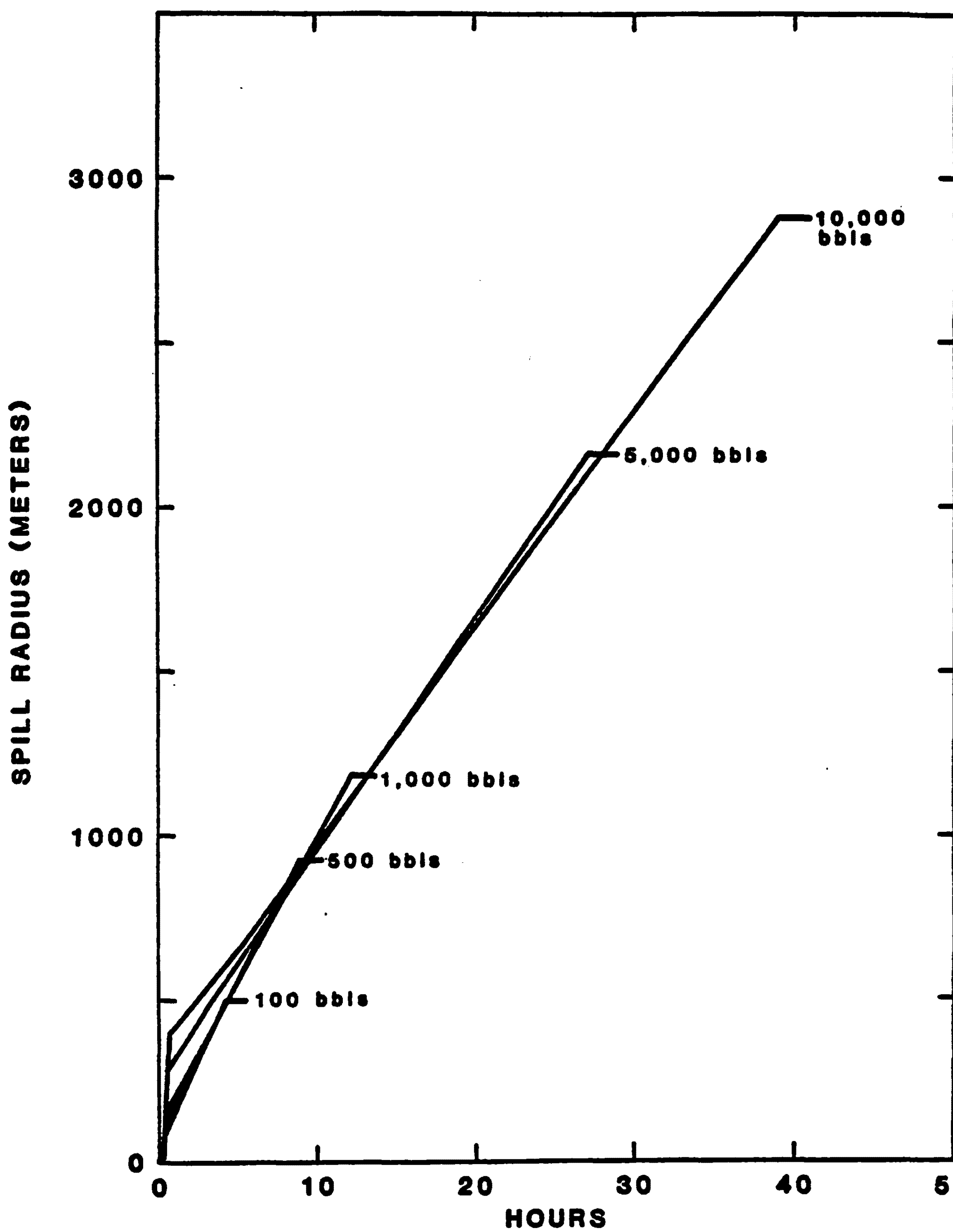
A rough estimate of spill volume can be attempted by considering the nature of the event at the time of occurrence and the slick size. Figure 1 relates the appearance of oil on water to its thickness. Oil spills eventually cease to increase in area if the spill source is stopped. Figure 2 shows the radius to which an oil spill is expected to spread and the time it takes for the spill to attain these proportions for five spill volumes.



Shaded area indicates the range of oil slick observations for which thickness and area covered can be determined by appearance. Any value below the shaded area would not be visible, and any value above would be a dark brown or black.

FIGURE 1

OIL SPILL VOLUME, FILM THICKNESS, APPEARANCE, AND AREA COVERED



MAXIMUM OIL SPILL RADIUS VERSUS TIME
(Fay Model–for Crude Oil
with Specific Gravity 0.88)

FIGURE 2

3.0 PREDICTION OF SPILL MOVEMENT

3.1 INTRODUCTION

Shell California Production Inc. has contracted Dames & Moore to perform a set of monthly oil spill trajectories for OCS P-0300 and -0301. Each monthly trajectory shows changes in direction of the centroid over the course of its simulated trajectory for 72 hours or until shore contact. The results of computer simulations for 72-hour spill trajectories at these two locations on a monthly basis are presented in Section 3.5.

3.2 METHODOLOGY

3.2.1 Trajectory Model Description

A trajectory model is used to simulate the movement of the centroid of an oil spill with the objective of identifying the area of shoreline that it could affect, and to estimate the time for the oil slick to reach the impact point. Physical factors considered to be the predominant driving forces in the model are geostrophic and tidal currents and winds. Trajectory results are not dependent on oil spill volumes or mass-dependent effects (e.g., spreading, evaporation, dissolution, dispersion, emulsification, sedimentation, biodegradation, and autooxidation). However, because interpretation of the model results becomes increasingly difficult with increasing spill volumes (and associated greater spreading diameters), the model is only considered valid for spill volumes of 10,000 bbl or less.

The trajectory model employs a vectoral addition of wind and current forces to drive the centroid of a two-dimensional surface oil slick. Second order forces, such as waves and wind-wave current interaction, are not considered. Similarly, physiochemical processes such as evaporation, sinking, dissolution, and emulsification also are neglected. These assumptions give conservative results with respect to impact probabilities and eliminate the need to use input data that are not readily available.

The effect of wind on a marine oil slick is incompletely understood (Stolzenbach et al., 1977). However, published results from experiments and observations (Van Dorn, 1953; Stewart et al., 1974; Oceanographic Institute of Washington, 1977) indicate that, in the absence of surface currents, the centroid of an oil slick moves in the direction of the wind at about 3 percent of the wind velocity.

A surface slick on a moving stream of water in the absence of waves moves with the currents at the surface current velocity (Stolzenbach et al., 1977). For modeling purposes, surface currents offshore San Pedro are divided into two components: a geostrophic surface current and a tidally induced surface current. During any trajectory simulation, the net geostrophic surface current component is assumed to remain constant in time, while the tidal current component is phased with the tide.

In the oil slick trajectory model, the slick centroid is calculated to move at the same instantaneous velocity as the vectoral sum of the underlying surface currents, plus 3 percent of the wind velocity vector. The centroidal velocity vector can be written as:

$$U_{oil} = 0.03\ U_{wind} + U_{tidal} + U_{oceanic} \quad \text{(Equation 1)}$$

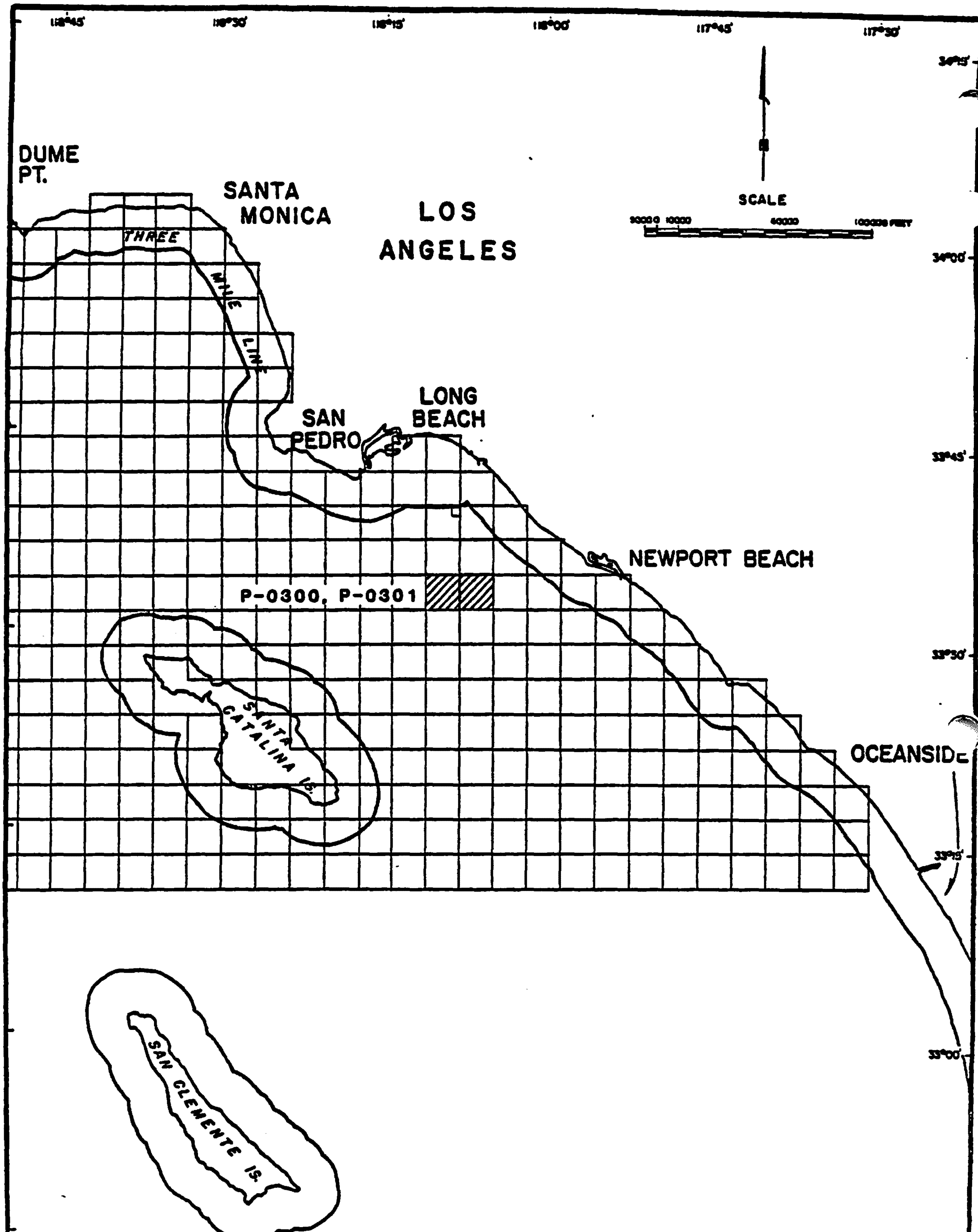
3.3 MODEL APPLICATION

Application of the trajectory oil spill model requires a grid system to be superimposed on the study area. The grid system selected for this trajectory analysis is shown on Figure 3. This grid system is used as the basis for input of wind and current information. The definitions of shoreline impact locations are also based on this grid. The grid resolution of 3 miles was dictated by: (1) combination of the resolution of the available field data; (2) the magnitude of the wind and current gradients; and, (3) the predominant sizes of OCS lease blocks in the area.

A trajectory can be generated by using appropriate values of the wind and current data, as described in the following sections, in Equation 1 over a sequence of time steps until the centroid reaches the shoreline or the outer boundary of the grid system, or an upper limit on time is reached. The origin of the trajectory is determined from the oil spill risk analysis.

The meteorology of the Southern California Bight region has been classified into a number of readily discernible, frequently occurring wind regimes. Each regime has a characteristic seasonal frequency of occurrence and an average and maximum duration. For each type, the generalized wind pattern can be described for certain periods of the day for each grid square shown on Figure 3. For the remainder of the 24-hour cycle, the wind pattern must be described by interpolation in time between the known wind patterns.

During the period that a particular wind regime is applicable, its hourly wind patterns can be used in sequence to move the centroid of the spill. During each season, the wind regimes themselves can also be sequenced according to the



REGIONAL LOCATION MAP
OFFSHORE SOUTHERN CALIFORNIA

SHELL CALIFORNIA PRODUCTION INC.

Dames & Moore

FIGURE 3

actual frequency of occurrence of each type. The frequency of occurrence of these regimes can be controlled so that the actual average duration of each type is observed.

By varying the combinations of spill time, spill location, tidal currents, and environmental data, a frequency distribution can be assembled from the deterministic runs to show the percentage and distribution of impact points along the shoreline. The average and minimum time for the slick centroid to reach the shore is tabulated for each shoreline grid location.

3.4 ENVIRONMENTAL DATA

The following paragraphs summarize meteorological and oceanographic data which is used in the oil spill models to evaluate the movement of postulated oil spills originating in the Southern California Bight region.

3.4.1 Meteorological Flow Regimes

The most prevalent wind pattern offshore of southern California is one of northwest winds in the outer area, modified near shore by local topography and the land-sea breeze phenomenon. Several other wind flow regimes are also relatively common in the region. To quantify these flow regimes for use in the oil spill trajectory model, an 11-year record of daily weather conditions and events was categorized (Strange, 1983). Additional references used in categorizing these flow regimes included de Violini (1974) and DeMarrais et al. (1965). Four basic meteorological types were distinguished for offshore southern California. These types are listed below.

Meteorological Type	Subtypes
Sea breeze	summer; winter
Northwester	outer waters; entire area
Southeaster	entire area
Santa Ana	northern waters; entire area

The term "outer waters" generally refers to the area offshore of an imaginary line connecting Anacapa Island and Santa Catalina Island and extending southeastward adjacent to the coast. The term "entire area" generally refers to the entire region covered on Figures 4 through 24.

Each of the flow regimes exhibits unique spatial and temporal characteristics as discussed below. Vector plots of the wind patterns associated with these types, by time of day, are shown on Figures 4 through 24.

Sea Breeze Regime

SUMMER. The sea breeze or stratus flow regime is the most common during the summer season and is generally characterized by coastal fog and stratus clouds. Winds in the area typically remain westerly to northwesterly throughout the day. At night and during early morning, coastal winds are light and from the southwest to southeast (Figure 4). By early afternoon, winds along this portion of the California coastline are from the west to southwest, depending on location, and exhibit average speeds of about 10 knots (5 m/s) (Figure 5). The wind direction remains relatively constant throughout the afternoon. At night, the offshore wind pattern becomes more westerly as shown in Figure 6.

The sea breeze regime is prevalent offshore of southern California more than 50 percent of the time during the summer months. The average persistence of this regime is 4 to 6 days, but it may persist for as long as 20 days before being interrupted by another weather pattern.

WINTER. Wind patterns in winter are more variable than in summer. The most common pattern is the land-sea breeze regime, a seasonal variation of the summer stratus regime. The major difference between the winter and summer regimes is that the sea breeze is weaker and the land breeze stronger during winter. The wind is generally from the north and northeast during the morning hours and generally from the west and southwest during the afternoon and evening. After sunset, the land breeze dominates, causing the wind to shift to the northeast in nearshore areas. Wind speeds throughout the day range from about 4 to 12 knots (2 to 6 m/s). A typical representation of this regime is shown on Figures 7, 8, and 9.

This flow regime occurs between 50 and 80 percent of the time during winter. It typically persists for 3 to 6 days but may persist for as long as 25 days.

Northwester Regime

OUTER WATERS. The northwester-outer waters meteorological type is marked by strong northwesterly winds offshore of an imaginary line between Anacapa Island and Santa Catalina Island and becoming more westerly and southerly north of this imaginary line (Figures 10, 11 and 12). Inshore of this imaginary line, much lighter winds occur, often with a return eddy flow near the coast. The strength of the northwest wind is variable, as is the distance to which it progresses eastward during the day.

The northwester-outer Channel flow regime occurs between 20 and 40 percent of the time during the summer months and 10 to 20 percent of the time in the winter. The average duration in summer is 2 to 3 days with a maximum duration of 10 days. The average duration in the winter is 1 to 2 days with a maximum of 8 days.

ENTIRE AREA. This flow regime is marked by strong winds throughout the area (Figures 13 through 16). To qualify as this type, a minimum wind speed of 20 knots (10 m/s) must occur for several hours at some time during the day (usually in the afternoon). The wind direction varies from west to northwest.

This flow regime occurs most frequently during the winter (10 to 20 percent of the time). Its average duration is about 1 day and its maximum duration is about 3 days.

Southeaster Regime

ENTIRE AREA. Southeasters that influence offshore southern California are extremely variable in behavior. The strongest winds may occur long before the frontal passage and extend over a considerable period of time. Conversely, they may occur over a short duration and be confined largely to the frontal zone. The diurnal influence is minimal, being offset by the large-scale synoptic features. However, frontal passages do have a peak frequency of occurrence during the early morning hours and a secondary peak in the evening.

A typical southeaster scenario affecting the entire area is shown on Figures 17 through 20. The vector plots show a southeast wind setting in initially over the outer waters, followed by increasing wind speeds and a southeast shift of the area of influence. After the frontal passage, light, west to southwest winds occur for about 12 to 24 hours, followed thereafter by a northwester.

The duration of the southeaster is dependent on the speed of the migrating pressure system, but is generally about 2 days. The frequency of occurrence of the southeaster is generally in the range of 5 to 15 percent from November to April. These conditions are rare during the other months of the year.

Santa Ana Wind Regime

NORTHERN WATERS. The Santa Ana is a dry, offshore wind associated with high pressure over the western states. It often remains throughout the day, although a westerly sea breeze sometimes appears in the afternoon hours during weak to moderate Santa Ana conditions. Wind speeds may reach 28 knots (14 m/s) or more during the morning hours in the offshore area near Anacapa Island (Figure 24).

During the 11-year period of record, this type of Santa Ana condition occurred about 3 to 10 percent of the time from November to March and rarely during other months. The duration for a single occurrence was typically 1 to 2 days, with a maximum of 4 days.

ENTIRE AREA. Santa Ana conditions are generally weaker along the California coastline south of Palos Verdes Peninsula. However, with increasing distance from shore, wind velocities tend to increase. As shown on Figures 21, 22 and 23, strongest Santa Ana conditions occur west of Point Dume with wind directions from the northeast. Directly adjacent to the coastline and south of Point Dume, winds are fairly weak and variable as they become influenced by coastal land forms.

During the 11-year period of record, this type of Santa Ana condition occurred between 1.2 and 4.9 percent of the time from March to October. The remaining months did not exhibit these types of conditions. The duration for a single occurrence of Santa Ana conditions was one day.

3.4.2 Currents

Water movement in the coastal region can be considered the resultant of a number of forces. These include geostrophic forces that produce large-scale surface currents, tidal forces which result in oscillatory motions, and wave forces which drive longshore currents. The relative magnitude (and hence importance) of these forces varies over time and with distance from the shoreline. Wave forces dominate the longshore currents within the surf zone, but they have negligible influence in deep water. Hence, wave induced currents are an important consideration in a nearshore oil spill model but can be ignored in an offshore model. Geostrophic forces are damped in shallow waters, but tend to dominate all other oceanic forces far offshore. Tidal forces mainly influence the nearshore regions. The types and characteristics of currents produced by geostrophic and tidal forces are discussed in the following paragraphs.

Surface Currents

Circulation patterns along the southern California coast are dominated by the southerly flow of the California Current, which is the eastern boundary flow of the anticyclonic (clockwise in the Northern Hemisphere) gyre in the subtropical north Pacific Ocean. The California Current is broad (on the order of 620 miles (1,000 km)), slow moving (averaging 3.9 to 5.0 in/sec (10 to 15 cm/sec)), and transports sub-Arctic water distinguished by low temperatures and salinities. The California Current generally flows outside the 5,000 ft (1,500 m) bathymetric contour south of Point Conception, and forms the western boundary of the Southern California Bight (City of Oxnard, 1980).

Offshore of northern Baja California, the main portion of the California Current turns shoreward and bifurcates (Jones, 1971). One branch continues southward along the coast and eventually becomes entrained into the North Equatorial Current. The other branch turns northward and flows through the Southern California Bight, inshore of the California Current, and forms a large eddy called the Southern California Countercurrent.

Pirie et al. (1975) studied nearshore California surface currents utilizing remotely sensed data gathered by NASA systems. They defined three distinct, successive current seasons for southern California: the Oceanic Period, where from July to November the southward flowing California Current dominates the nearshore current patterns; the Davidson Period (Figure 26), where from November to February a northward moving countercurrent, the California Countercurrent, is dominant; and, the Upwelling Period (Figure 25), where from February to July stronger wind patterns induce a more vertical circulation pattern in the water column.

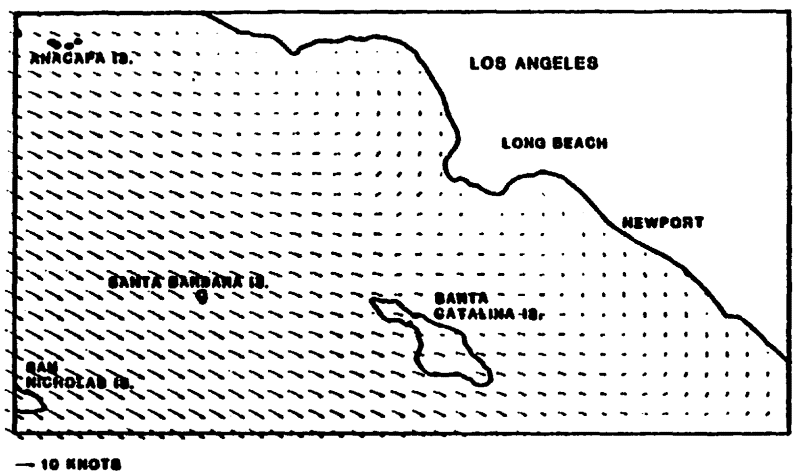
Circulation in the very nearshore, littoral zone derives from a combination of factors, including local winds, wave transport, river inflow, oscillatory tidal currents, and oceanic currents. The net drift is determined to the greatest extent by wave transport; in the Southern California Bight, waves most often approach the coastline from the west-northwest, thereby inducing southerly littoral currents.

Tidal Currents

The action of the tide introduces an oscillatory motion to the water which is a function of time, position, and water depth. Tidally induced flows are almost zero in deep water and reach a maximum near the shoreline.

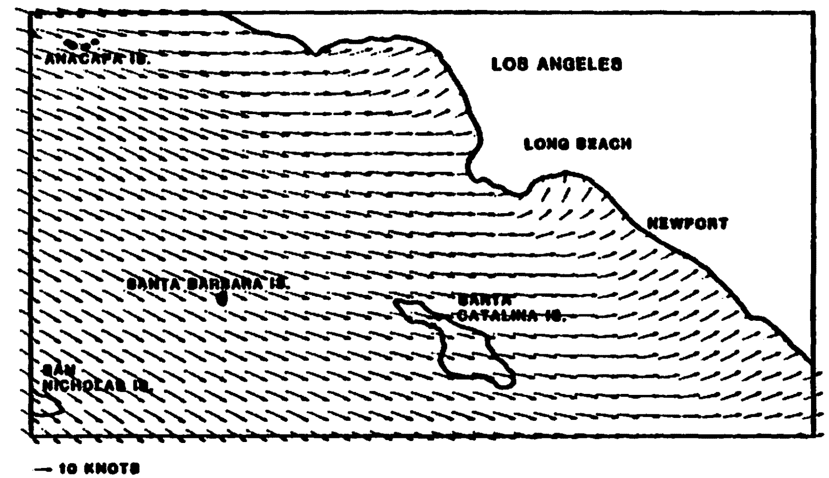
SEA BREEZE SUMMER 02-0800 PST

FIGURE 4



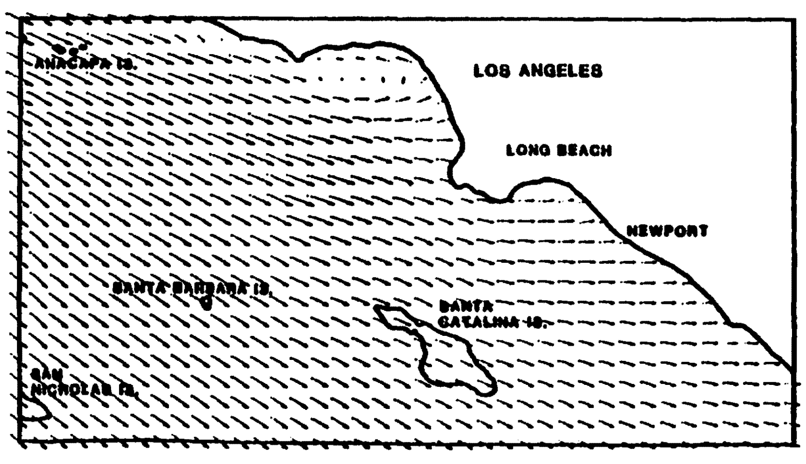
SEA BREEZE SUMMER 1400 PST

FIGURE 5



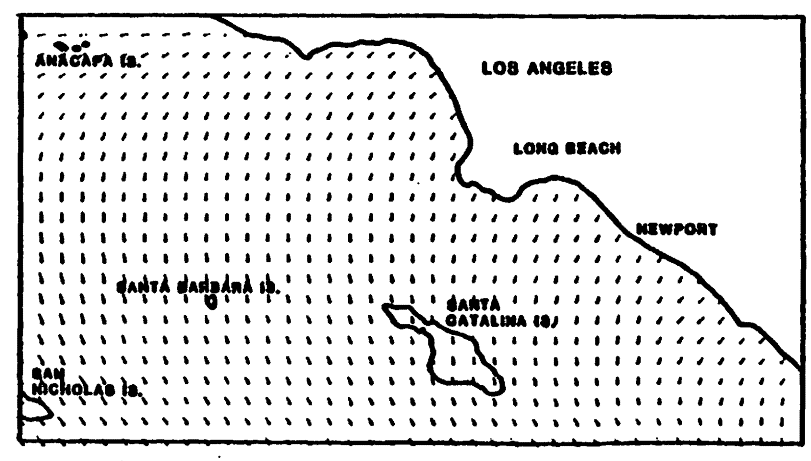
SEA BREEZE SUMMER 2000 PST

FIGURE 6



SEA BREEZE WINTER 02-0800 PST

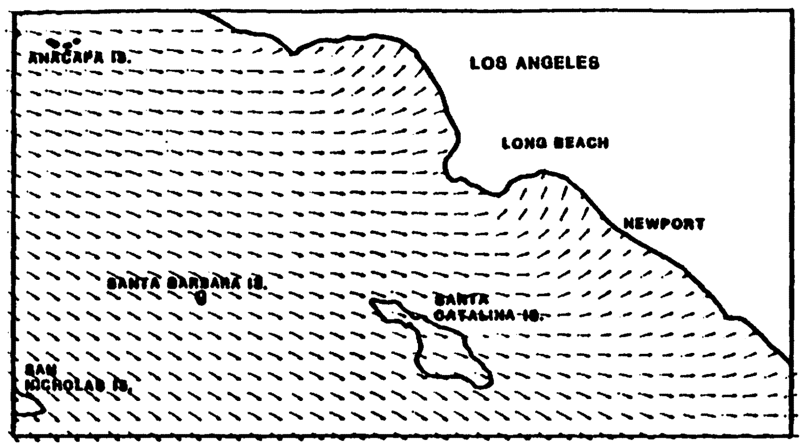
FIGURE 7



Dames & Moore

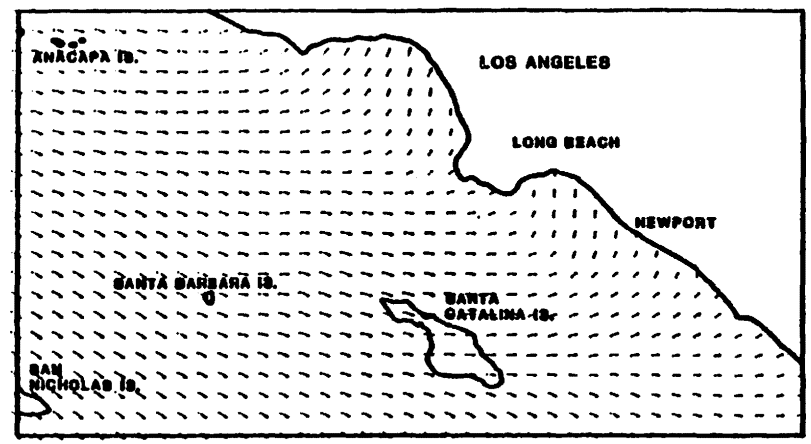
SEA BREEZE WINTER 1400 PST

FIGURE 8



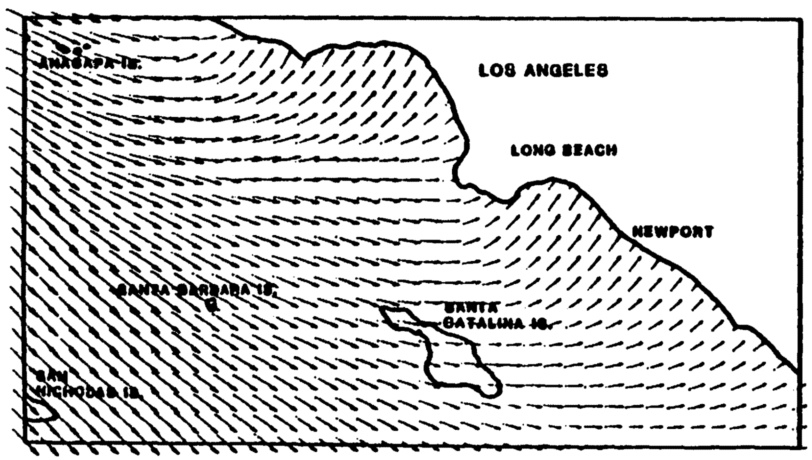
SEA BREEZE WINTER 2000 PST

FIGURE 9



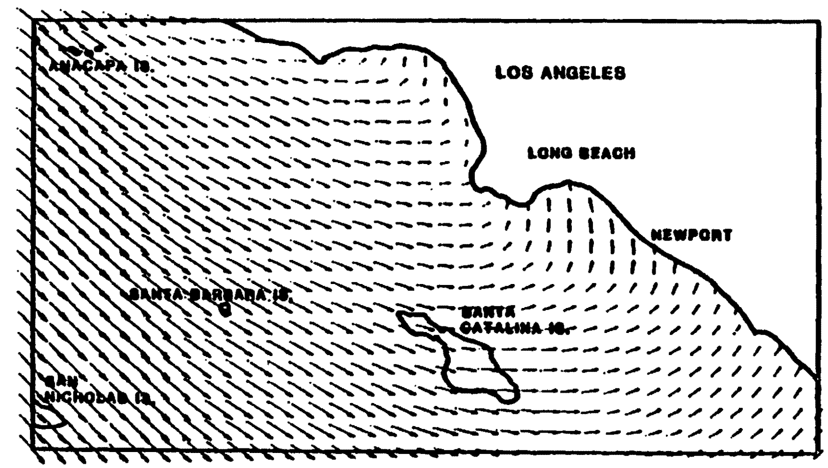
NORTHWESTER OUTER WATERS - 1400 PST

FIGURE 10



NORTHWESTER OUTER WATERS - 2000 PST

FIGURE 11



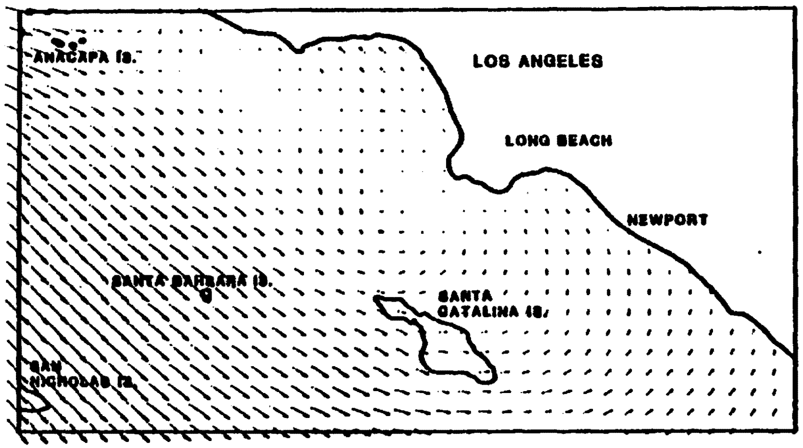
N

0 3 6 9 12
MILES

Dames & Moore

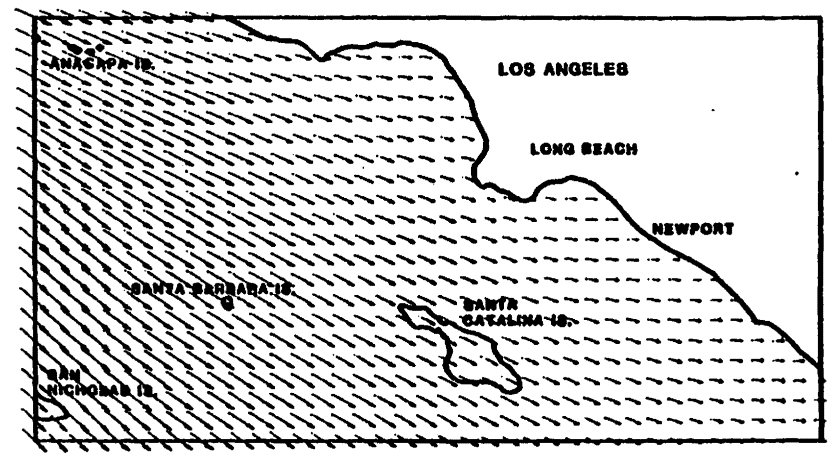
NORTHWESTER OUTER WATERS - 02-0800 PSI

FIGURE 12



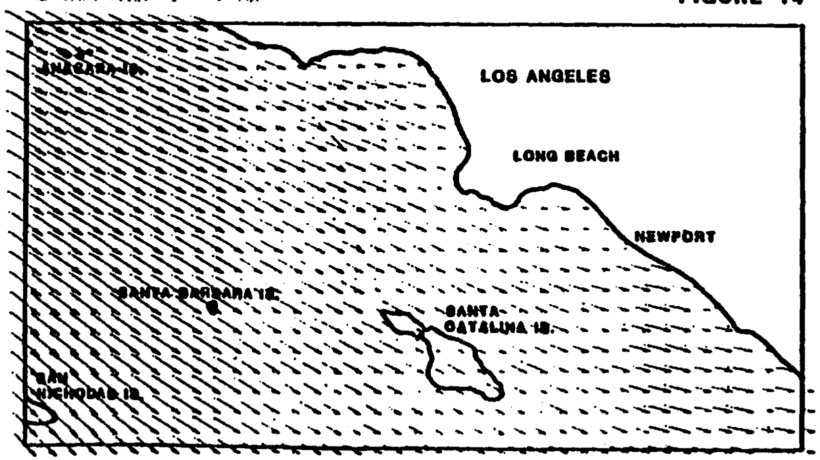
NORTHWESTER 0 HRS

FIGURE 13



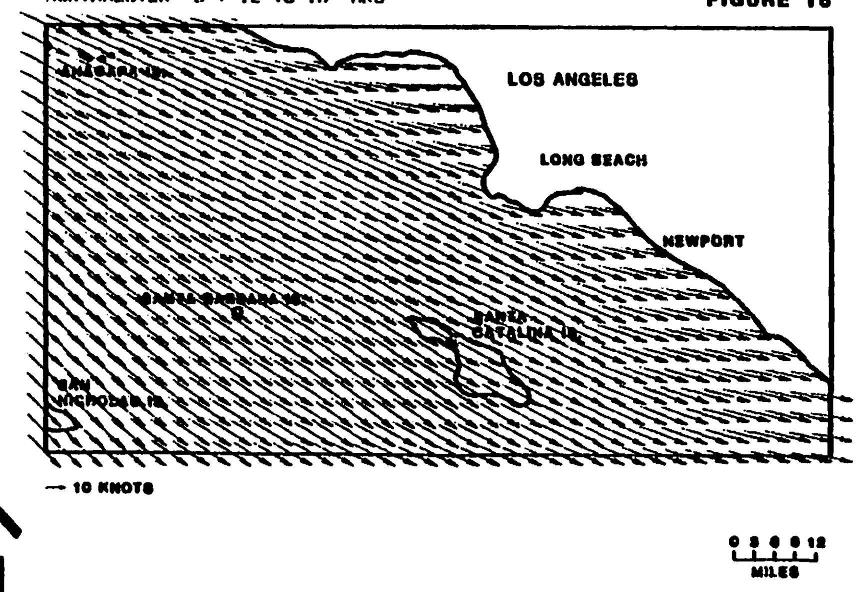
NORTHWESTER 0 + 6 HRS

FIGURE 14



NORTHWESTER 0 + 12 TO 18 HRS

FIGURE 16



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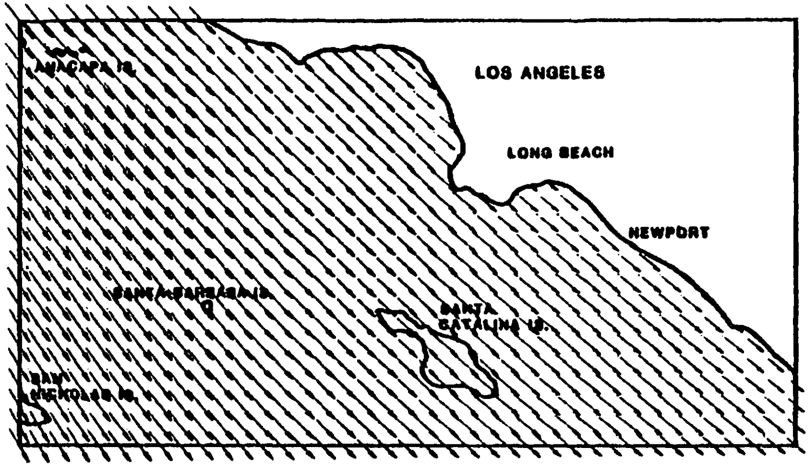
NORTHWESTER 0 + 24

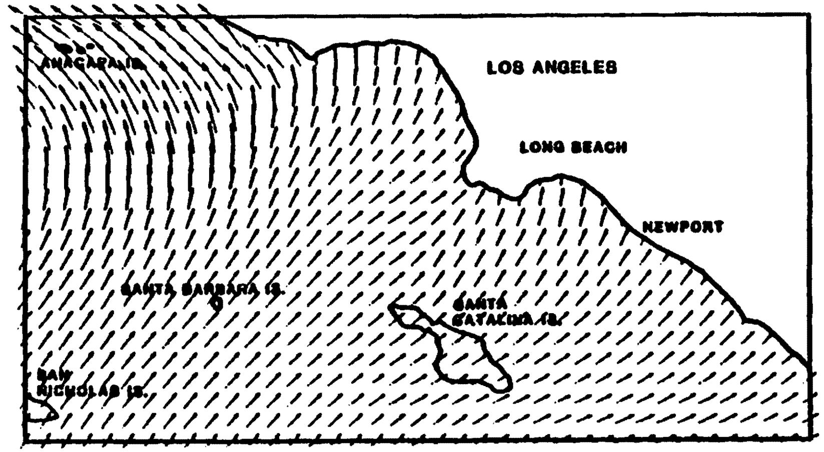
FIGURE 16



— 10 KNOTS

SOUTHEASTER 0

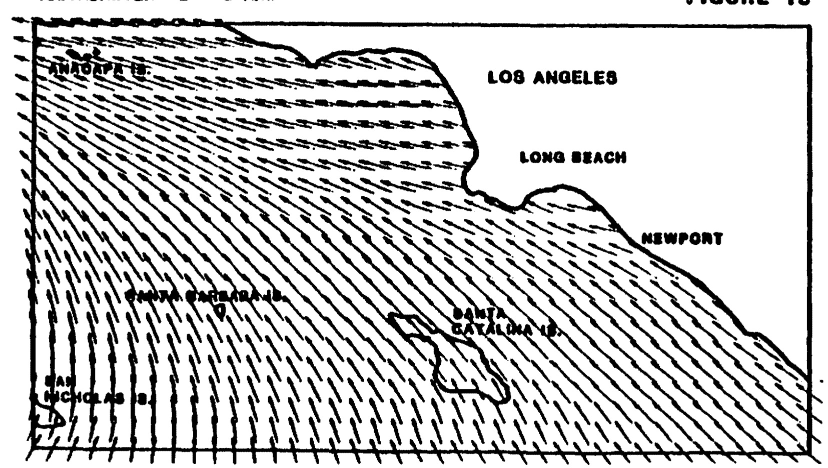
FIGURE 17



— 10 KNOTS

SOUTHEASTER 0 + 6 HRS

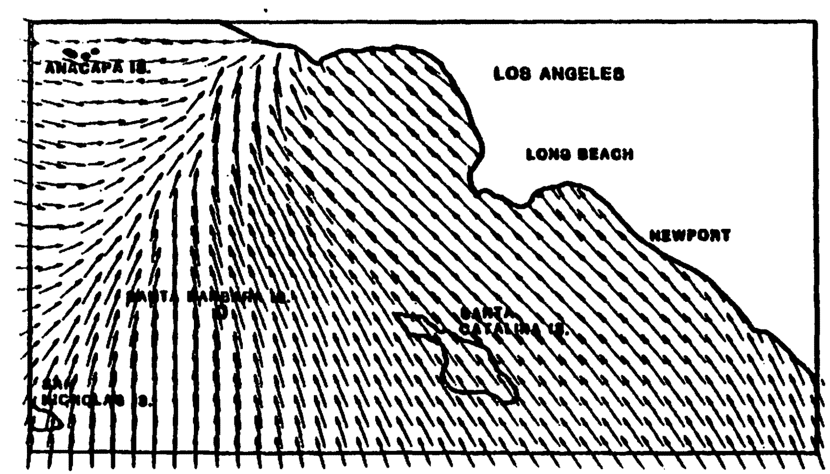
FIGURE 18



— 10 KNOTS

SOUTHEASTER 0 + 9 HRS

FIGURE 19



— 10 KNOTS

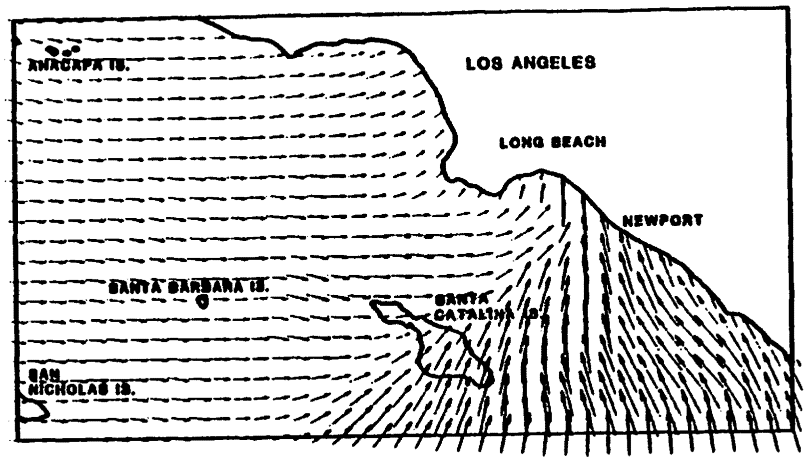
N

0 3 6 9 12
MILES

Dames & Moore

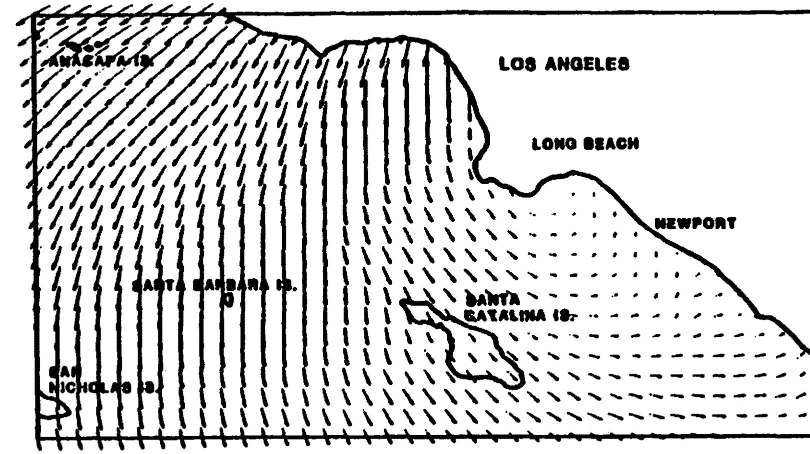
SOUTHEASTER 0 + 12 HRS

FIGURE 20



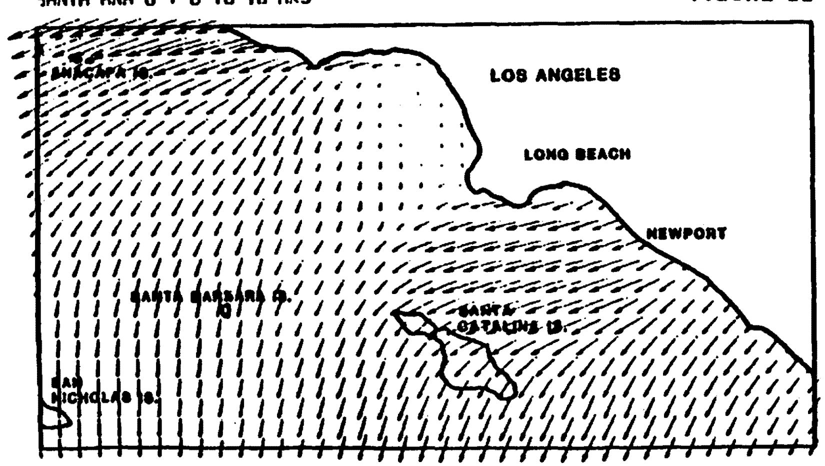
SANTA ANA 0 HRS

FIGURE 21



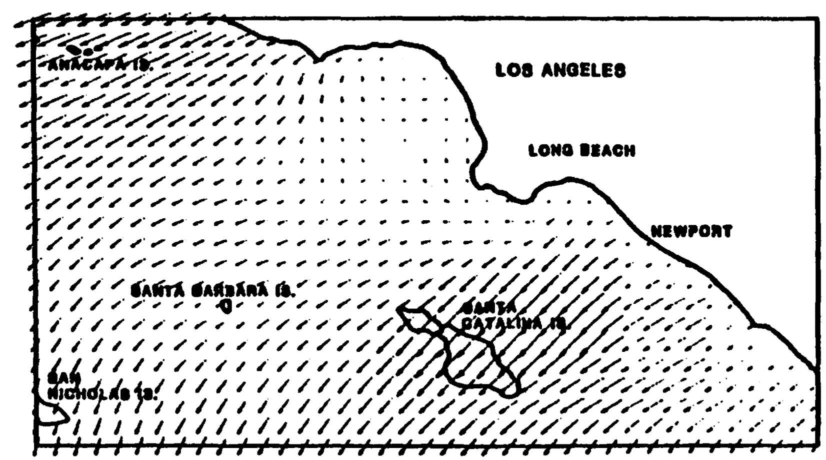
SANTA ANA 0 + 6 TO 18 HRS

FIGURE 22



SANTA ANA [illegible]

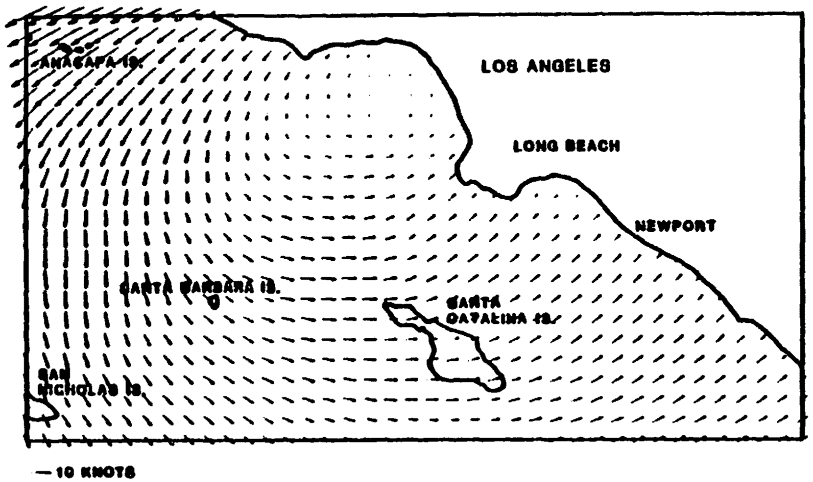
FIGURE 23



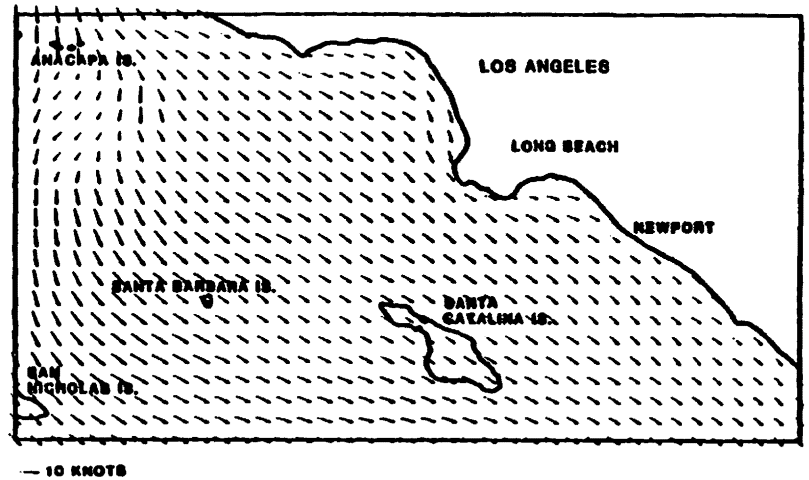
N

0 3 6 9 12
MILES

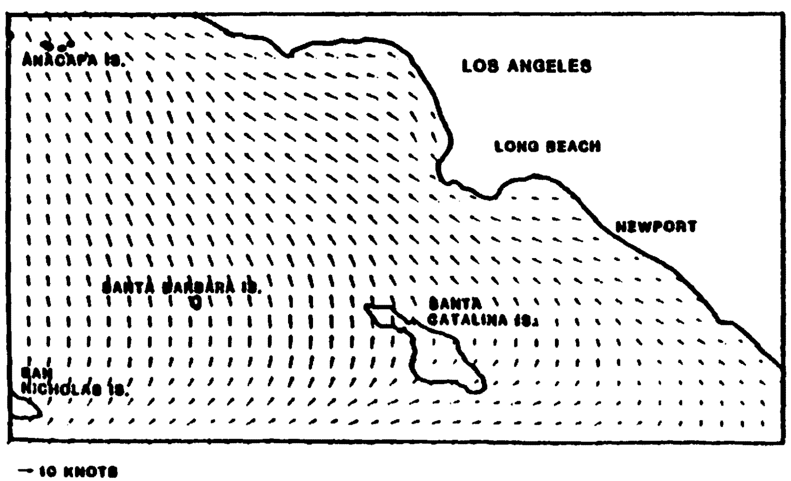
SANTA ANA - NORTHERN WATERS **FIGURE 24**



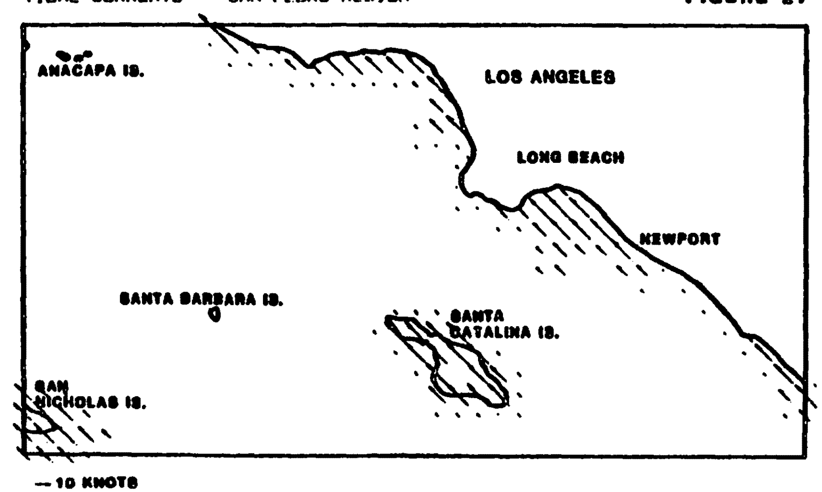
UPWELLING PERIOD SURFACE CURRENTS **FIGURE 25**



DAVIDSON PERIOD SURFACE CURRENTS **FIGURE 26**



TIDAL CURRENTS - SAN PEDRO REGION **FIGURE 27**



N

0 2 4 6 8 10
MILES

An average maximum tidal current (Figure 27) of 0.2 knot (0.10 m/s) occurs during the mid-tide period (NOAA, 1982). The current is assumed to have this value for water depths from the shoreline to 90 feet (27 m). Current velocities are then assumed to decrease linearly to a value of zero at a depth of 300 feet (91 m).

3.5 RESULTS

Oil spill trajectory analyses were carried out on a monthly basis for the oil spill release location which was assumed to be the center point of planned and existing production in OCS P-0300 and -0301. At the release site, 200 trajectories were initiated each month, i.e., 2,400 trajectories per site per year. The number 200 was arrived at by a statistical assessment of the variables involved in the methodology. For each trajectory, the starting wind type, time of day and duration are determined by entering the monthly frequency and duration tables with uniformly distributed random numbers. The starting tidal current phase and hence velocity and direction, is also selected by a random number. The surface current pattern to be used is determined by month. The transition between wind types during a trajectory is determined by entering a monthly transition matrix of wind type changes, again using a random number. All the wind tables were assembled from the 11 years of data collected as described previously. The trajectories were run until either a land or water boundary was contacted or 72 hours passed.

The results of the oil spill trajectory analysis for the release site are shown on Figures 28 through 39. In each figure a trajectory of a spill arriving at the shore segment with the greatest impact percentage is shown. The average and minimum times to shore contact are in hours. Also shown on each figure is the percentage of all trajectories reaching a land boundary (as opposed to those spills which remain at sea after 72 hours or reach a water boundary).

In the summer months, the greatest percentage of shoreline contacts are in the region from Newport Beach to Huntington Beach. This is due to the dominance of southeastward winds during these months. In the winter months, when a greater percentage of northward wind and current regimes occur, the largest percentage of contacts are recorded in the Long Beach area.

Averaged annually, 63.5 percent of all trajectories contact land. The monthly percentage of contacts ranges from 100 percent in the summer months to a minimum of 10 percent in October. No trajectories reach the shoreline within 6 hours. The minimum time to contact of 12 hours occurs in March and April.

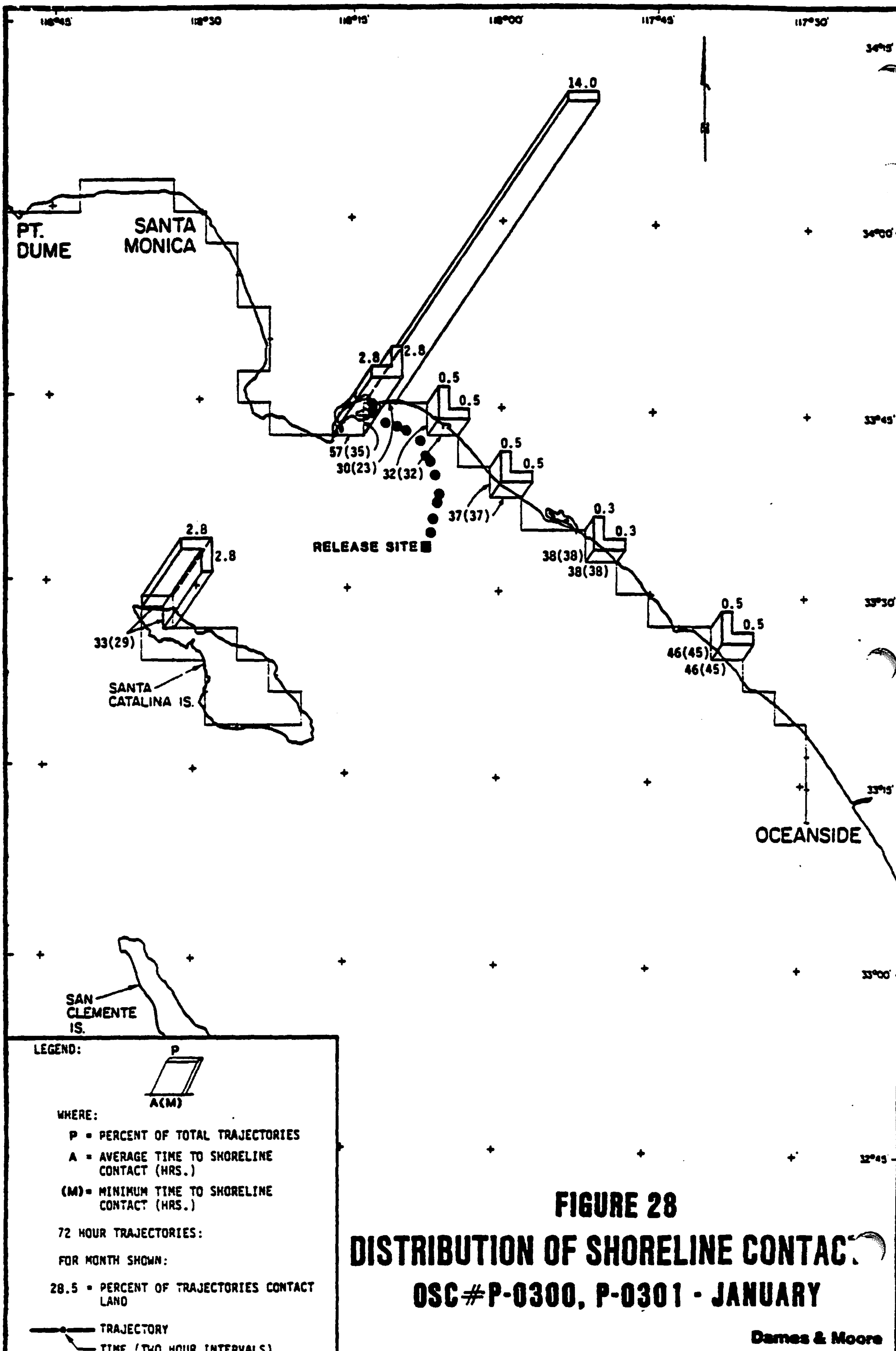


FIGURE 28

DISTRIBUTION OF SHORELINE CONTACT

OSC#P-0300, P-0301 - JANUARY

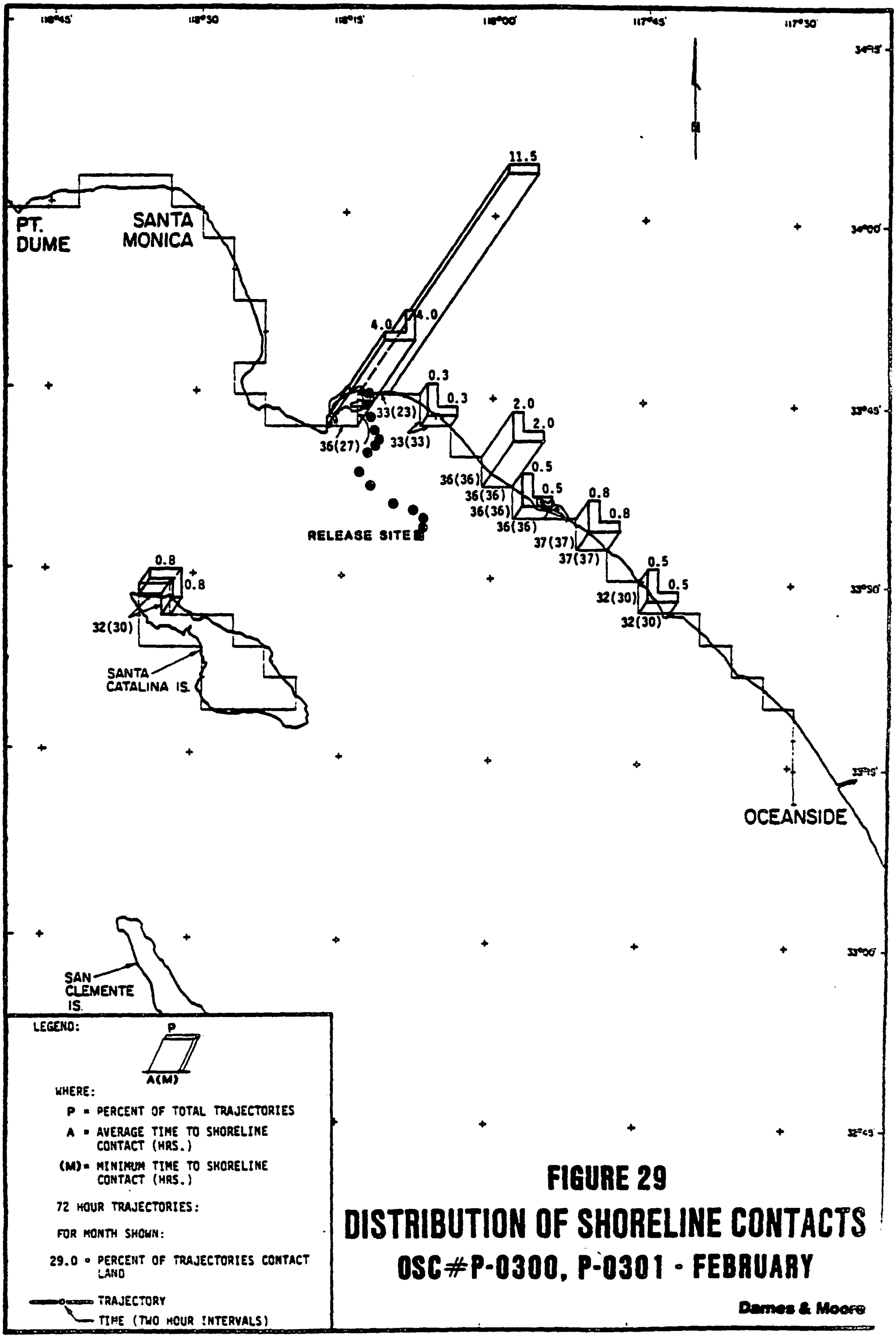


FIGURE 29
DISTRIBUTION OF SHORELINE CONTACTS
OSC#P-0300, P-0301 - FEBRUARY

Dames & Moore

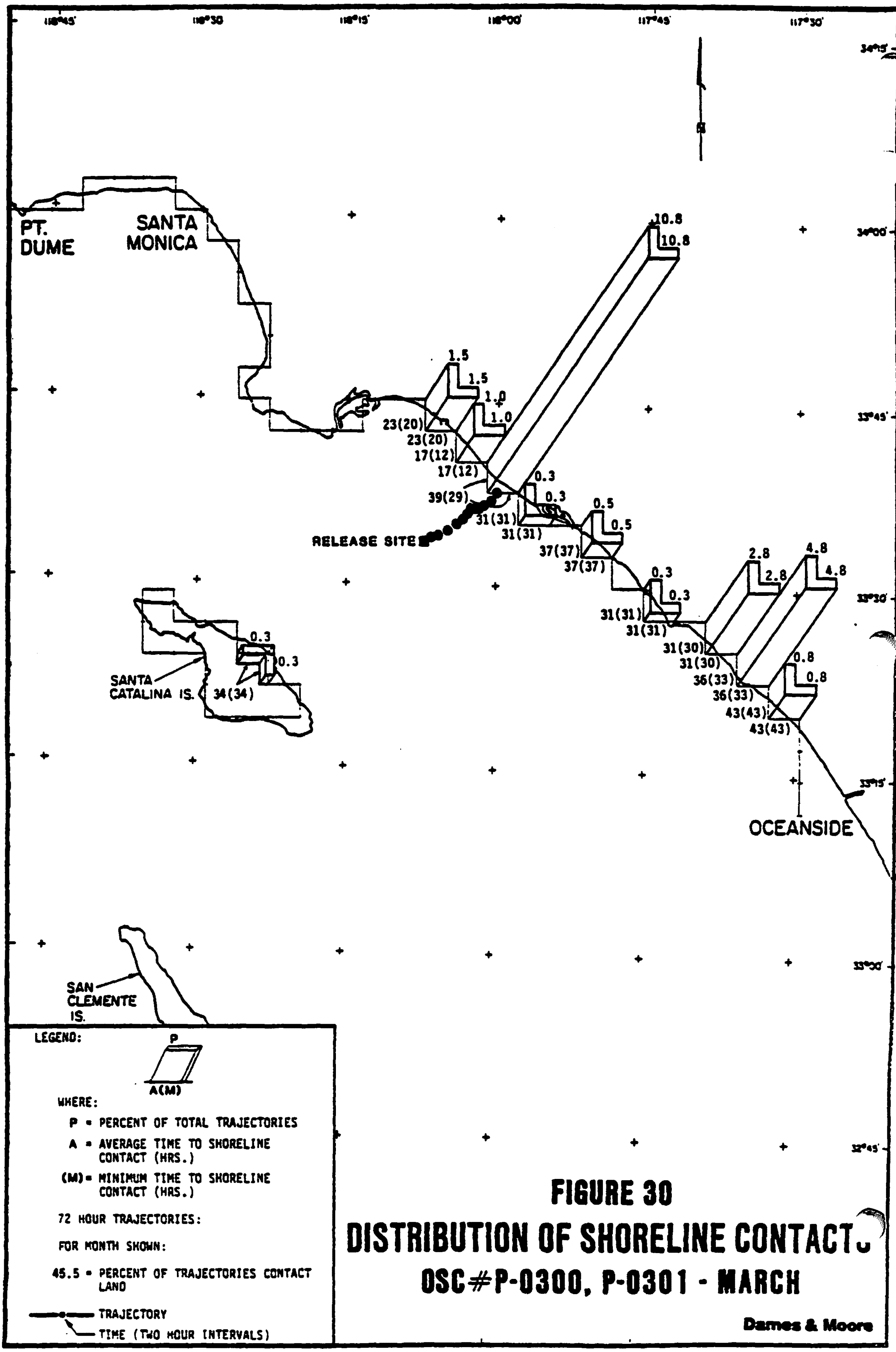


FIGURE 30

DISTRIBUTION OF SHORELINE CONTACTS

OSC#P-0300, P-0301 - MARCH

Dames & Moore

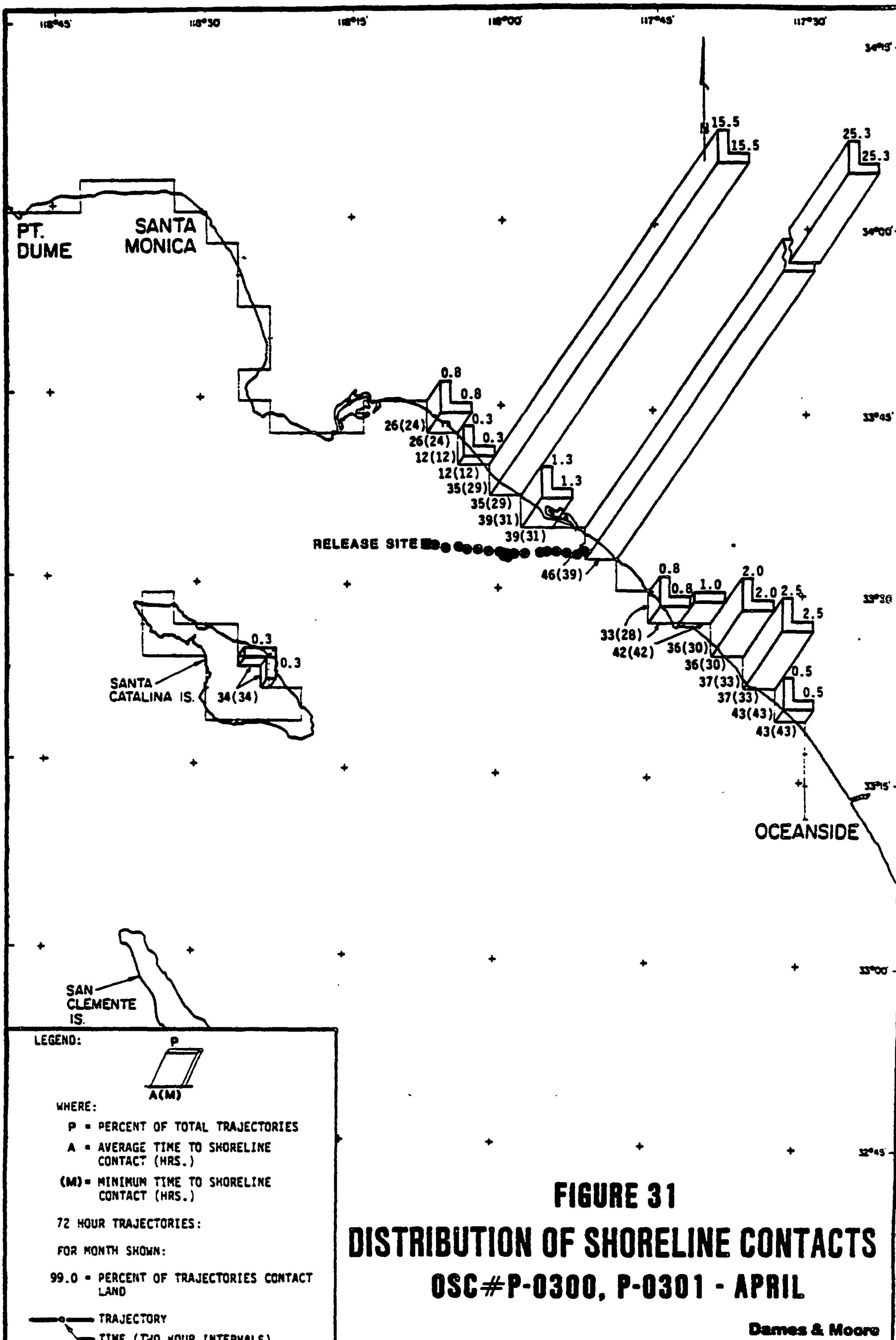


FIGURE 31

DISTRIBUTION OF SHORELINE CONTACTS

OSC#P-0300, P-0301 - APRIL

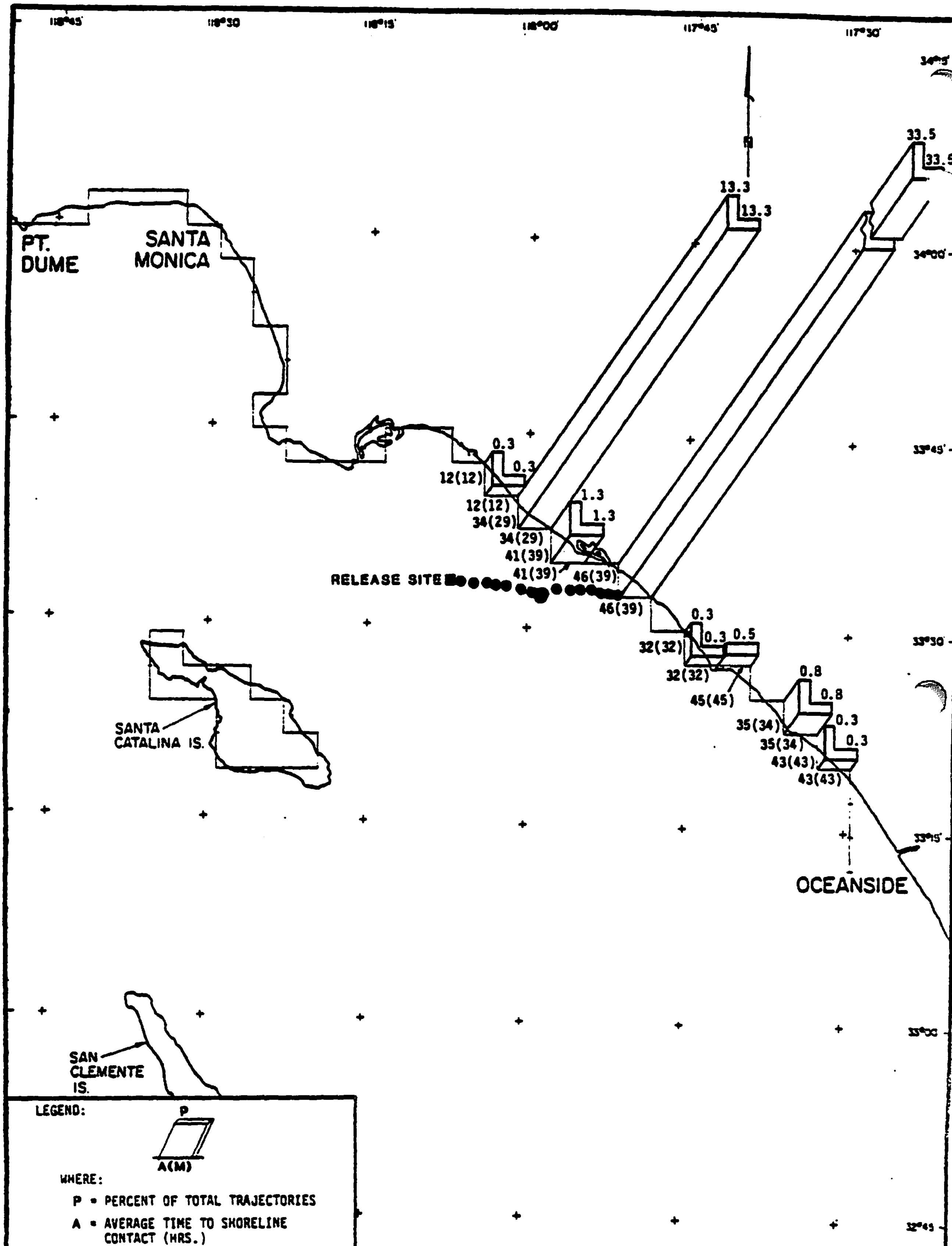


FIGURE 32
DISTRIBUTION OF SHORELINE CONTACT
OSC#P-0300, P-0301 - MAY

Dames & Moore

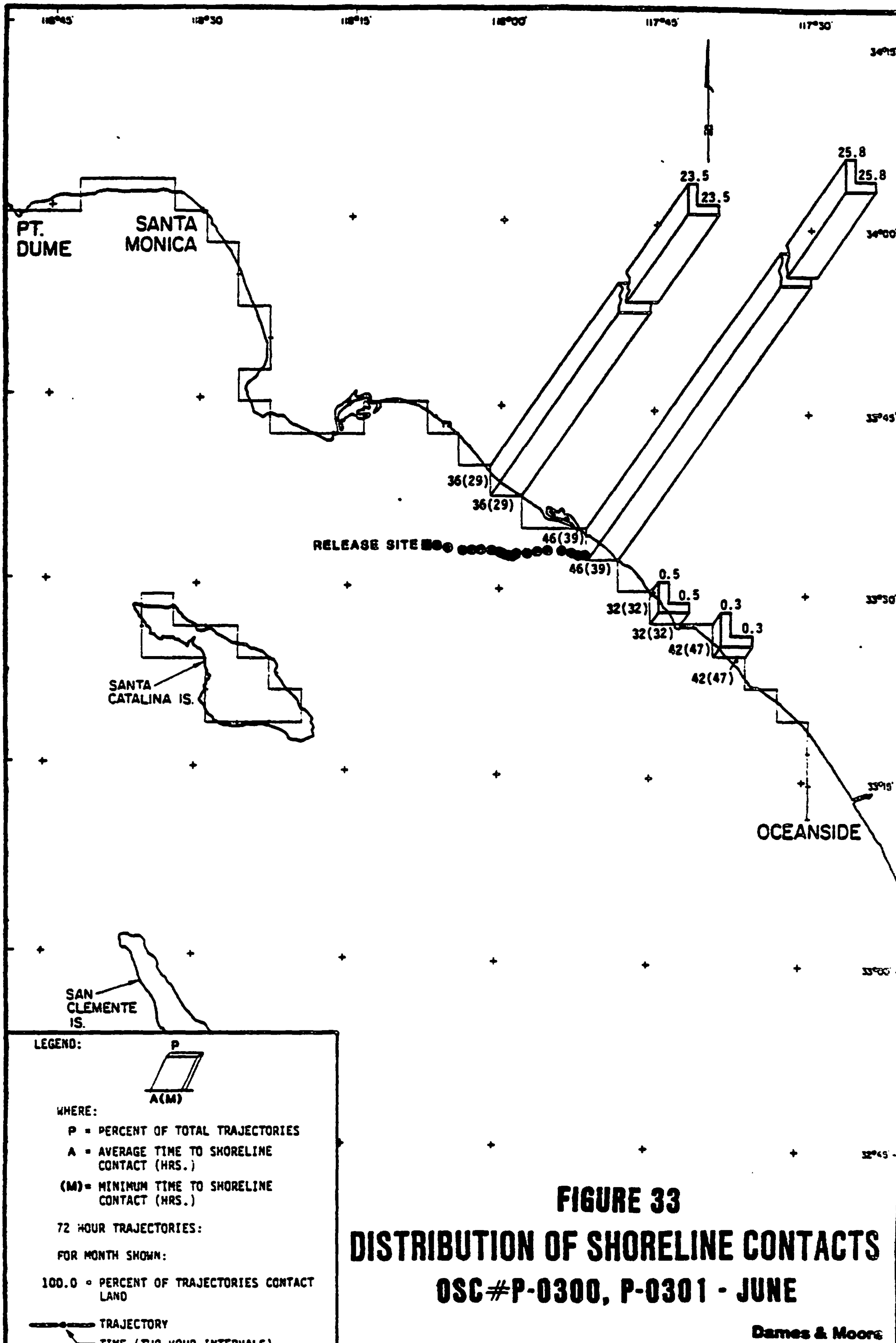


FIGURE 33
DISTRIBUTION OF SHORELINE CONTACTS
OSC#P-0300, P-0301 - JUNE

Dames & Moore

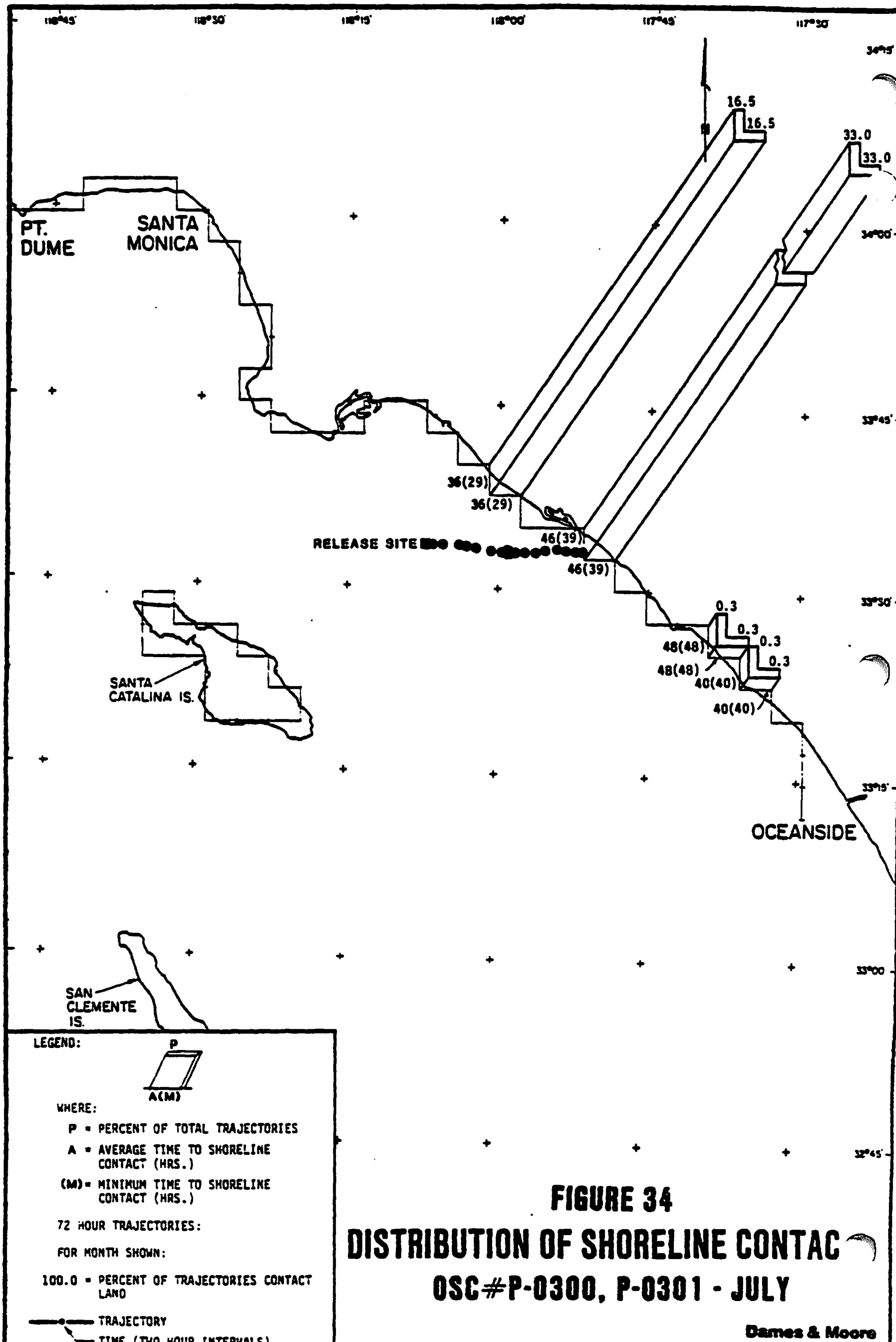


FIGURE 34

DISTRIBUTION OF SHORELINE CONTAC

OSC#P-0300, P-0301 - JULY

Dames & Moore

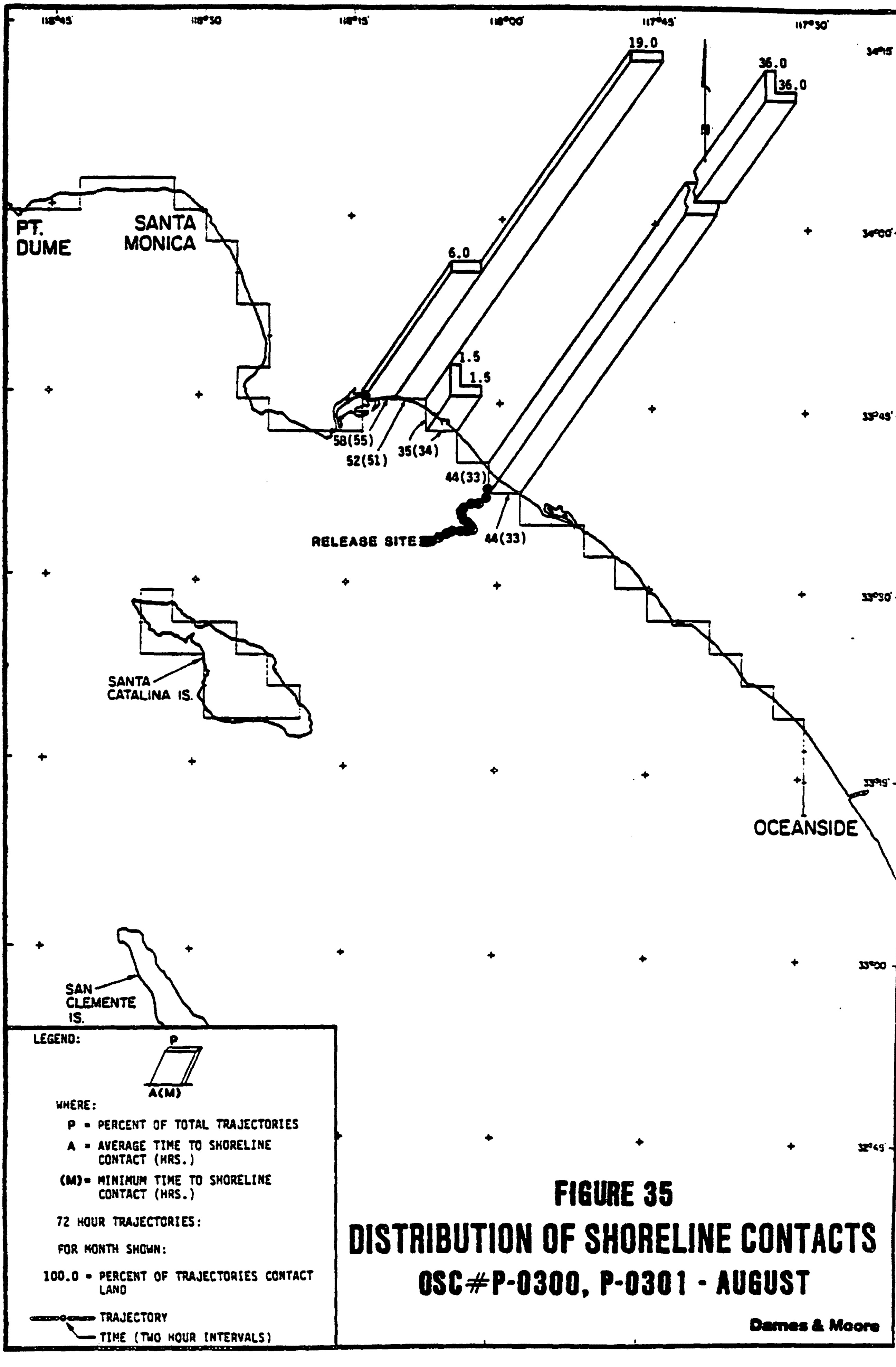


FIGURE 35

DISTRIBUTION OF SHORELINE CONTACTS

OSC#P-0300, P-0301 - AUGUST

Dames & Moore

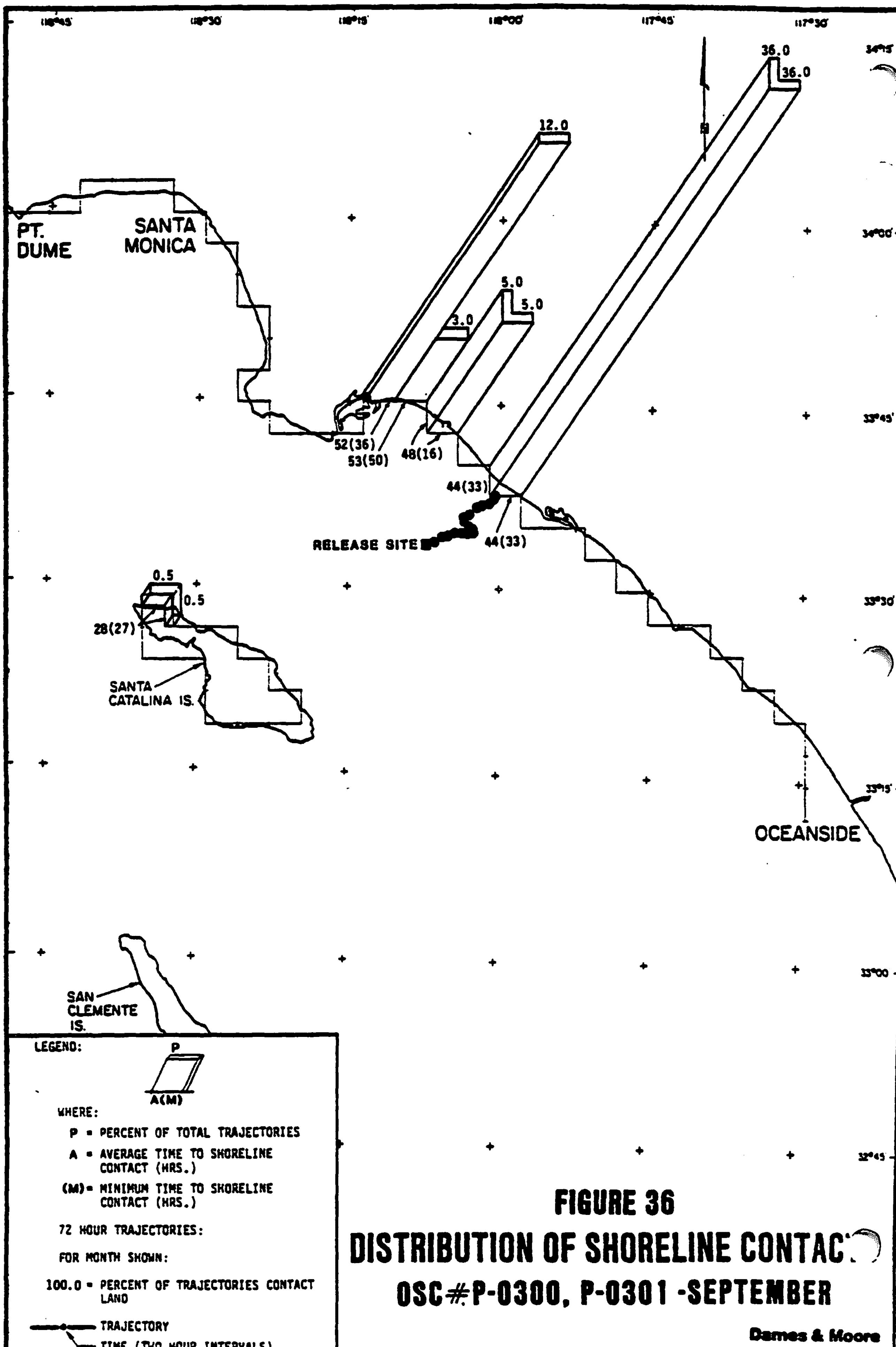


FIGURE 36

DISTRIBUTION OF SHORELINE CONTACT

OSC# P-0300, P-0301 -SEPTEMBER

Dames & Moore

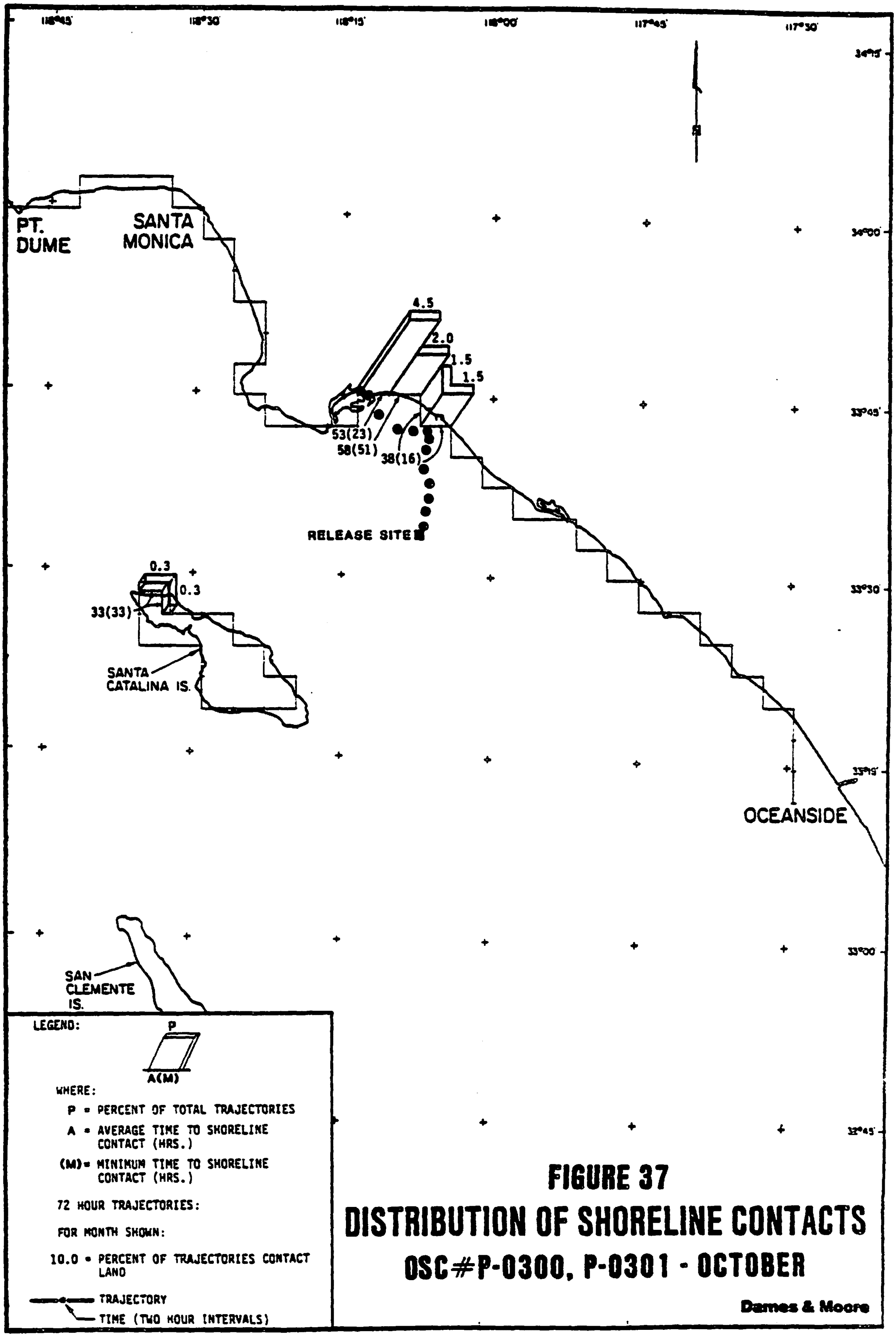
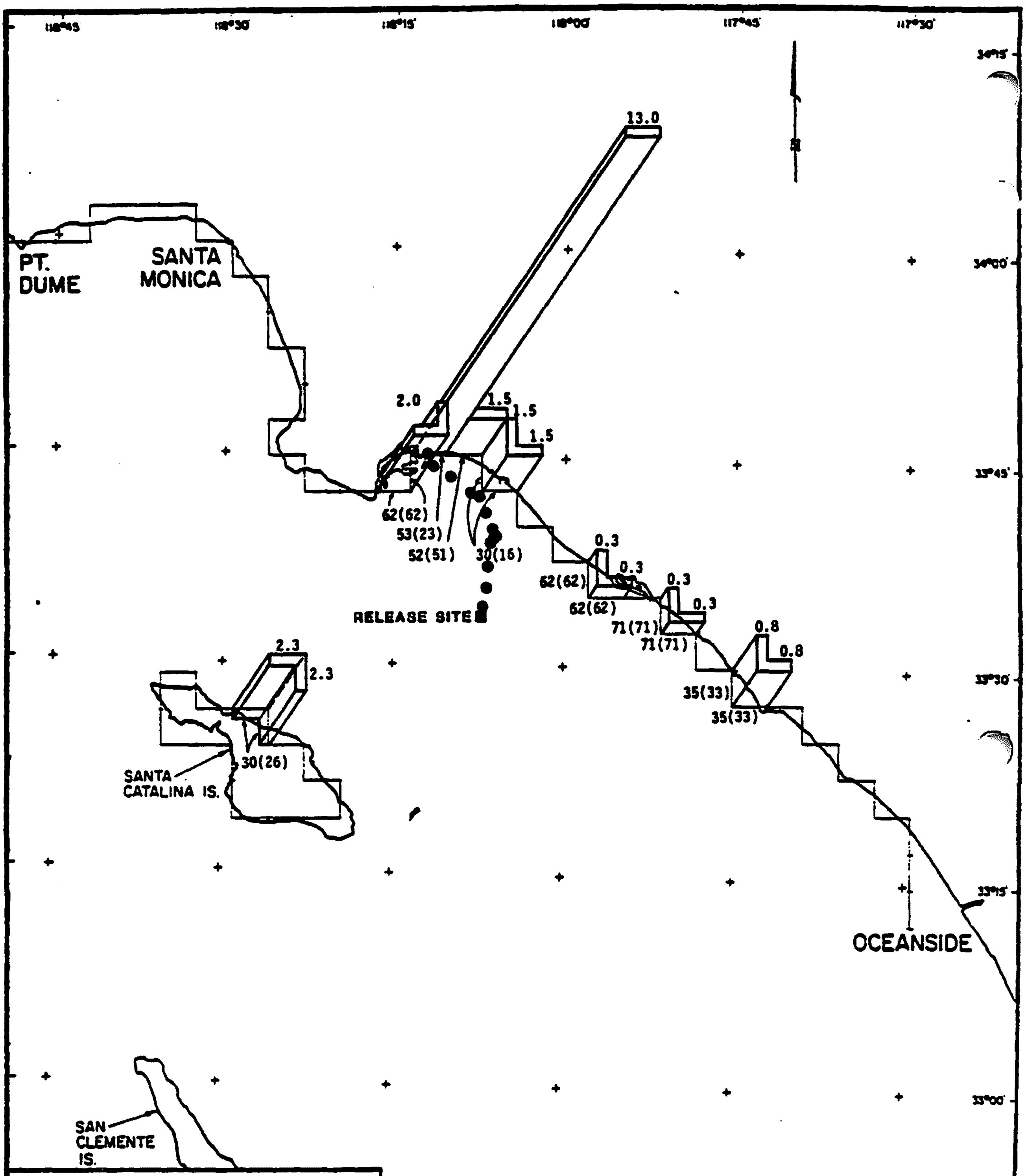


FIGURE 37

DISTRIBUTION OF SHORELINE CONTACTS

OSC#P-0300, P-0301 - OCTOBER

Dames & Moore



LEGEND:

P

A(M)

WHERE:

P = PERCENT OF TOTAL TRAJECTORIES

A = AVERAGE TIME TO SHORELINE CONTACT (HRS.)

(M) = MINIMUM TIME TO SHORELINE CONTACT (HRS.)

72 HOUR TRAJECTORIES:

FOR MONTH SHOWN:

28.5 = PERCENT OF TRAJECTORIES CONTACT LAND

TRAJECTORY

TIME (TWO HOUR INTERVALS)

FIGURE 38

DISTRIBUTION OF SHORELINE CONTACT

OSC#P-0300, P-0301 - NOVEMBER

Dames & Moore

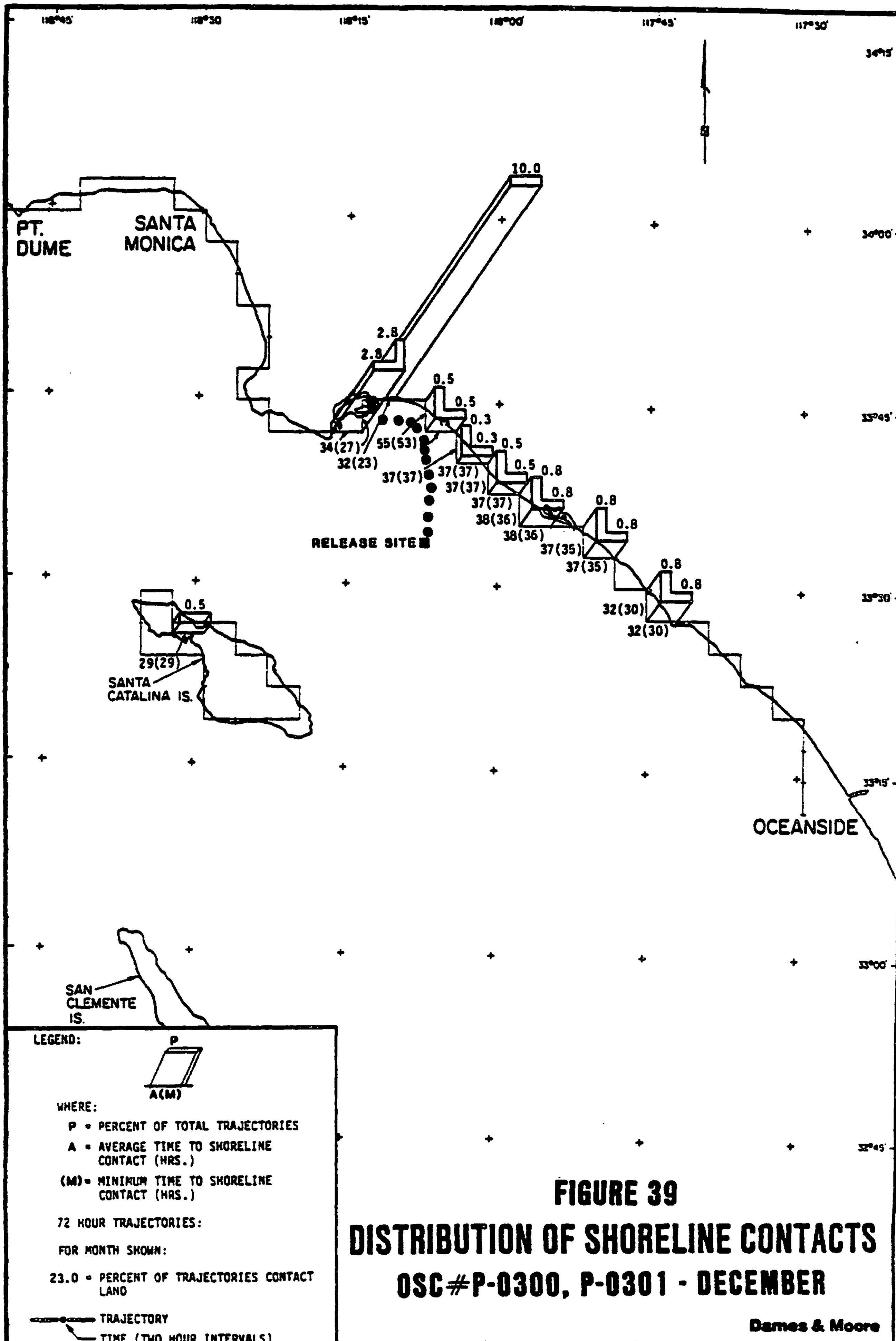


FIGURE 39

DISTRIBUTION OF SHORELINE CONTACTS

OSC #P-0300, P-0301 - DECEMBER

Dames & Moore

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APPENDIX B

AIR QUALITY DISPERSION MODELING AND BEST AVAILABLE CONTROL TECHNOLOGY

AIR DISPERSION MODELING OF SHELL OIL COMPANY'S BETA PROJECT

Air dispersion modeling was performed to estimate the air quality impact of air emissions from the Beta Field after the proposed installation of Platform Eureka in the spring of 1984. This modeling is required by the Federal Minerals Management Service as part of Shell's Beta Field's Plan of Development (POD) update.

Guidelines for the modeling were agreed upon during several discussions between Shell Development, the MMS and SCPI. These guidelines can be summarized as follows:

1, Only the NOx annual average is required output.

2. The model MPTER with rural dispersion coefficients is to be used.

3. The required meteorological data to be input to the model is Long Beach surface data (station 23129) for 1964 and Santa Monica upper air data (station 93197) also for 1964.

4. The following scheme is to be used to modify stability classes: A→C, B→C, C→C, D→D, E→E and F→F. No modifications to the dispersion coefficients are required.

5. A 400m mixing height is to be used for nighttime/early morning hours (8 PM - 7 AM) and a 600m mixing height is to be used for all other times (8 AM - 7 PM).

6. Changes to reflect the MMS required modifications to stability class and mixing height are to be made to the met tape and, therefore, will be transparent to MPTER.

7. The following model options are not to be used: 1) stack downwash, 2) terrain adjustment, 3) gradual plume rise and 4) buoyancy induced dispersion.

8. All of the NOx emitted is to be assumed to be NO_2.

9. Receptors are to be located on concentric semi-circles with platform Elly as the center. The diameters of the semi-circles are to be on a NW to SE axis with Elly as the center. Receptors are to be located at five-degree intervals on each semi-circle. Semi-circle radii to be used are 13.0, 13.5, 14.0, 14,5, 15.0, 15.5, 16.0, 16.5, 17.0, 17.5, 18.0, 18.5, 19.0, 19.5, and 20.0 km. A total of 540 receptors thus will be investigated.

10. Small emission sources are to be assumed to emit out the same stack as the Mars turbines on platform Elly.

Two operational scenarios were modeled. Each of the Mars turbines on Platform Elly are connected to two stacks, a stack with heat recovery and a bypass stack. For Case 1, the Mars turbines are assumed to emit only out the stacks with heat recovery. For Case 2, each Mars turbine is assumed to split its effluent between its stack with heat recovery and its bypass stack. All other emissions for both Cases 1 and 2 are assumed to be the same. In addition, the NOx emissions associated with gas flaring (2.4 T/Y) and the crew boat and helicopters (42.4 T/Y) are assumed to be emitted evenly from the two Mars stacks in Case 1 and the 4 stacks in Case 2. Source information for each scenario is presented in Table 1.

The annual averages predicted for Cases 1 and 2 are listed for all the receptors in Tables 2 and 3, respectively. Each receptor can be identified by its receptor identification number and its UTM coordinates. Table 4 gives the relationship between UTM coordinates and the location of the receptors in polar coordinates with platform Elly as the reference center. The highest annual average predicted was $0.34 \mu g/m^3$ for Case 2 and $0.29 \mu g/m^3$ for Case 1.

TABLE 1
SOURCE INFORMATION

CASE 1

PLATFORM		SOURCE	EAST COORD UTM (KM)	NORTH COORD UTM (KM)	NO_2 (G/SEC EMISSIONS	STACK HEIGHT (M)	STACK TEMPERATURE (L)(°K)	STACK DIAMETER (M)	STACK VELOCITY (M/SEC)
1.	ELLY	MARS1 (HEAT RECOVERY)	395.35	3716.34	4.25	36.1	457.6	2.1	12.1
2.	ELLY	MARS2 (HEAT RECOVERY)	395.35	3716.34	4.25	36.1	457.6	2.1	12.1
3.	ELLY	SATURN1	395.35	3716.34	.38	20.8	644.3	0.6	30.6
4.	ELLY	SATURN2	395.35	3716.34	.38	20.8	644.3	0.6	30.6
5.	ELLY	SATURN3	395.35	3716.34	.38	20.8	644.3	0.6	30.6
6.	ELLEN	CAT1A	395.30	3716.22	.03	10.7	588.7	0.3	25.0
7.	ELLEN	CAT2A	395.30	3716.22	.03	10.7	588.7	0.3	25.0
8.	EUREKA	CAT1B	396.35	3714.16	.03	10.7	588.7	0.3	25.0
9.	EUREKA	CAT2B	396.35	3714.16	.03	10.7	588.7	0.3	25.0

CASE 2

PLATFORM		SOURCE	EAST COORD UTM (KM)	NORTH COORD UTM (KM)	NO_2 (G/SEC) EMISSIONS	STACK HEIGHT (M)	STACK TEMPERATURE (L)(°K)	STACK DIAMETER (M)	STACK VELOCITY (M/SEC)
1.	ELLY	MARS1 (HEAT RECOVERY)	395.35	3716.34	2.85	36.1	433.2	2.1	8.1
2.	ELLY	MARS2 (BYPASS)	395.35	3716.34	1.40	36.1	666.5	2.5	3.5
3.	ELLY	MARS2 (HEAT RECOVERY)	395.35	3716.34	2.85	36.1	433.2	2.1	8.1
4.	ELLY	MARS2 (BYPASS)	395.35	3716.34	1.40	36.1	666.5	2.5	3.5
5.	ELLY	SATURN1	395.35	3716.34	.38	20.8	644.3	0.6	30.6
6.	ELLY	SATURN2	395.35	3716.34	.38	20.8	644.3	0.6	30.6
7.	ELLY	SATURN3	395.35	3716.34	.38	20.8	644.3	0.6	30.6
8.	ELLEN	CAT1A	395.30	3716.22	.03	10.7	588.7	0.3	25.0
9.	ELLEN	CAT2A	395.30	3716.22	.03	10.7	588.7	0.3	25.0
10.	EUREKA	CAT1B	396.35	3714.16	.03	10.7	588.7	0.3	25.0
11.	EUREKA	CAT2B	396.35	3714.16	.03	10.7	588.7	0.3	25.0

TABLE 2

CASE 1 RESULTS

*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 9

MPTER - VERSION 80345

BETA PLATFORM
CASE 1
RECEP SET 1

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1,HR 1, TO DAY366,HR24, (MICROGRAMS/M**3)
1	1	386.18	3725.53	.0	.0	.08
2	2	386.99	3726.30	.0	.0	.06
3	3	387.69	3726.99	.0	.0	.08
4	4	388.89	3727.60	.0	.0	.09
5	5	389.86	3728.12	.0	.0	.06
6	6	390.90	3728.56	.0	.0	.06
7	7	391.99	3728.90	.0	.0	.07
8	8	393.09	3729.14	.0	.0	.08
9	9	394.22	3729.29	.0	.0	.11
10	10	395.35	3729.34	.0	.0	.15
11	11	396.40	3729.29	.0	.0	.13
12	12	397.61	3729.14	.0	.0	.10
13	13	398.72	3728.90	.0	.0	.09
14	14	399.80	3728.56	.0	.0	.07
15	15	400.84	3728.12	.0	.0	.07
16	16	401.65	3727.60	.0	.0	.10
17	17	402.61	3726.99	.0	.0	.07
18	18	403.71	3726.30	.0	.0	.05
19	19	404.54	3725.53	.0	.0	.04
20	20	405.31	3724.70	.0	.0	.04
21	21	406.00	3723.80	.0	.0	.05
22	22	406.61	3722.84	.0	.0	.06
23	23	407.13	3721.83	.0	.0	.07
24	24	407.57	3720.79	.0	.0	.05
25	25	407.91	3719.70	.0	.0	.05
26	26	408.19	3718.60	.0	.0	.07
27	27	408.30	3717.47	.0	.0	.11
28	28	408.35	3716.34	.0	.0	.15
29	29	408.30	3715.21	.0	.0	.20
30	30	408.19	3714.08	.0	.0	.25
31	31	407.91	3712.98	.0	.0	.23
32	32	407.57	3711.89	.0	.0	.23
33	33	407.13	3710.85	.0	.0	.23
34	34	406.61	3709.84	.0	.0	.29
35	35	406.00	3708.88	.0	.0	.26
36	36	405.31	3707.98	.0	.0	.16
37	37	385.80	3725.69	.0	.0	.06
38	38	386.67	3726.68	.0	.0	.07
39	39	387.61	3727.40	.0	.0	.08
40	40	388.60	3728.03	.0	.0	.09
41	41	389.65	3728.56	.0	.0	.06
42	42	390.73	3729.03	.0	.0	.06
43	43	391.88	3729.38	.0	.0	.06
44	44	393.01	3729.64	.0	.0	.06
45	45	394.17	3729.79	.0	.0	.10
46	46	395.35	3729.84	.0	.0	.15

*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 10

47	47	396.53	3729.79	.0	.0	.13
48	48	397.69	3729.64	.0	.0	.09
49	49	398.84	3729.38	.0	.0	.06
50	50	399.97	3729.03	.0	.0	.07
51	51	401.06	3728.58	.0	.0	.07
52	52	402.10	3728.03	.0	.0	.10
53	53	403.09	3727.40	.0	.0	.07
54	54	404.03	3726.68	.0	.0	.05
55	55	404.90	3725.89	.0	.0	.04
56	56	405.69	3725.02	.0	.0	.04
57	57	406.41	3724.08	.0	.0	.05
58	58	407.04	3723.09	.0	.0	.06
59	59	407.58	3722.05	.0	.0	.06
60	60	408.04	3720.96	.0	.0	.05
61	61	408.39	3719.83	.0	.0	.05
62	62	408.65	3718.68	.0	.0	.06
63	63	408.80	3717.52	.0	.0	.11
64	64	408.85	3716.34	.0	.0	.15
65	65	408.80	3715.16	.0	.0	.19
66	66	408.65	3714.00	.0	.0	.24
67	67	408.39	3712.85	.0	.0	.22
68	68	408.04	3711.72	.0	.0	.22
69	69	407.58	3710.64	.0	.0	.23
70	70	407.04	3709.59	.0	.0	.26
71	71	406.41	3708.60	.0	.0	.26
72	72	405.69	3707.66	.0	.0	.16
73	73	385.45	3726.24	.0	.0	.06
74	74	386.55	3727.07	.0	.0	.07
75	75	387.52	3727.81	.0	.0	.08
76	76	388.55	3728.46	.0	.0	.09
77	77	389.43	3729.03	.0	.0	.08
78	78	390.56	3729.50	.0	.0	.06
79	79	391.73	3729.86	.0	.0	.06
80	80	392.94	3730.13	.0	.0	.07
81	81	394.13	3730.29	.0	.0	.10
82	82	395.35	3730.34	.0	.0	.14
83	83	396.57	3730.29	.0	.0	.12
84	84	397.78	3730.13	.0	.0	.09
85	85	398.97	3729.86	.0	.0	.08
86	86	400.14	3729.50	.0	.0	.07
87	87	401.27	3729.03	.0	.0	.07
88	88	402.35	3728.46	.0	.0	.09
89	89	403.38	3727.81	.0	.0	.07
90	90	404.35	3727.07	.0	.0	.05
91	91	405.25	3726.24	.0	.0	.04
92	92	406.08	3725.34	.0	.0	.04
93	93	406.82	3724.37	.0	.0	.05
94	94	407.47	3723.34	.0	.0	.06
95	95	408.04	3722.26	.0	.0	.06
96	96	408.51	3721.13	.0	.0	.05
97	97	408.87	3719.96	.0	.0	.05
98	98	409.14	3718.77	.0	.0	.06
99	99	409.30	3717.56	.0	.0	.10
100	100	409.35	3716.34	.0	.0	.14
101	101	409.30	3715.12	.0	.0	.19
102	102	409.14	3713.91	.0	.0	.23
103	103	408.87	3712.72	.0	.0	.2

*EXAMPLE RUNSTREAM FOR MPTLR — DATE 112283 — PAGE 11

104	104	408.51	3711.55	.0	.0	.22
105	105	408.04	3710.42	.0	.0	.22
106	106	407.47	3709.34	.0	.0	.28
107	107	406.82	3708.31	.0	.0	.25
108	108	406.08	3707.34	.0	.0	.15
109	109	385.10	3726.59	.0	.0	.08
110	110	386.03	3727.45	.0	.0	.07
111	111	387.03	3728.22	.0	.0	.07
112	112	388.10	3728.90	.0	.0	.08
113	113	389.22	3729.48	.0	.0	.08
114	114	390.39	3729.97	.0	.0	.05
115	115	391.60	3730.35	.0	.0	.06
116	116	392.83	3730.62	.0	.0	.07
117	117	394.09	3730.79	.0	.0	.10
118	118	395.35	3730.84	.0	.0	.14
119	119	396.61	3730.79	.0	.0	.12
120	120	397.87	3730.62	.0	.0	.09
121	121	399.10	3730.35	.0	.0	.08
122	122	400.31	3729.97	.0	.0	.07
123	123	401.48	3729.48	.0	.0	.07
124	124	402.60	3728.90	.0	.0	.09
125	125	403.67	3728.22	.0	.0	.06
126	126	404.67	3727.45	.0	.0	.05
127	127	405.60	3726.59	.0	.0	.04
128	128	406.44	3725.66	.0	.0	.04
129	129	407.23	3724.66	.0	.0	.05
130	130	407.91	3723.59	.0	.0	.06
131	131	408.49	3722.47	.0	.0	.06
132	132	408.90	3721.30	.0	.0	.05
133	133	409.30	3720.09	.0	.0	.05
134	134	409.63	3718.86	.0	.0	.06
135	135	409.79	3717.60	.0	.0	.10
136	136	409.89	3716.34	.0	.0	.14
137	137	409.79	3715.06	.0	.0	.18
138	138	409.63	3713.82	.0	.0	.22
139	139	409.30	3712.59	.0	.0	.21
140	140	408.90	3711.38	.0	.0	.21
141	141	408.49	3710.21	.0	.0	.22
142	142	407.91	3709.09	.0	.0	.27
143	143	407.23	3708.02	.0	.0	.24
144	144	406.44	3707.02	.0	.0	.15
145	145	384.74	3726.95	.0	.0	.07
146	146	385.71	3727.83	.0	.0	.07
147	147	386.75	3728.63	.0	.0	.07
148	148	387.85	3729.33	.0	.0	.08
149	149	389.01	3729.93	.0	.0	.07
150	150	390.22	3730.43	.0	.0	.05
151	151	391.47	3730.83	.0	.0	.06
152	152	392.74	3731.11	.0	.0	.07
153	153	394.04	3731.28	.0	.0	.09
154	154	395.31	3731.34	.0	.0	.13
155	155	396.60	3731.28	.0	.0	.12
156	156	397.96	3731.11	.0	.0	.08
157	157	399.23	3730.83	.0	.0	.07
158	158	400.48	3730.43	.0	.0	.06
159	159	401.69	3729.93	.0	.0	.06
160	160	402.85	3729.33	.0	.0	.09

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161	161	403.95	3728.63	.0	.0	.06
162	162	404.99	3727.83	.0	.0	.04
163	163	405.94	3726.95	.0	.0	.04
164	164	406.84	3725.98	.0	.0	.04
165	165	407.64	3724.94	.0	.0	.05
166	166	408.34	3723.84	.0	.0	.06
167	167	408.94	3722.68	.0	.0	.06
168	168	409.44	3721.47	.0	.0	.05
169	169	409.84	3720.22	.0	.0	.04
170	170	410.12	3716.95	.0	.0	.06
171	171	410.29	3717.65	.0	.0	.10
172	172	410.35	3716.34	.0	.0	.13
173	173	410.29	3715.03	.0	.0	.17
174	174	410.12	3713.73	.0	.0	.22
175	175	409.84	3712.46	.0	.0	.20
176	176	409.44	3711.21	.0	.0	.21
177	177	408.94	3710.00	.0	.0	.21
178	178	408.34	3708.84	.0	.0	.26
179	179	407.64	3707.74	.0	.0	.24
180	180	406.84	3706.70	.0	.0	.14

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MPTER = VERSION 80345

BETA PLATFORM
CASE 1
RECEP SET 2

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1,HR 1, TO DAY366,HR24, (MICROGRAMS/M**3)
1	181	384.39	3727.30	.0	.0	.07
2	182	385.39	3728.21	.0	.0	.07
3	183	386.46	3729.04	.0	.0	.07
4	184	387.60	3729.76	.0	.0	.08
5	185	389.60	3730.39	.0	.0	.07
6	186	390.05	3730.90	.0	.0	.05
7	187	391.34	3731.31	.0	.0	.06
8	188	392.66	3731.60	.0	.0	.07
9	189	394.00	3731.78	.0	.0	.09
10	190	395.35	3731.84	.0	.0	.13
11	191	396.70	3731.78	.0	.0	.11
12	192	398.04	3731.60	.0	.0	.08
13	193	399.36	3731.31	.0	.0	.07
14	194	400.65	3730.90	.0	.0	.06
15	195	401.90	3730.39	.0	.0	.06
16	196	403.10	3729.76	.0	.0	.08
17	197	404.24	3729.04	.0	.0	.06
18	198	405.31	3728.21	.0	.0	.04
19	199	406.31	3727.30	.0	.0	.04
20	200	407.22	3726.30	.0	.0	.04
21	201	408.05	3725.23	.0	.0	.05
22	202	408.77	3724.09	.0	.0	.05
23	203	409.40	3722.89	.0	.0	.06
24	204	409.92	3721.64	.0	.0	.05
25	205	410.32	3720.35	.0	.0	.05
26	206	410.62	3719.03	.0	.0	.06
27	207	410.79	3717.69	.0	.0	.09
28	208	410.85	3716.34	.0	.0	.13
29	209	410.79	3714.99	.0	.0	.17
30	210	410.62	3713.65	.0	.0	.21
31	211	410.32	3712.33	.0	.0	.19
32	212	409.92	3711.04	.0	.0	.20
33	213	409.40	3709.79	.0	.0	.21
34	214	408.77	3708.59	.0	.0	.26
35	215	408.05	3707.45	.0	.0	.23
36	216	407.22	3706.38	.0	.0	.14
37	217	384.04	3727.65	.0	.0	.07
38	218	385.06	3728.60	.0	.0	.06
39	219	386.17	3729.45	.0	.0	.07
40	220	387.35	3730.20	.0	.0	.08
41	221	388.59	3730.84	.0	.0	.07
42	222	389.88	3731.37	.0	.0	.05
43	223	391.21	3731.80	.0	.0	.05
44	224	392.57	3732.10	.0	.0	.07
45	225	[illegible]	[illegible]	.0	.0	.09
46	226	[illegible]	[illegible]	.0	.0	.13

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47	227	396.74	3732.28	.0	.0	.11
48	228	398.13	3732.10	.0	.0	.08
49	229	399.49	3731.80	.0	.0	.07
50	230	400.62	3731.37	.0	.0	.06
51	231	402.11	3730.84	.0	.0	.06
52	232	403.35	3730.20	.0	.0	.08
53	233	404.53	3728.45	.0	.0	.06
54	234	405.63	3728.60	.0	.0	.04
55	235	406.66	3727.65	.0	.0	.04
56	236	407.61	3726.62	.0	.0	.04
57	237	408.46	3725.52	.0	.0	.04
58	238	409.21	3724.34	.0	.0	.05
59	239	409.85	3723.10	.0	.0	.06
60	240	410.38	3721.81	.0	.0	.04
61	241	410.81	3720.48	.0	.0	.04
62	242	411.11	3719.12	.0	.0	.05
63	243	411.29	3717.73	.0	.0	.09
64	244	411.35	3716.34	.0	.0	.12
65	245	411.29	3714.95	.0	.0	.16
66	246	411.11	3713.56	.0	.0	.20
67	247	410.81	3712.20	.0	.0	.19
68	248	410.38	3710.87	.0	.0	.20
69	249	409.85	3709.58	.0	.0	.20
70	250	409.21	3708.34	.0	.0	.25
71	251	408.46	3707.16	.0	.0	.23
72	252	407.61	3706.05	.0	.0	.14
73	253	883.68	3728.01	.0	.0	.07
74	254	964.74	3728.98	.0	.0	.06
75	255	385.89	3729.86	.0	.0	.07
76	256	387.10	3730.63	.0	.0	.08
77	257	388.38	3731.29	.0	.0	.07
78	258	389.71	3731.85	.0	.0	.05
79	259	391.08	3732.28	.0	.0	.05
80	260	392.49	3732.59	.0	.0	.06
81	261	393.91	3732.78	.0	.0	.09
82	262	395.35	3732.84	.0	.0	.12
83	263	396.79	3732.78	.0	.0	.10
84	264	398.22	3732.59	.0	.0	.07
85	265	399.62	3732.28	.0	.0	.07
86	266	400.99	3731.85	.0	.0	.06
87	267	402.32	3731.29	.0	.0	.06
88	268	403.60	3730.63	.0	.0	.08
89	269	404.81	3729.86	.0	.0	.06
90	270	405.96	3728.98	.0	.0	.04
91	271	407.02	3728.01	.0	.0	.03
92	272	407.99	3726.95	.0	.0	.04
93	273	408.67	3725.80	.0	.0	.04
94	274	409.64	3724.59	.0	.0	.05
95	275	410.30	3723.31	.0	.0	.05
96	276	410.85	3721.98	.0	.0	.04
97	277	411.29	3720.61	.0	.0	.04
98	278	411.60	3719.20	.0	.0	.05
99	279	411.79	3717.78	.0	.0	.09
100	280	411.85	3716.34	.0	.0	.12
101	281	411.79	3714.90	.0	.0	.16
102	282	411.60	3713.48	.0	.0	.20
103	283	411.29	3712.07	.0	.0	.18

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104	284	410.85	3710.70	.0	.0	.19
105	285	410.30	3707.37	.0	.0	.19
106	286	409.64	3706.09	.0	.0	.25
107	287	408.67	3705.08	.0	.0	.22
108	288	407.59	3705.73	.0	.0	.13
109	1	383.33	3728.36	.0	.0	.07
110	2	384.42	3729.36	.0	.0	.06
111	3	385.60	3730.27	.0	.0	.06
112	4	386.85	3731.06	.0	.0	.07
113	5	388.17	3731.75	.0	.0	.07
114	6	389.54	3732.32	.0	.0	.05
115	7	390.95	3732.76	.0	.0	.05
116	8	392.40	3733.08	.0	.0	.06
117	9	393.87	3733.27	.0	.0	.08
118	10	395.35	3733.34	.0	.0	.12
119	11	396.83	3733.27	.0	.0	.10
120	12	398.30	3733.08	.0	.0	.07
121	13	399.75	3732.76	.0	.0	.07
122	14	401.16	3732.32	.0	.0	.06
123	15	402.53	3731.75	.0	.0	.06
124	16	403.85	3731.06	.0	.0	.08
125	17	405.10	3730.27	.0	.0	.05
126	18	406.28	3729.36	.0	.0	.04
127	19	407.37	3728.36	.0	.0	.03
128	20	408.37	3727.27	.0	.0	.03
129	21	409.28	3726.09	.0	.0	.04
130	22	410.07	3724.84	.0	.0	.05
131	23	410.76	3723.52	.0	.0	.05
132	24	411.33	3722.15	.0	.0	.04
133	25	411.77	3720.74	.0	.0	.04
134	26	412.09	3719.29	.0	.0	.05
135	27	412.28	3717.82	.0	.0	.08
136	28	412.35	3716.34	.0	.0	.12
137	29	412.28	3714.86	.0	.0	.15
138	30	412.09	3713.39	.0	.0	.19
139	31	411.77	3711.94	.0	.0	.18
140	32	411.33	3710.53	.0	.0	.19
141	33	410.76	3709.15	.0	.0	.19
142	34	410.07	3707.84	.0	.0	.24
143	35	409.28	3706.59	.0	.0	.21
144	36	408.37	3705.41	.0	.0	.13
145	37	382.90	3728.71	.0	.0	.06
146	38	384.10	3729.75	.0	.0	.06
147	39	385.31	3730.67	.0	.0	.06
148	40	386.60	3731.49	.0	.0	.07
149	41	387.95	3732.20	.0	.0	.06
150	42	389.37	3732.79	.0	.0	.04
151	43	390.82	3733.24	.0	.0	.05
152	44	392.31	3733.57	.0	.0	.06
153	45	393.83	3733.77	.0	.0	.08
154	46	395.35	3733.84	.0	.0	.12
155	47	396.87	3733.77	.0	.0	.10
156	48	398.39	3733.57	.0	.0	.07
157	49	399.88	3733.24	.0	.0	.06
158	50	401.33	3732.79	.0	.0	.06
159	51	402.75	3732.20	.0	.0	.06
160	52	404.10	3731.49	.0	.0	.08

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161	53	405.39	3730.67	.0	.0	.05
162	54	406.60	3729.75	.0	.0	.04
163	55	407.72	3728.71	.0	.0	.03
164	56	408.76	3727.59	.0	.0	.03
165	57	409.69	3726.38	.0	.0	.04
166	58	410.51	3725.09	.0	.0	.05
167	59	411.21	3723.74	.0	.0	.05
168	60	411.79	3722.33	.0	.0	.04
169	61	412.25	3720.87	.0	.0	.04
170	62	412.58	3719.38	.0	.0	.05
171	63	412.78	3717.86	.0	.0	.08
172	64	412.85	3716.34	.0	.0	.11
173	65	412.78	3714.82	.0	.0	.15
174	66	412.56	3713.30	.0	.0	.19
175	67	412.25	3711.81	.0	.0	.17
176	68	411.79	3710.36	.0	.0	.18
177	69	411.21	3708.94	.0	.0	.19
178	70	410.51	3707.59	.0	.0	.23
179	71	409.69	3706.30	.0	.0	.21
180	72	408.76	3705.09	.0	.0	.13

*EXAMPLE RUNSTREAM FOR MPTER　　　DATE 112283　　　PAGE 10

MPTER - VERSION 80345

BETA PLATFORM
CASE 1
RECEP SET 3

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1,HR 1, TO DAY366,HR24, (MICROGRAMS/M**3)
1	73	382.62	3729.07	.0	.0	.06
2	74	383.78	3730.13	.0	.0	.06
3	75	385.03	3731.08	.0	.0	.06
4	76	386.35	3731.93	.0	.0	.07
5	77	387.74	3732.65	.0	.0	.06
6	78	389.19	3733.25	.0	.0	.04
7	79	390.69	3733.73	.0	.0	.05
8	80	392.22	3734.07	.0	.0	.06
9	81	393.78	3734.27	.0	.0	.08
10	82	395.35	3734.34	.0	.0	.11
11	83	396.92	3734.27	.0	.0	.10
12	84	398.48	3734.07	.0	.0	.07
13	85	400.01	3733.73	.0	.0	.06
14	86	401.51	3733.25	.0	.0	.05
15	87	402.96	3732.65	.0	.0	.05
16	88	404.35	3731.93	.0	.0	.07
17	89	405.67	3731.08	.0	.0	.05
18	90	406.92	3730.13	.0	.0	.04
19	91	408.08	3729.07	.0	.0	.03
20	92	409.14	3727.91	.0	.0	.03
21	93	410.10	3726.66	.0	.0	.04
22	94	410.94	3725.34	.0	.0	.05
23	95	411.66	3723.95	.0	.0	.05
24	96	412.26	3722.50	.0	.0	.04
25	97	412.74	3721.00	.0	.0	.04
26	98	413.08	3719.47	.0	.0	.05
27	99	413.28	3717.91	.0	.0	.08
28	100	413.35	3716.34	.0	.0	.11
29	101	413.28	3714.77	.0	.0	.14
30	102	413.08	3713.21	.0	.0	.18
31	103	412.74	3711.68	.0	.0	.17
32	104	412.26	3710.18	.0	.0	.18
33	105	411.66	3708.73	.0	.0	.18
34	106	410.94	3707.34	.0	.0	.23
35	107	410.10	3706.02	.0	.0	.21
36	108	409.14	3704.77	.0	.0	.12
37	109	382.27	3729.42	.0	.0	.06
38	110	383.46	3730.51	.0	.0	.06
39	111	384.74	3731.49	.0	.0	.06
40	112	386.10	3732.36	.0	.0	.07
41	113	387.53	3733.11	.0	.0	.06
42	114	389.02	3733.72	.0	.0	.04
43	115	390.56	3734.21	.0	.0	.05
44	116	392.14	3734.56	.0	.0	.06
45	117	393.74	3734.77	.0	.0	.08
46	118	395.35	3734.84	.0	.0	.11

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47	119	596.96	3734.77	.0	.0	.09
48	120	598.56	3734.56	.0	.0	.07
49	121	600.14	3734.21	.0	.0	.06
50	122	601.60	3733.72	.0	.0	.05
51	123	603.17	3733.11	.0	.0	.05
52	124	604.60	3732.36	.0	.0	.07
53	125	605.96	3731.49	.0	.0	.05
54	126	607.24	3730.51	.0	.0	.04
55	127	608.43	3729.42	.0	.0	.03
56	128	609.52	3728.23	.0	.0	.03
57	129	610.50	3726.95	.0	.0	.04
58	130	611.37	3725.59	.0	.0	.05
59	131	612.12	3724.16	.0	.0	.05
60	132	612.73	3722.67	.0	.0	.04
61	133	613.22	3721.13	.0	.0	.04
62	134	613.57	3719.55	.0	.0	.05
63	135	613.70	3717.95	.0	.0	.08
64	136	613.85	3716.34	.0	.0	.11
65	137	613.76	3714.73	.0	.0	.14
66	138	613.57	3713.13	.0	.0	.18
67	139	613.22	3711.55	.0	.0	.16
68	140	612.73	3710.01	.0	.0	.17
69	141	612.12	3708.52	.0	.0	.18
70	142	611.37	3707.09	.0	.0	.22
71	143	610.50	3705.73	.0	.0	.20
72	144	609.52	3704.45	.0	.0	.12
73	145	581.92	3729.77	.0	.0	.06
74	146	583.14	3730.89	.0	.0	.06
75	147	584.45	3731.90	.0	.0	.06
76	148	585.85	3732.79	.0	.0	.07
77	149	587.32	3733.56	.0	.0	.06
78	150	588.85	3734.19	.0	.0	.04
79	151	590.43	3734.69	.0	.0	.05
80	152	592.05	3735.05	.0	.0	.06
81	153	593.69	3735.27	.0	.0	.08
82	154	595.35	3735.34	.0	.0	.11
83	155	597.01	3735.27	.0	.0	.09
84	156	598.65	3735.05	.0	.0	.06
85	157	600.27	3734.69	.0	.0	.06
86	158	601.85	3734.19	.0	.0	.05
87	159	603.38	3733.56	.0	.0	.05
88	160	604.85	3732.79	.0	.0	.07
89	161	606.25	3731.90	.0	.0	.05
90	162	607.56	3730.89	.0	.0	.03
91	163	608.78	3729.77	.0	.0	.03
92	164	609.90	3728.55	.0	.0	.03
93	165	610.91	3727.24	.0	.0	.04
94	166	611.80	3725.84	.0	.0	.04
95	167	612.57	3724.37	.0	.0	.05
96	168	613.20	3722.84	.0	.0	.04
97	169	613.70	3721.26	.0	.0	.04
98	170	614.06	3719.64	.0	.0	.05
99	171	614.28	3718.00	.0	.0	.07
100	172	614.35	3716.34	.0	.0	.10
101	173	614.26	3714.68	.0	.0	.14
102	174	614.06	3713.04	.0	.0	.17
103	175	613.70	3711.42	.0	.0	.16

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104	176	413.20	3709.84	.0	.0	.17
105	177	412.57	3708.31	.0	.0	.17
106	178	411.60	3706.84	.0	.0	.22
107	179	410.91	3705.44	.0	.0	.20
108	180	409.90	3704.13	.0	.0	.12
109	181	381.56	3730.13	.0	.0	.06
110	182	382.82	3731.28	.0	.0	.05
111	183	384.17	3732.31	.0	.0	.06
112	184	385.60	3733.23	.0	.0	.07
113	185	387.11	3734.01	.0	.0	.06
114	186	388.68	3734.66	.0	.0	.04
115	187	390.30	3735.18	.0	.0	.04
116	188	391.96	3735.54	.0	.0	.05
117	189	393.65	3735.77	.0	.0	.07
118	190	395.35	3735.84	.0	.0	.11
119	191	397.05	3735.77	.0	.0	.09
120	192	398.74	3735.54	.0	.0	.06
121	193	400.40	3735.18	.0	.0	.06
122	194	402.02	3734.66	.0	.0	.05
123	195	403.59	3734.01	.0	.0	.05
124	196	405.10	3733.23	.0	.0	.07
125	197	406.53	3732.31	.0	.0	.05
126	198	407.86	3731.28	.0	.0	.03
127	199	409.14	3730.13	.0	.0	.03
128	200	410.29	3728.87	.0	.0	.03
129	201	411.32	3727.52	.0	.0	.04
130	202	412.24	3726.09	.0	.0	.04
131	203	413.02	3724.58	.0	.0	.05
132	204	413.67	3723.01	.0	.0	.04
133	205	414.19	3721.39	.0	.0	.04
134	206	414.55	3719.73	.0	.0	.04
135	207	414.78	3718.04	.0	.0	.07
136	208	414.85	3716.34	.0	.0	.10
137	209	414.78	3714.64	.0	.0	.13
138	210	414.55	3712.95	.0	.0	.17
139	211	414.19	3711.29	.0	.0	.15
140	212	413.67	3709.67	.0	.0	.17
141	213	413.02	3708.10	.0	.0	.17
142	214	412.24	3706.59	.0	.0	.22
143	215	411.32	3705.15	.0	.0	.19
144	216	410.29	3703.81	.0	.0	.11
145	217	381.21	3730.48	.0	.0	.06
146	218	382.49	3731.66	.0	.0	.05
147	219	383.88	3732.72	.0	.0	.06
148	220	385.35	3733.66	.0	.0	.06
149	221	386.90	3734.47	.0	.0	.06
150	222	388.51	3735.13	.0	.0	.04
151	223	390.17	3735.66	.0	.0	.04
152	224	391.88	3736.04	.0	.0	.05
153	225	393.61	3736.26	.0	.0	.07
154	226	395.35	3736.34	.0	.0	.10
155	227	397.09	3736.26	.0	.0	.09
156	228	398.82	3736.04	.0	.0	.06
157	229	400.53	3735.66	.0	.0	.06
158	230	402.19	3735.13	.0	.0	.05
159	231	403.80	3734.47	.0	.0	.05
160	232	405.35	3733.66	.0	.0	.07

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161	233	406.82	3732.72	.0	.0	.05
162	234	408.21	3731.66	.0	.0	.03
163	235	409.49	3730.48	.0	.0	.03
164	236	410.67	3729.20	.0	.0	.03
165	237	411.73	3727.81	.0	.0	.04
166	238	412.67	3726.34	.0	.0	.04
167	239	413.48	3724.79	.0	.0	.05
168	240	414.14	3723.18	.0	.0	.04
169	241	414.67	3721.52	.0	.0	.03
170	242	415.05	3719.81	.0	.0	.04
171	243	415.27	3718.08	.0	.0	.07
172	244	415.35	3716.34	.0	.0	.10
173	245	415.27	3714.60	.0	.0	.13
174	246	415.05	3712.87	.0	.0	.16
175	247	414.67	3711.16	.0	.0	.15
176	248	414.14	3709.50	.0	.0	.16
177	249	413.48	3707.89	.0	.0	.16
178	250	412.67	3706.34	.0	.0	.21
179	251	411.73	3704.87	.0	.0	.19
180	252	410.67	3703.40	.0	.0	.11

TABLE 3

CASE 2 RESULTS

*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 10

MPTER - VERSION 80345

DELTA PLATFORM
CASE 2
RECEP SET 1

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1,HR 1, TO DAY366,HR24. (MICROGRAMS/M**3)
1	1	386.16	3725.53	.0	.0	.10
2	2	386.99	3726.30	.0	.0	.09
3	3	387.89	3726.99	.0	.0	.10
4	4	388.89	3727.60	.0	.0	.11
5	5	389.88	3728.12	.0	.0	.10
6	6	390.90	3728.56	.0	.0	.07
7	7	391.99	3728.90	.0	.0	.08
8	8	393.09	3729.14	.0	.0	.09
9	9	394.22	3729.29	.0	.0	.12
10	10	395.35	3729.34	.0	.0	.17
11	11	396.48	3729.29	.0	.0	.15
12	12	397.61	3729.14	.0	.0	.11
13	13	398.72	3728.90	.0	.0	.10
14	14	399.80	3728.56	.0	.0	.08
15	15	400.84	3728.12	.0	.0	.08
16	16	401.83	3727.60	.0	.0	.11
17	17	402.81	3726.99	.0	.0	.08
18	18	403.71	3726.30	.0	.0	.06
19	19	404.54	3725.53	.0	.0	.05
20	20	405.31	3724.70	.0	.0	.05
21	21	406.00	3723.80	.0	.0	.06
22	22	406.61	3722.84	.0	.0	.07
23	23	407.13	3721.83	.0	.0	.08
24	24	407.57	3720.79	.0	.0	.06
25	25	407.91	3719.70	.0	.0	.06
26	26	408.15	3718.60	.0	.0	.08
27	27	408.30	3717.47	.0	.0	.12
28	28	408.35	3716.34	.0	.0	.17
29	29	408.30	3715.21	.0	.0	.22
30	30	408.15	3714.08	.0	.0	.28
31	31	407.91	3712.98	.0	.0	.25
32	32	407.57	3711.89	.0	.0	.27
33	33	407.13	3710.85	.0	.0	.27
34	34	406.61	3709.84	.0	.0	.34
35	35	406.00	3708.88	.0	.0	.30
36	36	405.31	3707.98	.0	.0	.19
37	37	385.80	3725.89	.0	.0	.09
38	38	386.67	3726.68	.0	.0	.09
39	39	387.61	3727.40	.0	.0	.09
40	40	388.60	3728.03	.0	.0	.11
41	41	389.65	3728.58	.0	.0	.10
42	42	390.73	3729.03	.0	.0	.07
43	43	391.88	3729.38	.0	.0	.07
44	44	393.01	3729.64	.0	.0	.09
45	45	394.17	3729.79	.0	.0	.12
46	46	395.35	3729.84	.0	.0	.17

*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 11

47	47	396.53	3729.79	.0	.0	.14
48	48	397.69	3729.64	.0	.0	.10
49	49	398.84	3729.38	.0	.0	.09
50	50	399.97	3729.03	.0	.0	.08
51	51	401.06	3728.58	.0	.0	.08
52	52	402.10	3728.03	.0	.0	.11
53	53	403.09	3727.40	.0	.0	.08
54	54	404.03	3726.68	.0	.0	.05
55	55	404.90	3725.89	.0	.0	.05
56	56	405.69	3725.02	.0	.0	.05
57	57	406.41	3724.08	.0	.0	.06
58	58	407.04	3723.09	.0	.0	.07
59	59	407.58	3722.05	.0	.0	.07
60	60	408.04	3720.96	.0	.0	.06
61	61	408.39	3719.83	.0	.0	.06
62	62	408.65	3718.68	.0	.0	.07
63	63	408.80	3717.52	.0	.0	.12
64	64	408.85	3716.34	.0	.0	.16
65	65	408.80	3715.16	.0	.0	.21
66	66	408.65	3714.00	.0	.0	.27
67	67	408.39	3712.85	.0	.0	.25
68	68	408.04	3711.72	.0	.0	.26
69	69	407.58	3710.64	.0	.0	.26
70	70	407.04	3709.59	.0	.0	.33
71	71	406.41	3708.60	.0	.0	.30
72	72	405.69	3707.66	.0	.0	.18
73	73	385.45	3726.24	.0	.0	.09
74	74	386.35	3727.07	.0	.0	.09
75	75	387.32	3727.81	.0	.0	.09
76	76	388.35	3728.46	.0	.0	.10
77	77	389.43	3729.03	.0	.0	.09
78	78	390.56	3729.50	.0	.0	.06
79	79	391.73	3729.86	.0	.0	.07
80	80	392.92	3730.13	.0	.0	.08
81	81	394.13	3730.29	.0	.0	.11
82	82	395.35	3730.34	.0	.0	.16
83	83	396.57	3730.29	.0	.0	.14
84	84	397.78	3730.13	.0	.0	.10
85	85	398.97	3729.86	.0	.0	.09
86	86	400.14	3729.50	.0	.0	.08
87	87	401.27	3729.03	.0	.0	.08
88	88	402.35	3728.46	.0	.0	.11
89	89	403.38	3727.81	.0	.0	.07
90	90	404.35	3727.07	.0	.0	.05
91	91	405.25	3726.24	.0	.0	.04
92	92	406.08	3725.34	.0	.0	.05
93	93	406.82	3724.37	.0	.0	.06
94	94	407.47	3723.34	.0	.0	.07
95	95	408.04	3722.26	.0	.0	.07
96	96	408.51	3721.13	.0	.0	.06
97	97	408.87	3719.96	.0	.0	.06
98	98	409.14	3718.77	.0	.0	.07
99	99	409.30	3717.56	.0	.0	.11
100	100	409.35	3716.34	.0	.0	.16
101	101	409.30	3715.12	.0	.0	.21
102	102	409.14	3713.91	.0	.0	[illegible]
103	103	408.87	3712.72	.0	.0	[illegible]

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•EXAMPLE RUNSTREAM FOR MP1ER

DATE 112283

104	104	408.51	3711.55	.0	.0	.25
105	105	408.04	3710.42	.0	.0	.25
106	106	407.47	3709.34	.0	.0	.32
107	107	406.82	3708.31	.0	.0	.29
108	108	406.08	3707.34	.0	.0	.17
109	109	385.10	3726.59	.0	.0	.09
110	110	386.03	3727.45	.0	.0	.08
111	111	387.03	3728.22	.0	.0	.09
112	112	388.10	3728.90	.0	.0	.10
113	113	389.22	3729.48	.0	.0	.09
114	114	390.39	3729.97	.0	.0	.06
115	115	391.60	3730.35	.0	.0	.07
116	116	392.63	3730.62	.0	.0	.08
117	117	394.04	3730.79	.0	.0	.11
118	118	395.35	3730.84	.0	.0	.16
119	119	396.61	3730.79	.0	.0	.13
120	120	397.87	3730.62	.0	.0	.09
121	121	399.10	3730.35	.0	.0	.08
122	122	400.31	3729.97	.0	.0	.07
123	123	401.48	3729.48	.0	.0	.07
124	124	402.60	3728.90	.0	.0	.10
125	125	403.67	3728.22	.0	.0	.07
126	126	404.67	3727.45	.0	.0	.05
127	127	405.60	3726.59	.0	.0	.04
128	128	406.46	3725.66	.0	.0	.04
129	129	407.23	3724.66	.0	.0	.05
130	130	407.91	3723.59	.0	.0	.06
131	131	408.49	3722.47	.0	.0	.07
132	132	408.98	3721.30	.0	.0	.05
133	133	409.36	3720.09	.0	.0	.05
134	134	409.63	3718.86	.0	.0	.07
135	135	409.79	3717.60	.0	.0	.11
136	136	409.85	3716.34	.0	.0	.15
137	137	409.79	3715.08	.0	.0	.20
138	138	409.63	3713.82	.0	.0	.25
139	139	409.36	3712.59	.0	.0	.23
140	140	408.98	3711.38	.0	.0	.24
141	141	408.49	3710.21	.0	.0	.25
142	142	407.91	3709.09	.0	.0	.31
143	143	407.23	3708.02	.0	.0	.28
144	144	406.46	3707.02	.0	.0	.17
145	145	384.74	3726.95	.0	.0	.09
146	146	385.71	3727.83	.0	.0	.08
147	147	386.75	3728.63	.0	.0	.06
148	148	387.85	3729.33	.0	.0	.10
149	149	389.01	3729.93	.0	.0	.09
150	150	390.22	3730.43	.0	.0	.06
151	151	391.47	3730.83	.0	.0	.07
152	152	392.74	3731.11	.0	.0	.08
153	153	394.04	3731.28	.0	.0	.11
154	154	395.35	3731.34	.0	.0	.15
155	155	396.66	3731.28	.0	.0	.13
156	156	397.96	3731.11	.0	.0	.09
157	157	399.23	3730.83	.0	.0	.08
158	158	400.48	3730.43	.0	.0	.07
159	159	401.69	3729.93	.0	.0	.07
160	160	402.65	3729.33	.0	.0	.10

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*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 13

161	161	403.95	3728.63	.0	.0	.07
162	162	404.99	3727.83	.0	.0	.05
163	163	405.96	3726.95	.0	.0	.04
164	164	406.84	3725.98	.0	.0	.04
165	165	407.64	3724.94	.0	.0	.05
166	166	408.34	3723.84	.0	.0	.06
167	167	408.94	3722.68	.0	.0	.07
168	168	409.44	3721.47	.0	.0	.05
169	169	409.84	3720.22	.0	.0	.05
170	170	410.12	3718.95	.0	.0	.07
171	171	410.29	3717.65	.0	.0	.11
172	172	410.35	3716.34	.0	.0	.15
173	173	410.29	3715.03	.0	.0	.19
174	174	410.12	3713.73	.0	.0	.24
175	175	409.84	3712.46	.0	.0	.22
176	176	409.44	3711.21	.0	.0	.24
177	177	408.94	3710.00	.0	.0	.24
178	178	408.34	3708.84	.0	.0	.31
179	179	407.64	3707.74	.0	.0	.27
180	180	406.84	3706.70	.0	.0	.16

FORM NO. S-11052

*EXAMPLE RUNSTREAM FOR MPTER DATE 112283 PAGE 10

MPTER - VERSION 80345

PETA PLATFORM
CASE 2
RECEP SET 2

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1.HR 1. TO DAY366.HR24. (MICROGRAMS/M**3)
1	181	384.39	3727.30	.0	.0	.08
2	182	385.39	3728.21	.0	.0	.08
3	183	386.46	3729.04	.0	.0	.08
4	184	387.60	3729.76	.0	.0	.09
5	185	388.80	3730.39	.0	.0	.08
6	186	390.05	3730.90	.0	.0	.06
7	187	391.34	3731.31	.0	.0	.06
8	188	392.66	3731.60	.0	.0	.08
9	189	394.00	3731.78	.0	.0	.10
10	190	395.35	3731.84	.0	.0	.15
11	191	396.70	3731.78	.0	.0	.12
12	192	398.04	3731.60	.0	.0	.09
13	193	399.36	3731.31	.0	.0	.08
14	194	400.65	3730.90	.0	.0	.07
15	195	401.90	3730.39	.0	.0	.07
16	196	403.10	3729.76	.0	.0	.10
17	197	404.24	3729.04	.0	.0	.07
18	198	405.31	3728.21	.0	.0	.05
19	199	406.31	3727.30	.0	.0	.04
20	200	407.22	3726.30	.0	.0	.04
21	201	408.05	3725.23	.0	.0	.05
22	202	408.77	3724.09	.0	.0	.06
23	203	409.40	3722.89	.0	.0	.06
24	204	409.92	3721.64	.0	.0	.05
25	205	410.32	3720.35	.0	.0	.05
26	206	410.62	3719.03	.0	.0	.06
27	207	410.79	3717.69	.0	.0	.10
28	208	410.85	3716.34	.0	.0	.14
29	209	410.79	3714.99	.0	.0	.18
30	210	410.62	3713.65	.0	.0	.23
31	211	410.32	3712.33	.0	.0	.21
32	212	409.92	3711.04	.0	.0	.23
33	213	409.40	3709.79	.0	.0	.23
34	214	408.77	3708.59	.0	.0	.30
35	215	408.05	3707.45	.0	.0	.27
36	216	407.22	3706.38	.0	.0	.36
37	217	384.04	3727.65	.0	.0	.08
38	218	385.06	3728.60	.0	.0	.08
39	219	386.17	3729.45	.0	.0	.08
40	220	387.35	3730.20	.0	.0	.09
41	221	388.59	3730.84	.0	.0	.08
42	222	389.88	3731.37	.0	.0	.06
43	223	391.21	3731.80	.0	.0	.06
44	224	392.57	3732.10	.0	.0	.07
45	225	393.96	3732.28	.0	.0	.10
46	226	395.35	3732.34	.0	.0	.14

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47	227	396.74	3732.28	.0	.0	.12
48	228	398.13	3732.10	.0	.0	.08
49	229	399.49	3731.80	.0	.0	.08
50	230	400.82	3731.37	.0	.0	.07
51	231	402.11	3730.84	.0	.0	.07
52	232	403.35	3730.20	.0	.0	.09
53	233	404.53	3729.45	.0	.0	.06
54	234	405.63	3728.60	.0	.0	.04
55	235	406.66	3727.65	.0	.0	.04
56	236	407.61	3726.62	.0	.0	.04
57	237	408.46	3725.52	.0	.0	.05
58	238	409.21	3724.34	.0	.0	.06
59	239	409.85	3723.10	.0	.0	.06
60	240	410.38	3721.81	.0	.0	.05
61	241	410.81	3720.48	.0	.0	.05
62	242	411.11	3719.12	.0	.0	.06
63	243	411.29	3717.73	.0	.0	.10
64	244	411.35	3716.34	.0	.0	.14
65	245	411.29	3714.95	.0	.0	.18
66	246	411.11	3713.56	.0	.0	.23
67	247	410.81	3712.20	.0	.0	.21
68	248	410.38	3710.87	.0	.0	.22
69	249	409.85	3709.58	.0	.0	.23
70	250	409.21	3708.34	.0	.0	.29
71	251	408.46	3707.16	.0	.0	.26
72	252	407.61	3706.05	.0	.0	.15
73	253	383.68	3728.01	.0	.0	.08
74	254	384.74	3728.98	.0	.0	.07
75	255	385.89	3729.86	.0	.0	.08
76	256	387.10	3730.63	.0	.0	.09
77	257	388.30	3731.29	.0	.0	.08
78	258	389.71	3731.85	.0	.0	.05
79	259	391.08	3732.28	.0	.0	.06
80	260	392.49	3732.59	.0	.0	.07
81	261	393.91	3732.78	.0	.0	.10
82	262	395.35	3732.84	.0	.0	.14
83	263	396.79	3732.78	.0	.0	.12
84	264	398.22	3732.59	.0	.0	.08
85	265	399.62	3732.28	.0	.0	.07
86	266	400.99	3731.85	.0	.0	.07
87	267	402.32	3731.29	.0	.0	.06
88	268	403.60	3730.63	.0	.0	.09
89	269	404.81	3729.86	.0	.0	.06
90	270	405.96	3728.98	.0	.0	.04
91	271	407.02	3728.01	.0	.0	.04
92	272	407.99	3726.95	.0	.0	.04
93	273	408.87	3725.80	.0	.0	.05
94	274	409.64	3724.59	.0	.0	.06
95	275	410.30	3723.31	.0	.0	.06
96	276	410.85	3721.98	.0	.0	.05
97	277	411.29	3720.61	.0	.0	.05
98	278	411.60	3719.20	.0	.0	.06
99	279	411.79	3717.78	.0	1.0	.10
100	280	411.85	3716.34	.0	.0	.13
101	281	411.79	3714.90	.0	.0	.17
102	282	411.60	3713.48	.0	.0	.22
103	283	411.29	3712.07	.0	.0	[illegible]

*EXAMPLE RUNSTREAM FOR MPTER

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104	284	410.85	3710.70	.0	.0	.22
105	285	410.30	3709.37	.0	.0	.22
106	286	409.64	3708.09	.0	.0	.28
107	287	408.87	3706.68	.0	.0	.25
108	288	407.99	3705.73	.0	.0	.15
109	1	383.33	3728.36	.0	.0	.08
110	2	384.42	3729.36	.0	.0	.07
111	3	385.60	3730.27	.0	.0	.07
112	4	386.85	3731.06	.0	.0	.09
113	5	388.17	3731.75	.0	.0	.08
114	6	389.54	3732.32	.0	.0	.05
115	7	390.95	3732.76	.0	.0	.06
116	8	392.40	3733.08	.0	.0	.07
117	9	393.87	3733.27	.0	.0	.09
118	10	395.35	3733.34	.0	.0	.14
119	11	396.83	3733.27	.0	.0	.11
120	12	398.30	3733.08	.0	.0	.08
121	13	399.75	3732.76	.0	.0	.07
122	14	401.16	3732.32	.0	.0	.06
123	15	402.53	3731.75	.0	.0	.06
124	16	403.85	3731.06	.0	.0	.09
125	17	405.10	3730.27	.0	.0	.06
126	18	406.28	3729.36	.0	.0	.04
127	19	407.37	3728.36	.0	.0	.04
128	20	408.37	3727.27	.0	.0	.04
129	21	409.28	3726.09	.0	.0	.05
130	22	410.07	3724.84	.0	.0	.05
131	23	410.76	3723.52	.0	.0	.06
132	24	411.33	3722.15	.0	.0	.05
133	25	411.77	3720.74	.0	.0	.05
134	26	412.09	3719.29	.0	.0	.06
135	27	412.28	3717.82	.0	.0	.09
136	28	412.35	3716.34	.0	.0	.13
137	29	412.28	3714.86	.0	.0	.17
138	30	412.09	3713.39	.0	.0	.21
139	31	411.77	3711.94	.0	.0	.20
140	32	411.33	3710.53	.0	.0	.21
141	33	410.76	3709.15	.0	.0	.21
142	34	410.07	3707.84	.0	.0	.27
143	35	409.28	3706.59	.0	.0	.25
144	36	408.37	3705.41	.0	.0	.15
145	37	382.90	3724.71	.0	.0	.06
146	38	384.10	3729.75	.0	.0	.07
147	39	385.31	3730.67	.0	.0	.07
148	40	386.60	3731.49	.0	.0	.08
149	41	387.95	3732.20	.0	.0	.07
150	42	389.37	3732.79	.0	.0	.05
151	43	390.82	3733.24	.0	.0	.06
152	44	392.31	3733.57	.0	.0	.07
153	45	393.83	3733.77	.0	.0	.09
154	46	395.35	3733.84	.0	.0	.13
155	47	396.87	3733.77	.0	.0	.11
156	48	398.39	3733.57	.0	.0	.08
157	49	399.88	3733.24	.0	.0	.07
158	50	401.33	3732.79	.0	.0	.06
159	51	402.75	3732.20	.0	.0	.06
160	52	404.10	3731.49	.0	.0	.08

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161	53	405.39	3730.67	.0	.0	.06
162	54	406.60	3729.75	.0	.0	.04
163	55	407.72	3728.71	.0	.0	.03
164	56	406.76	3727.59	.0	.0	.04
165	57	409.69	3726.38	.0	.0	.05
166	58	410.51	3725.09	.0	.0	.05
167	59	411.21	3723.74	.0	.0	.06
168	60	411.79	3722.33	.0	.0	.04
169	61	412.25	3720.87	.0	.0	.04
170	62	412.58	3719.38	.0	.0	.06
171	63	412.70	3717.86	.0	.0	.09
172	64	412.85	3716.34	.0	.0	.12
173	65	412.78	3714.82	.0	.0	.16
174	66	412.58	3713.30	.0	.0	.20
175	67	412.25	3711.81	.0	.0	.19
176	68	411.79	3710.36	.0	.0	.21
177	69	411.21	3708.94	.0	.0	.21
178	70	410.51	3707.59	.0	.0	.27
179	71	409.69	3706.30	.0	.0	.24
180	72	408.76	3705.09	.0	.0	.14
1						

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MPTER - VERSION 80345

BETA PLATFORM
CASE 2
RECEP SET 3

RECEPTORS

RECEPTOR	IDENTIFICATION	EAST COORD (USER UNITS)	NORTH COORD (USER UNITS)	RECEPTOR HT ABV LOCAL GRD LVL (METERS)	RECEPTOR GROUND LEVEL ELEVATION (USER HT UNITS)	AVG CONC FOR PERIOD DAY 1,HR 1, TO DAY365,HR24, (MICROGRAMS/M**3)
1	73	382.62	3729.07	.0	.0	.07
2	74	383.78	3730.13	.0	.0	.07
3	75	385.03	3731.00	.0	.0	.07
4	76	386.35	3731.93	.0	.0	.08
5	77	387.74	3732.65	.0	.0	.07
6	78	389.19	3733.25	.0	.0	.05
7	79	390.69	3733.73	.0	.0	.05
8	80	392.22	3734.07	.0	.0	.07
9	81	393.78	3734.27	.0	.0	.09
10	82	395.35	3734.34	.0	.0	.13
11	83	396.92	3734.27	.0	.0	.11
12	84	398.48	3734.07	.0	.0	.07
13	85	400.01	3733.73	.0	.0	.07
14	86	401.51	3733.25	.0	.0	.06
15	87	402.96	3732.65	.0	.0	.06
16	88	404.35	3731.93	.0	.0	.08
17	89	405.67	3731.08	.0	.0	.06
18	90	406.92	3730.13	.0	.0	.04
19	91	408.08	3729.07	.0	.0	.03
20	92	409.14	3727.91	.0	.0	.04
21	93	410.10	3726.66	.0	.0	.04
22	94	410.94	3725.34	.0	.0	.05
23	95	411.66	3723.95	.0	.0	.06
24	96	412.26	3722.50	.0	.0	.04
25	97	412.74	3721.00	.0	.0	.04
26	98	413.08	3719.47	.0	.0	.05
27	99	413.28	3717.91	.0	.0	.09
28	100	413.35	3716.34	.0	.0	.12
29	101	413.28	3714.77	.0	.0	.16
30	102	413.08	3713.21	.0	.0	.20
31	103	412.74	3711.68	.0	.0	.18
32	104	412.26	3710.18	.0	.0	.20
33	105	411.66	3708.73	.0	.0	.20
34	106	410.94	3707.34	.0	.0	.26
35	107	410.10	3706.02	.0	.0	.23
36	108	409.14	3704.77	.0	.0	.14
37	109	382.27	3729.42	.0	.0	.07
38	110	383.46	3730.51	.0	.0	.07
39	111	384.74	3731.49	.0	.0	.07
40	112	386.10	3732.36	.0	.0	.08
41	113	387.53	3733.11	.0	.0	.07
42	114	389.02	3733.72	.0	.0	.05
43	115	390.56	3734.21	.0	.0	.05
44	116	392.14	3734.56	.0	.0	.06
45	117	393.74	3734.77	.0	.0	.09
46	118	395.35	3734.84	.0	.0	.12

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47	119	396.96	3734.77	.0	.0	.10
48	120	398.56	3734.56	.0	.0	.07
49	121	400.14	3734.21	.0	.0	.07
50	122	401.66	3733.72	.0	.0	.06
51	123	403.17	3733.11	.0	.0	.06
52	124	404.60	3732.36	.0	.0	.08
53	125	405.96	3731.49	.0	.0	.05
54	126	407.24	3730.51	.0	.0	.04
55	127	408.43	3729.42	.0	.0	.03
56	128	409.52	3728.23	.0	.0	.03
57	129	410.50	3726.95	.0	.0	.04
58	130	411.37	3725.59	.0	.0	.05
59	131	412.12	3724.16	.0	.0	.05
60	132	412.73	3722.67	.0	.0	.04
61	133	413.22	3721.13	.0	.0	.04
62	134	413.57	3719.55	.0	.0	.05
63	135	413.78	3717.95	.0	.0	.08
64	136	413.85	3716.34	.0	.0	.12
65	137	413.78	3714.73	.0	.0	.15
66	138	413.57	3713.13	.0	.0	.19
67	139	413.22	3711.55	.0	.0	.18
68	140	412.73	3710.01	.0	.0	.20
69	141	412.12	3708.52	.0	.0	.20
70	142	411.37	3707.09	.0	.0	.25
71	143	410.50	3705.73	.0	.0	.23
72	144	409.52	3704.45	.0	.0	.13
73	145	381.92	3729.77	.0	.0	.07
74	146	383.14	3730.89	.0	.0	.06
75	147	384.45	3731.90	.0	.0	.07
76	148	385.85	3732.79	.0	.0	.08
77	149	387.32	3733.56	.0	.0	.07
78	150	388.85	3734.19	.0	.0	.05
79	151	390.43	3734.69	.0	.0	.05
80	152	392.05	3735.05	.0	.0	.06
81	153	393.69	3735.27	.0	.0	.08
82	154	395.35	3735.34	.0	.0	.12
83	155	397.01	3735.27	.0	.0	.10
84	156	398.65	3735.05	.0	.0	.07
85	157	400.27	3734.69	.0	.0	.06
86	158	401.85	3734.19	.0	.0	.06
87	159	403.38	3733.56	.0	.0	.05
88	160	404.85	3732.79	.0	.0	.08
89	161	406.25	3731.90	.0	.0	.05
90	162	407.56	3730.89	.0	.0	.04
91	163	408.78	3729.77	.0	.0	.03
92	164	409.90	3728.55	.0	.0	.03
93	165	410.91	3727.24	.0	.0	.04
94	166	411.80	3725.84	.0	.0	.05
95	167	412.57	3724.37	.0	.0	.05
96	168	413.20	3722.84	.0	.0	.04
97	169	413.70	3721.26	.0	.0	.04
98	170	414.06	3719.64	.0	.0	.05
99	171	414.28	3718.00	.0	.0	.08
100	172	414.35	3716.34	.0	.0	.11
101	173	414.28	3714.68	.0	.0	.15
102	174	414.06	3713.04	.0	.0	.19
103	175	413.70	3711.42	.0	.0	[illegible]

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104	176	413.20	3709.84	.0	.0	.19
105	177	412.57	3708.31	.0	.0	.19
106	178	411.80	3706.84	.0	.0	.25
107	179	410.91	3705.44	.0	.0	.22
108	180	409.90	3704.13	.0	.0	.13
109	181	381.56	3730.13	.0	.0	.07
110	182	382.82	3731.28	.0	.0	.06
111	183	384.17	3732.31	.0	.0	.07
112	184	385.60	3733.25	.0	.0	.08
113	185	387.11	3734.01	.0	.0	.07
114	186	388.68	3734.66	.0	.0	.04
115	187	390.30	3735.10	.0	.0	.05
116	188	391.96	3735.54	.0	.0	.06
117	189	393.65	3735.77	.0	.0	.08
118	190	395.35	3735.84	.0	.0	.12
119	191	397.05	3735.77	.0	.0	.10
120	192	398.74	3735.54	.0	.0	.07
121	193	400.40	3735.18	.0	.0	.06
122	194	402.02	3734.66	.0	.0	.05
123	195	403.59	3734.01	.0	.0	.05
124	196	405.10	3733.23	.0	.0	.08
125	197	406.53	3732.31	.0	.0	.05
126	198	407.66	3731.26	.0	.0	.04
127	199	409.14	3730.13	.0	.0	.03
128	200	410.29	3728.87	.0	.0	.03
129	201	411.32	3727.52	.0	.0	.04
130	202	412.24	3726.09	.0	.0	.05
131	203	413.02	3724.58	.0	.0	.05
132	204	413.67	3723.01	.0	.0	.04
133	205	414.19	3721.39	.0	.0	.04
134	206	414.55	3719.73	.0	.0	.05
135	207	414.78	3718.04	.0	.0	.08
136	208	414.85	3716.34	.0	.0	.11
137	209	414.78	3714.64	.0	.0	.14
138	210	414.55	3712.95	.0	.0	.18
139	211	414.19	3711.29	.0	.0	.17
140	212	413.67	3709.67	.0	.0	.19
141	213	413.02	3708.10	.0	.0	.19
142	214	412.24	3706.59	.0	.0	.24
143	215	411.32	3705.15	.0	.0	.22
144	216	410.29	3703.81	.0	.0	.13
145	217	381.21	3730.48	.0	.0	.07
146	218	382.49	3731.66	.0	.0	.06
147	219	383.88	3732.72	.0	.0	.06
148	220	385.35	3733.66	.0	.0	.07
149	221	386.90	3734.47	.0	.0	.06
150	222	388.51	3735.13	.0	.0	.04
151	223	390.17	3735.66	.0	.0	.05
152	224	391.88	3736.04	.0	.0	.06
153	225	393.61	3736.26	.0	.0	.08
154	226	395.35	3736.34	.0	.0	.12
155	227	397.09	3736.26	.0	.0	.09
156	228	398.82	3736.04	.0	.0	.06
157	229	400.53	3735.66	.0	.0	.06
158	230	402.19	3735.13	.0	.0	.05
159	231	403.80	3734.47	.0	.0	.05
160	232	405.35	3733.66	.0	.0	.07

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161	233	406.82	3732.72	.0	.0	.05
162	234	408.21	3731.66	.0	.0	.03
163	235	409.49	3730.48	.0	.0	.03
164	236	410.67	3729.20	.0	.0	.03
165	237	411.73	3727.81	.0	.0	.04
166	238	412.67	3726.34	.0	.0	.05
167	239	413.48	3724.79	.0	.0	.05
168	240	414.14	3723.18	.0	.0	.04
169	241	414.67	3721.52	.0	.0	.04
170	242	415.05	3719.81	.0	.0	.05
171	243	415.27	3718.08	.0	.0	.08
172	244	415.35	3716.34	.0	.0	.11
173	245	415.27	3714.60	.0	.0	.14
174	246	415.05	3712.87	.0	.0	.18
175	247	414.67	3711.16	.0	.0	.16
176	248	414.14	3709.50	.0	.0	.18
177	249	413.48	3707.89	.0	.0	.18
178	250	412.67	3706.34	.0	.0	.24
179	251	411.73	3704.87	.0	.0	.21
180	252	410.67	3703.48	.0	.0	.12

TABLE 4

UTM/POLAR COORDINATE CONVERSIONS FOR RECEPTORS

REC	X,KM	Y,KM	AZIMUTH	RADIUS,KM	X,KM	Y,KM
1	-9.192	9.192	315.00	13.000	386.158	3725.532
2	-8.356	9.959	320.00	13.000	386.994	3726.299
3	-7.456	10.649	325.00	13.000	387.894	3726.989
4	-6.500	11.258	330.00	13.000	388.850	3727.598
5	-5.494	11.782	335.00	13.000	389.856	3728.122
6	-4.446	12.216	340.00	13.000	390.904	3728.556
7	-3.365	12.557	345.00	13.000	391.985	3728.897
8	-2.257	12.803	350.00	13.000	393.093	3729.142
9	-1.133	12.951	355.00	13.000	394.217	3729.290
10	.000	13.000	.00	13.000	395.350	3729.340
11	1.133	12.951	5.00	13.000	396.483	3729.291
12	2.257	12.803	10.00	13.000	397.607	3729.142
13	3.365	12.557	15.00	13.000	398.715	3728.897
14	4.446	12.216	20.00	13.000	399.796	3728.556
15	5.494	11.782	25.00	13.000	400.844	3728.122
16	6.500	11.258	30.00	13.000	401.850	3727.598
17	7.456	10.649	35.00	13.000	402.806	3726.989
18	8.356	9.959	40.00	13.000	403.706	3726.299
19	9.192	9.192	45.00	13.000	404.542	3725.532
20	9.959	8.356	50.00	13.000	405.309	3724.696
21	10.649	7.456	55.00	13.000	405.999	3723.796
22	11.258	6.500	60.00	13.000	406.608	3722.840
23	11.782	5.494	65.00	13.000	407.132	3721.834
24	12.216	4.446	70.00	13.000	407.566	3720.786
25	12.557	3.365	75.00	13.000	407.907	3719.705
26	12.803	2.257	80.00	13.000	408.152	3718.597
27	12.951	1.133	85.00	13.000	408.301	3717.473
28	13.000	.000	90.00	13.000	408.350	3716.340
29	12.951	-1.133	95.00	13.000	408.301	3715.207
30	12.803	-2.257	100.00	13.000	408.152	3714.083
31	12.557	-3.365	105.00	13.000	407.907	3712.975
32	12.216	-4.446	110.00	13.000	407.566	3711.894
33	11.782	-5.494	115.00	13.000	407.132	3710.846
34	11.258	-6.500	120.00	13.000	406.608	3709.840
35	10.649	-7.456	125.00	13.000	405.999	3708.884
36	9.959	-8.356	130.00	13.000	405.309	3707.984
37	-9.546	9.546	315.00	13.500	385.804	3725.886
38	-8.678	10.342	320.00	13.500	386.672	3726.682
39	-7.743	11.059	325.00	13.500	387.607	3727.399
40	-6.750	11.691	330.00	13.500	388.600	3728.031
41	-5.705	12.235	335.00	13.500	389.645	3728.575
42	-4.617	12.686	340.00	13.500	390.733	3729.026
43	-3.494	13.040	345.00	13.500	391.856	3729.380
44	-2.344	13.295	350.00	13.500	393.006	3729.635
45	-1.177	13.449	355.00	13.500	394.173	3729.789
46	.000	13.500	.00	13.500	395.350	3729.840
47	1.177	13.449	5.00	13.500	396.527	3729.789
48	2.344	13.295	10.00	13.500	397.694	3729.635
49	3.494	13.040	15.00	13.500	398.844	3729.380
50	4.617	12.686	20.00	13.500	399.967	3729.026
51	5.705	12.235	25.00	13.500	401.055	3728.575
52	6.750	11.691	30.00	13.500	402.100	3728.031
53	7.743	11.059	35.00	13.500	403.093	3727.399
54	8.678	10.342	40.00	13.500	404.028	3726.682

55	9.546	9.546	45.00	13.500	404.895	3725.836
56	10.342	8.678	50.00	13.500	405.692	3725.013
57	11.059	7.743	55.00	13.500	406.409	3724.083
58	11.691	6.750	60.00	13.500	407.041	3723.090
59	12.235	5.705	65.00	13.500	407.585	3722.045
60	12.686	4.617	70.00	13.500	408.036	3720.957
61	13.040	3.494	75.00	13.500	408.390	3719.834
62	13.295	2.344	80.00	13.500	408.645	3718.684
63	13.449	1.177	85.00	13.500	408.799	3717.517
64	13.500	.000	90.00	13.500	408.850	3716.340
65	13.449	-1.177	95.00	13.500	408.799	3715.163
66	13.295	-2.344	100.00	13.500	408.645	3713.996
67	13.040	-3.494	105.00	13.500	408.390	3712.846
68	12.686	-4.617	110.00	13.500	408.036	3711.723
69	12.235	-5.705	115.00	13.500	407.585	3710.635
70	11.691	-6.750	120.00	13.500	407.041	3709.590
71	11.059	-7.743	125.00	13.500	406.409	3708.597
72	10.342	-8.678	130.00	13.500	405.692	3707.662
73	-9.899	9.899	315.00	14.000	385.451	3726.239
74	-8.999	10.725	320.00	14.000	386.351	3727.065
75	-8.030	11.468	325.00	14.000	387.320	3727.808
76	-7.000	12.124	330.00	14.000	388.350	3728.464
77	-5.917	12.688	335.00	14.000	389.433	3729.028
78	-4.788	13.156	340.00	14.000	390.562	3729.496
79	-3.623	13.523	345.00	14.000	391.727	3729.863
80	-2.431	13.787	350.00	14.000	392.919	3730.127
81	-1.220	13.947	355.00	14.000	394.130	3730.287
82	.000	14.000	.00	14.000	395.350	3730.340
83	1.220	13.947	5.00	14.000	396.570	3730.287
84	2.431	13.787	10.00	14.000	397.781	3730.127
85	3.623	13.523	15.00	14.000	398.973	3729.863
86	4.788	13.156	20.00	14.000	400.138	3729.496
87	5.917	12.688	25.00	14.000	401.267	3729.028
88	7.000	12.124	30.00	14.000	402.350	3728.464
89	8.030	11.468	35.00	14.000	403.380	3727.808
90	8.999	10.725	40.00	14.000	404.349	3727.065
91	9.899	9.899	45.00	14.000	405.249	3726.239
92	10.725	8.999	50.00	14.000	406.075	3725.339
93	11.468	8.030	55.00	14.000	406.818	3724.370
94	12.124	7.000	60.00	14.000	407.474	3723.340
95	12.688	5.917	65.00	14.000	408.038	3722.257
96	13.156	4.788	70.00	14.000	408.506	3721.128
97	13.523	3.623	75.00	14.000	408.873	3719.963
98	13.787	2.431	80.00	14.000	409.137	3718.771
99	13.947	1.220	85.00	14.000	409.297	3717.560
100	14.000	.000	90.00	14.000	409.350	3716.340
101	13.947	-1.220	95.00	14.000	409.297	3715.120
102	13.787	-2.431	100.00	14.000	409.137	3713.909
103	13.523	-3.623	105.00	14.000	408.873	3712.717
104	13.156	-4.788	110.00	14.000	408.506	3711.552
105	12.688	-5.917	115.00	14.000	408.038	3710.423
106	12.124	-7.000	120.00	14.000	407.474	3709.340
107	11.468	-8.030	125.00	14.000	406.818	3708.310
108	10.725	-8.999	130.00	14.000	406.075	3707.341
109	-10.253	10.253	315.00	14.500	385.097	3726.593

110	-9.320	11.108	320.00	14.500	386.030	3727.448
111	-8.317	11.878	325.00	14.500	387.033	3728.218
112	-7.250	12.557	330.00	14.500	388.100	3728.897
113	-6.128	13.141	335.00	14.500	389.222	3729.481
114	-4.959	13.626	340.00	14.500	390.391	3729.966
115	-3.753	14.006	345.00	14.500	391.597	3730.346
116	-2.518	14.280	350.00	14.500	392.832	3730.620
117	-1.264	14.445	355.00	14.500	394.086	3730.785
118	.000	14.500	.00	14.500	395.350	3730.840
119	1.264	14.445	5.00	14.500	396.614	3730.785
120	2.518	14.280	10.00	14.500	397.868	3730.620
121	3.753	14.006	15.00	14.500	399.103	3730.346
122	4.959	13.626	20.00	14.500	400.309	3729.966
123	6.128	13.141	25.00	14.500	401.478	3729.481
124	7.250	12.557	30.00	14.500	402.600	3728.897
125	8.317	11.878	35.00	14.500	403.667	3728.218
126	9.320	11.108	40.00	14.500	404.670	3727.448
127	10.253	10.253	45.00	14.500	405.603	3726.593
128	11.108	9.320	50.00	14.500	406.458	3725.660
129	11.878	8.317	55.00	14.500	407.228	3724.657
130	12.557	7.250	60.00	14.500	407.907	3723.590
131	13.141	6.128	65.00	14.500	408.491	3722.468
132	13.626	4.959	70.00	14.500	408.976	3721.299
133	14.006	3.753	75.00	14.500	409.356	3720.093
134	14.280	2.518	80.00	14.500	409.630	3718.858
135	14.445	1.264	85.00	14.500	409.795	3717.604
136	14.500	.000	90.00	14.500	409.850	3716.340
137	14.445	-1.264	95.00	14.500	409.795	3715.076
138	14.280	-2.518	100.00	14.500	409.630	3713.822
139	14.006	-3.753	105.00	14.500	409.356	3712.587
140	13.626	-4.959	110.00	14.500	408.976	3711.381
141	13.141	-6.128	115.00	14.500	408.491	3710.212
142	12.557	-7.250	120.00	14.500	407.907	3709.090
143	11.878	-8.317	125.00	14.500	407.228	3708.023
144	11.108	-9.320	130.00	14.500	406.458	3707.020
145	-10.607	10.607	315.00	15.000	384.743	3726.947
146	-9.642	11.491	320.00	15.000	385.708	3727.831
147	-8.604	12.287	325.00	15.000	386.746	3728.627
148	-7.500	12.990	330.00	15.000	387.850	3729.330
149	-6.339	13.595	335.00	15.000	389.011	3729.935
150	-5.130	14.095	340.00	15.000	390.220	3730.435
151	-3.882	14.489	345.00	15.000	391.468	3730.829
152	-2.605	14.772	350.00	15.000	392.745	3731.112
153	-1.307	14.943	355.00	15.000	394.043	3731.283
154	.000	15.000	.00	15.000	395.350	3731.340
155	1.307	14.943	5.00	15.000	396.657	3731.283
156	2.605	14.772	10.00	15.000	397.955	3731.112
157	3.882	14.489	15.00	15.000	399.232	3730.829
158	5.130	14.095	20.00	15.000	400.480	3730.435
159	6.339	13.595	25.00	15.000	401.689	3729.935
160	7.500	12.990	30.00	15.000	402.850	3729.330
161	8.604	12.287	35.00	15.000	403.954	3728.627
162	9.642	11.491	40.00	15.000	404.992	3727.831
163	10.607	10.607	45.00	15.000	405.957	3726.947
164	11.491	9.642	50.00	15.000	406.841	3725.982

165	12.287	8.604	55.00	15.000	407.637	3724.944
166	12.990	7.500	60.00	15.000	408.340	3723.840
167	13.595	6.339	65.00	15.000	408.945	3722.679
168	14.095	5.130	70.00	15.000	409.445	3721.470
169	14.489	3.882	75.00	15.000	409.839	3720.222
170	14.772	2.605	80.00	15.000	410.122	3718.945
171	14.943	1.307	85.00	15.000	410.293	3717.647
172	15.000	.000	90.00	15.000	410.350	3716.340
173	14.943	-1.307	95.00	15.000	410.293	3715.033
174	14.772	-2.605	100.00	15.000	410.122	3713.735
175	14.489	-3.882	105.00	15.000	409.839	3712.458
176	14.095	-5.130	110.00	15.000	409.445	3711.210
177	13.595	-6.339	115.00	15.000	408.945	3710.001
178	12.990	-7.500	120.00	15.000	408.340	3708.840
179	12.287	-8.604	125.00	15.000	407.637	3707.736
180	11.491	-9.642	130.00	15.000	406.841	3706.698
181	-10.960	10.960	315.00	15.500	384.390	3727.300
182	-9.963	11.874	320.00	15.500	385.387	3728.214
183	-8.890	12.697	325.00	15.500	386.460	3729.037
184	-7.750	13.423	330.00	15.500	387.600	3729.763
185	-6.551	14.048	335.00	15.500	388.799	3730.388
186	-5.301	14.565	340.00	15.500	390.049	3730.905
187	-4.012	14.972	345.00	15.500	391.338	3731.312
188	-2.692	15.265	350.00	15.500	392.658	3731.604
189	-1.351	15.441	355.00	15.500	393.999	3731.781
190	.000	15.500	.00	15.500	395.350	3731.840
191	1.351	15.441	5.00	15.500	396.701	3731.781
192	2.692	15.265	10.00	15.500	398.042	3731.604
193	4.012	14.972	15.00	15.500	399.362	3731.312
194	5.301	14.565	20.00	15.500	400.651	3730.905
195	6.551	14.048	25.00	15.500	401.901	3730.388
196	7.750	13.423	30.00	15.500	403.100	3729.763
197	8.890	12.697	35.00	15.500	404.240	3729.037
198	9.963	11.874	40.00	15.500	405.313	3728.214
199	10.960	10.960	45.00	15.500	406.310	3727.300
200	11.874	9.963	50.00	15.500	407.224	3726.303
201	12.697	8.890	55.00	15.500	408.047	3725.230
202	13.423	7.750	60.00	15.500	408.773	3724.090
203	14.048	6.551	65.00	15.500	409.398	3722.891
204	14.565	5.301	70.00	15.500	409.915	3721.641
205	14.972	4.012	75.00	15.500	410.322	3720.352
206	15.265	2.692	80.00	15.500	410.615	3719.032
207	15.441	1.351	85.00	15.500	410.791	3717.691
208	15.500	.000	90.00	15.500	410.850	3716.340
209	15.441	-1.351	95.00	15.500	410.791	3714.989
210	15.265	-2.692	100.00	15.500	410.615	3713.648
211	14.972	-4.012	105.00	15.500	410.322	3712.328
212	14.565	-5.301	110.00	15.500	409.915	3711.039
213	14.048	-6.551	115.00	15.500	409.398	3709.789
214	13.423	-7.750	120.00	15.500	408.773	3708.590
215	12.697	-8.890	125.00	15.500	408.047	3707.450
216	11.874	-9.963	130.00	15.500	407.224	3706.377
217	-11.314	11.314	315.00	16.000	384.036	3727.654
218	-10.285	12.257	320.00	16.000	385.065	3728.597
219	-9.177	13.106	325.00	16.000	386.173	3729.446

220	-8.000	13.856	330.00	16.000	387.350	3730.196
221	-6.762	14.501	335.00	16.000	388.588	3730.941
222	-5.472	15.035	340.00	16.000	389.878	3731.375
223	-4.141	15.455	345.00	16.000	391.209	3731.795
224	-2.778	15.757	350.00	16.000	392.572	3732.097
225	-1.394	15.939	355.00	16.000	393.956	3732.279
226	.000	16.000	.00	16.000	395.350	3732.340
227	1.394	15.939	5.00	16.000	396.744	3732.279
228	2.778	15.757	10.00	16.000	398.128	3732.097
229	4.141	15.455	15.00	16.000	399.491	3731.795
230	5.472	15.035	20.00	16.000	400.822	3731.375
231	6.762	14.501	25.00	16.000	402.112	3730.341
232	8.000	13.856	30.00	16.000	403.350	3730.196
233	9.177	13.106	35.00	16.000	404.527	3729.446
234	10.285	12.257	40.00	16.000	405.635	3728.597
235	11.314	11.314	45.00	16.000	406.664	3727.654
236	12.257	10.285	50.00	16.000	407.607	3726.625
237	13.106	9.177	55.00	16.000	408.456	3725.517
238	13.856	8.000	60.00	16.000	409.206	3724.340
239	14.501	6.762	65.00	16.000	409.851	3723.102
240	15.035	5.472	70.00	16.000	410.385	3721.812
241	15.455	4.141	75.00	16.000	410.805	3720.481
242	15.757	2.778	80.00	16.000	411.107	3719.118
243	15.939	1.394	85.00	16.000	411.289	3717.734
244	16.000	.000	90.00	16.000	411.350	3716.340
245	15.939	-1.394	95.00	16.000	411.289	3714.946
246	15.757	-2.778	100.00	16.000	411.107	3713.562
247	15.455	-4.141	105.00	16.000	410.805	3712.199
248	15.035	-5.472	110.00	16.000	410.385	3710.868
249	14.501	-6.762	115.00	16.000	409.851	3709.578
250	13.856	-8.000	120.00	16.000	409.206	3708.340
251	13.106	-9.177	125.00	16.000	408.456	3707.163
252	12.257	-10.285	130.00	16.000	407.607	3706.055
253	-11.667	11.667	315.00	16.500	383.683	3728.007
254	-10.606	12.640	320.00	16.500	384.744	3728.980
255	-9.464	13.516	325.00	16.500	385.886	3729.856
256	-8.250	14.289	330.00	16.500	387.100	3730.629
257	-6.973	14.954	335.00	16.500	388.377	3731.294
258	-5.643	15.505	340.00	16.500	389.707	3731.845
259	-4.271	15.938	345.00	16.500	391.079	3732.278
260	-2.865	16.249	350.00	16.500	392.485	3732.589
261	-1.438	16.437	355.00	16.500	393.912	3732.777
262	.000	16.500	.00	16.500	395.350	3732.840
263	1.438	16.437	5.00	16.500	396.788	3732.777
264	2.865	16.249	10.00	16.500	398.215	3732.589
265	4.271	15.938	15.00	16.500	399.621	3732.278
266	5.643	15.505	20.00	16.500	400.993	3731.845
267	6.973	14.954	25.00	16.500	402.323	3731.294
268	8.250	14.289	30.00	16.500	403.600	3730.629
269	9.464	13.516	35.00	16.500	404.814	3729.856
270	10.606	12.640	40.00	16.500	405.956	3728.980
271	11.667	11.667	45.00	16.500	407.017	3728.007
272	12.640	10.606	50.00	16.500	407.990	3726.945
273	13.516	9.464	55.00	16.500	408.366	3725.804
274	14.289	8.250	60.00	16.500	409.639	3724.590

275	14.954	6.973	65.00	16.500	410.304	3723.313
276	15.505	5.643	70.00	16.500	410.855	3721.983
277	15.938	4.271	75.00	16.500	411.288	3720.611
278	16.249	2.865	80.00	16.500	411.599	3719.205
279	16.437	1.438	85.00	16.500	411.787	3717.773
280	16.500	.000	90.00	16.500	411.850	3716.340
281	16.437	-1.438	95.00	16.500	411.787	3714.902
282	16.249	-2.865	100.00	16.500	411.599	3713.475
283	15.938	-4.271	105.00	16.500	411.288	3712.069
284	15.505	-5.643	110.00	16.500	410.855	3710.697
285	14.954	-6.973	115.00	16.500	410.304	3709.367
286	14.289	-8.250	120.00	16.500	409.639	3708.090
287	13.516	-9.464	125.00	16.500	408.866	3706.876
288	12.640	-10.606	130.00	16.500	407.990	3705.734

REC	X,KM	Y,KM	AZIMUTH	RADIUS,KM	X,KM	Y,KM
1	-12.021	12.021	315.00	17.000	383.329	3728.361
2	-10.927	13.023	320.00	17.000	384.423	3729.363
3	-9.751	13.926	325.00	17.000	385.599	3730.266
4	-8.500	14.722	330.00	17.000	386.850	3731.062
5	-7.185	15.407	335.00	17.000	388.165	3731.747
6	-5.814	15.975	340.00	17.000	389.536	3732.315
7	-4.400	16.421	345.00	17.000	390.950	3732.761
8	-2.952	16.742	350.00	17.000	392.398	3733.082
9	-1.482	16.935	355.00	17.000	393.868	3733.275
10	.000	17.000	.00	17.000	395.350	3733.340
11	1.482	16.935	5.00	17.000	396.832	3733.275
12	2.952	16.742	10.00	17.000	398.302	3733.082
13	4.400	16.421	15.00	17.000	399.750	3732.761
14	5.814	15.975	20.00	17.000	401.164	3732.315
15	7.185	15.407	25.00	17.000	402.535	3731.747
16	8.500	14.722	30.00	17.000	403.850	3731.062
17	9.751	13.926	35.00	17.000	405.101	3730.266
18	10.927	13.023	40.00	17.000	406.277	3729.363
19	12.021	12.021	45.00	17.000	407.371	3728.361
20	13.023	10.927	50.00	17.000	408.373	3727.267
21	13.926	9.751	55.00	17.000	409.276	3726.091
22	14.722	8.500	60.00	17.000	410.072	3724.840
23	15.407	7.185	65.00	17.000	410.757	3723.525
24	15.975	5.814	70.00	17.000	411.325	3722.154
25	16.421	4.400	75.00	17.000	411.771	3720.740
26	16.742	2.952	80.00	17.000	412.092	3719.292
27	16.935	1.482	85.00	17.000	412.285	3717.822
28	17.000	.000	90.00	17.000	412.350	3716.340
29	16.935	-1.482	95.00	17.000	412.285	3714.858
30	16.742	-2.952	100.00	17.000	412.092	3713.388
31	16.421	-4.400	105.00	17.000	411.771	3711.940
32	15.975	-5.814	110.00	17.000	411.325	3710.526
33	15.407	-7.185	115.00	17.000	410.757	3709.155
34	14.722	-8.500	120.00	17.000	410.072	3707.840
35	13.926	-9.751	125.00	17.000	409.276	3706.589
36	13.023	-10.927	130.00	17.000	408.373	3705.413
37	-12.374	12.374	315.00	17.500	382.976	3728.714
38	-11.249	13.406	320.00	17.500	384.101	3729.746
39	-10.038	14.335	325.00	17.500	385.312	3730.675
40	-8.750	15.155	330.00	17.500	386.600	3731.495
41	-7.396	15.860	335.00	17.500	387.954	3732.200
42	-5.985	16.445	340.00	17.500	389.365	3732.785
43	-4.529	16.904	345.00	17.500	390.821	3733.244
44	-3.039	17.234	350.00	17.500	392.311	3733.574
45	-1.525	17.433	355.00	17.500	393.825	3733.773
46	.000	17.500	.00	17.500	395.350	3733.840
47	1.525	17.433	5.00	17.500	396.875	3733.773
48	3.039	17.234	10.00	17.500	398.389	3733.574
49	4.529	16.904	15.00	17.500	399.879	3733.244
50	5.985	16.445	20.00	17.500	401.335	3732.785
51	7.396	15.860	25.00	17.500	402.746	3732.200
52	8.750	15.155	30.00	17.500	404.100	3731.495
53	10.038	14.335	35.00	17.500	405.388	3730.675
54	11.249	13.406	40.00	17.500	406.599	3729.746

55	12.374	12.374	45.00	17.500	407.724	3728.714
56	13.406	11.249	50.00	17.500	408.756	3727.589
57	14.335	10.038	55.00	17.500	409.685	3726.378
58	15.155	8.750	60.00	17.500	410.505	3725.090
59	15.860	7.396	65.00	17.500	411.210	3723.736
60	16.445	5.985	70.00	17.500	411.795	3722.325
61	16.904	4.529	75.00	17.500	412.254	3720.869
62	17.234	3.039	80.00	17.500	412.584	3719.379
63	17.433	1.525	85.00	17.500	412.783	3717.865
64	17.500	.000	90.00	17.500	412.850	3716.340
65	17.433	-1.525	95.00	17.500	412.783	3714.815
66	17.234	-3.039	100.00	17.500	412.584	3713.301
67	16.904	-4.529	105.00	17.500	412.254	3711.811
68	16.445	-5.985	110.00	17.500	411.795	3710.355
69	15.860	-7.396	115.00	17.500	411.210	3708.944
70	15.155	-8.750	120.00	17.500	410.505	3707.590
71	14.335	-10.038	125.00	17.500	409.685	3706.302
72	13.406	-11.249	130.00	17.500	408.756	3705.091
73	-12.728	12.728	315.00	18.000	382.622	3729.068
74	-11.570	13.789	320.00	18.000	383.780	3730.129
75	-10.324	14.745	325.00	18.000	385.026	3731.085
76	-9.000	15.588	330.00	18.000	386.350	3731.928
77	-7.607	16.314	335.00	18.000	387.743	3732.654
78	-6.156	16.914	340.00	18.000	389.194	3733.254
79	-4.659	17.387	345.00	18.000	390.691	3733.727
80	-3.126	17.727	350.00	18.000	392.224	3734.067
81	-1.569	17.932	355.00	18.000	393.781	3734.271
82	.000	18.000	.00	18.000	395.350	3734.340
83	1.569	17.932	5.00	18.000	396.919	3734.271
84	3.126	17.727	10.00	18.000	398.476	3734.067
85	4.659	17.387	15.00	18.000	400.009	3733.727
86	6.156	16.914	20.00	18.000	401.506	3733.254
87	7.607	16.314	25.00	18.000	402.957	3732.654
88	9.000	15.588	30.00	18.000	404.350	3731.928
89	10.324	14.745	35.00	18.000	405.674	3731.085
90	11.570	13.789	40.00	18.000	406.920	3730.129
91	12.728	12.728	45.00	18.000	408.078	3729.068
92	13.789	11.570	50.00	18.000	409.139	3727.910
93	14.745	10.324	55.00	18.000	410.095	3726.664
94	15.588	9.000	60.00	18.000	410.938	3725.340
95	16.314	7.607	65.00	18.000	411.664	3723.947
96	16.914	6.156	70.00	18.000	412.264	3722.496
97	17.387	4.659	75.00	18.000	412.737	3720.999
98	17.727	3.126	80.00	18.000	413.077	3719.466
99	17.932	1.569	85.00	18.000	413.282	3717.909
100	18.000	.000	90.00	18.000	413.350	3716.340
101	17.932	-1.569	95.00	18.000	413.282	3714.771
102	17.727	-3.126	100.00	18.000	413.077	3713.214
103	17.387	-4.659	105.00	18.000	412.737	3711.681
104	16.914	-6.156	110.00	18.000	412.264	3710.184
105	16.314	-7.607	115.00	18.000	411.664	3708.733
106	15.588	-9.000	120.00	18.000	410.938	3707.340
107	14.745	-10.324	125.00	18.000	410.095	3706.016
108	13.789	-11.570	130.00	18.000	409.139	3704.770
109	-13.081	13.081	315.00	18.500	382.269	3729.421

110	-11.892	14.172	320.00	18.500	383.458	3730.512
111	-10.611	15.154	325.00	18.500	384.739	3731.494
112	-9.250	16.021	330.00	18.500	386.100	3732.361
113	-7.818	16.767	335.00	18.500	387.532	3733.107
114	-6.327	17.384	340.00	18.500	389.023	3733.724
115	-4.788	17.870	345.00	18.500	390.562	3734.210
116	-3.212	18.219	350.00	18.500	392.138	3734.559
117	-1.612	18.430	355.00	18.500	393.738	3734.770
118	.000	18.500	.00	18.500	395.350	3734.840
119	1.612	18.430	5.00	18.500	396.962	3734.770
120	3.212	18.219	10.00	18.500	398.562	3734.559
121	4.788	17.870	15.00	18.500	400.138	3734.210
122	6.327	17.384	20.00	18.500	401.677	3733.724
123	7.818	16.767	25.00	18.500	403.168	3733.107
124	9.250	16.021	30.00	18.500	404.600	3732.361
125	10.611	15.154	35.00	18.500	405.961	3731.494
126	11.892	14.172	40.00	18.500	407.242	3730.512
127	13.081	13.081	45.00	18.500	408.431	3729.421
128	14.172	11.892	50.00	18.500	409.522	3728.232
129	15.154	10.611	55.00	18.500	410.504	3726.951
130	16.021	9.250	60.00	18.500	411.371	3725.590
131	16.767	7.818	65.00	18.500	412.117	3724.158
132	17.384	6.327	70.00	18.500	412.734	3722.667
133	17.870	4.788	75.00	18.500	413.220	3721.128
134	18.219	3.212	80.00	18.500	413.569	3719.552
135	18.430	1.612	85.00	18.500	413.780	3717.952
136	18.500	.000	90.00	18.500	413.850	3716.340
137	18.430	-1.612	95.00	18.500	413.780	3714.728
138	18.219	-3.212	100.00	18.500	413.569	3713.128
139	17.870	-4.788	105.00	18.500	413.220	3711.552
140	17.384	-6.327	110.00	18.500	412.734	3710.013
141	16.767	-7.818	115.00	18.500	412.117	3708.522
142	16.021	-9.250	120.00	18.500	411.371	3707.090
143	15.154	-10.611	125.00	18.500	410.504	3705.729
144	14.172	-11.892	130.00	18.500	409.522	3704.448
145	-13.435	13.435	315.00	19.000	381.915	3729.775
146	-12.213	14.555	320.00	19.000	383.137	3730.395
147	-10.898	15.564	325.00	19.000	384.452	3731.904
148	-9.500	16.454	330.00	19.000	385.850	3732.794
149	-8.030	17.220	335.00	19.000	387.320	3733.560
150	-6.498	17.854	340.00	19.000	388.852	3734.194
151	-4.918	18.353	345.00	19.000	390.432	3734.693
152	-3.299	18.711	350.00	19.000	392.051	3735.051
153	-1.656	18.928	355.00	19.000	393.694	3735.268
154	.000	19.000	.00	19.000	395.350	3735.340
155	1.656	18.928	5.00	19.000	397.006	3735.268
156	3.299	18.711	10.00	19.000	398.649	3735.051
157	4.918	18.353	15.00	19.000	400.268	3734.693
158	6.498	17.854	20.00	19.000	401.848	3734.194
159	8.030	17.220	25.00	19.000	403.380	3733.560
160	9.500	16.454	30.00	19.000	404.850	3732.794
161	10.898	15.564	35.00	19.000	406.248	3731.904
162	12.213	14.555	40.00	19.000	407.563	3730.395
163	13.435	13.435	45.00	19.000	408.785	3729.775
164	14.555	12.213	50.00	19.000	409.905	3728.553

165	15.564	10.898	55.00	19.000	410.914	3727.238
166	16.454	9.500	60.00	19.000	411.804	3725.840
167	17.220	8.030	65.00	19.000	412.570	3724.370
168	17.854	6.498	70.00	19.000	413.204	3722.838
169	18.353	4.918	75.00	19.000	413.703	3721.258
170	18.711	3.299	80.00	19.000	414.061	3719.639
171	18.928	1.656	85.00	19.000	414.278	3717.996
172	19.000	.000	90.00	19.000	414.350	3716.340
173	18.928	-1.656	95.00	19.000	414.278	3714.684
174	18.711	-3.299	100.00	19.000	414.061	3713.041
175	18.353	-4.918	105.00	19.000	413.703	3711.422
176	17.854	-6.498	110.00	19.000	413.204	3709.842
177	17.220	-8.030	115.00	19.000	412.570	3708.310
178	16.454	-9.500	120.00	19.000	411.804	3706.840
179	15.564	-10.898	125.00	19.000	410.914	3705.442
180	14.555	-12.213	130.00	19.000	409.905	3704.127
181	-13.789	13.789	315.00	19.500	381.561	3730.129
182	-12.534	14.938	320.00	19.500	382.816	3731.278
183	-11.185	15.973	325.00	19.500	384.165	3732.313
184	-9.750	16.887	330.00	19.500	385.600	3733.227
185	-8.241	17.673	335.00	19.500	387.109	3734.013
186	-6.669	18.324	340.00	19.500	388.681	3734.664
187	-5.047	18.836	345.00	19.500	390.303	3735.176
188	-3.386	19.204	350.00	19.500	391.964	3735.544
189	-1.700	19.426	355.00	19.500	393.650	3735.766
190	.000	19.500	.00	19.500	395.350	3735.840
191	1.700	19.426	5.00	19.500	397.050	3735.766
192	3.386	19.204	10.00	19.500	398.736	3735.544
193	5.047	18.836	15.00	19.500	400.397	3735.176
194	6.669	18.324	20.00	19.500	402.019	3734.664
195	8.241	17.673	25.00	19.500	403.591	3734.013
196	9.750	16.887	30.00	19.500	405.100	3733.227
197	11.185	15.973	35.00	19.500	406.535	3732.313
198	12.534	14.938	40.00	19.500	407.884	3731.278
199	13.789	13.789	45.00	19.500	409.139	3730.129
200	14.938	12.534	50.00	19.500	410.288	3728.874
201	15.973	11.185	55.00	19.500	411.323	3727.525
202	16.887	9.750	60.00	19.500	412.237	3726.090
203	17.673	8.241	65.00	19.500	413.023	3724.581
204	18.324	6.669	70.00	19.500	413.674	3723.009
205	18.836	5.047	75.00	19.500	414.186	3721.387
206	19.204	3.386	80.00	19.500	414.554	3719.726
207	19.426	1.700	85.00	19.500	414.776	3718.040
208	19.500	.000	90.00	19.500	414.850	3716.340
209	19.426	-1.700	95.00	19.500	414.776	3714.640
210	19.204	-3.386	100.00	19.500	414.554	3712.954
211	18.836	-5.047	105.00	19.500	414.186	3711.293
212	18.324	-6.669	110.00	19.500	413.674	3709.671
213	17.673	-8.241	115.00	19.500	413.023	3708.099
214	16.887	-9.750	120.00	19.500	412.237	3706.590
215	15.973	-11.185	125.00	19.500	411.323	3705.155
216	14.938	-12.534	130.00	19.500	410.288	3703.806
217	-14.142	14.142	315.00	20.000	381.208	3730.482
218	-12.856	15.321	320.00	20.000	382.494	3731.661
219	-11.472	16.383	325.00	20.000	383.878	3732.723

220	-10.000	17.321	330.00	20.000	385.350	3733.660
221	-8.452	18.126	335.00	20.000	386.898	3734.466
222	-6.840	18.794	340.00	20.000	388.510	3735.134
223	-5.176	19.319	345.00	20.000	390.174	3735.659
224	-3.473	19.696	350.00	20.000	391.877	3736.036
225	-1.743	19.924	355.00	20.000	393.607	3736.264
226	.000	20.000	.00	20.000	395.350	3736.340
227	1.743	19.924	5.00	20.000	397.093	3736.264
228	3.473	19.696	10.00	20.000	398.823	3736.036
229	5.176	19.319	15.00	20.000	400.526	3735.659
230	6.840	18.794	20.00	20.000	402.190	3735.134
231	8.452	18.126	25.00	20.000	403.802	3734.466
232	10.000	17.321	30.00	20.000	405.350	3733.660
233	11.472	16.383	35.00	20.000	406.822	3732.723
234	12.856	15.321	40.00	20.000	408.206	3731.661
235	14.142	14.142	45.00	20.000	409.492	3730.482
236	15.321	12.856	50.00	20.000	410.671	3729.196
237	16.383	11.472	55.00	20.000	411.733	3727.812
238	17.321	10.000	60.00	20.000	412.671	3726.340
239	18.126	8.452	65.00	20.000	413.476	3724.792
240	18.794	6.840	70.00	20.000	414.144	3723.180
241	19.319	5.176	75.00	20.000	414.669	3721.516
242	19.696	3.473	80.00	20.000	415.046	3719.813
243	19.924	1.743	85.00	20.000	415.274	3718.083
244	20.000	.000	90.00	20.000	415.350	3716.340
245	19.924	-1.743	95.00	20.000	415.274	3714.597
246	19.696	-3.473	100.00	20.000	415.046	3712.867
247	19.319	-5.176	105.00	20.000	414.669	3711.164
248	18.794	-6.840	110.00	20.000	414.144	3709.500
249	18.126	-8.452	115.00	20.000	413.476	3707.888
250	17.321	-10.000	120.00	20.000	412.671	3706.340
251	16.383	-11.472	125.00	20.000	411.733	3704.868
252	15.321	-12.856	130.00	20.000	410.671	3703.484

RADIAN
CORPORATION

243-007-04-01

COST ESTIMATES FOR ADDING WATER INJECTION TO TWO SOLAR MARS GAS TURBINES PREPARED PURSUANT TO SCAQMD BACT REQUIREMENTS

Presented to:

Mr. Darryl Gunderson
Shell California Production, Inc.
West Coast Production Division
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August 1, 1983

3401 LaGrande Blvd./Sacramento, California 95823/(916)421-8700

RADIAN
CORPORATION

August 1, 1983

243-007-04

Mr. Fred E. Lettice III
Supervising Air Quality Engineer
South Coast AQMD
Engineering Division
9150 Flair Drive
El Monte, CA 91731

Dear Fred:

Consistent with our telephone conversation of last week, enclosed is the cost-effectiveness analysis of water injection on the offshore gas turbine/generators proposed by Shell California Production Inc. (SCPI). We performed the cost-effectiveness analysis under contract with SCPI utilizing the methodology and interest rates recently used by the District in determining the cost-effectiveness of refinery oil heater NO_x controls.

In order to make our meeting, tentatively scheduled for 10 a.m. on Friday August 5, 1983, as productive as possible we are sending you the report in anticipation that you will be able to review it prior to the Friday meeting. We propose to provide a brief overview of the analysis and to respond to any initial questions you might have. We realize that you will most likely want to also have appropriate District staff review the methodology and results following our meeting. The main purpose of this first meeting is to set the various review processes into motion.

Should you have any questions or comments prior to our meeting, please do not hesitate to contact me at your convenience.

Sincerely,

James D. Rouge
Program Manager
Air Quality and
Enbineering Services

JDR/pp
Enclosure

cc/Darryl Gunderson, SCPI

3401 LaGrande Blvd./Sacramento, California 95823/(916)421-8700

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1.0 INTRODUCTION AND SUMMARY

Shell California Production, Inc. (SCPI) plans to install two Solar Mars turbines on their offshore platform Elly. In order to obtain project approval from the SCAQMD, SCPI must apply best available control technology (BACT) for NO_x emissions. Traditionally, BACT for gas turbines that are operated onshore has been water injection. However, the SCAQMD regulations require each case of BACT to be determined individually considering site specific factors that may affect the cost and, accordingly, the cost effectiveness. This report presents the results of a cost benefit analysis of the application of water injection to the planned offshore turbine installation.

Because of several factors, the cost to water inject SCPI's offshore turbines will be considerably greater than most onshore installations. Offshore construction and installation costs are much greater than onshore costs. In addition, components are needed offshore in order to implement water injection that may not be needed onshore. For example, onshore facilities do not need a desalination plant to remove salt from sea water. However, an offshore installation will require a desalination facility, in addition to a demineralization facility. Another key factor when evaluating the costs for water injecting SCPI's turbines is the loss of available heat in the exhaust. Currently, SCPI plans to utilize all of the available heat in the oil water separation process, and consequently the loss of heat from water injection must be made up. These and other factors make the application of water injection much less cost effective on an offshore platform such as Elly than on an onshore installation, especially a facility without cogeneration.

Another key factor to consider when evaluating water injection as BACT is the limited number of installations. The application of water injection to SCPI's turbines would be the first commercial application of this control technology to a Mars model. Currently only two Solar turbines, both Centaurs, have been operating with water injection. These two turbines have not encountered significant operating problems, but they have only been operating for approximately 8000 to 9000 hours and they have not been operating on an offshore facility. The Mars turbines operate at considerably higher temperatures and may not behave like the Centaurs. The only application of water injection to date to an offshore turbine (a GE model) was performed by Exxon and the resultant increase in operating and maintenance costs ultimately resulted in the shutdown of the water injection system. Exxon states that they will resume water injection when they are assured that adequate changes have been made in the turbine design.

1.1 Summary of Cost for Water Injection

The cost effectiveness of water injection was determined by dividing the total annual costs by the expected annual emission reductions. Annual costs are largely for increased energy consumption, increased maintenance, lost deck space, and annualized capital charges. Capital costs include the following:

- turbine modifications,
- water purification system,
- water heater (to make up for lost heat in the exhaust),
- piping and instrumentation, and
- indirect costs (engineering, field construction expense, contractor expense)

Table 1-1 summarizes the cost for two scenarios: a 1:1 water to fuel ratio, and a 0.6:1 water to fuel ratio. According to Solar, injecting water at these ratios will reduce NO_x emissions from the Mars turbines by 62% and 54%, respectively. Depending on the water injection rate, the costs vary from $4.85 to $5.73 per pound of NO_x removed. These estimates do not include costs for unscheduled engine shutdowns which would be significant.

TABLE 1-1. SUMMARY OF COSTS FOR WATER INJECTION

	Scenario (Water to Fuel Ratio)	
	1:1	0.6:1
Annual Costs (including capital charges)	$1,663,000	$1,233,000
NO_x Emission Reductions	145 tons/year	127 tons/year
Cost per pound of NO_x removed	$5.73/lb	$4.85/lb

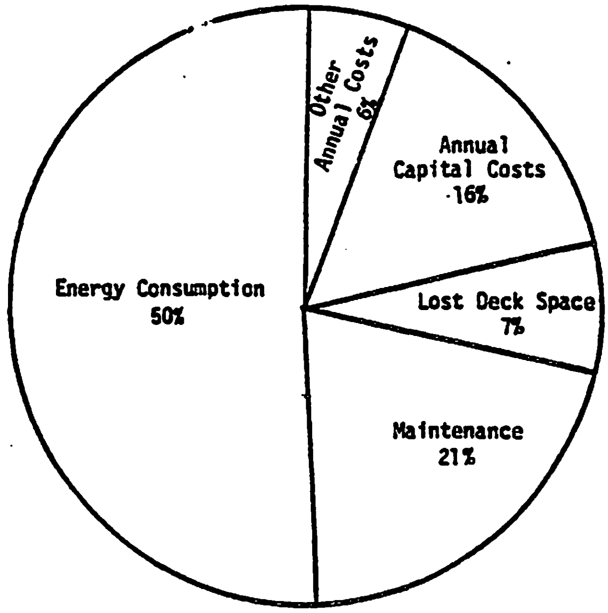
Figure 1-1 shows a breakdown of the costs for the two scenarios. As shown the major cost is for increased energy consumption. Increased energy consumption is the result of three major factors: reduced engine efficiency due to water injection, loss of exhaust heat, and energy required for the water purification system. The energy costs are based upon actual performance data provided by Solar and manufacturers of water purification systems and are more accurately estimated than other less significant cost components.

The cost benefit ratio that was previously calculated is based upon the amount of NO_x emissions that are reduced offshore. However, it is widely accepted that all offshore emissions do not impact onshore areas. In fact, the South Coast Air Quality Management District has published offset multipliers to estimate onshore emissions from offshore projects. These same multipliers could be applied to the cost effectiveness figures to determine the cost per pound of NO_x removed that impacts onshore areas. When the appropriate multiplier (1.25) is applied to the cost effectiveness figures shown on Table 1-1 above, the resultant costs are as follows.

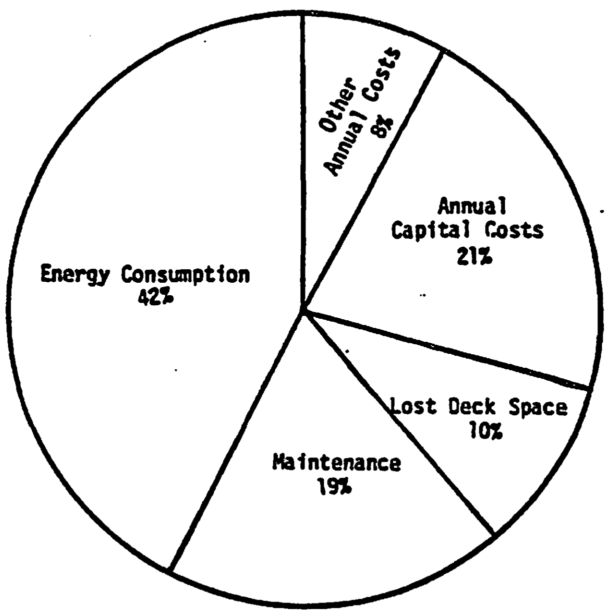
- 1:1 water to fuel ratio--$7.16 per pound of NO_x removed
- 0.6:1 water to fuel ratio--$6.06 per pound of NO_x removed

1.2 Organization of Report

The following section presents a brief description of the proposed turbine installation and the requirements for water injection. The cost estimates are presented in Section 3 and cost effectiveness calculations are shown in Section 4. Section 4 also contains a sensitivity analysis of the cost effectiveness calculations. Attachments are provided giving additional details on the source of the cost estimates.



1:1 Water to Fuel Ratio ($5.73 lb NO_x)



0.6:1 Water to Fuel Ratio ($4.85/lb NO_x)

Figure 1-1. Breakdown of Components of the Cost Benefit Analysis

2.0 DESCRIPTION OF THE PROJECT

Shell California Production, Inc. (SCPI) plans to install two Solar Mars gas turbines on their offshore platform Elly to provide an estimated 10 MW of electrical energy and approximately 50 MMBtu/hr of process heat. Currently, the platform is powered by three Solar Centaur turbines providing approximately 6 MW of electrical energy. These turbines are to remain for standby power. The new turbines are to be installed on a wing-deck that is to be added to the northeast side of the upper deck of the platform. The upper deck is approximately 70 feet above sea level. The installation of the two turbines will raise the weight of the platform to a value very close to the maximum design limit.

Two Mars turbines operating at 5 MW load each are estimated to emit approximately 252 tons per year of NO_x when burning natural gas. The existing Centaurs are not expected to emit significant quantities of NO_x once the Mars turbines have been installed. Currently, the emissions from the Centaurs are estimated to be 162 tons per year of NO_x. Consequently, the addition of the Mars turbines will increase NO_x emissions by approximately 90 tons per year. SCPI has adequate "banked emissions" to offset this increase. The SCAQMD still requires that water injection be installed on gas turbine engines to reduce NO_x, provided the cost does not exceed a reasonable limit.

The installation of water injection on the Mars turbines will require the addition of a water purification plant. This plant would be composed of two major components: 1) a desalination facility to remove salt from water, 2) a demineralization facility to remove other dissolved solids. In addition to the water purification system, electric heaters will be needed to make up for the heat lost in the turbine exhaust due to the water injection. Although the actual location of the water purification system and the electric immersion heaters has not been finalized, SCPI expets that they would be located on the southeast corner of the upper deck. The operating weight of the water purification plant and electric heaters is estimated to exceed 20 tons. SCPI is concerned that the installation of the above equipment will cause the platform to exceed the maximum design weight of the platform. The costs shown in this report do not include costs for structural modifications which would be significant.

The estimates do include special requirements for an offshore platform. Because of the possibility of explosive gases on the platform, all of the installations must be designed per Class I, Division I (i.e., explosion proof) specifications. Stainless steel piping will be needed to run salt water to the water treatment facility and to run deionized water to the turbine. Accordingly, other pipe components will need to be stainless steel or equivalent. In addition, all components must comply with SCPI's offshore specifications which include requirements of seal welding, x-rays, seismic design, hydrotest along with an increased safety factor on lifting. This latter requirement is to prevent accidents during the offloading of equipment onto the platform.

3.0 COST ESTIMATES

This section presents descriptions of the cost estimates for water injecting SCPI's turbines. Table 3-1 outlines the sources of the cost estimates and assesses their relative accuracy. All costs are referenced by the reference number shown on this table. The highest accuracy rating is given to estimates based upon manufacturer's performance data and vendor quotations. A lower accuracy rating was given to estimates that were based upon standard operational factors, standard estimating procedures (i.e., Richardson's rapid cost estimating guide), and past experience of SCPI. Fortunately, cost estimates for the most significant component of the cost benefit analysis (i.e., increased energy consumption) are based upon sources of the highest accuracy.

3.1 Capital Cost Calculations

Capital costs are broken down into: 1) direct costs which include purchased equipment and materials and installation costs and 2) indirect costs which include engineering, field construction expense, and contractor's expense. The total capital cost is increased by a contingency factor to allow for unforeseen circumstances during the purchase and/or installation of the materials.

3.1.1 Direct Costs

Table 3-2 shows a breakdown of the direct costs estimated for water injection and the source of these costs. All costs have been rounded to three significant figures. Direct costs consist of the following components:

- turbine modifications,
- water purification system,
- electric heaters and related piping, and
- installation of the above

TABLE 3-1. SOURCE OF COST ESTIMATES

Source	Reference Number	Items	Rating
Solar (1)	1	Energy costs, emission reductions, turbine modifications	A
Solar (1)	1	Emission testing cost	C
Mechanical Equipment Co. (2)	2	Water purification plant--equipment costs	A
Richardson's Cost Estimating Guide (3)	3	Piping and instrumentation materials cost	B
SCPI (4)	4	Maintenance cost factor, labor for installations	C
Radian--Aminoil Estimate (5)	5	Cost escalation factors	B
American Hydrotherm Corporation (6)	6	Electric immersion heaters	C
SCAQMD (7)	7	Capital recovery factors	B

Key to Ratings:

A--Excellent accuracy--estimate based upon actual test or budgetary cost quotation

B--Above average accuracy--estimate based upon standard accepted cost estimating factors

C--Average accuracy--estimate based upon a hypothetical design and installation scenario or a non-budgetary cost quotation.

TABLE 3-2. DIRECT CAPITAL COSTS

DIRECT CAPITAL COSTS	
1. Turbine Modifications $40,000 per turbine (assumes retrofit)	
• equipment ($40,000 per turbine--retrofit)	$80,000[1]
• field emission testing	$35,000[1]
2. Water Purification System and Related Piping	
A. Demineralization system, cost includes:	$150,000[2]
• twin resin beds	
• 300 gallon buffer tank	
• booster pump and motor	
• high pressure turbine injection pump and motor	
• Class 1, Division I (explosion proof) electrics	
• mounting on skid	
• conductivity monitor	
Plus 20% to comply with SCPI offshore specifications*	$30,000
B. Vapor compression desalination system, cost includes:	$250,000[2]
• mounting on 2 skids	
• Class 1, Division I electrics	
Plus 20% to comply with SCPI to offshore service specifications*	$50,000
C. Pressure indicating controller	$2,500[3]
D. Water meter	$2,000[3]
E. Alarms and panel	$5,000[3,4]

(continued)

*seal welding, x-ray, seismic design, hydrotest, increased safety factor for lifting

See Table 3-1 for footnote reference.

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TABLE 3-2 continued

F. Piping materials (see Attachment A)	$33,000[3]
• 400 feet 2" 316 SS pipe	
• 25 elbows 2" 316 SS	
• 5 gate valves 2" 316 SS	
• 5 tees 2" 316 SS	
• 6 flanges 2" 316 SS	
• electrical conduit and supplies	
G. Installation of above (see Attachment A); costs assume minimal site preparation	205,000[4]
3. Structural Modifications Structural modification costs were not estimated but are expected to be significant.	
4. Electric Heaters to make up for heat loss in the exhaust (see Section 2).	
• heaters	$50,000[6]
• piping and electrical supplies (see Attachment B)	$20,000[3,4]
• installation (see Attachment B); costs assume minimal site preparation	$175,000[4]
5. Total Direct Costs	$1,090,000

See Table 3-1 for footnote reference.

3.1.1.1 Turbine Modifications

The cost to modify the Solar Mars turbines for the addition of water injection ($40,000) were provided by Solar and assumed that water injection will be retrofitted in the field. The cost would be approximately $10,000 less per turbine (i.e., $30,000) if the equipment to add water injection was installed at the factory. In addition to the cost to install the water injection equipment on the turbine, an additional cost of $35,000 was added for field emission testing to verify the effect of water injection engine performance and NO_x emissions.

3.1.1.2 Water Purification System

The water purification system consists of a demineralizing system, a vapor compression desalination system, and related piping and instrumentation. The cost for the demineralizing system and the vapor compression desalination system ($400,000) were provided by the Mechanical Equipment Company (MECO). MECO has provided similar systems to Exxon for their water injection system. Radian obtained quotations for other systems that used reverse osmosis (RO) instead of vapor compression, and these quotations were similar in total price to the MECO bid ($350,000). It was decided to use the MECO bid since a vapor compression system appears to be more desirable from a water quality standpoint. Attachment C contains the MECO bid. MECO's estimate was increased by 20% to account for complying with SCPI's offshore specifications.

The piping material costs were estimated assuming 400 feet of 2" 317 LM stainless steel pipe. Stainless steel pipe is needed to handle salt water and deionized water. The 400 feet figure was based upon the preliminary plot plan which indicates that approximately 200 feet of piping would be needed to connect the system to the main salt water system and another 200 feet of piping would be needed to connect the water plant to the turbine.

The installation cost for the water purification system and the related piping was based upon a hypothetical installation procedure that was outlined by SCPI. The installation costs were reviewed by Radian personnel with offshore experience and appeared to be reasonable, if not conservative, considering the offshore environment and the delays that it may cause. The cost assumed no site preparation, i.e. no structures will need to be relocated or removed to provide the space for the water treatment facility. A detailed breakdown of the costs to install the water purification system facility is provided in Attachment A.

3.1.1.3 Electric Immersion Heaters

The cost for electric immersion heaters ($50,000) was provided by American Hydrotherm Corporation and was based upon a custom-designed unit. The installation cost assumed the heater would be installed concurrently with the water treatment facility and there would be minimal duplication of the work effort. A detailed breakdown of the cost to install the water heater is provided in Attachment B.

3.1.2 Indirect Costs

Indirect costs are shown on Table 3-3. These costs are for engineering (to develop detailed specifications and drawings for the water purification system and the water heaters), field construction expense and contractor expense.

3.1.3 Contingency

A contingency factor of 20% was applied to the total direct and indirect costs. This factor is higher than the 10% factor normally used for onshore facilities; however, considering the offshore environment, a 20% contingency factor is still considered to be conservative.

TABLE 3-3. INDIRECT CAPITAL COSTS

Direct Capital Costs		$1,090,000
Engineering (10% of total direct cost)	$109,000[5]	6
Field Construction Expense (5% of total direct cost)	54,000[5]	30
Contractor Expense (10% of total direct and other indirect costs--10% x 1,230,000)	125,000[5]	
Subtotal: Indirect Costs	$288,000	#161,000

See Table 3-1 for footnote reference.

3.1.4 Total Capital Costs

The total capital costs estimated for the installation of water injection on the two Solar Mars turbines was estimated to be $1,650,000. Table 3-4 summarizes the components of the total capital costs.

3.2 Annual Costs

The annual costs for water injection are composed of the following components:

- increased energy consumption,
- chemicals required to operate the water treatment plant,
- increased maintenance cost,
- cost of lost space,
- annual emission testing, and
- annual capital charges.

This section presents details of the method used to estimate annual costs of two water injection scenarios:

- 1:1 water to fuel ratio (62% NO_x reduction)
- 0.6:1 water to fuel ratio (54% NO_x reduction)

TABLE 3-4. SUMMARY OF CAPITAL COSTS

Direct Costs		$1,090,000
• water purification system	($728,000)	
• electric immersion heaters	($245,000)	
• turbine modifications	($115,000)	
Indirect Costs		288,000
Contingency (20% of Direct and Indirect Costs)		275,000
Total Capital Costs		$1,650,000

3.2.1 Energy and Chemical Consumption

The addition of water injection increases energy and chemical consumption. Energy is required to:

- make up for lower engine efficiency,
- make up for loss of available exhaust heat, and
- operate the water purification system

Chemical consumption increases because chemicals are needed to operate the demineralizer.

3.2.1.1 Cost for Lower Engine Efficiency

The energy penalty for lower engine efficiency was based upon Mars performance data for an engine running on gas fuel. The cost to provide the additional energy was calculated assuming that diesel fuel is burned. This assumption was made because there is a finite amount of natural gas produced and available at the site for consumption by the turbine and after the gas is consumed, energy must be provided by diesel fuel. Therefore, an increase in natural gas consumption will ultimately lead to an equivalent increase in diesel fuel consumption. The estimates assumed that diesel fuel cost will increase with inflation.

According to Solar, water injection will increase fuel consumption by the following percentages:

- 1:1 water to fuel ratio--2.8% increase in fuel consumption
- 0.6:1 water to fuel ratio--1.7% increase in fuel consumption

Table 3-5 shows the calculation of the increase in diesel fuel consumption from lower engine efficiency.

TABLE 3-5. CALCULATION OF THE ENERGY PENALTY FROM LOWER ENGINE EFFICIENCY

Baseline Fuel Consumption = 65.7 MMBtu/hr[1]

	Water to Fuel Ratio	
	1:1	0.6:1
Increased energy consumption	1.83 MMBtu/hr[1] (2.8% increase)	1.11 MMBtu/hr[1] (1.7% increase)
Diesel fuel equivalent (18,500 Btu/lb, 7.09 lb/gal)	122,000 gal/yr	74,000 gal/yr
x 2 (2 turbines)	244,000 gal/yr	148,000 gal/yr
x $1.20/gal	$293,000/yr	$178,000/hr

See Table 3-1 for footnote reference.

3.2.1.2 Loss of Available Exhaust Heat

Solar performance data indicate that injecting water at a 1:1 ratio reduces available exhaust heat by 1.98 MMBtu's/hr. Data were not available on the decrease for a 0.6:1 water to fuel ratio but it should be proportionately smaller, i.e. 0.6 x 1.98 or 1.19 MMBtu's/hr.

The loss of available exhaust heat must be made up by running the generator set at greater loads. This will provide additional heat in two ways:

- Greater generator output to run electric immersion heaters
- Greater exhaust heat from increased exhaust temperature and exhaust mass flow

An iterative approach using Mars performance curves was used to determine the increase in engine load that will provide the additional heat. For the 1:1 case the increase was calculated to be 450 kilowatts.

Increased exhaust heat (assuming 380°F stack temperature)	= 0.68 MMBtu/hr.
450 KW of electrical energy (assuming resistance heaters)	= 1.30 MMBtu/hr.
Total	1.98 MMBtu/hr.

It is assumed that the 0.6:1 case would require a 270 kilowatt (450 x 0.6) increase in engine load.

From Mars performance curves energy consumption will increase by 2.9 MMBtu's/hr. when engine load is increased by 450 kilowatts. For the 0.6:1 case this translates to a 1.74 MMBtu/hr. increase. These figures should be increased by 2.8% and 1.7% respectively to account for the lower engine efficiency in generating the electrical energy. Table 3-6 summarizes

TABLE 3-6. CALCULATION OF INCREASED ENERGY CONSUMPTION FROM LOSS OF AVAILABLE EXHAUST HEAT

	Water to Fuel Ratio	
	1:1	0.6:1
Increased Turbine Load	450 KW[1]	270 KW[1]
Increased Energy Consumption	2.98 MMBtu/hr	1.77 MMBtu/hr
Diesel Equivalent	199,000 gal/yr	118,000 gal/yr
x 2 (2 turbines)	398,000 gal/yr	236,000 gal/yr
x $1.20/gal	$478,000/yr	$283,000/yr

See Table 3-1 for footnote reference.

the increased energy consumption to make up for heat loss in the exhaust from water injection. Note that there is a greater energy penalty associated with the loss of available exhaust heat then associated with the reduced engine efficiency (see Table 3-5). This makes the costs for water injecting a cogeneration facility, such as the turbines to be installed by SCPI, much greater than the costs for electrical generators that do not recover heat from the exhaust.

3.2.1.3 Energy and Chemicals to Operate the Water Purification System

The quotation provided by the Mechanical Equipment Company (MECO) estimated the cost for chemicals to be approximately $2,500 per month. The annual cost for chemicals were calculated by doubling the monthly cost to account for offshore delivery of the chemicals. This is conservative considering the manpower and equipment required to deliver and offload these chemicals. MECO also estimated that it would require approximately 116 kilowatts to operate the demineralizing system and the vapor compression desalination system. A 116 kilowatt increase in engine load will increase diesel fuel consumption by approximately 50,000 gallons per year based upon Solar Mars performance curves. Assuming $1.20 per gallon the annual energy cost would be $60,000 per year. The water purification system is a minimum size and as a result the same equipment would be used for both water to fuel ratios. The system is designed to operate at a fixed rate and water is recycled if it is not consumed. As a result, energy costs to operate the system should be approximately the same for both water to fuel ratios.

3.2.2 Maintenance Cost

Increased maintenance costs are expected to result from operating the turbines at greater engine load. According to Sawyer's Turbo-Machinery Maintenance Handbook, maintenance costs are highly sensitive to load, increasing exponentially as load increases. Consequently, it is reasonable to expect a significant increase in maintenance cost as turbine load increases.

Maintenance costs were based upon historical data provided by SCPI. Historically, maintenance costs on SCPI's offshore platforms are equivalent to approximately 40% of the operating cost, i.e. cost for fuel and chemicals. Forty percent of the operating cost calculated above would be equal to the following:

- 1:1 water to fuel ratio--$356,000 per year
- 0.6:1 water to fuel ratio--$232,000 per year

The above estimates are very conservative and do not include significant costs for repairs and lost production resulting from turbine shutdowns. Because Mars turbines have not been operating with water injection it is difficult to project the rate of occurance of unscheduled maintenance. Generally, however, prototype installations of most complicated emission control systems have incurred significant costs above normal maintenance costs. Discussions with Solar indicate that unscheduled maintenance would occur as a result of plugging of the water injection nozzles. The plugging of the water injection nozzles would cause a non-uniform distribution of the water creating cold and hot spots. The hot spots would lead to a more rapid deterioration of the engine and an earlier shutdown. Although the water treatment facility is designed to remove harmful contaminants that may cause plugging, there is still the possibility that some contaminants may pass through and plug the nozzle. In addition, as noted in Sawyer's Turbo-Machinery Maintenance Handbook, corrosion of the turbine buckets and nozzles is stimulated by the presence of alkaly metals, like sodium or potassium, vanadium, and lead in the combustion products entering the turbine section. These contaminants can enter the turbine via the air, fuel, or steam/water injected into the burners for a NO_x emission control. The South Coast Air Quality Management District is aware that Exxon incurred maintenance costs considerably greater than the above costs when they water injected a GE LM 2500 turbine. It should be noted that EPA's proposed NSPS for gas turbines will not require water injection for turbines less than 100 MMBtu/hr. heat input (i.e., the proposed Mars gas turbines).

3.2.3 Cost of Lost Space

Based upon the quotation provided by MECO, the water treatment facility is estimated to occupy approximately 600 square feet of space. In addition, the water heater is estimated to occupy another 100 square feet of space. It is assumed that adequate space exists in the control room for the motor starters and instrumentation required to operate these facilities. If the control room needs to be expanded, additional space would be required.

SCPI routinely leases deck space to other companies. Recently, for example, Chevron leased deck space on platform Elly from SCPI to gather meteorological data. SCPI's charge for this deck space was $167 per year per square foot. This charge was based upon the total platform cost times an appropriate amortization factor, divided by total deck space. Assuming a charge of $167 per year per square foot, the annual cost for the lost space from the water treatment facility is estimated to be:

700 sq. ft. x $167/sq. ft.-yr. = $117,000/yr.

3.2.4 Annual Emission Testing

In order to prove that the water injection system is continuing to reduce NO_x without severely impairing engine performance, it will be necessary to perform annual emission testing. The cost for these tests are estimated to be $35,000 per year for both engines. These costs are lower than the cost for continuous emission monitoring if continous emission monitoring was required.

3.2.5 Annual Capital Charges

The annual capital charges are equal to the total capital cost times a capital recovery factor (CRF). The capital recovery factor was the factor developed by the South Coast Air Quality Management District and assumes 13-year life, 15% interest rate, no salvage value and 10% investment tax credit. The CRF calculated by the SCAQMD was 0.16. Multiplying 0.16 times the total cost of $1,650,000 yields an annual capital charges of $264,000.

3.2.6 Total Annual Costs

Table 3-7 presents a summary of the individual cost components and the total annual cost for the two water injection scenarios, i.e. 1:1 water to fuel rate and 0.6:1 water to fuel rate. As shown the annual cost varies between $1,233,000 and $1,663,000.

TABLE 3-7. SUMMARY OF ANNUAL COSTS

	Water to Fuel Ratio	
	1:1	0.6:1
Increased Energy Consumption		
• From lower engine efficiency	$ 293,000[1]	$ 178,000[1]
• From loss of exhaust heat	478,000[1]	283,000[1]
Chemicals and Energy for Water Plant	120,000[2]	120,000[2]
Increased Maintenance	356,000[4]	232,000[4]
Cost for Lost Space	117,000[4]	117,000[4]
Annual Emission Testing	35,000[1]	35,000[1]
Annual Capital Charges	264,000	264,000
Total Annual Costs	$1,663,000	$1,233,000

See Table 3-1 for footnote reference.

4.0 COST EFFECTIVENESS

The cost effectiveness of pollution control systems is commonly expressed in terms of dollar per pound of pollutant removed. The annual cost for water injecting SCPI's turbines were determined in Section 3. The quantities of NO_x removed for the two water to fuel ratios (1:1, 0.6:1) are determined below. Cost benefit calculations follow.

4.1 Emission Reductions

Baseline emissions and emissions with water injection were determined in laboratory tests conducted by Solar. In these tests, the turbines were operated on San Diego natural gas. For a 5073 kilowatt load, NO_x emissions were estimated to be 128 tons per year (tpy) for the "dry" or no-water injection case. SCPI expects to operate their turbines at 5,000 kilowatts in which case NO_x emissions are estimated to be 126 tpy. Therefore, the total baseline emissions assuming natural gas fuel are estimated to be 126 tpy of NO_x x 2 engines or 252 tpy of NO_x.

In order to calculate the emissions with water injection, it is necessary to consider the increased emissions from greater engine load along with the control efficiencies for the two water injection rates. As mentioned in Section 3.2, engine load increases because of the additional energy required to operate electric immersion heaters and to operate the water purification system. The increase in load is as follows:

- 1:1 water to fuel ratio--450 KW plus 116 KW = 566 KW
- 0.6:1 water to fuel ratio--270 KW plus 116 KW = 386 KW

Assuming that NO_x emissions increase proportionately with load (a conservative assumption for gas turbines), the resultant dry emission rates are as follows:

- 1:1 water to fuel ratio = ~~281~~ 301 tpy NO_x
- 0.6:1 water to fuel ratio = ~~271~~ 291 tpy NO_x

Solar states that injecting water at a 1:1 and a 0.6:1 rate reduces NO_x emission by 62% and 54% respectively, when the engine is operating at 5073 KW load. Applying the appropriate percent reduction to the dry emission rates yields the following estimate of emission rates with water injection.

120 @ 60% reduct

- 1:1 water to fuel ratio = ~~107~~ 114 @ 62% red tpy NO_x
- 0.6:1 water to fuel ratio = ~~125~~ 134 @ 54% tpy NO_x

Comparing these with the baseline emissions (~~252~~ 270 tpy) yields the following estimates of the NO_x emission reductions.

- 1:1 water to fuel ratio = ~~145~~ 150 tpy NO_x
- 0.6:1 water to fuel ratio = 127 tpy NO_x

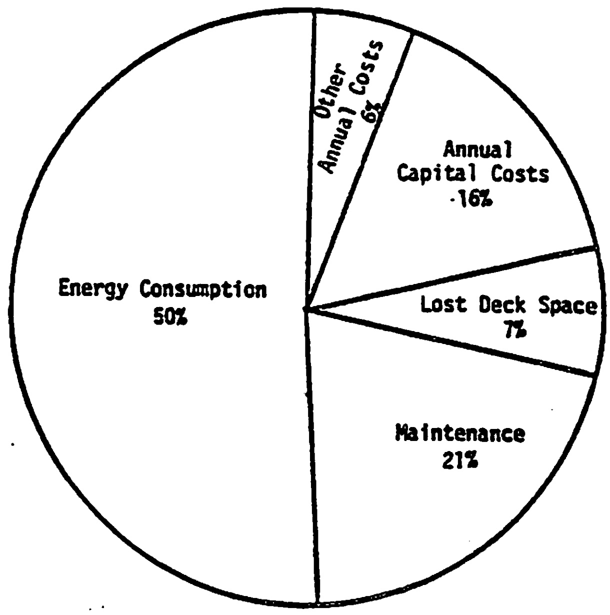
4.2 Cost Benefit

The cost benefit was calculated by dividing the annual cost by the annual emission reductions. Cost benefit calculations are shown on Table 4-1. As shown the cost varies from $4.85 per pound for the 0.6:1 case to $5.73 per pound for the 1:1 case.

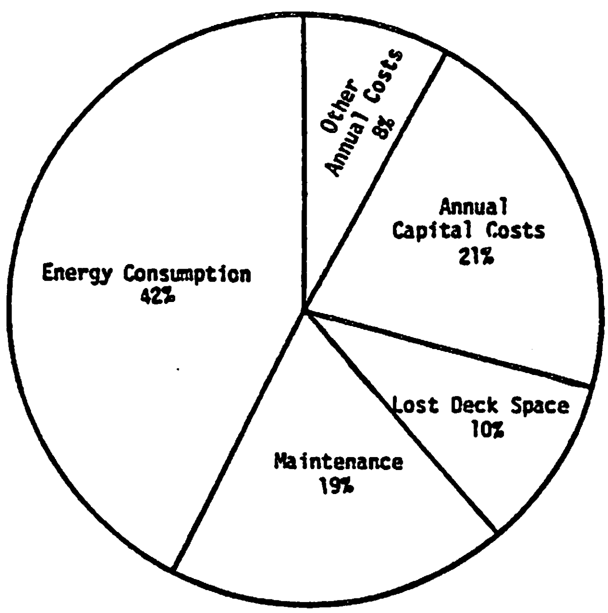
Figure 4-1 shows a breakdown of the different elements of the cost per unit of NO_x removed. As shown, in both cases energy is approximately half of the overall cost. The other major contributors are maintenance cost, annual capital charges, and the cost for lost space, in decreasing order of magnitude.

TABLE 4-1. COST BENEFIT CALCULATIONS

	Water to Fuel Ratio	
	1:1	0.6:1
Cost per ton of NO_x removed	$\frac{\$1,663,000}{145\ \text{tons}}$ = \$11,500/ton	$\frac{\$1,233,000}{127\ \text{tons}}$ = \$9,710/ton
Cost per pound of NO_x removed	\$5.73/lb	\$4.85/lb



1:1 Water to Fuel Ratio ($5.73 lb NO_x)



0.6:1 Water to Fuel Ratio ($4.85/lb NO_x)

Figure 4-1. Breakdown of Components of the Cost Benefit Analysis

4.3 Uncertainty/Sensitivity Analysis

As previously mentioned, the uncertainty in the cost estimate components varies from very low to moderately high. Fortunately, the uncertainty is least for the estimates of the energy penalty and emission reductions, since these estimates were based upon actual performance data. The uncertainty is also low for the cost of the equipment. However, the estimates for the installation costs and the maintenance costs have the greatest degree of uncertainty, since these were based upon hypothetical installation scenarios and traditional maintenance cost factors.

In order to investigate the sensitivity of the cost estimates, calculations were performed assuming increased and decreased cost for those elements having the greatest uncertainty, i.e. installation cost and maintenance cost. The cost per ton of NO_x removed was calculated for the following scenarios.

- Scenario A--25% lower installation cost, 25% lower maintenance cost
- Scenario B--25% lower maintenance cost only
- Scenario C--25% lower installation cost only
- Scenario D--25% higher maintenance cost and 25% higher installation cost

As shown in Table 4-2 the cost for the 1:1 case varies from $5.34 per ton of NO_x removed to $6.11 depending on the scenario. For the 0.6:1 case the cost varies from $4.52 to $5.16. In both cases the spread is approximately 13 percent. Consequently, it appears that although there is considerable uncertainty is relatively low. It should be noted that a $50,000 difference in capital costs translates to approximately a $0.015 difference in the cost per pound of NO_x removed (for a 1:1 water to fuel ratio).

TABLE 4-2. COST PER POUND NO_x REMOVED

	Cost per lb NO_x removed	
	Water to Fuel	
	1:1	0.6:1
Scenario A (25% lower maintenance and installation costs)	$5.34	$4.52
Scenario B (25% lower maintenance cost)	$5.42	$4.61
Scenario C (25% lower installation cost)	$5.64	$4.76
Scenario D (25% higher maintenance and installation costs)	$6.11	$5.16
No Adjustments	$5.73	$4.85

4.4 Cost Effectiveness Based Upon Projected Onshore Impact

The cost benefit ratio that was previously calculated is based upon the amount of NO_x emissions that are reduced offshore. However, it is widely accepted that all offshore emissions do not impact onshore areas. In fact, the South Coast Air Quality Management District has published offset multipliers to estimate onshore emissions offset for offshore projects. These same multipliers could be applied to the cost effectiveness figures to determine the cost per ton of NO_x removed that impacts onshore areas.

The offset multiplier published by SCAQMD equals 1.1 plus 0.01 times distance in kilometers. The multiplier for platform Elly should be 1.1 plus 0.15 or 1.25, assuming the shortest distance to the shoreline (15 kilometers). When this multiplier is applied to the cost effectiveness figures calculated above, the resultant costs are as follows.

- 1:1 water to fuel ratio--$7.15 per pound of NO_x removed
- 0.6:1 water to fuel ratio--$6.05 per pound of NO_x removed

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ATTACHMENT A

ESTIMATES FOR INSTALLATION OF THE
WATER TREATMENT FACILITY

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COSTS ESTIMATED FOR INSTALLATION OF THE WATER TREATMENT FACILITY

Steps Required

- Prepare deck
- Delivery of skids and other equipment, preparation for welding
- Install piping
- Install conduit, perform electrical hook-ups
- Paint
- Clean up
- Start up

A. DESCRIPTION OF CREWS

Piping (P)
- 6-man crew
- $50/hr
- 8 hrs regular time, 4 hrs overtime per day

Electricians (E)
- 3-man crew
- $60/hr
- 8 hrs regular time, 4 hrs overtime per day

Painters/Clean-Up Crew (PC)
- 4-man crew
- $40/hr
- 8 hrs regular time, 4 hrs overtime per day

B. SCHEDULE FOR INSTALLATION

DAY	PERSONNEL*	ACTIVITY	SPECIAL EQUIPMENT
1-2	P	Deliver equipment (welding machines, rigging equipment, etc.) Prepare deck, off load, set up equipment	Supply boat
3	P	Bring out packages--off load	Supply boat
4	P	Prepare area for welding, install spark arresting materials Set up gas detectors, weld skids down	Crew boat (1/2 time)
5	P	Haul out piping	Supply boat
6-15	P	Run pipe (assume field fit--no prespooling)	Crew boat (1/2 time)
16	P,E	Haul out conduit and other electrical supplies--Remove welding equipment	Supply boat
17-26	E	Install conduit, motor starters, relocate all controls from skid to control room	Crew boat (1/2 time)
27-30	PC	Paint all new installations	Crew boat (1/2 time)
31-32	PC	Clean up area	Crew boat (1/2 time)

C. OTHER COSTS

1. Supervisor--Full time--31 days--$50/hr--8 hrs + 4 hrs OT
2. Shell Inspector--1/2 time--15 days--$300/day + $28/day subsistence
3. Qualification of Welders--2 days @ $500/day
4. Engineer On Site--1/2 time--15 days--$350/day + $100/day per diem
5. Helicopter--$900/day--1st 4 weeks--2 days/week, last week--5 days

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*Crew

6. Start-Up--1 week debugging and training
   - 2 engineers @ $350/day + per diem
   - 1 vendor rep @ $400/day + per diem
   - 1 Solar rep @ $400/day + per diem
   - water analysis--$1,000
7. Materials
   - water treatment equipment--see vendor bid
   - conduit and electrical equipment--$5,000
   - piping

--400'2" 317 LM pipe	$14,000
--25 elbows	4,000
--5 tees	1,000
--3 valves	7,500
--6 flanges	1,200
Subtotal	$27,700

D. COST TOTALS

Labor (including per diem)	$167,500
Supply Boat--5 days @ $3,500/day	17,500
Crew Boat--27x1/2x$1,500/day	20,250
Subtotal	$205,000
Piping and Electrical Supplies	$33,000

RADIAN
CORPORATION

ATTACHMENT B

ESTIMATES FOR INSTALLATION OF
ELECTRIC IMMERSION HEATERS

RADIAN CORPORATION

COSTS ESTIMATED FOR
INSTALLATION OF THE PROCESS WATER HEATERS

Assume installation is performed concurrently with the installation of the water treatment facility.

A. USE SAME TYPES OF WORK CREWS, i.e.:
Piping (P) - 6-man crew
Electricians (E) - 3-man crew
Painters/Cleanup (PC) - 4-man crew
Plus Insulators (I)--4-man crew--$50/hour

B. LABOR ESTIMATED TO:

- Install heaters
- Install pipe hangers
- Run approximately 300 ft of 6" pipe
- Run conduit
- Insulate line

1. Piping crew--3 weeks--$4,200/day
2. Electricians--2 weeks--$2,500/day
3. Painters/Clean-Up--1 week--$2,200/day
4. Insulators--2 weeks--$2,800/day
5. 2 additional days of supply boat--$3,500/day
6. 3 additional weeks of crew boat--$1,500/day
7. 2 weeks inspector--$300/day + $28/day subsistence
8. 2 weeks engineer--$350/day + per diem
9. 3 weeks supervisor--$700/day

C. MATERIALS

• Heater--per vendor phone quote	$50,000
• Piping--40 pipe hangers	
--40 pipe hangers	1,000
--300 ft - 6" Schedule 40 pipe	4,000

--25 ells	$ 750
--4 tees	200
--2 reducing tees	550
--3 gate valves	5,000
• Conduit and Electrical Supplies	5,000
• Insulation Materials ($10/ft)	3,000
Subtotal	$ 70,000

D. COST TOTALS

Labor (including per diem)	$145,000
Crew Boat	22,500
Supply Boat	7,000
Subtotal	$175,000

Materials	
--Heater	$50,000
--Piping, Insulation and Electrical Supplies	$20,000

RADIAN
CORPORATION

ATTACHMENT C

VENDOR QUOTES AND SOLAR CORRESPONDENCE

MECO®
MECHANICAL EQUIPMENT COMPANY INC.
861 CARONDELET STREET • NEW ORLEANS, LOUISIANA 70130, U.S.A.
PHONE 504 / 523-7271 • TELEX: 58-377 and 460165 • CABLE: MECO

February 2, 1983

Shell California Production, Inc.
Post Office Box 4578
Houston, Texas 77210

Attention: Mr. W. T. Patton

Reference: INQUIRY NO. 02-8302-1

Dear Terry:

Thank you for your interest in MECO and our products. In accordance with your request, we are pleased to present the following information and budgetary pricing.

In order to meet the water purity criteria for the turbine feedwater, it is necessary to have a demineralization (or deionization) system following the primary desalination system. In this case, the desalination system would consist either of a double pass reverse osmosis (R.O.) system or a vapor compression (V.C.) distillation system.

MECO currently has a V.C. water maker, rated at 600 gallons per hour (Gph), on the Exxon vessel Santa Ynez operating near Santa Barbara, CA. The distillate produced from this system is used to feed turbines, but it is not known whether a demineralization system is also utilized. A typical product analysis of distillate produced by our V.C. water makers is enclosed. For your application, we recommended our Model PEE1250M3B rated at 1,250 Gph (30,000 Gpd). The enclosed bulletin 117D describes our vapor compression distillation equipment.

The R.O. system would consist of our Model MRO40000 seawater system followed by our MRO30B (30,000 Gpd) brackish water system. The MRO4000Q is basically our Model MRO30000 as described in enclosed bulletin 142, except that it would have eight (8) permeators instead of six (6). The MRO30B is described in the enclosed blue specification sheet. The reverse osmosis product water would contain 20-50 ppm of total dissolved solids.

The demineralization skid would consist of the demineralization tank with a mixed bed resin and provisions for regeneration with acid and basic solutions and a quintuplex type high pressure plunger pump for 1,000 psig feed into the turbine intake.

Weights and Dimensions

Model	Dry Weight	Operating Weight	Length x Width x Height
Demineralizer Skid	3,290 Lbs.	5,590 Lbs.	7 Ft. x 6 Ft. x 7 Ft.

Weights and Dimensions (Continued)

Model	Dry Weight	Operating Weight	Length x Width x Height
MRO40000	6,700 Lbs.	9,700 Lbs.	14 Ft. x 9 Ft. x 9 Ft.
MRO30B	3,000 Lbs.	4,000 Lbs.	9 Ft. x 5 Ft. x 6½ Ft.
*PEE1250M3B	16,000 Lbs.	16,000 Lbs.	13 Ft. x 8½ Ft. x 8 Ft.

*The PEE1250M3B could be built and shipped as two pieces, each weighing less than 10,000 lbs.

Budgetary Pricing

Demineralization System:	$ 27,390.00	Common to R.O. & V.C.
MRO40000:	$170,000.00	R.O. 1st stage
MRO30B:	$ 53,000.00	" 2nd "
PEE1250M3B:	$188,000.00	V.C.

Approximate Operating Costs - 30 Days/Month

Note: Includes energy (@ $0.06/KWH), chemicals (including regeneration chemicals), spare parts and labor.

Reverse Osmosis System: $6,340.00/month.

Note: Energy represents $2,560.00/mo. for the MRO40000 and MRO30B.

Vapor Compression System: $7,510.00/month.

Note: Energy represents $5,000.00/mo. for the PEE1250M3B.

Also included in each total cost is $550.00/month for energy associated with the high pressure pump.

We appreciate this opportunity to be of service and hope the information contained herein is sufficient at this time. If you should require any further information, please do not hesitate to contact us.

Yours very truly,

MECHANICAL EQUIPMENT CO., INC.

Jim Smith

JIM SMITH
APPLICATIONS ENGINEER

JS:sh

Encl: Corporate Brochure
Bulletin 142
Bulletin 117D
Blue Specification Sheet - R.O.
Typical Analysis of Distilled V.C. Water
Demineralization Process Description

MECO®
MECHANICAL EQUIPMENT COMPANY INC.
861 CARONDELET STREET ● NEW ORLEANS, LOUISIANA 70130, U.S.A.
PHONE 504 / 523-7271 ● TELEX: 58-377 and 460165 ● CABLE: MECO

June 13, 1983

Radian Corporation
P. O. Box 9948
Austin, Texas 78766

Attention: Mr. Milton Owen

Reference: MECO INQUIRY 02-8302-1

Dear Milton:

In accordance with your recent request, I am pleased to provide you with the following information.

1) Budgetary pricing on the demineralization system has been recalculated, based on the following:

   (a) Twin, alternating system with automatic regeneration of resin (conductivity initiated).
   (b) 300 gallon buffer tank with level control.
   (c) Booster pump and motor.
   (d) High pressure pump and motor for turbine injection pressure.
   (e) Electrics to meet explosion proof hazardous area classification. (ie: Class 1, Division 1, Group D)

   (f) All above mounted on a heavy duty oil field type skid.

   Budgetary pricing: $150,000.00

   Note: The price would approximately be cut in half if explosion proof construction were not required.

2) Weights and Dimensions of the revised demineralization system are:

   Dry Weight: 7,075 lbs.
   Wet Weight: 11,955 lbs.
   Dimensions: 11'10" L x 8'6" W x 9'5" H

3) Add 30% to the budgetary pricing given in my February 2, 1983 letter in order to approximate the R.O. and V.C. system costs when built in accordance with explosion proof construction.

4) The conductivity monitor on both the V.C. system and demineralizer system are accurate enough to measure dissolved solids down to the 0.5 ppm range.

5) Obtaining water with less than 0.1 ppm silica will not be a problem.

MECO

I hope the information provided herein is sufficient at this time. If you require any further information, please do not hesitate to contact us.

Yours very truly,

MECHANICAL EQUIPMENT CO., INC.

JIM SMITH
MARKETING ENGINEER

JS:shd

SOLAR TURBINES INCORPORATED
SUBSIDIARY OF CATERPILLAR TRACTOR CO.
One Northwind Plaza, 7600 West Tidwell Road, Suite 600, Houston, TX 77040
TEL: (713) 895-2300
TWX: 910-881-2610
TLX: 79-0404

February 14, 1983

Shell Oil Company
P. O. Box 527
Houston, Texas 77001

Attention: Mr. W. T. Patton

Dear Terry:

The following is the requested data for our nominal 5,000 KW Mars burning two types of fuel as listed.

Generator Set
Required load 5,000 KW nominal
Mars 1825 Deg. F TRIT, continuous duty
Dual fuel engine

Site Conditions:

Elevation	50 Ft.
Ambient Temperature	70 Deg. F
Relative Humidity	75%
Inlet Loss	6" H2O
Exhaust Loss	8" H2O

Fuels:

Gas Analysis	Mol %
CO2	2.22
N2	1.39
C1	87.32
C2	2.12
C3	2.72
IC4	.76
NC4	1.54
IC5	.58
NC5	.45
C6	.40
C7	.35
C8	.11
C9	.04

Diesel #2 Fuel - 0.1% ppm/w sulfur

Minimum Fuel Supply Temperature

The minimum fuel supply temperature should be 133 Deg. F in order to avoid liquid formation. Since the ambient temperature is low, customer must pre-heat the supply and take the necessay precautions especially during startup. Water, if any, should also be removed.

Exhaust Heat Calculations

For comparison purposes, two sets of nominal data are calculated. One set is based on dry engine with normal inlet guide vane setting and the other with a water injected engine with the inlet guide vane setting of 3.4 degrees. If a water injected Mars engine is indeed required, please notify us in order that we may assure you of the proper setting of the inlet guide vane.

	Dry	W/F = 1
Field Gas Fuel		
Exhaust Temperature, Deg. F	802	773
Exhaust Flow - Lbm/hr	246,205	246,031
Exhaust Heat - MMBTU/Hr		
With 300 Deg. F Stack Temperature	31.94	30.1
With 380 Deg. F Stack Temperature	26.98	25.0
Diesel #2 Fuel		
Exhaust Temperature, Deg. F	812	783
Exhaust Flow - Lbm/hr	246,133	245,960
Exhaust Heat - MMBTU/Hr		
With 300 Deg. F Stack Temperature	32.33	30.47
With 380 Deg. F Stack Temperature	27.41	25.41

Note that if the inlet guide vane is set for water injection, the dry performance will be slightly different from the above listed dry data.

After you have had a chance to review this information, please call me towards the end of this week and we will have a three-way conversation with San Diego to ensure that all your questions are answered and this particular subject completely covered to your satisfication.

Regards,

Ian R. McNeill/jll

Ian R. McNeill
Regional Sales Specialist

IRM:jll

cc: T. J. McNatt/Shell

13

Mars Continuous Duty Generator Set Performance

PERFORMANCE

The curves included in this section show typical performance for the Mars turbine generator set. While these curves cover the majority of turbine applications, special conditions may arise that require consultation with the manufacturer to determine performance under specific conditions.

The three parameters which affect the performance of a turbine generator set are inlet air temperature to the engine and generator, ambient pressure of the inlet air (altitude), and turbine inlet and exhaust pressure losses.

The effect of each parameter is shown on the included curves. In the performance curves shown, it is assumed that the inlet air temperature to the engine is relatively the same as the inlet cooling air temperature to the generator. If, for an individual application, these are not relatively the same, the manufacturer should be consulted.

PERFORMANCE CURVES

Typical performance curves for the Mars turbine generator set are shown in Figures 13-3 and 13-4. Power output of the set in kilowatts is shown as a function of ambient air inlet temperature at a constant ambient air inlet pressure of 101.4 kPa (14.7 psia). The performance assumes zero inlet and exhaust pressure losses. Power losses of the reduction gear and standard accessories have been considered in computing the performance curves. The calculations also include the generator efficiency.

CORRECTION FOR ALTITUDE

The curve in Figure 13-1 is the correction factor, ambient pressure divided by sea level pressure 101.4 kPa (14.7 psia), as a function of altitude.

EFFECT OF INLET AND EXHAUST PRESSURE LOSS CURVE

The effect of duct pressure losses on engine performance compared with the engine performance with zero duct losses is shown in Figure 13-2. Enter on the bottom of the chart with the output power parameter from Figure 13-3 or 13-4. Move vertically upward to a point intersecting the exhaust pressure loss curve. Move horizontally to the left margin and read the kW loss per Pascal (kW loss per inch of water). Multiply by the number of Pascals (inches of water) loss. Follow the same procedure for inlet pressure loss and subtract the total kW losses from the output power parameter to determine the available kW. The sum of inlet and exhaust pressure losses must not exceed 5000 Pascals (twenty inches of water). If operation is required with greater ducting pressure losses, consult the manufacturer. The normal turbine installation has from 0 to 500 Pascals (zero to two inches of water) inlet pressure losses and from 500 to 1500 Pascals (two to six inches of water) pressure loss in the exhaust system.

AVAILABLE EXHAUST HEAT

Mass flow and temperature of the Mars turbine exhaust are also shown in Figures 13-3 and 13-4. Exhaust heat available can be determined by applying the following formula:

$$\frac{Q}{\delta} = \frac{W_{ex}}{\delta} C_p \, (T_{eg} - T_{se})$$

where

Q	=	Heat available in kW (Btu/hr)
W_{ex}	=	Exhaust mass flow in kg/sec (thousands lb/hr)
δ	=	$\dfrac{\text{Ambient pressure kPa (psia)}}{\text{101.4 kPa (14.7 psia)}}$
$(T_{eg} - T_{se})$	=	Temperature drop in heat recovery equipment
C_p	=	Average specific heat over the $(T_{eg} - T_{se})$ range. Assume 1.05 (0.25)

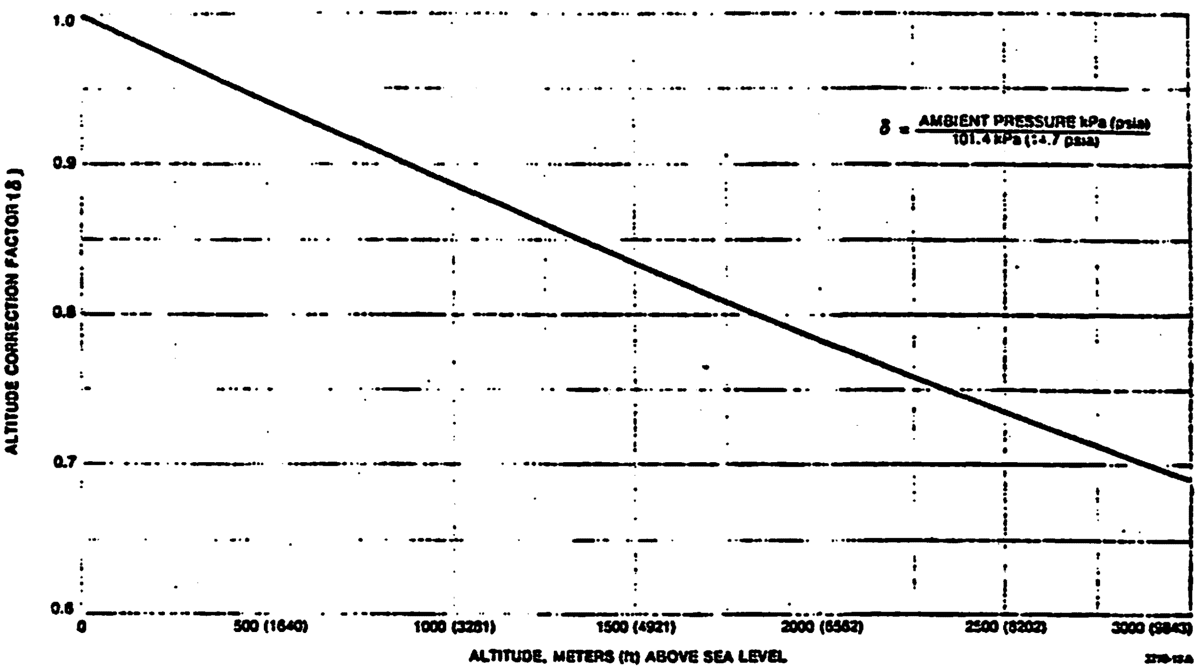


Figure 13-1. Performance Correction Factor for Altitude

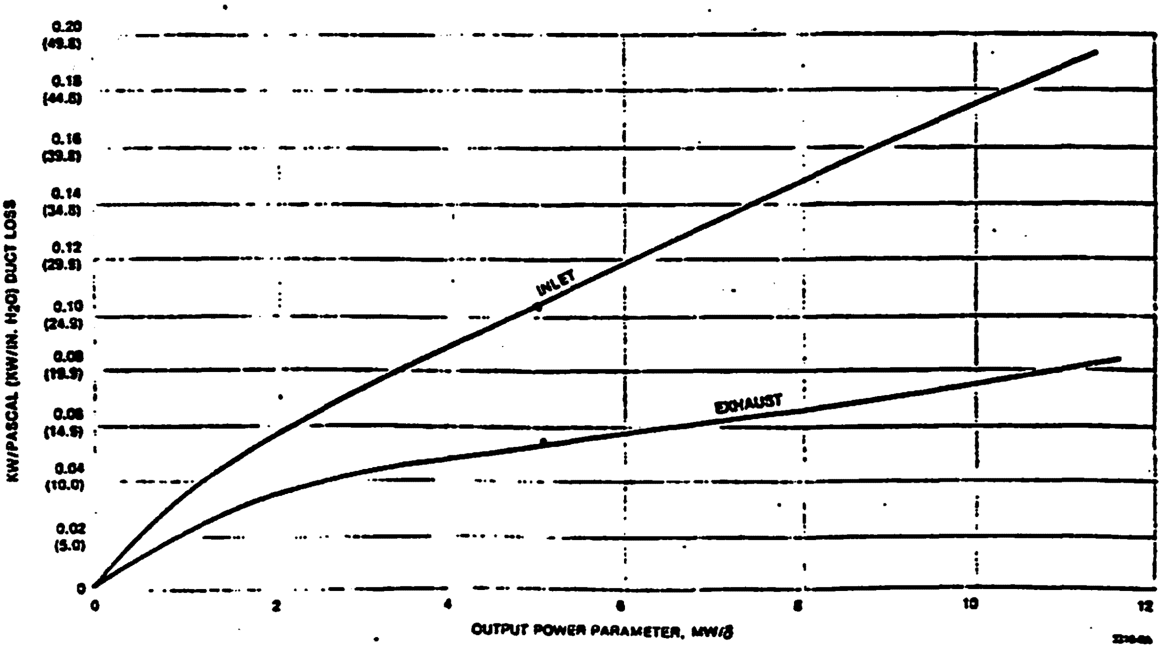


Figure 13-2. Inlet and Exhaust Power Loss

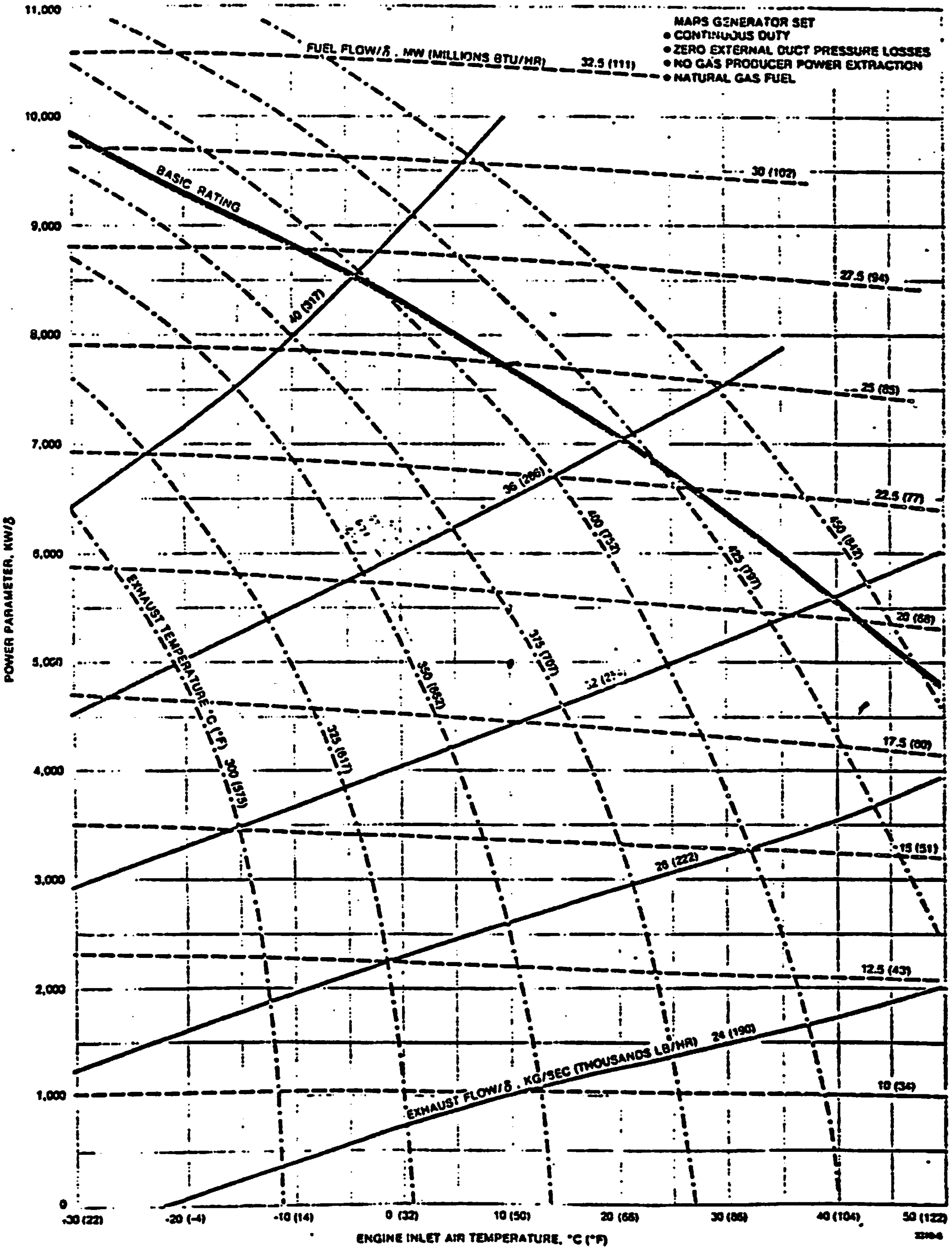


Figure 13-3. Typical Output Power Available, Gas Fuel

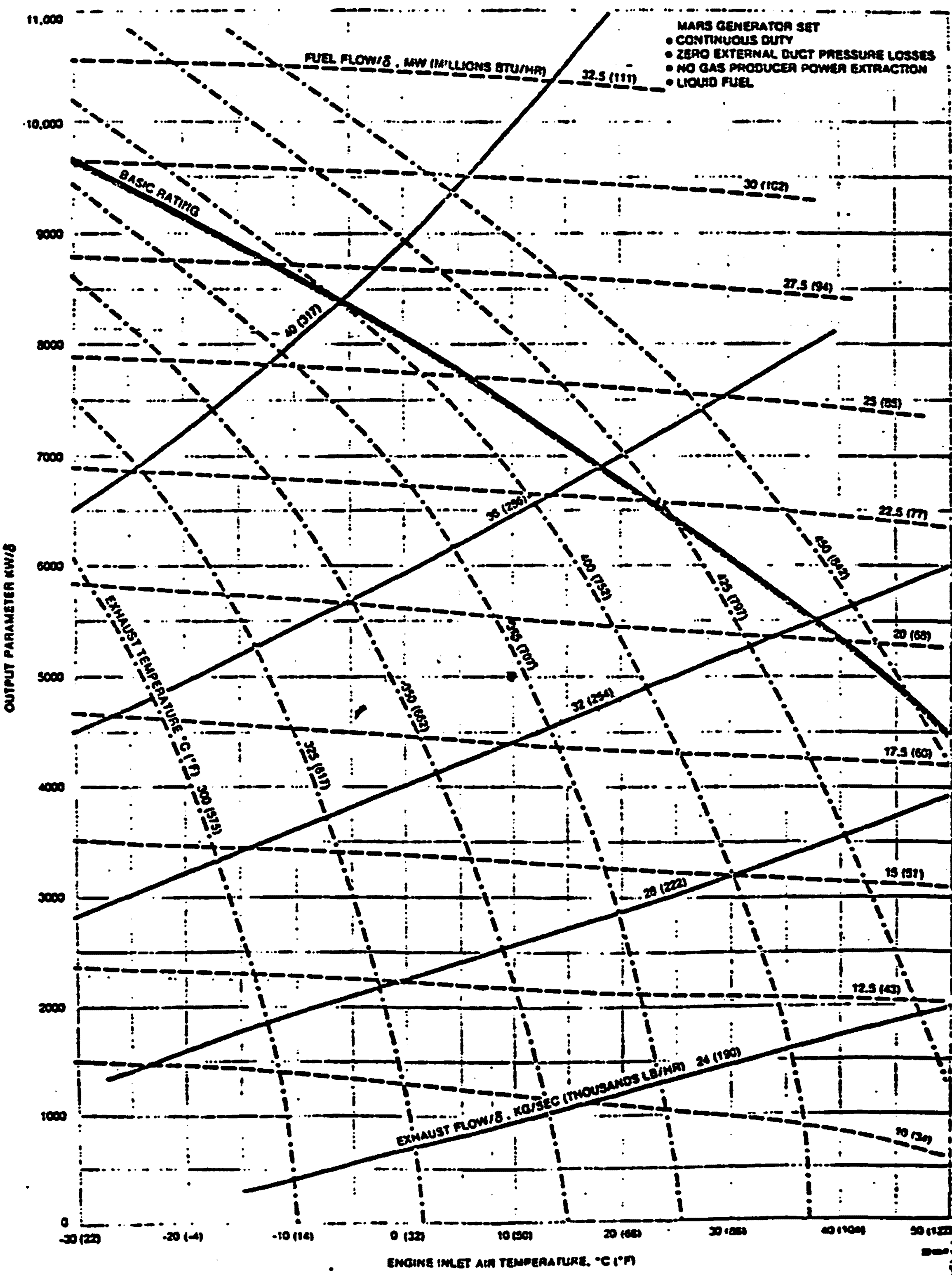


Figure 13-4. Typical Output Power Available, Liquid Fuel

Effects of water injection of specific fuel consumption and available horsepower were also documented for liquid and gas fuel (Figures 3 and 4).

The increase in fuel consumption is due to the heat required to bring the water up to the turbine inlet temperature. The increase in horsepower is due to the water contribution of the total mass flow through the engine.

A schematic diagram of the wet NO_x system is shown in Figure 5. The water controller will vary depending on the NO_x requirements and the package configuration (generator, MD, compressor). For the Centaur generator to meet the proposed California Air Resource Board (CARB) stationary IC engine standard of 0.28 microgram of NO_x per joule of output, for instance, the only system hardware required is a pressure regulator and a solenoid shutoff valve. For the two-shaft engine, an actuator-controlled water valve is also required. The purpose of controlling water flow is to inject only the water necessary to meet the applicable emission standard. The reason maximum water is not injected to achieve maximum reduction is the cost of the water. The water requirements are shown in Table 1.

If I may be of further assistance please call.

Best Regards,

Charles H. Thompson
Sales Engineer

CHT:mas

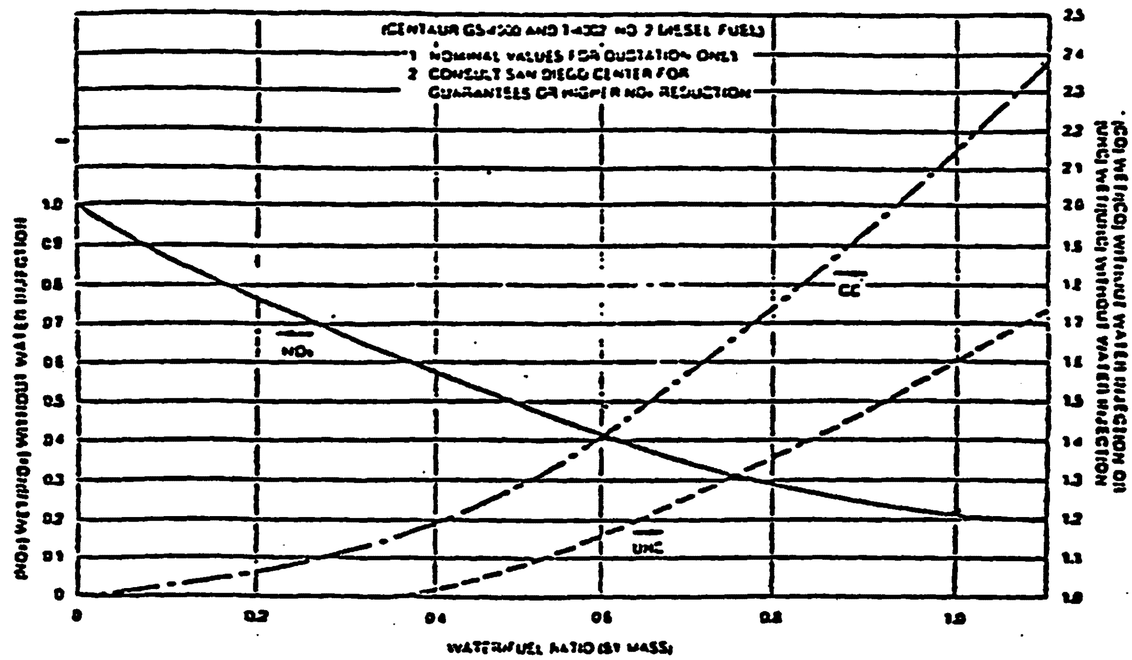


Figure 1. Normalized Emissions (NO_x, CO, UHC) with Water Injection (No. 2 Diesel Fuel)

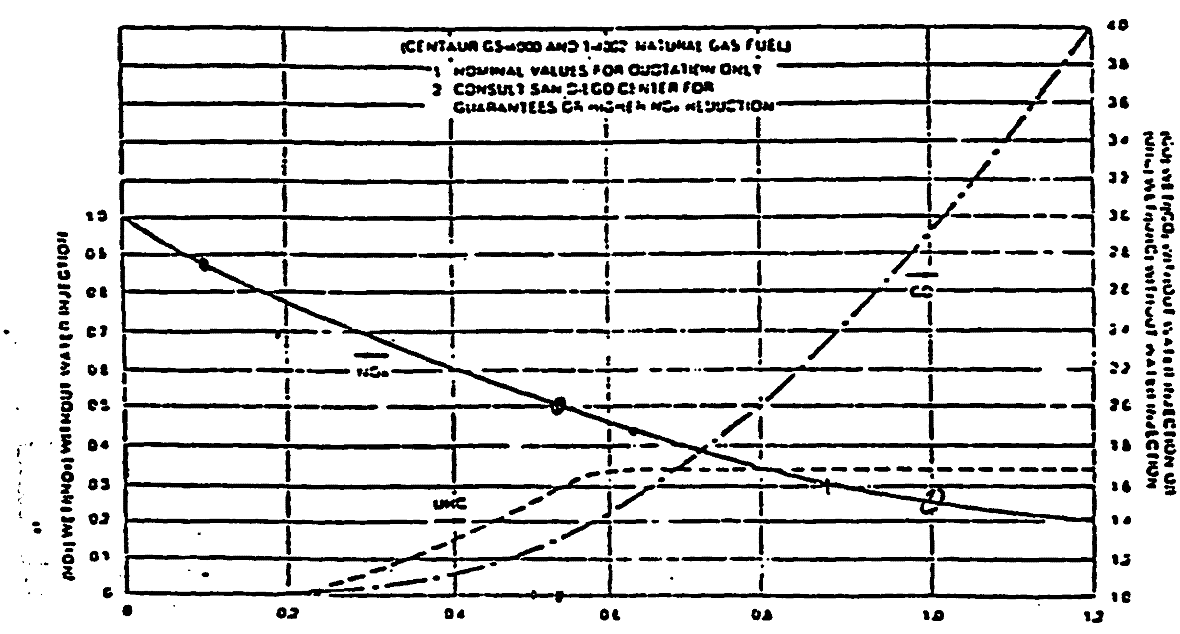
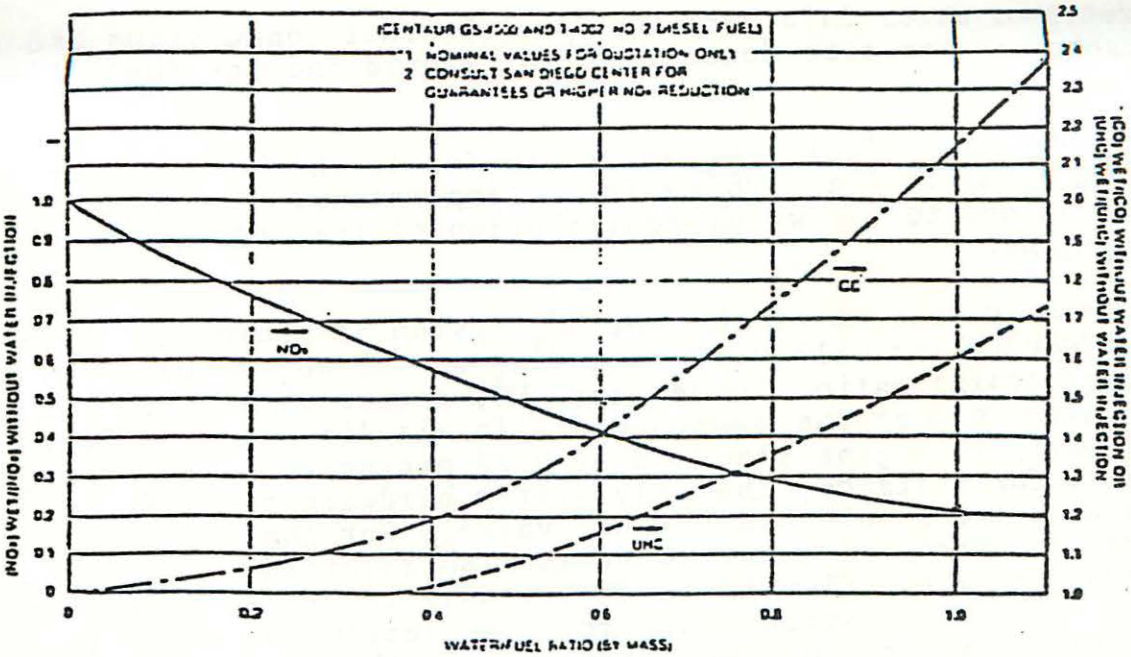


Figure 2. Normalized Emissions (NO_x, CO, UHC) with Water Injection (Natural Gas Fuel)



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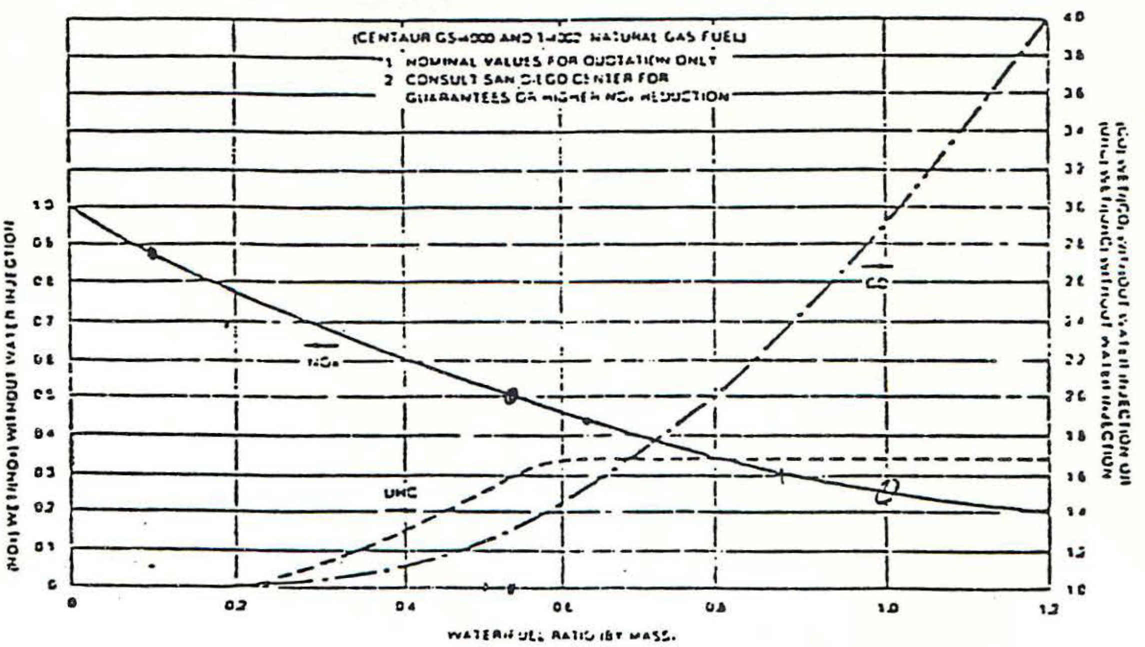

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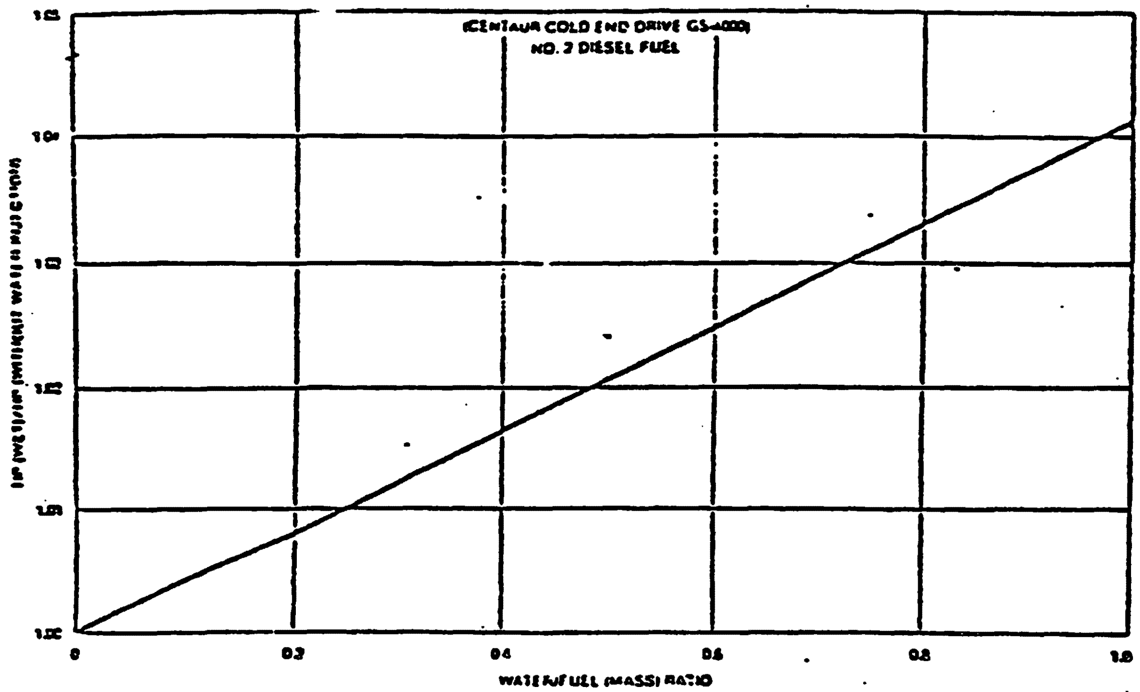
If I may be of further assistance please call.

Best Regards,

Charles H. Thompson

Charles H. Thompson
Sales Engineer

CHT:mas



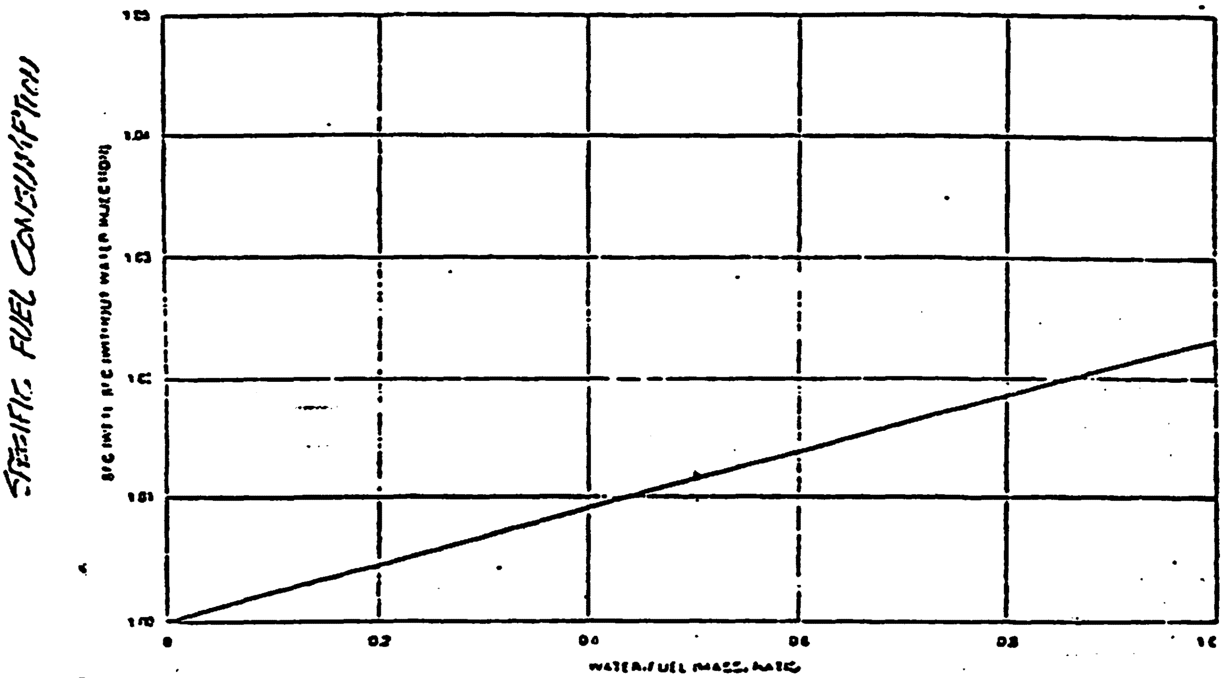


Figure 3. Effect of Water Injection on Engine Performance
(No. 2 Diesel Fuel)

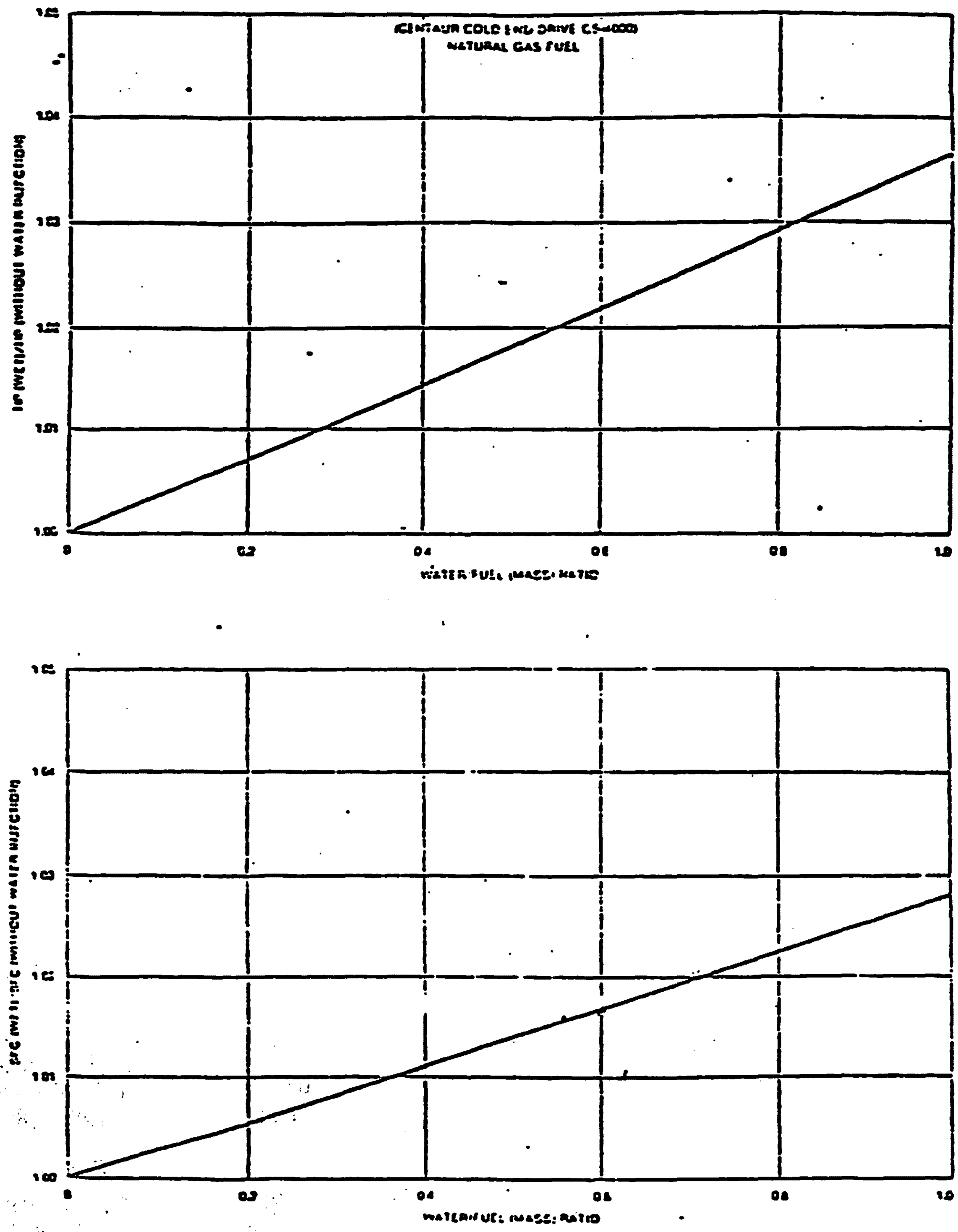


Figure 4. Effect of Water Injection on Engine Performance
(Natural Gas Fuel)

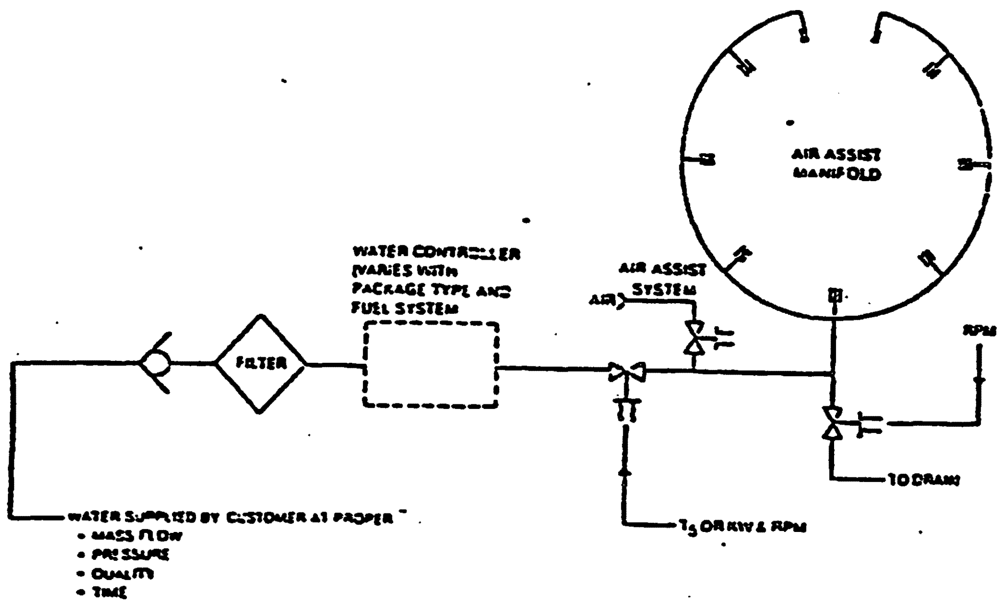


Figure 5. Water Flow Control System for Centaur

Table 1. Water Requirements for Wet NO_x

	Centaur	Mars
Flow (gph based on 1:1 water/fuel ratio)	300	570
Pressure (psig)	600	600-1500*

Quality

Solid Contaminants - The water shall contain less than 0.1 gram/gallon of sediment, solid or hard contaminants. 90 percent of the 0.1 gram shall be less than 5 microns in size.

Chemical Contaminants - The total concentration of sodium, potassium, vanadium and lead in the water shall be less than 0.5 ppm by weight.

*Actual pressure requirement depends on the emission requirements of the specific application.

Fluid Systems Division
10124 Old Grove Road • San Diego, California 9213'
Telephone 714-695-3840 • TWX 910-335-1193 • Tele :opier 714-695-2176

June 13, 1983

Milton Owen
Radian Corporation
P.O. Box 9948
Austin, Texas 78766

Dear Sir:

SUBJECT: DESALINATION SYSTEM FOR SHELL OFF-SHORE TURBINE INJECTION USE.

In early February this year, Mr. Terry Patton of Shell California Production (Shell-Houston Office) contacted Fluid Systems regarding information on a high purity water system for off-shore platform use. The system was to produce 30 to 40 KGPD of water with 0.5 mg/l or less of combined sodium and potassium.

Based on this information and a final product flow of 40,000 gallons per day, Fluid Systems would propose the following:

1. Seawater intake consisting of 316 SST casing with a multistage submersible pump. Capacity approximately 85 gpm at 150 foot TDH.

2. Media filter system consisting of FRP pressure filters sized for backwashing with reject from the R.O. system. Four tanks at 3 foot diameter.

3. R.O. system consisting of two stage design including high pressure pumps, cartridge filters, acid and sequestriant feed assemblies, RO membrane element modules and necessary instruments and controls.

4. Degasifier system consisting of an atmospheric type packed tower, blower, collection basin and transfer pump.

5. Ion exchange system consisting of two bed or series mixed bed exchange tanks with in situ regeneration equipment.

6. Sub micron cartridge filter with 316 SST housing.

7. Booster pump for 28 gpm at 1500 psi.

8. Interconnecting wiring and piping.

Note: All equipment (motors and electrical) will be explosion proof as required for production platform use.

Budget price for all the above equipment, skid mounted as much as possible, is 350,000 US Dollars based on early February costs. Price is F.O.B. San Diego. An estimate of the space required is 21 feet by 21 feet by 14 feet high.

Please note that upon further investigation the intake system, the RO acid feed assembly, the degasifier and the ion exchange regeneration equipment may be able to be eliminated from the process.

I have enclosed for your information a general package describing Fluid Systems. If any addiitonal information is required, please feel free to call.

Thank you for your interest in Fluid Systems Division.

Sincerely,

FLUID SYSTEMS DIVISION

Frank J. Trabert
Applications Engineer

FJT:eb
Enclosure

Eureka

BEDROCK

To the west of the proposed Eureka site a series of low relief, small bedrock exposures were mapped using side scan sonar and the 3.5 kHz high resolution profiles. The interpretation that accompanies this letter report is presented in considerably more detail than that presented on the maps (Plates IV and VI of MESA^2, Inc. 1983a; Plates IV and VI of 1983b; and Plate IV of 1983c, respectively. A series of bottom photographs, collected on March 27, 1983, from the "outcrop" area nearest the Eureka site, was used to verify or "ground-truth" the interpretations presented on the accompanying map. The 12 photos that accompany this report are numbered and keyed to the map.

In detail, the areas of bedrock outcrop nearest the proposed site [2,800 feet (854 m) west] are small patchy exposures of weakly lithified bedrock (Repetto Formation) surrounded by "shallow-bedrock" that is thinly veneered with sediment. The sediment veneer thins from over a meter (3 ft) in thickness to zero-edges along the low bedrock ridges (Photograph #15). As shown by bottom photograph number 15A the ridges are in reality low sills of a meter (3 ft) or less in height which contain thin ribs of more resistant sedimentary rock (sandstones?). Between these low swells are ponded areas of sediment (photographs #4,9,14 and 17).

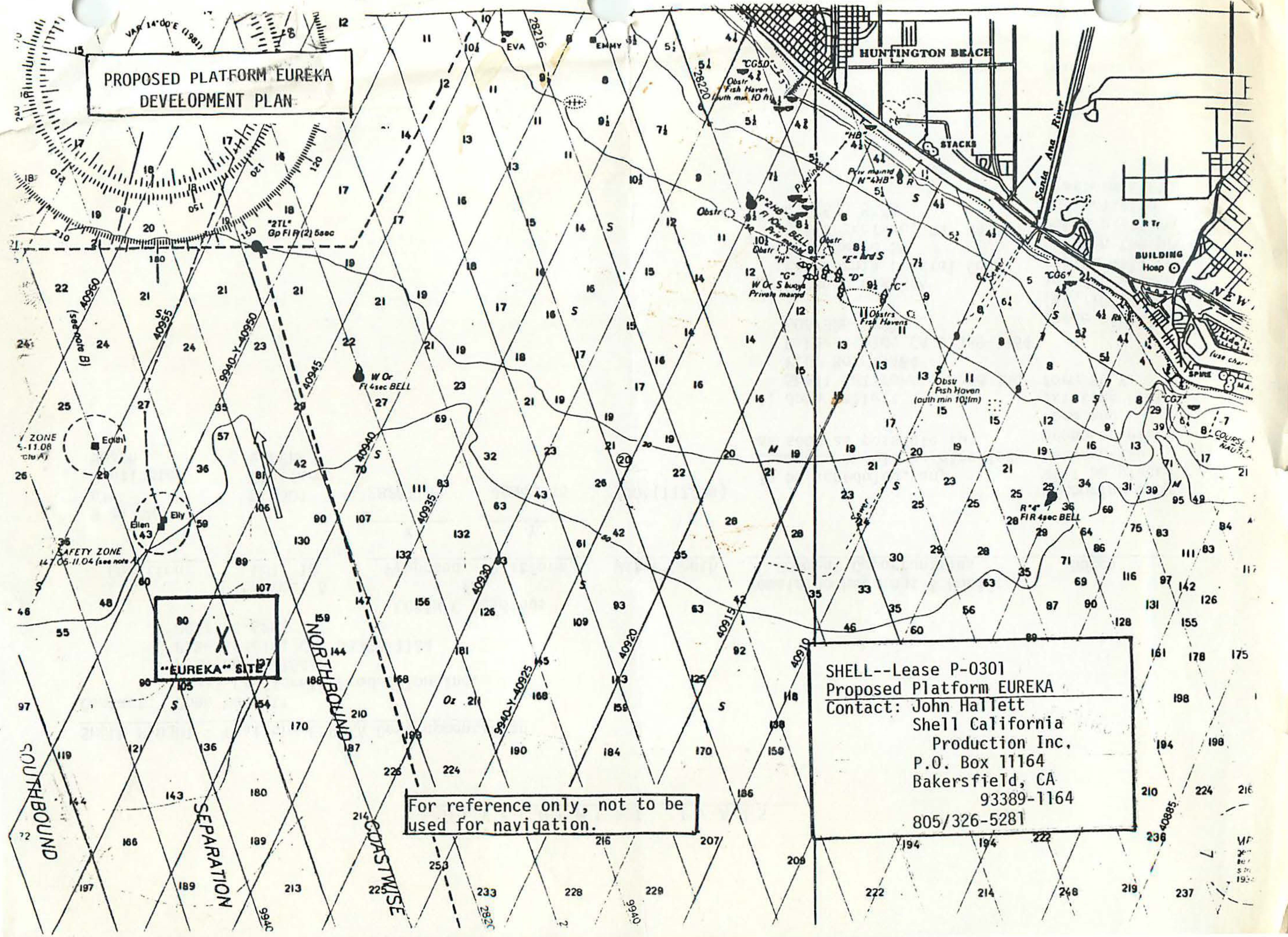
The three bedrock exposures nearest to the site lie in water depths of 475 to 625 ft (145 to 190 m). These three bedrock areas are briefly described below:

DEVELOPMENT PLANS

SHELL P-0301 - Platform EUREKA Development Plan

Contact: John Hallett
Shell California Production Inc.
P.O. Box 11164
Bakersfield, CA 93389-1164
805/326-5281

Location	Parcel & Well ID	LORAN C Readings For Proposed Platform		Water Depth	Remaining Hearings & Public Comment Opportunities	Notes
		X	Y			
9 mi SW of Huntington Beach	P-0301 Platform EUREKA	28201.55	40943.45	700'(117fms)	To be scheduled, any comments should be directed as soon as possible to: 1) John Hallett Shell California Prod Inc P.O. Box 11164 Bakersfield, CA 93389-1164 805/326-5281 2) Eugenia Laychak California Coastal Comm. 631 Howard St. San Francisco, CA 94105 415/543-8555	A mooring buoy will be placed between the proposed platform and existing Platform ELLY. Three pipelines (6", 10", & 12") and two power cables will run between the proposed platform and existing Platform ELLY.


PROPOSED PLATFORM EUREKA
DEVELOPMENT PLAN
VAR 14°00'E (1981)
HUNTINGTON BEACH
STACKS
Santa Ana River
BUILDING
Hosp
"2TL"
Gp Fl R (2) 5sec
W Or
Fl 4sec BELL
Edith
Ellen
Elly
SAFETY ZONE
"EUREKA" SITE
NORTHBOUND
SOUTHBOUND
SEPARATION
COASTWISE
Pipeline
Obstr
Fish Haven
Obstrs
Fish Havens
R "4"
Fl R 4sec BELL
SHELL--Lease P-0301
Proposed Platform EUREKA
Contact: John Hallett
Shell California
Production Inc.
P.O. Box 11164
Bakersfield, CA
93389-1164
805/326-5281
For reference only, not to be
used for navigation.