Final

environmental statement

related to the

NUCLEAR GENERATING STATION DIABLO CANYON UNITS 1 & 2

PACIFIC GAS AND ELECTRIC COMPANY

DOCKET NOS. 50–275 AND 50–323

MAY 1973

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the U.S. Atomic Energy Commission, Directorate of Licensing.

1. The action is administrative.

2. The proposed action is the continuation of construction permits Nos. CPPR-39 and CPPR-69 and issuance of operating license to the Pacific Gas and Electric Company for the Diablo Canyon Units 1 and 2, located on the California coast 12 miles southwest of San Luis Obispo, California (Docket Nos. 50-275 and 50-323).

   Both units will employ pressurized water reactors designed to produce up to 7136 thermal megawatts (3568 MWt each). This heat will be used to produce steam to drive steam turbines, providing up to a guaranteed output of about 2300 MW of electrical power capacity.

   The units will be cooled by once-through flow of water from the Pacific Ocean.

3. Summary of environmental impact and adverse effects.

   a. Construction activity associated with the plant and its transmission facilities will have the following environmental effects:

      (1) Construction-related activities on the site have disturbed 142 acres of land, resulting in some alteration of wildlife habitat. Of this area, 51 acres are to be used for plant facilities, parking lots, roads, and switchyards; the remaining 91 acres will be restored by seeding and other plantings. Use of the rest of the 750-acre exclusion area will be restricted.

      (2) Construction of transmission lines has affected 6000 acres of right-of-way. Service roads and tower bases occupy 1500 acres. There has been some loss of vegetation near the roads and towers, but most of this loss will be temporary. Erosion of steep areas along the roads can be serious if not controlled. A visual impact has been created by this construction.

(3) Construction of the intake breakwaters and the coffer dams at the intake and discharge has occupied about 14-1/2 acres of ocean bottom that previously provided habitat for benthic organisms; in addition, a small area was affected by the Avila Beach barge landing. The barge landing and the coffer dams are to be removed, permitting reestablishment of the natural populations. The breakwaters will provide new habitat for intertidal and subtidal organisms.

(4) There will be some shifts in natural animal populations as a result of increased human activity.

b. Operation of the plant is expected to result in the following impacts:

(1) At design power, condenser cooling water will be heated to a maximum of 82.5°F (28.1°C) and will be discharged at a rate of up to 3864 cfs (at a temperature rise of 19°F above ambient). The heated water will mix with the cooler water of the Pacific Ocean, where the heat will eventually be dissipated to the atmosphere. As much as 68 acres will be enclosed by the 4°F above ambient isotherm.

(2) The radioactivity to be released to the environment during normal operation will result in an estimated radiation dose of approximately 3.6 man-rems per year to the population. The impact from this dose is not considered to be significant when compared to the natural background radiation doses.

(3) A very low risk of accidental radiation exposure to nearby residents will be created.

(4) Some chemicals will be added to the water used for cooling; however, the concentration of these chemicals in Diablo Cove is not expected to have adverse effects on aquatic life.

(5) There will be very little, if any decline in the concentration of dissolved oxygen in the discharged cooling water.

(6) The thermal discharge from the plant will cause an ecological shift in benthic organisms and fish that will result in an increase in the number of warm-water-tolerant forms. The higher temperatures in Diablo Cove may cause those parts of the bull kelp that are near the surface to degenerate earlier in the year than they normally do; at most, 2 or 3 acres will be affected. The higher temperatures will also increase the feeding activity of the giant sea urchin, which competes with the abalone for the existing food supply (mainly kelp); this may lead to a decline in the abalone population unless measures are taken to control the urchin. A total of 110,000 abalone may be lost as a result of the station operation.

(7) No adverse effect on phytoplankton populations is expected, because of the rapid regeneration times and large stocks available for recruitment from outside Diablo Cove. A mortality of as much as 8.5% of the zooplankton passing through the cooling system may occur, but the generation times for California zooplankton are generally 24 hours to 8 weeks, and recruitment from the open ocean will be copious; therefore, the impact on the local ecosystem is believed to be insignificant.

(8) Some jellyfish will be killed in the intake structures as a result of impingement. The ecological consequences of this loss are expected to be small.

(9) No fish losses are expected to occur in Diablo Cove as a result of the thermal discharge. Some small fish (less than 3 inches) will be killed as a result of impingement or entrainment in the cooling system.

(10) There appears to be some potential for increased mortality of avian species from contact with transmission line facilities.

4. Principal alternatives considered:

a. Sources of energy other than nuclear.

b. The construction of an equivalent plant at some other site.

c. The use of cooling towers instead of the proposed once-through cooling.

d. The discharge of heated water at some distance from the shore instead of at the shoreline.

5. Comments on the Draft Environmental Statement were received from the agencies and organizations listed below and have been considered in the preparation of the Final Environmental Statement. Copies of those comments are included as Appendix 14 and the comments are discussed in Section 14.

   Advisory Council on Historic Preservation
   Department of Agriculture
   Department of the Army, Corps of Engineers
   Department of Commerce
   Department of Health, Education, and Welfare
   Department of Housing and Urban Development
   Department of the Interior
   Department of Transportation
   Environmental Protection Agency
   Federal Power Commission
   California Resources Agency (Departments of: Conservation, Water Resources, Parks and Recreation, Fish and Game, Harbors and Watercraft)
   Geothermal Energy Institute
   Kenneth B. Kilbourne, Carpenteria, California

6. This statement was made available to the public, to the Council on Environmental Quality, and to the other specified agencies in May 1973.

7. On the basis of the analysis and evaluation set forth in this Statement, after weighing the environmental, economic, technical and other benefits against environmental costs and considering available alternatives, it is concluded that the action called for under NEPA and Appendix D to 10 CFR Part 50, is the continuation of construction permits* for the facilities subject to the following conditions for the protection of the environment:

   a. The continuation of the ecological and radiological baseline monitoring program as specified in Section 6. In

* Staff consideration of issuance of an operating license follows submission of applicant's Final Safety Analysis Report.

addition, the applicant shall develop a monitoring program for operation in accordance with the requirements in Section 6.

b. The applicant shall implement a program, which is acceptable to the staff, to determine and document the concentration of small fish and the concentration of eggs and larvae of marine organisms in the intake cove. This information should be used to determine susceptibility to entrainment and impingement for the organisms present; and to determine the mortality resulting from such impacts (entrainment, or impingement). (Sect. 5.3.2; Sect. 6.2.2).

c. The applicant shall develop and be prepared to implement a program which will confirm that the total available chlorine in the plant discharge does not exceed 0.1 ppm even during heat treatment for organism removal. The applicant will be required to conduct additional onsite chlorine studies to determine the acute and chronic impacts on both entrained and receiving water marine life. These studies shall start prior to operation of the first unit and continue for at least one year after operation of both units. If there are adverse effects in Diablo Cove from chlorine in the station effluent, the applicant shall modify the station or procedures to eliminate the adverse effects. (Sect. 3.5.1; Sect. 3.5.7; Sect. 5.3.2; Sect. 6.3; Sect. 12.3.4; and Sect. 13.3).

d. The applicant will be required to operate the defouling treatment in such a manner that the thermal alteration of the ocean is no more than that for the treatment of one unit with the other unit in full operation. (Sect. 3.3.3; and Sect. 5.3.2).

e. The applicant shall implement a program, which is acceptable to the staff, for redress of the areas affected by transmission line construction. (Sect. 4.2.2; and Sect. 4.4.1).

f. If harmful effects or evidence of irreversible damage are detected by the monitoring programs, the applicant shall provide an analysis of the problem and implement a program of remedial action to be taken promptly to eliminate or significantly reduce the detrimental effects or damage. (Sect. 3.5.1; Sect. 3.5.7; Sect. 5.3.2; and Sect. 6).

g. The applicant will be required to initiate additional ocean current studies starting at least one year before operation of the first unit and continuing for one year after full-power operation of both units. (Sect. 3.3.3; and Sect. 6.1).

h. The applicant shall develop and implement a program subject to staff approval to determine the actual effect of ocean currents on the thermal plume. As part of the program the applicant shall measure the extent of the thermal plume in increments of 2°F from 10°F to 2°F above ambient at 50% and 100% power of the first unit. The results of these studies must show, that the area of the projected thermal plume for operation with two units does not exceed the predictions in this Statement, or an alternative discharge arrangement shall be considered for the second unit. (Sect. 3.3.3; and Sect. 6.3).

TABLE OF CONTENTS

Page

Page

Page

LIST OF FIGURES

LIST OF TABLES

Table		Page

FOREWORD

This final statement on environmental considerations associated with the proposed continuation of the construction permits for Diablo Canyon Units 1 and 2 was prepared by the U.S. Atomic Energy Commission's Directorate of Licensing (staff) in accordance with the Commission's regulation, 10 CFR Part 50, Appendix D, implementing the requirements of the National Environmental Policy Act of 1969 (NEPA).

The NEPA states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

(i) The environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Pursuant to Appendix D of 10 CFR Part 50, the AEC Directorate of Licensing prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or a full-power operating license, the applicant submits an environmental report to the AEC. The staff evaluates this report and may seek further information from the applicant, as well as other sources, in making an independent assessment of the considerations specified in Section 102(2) (C) of NEPA and Appendix D of 10 CFR Part 50. This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State, and local governmental agencies for comment. Interested persons are also invited to comment on the draft statement.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of problems and objections raised by the comments and the disposition thereof; a final cost-benefit analysis which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects, with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether, after weighing the environmental, economic, technical, and other benefits against environmental costs and considering available alternatives, the action called for is the issuance or denial of the proposed permit or license or its appropriate conditioning to protect environmental values.

In addition, in a proceeding such as this which is subject to Sections B and C of Appendix D of 10 CFR Part 50, the final detailed statement includes a conclusion as to whether, after weighing the environmental, economic, technical, and other benefits against environmental costs and considering available alternatives, the action called for as regards the previously issued construction permit is the continuation, modification, or termination of the permit or its appropriate conditioning to protect environmental values.

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545.

Dr. Louis B. Werner is the AEC Environmental Project Manager for this statement (301-973-7455).

1. INTRODUCTION

At present Units 1 and 2 are under construction at the Diablo Canyon Site. Each consists of an 1060-MW(e) pressurized water reactor and the necessary auxiliary equipment. The impact of the construction and operation of both units is assessed in this report.

The Diablo Canyon Site is on the California coast about midway between Los Angeles and San Francisco. It is in San Luis Obispo County about 12 miles southwest of the city of San Luis Obispo.

The applicant, the Pacific Gas and Electric Company (PG&E), is requesting continuation of construction permits for Units 1 and 2, docket numbers 50-275 and 50-323. The applicant submitted an Environmental Report (ER)[1] and a Preliminary Safety Analysis Report (PSAR)[2] in conjunction with the construction of Diablo Canyon Units 1 and 2. The ER, PSAR, and supplemental information obtained by the staff were used in preparation of this environmental statement.

1.1 STATUS OF THE PROJECT

Under existing AEC regulations, site work was begun in June of 1968 when the access road was started. The dome of the containment building for the Unit 1 reactor is nearing completion as shown in Fig. 1.1. The cylindrical shell of the containment building for Unit 2 is under construction. On June 1, 1972, Unit 1 was estimated to be about 45.6% percent complete and Unit 2 about 12.8% complete.

The grading, excavation, and fill operations are almost complete. The removal of the coffer dams in the ocean at the intake and discharge structures is the major earth moving work remaining. Most of the environmental impact from construction of the transmission lines has already occurred.

1.2 STATUS OF APPLICATIONS AND APPROVALS

The various necessary Federal, State, and local permit requirements and approvals for the Diablo Canyon Nuclear station are given in Appendix 1-1.

The applicant must still obtain a license to operate each unit from the Atomic Energy Commission before operation of that unit.

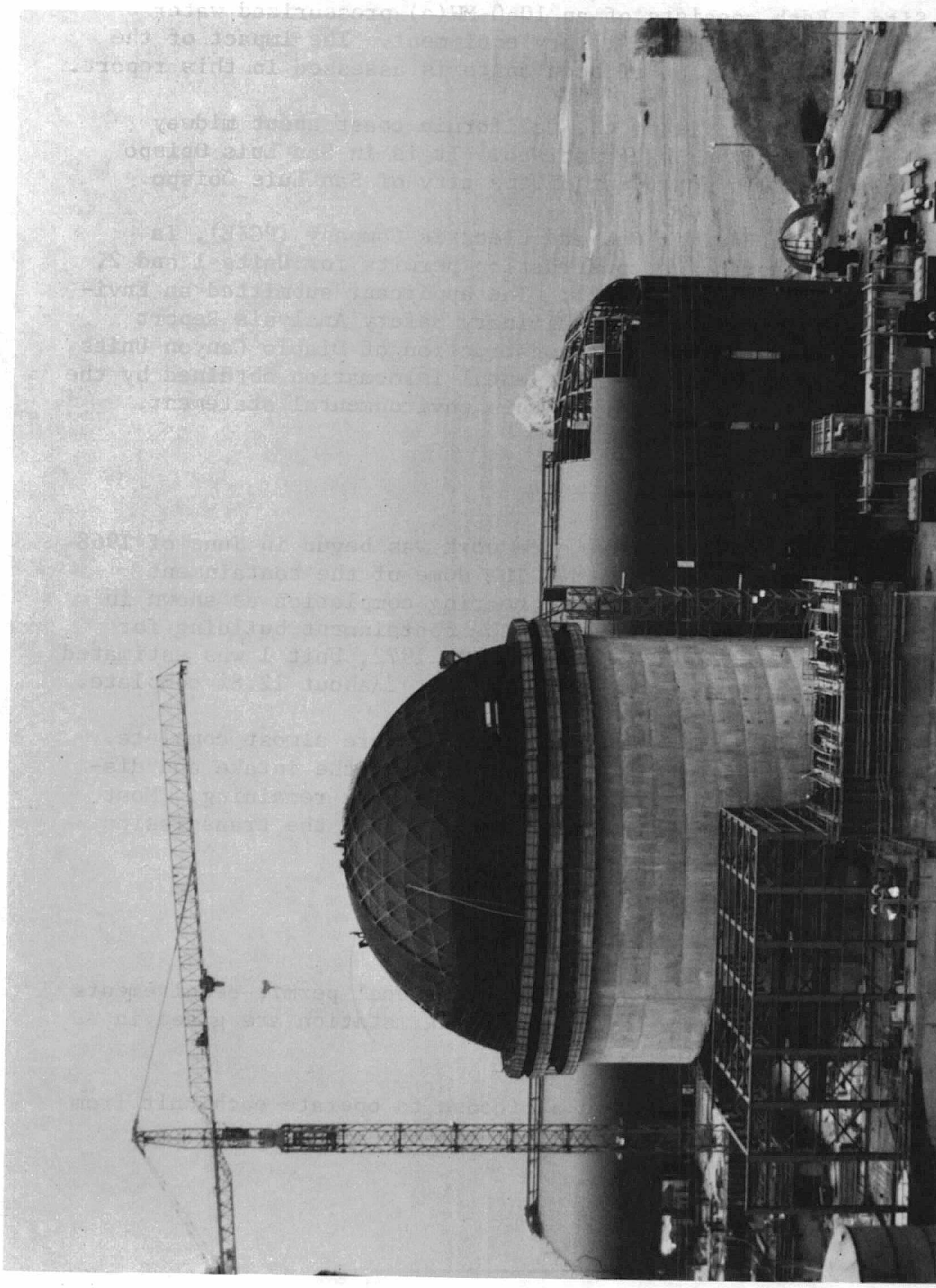


Fig. 1.1 Status of Diablo Canyon site construction, staff photograph, June 1972.

REFERENCES FOR SECTION 1

1. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2, Diablo Canyon Site, July 1971; Supplements No. 1, November 1971, No. 2, July 1972, and No. 3, August 1972.*

2. Pacific Gas and Electric Company, *Preliminary Safety Analysis Report, Diablo Canyon Units 1 and 2, July 1968, and Subsequent Amendments.*

2. THE SITE

The purpose of this section is to present information on the location of the site; demographic, economic, and historic facts; environmental features of geology, hydrology, and meteorology; and ecological characteristics of the area that may be used for environmental impact assessment. Site and environs data used in this statement were obtained on the staff site visit or taken from the applicant's ER and PSAR unless otherwise specified.

2.1 LOCATION OF PLANT

The Diablo Canyon nuclear power plant is being constructed on a 750-acre site on the Pacific coast of California about halfway between Los Angeles and San Francisco, in an undeveloped section of the coastline remote from any city or small village. The site is in a mountainous area with steep rugged and rocky slopes at the edge of the ocean. The only major highways near the site (Figs. 2.1 and 2.2) are U.S. Highway 101 and California State Highway 1 which run north and south about 9 miles east of the site. County roads run through Clark Valley 4 miles north and through See Canyon, five miles east. The Southern Pacific Railroad runs through San Luis Obispo, about 12 miles ENE, running generally north and south. The Pacific Ocean is the only nearby major body of water. Passing within 2-1/2 miles of the plant, the small Coon Creek flows WNW to the ocean, and Diablo Canyon Creek is immediately north of the reactor buildings.

The site is in a remote, undeveloped, and relatively uninhabited region of the county, the plant being located on a sloping marine terrace about 1000 ft wide with elevations ranging from 50 to 150 ft above MSL. The coast in this area is rugged with tidal pools and offshore rocks, and cliffs rise steeply from the high water line to the marine terraces. The site area slopes upward to the Irish Hills which are a part of the San Luis Mountains. Diablo Canyon passes through the site and runs ENE for about 4 miles cutting into the San Luis Mountain Range.

Most of the area surrounding the site is either denuded from cattle grazing or covered with a low scrub growth. Since the area is somewhat dry (16 in. average annual rainfall) vegetation is sparse.

The nearest town is Avila Beach (1970 population of 400) about 7 miles WSW. Other communities within 12 miles are:

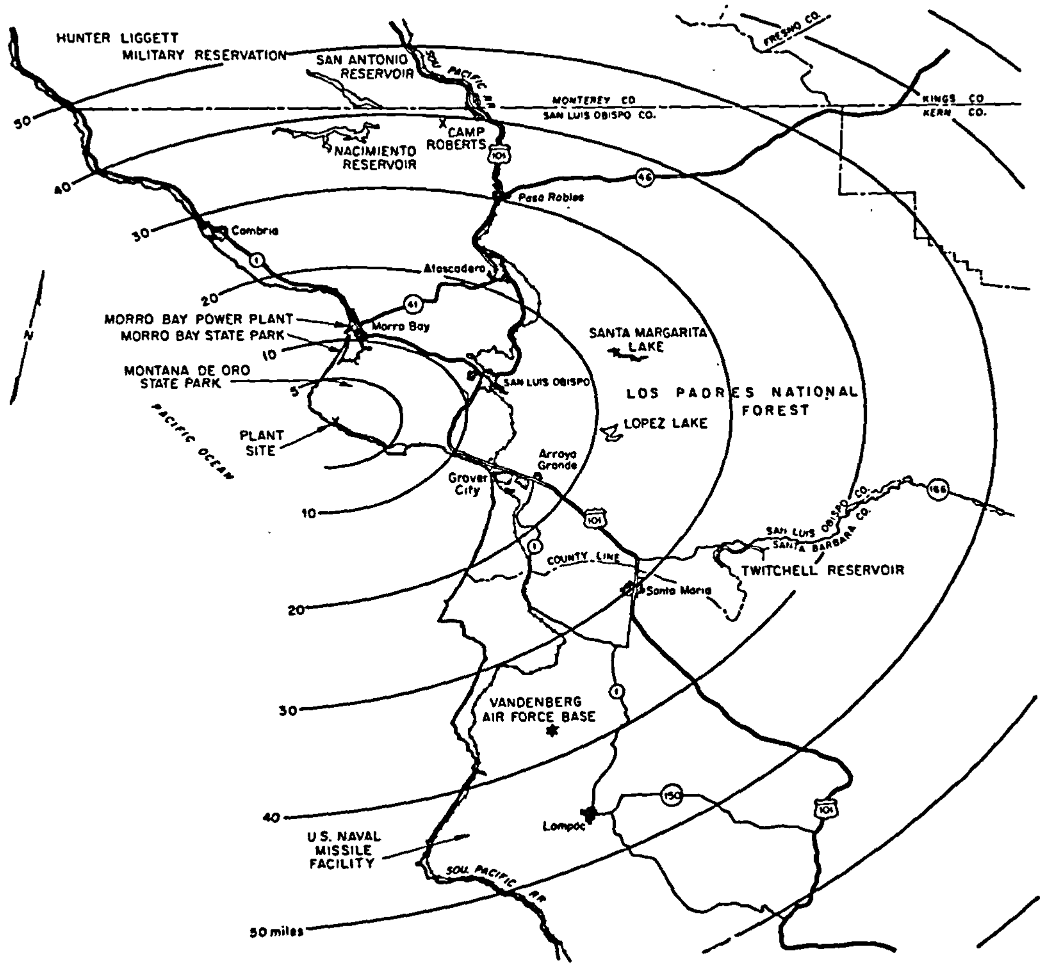


Fig. 2.1. 50-mile area around the Diablo Canyon site.

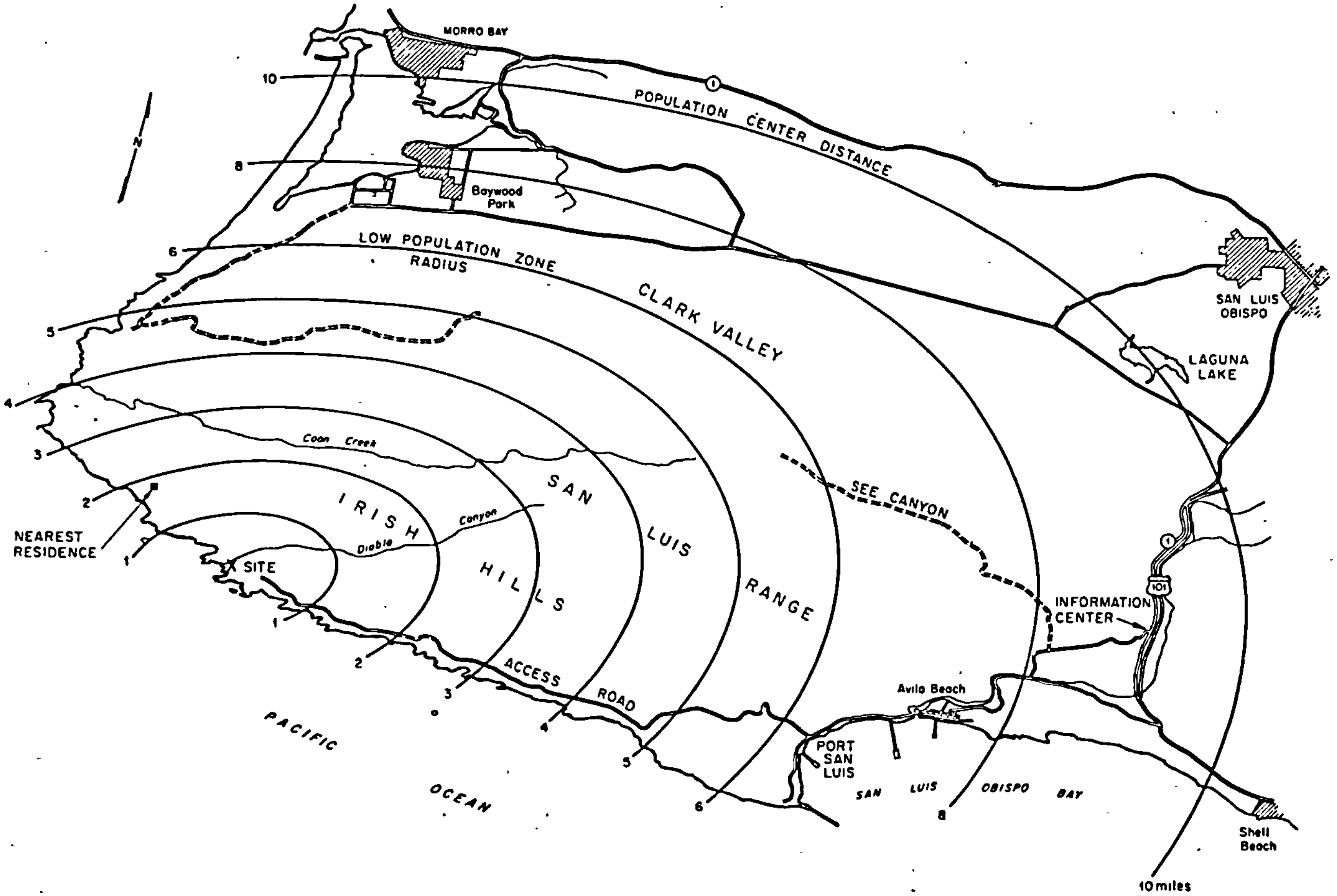


Fig. 2.2. 10-mile area around the Diablo Canyon site.

Community	Location (relative to plant site)	1970 population
Baywood Park — Los Osos	8 miles N	3,487
Morro Bay	11 miles N	7,109
Shell Beach	12 miles ESE	∿2,000
San Luis Obispo	12 miles ENE	28,036

The distance from the Unit No. 1 reactor to the nearest site boundary is 1/2 mile. The low population-zone radius is 6 miles and the population-center distance is 10 miles. The nearest residence is about 1-1/2 miles from the site.

Access to the site is not easy. The applicant has built a new road to the site from Port San Luis Road at Avila Beach which follows an existing unimproved private dirt road from Avila Beach. The applicant's new road (8 miles long), shown on Fig. 2.2, will have a privately controlled access.

An information center has been constructed adjacent to the offramp at San Luis Bay Drive interchange on U.S. Highway 101 and was opened to the public on December 13, 1972. Location of this facility is approximately 6-1/2 miles south of San Luis Obispo.

Some of the most significant features of the area within a 50-mile radius of the site and their relative locations are shown on Fig. 2.1 and are listed below:

Montana de Oro State Park	6 miles N
Morro Bay State Park	8 miles N
Morro Bay Power Plant	10 miles N
Los Padres National Forest	25 miles E
Vandenberg Air Force Base	36 miles ESE
Camp Roberts Military Reservation	40 miles N
U.S. Naval Missile Facility — Point Arguello	44 miles SSE
Hunter-Liggett Military Reservation	50 miles N

Figure 2.3 shows a plot plan of the Diablo Canyon Plant area. The 750-acre site is divided into two parts which are north and south of Diablo Canyon. The 585-acre portion south of the canyon has been leased by the applicant for 99 years with a renewal option for another 99 years. The 165-acre north portion is owned by the applicant.

San Luis Obispo County (one of 15 coastal counties) lies about 1/3 of the way up the 1072-mile California coast from Mexico. The total ocean shoreline in the county is 84 miles and the total land

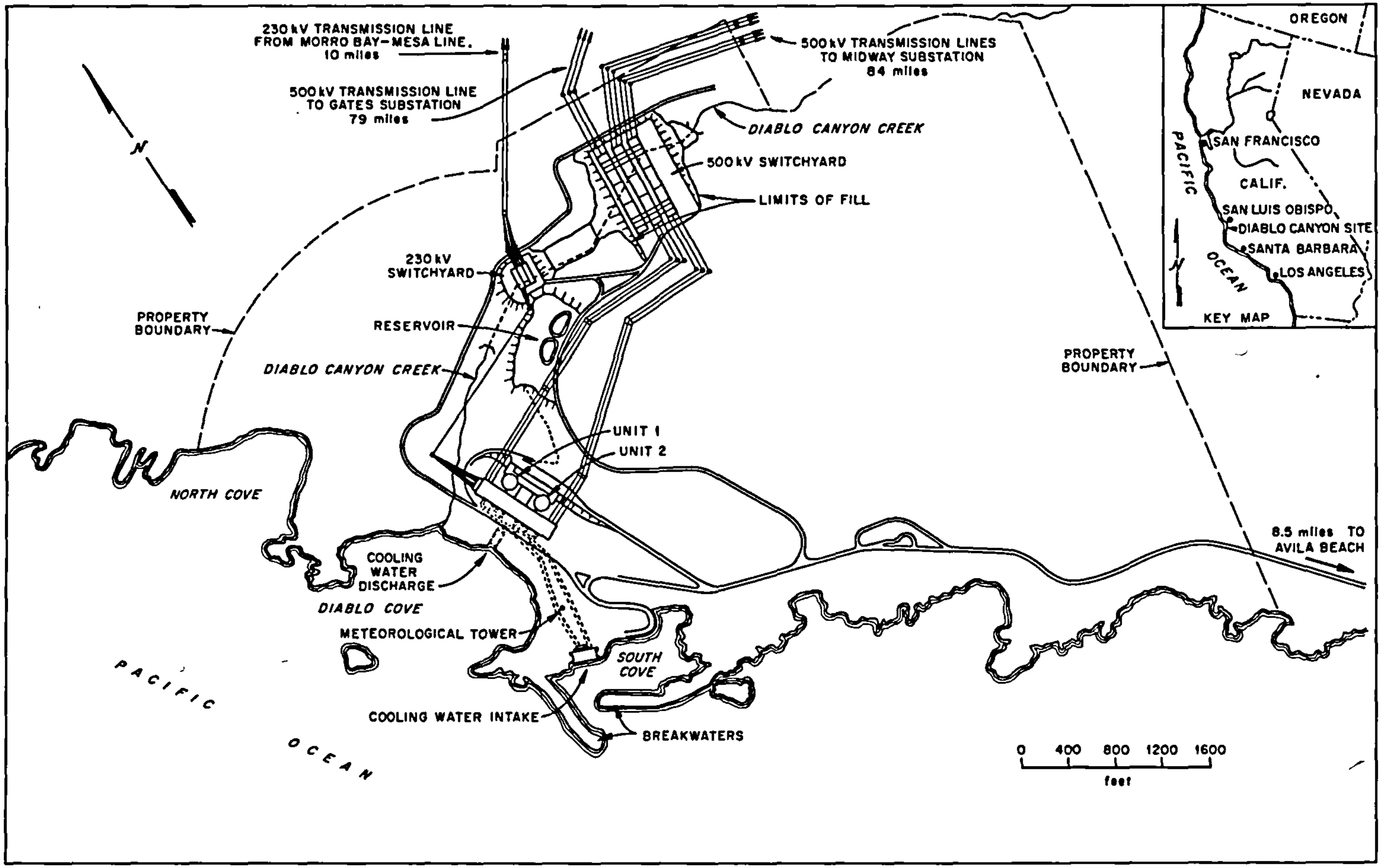


Fig. 2.3. Plot plan of the Diablo Canyon plant site.

area is 3,316 square miles, about 1/10 being under cultivation and 1/7 covered by the Los Padres National Forest.

Within the county, mountain ranges and valleys are well defined (Fig. 2.4). The majority of these geomorphic regions extend beyond the county's boundaries. The five mountain ranges include the Santa Lucia Range, which borders the ocean in the northern 2/3 of the county; the Tremblor Range forming the eastern boundary; the Caliente Range; the La Panza Range; and the San Luis Range. These ranges are generally oriented along a NW-SE axis. None is particularly high, although extensive sections are quite rugged and have been effective barriers to transportation. The higher peaks, many of which exceed 3000 ft, are located in the Santa Lucia and Caliente Ranges.

The coastal plains and valleys may be divided at Pt. Buchon into a northern and southern section by the interposition of the San Luis Range. The northern coastal plain consists primarily of a relatively narrow bench that backs up to the Santa Lucia Range. It is cut by numerous short stream valleys that empty into the Pacific Ocean. The southern sector consists primarily of the Arroyo Grande Valley, an upland area of ancient dunes referred to as the Nipomo Mesa, and a portion of the Santa Maria River Valley. The two valleys are relatively small but do contain some of the best agricultural land in the County. The south coastal area is also characterized by an extensive dune area of recent origin along the coast.

2.2 REGIONAL DEMOGRAPHY AND LAND USE

2.2.1 Population

San Luis Obispo County had a 1970 population of 105,690 and has a projected population of 131,500 for 1980. Population distributions for 1970 and projected population distributions for 1980 provided by the applicant for areas in 22-1/2° sectors at various distances from the plant site are shown in Figs. 2.5 through 2.8. Population growth in San Luis Obispo County has averaged 2% per year in the past few years due to the influx of retired people. Most of these people have settled in the coastal belt 10 to 40 miles northwest of Diablo Canyon. At the present time this area is growing at a rate of 4% per year and growth is expected to accelerate due to development of recreational facilities along the coast. Population projections through the year 2000 as tabulated by San Luis Obispo County[1] are presented in Table 2.1. These figures for 1980 differ from those presented by the applicant in Fig. 2.8, i.e., San Luis Obispo County's population projections are about 30% lower than the

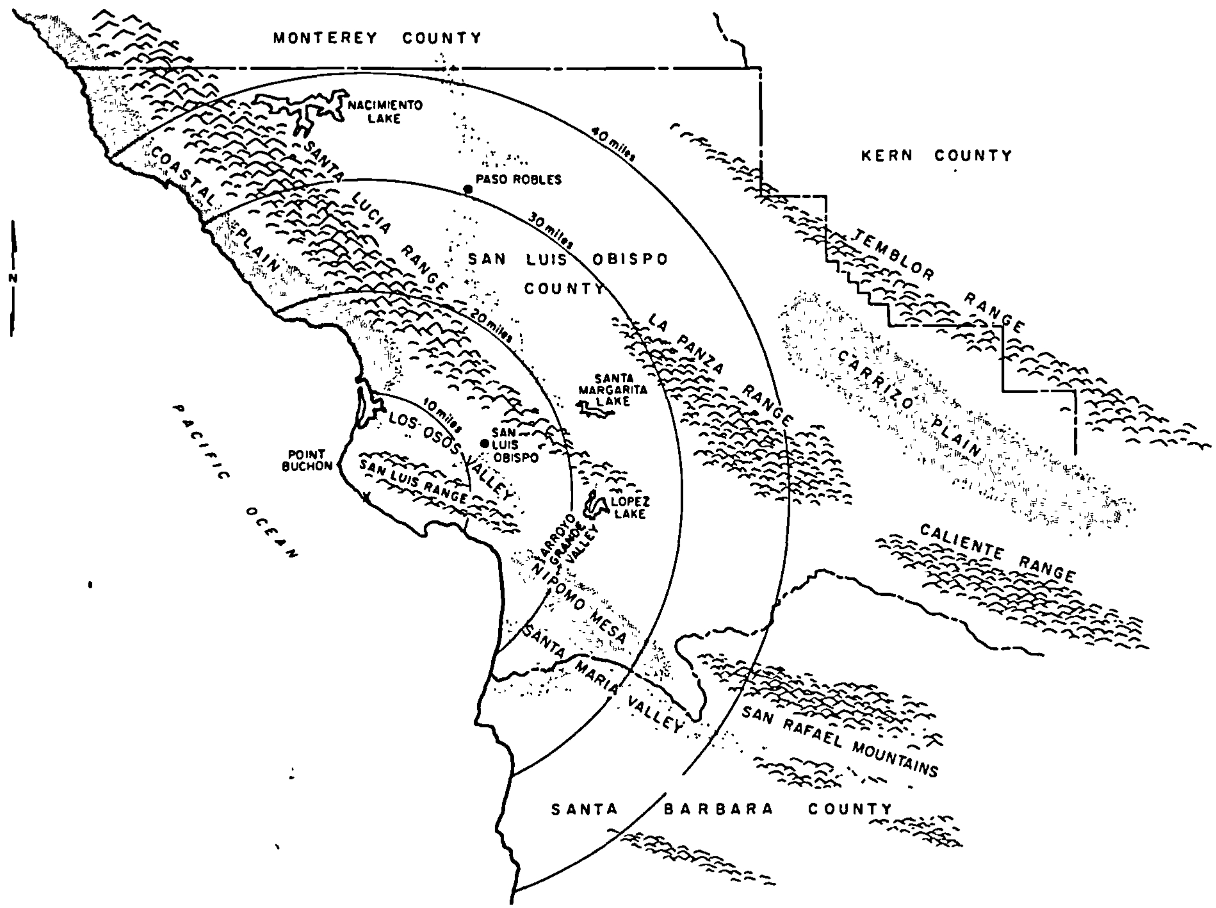


Fig. 2.4. Mountain ranges and principal drainage basins in San Luis Obispo County.

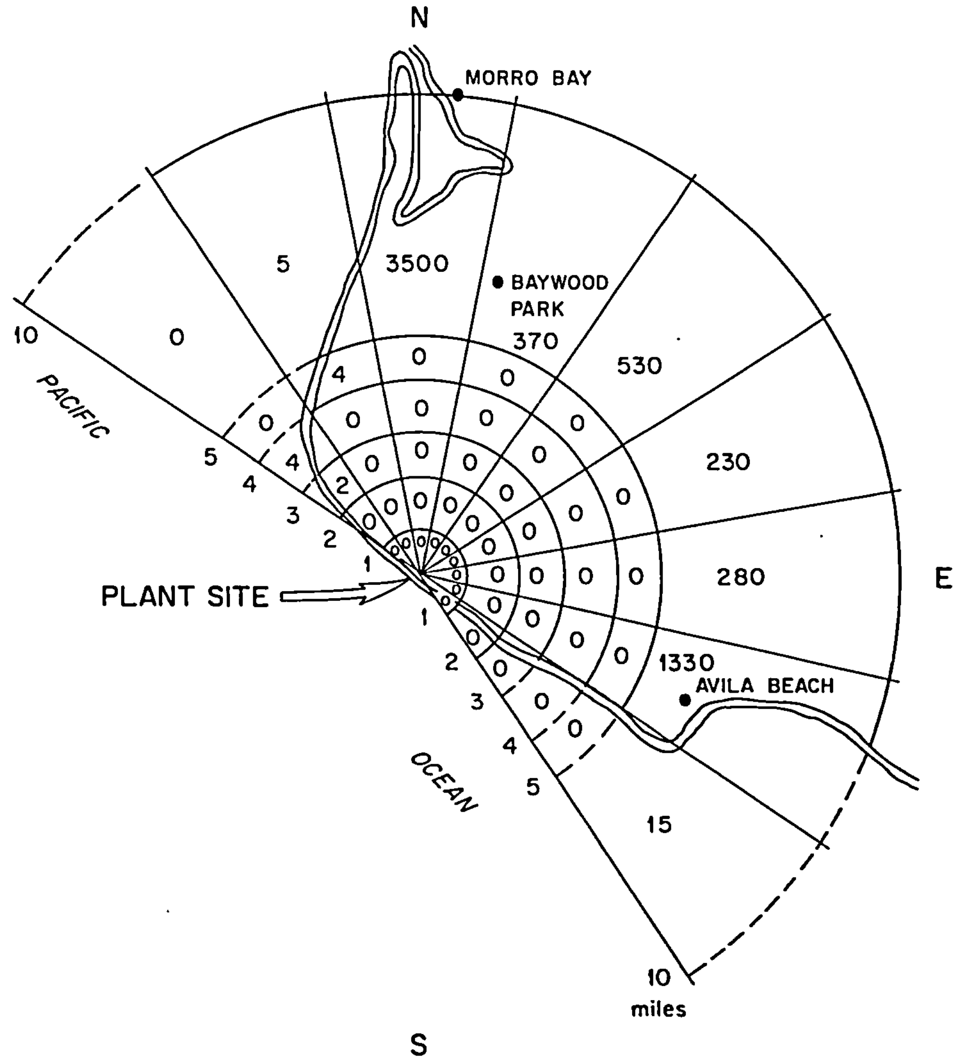


Fig. 2.5. Population distribution (1970 census) within 10 miles of the Diablo Canyon site.

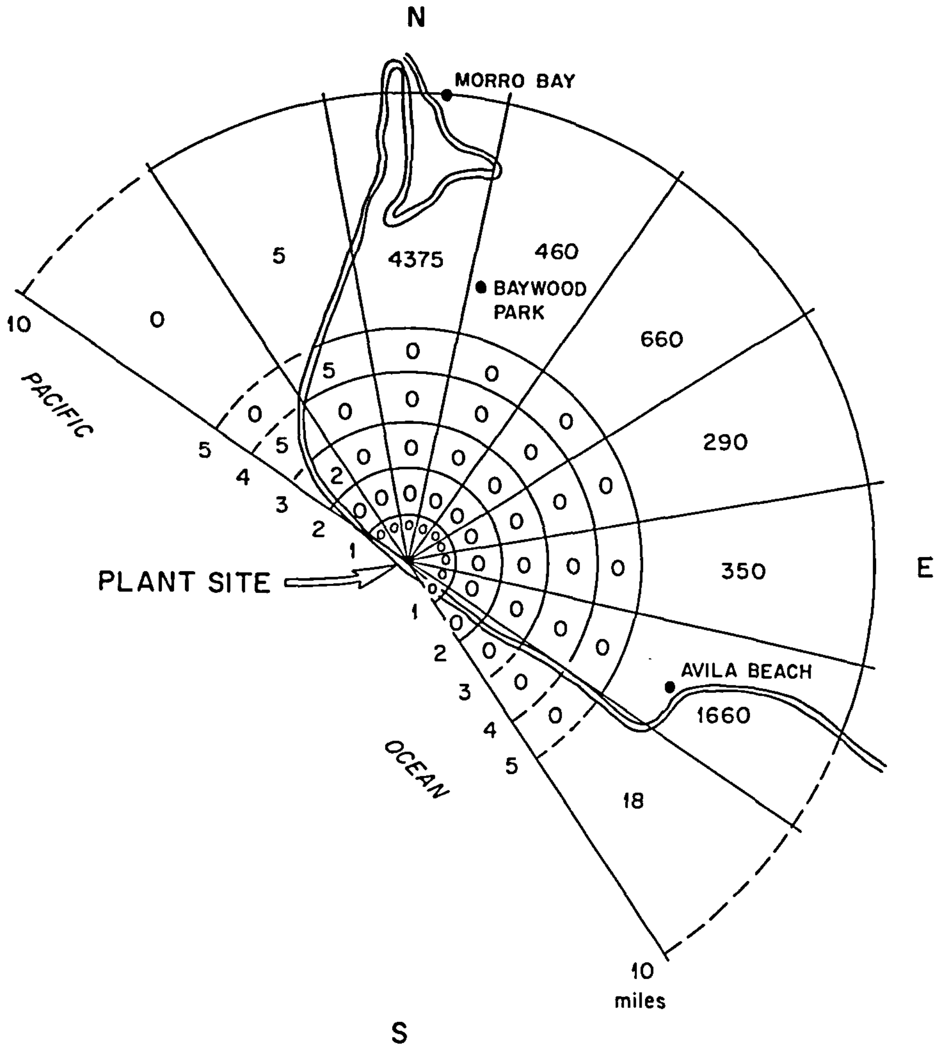


Fig. 2.6. Projected 1980 population distribution within 10 miles of the Diablo Canyon site.

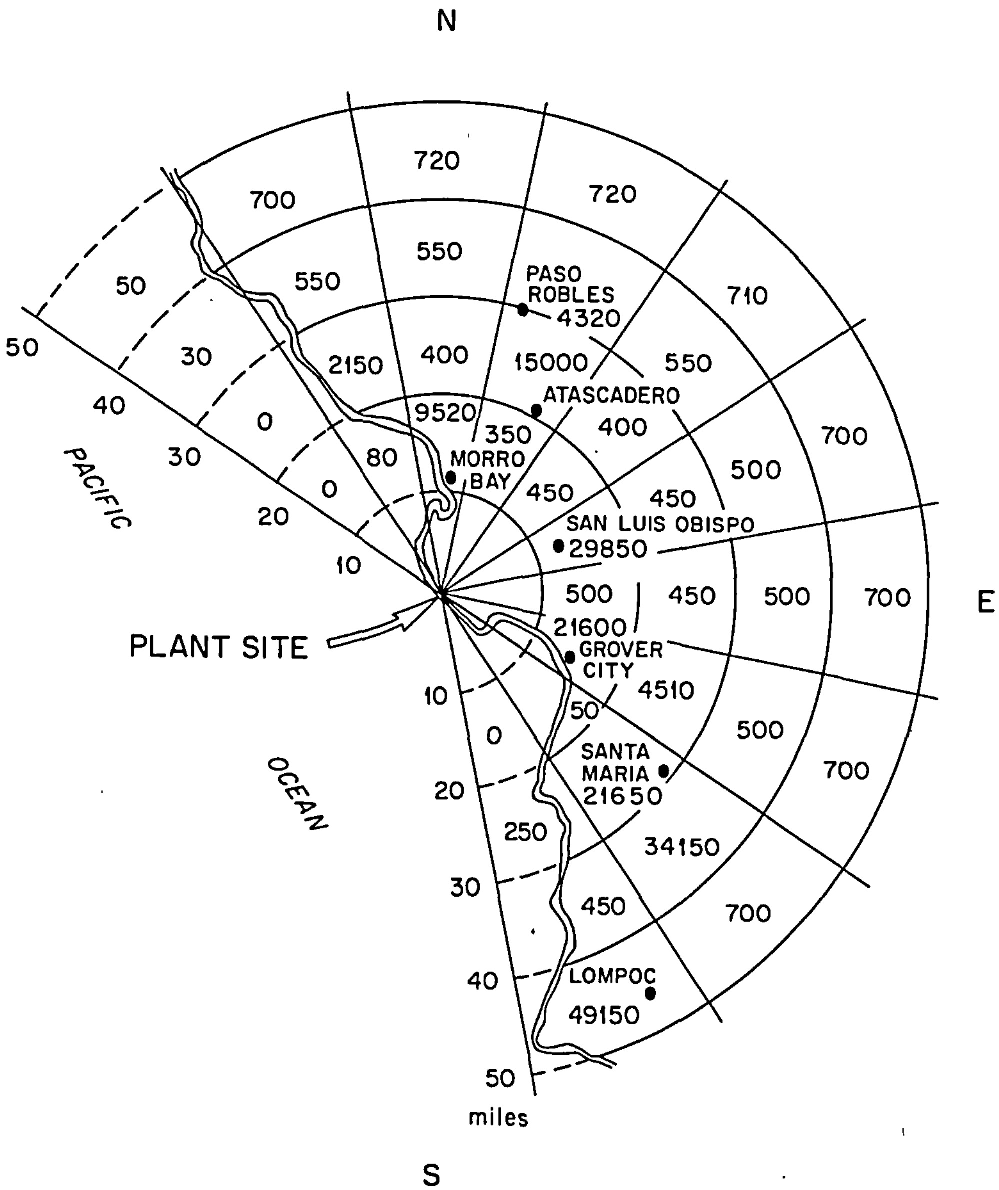


Fig. 2.7. Population distribution (1970 census) within 50 miles of the Diablo Canyon site.

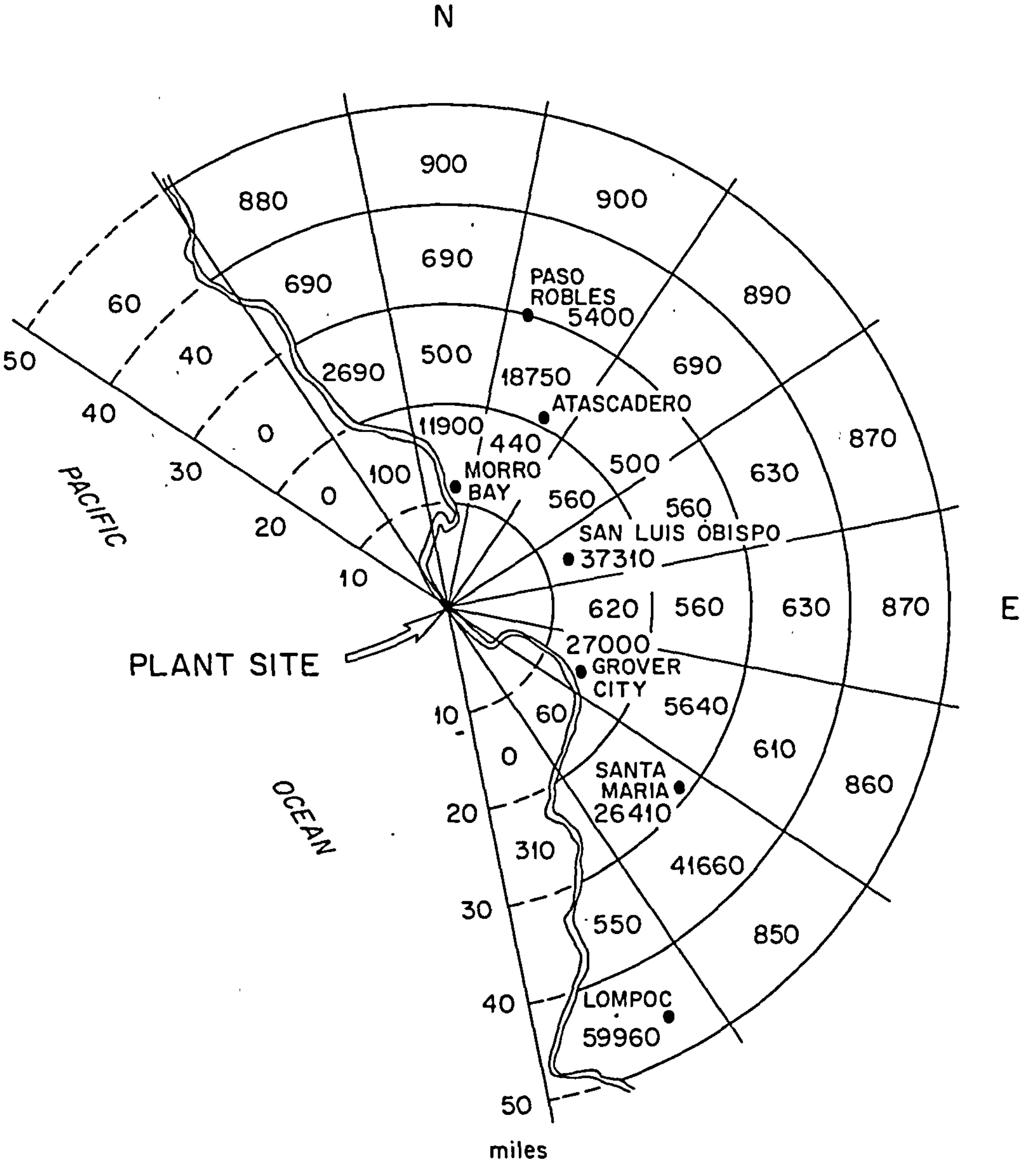


Fig. 2.8. Projected 1980 population distribution within 50 miles of the Diablo Canyon site.

Table 2.1. San Luis Obispo County Population Projection, 1970–2000

	1970	1975	1980	1985	1990	1995	2000
North Coast Division	15,152	17,100	20,300	24,600	29,500	35,000	41,700
Baywood–Los Osos	3,487	4,000	4,650	5,550	6,550	7,700	9,050
Cambria	1,716	2,050	2,550	3,150	3,750	4,450	5,200
Cayucos	1,772	1,900	2,100	2,300	2,600	2,900	3,300
Morro Bay	7,109	8,000	9,150	10,900	12,950	15,300	18,050
Atascadero Division	14,158	15,300	16,700	18,700	20,800	23,000	25,100
Atascadero (Town)	10,290	11,500	12,800	13,950	14,950	16,200	17,400
Templeton	743	780	830	900	960	1,050	1,150
Santa Margarita	726	780	850	930	1,030	1,100	1,250
Arroyo Grande Division	23,793	26,300	29,500	33,600	38,400	43,600	49,700
Arroyo Grande (City)	7,454	8,750	10,150	11,700	13,200	14,900	16,850
Grover City	5,939	6,500	7,050	7,800	8,600	9,400	10,250
Nipomo	3,642	3,900	4,300	4,800	5,450	6,100	6,850
Oceano	2,564	2,800	3,100	3,400	3,800	4,350	4,850
Paso Robles Division	12,194	12,800	13,400	14,300	15,400	16,800	18,300
Paso Robles (City)	7,168	7,700	8,150	8,700	9,250	10,000	10,800
San Miguel	808	800	805	815	830	850	875
San Luis Bay Division	5,711	6,300	6,900	7,800	8,800	9,800	11,000
Avila Beach	400	420	450	500	550	600	660
Pismo Beach	4,043	4,600	5,200	5,850	6,500	7,200	7,900
San Luis Obispo Divisions	34,682	39,200	44,700	51,000	58,600	67,300	77,200
San Luis Obispo (City)	28,036	32,500	36,900	42,250	48,800	56,850	66,200
County total	105,690	117,000	131,500	150,000	171,500	195,500	223,000

applicant's. Since dose calculations are made on the applicant's projections, calculations will be on the conservative side. The areas of higher population density are along the cost north of the plant site starting at Morro Bay and running north abbut 10 miles with scattered population areas further northwest around Harmony, Cambria, and San Simeon. Other areas of higher population density lie along the coast from Avila Beach south and the valley area between San Luis Obispo and Paso Robles. The mountainous areas, as would be expected, have low population densities and include the coastline from Avila Beach up to the Morro Bay area (a distance about 14 miles with Diablo Canyon approximately in the middle). Areas within 6 miles of the plant are practically uninhabited as shown in Figs. 2.5 and 2.6. The tabulation below indicates the location of all individual residences within 6 miles and Fig. 5.4 shows these locations.

Residence location	Distance from site (miles)
NNW	1-1/2
NW	1-3/4
NW	3-1/2
NNW	4-1/2
NNW	5
NNW	5-1/4
ENE	5-3/4
ENE	5-3/4
ENE	5-3/4

Since the area within 50 miles of the plant offers many recreation opportunities, there is a large influx of visitors to the parks, beaches, and Los Padres National Forest. A tabulation of transient populations is presented in Table G-4, of the applicant's Supplement #2 to his Environmental Report.[2] This table shows total yearly visitor-days as follows:

State Parks	5,090,000
County Parks	4,560,000
Los Padres National Forest	45,000

2.2.2 Land Use

For many years the land surrounding the site, for at least five miles, has been idle or used for cattle grazing. Since all these lands are privately owned large land grants, there have been no residential, industrial, or recreational developments. Much of the steeper sloped land within 8 miles of the site is wooded. In 1962 this land was rezoned at the owner request for recreational and commercial development. However, the County Planning Commission has no knowledge of plans to pursue such developments.[3] Since there are no public roads into the area and since the land is so rough, it is unlikely that land use will change in the next decade. Farther away from the site, 20 to 40 miles to the east, the Los Padres National Forest covers the majority of the land. Federal and state governments own 18% of San Luis Obispo County.

Agriculture

Because of the mountainous terrain, almost 2/3 of the county land has slopes of 30% or more. Land with slopes of less than 10% comprises only about 1/5 of the county. This nearly level land lies in a few coastal valleys such as Santa Maria and San Luis Valleys and along the northern border in the Salinas Valley and in the Carrizo Plains. It is understandable that these are the best agricultural lands. A report[4] on agricultural products produced in San Luis Obispo County in 1971 indicates the following:

Product	Monetary value ($)
Broccoli, cauliflower, celery, lettuce, romaine, and other vegetables	21,111,000
Hay; beets; wheat, barley, and other grain	11,487,730
Beef cattle, turkeys, and other livestock and poultry	20,819,000
Milk and eggs	3,966,400
Fruit and nuts	2,080,100
Total	59,464,230

In 1940, 1/3 of the work force was engaged in agriculture — in 1970 this force had decreased to less than 10%.

An Open Space Plan[5] developed by San Luis Obispo County Planning Department was issued in December 1971, and describes the county agricultural lands, crops, and problems. In brief, the use of land for agriculture is divided into six classifications: cropland, marginal cropland, orchards and vineyards, dry farmland and grains, range land, and marginal rangeland. San Luis Obispo County has had very limited success with its agricultural zoning program. For more complete information on the Open Space zoning program, see Appendix A of the referenced report.[5]

During the site visit, The San Luis Obispo County Agricultural Extension Office provided information on dairy farms (see Fig. 5.4) within 12-1/2 miles of the plant as follows:

Dairy Herd	Location (relative to plant site)
L. F. Domenghini (500 cows)	NNE, 12.5 miles
Roemer and Jones (200 cows)	NNE, 11 miles
Dutch Maid Farm (100 cows)	NE, 8 miles
Don Warden (200 cows)	NE, 8 miles
Jim Spreafico (150 cows)	E, 9.5 miles

Industry

The major industrial complex within about 50 miles of the plant is Vandenberg Air Force Base which is located 36 miles to the southeast in Santa Barbara County. It employs about 6,000 people. Other military bases are Hunter Liggett, 50 miles north; Camp Roberts, east of Hunter Liggett; and Camp San Luis Obispo, about 8 miles northeast. About 1/3 of the civilian work force in the county is employed by local, State, and Federal government, including the operation of State colleges, a State-owned hospital, and two State correction facilities. Other industries include petroleum production, printing, publishing, and food processing. Light miscellaneous industry (such as manufacturing) employs only about 5% of the work force. Sport fishing and recreational operations comprise the balance of employment.

A feasibility study on a 30 to 50 million gallon per day (Mgd) prototype desalting plant was announced on May 4, 1970 as a joint project between the United States Department of Interior — Office of Saline Water (OSW) and the State of California Department of Water Resources (CDWR). In a report[6] dated January 1971, it was announced that the Diablo Canyon Nuclear Power Plant site was the preferred location for such a desalting plant. Sites along the California coast from San Francisco to the Mexican Border were studied[7] and Diablo Canyon was selected because of the land features, remoteness, closeness to a nuclear plant, and the need for fresh, potable water in the San Luis Obispo-Santa Barbara County areas.

Kaiser Engineers performed the feasibility study and recommended that a 40-Mgd multistage flash seawater desalting plant be located NNW of the nuclear plant a distance of about 2000 ft. A plot plan showing the power plant and the proposed desalting plant is presented in Fig. 2.9. An artist sketch, Fig. 2.10, shows both plants, their relative location, and nearness to the ocean.

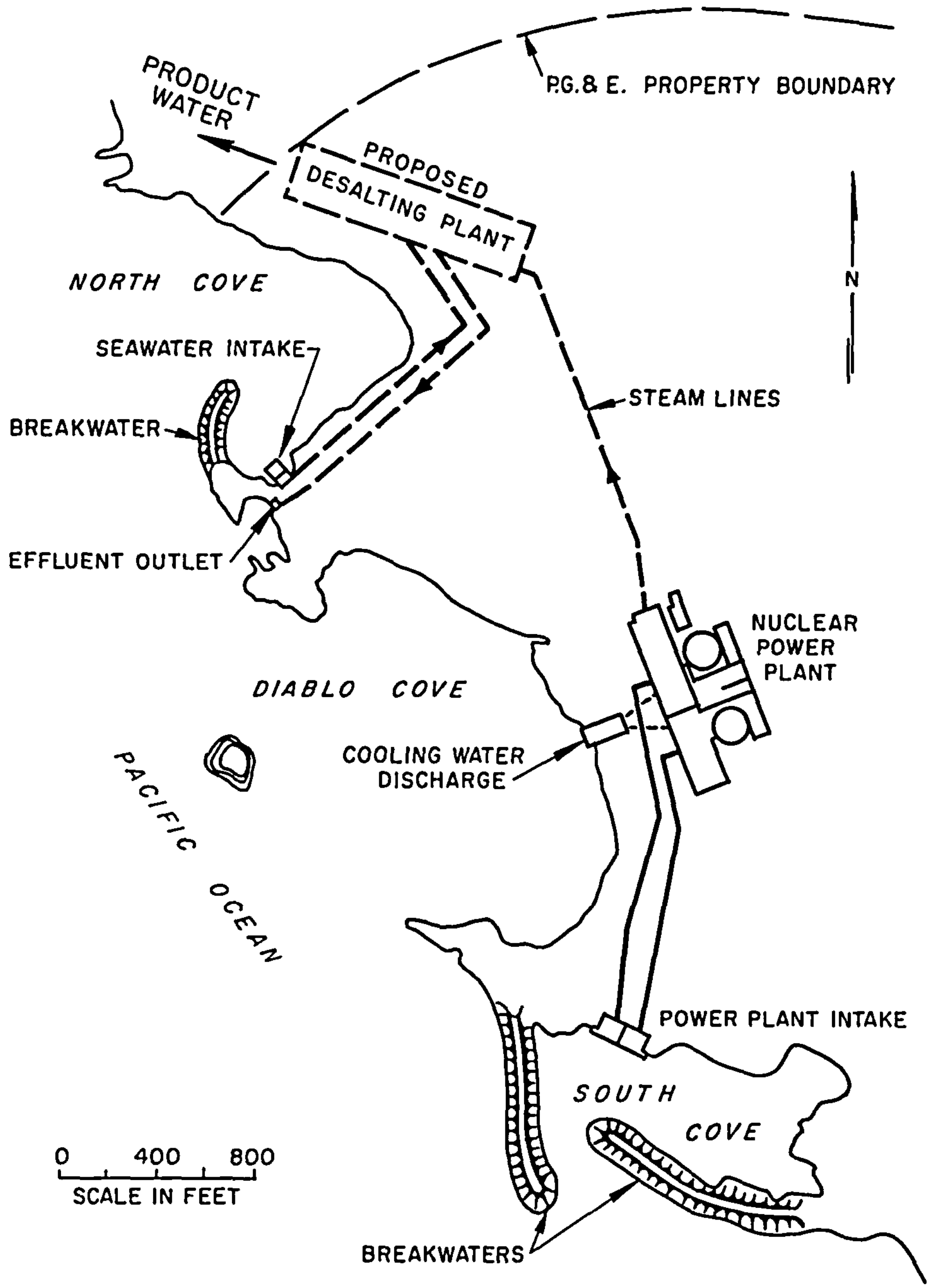


Fig. 2.9. Diablo Canyon plot plan, showing both the power plant and the desalting plant.

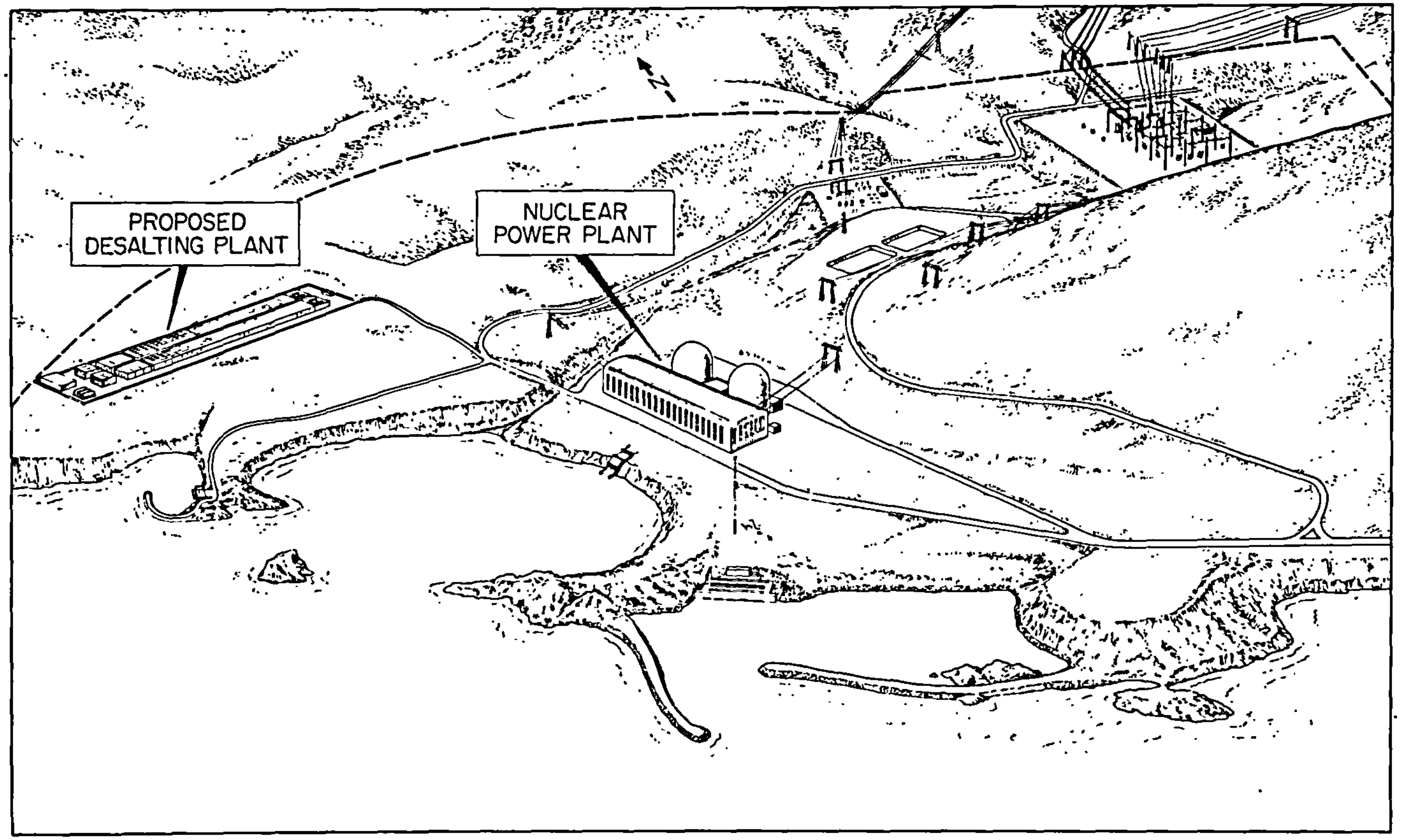


Fig. 2.10. Perspective of site showing relative locations of the desalting plant and the nuclear power plant.

Each of the nuclear plants (Unit 1 and Unit 2) would supply 600,000 lb/hr of steam (1,200,000 lbs/hr total) to the proposed desalting plant. This steam would be supplied at 80 psia so that brine temperatures would be optimized at 250°F.

Since the desalting plant has not been approved, an environmental impact assessment of the combined plants is not included in this report. Instead, the environmental impact assessment of the desalting plant has been prepared separately.[7]

Recreation

Recreation activities in San Luis Obispo County are concentrated along the coast line (except for the 12-mile stretch bordering Diablo Canyon), and around the lakes and reservoirs in the county. Recreational areas, i.e., state parks, state beaches, historic sites, etc., are listed in Table 2.2 and major recreational area locations are shown on Fig. 2.11.

The community of Morro Bay and the area around it has become one of the west coast's major private fishing-party centers, with many supporting attractions such as good restaurants, a museum, an artist colony, fishing piers, and quaint shops. The county provides areas for numerous recreational pursuits including fishing, boating, swimming, surfing, horseback riding, camping, hiking, and hunting.

It is evident that the area abounds in recreational opportunities; however, within a 5-mile radius from the plant site there are no designated lands or facilities for recreation. The coast line for about 6 or 8 miles on both sides of the plant is privately owned. The area is mountainous with no public road for access and the shore line is rocky. A study,[8] "Comprehensive Ocean Area Plan" and "Supplement," by the State of California indicates no plans for this area of shore line. The reports disclose that the area is undeveloped, and that the shore line is too rough for water use. It is considered to be valuable as a scenic attraction.

A study[9] by the State of California Department of Parks and Recreation reviewed recreational habits of Californians, the time they spend in recreation, their favorite activities, and the time they are willing to spend to reach recreational sites. In their study, they found Diablo Canyon area to be about 4 hours driving time away from most of the state residents except for the Santa Barbara population who could reach Diablo Canyon in one to two hours. They also found a preference among the majority of state residents to limit driving time to less than 2 hours for all recreational activities except camping. This study indicates that Diablo Canyon area

Table 2.2. Recreation areas within 40 miles of the Diablo Canyon Nuclear Power Plant

	Location (relative to plant site)		Ocean frontage (feet)	Area (acres)
	Direction	Distance (miles)		
San Simeon Beach State Beach	NNE	30	13,050	500
Atascadero Beach State Beach	N	13	9,950	72
Montana de Oro State Park	NW	3	19,200	4000
Morro Bay State Park	N	8	38,600	1477
Morro Strand State Beach	N	15	6,850	34
Pismo Beach State Beach	SE	15	29,652	959
Avila Beach County Park	ESE	7	2,046	4
Cayucos Beach Park	N	16		14
Hearst State Park	N	37		7
Morro Rock Park	N	11		100
Oso Flaco Lake	SE	18		80
El Choro Regional Park	NE	12		500
Lopez Recreational Area	E	24		4300
Laguna Lake	E	10		
Santa Margarita Lake	ENE	23		1068
Atascadero Lake County Park	ENE	19		19
Nacimiento Recreation Area	N	37		5400
Hearst Castle, a State Historical Monument	N	37		
Mission San Miguel	NNE	36		
Port San Luis	ESE	7		
Mission San Luis Obispo de Tolosa	E	12		

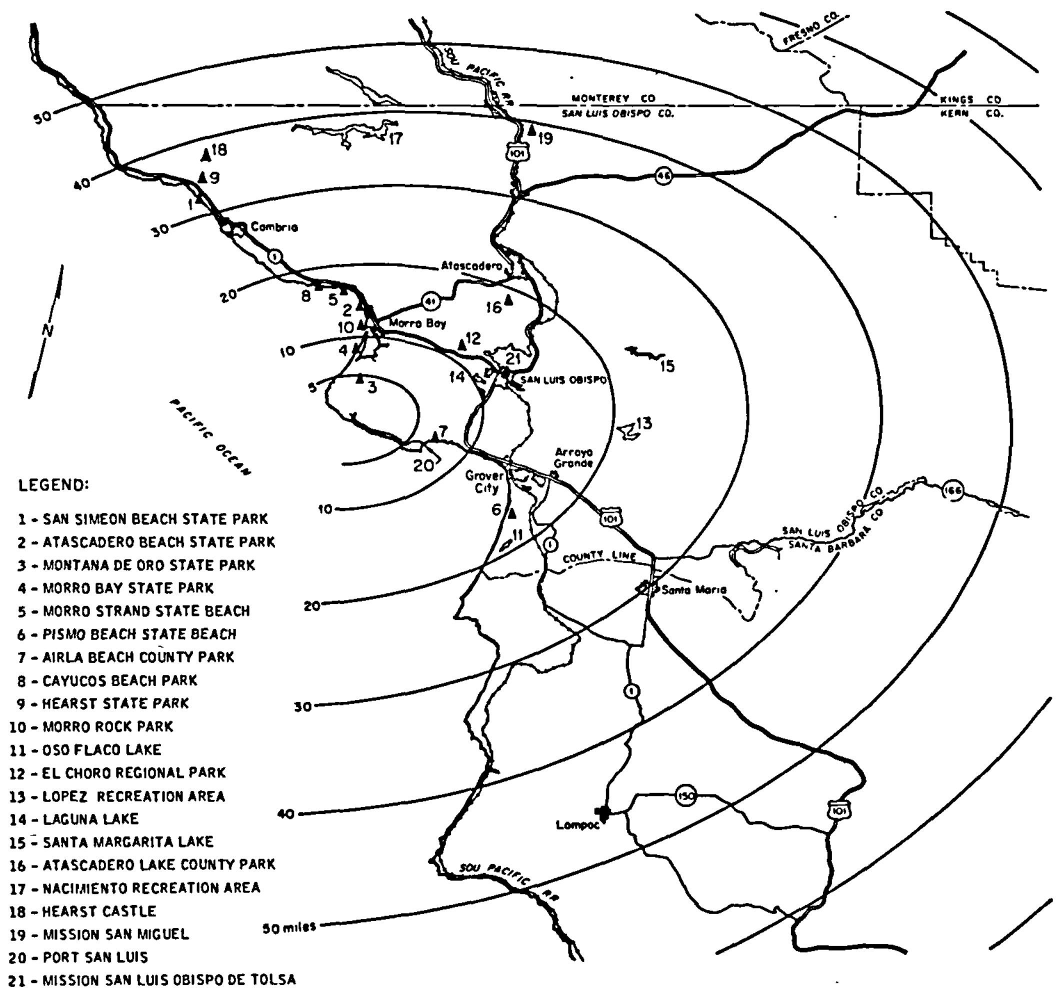


Fig. 2.11. Recreation areas within 50 miles of the Diablo Canyon site.

will not be used for recreation until many other areas have been developed. Another California State study[10] investigated ocean shore-line recreational demands, availability of use facilities, and deficiencies or shortage of use facilities. They found that for the central coast area, the most popular recreational activities, by percent of participation, were

beach use	86%
walking-hiking	65%
swimming	50%
picnicking	45%
camping	42%
photography — painting	38%
beach combing	32%
fishing	30%

At Diablo Canyon Area and the 12 miles of adjacent coast line, beach use, swimming, fishing, and beach combing would not be practical. However, hiking, camping, picnicking, and artistic pursuits could be enjoyed along the coast line if access roads were available.

San Luis Obispo County "Open Space Plan"[5] describes the work being done by the county to acquire lands and to develop recreational properties. This study has designated usage assignments for all lands in the county. Figure 2.12 shows their assignments for the lands within a 10-mile radius of the plant.

On the site visit, the staff talked with the State Director of Parks and Recreation.[3] He stated that, of the sites considered for the plant, his department thought Diablo Canyon was probably the best choice from their point of view.

2.2.3 Ocean Use

In the Morro Bay, Port San Luis, Avila Beach, and Pismo Beach areas (for locations see Fig. 5.1), the ocean provides opportunity for water sports and fishing. Sport fishing, including deep-sea fishing, is popular around Morro Bay and Avila Beach. The area offshore Diablo Canyon is an important and significant area for production of abalone and is heavily fished commercially[11] (transcript of hearing pages 439 and 838). The applicant[2] has submitted fishing information (ER, Supplement No. 2, Volume I, pages IV-B-2 through IV-B-20) that discusses both commercial and sport fishing in detail. Summaries of these data are presented in Section 5.2.

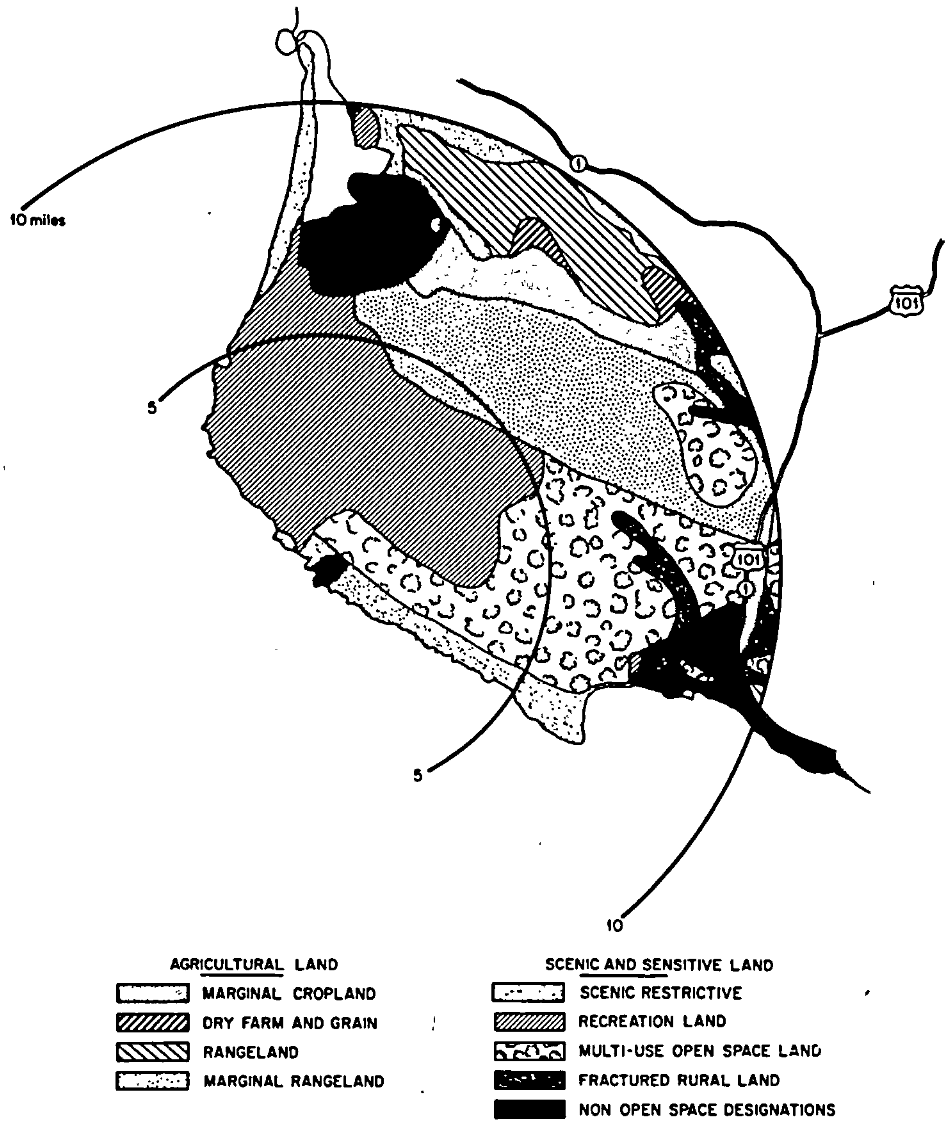


Fig. 2.12. Open space plan for San Luis Obispo County.

The California Department of Fish and Game[12] states that fish catches for the Morro Bay area and Avila Beach area for 1970 were as follows:

	Pounds	Value ($)
Morro Bay	6,834,947	1,672,566
Avila Beach	1,925,676	420,770
		2,093,336

Another use of the ocean involves transportation of petroleum. There are two oil-loading facilities — one at Avila Beach, and one just north of Morro Bay.

2.2.4 Economy

The economy of San Luis Obispo County is reasonably stable because of the high employment by the state, county, and local governments (about 1/3 of work force). Trade and service employment makes up another 1/3 of the labor force. Total taxable sales in the county's retail stores was 1.3 billion in 1970[13] at which time the estimated personal income was $330 million. A guide to the economic makeup is shown by Table 2.3.[13]

2.3 HISTORIC AND NATURAL LANDMARKS

The recorded history of San Luis Obispo County begins in 1542 when the first Spaniards were met by friendly Indians who presented gifts of acorns and fish to the explorers. The principal Indian tribe of the county was the Chumash who buried their dead, spoke a dialect of the Hokan language, wove beautiful basketry, and made the finest plank boats in all of North America. Artifacts of the Chumash have been preserved in the San Luis Obispo County Museum and the museum of the San Luis Obispo de Tolosa Mission.

Actual settlement of the land began in 1772 when Father Junipero Serra established California's fifth mission (the county's first mission), named San Luis Obispo de Tolosa, see Fig. 2.13. In 1797, Father Fermin Francisco de Lasuer founded a second mission in the northern part of the County and called it San Miguel Arcangel.

There is no recorded history that mentions the Diablo Canyon site area. Whether or not early explorers visited the site is not known. The earliest known visits to the area tell of white traders

Table 2.3. Statistical profile of San Luis Obispo County, 1966–1970

	1966	1967	1968	1969	1970
Population (midyear)	99,400	100,500	101,700	103,200	106,700
Taxable sales in retail stores[a]	1,250.0	1,252.0	1,253.0	1,287.0	1,307.0
Personal income[a]	236.9	253.1	284.6	309.3	330.0[b]
Construction					
Total building valuation[a]	13.5	15.2	17.1	22.0	25.7
Residential valuation[a]	8.3	8.8	10.5	12.2	19.5
Nonresidential valuation[a]	5.2	6.4	6.6	9.9	6.2
Number of dwelling units included in building permits	461	547	566	708	1,249
Employment					
Labor force	31,250	31,950	33,300	35,450	37,850
Total civilian employment	29,650	30,400	31,850	33,750	35,850
Unemployment	1,600	1,550	1,450	1,700	2,000
Percent unemployment	5.2	4.9	4.4	4.9	5.3
Seasonally adjusted	5.2	4.9	4.4	4.9	5.3
Mining	150	100	150	150	150
Construction	1,100	950	1,050	1,150	1,550
Manufacturing	1,000	1,150	1,200	1,250	1,350
Transportation, communications, and utilities	1,500	1,550	1,500	1,450	1,650
Trade	5,450	5,500	6,000	6,500	6,250
Finance, insurance, and real estate	650	650	700	750	800
Services	3,950	4,200	4,450	4,550	5,000
Government	8,450	9,100	9,400	10,300	10,750
Other nonagricultural employment	4,400	4,350	4,550	4,650	4,650
Agriculture	3,000	2,850	2,850	3,000	3,050

[a]In millions of dollars.
[b]Estimate.

Fig. 2.13. San Luis Obispo de Tolosa Mission

who visited the Morro Bay area about 1587 and San Luis Bay about 1595. During Mexican rule, the land around Diablo Canyon was a part of one of the land grants made by the Mexican Government to an individual. Since that early grant, the land has had many owners. The south portion of the site has been in the possession of the Luigi Marre family since 1892.

In the long period of history before the Spanish explorers, it is thought that the site was inhabited by Indians who lived along the coast fishing and hunting for their food. Consequently, three archaeological sites in the plant area were investigated by archaeologists. The report of their findings has not yet been published; however, a manuscript is on file with the Central Archaeological Foundation, Sacramento, California. A letter and map from the State Park Archaeologist for California Department of Parks and Recreation, is included in this report as Appendix 2-1. He states that three areas on the site are of archaeological importance because they have not been vandalized and very little is known about habitation patterns and material customs of the Indians. One of these sites has been partially covered with stockpiled excess fill, consequently, the State Park Archaeologist has requested that the applicant keep his office advised of construction activities so that he can recommend salvage archaeology as required. The State Archaeologist also states that there are no known historic sites located directly on Pacific Gas and Electric Company property. The nearest item of even remote interest is an adobe two or three miles southeast. San Luis Obispo County has several adobes which have been preserved for historical significance.

The February 28, 1973, National Register of Historic Places and the supplement of March 6, 1973, list four locations in San Luis Obispo County. These are

Nipomo, "Dana Adobe," southern end of Oak Glen Ave.
San Miguel, "Caledonia Adobe," 0.5 miles south of 10th St.
San Miguel, "Mission San Miguel," U.S. Highway 101
Hearst San Simeon State Historic Park, about 3 miles northeast of San Simeon

2.4 GEOLOGY AND SEISMOLOGY

The information presented in this section is summarized from the PSAR, Appendices B-E, and other sources.[14-22]

2.4.1 Geology

The coast in the vicinity of the site is generally straight but rugged with small coves, points of rock, and many big rocks half awash in the water. The seaward edge of the coastal terrace is a near-vertical cliff about 60 ft high which shows clearly a cross section of the geological formations that underlie the site. Bedrock and overlying surficial deposits are exposed almost continuously along the walls of Diablo Canyon and on the main hillslopes in the northeastern part of the area. The prominent points and ranges along the coastline, as well as the offshore rocks and shoals, are essentially bare bedrock. Man-made exposures were at first limited to a few shallow road cuts in and near Diablo Canyon. However, in the course of the geological studies, a number of large deep trenches were dug, totaling several thousand feet in length, so that ample opportunity was given for study. The entire area is underlain by a complex sequence of stratified marine sedimentary rocks and tuffaceous volcanic rocks, all of Tertiary (Miocene) age. Diabasic intrusive rocks are locally exposed high on the walls of Diablo Canyon at the edge of the area. Both the sedimentary and volcanic rocks have been folded and otherwise disturbed over a considerable range of scales. Surficial deposits of Quaternary age are widespread. In a few places they are as thick as 50 ft. Like many other parts of the California coast, the Diablo Canyon area is characterized by several wave-cut benches of Pleistocene age. The oldest bedrock unit exposed in the power plant area is the Obispo Tuff, of Miocene age. The rock varies from dense to highly porous and from thin layered to nearly massive. The most widespread rock type is a vitric tuff with rare to moderately abundant tabular crystals of sodic plagioclase. The Monterey formation underlies most of the power plant area including the location of the plant itself. The predominant rock types making up the formation are silty and tuffaceous sandstone, siliceous shale, shaly siltstone and mudstone, and impure vitric tuff and silicified limestone and shale.

The site has been investigated by cutting four trenches down to the bedrock. This investigation revealed no evidence of a major fault in the area. There is evidence of surface disturbances, some of which are faults, in the plant site. None of the breaks offsets the interface between the bedrock and the terrace deposits and none extends upward into the surficial cover. The age of the breaks at the site has been established to be at least 100,000 years, indicating that the possibility of fault-induced displacements at the site is sufficiently remote to be disregarded.

2.4.2 Seismology

There is a record of only one earthquake within 20 miles of the site which has caused damage, and this one was at San Luis Obispo in 1830. A church was damaged but, as these structures in those days were generally poorly built, the shock need not have been a heavy one. The Earthquake and Epicenter Fault Map[15] prepared by the Department of Water Resources, State of California, shows several small shocks of magnitude 4 to 4.4 with epicenters distant about 20 miles from the site. On November 4, 1927, a fairly large earthquake with a magnitude of 7.3 occurred off the coast some 60 miles southwest of the site, presumably on the western extension of the Santa Ynez Fault. The same fault system was responsible for a magnitude 6.3 shock in 1925 and a magnitude 6.1 shock in 1941. These three off-shore shocks were too distant to have posed any threat to structures at the site.

The nearest major fault system to the site is the Nacimiento Fault some 20 miles distant. In 1952 there was a shock of magnitude 6.0 on this fault at a distance of 44 miles from the site. This is the largest recorded earthquake on this fault. However, the fault system is an important one, and must be assumed to be capable of producing a major shock.

The San Andreas fault passes some 48 miles from the site.

The maximum earthquakes which might disturb the site have been taken as follows:

A. A great earthquake on the San Andreas fault at a distance of 48 miles and with a magnitude of 8-1/2. The ground acceleration at the site would be 0.1 g.

B. A large earthquake on the Nacimiento fault at a distance of 20 miles, and with a magnitude of 7-1/4. The ground acceleration at the site would be 0.12 g.

C. A large offshore earthquake on the extension of the Santa Ynez fault at a distance of 50 miles and with a magnitude of 7-1/2. The ground acceleration at the site would be 0.05 g.

D. An aftershock triggered by earthquake A above, having magnitude 6-3/4 and centered at the site at a depth of 6 miles. The ground acceleration would be 0.20 g.

The Diablo Canyon plant has been designed to withstand safely such earthquakes as discussed in the staff's Safety Evaluation Report.[23]

The possibility of a tsunami, or an earthquake induced "tidal wave," was considered at length by the applicant. However, experience has shown that the generally straight coastline at the site fails to amplify the tsunami waves from distant sources so that the waves have, at most, an amplitude of only 5 to 6 ft. Nearby earthquakes are largely the result of horizontal motion of the earth which offers poor coupling with the water and large waves are not produced. A study of areas where earthquakes of moderate magnitude have been reported to have produced large tsunamis has shown either that the reported wave was much exaggerated or that the shape and profile of the shoreline were markedly different from that at Diablo Canyon. The combination of maximum tsunami with maximum tide and storm waves would produce a runup of only 18 ft above MLLW, while the plant could tolerate a runup of 30 ft.

2.5 HYDROLOGY

Diablo Canyon Creek drains into the ocean in the northern part of the site. The Creek has a drainage area of 2500 acres and is incapable of producing a flood that would cause any damage.

Groundwater below the site probably lies at levels about that of the bottom of the lower Diablo Canyon. No significant groundwater resource exists in this area.

The hydrology of San Luis Obispo County is described in detail in the San Luis Obispo County Planning Department's "Open Space Plan."[5]

Water for the city of San Luis Obispo is obtained principally from Salinas Reservoir about 23 miles ENE of the site. The city also obtains smaller quantities of water from Whale Rock Reservoir 17 miles N of the site, from Chorro Reservoir about 13 miles NE of the site, and from a few small uncovered reservoirs 18 miles NE of the site. There is also a proposal to build a reservoir in Lopez Canyon 20 miles E of the site. Smaller towns in the region of the San Luis Obispo depend on wells for domestic water although, in general, groundwater is not an important resource in this area. The closest water supply is located 6 miles to the N of the site. The operation of the Diablo Canyon power plant poses no threat to any of these water supplies.

There is little change in the ambient ocean water temperature at the Diablo Canyon Site throughout the year. Monthly averages range from a low of about 50°F, which may occur during any or all of the first six months of a given year, to a high of about 63°F, usually observed in the months of September and October. The lowest observed temperature in the past 5 years is 45°F and the highest is 63.5°F. The maximum diurnal variation observed at Diablo Cove is 6.0°F.

Additional information on the ocean, particularly ocean currents, is given in Section 3.

2.6 METEOROLOGY

Weather typical of the central California coast best describes the climate at the site. During May through September the climate is dry because of the Pacific Anticyclone which prevents Pacific storms from moving in across the site. As the Pacific Anticyclone moves south in the winter, the Pacific storms move in bringing the wet season (November through March). Wind directions generally follow the coast blowing usually from the northwest. Second most frequent direction is from the southeast. Temperatures are mild with very little variation from summer to winter.

Rainfall averages about 16 inches per year at the site but records indicate that rainfall varies from 9 inches in a dry year to 27 inches in a wet year.

Precipitation data for areas around the site were presented by the applicant in his Preliminary Safety Analysis Report (PSAR), Appendix A. Table 2.4 shows portion of this data. More than 80% of the

Table 2.4. Rainfall in the Diablo Canyon area

Month	Inches of rainfall		
	Pismo Beach (10 years of records)	San Luis Obispo (10 years of records)	Morro Bay fire station (7 years of records)
November	1.82	1.72	2.38
December	2.65	3.94	1.80
January	3.79	4.72	1.94
February	3.05	4.12	3.45
March	2.10	3.34	1.74
Wet season monthly average	2.68	3.57	2.26
April	1.92	1.60	1.42
May	0.34	0.51	0.25
June	0.04	0.11	0.05
July	0.06	0.01	0.00
August	0.01	0.02	0.02
September	0.20	0.20	0.23
Dry season monthly average	0.13	0.17	0.11
October	0.46	0.82	0.59
Yearly average	16.44	21.11	13.87

annual rainfall occurs during the winter wet season. Cloudiness is more prevalent during winter storm periods, and fogging occurs most frequently during the dry season.

The average annual temperature at the site and surrounding area is about 55°F with a high mean of 60°F in August and a low mean of 52°F in January. Extremes range from 100°F to 26°F. Table 2.5 shows average temperatures for Morro Bay and Pismo Beach. All these temperatures show the strong coastal maritime influence.

Prevailing wind direction is from the NW (12 miles/hr average) occurring predominantly during the dry season. The second predominant direction is from the SE (6 mph) during the wet season. Tables in Appendix 2-2 show direction frequency of all wind occurrences under C, D, and F stability conditions.

In July of 1967, an on-site program of meteorological measurements was started and data collection has continued. Data for the period from July 1967 to July 1969 were summarized to establish baseline conditions of the site. Supplement No. 2 to the Environmental Report[2] published data[24] collected from July 1967 through October 1969. Data on temperatures, wind speed and direction, and turbulence intensities were recorded at 4 stations, and two more stations in Diablo Canyon recorded wind speeds only.

The staff has made detailed studies of the meteorological conditions at the site and presented their findings in the Safety Evaluation Report.[23] The summary of their findings, and the comments of the Environmental Science Service Administration are both contained in Appendices 2-3 and 2-4.

2.7 ECOLOGY OF THE SITE AND ENVIRONS

2.7.1 Terrestrial Environs

The coastal zone in the Diablo Canyon area is typical of the central California coast. Physiographically the site area varies from open ocean, coastal rocks, rocky headlands, and sandy beaches to a coastal stream (Diablo Canyon creek) which drains the slopes of the Irish hills and a coastal plain which rises above the ocean. The major vegetative communities extending from the ocean inland are coastal sagebrush, chaparral, grassland, and woodland-savannah. General characteristics of these abundant communities are shown in Table 2.6. Although the above occur in pure stands, mixed stands are also quite common.

Table 2.5. Temperature data for the Diablo Canyon area

In degrees F

Month	Morro Bay[a] mean temperature	Pismo Beach[b]				
		Mean temperature	Mean maximum	Mean minimum	Extreme maximum	Extreme minimum
November	56.0	58.3	69.4	47.1	91	29
December	53.0	54.6	65.3	43.9	92	28
January	52.4	51.7	61.3	42.0	80	24
February	53.3	53.7	64.0	43.4	82	29
March	53.1	54.8	65.5	44.0	88	30
Wet season average	53.6	54.6	65.1	44.1		
April	54.8	56.0	66.1	46.1	90	32
May	54.1	57.3	67.5	47.1	89	36
June	56.8	59.8	69.8	49.7	96	40
July	58.2	60.5	68.7	52.3	104	38
August	59.7	60.6	68.5	52.7	102	43
September	59.7	62.1	71.8	52.3	99	41
Dry season average	57.7	60.1	69.3	50.8		
October	60.9	60.6	71.3	49.8	95	32

[a]Seven years of records.
[b]From 1951 to 1960.

Table 2.6. Characteristics of three major plant communities found in the Diablo Canyon Area[a]

Chaparral (*Adenostoma-Arctostaphylos-Ceanothus*): Very dense vegetation of broadleaf evergreen sclerophyll shrubs	
Dominants:	Chamise (*Adenostoma fasciculatum*), Manzanita (*Arctostaphylos* spp.), California lilac (*Ceanothus* spp.)
Other components:	*Arctostaphylos glandulosa, A. glauca, A. manzanita, A. parryana, A. pungens, A. viscida, A.* spp., *Ceanothus cuneatus, C. foliosus, C. impressus, C. integerrimus, C. leucodermis, C. sorediatus, C. spinosus, C. thyrsiflorus, C. velutinus, Cercocarpus betuloides, Fremontia californica, Heteromeles arbutifolia, Pickeringa montana, Prunus ilicifolia, Quercus dumosa, Rhamnus californica, R. crocea, Trichostema langtum, Yucca whipplei*
Coastal sagebrush (*Salvia-Eriogonum*): Moderately dense vegetation of broadleaf evergreen shrubs, rarely more than 1.5 m tall	
Dominants:	California buckwheat (*Eriogonum fasciculatum*), White sage (*Salvia apiana*), Black sage (*Salvia mellifera*)
Other components:	*Artemisia californica, Encelia californica, Eriophyllum confertiflorum, Haplopappus squarrosus, H. venetus, Horkelia cuneata, Rhus integrifolia, Salvia leucophylla*
California oakwoods (*Quercus*): Medium tall or low broadleaf evergreen or semideciduous forests with an admixture of low to medium tall needle-leaf evergreen trees	
Dominants:	Coulter pine (*Pinus coulteri*) (mostly in higher elevations), Digger pine (*Pinus sabiniana*), Coast live oak (*Quercus agrifolia*), Canyon live oak (*Quercus chrysolepis*), Blue oak (*Quercus douglasii*), Valley Oak (*Quercus lobata*), Interior live oak (*Quercus wislizenii*)
Other components:	*Aesculus californica, Ceanothus cuneatus, Cercis occidentalis, Eriodyction californicum, Rhamnus californica, Ribes quercetorum, Umbellularia californica, Juglans californica, Quercus engelmannii, Rhus integrifolia, R. ovata*

[a]From A. W. Kuchler, "Potential Natural Vegetation of the Conterminous United States," Am. Geograph. Soc. Spec. Publ. 36, American Geographical Society, New York.

The Diablo Canyon Power Plant Site is located on a gently sloping marine terrace at an elevation of 50-150 ft. To the west, directly adjacent to the power plant site, are steep rock cliffs. To the east, the marine terrace rises rapidly, forming peaks and ridges with elevations exceeding 1,000 feet.

Vegetation of the cliffs, headlands, and marine terrace is composed of low growing perennials and patches of herbaceous annuals (Fig. 2.14). *Dudleya abramsii* is commonly found on the sheer cliff faces. Italian ryegrass and members of the mint and dandelion families generally occur in association with *Dudleya* on the rocky outcroppings.[2] The rocky shoreline and bluffs comprise a special ecological niche for some birds, and several species are resident and nest in this type of habitat. Double-crested cormorants and western gulls, along with lesser numbers of pigeon guillemots and black oystercatchers inhabit the rocky shoreline and immediate offshore rocks.[25] The tabulation of species in Table 2.7 and those tables following are composites of the species found in all habitats and are not broken down to the particular community level. California sea lions also utilize the offshore rocks. Upland game does not contribute significantly to overall recreational hunting within this part of the coastal zone. Mammals which probably occur in the vicinity of Diablo Canyon are listed in Table 2.8.

Chaparral vegetation is a woody scrub community which characteristically contains *Adenostoma, Arctostaphylos*, and *Ceanothus*. The chaparral of the rolling hills in the coastal area (Fig. 2.15) are mixed stands of these species and various species of *Quercus* and *Rhus*.[26] The scrub growth varies between 2 and 5 ft in height and is considered unsocial in that each plant stands by itself and has a clear space about it.[27] Pockets of grassland vegetation are interdispersed in the chaparral. This vegetation is dominated by naturalized grasses: soft chess (*Bromus mollis*), wild barley (*Hordeum leporinum*), foxtail chess (*Bromus rebens*), and wild oats (*Avena fatus*). Also scattered throughout the chaparral and grassland species are shrubs which form the coastal sagebrush community.

The dominant species of the coastal sage community are typically shallow-rooted subshrubs that rarely exceed 5 ft in height. The most common and widespread species of the coastal sage is *Artemisia*

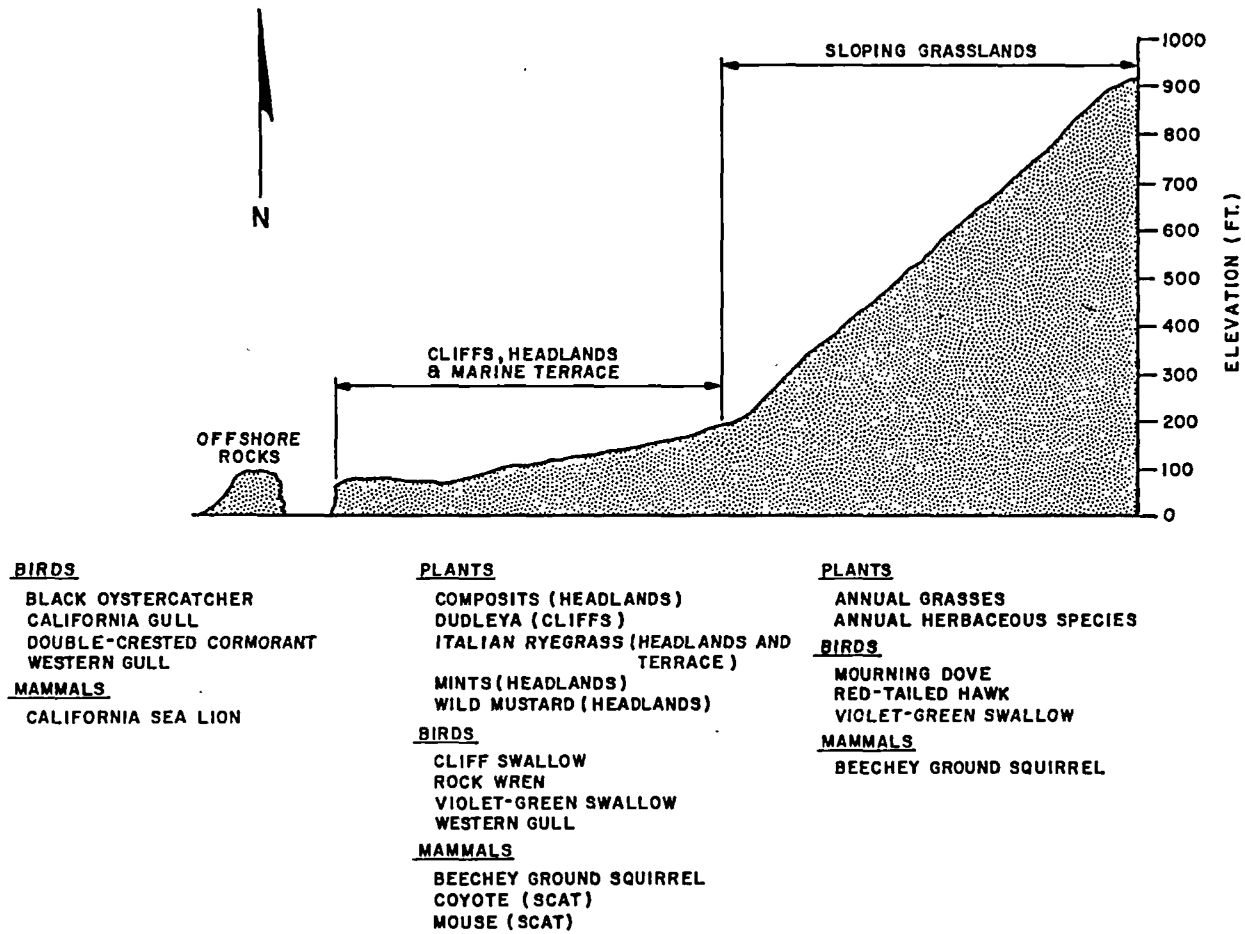


Fig. 2.14. Generalized cross-sectional representation of ecological zones on exposed slope at Diablo Canyon.

Table 2.7. Common and scientific names of some birds in areas of the Diablo Canyon Nuclear Plant Project[a]

Common name	Scientific name
Common loon	*Gavia immer*
Arctic loon	*Gavia pacifica*
Western grebe	*Aechmophorus occidentalis*
Brown pelican	*Pelecanus occidentalis*
Double-crested cormorant	*Phalacrocorax auritus*
Brandt's cormorant	*Phalacrocorax penicillatus*
Pelagic cormorant	*Phalacrocorax pelagicus*
Black brant	*Branta bernicla*
Mallard	*Anas platyrhynchos*
Gadwall	*Anas strepera*
American widgeon	*Mareca americana*
Pintail	*Anas acuta*
Green-winged teal	*Anas carolinensis*
Cinnamon teal	*Anas cyanoptera*
Shoveler	*Spatula clypeata*
Wood duck	*Aix sponsa*
Ring-necked duck	*Aythya collaris*
Canvasback	*Aythya valisineria*
Lesser scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Ruddy duck	*Oxyura jamaicensis*
White-winged scoter	*Melanitta fusca*
Surf scoter	*Melanitta perspicillata*
Red-breasted merganser	*Mergus serrator*
Peregrine falcon	*Falco peregrinus*
Black oystercatcher	*Haematopus bachmani*
Black turnstone	*Arenaria melanocephala*
Wandering tattler	*Heteroscelus incanum*
Willet	*Catoptrophorus semipalmatus*
Red phalarope	*Phalaropus fulicarius*
Northern phalarope	*Lobipes lobatus*
Western gull	*Larus occidentalis*
Herring gull	*Larus argentatus*
Heermann's gull	*Larus heermanni*
Common murre	*Uria aalge*
Pigeon guillemot	*Cepphus columba*
Band-tailed pigeon	*Columba fasciata*
Mourning dove	*Zenaidura macroura*
Turkey	*Meleagris gallopavo*
California gull	*Larus californicus*
Cliff swallow	*Petrochelidon pyrrhonota*
Rock wren	*Salpinetes absoletus*
Anna's hummingbird	*Calypte anna*
Black phoebe	*Sayornis nigricans*
Brown towhee	*Pipilo fuscus*
Bush tit	*Psaltriparus minimus*
California valley quail	*Lophortyx californicus*
Housefinch	*Carpodacus mexicanus*
Rufous hummingbird	*Selasphorus rufus*
Scrub jay	*Aphelocoma coerulescens*
American goldfinch	*Spinus tristis*
Lark sparrow	*Chondestes grammacus*

Table 2.7 (continued)

Common name	Scientific name
Red-tailed hawk	*Buteo jamaicensis*
Sage sparrow	*Amphispiza belli*
Savannah sparrow	*Passerculus sandwichensis*
Turkey vulture	*Cathartes aura*

[a]Table compiled from "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," California Department of Fish and Game, Environmental Services Branch, Office Report, March 1972, 85 pp.; Pacific Gas and Electric Company, Diablo Canyon Site, Supplement No. 2 Environmental Report, Vol. I, July, 1972.

Table 2.8. Common and scientific names of some mammals in the Diablo Canyon area[a]

Scientific name	Common name
Didelphidae	
Didelphis marsupialis	Opossum
Soricidae	
Sorex ornatus	Ornate shrew
Sorex trowbridgii	Trowbridge's shrew
Talpidae	
Scapanus latimanus	Broad-footed mole
Vespertilionidae	
Myotis lucifugus	Little brown bat
Myotis gymanensis	Yuma myotis
Myotis evotis	Long-eared myotis
Myotis thysanodes	Fringed myotis
Myotis volans	Long-legged myotis
Myotis californicus	California myotis
Myotis subulatus	Small-footed myotis
Pipistrellus hesperus	Western pipistrelle
Eptesicus fuscus	Big brown bat
Lasiurus borealis	Red bat
Lasiurus cinereus	Hoary bat
Corynorhinus townsendii	Big-eared bat
Antrozous pallidus	Pallid bat
Molossidae	
Tadarida brasiliensis	Brazilian free-tailed bat
Eumops perotis	Greater mastiff bat
Leporidae	
Sylvilagus bachmani	Brush rabbit
Sylvilagus audobonii	Desert cottontail
Lepus californicus	Black-tailed jack rabbit
Sciuridae	
Eutamias merriami	Merriam's chipmunk
Citellus beecheyi	Beechey ground squirrel
Sciurus griseus	Western gray squirrel
Geomyadae	
Thomomys umbrinus	Southern pocket gopher
Heteromyidae	
Perognathus longimembris	Little pocket mouse
Perognathus californicus	California pocket mouse
Dipodomys heermanni morroensis	Morro Bay kangaroo rat
Dipodomys merriami	Merriam's kangaroo rat
Cricetidae	
Reithrodontomys megalotis	Western harvest mouse
Peromyscus californicus	California mouse
Peromyscus maniculatus	Deer mouse
Peromyscus boylii	Brush mouse
Peromyscus truei	Pinon mouse
Neotoma lepida	Desert woodrat
Neotoma fuscipes	Dusky-footed woodrat
Microtus californicus	California vole
Muridae	
Rattus norvegicus	Norway rat
Mus musculus	House mouse

Table 2.8 (continued)

Scientific name	Common name
Canidae	
Canis latrans	Coyote
Urocyon cinereoargenteus	Gray fox
Procyonidae	
Bassariscus astutus	Ringtail
Procyon lotor	Raccoon
Mustelidae	
Mustela frenata	Long-tailed weasel
Taxidea taxus	Badger
Spilogale gracilis	Western spotted shunk
Mephitis mephitis	Striped skunk
Felidae	
Felis concolor	Mountain lion
Lynx rafus	Bobcat
Cervidae	
Odocoileus dama hemionus	Mule deer

[a]Table compiled from E. R. Hall and K. R. Kelson, *The Mammals of North America,* vols. I and II, Ronald Press Co., New York, 1959; L. G. Ingles, *Mammals of the Pacific States,* Stanford University Press, Stanford, California, 1965.

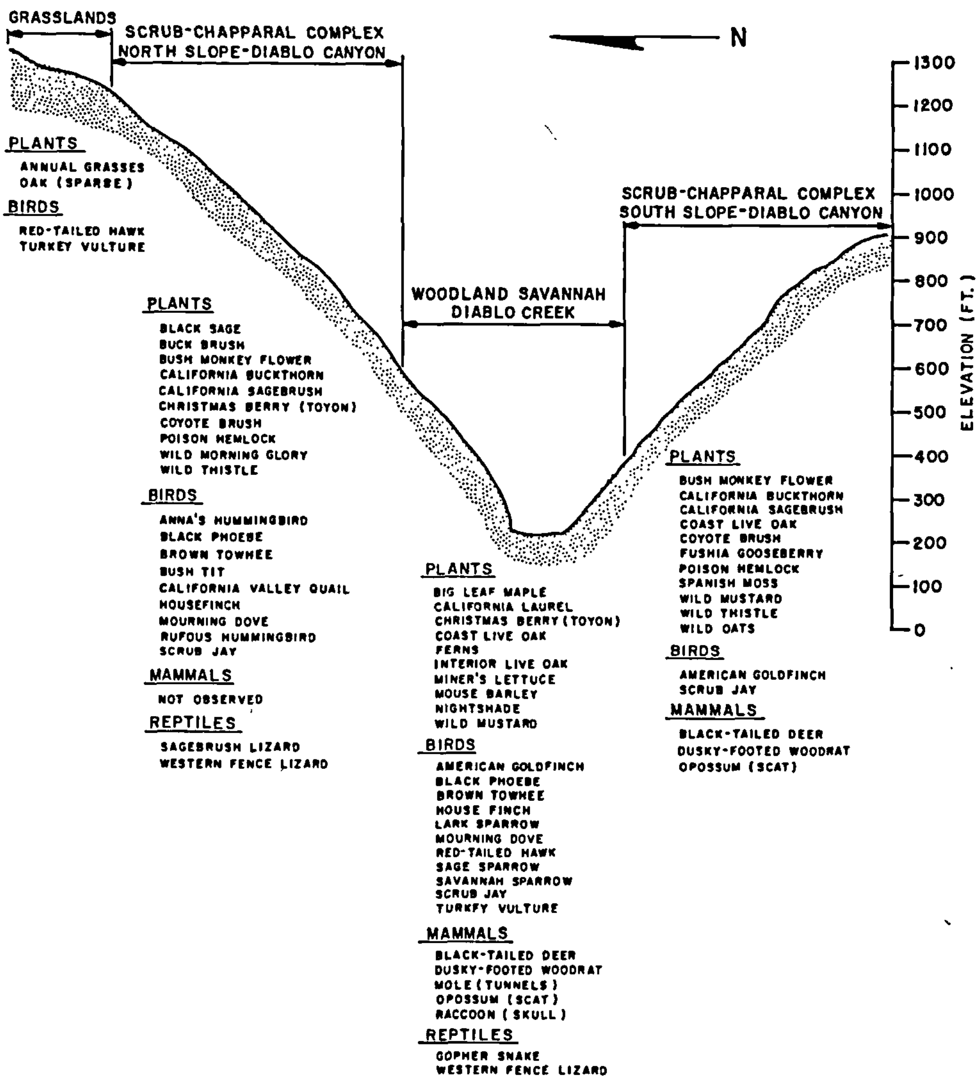


Fig. 2.15. Generalized cross-sectional representation of ecological zones in the vicinity of Diablo Creek and adjacent slopes.

californica. Lotus scoparius, Eriogonum fasciculatum, Viquera laciniata, several species of *Eriodictyon,* and five species of *Salvia* are variously associated with *Artemisia.*[26] California sagebrush is generally distributed in this area and may occur in pure stands along the coastal hills. This community varies from lower to higher elevations but black sage, wild buckwheat, scalebroom, and *Eriodictyon trichocalyx* occur throughout.

Bird species common to these communities included scrub jays (*Aphelocoma coerulescens*), Savannah sparrows (*Passerculus sandwichensis*), lark sparrows (*Chondestes grammacus*), and sage sparrows (*Amphispiza belli*).

Diablo Creek flows through the canyon, emptying into Diablo Cove. Vegetation in this area is composed principally of live oaks (*Quercus agrifolia*), California laurel (*Umbellularia californica*), and big leaf maples (*Acer macrophyllum*). A dense mixture of scrub and chaparral species dominates the ground surface. The banks along the creek consist of shade-tolerant plants such as Miner's lettuce (*Montia perfoliata*) and ferns (*Polystichum dudleyi*). The drier terrain above the creek supports smaller woody shrubs including the toyon (*Heteromeles arbutifolia*).[2]

In the immediate vicinity of the creek, black phoebes (*Sayornia nigricans*), American goldfinches (*Spinus tristis*), and house finches (*Carpodacus mexicanus*) were abundant in the scrub vegetation.

Woodlands in the central coastal area consist of scattered trees with some other types of vegetation (grass, chaparral, sagebrush, or mixtures of these) dominating the ground surface between and beneath the trees. In the higher elevations, native vegetation consists primarily of Bishop pine, coastal live oak, and black and white oak mixed with various species of lower growing shrubs (manzanita).[28]

Upland game, big game, and nongame wildlife populations generally are not dependent exclusively for survival upon the upland habitat which is found in the coastal zone. There are, however, areas in the coastal zone that apparently provide optimum habitat conditions and thus support large populations of upland game. High densities of quail, cottontail rabbits, and brush rabbits have been found in the vegetated sand dunes of the northern and central California coast.

During the annual migration period over 1 million birds frequent California's coastal wetlands. Sandy beaches bordering the ocean seasonally attract hundreds of thousands of shorebirds. Birds normally begin arriving from the north in late July and are present all winter in varying degrees of abundance. Plovers, sandpipers, phalaropes, and other shorebirds move on farther south in winter; other birds remain to winter in California. Some remain as non-breeders and frequent beaches and mudflats during summer months. Lion Rock has been listed as a major rookery for Brandt's cormorant.[29]

Cetaceans (i.e., whales, dolphins and porpoises) also inhabit the ocean waters around the Diablo Canyon site (Table 2.9). The California gray whale is observed off San Luis Obispo County during annual north-south migrations. A number of marine carnivora (i.e., seals, sea otters and sea lions) which probably occur off the shore in the plant area are shown in Table 2.10. The principal distribution of the sea otter, *Enhydra lutris*, off California is from Pacific Grove to Cambria, with occasional sightings in recent years both to the north and south of this range.[30,31] A herd of 175 animals has been reported residing in the Cayucos area (for location see Fig. 2.11).[32]

Environmental Features of Areas Traversed by Transmission Lines

The two transmission line routes cross the central coastline, the innermost mountain range, foothill regions, and a portion of the Central Valley. These routes encompass a diverse complement of terrestrial flora and fauna which have been previously described. In higher elevations the dominant native vegetation consists of Bishop pine, coastal live oak, black and white oak, and various species of brushes (e.g., manzanita). In the valleys and plains areas, vegetation utilized for grazing or crop production dominates. Maps of vegetation types traversed by the transmission corridors were prepared by the applicant[2] from information obtained from the Pacific Southwest Forest and Range Experiment Station.

Since California falls within the corridor of the Pacific flyway, one of the four nationwide pathways of migratory waterfowl, a number of waterfowl migrate through the areas occupied by the transmission lines.

San Luis Obispo contains little waterfowl habitat, but Morro Bay, approximately 4 miles west of the Gates line, does contain the third most important black brant habitat on the coast. In some years up to 7,000 birds have been recorded on the bay. Soda Lake in the vicinity of the Midway line does provide suitable water habitat during the wet spring runoff period. The National Audubon Society here conducts yearly bird counts in Morro Bay.[2] Two areas containing state- and federal-managed waterfowl habitat within the

Table 2.9. Cetacea observed offshore from San Luis Obispo County[a]

Common name	Scientific name
Gray whale	*Eschrichtius gibbosus*
Minke whale	*Balaenoptera acutorostrata*
Humpback whale	*Megaptera novaeangliae*
North Pacific whiteside dolphin	*Lagenorhynchus obliquidens*
Northern right whale dolphin	*Lissodelphis borealis*
Short-finned pilot whale	*Globicephala sieblodi*
Killer whale	*Orcinus orca*
Harbor porpoise	*Phocoena phocoena*
Dall porpoise	*Phocoenoides dalli*
Pygmy sperm whale	*Kogia breviceps*
Dwarf sperm whale	*Kogia simus*
Goosebeaked whale	*Ziphius cavirostris*

[a]From C. A. I. Roest, *Kogia simus* and other Cetaceans from San Luis Obispo County, California, *J. Mamm.* 51(2): 410–417 (1970).

Table 2.10. Carnivora observed along the California coast[a]

Common name	Scientific name
Guadalupe fur seal	*Arctocephalus philippii townsendi*
Northern (Alaska) fur seal	*Callorhinus ursinus*
Steller sea lion	*Eumetopias jubata*
California sea lion	*Zalophus californianus*
Ribbon seal	*Histriophoca fasciata*
Northern elephant seal	*Mirounga angustirostris*
Harbor seal	*Phoca vitulina*
Sea otter	*Enhydra lutris*

[a]Table compiled from A. E. Daugherty, Marine mammals of California. State of California, Resources Agency, Dept. Fish Game, 1965. 87 pp.

vicinity of the transmission corridors are the Mendota Waterfowl Management Area and the Kern National Wildlife Refuge. These areas, within the Central Valley, are part of the main wintering grounds for migratory waterfowl. Mendota Waterfowl Management Area lies approximately 34 miles north of the Gates Substation, and Kern National Wildlife Refuge is approximately 22 miles north of the Midway Substation. In addition to the above, approximately 16 miles of access roads and right-of-way corridor extend through the Los Padres National Forest. The California condor has been seen soaring over the counties traversed by the lines. Peregrine falcons are found near Morro Rock on the coast and both the peregrine falcon and golden eagle are found in Los Padres National Forest.

Further discussion of the impact of transmission lines is found in Sect. 4.2.2.

2.7.2 Aquatic Environs

Diablo Cove is characterized by an irregular ocean bottom where the rock substrate is criss-crossed by narrow channels. Shelves with deep crevices and a few ledges three to four feet high also are prominent. Such topographical features provide for an oceanic turbulence that keeps the cover area of the cove flushed. The shoreline in this area is a series of sheer, wave-eroded cliffs, jutting headlands, and massive offshore rocks and reefs. The tidal zone is narrow and may even terminate where there is no protection from wave shock and where there is little or no sediment deposition.

The subtidal shoaling area west of the peninsula which bounds the north side of the 32-acre Diablo Cove is vulnerable to rough ocean conditions. The tidal zone along the inside of the cove consists of beveling layers of bedrock and large strewn boulders which are continuous to 10 to 15 ft depths. These formations provide numerous protective crevices and ledges for marine animals. The subtidal cove bottom is traversed by rocky reefs that parallel the shoreline. Boulders, gravel, and coarse sand gradually grade to the finer materials at greater depths.

The Diablo Cove area and vicinity are generally composed of six habitat types.[28]

Sandy Intertidal Beaches. The most prominent species found in this habitat are the surf-perch and invertebrates such as the sand crab.

Rocky Intertidal. The most important invertebrates found within the rocky intertidal zone are the abalone, both black and red. This area also serves as habitat and nursery grounds for many important fish including rockfish, greenling, and cabezon. The rocks also serve as attachment for a diversity of algae that feed the multitude of animals found here.

Cobble-Boulder Intertidal. Some important sport fish such as monkeyface and rock prickleback rely on this type of habitat. Abalone also are found in this zone, particularly juveniles.

Sandy Subtidal Bottoms. This area supports populations of juvenile and adult flatfish, surfperch, and a few species of rockfish.

Rocky Subtidal Reefs. Reefs are a vital habitat for several species of rockfish, surfperch, and greenling. The lingcod, cabezon, and red abalone also inhabit this area. Attachment surfaces for bull kelp and for smaller species of brown and red algae are provided by the rocky substrate.

Cobble-Boulder Subtidal Bottoms. These areas provide protective habitat for small fishes and invertebrates and attachment for algae.

Sandy intertidal beaches and subtidal bottoms are not found in Diablo Cove.

Rocky shores generally support the most varied and most luxurious algal communities, and the substratum intertidal zone at Diablo Canyon supports numerous species of green, red, and brown algae (Chlorophyceae, Rhodophyceae, and Phaeophyceae, respectively). Most of these species are low growing filamentous and foliose reds and lime encrusting coralline red algae.

Intertidal surveys in the Diablo Canyon study area during 1970 and 1971[28] have documented the presence of at least 65 species of invertebrates and 113 species of marine algae and flowering plants (see Appendix 2.5 for a listing of marine organisms found in Diablo Cove).

During the summer months the most abundant marine alga in the intertidal zone is the foliose red, *Iridaea splendens*, which covers most rocky surfaces. In the fall, the green sea lettuce, *Ulva lactuca*, partially replaces *Iridaea* in many areas. Surf grass, *Phyllospadix scouleri*, was abundant in the shallow zone.

In the shallow subtidal in areas protected from rough seas, the cover consists of *Gigartina corymbifera, Prionitis, Iridaea,* crustose and articulated corallines, *Ulva, Phyllospadix, Microcladia* and *Smithora*. In exposed surf areas, the cover includes *Laminaria,* *Dictyoneureum, Gigartina corymbifera, Botryoglossum, Prionitis, Erythrophyllum, Microcladia,* and crustose and articulated corallines.

In addition to these species, the short growing *Microcladia borealis* is common in exposed areas, and the annual brown alga, *Alaria marginata,* was very abundant in exposed areas during the summer. One hundred seventy-three stipes of this alga were counted during the summer from a 1/4 m^2 quadrat at a control station south of Diablo Cove.[28]

Much of the algae present are vital food items for many invertebrates including black and red abalone, the turban snails, and sea urchins. Several fishes, including the rock prickleback, *Xiphister mucosus*, the black prickleback, *X. atropurpureus,* and the monkeyface prickleback, *Cebidichthys violaceus*, also feed on the algae. The larger subtidal kelps and smaller red and brown algae supply the intertidal herbivores as they break up and drift to shore during the winter months.

Those invertebrates found to be in major association with abalone include rock crabs, *Cancer antennarius*, sun stars, *Pycnopodia helianthoides*, turban snails, *Tegula funebralis, T. brunnea,* and *Astraea gibberosa,* and the purple sea urchin, *Strongylocentrotus purpuratus.*[28]

Black abalone, *Haliotis cracherodii* were common in the tidal zone throughout the Diablo Canyon survey area.[28] In the low tidal zone, a transition to red abalone, *H. rufescens,* occurs; however, black abalone still remain the dominant form.

Counts of black abalone from the California Fish and Game transects varied considerably, reflecting mostly the masking effect of a dense algal cover during some seasons.[28] Counts were made (three each year) at one station, including two transects, in the north cove area just inside Lion Rock during 1970 and 1971. The highest count made at this station during 1970 was 387 black abalone on a 28 × 2 m transect and all counts for both transects for the year averaged $6.3/m^2$. Counts of black abalone inside Diablo Cove were lower, ranging from 11 to 274 on 4 transects (normally 30 × 2 m) and averaging $2.4/m^2$.[28]

The transition from black to red abalone begins in the lower reaches of the intertidal zone and is nearly complete at 2 to 5 ft. The bottom is composed of rocky ledges and large strewn boulders that provide a good habitat for large numbers of red abalone. One station representing this depth region was monitored inside Diablo Cove. In the summer of 1970, 73 red abalone were counted along a 30 × 2 m transect and 57 in the fall, averaging 1.08 per square meter.

Much of the bottom deeper than 20 ft is composed of flat bedrock, boulders, cobble, and sand in all mixtures and therefore does not provide the necessary abalone habitat. The areas within the cove that are less than 20 ft deep provide extremely important habitat for abalone. An occasional abalone was observed in depths greater than 20 ft and a few small beds were found in areas where the habitat was satisfactory.

Flat abalone, *H. walallensis*, and pinto abalone, *H. kamtschatkana*, were occasionally observed in the central region of the cove but were never numerous.[28]

The massive reef structure in the north cove area provides good habitat for abalone and hard substrate for bull kelp, *Nereocystis luetkeana*, attachment. Important algae growing on these reefs include *Nereocystis, Macrocystis, Pterygophora, Dictyoneurum, Desmerestia, Botryoglossum, Callophyllis, Ptilota, Polyneura, Prionitis, Opuntiella*, and crustose and articulated corallines.[28] California Department of Fish and Game block (area) landing records indicate that a substantial catch of abalone is made each year between Morro Bay and Diablo Cove; 365,817 lb were registered from this area during 1968 and 288,717 lb during 1969.[28]

A luxurious fauna is found in cobble rock regions. Various sponges, cnidarians, polychaete annelids, ectoprocts, crustaceans, molluscs, echinoderms, and ascidians are recorded from the sampling stations. The red turban, *Astraea gibberosa*, reached highest densities at 20 to 30-ft depths in the California Fish and Game surveys.[28] Other turbans such as *Tegula brunnea, T. pulligo, T. monteryi*, top snails, *Calliostoma ligatum, C. annulatum*, and *C. canaliculata*, and red sea urchins, *Strongylocentrotus franciscanus*, were also present.

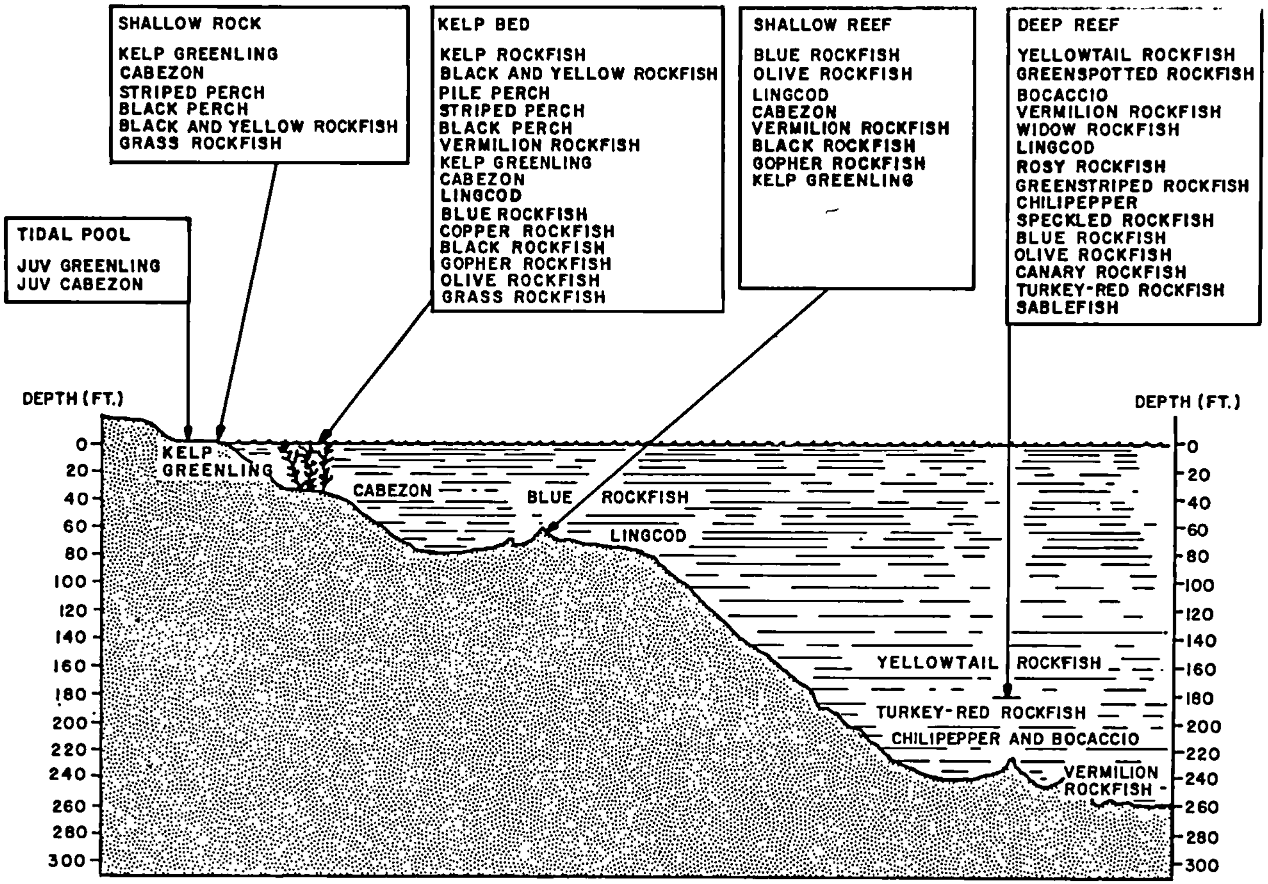
Red urchins are abundant inside Diablo Cove in 20 to 50-ft depths. This urchin is known to compete with abalones for both habitat and food and have reached densities at these depths great enough to replace the abalone.[28]

At least 50 species of invertebrates and 66 species of marine algae and flowering plants have been documented in the subtidal Diablo Cove area.[28] The listing of invertebrates is not complete since only those that are important associates of abalone, or because of size or abundance are conspicuous, have been identified.

Three Diablo Cove fish collections yielded 4,902 specimens representing 80 species. In north Diablo Cove 5,669 specimens were taken during a collection made in July 1971 and represented 75 species. The most common adult fishes were rockfish, with the blue rockfish, *Sebastes mystinis*, the most abundant (see Appendix 2-5).

Schools, estimated up to 1,000 individuals, were observed in the midwater column and were seen above or along side a reef or in the area: the most common forms include the olive rockfish, *S. serranoides*; the black-and-yellow rockfish, *S. chrysomelas*; the gopher rockfish, *S. carnatus*; and the black rockfish, *S. melanops*. Large schools of juveniles, estimated between 500 and 2,000, were observed during surveys. The presence of numerous juveniles during all seasons indicates that the nearshore environment in the vicinity of Diablo Cove may be a major nursery area for rockfish.[28] Seven species of ocean surfperch were collected and observed in the area. The three most abundant species included the pile perch, *Damalichthys vacca*, the black perch, *Embiotoca jacksoni*, and the striped perch, *E. lateralis*. Larger fish of the area include the lingcod, *Ophidon elongatus*, and the cabezon, *Scorpaenichthys marmoratus*. Lingcod were seen swimming along the bottom in search of food or were found in deep crevices. Adult cabezon were found mostly in shallow water even though they were seen at all depths. The large number of juvenile cabezon taken in January at the shore station and in July at both the shore and 25-ft fish collection stations points to these shallow depths as an important nursery area for the species.[28] The surfperch, the rockfish, the lingcod, and the cabezon are important in sport fishing and commerical fisheries of Avila and Morro Bays. The party boat fleet from these ports landed 367,178 lb of rockfish, 16,159 lb of lingcod, and 1,874 lb of cabezon during 1970.[28] A graphic representation of the vertical distribution of fish found in Diablo area is given in Fig. 2.16. In addition to the fishes listed, juvenile rockfish of several species extend from the shallow rock through the shallow reef zone. The list for the deep reef zone should be considered as a general list, because specific information on the presence of these fishes in the Diablo Canyon area is not available.

Five new species of fish collected from the Diablo area by the California Fish and Game survey were: (1) 6 specimens from the 20-ft Diablo Cove station of a prickleback, *Kasatkia* sp. nov., (2) 7 specimens from Diablo Cove and north cove of a prickleback [up to 250 mm total length (TL)], *Stichaeopsis* sp. nov., (3) 13 specimens from north cove of a small red prickleback, *Lumpenopsis* sp. nov., (4) a small snailfish, *Liparis* sp. nov. (mature female at 58 mm TL and 2 years), and (5) 14 fanged ronquil, *Rathbunella* sp. nov. from north cove.[28] Range extensions were also established for some species: (1) 3 gobies for northern range records — a zebra goby, *Lythrypnus zebra*, from north cove; a bluebanded goby, *Lythrypnus dalli*, observed at Diablo Rock; and 2 blind gobies, *Typhlogobius californiansis*, from Diablo Cove, (2) 23 graveldivers, *Scytalina cerdale*, for a southern range record, were collected at stations 6 and 17, and (3) 5 rare rockheads, *Bothragonus swanii* from north cove, established new southern records. Eleven species of fish



COMMONLY TAKEN FISH IN ROCKY BOTTOM HABITATS IN THE DIABLO CANYON AREA

Fig. 2.16. Fish commonly taken in rocky bottom habitats in the Diablo Canyon area. Modified from California Department of Fish and Game, Fish Bulletin 130.

collected in north cove but not found in Diablo Cove were rockheads; a zebra goby; shiner perch; *Cymatogaster aggregata*; a half-blind goby, *Lethops connectens*; and new pricklebacks. Fifteen species collected from Diablo Cove were not collected in north cove; however, this number may be reduced as additional north cove samples are taken.[28]

REFERENCES FOR SECTION 2

1. "San Luis Obispo County Population Projection — 1970-2000" given to the Staff by County Planning Department of San Luis Obispo County, p. 6.

2. Pacific Gas and Electric Company, Environmental Report, Supplement No. 2, Diablo Canyon, Units 1 and 2, July, 1972.

3. Report of Diablo Canyon Plant — Site Visit, June 19-23, 1972, Docket Nos. 50-275 and 50-323, July 31, 1972, and Supplement, December 1972.

4. San Luis Obispo County Department of Agriculture, "Agricultural Products Produced in San Luis Obispo County During 1971."

5. San Luis Obispo County Planning Department, "Open Space Plan," San Luis Obispo County, December 1971.

6. California Department of Water Resources, "Site Selection for a Large Desalting Plant," January 1971.

7. The Office of Saline Water, Department of Interior, and the Department of Water Resources, the State of California, "Draft Environmental Statement for Proposed Diablo Canyon Desalting Project," March 1972.

8. Department of Navigation & Ocean Development, State of California, Department of Parks & Recreation, "Comprehensive Ocean Area Plan" and the "Supplement," 1970.

9. Department of Parks and Recreation, State of California, "Supply-Demand Analysis for California Outdoor Recreation Facilities," Parks and Recreation Information System, Planning Monograph #2, November 1966.

10. Department of Parks and Recreation, State of California, "California Coastline Preservation and Recreation Plan," August 1971.

11. Transcript of Show Cause Hearing, USAEC Docket Nos. 50-275 and 50-323, Pacific Gas & Electric Co., Diablo Canyon Units 1 & 2, San Luis Obispo, California, May 17-20, 1972.

12. R. R. Bell, "California Marine Fish Landings for 1970," Fish Bulletin 154, Department of Fish and Game, The Resources Agency, State of California, 1971.

13. Research Department of Security, Pacific National Bank, Los Angeles, California, "Monthly Summary of Business Conditions in Southern California" — Spotlighting San Luis Obispo County, August, 1971.

14. H. O. Wood, "Catalog of California Earthquakes," *Bulletin Seismology Society of America*, 1961, Vol. VI, pp. 1-180.

15. Earthquake and Epicenter Fault Map, California Department of Water Resources Bulletin 116-2, Crustal Strain and Fault Movement Investigations, Sacramento, California, January 1964.

16. Gutenberg and Richter, *Seismicity of the Earth*, Princeton University Press, Princeton, New Jersey, 1949.

17. J. H. Carr, "Long-period Waves or Surges in Harbors," *Trans. ASCE* 118: Paper No. 2556, pp. 588-603 (1953).

18. C. K. Green, "Seismic Sea Wave of April 1, 1946, as Recorded on Tide Gages," *Trans. AGU*, 27, No. IV: 490-500 (1946).

19. W. H. Munk, "Long Ocean Waves," *The Sea*, Interscience Publishers, New York, 1963, Vol. I, pp. 659-61.

20. W. G. Van Dorn, "Tsunamis," *Advances in Hydrosciences*, Academic Press, New York, 1965, Vol. 2, pp. 1, 48.

21. R. L. Wiegel, *Oceanographical Engineering*, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1964.

22. R. L. Wiegel, "Laboratory Studies of Gravity Waves Generated by the Movement of a Submerged Body," *Trans. Amer. Geophys. Union*, 36(5): 759-74, 1955.

23. "Safety Evaluation by the Division of Reactor Licensing, USAEC, in the Matter of Pacific Gas & Electric Diablo Canyon Nuclear Power Plant Unit 2," November 18, 1969.

24. Pacific Gas and Electric Company, Environmental Report, Supplement No. 2, Volume II, Appendix U, Diablo Canyon Units 1 and 2, July 1972.

25. California Department of Fish and Game, "Fish and Wildlife in the Marine and Coastal Zone, Part A. Summary Planning Information and Recommendations," November 1971, 158 pp.

26. A. T. Harrison, E. Small, and H. A. Mooney, "Drought Relationships and Distribution of Two Mediterranean-Climate California Plant Communities," *Ecology* 52(5): 869-75 (1971).

27. Harshburger, *Phytogeographic Survey of North America,* Hafner Publ. Co., New York, New York, 1958, 790 pp.

28. California Department of Fish and Game, "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," Environmental Services Branch, Office Report, March 1972, 85 pp.

29. T. Osborne and J. G. Reynolds, 1969-70, California Seabird Breeding Ground Survey, Wildlife. California Department of Fish and Game. Management Branch Administrative Report No. 71-3 (January 1971).

30. E. E. Ebert, "The Sea Otter in California's Wildlife," Transactions, 15th Ann. Meeting Wildlife Soc., California-Nevada Section, Sacramento, 1968, 5 p.

31. E. E. Ebert, "A Food Habits Study of the Southern Sea Otter, *Enhydra lutris neries*," *Calif. Fish Game* 54(1): 33-42 (1968).

32. K. O. Emery, *The Sea off Southern California,* Wiley, New York, 1960, 366 pp.

3. THE PLANT

3.1 EXTERNAL APPEARANCE

Each reactor will be housed in an individual containment structure about 150 ft in diameter and 200 ft high with a hemispherical roof. The side walls, 3 ft 6 in. thick, and the domed roof, 2 ft 6 in. thick, will both be of reinforced concrete. The center line on which both structures are located runs generally north-northwest and south-southeast. The turbine buildings are located along the side of the containment structures closest to the ocean. The two turbine buildings are joined together to give the appearance of one building about 750 ft long, 140 ft wide, and 130 ft high. These latter buildings are designed with vertical depressions to give a more attractive appearance. The switchyards are located east of the plant and more distant from the ocean in Diablo Canyon. Two raw water storage ponds are located near the switchyards.

The plant is not visible from any public road or from the new access road beyond 3/4 mile from the site because of the rugged terrain. However, from the ocean the plant is readily visible, as shown by Fig. 3.1.

Breakwaters have been built to protect the intake structure along the shoreline south of the plant. The discharge structure is located along the shore of Diablo Cove west of the plant.

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

The two units of the Diablo Canyon Nuclear Station will be essentially identical. Each will consist of a pressurized water reactor producing steam to drive a turbine-generator. Figure 3.2 is a schematic diagram of one unit. A single reactor unit is described below.[1]

The uranium fission chain reaction will occur only in the reactor core, a 12-ft-high close-packed array of fuel assemblies inside the reactor vessel. There will be 39,372 fuel rods with 204 rods in each of 193 assemblies. Each fuel rod will consist of cylindrical pellets of uranium oxide sealed inside zirconium alloy tubes. The reactor will be contained within a thick concrete primary shield (see Fig. 3.2). The primary coolant circulating pumps and primary heat exchangers will be outside of the primary shield. The building structure will form the outer concrete shield, with a sealed steel liner. The steel shell must meet a test requirement of less than 0.1% of the containment free volume leakage over a 24-hr period at a pressure of 47 psig.

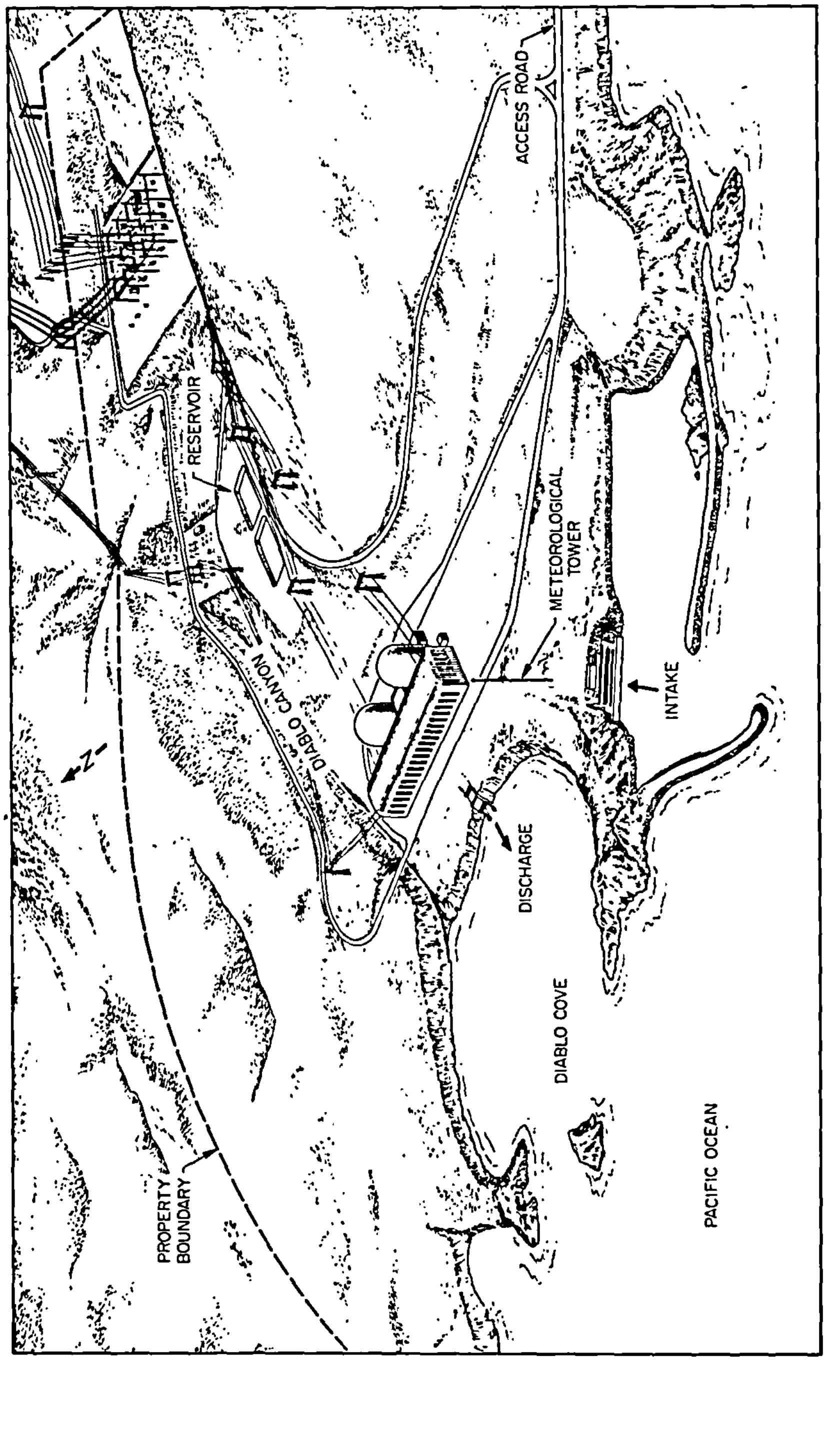


Fig. 3.1. Diablo Canyon plant site.

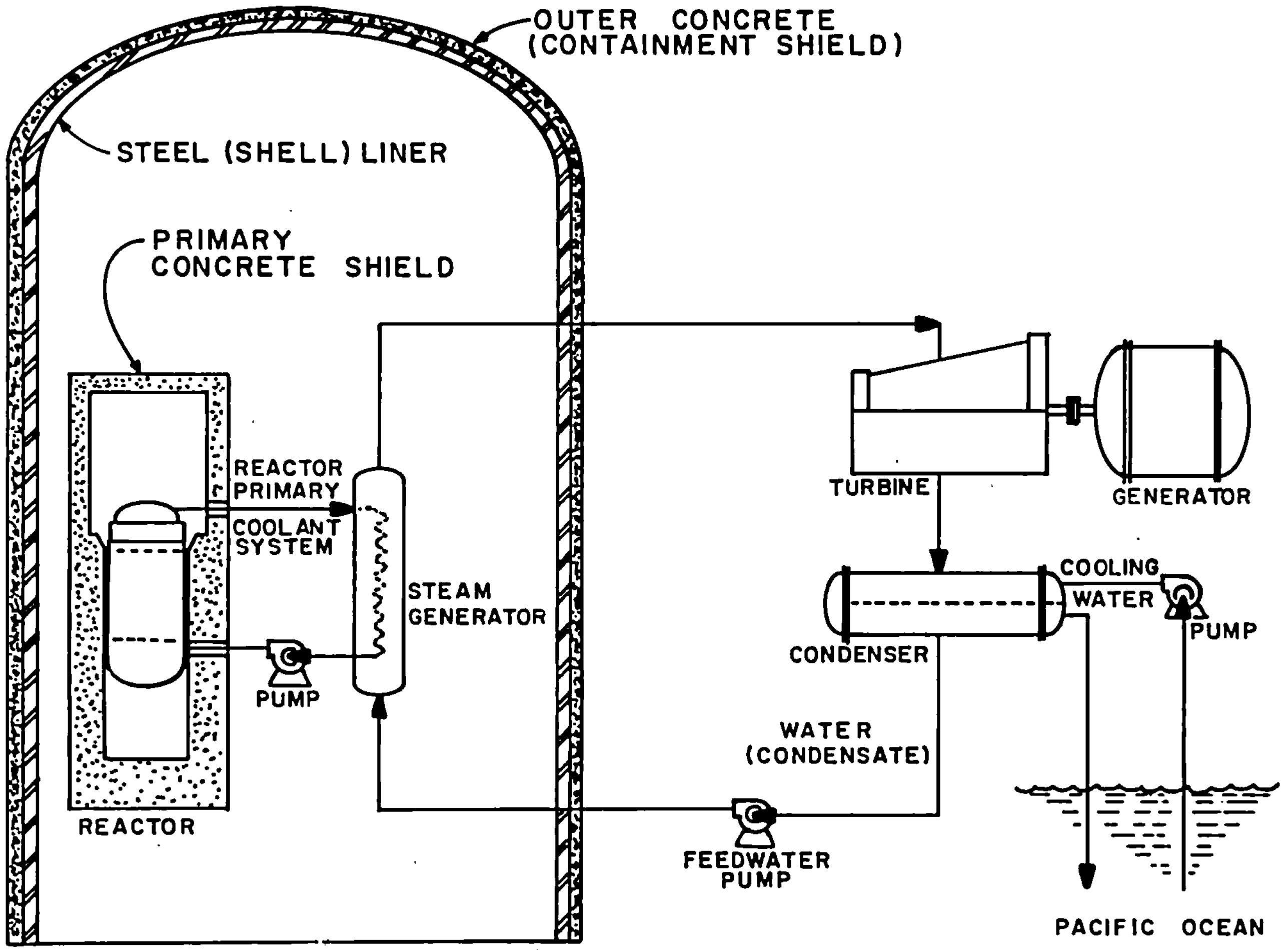


Fig. 3.2. Schematic flow diagram of heat removal.

The rate of the chain reaction will be controlled by neutron-absorbing metal rods that can be moved into or out of the core. Heat produced within the fuel rods will be transferred to water (actually a dilute boric acid solution) which circulates upward through the core. The boron concentration in this primary coolant will be changed as necessary to adjust ("shim") the reactivity of the core. (Boron readily absorbs neutrons.)

When the reactor is at design power, heat will be produced at a rate of about 3568 MW. Primary coolant water will leave the reactor at 602°F and 2250 psi; this pressure is high enough to prevent boiling on the fuel rods. The pressure will be maintained by electrically boiling a side stream of water in a vessel called the pressurizer. A small amount of hydrogen will be added to the pressurizer to aid in the recombination of any water decomposed by radiation in the fuel region. The hot primary coolant will pass through tubes in a steam generator, where it will transfer heat to water (secondary coolant) on the outside of the tubes. The pressure will be lower in the secondary system, and the water there will be converted to superheated steam at 600°F and 1005 psi. This steam will pass through a turbine, driving a shaft connected to a generator which will produce electricity. The initial net electric output of unit 1 is 1084 MW and unit 2 is 1106 MW, but the guaranteed combined output of the units is about 2300 MW(e).

In its passage through the turbine, the steam will expand and cool until it leaves as vapor at 80° to 100°F and at subatmospheric pressure. This water vapor will be very pure and will be condensed and recycled. Condensation will take place on the outside of condenser tubes cooled by ocean water being pumped through them. For each reactor unit, waste heat will be transferred to the cooling water at a rate of about 2408 MW.

Radiation emitted directly from the fission process will be absorbed in the reactor vessel, water, and shielding. The radioactive products of uranium fission will be almost entirely confined within the sealed fuel rods; some may appear in the primary coolant because of leaks in a very small fraction of the fuel rods. Part of the tritium generated in the fuel will diffuse through the fuel element cladding into the primary coolant, but even more tritium will be produced directly in the coolant by reactions of neutrons with the dissolved boron. The primary coolant will also contain some corrosion products that have become radioactive by exposure to neutrons in the core. The secondary coolant (steam) will not become radioactive unless there is some inleakage of primary coolant to the secondary system in the steam generator. Treatment of the primary coolant to remove corrosion and fission products and handling of leakage are described later in the section on the radioactive waste system.

Each unit will be shut down periodically, and the reactor vessel will be opened for replacement of fuel assemblies in which the uranium-235 has been consumed beyond the point of useful operation. Spent fuel assemblies will be transferred under water to a storage pool in a building adjoining the reactor containment building. (Further handling of fuel elements is described later in this Statement.)

The Diablo Canyon units are generally similar to other pressurized water reactors currently under construction or already in operation. The Westinghouse Electric Corporation is responsible for the design, manufacture, and delivery of the nuclear steam supply systems, the nuclear fuel, and the auxiliary and engineered safeguard systems. Westinghouse is also providing technical direction of the erection of this equipment; assistance in operator training; and consultation for initial fuel loading, testing, and initial startup of each of the units. The Pacific Gas and Electric Company is responsible for all other aspects of construction and startup and is also responsible for the coordination, scheduling, administrative direction, and operation of the power station after it becomes operational.

3.3 HEAT DISSIPATION SYSTEMS

3.3.1 General

Present steam-electric generating plants, nuclear or fossil fueled, discharge to the environment a large fraction of the heat that is produced by burning or fissioning fuel. In the case of the Diablo Canyon Nuclear Station, each unit when operating at design power must dissipate at the plant about 2408 of the 3568 MW of heat being produced. (The applicant states that normal operating power will be somewhat less — 3338 MW for Unit 1 and 3411 MW for Unit 2.) The waste heat discharged (16.4×10^9 Btu/hr for both units at design power) cannot be avoided, or, for present-day light-water power reactors, significantly reduced. Fossil-fueled steam power plants operate at higher thermal efficiency than present-day light-water nuclear power reactors. The waste heat at Diablo Canyon will be transferred into the water of the Pacific Ocean.

3.3.2 Physical Arrangement and Operating Procedures

The physical relationship of the ocean to the condenser cooling water intakes and discharges is shown in Fig. 3.3. The condensers will take water from an intake structure, shown in Fig. 3.4, on the shore just south of Diablo Cove. Breakwaters have been constructed to protect the structure from the open ocean. This created a small cove called South Cove. The breakwaters will also minimize recirculation of cooling water to the condenser from the discharge. The

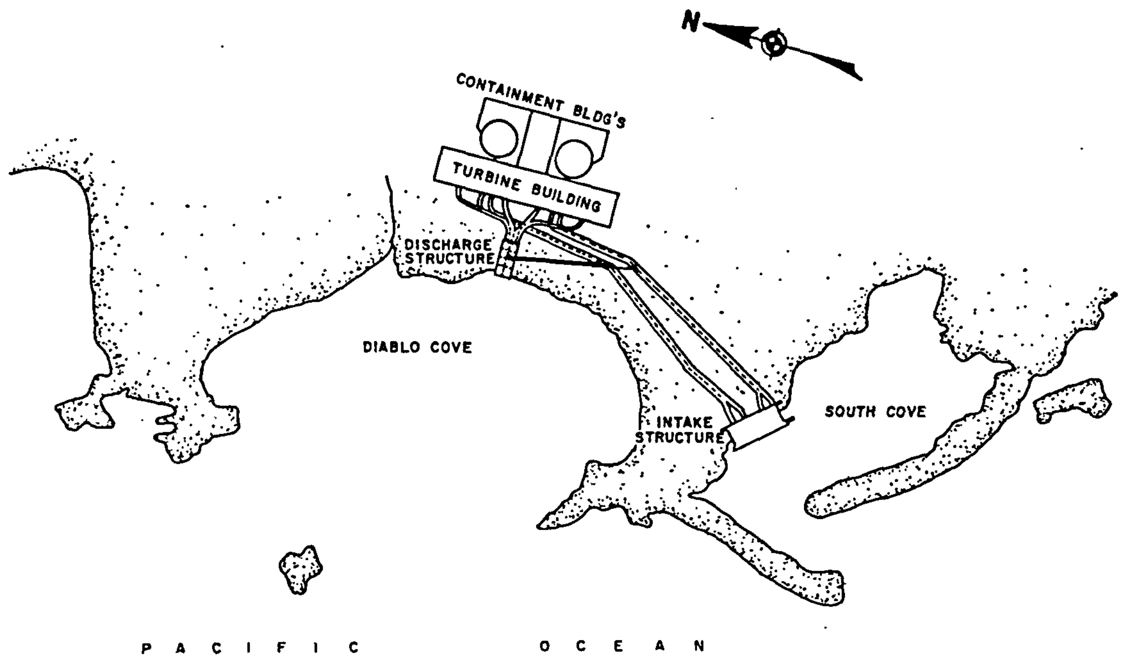


Fig. 3.3. Physical arrangement of Diablo Canyon Nuclear Plant.

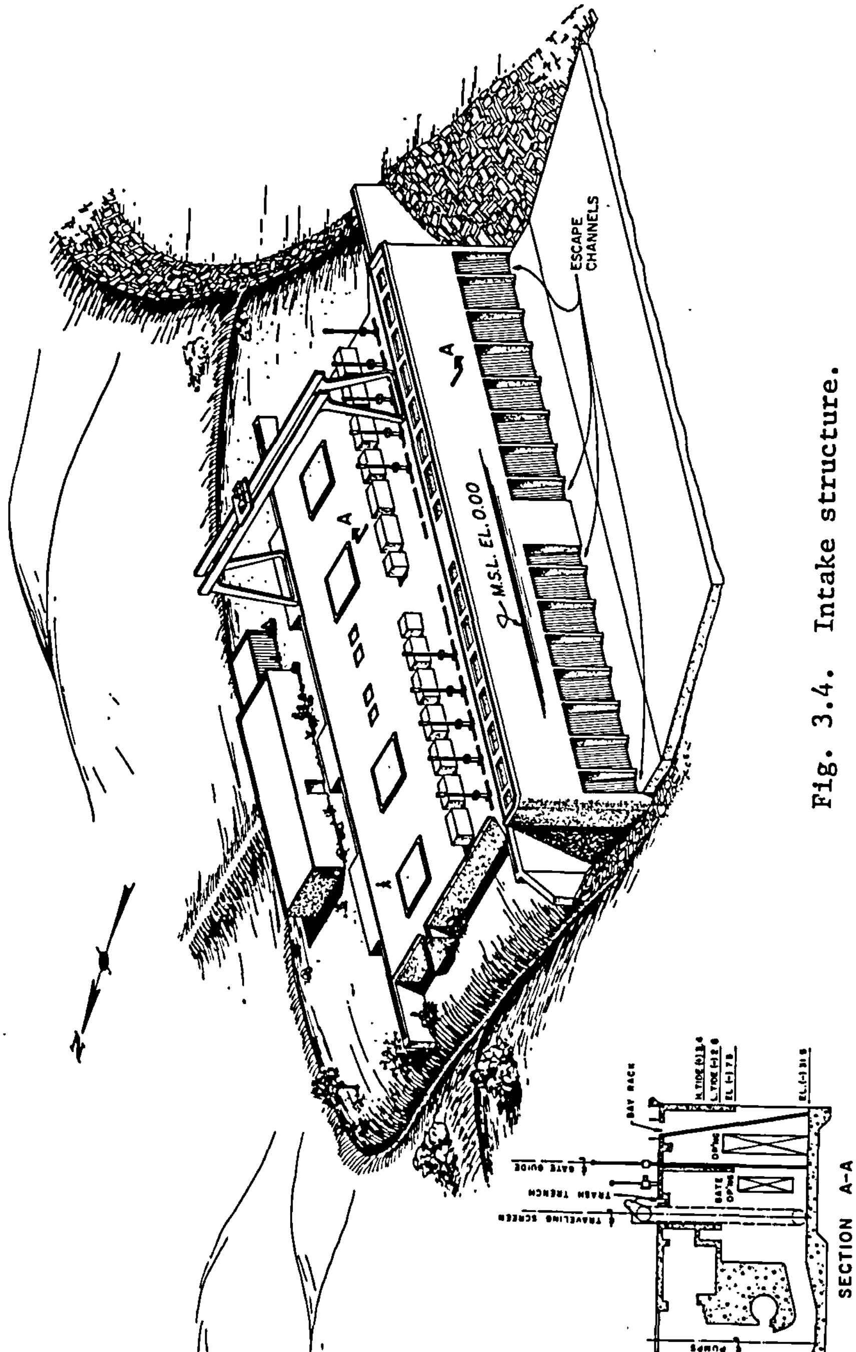


Fig. 3.4. Intake structure.

breakwaters form a channel with the narrowest point about 200 ft wide. From drawings supplied by the applicant, the cross section was found to vary from about 4100 ft^2 at low tide to about 5800 ft^2 at high tide. The resulting velocities at this point at full pumping will range from 0.92 fps at low tide to 0.65 fps at high tide.

Each principal opening of the intake structure is 11.25 by 24.75 ft, with three openings per pump and two pumps per unit (each pump will have a capacity of 433,500 gpm at low tide). Just inside the opening is a series of bar racks set at an angle. These racks are to prevent large objects from entering the cooling system. There are four pump cells, one for each pump. Each cell has four entrances; the three principal ones are provided with traveling screens recessed about 20 ft from the bar racks. Openings of 5 by 28 ft are located between the cells immediately behind the bar racks to permit free passage of fish to the fourth opening, from which escape is easier (ER Suppl. No. 2 page IV-c-1).[2]

Each of the traveling Monel screens has a square mesh with 3/8-in. openings and is normally stationary. The screens will be operated routinely every 4 hr or so and at the same time back sprayed with high-pressure seawater through nozzles to remove collected debris. The wash water will be supplied by two pumps having a capacity of 3900 gpm at a head of 260 ft. Trash will be collected in a refuse sump and then pumped back to the ocean, outside of the breakwaters. If the differential pressure across the screen reaches a specified level, the screens will be actuated automatically.

The water velocity at the intake structure will vary from 0.8 fps a short distance in front of the structure to 1.1 fps going through the bar racks and 1.0 fps in front of the traveling screens. The velocity in the water as it passes through the screen will rise to about 2 fps because of the reduced cross section open to flow in the screen mesh.

About 10,000 gpm per unit of auxiliary service water will also be drawn through the intake structure in addition to the circulating cooling water and will be discharged directly to the condenser effluent at the head of the discharge structure.

The inlet and outlet conduits that connect the condensers to the intake and outlet structures are square in cross section and 11.75 ft on a side. At a flow of about 966 cfs per pump, this will result in a velocity in the conduits of about 7 fps. The inlet conduits are about 1600 ft long, and the outlet conduits are about 540 ft long.

Each unit has a separate condenser, with 58,216 1-in. tubes of nominal 90-10 copper nickel. The tubes are 40.75 ft long. The condensers are "split"; that is, each is divided so that half of the tubes is supplied by one circulating pump. The two streams of cooling water from a condenser are not combined until they enter the discharge structure. This arrangement facilitates the defouling operation discussed later in this section and permits selective chemical treatment of the condenser sections.

The plant is located on a marine terrace with the condenser about 90 ft above mean sea level; therefore the circulating water pumps must pump against a substantial head to raise water to the condensers. The pressure in the water in passing through the system will vary from about 40 psig at the circulating pump discharge to atmospheric, or slightly less, at the condenser outlet. The outlet conduit is vented to the atmosphere a short distance downstream from the condensers. A simple closed conduit was not used in order to avoid the development of a vacuum in the condenser which could cause a vapor lock and attendant loss of cooling capacity. A cascade was constructed to return the cooling water to the ocean. The discharge structure is shown in Fig. 3.6.[2] The cascade serves to dissipate the energy of the water falling back to sea level.

The time from pumps to condenser will be about 3.8 min and from the condenser to the ocean about 1.3 min. The time-temperature relationship of cooling water from intake pump to discharge in the ocean is given in Fig. 3.7.

Of concern in the movement of cooling water discharged from the plant are water depths and bottom contours. Numerous soundings have been made in Diablo Cove by the applicant. The depths are highly variable, making a contour map of the cove bottom marginally useful. Contours drawn from soundings supplied by the applicant are shown in Fig. 3.5. The bottom of the cove slopes downward toward the ocean to a depth of about 40 ft at the outlet of the cove. The bottom continues to slope downward, and at a distance of about 2000 ft from the outfall, its depth is about 70 ft.

Defouling

In the marine environment, organisms will attach to the interior of the cooling water system surfaces. These organisms must be removed or they will eventually grow until the flow of cooling water is severely reduced.

Three methods can be used to accomplish this: (1) physical removal by entering the conduits and scraping the organisms loose, (2) continuous chemical treatment (intermittent treatment is ineffective),

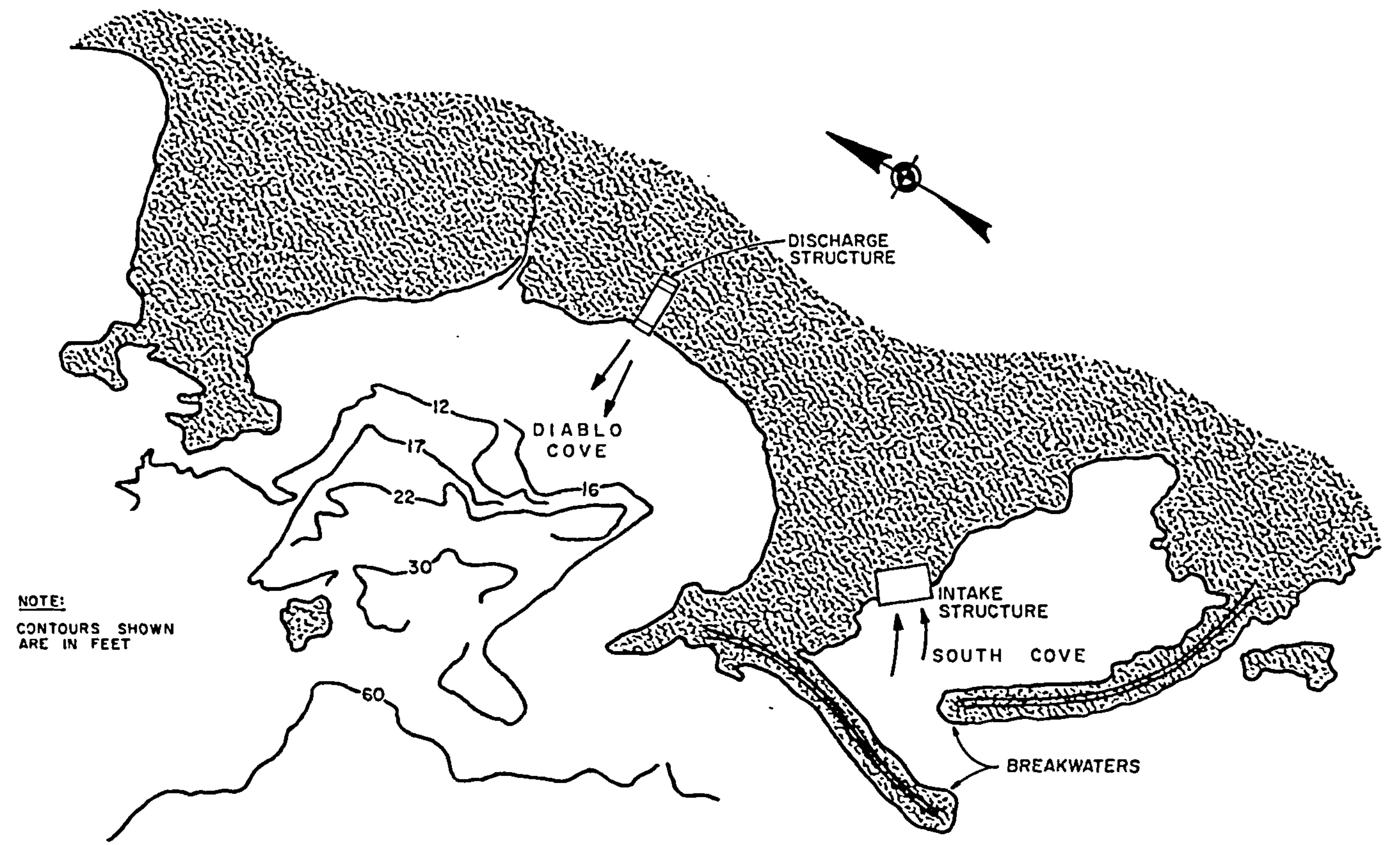


Fig. 3.5. Depth contours in Diablo Cove.

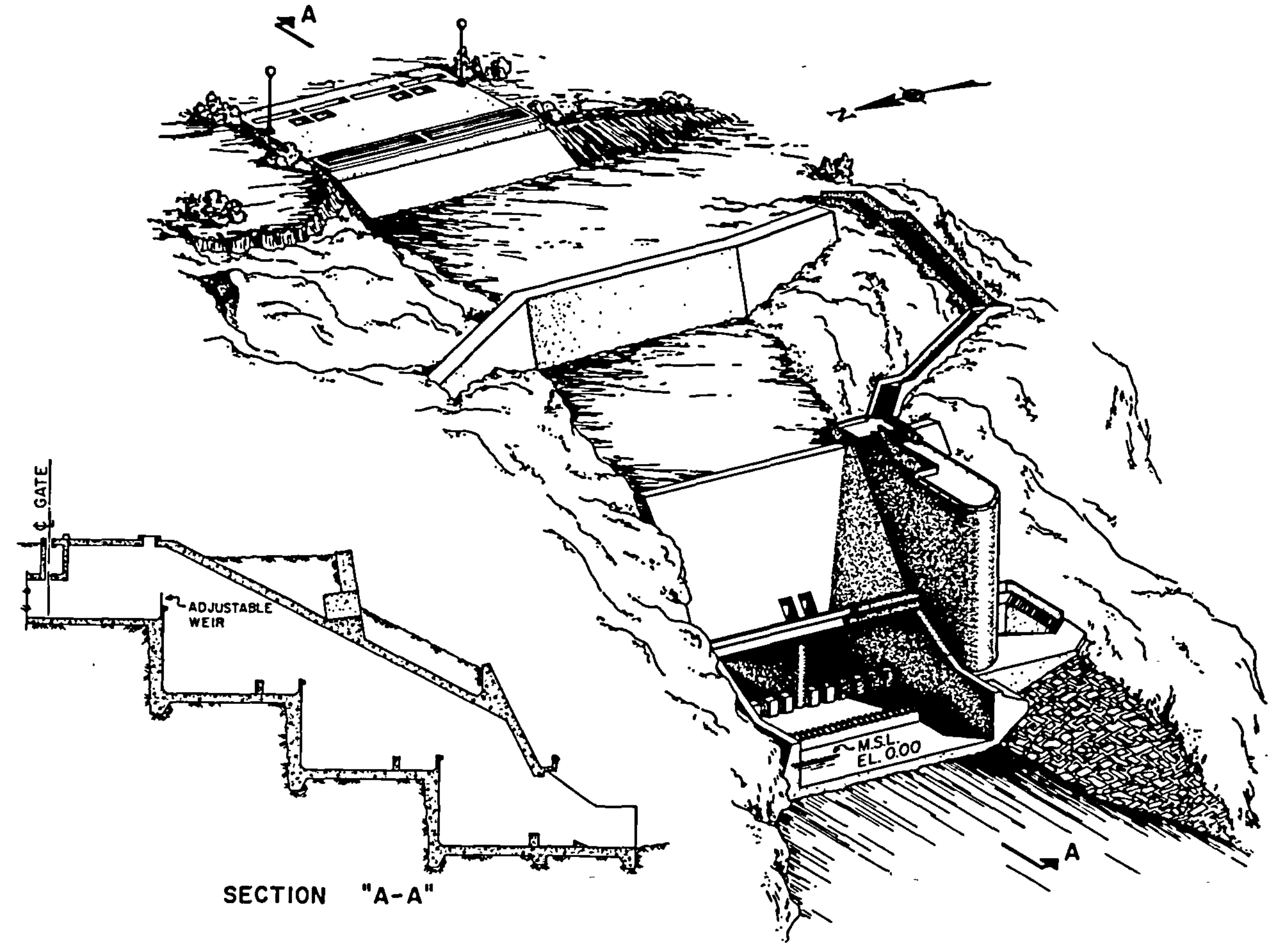


Fig. 3.6. Discharge structure.

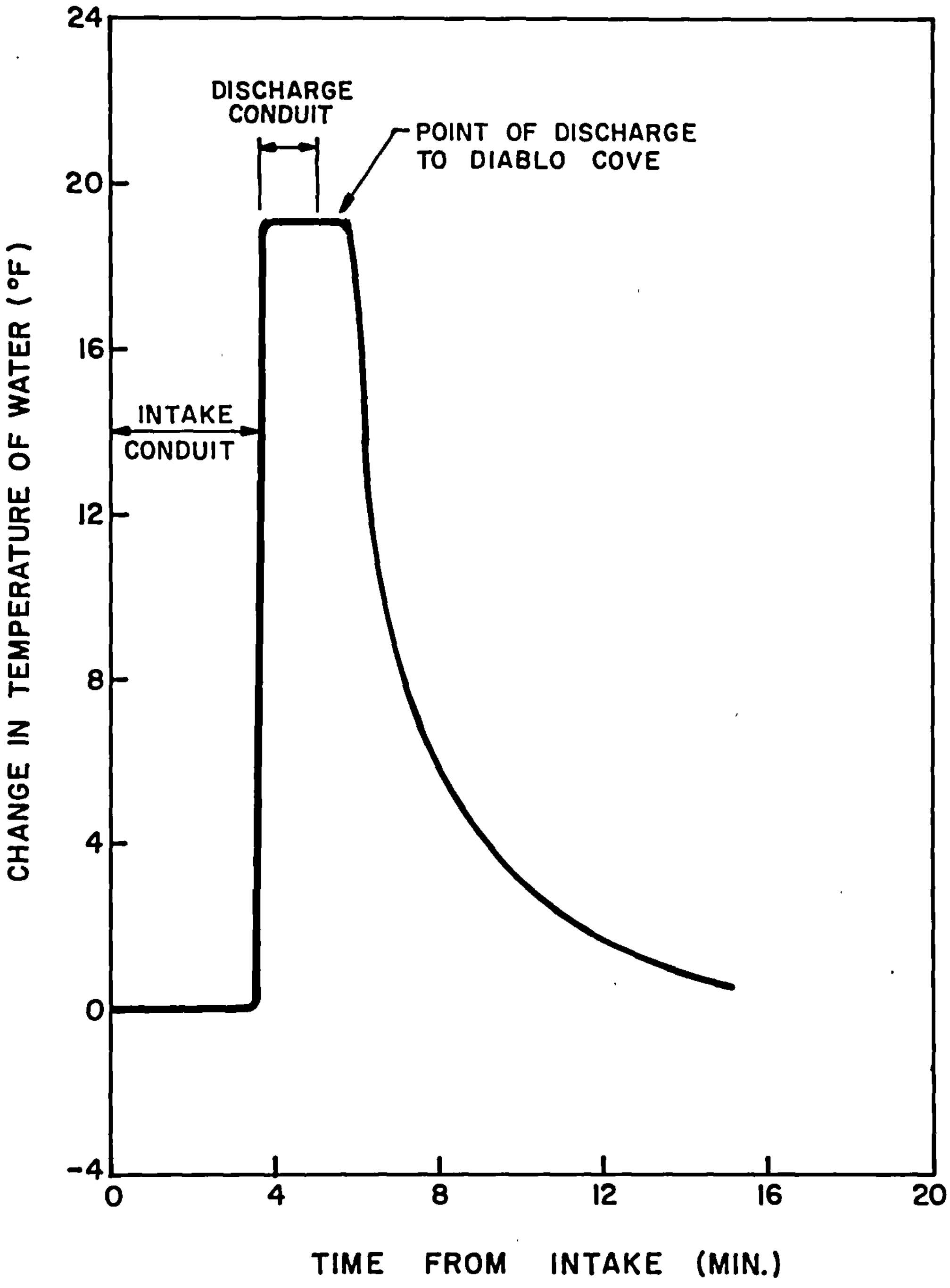


Fig. 3.7. Temperature-time curve for cooling water.

or (3) thermal shock. The third method was chosen by the applicant. The alternative methods are discussed in Sect. 12.3.4.

About each four to six weeks the applicant will perform heat treatment on the condenser for each unit using thermal shock. This consists of adjusting the gates and valves at the intake structure and at the head of the discharge cascade to recirculate part of the cooling water flow. Only one of the two pumps for this unit will be in operation during defouling, which will supply 1/2 of the normal flow. In effect, the water flows through one half of the condenser to the discharge structure, where the gates are adjusted so that one-fourth of the normal flow passes out to Diablo Cove. The other one-fourth of the normal flow for that condenser passes through the other half of the condenser in reverse flow, and back to the intake structure, where it passes, in reverse direction, through the idle pump. A gate is closed between the pump and the bar racks to prevent the return flow from entering South Cove, and the gate between paired pumps is open to permit the recirculated flow to enter the suction stream of the active pump. The power of the unit is reduced to 85%, and the temperature increases about 50°F in the cooling system to 105°—110°F. While the duration of the heat treatment is about 1 hr, approximately 3-4 hr are required to build up the necessary 50°F rise in coolant water temperature.

3.3.3 Thermal

Tides

The tidal cycle at Diablo Cove (35° 12' N; 120° 57' W) is a commonly observed type, having about two full cycles per day. The mean tidal range is 3.4 ft, the diurnal range is 5.3 ft, and the mean level is 3.1 ft.[2]

Diablo Cove is too small and open to the ocean to be subject to tidal amplification. The action of the tides on the shore within the cove is little different from the action at a completely open site.

The tides produce a "flushing" action in the cove, but the volume change of water in the cove due to tidal action is only about 4% of the flow from the condensers; therefore, each tidal stage may as an approximation be looked upon as a "steady state condition."

Currents

The ocean currents off the California coast are highly variable, being subject to several natural forces,[3] and not amenable to simple description. In the offshore area of Diablo Canyon, water movements are subject to the behavior of the California Current. The California Current moves in a southerly direction at distances from the coast that depend on the time of year and a variety of climatological factors. For a period each year the Davidson Current appears at the surface, moving in a northerly direction between the California Current and the coastline. Between the periods dominated by these two main currents, a period characterized by variable and erratic currents occurs. In general, the main currents move at about 0.5 to 1.0 knot.

Even during periods when a major current would be expected to dominate, the local geography and climatological conditions can create anomalous currents. The applicant has conducted several studies in an effort to identify and characterize the currents offshore of the Diablo Canyon area. The applicant will be required to initiate additional ocean current studies starting at least one year before operation of the first unit and continuing for one year after full-power operation of both units.

Salinity

The applicant has conducted a study of the oceanographic character of the Diablo Canyon area. Only very minor variations in salinity were observed. Considering the proximity of the intake to the discharge and the fact that both are essentially surface, no significant salinity gradients will be introduced by the action of the cooling water system.

Oxygen

At ambient temperature the ocean water has an oxygen saturation solubility of about 10 to 12 ppm. The saturation solubility is about 8 ppm at 82.5°F, the maximum temperature during normal operation. The normal concentration of oxygen in the Diablo Canyon area is 8 ppm;[4] therefore, the staff expects no effect on oxygen concentration from normal plant operation. There is, however, a partial vacuum at the condenser discharge, but the time at this condition is only a few seconds. The heat treatment operation could reduce the oxygen solubility to about 6 ppm. This operation occurs only for a 3- to 5-hr period about once a month for each condenser, which is too short a period for a steady state plume to develop. In any event, after initial dilution within the cove, the staff expects the oxygen concentration will not be depressed more than 10% below ambient.

Dye Dispersion

During the course of studying the Diablo Cove site, the applicant conducted several dye dispersion tests (ER Suppl. No. 2, Appendix R).[2] The tests consisted of depositing a dye in the ocean or cove and measuring concentration with time. The results indicated that natural dispersion forces worked rapidly in the area. The data were found to fit an expression of the form

$$C_{max} = A(\text{time})^{-n} ,$$

where C_{max} is the concentration of the center of a dye patch, time is in minutes, A is the initial concentration, and n is determined by observation.

Data fitted to the above equation yield a constant of about 2.0 for n. For a continuous release, a value of 1.0 for n would be more realistic; therefore, the equation for concentration of a chemical outside of the influence of the discharge plume is

$$C = \frac{A}{D \times \text{time}} ,$$

where time is in minutes and D is the dilution factor. The staff made independent dilution calculations for the near field using the more conservative staff's thermal model as a basis.

Thermal Dissipation at Full-Power Operation

The applicant has made temperature measurements in Diablo Cove and South Cove. The measurements for 1968 from Diablo Cove are shown graphically in Fig. 3.8. The maximum historical temperature observed has been 63.5°F, and the minimum observed has been about 45°F.

With two units operating at design power, the cooling water flow rate will be about 3864 cfs. The temperature rise through the condenser will be about 19°F, to give a maximum discharge temperature of 82.5°F. This maximum temperature would be experienced only during early fall, when the ambient ocean temperature approaches a maximum of about 63.5°F. (The temperature rise through the condenser during normal operation is expected to be 18°F.) The discharge structure is such that the condenser effluent is delivered to the surface water in Diablo Cove. The lowest stage of the cascade in the discharge structure acts as a short canal that connects the cascade to the ocean. The bottom of the cascade is at 7.5 feet below mean sea level, and with the fixed width of the structure, the cross-sectional area of the outfall will vary with the tide phase. This variation will cause a fluctuation in velocity that will follow the tidal cycles. The high tide velocity will be about 6.4 fps, and the low tide velocity will be about 14.3 fps. The

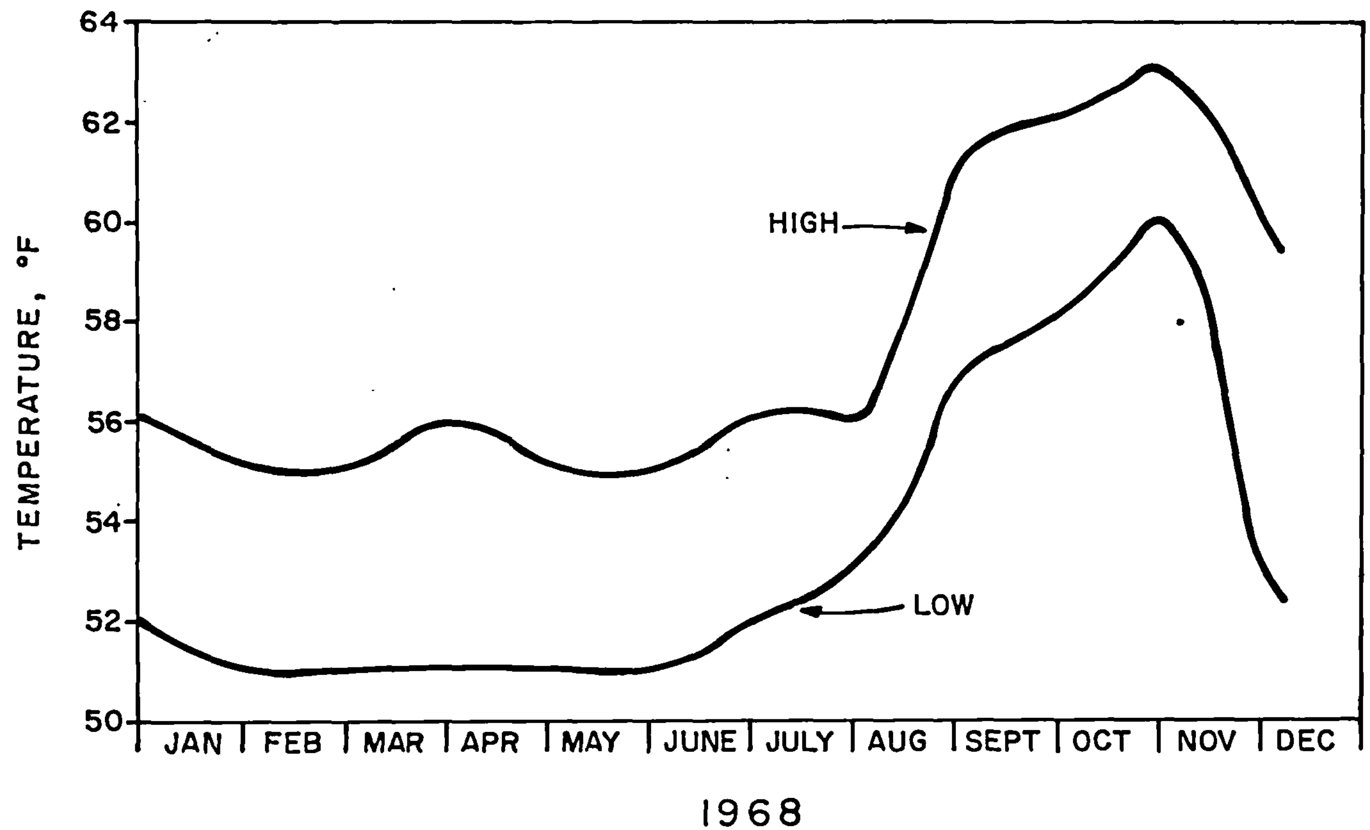


Fig. 3.8. Daily high and low surface water temperatures recorded in Diablo Cove in 1968.

densimetric Froude number thus varies from about 6 to 15 from high to low tide. In both extremes the discharge is primarily a momentum jet in which the principal mechanism of heat dissipation is through mixing with the ambient water. As the jet progresses into the cove, the velocity is materially reduced until the Froude number approaches unity, at which point the plume of warm water progresses by spreading, and temperature decline is significantly affected by heat transfer to the atmosphere. During the early phase of dilution, the jet will spread laterally and vertically, the plume depth in this case being constrained by the bottom of the cove. When the Froude number drops enough to dictate a change in flow mechanism, the rate of lateral spread of the plume will increase, and the plume will thin out, spreading primarily through some form of diffusion or density flow, until the combination of low temperature and reduced plume depth make the plume indistinguishable from its surroundings.

The ocean in the region of Diablo Canyon is usually highly turbulent. The degree of turbulence is quite variable. Mixing of the warm water with the ocean will be dependent on the degree of this turbulence, and in addition, plume areas are a function of outfall geometry, which has been shown to be a variable factor. The area of the plume itself should, thus, also be highly variable. This is demonstrated through examination of plume areas measured at the nearby Morro Bay power plant, which has an electric power output similar to one unit of the Diablo Canyon plant and a surface outfall. The Morro Bay 4°F isotherm varies from less than 3 acres to more than 100 acres. The maximum area should be observed on a high tide under calm conditions.

Applicant's Thermal Model. The applicant used a method described by Jen et al.[5] and extrapolated measurements made at the Morro Bay plant to a hypothetical three-unit plant located at Diablo Canyon. Plume areas are given in Table 3.1. Jen assumed that the velocity and temperature would follow an exponential decline with distance from the outfall. Constants for the equations were found experimentally. The results indicated the plume to be a function primarily of outfall cross-sectional dimensions.

Staff's Thermal Model. The staff conducted an independent analysis of the thermal effluent effects. Because of the geographical configuration of Diablo Cove the effluent system does not correspond exactly to solutions of jet problems that have been solved and published. After examination of the various mathematical models extant, one published by Stoltzenbach and Harleman[6] was selected by the staff as the one most applicable to the conditions in Diablo Cove.

Table 3.1. Plume areas calculated by the applicant for three units

Area (acres)	Probability[a]
10°F isotherm	
2.0	0.50
4.2	0.20
4°F isotherm	
15	0.80
32	0.50
82	0.20

[a]Plume area will equal or exceed the listed value according to the associated probability; e.g., the 4° isotherm will enclose 82 or more acres 20% of the time.

At the point of discharge, the bottom of the cove is about the same depth as the bottom of the discharge structure. The bottom then slopes irregularly from about 7 ft below mean sea level to about 40 ft deep at the opening of the cove.

A line representing the direction of flow from the discharge structure roughly intersects the midpoint of a line drawn between the southern arm of the cove and an island about 700 ft northwest of the arm. The island is about 1 acre in area at low tide. It is some 500 ft southwest of the northern arm of the cove, as shown in Fig. 3.5.

In using the mathematical model, the assumption was made that the jet, while in the cove, entrains water only from the northern side of the plume. For this calculation the staff employed the one-sided adaptation of the above model (ref. 6, p. 156). For the region outside the cove, the standard form of the model was used, which assumes entrainment from both sides of the plume.

The calculations gave isotherms shown in Figs. 3.9 and 3.10 for high and low tides. The isotherms north of the center line of the plume are those calculated by the above model, and the broken lines south of the center line are visual estimates of isotherms resulting from the expected formation of an eddy in the south portion of the cove.

The figures show the location where the model results indicate that the plume separates from the bottom. From this location outward, entrainment may take place from the bottom as well as the sides of the plume.

Full isotherms of 10°, 5°, 4°, and 2° for high tide are shown in Fig. 3.11. Areas within several isotherms are given in Table 3.2. These isotherms are considered applicable only for periods of relative calm in the ocean. Normally, the Pacific Ocean in this area is highly turbulent, and such turbulence is expected to promote early dilution of the plume and result in less affected area than noted above.

The method adopted for plume analysis predicts the plume velocity at the south outlet from the cove to be about 1 fps. A plume 30 ft deep and 600 ft wide (as predicted by the model) would therefore transport about 18,000 cfs out of the cove. This requires about 15,000 cfs of entrained water to enter the cove, primarily between the offshore island and the northern arm of the cove. The dimensions of this latter opening are about 500 ft wide and 15 ft deep. This flow would, therefore, require a velocity of about 2 fps. The

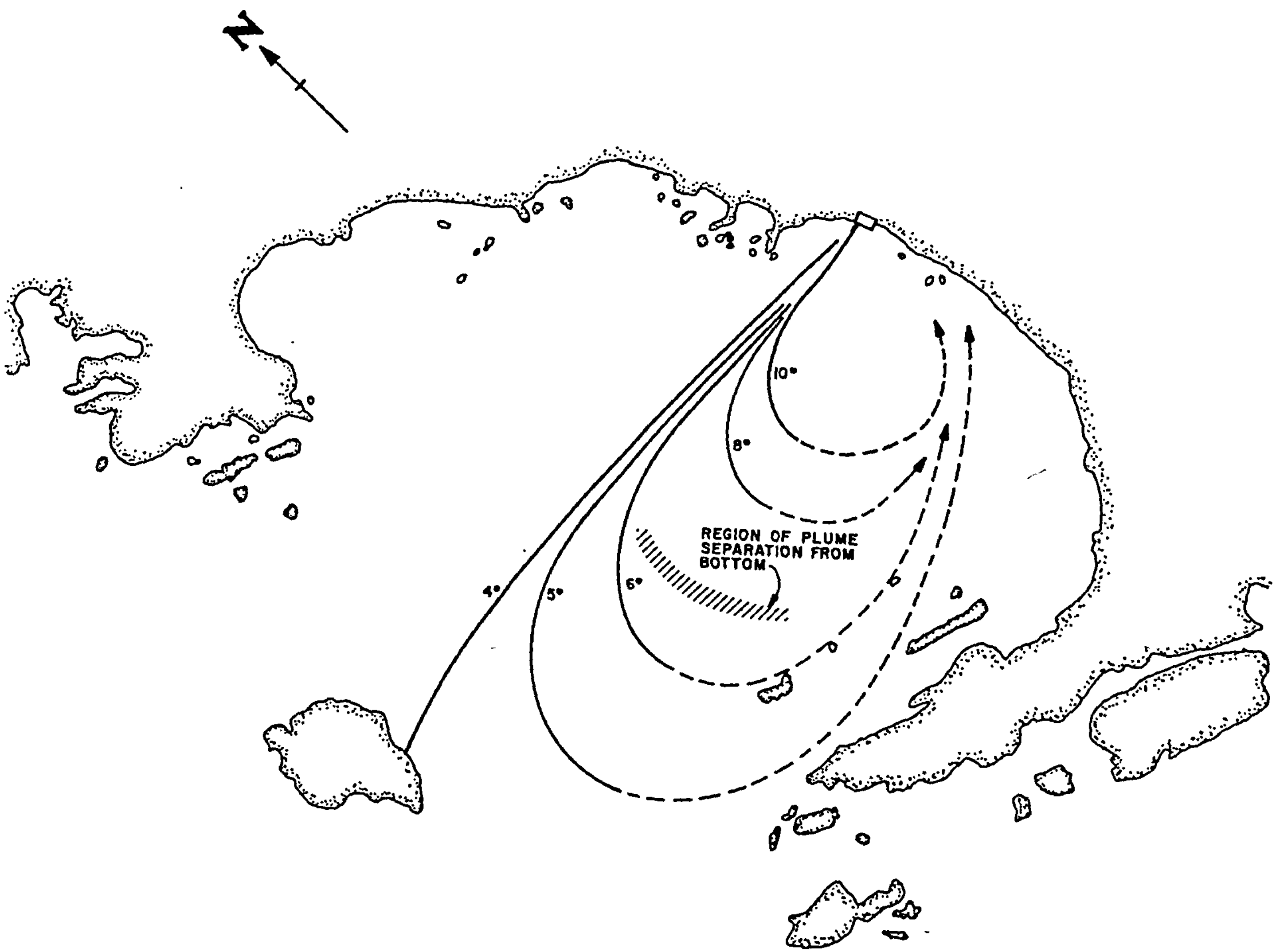


Fig. 3.9. High tide isotherms of thermal plume in Diablo Cove.

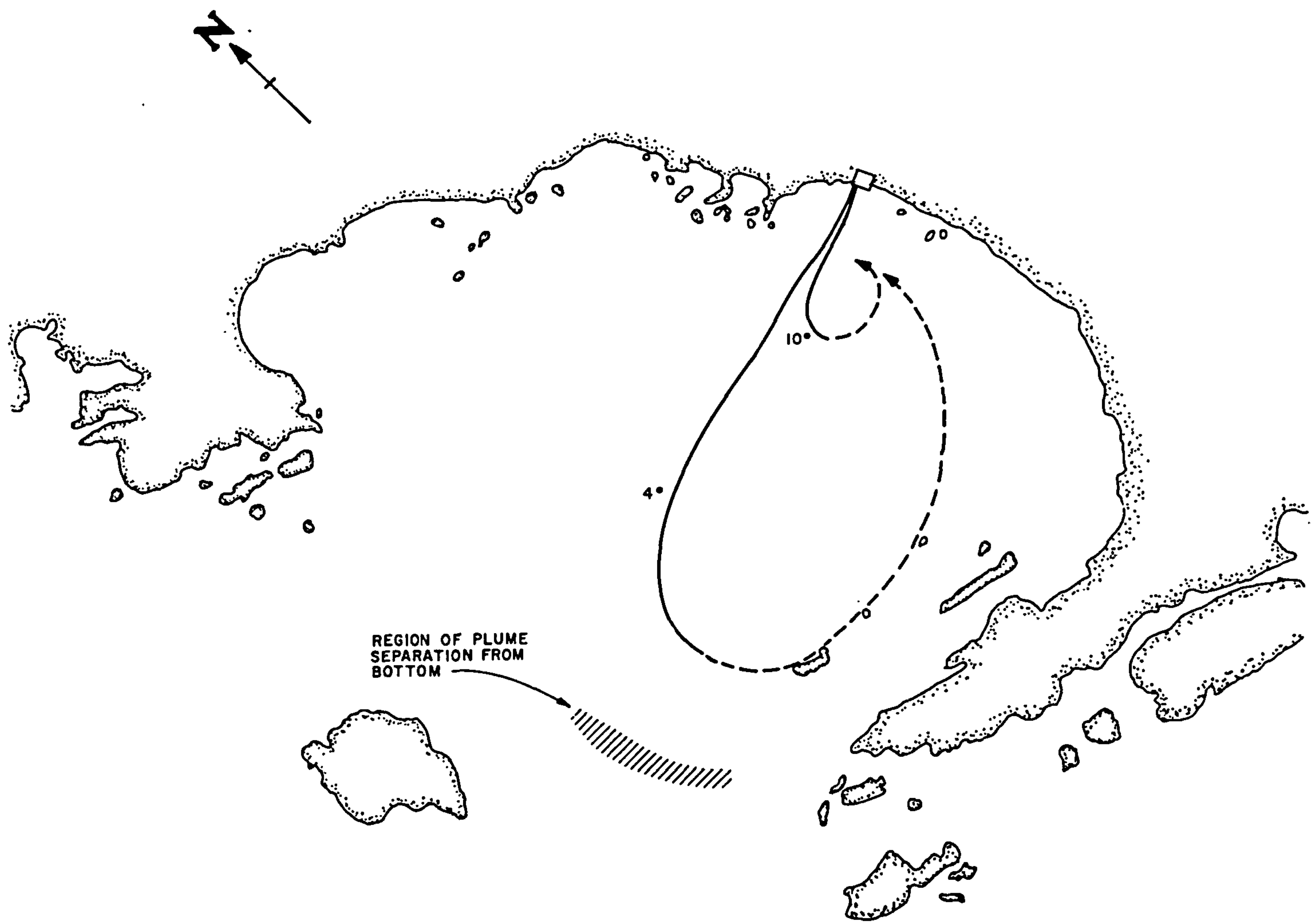


Fig. 3.10. Low tide isotherms of thermal plume in Diablo Cove.

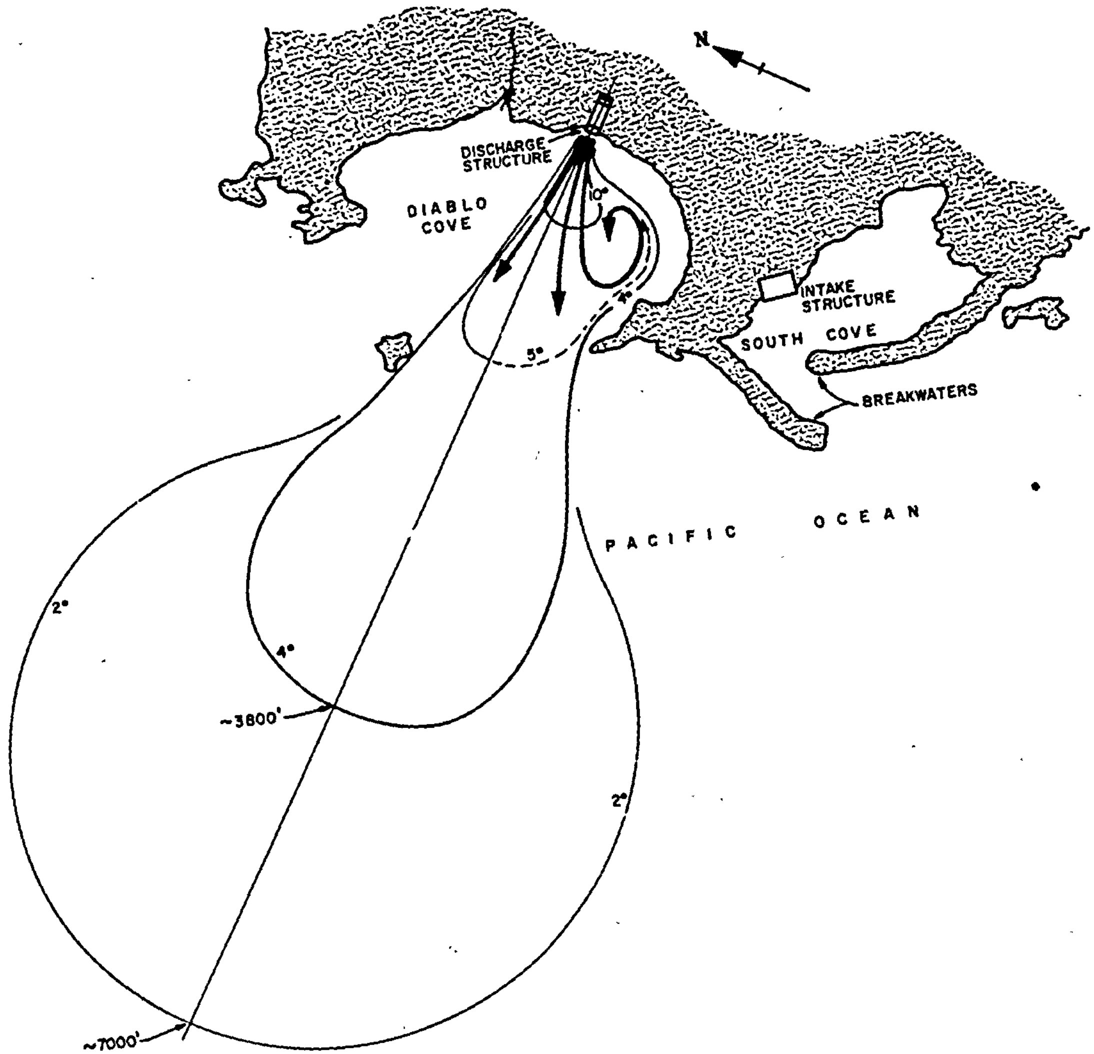


Fig. 3-11 High-tide isotherms of thermal plume outside Diablo Cove.

Table 3.2. Plume areas calculated by the staff

Isotherm (°F)	Area (acres)	
	High tide	Low tide
10	5	1.4
8	8	2.5
6	15	5
5	25	7
4	68	12

driving force for such a velocity is readily created by the entrainment of water in the discharge jet.

From studies made by the applicant, currents in the immediate area of Diablo Cove are known to be highly variable. In the event a strong current out of the north exists, the plume, at high tide only, will be bent around and possibly enter South Cove, where the intake structure is located. However, the plume at this distance is only about 10 ft thick, and since the opening to the intake structure is at least 10 ft below the surface at high tide, no significant recirculation effect is expected.

If a strong current out of the south exists, then the plume will be bent toward the north, and entrainment on the south boundary of the plume will be increased, compensating for any reentrainment of the plume, or restriction of the north entrance to the cove.

Conclusions Regarding Thermal Modeling. The staff analysis indicates that the maximum area enclosed in the 10°F isotherm is 5 acres and that in the 4°F isotherm is 68 acres. These occur at high tide. Any wind or ocean currents would tend to reduce these areas. Further, the water outside of Diablo Cove is expected to be less than 5°F above ambient.

The staff results are in reasonable agreement with those predicted by the applicant.

Thermal Alteration during Defouling

The defouling procedure was discussed in Sect. 3.3.2. If both units are operating at the time one is being defouled, the plume from the unit in full operation will entrain the hot water from the unit being defouled. The staff estimated the resulting plume for this case using the mathematical model as indicated in the staff's analysis above. The results of the calculations are given in Table 3.3. The area of the 10°F isotherm is less than that for full operation of both units; however, the area of the 4°F isotherm is greater.

If one unit is being defouled when the other unit is not in operation, the flow from the discharge structure will be only one-fourth of the normal flow from one unit. This low flow of water with a temperature rise of 50°F above ambient will result in a more buoyant plume which will be governed by buoyant rather than kinetic forces. The warm water will therefore spread throughout the cove before it has entrained sufficient water to reduce the temperature to 10°F above ambient. The spreading action will reduce the thickness of the plume to about 1 ft deep at the mouth of the cove. The areas

Table 3.3. Areas (in acres) of isotherms during defouling of one unit

Isotherm (°F above ambient)	Other unit in full operation		Other unit not in operation	
	High tide	Low tide	High tide	Low tide
10	3	1	>500	>500
8	7	2		
6	19	3		
5	51	4		
4	128	7		

of the isotherms for this latter case were estimated by the staff using the model discussed above but with entrainment from both sides. The areas of the isotherms are given in Table 3.3. These latter thermal alterations are considered unacceptable by the staff. The applicant will be required to operate the defouling treatment in such a manner that the thermal alteration is no more than that for the treatment of one unit with the other unit in full operation.

3.3.4 Auxiliary Steam Boiler

An auxiliary steam boiler will be used at Diablo Canyon Units 1 and 2 to supply steam for space heating and certain other purposes during periods when neither unit is in operation. The auxiliary steam boiler will not normally be used if either unit is operating.

The auxiliary steam boiler is designed to use No. 2 fuel oil. Estimates of emissions and usage are given in Table 3.4.

3.4 RADIOACTIVE WASTE SYSTEMS

During the operation of the Diablo Canyon Nuclear Units 1 and 2, radioactive material will be produced by fission and by neutron activation reactions in metals and other material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes will enter the wastes streams, which will be monitored and processed within the plant to reduce the amount of radionuclides that will be released to the atmosphere and into Diablo Cove of the Pacific Ocean. The levels of radioactivity that may be released in liquid and gaseous effluents during operation of the plant will be in accordance with the Commission's regulations, as set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste handling and treatment systems being installed at the plant are discussed in the Preliminary Safety Analysis Reports for Units 1 and 2, in the Applicant's Environmental Report, dated July 1971 and Supplement 1, dated November 1971. The steam generator blowdown treatment system proposed for Units 1 and 2 is described in a supplemental report dated April 1973.[7] In these references, the applicant has prepared an analysis of the radwaste treatment systems, and has calculated annual releases of radioactivity in effluents for two basic sets of plant operating conditions referred to as the Design Basic Case and the Anticipated Operational Occurrence Case. The following evaluation is based on the staff's source term model and uses somewhat different operating conditions than those used by the applicant. A comparison of the principal parameters used by the staff and the applicant are given in Table 3.5. The staff's calculated releases

Table 3.4. Estimated emissions from auxiliary steam boiler

Startup period for Unit 1 will require an estimated six months of auxiliary steam boiler operation. After startup of Unit 1 but prior to the startup of Unit 2, expected usage of auxiliary steam boiler is eight weeks per year. After startup of Unit 2, expected usage of auxiliary steam boiler is two weeks per year

Type of emission	Emission factor[a] (lb per thousand gallons of fuel)	Estimated emissions[b] (lb/hr)
Particulates	15	2.7
Sulfur dioxide	$142S$[c]	11.5
Sulfur trioxide	$2S$[c]	0.16
Carbon monoxide	0.2	0.04
Hydrocarbons	3	0.54
Nitrogen oxides (as NO_2)	80	14.4
Aldehydes (as HCHO)	2	0.36

[a]From *Compilation of Air Pollutant Emission Factors (Revised)*, U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina (February 1972).

[b]Based on fuel consumption at rated output of 179.5 gal/hr.

[c]*S* equals percent by weight of sulfur in fuel. It is estimated that the No. 2 fuel oil to be used will contain a maximum of 0.45% sulfur.

Table 3.5 Comparison of Principal Parameters Used In Determining Radioactivity Released In Liquid and Gaseous Effluent From Diable Canyon, Units 1 and 2

Parameter	Value/Reactor	
	Staff	Applicant
Reactor Power, MW_t	3568	3568
Plant Capacity Factor	80%	85%
Percent of Fuel Releasing Radioactivity To Primary Coolant (1)	0.25%	0.20%
Number of Steam Generators	4	4
Weight of Steam In Each Generator	6.75×10^3 lbs.	6.75×10^3 lbs.
Weight of Liquid In Each Generator	8.0×10^4 lbs.	8.0×10^4 lbs.
Total Steam Flow	1.4×10^7 lbs/hr.	1.4×10^7 lbs/hr.
Volume of Primary Coolant	1.26×10^4 cf.	1.26×10^4 cf.
Primary Coolant Volumes Degassed	2/yr.	1/yr.
Volume of the Containment Building	2.6×10^6 cf.	2.6×10^6 cf.
Internal Recirculation System (2-12,000 cfm)	24,000 cfm(2)	24,000 cfm
Containment Purges	4/yr.	52/yr.
Primary to Secondary Leakage Rate	110 lbs/day	110 lbs/day
Containment Building Leakage Rate	240 lbs/day	50 lbs/day
Auxiliary Building Leakage Rate	160 lbs/day	160 lbs/day
Turbine Building Steam Leakage	1700 lbs/day	1940 lbs/day
Letdown Rate	75 gpm	75 gpm
Shim Bleed Rate	1 gpm	1 gpm
Steam Generator Blowdown Rate	8400 lbs/hr	72000 lbs/hr
Total Mass of Secondary Coolant	5×10^5 lbs.	5×10^5 lbs
Gas Decay Time	45 days	45 days
Partition Factors For Radioiodine Steam Generator, Internal Partition	0.01	0.01
Steam Generator Blowdown Tank Vent	0.05	0.1
Primary Coolant - Hot	0.1	a
Primary Coolant - Cold	0.001	a
Decontamination Factors For Radioiodine Charcoal Adsorber	10	100
Main Condenser/Air Ejector	2000	10,000

Liquid Waste Flow Rates and Holdup Times

Source	Flow Rate (gpd)	Fraction of Primary Coolant Activity	Average Holdup Time (days)
Shim Bleed	1,440	0.1	27
Equipment Drains	240	1.0	4.4
Floor Drains	97975	0.1	7
Chemical Drains	500	0.002	0.2
Steam Generator Blowdown			
Treated	21,900	-	0.13
Untreated	2,430	-	0

Decontamination Factors For Liquid Waste Treatment System

Source	Decontamination Factor				
	I	Cs	Mo	Y	Others
Shim Bleed	10^4	10^4	10^5	10^4	10^5
Equipment Drain	10^3	10^4	10^6	10^5	10^4
Floor Drains	10^3	10^4	10^6	10^5	10^4
Chemical Drains	1	1	10^2	10	1
Steam Generator Blowdown					
Treated	10^3	10	10^2	10	10^2
Untreated	1	1	10^2	10	1

(1) This value is constant and corresponds to 0.25% of the operating fission product source term.

(2) Assume system operates 16 hrs prior to purging and a mixing efficiency of 70%.

a. Information not available

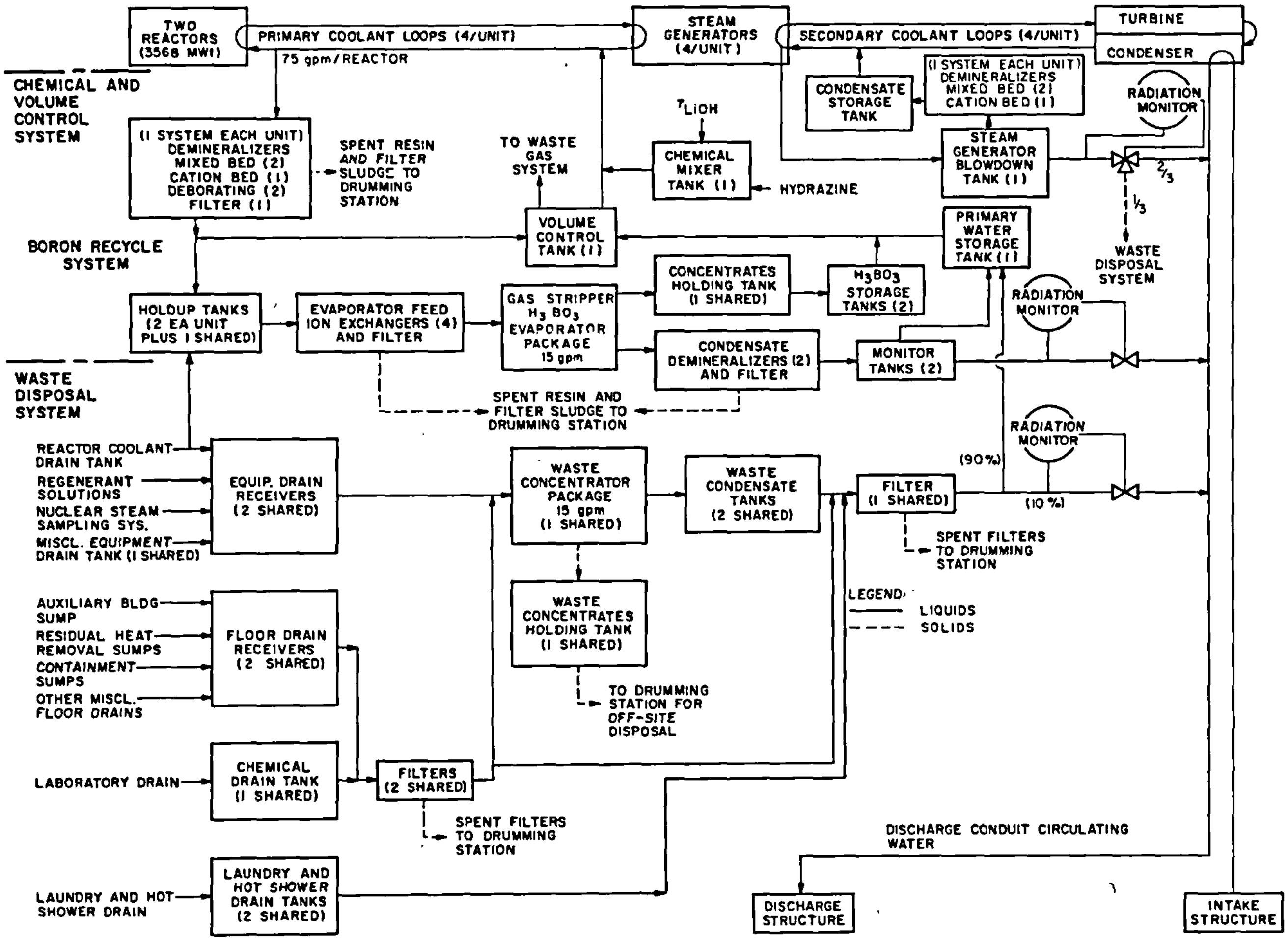
of radioactive materials in effluents are different from the applicant; however, the model used in the staff's evaluation results from a review of available data from operating power reactors. In comparing the calculated releases of radioactivity the staff has used the applicant's case referred to as Anticipated Operational Occurrences[7], since the operating conditions are more representative of routine plant operations.

3.4.1 Liquid Wastes

The liquid radioactive waste treatment system common to Units 1 and 2 will consist of process equipment and instrumentation necessary to collect, process, monitor and dispose of potentially radioactive liquid waste from the station. Liquid wastes will be handled on a batch basis as required to permit optimum control in the releases. Prior to release of any liquid waste, samples will be analyzed to determine the type and amount of radioactivity in the batch. Based on the results of the analyses, these wastes will be either released under controlled conditions to Diablo Cove of the Pacific Ocean or retained for further processing. Radiation monitoring will automatically terminate liquid waste discharge if radiation levels are above a predetermined level in the discharge line.

The liquid waste treatment system is divided into two main parts. The chemical and volume control system (CVCS), consisting of the boron recycle system, will process liquids from the reactor coolant system which is the principal source of radioactive liquid wastes. The majority of these wastes is processed and retained within the CVCS for reuse in the reactor. By recycling, the CVCS limits the input to the liquid waste system (LWS). The liquid waste system will consist of the equipment drain subsystem, floor drain subsystem, chemical drain subsystem and laundry and hot shower drain subsystem. The interrelations of these subsystems are shown schematically in Figure 3.12.

The boron recycle system is an integral part of the CVCS and will be used to control the reactivity of the core by changing the boron concentration in the reactor. A sidestream of approximately 75 gpm of primary coolant will be let down from the reactor coolant system to the CVCS and processed through one of two mixed bed demineralizers where ionic impurities will be continuously removed from the primary coolant. When necessary for control of cesium and lithium, this stream will be processed through a single cation demineralizer. Two deborating demineralizers will be provided and used in series with the mixed bed demineralizers to remove boron from the primary coolant near the end of core life.



LIQUID RADIOACTIVE WASTE SYSTEM
DIABLO CANYON, UNITS 1 AND 2

Fig. 3.12 - Liquid Radioactive Waste System
Diablo Canyon, Units 1 and 2

Approximately 1 gpm (shim bleed) of the CVCS stream will be diverted to the boron recycle system (BRS) holdup tanks to adjust the boric acid concentration in the primary coolant. The BRS will also receive inputs from the reactor coolant drain tank which will accumulate minor quantities of primary grade water wastes from other sources. Five 83,200 gal. holdup tanks will be provided, two serving each unit and a fifth shared between the units to provide additional storage capacity. The contents of one tank normally will be processed in the BRS while another is being filled. Flexibility will be provided in processing the holdup tank liquid in the BRS. The processing systems of each unit can be used interchangeably, the effluent being pumped in turn through the evaporator feed ion exchangers and filter, the gas stripper where dissolved gases will be removed, and the boric acid evaporator. The recovered boric acid will be collected in the concentrates holding tank, sampled, analyzed and returned to the boric acid storage tank for reuse or transferred to the solid waste system and packaged as solid waste for offsite shipment. The distillate will pass through one of the two condensate demineralizers and filter and will be collected in one of two 24,600 gal monitor tanks. After sampling and analysis, the water will be transferred to the primary water storage tank, recycled through the holdup tanks, or discharged to the environment.

The staff's evaluation considered a daily input into the two boron recycle systems of 2880 gallons of primary coolant activity water. The staff further considered that 90% of this water would be recycled and that 10% would be discharged to the circulation water system.

The liquid waste system (LWS) is common to Units 1 and 2, except for wastes collected in containment and turbine sumps and tanks. The LWS will process batchwise, liquids from the following sources; equipment drains and demineralizer regenerants, floor drains, chemical laboratory and sampling drains, radioactive laundry and shower drains, and liquid wastes from steam generator blowdown.

High purity (low conductivity), primary grade waste water, mainly from valve and pump seal leakoff tank overflows and demineralizer regenerants from the steam generator blowdown treatment system will be collected in two 15,000 gal equipment drain receiver tanks. The wastes will be processed through a 15 gpm waste concentrator. The concentrator bottoms will be solidified for offsite disposal and the distillate collected in two 15,000 gallon waste condensate sample tanks. In its evaluation the staff considered a daily input of 2500 gal/reactor into the equipment drain system and that all of the wastes after processing will be discharged to the environment. The staff calculated that approximately 0.14 Ci/yr/reactor will be released from this system and the shim bleed system combined.

The LWS will provide flexibility for processing non-primary grade wastes from the floor drain and chemical laboratory subsystems. Liquid wastes from auxiliary, containment and miscellaneous equipment sumps and sample drains will be collected in two 15,000 gal floor drain receiver tanks. Depending on the activity level, these wastes can be processed through two stages of filtration and released to the circulating water discharge canal or processed through the waste concentrator. The staff's evaluation considered a daily input into the floor drain system of approximately 975 gal/reactor and that 100% of the treated waste will be released.

Chemical wastes generated from routine sampling and analyses will be collected in a 1000 gal chemical receiver tank. After appropriate sampling and analysis these wastes will be processed through two stages of filtration and released to the circulating water discharge canal. The staff calculated that approximately 2.7 Ci/yr/reactor will be released from the floor drain and chemical waste systems.

The staff's evaluation considered that liquid wastes from the laundry and hot showers will be collected at a rate of 450 gal/d/reactor at an activity level of approximately 10^{-4} μCi/cc. The liquid wastes will be collected in two 1000 gal laundry drain tanks held for approximately 2 days for decay of short lived activity, sampled, processed through two stages of filtration, and released to the discharge canal. The staff calculated that approximately 0.06 Ci/yr/reactor will be released from this source.

To maintain the proper water chemistry in the secondary coolant water, it is necessary to blowdown the steam generators. Some or all of this blowdown water will be released to the environment. The steam generator blowdown treatment system for each reactor is composed of two paths. During operation, when the secondary system contains radioactivity below a predetermined level, blowdown will be routed to the blowdown tank and released to the discharge canal without treatment. During periods when the secondary system contains radioactivity above a predetermined level, the blowdown is diverted to the blowdown treatment system consisting of a flash tank, heat exchanger, prefilter and three demineralizers. Following the prefilter, the blowdown will be processed through a cation (60 cf) demineralizer to reduce cationic impurities, then through one of two anion (150 cf) demineralizers, to remove ionic impurities (iodines). The third anion (60 cf) demineralizer will remove anionic solids that may have gone through the first demineralizer. The treated blowdown will be returned to the condensate storage tank for reuse.

Upon exhaustion of the cation and anion demineralizers, the units will be regenerated. Regenerant wastes will be neutralized and pumped to the equipment drain receiver tank for further processing. The applicant estimates that these units will require regeneration approximately every 4 days when blowdown is diverted to the blowdown tank. The applicant has estimated that the anion demineralizers will have a process time of 40 days before iodine saturation. After a demineralizer has been exhausted, it will be held for 40 days before regeneration to allow most of the iodine to decay. During this time, the second demineralizer will be placed in service. Regenerant wastes will be neutralized, sampled and released to the discharge canal. In addition, the applicant has considered the effects of sea water inleakage into the main condenser and has assumed 36 leaks per year of 6 hours each when the blowdown is diverted for further processing. During these periods, blowdown will be processed through the steam generator blowdown tank, since operation of the demineralizers with sea water inleakage is not practicable. The staff believes the applicant's estimates of condenser inleakage and frequency of regeneration of the demineralizers to be reasonable and has considered these values in its source term calculations.

The staff's evaluation of the steam generator blowdown system considered a primary to secondary leakage rate of 20 gpd and considered that approximately 10% of the time the blowdown will be released without treatment. The applicant assumed the same leakage rate but only 5% of the time when the blowdown will not be treated. Based on a blowdown rate of 17 gpm (0.06% steam flow) the staff calculated that approximately 2.2 Ci/yr/reactor, excluding tritium, will be released from steam generator blowdown and that 0.09 Ci/yr/reactor will be released in untreated regenerant waste. The applicant, based on a blowdown rate of 150 gpm, calculated a release of 0.07 Ci/yr/reactor from both sources.

In addition, there will be some leakage from the secondary system to the turbine building which will be released without treatment for further removal of radionuclides. The staff calculated that approximately 0.048 Ci/yr/reactor will be released from this source. The applicant has calculated that 0.13 Ci/yr/reactor will be released from the turbine building.

Based on the principal parameters shown in Table 3.5, the annual releases of radioactive materials in liquid waste were calculated to be 5.3 Ci/yr/reactor, excluding tritium. The principal sources together with the isotopic distribution are shown in Table 3.6. Based on operating experience at PWR's the staff estimates that approximately 350 Ci/yr/reactor of tritium will be released to the environment. The

Table 3.6. Annual release of radioactive material in liquid effluents from Diablo Canyon Nuclear Power Plant, each unit (1 or 2)

In curies per year per unit

Nuclide	Clean waste	Floor drains and chemical waste	Steam generator blowdown	Turbine building	Total
		Corrosion and activation products			
Na-24	*a*	0.002	0.001	*a*	0.003
Si-31	*a*	0.00001	*a*	*a*	0.00002
P-32	*a*	0.0002	0.00028	*a*	0.0005
P-33	0.00002	0.00075	0.0010	*a*	0.0018
Sc-47	*a*	0.00001	0.00001	*a*	0.00002
Cr-51	0.00006	0.0029	0.0039	0.00001	0.0069
Mn-54	0.00001	0.00046	0.00065	*a*	0.0011
Mn-56	*a*	0.07	0.012	0.00001	0.083
Fe-55	0.00006	0.0025	0.0034	0.00001	0.0059
Fe-59	0.00003	0.0016	0.0021	0.00001	0.0037
Co-58	0.00056	0.024	0.034	0.0001	0.059
Co-60m	*a*	0.00003	*a*	*a*	0.00003
Co-60	0.00007	0.0030	0.0042	0.00001	0.0073
Ni-63	0.00001	0.00024	0.00034	*a*	0.00059
Ni-65	*a*	0.00033	0.00006	*a*	0.00039
Zn-65	*a*	0.00001	0.00002	*a*	0.00003
Zn-67m	*a*	0.00002	0.00001	*a*	0.00003
Zn-69	*a*	0.00002	0.00001	*a*	0.00003
Zr-95	*a*	0.00001	0.00001	*a*	0.00002
Nb-92	0.00001	0.00063	0.0008	*a*	0.0014
Nb-95	*a*	0.00001	0.00002	*a*	0.00003
Nb-96	*a*	0.00001	0.00001	*a*	0.0000
Mo-99	*a*	0.00004	0.00005	*a*	0.00009
Tc-99m	*a*	0.00004	0.00005	*a*	0.00009
Sn-117m	*a*	0.0002	0.00026	*a*	0.00047
Sn-121	*a*	0.00003	0.00002	*a*	0.00005
W-185	*a*	0.00012	0.00016	*a*	0.00028
W-187	0.00001	0.0071	0.005	0.00001	0.012
U-237	*a*	0.00006	0.00007	*a*	0.00013
Np-238	*a*	0.00002	0.00001	*a*	0.00003
Np-239	0.00001	0.0016	0.0016	*a*	0.0032
Pu-241	*a*	*a*	0.00001	*a*	0.00001
		Fission products			
Br-82	0.00002	0.0006	0.0005	0.00001	0.0012
Br-83	*a*	0.0049	0.0008	0.00001	0.0057
Br-84	*a*	0.00063	0.00003	*a*	0.00066
Rb-86	0.00001	0.00026	0.00037	*a*	0.00063
Rb-88	*a*	0.028	0.00080	*a*	0.029
Rb-89	*a*	0.0014	0.00003	*a*	0.0015
Sr-89	0.00002	0.0010	0.0014	*a*	0.0024
Rb-90	*a*	0.00005	*a*	*a*	0.00005
Sr-90	*a*	0.00003	0.00004	*a*	0.00007
Y-90	*a*	0.00001	0.00001	*a*	0.00002
Sr-91	*a*	0.0013	0.00055	*a*	0.0019
Y-91m	*a*	0.00009	0.00007	*a*	0.00016
Y-91	0.00017	0.0013	0.0021	*a*	0.0037
Sr-92	*a*	0.00014	0.00003	*a*	0.00017

Table 3.6 (continued)

Nuclide	Clean waste	Floor drains and chemical waste	Steam generator blowdown	Turbine building	Total
Y-92	*a*	0.00003	0.00001	*a*	0.00004
Y-93	*a*	0.00003	0.0001	*a*	0.00004
Zr-95	*a*	0.00016	0.00023	*a*	0.0004
Nb-95	*a*	0.00016	0.00022	*a*	0.00038
Zr-97	*a*	0.00009	0.00005	*a*	0.00014
Nb-97m	*a*	0.00008	0.00005	*a*	0.00013
Nb-97	*a*	0.00009	0.00006	*a*	0.00015
Mo-99	0.00017	0.013	0.016	0.00002	0.029
Tc-99m	0.00017	0.012	0.015	0.00002	0.027
Ru-103	*a*	0.00013	0.00017	*a*	0.0003
Rh-103m	*a*	0.00015	0.00017	*a*	0.00032
Ru-105	*a*	0.00005	0.00001	*a*	0.00007
Rh-105m	*a*	0.00005	0.00001	*a*	0.00007
Rh-105	*a*	0.00007	0.00006	*a*	0.00013
Ru-106	*a*	0.00003	0.00004	*a*	0.00007
Rh-106	*a*	0.00003	0.00004	*a*	0.00007
Pd-109	*a*	0.0001	*a*	*a*	0.00001
Ag-109m	*a*	0.00001	*a*	*a*	0.00001
Te-125m	*a*	0.00008	0.00011	*a*	0.0002
Sb-127	*a*	0.00001	0.00001	*a*	0.00002
Te-127m	0.00002	0.00079	0.0011	*a*	0.0019
Te-127	0.00002	0.0019	0.0016	*a*	0.0035
Te-129m	0.00008	0.0038	0.0051	0.00002	0.009
Te-129	0.00005	0.0028	0.0033	0.00001	0.0061
I-130	0.00001	0.0050	0.0025	0.00006	0.0075
Te-131m	0.00002	0.006	0.0048	0.00001	0.011
Te-131	*a*	0.0013	0.00096	*a*	0.0023
I-131	0.13	0.79	0.93	0.027	1.9
Te-132	0.00072	0.073	0.079	0.00022	0.15
I-132	0.00075	0.14	0.089	0.00069	0.23
Te-133m	*a*	0.00082	0.00006	*a*	0.00088
Te-133	*a*	0.00015	0.00001	*a*	0.00016
I-133	0.0089	0.90	0.59	0.016	1.52
Te-134	*a*	0.00078	0.00005	*a*	0.00083
I-134	*a*	0.019	0.0014	*a*	0.021
Cs-134m	*a*	0.0020	0.00042	*a*	0.0024
Cs-134	0.0023	0.076	0.12	0.00031	0.20
I-135	0.00001	0.34	0.11	0.0024	0.46
Cs-135m	*a*	0.00010	0.00001	*a*	0.00011
Cs-136	0.00076	0.036	0.05	0.00014	0.087
Cs-137	0.0015	0.050	0.076	0.00021	0.13
Ba-137m	0.0014	0.047	0.066	0.00019	0.11
Cs-138	*a*	0.020	0.00097	*a*	0.02
Cs-139	*a*	0.00066	0.00001	*a*	0.00067
Ba-139	*a*	0.0058	0.00064	*a*	0.0064
Cs-140	*a*	0.00001	*a*	*a*	0.00001
Ba-140	0.00002	0.00124	0.0016	*a*	0.0029
La-140	0.00002	0.00049	0.001	*a*	0.0015
Ba-141	*a*	0.00003	*a*	*a*	0.00003
La-141	*a*	0.00030	0.00007	*a*	0.00037
Ce-147	*a*	0.00019	0.00025	*a*	0.00044
La-142	*a*	0.00002	*a*	*a*	0.00002

Table 3.6 (continued)

Nuclide	Clean waste	Floor drains and chemical waste	Steam generator blowdown	Turbine building	Total
Ce-143	*a*	0.00011	0.00009	*a*	0.0002
Pr-143	*a*	0.00016	0.00021	*a*	0.00037
Ce-144	*a*	0.00009	0.00013	*a*	0.00023
Pr-144	*a*	0.00010	0.00014	*a*	0.00024
Pr-145	*a*	0.00002	0.00001	*a*	0.00003
Nd-147	*a*	0.00007	0.00009	*a*	0.00016
Pm-147	*a*	0.00001	0.00001	*a*	0.00002
Pm-148	*a*	0.00002	0.00002	*a*	0.00004
Pm-149	*a*	0.00005	0.00005	*a*	0.00010
Pm-151	*a*	0.00001	0.00001	*a*	0.00002
Sm-153	*a*	0.00003	0.00002	*a*	0.00005
Eu-156	*a*	0.00001	0.00002	*a*	0.00003
All others	*a*	0.00010	0.00004	*a*	0.00014
Total					
	0.14	2.7	2.2	0.048	5.1 approx

Source	Curies per year per unit
Liquid waste treatment system	5.1
Detergent wastes	0.06
Regenerant wastes	0.09
	5.3 approx (excluding tritium)
Tritium	350

[a]Less than 10^{-5} Ci/year.

applicant's principal parameters are also listed in Table 3.5. The applicant has calculated that approximately 2.3 Ci/yr/reactor, excluding tritium, and 690 Ci/yr/reactor of tritium will be released from the station. Staff estimates of radiation dose to man resulting from these releases is given in section 5.5.4. Based on its evaluation the staff concludes that the liquid waste treatment system meets the requirements of 10 CFR Part 20 and the as low as practicable guidelines.

3.4.2 Gaseous Waste

During operation of the reactor, radioactive materials released to the atmosphere in gaseous effluents will include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material, including both fission products and activated corrosion products.

The primary source of gaseous radioactive wastes results from the collection of excess cover gas in the liquid holdup tanks, gases stripped from primary coolant in the boric acid evaporator, degasification in the volume control tank, and cover gas displaced from the pressure relief tank and reactor coolant tank. These gases will be collected by the vent header system, routed to a surge tank and compressed in pressurized storage tanks. The waste gas processing system is common to Units 1 and 2. The gas decay tanks (6-705 cf tanks @ 110 psig) are sized to provide a holdup time of 45 days to permit decay of radioactivity prior to release to the atmosphere through the monitored plant vent.

Based on the staff's evaluation of the waste gas processing system the calculated release from the gas decay tanks was 1300 Ci/yr/reactor of noble gases and a negligible release of iodine (less than 10^{-4} Ci/yr). The applicant calculated a release of 3300 Ci/yr/reactor of noble gases and a negligible release of iodine. The staff's evaluation considered processing 50,000 cf/yr of waste gases through this system, whereas the applicant's calculations are based upon a processing rate of 100,000 cf/yr, which accounts for most of the difference in the calculated releases of noble gases from this source.

Additional sources of radioactive gases, which are not concentrated enough to permit collection and storage, include the auxiliary building exhaust, the fuel handling building exhaust, the turbine building exhaust, the reactor building containment air, the main condenser air ejectors, and the steam generator blowdown tank vents.

The various systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figure 3.13.

The ventilation systems for the auxiliary building and fuel handling building will be designed to ensure that air flow is from areas of low potential to areas having a greater potential for the release of airborne radioactivity. The entire air flow of 73,500 cfm from the auxiliary building will normally be vented to the plant vent through high efficiency particulate air filters (HEPA) to remove particulate activity. An alternate route for the Auxiliary Building ventilation exhaust will be through charcoal adsorbers. Ventilation air (30,000 cfm) from the refueling and spent fuel areas will pass through HEPA filters and charcoal adsorbers before being released to the plant vent.

The staff's evaluation considered a primary coolant leakage of 160 lbs/day into the auxiliary building and a partition factor of 0.005 for iodine. Ventilation air from the auxiliary building will be released without treatment for radioiodine to the plant vent. The staff calculated an annual release per reactor of 1200 Ci of noble gases and 0.074 Ci of iodine-131. The applicant considering the same leakage rate calculated a release of 1100 Ci/yr/reactor of noble gases and 0.0006 Ci/yr of iodine-131.

The waste concentrator normally will be used to process waste liquids from the equipment and floor drain subsystems, and can be used to process liquids from the chemical and laundry drain subsystems. The gaseous discharges will pass through the waste concentrator condenser before being released to the atmosphere through the monitored plant vent. The staff's evaluation assumed negligible releases of radioiodine (less than 10^{-4} Ci/yr/reactor) from this source.

Gaseous fission products from steam system leakage which may occur in the turbine and/or ancillary equipment will be released directly to the turbine building atmosphere without treatment. The staff calculated a negligible release of noble gases (less than 1 Ci/yr/reactor) and 0.027 Ci/yr/reactor of iodine-131 from this source. The applicant calculated negligible releases of noble gas and 0.03 Ci/yr/reactor of iodine-131 from miscellaneous steam leakage.

Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons, or when minor leaks

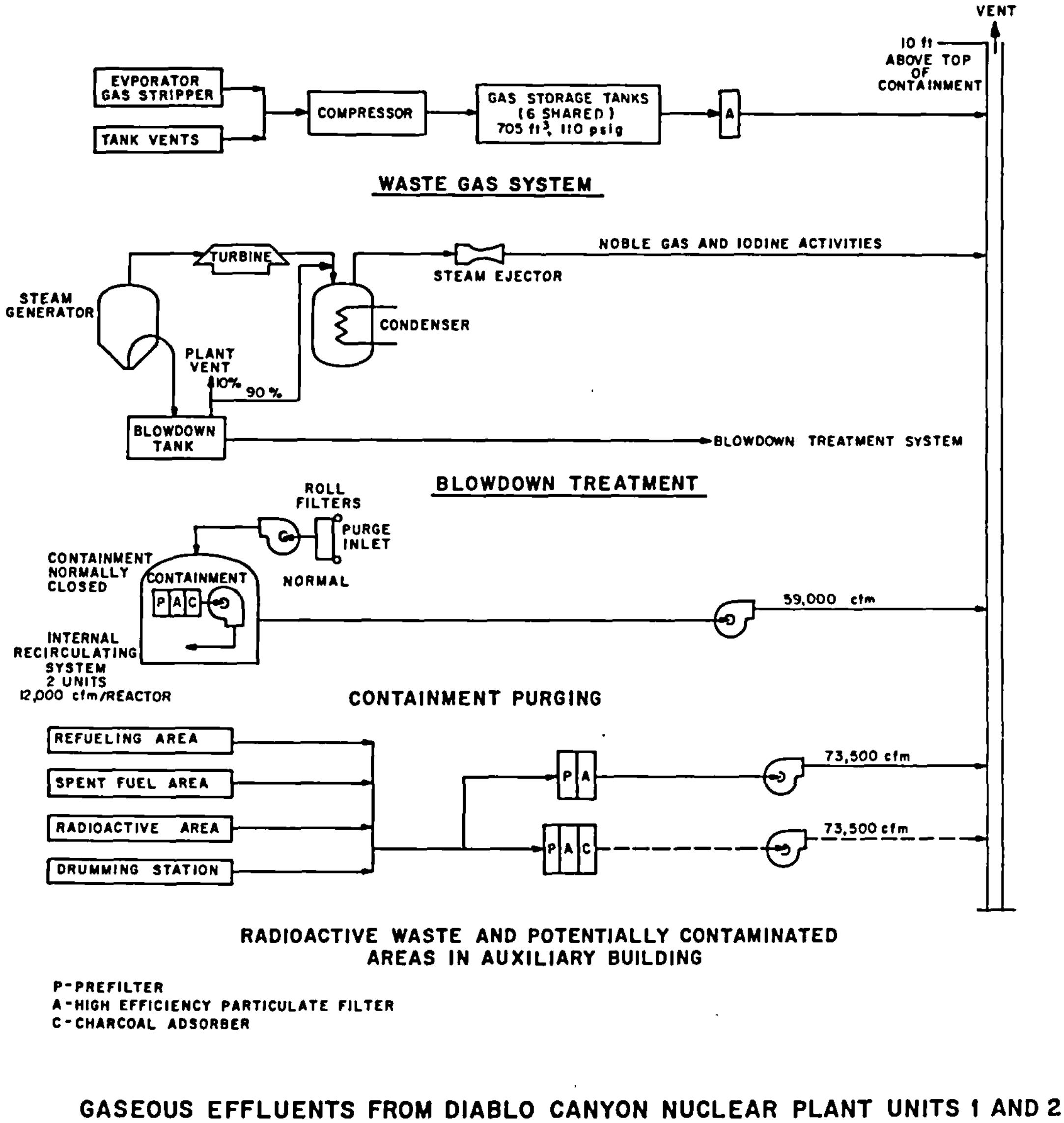


Fig. 3.13 - Gaseous Effluents from Diablo Canyon Nuclear Plant Units 1 and 2

occur in the primary system. Prior to purging, the staff assumed that the containment atmosphere will be circulated at a rate of 24,000 cfm for 16 hours through an internal cleanup system consisting of HEPA filters and charcoal adsorbers in series. Before entry, this containment atmosphere will be purged to the unit vent. The staff's evaluation considered a primary coolant leakage rate within the containment building of 240 lbs/day and a need to purge the containment 4 times/yr. The staff calculated a release of 24 Ci/yr/reactor of noble gases and 0.0054 Ci/yr/reactor of iodine-131. The applicant assumed a primary coolant leakage of 50 lbs/day and a need to purge the containment 52 times/yr. Based on these operating conditions the applicant calculated an annual release per reactor of 42 Ci of noble gases and 6×10^{-9} Ci of iodine-131.

Offgases from the condenser air ejectors (which remove radioactive gases collected in the condenser as a result of primary to secondary system leakage) will be released through the plant vent without treatment to remove radioiodine which may be present in the effluent steam. Based on the staff's evaluation, an annual release per reactor was calculated of 1200 Ci of noble gases and 0.11 Ci of iodine-131 from this source. The applicant using similar operating parameters calculated an annual release per reactor of 1100 Ci of noble gases and 0.024 Ci of iodine-131. The staff's evaluation considered an iodine partition factor of 2000 in the condenser, whereas the applicant assumed a partition factor of 10,000, which accounts for the difference in the calculated releases of iodine-131.

The steam generator blowdown system is designed to maintain the proper water chemistry in the secondary coolant. During periods when primary to secondary leakage occurs, the blowdown will be routed to the steam generator blowdown treatment system described in Section 3.4, Liquid Wastes. The waste gases generated during treatment will be vented to the main condenser. When sea water leaks occur into the main condenser or the treatment system demineralizers are being regenerated, the blowdown will be diverted to the blowdown tank and the gases vented directly to the atmosphere without treatment. In its evaluation the staff considered that 10% of the operating time the blowdown will be vented to atmosphere and calculated a release of 0.065 Ci/yr/reactor of iodine-131 and a negligible release of noble gases. The applicant calculated a release of 0.05 Ci/yr/reactor of iodine and a negligible release of noble gases.

Based on the principal parameters shown in Table 3.5, the total annual releases of radioactive materials in gaseous wastes were calculated to be approximately 3700 Ci/yr/reactor of noble gases and 0.28 Ci/yr/reactor of iodine-131. The principal sources together with the isotopic distribution are shown in Table 3.7. The applicant's principal parameters are also listed in Table 3.5. The applicant has calculated a total annual release of approximately 5500 Ci/reactor of noble gases and 0.11 Ci/reactor of iodine-131 from the station.

Staff estimates of radiation dose to man resulting from these releases is given in Section 5.4.4. The staff concludes that the gaseous waste treatment system meets the requirements of 10 CFR Part 20 and the as low as practicable guidelines.

3.4.3 Solid Wastes

Radioactive solid wastes will consist mainly of spent demineralizer resins, bottoms from the waste concentrator, and spent filters. In addition, there will be miscellaneous solid wastes such as paper, rags, and protective clothing.

The spent resins from the CVCS demineralizers will be flushed to two spent resin storage tanks. Periodically, batches will be transferred to the drumming station where the material will be slurried into 55-gallon steel drums or 50-cu ft spent resin transfer tanks, dewatered, and provided with shielding as necessary for offsite disposal. Bottoms from the waste concentrator also will be sent to the drumming station where the material will be mixed with a suitable filler and binder for offsite disposal. Miscellaneous materials, such as paper and protective clothing, will be compressed and drummed for offsite disposal.

All solid waste will be packaged and shipped to a licensed burial site in accordance with AEC and DOT regulations. Based on plants presently in operation, it is expected that approximately 250 drums/yr/reactor of spent resin and evaporator bottoms totaling approximately 5,000 Ci/yr will be transported offsite. It is also expected that 500 drums/yr/reactor of dry waste containing less than 5 Ci/yr will be transported offsite. Based on its evaluation, the staff finds the proposed solid waste system acceptable.

Table 3.7. Annual release of radioactive material in gaseous effluents from Diablo Canyon Nuclear Power Plant, Units 1 and 2

In curies per year per unit

Nuclide	Waste gas processing system	Containment purge	Auxiliary building	Turbine building	Steam generator blowdown	Condenser air ejector	Total
Kr-83m	*a*	*a*	1	*a*	*a*	1	2
Kr-85m	*a*	*a*	7	*a*	*a*	7	14
Kr-85	950	2	9	*a*	*a*	9	970
Kr-87	*a*	*a*	4	*a*	*a*	4	8
Kr-88	*a*	*a*	11	*a*	*a*	11	22
Kr-89	*a*	*a*	*a*	*a*	*a*	*a*	*a*
Xe-131m	47	3	7	*a*	*a*	7	58
Xe-133m	*a*	1	13	*a*	*a*	13	27
Xe-133	280	18	1100	1	*a*	1100	2500
Xe-135m	*a*	*a*	1	*a*	*a*	1	2
Xe-135	*a*	*a*	19	*a*	*a*	19	38
Xe-137	*a*	*a*	1	*a*	*a*	1	2
Xe-138	*a*	*a*	3	*a*	*a*	3	6
Total	1300	24	1200	1	*a*	1200	3700
I-131	*b*	0.0054	0.074	0.027	0.065	0.11	0.28
I-133	*b*	0.0046	0.092	0.017	0.041	0.069	0.22

[a]Less than 1 Ci/year of noble gases.
[b]Less than 10^{-4} Ci/year of iodines.

3.5 CHEMICAL AND BIOCIDE SYSTEMS

Diablo Canyon Units 1 and 2, as all power plants do, will discharge chemicals to the environment. A summary of these is given in Table 3.8. In Table 3.9 are given some of the elements found in seawater and their range of concentrations. This table may be used as a basis for judging the relative magnitude of the chemical species discharged into Diablo Cove. It should be noted that the effluent concentrations given are those which will be obtained at the discharge structure. After the effluent stream enters the waters of Diablo Cove, further dilution will occur. The extent of such dilution is a function of many variables such as wave action, tidal action, and offshore currents. The staff expects the chemical dilution to follow the same mode as the thermal dilution. However, some recirculation of chemicals will occur. This is expected to be less than 10% even during extreme ocean current and weather conditions. It follows, therefore, that a twofold dilution of the effluent contaminants will occur over an area of about 6 acres and that a fivefold dilution will occur over about an 80-acre area.

3.5.1 Condenser Cooling System Output

The condensers at Diablo Canyon Units 1 and 2 will be cooled by a once-through flow of water from the Pacific Ocean. The flow rate for each unit is 867,000 gpm. As pointed out in Section 3.3.2, the condensers are "split"; i.e., a separate circulating pump and conduit supply the coolant water for half the tubes in each condenser. The coolant streams from Units 1 and 2 are not combined until they reach the discharge structure. Therefore it is possible to chemically treat half a condenser unit at a time.

The applicant states that the condenser cooling system is to be treated periodically with elemental chlorine to control organic growth on exposed surfaces. The expected chlorine injection rate is 110 lb/day per unit (220 lb/day total), with the chlorine being injected into the circulating water just ahead of the pumps to ensure thorough mixing. Each pump system (one-half unit) is to be treated for 10 min per day in sequence; i.e., not more than one pump system is to be treated at a time. The maximum rate of injection will be 5.5 lb of chlorine per minute (1.5 ppm), with the actual rate such that an active chlorine concentration of 0.5 ppm at the condenser inlet will result (see Appendix 3-1). Since the chlorine added to the single pump conduit will be diluted by the other half of the condenser coolant stream, plus the cooling water from the other unit, the "actual residual free chlorine" at the discharge outlet will be less than 0.1 ppm. Staff calculations show this concentration to be approximately correct assuming operation of both units and some consumption of chlorine by organic

Table 3.8. Chemicals added to liquid effluent discharge

Chemical	Yearly discharge (2 units)	Concentration in effluent (ppm)
Copper	4×10^4–6×10^4 lb	6×10^{-3}
Nickel	6×10^3–8×10^3 lb	9×10^{-4}
Chlorine	8×10^4 lb	
Chloride ion		3.7×10^{-1}
Free available chlorine[a]		1.0×10^{-1}
Combined available chlorine[b]		2.7×10^{-1}
Sulfate	3.2×10^5 lb	4.5×10^{-2}
Sodium sulfate[c]	3.8×10^3 lb	5.0×10^{-1}
Dissolved solids (salinity)[d]	4.4×10^7 lb	6.0
Phosphate	1.3×10^3 lb	2.0×10^{-3}
Hydrazine	Decomposes	
Lithium	3.6×10^1 lb[e]	5×10^{-6}
Boron	7.2×10^3 lb[e]	1×10^{-3}
Ammonia	1.7×10^3 lb[e]	2.3×10^{-4}
Chromium	4.4×10^2 lb[e]	6×10^{-5}
Detergent (TURCO)	1.5×10^2 lb	4×10^{-5}

[a]Free available chlorine (hypochlorous acid, hypochlorite ion, and molecular chlorine).

[b]Combined available chlorine (sum of chloroamines and other chloro derivatives).

[c]Results from use of H_2SO_4 and NaOH to regenerate makeup demineralizer – intermittent, occurring every 96 days.

[d]Results from concentration of seawater in flash evaporator.

[e]Approximate yearly use calculated from estimated effluent concentration.

Table 3.9. Partial list of elements known to occur in seawater as dissolved solids

Element	Concentration (ppm)	Element	Concentration (ppm)
Na	10,556	S	880
Li	0.17	Dissolved O_2	6.2–8.1
K	380	Ba	0.02
Mg	1,272	Al	0.001
Ca	400	I	0.06
Sr	8.5	Pb	0.00003
Br	66	Hg	0.00003–0.0002
Cl	18,980	Cd	0.0001
F	1	Sn	0.0008
B	44	As	0.01–0.02
Si	1–7	Mo	0.0003–0.016
P	0.001–0.017	V	0.0002–0.007
Fe	0.001–0.29	Cr	0.001–0.003
Mn	0.001–0.01	Co	0.0001–0.0005
Cu	0.001–0.09	Ni	0.0001–0.007
Zn	0.005–0.014		

matter in the cooling system. In any event, the applicant states[2] monitoring equipment will be used during chlorination to ensure that the 0.1 ppm concentration of residual free chlorine is not exceeded. The staff agrees that this should be done.

The applicant in the Environmental Report does not indicate that the total available chlorine will be monitored. It is pertinent, therefore, to point out that the effect of the discharge of 0.1 ppm free available chlorine may be enhanced by the combined available chlorine species present. The total maximum discharge from the chlorine addition would be on the order of 55 lb of chloride ion and 55 lb of active chlorine (molecular chlorine, hypochlorous acid, hypochlorite ion, chloroamines and other chloro derivatives) per day per unit if no reduction of active chlorine species to chloride ions were to occur. The staff will require that the effluent be monitored for total available chlorine rather than just for free available chlorine, since the discharge may contain up to approximately 0.4 ppm total available chlorine, and that discharge of total available chlorine be limited to 0.1 ppm in the discharged cooling water.

The steam condenser in the conventional part of the generating system is fabricated with copper-nickel tubes (nominally 90%-10% but actually 87% copper, 11% nickel, and 2% other metals). During operation of the condenser, copper and nickel will be present in the effluent from the condenser because of tube corrosion. The corrosion product concentrations may be calculated from the following data supplied by the applicant:[2]

Circulating: 3.87×10^{12} lb/year
Condenser tubes: 58,214 tubes per condenser
Tube length: 40.75 ft
Specific gravity of alloy: 556 lb/ft^3
Area of inner surface of total tube assembly: 655,200 ft^2

Utilizing a staff-assumed corrosion rate of 1 mil/year, it can be shown that 54.6 ft^3 of tubing per year is lost to the circulating water system. This results in 26,411 lb of copper and 3,339 lb of nickel in the effluent over the period of a year. Therefore the average concentration will be

$$\frac{26{,}411}{3.87 \times 10^{12}} = 6.8 \text{ ppb of copper,}$$

$$\frac{3{,}339}{3.87 \times 10^{12}} = 0.86 \text{ ppb of nickel .}$$

The Long Island Lighting Company has studied the corrosion of essentially the same alloy in the condenser tubes at their Northport Power Plant.[8] The results from that study were used to estimate the amount of copper that may be discharged at their Shoreham Nuclear Power Station. These studies, carried out under conditions approximating those which will result at Diablo Canyon, indicate that a copper concentration of 4-6 ppb could be expected. This is in good agreement with the 6.8 ppb figure calculated by the staff.

During the heat treatment operation, the temperature of the cooling water will be raised 50°F and the flow rate decreased to approximately one-fourth of normal. The corrosion rate during this period may increase by a factor of approximately 4, and therefore the copper and nickel concentrations may increase by a factor of approximately 16. This is assuming as a worst case that the corrosion rate is not materially decreased by the decreased flow rate, and that the fourfold increase in corrosion will be contained in one-quarter of normal operating water volume.

3.5.2 Demineralizer Regeneration Solutions

The fresh water required for the power plant will be supplied by two seawater evaporators (one per unit) designed to produce 9000 gph per unit of distillate having a 0.5-ppm dissolved solids concentration. The evaporators will operate on a 2:1 cycle; i.e., the volume of seawater taken in will be twice the output of fresh water, and therefore half the original intake of seawater will be returned to the effluent stream with a twofold increase in salinity. The staff's calculations indicate an increase of about 6 ppm in the salinity of the effluent.

The supply water to each evaporator will be treated with 18 lb/hr of sulfuric acid to control scaling. This will result in a 0.04-ppm increase in the sulfate concentration of the effluent.

To provide the necessary reactor makeup water, distillate from the evaporators will be processed by a makeup demineralizer. The applicant states that each demineralizer will run approximately 96 days between regenerations. During regeneration, 338 lb of sulfuric acid and 276 lb of sodium hydroxide will be used, resulting in 490 lb of sodium sulfate per regeneration. These regenerant wastes, contained in about 8650 gal, are to be discharged into the circulating water over a period of 155 to 175 min. At the highest rate of discharge (155 min), this source will contribute an increase of about 0.5 ppm dissolved solids to the effluent.

There are several other demineralizers in the chemical and volume control system. Of these the deborating and evaporator waste condensate demineralizers can be regenerated. The waste solutions from these will be processed in the radioactive waste system (see Fig. 3.12).

3.5.3 Reactor Coolant Chemicals

The chemicals added to the reactor coolant system will normally be present in the effluent only because of leakage, blowdown, or as a result of processing in the chemical and volume control system. The expected releases (expressed as ppm in the effluent) are given in Table 3.8.

Hydrazine (N_2H_4), added to the reactor coolant system following shutdown and subsequent startup, will be used to control the oxygen content. The hydrazine undergoes reaction with oxygen to form nitrogen and water. A small amount of ammonia will also be formed in the decomposition of hydrazine. No significant amount of hydrazine from this source will enter the effluent stream.

Lithium hydroxide (LiOH) will be used to control the pH of the reactor coolant system. The concentration will be maintained between 0.2 and 2.2 ppm. The only source of lithium in the circulating water system will be that present in the discharge from the waste disposal system.

Boric acid is used as a chemical "shim" and will be added to the reactor coolant system in quantities sufficient to give concentrations of from 2050 ppm at refueling to essentially zero concentration at the end of core life. All leakages will be collected and processed (see Fig. 3.12). Part of the distillate from the process may be discharged to the effluent stream, resulting in some small "boron" concentration estimated to be three orders of magnitude lower than that in the reactor coolant system (Table 3.8).

3.5.4 Steam Generator Feedwater Chemicals

Hydrazine will be added to the steam generator water system as a corrosion inhibitor. It is expected that approximately 80 lb/day for both units will be used. As in the case of the reactor coolant, no hydrazine is expected to be discharged to the environment.

Sodium phosphate, used to control pH between 9.0 and 10.0, will be injected into the steam generator feedwater at the rate of 1.8 lb/day per unit. Some phosphate will be discharged to the environment during steam generator blowdown, which is discharged intermittently at a rate of approximately 150 gpm. The applicant states that approximately 1.8 lb/day per unit will be discharged. This will result in an increase of about 2 ppb phosphate concentration in the effluent during blowdown.

Ammonia (NH_3) formed by decomposition of hydrazine and that which is added to the steam generator feedwater for corrosion and pH control will be released to the effluent stream. The concentration is given in Table 3.8.

3.5.5 Closed Cooling Systems

The service water system and the component cooling water system will be treated with potassium chromate and dichromate sufficient to maintain a 200-ppm chromate concentration. Leakage from these systems collected by the floor drains will eventually be discharged to the effluent stream. The applicant estimates that this will increase the chromate concentration of the circulating water by 0.01 ppb. The staff finds that this is a reasonable estimate.

3.5.6 Miscellaneous

The laundry facility for the plant will discharge to the environment approximately 3 lb/week of the laundry detergent Turco. This is a proprietary combination of complex phosphates, carbonates, and wetting agents. The laundry wastes will be collected in the waste disposal system and after treatment discharged to the condenser circulating water of Unit 1. The staff estimates that the average increase in effluent concentration will be approximately 0.05 ppb detergent.

All trash and nonradioactive solid waste generated at the plant site are now being disposed of through an authorized disposal agency who uses a sanitary landfill. The applicant plans to continue this method of disposal during plant operation.

Oil spillage that may occur in equipment areas will be processed in an air flotation type separator. The applicant[2] states that the effluent from this separator, which will be discharged to the condenser cooling water system, will contain less than 20 ppm oil. After mixing with the cooling water the concentration of oil will be negligible.

3.5.7 Chemical Discharge during Heat Treatment

The applicant proposes that, in order to remove organisms from the conduits and equipment between the intake and discharge structures, periodic heat treatment of the condenser cooling water system be carried out as described in Section 3.3.2. It is estimated that the discharge during heat treatment will be decreased to approximately one-quarter of the normal operating flow rate (867,000 gpm per unit). Consequently if the chemicals that are normally discharged to the effluent stream are still being discharged during the treatment period, they will increase in effluent concentration by a factor of 4 for that unit. This does not hold for the free chlorine content, since the applicant[2] has stated that this will be monitored and controlled. The staff will require that, during this period, no chemicals that can be controlled be added to the effluent stream.

3.6 SANITARY DISCHARGES

The sewage treatment facility for the plant will consist of a dual-chambered septic tank with a leach field. The design load of this system is 70 persons at 30 gal/day per person. The applicant[2] states that no chlorine will be used.

During the construction period, two separate septic tanks and leach fields are being used. The first serves the plant site, and the second the construction camp. The construction camp site facility will be closed when the plant begins operation.

Two additional sewage treatment systems have been constructed at the switchyard control buildings. These are designed for intermittent use by eight to ten persons each.[2] The applicant estimates the load to be 300 gal/day per system. These systems will be used largely during maintenance and inspection.

3.7 TRANSMISSION LINES

3.7.1 Transmission Routes

A schematic of the switching facilities and line junctures at the site is included in Fig. 2.3. The transmission routes connecting Diablo Canyon to the applicant's existing distribution system are shown in Figs. 3.14 and 11.1 and are described as follows:

1. The Diablo-Midway route consists of two single-circuit 500-kV transmission lines with a combined right-of-way width of 400 ft extending about 84 miles from the site to the existing Midway Substation in Kern County. These lines pass over the San Luis Range, cross Highway 101 about 5 miles south of San Luis Obispo, and proceed easterly, passing about 4 miles north of the town of Arroyo Grande. They then pass over the Santa Lucia Range, turn somewhat northerly, cross the Panza Range, and drop into the Carrizo Plain, crossing the northern end of Soda Lake. The lines split approximately 19 miles west of Midway and proceed

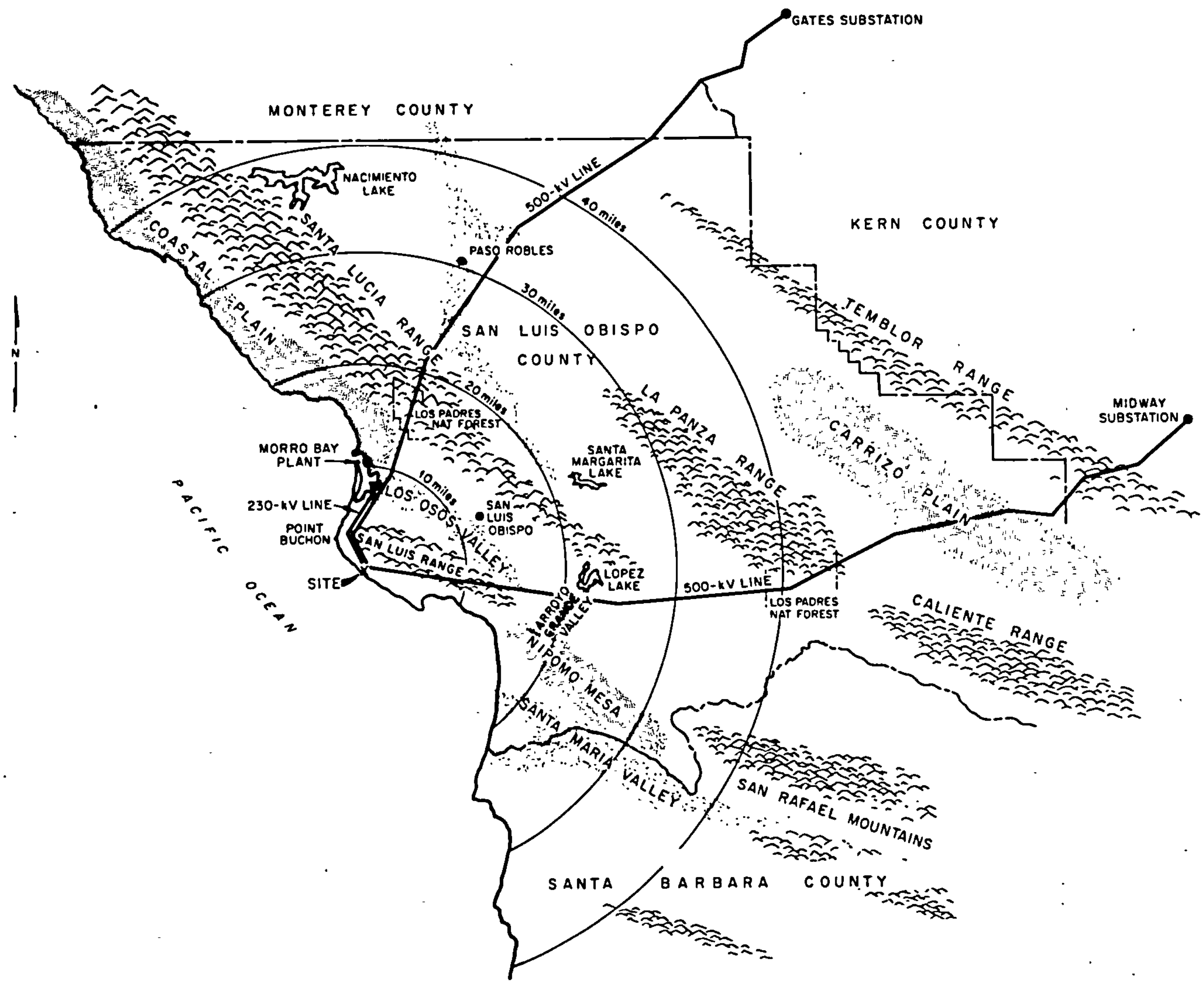


Fig. 3.14. Tranmission lines associated with Diablo Canyon Station.

on different rights-of-way separated 3/4 to 3-3/4 miles from the split to Midway Substation. The right-of-way for this route requires 4085 acres.

2. The Diablo-Gates route is a single-circuit 500-kV transmission line extending about 79 miles from the site to the existing Gates Substation in Fresno County, paralleling an existing 230-kV line most of the way. This line proceeds northeasterly from the Diablo Canyon Site, traversing the Santa Lucia Range and crossing Highway 101 east of the town of Paso Robles, and across the Estrella River. Beyond the river the line enters the Cholame Hills and crosses the Cholame Valley. The line then crosses the Diablo Range, drops down into the Kettleman Plain northwest of Avenal, crosses the Kettleman Hills (a producing oil field), and then proceeds about 3 miles into Gates Substation. Paralleling the Diablo to Gates 500-kV line is a 10-1/4-mile section of 230-kV feeder line, connecting to an existing Morro Bay to Mesa 230-kV line just south of Highway 1. Right-of-way requirements for the Diablo to Gates line are a 280-ft corridor over the 10-1/4-mile section used jointly with the 230-kV Diablo to Morro feeder and a 200-ft corridor for the remainder of the route (69 miles), involving a total of approximately 1940 acres. Ultimately this line routing will be used for an additional 500-kV line, requiring a 430-ft right-of-way for the initial 10-1/4-mile section and a 350-ft corridor over the remaining distance, involving some 3388 acres of land area.

The California Public Utilities Commission has issued a certificate of public convenience and necessity for the transmission lines.

3.7.2 Access Roads

Access roads for the Diablo to Gates and Diablo to Midway lines total 317 miles; however, due to the nature of existing topography, areas occupied by these are not contained entirely within rights-of-way given. Roads outside U.S. Forest Service lands were commonly outsloped, without the addition of berms on outside road edges. In some areas, insloping and construction of drainage ditches, water checks, and berms were practiced in attempts to minimize erosion. Those roads constructed within the Los Padres National Forest conformed to Forest Service specifications in that these were insloped, with a 14-ft width of traversable way on straight stretches, for a total width of 18 ft including inside ditch and outside berm. Some turns are as much as twice the width of straight sections, and in most cases, roads on National Forest lands were required to be much less steep than those on other areas.

3.7.3 Transmission Towers

Lattice-type steel towers (Fig. 3.15) will be employed on all lines associated with the Diablo Canyon plant. These have an average basal area (including foundations) of approximately 1000 ft^2 and are anchored at each of the four corners by means of a pier-type foundation. Excavation to depths of 10 to 15 ft is required for setting these foundations. In general, tower design for the type of structure shown allows for a 1300-ft ruling span, requiring approximately four towers per mile. Variations in local topography often result in a requirement for additional towers, so that frequencies of five to six towers per mile may occur over some sections of a given route. There are 325 towers on the Diablo to Gates line and 346 in the Diablo to Midway section.

3.8 TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the 2 reactors at the Diablo Canyon Nuclear Power Plant near San Luis Obispo, California is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation of both reactors, the Staff estimates about 126 fuel elements are replaced.

3.8.1 Transport of New Fuel

The applicant has indicated that new fuel will be shipped by truck in Type B AEC-DOT approved containers which hold two fuel assemblies per container. About 10 to 14 truckloads will be required each year for replacement fuel and about 28 to 40 truckloads for the initial loading. The applicant has indicated the source of the new fuel will be the Westinghouse fuel fabrication facility in South Carolina, a shipping distance of about 3000 miles.

3.8.2 Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed under water in a storage pool for cooling prior to being loaded into a cask for transport.

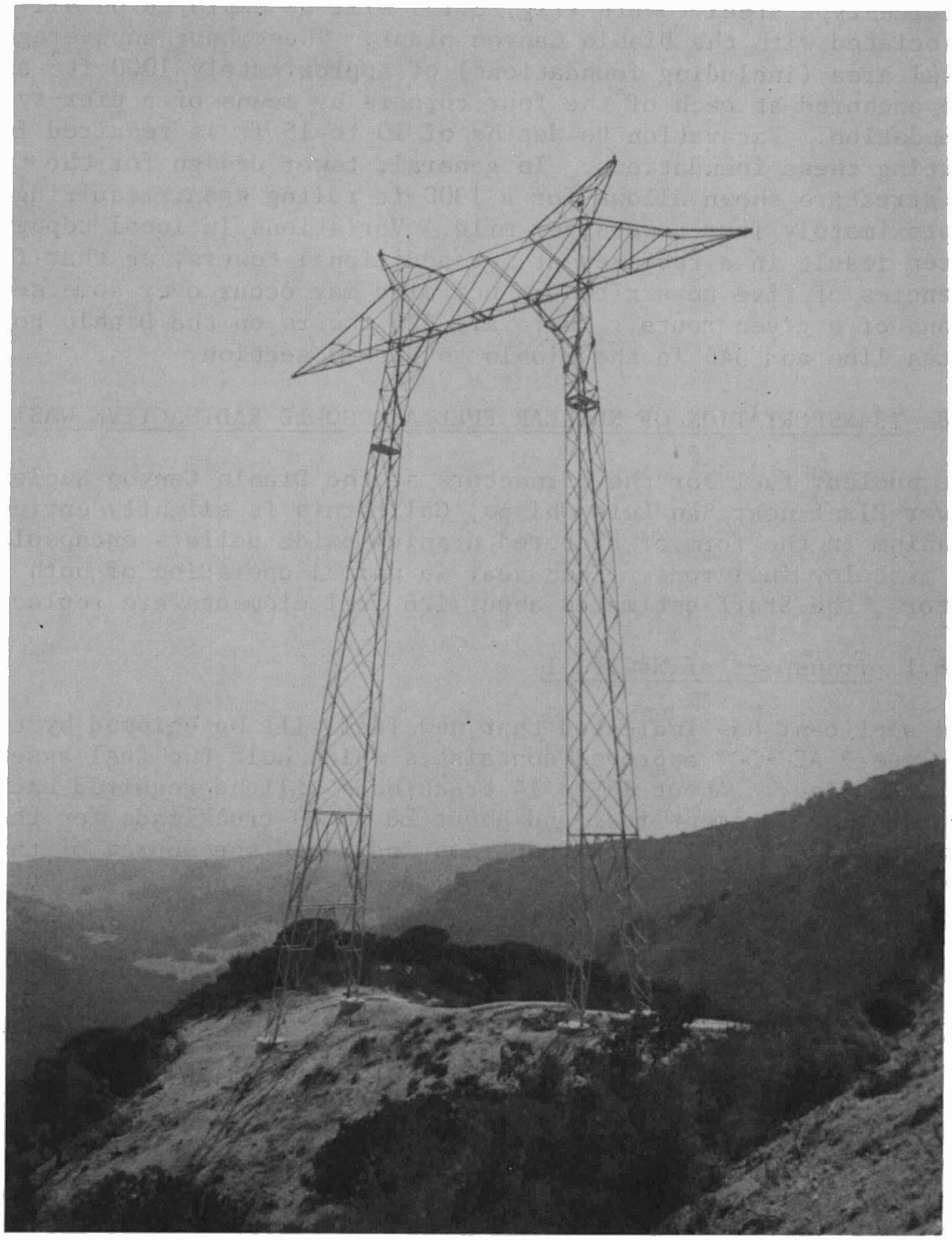


Fig. 3.15. Lattice-type transmission tower.

The Applicant has indicated the irradiated fuel will be transported by oversized truck to the nearest railroad which is 16 miles from the plant, and then by rail to the reprocessing facility. Seven to 15 fuel assemblies can be handled in one shipment by rail.

Based on this plan, a total of 10 to 18 shipments will be made each year. Destination for these shipments has not been decided but for purposes of conservative calculation of transportation dose will be assumed to be Barnwell, South Carolina, a shipping distance of about 3,000 miles.

Although the specific design of containers for shipping of spent fuel has not been identified, the applicant states that the irradiated fuel assemblies will be shipped in approved AEC-licensed and DOT-approved casks.

3.8.3 Transport of Solid Radioactive Wastes

The applicant has indicated that spent ion exchange resins, waste evaporator bottoms, and miscellaneous low level wastes will be shipped in drums or "large quantity" shipping containers. The applicant has estimated approximately 3 shipments of evaporator wastes and 2 shipments of miscellaneous wastes will be required to be shipped from the plant each year for the 2 units. Four shipments a year of "Large Quantity" containers will be required to dispose of ion exchange resins. The applicant has not indicated which of the approved burial sites he will use. The staff has assumed Hanford, Washington, a shipping distance of about 1,000 miles.

REFERENCES FOR SECTION 3

1. Pacific Gas and Electric Company, *Preliminary Safety Analysis Report, Diablo Canyon Units 1 and 2*, p. 1-11.

2. Pacific Gas and Electric Company, *Environmental Report, Supplement No. 2, Units 1 and 2, Diablo Canyon Site*, July 28, 1972.

3. J. H. Jones, *General Circulation and Water Characteristics in the Southern California Bight*, Southern California Coastal Water Research Project (October 1971).

4. California Dept. of Fish and Game, "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," Environmental Service Branch Office Report, March 1972, p. 10.

5. T. Jen, R. L. Wiegel, and I. Molearek, "Surface Discharge of Horizontal Warm-Water Jet," *J. Power Div., Proc. Amer. Soc. Civil Eng.*, April 1966.

6. K. D. Stolzenbach, and D.R.F. Harleman, "An Analytical and Experimental Investigation of Heated Water, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, or, The Water Quality Office of EPA, Research Grant No. 16130 DJU, February 1971."

7. Pacific Gas and Electric Company, *Supplemental Material Describing Diablo Canyon Blowdown Treatment System*, April 6, 1973.

8. Long Island Lighting Company, *Environmental Report, Shoreham Nuclear Station.*

4. ENVIRONMENTAL IMPACTS OF SITE PREPARATION, STATION CONSTRUCTION, AND CONSTRUCTION OF TRANSMISSION FACILITIES

4.1 SCHEDULES AND MANPOWER

The planned dates for start of commercial operation of Diablo Canyon Units 1 and 2 are March 1, 1975, and March 1, 1976, respectively. The construction permits were issued by the AEC in April 1968 for Unit 1 and in December 1970 for Unit 2. As of June 1, 1972, it was estimated that Unit 1 was 45.6% complete and Unit 2 was 12.8% complete.[1]

Table 4.1 shows the highlights of the construction schedule for each unit as revised in May 1972.[2]

The manpower required for construction is shown graphically in Fig. 4.1. A peak work force of about 1530 men is expected to occur during the last quarter of 1973, at which time the estimated hourly contractor wage rate will be about $9.00 per hour.

4.2 IMPACT ON THE TERRESTRIAL ENVIRONMENT

4.2.1 Impacts from Plant and Related Structure Construction

Construction of the Diablo Canyon nuclear station and the two closely associated switchyards will result in environmental impacts associated with: (1) the preemption of land as wildlife habitat due to the erection of permanent structures and (2) habitat alteration due to vegetation removal.

Although a total of 142 acres was directly affected by construction, the permanent facilities will occupy only 51 acres. The buildings shown in black in Fig. 4.2 will be removed when construction is complete. The breakwaters are discussed in Section 4.3. A photograph of the status of construction in June of 1972 is shown in Fig. 4.3.

Not all forms of wildlife will be excluded from the plant site, but the species composition will consist of those that can accommodate man's interference. In areas that have been altered or

Table 4.1. Construction schedule

	Unit 1	Unit 2
Construction permit obtained from AEC	April 23, 1968	Dec. 9, 1970
Start construction of access road	June 14, 1968	June 14, 1968
Complete access road	Oct. 29, 1969	Oct. 29, 1969
Start grading and earth moving	Aug. 22, 1968	Aug. 22, 1968
Complete grading and earth moving	Dec. 5, 1969	Dec. 5, 1969
Start concrete foundations for containment	Sept. 10, 1969	May 12, 1971
Discharge structure	Sept. 10, 1970	Sept. 10, 1970
Discharge structure finished (except cofferdam)	Sept. 10, 1972	Sept. 10, 1972
Start intake structure	June 2, 1971	June 2, 1971
Complete intake structure	Feb. 27, 1973	Feb. 27, 1973
Start turbine generator erection	Nov. 1, 1971	Nov. 8, 1973
Turbine generator construction completed	June 26, 1973	Sept. 26, 1974
Start reactor vessel installation	Dec. 26, 1972	Sept. 27, 1973
Complete containment structure	Dec. 25, 1973	Feb. 20, 1975
Complete nuclear steam supply system installation	Mar. 26, 1974	June 5, 1975
Start hot functional test	Feb. 26, 1974	June 5, 1975
Fuel loaded	May 27, 1974	Sept. 8, 1975
Initial criticality	June 10, 1974	Sept. 22, 1975
Full power operation	Oct. 28, 1974	Feb. 2, 1976
Commercial operation	Mar. 1, 1975	Mar. 1, 1976

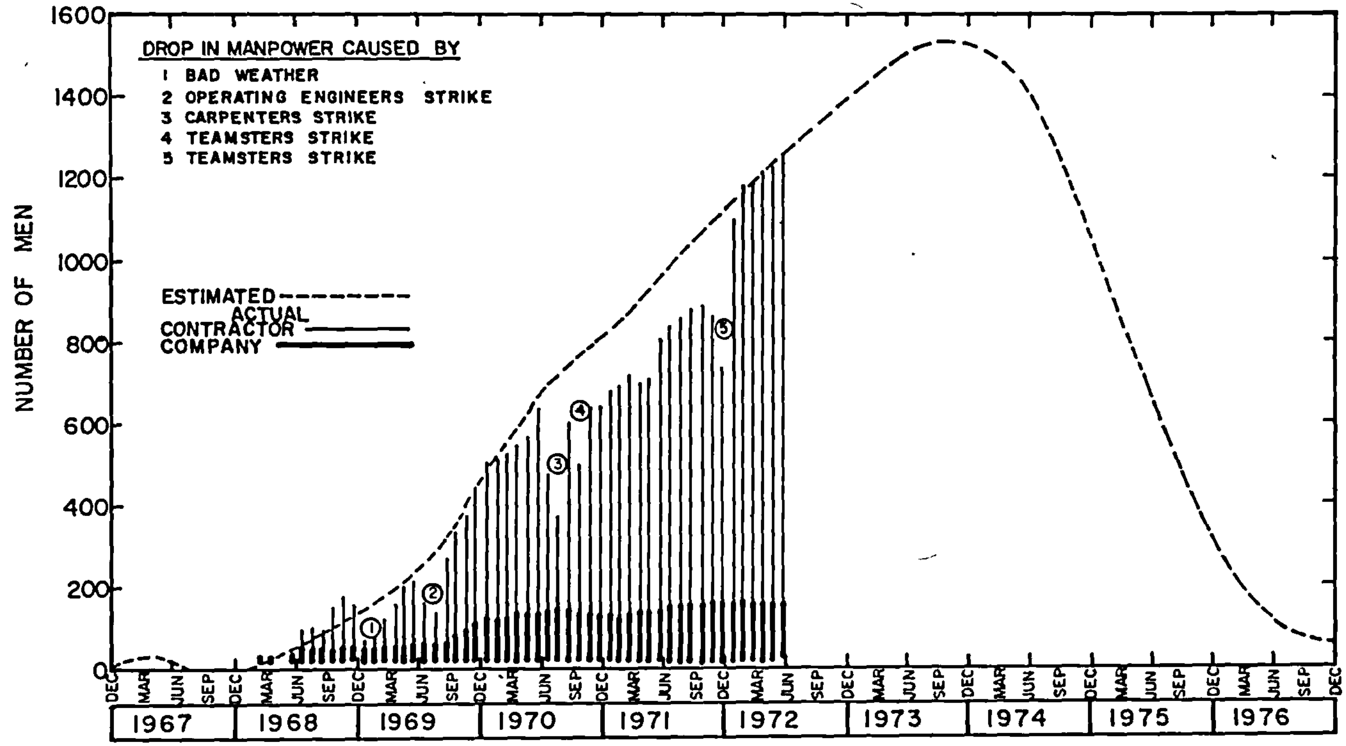


Fig. 4.1. Manpower required for construction of Diablo Canyon Units 1 and 2.

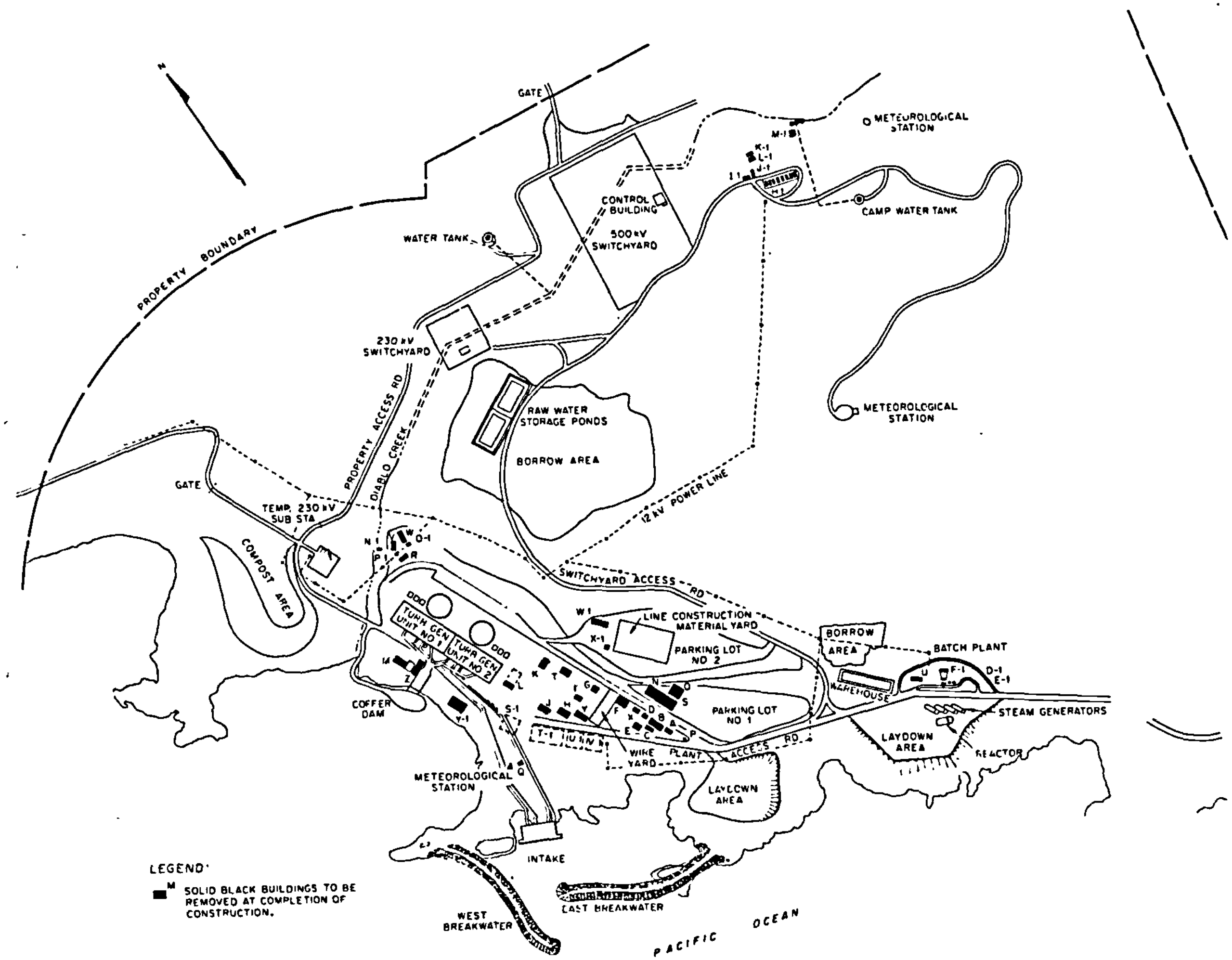


Fig. 4.2. Area affected by construction.
See legend next page

Legend for Fig. 4.2

Bldg	Contractor	Spec	Bldg	Contractor	Spec
A	Guy F. Atkinson Co.	8831	A-1	PG&E First aid shack	
B	Guy F. Atkinson Co.	8831	B-1	Temp 230/12kV sub sta	
C	Bigge Co.	8823	C-1	Meteor & transm bldg	
D	Murphy Pacific	8833	D-1	Batch plt control tlr	
E	M. W. Kellogg	8711	E-1	Change & stor bldg	
F	Wismer & Becker	8735	F-1	Batch plt complex	
G	Endurance Metal	8737	G-1	PG&E Warehouse	
H	H. P. Foley	8807	H-1	PG&E Camp	
I	Westinghouse turb.	8751	I-1	Soils lab trailer	
J	G.F.A. shop-warehouse	8831	J-1	PG&E wash rack	
K	Bostrom Bergen	8831-R	K-1	PG&E Porta house	
K	Scott Co.		L-1		
K	Consol. Comstock		M-1	Camp water treat facil	
K	Pacific State Steel		N-1	H. H. Robertson	8830
K	Pitts. Testing Lab		O-1	Mech survey shack	
L	G. F. A. carpenters	8831	P-1	Const power storage	
M	M. W. Kell.-warehouse	8711	Q-1	PG&E Survey shack	
N	PG&E & Westinghse	8700	R-1		
O	PG&E Conf. bldg.	PG&E	S-1		2748
P	Guard shack	9636	T-1		8737
Q	Met. equip. bldg	PG&E	U-1		8749
R	Compressor bldg.		V-1		8752
S	Fire & emerg. vehicle		W-1	Upper intern. stor.	
T	PDM	8832	X-1	Paint storage	
U	Concrete test lab	PG&E	Y-1	McMullen & Son	8843
V	Battery stor. bldg				
W	Reactor pump bldg	Equip			
X	Scott Co.	8796			
Y	H. P. Foley	8802			
Z	PG&E Operations				

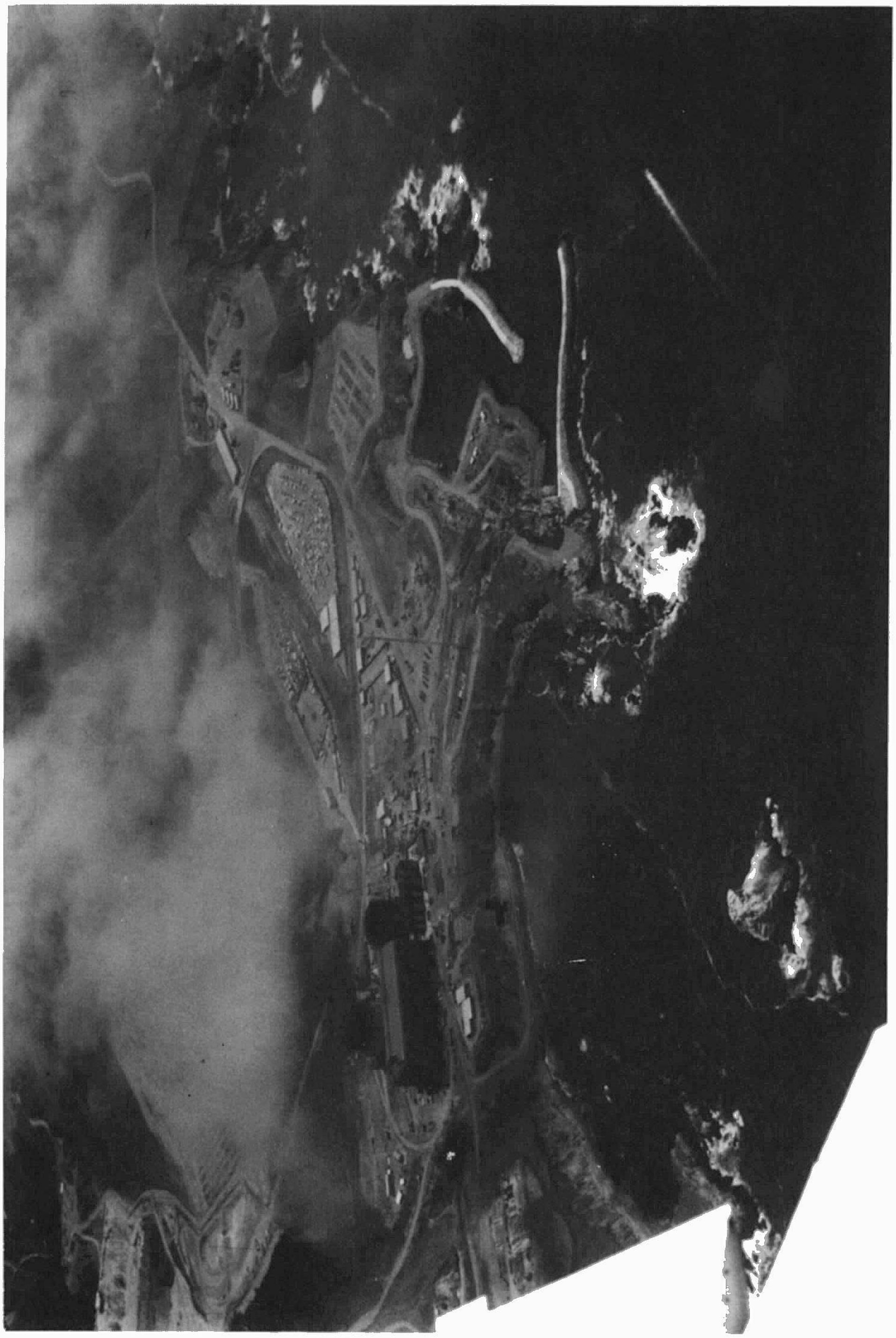


Fig. 4.3. Status of construction in June 1972.

modified by man's action, e.g., recreation areas, farms, and urban areas, the most abundant species are those that are capable of thriving in a disrupted ecological system. Species present in these stages have such varied requirements for survival that they can readily adapt to the ecologically transitory, unstable conditions encountered.

The impact on the terrestrial environment due to loss of vegetation as a result of construction probably will be short-term and minimum for the laydown areas. These areas will revegetate in the normal succession progression. However, the switchyard areas and the plant site area have permanent structures and are lost as wildlife habitat.

While excessive noise from construction activities is objectionable, its effect on wildlife is the same as discussed above for the alteration of vegetation. Both are integrally associated with man's invasion, and those species capable of tolerating his presence will remain.

Mammals expected to dominate the community structure include the opossum, raccoon, striped skunk, black-tailed deer, and various species of rodents. Songbirds such as sparrows and housefinches are active among the construction buildings on the plant site, and nesting of these species in eaves of the buildings was recorded last spring.

Rookeries for pelagic birds and shorebirds and haul-out areas for seals and sea lions provide a restricted habitat found in short supply in California. Several rocky islands exist off Diablo Canyon's shoreline (Lion Rock, Pecho Rock). Lion Rock is about one mile from the site, and Pecho Rock is about 3 miles from the site. The only impact to birds and aquatic mammals is the disturbance created by plant construction noise. Excessive noise is expected to terminate when construction ceases, although some noise will persist from generators and turbines.

4.2.2 Impacts from Construction of Transmission Lines and Access Roads

The construction of the transmission lines and concomitant rights-of-way necessary for the Diablo Canyon station will not affect agricultural crop production, nor will the forest resources of the region be significantly altered as a result of the necessary clearing. The primary uses of these National Forest lands are for grazing, watershed protection, and wildlife production. Right-of-way for the Diablo to Gates line covers approximately 22.4 acres within the Los Padres National Forest, and that for the Diablo to Midway extension, approximately 311 acres. Impact to the terrestrial environment from the lines themselves is minimal. Of more importance are the longer-term effects of access road construction. Access roads for the Diablo to Gates route occupy approximately 12.6 acres, and those for the Diablo to Midway lines, approximately 63.6 acres within Los Padres boundaries. Thus, about 76.2 acres of National Forest land will be converted into service roads by the project.

As mentioned above in connection with National Forest lands, and as applied to other lands, except for canyon areas, which both the Diablo to Gates and the Diablo to Midway lines cross, vegetation removal for tower and right-of-way is minimal. The impact to the terrestrial environment from these actions is considered as temporary for areas such as the tower footings, since these areas will revegetate in time. A more serious problem arises on steep terrain during construction of access roads in that the removal of vegetation and topsoil provides an avenue for erosion.

Surface erosion poses a definite threat in that the nutritional requirements of terrestrial ecosystems depend on internal nutrient cycles which are sustained by surface organic and mineral reserves. Over extended periods, the loss of these nutrients will lead to a decline in total ecosystem productivity.

The construction of the applicant's access roads has been a source of contention for some time in that extensive erosion has occurred in some areas. A review of evidence presented in public hearings[3,4] indicates that PG&E's construction and replanting practices appear to have been inadequate in canyon areas where road grades were steep. While such areas constitute approximately 5% of total access road mileage, the incidence of significant erosion has been sufficient to cause involuntary corrective measures by the applicant.

PG&E roads on private lands are primarily outsloped, meaning that water drainage from roads located on hillsides is not collected but is allowed to run off and down the sides of fill slopes. In contrast, those built on Forest Service lands are insloped, with a drainage ditch to collect water along the hill side of the road, and have culverts under the road to carry the water off and beyond the fill slopes. While the construction of the outsloping roads is not necessarily less desirable than insloped roads, the deposition of water runoff from the road is a major factor in controlling the degree and rate of erosion.

PG&E has placed some fill on steep slopes, and water running rapidly over the surfaces has speeded erosion. Culverts, such as those used on Forest Service lands, carry water from the fill slopes onto undamaged soil. On some private roads built by the applicant, water bars spill the runoff in the midst of fill slopes, thus accentuating erosion.

Testimony by Dr. Wayne T. Williams[4] indicated that in the vicinity of the road built along Coon Creek Canyon, landslides have resulted in "so much degradation occurring along the slopes that the entire canyon bottoms are white with the white Monterey formation material that has moved down from these roads. It has killed mature Bishop pines in this canyon as well as definitely being detrimental to many of the rare Bishop pine outcroppings along other parts of the road." Rebuttal testimony was offered by the applicant's witness which suggested that Dr. Williams's testimony was exaggerated and further that the Bishop pine is not considered rare within the areas in question.[4] In this regard it is significant to note that the tree does not appear in an inventory of rare and endangered plants of California, prepared by the California Native Plant Society.[5]

In consideration of the potential for environmental impacts associated with the Diablo Canyon lines, a number of conditions were set forth by the California Public Service Commission in its decision concerning routings for the lines.[3]

"5. PG&E shall promptly survey all existing access roads of transmission lines from the nuclear fuel power plant in Diablo Canyon and shall report in writing on or before ninety days after the effective date hereof what action is now required to reasonably control erosion and to reasonably restore the areas affected by construction to their natural state. The reports shall identify areas of required action by maps, mileage reference and photographs and shall include proposed programs and estimated completion dates to implement proposed programs. Thereafter, at 6-month intervals, PG&E shall make, in writing, progress reports on the said programs.

"6. PG&E shall designate appropriate PG&E personnel with specific responsibility and authority to assure that the construction, maintenance and repair of transmission facilities are accomplished in a manner giving reasonable consideration to aesthetic values and conservation of natural resources and the environment and shall report in writing on or before ninety days after the effective date hereof the names, title, position and designated responsibilities and authority of said personnel.

"9. PG&E shall promptly solicit or design, consider and test towers made of aluminum or other material suitable for the construction of 230- and 500-kv transmission lines by the use of helicopters for tower delivery to and erected on the tower sites and shall report on or before January 1, 1973 progress of compliance with this ordering paragraph.

"10. PG&E shall promptly develop comprehensive written standards and policies for the design, construction, maintenance and repair of access roads, transmission towers and lines, and attendant facilities which will give reasonable consideration to aesthetic values and conservation of the natural resources and the environment of the areas involved. Said written standards and policies shall be filed in this proceeding, with copies to the parties herein, on or before January 1, 1973."

Concerning the first of the above directives (No. 5) the applicant has submitted reports presented in Appendix 4-1. The staff has evaluated information presented in the attached reports, including photographic evidence, and has concluded that as of June 1972, germination of hydroseedings has been generally poor in most areas. Recommendations were made for insloping of roads and installation of culverts where necessary, and reseeding and hand planting in particularly erosion-prone areas. A survey conducted six months later (Report No. 2, December 1972) reveals that insloping and restoration of proper drainage have stabilized erosion potential in most areas. Germination of hydroseedings has not improved; however, natural revegetation is progressing in some areas. Continued surveillance of these and remaining areas of Diablo Canyon lines is requisite, including immediate protective measures as outlined in the attached reports, in order that further deterioration of the landscape might be minimized.

An additional avenue of impact associated with construction of transmission lines and access roads for the Diablo Canyon plant is the potential for interference with habitats unique to endangered or declining wildlife species. In this respect, the California condor (*Gymnogyps californianus*) deserves mention in that it has been designated as an endangered species whose range encompasses areas traversed by the lines.[6] Principal nesting areas for the species are located approximately 40 to 75 miles to the south in the Sisquoc Condor Sanctuary of Santa Barbara County and the Sespe-Piru Condor Sanctuary of Ventura County.[6] Nesting sites have been reported within the Hi Mountain — Beartrap Canyon area of San Luis Obispo County,[6] approximately 5 to 10 miles from the Diablo to

Midway routing. This area is not considered as a major nesting site, however, and construction impacts associated with Diablo Canyon lines would be limited to disturbance effects. In this respect, construction activities have potential for influencing both nesting and foraging specimens in that condors are susceptible to loud noise and disturbances caused by heavy equipment, blasting, and increased human activity.

Other rare, endangered, and declining wildlife species known to inhabit areas involved in construction of the Diablo Canyon plant and transmission include the following:

Endangered

California brown pelican (*Pelecanus occidentalis californicus*)
Southern bald eagle (*Haliaeetus leucocephalus leucocephalus*)
American peregrine falcon (*Falco pergrinus anatum*)
Blunt-nosed leopard lizard (*Crotaphytus wizlizenii silus*)

Rare

San Joaquin kit fox (*Vulpes macrotis mutica*)
Giant garter snake (*Thamnophis couchi gigas*)

Declining

Golden eagle (*Aquila chrysaetos*)
Burrowing owl (*Speotyto cunicularia*)
White pelican (*Pelecanus erythrorynchos*)

Information concerning life histories and/or other information with respect to these is presented in Appendix 2-6.

Realizing that construction of transmission lines is nearly complete and that most construction-related impacts have already occurred, pertinent findings of the California Public Service Commission's Show Cause Hearing, Decision No. 79726[3] are offered.

"38. All transmission lines have an adverse effect on the natural resources environment and aesthetic values of an area in which the proposed facilities are to be located.

"39. None of the relocations of the transmission lines herein proposed by complaints, except around Hill 2284 and possibly through the shale deposits which relocation requires further study, produce a lesser burden than those proposed by PG&E on the natural resources, environment and aesthetic values of the areas in which the lines will be located.

"40. The transmission lines proposed herein by PG&E between Diablo Canyon Nuclear Power Plant and its Gates and Midway Substation lines will not produce an unreasonable burden on natural resources, environment and aesthetic values of the area in which the proposed facilities are to be located, public health and safety, air and water quality in the vicinity, or parks, recreational and scenic areas, or historic sites and buildings or archaeological sites.

"41. Complainants' proposed relocation of portions of Diablo-Gates 500-kv transmission line and the Diablo-Morro Bay-Mesa 230-kv transmission line is inferior to the route proposed by PG&E.

"42. Complainants' proposed relocation of portions of the Diablo-Midway 500-kv transmission line are inferior to the routes proposed by PG&E except as herein indicated."

After a review of alternate routes, and considering the above findings and the degree of completion of the lines, the staff concludes that the 230-kV line and the Diablo-Gates 500-kV line represent the best route available. After review of the exceptions taken to the adequacy of the Diablo-Midway line and a site visit in June 1972, the staff concludes that no other route offers significant advantages over the applicant's route, as proposed.

The staff recognizes an important factor regarding alternative routes for these transmission lines. Except for the oil shale area, relocation of lines would result in a duplication of construction impact because the line and roadway construction has already progressed to a point that further work on the existing routes will have little additional effect. Relocation of transmission lines would therefore result in greater overall impact than maintaining the existing corridors.

4.3 IMPACT ON THE AQUATIC ENVIRONMENT

During construction, impacts on the marine environment resulted from construction of the barge landing at Avila Beach, the construction of the breakwater at South Cove, and the building of the intake structure at South Cove and the discharge structure in Diablo Cove.

4.3.1 Barge Landing — Avila Beach

A dock has been built at Avila Beach to receive the reactor pressure vessels, which were shipped by special seagoing barges.[7] Some disturbance of the marine environment occurred during construction of the dock, which has resulted in some local loss of benthic area where pilings were driven, has caused some siltation in the vicinity of the pilings, and has resulted in the temporary loss of some benthic habitat. The pilings serve as new habitat, however, and the net adverse impact on benthic organisms from this construction is small and temporary.

4.3.2 Breakwater Construction in South Cove

The location of the intake structure on the ocean shore requires protection from wave action. This protection is provided at the Diablo Canyon site by a breakwater, which has been constructed by the applicant using methods approved by the California Department of Fish and Game.[8,9] Dirt and debris are controlled to prevent "objectionable foaming, discoloration, and floating solids," but this action can result in some turbidity during construction. Although siltation has been observed, most of the silt has apparently been removed from the intake area by wave action, as evidenced by the small amounts of silt observed during a reconnaissance study on April 3, 1972 (Table 4.2). The presence of "muddy water" has been documented by Clifton.[10]

While the loss of habitat resulting from the dumping of rock for the breakwater construction is offset in part by the new habitat created, the displacement of harbor seals (*Phoca vitulina*) by construction activity may not be offset by new habitat formation. Clifton feels that the harbor seals will return to the area when construction is completed;[10] however, construction of the breakwater has been completed for some time, and no significant return of the harbor seals has occurred to date (p. A14-1-60). There is a possibility that the displacement of harbor seals may be permanent.

Fairbrother[11] has examined recolonization and free space recruitment of algal and invertebrate life on the tribars of the east breakwater at Diablo Canyon. She has determined that recolonization on the outside of the breakwater was more rapid than on the inside and attributes this to the greater turbulence and wave action. The most prominant algal form was the green alga *Ulva lobata*. Colonization *Balanus glandula* and *B. crenatus* was also noted on the outside tribars of the east breakwater. The difference in colonization rate between the inside and outside of the breakwater may be due to siltation in the inlet cove, resulting from erosion occurring during the construction of the road and coffer dam for the intake structure.

The construction of the breakwater has removed 12.5 acres of benthic area[12] from South Cove. Prior to the construction, the

Table 4.2. Reconnaissance subtidal survey of east and west breakwater at Diablo Canyon, April 3, 1972

Inside edge east breakwater
0–8 ft depth (siltation minimal)
Ulva sp.
Laminaria sp.
Ceramium sp.
Patiria miniata
Embiotocids
Sebastes sp. juveniles
35–40 ft depth (3/4 in. silt, pockets to 8 in. deep)
No conspicuous algae; rock cobble bottom
Channel between east and west breakwater
Anthopleura xanthogrammica
Cancer antennarius
Pisaster ochraceus
Pycnopodia helianthoides
Patiria miniata
Strongylocentrotus franciscanus (common in clusters on vertical rock faces)
Sebastes mystinus (dominant fish species observed)
Inside edge west breakwater
0–25 ft depth (siltation minimal on tribars)
Ulva sp.
Alaria marginata (extensive stands)
Egregia menziesii
Nereocystis luetkeana, maturing sporophytes to 25 ft length
Edge of west breakwater
0–25 ft depths (no silt on tribars)
Ulva sp.
Alaria marginata
Nereocystis luetkeana, sporophytes 14–15 ft length
Haliotis rufescens (on tribars)
Sebastes sp., extensive juveniles
25–30 ft depth (devoid of silt)
Rock cobble with barren bottom
No conspicuous algae
Calliostoma sp.
Patiria miniata
Strongylocentrotus franciscanus

From: Pacific Gas and Electric Co., Environmental Report, Supplement 2. Units 1 and 2 Diablo Canyon Site (July 28, 1972).

breakwater area was part of a small cove which included a rock shelf protected on three sides. This area was used as a haul-out area by the harbor seals (*Phoca vitulina*). South Cove itself was characterized by organisms similar to those found in Diablo Cove. It is possible that construction activity may have resulted in a reduction in sporophyte development of bull kelp (*Nereocystis luetkeana*) in the area adjacent to the breakwater during the spring and summer of 1970.[13]

4.3.3 Intake and Discharge Structure

Construction of the intake structure has resulted in the loss of 2 acres of benthic area,[12] and the construction of the coffer dam necessary for construction has resulted in temporary loss of additional benthic area.

The intake cofferdam in South Cove encompassed 4.5 acres of intertidal and subtidal zones, with depths of up to 30 ft. The access road and haul leg to the outer part of the cofferdam were constructed of nonwashed material, including waste rock from the Kaiser quarry and sand and dirt from a borrow area on the plant site.[14] During the pumping operations to remove water from behind the cofferdams, leaks developed along the haul road, washing mud into the reservoir. The resulting siltation, combined with the impact of the suspended material, resulted in extensive damage to abalone, bony fish, and other organisms before it was possible to remove them from the reservoir. Sediment buildup of up to 16 in. was noted in some areas, while the rocky reefs had up to 4 in. of silt. Suspended material was pumped with the reservoir water, and this was deposited in South Cove. The damage to the benthos was considered excessive by the California Department of Fish and Game.[14] As a result of a subsequent meeting with the Department, the applicant agreed to restore the cove to its original condition following the removal of the cofferdam.[14] The staff concurs with this agreement.

The cofferdam at the discharge area was built in the intertidal zone and was composed of washed gravel and rock. Water clarity in the discharge area did not differ from other areas, and no silt deposits were observed.[14]

The results of these impacts are considered to be temporary, since the organisms will be able to recolonize the area following the removal of the coffer dams (except where affected by operational impacts, discussed in Section 5). Additional silting during the removal of the coffer dams is considered to be unavoidable and will result in a short-term displacement of species (with possibly some alteration of community composition as a result of changes in the benthos).

4.4 CONTROLS TO LIMIT IMPACT OF SITE PREPARATION

4.4.1 Terrestrial

The locations that will be in need of restoration closely following the clearing and plant construction are the plant area, the borrow area, and the access roads to the transmission line towers. Both the plant site and the borrow area have served as test plots to obtain data on:

1. Methods of soil stabilization.

2. Ways to reestablish native vegetation species as quickly as possible.

3. Development of an economical program for supplying revegetation and natural landscaping materials to be employed during the final stages of the Diablo Canyon project.[2]

Methods being used for controlling erosion and promoting revegetation in the areas disturbed by the transmission lines are outlined in reports contained within Appendix 4-1.

The staff concludes that rapid revegetation is difficult under the climatic conditions at Diablo Canyon. Further, it is the opinion of the staff that careful application of the practices outlined in Appendix 4-1. will reduce erosion potential and speed revegetation and soil stabilization in areas affected by road construction and tower placement.

4.4.2 Aquatic Impact (Marine Environment)

During construction of the breakwaters, special attention was paid to reducing dirt and debris discharged to the ocean.[8] As noted earlier, some siltation has been observed; however, the small amount of silt observed during a subtidal survey[2] on April 3, 1972, suggests that wave action has carried most of the silt out of South Cove and dispersed it in the adjacent ocean area. In addition, abalone were removed from the intake and discharge areas and transplanted to areas that "would remain undisturbed by construction activities." A total of 15,129 abalones were transplanted as a result of this program.[15] Most of the abalone in the shallow water were subsequently taken by public visitors to the transplanted area. Overall survival was low.[14] The applicant has stated (Public Gas and Electric Company, Response to Comments Submitted by Department of the Interior and the State of California, May 7, 1973) that survival rates were above 80 percent, except for those abalone which were cut during removal (less than 10% of the total transplanted). Many legal-sized abalone were removed by sports fishermen immediately after transplanting.

The intake and discharge structures required cofferdams during the construction period. The intake cofferdam was built using a series of circular cells connected by sheet piling. A connecting haul leg was also constructed. This haul leg was constructed of unwashed waste rock and dirt fill, and although attempts were made to prevent silting, the leakage that developed along the haul leg resulted in extensive silting and an increase in the suspended material in the water within the cofferdam. This water was pumped and released to South Cove. The resulting damage was discussed in Sect. 4.3.3.

The discharge cofferdam was built of washed gravel and rock. No silting was observed as a result of this construction.

4.5 EFFECTS ON COMMUNITY

The effects of construction activity at the Diablo Canyon site have not been a significant factor in the surrounding community, based on interviews, reports, and testimony available to the staff.[16] This lack of direct effect can be attributed to the remoteness of the site and to the relatively small percentage of the local economy represented by the construction expenditures.

The construction activity associated with the transmission lines from the site has caused some concern in the local community, however,[3,4] with regard to aesthetics, visibility, and erosion potential. These effects are discussed in more detail in Section 12.2, Alternative Sites.

4.5.1 Economic Effects

Table 2.3 shows[17] a summary of the economic development in San Luis Obispo County starting in 1966. The payroll at the site during the construction period was calculated by the staff from figures supplied by the applicant[2] and is summarized in Table 4.3. This payroll amounted to only 2% of the total personal income in the county in 1970, but it could equal as much as 15% of the personal income in 1974, assuming that the 1966-1970 personal income growth rate continues.

Table 4.3. Construction payroll

Year	Payroll ($)	Peak work force
1968	670,790	160
1969	2,279,110	430
1970	6,878,900	630
1971	11,198,070	880
1972	21,040,320	1,390
1973	27,966,960	1,530
1974	27,984,320	1,520
1975	14,703,920	1,000
1976	3,370,660	275

The construction wages cannot be considered as a direct contribution to San Luis Obispo County, because much of the work force does not reside in the county (exact figures unavailable), so the actual percentage of the county economic status will be less than that calculated by the staff.

At least two areas in San Luis Obispo County are reported[16] to have felt a relatively important impact from construction activity — the small town of Port San Luis (population less than 500) near the entrance to the site and the five cities in the vicinity of Pismo Beach (total population about 20,000).

The major effect of site construction on these areas is reported to be a substantial increase in construction of residential dwellings. This effect is not accurately documented, and a definite correlation between site construction and residential construction activity would be difficult to establish. The city of San Luis Obispo, for example, has also recorded a substantial increase in residential construction, but there are no claims and no data to tie this activity with the construction at Diablo Canyon.[16] As can be seen in Table 2.3, the increase in dwelling units in San Luis Obispo County, with the possible exception of the local effects at Port San Luis and the "Five Cities Area" mentioned above, is out of proportion to the relatively small contribution of construction payroll to the community. Also, a 171% increase in dwelling unit building permits was recorded from 1966 to 1970, compared with a 39.3% increase in personal income, 7.3% increase in population, and the less than 2% annual contribution to county personal income from the plant construction payroll.

Table 2.3 also shows that a measurable drop in unemployment in the county coincided with the start of construction activity. While there is no available evidence that the two events are related, this factor is of importance in considering the economic effects resulting from the end of construction activity in 1976.

The staff concludes that the economic effects of construction have had a small economic impact on San Luis Obispo County, although some economic growth in small local areas may be related to construction.

4.5.2 Effect on Traffic

The construction activity at the plant site has resulted in traffic increases along the road from U.S. 101 to Avila Beach, although it is difficult to establish a correlation between preconstruction and construction counts. Table 4.4 shows traffic counts supplied

Table 4.4. Traffic counts prior to and during construction *of Diablo Canyon Units 1 and 2*

Count made on Avila Road between Avila Beach and Bay Drive

Month	Two-way traffic count	Percent related to construction	Approximate work force
September 1966	5559		
March 1967	3035		
October 1967	2185		
April 1968	4475	0.7	40
October 1968	2216	6.7	180
April 1969	4239	2.9	160
October 1969	3439	5.3	240
April 1970	4417	9.7	560
October 1970	3074	15.8	640
March 1971	3189	17.2	720
September 1971	6871	9.7	880
April 1972	5497	16.9	1220

by the San Luis Obispo County Engineering Department,[16] together with the applicant's stated construction work force at the time. A one-way traffic count on the site access road in September 1971 showed 672 vehicles leaving the site for an approximate work force of 880 people. This figure serves as the basis for a rough estimate of the percentage of the two-way traffic count on Avila Road contributed by Diablo Canyon. While Table 4.4 shows that this percentage increased significantly from 1968 to 1972, the construction work force obviously was not the only source of the increased traffic on Avila Road, as indicated by the variation of traffic counts compared with the steadily increasing work force.

Avila Road at the location of the traffic count is the only public road from U.S. 101 to the site entrance. The primary effects of any increased traffic flow would therefore be most pronounced in the community of Avila Beach. The county resurfaced a short stretch of road and relocated another section of road through Avila Beach to reduce the effects of construction traffic.[16] The section of road relocated around Avila Beach was constructed by the applicant with subsequent dedication to the county.

The staff concludes that the effects on traffic, while measurable, are not serious and that other factors apparently are at work which tend to reduce the contribution of Diablo Canyon traffic to the total traffic count near the site.

4.5.3 Noise and Dust

The noise and dust from plant construction activity are not a factor to the human environment because of the remoteness of the site.

Particulate emissions from the onsite concrete batch plant are controlled through utilization of dust filters. In addition, aggregate is washed prior to delivery at the site in order to remove finely divided rock, etc., which might otherwise constitute a dust problem.

There were statements[16] to the staff by the County Engineering Department that truck traffic off the site but associated with plant construction resulted in complaints from residents in the Santa Margarita area, about 20 miles from the site. Similar complaints by residents in See Canyon reportedly resulted in cessation of truck traffic on See Canyon Road earlier.

The staff recommends that an effort be made by the applicant to reduce this nuisance to a practical minimum.

4.5.4 County Facilities

Inquiries made by the staff produced no evidence that construction activity has burdened the public services of San Luis Obispo County. During the site visit, officials of the local government, including those from the School Superintendent's Office and the County Planning Commission Office, stated they were not aware of any burden placed upon the county as a result of Diablo Canyon construction.[16]

REFERENCES FOR SECTION 4

1. Initial Decision, Atomic Safety and Licensing Board, USAEC, In the Matter of Pacific Gas and Electric Company (Diablo Canyon Nuclear Power Plants, Units 1 and 2), Docket Nos. 50-275 and 50-323, June 5, 1972, p. 9.

2. Pacific Gas and Electric Company, *Environmental Report, Supplemen No. 2, Units 1 and 2, Diablo Canyon Site,* Vols. 1 and 2, July, 1972.

3. California Public Utilities Commission of the State of California, Decision No. 79726, Feb. 15, 1972.

4. Transcript of Show-Cause Hearings, USAEC Docket Nos. 50-275 and 50-323, Pacific Gas and Electric Company, Diablo Canyon Units 1 and 2, San Luis Obispo, Calif, May 17-20, 1972, pp. 958-1008.

5. Ibid, p. 975.
"Inventory of Rare, Endangered, and Possibly Extinct Plants of California," prepared by California Native Plant Society--information as of June 1971.

6. USDA, Forest Service, "Habitat Management Plan for the California Condor," available at Forest Service offices in San Francisco, Santa Barbara, and Ojai, California.

7. Pacific Gas and Electric Co. *Environmental Report, Units 1 and 2, Diablo Canyon Site,* July 1971, p. 56.

8. Pacific Gas and Electric Co. *Environmental Report, Units 1 and 2, Diablo Canyon Site*, July 1971, p. 57.

9. Transcript of Show-Cause Hearing, USAEC Docket Nos. 50-275 and 50-323, Pacific Gas and Electric Company, Diablo Canyon Units 1 and 2, San Luis Obispo, California, May 18, 1972, p. 5 (Testimony of Richard S. Bain).

10. D. Clifton, "The Effect of Construction on the Harbor Seal (*Phoca vitulina*) in Diablo Cove, San Luis Obispo County, California," California State Polytechnic College, San Luis Obispo, 1971; Pacific Gas and Electric Company, Department of Engineering Research, "Marine Environmental Investigation at the Diablo Canyon, Units 1 and 2, Nuclear Power Plant Site, 1969-1971," Emeryville, California, July 1972.

11. K. Fairbrother, "Interim Progress Report — Diablo Canyon East Breakwater, June-December 1971." in *Marine Environmental Investigations at the Diablo Canyon, Units 1 and 2, Nuclear Power Plant Site, 1969-1971*, Pacific Gas and Electric Company, Department of Engineering Research, Emeryville, California, July 1972.

12. Pacific Gas and Electric Company, *Environmental Report, Supplement No. 2., Units 1 and 2, Diablo Canyon Site*, July 1972, page IV-E-27.

13. R. T. Burge and S. Schultz, "Diablo Canyon Ecological Survey; Annual Report for the Period January 1, 1970 to December 3, 1970" (submitted May 25, 1971), CDF & G Cooperative Research Agreement S-1092L, 22 pp.

14. Richard T. Burge and Steven A. Schultz, "The Marine Environment in the Vicinity of Diablo Canyon with Special Reference to the Abalone, Including Its Food Chain, and to Bony Fish (a Pre-Operational Warm Water Discharge Area)," Marine Resources Technical Report, State of California, The Resources Agency, Department of Fish and Game, Marine Resources Region.

15. B. F. Waters, "Abalone Transplants in Marine Environmental Investigations at the Diablo Canyon Units 1 and 2 Nuclear Power Plant Site, 1969-1971," Pacific Gas and Electric Company, Department of Engineering Research report (July 1972), pp. 101-108.

16. Report of Diablo Canyon Plant-Site Visit, June 19-23, 1972, Docket Nos. 50-275 and 50-323, July 31, 1972, and Supplement, December 1972.

17. Research Department of Security, Pacific National Bank, Los Angeles, Calif., "Monthly Summary of Business Conditions in Southern California," August 1971.

5. ENVIRONMENTAL IMPACTS OF STATION OPERATION

5.1 LAND USE

Operation of the station requires the restricted use of approximately 750 acres of land previously used for grazing. The staff considers this an acceptable impact in view of the total area available for grazing in the immediate surroundings. The applicant intends ultimately to install six units at the site, but no definite dates have been set, and this statement is concerned only with installation of Units 1 and 2.[1]

The current and proposed use of the land beneath the transmission lines and included in the rights-of-way has been described by the Pacific Gas and Electric Company. The patterns do not reveal any major conflicts created by the lines (see Table 5.1). In a document prepared by the applicant,[2] letters from the San Luis Obispo County Planning Commission attest to the cooperation between the applicant and this commission regarding the consideration of the county's land use intentions. The major impact of the transmission lines results from construction, which was discussed in Section 4.2.2. Operation of the transmission lines will result in continuing aesthetic impacts but not additional adverse impact on land use, provided that erosion abatement procedures are successful. Aesthetic impacts due to transmission lines are difficult to quantify but are nonetheless present as a constant visual impact over the lifetime of the facility. Regarding this latter aspect, in determining that the routings for Diablo Canyon lines represent the best choice in view of proposed alternates, aesthetic impacts were considered and deemed acceptable.

5.2 WATER AND AIR USE

5.2.1 Water Use

Fresh Water

Diablo Canyon Creek is the only significant fresh water source near the plant. All fresh water from the creek is and will continue to be reserved by the property owners adjacent to the creek during the operation of the plant.[3] Fresh water for the plant will be supplied by distillation of seawater during operation. Therefore no reduction in the availability of water to property owners will result from operation of the plant. Groundwater and domestic water supplies in the area should not be affected by the operation of the plant.

Table 5.1. Current and projected land use in the transmission line corridors

Section	Current use	Projected use (same as current use except as noted)
	Diablo-Midway 500 KV transmission line corridor	
Plant Site – Highway 101	Grazing	
Highway 101 – $1\frac{1}{2}$ miles east of Highway 101	Grazing with some subdivision on the easterly end of this section. Lots are 5–30 acres in size	Additional subdivisions closer to Highway 101
$1\frac{1}{2}$ miles east of Highway 101 – southeast corner of T31S R12E MDB&M	Grazing	Potential oil tar sands development
Southeast corner of T31S R12E MDB&M – Ormonde Road	Grazing and low production oil wells	Potential for some large parcel subdivision
Ormonde Road – $\frac{1}{2}$ Mile East of Arroyo Grande Road	Rural residential development	
$\frac{1}{2}$ mile east of Arroyo Grande Road – Section 10 T31S R18E MDB&M	Grazing	
Section 10 T31S R18E MDB&M – Section 12 T31S R18E MDB&M	Dry farming	
Section 12 T31S R18E MDB&M – Section 6 T31S R20E MDB&M	Grazing	
Section 6 T31S R20E MDB&M – Section 33 T30S R20E MDB&M	Dry farming	
Section 33 T30S R20E MDB&M – Section 13 T30S R20E MDB&M (At this point, the lines split. The following is the north line)	Grazing	
Section 13 T30S R20E MDB&M – Section 24 T29S R21E MDB&M	Oil production, dry farming, some grazing	
Section 24 T29S R21E MDB&M – Kern River Flood Canal	Undeveloped desert	The last 2 miles (east of the California Aqueduct) can be developed to row crop or orchard
Kern River Flood Canal – Midway Substation (The following is the south line)	High yield row crop	
Section 13 T30S R20E MDB&M – Section 9 T30S R21E MDB&M	Oil production, some grazing	
Section 9 T30S R21E MDB&M – Kern River Flood Canal	Undeveloped desert	The last $1\frac{1}{4}$ miles (east of the California Aqueduct) can be developed to row crop or orchard
Kern River Flood Canal – Midway Substation	High yield row crop	

Ocean Water

The Central Coastal Regional Water Quality Control Board has noted seven existing beneficial uses for the shoreline in the vicinity of the proposed discharge.[4] These uses are:

1. Scenic attraction and aesthetic enjoyment.
2. Marine habitat for sustenance and propagation of fish, aquatic life, and wildlife.
3. Fishing.
4. Industrial water supply.
5. Boating, shipping, and navigation.
6. Scientific study.
7. Potential water contact sports.

The requirements of this water quality board include monitoring and reporting procedures for use in evaluating the impact of operation. These requirements and the program for protection of the beneficial uses noted above are given in Section 6 of this statement.

The principal beneficial use of the ocean waters near the plant is for commercial and sport fishing. Block designations of the California Department of Fish and Game for the Diablo Canyon area are given in Fig. 5.1. The details for statistical block 615 are given in Tables 5.2 to 5.7. As noted in the applicant's Environmental Report, the catches of blocks 614 and 615 are combined under block 615.[3] Therefore, fish taken from the nearshore area from Point Buchon to Point San Luis are included in the statistics for block 615.

Over the years reported, the yield has been quite variable; this may be due to any of a number of reasons. The principal concern from operation of the plant is related to possible impact on the abalone population that could occur if the heated discharge should reduce the abundance of kelp, a primary food of the abalone. (This problem will be discussed in more detail in Section 5.3.2.)

It is not expected that any of the beneficial uses identified by the Central Coastal Regional Water Quality Control Board will be foreclosed as a result of construction or operation of the plant. Some changes will occur as a result of operation, however, and these are discussed in Section 5.3.

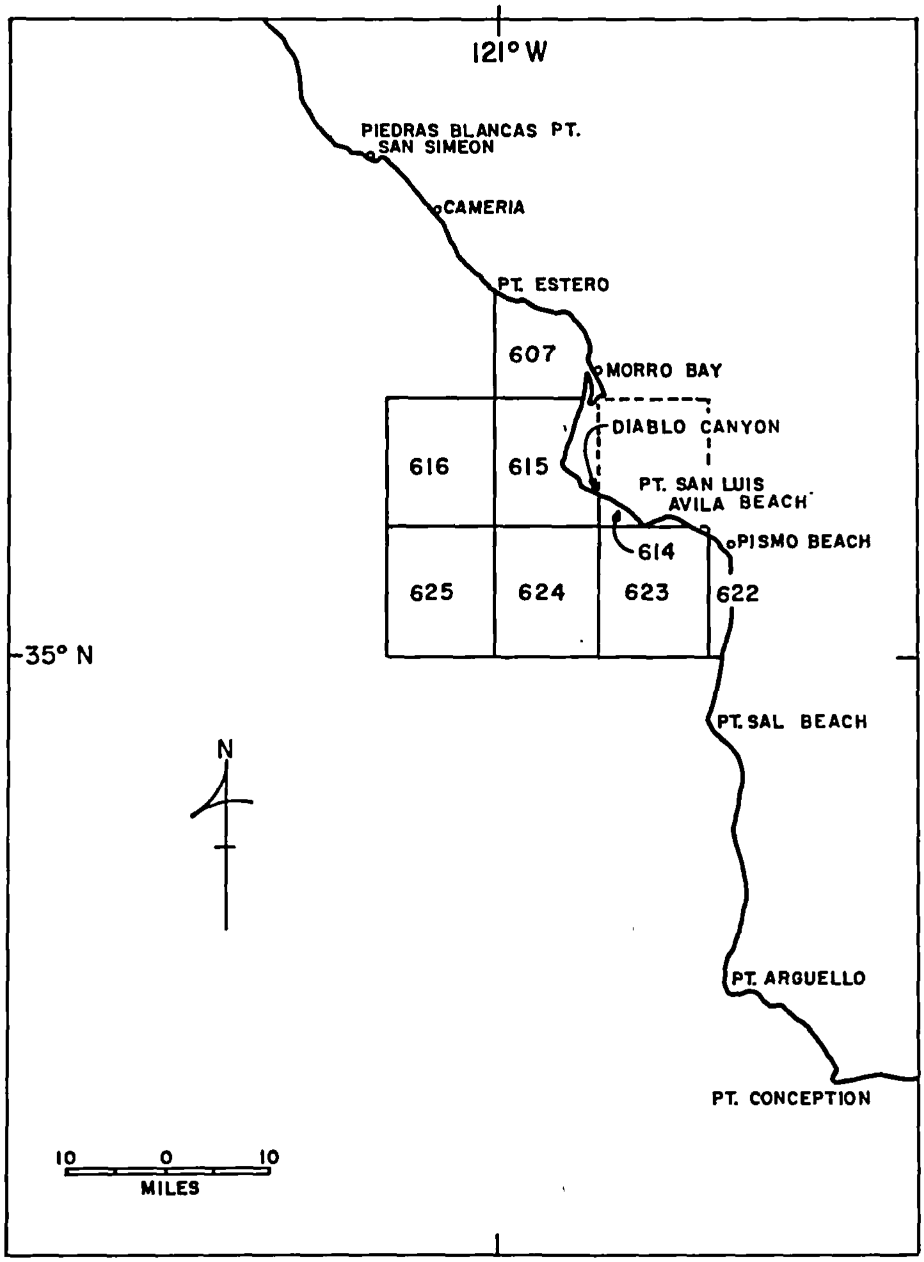


Fig. 5.1. Location of California Department of Fish and Game fishing blocks in the Diablo Canyon area.

Table 5.2. Commercial fish catch for block 615, 1965–1970

In pounds

Common name	1965	1966	1967	1968	1969	1970	Average
Pacific bonita		55	180		668		151
Albacore	583,899	21,951	33,257	261,352	212,357	9,740	187,093
Pacific mackerel		4,575					763
Jack mackerel		147,925	327,318				79,207
Sardine			2,487				415
Shark	142	32	326	95	118		119
Lingcod	1,188	3,176	1,715	539	736	630	1,331
Sole					5		1
Sand sole			285	265			92
English sole	1,495	8,537	12,565	13,630	504	465	6,199
Rex sole	715	3,340	5,830	1,795	295	325	2,050
Petrale sole	4,518	23,967	26,855	28,020	1,332	960	14,275
Dover sole	1,653	225			67		324
California halibut	13	186	226	84			85
Turbot		180					30
Whitebelly rockfish	18						3
Rockfish	5,808	11,591	7,497	8,495	3,260	5,133	6,964
Black rockfish	130	410	3,505				674
Bocaccio		15	4,495	560	102		862
Chilipepper	790						132
Cabezon	220				52		45
Gopher rockfish	401	1,158			320		313
Red rockfish	20	82			828		155
Salmon	29		19		450		83
King salmon	3,228	2,465	749	308	1,140		1,315
Silver salmon	1,104	7	398				252
White sea bass		2,726	935		1,102	147	818
Barred surf perch	187						31
Black perch	35						6
Salt water perch	6		58	6	80		25
Red abalone	603,034	389,919	296,614	365,767	284,417	183,654	353,901
Pink abalone	60			50	4,300	225	773
Octopus		95					16
Market crab	915	1,993	118	12			506
Rock crab					621		103
Animal food	6,085	12,485	15,405	13,815			7,965
Total	1,215,693	637,095	740,837	694,793	512,634	201,279	667,055

Table 5.3. The ten most important commercial fish, by weight, taken in statistical block 615, 1965–1970

Rank	Name	Average catch (lb)	Percent
1	Red abalone	353,901	53.1
2	Albacore	187,093	28.0
3	Jack mackerel	79,207	11.9
4	Petrale sole	14,275	2.1
5	Rockfish	9,148	1.4
6	English sole	6,199	0.9
7	Rex sole	2,050	0.3
8	Salmon	1,648	0.2
9	Lingcod	1,331	0.2
10	White sea bass	818	0.1
	Other	12,007	1.8
	Total	667,055	100.0

Table 5.4. Comparison of abalone landings in block 615 with landings for Morro Bay and Avila, and for State of California, 1965–1970

In pounds

	1965	1966	1967	1968	1969	1970	Average
Block 615	603,094	389,919	296,614	365,817	288,717	183,878	354,674
Morro Bay	1,283,416	1,452,553	1,397,207	663,828	433,475	163,681	899,027
Avila	57,077	116,850	224,616	269,905	184,132	121,105	162,281
Morro and Avila combined	1,340,493	1,569,403	1,621,823	933,733	617,607	284,786	1,061,308
615 as percent of Morro and Avila	45.0%	24.8%	18.3%	39.2%	46.7%	64.6%	33.4%
State of California	4,576,084	4,963,556	4,421,581	4,474,842	3,658,078	2,900,813	4,165,826
615 as percent of state	13.2%	7.9%	6.7%	8.2%	7.9%	6.3%	8.5%

Table 5.5. Comparison of albacore landings in block 615 with landings for Morro Bay and Avila, and for State of California, 1965–1970

In pounds

	1965	1966	1967	1968	1969	1970	Average
Block 615	583,899	21,951	33,257	261,352	212,357	9,740	187,093
Morro Bay	3,140,948	1,517,971	2,510,808	1,600,372	1,115,501	3,681,371	2,261,161
Avila	0	31,628	312,143	529,971	74,917	635,649	264,051
Morro and Avila combined	3,140,948	1,549,599	2,822,951	2,130,343	1,190,418	4,317,020	2,525,212
State of California	19,850,865	16,141,399	15,184,473	11,617,055	11,162,742	25,946,105	16,650,440
615 as percent of Morro and Avila	18.6%	1.4%	1.2%	12.3%	17.8%	0.23%	7.4%
615 as percent of State	2.9%	0.1%	0.2%	2.2%	1.9%	0.04%	1.1%

Table 5.6. The ten most important sport fish caught by party boats in statistical block 615, 1965–1970

Rank	Name	Average number of fish	Percent
1	Rockfish	61,179	92.79
2	Lingcod	3,098	4.70
3	Flounder	612	0.93
4	Cabezon	414	0.63
5	Albacore	216	0.33
6	Salmon	127	0.19
7	California halibut	55	0.08
8	Pacific bonita	49	0.07
9	Sand dab	46	0.07
10	Sablefish	24	0.04
	Other	112	0.17
	Total	65,936	100.00

Table 5.7. Party boat data for statistical blocks adjacent to Diablo, 1965–1970

Block	Item	1965	1966	1967	1968	1969	1970	Average
607	Boat days	289	262	181	296	385	473	314
	Catch[a]	72,702	49,104	22,444	43,766	82,656	111,163	63,639
615	Boat days	417	312	442	372	356	337	373
	Catch	101,249	59,132	50,186	62,690	63,133	59,226	65,936
616	Boat days	14	14	36	24	13	26	21
	Catch	712	675	1,623	1,694	566	1,739	1,168
622	Boat days	16	2		1			
	Catch	216	248		95			
623	Boat days	128	57	19	33	52	68	60
	Catch	4,571	2,725	106	338	1,441	729	1,652
624	Boat days	4	1	5		6	11	5
	Catch	55	2	141		139	204	90
625	Boat days		1	15	24	9	8	10
	Catch		0	353	993	166	417	322

[a]Numbers of fish.

5.2.2 Air Use

The use of air at the Diablo Canyon site is primarily for dilution of radioactive gaseous effluent. The assessment of the doses to man and the other biota is given in Section 5.4. The air space use by the man-made structures is most extensive with respect to the long transmission lines, described in Section 3.7. The aesthetic impacts of these facilities, as well as the possibility for interference with avian species by high-voltage lines, have been evaluated (Sect. 4.2.2) and are considered acceptable in terms of their respective potential.

An additional aspect of air usage stems from the use of an auxiliary boiler to supply steam for space heating and other purposes when the main reactors are not operating. The boiler is designed to use No. 2 fuel oil. Estimates of emissions and usage are tabulated in Table 3.4.

Some increase in local fogging can be expected during periods favoring natural fog formation, resulting from the mixing of warm moisture-laden air rising from areas of the thermal discharge with cooler ambient air. Under certain conditions, this increased fogging has potential for interfering with traffic over adjacent roadways. The Diablo Canyon plant is located at distances of several miles from any well-traveled roads, however. The nearest public roads are a county road located 4 miles north of the site and another located 5 miles to the east. At the closest, U.S. Highway 101 is almost 9 miles inland to the east and is separated from the plant by the Irish Hills (elevations 1000 ft and above). When the wind flow is from the northwest (the prevailing direction at the site), the nearest highway in that wind direction is State Route 1, approximately 20 miles downwind. Thus, the incremental addition of fog due to operation of the Diablo Canyon plant with once-through condenser cooling is not expected to be a major problem.

5.3 BIOLOGICAL IMPACTS

5.3.1 Impact on the Terrestrial Environment

Sources of impact on the terrestrial environment include (1) radiation effects to all biota resulting from gaseous releases of radionuclides to the atmosphere or to semiaquatic animals (e.g., shorebirds) consuming aquatic plants contaminated with radionuclides from liquid releases, (2) potential effects on terrestrial communities resulting from both periodic clearing and herbicide application for brush control on transmission line corridors, and (3) disturbance of native animals by the increased presence of automotive vehicles (cars, trucks) and personnel.

No herbicide treatment to control vegetation growth along the transmission corridors is anticipated by the applicant[5] and the staff concludes that none is required. Periodic cutting to remove hazard vegetation will result in the continuance of successional community types within areas involved.

Regarding operational impacts on wildlife, the Diablo Canyon lines bisect a subflyway having frequent high densities of avian species.[2] Thus there exists potential for interference by the lines resulting in possible electrocution or collision. Death by electrocution requires a phase-to-phase or phase-to-ground contact. Minimum phase spacings for the 500-kV lines are 42 to 51 ft,[6] with a 15-ft minimum distance between conductors and steel tower elements. Thus, electrocution of even the largest raptor species (the California condor, wingspan about 10 ft) by Diablo Canyon 500-kV lines would appear an unlikely possibility. Confrontations with the Diablo to Morro Bay 230-kV feeder line would be more limited in that this line is located on the fringes of the condor's range.

In terms of avian collisions with lines, Arend has reported that large-diameter power transmission cables operating at voltages higher than 100 kV are seldom, if ever, hazardous to birds, even in dense fog.[7] Hockbaum has commented that resident birdlife is aware and familiar with all components forming its environment and is not affected by aerial obstructions unless fog reduces its visibility.[8] In such a situation, however, birdlife usually remains grounded unless disturbed. Waterfowl are able to perceive objects by moonlight, but not total darkness, and generally alight by nightfall.[8]

Therefore, when taken into consideration with other man-made obstacles which confront avian species, such as telegraph wires, television antennas, buildings, etc., the hazard presented by large-diameter transmission lines is probably negligible.

An additional operating impact associated with transmission lines is the possible production of ozone (O_3) around high-voltage carriers. Contributions of ozone in excess of ambient levels by transmission lines and substations have not been documented in the literature. Available data do suggest that measurable increases in ozone around 500-kV lines such as those proposed for Diablo Canyon are generally on the order of 0.010 to 0.012 ppm above background, except during stagnant conditions, when increases may approach 0.2 ppm.[9] Chronic exposure to at least 0.030 to 0.15 ppm ozone are required to elicit damage in sensitive species,[10,11] hence vegetation damage due to ozone drift from 500-kV lines may be considered as generally unlikely. This conclusion may require modification as more data become available, especially in cases where multiple high-voltage circuits are routed along a single corridor.

A further operational impact that merits consideration is the opening of heretofore inaccessible lands to the general public by way of access roads. This feature may be construed as being beneficial in most cases, in that it lends itself well to the multiple-use concept of right-of-way management. On the other hand, considering that there exists serious potential for erosion along portions of Diablo Canyon lines and considering that these lines traverse habitats unique to several rare, endangered, or declining wildlife species (e.g., California condor), it would appear that some restriction of public usage of these rights-of-way and access roads is required. Regarding this latter aspect, the staff recognizes that PG&E does not own or control the lands upon which the access roads are located. These are under the supervision of the respective landowners and the U.S. Forest Service (in the case of Los Padres areas). The staff nonetheless recommends that the applicant attempt to seek the cooperation of the parties in question to establish programs of restrictive entrance to areas having serious potential for erosion (as outlined in Appendix 4-1, plus other problem areas as identified), or which extend through areas known to be inhabited by various of those species mentioned in Sect. 4.2.2 and described in Appendix 2-6 as being rare, endangered, or declining.

5.3.2 Impact on the Aquatic Environment

Sources of potential biological damage to aquatic biota from operation of the once-through cooling system at the Diablo Canyon nuclear station are:

(1) Chemicals used in the condenser cooling water and perhaps other chemicals released to the cooling water from a variety of plant operations, some of which are toxic to aquatic life.

(2) Reduction of dissolved oxygen in the water body during periods of warmer water temperatures and increased biological requirements.

(3) Temperature increases from the warm cooling water, causing both direct effects and indirect effects on metabolism, growth, disease, predation, etc.

(4) Impingement on intake screens of large organisms, principally fish and jellyfish, drawn into the cooling-water intake.

(5) Mechanical entrainment and temperature damage to small organisms passing through the pumps and condenser tubing.

(6) Radiation derived largely from radioactive nuclides taken up internally by aquatic organisms residing in the reactor effluent.

(7) Combinations of the above, which may cause effects greater than the sum of individual effects (synergism).

Chemicals

As described in Section 3.5, several chemicals will be discharged to Diablo cove via the cooling water effluent. The staff has identified and evaluated the environmental impact of the following chemicals: chlorine (used intermittently as a biocide in the auxiliary cooling system and occasionally in the condenser cooling system); copper and nickel from continuous corrosion of the copper-nickel alloy condenser tubing; sodium hydroxide and sulfuric acid, which will be mutually neutralizing and yield sodium sulfate (when released intermittently from drains of acid and caustic pumps); and chromium (released by leakage from the service water and cooling water system).

(1) Chlorine.[12] The effects of chlorination on marine organisms at power plants are well documented. Excessive use of chlorine has caused the deaths of striped bass (*Morone saxatilis*) and blue crabs (*Callinectes sapidus*), depressed primary productivity and numbers of bacteria, and caused mortalities in zooplankton. These effects were all noted at a power plant on the Chesapeake, where chlorine levels of 5 ppm have been measured in the discharge. Recently, Carpenter, Peck, and Anderson[71] have shown that entrained phytoplankton are very sensitive to chlorine. Continuous addition of .1 ppm at the intake (<.05 residual at discharge) of a nuclear power station on Long Island Sound resulted in a production decrease of 79%. Periodic application caused a somewhat lesser decrease in primary productivity.

Chlorine toxicity information on marine organisms is shown in Table 5.8.

Based on the previously cited chlorine discharge concentrations (Table 5.8) and the expected dilution factors, the 6-acre area beyond the immediate outfall will periodically contain maximum concentrations of approximately 0.1 ppm free available chlorine and the 80-acre area will periodically have maximum concentrations of about 0.05 ppm. The chlorine toxicity data in Table 5.8 indicate

Table 5.8. Effects of chlorine on some marine organisms

Species	Concentration (ppm)	Effect (duration of exposure)	Reference
Acartia tonsa	0.75	30% killed (2 min)	Dressel
Botryllus sp. (tunicate)	10.0	Killed (24 hr)	Turner
Bugula sp.	2.5	Killed (48 hr)	Turner
(bryozoan)	10.0	Killed (24 hr)	
Crassostrea virginica	0.01–0.05	Pumping activity reduced	McKee
(oyster)	1.0	Pumping halted	
Ostrea edulis (oyster larvae)	10.0	No effect	Waugh
Mytilus edulis	1.0	Killed (15 days)	Turner
(mussel)	2.5	Killed (5 days)	
	10.0	Killed (5 days)	
Elminis modestus (barnacle nauplii)	0.5	Heavy mortality (10 min)	Waugh
Molgula sp.	1.0	Killed (3 days)	Turner
(ascidian)	2.5	Killed (1 day)	
	10.0	Killed (1 day)	
Macrocystis pyrifera	1.0	No effect (5 days)	McKee
(giant kelp)	5.0–10.0	10–15% photosynthesis 2 days reduction	
	5.0–10.0	50–70% photosynthesis 5–7 days reduction	
Mixed phytoplankton	<0.5	79% decrease in production	Carpenter

Carpenter, E. J., B. B. Peck, and S. J. Anderson, "Cooling water chlorination and productivity of entrained phytoplankton," *Mar. Biol.* 16: 37–40, 1972.

Dressel, D. M., "The effects of thermal shock and chlorine on the estuarine copepod *Acartia tonsa*," master's thesis, University of Virginia, 1972.

McKee, J. E., and H. W. Wolf, *Water Quality Criteria*, California State Water Quality Control Board, Publ. No. 3–2 (1963).

Turner, H. J., D. M. Reynolds, A. C. Redfield, "Chlorine and sodium pentachlorophenate as fouling preventives in seawater conduits," *Ind. Eng. Chem.*, 40(3): 450–453, 1948.

Waugh, G. D., "Observations on the effects of chlorine on the larvae of oysters (*Ostrea edulis* L.) and barnacles (*Elminius modestus* Darwin)," *Annals, Appl. Biol.*, 54(3): 432–440, 1964.

that the concentration of chlorine found in the immediate outfall area is not lethal to the organisms listed in the table. However, no information is available on the effect of chlorine on abalone adults or larvae, or on other invertebrates common to the Diablo Canyon area. In addition, chlorine toxicity to marine fish and their larvae has not been extensively studied. Thus, one must be cautious in concluding that there will be no mortality in the outfall environs. Also, experience with chronic low-level exposures is limited, and exact predictions of sublethal effects cannot be made at this time.

Although the impact of chlorine on organisms in Diablo Cove is expected to be small, because of the low concentrations, the concentration in the system at the time of chlorination is judged as sufficiently toxic to kill any organisms in the condenser tubes at the time of chlorination. The planned chlorine application is equivalent to treating the entire flow through the plant for a period of 10 min, although the practice is to chlorinate only one part of a condenser at a time and to chlorinate only 1 hr per day (for a complete explanation see Sect. 3.5.1 of this Statement or p. XII-E-13 of the applicant's Environmental Report). Since all organisms in the system during this time will be killed, the staff has estimated that the yearly losses will include:

$$\text{Phytoplankton} = 59.69 \times 10^9 \text{ g/year} \times \frac{10 \text{ min}}{60 \text{ min} \times 24} \times \frac{1}{454 \text{ g/lb}}$$

$$= 9.12 \times 10^5 \text{ lb}$$

$$\text{Zooplankton} = 1.052 \times 10^9 \text{ g/year} \times \frac{10 \text{ min}}{60 \text{ min} \times 24} \times \frac{1}{454 \text{ g/lb}}$$

$$= 16 \times 10^3 \text{ lb}$$

$$\text{Fish} = 3.8308 \times 10^9 \text{ fish/year} \times \frac{10 \text{ min}}{60 \text{ min} \times 24}$$

$$= 27.9 \times 10^6 \text{ fish}$$

The calculations are the upper-limit values based on operation of the station 100% of the time. The actual values will be lower than those shown because the impact is a function of the amount of operation, which is less than a use factor of 100% because of time required for refueling or other maintenance.

Table 5.9. Effect of copper on marine organisms

Species	Concentration (ppm)	Effect (duration of exposure)	Reference
Acartia clausi (copepod)	0.5	50% mortality (13 hours)	Corner
Balanus balanoides (barnacles)	0.06	Not toxic (2 weeks)	Clarke
	0.42	Lethal (2 days)	
Balanus eburneus (barnacle nauplii)	0.06	Lethal (22 hours)	Clarke
Balanus eburneus (adult barnacles)	0.14	Lethal (2–5 days)	
	0.90		
Carcinus maenas (shore crab)	1–2	No effect (11–12 days)	Raymont
Fundulus heteroclitus (killifish)	30	Tolerated (4 days)	Doudoroff
Gymnodinium breve (plankton)	0.003	Minimum lethal	Marvin
Gymnodinium brevis (algae-red tide organism)	0.1	Lethal	Starr
Haliotis fulgens (mollusk)	0.05	Less than 100% mortality (30 days)	Marks
		100% mortality (3 days)	Marks
Ischnochiton conspicous (mollusk)	0.10	Less than 100% mortality (60 days)	Marks
	0.15	100% mortality (10 days)	Marks
Macrocystis pyrifera (giant kelp)	0.1	50% photosynthesis inhibition (2–5 days)	McKee
Mytilus californianus (mussel)	0.10	Less than 100% mortality (60 days)	Marks
	0.15	Less than 100% mortality (30 days)	
	0.20	100% mortality (2 days)	
Mytilus edulis	0.02	No mortality (4 days)	Clarke
	0.04	Some mortality (3 days)	
	0.08	Killed (2 days)	
	0.14	Killed (1 day)	
	0.55	Killed (12 hrs)	

Sources

Clarke, G. L., "Poisoning and recovery in barnacles and mussels," *Biol. Bull. Woods Hole*, 92: 73–91 (1947).

Corner, E. D. S., and B. W. Sparrow, "The modes of action to toxic agents. I. Observations on the poisoning of certain crustaceans by copper and mercury," *J. Mar. Biol. Assoc. U. K.*, 35: 531–548 (1956).

Doudoroff, P., and M. Katz, "Critical review of literature of industrial wastes and their components to fish. II. The metal as salts," *Sewage Industr. Wastes*, 25: 802–839 (1953).

Marks, G. W., "The copper content and copper tolerance of some species of mollusks of the Southern California coast," *Biol. Bull.*, 75: 224–237 (1938).

Marvin, K. T., C. M. Lansford and R. S. Wheeler, "Effects of copper ore on the ecology of a lagoon," *U.S. Fish and Wildl. Serv. Fish. Bull.*, 61: 153–160 (1961).

McKee, J. E., and H. W. Wolf, *Water Quality Criteria*, California State Water Quality Control Board, Publ. No. 3–2 (1963).

Raymont, J. E. G., and J. Shields, "Toxicity of copper and chromium in the marine environment," pp. 275–286 in *Advances in Water Pollution Research*, vol. 3, ed. by E. A. Pearson, Macmillan and Company, N.Y., N.Y., 1964.

Starr, T. J., and M. E. Jones, "The effect of copper on the growth of bacteria isolated from marine environments," *Limnol. Oceanog.*, 2(1): 33–36 (1957).

The applicant will be required to conduct additional onsite chlorine studies to determine the acute and chronic impacts on both entrained and receiving water marine life. These studies shall start prior to operation of the first unit and continue for at least one year after operation of both units.

(2) Copper. Table 3.9 (Section 3) indicates the copper content of seawater to range from 1 to 10 ppb.

The effects of copper on a number of marine organisms are shown in Table 5.9. At the immediate outfall of the Diablo Canyon Plant, the concentration of copper released from tubing corrosion was estimated in Section 3.5.1 to be approximately 6 ppb. Within a 6-acre area immediate to the outfall, the concentration of copper will be reduced to 3.0 ppb, and within an area of 80 acres the concentration will be reduced to 1.2 ppb. In view of the naturally occurring concentrations of copper in seawater, the estimates of copper concentrations which result from plant releases, and the available information on effects of copper on marine organisms, no adverse effects are expected by the staff. However, because of the potential buildup of copper in the food chain, the staff recommends that the applicant conduct copper buildup studies of the marine life in Diablo Cove for the life of the station or until it can be shown that there is no buildup.

(3) Nickel. The estimate of the addition of nickel to Diablo Cove is 9×10^{-4} ppm (Section 3.5). Nickel is concentrated by organisms by factors ranging from 100 to 100,000.[13] Marine plants contain up to 3,000 ppb, and plankton concentrations may be higher. Four hundred parts per billion has been found in marine animals.[14] Results of nickel tolerance tests are shown in Table 5.10.

Nickel concentrations in seawater are expected to be between 0.1 and 6 ppb, and 2 to 3 ppb is the most probable range.[15] Since the amount added by the plant is less than 1 ppb no adverse effects are expected.

(4) Chromium. Chromium is expected to be discharged at approximately 6×10^{-5} ppm in the effluent (Section 3.5).

Table 5.11 shows the results of a number of investigations on the tolerance of marine organisms to chromium. The amount to be released from the Diablo Canyon Plant, Units 1 and 2, is not expected to have any impact on the marine ecology in the cove.

(5) Sodium Hydroxide, Sulfuric Acid. The toxicity of these compounds is related to their ability to alter pH. Because of the

Table 5.10. Effects of nickel on two marine organisms

Species	Concentration (ppm)	Effect (duration of exposure)	Reference
Fundulus hetenclitus (killifish)	100.0	Tolerated (2 weeks)	Doudoroff
	200.0	Tolerated (1–2 weeks)	
Marcocystis pyrifera (giant kelp)	1.31	No effect	McKee
	13.1	50% photosynthesis 4 days reduction	

Doudoroff, P., and M. Katz, "Critical review of literature of industrial wastes and their components to fish. II. The metal as salts," *Sewage Industr. Wastes,* 25: 802–839 (1953).

McKee, J. E., and H. W. Wolf, *Water Quality Criteria,* California State Water Quality Control Board, Publ. No. 3–2 (1963).

Table 5.11. Chromium tolerance in marine organisms

Species	Concentration (ppm)	Effect (duration of exposure)	Reference
Carcinus maenas (shore crab)	40.0–60.0	Non-toxic (12 days)	Raymont
Fundulus heteroclitus (killifish)	200.0 ppm	Non-toxic (12 days)	Doudoroff
Macrocystis pyrifera (giant kelp)	1.0 ppm	10–20% reduction 5 days in photosynthesis	McKee
Nereis virens (polychaete worms)	0.2 ppm	No effect (2 weeks)	U.S. Dept. Interior

Doudoroff, P., and M. Katz, "Critical review of literature of industrial wastes and their components to fish. II. The metal as salts," *Sewage Industr. Wastes*, 25: 802–839 (1953).

McKee, J. E., and H. W. Wolf, *Water Quality Criteria*, California State Water Quality Control Board, Publ. No. 3–2 (1963).

Raymont, J. E. G., and J. Shields, "Toxicity of copper and chromium in the marine environment," pp. 275–286 in *Advances in Water Pollution Research*, vol. 3, ed. by E. A. Pearson, Macmillan and Company, New York, N.Y., 1964.

U.S. Dept. Interior, Water Quality Criteria, Federal Water Pollution Control Administration, Washington, 234 p., 1968.

buffering capacity of the dilution water, discharges of these substances are not expected to alter the pH appreciably, as indicated by pH measurements made during releases of these chemicals from the Indian Point Unit 1 on the Hudson River.[16]

(6) Sodium Sulfate, Calcium, and Magnesium. These elements will be discharged in quantities that are minute compared with concentrations in natural seawater. No impact is anticipated.

(7) Sodium Phosphate. The toxicity of phosphates has been discussed,[17] and *Daphnia magna* was found to be the most sensitive organism studied, being affected by levels above 50 ppm. Most other organisms were much less sensitive. The quantities of sodium phosphate to be released are well below toxic levels and will be an insignificant contribution to nutrient enrichment of Diablo Cove.

(8) Hydrazine. Since no hydrazine will be present in the discharge, no further consideration is given to possible effects on the Diablo Cove ecosystem.

(9) Boron. While boric acid and other boron compounds can have a lethal effect on aquatic life, the concentrations required to elicit such responses are usually parts per thousand.[17] Since boron concentrations have been estimated (Section 3.5.3) to be orders of magnitude below such concentrations, any effect of boron releases is judged to be completely negligible in comparison with naturally occurring concentrations in seawater.

Dissolved Oxygen

Analyses at California power stations[18] have demonstrated that dissolved-oxygen concentrations were not decreased in passing through the cooling water system. Rather, the water merely became supersaturated with oxygen. As the temperature of the effluent dropped in the mixing zone, saturation values dropped correspondingly, with little loss of dissolved oxygen. The staff concludes in view of the above information and data given in Section 3.3.3 that there is no significant reduction in dissolved oxygen to be expected from operation of the Diablo Canyon Plant.

Effects of Temperature

Biological effects associated with temperature or temperature patterns may vary according to age of individuals, life cycle stages, temperature history of the individuals tested, and effects of other environmental factors.[19]

Generally, marine organisms can tolerate only a narrow range of temperatures (stenothermal) compared with freshwater or estuarine species. Naylor[20] noted that estuarine species were more tolerant of heated effluents than marine forms and concluded that some cold-water stenothermal species may be eliminated by heated discharges, while species able to tolerate a wide range of temperatures (eury-thermal) may be increased.

Based on the analyses described in Section 3, the cooling water discharge from Units 1 and 2 at Diablo Canyon can be expected to raise the surface water temperature 10°F (5.6°C) to 19°F (10.6°C) above ambient over an area of 5 acres. The temperature isotherm of 4°F (2.2°C) above ambient is predicted to enclose a surface area of 68 acres; therefore the 4°F (2.2°C) isotherm is expected to extend outside the cove. However, the 5°F (2.8°C) isotherm is within the cove.

Normal monthly average, maximum, and minimum temperatures for Diablo Cove are given in Tables 5.12 and 5.13. It can be noted from Tables 5.12 and 5.13 that the minimum temperature recorded at Diablo Cove was 45°F (7.2°C) and the maximum temperature was 63.5°F (17.5°C). Therefore, the water temperature at the point of discharge may become 82.5°F (28.1°C) during normal operation. Another 5 acres may be heated above 73.5°F (23.1°C), and 25 acres will be elevated above 68.5°F (20.3°C). The projection of the anticipated plume in relation to zones of plant growth is shown in Figure 5.2.

The impact of the thermal discharge at Diablo Canyon on aquatic organisms will affect the following community types as to species composition and ecological relationships:

(1) Phytoplankton and macroalgae
(2) Invertebrates (zooplankton and benthic communities)
(3) Fish

(1) <u>Phytoplankton and Macroalgae</u>. (a) <u>Phytoplankton</u>. Experiments have been carried out to determine the effect of temperature on the composition of plankton populations.[21] In addition, tolerance limits are known for many of the phytoplankton species (see Tables 5.14 and 5.15). Examination of the temperature tolerance limits indicates that for the species listed, the temperature resulting from the operation of Diablo Canyon would not result in losses, assuming that the tolerance limits of the phytoplankton in Diablo Cove are similar to those in Tables 5.14 and 5.15.

Table 5.12. Monthly average, maximum, and minimum temperatures recorded at Diablo Cove, 1967–1968

Month	Minimum (°F)	Maximum (°F)	Average (°F)
March 1967	49	54	51.22
April 1967	48	55	50.45
May 1967	48	54	50.29
June 1967	47.5	53	49.59
July 1967	49	55	52.30
August 1967		No data	
September 1967	57	62	59.70
October 1967		No data	
November 1967	60	63	61.40
December 1967	50	61	55.52
January 1968	51	56	53.6
February 1968	51	55.5	53.1
March 1968	51	56	53.2
April 1968	51	56	53.4
May 1968	51	55.5	53.1
June 1968	51	56	53.5
July 1968	52	56	54.2
August 1968	53	61	56.7
September 1968	57	62	59.6
October 1968	58	63	61.0
November 1968	53	63	59.4
December 1968	52	61	56.2
1969		Data unavailable	

Table 5.13. Monthly average, maximum, and minimum temperatures recorded at Diablo Cove and South Cove, 1970–1971

Month	Diablo Cove			South Cove		
	Minimum (°F)	Maximum (°F)	Average (°F)	Minimum (°F)	Maximum (°F)	Average (°F)
1-70						
2-70				50	53	
3-70				50	54	52.38
4-70				47	53.5	50.05
5-70	51	55	52.00	46	55	49.61
6-70	51	57	54.31	48	54	51.28
7-70	52	58.5	55.61	49	56	52.08
8-70	52	58.5	55.74	50.5	57	54.07
9-70	53.5	60	55.85	52	59	54.95
10-70	56	60	57.87	53.5	59	56.72
11-70				52	59	54.53
12-70				54	55.5	54.90
1-71	52.5	54	53.17			
2-71	45	54	50.62	49.5	52	50.22
3-71	45	53	48.84	49	53	50.72
4-71	47.5	53	50.41	48	52.5	50.84
5-71	48.5	54	51.37	47	52	49.48
6-71	49.5	55.5	51.86	48	59	52.63
7-71	52	54	53.00	51	58.5	53.64
8-71				52	63.5	57.70
9-71	53	55	54.08	53	62.5	57.83
10-71	49	57	54.35	51	58	55.14
11-71	51	55	53.21	51.5	55.5	53.86
12-71				49	54.5	51.98

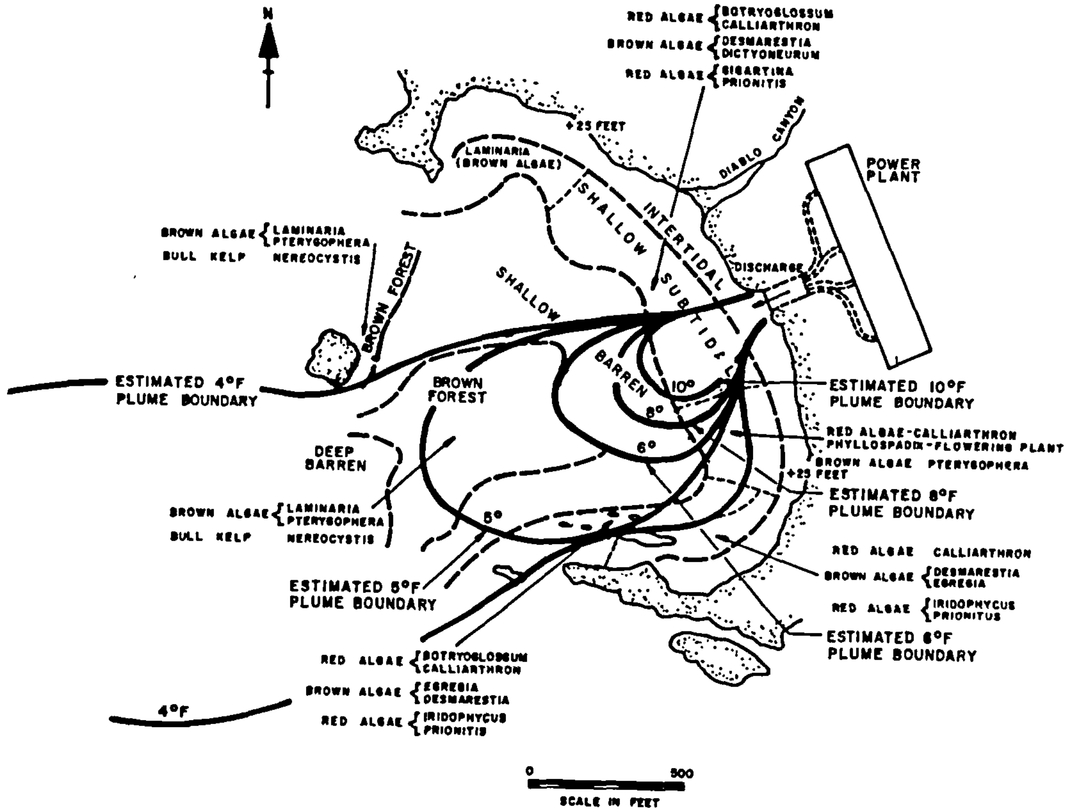


Fig. 5.2 Overlay of high tide isotherms shown in Fig. 3.9 on the location of principal plant species observed at Diablo Canyon.

Table 5.14. Thermal tolerance limits of various marine phytoplankton, algae, and marine plants

Species	Tolerance limit (°C)	Time of exposure (hr)	Acclimation temperature (°C)
Enteromorpha compressa	35.0	12	
Rhizoclonium hookeri	35.0		
Ulva lactuca	30.0		
	35.0		
Valonia macrophysa	31.2 ± 0.2	3 days	23
Penicillus capitatus	31.0	5 days	23
Dictyosphera cavernosa	33.0–34.0	Sustained	23
Chlamydomonas sp.	32.0–35.0		
Chlorella sp.	32.0–35.0		
Dunaliella euchlora	39.0		
Nannochloris	40.0		
Platymonas sp.	35.0		
Protococcus sp.	26.0		
Protococcus sp.	35.0		
Chaetoceros	41.0		
Detonula confervacea	16.0		
Melosira sp.	27.0–30.0		
Nitzschia laevis	30.0		
Phaeodactylum tricornutum	29.0–35.0		
Isocrysis galbana	27.0–35.0		
Monochrysis lutheri	29.0–35.0		
Gymnodinium	32.0–34.0		
Dictyota dichotoma	27.0		
	32.0		
D. divaricata	32.0		
Pylaiella littoralis	30.0		
Ascophylum nodosum	39.3–41.5		
Fucus serratus	39.0–40.7		
F. vesiculosus	41.6–42.5		
	41.9		
Porphyra umbilicans	30.0		
Callithamnion hookeri	30.0	12	
Polysiphonia elongata	27.0	12	
P. ferrulacea	35.0	12	

Adapted from General Dynamics Electric Boat Division, "Potential Environmental Effects of an Offshore Submerged Nuclear Power Plant," published by the Environmental Protection Agency, Water Quality Office, June, 1971.

Table 5.15. Temperature data on some phytoplankton and algae

R: Range of occurrence; L: Lethal limit; E: Experimentally determined; O: Optimum

Name	Temperature (°C)
Phytoplankton	
Phytoplankton (gen. inform.)	10.5–14 (E)
Amphidinium cortesi	18–33 (R)
Asterionella japonica	<30 (L), 20–25 (O)
Chaetoceros curuisetus	17–18 (E)
Chaetoceros gracilis	11–41 (R), 23–37 (O)
Chaetoceros lacinisosus	17–18 (E)
Dunaliella tertiolecta	11–36 (R) 39 (L)
Eucampia zoodiacus	17–18 (E)
Isocrysis galbana	
Monochrysis lutheri	8–<30 (R) 14–25 (O) 20–35 (L)
Nitzschia closterium	8–<27 (R) 18–20 (E)
Prorocentrum micans	5–30 (R)
Phaeodactylum tricornutum	9–25 (R)
Rhizosolenia setigera	5–25 (R), 5–20 (E)
Skeletonema costatum	5–30 (R), 37–40 (L)
Skeletonema tropicum	13–31 (E)
Thalassiosira nordenskjoldii	<2–19 (R)
Dinoflagellates (gen. inform.)	14.2–39, –1.39–12.22
Macroalgae	
Bossea	
Chlamydomonas reinhardi	6–28, 18–28 (O)
Macrocystis	15–17 (E),
Nereocystis luetkeana	16–18 (E)

Adapted from Oregon State University, "Oceanography of the Near Shore Coastal Waters of the Pacific Northwest Relating to Possible Pollution," vol. 1, published by the Environmental Protection Agency, Water Quality Office, July 1971.

While information on phytoplankton has not been collected for Diablo Cove, the species of phytoplankton on this portion of the Pacific Coast have a wide distribution. Phytoplankton doubling rates have been estimated to be 0.5 to 3 per day off southern California.[22] The staff does not expect the doubling rates at Diablo Canyon to be substantially less than for southern California.

The staff has concluded that even though some forms of plankton are killed by entrainment in the cooling system or elevated temperature near the discharge, the presence of more tolerant forms, the high rate of reproduction, and the recruitment from phytoplankton outside the affected areas should result in very little change in the abundance of phytoplankton.

(b) Macroalgae. Only a few members of the marine macroalgae have a well-known thermal response. The commercially important *Macrocystis pyrifera* has been studied extensively off southern California.[23] It occurs in the Pacific Northwest but is less abundant, and *Macrocystis integrifolia* tends to replace it. Studies of temperature, light requirements, effects of turbidity, nutrients, effects of predation, and *in situ* growth rates have been attempted.

Even though little information has been collected describing the effects of temperature on *Nereocystis luetkeana* (see Appendix 2-6), studies on giant kelp, *Macrocystis pyrifera*, indicate that water temperature in excess of 68°F (20.0°C) may cause a decrease in existing beds.

In southern California, mature *Macrocystis pyrifera* can exist without adverse effects at surface seawater temperatures of up to 62-68°F (16.7-20.0°C).[24] A continuous temperature of 68°F can be withstood for one month, while a surface temperature of 72°F (22.2°C) results in the deterioration of tissues.

The intake cove temperatures at Diablo Canyon are expected to reach lows of 45°F (7.2°C) in March and highs of 63.5°F (17.5°C) in the late summer and fall. The areas of isotherms are given in Table 3.2 for operation of both units. Therefore, when the ambient temperature is 63.5°F (17.5°C), an area of 25 acres [5°F (2.8°C) isotherm] can be above 68.5 F (20.3°C) during a few hours of high tide each day. This will be within Diablo Cove. This temperature will decrease to 67.5°F (19.7°C) within an additional 43 acres [4°F (2.2°C) isotherm acreage less 5°F isotherm acreage] outside of Diablo Cove. The areas of isotherms will be less at low tide. The thermal plume will be in contact with the ocean floor within 900 ft of the discharge point during high tide and within 1200 ft during low tide. Since the mouth of the cove is roughly at 1200 ft from the discharge point and since the ocean depth is increasing, the thermal ıme will be well above the ocean floor outside of Diablo Cove. :ther, the temperature decreases from a maximum on the ocean rface to ambient at the bottom of the thermal plume. Therefore, .side of the cove, the benthic organisms and portions of the dom- ınt alga *Nereocystis* sporophyte would not be subjected to the nperature elevation. Outside the cove, only the tops of the kelp ıld be affected, and this could cause a reduction in the canopy thin the 4°F (2.2°C) isotherm (Appendix 2-6). This decline would ıse the deterioration of the canopy to occur earlier than normal .d would provide additional food to the abalone before the onset the winter storms. Because of the turbulence in the open ocean, ə staff does not believe that kelp outside the cove will be versely affected, since only the ocean surface temperatures would altered. Within the cove, however, some kelp may be affected. is difficult to determine whether the impact of the release of ·ated water will be adverse. The scouring caused by the plume (if : touches the bottom) may enable better attachment by the kelp. Also, .e recently reported increased growth of *Nereocystis* near the intake[25] ıy cause many of the zoospores released near the intake to be carried ıd dispersed by the cooling water flow. This may cause an increase ı the kelp within the cove. Because of these opposing possibilities, ıe staff is unable to determine whether the net effects of the cooling ıter discharge on kelp are adverse or beneficial, and concludes hat any detrimental effects will be limited to the interior of he cove. As will be discussed later, bull kelp may decline as a esult of the increased feeding activity of the giant red urchin (*Strongylocentrotus franciscanus*).

(2) Invertebrates. (a) Zooplankton. Different investigators ıave studied the effects of passing zooplankton through the cooling ɹater system of thermal power plants.[26-30] In general, the results ıave been similar to Hair's work with the opossum shrimp, *Neomysis waatchensis*, in that each species has an upper thermal limit, for short-term exposures, that cannot be exceeded. This upper thermal imit for the opossum shrimp was 87°F (30.6°C) for a 6-min exposure, 88°F (31.1°C) for a 4-min exposure, 89°F (31.7°C) for a 2-min expo- sure, and 90°F (32.2°C) for an instantaneous exposure.[26] Values for other species are given in Tables 5.16 and 5.17. Species listed either exist in the vicinity of Diablo Cove or are the nearest re- lated species for which data could be found.

Studies conducted at San Onofre Nuclear Power Plant indicated an average mortality of 12.7% (most of which were copepods and nysids).[28] Additional studies have been conducted at the applicant's power plants located at Morro Bay and in Monterey Bay. The techniques have been described by Icanberry and Richardson.[31] Based on infor- mation gained from these studies, a mortality of as much as 8.5%

Table 5.16. Thermal tolerance for some marine invertebrates

Class	Species	Tolerance limit (°C)	Time of exposure (hr)	Acclimation temperature (°C)	Size or life stage
Ophiuroidea	*Ophioderma brevispinum*	40.5	9 min		
		37.0	28 min		
Ascidiacea	*Asterias forbesi*	42.0	9 min		
		36.0	9 min		
		32.0	43 min		
	A. vulgaris	32.0	1° increase/5 min	20	
Echinoidea	*Arbacia punctulata*	42.0	9 min		
		38.0	45 min		
		37.0	89 min		
	Echinus microtuberculatus	39.1			
	Lytechinus varigeatus	37.7		24.6–25.1	
	L. anamesus	31.5	1		
	Strongylocentrotus franciscanus	29.5	1		
	S. purpuratus	29.5	1		
	S. lividus	40.7			
Chaetognatha	*Sagitta elegans*	25.5–27.5	1° increase/5 min	20	
Merostomata	*Limulus polyphemus*	46.2		30	
		41.0		22	
		41.0		16	
Malacostraca	*Allorchestes littoralis*	34.5–35.0	1° increase/5 min	20	
	Asellus aquaticus	43.5			
	Calliopius laeviusculus	26.7–29.7	1° increase/5 min	20	
	Cancer irroratus	32.0–33.2		20	
	Carcinus maenas	38.0			
	Corophium volutator	36.5–37.5	1° increase/5 min	20	
	Callinectes sapidus	38.7	48	30	Adult
		36.9	48	22	
		34.7	48	14	
		33.1	48	6	
		39.0	48	30	Juv 40–60 mm
		39.0	48		Juv 40–60 mm
		39.0	48	22	Juv 40–60 mm
		35.3	48	14	Juv 40–60 mm
		33.0	48	6	Juv 40–60 mm
	Cragon septemspinosus	31.0–33.0	24	25–35	Adult
		28.0	24	15	Adult
		30.0–32.5	1° increase/5 min	20	
	Gammarus locusta	32.2–34.8		20	
	G. marinus	30.1–32.5		20	
	G. roselii	36.0			
	G. morroculodes	29.0	24	15	Adult
	Homarus americanus	<26.0	Sustained		
		32	22 days	27.5	
		29.5		25.0	
		28.2		15	
		22.1		5	
		32.5		15	Stage 3
		34.2		25	Stage 4
		34.0		15	Stage 4
		34.9		20	Stage 5
		33.4		15	Stage 5
	Mysis stenolepis	27.5–29.5		20	
	Neomysis americana	31.0–33.0	24	25–35	Adult
		25.0	24	15	Adult
		16	24	1	Adult
		20	24	5	

Table 5.16. (continued)

Class	Species	Tolerance limit (°C)	Time of exposure (hr)	Acclimation temperature (°C)	Size or life stage
	Orchomenella pinguis	27.5	1° increase/5 min	20	
	Pagurus acadianus	29.6–32.0		20	
	P. prideauxii	36.0			
	Palaemonetes vulgaris	42.0	4 min		
		37	9 min		
		34	52 min		
	P. intermedius	36.5	5 days	30	Gravid female
		37.0	2 min		
	Pandalus montagui	22.8–27.8	1° increase/5 min	20	
	Paneus duorarum	30.9–31.9	Sustained	30	Nauplii
		~37.0	Sustained		Adult
	Palaemonetes pugio	35.0–38.3	24	25–35	Adult
	Periclemenes americanus	34.2	5 days	30	Adult
		37.0	2 min		
	Panuilirus interruptus	38.0	Sustained		
	Pugettia producta	32.5	1		
	Rhithropanopeus harrisi	35.0–38.3	24	25–35	Adult
		33.0	24	15	Adult
	Taliepus nuttali	32	1		
	Uca pugilator	46.0	5 min		
		41.0	18 min		
		40.0	82 min		
Cirripedia	*Balanus balanoides*	45.3			
	B. perforatus	47.0			
	Chthamalus stellatus	53.7			
	Eliminus modestus	49.5			
	Lepas fasicularis	42.3		29	
Copepoda	*Acartia tonsa*	35.5	3	25	Adult
		>30.5	Brief		
	Calanus finmarchicus	26.5–29.5	1° increase/5 min	20	
	Eurytemora affinis	30.0	12	25	Adult
Branchipoda	*Alonia affinis*	40.5			
	Eurycercus lamellatus	35.0			
Polychaeta	*Eunice fucata*	42.7		29	4–5 days old
	Hydroides dianthus	>30.0	31 days		Adults
		>32.0	7		Larvae
	Tomopteris catharina	31.6	1° increase/5 min	20	
Cephalopoda	*Octopus vulgaris*	36.0			
Pelecypoda	*Astarte undata*	33.5	1° increase/5 min	15	
	Crassostrea virginica	47.5	Rapid inc.	24	
		41.0	Slow inc.	24	
		48.5			Adults
		33.0	8	27	Egg and larva
	Gemma gemma	35.0–38.3	24	25–35	Adult
	Hiatella rugosa	32.8	1° increase/5 min	15	
	Mercenaria mercenaria	45.2		15	
	Musculars discors	31.9		15	
	M. nigra	34.9		15	
	Nuculana tenuisulcata	31.5	1° increase/5 min	15	
	Mytilus edulis	40.8			Adult
		28.0	20–100	Variable	Adult
	Pandora trilineata	33.5	1° increase/5 min	15	
	Placopecten magellanicus	23.5		Summer	
	Spisula solidissima	37.0		Nat. water 15	

Table 5.17. Physical data on invertebrates

A	Adult	E	Experimental
J	Juvenile	R	Range
L	Larva	N	Natural or "in situ"
E	Egg	O	Optimum
L	Lethal	T	Tolerance level

Name	Age class	Temperature	Salinity (parts per thousand)
Coelenterata			
Actina equina		41.5–43.5°C (L)	
Aequoria aequoria		0.1–11°C (E)	
Gonionemus		20–30°C (O) (R)	
Ctenophore			
Beroe ovata	A	34.2–36.4°C (L)	
Kinorhyncha			
Echinoderes pennaki	A	16°C (N)	
Crustaceans			
Branchiopoda			
Evadne normanni	A	6–18.5°C (R)	2–35.47
Pondon polyphemoides	A	2.46–19.8°C (R)	1.05–35.1
Copepods			
Calanus finmarchicus	A	0°–10°C (R)	
Ismalia montrosa	A	15°–16°C (N)	
Tigriops californicus	A	?–39°C (R)	2–90 (R)
			90–175 (L)
Decapods			
Cancer gibbocuius	A	9.7–11.5°C (R)	33.9 (N)
Cancer magister	A	38–75°F (R)	11–32 (R)
	J		<10 (R)
	L	71°F (L)	20 (L)
		50–57°F (O)	25–30 (O)
		6.1–21.7°C (L)	
		10–17.8°C (O)	
Cancer oregonensis	A	11.5–13°C (E)	
		24–30°C (L)	
Cancer productus	A and L	11°C (adult spawned and larvae reared)	33 ± 1 (E)
		11.5–13°C (E)	
		30°C (L)	
Crangon alaskensis elongata	A	9.3–12.2°C (R)	33.8–34.3 (R)
		24–27 (L)	
Crangon munita	A	11.5–13.0°C (E)	
		24–26°C (L)	
Crangon munitella		11.0–13.5°C (R)	26.6–31.6 (R)
Crangon communis	A	11.5–13.0 (E)	
		24°C (L)	
Crangon spinosissima		9.3–11.4°C (R)	33.8–34.3 (R)
Hemigrapsus nudus	A	11.5–13.0°C (E)	4–8 (R)
		24°C (L)	
Pagurus samuelis	L	17–18°C (E) reared	
Pandalis dana	A	11.5–13.0°C (E)	
		24–30°C (L)	
Pandalus jordani	L	13 ± 0.2°C (reared)	
	E	50–54°F (hatching)	7.8–24.1 (R)
		13 ± 0.2°C (O)	
Petrolistles eriomerus	A	11.5–13°C (E)	
		24°C (L)	

Table 5.17 (continued)

Name	Age class	Temperature	Salinity (parts per thousand)
Pugettia gracilis	A	11.5–13°C (E)	
		24–30°C (L)	
Spirontocaris cristata		7.6–19.4°C (R)	22.5–34.3 (R)
		13.8–14.6°C (N)	20.8–32.2 (N)
Spirontocaris gracilis		9.6–9.8°C (N)	34.2–34.3 (N)
Barnacles			
Balanus crenatus	A	7.6–8.6°C	
Mollusca			
Acmea digitalis		42°C	
Acmea persona		3.4–31°C (R)	
Acmea scabra		42°–44°C (L)	
Adula californiensis			
Callistoma costatum		60°C air temp.	
		10–13°C (N)	
Crassostrea gigas		10–20° (N)	
Crassostrea virginica	A	10 & 20° (N)	
Littorina (gen)			
Littorina scutulata		34–36.5°C lower limit	16–20 lower limit
Littorina sitkana		34–36.5 (R)	16–20
Mytilus edulus		82–106°F (L)	
		77°F (O)	
Mytilus californianus	A	7°–28°C (R)	17–45 (R) well studied
		15–20°C (O)	12 & 55 (L)
Mytilus californianus	L		>21.5
Octopus vulgaris		33.7–36.0°C	
Ostrea edulis		15°C gametogenesis	
Placopecten magellanicus		21.0–23.5°C (L) upper lethal raise °C/5°C inc. in acclimation temperature	
Pododesmus cepio		15°C (gametogenesis)	
Pterotrachea cornata		39.2–42.5°C (L)	
Tegula fundbralis		60°C air	
		10–13°C (N)	
Echinodermata			
Pisaster ochraceous		10–16°C (N) (R)	
		12–18°C	
		21°C (T)	
Strongylocentrotus franciscanus		7.4°C (N)	
Strongylocentrotus purpuratus	A	8–23.5°C (R) lab	
		25°C (L)	
Strongylocentrotus purpuratus	E	13–20°C (R)	
		25°C (L)	
		5°C and 30°C no fertilization	

Adapted from Oregon State University, "Oceanography of the Near Shore Coastal Waters of the Pacific Northwest Relating to Possible Pollution," vol. 1, published by the Environmental Protection Agency, Water Quality Office, July 1971.

of the organisms passing through the cooling system may be expected when temperatures exceed 76°F (24.4°C) (11% of the time).[32] On this basis, the staff estimates that up to 91,000 lb of zooplankton might be lost per year from operation of the plant.

Preliminary studies of delayed mortality to zooplankton have shown that no significant differences exist between zooplankton samples from the discharge and from the intake when both were incubated at intake temperature.[25-28]

The impact on pelagic holoplankton will be insignificant for those species with short generation times. (The generation times for California zooplankton are generally 24 hr[33] to 8 weeks.[34]) Recruitment from the open ocean will occur, and the mortality is expected to be low.

The impact on meroplankton, however, is less certain. The staff has concluded that no accurate way of predicting the impact now exists. Since most of the species found in Diablo Cove and in South Cove are not known to migrate, it can be expected that changes in populations of organisms will be largely confined to the immediate area near Diablo Cove.

(b) Benthic Communities. The discharge of heated water from the Diablo Canyon Nuclear Plant is expected to result in replacement communities in the area between the 10°F (5.6°C) isotherm and the area of ambient conditions. This concept was discussed by Naylor,[20] who concluded that artificially heated areas were invaded by warm-water-tolerant organisms that could live in the thermally altered water. Study of the effects of thermal discharge on the marine environment has been carried out at the applicant's Morro Bay Power Plant (a 1030-MW natural-gas-fired plant with a ΔT of 20°F). Adams[35] has concluded that the aquatic community had returned to normal within 500 ft of the discharge at the Morro Bay Power Plant, which is 10 miles north of the Diablo Canyon site. This area between the point of discharge and the point where no effects could be noticed is an area of transition characterized by more warm-water species. At Morro Bay, the area showing response to the thermal discharge was only 1-1/2 acres, although a definite temperature elevation could be observed over a 50-acre area. Thus a transition community occurs only within this small zone at Morro Bay (see Table 5.18). Since the maximum temperature rise at the Morro Bay Power Plant is the same as that at Diablo Canyon (and the absolute temperatures are nearly equal), the staff concludes that the impact on benthic communities at Diablo Canyon will be somewhat similar to that at Morro Bay, where an increase in warm-water-tolerant forms was observed in the small transition area. Although the transition area at Morro Bay was only 1-1/2 acres, it is expected

Table 5.18. Plant and animal species observed in the vicinity of the Morro Bay discharge canal during survey 3

Species	Discharge canal	Transitional region	Normal region
Plant species			
Chlorophyta			
Codium setchellii			x
Ulva sp.			x
Phaeophyta			
Laminaria setchellii		x	x
L. sinclairii			
Rhodophyta			
Aeodes gardneri			x
Agardhiella coulteri			x
Ahnfeltia plicata			x
Calliarthron cheilosporiodes			x
Callophyllis flabellulata		x	x
C. heanophylla			x
Cryptopleura violacea			x
Gelidium robustum			x
G. coulteri			x
Gigartina volans			x
Gracilariopsis sjoestedtii		x	x
Gymnogongrus leptophyllus			x
Hymenena flabelligera			x
Iridaea flaccida			x
I. lineare		x	x
I. splendens			x
Laurencia gardneri			x
Melobesia marginata		x	
Peyssonelia pacifica		x	x
Plocamium coccineum			x
Polyneura latissima			x
Polysiphonia brodiaei			x
Prionitis lanceolata		x	x
P. linearis			x
Pterosiphonia dendroidea		x	x
Ptilota densa			x
Rhodymenia pacifica		x	x
Schizymenia epiphytica			x
Spermatophyta			
Phyllospadix torreyi		x	x
Total number of plant species	0	10	30
Animal species			
Porifera			
Acarnus erithacus			x
Ficulina suberea		x	x
Haliclona permollis		x	x
Lissodendoryx firma		x	x
Plocamia karykina			x
Rhabdodermella nuttingi		x	x

Table 5.18 (continued)

Species	Discharge canal	Transitional region	Normal region
Coelenterata (Hydrozoa)			
Sertularia sp.		x	
Tubularia sp.	x		
Coelenterate (Anthozoa)			
Anthopleura artemesia		x	x
A. elegantissima	x	x	x
A. xanthogrammica	x	x	x
Corynactis californica			x
Epiactis prolifera	x		
Tealia sp.			x
Bryozoa			
Bugula sp.	x		
Rhynocozoon rostratum		x	x
Annelida			
Diopatra ornata			x
Eudistyla polymorpha			x
Phragmatopoma californica			x
Phyllochaesopterus prolifica	x		
Spirabranchis spinosus			x
Mollusca (Gastropoda)			
Acmaea limatula	x		
A. mitra			x
A. pelta	x		
A. scabra	x		
Aeolidia papillosa	x		
Anisodoris nobilis			x
Archidoris monteryensis			x
Diaulula sandierensis	x		
Hermissenda crassicornis	x	x	x
Mitrella sp.			x
Olivella biplicata			x
Phidiana niger			x
Rostangia pulchra			x
Tegula funebralis	x		
Mollusca (Pelecypoda)			
Chama pellucida	x		
Mytilus californianus			x
M. edulis	x		
Pododesmus macroschisma	x	x	x
Arthropoda			
Balanus glandula	x		
B. tintinnabulum	x		
Cancer sp.	x		
Chthamalus fissus	x		x
Pollicipes polymerus			x
Pachygrapsus crassipes	x		
Echinodermata			
Leplasterias aequalis		x	
Pisaster brevispinus			x
P. giganteus			x
P. ochraceous	x	x	x

Table 5.18 (continued)

Species	Discharge canal	Transitional region	Normal region
Chordata (Tunicata)			
Amaroucium sp.		x	
Botrylloides diegensis	x		
Didemnum carnulentum			x
Euherdmania claviformis			x
Perophora annectans		x	
Polyclinum planum		x	x
Sigillinaria pulchra			x
Styela montereyensis			x
Chordata (Pisces)			
Unidentified atherinid	x	x	
Embiotoca jacksoni	x		
E. lateralis		x	x
Girella nigricans	x	x	
Hexagrammos decagrammus		x	x
Hypsurus caryi			x
Ophiodon elongatus		x	x
Paralabrax clathratus (juveniles)	x		
Phanerodon furcatus		x	
Platyrhinoides triseriatus			x
Rhacochilus vacca		x	x
Scorpaena guttata			x
Scorpaenicthys marmoratus			
Total number of animal species	27	23	44

Source: applicant's Environmental Report.

that the transition area at Diablo Cove will be larger, but it should not exceed 10 acres. A good discussion of these changes can be found in the applicant's Environmental Report[2] (pages IV-E-32 to IV-E-56).

Exact comparison between the two areas is not possible because many of the benthic invertebrate species found in Diablo Cove were not found in Morro Bay. Also, not one species of *Sebastes* was listed in ER Table 5-18 for Morro Bay, while at Diablo *Sebastes* were the most abundant of the fish (Table 5.21). Of especial importance, several of the more important brown algae, serving as food for abalone, were not found at Morro Bay.

The principal species of concern in the vicinity of Diablo Canyon is the abalone. Because of the close relationship between the abalone and the kelp, concern has been expressed that a reduction in the abundance of kelp could affect the abundance of the abalone.

The harvesting of red abalone (*Haliotis rufescens*) by divers is the most important commercial fishing activity in the vicinity of Diablo Cove. In the cove, both North et al.[23] and Ebert[36] found the highest densities of red abalone in the deep water (50 to 60 ft) approximately 600 to 700 ft southwest from the discharge structure, where the major forage plant species were low-growing brown algae.

Burge and Schultz (applicant's Environmental Report, Supplement 2, Vol. II, Appendix T), however, found that the habitat for abalone declined with depth. They suggested that the nearshore area from 0 to 20 ft was the most important area for the red abalone and that smaller beds were found in depths of 20 to 50 ft. The density of red abalone at Station 16 of the California Department of Fish and Game (south side of Diablo Cove) averaged 1.08 red abalone per square meter for 1970. The average for four seasons was 1.29 red abalone per square meter.[25] Station 16 was representative of the 5-to-10-ft zone.

Black abalone (*Haliotis cracherodii*) were found to be among the most common animals in the intertidal zone, averaging two to four black abalone/m^2 for 1970 in the two stations in Diablo Cove. The staff believes that over half of the intertidal zone will be altered by the effluent plume. If reduction in species diversity occurs as at Morro Bay Power Plant, the species of algae normally associated with black abalone grazing will be reduced. This may result in a loss of as much as 70,000 black abalone, since abalone are not thought to migrate significantly. The staff does not believe there will be reduction in black abalone outside the cove resulting from the discharge of heated water. Stations outside the cove have higher densities of black abalone than stations inside the cove, and thus the staff does not consider the impact to be serious since the shutdown of the plant would allow the black abalone to re-establish in the cove.

Total loss of abalone is estimated at 110,000 abalone (assuming that algae will be reduced in an area equal to one-half the cove and that this reduction will produce a corresponding decrease in abalone within the cove).

A more complete discussion of the relationship between temperature, abalone life history, and temperature effects is given in the applicant's Environmental Report[2] (pages IV-E-52 to IV-E-56) and in this Statement (Appendix 2-6).

Two urchins, the giant red urchin (*Strongylocentrotus franciscanus*) and the purple urchin (*S. purpuratus*), are also important benthic organisms which graze on the kelp. *S. purpuratus* has been linked to the decline of kelp forests in southern California and can be considered a competitor of the abalone.

Critical and optimum temperatures for the abalone, kelp crab, and the urchins are given in Table 5.19. It can be noted that the urchins are less tolerant of high temperatures than the abalone, although the higher temperatures from Diablo Canyon induce greater feeding activity in the urchins. Thus, the indirect effect of the heated discharge may be the reduction in abalone as a result of increased feeding activity by the giant urchin (*S. franciscanus*), which is a competitor for the existing food supply.

(3) Fish. (a) Fish Eggs and Larvae. Ahlstrom[37] presented a comprehensive summary of fish larvae in the Point Arguello region, which includes Diablo Canyon. The percent occurrence of the 10 most common larval fish taken for the 1950-1960 sampling period is computed from his Table 11 and presented in Table 5.20. These data are taken from CalCOFI station lines 73 and 77, which run perpendicular to the coast on either side of Diablo Cove. The nearest station is located about 8 miles south of the site. The estimated number of fish larvae from Ahlstrom's information is 1.1 per cubic meter.

This sampling is based on studies made off the coast in the vicinity of Diablo Cove. Sampling data from within the cove have not been reported. Of the fish listed, most are known to spawn off the coast and to lay pelagic (free floating) eggs. The rockfish is an exception; its young are born alive and may be found in areas occupied

Table 5.19. Critical and optimum temperatures for some benthic grazers

Species	Temperature levels of feeding activity (°F)			Upper lethal exposure, 1 hr (°F)
	Minimum	Optimum	Maximum	
Red abalone, *Haliotis rufescens*	50	62.6–65.3	68	91.4
Kelp crab, *Pugettia producta*		Variable		90.5
Giant red urchin, *Strongylocentrotus franciscanus*	43	60–62.6	77	85
Purple urchin, *S. purpuratus*	34.7	62.6–65.3	74.8	85

Adapted from W. J. North, K. A. Clendenning, L. G. Jones, J. B. Lackey, D. L. Leighton, M. Neushal, Jr., M. C. Sargent, and H. L. Scotten, *An Investigation of the Effects of Discharged Wastes on Kelp,* California State Water Quality Control Board Publication 26, Table 48.

Table 5.20. Percent occurrence of the ten most common larval fish taken in CalCOFI Station lines 73 and 77 during 1950–1960

Species	Percent occurrence
1. *Sebastes* spp., rockfish	24.8
2. *Engraulis mordax*, Northern anchovy	19.0
3. *Lampanyctus leucopsarus*, lantern fish	17.7
4. *Leuroglossus stilbius*, deep-sea smelt	7.5
5. *Tarletonbeania crenulauis*, lantern fish	6.2
6. *Merluccius productus*, Pacific hake	4.0
7. *Trachurus symmetricus*, jack mackerel	3.8
8. *Citharichthys* spp., sand dab	2.1
9. *Bathylagus* spp., deep-sea smelt	1.3
10. *Icichthys lockingtoni*, butterfish	1.0
Other	12.6
Total	100.0

by the adults. Because of these characteristics, it is believed that the concentration of larval fish in Diablo Cove or South Cove is well approximated by the figures derived from the data of Ahlstrom.

If the larval rockfish abundances fluctuate at Diablo Cove similarly to those of station 77.50, a valid estimate of densities at Diablo would require an extensive sampling effort to estimate the true mean.[2] The data necessary to accurately estimate entrainment is not available.

However, using the assumptions that:

a. The density of fish larvae at Diablo Canyon is well approximated by CalCOFI data (1.1102 fish/m^3);

b. Mortality is assumed to be 70% between discharge temperatures of 76°F (24.4°C) and 82.5°F (28.1°C) (September to November) and 35% at or below 76°F (the remainder of the year).[72] Therefore, since 4×10^9 larval fish are entrained, about 1.8×10^9 would be lost (see Appendix 13-2).

There is no way to accurately estimate the significance of this impact. Nevertheless, the staff believes that the effect on pelagic larval fishes drawn in from areas outside of the cove will be small. Prediction of the effects on larvae of species that spawn in shallow water, which include most of the *Sebastes* of the Diablo Cove region, is more difficult. Loss of the live-born young of *Sebastes* and of young cabezon, which hatch from adhesive eggs, can be expected near the intake, possibly resulting in a reduction of adults in the Diablo Canyon area.

No impact is expected from the discharge plume.

(b) Juveniles and Adults. The 40 most important juvenile fish recovered by California Department of Fish and Game surveys at Diablo Canyon are shown in Table 5.21. Table 5.22 shows temperature ranges of fish from Pacific Northwest coastal waters as well as lethal temperatures. Unfortunately, only two of the species — *Engraulis mordax* and *Oligocottus snyderi* — found in Table 5.21 are listed in Table 5.22. For these species the lethal temperatures or the upper limit of the temperature range will not be exceeded in Diablo Cove. Also, note that for the species listed in Table 5.22, most upper lethal temperatures exceed the highest temperatures expected in Diablo Cove. Some species may be attracted to the discharge area, while others will be displaced.

Table 5.21. The 40 most important juvenile fish recovered during fish sampling in the Diablo area, 1970–1971

Rank	Common name	Scientific name	Number	Percent frequency
1	Blue rockfish	*Sebastes mystinus*	1421	13.6
2	Speckled sanddab	*Citharichthys stigmaeus*	1047	10.0
3	Rockweed gunnel	*Xererpes fucorum*	939	9.0
4	Tube snout	*Aulorhynchus flavidus*	728	7.0
5	Black prickleback	*Xiphister atropurpureus*	558	5.3
6	Rock prickleback	*Xiphister mucosus*	541	5.2
7	Painted greenling	*Oxylebius pictus*	524	5.0
8	Canary rockfish	*Sebastes pinniger*	393	3.7
9	Coralline sculpin	*Artedius corallinus*	326	3.1
10	Crevice kelpfish	*Gibbonsia metzi*	274	2.6
11	Snubnose sculpin	*Orthonopias triacis*	273	2.6
12	Cabezon	*Scorpaenichthys marmoratus*	230	2.2
13	Blackeye goby	*Coryphopterus nicholsi*	201	1.9
14	Spotted cusk eel	*Otophidium taylori*	185	1.8
15	Black rockfish	*Sebastes melanops*	150	1.4
16	Olive rockfish	*Sebastes serranoides*	148	1.4
17	Black and yellow rockfish	*Sebastes chrysomelas*	141	1.4
18	Bocaccio	*Sebastes paucispinis*	137	1.3
19	Red brotula	*Brosmophycis marginata*	137	1.3
20	Mosshead warbonnet	*Chirolophis nugator*	135	1.3
21	Gopher rockfish	*Sebastes carnatus*	133	1.3
22	Ronquil	*Rathbunella alleni*	130	1.2
23	Smooth-head sculpin	*Artedius lateralis*	124	1.2
24	Northern anchovy	*Engraulis mordax*	115	1.1
25	Scaly head sculpin	*Artedius harringtoni*	88	0.8
26	Northern clingfish	*Gobiesox maeandricus*	88	0.8
27	Striped kelpfish	*Gibbonsia metzi*	79	0.8
28	Longfin sculpin	*Jordania zonope*	77	0.8
29	High cockscomb	*Anoplarchus purpurescens*	71	0.7
30	Brown Irish lord	*Hemilepidotus spinosus*	69	0.7
31	Copper rockfish	*Sebastes caurinus*	60	0.6
32	White-belly rockfish	*Sebastes vexillaris*		
33	Penpoint gunnel	*Apodichthys flavidus*	56	0.5
34	Kelp greenling	*Hexagrammos decagrammus*	55	0.5
35	Senorita	*Oxyjulis californica*	51	0.5
36	Spotted kelpfish	*Gibbonsia elegans*	47	0.5
37	Wooly sculpin	*Clinocottus analis*	44	0.4
38	Fluffy sculpin	*Oligocottus snyderi*	40	0.4
39	Crisscross prickleback	*Plagiogrammus hopkinsi*	40	0.4
40	Striped perch	*Embiotoca lateralis*	39	0.4
Total				94.6

Table 5.22. Summary of physical data on fish

Key: Nat. hatch, natural hatch conditions; Hatch exp., hatch experiment conditions; T., temperature; Max. surv., maximum survival; R., range; L., lethal.

Name	Age class[a]	Temperature range	Upper lethal temperature	Optimum temperature	H_2O etc. and natural environment temperature	Miscellaneous temperature data	Salinity (parts per thousand)	Miscellaneous salinity data (parts per thousand)
Alosa sapidissima	A	16–26°F						
	J	45–70°F						
	J	55–70°F						
Artherinops affinis oregonia		12.8–28.5°C						
Brachyistius frenatus		13–19°C					26–32 R	
Bram rail					57°F			
Clinocottus globiceps						Max. surv. 26°C, Q_{10} = 3.6	Max 75, 12°C L.	Tolerated 4, 26°C
Clinocottus recalvus						Q_{10} = 2.9		
Clupea harangus pallasi		20.8–24.7°C						
	E	"Large"			Nat. hatch, 3–6°C	Hatch exp., 9–14°C	R = "large"	
Cymatogaster aggregata	A						20–100 R	
	J						25–36 R	
Engraulis mordax	A					Spawning thres-old, 11.5–12.0°C		
	A			14.5 & 20.0°C	8.5–25.0°C	Spawning, 13°C		
	L	10.0–19.7°C		14.0–17.4°C				
	E	9.9–23.3°C		13.0 & 17.5°C			In situ 32	26
Embiotocid					13°C	Unfavorable, 19°C	19–31 R	
Fundulus heteroditus		40.5–42	40.5–42°C					
Gadus macrocephalus		2–11°C						
Girella nigrans		11.8–27.0°C						

Table 5.22 (continued)

Name	Age class[a]	Temperature range	Upper lethal temperature	Optimum temperature	H_2O etc. and natural environment temperature	Miscellaneous temperature data	Salinity (parts per thousand)	Miscellaneous salinity data (parts per thousand)
Hippoglossus stenolepis		2°C, north; 10–11°C, south			3–8°C	Breeding, 2.3–3.5°C		Breeding, 33.5–34.1
	L			1–10°C		Development, 3.5–6.5°C		
Leptocottus armatus		12–29.5°C						
Merluccius productus	L & E	10.6–15.0°C			47.5–67.3°F		37.5–67.5 R; max 67.5, 12°C	
Oligocottus maculosus		12–26.5°C				Q_{10} = 2.1	21–75 R, max 75, 12°C	
O. snyderi		2–28°C	30°C				1–50	
Osmerus mordax		2.3–18°C	21.5–28.5°C					25
Parophrys vetalus	E	2.3–13.8°C	Extremes, 2.3–18°C	Viable hatch, 6.5–10°C	10.6 ± 0.4°C	Hatched at 4–13°C	Viable hatch, 20–32	Hatch, 10–40
	E					Won't hatch at 2°C	In situ, 20–34	
Pholis clemensi		8.8–10.5°C						28
Platichthys stellatus	E					Embryo devel., 12.5°C		
Psettichthys melanostictus	E					Hatch, 7–9°C		
Quietula y-cauda			Max. critical 37°C			Mar. 37.4 + 0.1°C & Sept. 42.3 + 0.3°C		
Raja diaphanes			28.6 & 29.0°C					
Raja erinacea			30.2°C (2 small), 29.1–29.5°C (2 large)					
Raja radiata			3 died at 26.5–26.9°C					30

Table 5.22 (continued)

Name	Age class[a]	Temperature range	Upper lethal temperature	Optimum temperature	H_2O etc. and natural environment temperature	Miscellaneous temperature data	Salinity (parts per thousand)	Miscellaneous salinity data (parts per thousand)
Remicola muscuram					14°C			
Roccus saxatilis	A	45–80°F						
	J	55–70°F				Can't tolerate 45°F		
Sardinops sagax (caerulca)		11–27.4°C				Spawns 12.5–16.5°C Devel. impaired, 13°C		
Sebastodes alutus					4–5–14°C	Spawning, 3.8–4.2°C		
Squalus acanthias			28.5–29.1°C					
Thunnas alalunga		16.3–22.8°C						
Trachurus symmetricus	A				10–19.5°C			
	L				14–16°C	Spawning, 14–15.5°C		
	E	14–16°C		15.5°C	10–19.5°C			

[a] A, adult; J, juvenile; L, larva; E, embryo.

[b] *Parophrys vetulus* – development time: 50% hatching ranged from 3.5 days at 12°C and 25 parts per thousand salinity to 11.8 days at 4°C and salinity of 25. Between 6–12°C development time to 50% hatching was delayed by salinities above and below 25. At 4°C hatching seemed to be accelerated by salinities greater and smaller than 25. Oxygen consumption: 0.560 g/hr per embryo.

Adapted from Oregon State University, "Oceanography of the Near shore Coastal Waters of the Pacific Northwest Relating to Possible Pollution," vol. 1, published by the Environmental Protection Agency, Water Quality Office, July 1971.

The operation of the plant is not expected to produce an adverse effect on either the sport or commercial fishery outside Diablo Cove. Inside the cove, more warm-water-tolerant forms can be expected.

Cold Shock

During the operation of the plant, some fish may be attracted to the discharge area. In the event of a rapid shutdown of the plant, these fish would experience a rapid decline in temperature.

The staff has examined the range of ambient temperatures for Diablo Cove (Tables 5.12 and 5.13) and the temperature ranges for fish found in the vicinity of Diablo Cove and has concluded that a rapid shutdown is not a problem outside of Diablo Cove even if both units are shut down concurrently.

Heat Treatment for Defouling the Conduits

As discussed in Section 3.3.2, heat treatment will be used to remove marine organisms attached to the interior of the cooling water system. During treatment, the flow of water will be reduced, and the temperature will be increased to 105-110°F (40.6-43.3°C) and held at this temperature for 1 hr. Organisms entrained during this period will be subjected to lethal temperatures; however, the reduction in flow will result in fewer organisms being entrained.

During operation, it is necessary to defoul the cooling water system conduits. Once each month, the flow through the plant is reduced to one-fourth of the normal flow, and the temperature is elevated to about 50°F (28°C) above ambient. It requires from 3 to 4 hr to elevate the temperature and 1 hr for the heat treatment. All organisms in the conduit as estimated below are considered to be lost:

$$\text{Mortality} = \frac{60\ \text{hr/year}}{8760\ \text{hr/year}} \times \frac{(\text{entrained organism/year})}{4}$$

$$= 0.001712 \times \text{yearly entrainment}$$

$$\text{Phytoplankton} = 0.001712 \times 59.69 \times 10^9\ \text{g/year} = 0.1022 \times 10^9\ \text{g/year}$$

$$= 225.1 \times 10^3\ \text{lb/year}$$

$$\text{Zooplankton} = 0.001712 \times 1.052 \times 10^9 \text{ g/year}$$

$$= 0.001801 \times 10^9 \text{ g/year} = 3.97 \times 10^3 \text{ lb/year}$$

$$\text{Larval fish} = 0.001712 \times 3.8308 \times 10^9 \text{ fish/year}$$

$$= 0.006559 \times 10^9 \text{ fish/year} = 6.559 \times 10^6 \text{ fish/year} .$$

While mechanical means can be employed for cleaning the condensers, the need to clean the large-diameter conduits requires (1) physical removal by entering the conduits, (2) continuous chemical treatment, or (3) thermal shock. The staff believes that thermal shock represents the best alternative for removal of organisms in the conduits.

The isotherm areas for defouling treatment are given in Table 3.3. The applicant will be required to modify his operating conditions when defouling one unit such that the thermal alteration of the ocean water does not exceed that when the other unit is in full operation. Even at these latter conditions, the 5°F (2.8°C) isotherm will enclose 51 acres and will extend outside of Diablo Cove. However, the 6°F (3.3°C) isotherm will be within the cove and the 10°F (5.6°C) isotherm will enclose only 3 acres. This condition will exist for about 2 hrs each month and only at high tide. (At low tide the areas of the isotherms are less.) This short term effect is not expected by the staff to produce any significant incremental effect.

Mechanical Effects

(1) Fish. Operation of the plant's cooling water system has the potential for causing mortalities to aquatic organisms as a result of impingement on the intake screens or from entrainment in the cooling water system, where organisms can be subjected to changes in pressure and temperature and to abrasion.

Serious problems of both entrainment and impingement have been observed at the Indian Point plant on the Hudson River[39] and were also observed in the operation of the applicant's Contra Costa Plant in 1951.[2] The shoreline intake screen design of the type being used at Diablo Canyon is one which has been studied by the California Department of Fish and Game at other plants in the applicant's system, and this design has caused no problems for finfish.[2,40] (Details of the intake structure can be found in Sect. 3.3.2.) At the present time, no model is available which accurately predicts the impact of the intake structure on the impingement of fish, and therefore the staff cannot accurately predict the magnitude of impingement impact. However, the staff has evaluated the design of the intake structure and compared the Diablo Canyon design against others in the applicant's system which have been in use without adverse effects on finfish. Because Diablo Canyon has similar ambient water temperatures, has an intake design with velocities and configuration similar to these operating plants, and is not unique because of location, the staff has concluded that no adverse effects on finfish populations are likely to occur from impingement.

(2) Jellyfish. Jellyfish (Scyphomedusae) have been observed to be impinged on the Morro Bay Plant intake structure and mortality undoubtedly will result from their impingement on the screens of the Diablo Canyon Plant intake.

Conclusions

Of the impacts expected from the operation of the plant, only the losses due to chlorination are readily reduced. The staff believes that further consideration of alternative condenser cleaning systems should be undertaken by the applicant.

The operation of the plant will result in some losses from entraining organisms in the cooling water system. This loss is unavoidable. The low temperature rise, when combined with the low ambient temperature, should result in an acceptable impact on the populations affected. The entraining of larval abalone or zoospores of kelp is hard to evaluate. Both the positive effects of increased dispersion, which could lead to increased numbers, and the exposure to elevated temperatures must be balanced. Insufficient information exists at present to accurately determine whether the net effect of operation of the plant at this site will be detrimental or beneficial. The staff has evaluated the sources of impact and concludes that although there is uncertainty concerning the overall net effect, the staff is convinced that any detrimental impacts would be confined to Diablo Cove.

5.4 RADIOLOGICAL IMPACT

5.4.1 General Considerations

The radiological impact to biota and man is assessed here for the anticipated release of radioactive effluents from normal operations that are discussed in Sect. 3.4. Except where otherwise noted, the estimates and figures in Section 5.4 are those of the staff.

Dispersion of Gaseous Effluents

Gaseous effluents will be discharged from the station by vents on the reactor buildings. Because these vents are only slightly above the station yard elevation and do not physically approximate an elevated stack release, the discharge of gaseous effluent was treated as a ground level release. Concentrations of radionuclides contained in the air and deposited by impaction on the ground were estimated at distances up to 50 miles from the station using an atmospheric transport model[41] incorporated in a computer program.[42] The annual average atmospheric dilution of radioactive effluents is given in Table 5.27. In this atmospheric transport model, the reduction of radioactivity concentrations in the air at ground level by radioactive decay and deposition on land are taken into account. The deposition velocities used in the calculation were 10^{-6} cm/sec for the noble gases (krypton and xenon), 10^{-3} cm/sec for methyl iodide (CH_3I), 1 cm/sec for molecular iodine (I_2), and 1 cm/sec for particulate matter (rubidium and cesium).[41,43] If a particular radionuclide has a short half life or a large deposition velocity, the concentration, X, in Ci/m^3 of this radionuclide in air obtained by this model will be less than the average annual rate of release, Q, in Ci/sec multiplied by the X/Q, in sec/m^3.

Dispersion of Liquid Effluents

Liquid effluents will be discharged from the plant in the condenser cooling water which flows into Diablo Cove and then into the ocean. The average yearly concentration, C_o, in the condenser cooling water will be the anticipated annual release of the radionuclide in the liquid effluent (Table 3.6) for two units divided by the average condenser cooling water flow of 3864 ft^3/sec for the two reactor units.

In the ocean, the condenser cooling water containing the liquid effluent will be further diluted both by inshore currents and tides. From calculations based on the Stoltzenbach model[44] for thermal dispersion (see Section 3.3.3) the staff estimated that the average radionuclide concentration at the surface will be $C_o/10$ at a distance of one mile. Naturally, the concentration will be lower away from the center of the dispersing plume or below the ocean surface.

At distances greater than one mile from the station, the radioactivity concentrations in the center of the plume can be estimated by the relation $C_o/(10 \times D)$ where D is the distance in miles from the station to the point or location of interest. This extrapolation of radioactivity concentration in the center of the plume is based on a linear model of the dispersing plume recommended by the International Atomic Energy Agency.[45]

In the area (approximately 100 square miles) designated as statistical block 615 by the California Department of Fish and Game (Fig. 5.1) for recording fish catches, the average radioactivity concentration is taken to be $C_o/100$.

This estimate has been used here in calculating the radiation exposure of man from consumption of abalone taken in shallow waters close to the shore and of fish taken in deeper waters farther from the shore. However, an average radioactivity concentration about 10 times smaller, that is, $C_o/1000$, would probably be more appropriate in calculating the radiological exposure to man from consumption of seafood taken in the shallow waters along the coast several miles from Diablo Cove or in the deeper waters of this area.

5.4.2 Estimates of Radiation Dose to Biota

Annual radiation doses to aquatic and terrestrial biota (in millirads) were estimated on the assumption that the concentration of radionuclides remained constant at the specified location. The radiation dose has two components which must be considered in these estimates: one due to penetrating radiation from radionuclides outside the body (external exposure) and the other due to radiation from radionuclides deposited within the body (internal exposure).

The dose to aquatic biota from penetrating radiation during continuous immersion in Diablo Cove was estimated by the staff by an external exposure model contained in a computer program[46] to be 0.023 millirad/year. Doses to terrestrial biota from external exposure will be similar to those received by man, and comparisons indicate that the doses to waterfowl from external exposure are very small compared with the estimates of dose from internal exposure. There is also the possibility of a dose to some types of biota from external exposure to radionuclides accumulated in sediments, but this dose will be less than the dose resulting from internal exposure of the biota.

The doses from internal exposure to algae, mollusca or crustaceans, fish, and water fowl or shore birds living in or near the cove are 150, 4.8, 0.5, and 42 millirads/year, respectively. The equation for calculating the internal doses is described in Appendix 5-1. An average radioactivity concentration of $C_o/2$ was used in these dose estimates. Bioaccumulation factors from the literature[47] for algae, mollusca or crustaceans, and fish used in the dose calculations are listed in Table 5.23. Since no bioaccumulation factors are available for water fowl or shore birds eating aquatic plants contaminated with radionuclides, these factors were calculated with Eq. (5) of Appendix 5-1. Most of the assumptions which are listed for this derivation tend to maximize the bioaccumulation factors,

Table 5.23. Summary of bioaccumulation factors for marine biota

Radionuclide	Bioaccumulation factor			
	Algae	Crustacea or Mollusca	Fish	Water fowl or shorebirds
H-3	1.0	1.0	1.0	1.0
Cr-51	1,000	1,000	100	19
Mn-54	10,000	50,000	3,000	810
Fe-55	6,000	20,000	1,000	40,000
Fe-59	6,000	20,000	1,000	3,700
Co-58	100	10,000	100	36
Co-60	100	10,000	100	40
Rb-86	10	50	30	19
Sr-89	20	1.0	1.0	43
Sr-90	20	1.0	1.0	60
Sr-91	20	1.0	1.0	0.35
Y-90	300	100	30	0.0008
Y-91	300	100	30	0.25
Zr-95	1,000	100	30	0.80
Zr-97	1,000	100	30	0.010
Nb-95	100	200	100	0.34
Mo-99	100	100	10	21
Ru-103	1,000	100	3	27
Ru-106	1,000	100	3	31
Rh-105	100	100	10	0.58
Sn-125	10	3	3	2.5
Sb-125	10,000	1,000	1,000	1,600
Sb-127	10,000	1,000	1,000	150
Te-125m	1,000	100	10	430
Te-127m	1,000	100	10	470
Te-127	1,000	100	10	14
Te-129m	1,000	100	10	360
Te-131m	1,000	100	10	41
Te-132	1,000	100	10	94
I-130	10,000	100	20	720
I-131	10,000	100	20	11,000
I-133	10,000	100	20	1,300
I-135	10,000	100	20	400
Cs-134	10	50	30	94
Cs-136	10	50	30	16
Cs-137	10	50	30	100
Ba-140	100	3.0	3.0	7.7
La-140	30	100	30	0.0073
Ce-141	300	100	30	0.13
Ce-143	300	100	30	0.0058
Ce-144	300	100	30	0.83
Pr-143	1,000	1,000	100	0.20
Pm-147	1,000	1,000	100	5.5
Nd-147	1,000	1,000	100	0.16
Np-239	1,000	290	10,000	0.024

and in any actual exposure situation the bioaccumulation factors are expected to be smaller because of dietary dilution by non-contaminated foods or because of consumption of aquatic plants with bioaccumulation factors lower than those which were assumed.

All these calculated doses are believed to represent upper limit estimates also because equilibrium was assumed to exist between all organisms and all radionuclides in the water in the vicinity of the Diablo Canyon Station (a nonequilibrium situation would result in a lower concentration of radioactivity in tissues and thus a lower internal dose). While there are many pathways of internal radiation exposure to animals, one pathway was selected which would tend to maximize the dose received by a waterfowl by assuming that it consumes only algae growing in the cove near the point of discharge of the liquid radioactive effluents. If the waterfowl consume other food in addition to the algae, or if part of the feeding takes place other than in the cove, then the nuclide concentrations probably will be lower and thus the dose will be decreased.

5.4.3 Assessment of Dose to Biota

A voluminous amount of literature relating to radiation effects on organisms has been published, but very few studies have been conducted on the effects of chronic low-level radiation (from ingested radioactive material) on natural aquatic or terrestrial populations. The most recent and pertinent studies have been reviewed.[48-50] The results of these reviews point out that, while the existence of extremely radiosensitive organisms is possible and that increased radiosensitivity in organisms may result from environmental interactions, no organisms have yet been discovered that show a sensitivity to radiation levels as low as those anticipated for the area surrounding the Diablo Canyon nuclear power plant.

There is a paucity of literature on the effects of chronic low-level radiation on terrestrial animals.[50] French[51] suggested a possible shortening of the life span in the pocket mouse induced by 330 rads/year of chronic gamma radiation (administered at the rate of 0.9 rad/day). However, there is no information available to indicate that a detectable radiation effect would be found at the maximum predicted dose rate of 42 millirads/year for waterfowl.

Exposure to irradiation is known to increase mutation rates; however, at dose rates less than natural background radiation, an increased mutation rate above the spontaneous mutation rate would be extremely difficult to detect.

No detectable effect is expected by the staff on the aquatic biota or waterfowl as a result of the quantity of radionuclides to be released in the liquid effluents of Diablo Canyon nuclear power plant.

5.4.4 Staff Estimates of Radiation Dose to Man

Potential pathways of exposure to man from radioactive effluents released by the station that are considered in the dose estimates are presented schematically in Fig. 5.3. Those shown in the figure are not exhaustive, but they illustrate the principal pathways of exposure based on experience.

Radiation doses to individuals (in millirem) and to the population (in man-rem) from these pathways were estimated per year of release of radioactive effluents from normal operation of the station. A summary of the estimated radiation doses to adult individuals at locations of maximum exposure to the gaseous and liquid effluents where the pathways are likely to be operable is given in Table 5.24, and a summary of the estimated population doses from exposure to the effluents released by the station is given in Table 5.25.

Exposures to radionuclides that originate in the effluents released by the station were converted to estimates of radiation dose to individuals using models and data presented in Publication 2 of the International Commission on Radiological Protection[52] and other recognized texts on radiation protection.[53,54] Computer programs incorporating these models[46,55] were used to calculate (1) the radiation dose from external exposure to radionuclides in air, in water, or on the ground and (2) the radiation dose from internal exposure to inhaled or ingested radionuclides. Radioactivity taken into the body by inhalation or ingestion will continuously irradiate the body until removed by processes of metabolism and radioactive decay.

The radiation doses to the total body and internal organs from external exposures to penetrating radiation are approximately equal, but they may vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation dose to the total body, thyroid, lungs, bone, liver, kidney, and gastrointestinal tract were considered for pathways of internal exposure based on parameters applicable to an average adult.[52]

Radiation doses to the internal organs of children in the population will vary from those of an average adult because of differences in metabolism, organ size, and diet. However, differences between the organ doses of a child and those of an average adult by more than a factor of 3 would be unusual for pathways of internal exposure,

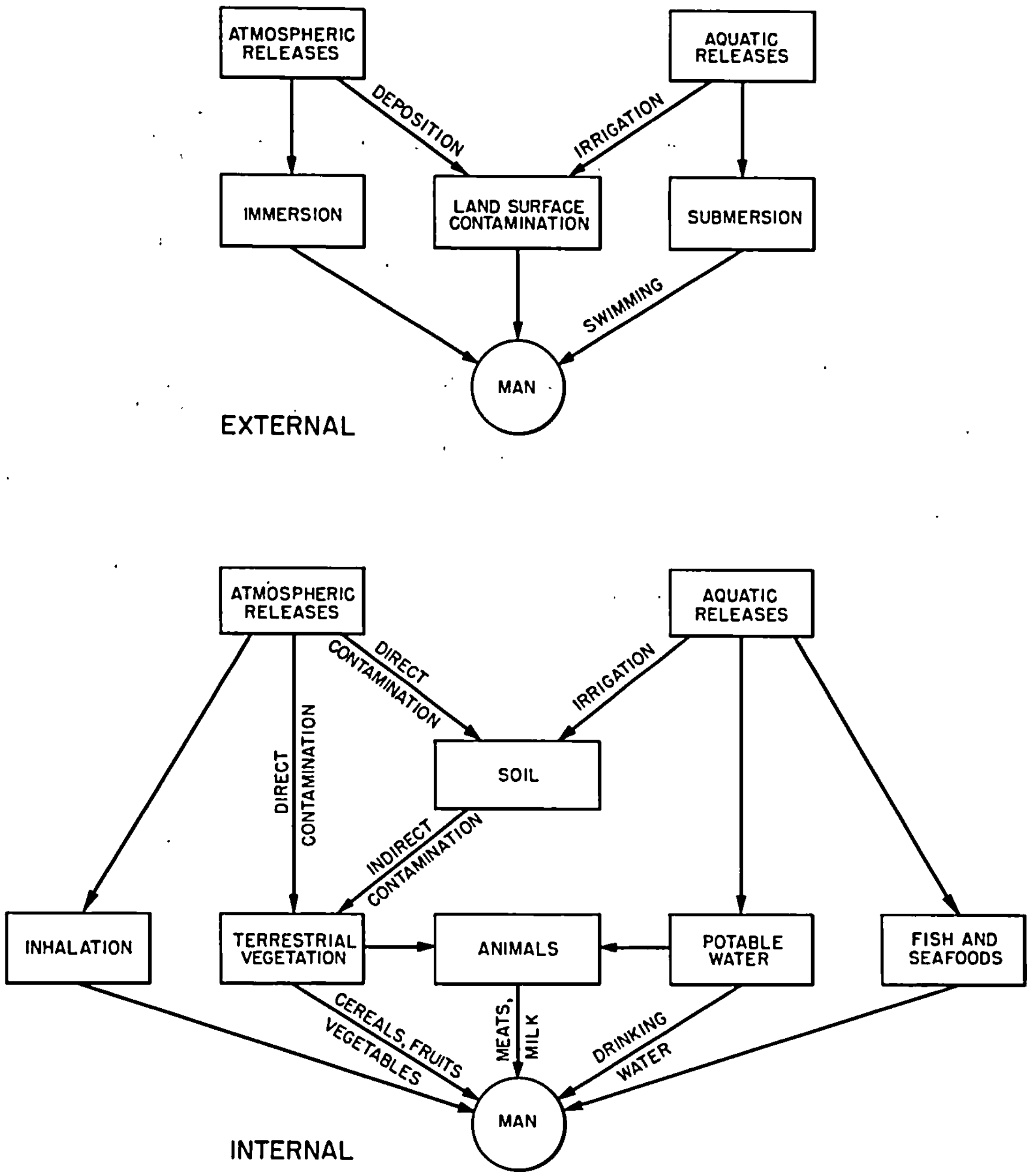


Fig. 5.3 Pathways for radiation exposure of man.

Table 5.24. Summary of the estimated radiation doses to an adult individual per year of release at locations of maximum exposure to gaseous and liquid effluents from two reactor units at the Diablo Canyon Station

Pathway	Location	Dose (millirems)	
		Total body[a]	Thyroid
	Gaseous effluents		
Direct radiation from air and ground	1.5 miles NNW of site	0.13	0.13
Inhalation of contaminated air	1.5 miles NNW of site	<0.01	0.07
Terrestial food chain	Dairy herd at 9.5 miles E of site	<0.01	0.06
	Liquid effluents		
Aquatic food chain	Pacific Ocean	<0.01	0.02
Direct radiation from water and shores	Pacific Ocean	<0.01	<0.01

[a]The estimated doses to the bone, kidneys, liver, lungs, and gastrointestinal tract were equal to or less than the dose to the total body given in the table.

Table 5.25. Summary of estimated total body radiation doses per year to the population from all pathways from two reactor units at the Diablo Canyon Station

Pathway	Population dose (man-rems)
Gaseous effluents	
Direct radiation from air and ground	0.5
Inhalation of contaminated air	<0.1
Terrestrial food chains	<0.1
Liquid effluents	
Direct radiation from water and shores	<0.1
Aquatic food chains	<0.1
Transportation[a]	2.7
Total population dose	3.6

[a]Transportation of radioactive materials is discussed in Section 5.4.6.

with the exception of the atmosphere-pasture-cow-milk food chain. For this food-chain pathway, the dose estimated to the thyroid of a two-year-old child from radioactive iodine in milk is 10 times that for an average adult.[56,57]

The population dose estimates are the sums of the total-body doses to exposed individuals. Total-body doses from gamma-ray exposures approximate those to gonads and therefore are used in the man-rem estimates because gonads have the most restrictive numerical dose limits.[58,59] Since radiation doses to the total body are relatively independent of age,[60] the man-rem estimates are based on total-body doses calculated for adults.

Estimates of dose to individuals of less than 0.01 millirem and to the population of less than 0.1 man-rem are given for the sake of completeness but are not considered to be radiologically significant. The transient population dose from immersion and ground contamination is estimated to be less than 0.1 man-rem, based on the transient population about the station for the vacation year 1971-1972 as given by the applicant.[61]

Estimates of Radiation Dose from Exposure to Gaseous Effluents

The estimates of radiation dose from exposure to gaseous effluents originating at the station are based on the radionuclide releases given in Table 3.7. Radioactive iodine releases from the station are assumed to be molecular iodine with a deposition velocity of 1 cm/sec.

Immersion and Ground Contamination Pathways. The maximum total body radiation dose from immersion in the gaseous effluent to an individual residing continuously at a point (the residence 1-1/2 miles NNW of the site) is estimated to be 0.13 millirem. The radionuclides making contributions to this dose are: Xe-133 (68%), Kr-88 (16%), Xe-135 (5%), Kr-87 (2%), Kr-85 (1%), Kr-85m (1%), Xe-131m (1%), Xe-133m (1%), Xe-135m (1%), and Rb-88 from radioactive decay of Kr-88 (3%). The total skin dose at this point is 0.5 millirem.

If a person were to live adjacent to the property boundary at the point of the maximum radiation dose from immersion in the gaseous effluent (0.5 mile northwest), the total body dose would be 0.98 millirem, and the skin dose would be 3.7 millirems.

The population dose for immersion is estimated to be 0.43 man-rem, and the average dose to an individual of the population within 50 miles of the site is estimated to be 0.0016 millirem. A summary of the population doses and the average individual doses as a function of radial distances from the station is given in Table 5.26.

Table 5.26. Summary of estimated dose to the permanent population from immersion in the gaseous effluent per year of release from two reactor units at the Diablo Canyon Nuclear Station

Radial distance from station (miles)	Projected 1980 cumulative population	Cumulative population dose (man-rems/year)	Average individual dose (millirems/year)
0–0.5	0	0	0
0–1	0	0	0
0–2	4	0.00052	0.13
0–3	6	0.00065	0.11
0–4	11	0.00084	0.076
0–5	16	0.001	0.059
0–10	7,834	0.049	0.0062
0–20	85,812	0.22	0.0026
0–30	141,732	0.32	0.0023
0–40	193,322	0.41	0.0021
0–50	260,362	0.43	0.0016

For the direct external exposure to radionuclides deposited on the ground, the radiation dose to an individual at the nearest residence, 1-1/2 miles NNW from the site, is estimated to be 0.01 millirem, and the dose to the population is estimated to be less than 0.1 man-rem.

The man-rem estimates for immersion and ground contamination pathways of external exposure to the gaseous effluents are based on the projected 1980 population distribution within a 50-mile radius of the station given in Fig. 2.8.

Inhalation Pathways. An estimated radiation dose of less than 0.01 millirem to the total body of an individual at 1-1/2 miles NNW from the site is based on an inhalation rate for an average adult of 2×10^4 liters per day.[52] For the internal organs of an individual the corresponding estimates of dose are 0.07 millirem for the thyroid, 0.01 millirem to the gastrointestinal tract, and less than 0.01 millirem to the lungs, kidneys, liver, and bone. Radionuclides making important contributions to the dose are: I-131 (83% of the thyroid dose); I-133 (17% of the thyroid dose); Rb-88 from radioactive decay of Kr-88 (94% of the gastrointestinal tract dose); Cs-138 from radioactive decay of Xe-138 (5% of the gastrointestinal tract dose).

The estimated dose to the population from the inhalation pathway is less than 0.1 man-rem. This man-rem estimate is also based on the projected population distribution in 1980 within a 50-mile radius of the station given in Fig. 2.8.

Terrestrial Food-Chain Pathways. Ingestion of radionuclides accumulated by food crops is one possible pathway of exposure, and ingestion of radionuclides accumulated in meat and milk from animals pastured in areas exposed to gaseous effluents from the station is another. Both of these pathways of exposure exist for direct contamination of the vegetation by deposition of radionuclides contained in the air. These pathways also exist for indirect contamination of terrestrial vegetation, i.e., by radionuclides deposited on the soil and subsequently incorporated in food plants through their roots. Because of the very short half-lives of Rb-88 (18 min) and Cs-138 (32 min) and the short half-life of I-131 (8 days), the dose contribution from indirect contamination of terrestrial food chains by radionuclides originating in the gaseous effluent released by the Diablo Canyon Station will be negligible.

The most important contribution to dose for direct contamination of vegetation by gaseous effluents released by the station is from I-131 by the atmosphere-pasture-cow-milk food chain pathway. Concentrations in milk used in the dose estimates for this pathway of internal exposure are based on the value of 0.2 μCi of I-131 per liter from the presence of each 1 μCi of I-131 per square meter of pasture.[62,63] In addition to radioactive decay of the I-131, the contamination of the pasture is assumed to decrease by one-half every 14 days from weathering and grazing.[63]

The doses to an adult drinking processed milk from dairies supplied from dairy herds pastured about the station were estimated to be less than 0.07 millirem to the thyroid and less than 0.01 millirem to the other internal organs and to the total body. For a two-year-old child, the dose to the thyroid was estimated to be less than 0.7 millirem. These estimates were based on milk produced by the dairy herd whose grazing land was subjected to the highest concentration of I-131 deposition (that at 9.5 miles E of the station as is shown in Fig. 5.4). A consumption of 1 liter (about 2.1 pt) per day by both a child and an adult was assumed in the dose estimates.

A population dose of less than 0.1 man-rem was estimated for this internal exposure pathway for the approximately 6.3 million gallons of milk produced yearly[64] in San Luis Obispo county.

If a cow were pastured on one of the closest nondairy farms to the station (between 5 and 6 miles NNW of the site) as shown in Fig. 5.4, the estimated doses to an adult drinking raw milk from the cow would be 0.47 millirem to the thyroid and less than 0.01 millirem to the total body and to other internal organs. The corresponding dose estimate to the thyroid of a two-year-old child would be 4.7 millirems.

Selected values of X/Q for points of interest are presented in Table 5.27 (refer to Fig. 5.4).

Estimates of Dose from Exposure to Liquid Effluents

The estimates of dose from exposure to liquid effluents from the station were based on the radionuclide releases given in Table 3.4. All radionuclides released in the liquid effluent were assumed to be in chemical forms that are soluble in water.

Submersion and Shore Contamination Pathways. If an individual is assumed to spend 2 days per week at the beach during the 3 summer months, the maximum dose due to direct radiation from the water and the shores would be less than 0.01 millirem. The maximum dose would occur for a person who spends all of his time at the closest popular beach recreation point, Avila Beach. Approximately 100 ft of sandy beach subject to water cover during high tide is assumed in the calculation of the dose due to radionuclides deposited on a beach

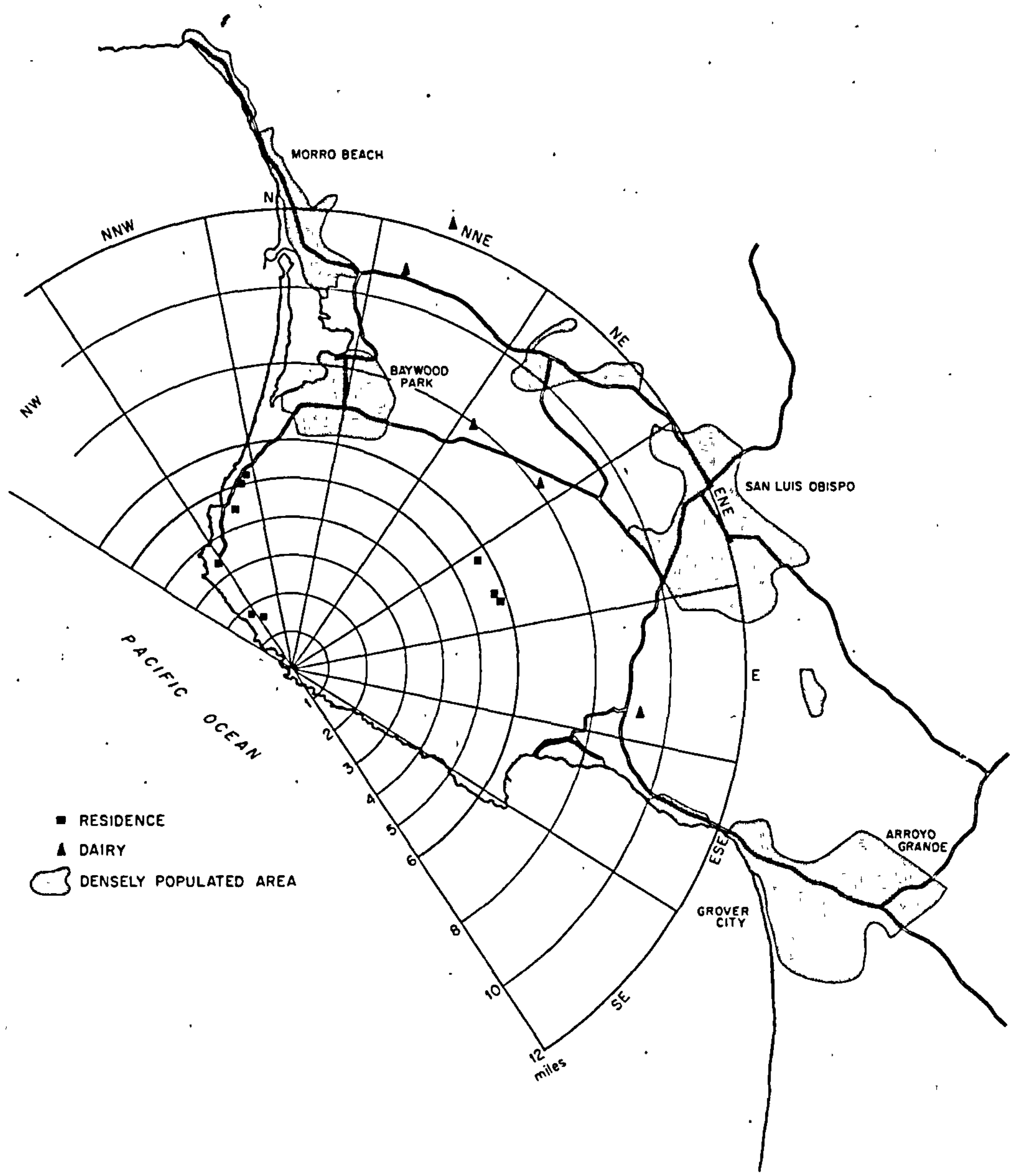


Fig. 5.4. Location of residences, dairies, and densely populated areas within 12 miles of the Diablo Canyon site.

Table 5.27. Summary of X/Q values for selected points of interest

Direction	Distance (miles)	X/Q (sec/m^3)
NW[a]	0.5	8.8×10^{-6}
NW	1.75	1.1×10^{-6}
NNW	1.5	1.2×10^{-6}
NNW	5	1.9×10^{-7}
N	6	7.4×10^{-8}
NNE	6	3.5×10^{-8}
NNE	11	1.7×10^{-8}
NE	8	2.9×10^{-8}
ENE	5.75	4.1×10^{-8}
E	9.5	3.7×10^{-8}
ESE	7	9.0×10^{-8}

[a]This is the position of the highest value of X/Q at the property boundary.

from the ocean water as described in Appendix 5-2. A population dose for the beach recreation areas within a 50-mile radius of the station is estimated to be less than 0.1 man-rem. This estimate is based on the number of visitor-days spent in the last year at the various beaches in the area as supplied by the applicant and by assuming that the entire time was spent on the beach. Several special population groups have been considered, and in each case the annual individual dose was estimated to be less than 0.01 millirem. The cases considered were: (1) a commercial abalone diver who might spend a maximum of 500 hr/year underwater in Diablo Cove where the average radionuclide concentration is assumed to be $C_o/2$; (2) the captain of a sports fishing boat who might spend 1000 hr/year off the shore of Diablo Cove where the average radionuclide concentration is assumed to be $C_o/100$; and (3) a clam digger who might spend 500 hr/year on the beach at Morro Bay State Park where the beach waters are assumed to have an average radionuclide concentration of $C_o/1400$.

Drinking Water Pathway. Radiation dose from this pathway is disregarded in this statement because of the low mixing of the ocean with the fresh water table and since no desalination plant at or near the station produces drinking water.

Aquatic Food-Chain Pathways. Estimates of radiation dose to an adult were based on an average consumption of 60 g/day (about 1 lb/week) of fish from that portion of the ocean near the station. This consumption is about 3 to 4 times the national average fish consumption[65] and is used because of the location. In addition, it was assumed that the individual consumed 15 g/day (about 1 lb/month) of abalone. The dose estimates for consumption of fresh fish are 0.01 millirem to the thyroid and less than 0.01 millirem to the total body and the other internal organs; for consumption of abalone the dose estimates are 0.01 millirem to the thyroid and less than 0.01 millirem to the total body and the other internal organs. The concentrations of radionuclides in these seafoods were obtained by multiplying the radionuclide concentrations in the ocean by the bioaccumulation factors for fish and abalone (i.e., mollusca) given in Table 5.23. The average bioaccumulation of radionuclides in seafood taken from the ocean near the station was based on a radioactivity concentration in the water of $C_o/100$ (see Section 5.4.1). Cesium-134 is the most important individual radionuclide contributing to the total-body dose (about 50% of the total for fresh fish and about 21% of the total for abalone). Iodine-131 contributes up to 90% of the thyroid dose for both fresh fish and abalone.

A population dose from the consumption of all seafoods was estimated to be less than 0.1 man-rem. The assumptions made in this estimate were that all of the albacore (tuna) were caught commercially and were consumed after a 10-week delay to account for processing and marketing and that the other fish and abalone caught commercially as well as all of the sports fish catch were consumed as fresh seafood. The population dose was considered for seafood taken from the California Department of Fish and Game statistical block number 615 (Fig. 5.1), which covers about 100 square miles around Diablo Cove. The population dose for seafood taken from the surrounding blocks was estimated, but because of the large dilution (see Sect. 5.4.1), it was much less than 0.1 man-rem.

Terrestrial Food-Chain Pathways. Radiation doses from these pathways are disregarded in this statement because of the low mixing of the ocean with the fresh water table.

5.4.5 Assessment of Radiation Dose to Man

Assessment of the potential radiological impact from estimates of dose to man from gaseous and liquid radioactive effluents released by the Diablo Canyon Nuclear Station can be given some perspective by comparisons with (1) the recommended numerical dose limits[58,59] and (2) the doses from the natural radiation background. The radiation dose to the total body and internal organs from the natural radiation background in the area of Diablo Canyon averages about 115 millirem per year.[66]

The release of radioactive effluents during normal operations of the station will be regulated through an operating license issued by the Commission. This license will require that the station be operated according to written Technical Specifications approved by the Commission. Numerical guidelines[67] defining "as low as practicable" will be applied to these facilities when adopted. The limitations set forth in 10 CFR 20[68] are based upon the recommended numerical dose limits of recognized national and international radiation protection groups.

The largest estimate of radiation dose to the total body from the gaseous effluent occurs at the residence at 1-1/2 miles NNW of the station. These estimates of dose have not been reduced by occupancy factors or by shielding factors provided by houses against radionuclides contained in the air or deposited on the ground.[41] Without any consideration of these factors, the sum of the dose estimates to the whole body of 0.14 millirem to an individual residing at 1-1/2 miles NNW of the station is about 0.1% of the dose from natural background and less than 0.03% of the recommended numerical dose limit, 500 millirem.[58,59]

A realistic estimate of the total dose from the gaseous effluent to the thyroid of an individual residing at 1-1/2 miles NNW of the station would be to assume consumption of processed milk from the closest dairy herd to the station. For this situation, the sum of the thyroid dose estimates is about 0.26 millirem for an adult and about 0.8 millirem to a two-year-old child. These estimates of dose to the thyroid have not been reduced by the shielding factors provided by houses or by the supplemental feeding to cows of stored or commercial feeds. In the estimates of dose by terrestrial food-chain pathways, it was assumed that the cow's food was obtained entirely from grazing.[62,63] Without any consideration of these possible dose reduction factors, the estimates of dose to the thyroid of both an adult and a child in this situation are less than 1% of the dose from natural background.

If the atmosphere-pasture-cow-milk pathway is operative at the closest nondairy farm for the gaseous effluent released from the station, an adult could receive an estimated dose to the thyroid of 0.47 millirem and a one-year-old child an estimated dose to the thyroid of 4.7 millirems from raw milk consumption. This estimate of dose to the thyroid of both an adult or a child is less than 4% of the dose to the thyroid from natural background.

The largest estimates of dose from liquid effluents released from the station are for a resident of the Diablo Canyon area who makes frequent use of the ocean shore and whose dietary habits include substantial amounts of fish and abalone. The estimates of the total dose to the thyroid of an individual are 0.02 millirem and less than 0.01 millirem to the total body and the other internal organs. These estimates of dose, based on reasonable dilution ffactors of the liquid effluent for the ocean and on reasonable deposition rates from the water to the beaches, are less than 0.02% of the dose from the natural radiation background and less than 0.04% of the recommended numerical dose limits.[58,59]

These dose estimates indicate that the release of radioactive effluents from normal operations of the station can be conducted well within the limits of 10 CFR 20.

The estimated population dose from exposure from all sources associated with the station is about 3.7 man-rems and is very small compared with the 30,000 man-rems that the population within a 50-mile radius of the station receives each year from natural radiation background and even with the 900 man-rems that the population within a 10-mile radius receives from natural background. Hence, no discernible radiological impact on individuals and the population is expected from normal operations of the Diablo Canyon Station.

5.5 COMPLIANCE WITH CALIFORNIA WATER QUALITY CRITERIA AND THE FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972

On January 29, 1973, the Commission published an Interim Policy Statement, effective on that date, implementing the FWPCA, particularly section 511 thereof (38 F.R. 2679). On the same date, a Memorandum of Understanding between the Environmental Protection Agency (EPA) and the Commission for the purpose of implementing NEPA and the FWPCA in a manner consistent with both acts was published in the Federal Register (38 F.R. 2713).

In general, the Interim Policy Statement provides that the Commission will continue to exercise its NEPA authority and responsibility in licensing proceedings subject to Appendix D of 10 CFR Part 50 so as to avoid, to the maximum extent possible, needless duplication of regulatory effort or, conversely, any hiatus in Federal responsibility and authority, respecting environmental matters embraced by both NEPA and FWPCA, in the interim period before various actions are taken under the FWPCA.

Section 3 of the Interim Policy Statement indicates one major impact of the FWPCA on the Commission's NEPA authority. It provides that if and to the extent that there are applicable limitations or other requirements imposed pursuant to the FWPCA, the Commission will not (with certain exceptions) impose different limitations or requirements pursuant to NEPA as a condition to any license or permit.

Section 4 sets out the limitations on AEC consideration of alternatives relevant to water quality in particular situations. Generally, it indicates that the Commission will not consider various alternatives where such action would constitute a review of similar consideration of alternatives under the FWPCA and upset a limitation or requirement imposed as a result thereof or where a particular alternative has been required to be adopted pursuant to the FWPCA.

Section 5 concerns the effect of the FWPCA on cost-benefit analyses. It states, in summary, that the Commission will continue to evaluate and give full consideration to environmental impact provided that, with certain exceptions, such evaluation will be conducted on the basis of activities at the level of limitations or requirements promulgated or imposed pursuant to the FWPCA. In addition, section 5 provides that the Commission will also determine, except in certain situations specified in section 5(c), whether the facility will comply with applicable requirements.

The impact of the Commission's Interim Policy Statement depends on whether and to what extent there are "limitations or other requirements promulgated or imposed pursuant to the FWPCA," as defined in Section 2(a) of the Statement. In this case the applicable thermal limitation of the State of California for the area of the Diablo Canyon facilities is contained in the new "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California," adopted May 18, 1972. This plan was approved by the Environmental Protection Agency, August 10, 1972.[69] Pursuant to Section 303(a)(1) of the FWPCA, as amended, this Plan remains in effect, since the EPA did not notify the State of California of a desired change by January 18, 1973.[70]

Under the Interim Policy Statement, it is necessary to determine whether the Diablo Canyon facilities will be in compliance with the thermal standard embodied in the approved Plan for Control of Temperature. The Plan establishes standards inter alia for both "new" and "existing discharges" and sets numerical limitations for the former. Diablo Canyon Units 1 and 2 are specifically identified in the Plan and included as existing discharges. The standard for existing discharges for coastal waters is that "elevated temperature wastes shall comply with limitations necessary to assure protection of the beneficial uses and areas of special biological significance." Both existing and future dischargers are required to conduct studies on the effect of the discharge on beneficial uses and, for existing discharges, to determine whether design and operating changes are necessary to achieve compliance with the Plan. The applicant is presently completing this study, which will be submitted to the appropriate California regional control board prior to July 1973 as contemplated by the Plan.

Based on the foregoing, under the Commission's Interim Policy Statement the staff concludes that there is compliance with the applicable thermal criteria at the present time. The impact of the thermal discharge from the facilities upon the aquatic environment is not expected to undermine the protection of beneficial uses and areas of special biological significance.

With respect to other matters covered by applicable approved California water quality criteria, it is the judgment of the staff that the facilities will be in compliance with the relevant State Standards. Total available chlorine in the plant discharge will be required not to exceed 0.1 ppm.

5.6 EFFECTS ON COMMUNITY

Because of the remoteness of the site and the relatively small work force of 70 permanent employees[2] to be involved in plant operation, the staff does not expect the effects of plant operation to be measurable in the San Luis Obispo area. The cessation of construction could have a one-time effect that might adversely affect the economic development of the Avila Community (see Section 4.5) with a smaller effect on the "Five Cities Area." Because of the dependence of this area on tourism, this effect should not be prolonged or serious if it occurs.

REFERENCES FOR SECTION 5

1. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2, Diablo Canyon Site,* Dockets Nos. 50-275 and 50-323, July 1971.

2. Pacific Gas and Electric Company, *Environmental Report, Supplement No. 2, Units 1 and 2, Diablo Canyon Site*, Jyly 1972.

3. Ibid., p. IV-B-1 and IV-B-2.

4. Central Coastal Regional Water Quality Control Board, The Resources Agency of California, *Waste Discharge Requirements, Pacific Gas and Electric Company, Diablo Canyon Nuclear Power Plant, San Luis Obispo, California,* October 17, 1969.

5. Pacific Gas and Electric Company, Environmental Report, Diablo Canyon Site, Supplement No. 2, July 1972, p. XI-E-3.

6. Pacific Gas and Electric response to agency comments on the Draft Environmental Statement for Diablo Canyon Units 1 and 2, Docket Nos. 50-275, 50-323, March 23, 1973.

7. P. H. Arend, "The Ecological Impacts of Transmission Lines on the Wildlife of San Francisco Bay," Wildlife Associates, Novato, California (August 1970).

8. H. A. Hockbaum, *Travels and Traditions of Water Fowl*, Chales T. Branford Company, Newton, Mass., 1960.

9. *Environmental Sciences Division Annual Progress Report, Period Ending Sept. 30, 1972*, Oak Ridge National Laboratory Report ORNL-4848, p. 36 (1973).

10. L. S. Dochinger, "The Impact of Air Pollution on Eastern White Pine: The Chlorotic Dwarf Disease," *J. Air Pollut. Contr. Ass.* 18: 814 (1968).

11. P. R. Miller and J. R. Parmeter, "Effects of Ozone Injury to Ponderosa Pine," *Phytopathology* 57: 822 (1967).

12. Pacific Gas and Electric Company, *Investigations Related to the Effect of the Proposed Mendocino Thermal Power Plant on the Marine Environment*, ed. by J. R. Adams, Emeryville, Calif., August 1971, pp. 362-364.

13. W. Forster and H. Zeittin, A Modified Dimethylglyoxime Method for the Determination of Nickel in Sea Water, *Anal. Chim. Acta*, 35: 42-52, 1966.

14. U. S. Dept. Interior, *Water Quality Criteria*, Federal Water Pollution Control Administration, Washington, 234 p., 1968.

15. Environmental Protection Agency, *Oceanography of the Near-shore Coastal Waters of the Pacific Northwest Relating to Possible Pollution*, Vol. 1., Water Quality Office, EPA, Water Pollution Control Research Series 16070 EOK 07/71, July, 1971.

16. Draft Detailed Statement on Environmental Considerations, Indian Point No. 2 Nuclear Generating Plant, Docket No. 50-247, by U.S. Atomic Energy Commission, Directorate of Licensing, April 13, 1972, p. V-11.

17. J. E. McKee and H. W. Wolf, *Water Quality Criteria*, California State Water Quality Control Board, Publ. No. 3-2 (1936).

18. J. R. Adams, "Thermal Power, Aquatic Life, and Kilowatts on the Pacific Coast," *Nuclear News* (Sept.): 75 (1969).

19. John Cairns, Jr., "We're in Hot Water," *Scientist and Citizen* 10(8): 187-98 (1968).

20. E. Naylor, "Effects of Heated Effluents Upon Marine and Estuarine Organisms," *Adv. Mar. Biol.* 3: 63-103 (1965).

21. E. J. Carpenter, "Brackish-Water Phytoplankton Response to Temperature Elevation," *J. Coastal Marine Science* (in press).

22. R. W. Eppley, M. H. Reid, and J. D. H. Strickland, Estimates of Phytoplankton Crop Size, Growth Rate, and Primary Production, in "The Ecology of the Plankton off La Jolla, California in the Period April through September, 1967," ed. by J. D. H. Strickland, *Bulletin Scripps Institution of Oceanography* 17: 33-42, 1970.

23. W. J. North, K. A. Clendenning, L. G. Jones, J. B. Lackey, D. L. Leighton, M. Neushal, Jr., M. C. Sargent, and H. L. Scotten, *An Investigation of the Effects of Discharged Wastes on Kelp*, California State Water Quality Control Board *Publ. No. 26:* 124 p.

24. Marine Advisers, Inc., *An Evaluation of the Marine Flora in the Vicinity of Diablo Cove, California*, La Jolla, California. Also in: *Thermal Pollution* — 1968 Part 4 Hearings before the Senate Subcommittee in Air and Water Pollution, U.S. Senate, Ninetieth Congress: 1097-1128.

25. Richard T. Burge and Steven A. Schultz, "The Marine Environment in the Vicinity of Diablo Canyon with Special Reference to the Abalone, Including Its Food Chain, and to Bony Fish (a Pre-Operational Warm Water Discharge Area)," Marine Resources Technical Report, State of California, The Resources Agency, Department of Fish and Game, Marine Resources Region.

26. J. H. Hair, "Upper Lethal Temperature and Thermal Shock Tolerances of the Opossum Shrimp, *Neomysis awatschensis*, from the Sacramento — San Joaquin Estuary, California." *California Department of Fish and Game* 57(1): 17-27, 1971.

27. R. W. Kelly, "Mortality of *Neomysis awatschensis* Brant Resulting from Exposure to High Temperatures at Pacific Gas and Electric Company's Pittsburg Power Plant." California Department of Fish and Game, *Anadromous Fish. Br. Report* 71-3:6 p. 1971.

28. Pacific Gas and Electric Company, Environmental Report, Diablo Canyon Site, Supplement No. 2, July 1972, p. IV-E-59.

29. D. R. Heinle, "Temperature and Zooplankton," *Chesapeake Science* 10(3-4): 186-209, 1969.

30. P. R. O. Barnett and B. L. S. Hardy, "The Effects of Temperature on the Benthos near the Hunterston Generating Station, Scotland." *Chesapeake Science* 10(3-4): 255-56, 1969.

31. Pacific Gas and Electric Company, Environmental Report, Diablo Canyon Site, Supplement No. 2, July 1972, p. IV-E-60.

32. John Icanberry and J. R. Adams, *Interim Report, Zooplankton Survival after Passage through the Cooling Water Systems of Four Thermal Power Plants on the California Coast: March 1971 — January 1972*, Report 7598-19-72, Pacific Gas and Electric Company, Department of Engineering Research, Emeryville, California (October 1972).

33. J. R. Beers and G. L. Stewart, Numerical Abundance and Estimated Biomass of Microplankton in the Ecology of the Plankton off La Jolla California in April through September, 1967, ed. by J. D. H. Strickland, *Bull. Scripps Institute of Oceanography* 17: 67-87 (1970).

34. M. M. Mullin and E. R. Brooks, "Laboratory Culture, Growth Rate, and Feeding Behavior of a Planktonic Marine Copepod," *Limnol. Ocean.* 12: 657-66 (1967).

35. James R. Adams, "Ecological Investigations Around Some Thermal Power Stations in California Tidal Waters," *Chesapeake Science* 10(3-4): 145-54, 1969.

36. E. E. Ebert, *An Evaluation of Marine Resources in the Diablo Canyon Area, May 2-4, 1966.* California Department of Fish and Game, MRO Ref. No. 66-10 (May 11, 1966): 15 p., 1966.

37. Elbert H. Ahlstron, *A Report on Evaluation of Fish Resources of the Pt. Arguello Area. Part 1, Fish Larvae of the Pt. Arguello Area.* Bureau of Commercial Fisheries, Agreement AT (49-7)-2428 for Division of Biology and Medicine, USAEC (July 1965): 118 p, 1965.

38. John S. MacGregor, "Fecundity, Multiple Spawning and Description of the Gonads in *Sebastodes*," United States Fish and Wildlife Service, Special Scientific Report — Fisheries, No. 596 (March 1970).

39. Draft Detailed Statement on the Environmental Considerations Related to the Proposed Issuance of an Operating License to the Consolidated Edison Company of New York for the Indian Point Unit No. 2 Nuclear Generation Plant. Docket No. 50-247. U.S. Atomic Energy Commission, Division of Radiological and Environmental Protection, April 13, 1972.

40. J. R. Adams, "Thermal Power, Aquatic Life, and Kilowatts on the Pacific Coast," *Nuclear News* 12(9): 75-79, 1969.

41. D. H. Slade (ed.), *Meteorology and Atomic Energy 1968,* TID-24190 (July 1968).

42. M. Reeves III, P. G. Fowler, and K. E. Cowser, *A Computer Code for Routine Atmospheric Releases of Short-Lived Radioactive Nuclides,* ORNL-TM-3613.

43. G. G. Polikarpov, *Radioecology of Aquatic Organisms,* Reinhold Publishing Co., New York, 1967.

44. K. D. Stolzenbach, and D.R.F. Harleman, "An Analytical and Experimental Investigation of Heated Water, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, or, The Water Quality Office of EPA, Research Grant No. 16130 DJU, February 1971."

45. International Atomic Energy Agency, *Radioactive Waste Disposal Into the Sea,* Safety Series Report No. 5, Vienna, 1961.

46. W. Doyle Turner, *The EXREM II Computer Code for Estimating External Doses to Populations from Construction of a Sea-Level Canal with Nuclear Explosives,* CTC-8 (July 21, 1969).

47. A. M. Freke, "A Model for the Approximate Calculation of Safe Rates of Discharge of Radioactive Wastes into Marine Environments," *Health Phys.* 13: 743 (1967).

48. S. I. Auerbach, D. J. Nelson, S. V. Kaye, D. E. Reichle, and C. C. Coutant, "Ecological Considerations in Reactor Power Plant Siting," *Proceedings of a Symposium on Environmental Aspects of Nuclear Power Stations,* held by the International Atomic Energy Agency in cooperation with the United States Atomic Energy Commission in New York, 10-14 August 1970, pp. 805-20, International Atomic Energy Agency, Vienna, 1971.

49. W. L. Templeton, R. E. Nakatani, and E. Held, "Radiation Effects in Radioactivity in the Marine Environment," a report in preparation by the National Academy of Sciences, Washington, D.C., 1970.

50. S. I. Auerbach, S. V. Kaye, D. J. Nelson, D. E. Reichle, P. B. Dunaway, and R. S. Booth, "Understanding the Dynamic Behavior of Radionuclides to the Environment and Implications," presented at the Fourth International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, Sept. 6-16, 1971; to be published in the proceedings.

51. N. R. French, B. G. Maza, and H. W. Kaoz, "Mortality Rates in Irradiated Rodent Populations," Proceedings of the Second National Symposium on Radioecology, D. J. Nelson and F. C. Evans (eds.), USAEC CONF-670503, p. 46 (1969).

52. International Commission on Radiological Protection, *Recommendations of the International Commission on Radiological Protection,* ICRP Publ. 2, Pergamon Press, London, 1969.

53. G. J. Hine and G. L. Brownell (eds.), *Radiation Dosimetry,* Academic Press, 1956.

54. K. Z. Morgan and J. E. Turner (eds.), *Principles of Radiation Protection*, John Wiley and Sons, Inc., 1967.

55. W. Doyle Turner, S. V. Kaye, and P. S. Rohwer, *EXREM and INREM Computer Codes for Estimating Radiation Doses to Population from Construction of a Sea-Level Canal with Nuclear Explosives*, K-1752 (Sept. 16, 1968).

56. J. K. Soldat, "Environmental Evaluation of an Acute Release of I-131 to the Atmosphere," *Health Phys*. 11: 1009 (1965).

57. B. Shleien, "An Evaluation of Internal Radiation Exposure Based on Dose Commitments from Radionuclides in Milk, Food, and Air," *Health Phys*. 18: 267 (1970).

58. International Commission on Radiological Protection, *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 9, Pergamon Press, London, 1966.

59. National Council on Radiation Protection and Measurements, *Basic Radiation Protection Criteria*, NCRP Report No. 39, NCRP Publications, Washington, D.C. (1971).

60. Federal Radiation Council, *Estimates and Evaluation of Fallout in the United States from Nuclear Weapons Testing Conducted through 1962*, Report No. 4, U.S. Government Printing Office, Washington, D.C., May 1963.

61. Pacific Gas and Electric Company, *Supplement No. 2, Environmental Report Units 1 and 2, Table G-4*, July 1972.

62. P. M. Bryant, "Derivation of Working Limits for Continuous Release Rates of Iodine-131 to Atmosphere in a Milk Producing Area," *Health Phys*. 10: 249 (1964).

63. J. D. Burton, R. J. Garner, and R. S. Russel, "Possible Relationships between the Deposition of Fission Products and Levels of Dietary Contamination," *Radioactivity and Human Diet*, ed. by R. S. Scott, Pergamon Press, London, 1966, p. 457.

64. County Department of Agriculture, *Agriculture Products*, San Luis Obispo County, California, 1971.

65. U.S. Dept. of Agriculture, *Agricultural Statistics*, U.S. Government Printing Office, Washington, D.C., 1969.

66. EPA Lists Background Levels by States, *Nuclear News*, January 1972, p. 47.

67. Title 10, Atomic Energy, Part 50, "Licensing of Production and Utilization Facilities," *Code of Federal Regulations*.

68. Title 10, Atomic Energy, Part 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*.

69. Letter from P. De Falco, Jr., EPA, to Gov. R. Reagan, State of California, Aug. 10, 1972, Docket Nos. 50-275 and 50-323; see also 40 CFR Sect. 120.10 as amended, 37 F.R. 20243 (1972).

70. Letter from P. De Falco, Jr., EPA, to W. W. Adams, California State Water Resources Control Board, Jan. 18, 1973, Docket Nos. 50-275 and 50-323.

71. Carpenter, E. J., B. B. Peck, and S. J. Anderson, Cooling Water Chlorination and Productivity of Entrained Phytoplankton, Marine Biology, 16: 37-40, 1972.

72. B. C. Macy, "Survival of Young Fish in the Discharge Canal of a Nuclear Power Plant," *J. Fish. Res. Bd. Canada* 28: 1057-1060 (1971).

6. EFFLUENT AND ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

6.1 PREOPERATIONAL SURVEYS

Preoperational background studies for Diablo Canyon have been under way since May of 1966 when an intertidal survey and subtidal reconnaissance were conducted by staff members of the California Department of Fish and Game.[1] Since that initial survey, studies of the Diablo Canyon area have been conducted by staff members of the California Institute of Technology, Pacific Gas and Electric Company, and the California Department of Fish and Game. Numerous field trips were made by these groups during the period May 1966 to July 1972.

Preoperational surveys were initiated under terms of an agreement between PG&E and the California Resources Agency.[2]

Pacific Gas and Electric has conducted studies[1] that:

1. Mapped the bottom topography within one-quarter mile of the plant.
2. Recorded tide levels to establish a correlation with published data.
3. Determined vertical temperature and salinity profiles at various times of the year and evaluated changes in stability.
4. Continuously measured surface water temperature and correlated the measurements with long-term temperature records.
5. Measured currents to establish seasonal and other variations.
6. Studied dye dispersion and dilution rates.
7. Developed qualitative descriptions of the biotic community near the plant site.
8. Related the ecological surveys to similar surveys made by other agencies in the same area.
9. Made preliminary prediction of the extent of thermal discharge from the power plant under different hydrographic conditions.
10. Predicted the probable effect of the thermal discharge on the principal ecological communities.

Preoperational terrestrial ecological studies were conducted by PG&E biologists, a consultant (Wildlife Associates), and professors and students from California Polytechnic College. Information gathered was used by PG&E as pre-operational baseline data (see the applicant's Environmental Report and Supplement 2).

The California Department of Fish and Game has conducted studies that:

1. Developed qualitative and quantitative biological descriptions of the biotic community near the plant site to provide background data prior to construction and operation of the discharge facilities.

2. Evaluated simple indices or parameters that can be used for continuing surveillance after the plant is operating to determine quantitatively the effect of discharges upon beneficial uses of ocean water.

The ecological surveys for PG&E were directed by Dr. W. J. North. Locations of all study sites are shown in Figs. 6.1 and 6.2.

In addition to the studies noted above, zooplankton survival tests are underway at operating power plants and sampling at the Diablo Canyon intake is scheduled to begin in 1972 for collection of zooplankton data for this site.

The staff will require that the applicant conduct some additional preoperational studies. Additional work should be done on the effects of ocean current direction and winds on the predicted plume areas.

The biological base-line information is adequate for providing the relative abundance of animals. Postoperational monitoring will only determine gross effects such as the disappearance of species. The more subtle effects, such as changes in food habits, growth, or reproduction, cannot be assessed without additional base-line information on life history and biology of the species in the area. The applicant should obtain this base-line information prior to startup of the first unit.

6.2 OPERATIONAL BIOLOGICAL MONITORING PROGRAM

During operation of the Diablo Canyon Nuclear Plant, a biological monitoring program to collect six types of data will be conducted. The data collection which has been proposed is summarized in Table 6.1.

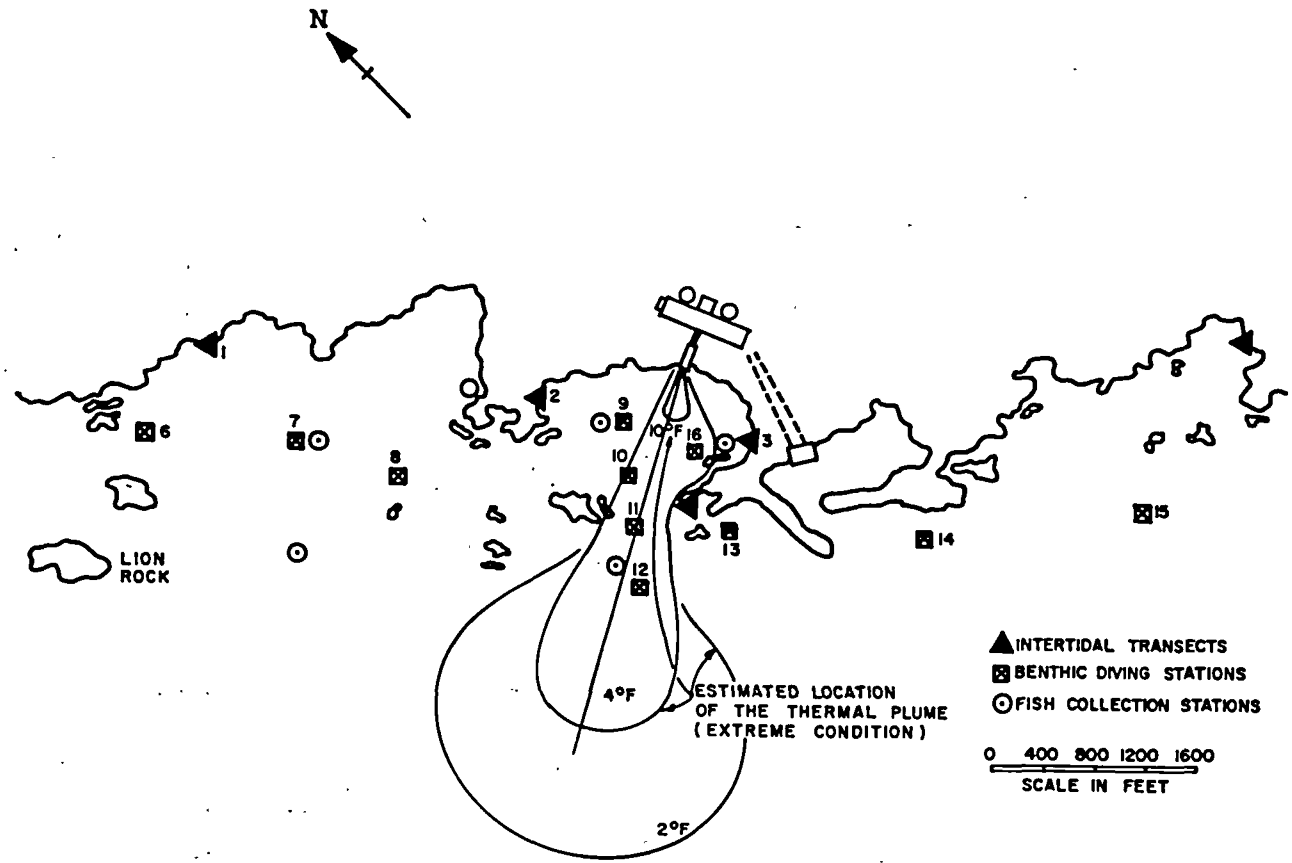


Fig. 6.1. Diablo Canyon study area including locations of permanent intertidal, subtidal, and fish-collection stations of the California Department of Fish and Game.

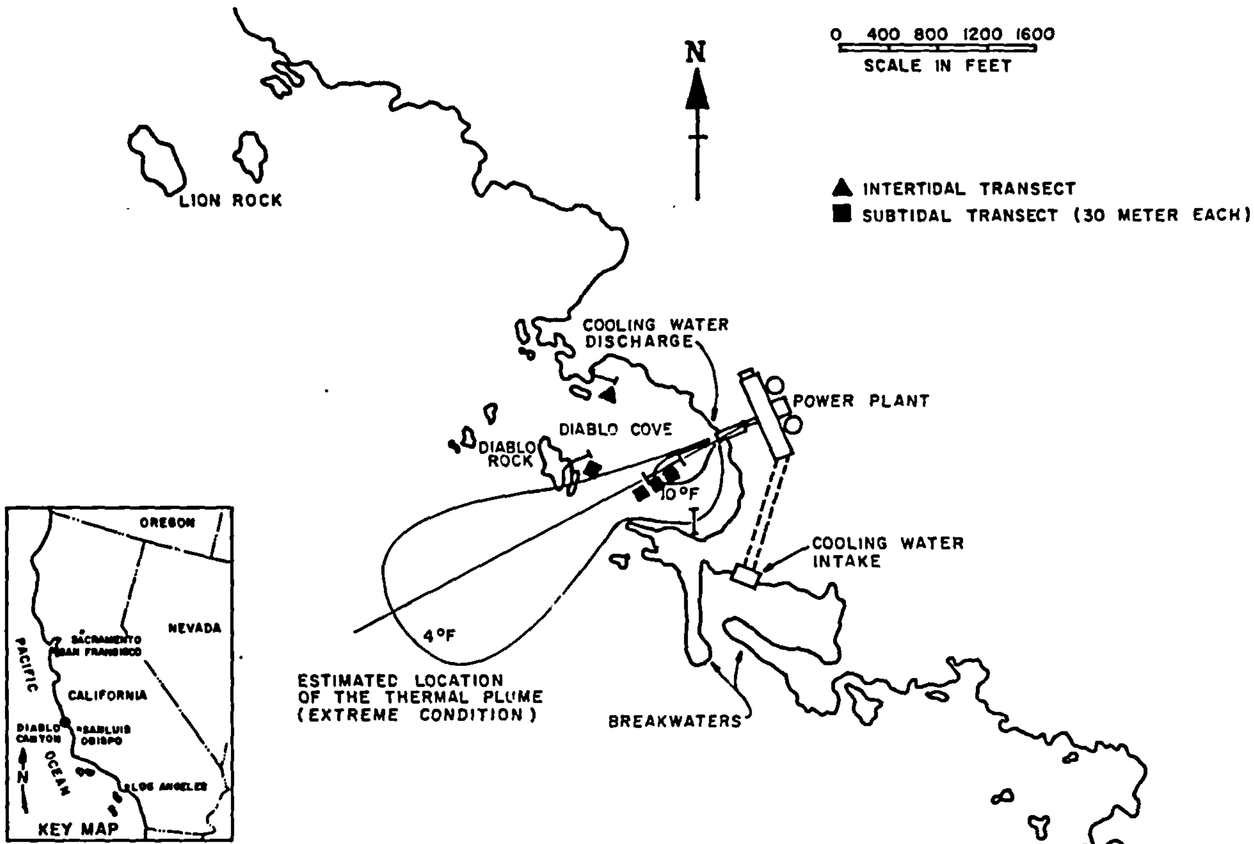


Fig. 6.2. Locations of biological monitoring stations in Diablo Cove and vicinity used by PG&E and consultants.

Table 6.1. Summary of continuing data collection at Diablo Canyon

Type of data	Agency responsible for data collection	Frequency of collection	Method of collection
1. Abalone counts	California Fish and Game	Three times each year[a]	(1) Photographic record of 1/4-m^2 quadrats[b] (2) Actual counting
2. Abalone associates (including food organisms)	Same as 1	Same as 1	Same as 1
3. Marine algae abundance estimates	Same as 1	Same as 1	Actual counting of benthic stations
4. Fish survey	Same as 1	Same as 1	Actual counts when feasible, estimates of large schools
5. Kelp bed distribution	PG & E	(1) October (2) February (3) June[c]	Aerial photographs
6. Complete biota survey (plant and animal) of intertidal and subtidal stations (see Fig. 6.1)	PG & E	Once	Actual counts made by scuba survey along permanent transect where possible

[a]The sampling scheme established by the California Fish and Game Department is conducted during 3 periods of the year: (1) a February and March survey to document the reduced winter flora and fish densities, (2) a survey in June and July to show the early summer algae growth, (3) a September and October survey to show the peak kelp canopy and the more southern migrant fish that frequent this area during the fall.

[b]Permanent benthic diving stations were constructed by cementing 5-ft lengths of 3/4-in. polypropylene rope to the substrate at 10- or 15-m intervals to delineate 30 × 2 m transects. Four benthic stations were positioned along a line bisecting the cove in progressive depths of 20, 35, 50, and 70 ft. A shallow station in 10-ft depths was set in the south corner of the cove (station 16) rather than along the central line of the first four stations to avoid projected construction activities. Six additional stations were set in beds of bull kelp, *Nereocystis luetkeana*, outside the cove, three to the north and three to the south, at about 1/3-mile intervals, to document the seasonal abundance of this important marine alga (Fig. 6.1).

[c]These periods were picked to coincide with significant life cycle periods.

6.2.1 Studies Planned by California Fish and Game

The quantitative studies of the plant and animal populations are being conducted by the California Department of Fish and Game as indicated in Table 6.1 under a Resource Agency Agreement with PG&E.

The biological transect information will be used to monitor the numbers of important sport and commercial marine species and their major predators, competitors, and prey present on the permanent transects. The study areas will continue to be both in the predicted thermal plume area and in the actual plume area during plant operation. California Department of Fish and Game study areas both northwest and southeast of the site (Fig. 6.1) can be used as control areas. Sedentary animals and algae of selected species will be counted, but visual estimates will be used to determine fish abundance. Methods indicated in Table 6.1 will be used at each station.

These studies will provide a relative base line and can be used as indices for gross changes induced by plant operation. Surveys should identify areas of significant ecological importance, including nursery areas, kelp beds, and large concentrations of shellfish.

Photographs will be used to document the types of communities and presence of major species. Underwater rotenone (chem-fish collector) operations will be conducted at selected stations to determine fish species present and their relative abundance.

6.2.2 Studies Planned by PG&E and Consultants

Both intertidal surveys and subtidal surveys using scuba will be conducted. The principal ecological communities will be surveyed qualitatively to identify the thermal impact of the plant on these communities. The permanent transect information can be used to compare the actual impact against the predicted impact after plant operation (Fig. 6.2).

Kelp is a very sensitive monitor of thermal change and will be mapped during periods of significant life cycle occurrences by means of aerial infrared photographs (see Table 6.1).

Studies on the survival of planktonic organisms passing through the cooling water systems of several existing PG&E plants operating in the marine environment have been completed.

Preliminary studies have been conducted to determine the species composition of zooplankton at Diablo Canyon as compared with those at existing plants. In addition, survival studies are planned for Diablo Canyon and other proposed sites.

The staff concludes that the information which the applicant and California Department of Fish and Game propose to collect should allow a valid assessment of the impact of operation resulting from thermal discharge. Further work should be conducted in the intake cove, however, to determine the concentration of small fish and to document the concentration of eggs and larva of aquatic organisms. Additional work to determine the magnitude and significance of losses due to entrainment is needed.

6.3 OPERATIONAL THERMAL AND CHEMICAL MONITORING PROGRAMS

Monitoring of the effluents from the plant operation (both thermal and chemical) and their impact on the receiving waters will be carried out by PG&E. Surface water temperatures are to be taken at two-month intervals beginning in February from Point Buchon to Pecho Rock for a two-year period following operational startup. Isotherms shall be determined in 2°F intervals.

Measurements of water temperature in the months of February, June, and October will consist of data collected at one meter intervals from the surface to the bottom. These sample points are to be prescribed by the Department of Fish and Game inside and adjacent to Diablo Cove. At the same time pH and dissolved oxygen content will be measured.

The following measurements and tests will also be conducted on the discharge:

1. Average volume of waste discharge daily.

2. Oil content of discharge from oil removal facilities — intermittent discharge to be sampled quarterly.

3. pH of discharge — continuously when chemical cleaning of equipment is in progress.

4. Temperature of cooling water intake and discharge — daily.

5. Bioassay (96 hr TLM, using species indigenous to receiving water area) of discharge during prestartup cleaning of equipment and piping. Bioassay of discharge once quarterly during first two years of plant operation.

6. Bacteriological samples shall be collected from the plant effluent at the point of final discharge to determine the most probable number (MPN) of coliform organisms — monthly.

Analysis and collection of samples will be as follows: Temperature, oil, dissolved oxygen, coliform, and pH samples shall be grab samples Chemical and physical analyses of samples and bioassay techniques shall be in accordance with the latest edition of *Standard Methods*, published by the American Public Health Association. The occurrence of any incident causing the level of toxic materials in concentrations detrimental to human, plant, bird, or fishlife shall be reported within 12 hours after its occurrence, and its cause, effect, and corrective action shall be described in detail in the next regular report submitted to the California Regional Water Quality Board.

The staff will require that the applicant submit for approval a more extensive monitoring program, which should include the following, in addition to the above:

1a. Additional onsite chlorine studies will be necessary in order to determine the acute and chronic impacts on both the entrained and receiving water marine life. Chlorine in the discharge shall be monitored continuously during its use.

2a. Additional onsite monitoring in the environment for copper and the other heavy metals, such as nickel and chromium, released by the plant should be included in the monitoring program. The long-term chronic effects of low levels of copper, nickel, and chromium and the potential for buildup in the food chain should be considered.

3a. The temperature of the thermal plume must be monitored hourly for a period of 24 hr whenever the daily average inlet temperature rises 1°F or the station power rises 5% above the level at which a previous measurement was made and at least one time during all defouling operations when the discharge temperature is a maximum. At least two points should be measured, about 300 and 1200 ft from the discharge on the center line of the plume.

6.4 RADIOLOGICAL MONITORING

The U.S. Atomic Energy Commission has jurisdiction and responsibility for radiation matters concerned with nuclear power plants. Nevertheless, the applicant's preoperational environmental radiation monitoring program was developed in cooperation with the State of California Department of Public Health, Bureau of Radiological Health and has been reviewed by other interested State agencies. The program was initiated in December 1969 and has two purposes: (a) to obtain information concerning naturally occurring radioactivity in the vicinity of the site before plant operation begins, and (b) to aid in confirming the effectiveness of waste disposal systems and procedures in protecting the public from radioactivity as a result of power plant operation.

The program consists of gamma dosimetry with thermoluminescent dosimeters (TLD's) and film packs, continuous air particulate sampling with analysis for gross beta activity, and gross beta and gamma analyses of various specimens collected periodically from the site environs.

Gamma dosimetry is performed with two dosimeters and a film pack located at each of the 18 stations shown in Figs. 6.3 and 6.4. The TLD's are collected and analyzed on a monthly basis.

The airborne particulate samplers are located at Stations 1, 9, 12, and 15*. The filters are collected and analyzed on a weekly basis.

Gross beta activity is determined on low background, thin window, gas flow proportional counters at least 72 hours after collection to allow for decay of naturally occurring shortlived radionuclides. The limit of detectability for this proportional counter is about 0.5 pCi/gm of a standard containing K-40.

Marine and terrestrial samples are collected and processed on a quarterly basis. The types of samples collected, sampling location, and sample size are presented in Table 6.2.

Marine and terrestrial samples are collected and processed quarterly. Except for seawater, samples are freeze-dried prior to determining gross beta activity. For the seawater, alkali metals are separated by adding phosphoric acid and sodium carbonate to the sample; the beta activity of the dried precipitate is then determined. The gross beta analysis is performed on the proportional counter described above, and activity per gram is reported on both the original and the dried sample basis.

A gamma scan, using a 3" × 3" NaI(Tl) detector and multichannel pulse height analyzer, is performed on the milk and bovine thyroid samples as received, on evaporated seawater, and on the freeze-dried samples. The limit of detectability attained in the gamma scan is typically 10 pCi/liter of water solution containing the radionuclide I-131 and 5 pCi/liter for Co-60. Freeze-dried samples, randomly selected, are sent to a qualified contractor for confirmatory analysis.

---

*Sampler moved to Station 14 in March 1971.

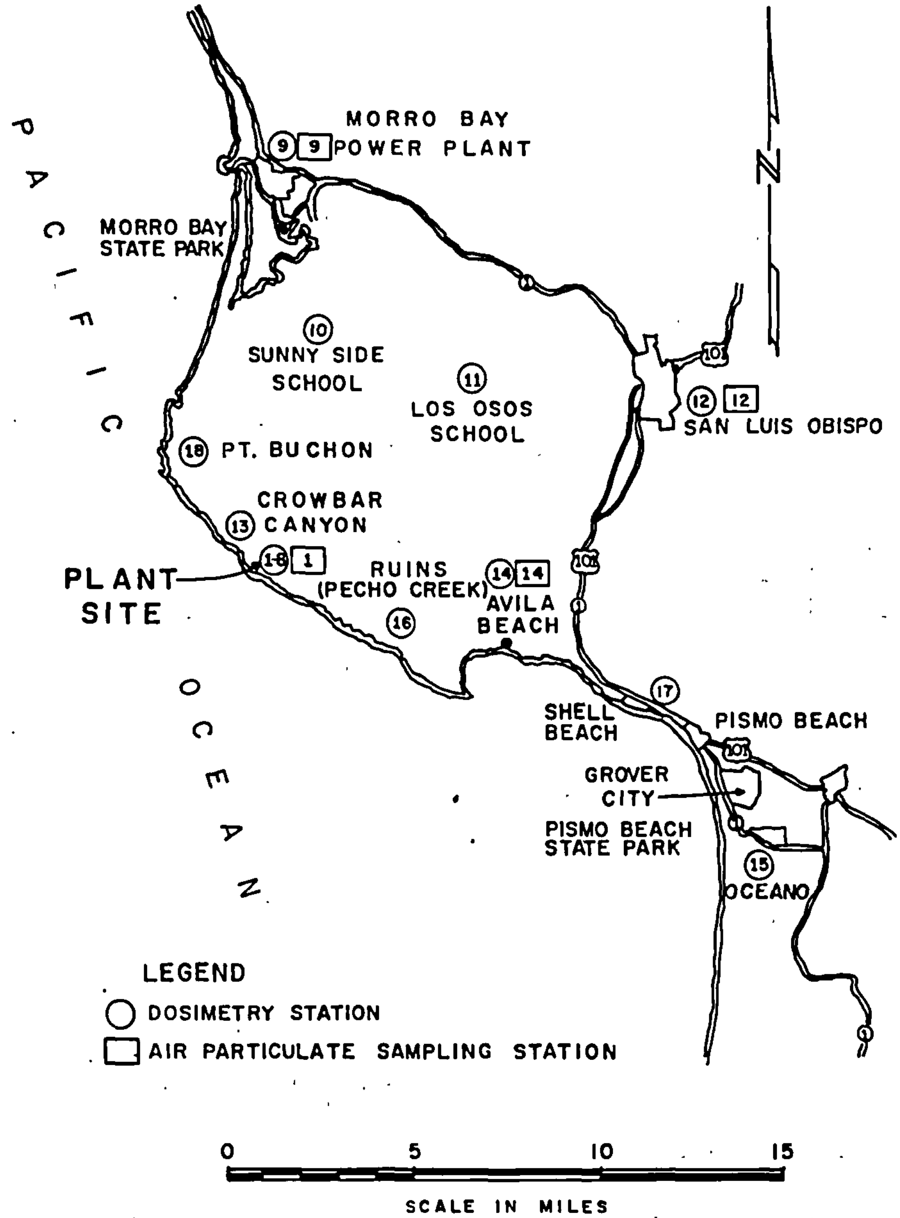


Fig. 6.3. Dosimetry and particulate sampling stations off site.

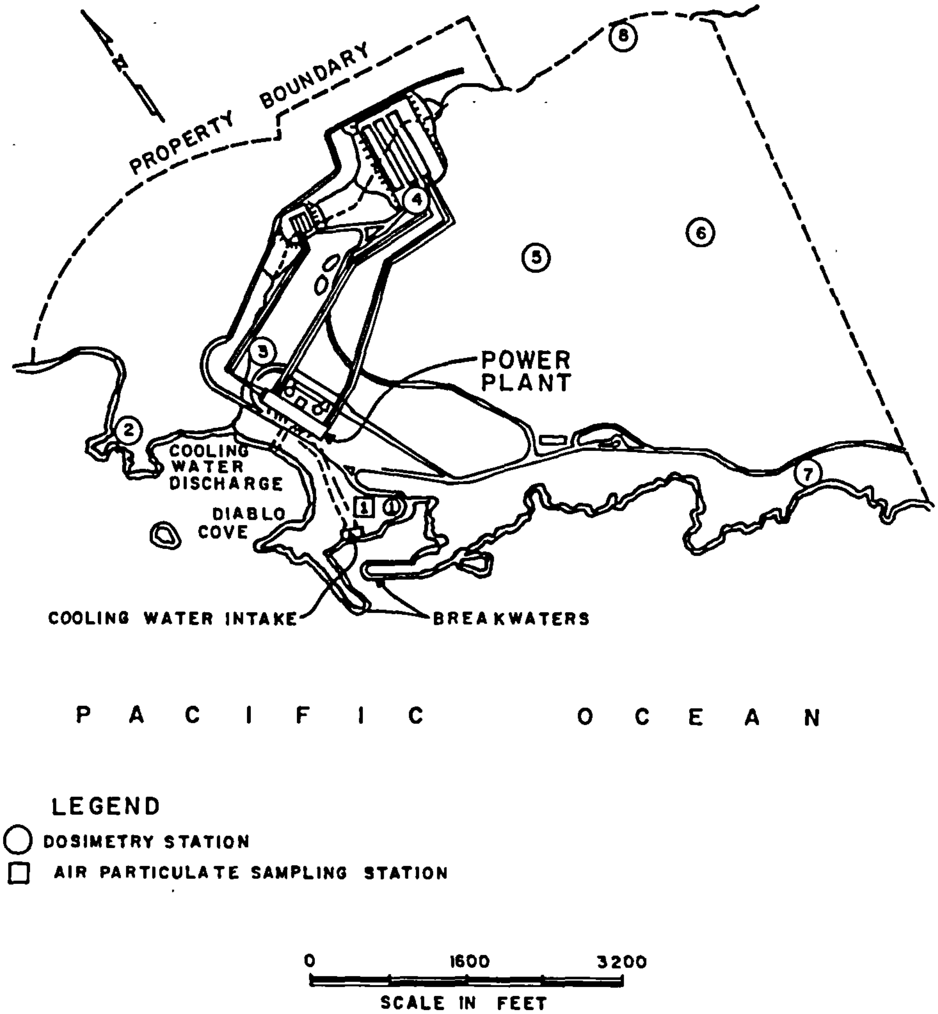


Fig. 6.4. Dosimetry and particulate sampling stations on site.

Table 6.2. Radiological Sampling Program

Samples are collected quarterly except where noted

Sample	Sample size	Collection location
	Marine sample	
Bull kelp (*Nereocystis leutkeana)*	1 kg	Diablo Cove
Red algae, foliose (*Iridaea* sp.)	1 kg	Diablo Cove
Red abalone (*Haliotis rufescens)*	One 7 to 8 in. abalone	Diablo Cove
Black abalone (*Haliotis cracherodii)*	Two 4 to 6 in. abalones	Diablo Cove
Goose barnacles (*Pollicipes polymerus)*	1 kg	Diablo Cove
Mussels (*Mytilus californianus)*	1 kg	Diablo Cove
Pismo clams (*Tivela stultorum)*	1 kg from each location	Pismo Beach and Morro Bay
Rockfish	1 kg (two fish)	Diablo Cove
Seawater	1 gal	Diablo Cove
Perch	1 kg	Diablo Cove
Red abalone[a,b] (*Haliotis rufescens)*	1 whole abalone in shell (if possible)	In vicinity of Diablo Canyon (El Morro Abalone Plant, Morro Bay)
Salmon[a,b]	1 kg	Commercial landing in Morro Bay
Rockfish[a]	1 kg	Commercial landing in Morro Bay

Table 6.2 (continued)

Sample	Sample size	Collection location
	Terrestrial sample	
Groundwater	1 gal	Diablo Creek above 500-kV switchyard
Milk	1 gal from each dairy	Cal Poly Dairy; M. Albertoni Dairy, 2 miles west of Guadalupe on Highway 1
Leafy vegetables[b]	1/2 kg from each farm	Cal Poly Farm; Bill H. Kawaoka, Star Route Box 7-A, Arroyo Grande; M. Albertoni Dairy, Guadalupe
Bovine thyroid	As available, 100 g minimum	From cattle raised on local grazing lands
	Bottom sample	
Sediment	1/2 gal	From north and south Diablo Cove

[a]Commercial samples.

[b]Sampled quarterly when in season.

6.4.1 Presentation of Results and Contact with the State

The results of the environmental radiation monitoring program are also reported quarterly to the State of California Department of Public Health.

The State of California, Department of Public Health, Bureau of Radiological Health, participates in a joint program of sampling and comparative analysis with PG&E once a year. Duplicate samples are taken by both parties and analyses are made. Results are compared as a check on equipment and technique.

In accordance with its responsibilities, the staff has carefully reviewed this radiological monitoring program and considers it to be adequate for establishing baseline data prior to the operation of the station. The staff will continue review of the program and adjustments will be considered in establishing the station's technical specifications and operational monitoring program.

REFERENCES FOR SECTION 6

1. Pacific Gas and Electric Company, *Environmental Report, Supplement No. 2, Units 1 and 2, Diablo Canyon Site*, July 1972.

2. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2, Diablo Canyon Site, Appendix F*, 1971.

7. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

7.1 PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Nuclear Units 1 and 2 - Diablo Canyon Site is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as considered in the staff's Safety Evaluations dated January 23, 1968 and November 18, 1969. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in the staff's safety reviews, extremely conservative assumptions were used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. The computed doses that would be received by the population and environment from actual accidents would be significantly less than those presented in the safety evaluations.

The staff issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicants' response was contained in the "Supplement to Environmental Report Units 1 and 2 - Diablo Canyon Site," dated November 9, 1971.

The applicants' report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the staff on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the staff. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant are presented in Table 7.1

Table 7.1. Classification of postulated accidents and occurrences

Classes	Description	Applicants' Examples
1.	Trivial incidents	Expected releases from normal operation with small primary system leakage or small steam generator leakage
2.	Miscellaneous small releases	Temporary occurrence of larger primary system leakage; loss of main condenser cooling.
3.	Radioactive waste system failures	Minor releases from chemical and volume control system or from waste gas and vent header system.
4.	Events that release radioactivity into the primary system (BWR)	Events which release radioactivity into the primary system.
5.	Events that release radioactivity into primary and secondary systems (PWR)	Temporary occurrence of larger steam generator leakage.
6.	Refueling accidents inside containment	Fuel handling accident inside containment building.
7.	Accidents to spent fuel outside containment	Fuel handling accident inside fuel handling building; spent fuel shipping accident; release of radioactivity from packaged radioactive wastes.

Table 7.1 (continued)

Classes	Description	Applicants' Examples
8.	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Loss of reactor primary coolant, control rod ejection accident; steam generator tube rupture accident; steam line rupture accident; major release from chemical and volume control system or from waste gas and vent header system.
9.	Hypothetical sequences of failures more severe than Class 8	None

and are reasonably homogeneous in terms of probability within each class, although we consider a major release from the waste gas and vent header system as more appropriately in Class 3 and the steam generator tube rupture as more appropriately in Class 5. Certain assumptions made by the applicant did not exactly agree with those in the proposed Annex to Appendix D, but the use of alternative assumptions does not significantly affect overall environmental risks.

The staff estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population around the site for the year 1980. (The projected population was based on 1960 census data.)

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation, but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers); quality assurance for design, manufacture, and operation; continued surveillance and testing; and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficently small in probability that the environmental risk is extremely low.

Table 7.2. Summary of radiological consequences of postulated accidents[a]

Class	Event	Estimated fraction of 10 CFR Part 20 at site boundary[b]	Estimated dose to population in 50-mile radius, man-rems
1.0	Trivial incidents	*c*	*c*
2.0	Small releases outside containment	*c*	*c*
3.0	Radioactive waste system failures		
3.1	Equipment leakage or malfunction	0.044	0.92
3.2	Release of waste gas storage tank contents	0.18	3.6
3.3	Release of liquid waste storage tank contents	0.005	0.1
4.0	Fission products to primary system (BWR)	N.A.[d]	N.A.[d]
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	*c*	*c*
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.001	<0.1
5.3	Steam generator tube rupture	0.058	1.2
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.009	0.19
6.2	Heavy object drop onto fuel in core	0.16	3.4
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.006	0.12
7.2	Heavy object drop onto fuel rack	0.024	0.49
7.3	Fuel cask drop	N.A.[d]	N.A.[d]
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-coolant accidents		
	Small break	0.094	3.6
	Large break	0.92	120
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.[d]	N.A.[d]
8.2(a)	Rod ejection accident (PWR)	0.092	12
8.2(b)	Rod drop accident (BWR)	N.A.[d]	N.A.[d]

Table 7.2 (continued)

Class	Event	Estimated fraction of 10 CFR Part 20 at site boundary[b]	Estimated dose to population in 50-mile radius, man-rems
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small break	<0.001	<0.1
	Large break	<0.001	<0.1
8.3(b)	Steamline breaks (BWR)	N.A.[d]	N.A.[d]

[a]The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. Our evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to an incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken, if necessary, to limit exposure from other potential pathways to man.

[b]Represents the calculated fraction of whole body dose of 500 millirems or the equivalent dose to an organ.

[c]These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 millirems/year to an individual from either gaseous or liquid effluents).

[d]Not applicable.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials within the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity, which corresponds to approximately 34,000 man-rems/year based on a natural background level of 0.1 rem/year. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

7.2 TRANSPORTATION ACCIDENTS

7.2.1 Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation and the Atomic Energy Commission. The regulations provide protection of the public and transport workers from radiation. This protection is achieved by a combination of standards and requirements applicable to packaging, limitations on the contents of packages and radiation levels from packages, and procedures to limit the exposure of persons under normal and accident conditions.

Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet regulatory standards[1] established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation. The standards provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The contents of packages not designed to withstand accidents are limited, thereby limiting the risk from releases which could occur in an accident. The contents of the package also must be limited so that the standards for external radiation levels, temperature, pressure, and containment are met.

Procedures applicable to the shipment of packages of radioactive material require that the package be labelled with a unique radioactive materials label. In transport the carrier is required to exercise control over radioactive material packages including loading and storage in areas separated from persons and limitations on aggregations of packages to limit the exposure of persons under normal conditions. The procedures carriers must follow in case of accident include segregation of damaged and leaking packages from people and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipment and trained personnel, if necessary, in such emergencies.

Within the regulatory standards, radioactive materials are required to be safely transported in routine commerce using conventional transportation equipment with no special restrictions on speed of vehicle, routing, or ambient transport conditions. According to the Department of Transportation (DOT), the record of safety in the transportation of radioactive materials exceeds that for any other type of hazardous commodity. DOT estimates approximately 800,000 packages of radioactive materials are currently being shipped in the United States each year. Thus far, based on the best available information, there have been no known deaths or serious injuries to the public or to transport workers due to radiation from a radioactive material shipment.

Safety in transportation is provided by the package design and limitations on the contents and external radiation levels and does not depend on controls over routing. Although the regulations require all carriers of hazardous materials to avoid congested areas[2] wherever practical to do so, in general, carriers choose the most direct and fastest route. Routing restrictions which require use of secondary highways or other than the most direct route may increase the overall environmental impact of transportation as a result of increased accident frequency or severity. Any attempt to specify routing would involve continued analysis of routes in view of the changing local conditions as well as changing of sources of material and delivery points.

7.2.2 Exposures During Normal (No Accident) Conditions

New Fuel

Since the nuclear radiations and heat emitted by new fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For 10 to 14 shipments, with two drivers for each vehicle, the total dose would be about 0.02 man-rem per year based on 70 hours of driving time per shipment and average radiation level in the cab of the truck estimated at 0.01 mrem/hr. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 3 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small.

Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, the staff estimates the radiation level at 3 feet from the railcar or truck will be about 25 mrem/hr.

The average exposure to the individual truck driver during a 16-mile shipment of irradiated fuel is estimated to be about 0.2 mrem. With 2 drivers on each vehicle, the annual cumulative dose for 10 to 18 shipments would be about 0.007 man-rem.

During transhipment of the spent fuel containers from the truck to the railcar exposure of persons will be generally limited to those loosening or attaching tie-downs and manipulating lifting hooks. Transfer of containers to railcar will require use of cranes. The staff estimates that it may require half an hour exposure at an average distance of 3 feet from each cask or about 12 mrem exposure for each of 2 persons handling the containers. For the 10 to 18 shipments, the cumulative annual dose would be about 0.4 man-rem or less. The crane operator and other workers in the area would be unlikely to receive any significant exposure.

Train brakemen might spend up to 10 minutes in the vicinity of the car for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose for 4 to 9 shipments is estimated to be about 0.09 man-rem or less.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck or railcar, might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose for the 10 to 18 shipments would be about 0.2 man-rem. Approximately 500,000 persons who reside along the 3000-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.6 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average about 300 persons per square mile along the route east of the Mississippi River and 100 persons per square mile west of the Mississippi River.

The amount of heat released to the air from each cask will be about 70 kw for a rail cask. This might be compared to about 50 kw of waste heat which is released from a 100 horsepower truck-engine. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

Solid Radioactive Wastes

Under normal conditions, the average exposure to the individual truck driver during a 1000-mile shipment of solid radioactive waste is estimated to be about 40 mrem. If the same driver were to drive 9 truckloads in a year, he could receive an estimated dose of about 360 mrem during the year. With 2 drivers on each vehicle, the annual cumulative dose for 9 shipments would be about 0.7 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 0.6 man-rem. Approximately 100,000 persons who reside along the 1000-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.05 man-rem. These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming about 100 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

7.2.3 Exposures Resulting from Postulated Accidents

Based on recent accident statistics,[3] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipments-miles. The staff has estimated that only about 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[4] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel, limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet from the accident might receive a serious exposure. Beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 feet. There would be very little dispersion of radioactive material.

Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

(a) Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the plant.

Leakage of liquid at a rate of 0.001 cc per second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

(b) Release of gases and coolant is an extremely remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 feet or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[5] of the Environmental Protection Agency.

Solid Radioactive Wastes

It is highly unlikely that a shipment of solid radioactive waste will be involved in a severe accident during the 40-year life of the plant. If a shipment of low-level waste (in drums) becomes involved in a severe accident, some release of waste might occur but the specific activity of the waste will be so low that the exposure of personnel would not be expected to be significant. Other solid radioactive wastes will be shipped in Type B packages. The probability of release from a Type B package, in even a very severe accident, is sufficiently small that, considering the solid form of the waste and the very remote probability that a shipment of such waste would be involved in a very severe accident, the likelihood of significant exposure would be extremely small.

In either case, spread of the contamination beyond the immediate area is unlikely and, although local clean-up might be required, no significant exposure to the general public would be expected to result.

Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages ensure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

7.2.4 Alternatives to Normal Transportation Procedures

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the containers, and constructing a fuel recovery and fabrication plant on the site rather than shipping fuel to and from the station, have been examined by the Staff for the general case. The impact on the environment of transportation under normal or postulated accident conditions is not considered to be sufficient to justify the additional effort required to implement any of the alternatives.

REFERENCES FOR SECTION 7

1. 10 CFR Part 71; 49 CFR Parts 173 and 178.

2. 49 CFR § 397.1(d).

3. Federal Highway Administration, "1969 Accidents of Large Motor Carriers of Property," December 1970; Federal Railroad Administration Accident Bulletin No. 138, "Summary and Analysis of Accidents on Railroads in the U. S.," 1969; U. S. Coast Guard, "Statistical Summary of Casualties to Commercial Vessels," December 1970.

4. 49 CFR §§ 171.15, 174.566, 177.861.

5. Federal Radiation Council Report No. 7, "Background Material for the Development of Radiation Protection Standards; Protective Action Guides for Strontium 89, Strontium 90, and Cesium 137," May 1965.

8. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

The construction and operation of the Diablo Canyon Nuclear Station will cause 750 acres of land to be removed from use as grazing land and to be committed to use for power production for the life of the plant. Similarly, 750 acres of approximately 6,000 acres of transmission line rights-of-way will be committed to use as service roads and transmission tower bases for the plant.

During construction of the transmission lines, there will be a loss of vegetation near the access roads. The loss will result in visible scarring in areas of steep terrain and may cause increased erosion and loss in productivity near the eroded areas.

The applicant has been directed to monitor specific sites having a high potential for erosion, and further, to take protective measures to alleviate this problem.[1] As reported in Sect. 4.2.2 and in Appendix A4-1, initial efforts at stabilizing erosion have been fairly successful. Continued surveillance and implementation of abatement procedures will aid revegetation and minimize potential long-term erosion and loss of productivity.

The visibility of transmission towers and access roads constitutes a potential adverse aesthetic impact.

Some benthic area (∿14 acres) has been lost as habitat due to the construction of intake and discharge structures and the building of a breakwater. In addition, losses of benthic organisms have resulted from construction at the Avila Beach barge landing.

Operation of the plant will cause an ecological shift in benthic organisms and fish that will result in an increase in the frequency of warm water tolerant forms. It is also expected that the feeding activity of the giant urchin (*Strongylocentrotus franciscanus*) will be increased. This increase in feeding activity is expected to result in a reduction of the bull kelp (*Nereocystis*) and cause a decline in the abundance of abalone within Diablo Cove. No noticeable effect is expected outside the cove.

Some losses of zooplankton and young fish are expected from entrainment in the cooling water system as a result of operation of the plant. The impact is unavoidable without use of a totally closed cooling system, but the effect is not considered to be serious. Likewise, some jellyfish will be killed on the intake structures as a result of impingement.

There appears to be some potential for increased mortality of larger avian species from contact with transmission line facilities.

Some additional truck and heavy equipment traffic will result from construction and operation activities.

Some chemicals will be added to the water used for cooling; however, the concentration of these chemicals in Diablo Cove is not expected to have adverse effects on aquatic life.

The operation of the plant will result in some small increase in radioactivity and will create a very low risk of accidental radiation exposure to nearby residents. The operation of the plant will also result in the production of radioactive wastes which must be processed and stored.

REFERENCE FOR SECTION 8

California Public Utilities Commission, Decision No. 79726, Feb. 15, 1972.

9. THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

In preparing a statement on the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, one must attempt to foresee the environmental uses of potential interest to succeeding generations and consider the extent to which a given use might limit or enhance the range of other beneficial uses.

9.1 ENHANCEMENT OF PRODUCTIVITY

The site for the nuclear plant is in a sparsely settled area and was formerly mostly rangeland used for grazing cattle; hence, it was of relatively low economic productivity. The erection of the nuclear power plant will increase the economic productivity by conversion of grazing land to industrial land. Biological productivity will correspondingly be decreased. The applicant[1] states that some of the electrical capacity will be used for rapid transit, irrigation, and other uses benefitting man.

9.2 USES ADVERSE TO PRODUCTIVITY

The staff has attempted to consider all of the effects of construction and operation of a nuclear power plant that would reduce environmental productivity through specific impacts on land, water, and air. Conversion of land use and discharges into the atmosphere and water are effects common to most power plants. The staff concludes that the effects reducing productivity are local and reversible. These effects are briefly discussed below.

9.2.1 Land Use

In converting the site to use for the power plant, some changes in the land are being made through construction of roads, buildings, water intake and discharge structures, and transmission lines. Seven hundred fifty acres of land for grazing are taken out of use. The historical and recreational facilities in the area are not expected to be affected. The transmission lines will extend from the plant site to two substations and another power plant through land that is nearly half grassland, nearly one-sixth agricultural land, and the rest chaparral or brushland not used for commercial purposes.[2] Most of the land traversed by the transmission lines is sparsely populated. The predominant land use is for grazing. Primary recreational uses are for hunting and other activities such as rock collecting. The utilization of lands as outlined for rights-of-way and access roads is not expected to hinder recreational usage. The major impact of the access roads, aside from erosion problems, is the opening up of some relatively inaccessible areas to the general public. This feature is recognized in terms of possible impacts upon rare and endangered wildlife species.

The applicant intends to continue using the site for power generation even after the 30- to 40-year expected life of the reactor. Upon termination of use of the power station, the plant could be decommissioned. This will consist of removing and reclaiming the fuel, decontaminating accessible surfaces of radioactivity or otherwise "fixing" the remaining radioactivity in place, removing salvageable equipment, and final sealing of the reactor and components. Conceivably, much of the facility could be dismantled and the land restored to near its original condition. The degree of dismantlement, as with most abandoned industrial plants, would be contingent on a balance of health and safety considerations, salvage values, and environmental impact.

No specific plan for the decommissioning of the plant has been developed. This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor and the Elk River Reactor.

There are several alternatives which can be and have been used in the decommissioning of reactors: 1) Remove the fuel (possibly followed by decontamination procedures), seal and cap the pipes, and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. 2) In addition to the steps outlined in 1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. 3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures 1) and 2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative 3) would not require any subsequent surveillance.

9.2.2 Water Use

The range of ground and surface water uses will not be curtailed significantly in the long term. Ocean water will be used for cooling and for discharge of liquid waste. The applicant will be required to monitor the effects of these.

Outside of Diablo Cove, plant operation is not expected to have an adverse effect on either sport or commercial fishing. Inside Diablo Cove there will be a decrease in abalone and kelp, but these species would presumably reestablish themselves to a level equal to that before operation after use of the power plant ceases.

Some 14-1/2 acres of benthic area in the sea are lost as a result of construction of breakwaters and intake and discharge structures. Some area and the associated benthic organisms ordinarily harvested there were temporarily lost because of the construction of the barge landing at Avila Beach.

REFERENCES FOR SECTION 9

1. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2, Diablo Canyon Site*, A.E.C. Dockets 50-275 and 50-323, San Francisco, California, July 1971, p. 67.

2. *Open Space Plan*, San Luis Obispo County, California, December 1971.

10. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

In this chapter, we discuss the commitments of resources involved in the construction and operation of the Diablo Canyon nuclear power plant. NEPA[1] requires each Federal agency to prepare a detailed statement on "any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented." Irreversible commitments generally concern changes set in motion by the proposed action which, at some later time, could not be altered so as to restore the present order of environmental resources. For example, if the action the applicant now proposes to take would affect aquatic organisms essential to maintaining a fish population to the extent that the population deteriorates beyond the point of rehabilitation, then operation would entail an irreversible commitment of water resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable economically for subsequent utilization.

10.1 COMMITMENTS CONSIDERED

A wide range of possible resource commitments must generally be considered for nuclear power plants. Many of these commitments will be similar for all plants of the same size and type. The types of resources of concern in this case can be identified as:

(1) material resources;
(2) nonmaterial resources.

Resources which would be irreversibly or irretrievably committed by the operation are:

(1) construction materials which cannot be recovered and recycled with present technology;

(2) materials which are rendered radioactive and cannot be decontaminated;

(3) materials consumed or reduced to unrecoverable forms of waste, including uranium-235 and -238 consumed;

(4) the atmosphere and bodies of water used for disposal of heat and certain waste effluents to the extent that other beneficial uses are curtailed;

(5) land areas rendered unfit for other uses:

(6) other environmental qualities degraded.

10.2 MATERIAL RESOURCES

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials, but there are numerous other mineral resources incorporated in the physical plant.

Consideration needs to be given to the possibility of recycling such materials after present use ends. The applicant[2] has expressed plans to continue using the site for power generation even after the end of the 30- to 40-year expected life of the nuclear power plant. If this is done, some of the structures, and therefore some of the materials, will continue to be used without recycling. The value of some materials is such that economics clearly promotes recycling; for other materials it does not. Assuming the possible necessity of eventually decommissioning the plant, the applicant[2] also has made estimates of the quantities of resulting reclaimable and un-reclaimable materials and has listed components presumed to become sufficiently radioactive to require AEC license.

The uranium is the most valuable material irretrievably consumed in plant operation. Energy resources for this country are estimated to be equivalent to 27×10^{21} joules† for all fossil fuels, 62×10^{21} joules for uranium, and 39×10^{21} joules for thorium.*[3-5] The energy values for uranium and thorium are based upon eventual utilization in breeder reactor fuel cycles.

The two reactors in the plant will be fueled with uranium enriched in the isotope uranium-235.

If the two units of this plant operate at 80% of capacity, about 10,700 metric tons of contained natural uranium in the form of U_3O_8 must be produced to feed the plant for forty years.

---

†1 joule is 1 watt-second.

*This considers only reasonably assured reserves and additional potential resources in conventional deposits recoverable at a cost less than \$10 per pound of U_3O_8 or ThO_2. Inclusion of byproduct uranium reserves, and resources recoverable at a cost of \$10 to \$15 per pound of U_3O_8 increases the energy equivalent by 45×10^{21} joule

The 10,700 metric tons of mined natural uranium required to feed the fuel cycle for this two-reactor plant consists of 76 metric tons of uranium-235; with the balance uranium-238. In the power plant itself, 54 metric tons of uranium-235 and 44 metric tons of uranium-238 will be consumed by fission or transmutation. In this process, 12 metric tons of recoverable fissionable plutonium-239 will be produced. We have estimated the additional irretrievable losses of uranium in other portions of the fuel cycle to amount to 1.4 metric tons of uranium-235 and 100 metric tons of uranium-238. A net residium of about 10,500 metric tons of uranium depleted to about 0.2% in uranium-235 would remain. In the long term, this stock of depleted uranium will be utilized as feed material in the fast breeder reactor fuel cycle.

Other materials irretrievably consumed, for practical purposes, are fuel cladding materials, reactor control elements and other components of the reactor core or coolant system that become too radioactive for recycling. Also so consumed are ion exchange resins and other chemicals used in maintenance and operation and in processes such as water treatment and ion exchanger regeneration. The materials so consumed and the reclaimable materials are both listed in Table 10.1.

In the opinion of the staff the consumption of these quantities of materials is justified in view of the electrical energy to be produced by the plant.

10.3 FINANCIAL COMMITMENT

As of June 1, 1972, Unit 1 was 45.6% and Unit 2 was 12.8% complete.[6] Exclusive of transmission lines, $314 million was actually spent, and an additional $150 million was committed. Abandonment of the plant would result in loss of most of the resources already committed in its construction. In its decision[7] the ASLB found that, had construction ceased in June and the plant been abandoned in January 1973, a net capital loss of $293 million would occur, allowing $100 million credit for salvage. If construction continued until January before abandonment, the net loss, allowing the same credit, would be $328 million.

10.4 BIOLOGICAL RESOURCES

A small amount of benthic area in the sea is lost as a result of the construction.

Table 10.1. Consumption of materials used in the Diablo Canyon Power Plant

Material	Quantity used in plant (kg)[a]	
	Consumed	Recoverable
Aluminum	47,568	41,732
Antimony	7.2	
Asbestos	92,534	1,814
Beryllium	2.4	636
Boron	60,844	
Cadmium	324	4.5
Chromium	215,210	
Copper	963,470	2,993,740
Cobalt		0.9
Gold		0.9
Indium	916	
Iron	3,661,738	
Jewel bearings		0.9
Lead		15,340
Manganese	858,399	
Mercury	9	18
Molybdenum	5,847	
Nickel	553,983	
Niobium	1,960	4,536
Platinum		1.8
Silver	5,172	2,314
Tin		136
Titanium	302	0.9
Tungsten		14
Uranium		
Total	97,800	
U-235	53,800	
U-238	44,000	
Zinc	181,439	18,140
Zirconium	282,611	

[a]Pacific Gas and Electric Co., *Environmental Report, Units 1 and 2, Diablo Canyon Site,* AEC Dockets 40-275, 50-323, San Francisco, Calif., Supplement No. 2, July 28, 1972, chap. XIV. Assumes 40-year life of the plant operating at an average of 72.5% of capacity.

Some large percentage of the aquatic species in Diablo Cove and a significant percentage of those entrained in the cooling system will be destroyed. A total of 110,000 abalone may be lost. About a hundred thousand pounds of zooplankton will be destroyed per year. A large number of fish eggs and larvae will be destroyed in the cooling system.

REFERENCES FOR SECTION 10

1. United States of America, 91st Congress, "National Environmental Policy Act of 1969," Public Law 91-190, S. 1075, Sect. 102(2)(C)(v), January 1, 1970.

2. Pacific Gas and Electric Company, *Supplement 2, Environmental Report, Units 1 and 2, Diablo Canyon Site*, Dockets 50-275 and 50-323, San Francisco, California, July 28, 1972.

3. Bureau of Mines, U.S. Department of Interior, *Mineral Facts and Problems*, 1970 ed., pp. 14-19.

4. R. L. Faulkner, "Outlook for Uranium Production to Meet Future Nuclear Fuel Needs in the United States," Fourth United Nations International Conference on the Peaceful Uses of Atomic Energy, Geneva, September 6-16, 1971.

5. United States Atomic Energy Commission, *Statistical Data of the Uranium Industry — January 1, 1972*, Report No. GJO-100, Grand Junction Office, Grand Junction, Colorado.

6. Initial Decision, Atomic Safety and Licensing Board, USAEC, In the Matter of Pacific Gas and Electric Company (Diablo Canyon Nuclear Power Plant, Units 1 and 2), Dockets 50-275 and 50-323, June 5, 1972, p. 9.

7. *Ibid.*, pp. 33-34.

11. NEED FOR POWER

11.1 APPLICANT'S SERVICE AREA SYSTEM

The applicant's service area encompasses about 94,000 square miles in northern and central California. The San Francisco Bay area is the location of major commerical and industrial activities within the service area, but a substantial amount of irrigation for agricultural production occurs in the central valley region. Figure 11.1 shows a schematic map of transmission lines and substations within the western area with the approximate boundary of the applicant's system indicated by a heavy line. Also included within the applicant's area system are agencies which have electrical generating and transmission systems including the Sacramento Municipal Utility District (SMUD), part of the U.S. Bureau of Reclamation's Central Valley Project, part of the California State Water Project, and several irrigation districts. The additions planned by these other agencies are taken into account by the applicant in determining the amount of additional resources that the applicant must add. The applicant also has contractual obligations to exchange power with the Northwest Power Area to the north and the Southwest Region Subareas to the south.

11.2 LOAD AND CAPACITY ESTIMATES

The load and capacity estimates made by the applicant are based on the total resources and commitments of the agencies within the system service area and the net power exchanged under intertie agreements. The service area system load is the total electrical demand measured at the generating units of all plants within the service area plus any power sold.[1]

In 1971 the energy requirements of the service area were 59,645 million kilowatt hours with a peak-hour demand of 10,965 MW. The estimated system resources available to meet the 1971 peak totaled 13,296 MW.[1] The historical growth rate for the peak-hour demand averaged 6.8% per year as computed by the staff from figures supplied by the applicant[2] based on a starting date of 1961.

11.2.1 Load Forecasts

The applicant states[1] that future generating capacity is planned on the basis of independent forecasts for each of the load categories of which the service area system is comprised. These categories include: (1) sales by class of service such as

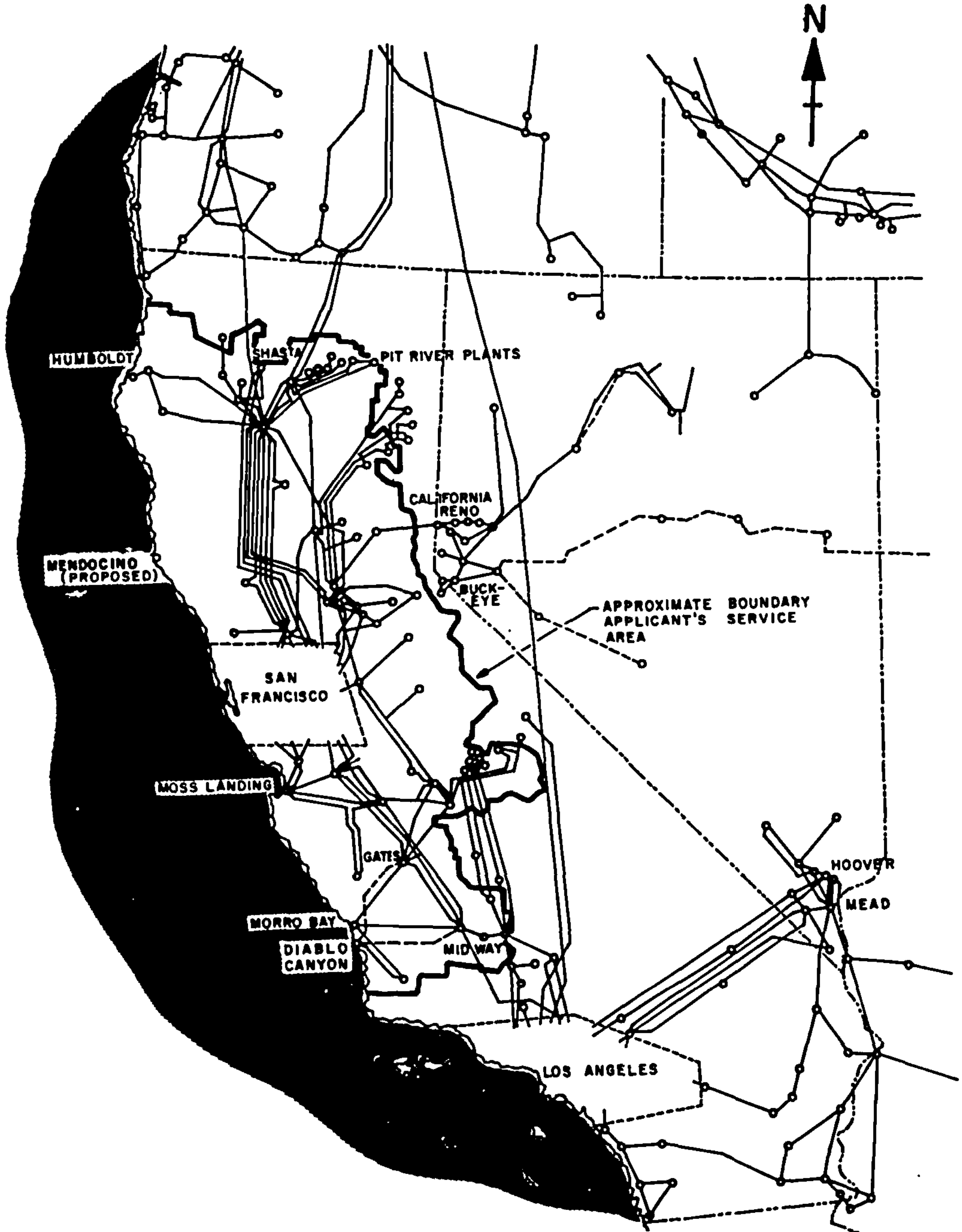


Fig. 11.1 Applicant's service area system.

residential, agricultural, or industrial; (2) special loads that are considered individually such as the Moffat Field Wind Tunnel, the Stanford Linear Accelerator, State Water Project Pumping, and the Bay Area Rapid Transit; and (3) districts and agencies interconnected with and served by the applicant's facilities.

The total energy forecast is the sum of these individual forecasts adjusted from a purely statistical estimate to account for the applicant's knowledge and experience relating to population, future economic activity, public projects, and major appliance saturation.

As a result of this adjustment, the applicant has forecast a growth rate that averages only 6.05% per year (as calculated by the staff) for the next ten years compared to the statistical estimate of 6.8%. Figure 11.2 shows the applicant's peak-hour demand compared to the applicant's own estimate of system resources. The annual growth rate of 6.8% for the 10 years prior to 1971 results in a peak-hour demand of 19,800 MW in 1980; however the applicant's estimate in 1972 modified to account for the other factors he considers resulted in an estimate of only 18,600 MW for the 1980 peak-hour demand. A comparison of the applicant's past forecasts with actual loads shows that the applicant has predicted the peak-hour demands five years in advance within ±5% for each of the last ten years. The staff concludes that the applicant's lower estimate of future power needs reflects refinements in the estimating process not incorporated in methods available to the staff. Although the indicators used by the staff show significantly higher growth rates than the applicant's estimations, the staff concludes that the applicant's values represent valid estimates of load growth rate.

The question of whether or not future load growth will follow the historical rate is all-important in estimating the need for power. The applicant obviously does not expect past growth rates to continue as evidenced by the data presented in Fig. 11.2. If for some reason the estimated future rate of growth should be further reduced, appropriate revisions would be necessary in the long-range load planning of the applicant. However, anything but zero load growth only delays the need for power (and does not account for obsolescence of existing capacity), and the effects of any reduced growth rate will not be felt immediately unless a substantial reduction occurs. For example, a growth rate 1/2 as great as that estimated by the applicant would not make a

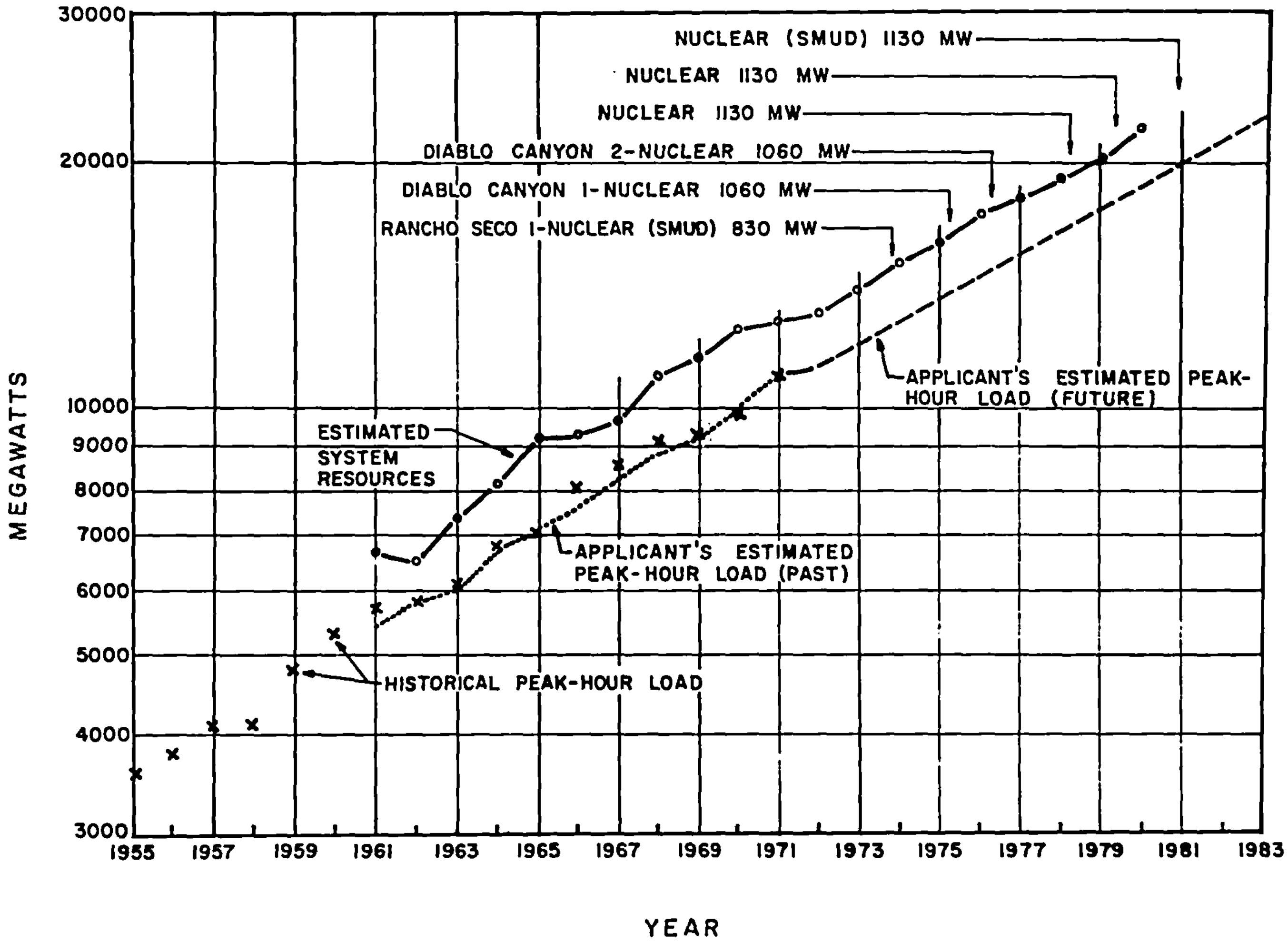


Fig. 11.2 System loads and resources.

difference of 1000 MW in estimated peak load for over 3 years in the applicant's service area (12,000 MW compounded annually at 3% versus 6%). Therefore, anything but a drastic and immediate change in growth rate would not substantially alter the applicant's load estimates for the years 1975 and 1976.

11.2.2 Resource Planning

Capacity in excess of estimated load is necessary to increase the probability of maintaining uninterrupted service to all firmly committed loads.[3] Some uncertainties which must be accounted for are higher-than-predicted loads, dry weather (which decreases hydroelectric capacity and increases irrigation pumping loads), delay in startup of new units, transmission line failures, and forced outages of generating units.[4]

The applicant states[1] that he uses two criteria in determining the amount of reserve capacity needed in his system. One criterion is a reliability index expressed as the number of years of operation per day of probable load loss. The applicant desires to maintain a reliability index of 10 which is equivalent to loss of load on one day every 10 years. (Typical index requirements range from 5 to 20 in other utilities' reserve criteria.) The second criterion is to allow a contingency reserve capacity at least equal to the size of the two largest generating units in the system plus any capacity reductions resulting from scheduled maintenance. In 1975 the two largest units based on existing schedules and exclusive of Diablo Canyon will total 1,565 MW. This amount should be considered as a minimum value because the applicant has over 225 generating units in service and it is unlikely that all of them can be scheduled to operate during the peak month even though it is the applicant's intent to do so.[1]

The applicant's stated reserve capacity without Diablo Canyon is 1,657 MW.[1] Since this is a dry year estimate, it is possible that this reserve will be marginally adequate for contingencies. Without Diablo Canyon in 1976 the reserve capacity as estimated by the applicant drops to 929 MW, and to 722 MW in 1977, while the reserve requirements will remain at 1,565 MW.

Additional generating capacity of about 1000 to 1500 MW would be required in 1976 to meet the applicant's contingency reserve criterion, but the 2120 MW capacity represented by Diablo Canyon Units 1 and 2 probably could not be justified solely on the basis of a contingency reserve criterion until 1977 or 1978.[3] There are other factors to consider, however. One is that the applicant wishes to achieve economies of scale associated with large nuclear plants. Thus, it would not necessarily be a wise decision to build two plants totaling 1500 megawatts simply because this amount is what will be required for one year. Diablo Canyon will represent a significant percentage of the applicant's added capacity for several years to come, and justification for this capacity must therefore consider that it will be needed in full by 1977 or 1978 although only a portion is required 2 or 3 years earlier. A second factor to consider is that the applicant's system has about 40% hydroelectric capacity which is deemed by the applicant and others[3] to be peaking capacity. Future expansion, while based on peak loads, must include substantial amounts of base-load capacity in order to meet the added energy requirements in the system. Thus Diablo Canyon is planned for operation at 80% capacity factor from the onset in order to retire older and less efficient units to peaking service as well as to relieve the possibility of having to run peaking plants as base load plants.

Finally, the applicant has calculated the reliability index for his system with and without Diablo Canyon.[1] In 1975 the index without Diablo Canyon will range from 1.4 to 4.7 depending upon the availability of emergency support in the form of peaking capacity from neighboring utilities. In 1976 the index will be 0.3 without Diablo Canyon but with full emergency support where an index of 0.3 is equivalent to a probable load loss at peak capacity every 3 or 4 months. With Diablo Unit 1 in 1975, this index will be 44 with full support while in 1976 the index with Diablo Units 1 and 2 will be 26. The importance of Units 1 and 2 in 1977 is emphasized by a reliability index of 7.5 in 1977 with both units operating, which is below the criterion of 10 desired by the applicant.

The reliability index was analyzed qualitatively by the staff. The index considers such events as the failure to meet schedule of the 735-MW Pittsburg fossil unit and the 830-MW Rancho Seco nuclear unit, and it includes the probability of forced outages of existing units that would eliminate the reserve capacity.

Other factors included are the probability of transmission line loss or other common mode failures. The staff has judged these numbers by observing the relatively low reliability index without Diablo Canyon as compared to a relatively high index with Diablo

Canyon until 1977. The staff analyzed the reliability index by calculating the data in Table 11.1 which shows the one-year loss of load probability equivalent to a stated reliability index. The staff viewed a difference in loss of load probability of a factor of five as significant. Based on this criterion for significance, an index of 5 or 26 is not significantly different from 10. The index of 7.5 with Diablo Canyon in 1977 would therefore probably be adequate when judged against the applicant's criterion of 10. This index would drop to 2.9 without emergency support, however, which the staff judges to be a marginal level of reliability, if not inadequate.

11.3 CONCLUSIONS

The staff concludes that the applicant's estimate of peak demand is a reasonable estimate that has been adjusted downward from the historical trend. The system capacity is such that in 1975 and 1976 at least part of the generating capacity of Diablo Canyon Units 1 and 2 will be needed to fulfill reliability commitments; however, the need for base-load capacity by the applicant is acknowledged by the staff to be an important justification for the total capacity of Diablo Canyon Units 1 and 2 prior to 1977. The staff concludes that the total capacity of Diablo Canyon will be needed by 1977 to fulfill the applicant's reliability criteria.

Table 11.1. Comparison of reliability index with probable load loss

Index	Loss of load probability
0.3	9×10^{-3}
1.4	2×10^{-3}
5	5×10^{-4}
9	3×10^{-4}
10	2.8×10^{-4}
26	1×10^{-4}
44	6×10^{-5}

REFERENCES FOR SECTION 11

1. Pacific Gas and Electric Company, *Supplement No. 2, Vol. I, Environmental Report, Units 1 and 2, Diablo Canyon*, July 1972.

2. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2, Diablo Canyon Site*, Docket Nos. 50-275 and 50-323, July 1971.

3. Letter from S. P. Crum, Deputy Chief Bureau of Power, FPC, to R. S. Boyd, Assistant Director for Boiling Water Reactors, Division of Reactor Licensing, USAEC, dated Feb. 9, 1972, Docket Nos. 50-275 and 50-323.

4. Testimony of J. K. Newton, Staff Electrical Engineer with FPC as recorded in transcript of Show-Cause Hearing at San Luis Obispo County, May 19, 1972, Docket Nos. 50-275 and 50-323, p. 511.

12. ALTERNATIVES

12.1 ALTERNATIVE SOURCES

The need for power in the applicant's service area requires the addition of 1500 to 2000 MW of generating capacity by 1977 (see Section 11). In addition, the applicant's economic incentive to add base-load generating capability in 1975 and 1976 coupled with the need for added reserve capacity of 500 to 1000 MW in those years results in an earlier need for the added capacity. Thus, in a period of from 2 to 4 years starting in 1973, the applicant will require 1500 to 2000 MW of additional capacity that is to be supplied by Diablo Canyon Units 1 and 2.

This time constraint eliminates many alternative sources of power from consideration. Large fossil plants require 5 to 7 years of planning and construction while hydroelectric or nuclear power plants would require even more time.[1] Nevertheless, the lack of availability of low-sulfur coal and oil fuel and the shortage of natural gas seriously affect the viability of the fossil fuel alternative at the Diablo site.[2] The most obvious way in which the applicant can add capacity by 1975 to 1977 is by completing the Diablo Canyon Nuclear units. There are alternative sources that could be made available in time, however — (1) combustion (gas) turbines, (2) geothermal energy, and (3) purchased power— but none of these sources is judged by the staff to be a reasonable alternative to Diablo Canyon with the possible exception of gas turbines.

12.1.1 Geothermal Energy

The applicant plans to add a total of 636 MW of geothermal capacity to his system by the fall of 1976 if present schedules are met. This amount is included in system capacity forecasts, and additional geothermal energy would be required to replace Diablo Canyon Units 1 and 2. Thus a total of over 2000 MW of geothermal capacity would have to be constructed by 1976 to replace Diablo Canyon Units 1 and 2 — more than 3 times the amount presently planned.

Both the applicant and the vendor of the geothermal steam state that more rapid development is not planned at this time, because the geothermal resources are depletable,[3] and the steam vendor considers it unadvisable to speed up development until the effect of the present energy consumption on the geothermal field is assessed. The applicant also wishes to be assured of a steam reserve of 30 years prior to capital investment in a generating plant for that steam. The present 30 year proven reserve of the geothermal field is estimated by the steam vendor to be about 750 MW,[3] with the possible reserve estimated to be between 1000 and 2000 MW.[4]

Thus any plans for capacity in excess of present predictions would require an extensive alteration in the estimates of the capacity of the geothermal fields. Estimates have been made that place the geothermal field potential as high as 25,000 MW.[15] There is a considerable amount of controversy on this point, however, and the staff recognizes the importance of proven reserves in the applicant's resource planning. Thus, the proven reserve of about 750 MW is assumed to be reasonable.

The staff does not consider geothermal energy to represent an alternative for more than a small fraction of the capacity of Diablo Canyon Units 1 and 2. Until there is evidence of estimated reserves in excess of the present proven reserves, the applicant could not be expected to consider geothermal energy as a firm source of power in 1975 and 1976 for more than the present estimate of about 750 to 1000 MW, 636 MW of which is already included in estimates of the applicant's system resources in 1976.

Another factor in the geothermal development is that an extensive speedup in development of geothermal energy represents an unknown environmental impact that must be adequately assessed prior to extensive development. Large scale production of geothermal energy may cause subsidence of the land surface. Large scale steam depletion or injection of condensate provides another potential hazard in increased seismic activity which also must be properly considered prior to large scale geothermal commitments.[5]

In addition to these factors, considerations of land use (20 to 30 sq miles per 1000 MW), noise abatement, hydrogen sulfide control, and heat dissipation would probably require more attention for large capacity plants than is presently the situation with relatively small plants.[3,5] The staff therefore concludes that geothermal energy is not a viable alternative to Diablo Canyon.

12.1.2 Combustion Turbines

Combustion turbines are not usually considered as an alternative to nuclear or large fossil plants because the turbine is better suited to peaking service while the other two are better suited to base load. Peaking plants alone are not an economic alternative to base-load plants, since both are required for peak load reliability, which is a key factor in the need for power. There are two major reasons for considering the combustion turbine primarily as peaking service: first is its higher consumption of fuel per kilowatt of generated power, and second is its higher forced outage rate when operated at base load.[1] The primary advantage of combustion turbine generation capacity is that a unit can usually be installed within about 32 months. However, the applicant questions whether or not 36 units (to equal the capacity needed by 1976) could be installed within the 32-month period. The staff concludes, however, that at least a significant portion of the added capacity in 1976 could be met with combustion turbines.

The staff does not recommend combustion turbine capacity as an alternative to Diablo Canyon because of the general unsuitability of combustion turbines for base load service, but the staff does recognize the possible use of combustion turbines as an alternative should Diablo Canyon not be available to the applicant. This alternative will be considered further in the Benefit-Cost Analysis in Section 13.

12.1.3 Purchased Power

The applicant has contractual intertie agreements with utilities to the north and south of his system.[2] At the present time there are no major transmission networks across Nevada to the east (Fig. 11.1), and any lines known to be planned across Nevada are to bring power into Nevada and will not represent sources to the applicant.

The Northwest power pool is presently committed to supply the applicant with 550 MW of peaking capacity in 1975 with existing contracts calling for this amount to decrease to 428 MW by 1981.[2] Emergency power from southern California will likely be available in excess of this amount but will not improve the reserve margin of the applicant's system since it is not guaranteed capacity. This emergency power would raise the reliability index in 1975 without Diablo Canyon from 1.4 to 4.7, but the reserve margin would remain 12.4%. The reliability index in 1976 would be 0.3 with this support, however, and the applicant has been informed recently that additional purchased power from the Northwest is not available.[6]

The utilities to the south are also purchasing peaking capacity from the Northwest power pool and this power is obtained on a transfer basis from the applicant who, in exchange for power from the Northwest power pool, supplies power to the Southern California Utilities. This exchange power plus an added amount purchased directly from the applicant amounts to about 1000 MW transferred from the applicant to his southern neighbors,[2] and is in fact one of the reasons that a site in the southern part of the applicant's system was selected for the 2120 MW of capacity represented by Diablo Canyon. Those utilities will have a reserve margin of 19.1% with capacity supplied by the applicant.[7] The staff therefore concludes that there are no known sources of purchased power available to the applicant.

12.1.4 Not to Provide Power

Another possible alternative, although one that is presently controversial, is to not provide any additional capacity as an alternative to Diablo Canyon Units 1 and 2. The applicant is presently preparing a contingency plan under directive from the FPC to outline the procedures to be followed in load curtailment and peak reduction in the event that capacity is insufficient for demand.[8] Until this plan is formally accepted, the staff can only speculate about the effects of not providing power.

It should be pointed out that forecasts of the need for power are based on historical growth patterns and on assumptions regarding future growth. Any such forecast is subject to error and revision, but the applicant has been somewhat consistent in accurately forecasting power needs at least five years in advance. It would therefore be prudent to assume that the forecast need will exist unless some unexpected event occurs. Barring the occurrence of such an event, the lack of capacity would possibly result in a sequence of predictable events as specified by experts other than the applicant.[1] First, the applicant would probably take steps to forestall load interruption to firm customers by purchasing emergency power, shedding customers who have interruption provisions in their contract, advertising to conserve electrical usage and to relieve peak hours, and finally by voltage reduction (brownouts). The next step would likely be load curtailment of firm customers, and if curtailment is not rapid enough, a blackout would result.

Thus, the alternative of not supplying power is a drastic one and is tied very closely to the need for power. For example, the above events are almost certain to happen in sequence if the demand continues to grow and if no capacity is added, while any of the above events might occur if both demand and capacity were stabilized at 1975 levels without power in the amount of Diablo Canyon. The staff does not consider the alternative of not providing power to be open to the applicant within the framework of existing expectations among the applicant's customers.

12.1.5 Conclusions

The staff concludes that the only alternative to Diablo Canyon open to the applicant would be combustion turbines because of the short length of time in which capacity must be provided. This alternative is evaluated in Section 13. Geothermal energy sources of power are judged by the staff to be in a developmental stage with uncertain capacity in excess of that presently included in the applicant's resource planning. Purchased power in addition to that already included in resource estimates is not available to the applicant.

12.2 ALTERNATIVE SITES

12.2.1 System Balance

While the need for power is based primarily on system reserve or reliability requirements, the acceptable limits of which are largely qualitative judgments, a further need — stability — must be met in the system. The two 500-kV transmission lines of the Pacific Northwest-Pacific Southwest intertie form a significant part of the applicant's system. The applicant states that faults in these lines result in surges that increase in magnitude with the length of line; thus generating capacity to reduce line lengths is necessary to improve system stability.[2]

The location of the plant is therefore closely associated with the applicant's assessment of system balance and stability criteria, making potential plant sites in the northern part of the applicant's system of less value for meeting the load demands of the Bakersfield area in the southern part of the applicant's system. The sites presently being considered for the applicant's Mendocino Plant, for example, are approximately 350 miles from the Midway Substation serving the Bakersfield area, while the sites considered for Diablo Canyon are generally less than 100 miles from the Midway Substation.

The applicant estimates that the Bakersfield area (Fig. 12.1 and Table 12.1) in his system will have a peak load of 2780 MW in 1974, but this area will have a generating capacity of only 1181 MW without Diablo Canyon. Thus, adding capacity to the Bakersfield area not only will improve the system balance which the applicant states will create greater system stability in the event of transmission line faults but will also place added capacity into a service subarea that is substantially deficient.

The major reason for sites being located even 100 miles away from the load center is availability of cooling water.[2] The applicant estimates that at the time the Diablo Canyon site was selected, the available methods of cooling at inland sites would have resulted in evaporative losses of 50,000 to 60,000 acre-ft of water per year. If one considers that a substantial amount of the Bakersfield electrical load is irrigation pumping power, the consumptive use of fresh water to generate this power at an inland site would be at cross purposes with water resource development. The available sites were therefore limited to areas in which cooling water was available, such as the Pacific Coast. Recent developments in dry cooling towers will alter the cooling water shortage problem at inland sites. But these alternative sites even with dry cooling towers are not considered by the staff to be practicable alternatives to Diablo Canyon.

Of the coastal sites considered, the applicant originally chose one located about 20 miles south of Diablo Canyon at the Nipomo Dunes beach area. This site was abandoned by the applicant after several interested parties including the Sierra Club and the California State Resources Agency opposed the construction of a plant closer than 4,000 feet to the shoreline. Diablo Canyon was then selected with the assistance of these groups and the County Planning Commission.[9]

Other sites considered were at Point Sierra Nevada, Cambria, Cayucos, Cuesta, Point Buchon, Avila Beach, Point Sal, Surf, and Jalama. The last three of these sites were rejected because they were located within the Vandenberg Air Force Base exclusion area. Each of the other sites except Avila Beach was rejected on the basis of unfavorable community acceptance since they were located near existing or proposed state parks and in some cases in residential areas. The Avila Beach site was rejected on the basis that the landowner planned extensive development of the area overlooking the site.

Thus, of eleven sites considered, the applicant rejected all but two on the basis of the Vandenberg exclusion area or potential

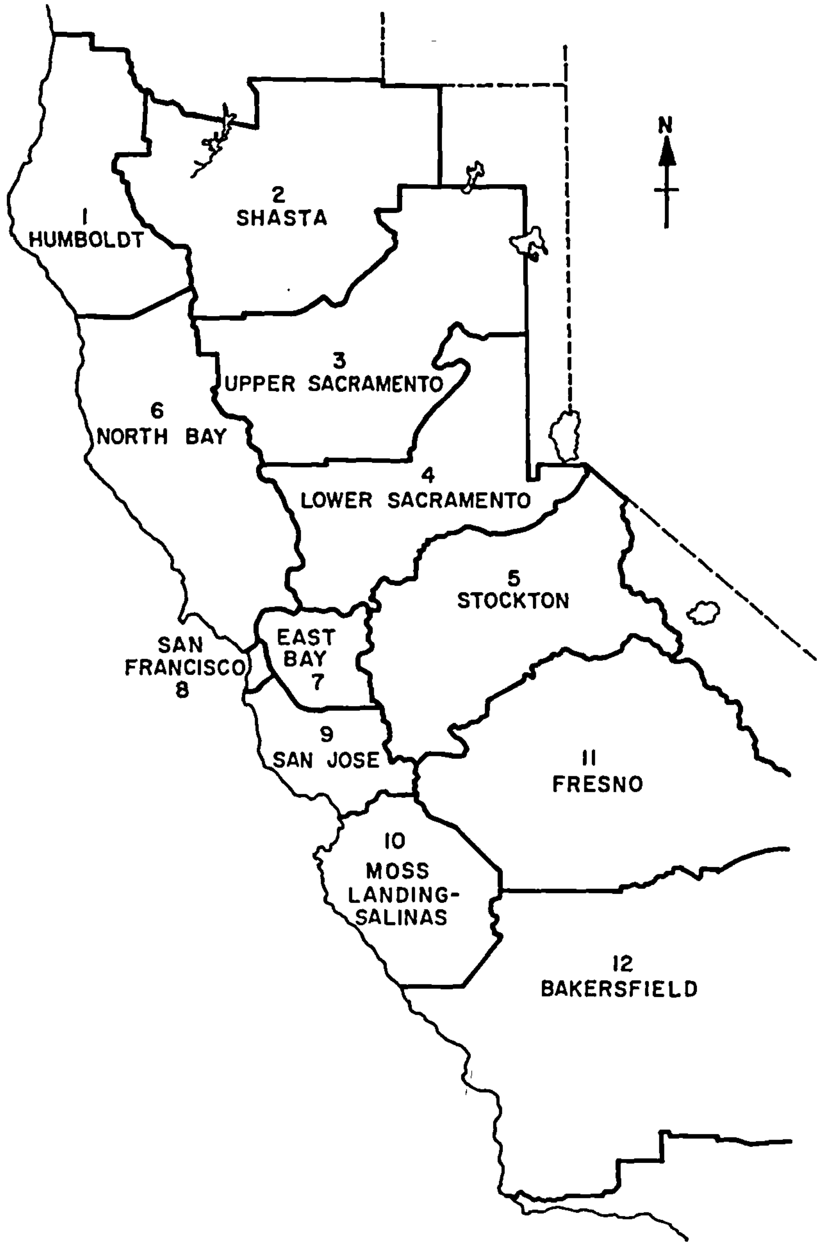


Fig. 12.1 Applicant's geographical subareas.

Table 12.1. Pacific Gas and Electric Company estimated area loads and generating capacity for 1974 summer peak (dry year basis)

Area No.	Area name	Load (MW)	Generating capacity (MW)
1	Humboldt	121	168
2	Shasta	271	2699[a]
3	Upper Sacramento	519	1844[b]
4	Lower Sacramento	2098	2060
5	Stockton	1141	647
6	North Bay	729	617
7	East Bay	2240	3461
8	San Francisco	1040	800
9	San Jose	2120	0
10	Moss Landing – Salinas	350	2060
11	Fresno	1332	497
12	Bakersfield	2365[c]	1183[d]

[a]Includes 550 MW import from the Northwest for northern and central California and 634 MW of northwestern power for delivery to southern California.

[b]Includes 346 MW of state power for delivery to southern California.

[c]Includes 927 MW delivery to southern California.

[d]Does not include Diablo Canyon.

societal impact. The staff is unable to judge the relative value of the other aspects of these sites but does conclude that the Diablo Canyon site was a logical choice in the framework of siting criteria that existed in 1966. At that time a primary consideration was community acceptance, and the Diablo Canyon site appears to have offered the least impact on the community at that time, being located on private land inaccessible to the general public for a radius of several miles. There is also evidence that consideration of environmental impact began at an early stage of site development as recorded in the interim opinion of the CPUC hearing on Diablo Canyon in 1966:[9]

"Applicant with the assistance of the State Resources Agency, County Planning Commission, Sierra Club, and other organizations turned its attention to other possible sites along the South Coastal Region and finally in the Summer of 1966 it appears that agreement was reached on Diablo Canyon as being a satisfactory alternative to the Nipomo Site."

"Applicant then conducted an extensive investigation to establish the suitability of the site from all aspects of safety, and acceptability from the standpoint of minimal effects on the environment. This investigation included detailed studies and reports from consulting experts in the field of geology, seismology, marine biology, oceanography, and structural engineering."

Thus, while a cost-benefit analysis was not made by the applicant of each site at the time of selection, consideration of environmental impact and community acceptance were apparently significant factors in the selection of Diablo Canyon. The staff, looking back at that decision, concludes that the Diablo Canyon site is probably as acceptable by today's standards as any site that was considered in 1965 or earlier.

12.2.2 Public Acceptance

There are several documented instances of public opposition to the Diablo Canyon site. There appear to be three major issues advanced by various groups of citizens: (1) destruction of natural coastline and vegetation, (2) interference with abalone fishing, and (3) potential erosion from transmission line construction. Several additional arguments are recorded, e.g., the presence of endangered species, visibility of plant from offshore, and transmission line aesthetics. These effects can be judged subjectively in some cases and quantitatively in others.

The impact on the natural coastline of constructing a nuclear power plant at the Diablo Canyon site is evident as discussed elsewhere in this statement. However, in the opinion of the staff, site selection did take place through a process of balancing of competing interests and considerations, and with concern for the views of representative interest groups.[8,9,10]

The applicant has performed evaluations of the impact on abalone and concluded that the effects of the plant on abalone yield in the area will be masked by natural predation and commercial harvesting. The staff concurs in this opinion (see Section 5).

The construction of transmission lines has been accomplished with considerations given to aesthetic appearance and resource destruction with the end result that, in the opinion of the staff, the construction roads appear to have more impact on the environment than the lines. The roads do not appear to present problems across flat terrain and farm land as witnessed on a staff visit in June 1972; however, the areas of forest and mountainous terrain have a potential for erosion problems, in addition to a significant visual impact. The applicant is in the process of preparing a plan for redress of the transmission line impact for approval by the CPUC,[11] and until such time the staff cannot assess the long range impact of the lines. The staff's opinion, however, is that there are some areas in which additional work should be done for the long term protection of the land immediately surrounding the lines, specifically the routes through steep terrains and the two portions of the routes that cross the Los Padres National Forest.

12.3 PLANT DESIGN ALTERNATIVES

12.3.1 Heat Removal Systems

The staff evaluated several alternative heat removal systems in addition to the once-through, shoreline discharge presently under construction at the Diablo Canyon site. The more important features of each alternative are discussed in the following paragraphs. Evaporative cooling using fresh water was not considered as an alternative since there is little fresh water at the site and in the surrounding region to replace the estimated evaporative losses of 50,000 acre-ft per year. The environmental effect of these alternatives is discussed in Appendix 12-1.

Cooling Towers - Wet

Wet cooling towers dissipate heat largely through evaporation of water resulting from circulation of air, drawn from the plant surroundings, through cascading warm water discharged from the condenser. The most common use of cooling towers is in a "closed cycle." That is, the cooling water for the turbine-exhaust-steam condensers is returned to these condensers after passing through the cooling towers. Only a fraction of the water is flushed from the system. This is known as "blowdown." Additional water is necessary to replace the blowdown and the amount that evaporates.

There are two basic types of cooling towers, distinguished by the mechanism of supplying the cooling air, i.e., natural draft and mechanical draft.

All wet cooling towers require a supply of replacement water to function. To date, almost all published data on cooling towers are for fresh water types. At the Diablo Canyon site, there simply isn't sufficient fresh water available to maintain cooling towers for the Diablo Canyon Nuclear Plant. Therefore, ocean water would be required and this would complicate the construction and operation of the towers. For example, salt water drift would be encountered.

Cooling tower operation is theoretically limited by the wet bulb temperature of the area. As a practical matter, the cooling is limited to about 10 to 15°F above the wet bulb temperature. This temperature differential is referred to as the "approach" temperature.

In Table 12.2 the significant meteorological conditions are given. It is significant that the exit temperatures from the cooling tower, given a 12° approach, is about equivalent to the discharge temperature from the condensers during the summer months. Also, the ocean temperature is 3 to 19°F cooler than the cooling tower exit temperature, thus giving a measure of the penalty imposed by the use of cooling towers rather than once-through cooling. The staff estimates a penalty of 100 to 160 MW(e) capacity if cooling towers are used.

Table 12.2. Average climatological conditions in Diablo Canyon vicinity

Month	Dry bulb temperature[a] (F°)	Relative humidity[a] (%)	Wet bulb temperature (F°)	Ocean temperature (F°)	Cooling tower exit temperature[b] (F°)	Condenser exit temperature[c] (F°)
Jan	53	70	48	54	60	73
Feb	55	74	50	53	62	72
Mar	56	73	51	53	63	72
Apr	58	74	54	53	66	72
May	61	76	56	53	68	72
Jun	63	78	59	53	71	72
Jul	65	79	61	54	73	73
Aug	65	79	61	55	73	74
Sep	66	78	61	60	73	79
Oct	63	74	58	60	70	79
Nov	59	66	52	61	64	80
Dec	55	67	49	56	61	75

[a]Reported in San Luis Obispo.
[b]Assuming an approach temperature of 12°F.
[c]Assuming a 20°F temperature rise across the condenser.

Because of the closer "approach" to wet bulb achieved with mechanical draft towers, they are generally more efficient but produce more fogging and drift than equivalent natural draft towers. In addition, there are power requirements for the fan drives amounting to an additional 15 MW(e) of lost capacity.

Natural draft towers, in addition to causing larger capacity losses than mechanical draft, are not as readily controlled, and they present a substantial visual impact. However, the plumes are discharged at a higher level, and less drift is experienced than with mechanical towers.

The drift factors vary, depending on many considerations, but factors of 0.002% for natural draft and 0.02% for forced draft towers are commonly estimated figures. Natural draft towers discharge the drift at a much higher level than that of forced draft towers; therefore, deposits from the water are spread over a much broader area.

Methods based on work done by Hanna[12] and Pasquill[13] were used to estimate drift deposition. Results of calculations for natural draft cooling towers indicate measurable salt deposited within 3 miles and a maximum rate of deposit for each tower of about 0.7 lb per acre per year from 3 to 10 miles. Forced draft towers would have a much higher drift and deposition would increase to about 100 lb per acre per year at about one mile. These estimates assume a constant wind speed and in only one direction. Natural drift from the ocean has been reported to be on the order of 25 to 300 lbs per acre per year.[14]

There will be 186 cfs of makeup water required for the cooling towers (p. X11-D-9 of the applicant's Environmental Report) part of which will be lost to evaporation. All marine organisms entrained in the makeup water are considered to be lost.

$$186 \text{ cfs} = 1.661 \times 10^8 \text{ m}^3/\text{year}$$

$$\text{Phytoplankton} = \frac{1.661 \times 10^8 \text{ m}^3/\text{year} \times 17.3 \text{ g/m}^3}{454 \text{ g/lb}}$$

$$= 6.33 \times 10^6 \text{ lb/year}$$

$$\text{Zooplankton} = \frac{1.661 \times 10^8 \text{ m}^3/\text{year} \times 0.305 \text{ g/m}^3}{454 \text{ g/lb}}$$

$$= 1.116 \times 10^5 \text{ lb/year}$$

$$\text{Larval fish} = 1.661 \times 10^8 \text{ m}^3/\text{year} \times 1.1102/\text{m}^3$$

$$= 184.4 \times 10^6 \text{ fish/year}$$

The blowdown from cooling towers would be on the order of 100 to 150 cfs of high concentration salt water (5-7%); however, areas affected by a detectable temperature rise would be only a very few acres. The chemical impact, however, is considerable, not only from the increased salinity in the effluent due to blowdown but from chemicals added to the system to inhibit corrosion and to prevent scale.

The marine terrace location of the plant is in an area of high fog incidence. Fogging from cooling towers would have a maximum effect under these conditions.

Cooling Towers — Dry

A dry cooling tower removes heat in much the same manner as the radiator on a car. Very few such towers have ever been built because of the very high initial cost, plus the extra penalty in power loss from a higher cooling water exit temperature. The higher temperature is the result of the dry bulb temperature being the limiting temperature for operation. The high cost of construction and adverse effect on operation make dry cooling towers unattractive as an alternative. In addition, the lack of experience with dry towers of the size required for Diablo Canyon makes economic or environmental cost data speculative.

Spray Canals and Cooling Ponds

Spray canals and cooling ponds require substantial acreages for operations of this size. The applicant has determined that 1950 acres (about 3 square miles) would be required for a cooling pond. This is an optimistic figure, and more area might be required.

Two or three miles of canal would be required for the spray canal option. In each case the terrain and land availability make these alternatives unattractive.

Effluent Cooling

The possibility of using some means of reducing the condenser cooling water temperature before being released to the ocean was examined. The most commonly used method for this application has been the open-cycle cooling tower. In this method a once through system is appended with cooling towers to reduce the cooling water temperature. However, for efficient operation, the local wet bulb temperature must be less than the ambient water temperature. Examination of Table 12.2 reveals that for six months of the year the wet bulb temperature exceeds the ocean ambient temperature, rendering such a scheme almost useless from April to September during a typical year in the Diablo Canyon area.

12.3.2 Intake Structures

The only viable alternative to the present intake structure would be an offshore ocean bottom intake. Several large conduits would be required to move the water. Either tunneling or trenching would be needed as a prefabricated conduit placed on the ocean floor probably could not withstand the natural turbulence of the ocean in this area.

An increase in pump head requirement would be needed to offset frictional losses in the conduits. Also, reverse flow through the conduit is probably the only reasonable defouling mechanism, which would, of course, generate a thermal plume.

The offshore intake is not believed to offer advantages that make the expenditure a reasonable choice.

12.3.3 Alternate Discharge Structures

Offshore Discharges

The applicant has studied the suggestion of using offshore discharges to return condenser effluent to the ocean. The arrangement that appears to be the overall best solution is to tunnel from the present shoreline outfall to a point 1700 ft offshore in about 60 ft of water. A sharp dropoff occurs that is attractive for the outlet to the ocean. The behavior of single port discharge and multiport diffusers was reported. The details summarized below were checked and found to be reasonable.

Single Port Discharge. The jet velocity from the single point horizontal jet would result in a plume with a long trajectory, rising to the surface about 350 to 400 ft from the outlet. Velocities drop from 20 fps at the outlet to about 3.5 fps at the surface. Plume areas and volumes are listed in Table 12.3. A maximum point temperature of 6°F would be expected.

Multiport Diffusers. A 900-ft further extension of the discharge with 2.5-ft-diameter openings on 50-ft centers was suggested. With this arrangement a smaller surface area would be affected by warmed water since more dilution would be experienced. The expected areas are listed in Table 12.4. A maximum point temperature for diffuser would be about 4°F.

In either of these cases, the water would remain at the elevated temperature 1-1/2 to 2 min longer, and the temperature decline after reaching the ocean would be more rapid than the shoreline discharge. The effluent chemical concentration would probably be decreased more rapidly due to the larger volume of water available for dilution.

12.3.4 Alternatives for Defouling, Chemical, and Biocide Systems

The plant design of Diablo Canyon Units 1 and 2 permits the release of a biocide, in this case chlorine in various forms, to the effluent stream. A main source of this release is the daily biocide treatment of the condenser cooling system to control organic growth on exposed surfaces. The expected chlorine usage for this purpose is estimated to be 220 lb/day added at the rate of 5.5 lb/min to give a 1.5 ppm concentration.

For decreasing the usage of a biocide in the condenser system, a system for "on-load" tube cleaning could be used. An example of such a system is "Amertap", which utilizes ball recirculation through the condenser tubes. Various other utilities have installed this system in power reactors. Among them are Virginia Electric and Power Company at North Anna and Surry, TVA at Brown's Ferry and Sequoyah, and Duke Power Company at Oconee. The usage of such a system would result in a large decrease in the amount of biocide released to the environment.

Another "on-load" system for tube cleaning is a cage system such as that offered by the American M.A.N. Corporation. In this system, plastic bristle brushes are shuttled through the condenser

Table 12.3. Single port offshore discharge

Temperature increase (°F)	Surface area enclosed (acres)	Mixing depth (ft)	Volume enclosed (acre-ft)
5	3	5	15
4	7	10	70
3	30	15	450
2	200	20	4000

Table 12.4. Multiple port offshore discharge

Temperature increase (°F)	Surface area enclosed (acres)	Mixing depth (ft)	Volume enclosed (acre-ft)
3	10	15	150
2	200	20	4000

tubes by reversal of water flow. As in the case of the "Amertap" system, the usage of brush system would drastically decrease the amount of biocide released to the environment. It is estimated that the cost of this system would be roughly comparable to the "Amertap" system.

The applicant will be required to monitor the concentration of chlorine in the discharge at all times during its use and shall not allow the effluent concentration to exceed 0.1 ppm of residual free chlorine. In addition, the applicant will be required to monitor the effect of chlorine on both entrained and receiving water marine life. If significant adverse effects occur, the applicant will be required to modify the system to include an alternative acceptable to the staff.

As discussed in Sects. 3.3.2 and 5.3.2, there are alternatives to the heat treatment or thermal shock used for defouling. One of these is to use a biocide. The staff estimates that much more ecological damage would result from the biocide in the effluent than from the heated water. A second alternative is physical removal of organic growths. This latter approach is not considered practical by the staff for this station because of the unacceptably long shutdown required for physical removal.

12.3.5 Design Alternatives for Liquid Radioactive Waste System

The liquid radioactive waste system releases are considered by the staff to be as low as practicable.

12.3.6 Design Alternatives for Gaseous Waste System

The gaseous radioactive waste system releases are considered by the staff to be as low as practicable.

In the event of changes in exposure pathways which would result in annual doses of 5 mrem or more to the whole body or any organ of an individual, the applicant will be required to improve his system to reduce the dose to less than 5 mrem.

12.3.7 Transmission Systems

Within the present state-of-the-art, there are no alternatives to the overhead transmission lines presently under construction between the Diablo Canyon site and the two substations. Alternatives considered by the staff were therefore restricted to the route alternatives.

The staff concluded on the basis of hearing findings[11] that the 230-kV line and the Diablo-Gates 500-kV line represent the best route available. After review of the exceptions taken to the adequacy of the Diablo-Midway line and a site visit in June 1972, the staff concluded that no other route offers significant advantages over the applicant's route, as proposed (see Sect. 4.2.2).

The staff recognizes an important factor regarding alternative routes for these transmission lines. Except for the oil shale area, relocation of lines would result in a duplication of construction impact because the line and roadway construction has already progressed to a point that further work on the existing routes will have little additional effect. Relocation of transmission lines would therefore result in greater overall impact than maintaining the existing corridors.

REFERENCES FOR SECTION 12

1. Testimony of George R. Bell, Engineer in Charge of Electrical Resources and Requirements, FPC Regional Office, San Francisco, as recorded in transcript of Show Cause Hearing May 19, 1972, Dockets 50-275 and 50-323, p. 550.

2. Pacific Gas and Electric Company, *Supplement 2 to Environmental Report, Units 1 and 2, Diablo Canyon Site*, July 1972.

3. Testimony of Chester A Budd, Union Oil Company as recorded in transcript of Show-Cause Hearing, May 19, 1972 in San Luis Obispo, Dockets 50-275 and 50-323, p. 300.

4. Draft Environmental Impact Statement for the Geothermal Leasing Program, U.S. Dept. of Interior, Supplement, May 1972.

5. Draft Environmental Impact Statement for the Geothermal Leasing Program Appendix C. U. S. Dept. of Interior, Sept. 1971.

6. Letter Bonneville Power Administrator (B. Goldhammer) to Pacific Gas and Electric Company (E. E. Hall) dated 7-19-72. See Response to question 6, part A. of Chapter XIV of Reference 5.

7. Summary of Estimated Loads and Resources, Western Systems Coordinating Council, April 1972.

8. Testimony of H. R. Perry, Chief Planning Engineer, Pacific Gas and Electric Company, as recorded in transcript of Show-Cause Hearing, May 19, 1972, in San Luis Obispo, Dockets 50-275 and 50-323, p. 696.

9. Pacific Gas and Electric Company, *Environmental Report, Units 1 and 2 Diablo Canyon Site*, Dockets 50-275 and 50-323, Appendix G. (Decision 73278 before the Public Utilities Commission of the State of California)

10. Testimony of Ross W. Woodward recorded in transcript of Show-Cause Hearing in San Luis Obispo, May 1972, Dockets 50-275 and 50-323, p. 190.

11. Pacific Gas and Electric Company, Supplement 2 to Environmental Report, Units 1 and 2, Diablo Canyon Site, July 1972, Appendix O, Decision 79276 before the Public Utilities Commission of the State of California, Feb. 15, 1972.

12. S. R. Hanna, "Cooling Tower Plume Rise and Condensation," *Proceedings Air Pollution, Turbulence, and Diffusion Symposium,* Las Cruces, New Mexico, December 7-10, 1971.

13. F. Pasquill, "The Estimation of Dispersion of Windborne Materials," *Meteorol. Mag.,* 90(1063): 33-49, 1961.

14. Bierman, F. G., Kunder, G. A., Sebald, J. F., and Visbisky, R. F., "Characteristics, Classification, and Incidence of Plumes from Large Natural Draft Cooling Towers," Combustion, October 1971.

15. Testimony of Dr. Robert Rex, Director of Geothermal Resources, University of California, Riverside, as recorded in transcript of Show-Cause Hearing at San Luis Obispo, May 1972, Dockets 50-275 and 50-323, page 620.

13. BENEFIT-COST ANALYSIS

The primary benefits resulting from the construction and operation of Diablo Canyon Units 1 and 2 derive from the large block of base load capacity they will add to the applicant's system. The direct benefits of this power accrue to the applicant in the form of improved system reliability, system balance, and added base load capacity in a system with a high percentage of existing peaking capacity. The community and general public in the applicant's service area will feel the secondary benefits which may take several forms — increased economic activity, a general rise in the quality of life, and reliable electrical service being only a few of the possible benefits.

Further benefits to be derived from Diablo Canyon Units 1 and 2 arise from the improved air quality that results with their operation as compared with the base-load operation of existing peaking plants and retired fossil-fueled plants.

San Luis Obispo County will receive benefits from the station in the form of tax revenues and the creation of about 70 permanent jobs.[1] Also, some tourist activity may result from the applicant's information center located near U.S. Highway 101. The costs of the plant to society, the environment, and the economy are largely subjective in nature. The actual impact of the station on the local community is minimal because of the remoteness and inaccessibility of the site. The impact of the station on the environment is measurable, but the staff has concluded that this impact is not serious.

The transmission lines associated with the plant, on the other hand, affect the community and the environment to a larger extent than the plant itself. The primary cost to society is aesthetic in nature, involving visibility and general proximity to residents.

The primary cost to the environment of these lines lies in the potential erosion from the construction roads associated with the lines. The evaluation of this impact cannot be fully assessed until the applicant's plans for redress are finalized with the State of California.

13.1 ALTERNATIVES SELECTED FOR BENEFIT-COST ANALYSIS

The alternatives selected for the benefit-cost discussion consist of: (A) the plant design as it is presently planned, (B) a plant with an offshore once-through condenser discharge, and (C) a plant with evaporative cooling towers. The environmental impacts of these alternatives are summarized in Table 13.1. Cost data were obtained from Table 13.3. The computation of the biological entrainment losses is given in Appendix 13-2.

Two alternate biocide systems were evaluated by the staff as well as alternatives for liquid and gaseous radioactive waste systems. The biocide systems are discussed in Section 13.3 and the radioactive waste systems in Section 12.3. These systems are not included in Table 13.1 because of the small incremental cost when expressed as a percentage of plant cost.

13.2 ALTERNATIVE COOLING SYSTEMS

13.2.1 Salt Water Cooling Towers

Both the natural draft and forced (mechanical) draft cooling towers were found by the staff to offer no net benefit to the marine environment compared to the once-through shoreline discharge. Although the discharge volume is less than the once-through discharge, the higher salinity of the effluent from the saltwater towers will result in a higher loss of benthic organisms than the once-through shoreline discharge. The loss of entrained fish larvae will be lower for the salt water towers, but the loss of entrained phytoplankton and zooplankton will be higher. The net effect is little or no advantage for the saltwater towers over the once-through shoreline discharge.

13.2.2 Once-Through Offshore Discharge

The primary effect of the offshore discharges would be to carry the heated effluent outside of Diablo Cove prior to releasing it to the Pacific Ocean. The applicant evaluated both a horizontal jet discharge and a diffuser, each located about 1700 feet from the shoreline discharge point and in about 60 ft of water. The effects of this release on abalone and the depletion of kelp beds will be less than that resulting from the shoreline discharge.

The staff estimates that the longer entrainment period could result in an increase in mortality of entrained organisms compared to the shoreline discharge. Any increased mortality of primary producers

Table 13.1. Alternative plant design summary

N.A.: Not applicable

Economic effects

	Alternative A: plant as is (base design)	Alternative B: offshore discharge	Alternative C: saltwater towers
Generating cost			
Present worth, millions of dollars	1095.7	1112.7	1142.3
Annualized, millions of dollars	104.2	105.8	108.6
Lost capacity, kWe	0	0	100,000–140,000

Incremental environmental effects

Primary impact	Population or resource affected	Unit	Alternative A	Alternative B	Alternative C
1. Natural surface water body (5.3.2)					
1.1 Cooling water intake structure	1.1.1 Fish[a]	lb/year	$<10^3$	$<10^3$	$<10^3$
1.2 Passage through the condenser and retention in closed cycle cooling systems	1.2.1 Primary producers and consumers	lb/year	1.2×10^6 [b]	$>1.2 \times 10^6$ [b]	6.4×10^6
	1.2.2 Fish (larval)	each	2×10^9 [b]	$>2 \times 10^9$ [b]	184×10^6
1.3 Discharge area and thermal plume (3.3.3, 12.3.1)	1.3.1 4° Isotherm	acres	68	7	Not calculated
	1.3.2 Oxygen availability		Negligible	Negligible	Negligible
	1.3.3 Aquatic biota		0	0	0
	1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		None	None	None
	1.3.5 Fish, migration		None	None	None
1.4 Chemical effluents (5.2.1, 5.3.2)	1.4.1 Water quality, chemical		None	None	Not calculated
	1.4.2 Aquatic biota	lb/year	0	0	0
	1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		None	None	None
	1.4.4 People		None	None	None
1.5 Radionuclides discharged to water body (5.4)	1.5.1 Aquatic organisms	millirads/year	<150	<150	<150
	1.5.2 People, external	man-rem/year	<0.1	<0.1	<0.1
	1.5.3 People, internal	man-rem/year	<0.1	<0.1	<0.1
1.6 Consumptive use (evaporative losses) (12.3.1)	1.6.1 People		None	None	None
	1.6.2 Property		None	None	None
1.7 Other impacts (5.3.2)	Kelp	acres	2	0	0

Table 13.1 (continued)

Primary impact	Population or resource affected	Unit	Alternative A	Alternative B	Alternative C
2. Groundwater					
2.1 Raising/lowering of groundwater levels (5.2.1)	2.1.1 People	N.A.			
	2.1.2 Plants				
2.2 Chemical contamination of groundwater (5.2.1)	2.2.1 People	N.A.			
	2.2.2 Plants				
2.3 Radionuclide contamination of groundwater (5.4.4)	2.3.1 People		Negligible	Negligible	Negligible
	2.3.2 Plants and animals		Negligible	Negligible	Negligible
3. Air					
3.1 Fogging and icing (caused by evaporation and drift)	3.1.1 Ground transportation	N.A.			
	3.1.2 Air transportation	N.A.			
	3.1.3 Water transportation	N.A.			
	3.1.4 Plants	N.A.			
3.2 Chemical discharge to ambient air	3.2.1 Air quality, chemical	N.A.			
	3.2.2 Air quality, odor	N.A.			
3.3 Radionuclides discharged to ambient air (5.4)	3.3.1 People, external	*man-rem/year*	0.5	0.5	0.5
	3.3.2 People, internal	man-rem/year	<0.2	<0.2	<0.2
4. Land					
4.1 Preemption of land (4.2.1)	4.1.1 Land, amount (includes *transmission line roads*)	acres	1500	1500	1500
4.2 Plant construction and operation (4.2.1, 4.2.2)	4.2.1 People (amenities)		Minimal	Minimal	Minimal
	4.2.2 People (aesthetics)		None	None	Some
	4.2.3 Wildlife		Negligible	Negligible	Negligible
	4.2.4 Land, flood control	N.A.			
4.3 Salts discharged from cooling towers	4.3.1 People	N.A.			
	4.3.2 Plants and animals	N.A.			
	4.3.3 Property resources	N.A.			
4.4 Other land impacts (4.2.2)	Erosion transmission line		Locally serious	Locally serious	Locally serious

[a]Does not include loss of jellyfish, which was not computed.
[b]Includes entrainment losses *from thermal, chemical,* and mechanical effects and from demusseling operations.

and consumers (including abalone larvae) from entrainment in the offshore discharge would tend to offset any reduction in abalone resulting from depletion of vegetation from the shoreline discharge.

The staff estimate of the cost of an offshore discharge is in substantial agreement with the applicant's estimate. However, no accurate estimate is possible for this case until the geology of the route is established if tunneling is the proposed construction method. The staff also concludes that trenching to lay pipes would result in substantial temporary disturbance of the ocean floor and may not be a suitable construction method for the irregular topography of Diablo Cove. The staff estimated cost of tunneling beneath Diablo Cove without pressure problems is about $13 million compared with the applicant's estimate of $21 million including overhead. Because of the uncertainty of the estimates, a median figure of $17 million was assumed as a rough estimate of offshore discharge construction costs. The possibility of water leaking into the tunnel would add considerably to this figure — the applicant estimates an additional $7 million — but this cost is a factor of the geology of the area through which the tunnel must pass.[2]

The staff concludes that the offshore discharge as described herein does not offer net environmental benefits but does result in substantial monetary costs. The applicant's existing design of a shoreline discharge, once-through cooling system will not be materially improved by the alternatives evaluated.

13.3 ALTERNATIVE CHEMICAL AND BIOCIDE SYSTEMS

Item 1.2.2 in Table 13.1 shows a predicted loss of larval fish from passage through the condenser system. The staff estimates that about 15% of this loss may result from the chlorine treatment of the condenser water. This loss could possibly be reduced by the use of mechanical treatment such as described in Section 12.3.4. However, the estimated loss is a small percentage of the total entrainment losses and no losses are expected to result from the discharge of chlorine into the cove. Further, the potential of increased copper erosion exists with the mechanical scrubbers. The staff therefore concludes that there is not sufficient benefit to justify the addition of the approximately $2 million cost of mechanical cleaning equipment.

The applicant will be required to monitor the effect of chlorine on both the entrained and receiving water marine life. If any significant adverse effects occur, the applicant will be required to modify the system.

13.4 ALTERNATIVE POWER SOURCES

The only alternative source of power available to the applicant within the period of time prior to the need for power is probably combustion turbines (see Section 12.1). Because the combustion turbines are not suited to base load operation, the applicant states[1] that deficient capacity without Diablo Canyon would be compensated for by operating older, less efficient, fossil plants at base load whereas they would be retired to peaking service with Diablo Canyon, and by operating some of the added combustion turbines at base load when necessary.

The environmental impact of this system mix can only be stated in gross terms because no large new station would be built at any specific site but about 36 combustion turbines would be installed at many sites as yet unspecified. Further, because of high economic costs, the use of combustion turbines would be a temporary alternative to Diablo Canyon requiring added base load capacity to the applicant's system as soon as construction permitted. The applicant states that nuclear capacity would be selected as this alternative base load capacity because of fuel shortages[3] and high fuel costs beginning to occur at his fossil fuel plants.

The applicant estimates that the system generating mix resulting from a combustion turbine capacity of 1800 MW added as an alternative to Diablo Canyon would result in increased costs of $32.5 million in 1975, $70.8 million in 1976, and $83.3 million in 1977 over the applicant's estimated $150 million cost of operating Diablo Canyon.[3] The total cost to the applicant until replacement base load capacity could be added in 1986 would be over $600 million,[3] which would include the $314 million cost of abandoning Diablo Canyon on January 1, 1973.

The staff agrees with the general magnitude of the estimates when compared to generalized calculations from data available to the staff. The magnitude of the cost of abandoning Diablo Canyon alone precludes from consideration any alternative generation source on an economic basis, and the staff has found no reason to abandon the Diablo Canyon site. The staff therefore concludes that combustion turbines are not a viable alternative to Diablo Canyon.

13.5 EXISTING DESIGN

The staff concludes that the existing design of Diablo Canyon Units 1 and 2 represents the optimum choice of the alternatives available to the applicant. The benefits and costs of this design are summarized in Tables 13.2 and 13.3 and in the following paragraphs. The sources of the values in Table 13.3 are given in Appendix 13-1.

13.5.1 Benefits

The direct benefits resulting from the construction and operation of Diablo Canyon are an annual generating output of $14,857 \times 10^6$ kWhr of electrical energy, 70 permanent jobs at the site, $28 million per year in taxes to state and local governments, and a saving in air pollutants of 40,860 tons/year SO_2, 24,550 tons/year NO_x, and 2733 tons/year of particulates that would result from the system mix of alternative generation methods. Other indirect societal benefits might accrue in the form of quality of life and economic activity.

Construction wages paid during the period from 1968 to 1976 will amount to more than $116 million, but the effect of this payroll will be spread over a fairly large area of about 200-mile radius.

13.5.2 Costs - Economic

The major economic costs of the plant are the annualized costs of construction and operation of about $104 million per year as calculated by the staff (see Table 13.3). The possibility of an increase in unemployment at the cessation of construction in 1976 also exists, but the effect on the community will be small and the staff would not attempt to estimate the quantitative effect of any such change.

The dollar value of lost land usage is also small, amounting to about 750 acres of grazing land. The same situation exists with transmission lines because the percentage of usable land diverted from productivity is small and was either purchased or leased by the applicant. The applicant stated[4] that attempts are made to return purchased and leased land to use after construction of transmission lines.

13.5.3 Costs - Environmental

The costs to the environment are a consequence of ecological changes resulting from construction impact on the terrestrial environment and the thermal discharge into Diablo Cove as a result of plant

Table 13.2. Benefits from the proposed facility

Direct benefits	
Expected average annual generation, kWhr	$14{,}857 \times 10^6$
Capacity, kW	$2{,}120 \times 10^3$
Proportional distribution of electrical energy – expected annual delivery, kWhr	
Industrial	$3{,}227 \times 10^6$
Commercial	$4{,}303 \times 10^6$
Residential	$4{,}303 \times 10^6$
Other	$1{,}613 \times 10^6$
Distribution losses	$1{,}411 \times 10^6$
Expected average annual Btu (in millions) of steam sold from the facility	0
Expected average annual delivery of other beneficial products	*a*
Indirect benefits	
Taxes (local, State, Federal), annual	$\$28.0 \times 10^6$
Research	0
Regional product	0
Environmental enhancement	
Recreation	0
Navigation	0
Air quality (saved over alternative)	
SO_2, tons/year	40.86×10^3
NO_x, tons/year	24.55×10^3
Particulates, tons/year	2.73×10^3
Others	0
Employment, annual	$\$1.4 \times 10^6$
Education	0
Construction wages (total)	$\$116 \times 10^6$
Other	*b*

[a] Improved system stability.
[b] Improved electrical reliability, quality of life, and economic activity.

Table 13.3. Summary cost analysis

In millions of dollars

Item	Base design	Off shore discharge	Salt water towers
Plant cost	665	682	705
Operation and maintenance	12	12	12.4
Fuel	29	29	29
Annual operation cost	41	41	41.4
30-year present worth of operation	430.7	430.7	437.3
Present worth of generating cost	1095.7	1112.7	1142.3
Annualized generating cost	104.2	105.8	108.6

operation. Neither of these impacts is considered to be serious by the staff in that no major upset in the local or regional ecology is expected to occur, and no aquatic impact is expected outside of Diablo Cove with the station modified in accordance with staff requirements.

The construction activity at the plant site will alter some 750 acres of habitat to varying degrees. The erosion from transmission line construction activity is expected to result in some permanent loss of plants and some soil movement in the vicinity of the roads and some towers. Plans for improving this situation are in progress and are to form the basis of a program acceptable to the staff for redress of the affected areas. Construction activity at the site has resulted in the displacement of harbor seals from a resting area adjacent to the cove, but this displacement may not be permanent. Siltation from breakwater construction also had a major impact by destruction of aquatic habitat.

During the months of August, September, and October, the operation of the plant with its resultant thermal discharge into Diablo Cove may result in a loss of some 2 to 3 acres of kelp, an estimated 20% to 30% of the total kelp acreage of the cove. The increased temperatures in the cove may also cause increased feeding by sea urchins which could further deplete kelp beds. The net effect of these two factors and the alteration of other algae communities could eventually lead to a maximum of 50% reduction in abalone population in Diablo Cove. The possibility of increased kelp production could result from the station's release of kelp zoospores into Diablo Cove, however, and the staff is unable to conclude whether or not the long-term effects on kelp will be detrimental.

The only other effect of noticeable consequence of which the staff is aware is the mortality of organisms entrained in the condenser water and the loss of jellyfish impinged on the intake racks. The quantities lost by entrainment and impingement are shown in Table 13.1.

13.5.4 Costs - Societal

The primary costs of plant construction and operation to society are qualitative in nature. The conversion of a short stretch of coastline from its natural state is one such loss. While similar losses to society have resulted inland from site excavation and transmission line construction, the major portion of the disturbed land was not open to the public prior to plant construction.[4] The staff concludes that the transmission lines, as proposed by the applicant, do not place an unreasonable burden on the aesthetic values of the area.

Construction traffic has created a problem about 20 miles from the site in the form of dust and noise. Except for this area the effects of traffic on the county in general and in the immediate vicinity of the site have not been significant (Section 4.5.2). No indications were found by the staff that local communities have been burdened by construction activity either from the standpoint of government services or by the presence of the construction crews.

13.6 CONCLUSIONS

The staff concludes that the benefits to be derived from operation of the plant exceed the impact of the applicant's proposed design on the environment and on society. Furthermore, the staff concludes with respect to adverse impacts, that conditions relating to construction and operation of the plant as discussed in this statement should be imposed upon the applicant in order to provide for protection of the environment and amelioration to the extent practicable of unfavorable impacts on the environment. Extensive capital investment by the applicant in the existing plant design and site, eliminates from consideration the alternative plant designs and energy sources available to the applicant. In general, little or no benefit is to be gained either economically or environmentally while substantial capital investment would be required to make the change.

REFERENCES FOR SECTION 13

1. Pacific Gas and Electric Company, *Supplement No.2 to Environmental Report, Units 1 and 2, Diablo Canyon Site,* July 1972.

2.. F. T. Wheby "Computer Estimates of Tunnel Costs Based on Rock Mechanics Data" in Proceedings of 12th Symposium of Mining Engineers, Rolla, Mo., Nov. 16-18, 1970, Society of Mining Engineers, New York, 1971.

3. Testimony of H. R. Perry, Planning Dept, PG&E, as recorded in transcript of Show-Cause Hearing, May 1972, San Luis Obispo, Docket Nos. 50-275 and 50-323, p. 668.

4. Summary of Site Visit and Meetings, Diablo Canyon Nuclear Power Plant, Pacific Gas and Electric Company, Docket Nos. 50-275 and 50-323, June 19-23, 1972 and Supplement, December 1972.

14. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to Paragraph A.6 of Appendix D to 10 CFR 50, the Draft Environmental Statement of December 1972 was transmitted, with a request for comments, to:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
California Resources Agency (Departments of: Conservation, Water Resources, Parks and Recreation, Fish and Game, Harbors and Watercraft)
California Public Utilities Commission
California Department of Public Health
California Office of the Governor
County Board of Supervisors, San Luis Obispo County

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on December 12, 1972 (37 FR 26459).

Comments in response to the requests referred to above were received from:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation, U. S. Coast Guard
Environmental Protection Agency
Federal Power Commission
State of California Resources Agency
Geothermal Energy Institute
Kenneth B. Kilbourne, Carpinteria, California

Our consideration of comments received and the disposition of the issues involved are reflected in part by revised text in other sections of this Final Environmental Statement and in part by the following discussion. The comments are included in this statement as Appendix 14-1.

14.1 <u>ADMINISTRATIVE ACTION</u> (Department of the Interior, p. A14-1-21 and 28; Environmental Protection Agency, p. A14-1-34)

The appropriate action under consideration for which this Environmental Statement has been prepared is continuation of the construction permits for Units 1 and 2. Considerations concerning operating licenses and issuance of construction permits for additional units at Diablo Canyon would be undertaken when and if applications for permits are received by AEC and would include evaluation of environmental impacts.

14.2 <u>HISTORIC AND NATURAL LANDMARKS</u> (Advisory Council on Historic Preservation, p. A14-1-3)

Three archaeological sites were found on the Diablo Canyon Property and investigated by Mrs. Roberta Greenwood, an archaeologist associated with the Central California Archaeological Foundation. A detailed report was written and is scheduled for publication in April 1973 by the San Luis Obispo County Archaeological Society.

One of the three sites was covered with surplus fill dirt during construction. Before dirt is removed for landscaping and fill purposes, the State Archaeologist, Mr. Richard B. Hastings, and Mrs. Greenwood will be notified so they can be present, as required, to prevent damage to the unexcavated site SLO-2.

14.3 <u>GEOLOGY AND SEISMOLOGY</u> (Department of Interior, p. A14-1-22)

The material in this section is only briefly noted since the proper comprehensive presentation is provided in the staff's Safety Evaluation Report for Diablo Canyon.

14.4 <u>THERMAL DISSIPATION</u> (Department of the Interior, p. A14-1-22; Environmental Protection Agency, p. A14-1-43; State of California, Resources Agency, p. A14-1-57; Kilbourne, p. A14-1-76)

The definition of the discharge plume in the staff's model is theoretical but is considered realistic. (Kilbourne) The staff's calculations of the discharge plume do not assume an infinite quantity of unheated dilution water at the point of discharge, but rather entrainment from only one side in Diablo Cove. (EPA)

As a result of its analysis, the staff feels that adequate turnover of dilution water will occur.

The intake and discharge temperatures and several Diablo Cove temperatures will be measured during plant operation. The staff assumed that ambient temperature at a specific time of year was the historical temperature measured in the area for that time of year. By "average conditions," the staff means those of intermediate tide and normal ocean turbulence. (Calif. Resources Agency)

The offshore discharge is evaluated in Sect. 13.2.2. The staff concluded that the environmental costs, while of different origin, would approximately equal those of the shoreline discharge. Therefore the high economic cost makes the offshore discharge unattractive. (Kilbourne)

The staff agrees that a physical model would provide some useful information concerning thermal plume behavior. It is noted that full-scale confirmation of predicted plume characteristics can be made upon startup of the first unit, and the applicant will be required to monitor in order to establish actual thermal plume effects. (EPA)

14.5 EFFECTS OF OCEAN CURRENTS (State of California, Resources Agency, p. A14-1-59)

Although the staff has very little information on currents in the region of Diablo Cove, analyses were made for what were assumed to be the worst case, primarily calm, current-free conditions. If a strong current exists, it is expected to contribute to dilution of the plume and therefore will reduce the area within a given isotherm.

In the case of a strong current from the south, the plume may be bent until recirculation within Diablo Cove occurs on the north side of the plume. However, recirculation is not expected to occur simultaneously both north and south of the jet.

Without precise knowledge of current strengths and duration, it is not possible to predict the amount of time or degree each portion of the cove would be affected. The best estimate is that a northerly current (one out of the south) would occur during winter months, when temperatures are low, hence impacts the least, and the duration of such currents is not believed to be long.

14.6 LIQUID RADIOACTIVE WASTE (Department of Health, Education, and Welfare, p. A14-1-18; Environmental Protection Agency, p. A14-1-34)

Staff recalculation of liquid waste effluent radioactivity on the basis of the applicant's current waste treatment system design indicates that releases will be about 5.3 Ci/year for each reactor and within "as low as practicable" guidelines.

14.7 SOLID WASTES (EPA, p. A14-1-47, 48)

The values for radioactivity contained in dry wastes are estimates based on experience with plants in operation. Estimates of dose to the population tend to be conservative since they are based on the maximum allowable radiation levels outside of packages. Greater quantities of radioactivity in the containers would require additonal shielding but would not result in greater population doses unless additional trips were also required. Further discussion may be found in the "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," issued by the Directorate of Regulatory Standards, U.S. Atomic Energy Commission, December 1972.

14.8 CHEMICALS (Department of the Interior, p. A14-1-24)

The added concentrations of copper, nickel, and chromium in the receiving body after near-field dilution will be on the order of: Cu, 1 ppb; Ni, 0.2 ppb; and Cr, 0.01 ppb. In view of the concentrations of these metals naturally occurring in seawater (approximate values are Cu, 45 ppb; Ni, 3 ppb; and Cr, 2 ppb) it is difficult to see how the small added increment could have any large effect.

14.9 DEMINERALIZER REGENERATION SOLUTIONS (Environmental Protection Agency, p. A14-1-48)

In conformance with the Regional Water Quality Control Board requirements (Appendix I of the applicant's Environmental Report), the applicant is required to regulate the pH of the effluent so that the pH of the receiving waters remains within the range 7.0-8.5. Therefore the discharge of sufficient sulfuric acid or sodium hydroxide to overcome the natural buffering action of the receiving waters would seem to be implicitly prohibited.

14.10 IMPACTS FROM THE CONSTRUCTION OF TRANSMISSION LINES AND ASSOCIATED ACCESS ROADS (Department of Agriculture, p. A14-1-7)

The transmission lines have been routed to run, where possible, through sparsely populated areas, and as such, most of the lands crossed are idle land used mostly for cattle grazing. Some areas are used for farming, and a few areas for oil production. Lines running across private lands cannot reasonably be expected to have an adverse effect on public recreation. In the case of National Forest lands, recreation aspects are more important. The transmission lines run through the Los Padres National Forest for about 8 miles on the Diablo-Midway corridor and for about 3 miles on the Diablo-Gates corridor. At the present time, the line corridors across Los Padres National Forest are not easily accessible by roads, and preference of the public for these areas as opposed to prepared recreational areas cannot be presumed. The Forest Service, U.S. Department of Agriculture, has commented, stating that "primary uses of these National Forest lands are for grazing, watershed protection, and wildlife production." The only recreational activities for which most of the transmission line corridors are suitable would be for hunting and hiking, and the transmission lines will not significantly affect these activities, except to make the pursuit of them easier.

14.11 AIR USE (Department of Commerce, p. A14-1-16)

There will be some increased fogging in the vicinity of Diablo Canyon as a result of the station operation. This is discussed in Sect. 5.2.2.

14.12 RADIOLOGICAL ASSESSMENT (Environmental Protection Agency, p. A14-1-37; Geothermal Energy Institute, p. A14-1-67)

Using the staff's revised source term (updated to conform with the applicant's current waste treatment system design) the dose to a child's thyroid from the milk pathway at the location of the nearest dairy cow was calculated to be 4.7 millrems/year and is considered by the staff to be within "as low as practicable" guidelines. Monitoring to ensure adherence to such guidelines will be incorporated within the Technical Specifications for Diablo Canyon.

The staff not only has provided qualitative analysis of impact of operation of waste systems and transportation of radioactive materials but has made quantitative estimates of doses to individuals and the general public.

14.13 STAFF ESTIMATES OF RADIATION DOSE TO MAN

14.13.1 Restrictive Numerical Dose (Department of Health, Education, and Welfare, p. A14-1-17)

The average population dose limit for somatic considerations as stated in paragraph 250 of NCRP No. 39 was formulated after the dose limit for genetic considerations was established. To quote paragraph 251: "The two limits have been numerically equated here by extending the organs of interest from the gonads to the total body."

14.13.2 Average Thyroid Dose (Department of Health, Education, and Welfare, p. A14-1-17)

The model provided by FRC No. 2 for determining the thyroid dose as a function of intake has been conservatively constructed. The dose to the thyroid of a child from a given intake of iodine is, among other things, a function of the thyroid mass, the effective half-time of the iodine in the thyroid, and the fractional intake of iodine which appears in the thyroid. In spite of evidence to indicate that several of these parameters may be smaller for the case of children as compared to adults (FRC No. 2), the only factor that is taken to be different from standard man values is the mass of the thyroid; this is taken to be 2 g, the normal value for a newborn infant. Since the thyroid mass for the standard man is 20 g, the dose to the child is taken to be ten times that for the standard man.

The passage quoted from FRC No. 4 relates to iodine concentrations measured in milk for different locations in the continental United States, Alaska, and Hawaii subsequent to the nuclear testing in 1961 and 1962; it has no direct bearing on the relative dose between standard man and children.

14.13.3 Dose from Processed and Raw Milk (Department of Health, Education, and Welfare, p. A14-1-17)

Paragraph 3 relates to the total dose to the thyroid of an adult and a child at 1.5 miles north-northwest; this includes contributions from direct radiation and ground, from inhalation of contaminated air, and from the terrestrial food chain (consumption of processed milk from the nearest dairy).

Paragraph 4 relates to the thyroid dose resulting from raw milk consumption at the closest nondairy farm.

The dose to a two-year-old child is calculated on the assumption that the thyroid of a two-year-old child has the same mass as that of a newborn infant, although it is actually slightly larger; therefore, the dose to the two-year-old thyroid is slightly overestimated and approximates that to an infant's thyroid.

14.13.4 Radiation Dose Period (Department of Health, Education, and Welfare, p. A14-1-17)

In Sect. 5.4.4, the first sentence of the second paragraph reads: "Radiation doses to individuals (in millirem) and to the population (in man-rem) from these pathways were estimated per year of release of radioactive effluents from normal operation of the station." For the case of radionuclides taken into the body by inhalation or ingestion, the dose calculated is the dose commitment for 50 years resulting from one year's accumulation of these radionuclides.

14.13.5 Potential Dose at Site Boundary (Environmental Protection Agency, p. A14-1-37)

The potential dose at the site boundary was not calculated because the locations of the nearest people were known. The limiting pathway for a receptor moving closer to the site than the present case would be the pasture-cow-milk pathway; therefore, the operational Technical Specifications will include provisions for a semiannual cow census, as well as the documentation of changes which may occur in the dose pathways and point of maximum offsite dose.

14.13.6 Thyroid Dose from Milk (Environmental Protection Agency, p. A14-1-39)

Please note that the estimation of the thyroid dose resulting from the ingestion of fresh milk from a cow pastured at 5 miles north-northwest has been changed from 3 to 16 millirems. However, with the present (modified) gaseous source term, this number will be reduced to 4.7 millirems. The Technical Specifications will be written so that the dose rate to the thyroid of an individual will not exceed the standards set by Federal regulation.

14.13.7 Transient Population Dose (Environmental Protection Agency, p. A14-1-48)

Contrary to comment 3, the transient population dose is included in the dose estimates. This problem is considered in Sect. 5.4.4. The dose to onsite construction workers was not considered, as is pointed out. The Radiological Impact section of an Environmental Statement assesses the radiological impact to the general population and does not include the dose to workers while they are on the job.

14.13.8 Population Doses from Crops (Environmental Protection Agency, p. A14-1-48)

The population dose from crops is discussed in the first paragraph under "Terrestrial Food-Chain Pathways" in Sect. 5.4.4; perhaps this was overlooked by the commenting agency.

14.14 EFFECTS ON COMMUNITY (Department of Housing and Urban Development, p. A14-1-19)

The comment relative to possible stimulation of population growth appears to be of questionable application to Diablo Canyon, because a significant amount of its capacity will go outside the service area. Furthermore, the population growth rate in the service area is declining, and a large percentage of the need for power is due to increased per capita consumption.

14.15 ENVIRONMENTAL MONITORING (Department of Commerce, p. A14-1-13; Department of the Interior, p. A14-1-27; Environmental Protection Agency, p. A14-1-38)

Environmental and radiological monitoring programs proposed by the applicant will be reviewed and modified when the Technical Specifications for Diablo Canyon are prepared. At that time, the operational radiological monitoring program will be constrained to meet the guidelines set forth in Regulatory Guide 4.1, and the suggestions of the Department of the Interior and EPA will be considered.

14.16 THEFT OF RADIOACTIVE MATERIALS (Geothermal Energy Institute, p. A 14-1-67)

The principal concern of the referenced reports is with strategic quantities of refined plutonium and quantities and enrichments of uranium. The radioactive materials used in or produced by a nuclear power plant do not qualify in that highly sophisticated utilization facilities, fuel reprocessing facilities, or isotopic enrichment capabilities would be needed to convert uranium and plutonium in new and irradiated fuel elements to strategic amounts or enrichments. In part, the intensity of radioactivity, particularly from irradiated fuel elements provides effective self protection. Additional protection also derives from the large size and weight of containers, the radiation warning signs which accompany all shipments of radioactive materials, and the normal precautions used in handling such materials. The staff does not believe that theft poses the prospect of a significant environmental impact for the Diablo Canyon plant.

14.17 PLANT ACCIDENTS

14.17.1 Accidental Releases to Water (Department of the Interior, p. A14-1-26)

A comment was made that releases to water should be considered. The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. Our evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to an incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

14.17.2 Evaluation of Risk (Kilbourne, pp. A14-1-77 to 80)

Comments were made concerning the conclusions of Sect. 7. To rigorously quantify an environmental risk, the computed radiological consequences would have to be multiplied by numerical values for probability. However, because of the absence of significant radiological accidents in the nuclear power industry to date and because of the extensive precautions taken in the design, construction, and operation to assure a low probability of accidents in the future, definitive estimates of accident occurrence probability are not available. Therefore, the consequences of the plant accidents considered in Sect. 7.1 are weighted by probability but assume each accident to occur. As indicated in this section, the environmental risk is small even assuming the occurrence of the accidents listed.

Areas covered by the water reactor safety program plan are considered in the safety review by the AEC Licensing Staff. While the safety research program is directed at obtaining additional information in key safety areas, current reactor designs incorporate large safety margins (in both design and operating procedures) to take into account any uncertainties in existing data. One of the principal features of the safety review process for nuclear power facilities is that if an accident mechanism is identified which could lead to significant radiological consequences, measures are required to be implemented to reduce the probability of a significant release of radioactivity. These measures can include safety features to reduce both the probability of the initiating event and the resulting radiological consequences given the event. Because the measures taken are evaluated in a conservative manner in the safety review, the subsequent environmental risk, when realistically evaluated, is extremely small.

14.18 IRRADIATED FUEL SHIPMENT (EPA, p. A 14-1-47, 48)

The location of the transshipment point for loading fuel containers is stated by the applicant to be at its Pismo Beach yard. The yard is located in Price Canyon on the outskirts of Pismo Beach approximately a mile from the center of the town. The land area adjacent to the yard is lightly populated. The population of Pismo Beach is about 4,000. San Luis Obispo with a population of about 40,000 is approximately 10 miles away. An estimate of the population dose to residents in the area can be made from information given in a staff publication, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," issued by the Directorate of Regulatory Standards, U.S. Atomic Energy Commission, December, 1972. Assuming an average population density around the PG&E rail yard of 1,000 persons per square mile and an average standing time per shipment before rail movement of irradiated fuel of two days, the cumulative population dose is about 2.4×10^{-2} man-rem per shipment, or about 0.2 man-rem per year. This represents a small fraction of the estimated population dose (0.6 man-rem) from transportation of irradiated fuel and an even smaller fraction of dose from natural radiation as discussed in Section 5.4.5.

14.19 LOAD FORECASTS (Department of Agriculture, p. A14-1-7)

The importance of energy conservation is recognized by the staff; however, the possible impact of public campaigns to decrease energy consumption cannot be discussed by the staff until the results of such campaigns are measurable. The need for fuel conservation is one reason that fossil-fueled plants were not considered as an alternative.

14.20 GEOTHERMAL ENERGY (Geothermal Energy Institute, p. A14-1-67)

In response to comments on geothermal energy received from the Geothermal Energy Institute the staff offers the following discussion. Because many of the individual comments are in reference to the overall comparison of geothermal energy to other sources rather than to Diablo Canyon specifically, the staff has treated these as generic problem areas for the purposes of preparing this response.

1. In response to the statement that Union Oil now has three rigs operating, the staff has accepted a 50% increase in drilling capability as necessary to meet the already planned expansion of the geothermal fields at a rate of 106 to 212 MW per year. The total installed capacity of the Geysers is now only about 300 MW, so it would be expected that additional drilling rigs will be required to supply an additional 1060 MW of capacity in the next seven years.

2. With regard to proven reserves versus established fields and geothermal potential, the staff only declares that geothermal energy is not a viable alternative to Diablo Canyon because the amount of capacity required by 1976 would necessitate a tripling of the planned growth. The cumulative total for all of California cited by the Institute for 1976 by reference to the *Gas and Oil Journal* article (January 1973) is 1136 MW, 820 MW of which is already planned for firm capacity by the applicant.

   The staff conclusion that geothermal energy is not a viable alternative to Diablo Canyon should not be extrapolated to other nuclear reactors starting at a point in time wherein newly discovered geothermal resources may be utilized.

3. With regard to the environmental impact of geothermal energy, the staff bases its statements directly upon the draft environmental statement on geothermal energy prepared by the Department of the Interior. The staff suggested that the effects of land subsidence, seismic activity, land use, noise abatement, hydrogen sulfide control, and heat dissipation should not be ignored and probably require more attention for large-scale development than for the present development rate

as acknowledged in that report. The staff does not intend to imply that any of these impacts represent de facto insurmountable obstacles for long-term development, but the staff does believe that the environmental impact of geothermal energy should be objectively evaluated in terms of large-scale development.

4. With regard to the proven reserve at the Geysers, the staff is willing to update this figure to any amount that can be documented by credible references or experts. The "about" 750 MW proven and 1000 to 1500 MW possible reserve referred to by the staff are based on sworn testimony of a Union Oil Company representative in direct connection with Diablo Canyon. (Reference 3, Section 12.)

5. The data referred to by the Institute (that show a cumulative total geothermal capacity of 1136 MW in 1976) are estimates that reflect "only present development trend, not total state potential." Whether this is to be taken as a liberal or conservative estimate of potential geothermal capability rests largely on whether the reserve is required to be "proven" or "likely." The 1880 MW later capacity stated in those data obviously exceed the 750 MW proven reserve referred to by the staff, but they are in substantial conformance with the 1000 to 1500 MW likely reserve also referred to by the staff. The staff will revise the upper limit of likely reserve in the statement.

6. With reference to the "vast geothermal resources" cited by the Institute, the staff was indeed aware of most, but certainly not all, of the potential resources listed. The staff attempted to evaluate geothermal energy in the context of 1975 and 1976 potential, which in the staff's opinion precludes many of the long-range potential energy sources. Furthermore, the degree of resource "vastness" apparently depends to a large extent upon well spacing. The staff's estimates are based on well spacing of 10 to 20 acres per well with about three additional wells per year per 100 MW to assure capacity. Certainly, reducing the well spacing would reduce land use. However, whether or not it would increase resources of a geothermal reservoir is as yet undetermined, in the staff's opinion.

   The staff stated that total geothermal potential is a controversial subject (and will add here that it is a rapidly moving target because of the recent increase of public interest in the subject). The need for proven reserve compared to estimated possible reserve, added to the need to subtract presently planned capacity from that reserve, resulted in the staff conclusion that geothermal energy could replace only a "small fraction" of Diablo Canyon. A total of 2000 MW of geothermal power is needed to replace Diablo Canyon and to meet the applicant's present commitment to geothermal systems additions by 1976. The staff did not see in 1972, nor does the staff see in 1973, where this geothermal capacity can be installed by 1976, based on present estimates of development potential.

7. The staff did not evaluate geothermal energy as a "viable energy alternative to nuclear power plants." The staff evaluated geothermal energy as an alternative to Diablo Canyon Units 1 and 2. The staff's conclusions should therefore be considered in the context of the uniqueness of Diablo Canyon.

14.21 NEED FOR POWER ALTERNATIVES (Department of Agriculture, p. A14-1-7)

The comment discusses consideration of the alternative of "no additional capacity" over construction of the two units.

Section 12.1.4, taken in its entirety, indicates that the alternative of not providing power has been considered with particular reference to some of the measures which the Economic Research Service of the Department notes could affect demand projections factored into the applicant's need for power. To the extent that measures such as special metering, changes in rate structure, or promotional efforts (matters ultimately within the jurisdiction of the California Public Utilities Commission) can be considered to be within the range of reasonably available alternatives, the staff has not ruled out such measures. In considering the relevant factors in its analysis of alternatives, however, the staff has taken note of the effect of what it views as validly substantiated customer demand upon the viability of the no power alternative and indeed of the above-specified measures. It is questionable, for example, that negative advertising by the applicant will have a demonstrable effect upon the need for power in the short term, and the long-term effect of such measures is speculative. In the view of the staff, such measures in the present context do not constitute a sufficient basis for modifying the staff's conclusions concerning alternatives within the scope of the Commission's available courses of action.

14.22 UTILIZATION OF ELECTRICITY (Economic Research Service, p. A 14-1-7)

Comments by the Economic Research Service, USDA, includes one which deals with increasing the efficiency of utilization of electricity by means such as changing rate structure. The question of rate structure is the responsibility of public service commissions in the various states and, to some extent, of the Federal Power Commission. The Chairman of the AEC in remarks made on October 20, 1971 (AEC Release No. S-21-71), said: "Unquestionably it is the AEC's responsibility to take local power supply conditions into account when an application lies before the AEC. Our new regulations specifically recognize this responsibility, but I underscore that in the existing statutory framework our responsibility iis not the overall power supply situation, but rather providing technical options and seeing that the technology is appropriately and safely utilized."

With regard to the question of price elasticity, the following excerpts from page I-1-14 of "The 1970 National Power Survey" of the Federal Power Commission indicate that the demand for electricity is relatively insensitive to price changes:

> "Insofar as residential demand is concerned at present price levels, most household uses of electricity are considered to be relatively price-inelastic (i.e., insensitive to price changes) and, within reasonable limits, rate increases would not be expected to have marked impact on demand growth. An important exception is space heating....
>
> "In general, the same characterization holds true of the commercial demand for electricity and for the same reasons.
>
> "In the area of industrial use, although the availability of dependable low-cost electricity is a factor almost always taken into account in the selection of new plant sites, there are only a few industries in which the cost of electricity accounts for a substantial part of the cost of manufacture. With these exceptions, of which primary aluminum production is perhaps the outstanding example, the industrial use of electricity tends--again with limits--to be price inelastic. It is expected that increased emphasis on improving labor

> productivity and quality control standards will lead many industries to broaden, rather than contract, their uses of electricity and that a similar broadening of electricity usage will stem from steps taken in the interest of environmental protection."

A staff study on "The Potential for Energy Conservation" issued in October 1972 by the Office of Emergency Preparedness, Executive Office of the President, listed several short-term measures for energy conservation by electric utilities. One was to smooth out the daily demand cycle and thus reduce the use of inefficient peaking generation. Ways of doing this would include applying a demand charge penalizing heavy demand during the peak-load hours or the promotion of interruptible sales. Another conservation measure given was to facilitate new construction and reduce maintenance on new plants and equipment in order to reduce the use of old, inefficient equipment. Delay in operation of nuclear power plants, resulting in increased requirements for fuel oil, was said to have "short-term and high impact effects on our energy situation as well as our balance of trade and should receive national attention of the first order." A third conservation measure was to decrease electricity demand selectively, for example, by increased use of insulation in homes. However, it was pointed out that, in some cases, "reducing electric power demand can have adverse environmental effects by causing increased use of dirty fuels at many small installations where pollution emission control is difficult and expensive."

Although conservation measures may in time reduce somewhat the rate of growth of the demand for electricity, they are not likely to eliminate the need in the short term for additional large plants such as the Diablo Canyon Station.

14.23 BENEFITS OF EXISTING DESIGN (Department of Agriculture, p. A14-1-7; Department of the Interior, p. A14-1-27)

Section 13.5.1 states that the air pollutants saved are those that would result from the system mix of alternative generation. Since the staff does not claim this as a cost for an alternative and since it is essentially the result of operating peaking plants and retired units at base load until new capacity is added, it is listed as a benefit.

14.24 BENEFITS FROM TRANSMISSION LINE CONSTRUCTION (Department of Agriculture, p. A14-1-9)

The staff agrees with the Forest Service and has removed the quoted statement from Sect. 13.5.1.

Appendix 1-1

APPLICATIONS AND APPROVALS

Agency	Licenses, permits, approvals	Status
	Federal	
Atomic Energy Commission	Construction permit for Unit 1	Issued April 1968 after public hearing
	Construction permit for Unit 2	Issued December 1970 after public hearing
	Reactor operators' licenses	Scheduled to be obtained by August 1974
	Operating license for Unit 1	Scheduled to be obtained by September 1974
	Operating license for Unit 2	Scheduled to be obtained by September 1975
	Order permitting continued construction pending completion of NEPA review	Issued June 1972 after public hearing
Corps of Engineers (U.S. Army)	Permit to install wave recorder	Issued October 1968
	Permit to construct breakwater and intake	Issued June 1969
	Permit for barge landing	Issued April 1970
	Permit for cofferdam, roads, soil removal for discharge	Issued April 1970
	Permit for discharge, Units 1 and 2	To be obtained
Bureau of Land Management	Right-of-way for breakwater and filled areas	Issued August 1969
	Rights-of-way across Federal lands	Issued April 1968 and September 1970 (amended April 1969)

Agency	Licenses, permits, approvals	Status
Federal Aviation Agency	Determination of no hazard for meteorological mast	Issued December 1966
	Amendment to "determination," resulting from height change of meteorological mast	Approved January 1967
	Determination of no hazard for containment structures	Issued October 1969
	Determination of no hazard for tower crane	Issued December 1969
	Amendment to "determination," resulting from removal of lighting from meteorological mast	Approved December 1969
	Finding of no hazards to air navigation	Issued March 1967 and August 1969
U.S. Forest Service	Rights-of-way through Los Padres National Forest	Permits issued March 1970
	State of California	
Department of Fish and Game	Approval for culvert and fill	Approved July 1968
State Lands Commission	Lease of submerged lands for wave height transducer	Issued November 1968 after public hearing
	Boundary line agreement	Issued August 1969
	Lease for intake basin	Issued August 1969 after public hearing
	Extension of lease for wave height transducer	Issued February 1970 after public hearing
	Right-of-way for discharge channel	Issued June 1970 after public hearing
	Industrial lease right-of-way for road and cofferdam	Issued June 1970 after public hearing

Agency	Licenses, permits, approvals	Status
Resources Agency, Departments of Conservation, Water Resources, Parks and Recreation, Fish and Game, Harbors and Watercraft	Agreement	Issued December 1966
Public Utilities Commission	Certificate of public convenience and necessity for Unit 1	Issued November 1967 after public hearings
	Certificate of public convenience and necessity for Unit 2	Issued March 1969 after public hearings
	Order permitting construction of transmission lines	Issued February 1972 after public hearing
Central Coast Regional Water Quality Control Board, the Resources Agency	Waste discharge requirements	Issued May 1969 after public hearings
State Water Resources Control Board, the Resources Agency	Water quality certification, Sect. 21(b) of the Federal Water Pollution Control Act and Title 23, Chap. 3, Sub-chap. 11, of the California Administrative Code	Issued October 1971
Department of Public Health	Program of radiological monitoring	Continuing program
Division of Industrial Safety	Miscellaneous reviews of construction safety, pressure vessels, elevator permits, etc.	
Port San Luis Harbor District	Lease	Issued December 1969; became final with approval of Department of Navigation and Ocean Development, July 1970

Agency	Licenses, permits, approvals	Status
	Local	
County of San Luis Obispo	Excavation and grading permit for access road	Issued April 1968
	Excavation and grading permit for borrow area	Issued June 1968
	Excavation and grading permit for Point Patton to elevation 85 ft	Issued March 1970
	Excavation and grading permit for Point Patton, elevation 85 ft to 75 ft	Issued July 1970
	Excavation and grading permit for Unit 2	Issued April 1971
	Excavation and grading permit for barge landing	Issued June 1970
	Excavation and grading permit for temporary laydown area	Issued April 1971
	Conditional use permit for trailer housing	Issued July 1968
	Building permit for Unit 1 below elevation 85 ft	Issued October 1969
	Building permit for Unit 1 above elevation 85 ft	Issued June 1970
	Building permit for meteorological towers	Issued January 1967
	Building permit for barge landing	Issued June 1970
	Building permit for gate house	Issued September 1970
	Building permit for conference and construction office	Issued July 1969
	Building permit for warehouse	Issued June 1969

Agency	Licenses, permits, approvals	Status
	Building permit for compressor building	Issued June 1969
	Building permit for quality assurance laboratory and office	Issued June 1969
	Building permit for concrete batch plant	Issued April 1969
	Building permit for 230-kV switchyard control building	Issued April 1971
	Building permit for 500-kV switchyard control building	Issued May 1971
	Building permit for Unit 2	Issued July 1971
	Building permit for Black Butte microwave tower	Issued October 1971
	Building permit for Black Butte communications building	Issued October 1971
	Building permit for Davis Peak microwave tower	Issued October 1971
	Building permit for Davis Peak communications building	Issued October 1971
	Transmission route approval (Planning Commission)	Granted October 1966
County of Fresno	Transmission route approval (Director of Planning)	Granted November 1966
County of Kern	Transmission route approval (Planning Commission)	Granted November 1966
County of Kings	Transmission route approval (Planning Department)	Granted November 1966
County of Monterey	Transmission route approval (Planning Commission)	Granted November 1966

Appendix 2-1

COMMENTS BY RICHARD B. HASTINGS,

CALIFORNIA STATE PARK ARCHAEOLOGIST,

ON THE ENVIRONMENTAL REPORT

STATE OF CALIFORNIA—RESOURCES AGENCY RONALD REAGAN, Governor

DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 2390
SACRAMENTO 95811

CCA	MGR., LAND DEPT.
NWB	MAY 13 1971
EED	
PFM	JEW
LMM	Comment
	Pre Ply
WP	U-Reply
IMP	File

May 12, 1971

Mr. H. M. Gustafson
Coordinator of Land Management
Pacific Gas and Electric Company
77 Beale Street
San Francisco, California 94106

Dear Mr. Gustafson:

This is in reply to your letter of April 6, 1971 with respect to the Diablo Canyon power plant environmental report. Our records show three prehistoric sites within the Pacific Gas and Electric Company project boundary, SLO-2 SLO-61 SLO-584. SLO-2 had originally been surveyed as two separate sites, but later field survey work revealed the two sites as being connected and forming one large midden area with an attached cemetery. SLO-2 lies on the western uphill slope of Diablo Canyon starting approximately at the 50-foot contour level above the ocean and running uphill to the 450-foot contour level. SLO-61 lies in the area proposed for construction of turbine generators no. 1 and 2. SLO-584 is situated 3,600 feet upstream from the mouth of Diablo Canyon and lies on the southern slope of the canyon wall. Part of SLO-2 has now been covered with stockpiled excess fill which lies directly over the remaining portion of the cemetery.

These three site areas are the only ones which have been surveyed within the boundary at this time. The contour map of Diablo Canyon would indicate the possibility of finding further prehistoric sites along the ridges formed by the dry gullies south of the construction area. We feel that these areas deserve to be surveyed along with the remaining areas within the boundaries of the Diablo Canyon project. Mrs. Greenwood has stated the importance of the area archeologically, and the great amount of undisturbed sites that are available along the coast. These sites are doubly important to us in that they may not have yet been vandalized and very little is known about the habitation patterns and material customs of the people who lived there prior to European contact. Any work in conjunction with the construction of the desaltation plant, the turbine generator plant or other structures that may be built, even if not in themselves resting on a midden site, will probably cause secondary damage to the archeological areas due to supporting construction work that is needed on the project. We earnestly request that our office be kept advised of current construction proposals so that we may make recommendations as to any salvage archeology that would be needed due to the impact of the construction areas.

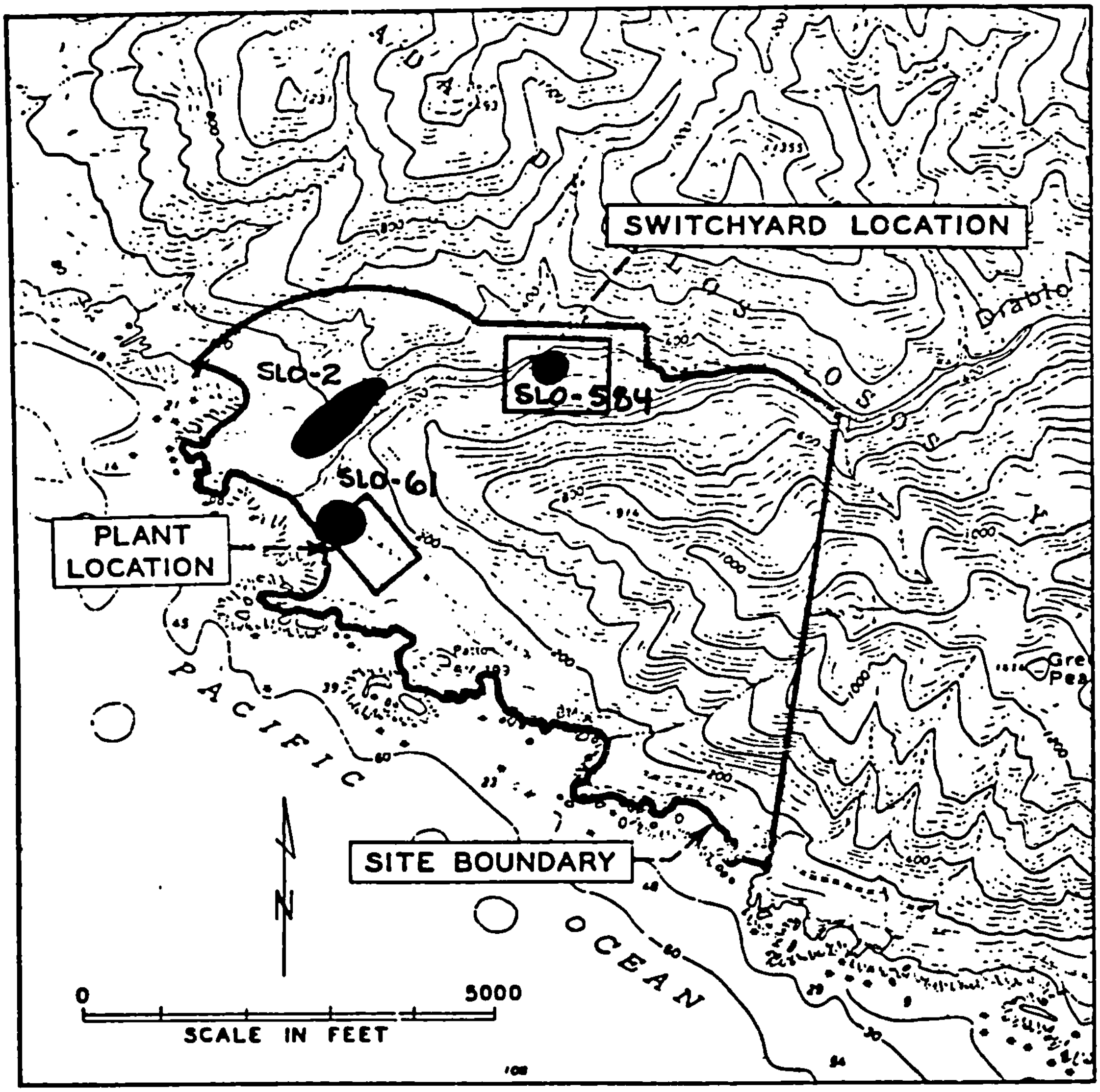
There are no known historic sites located directly on the Pacific Gas and Electric Company property, but there is an adobe two to three miles southeast of the plant site. It is not thought at this time to be of national significance, but it may have local historical importance. The enclosed map will show the number of known historic and prehistoric sites within a near proximity of the boundary lines of the P. G. & E. project. As of this date, no sites within or near this location have been placed on the National Register of Historic Places, but this in no way negates the importance of any archeological sites within the project area. The placement on the National Register of a site denotes the site's importance at either national, state, or local level of significance, but there are many more sites which are of importance that might not achieve nomination, and all archeological sites are vitally important for research work and for a further understanding of California history.

Thank you very much for allowing us to consult with your office on this project and please contact us if we may be of further service.

Sincerely,

Richard B. Hastings

Richard B. Hastings
State Park Archeologist II



UNIT 2
DIABLO CANYON SITE
PSAR

FIGURE 2-4
SITE PLAN

Appendix 2-2

METEOROLOGY

Notes to tables:

Tables of data (I-1 through I-6) furnished by the applicant in Supplement No. 2 to the Environmental Report, Appendix U, were reworked as follows:

1. a. Range in azimuth angle 0° - 15° was classified as Brookhaven type D or turbulence class V and subsequently classified as stability category F.

   b. Range in azimuth angle 15° - 30° was classified as Brookhaven type B or turbulence class III and subsequently classified as stability category D.

   c. Range in azimuth angle 30° - 49° was also classified as Brookhaven type B, as in item b above.

   d. Range in azimuth angle 49° - 69° was classified as Brookhaven type B_2 or turbulence class II and subsequently classified as stability category C.

   e. Azimuth angle greater than 69° was classified as Brookhaven type A or turbulence class I and subsequently classified as stability category C.

2. The mean wind speed was used rather than the range.

3. The wind speed was changed to meters per second:

   Mph x 0.44704 = m/sec.

4. The direction was changed to indicate the direction toward which the wind blows.

5. The east direction was placed first to aid key-punch operations.

6. Frequency tables were prepared by dividing by the total number of observations. These tables are Tables 2.2.1, 2.2.2, and 2.2.3.

Table 2-2.1. Frequency of wind speed and direction: C stability conditions

Wind toward:	Frequency for wind speed (m/sec) of –								Total
	0.45	0.89	1.34	2.46	5.14	9.16	18.11	20.00	
E	0.0034	0.0022	0.0024	0.0015	0.0004	0	0	0	0.0099
ESE	0.0031	0.0018	0.0018	0.0059	0.0037	0.0003	0	0	0.0166
SE	0.0024	0.0018	0.0024	0.0143	0.0171	0.0049	0.0006	0	0.0435
SSE	0.0021	0.0016	0.0015	0.0111	0.0150	0.0052	0.0008	0	0.0373
S	0.0027	0.0017	0.0027	0.0100	0.0094	0.0014	0.0001	0	0.0280
SSW	0.0012	0.0014	0.0020	0.0081	0.0060	0.0010	0	0	0.0197
SW	0.0012	0.0016	0.0014	0.0075	0.0051	0.0009	0	0	0.0177
WSW	0.0014	0.0011	0.0009	0.0039	0.0040	0.0001	0	0	0.0114
W	0.0024	0.0018	0.0013	0.0035	0.0009	0.0001	0	0	0.0100
WNW	0.0022	0.0017	0.0014	0.0019	0.0012	0.0002	0	0	0.0086
NW	0.0038	0.0023	0.0026	0.0053	0.0013	0.0002	0	0	0.0155
NNW	0.0052	0.0030	0.0023	0.0039	0.0009	0.0005	0	0	0.0158
N	0.0053	0.0027	0.0014	0.0017	0.0005	0.0006	0.0006	0	0.0128
NNE	0.0039	0.0012	0.0007	0.0006	0.0004	0.0001	0	0	0.0069
NE	0.0030	0.0014	0.0005	0.0004	0	0.0001	0	0	0.0054
ENE	0.0024	0.0019	0.0011	0.0007	0	0	0	0	0.0061
Total	0.0457	0.0292	0.0264	0.0803	0.0659	0.0156	0.0021	0	0.2652

Table 2-2.2. Frequency of wind speed and direction: D stability conditions

Wind toward:	Frequency for wind speed (m/sec) of –								Total
	0.45	0.89	1.34	2.46	5.14	9.16	18.11	20.00	
E	0.0032	0.0024	0.0029	0.0047	0.0009	0.0004	0	0	0.0145
ESE	0.0022	0.0021	0.0035	0.0123	0.0098	0.0043	0.0002	0	0.0344
SE	0.0024	0.0014	0.0031	0.0191	0.0651	0.0673	0.0223	0	0.1807
SSE	0.0015	0.0008	0.0008	0.0060	0.0177	0.0152	0.0062	0	0.0482
S	0.0006	0.0004	0.0005	0.0024	0.0085	0.0029	0.0002	0	0.0155
SSW	0.0003	0.0003	0.0005	0.0017	0.0064	0.0023	0.0001	0	0.0116
SW	0.0002	0.0004	0.0001	0.0018	0.0034	0.0004	0	0	0.0063
WSW	0.0004	0.0004	0.0004	0.0011	0.0013	0.0003	0	0	0.0039
W	0.0011	0.0008	0.0006	0.0014	0.0006	0.0002	0	0	0.0047
WNW	0.0021	0.0011	0.0017	0.0056	0.0063	0.0029	0.0006	0	0.0203
NW	0.0044	0.0024	0.0074	0.0207	0.0193	0.0109	0.0022	0	0.0673
NNW	0.0072	0.0041	0.0038	0.0111	0.0034	0.0013	0.0009	0	0.0318
N	0.0051	0.0023	0.0014	0.0016	0.0008	0.0008	0.0005	0	0.0125
NNE	0.0019	0.0007	0.0010	0.0014	0.0005	0.0001	0	0	0.0056
NE	0.0033	0.0014	0.0009	0.0010	0.0006	0.0004	0	0	0.0076
ENE	0.0030	0.0013	0.0014	0.0011	0.0001	0.0002	0	0	0.0071
Total	0.0389	0.0223	0.0300	0.0930	0.1447	0.1099	0.0332	0	0.4720

Table 2-2.3. Frequency of wind speed and direction: F stability conditions

Wind toward:	Frequency for wind speed (m/sec) of –								Total
	0.45	0.89	1.34	2.46	5.14	9.16	18.11	20.00	
E	0.0019	0.0011	0.0014	0.0039	0.0006	0.0002	0	0	0.0091
ESE	0.0016	0.0012	0.0012	0.0100	0.0233	0.0105	0.0006	0	0.0484
SE	0.0011	0.0006	0.0014	0.0086	0.0377	0.0525	0.0145	0	0.1164
SSE	0.0004	0.0004	0.0003	0.0004	0.0014	0.0016	0.0004	0	0.0049
S	0.0002	0.0001	0.0001	0.0002	0.0002	0.0001	0	0	0.0009
SSW	0.0001	0	0.0001	0.0001	0.0002	0	0	0	0.0005
SW	0.0003	0.0001	0.0001	0.0003	0.0004	0.0001	0	0	0.0013
WSW	0.0003	0	0.0001	0.0002	0.0001	0	0	0	0.0007
W	0.0006	0.0002	0.0002	0.0002	0.0001	0	0	0	0.0013
WNW	0.0009	0.0006	0.0009	0.0017	0.0017	0.0002	0	0	0.0060
NW	0.0042	0.0027	0.0029	0.0127	0.0118	0.0016	0.0006	0	0.0365
NNW	0.0055	0.0022	0.0030	0.0044	0.0021	0.0020	0.0013	0	0.0205
N	0.0032	0.0006	0.0006	0.0008	0.0007	0.0007	0.0003	0	0.0069
NNE	0.0016	0.0002	0.0002	0.0002	0.0006	0.0002	0.0001	0	0.0031
NE	0.0016	0.0003	0.0002	0.0005	0.0004	0.0002	0	0	0.0032
ENE	0.0013	0.0004	0.0006	0.0006	0.0002	0.0001	0.0001	0	0.0033
Total	0.0248	0.0107	0.0133	0.0448	0.0815	0.0700	0.0179	0	0.2630

Appendix 2-3

COMMENTS ON METEOROLOGY FROM THE AEC SAFETY EVALUATION REPORT FOR DIABLO CANYON, UNIT 2, November 18, 1969

For evaluation of accidents the applicant has chosen diffusion parameters which correspond to a Pasquill Category F meteorological condition with one meter per second wind speed for short term releases, and meteorological conditions corresponding to a distribution of Pasquill Category C, D, and F for long term releases. The Environmental Science Services Administration (ESSA) has evaluated the meteorological assumptions and has concluded that the assumptions chosen by the applicant are conservative. This conclusion is based on a review and analysis of the meteorological data taken by the applicant at the site. The data, presented in Amendment 6 in response to the questions raised by ESSA in its August 11, 1969 comments, show that more than 95% of the time the actual meteorological conditions at the site are more favorable for atmospheric dispersion in the on-shore direction than those assumed for accident evaluations. The ESSA reports are attached in Appendix C to this report. The applicant's meteorological program includes meteorological measurements from a 250-foot tower near the plant location, from a 100-foot tower at the top of a 914-foot hill on the site, and at four other locations. We conclude that the meteorological program is adequate to provide a basis for the development of a gaseous radioactive release limit and to confirm the conservatism of diffusion parameters used in the analysis of potential accidental releases.

Appendix 2-4

COMMENTS ON DIABLO CANYON SITE NUCLEAR UNIT 2, PACIFIC GAS AND ELECTRIC COMPANY, PRELIMINARY SAFETY ANALYSIS REPORT, AMENDMENT 6, DATED SEPTEMBER 25, 1969, PREPARED BY AIR RESOURCES ENVIRONMENTAL LABORATORY, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION, OCTOBER 6, 1969

The analysis presented in Amendment 6 makes it possible to evaluate the joint probability of low wind speeds, inversion conditions, and onshore flow, and thereby a determination of the degree of conservatism of the applicant's diffusion parameters can be made.

We have analyzed the 25-ft onsite wind data presented in Tables 2, 3, and 4 in the following manner. All cases with wind speeds of 2 mph or less were summed for onshore flow (SE clockwise through WNW), including the calm category. Thus, for temperature inversions greater than 0.7°F, 1.5°F, and 2.0°F per 200 feet the total cases, respectively were 663,517, and 421 out of a grand total of 11,353. This is, respectively, 5.8, 4.6, and 3.7 percent of the total over a two year period. Our percent values are somewhat higher than those of the applicant because we assumed a full 180° arc for onshore flow whereas the applicant assumed 157°.

It is our opinion that temperature inversion gradients greater than 1.5°F per 200 feet represents the Pasquill F inversion condition. Consequently, the data show that the probability of having onshore, Type F conditions with speeds of 1 m/sec or less is no greater than 4.6 percent. On this basis we feel the applicant's assumption of these conditions is reasonably conservative.

Appendix 2-5

INVENTORY OF MARINE BIOTA AT DIABLO CANYON

(For a complete listing see pages IV-E-13 to IV-E-15 in the applicant's Environmental Report)

Table 2-5.1. Some common organisms (excluding fish) found in Diablo Cove

Chlorophyta	
Bryopsis corticulans	Green alga
Ulva lobata	Sea lettuce
Phaeophyta	
Alaria marginata	Brown alga
Heterochordaria abientina	Brown alga
Ralfsia pacifica	Brown alga
Rhodophyta	
Botryoglossum farlowianum	Red alga
Callithamnion pikeanum	Red alga
Callophyllis sp.	Red alga
Corallina chilensis	Coralline alga
Crytopleura lobulifera	Red alga
Cryptosiphonia woodii	Red alga
Endocladia muricata	Red alga
Erythrophyllum delesserioides	Red alga
Farlowia mollis	Red alga
Gigartina sp.	Red alga
Gigartina agardhii	Red alga
G. canaliculata	Red alga
G. cristata	Red alga
G. papillata	Red alga
Grateloupia setchellii	Red alga
Iridaea flaccida	Red alga
I. splendens	Red alga
Lithothamnion sp.	Coralline alga
Microcladia borealis	Red alga
Microcladia coulteri	Red alga
Plocamium violaceum	Red alga
Polysiphonia pacifica	Red alga
Porphyra perforata	Red alga
Prionitis andersonii	Red alga
P. lanceolata	Red alga
Schizymenia pacifica	Red alga

Table 2.5.1 (continued)

Porifera	
Haliclona sp.	Sponge
Leucosolenia sp.	Sponge
Rhabdodermella nuttingi	Sponge
Coelenterata	
Anthopleura artemesia	Burrowing anemone
A. elegantissima	Aggregated anemone
A. xanthogrammica	Giant green anemone
Epiactis prolifera	Proliferating anemone
Bryozoa	
Membranipora membranacea	Encrusting bryozoan
Phidolopora pacifica	Coralline bryozoan
Annelida	
Sabellaria sp.	Polychaete worm
Terebellidae	Polychaete worm
Mollusca (Amphineura)	
Ischnochiton sp.	Chiton
Katharina tunicata	Chiton
Mollusca (Gastropoda)	
Acanthina spirata	Thorn shell
Acmaea digitalis	Rough limpet
A. scabra	Ribbed limpet
A. scutum	Plate limpet
Aletes squamigerus	Fixed snail
Hermissenda crassicornis	(Eolid nudibranch)
Jaton festivus	Festive rock shell
Littorina scutulata	Checkered periwinkle
Littorina planaxis	Eroded periwinkle
Mitrella carinata	Dove shell-snail
Olivella biplicata	Purple olive
Tegula funebralis	Black turban snail

Table 2.5.1 (continued)

Mollusca (Pelecypoda)	
Chama pellucida	Rock oyster
Hinnites multirugosus	Rock scallop
Mytilus californianus	California mussel
Pododesmus macroshisma	Jingle
Arthropoda	
Balanus glandula	Acorn barnacle
B. nubilis	Giant barnacle
B. tintinnabulus	Red and White barnacle
Cancer antennarius	Rock crab
Caprellidae	Caprellid amphipod
Caprella equilibra	Skeleton shrimp
Corophium acherusicum	
Hapalogaster cavicauda	Hairy crab
Hemigrapsus nudus	Purple shore crab
Neosphaeroma oregonensis	Isopod
Idothea sp.	Isopod
Pachycheles rudis	Porcelain crab
Pachygrapsis crassipes	Lined shore crab
Pagurus samuelis	Hermit crab
Pugettia producta	Kelp crab
Tetraclita squamosa rubescens	Red barnacle
Echinodermata	
Pateria miniata	Bat star
Pisaster brevispinus	Shortspined star
P. ochraceous	Ochre star
Chordata (Urochordata)	
Amaroucium californicum	Sea pork

Sources:

California Department of Fish and Game, "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," Environmental Services Branch, Office Report, March 1972, 85 pp.

R. F. Cayot and W. J. North, *Oceanographic Background Study, Diablo Canyon Nuclear Power Plant Site, 1967,* Pacific Gas and Electric Co., Department of Engineering Research, Rep. 6242. 4-68, 1968.

Table 2-5.2. Fishes observed and collected in the Diablo Canyon study areas during 1970 and 1971

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth normally collected or observed (ft)	Abundance and general remarks[a]
Ammodytes hexapterus Dekay	Pacific sand lance	x		25	(1) Only 1 taken in North Cove
Anarhichthys ocellatus Ayres	Wolf eel	x		20	(2) Only 1 observed in North Cove near Lion Rock
Anoplarchus purpurescens Gill	High cockscomb	x	x	To 10	(1) Abundant during fall in shallow water
Apodichthys flavidus Girard	Penpoint gunnel	x	x	To 10	(1) Common during fall in shallow water
Artedius corallinus (Hubbs)	Coralline sculpin	x	x	20-70	(1) Abundant during all seasons
Artedius creaseri (Hubbs)	Roughcheek sculpin	x	x	20-70	(1) Sparse during summer and fall
Artedius fenestralis Jordan Gilbert	Padded sculpin		x	20	(1) Sparse during winter only
Artedius harringtoni (Starks)	Scaly-head sculpin	x	x	20-70	(1) Very abundant during fall (65 specimens) at 70 ft
Artedius lateralis (Girard)	Smooth head sculpin	x	x	To 20	(1) Common during fall and winter

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Artedius notospilotus Girard	Bonehead sculpin	x	x	20–70	(1) Sparse during fall and winter
Asemichthys vinculus (Bolin)	Gottid		x	70	(1) Very sparse — total of 3 specimens taken
Atherinops affinis (Ayers)	Top smelt		x	To 10	(1) Sparse during winter only
Aulorhynchus flavidus Gill	Tube snout	x	x	To 20	(3) 724 taken during July in North Cove
Bothragonus swanii	Rockhead	x		60	(1) New southern record from North Cove collection
Brosmophycis marginata (Ayers)	Red brotula	x	x	20–70	(1) Common during all seasons at 70 ft
Cebidichthys violaceus (Girard)	Monkeyface prickleback	x	x	To 10	(1) Common during fall and winter in shallow water
Cephaloscyllium ventriosum (Garman)	Swell shark	x		30	(2) 2 observed in North Cove near Lion Rock during fall
Chirolophis nugator (Jordan and Williams)	Mosshead warbonnet	x	x	20–70	(1) Common during fall and winter

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Citharichthys stigmaeus Jordan and Gilbert	Speckled sanddab	x	x	20-70	(3) Abundant in sandy areas
Clinocottus analis (Girard)	Wooly sculpin	x	x	To 10	(1) Sparse to common — only in shallow water
Clinocottus globiceps (Girard)	Mosshead sculpin	x	x	To 10	(1) Sparse — taken during summer and fall only from shallow water
Clinocottus recalvus (Greeley)	Blad sculpin	x	x	To 10	(1) Sparse — taken during summer and fall only from shallow water
Coryphopterus nicholsi (Bean)	Blackeye goby	x	x	20-70	(3) Common throughout during all seasons
Cymatogaster aggregata Gibbons	Shiner perch	x		10	(3) Common during summer in North Cove
Damalichthys vacca Girard	Pile perch	x	x	To 70	(3) Common throughout
Embiotoca jacksoni Agassiz	Black perch	x	x	To 30	(3) Sparse throughout
Embiotoca lateralis Agassiz	Striped perch	x	x	To 30	(3) Sparse to common throughout

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Engraulis mordax Girard	Northern anchovy	x	x	To 10	(1) 115 juveniles taken during winter in shallow water
Enophrys taurina Gilbert	Bull sculpin		x	70	(1) Sparse during fall
Gibbonsia elegans (Cooper)	Spotted kelpfish	x	x	To 10	(1) Common during fall
Gibbonsia metzi Hubbs	Striped kelpfish	x	x	To 10	(1) Common during fall, new size record
Gibbonsia montereyensis Hubbs	Crevice kelpfish	x	x	To 25	(1) Common to abundant during all seasons
Girella nigricans (Ayres)	Opaleye		x	To 10	(1) 1 specimen collected during spring
Gobiesox maeandricus (Girard)	Northern clingfish	x	x	To 20	(1) Taken during summer and fall — common to abundant in shallow water
Hemilepidotus hemilepidotus (Tilesius)	Red Irish lord		x	70	(1) Very sparse
Hemilepidotus spinosus (Ayres)	Brown Irish lord	x	x	20-70	(1) Common in North Cove
Hexagrammos decagrammus (Pallas)	Kelp greenling	x	x	To 40	(3) Common in North Cove in 25-ft depths

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Hyperprosopon argenteum Gibbons	Walleye surfperch	x	x		(1) Very sparse
Hypsurus caryi (Agassiz)	Rainbow sea perch	x	x	To 25	(1) Very sparse
Jordania zonope Starks	Longfin sculpin	x	x	60-70	(1) Common during all seasons
Kasatkia sp. nov.			x	20	(1) 6 specimens collected during fall in Diablo Cove
Lethops connectens Hubbs	Halfblind goby	x	x	20-60	(1) very sparse, only 2 specimens taken
Liparis florae (Jordan & Starks)	Tidepool snailfish		x	To 20	(1) sparse
Liparis fucensis Gilbert	Slipskin snailfish	x	x	20	(1) 5 specimens collected in 20 ft
Liparis mucosus Ayres	Slimy snailfish	x	x	To 20	(1) Very sparse, only during fall
Liparis sp. nov.		x	x	20	(1) 1 specimen collected during each survey in 20 ft
Liparis sp. (unid.)		x	x	To 70	(1) Sparse

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Lumpenopsis sp. nov.		x			(1) 13 specimens taken from North Cove
Lythrypnus dalli (Gilbert)	Bluebanded goby		x	40	(2) One observed near Diablo Rock — northern record
Lythrypnus zebra (Gilbert)	Zebra goby	x			(1) Northern record — one collected in North Cove at 25 ft
Micrometrus aurora (Gibbons)	Dwarf perch	x	x	To 10	(1) Sparse to common
Micrometrus minimus (Gibbons)	Dwarf perch		x	To 10	(1) One specimen collected during fall in shallow water
Nautichthys oculofasciatus (Girard)	Sailfin sculpin	x	x	20-70	(1) Sparse, during all seasons
Oligocottus rimensis (Greeley)	Saddleback sculpin		x	To 10	(1) Two specimens collected in fall
Oligocottus rubellio (Greeley)	Rosy sculpin	x	x	To 20	(1) Sparse during summer and fall
Oligocottus snyderi Greeley	Fluffy sculpin	x	x	To 10	(1) Sparse during summer and fall
Ophiodon elongatus Girard	Lingcod	x	x	To 70	(3) Present throughout

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Orthonopias triacis Starks and Mann	Snubnose sculpin	x	x	20-70	(1) Common to abundant
Otophidium taylori (Girard)	Spotted cusk eel	x	x	25-70	(1) Common to abundant in sandy areas
Oxyjulis californica (Gunther)	Senorita	x	x	To 70	(3) Present during fall and spring
Oxylebius pictus Gill	Painted greenling	x	x	To 70	(3) Common to abundant throughout
Pimelometopon pulchrum (Ayres)	California sheephead	x			(2) One male, approximately 24 in. long, observed during fall
Plagiogrammus hopkinsi Bean	Crisscross prickleback	x	x	To 70	(1) Sparse throughout
Platyrhinoidis triseriata (Jordan and Gilbert)	Thornback		x		(1) One collected during spring in shallow water
Pleuronichthys coenosus Girard	C-O sole	x	x	20-70	(1) Very sparse
Pleuronichthys decurrens Jordan and Gilbert	Curlfin sole	x		25-60	(1) Abundant in 60-ft depths
Psettichthys melanostictus Girard	Sand sole	x		25	(1) Four collected during summer

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Rathbunella hypoplecta (Gilbert)	Smooth ronquil	x	x	60-70	(1) Abundant
Rathbunella sp. nov.		x	x	60-70	(1) Present
Rhacochilus toxotes Agassiz	Rubberlip seaperch	x		25	(1) Sparse, only in North Cove
Rimicola muscarum (Meek and Pierson)	Kelp clingfish	x		25	(1) Two collected during summer
Scorpaenichthys marmoratus (Ayres)	Cabezon	x	x	To 70	(3) Common throughout — juveniles abundant in 0-25 ft depths
Scytalina cerdale Jordan and Gilbert	Graveldiver	x	x	To 10	(1) 17 taken during fall in Diablo Cove and 6 in North Cove — new range record
Sebastes atrovirens Jordan and Gilbert	Kelp rockfish	x	x	10-40	(3) Occasionally observed
Sebastes aurora (Gilbert)	Aurora rock fish		x	70	(1) Present
Sebastes carnatus (Jordan and Gilbert)	Gopher rock fish	x	x	70	(3) Common on bottom in crevices
Sebastes caurinus Richardson	Copper rockfish	x	x	20-70	(3) Adults sparse

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence North Cove	Occurrence Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Sebastes vexillaris (Jordan and Gilbert)	Whitebelly rockfish	x	x	20-70	(3) Adults sparse
Sebastes chrysomelas (Jordan and Gilbert)	Black-and-yellow rockfish	x	x	To 50	(3) Common in 20-50 ft depths on bottom in crevices
Sebastes entomelas (Jordan and Gilbert)	Widow rockfish		x	70	(1) Common during fall
Sebastes flavidus (Ayres)	Yellowtail rockfish	x	x	To 70	(1) Sparse throughout
Sebastes goodei (Eigenmann and Eigenmann)	Chilipepper	x	x		(1) One specimen taken during the spring
Sebastes melanops Girard	Black rockfish	x	x	To 70	(3) Occasional
Sebastes miniatus (Jordan and Gilbert)	Vermilion rockfish	x	x	30-60	(3) occasionally observed during fall
Sebastes mystinus (Jordan and Gilbert)	Blue rockfish	x	x	To 70	(3) Abundant throughout
Sebastes nebulosus Ayres	China rockfish		x	70	(1) Sparse, collected only at 70 ft
Sebastes paucispinus	Bocaccio	x		25-60	(1) Juveniles abundant in North Cove in 60 ft

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Sebastes pinniger (Gill)	Canary rockfish		x	70	(1) Sparse, collected only at 70 ft
Sebastes rastrelliger (Jordan and Gilbert)	Grass rockfish	x	x	To 10	(1) Sparse, collected only in shallow water
Sebastes serranoides (Eigenmann and Eigenmann)	Olive rockfish	x	x		(3) Common, often observed schooling with blue rockfish
Sebastes spp. (juvenile)	Rockfish	x	x	To 70	(3) Very abundant throughout
Stellerina xyosterna	Pricklebreast poacher	x		20	(1) Sparse
Stichaeopsis sp. nov.		x	x		(1) 7 specimens collected
Sygnathus sp.	Pipefish		x	10	(1) Two specimens collected during spring
Synchirus gilli	Manacled sculpin	x		25	(1) 6 specimens taken in North Cove
Typhlogobius californiensis Steindachner	Blind goby		x	Intertidal	(2) Two specimens collected in the fall — new northern record
Xererpes fucorum (Jordan and Gilbert)	Rockweed gunnel	x	x	To 10	(1) Very abundant

Table 2-5.2 (continued)

Scientific name	Common name	Occurrence: North Cove	Occurrence: Diablo study area	Depth Normally collected or observed (ft)	Abundance and general remarks[a]
Xiphister atropurpureus (Kittlitz)	Black prickleback	x	x	10	(1) Very abundant
Xiphister mucosus (Girard)	Rock prickleback	x	x	10	(1) Very abundant during summer and fall — new size record

[a](1) collected only "Chem fish collector"; (2) only observed during routine surveys; (3) collected and observed. Abundance levels for fish collections at a particular station or depth mean: sparse: 1-10 specimens, common: 11-50 specimens; abundant: 51 and more.

Source: California Department of Fish and Game, "Impact on Fish and Wildlife of a Large Desalting Plant at Diablo Canyon," Environmental Services Branch Office Report, March 1972, 85 pp.

Appendix 2-6

LIFE HISTORIES OF IMPORTANT OR ENDANGERED TERRESTRIAL AND MARINE SPECIES FOUND IN THE AREAS INFLUENCED BY THE CONSTRUCTION AND OPERATION OF DIABLO CANYON NUCLEAR STATION

2-6.1 IMPORTANT MARINE ORGANISMS FOUND AT DIABLO COVE

Haliotis spp. (Abalone)

Abalone are marine gastropods and are related to clams, oysters, squid, and other mollusks. Of the marine snails, the abalone is one of the most primitive in form and structure; it is related to stocks whose fossil forms are found throughout the geologic record.[1]

California abalone spawn during spring and summer. Eggs and sperm are emitted into the water, where fertilization takes place. The fertilized egg develops into a free-swimming larva, which lasts one to two weeks. During the latter part of this stage a shell commences to form, and as it gradually increases in size and weight, the young abalone sinks to the bottom. Here it adheres to rocks and in cracks or crevices, where it begins to feed on minute algae growing on the substrate. The food is scraped off by the abalone's file-like tongue or radula.[1]

Abalone of less than 5 in. usually graze on lower-growing algae, especially coralline algae, and diatoms and reside in crevices and under rocks, where they cannot be reached by most free-swimming predators. When an abalone attains a size of about 5 in. (for a red abalone), it generally moves out of these inaccessible locations onto exposed rocks, where it remains for the rest of its life, feeding on kelp.

Since abalone of 4 to 5 in. are known to spawn, there is no apparent shortage of eggs and larvae in their environment, and there seems little danger of this mollusc becoming extinct because of lack of spawning activity.[2]

Species of abalone found at Diablo Canyon were red (*Haliotis rufescens*), black (*Haliotis cracherodii*), pinto (*Haliotis kamtschatkana*), and flat (*Haliotis walallensis*).

Red Abalone. This is the largest of all abalone, reaching over 11 in. in diameter. Outside color of the shell is dull brick red. Body and epipodium are smooth, usually black, although some have alternate "dark" and "light" vertical stripes. Edges of epipodium scalloped, with black tentacles extending beyond edge of shell. In some individuals upper edge of epipodium is white and projects just beyond edge of shell.[1]

The red abalone inhabits rock shores in certain areas along the coast from near high tide mark out to at least 540 ft, with maximum concentrations between 20 and 50 ft. In northern California, where it is not too plentiful, it is found near shore in shallower waters. It increases in abundance in central California, and in the area from Cape San Martin to Morro Bay the greatest numbers are found. South of Point Conception it is only occasionally found along the shoreline and then in deeper water. These abalone apparently require an active surf. Usually they are not found in sheltered bays but prefer locations where there is considerable wave action and water exchange, such as along rocky headlands and promontories.[1]

Red abalone grow best in water cooler than 65°, which not only seems to be directly beneficial to the abalones but also contributes to good growth of kelp, on which the abalone feed. Kelp in turn requires water of relatively low turbidity for penetration of sunlight, which supports the photosynthesis process. Kelp also grows best in uncontaminated water. (For generalized characteristics on the red abalone, see Table 2-6.1).

The dependency of abalone on cool water temperatures and luxuriant kelp growths was demonstrated in 1957, 1958, and 1959, when an influx of warm water virtually eliminated the kelp beds off central California. At the same time, abalone growth ceased, the meat became shrunken and watery, and reproduction may have been impaired[2].

When water temperatures began to fall in 1960, there was an immediate increase in abalone growth, which was reflected in the commercial harvest for that year. However, it should be noted that part of the increased harvest of 1960 was due to a reduction in the legal minimum size from 8 in. to 7-3/4 in.

After a year, red abalone reach 1.0 to 2.0 in. in length and begin to feed on larger algae and kelp. Bull kelp, *Nereocystis luetkeana,* and giant kelp, *Macrocystis* spp., are more important food items, although other shorter growing brown and red algae also are utilized. Growth after the first year is extremely irregular and varies according to abundance and type of food and number of abalone on a bed. Given similar conditions of food and habitat, growth generally is faster in areas that are regularly harvested. On the Point Estero beds near Morro Bay, red abalone normally will reach commercial size, 7.75 in. in five to eight years. Growth slows considerably after reaching 8.0 in. although 11.5-in. specimens have been taken.[3]

Table 2-6.1. Red Abalone, *Haliotis rufescens*

	Characteristics
Landings and economic importance	
Northern California	4,800 lb ($4,402)
Southern California	879,700 lb ($855,422)
Total	884,500 lb ($859,824)
Geographical range	Alaska to Cape San Lucas, Baja California
Habitat preferences	
Water depth	Coastal band including kelp beds; normally in low water, 100 ft approx
Type of bottom	Rocky near shore, and kelp beds
Food sources	Larvae: pelagic, plankton feeders; young feed on benthic diatoms and corraline algae Adults: selective plant feeders – *Macrocystis*, *Nereocystis*, and other macroalgal forms
Growth	Reach 11 in. diameter; 3–4 in. in 5 years
Mobility, migration	Limited crawling movement
Behavioral characteristics	Tend to segregate in depth by species; chief predators: otter, eel, cabezon, crab, octopuses, and starfish
Spawning	
Time of year	Spring and summer, depending on temperature (20°C)
Age	Mature when 4 in.

Table taken from "Potential Environmental Effects of an Offshore Submerged Nuclear Power Plant," vol. 1, Environmental Protection Agency, Water Pollution Control Research Series, 6130, June 1971.

Black Abalone. Color of outside shell typically dark blue or greenish black, sometimes orange. The body is smooth and black in color, with small scallops along the upper edge of the epipodium; scattered short, slender, black tentacles protrude slightly beyond the edge of the shell.

The black abalone can be found from near high tide out to about 20 ft, with the majority located intertidally. Usually found in great numbers crowded close together, and at times stacked two or three on top of each other. This serves to keep shells free of marine growth, since the intertidal area is sometimes lacking in seaweeds, and they obtain food by grazing on each other's shells. They also capture broken bits of seaweeds that wash by.

Growth of black abalone in southern California is slightly slower than red abalone. Young black abalone average 1.0 to 1.25 in. during the first year and under ideal conditions will reach legal size, 5.0 in., in about five years.

Pinto Abalone. This species exhibits considerable variation in shell form. In its northern range, which extends from Alaska south to point Sur, California, it is characterized by a long, narrow, highly arched shell, having a rough, irregular surface. Larger individuals usually have a prominent spire. In its southern form, which extends from Point Sur to Point Conception, the shell is more oval in shape and not as highly arched. The body is mottled tan and greenish brown; some with tinges of orange. The tentacles are green and slender, and the tips extend from under the edge of the shell when the animal is moving or feeding.[1]

In its northern range in Alaska the pinto abalone is found in shallow water among the rocks at low tide. Further south it is found in deeper water, and in central California the greatest numbers are found in the 35- to 50-ft depths. Although not a common species, it is not rare and in some areas in deep water offshore may be found in large numbers. In deeper water this abalone is found more or less in the open on top of the substrate rather than in cracks and crevices and on the underside of the rocks.[1]

Flat Abalone. The flat abalone ranges in size up to 7 in., but most individuals are 3 to 5. Shell oval, long and narrow, considerably flattened. Color dark brick red with occasional mottlings of greenish blue and white.

Habitat: found subtidally and to depths greater than 70 ft. Lives on and under rocks with other species of abalone, feeds by grazing on small attached algae.

Scorpaenidae (Rockfish)

The following discussion has been summarized from ref. 3. Rockfish are present in a wide variety of habitats in both deep and shallow water, over sandy and muddy bottoms, in rocky areas, and in kelp beds. Various species show relatively specific habitat preferences.

Tagging studies of the movements of California rockfish have been performed on the blue rockfish, an important shallow-water sport species. The study indicated that this shallow-reef-dwelling species displays little or no migratory behavior. Tag returns from other species tagged during studies indicated that most shallow-water rockfish show little or no movement.

All rockfish give birth to living young. Fertilization is internal; the embryos develop in the female's ovaries and the tiny larvae are newly hatched from the egg when born. The number of young born to grass rockfish is unknown, but other similar-sized species of rockfish spawn upwards of one-half million per year. Spawning apparently takes place during the winter months, and young are found from March to September in the same areas as the adults. They probably mature in about their third year of life. Newly hatched rockfish are small, generally 3.1 to 5.4 mm. in length, and are planktonic in nature. Larvae have been taken throughout the year to a depth of 100 m and 300 miles from shore. Growth rates of juvenile rockfish vary greatly depending upon species and environmental conditions. Males grow somewhat slower than females and fail to attain either lengths or ages of females.

Larval rockfish very likely feed upon the smaller planktonic organisms, while juveniles and some forms feed upon macroplankton and on smaller fishes.

Scorpaena guttata is not a true sculpin but a member of the rockfish family. It ranges from southern California south at least to Point Abreogos, Baja California. It commonly occurs in bays and along the shore. It may be caught throughout the year, but the peak fishing season is in the spring and summer. *Scorpaena guttata* is of minor commercial significance, with heaviest landings in the Los Angeles region. It is considered a desirable species by sportsmen; it ranked eleventh in numbers caught by marine anglers in 1951. The commercial catch is absorbed in its entirety by the fresh fish trade. Commercial landings have fluctuated from an annual average high of 130,000 lb during the period 1935-1940 to an annual average low of less than 100,000 lb.

Southern California party-boat operators rate sculpin as the tenth most important species in the sport catch. During the 21-year period 1947-1967, approximately 39,000 sculpin annually were caught by sportsmen fishing from party boats. To the sport angler, this fish may be more noted for its venomous spines than it is for standard game-fish qualities. All of the sharp, heavy dorsal, anal, and pelvic fin spines are venomous and can cause an extremely painful wound. The venom is produced in tissues located in grooves along the sides of these spines.

The fish are sometimes caught over sandy mud bottoms, but they share a definite preference for rocky or cobbly areas. They may be taken from the subtidal zone to depths as great as 600 ft but are most abundant in water less than 100 ft deep. Sculpin are believed to first spawn during their third or fourth year and to live 15 years or longer. Spawning takes place from April through August. Stomach analysis indicates that sculpin eat a wide assortment of food items, including crabs, squid, octopi, fish, and shrimp.

Sebastodes atrovirens, kelp rockfish (Scorpaenidae), belongs to the largest fish family occurring in California waters. Kelp rockfish occur along the California coast from San Francisco to the San Benito Island, Baja California, and around the southern California Channel Islands. They live in the lower levels of the kelp beds among rocks from the surface to 140 ft but are most abundant in depths averaging about 35 ft.

As with all rockfish (*Sebastodes*), fertilization is internal, and they give birth to living young. Mating apparently takes place during the winter months, as ripe adults have been taken during December and females ready to give birth were taken in March. The young are very small and helpless for a considerable time after they are born. Inch-long young appear in large numbers along the scattered rocks on open sand bottoms from April through August. By August or September they may be 2 or 3 in. long.

There have been only limited studies of their food habits. They apparently feed mostly upon shrimps, crabs, and a variety of small fishes.

They form a minor part of the commercial gopher and china rockfish catch in central California, where they are taken mostly with set lines or by hook and line.

Sebastodes caurinus, copper rockfish (Scorpaenidae), ranges from Monterey, California, to southern Alaska; the greatest depth at which the copper rockfish has been taken was 50 fathoms. Typically these heavy-bodied rockfishes live in shallow areas when young and in deeper water as adults.

Sebastodes diploproa, splitnose rockfish (Scorpaenidae), ranges from Coronado Islands, Baja California, to Vancouver, British Columbia. The greatest depth and maximum size of splitnose rockfish are 250 fathoms and 16 in., respectively.

A few fish mature when 7 1/2 in. long (four years old). Fifty percent are mature when 8 1/4 in. long (five years old). They attain a maximum age of about 18 years. The number of developing eggs in the paired ovaries increases from 14,000 in a fish 7 1/2 in. long to about 255,000 in a fish 14 1/2 in. long. Adults appear to feed exclusively on macroplanktonic organisms, primarily euphausiids. Occasionally, small salps or pteropods are found in their stomachs.

Sebastodes rubricinctus, flag rockfish (Scorpaenidae), usually ranges at a depth between 192 and 378 ft. It has been found, especially in the summer, associated with kelp beds. The flag rockfish ranges from Santo Tomas Bay, Baja California, to southeast Alaska. It is characteristically a deep, rocky-bank species taken occasionally by party-boat and skiff fishermen.

Sebastodes nigrocinctus, tiger rockfish (Scorpaenidae), ranges from Point Buchon, California, to southeast Alaska; the maximum depth of its distribution is 150 fathoms.

Sebastodes rastrelliger, grass rockfish (Scorpaenidae), ranges from Yaguina Bay, Oregon, to Playa Maria Bay, Baja California. They live among seaweeds, especially eel grass, in shallow-water rocky bottoms. The average depth in which they are found is about 15 ft, but they have been caught as deep as 150 ft. They are most concentrated in water less than 30 ft deep.

Nereocystis (Bull Kelp); *Macrocystis* (Giant Kelp)

The term "kelp" generally refers to various species of large brown seaweeds that range from the lower intertidal out to depths of 100 to 150 ft. South of Point Conception the harvesting consists almost entirely of species of the genus *Macrocystis* (giant kelp). North of Point Conception the harvest includes both *Macrocystis* and *Nereocystis* (bull kelp).[4]

In shallow (8-25 m) rocky regions of southern California, *Macrocystis pyrifera* is the dominant species in the climax community, while further north *M. integrefolia* increases in relative dominance. In the Pacific Northwest, especially Puget Sound, the closely related *Nereocystis luetkeana* (the bull kelp) becomes the dominant kelp. In areas along the open coast where wave action is moderate, *Macrocystis* attaches to rocks by means of a holdfast. In sheltered areas, however, giant kelp is able to establish on sedimentary bottom. When substantial numbers of plants occur in proximity, a forest type of environment is created.

The giant kelps extend from the bottom into the zones of bright illumination, providing a large surface area of photosynthetic tissue and creating a zone of plant productivity in deeper water.

Kelp growth probably increases about twofold for a 10°C rise in temperature. Q_{10} of 2.0 for kelp photosynthesis and a value of 1.7 for frond elongation have been reported.[5]

Little information has been collected describing the effects of temperature on *Nereocystis luetkeana* (bull kelp). However, studies on giant kelp indicate that water temperatures in excess of 4°F over ambient may cause a decrease in existing beds.

Along the exposed rocky coast extending from Point San Luis to Point Buchan, bull kelp, *Nereocystis luetkeana*, is the controlling influence over the ecological communities of the near-shore plant and animal life. Both the abalones and urchins are herbivorous grazers, occupying similar habitats and generally requiring an irregular rocky substrate, often interspersed with ledges and crevices. Although both species commonly forage for attached species of benthic algae, detritus drift from healthy bull kelp beds provide an optimum source of nutrition during much of the year. This generally reduces the need for active benthic foraging. In the fall, the long sporophytes, or vegetative stage of this annual plant (bull kelp sporophytes attain lengths of over 100 ft in a one-year growing season), begin to degenerate. In October or November the first winter storms mark the beginning of the kelp beds' decline.[5]

Many species have been observed and collected in the kelp areas. The list totals 128 plant species and 766 animal species, of which about a sixth commonly occur. *Macrocystis* is usually the dominant plant in the kelp beds habitat and may exclude other plant life by mere shading alone. No single animal genus or species occupies a dominant position similar to the importance of *Macrocystis*. The most important animal group is the bryozoan genus *Membranipora*.

Membranipora colonies encrust kelp blades, giving them a whitish or silvery appearance. These colonies feed on plankton that they filter from seawater. The colonies may become quite extensive and often serve as food for fishes.

The various biological associations involving *Macrocystis pyrifera* are indeed many and include invertebrates living between holdfast haptera; encrusting animals; endophytic, microscopic algae; grazing predators; fish; and other benthic, macroscopic red and brown algae.

The kelp beds have been shown[6,7] to contain *Calliarthron*, *Laminaria*, *Pelagophycus*, *Egregia*, *Costaria*, *Pterygophora*, *Nereocystis*, *Cystoseira*, *Dictyoneurum*, *Eisenia*, and many others, along with the giant kelp (*Macrocystis*, *Pterygophora*), and many varieties in organismic life history.

Studies of the holdfasts of *Nereocystis* in Puget Sound[8] showed 40 species of polychaetes, gastropods, brittle stars, and amphipods living among the haptera. Investigations of *Macrocystis* holdfasts in Monterey and Carmel bays elucidated similar invertebrate associations.[9] Many of these holdfast inhabitants were temporary residents (immature stages) seeking protection in the shelter of haptera.

Limbaugh[10] reports numerous bryozoans, hydroids, gastropods, and other forms attached to stipes and fronds of *Macrocystis*. McLean[7] notes various mollusks on giant kelp in Carmel Bay.

Mitchell and Hunter[11] report 21 fish species associated with drifting mats of mixed brown algae (*Macrocystis pyrifera*, *Pelagophycus porra*, *Pterygophora californica*, *Cystoseira osmundaceae*, and *Egregia laevigata*) off the coast of southern California (Table 2-6.2).

Table 2-6.2. Number of individuals, frequency, length, life stage, and month of occurrence of fishes collected beneath drifting kelp

Common name	Scientific name	Total number captured	Frequency[a]	Range of standard length (mm)	Life stage[b]	Occurrence
Albacore	*Thunnus alalunga*					
Kelp pipefish	*Syngnathus californiensis*	41	13	153–292	A	June, July, Sept., Dec., Jan.
Kelp bass	*Paralabrax clathratus*	8	4	31–80	J	Sept., Dec., Jan.
Yellowtail	*Seriola dorsalis*	7	1	35[c]	JA	Aug.
Jack mackerel	*Trachurus symmetricus*	753[d]	19	16–500	JA	June, July, Sept., Dec., Jan.
Pacific mackerel	*Scomber japonicus*	1	1	65	J	Sept.
Kelp perch	*Brachyistius frenatus*	1	1	49	J	July
Blacksmith	*Chromis punctipinnis*	179	8	15–34	J	June, Sept., Dec., Jan.
Opaleye	*Girella nigricans*	15	5	173–279	JA	June, Dec., Jan.
Half-moon	*Medialuna californiensis*	3,751[d]	37	23–292	JA	June, July, Sept., Dec., Jan.
Bocaccio	*Sebastes paucispinis*	25	7	31–76	J	June, Jan.
Olive rockfish	*Sebastes serranoides*	1	1	44	J	June
Splitnose rockfish	*Sebastes diploproa*	2,339[d]	32	17–49	J	June, July, Sept., Dec., Jan.
Flag rockfish	*Sebastes rubivinctus*	149[d]	9	15–38	J	Sept., Dec., Jan.
Treefish	*Sebastes serriceps*	97	15	17–49	J	June, July
Rockfish	*Sebastes sp.*	4[e]	3	14–34	J	June, Sept.
Sablefish	*Anoplopoma fimbria*	650	15	66–149	J	June, July
Cabezon	*Scorpaenichthys marmoratus*	3	1	70[c]	J	June
Giant kelpfish	*Heterostichus rostratus*	3	2	49–61	J	June, July
Bay blenny	*Hysoblennius gentilis*	4	2	34–60	JA	Dec.
Clingfish	*Gobiesox eugrammus*	1	1	15–5	J	June
Mola	*Mola mola*	1	1	400	A	June
Tiger rockfish	*Sebastes migrocinctus*					
Rockfish	*Sebastes caurinus*					
Dolphin fish	*Coryphaena hippurus*					

[a]Total number of collections in which species occurred.
[b]J represents juveniles, A adults.
[c]Standard length estimated.
[d]Includes some estimates of numbers. Range of standard length from individuals actually measured.
[e]No specific identification made.

Source: C. T. Mitchell and J. R. Hunter, "Fishes Associated with Drifting Kelp, *Macrocystis pyrifera*, off the Coast of Southern California," *Calif. Fish Game* 56(4): 288–297 (1970).

A rather curious relationship between the kelp and half-moon (*Medialuna californiensis*) has been documented.[12] A known associate of drifting kelp masses, the half-moon regularly feeds on algae.[13,14] In a controlled experiment, several half-moons were reared in large fish tanks, and after having been fed animal food for several months, a pronounced loss of equilibrium was observed. When native seaweeds (the kelps *Macrocystis pyrifera* and *Egregia laevigata*) were introduced, the fish ate hungrily, and all seemed to recover equilibrium within two or three days.

All kelps display complex life cycles known as "alternation of generations." For giant and bull kelp, the large familiar plants are called the sporophyte generation (i.e., reproduce by asexual spores). The alternate generation is microscopic and reproduces by sexual gametes, hence are known as the gametophyte generation.

In the sea the sporophyte typically liberates trillions of spores that are dispersed in the currents. Spores that settle on solid substrate in a suitable environment produce gametophytes. After several weeks of maturation, fertilization can occur between gametophytes fairly close to each other. The requirement for fertilization apparently limits dispersal powers of kelp, because juvenile sporophytes are usually found only near adult plants. Occasionally a drifting plant may "seed" barren territory with its spores, yielding a few juveniles far removed from adults. In general, however, juveniles become very sparse at one or two hundred feet from established beds.

Times required for completing life cycles range from about a year in shallow water to perhaps two years in deep water. Presumably reduced light intensity on deeper bottoms lengthens time requirements. Kelp bed survival requires a healthy environment for both sporophyte and gametophyte. The two generations obviously differ in their needs. Attention must be paid to the needs of both. For example, turbid water that seriously reduces bottom illumination will affect kelp gametophytes profoundly. Such water, however, may have little or no influence on the large sporophyte that displays most of its tissues at the surface.

Adverse Factors Influencing Kelp. A great many physical and biological factors are known to harm our kelp beds. Among the most important physical factors are storm damage and high water temperatures. Probably 50% or more of a typical giant kelp population in exposed locations is uprooted each winter by storm waves. Kelp canopies in southern California deteriorate to varying degrees each summer from temperature damage. Temperatures of 70° for a month will cause appreciable damage. Temperatures of 74° for a week will devastate most beds. As long as warm water is restricted to the surface layers, the lower portions remain healthy. When cool surface water returns in fall, the intact lower portions quickly regenerate the canopy. During the long warm-water period from 1957 to 1959, high temperatures extended deeper than most kelp holdfasts. Entire plants were soon lost. Many beds in southern California suffered losses of 90% to 100%.

From time to time, biological agents damage kelp excessively. Overgrazing is a common affliction. Gastropods, crustaceans, sea urchins, and fishes are known to decimate substantial kelp areas. Encrusting organisms can weigh down fronds and make them brittle and more easily damaged by waves, as well as reduce light available for photosynthesis. Fish nibbling on the encrustations injure blade tissues. Microorganisms occasionally damage kelp beds. A summertime disease called black rot becomes common at temperatures above 70°. The kelp tissue turns black, softens, and sloughs off. A similar thickening has been observed at the stipe bases in areas where sewage effluents mix with sea-water. This girdling disease eventually severs the stipe and causes frond loss.

REFERENCES FOR APPENDIX 2-6
(pages A2-6-1 to A2-6-13)

1. K. W. Cox, "Review of the Abalone in California," *Calif. Fish and Game* 46(4): 381-406 (1960).

2. "Report on the Sea Otter, Abalone and Kelp Resources in San Luis Obispo and Monterey Counties and Proposals for reducing the Conflict between the Commercial Abalone Industry and the Sea Otter," prepared by the Calif. Fish and Game Dept. as requested by Senate Concurrent Resolution 74 in the 1967 Legislative Session, January 1968.

3. H. W. Frey, ed., *California's Living Marine Resources and Their Utilization,* Calif. Fish and Game, 1971, 148 pp.

4. Bendix Marine Advisors, "Study of Fees for Harvest of Marine Plants on State Lands," prepared for State of Calif. Resources Agency, Dept. Fish and Game, September 1969.

5. Pacific Gas and Electric Co., *Environmental Report, Units 1 and 2, Diablo Canyon Site,* July 1971.

6. E. Y. Dawson, *Marine Botany,* Holt, Rinehart and Winston, New York, 1966, 371 pp.

7. J. H. McLean, "Sublittoral Ecology of Kelp Beds of the Open Coast Area near Carmel, California," *Biol. Bull.* 122: 95-114 (1962).

8. H. L. Andrews, "Animals Living on Kelp," *Publ. Puget Sound Bio. Sta.* 5: 25-57 (1925).

9. H. L. Andrews, "The Kelp Beds of the Monterey Region," *Ecology* 26: 24-37 (1945).

10. C. Limbaugh, *Fish Life in the Kelp Beds and the Effects of Kelp Harvesting,* Univ. of Calif., Inst. Mar. Res., Rep. 55-9, 1955, 158 pp.

11. C. T. Mitchell and J. R. Hunter, "Fishes Associated with Drifting Kelp, *Macrocystis pyrifera,* off the Coast of Southern California," *Calif. Fish Game* 56(4): 288-297 (1970).

12. W. Follett, D. Gotshall, and G. N. Smith, "Northerly Occurrences of the Scorpid Fish *Medialuna californiensis* (Steindachner), with Meristic Data, Life History Notes, and Discussions of the Fisheries," *Calif. Fish Game* 46(2): 165-175 (1960).

13. G. LaMonte, *North American Game Fishes*, Doubleday, Doran and Co., Garden City, 1945, 202 pp.

14. G. LaMonte, *Marine Game Fishes of the World*, Doubleday, Garden City, 1952, 190 pp.

A2-6.2 LIST HISTORIES AND/OR INFORMATION CONCERNING SOME ENDANGERED, RARE, AND DECLINING WILDLIFE SPECIES KNOWN TO INHABIT AREAS ENCOMPASSED BY DIABLO CANYON NUCLEAR STATION AND FACILITIES

Endangered Species

Pelecanus occidentalis californicus (Brown Pelican)

Though still commonly seen in bays and lagoons along the Pacific coast, the continued existence of the brown pelican in California is doubtful. Because of their long life span a decrease in their numbers is not readily apparent; however, in recent years successful breeding has declined[1] until the only remaining nesting colony in California is on Anacapa Island.[2] At this time, even this colony is incapable of reproducing.

The following discussion is summarized from ref. 3.

Thinning of the eggshells appears to be the primary cause of reproductive failure. Massive residues of the DDT compounds found in tissue and eggs of vulnerable species, controlled experiments showing DDE as highly effective in producing thin eggshells in several species, and the significant correlations between *p,p'*-DDE and eggshell thickness found in several species certainly implicated that compound as the prime factor.

The current breeding range of *P. o. californicus* extends from the Channel Islands (principally Anacapa Island) occasionally north to Bird Island off Point Lobos, Monterey County, California, and south, including the several islands along the coast of Baja California and in the Gulf of California, to Isabel Island and the Tres Marias Islands off Nayarit, Mexico.

Brown pelicans wander extensively along the coast between nesting seasons, with the movement north occurring primarily in June and July. The pelican's "wintering" range extends as far north as southern British Columbia and south along the west coast of Mexico to Colima. An occasional straggler has been reported on Guadaloupe Island, off the coast of Baja California, and inland in British Columbia, California, Utah, Nevada, and Arizona.

Breeding pelicans in California were first reported on Anacapa Island in 1898. They were then nesting on all three islands in the Anacapa Group. Five hundred nests were found on the east island in 1910. The records are obsure, but breeding on the east island has probably not occurred since the late 1920's. It was about this time that the lighthouse presently standing on the east island was constructed.

Santa Barbara Island could be considered as the second most important pelican breeding area in California. Data on numbers of birds breeding there are generally lacking. Twenty-five pairs were reported in 1911. In July 1912, 300 to 400 birds were breeding there. This was one of the years in which no nesting occurred on Anacapa. There are no published breeding records from Santa Barbara Island since. National Park Service personnel took pictures of birds nesting there in 1967, but there is no indication of the extent of breeding. The Smithsonian Pacific Bird Project found no evidence of nesting on Santa Barbara Island in 1968.

The pelican breeding range has extended as far north as the Monterey Bay area, where nesting has occurred irregularly. Nesting pelicans were reported on Bird Island, a small island off Point Lobos, in 1927. There was no nesting in 1928, but in 1929, 55 active nests with 78 young were reported. Thereafter, apparently, throughout the 1930's, nesting occurred infrequently. The last successful nesting attempt was in 1959.

Bress also determined that these birds were very prone to leave their nests and not return. Much care was taken to avoid disturbances that would cause the pelicans to leave their nests and thus expose the eggs to gull predation."[3]

Gymnogyps californianus (California Condor)

The following is taken from ref. 4 and 5.

The condors, like other vultures, live entirely on carrion — from dead animals the size of a squirrel up to the remains of a steer. After feeding, they return to their nesting area to feed their young or to roost silently on a tree snag or a ledge of rock close by.

They do not make a nest but choose a place in some inaccessible area — normally a cave in the face of a rocky ledge. Breeding takes place when they are five or six years old. The female lays only one egg every two years. The egg is pale green, about 4-1/2 in. long. It is hatched in from 42 to 45 days. It is brooded and fed for five months before it leaves the nest. The young condor, still dependent on its parents, continues to roost and make short flights around the nest for another nine months before it is able to fend for itself. Studies have indicated that during the nesting period, human intrusion even to within 1/2 mile may cause the parent birds to quietly abandon the nest for hours, exposing the eggs and young to the weather and to hunger, which could cause death.

The Sisquoc area was established by the Forest Service in 1937 in Santa Barbara County. The larger and more important Sespe Wildlife Area, some 53,000 acres, was established by the same agency in Ventura County in 1947 and expanded to its present size in 1951. Both areas are within the Los Padres National Forest and are closed to public use, and now both State and Federal laws protect the condors.

The Audubon report of 1965 points out that enforcement of the laws protecting the condor has been inadequate. The failure to educate hunters, increased intrusion, legally or otherwise, into private and public lands, and the heavy increase in human population centers near the range of the condor, along with the great development of roads, trails, and other types of access ways, have materially contributed to the serious loss from wanton shooting. "Starvation and limited food supplies are not considered to be adverse factors under existing conditions."

Falco peregrinus anatum (American Peregrine Falcon)

The peregrine falcon breeds in California along the coast near the Channel Islands and in the higher inland mountains. The population in 1970 was 10 birds; breeding of 2 pairs produced 4 young. One pair nesting on Morro Rock, 5 miles north of Diablo Canyon, produced 2 young in the spring of 1972. On two occasions, the fledgling birds were stolen by possible falconers. To date, the birds have not been recovered. Reasons for population decline are irresponsible acts as indicated above, mortality exceeding recruitment, food chain contamination by persistent pesticides, and occasional shooting.

Crotaphytus wislizenii situs (Blunt-Nosed Leopard Lizard)

This species is found in sparsely vegetated plains, alkali flats, low foothills, grasslands, canyon floors, large washes, and arroyos in Tulare, San Luis Obispo, and Kern counties, and on the eastern side of the Coast Range foothills. The reasons for population decline are land use change such as subdivisions, water control, and increasing agricultural use.

Rare Species

Vulpes macrotis mutica (San Joaquin Kit Fox)

This species numbers between 1,000 and 3,000 and occurs from the Tehachapi Mountain foothills near the southern end of the San Joaquin Valley, north to the western foothills of the San Joaquin Valley to Los Banos, and along the eastern edge of the valley north to

Porterville. The San Joaquin kit fox prefers native vegetation supporting kangaroo rats. Populations are declining because of conversion of valley lands to irrigated agricultural land, thereby reducing habitat.

Thamnophis couchi gigas (Giant Garter Snake)

This aquatic snake prefers permanent fresh water and is found on the floor of the Central Valley from Sacramento and Antioch to Buena Vista Lake in Kern County. Populations are declining because of land use changes, such as the filling of sloughs and draining of marshy areas. The use of persistent pesticides may also be contributing to decreasing populations.

Declining Species

Several species which are not on the endangered and rare species list but which are suffering from man's encroachment and disappearing habitat are the burrowing owl, golden eagle, and white pelican.

Aquila chrysaetae (Golden Eagle)

The following is summarized from ref. 6.

The golden eagle is a large bird, weighing up to 12 lb, and its broad wings spread to 7 ft and more. The overall color is dark brown, with the color on the head and neck a lighter golden brown. Much of its prey is killed with its long sharp claws and torn to bite-size bits with its strong hooked beak. They have been observed carrying to their nest animals as large as a jackrabbit. These may weigh as much as 4 lb.

In California it is more plentiful in the Coast Range mountains from San Francisco to San Diego. It is still found, although less common, in the Sierra Nevada, in the inner north Coast Range, and in northeastern California. There is some evidence of migratory movements except in the southerly areas, where some birds seem to remain in the vicinity of the nesting territory.

The nests (or aeries) of the golden eagle are found in a variety of places: in trees at low elevations and on ledges under overhanging cliffs, high in the mountains. They vary in size from 3 ft across and as many feet deep to platforms 5 ft wide and only 1 ft deep. The nest materials are dead sticks of varying sizes. The nests are cleaned up and added to each season until the wind or the weight of the nest tumbles it to the ground.

The golden eagle eats and feeds its young a wide variety of birds and mammals. Both living creatures and dead are included in their diets. They are especially busy hunting during the nesting season to meet the demands of their rapidly growing babies. Rabbits and ground squirrels seem to form the staple diet of the golden eagle, particularly for feeding their young.

The female usually lays two and rarely three large smooth eggs. They may vary in size, and also in color from snow white to a soft cream, splotched with russet brown spots. It takes 35 days for the eggs to be hatched. Golden eagles are shy and wary of man. The female might even desert the nest of eggs if molested, but she does not desert the young.

Speotyto cunicularia (Burrowing Owl)

This diurnal owl is found in open pasture lands and grassland areas of California. Numbers are believed to be declining because of land use changes and persistent pesticides found in food chain organisms.

Pelecanus erythrorhynchos (White Pelican)

This species, found on the west coast along lakes and reservoirs, prefers feeding on fish in shallows by wading, and does not dive for food as does the Brown Pelican. These birds have been seen in flight over the San Luis Obispo area.

REFERENCES FOR APPENDIX 2-6
(pages A2-6-16 to A2-6-20)

1. R. W. Schreiber and R. L. DeLong, "Brown Pelican Status in California," *Audubon Field Notes* 23: 57-59 (1969).

2. California Department of Fish and Game, *At the Crossroads: A Report on California's Endangered and Rare Fish and Wildlife,* January 1972, 99 pp.

3. F. Gress, *Reproductive Status of the California Brown Pelican with Notes on Breeding Biology and Natural History,* Calif. Dept. Fish and Game, Wildl. Mgmt. Br., Admin. Rep. 70-6, 1970, 21 pp.

4. George Seymour, "California Condor," California Wildlife Information Sheet, The Resources Agency of Calif., Dept. of Fish and Game, reprinted from *Outdoor California,* January 1966.

5. A. H. Miller, I. I. McMillan, and E. McMillan, *The Status and Welfare of the California Condor,* Nat. Audubon Soc. Rep. No. 6, 1965, 61 pp.

6. George Seymour, "Golden Eagle," California Wildlife Information Sheet. The Resources Agency of Calif., Dept. of Fish and Game, no date.

7. A. C. Bent, *Life Histories of North American Birds of Prey,* Part I, Dover Publications, New York, 1961, 410 pp.

Appendix 3-1

THE CHEMISTRY OF CHLORINE IN WATER

This information is based on J. S. Sconce, *Chlorine: Its Manufacture, Properties and Uses*, ACS Monograph Series, Reinhold Publishing Corp., New York, 1962.

Chlorine, a very effective biocide, is used extensively in power plants to prevent the fouling of piping and condenser surfaces by aquatic growth. However, since it is an effective biocide, it is also a possible source of danger to the biota in those natural waters into which the power plant may dump its effluent.

When molecular chlorine is added to water the following hydrolysis reaction occurs:

$$Cl_2 + H_2O \rightleftarrows HOCl + H^+ + Cl^- \ ,$$

$$K_{25°C} = 4.8 \times 10^{-4} \ .$$

In dilute solution and at pH levels above about 4 the equilibrium lies far to the right. However, in more acid medium or in the presence of large amounts of chloride ion, as in sea water, a significant portion of the added chlorine exists as dissolved molecular chlorine.

Hypochlorous acid is a weak acid (ionization constant 2.8 x 10^{-8}) and is almost totally un-ionized below a pH of about 6. Above this pH (from pH 6 to pH 8.5) a very sharp change occurs from almost completely undissociated hypochlorous acid to almost complete dissociation according to the following equation:

$$HOCl \rightleftarrows H^+ + OCl^- \ .$$

Chlorine existing in water as hypochlorous acid, hypochlorite ion (OCl^-), and molecular chlorine is defined as "free available chlorine" (also "residual free chlorine"). Various theories have been advanced to explain the mechanism by which chlorination of water destroys organisms. The commonly accepted concept is that organism death results from the chemical action of hypochlorous acid. The hypochlorous ion has little, if any, biocide effect. Therefore it is not the oxidizing power of a solution of chlorine that is a measure of its biocidal effect but the concentration of undissociated hypochlorous acid.

When chlorine is used in water treatment a variety of reactions may occur. The kind of reaction and the rate at which it occurs depend on the relative oxidation potential of the active chlorine and the chlorine compound formed in the reaction. Some of the variable components of natural water that may affect both the kind and rate of reaction are discussed briefly below.

Alkalinity. As implied earlier, the effectiveness of chlorination is highly dependent upon pH. It is obvious that the hydrolysis products of chlorine (hydrochloric acid and hypochlorous acid) would tend to lower the pH. However, the materials that produce hardness in water, such as the calcium and magnesium carbonates, tend to buffer against significant change in pH. It is evident, therefore, that in seawater such buffering occurs to a large degree.

Inorganic Reductants. The molecular chlorine that is present may react with reductants such as hydrogen sulfide, ferrous iron, and nitrites. If the pH is high enough, the metal ions may be oxidized to form insoluble precipitates.

Amines and Nitrogen Compounds. The reactions of chlorine with the inorganic amines are of great significance. When chlorine is added to water containing ammonia, various chloramines may be formed, depending on the pH and the initial ratio of chlorine to ammonia. The following equations suggest what may occur:

$$NH_3 + HOCl \rightarrow NH_2Cl + H_2O \ ,$$

$$NH_3 + 2HOCl \rightarrow NHCl_2 + 2H_2O \ ,$$

$$NH_3 + 3HOCl \rightarrow NCl_3 + 3H_2O.$$

Above a pH of about 8.5 the monochloramine exists almost exclusively, between pH 8.5 and 5 mono- and dichloramines exist together, at a pH between 5.5 and 4.5 dichloramine is dominant, and below a pH of about 4.5 nitrogen trichloride will be produced. Reactions analogous to those between chlorine and ammonia may also occur with organic nitrogen compounds. Since chlorine has a distinct affinity for organic nitrogen compounds, it readily combines with protein and amino acids to form organic chloramines. Chlorine existing in combination with ammonia or organic nitrogen compounds is defined as "combined available chlorine." Normally the oxidation potentials of such compounds are lower than those of free chlorine forms, but, through the hydrolysis of chloramines, chlorine (as hypochlorous acid) is available for reaction. The low hydrolysis constants of chloramines and, in some cases, the slow rate of establishing equilibrium are responsible for the slow biocidal action of these forms. The sum of the combined available chlorine and the free available chlorine is the "active chlorine" (also "residual chlorine" or "total available chlorine"). "Active chlorine" is normally considered to be the sum of the species present that will liberate iodine in equivalent amounts from an acid solution of potassium iodide.

Appendix 4-1

REPORTS SUBMITTED BY PACIFIC GAS AND ELECTRIC AS PER

ORDER NO. 5, CALIFORNIA PUBLIC UTILITIES

COMMISSION, DECISION NO. 79726, FEBRUARY 15, 1972

REPORT

by

PACIFIC GAS AND ELECTRIC COMPANY

on Existing Access Roads for the

Diablo Transmission Lines

in Compliance with

Decision No. 79726 of the

CALIFORNIA PUBLIC UTILITIES COMMISSION

June 1, 1972

Pursuant to Ordering Paragraph No. 5 in the Commission's Decision No. 79726 Pacific Gas and Electric Company submitted its report describing the conditions of existing access roads for the Diablo Transmission Lines on June 1, 1972. The company's continuing obligation under that decision is to submit reports at 6-month intervals to the Commission, to keep it apprised of progress in maintaining and restoring the environment traversed by the access roads. This second report is submitted to comply with that requirement.

The survey techniques developed for the first report were again employed. Representatives of the company's line construction department conducted periodic inspections on portions of the access road system, emphasizing active construction sites. Photopoints established for the first report were again visited, and, unless no significant changes had occurred during the 6-month interval, additional photographs were taken. These photographs are contained in the two binders which accompany this report.

As the first report pointed out, all construction was not complete at the time the initial survey was made. For this reason, this second report includes information about construction which took place since the filing of the first. New photopoints were established in these areas.

A. NEW ROAD CONSTRUCTION

1. Diablo-Midway 500 kV Transmission Access Roads.

a. Towers 29 - 32

The spur road from Highway 101 leading to Towers 30 and 31 was an existing road, overbuilt to accommodate construction equipment. The road follows the ridge top after leaving the existing road. Minimum earth moving was required and the disturbance should heal quickly.

The spur road from Tower 30 to Tower 29 is an end-haul road with a minimum amount of overcasting of spoil material. Fill slopes will be hand seeded to aid in stabilization and reduce visual impact from See Canyon. The pullsite at Tower 29 will be cultivated and seeded. At Tower Sites 31 and 32, the crane pad and spoil material will be returned as nearly as possible to the natural repose and seeded.

b. Towers 33 - 66:

Tower 33 stands on a knob east of Highway 101. The road and tower pad have been seeded to reduce the visual effect of the disturbed soil. Little can be done effectively to screen the tower from the freeway.

The road from Tower 33 deadends at Tower 38. The spur road into Tower 37 is visible from Highway 101 and was established as a photopoint. The road surface and tower pad will be seeded with a grass and brush mixture. No other problems were noted.

The road between Towers 39 and 51 was well located, following ridgetops where possible. A minimum impact was created by through cuts and more-or-less balanced cuts and fills. Incomplete right of way acquisition has delayed road construction into Towers 45, 46, and 47.

The most critical section of new road built on the Midway line extends between Towers 52 and 66. Tower 52 is visible from Price Canyon Road and was established as a photopoint. The soil is loose, sandy, and highly erosive. The road surface breaks down under heavy traffic and requires frequent maintenance to preserve water checks. The use of soil compactants seems to maintain the road surface for a longer period. Oil shale was placed on steeper grades to reduce erosion and to provide permanent water checks and a more reliable driving surface. Other areas have been insloped or seeded with a grass mixture to hold the road surface.

2. Diablo-Gates 500 kv Transmission Access Roads

a. Towers 68 - 80:

The roads here were built to U. S. Forest Service specifications. The roads are basically insloped to culverts and overside drains. The Forest Service dictates seeding and planting requirements as well as maintenance on the road. Two photopoints were established in this area.

b. Towers 88 - 95:

Access roads were built to the specifications of the area's owner and developer. Spur roads to towers were constructed to Pacific Gas and Electric Company's guidelines. Spur roads are of minimum width and length. No problems were evident.

c. Towers 95 - 100:

Standard road design prevails here with the road built to minimal width. Major portions of the road were existing access roads for the paralleling 230 kV line. The terrain is gentle and erosion is not expected to be a critical factor.

d. Towers 211 - 316:

The area between Towers 211 and 232 is gentle and rolling; agriculture is the main land use. Critical terrain is encountered from Towers 233 through 271. The road from Tower 233 to Tower 258 is insloped and inside ditched to culverts on inside turns. This portion of the road is in excellent condition, well maintained, and compacted. Road design should minimize erosion. The remaining portion of the road to Tower 271 is essentially outsloped. Some hand seeding has been done between Towers 257 and 266. Lack of rainfall has kept seed from germinating.

The main line road between Towers 271 and 316 traverses gently rolling to flat agricultural lands. The road surface is in good condition and well compacted. The most critical problem confronted was the maintenance of spur roads to towers. Dust was becoming a major source of erosion. The foreman was directed to water spur roads and use a soil compactant solution. Roads from Tower 317 to Gates Substation are now obliterated by cultivation.

A major portion of the access road system for the 500 kV transmission line was an existing road built for construction and maintenance of the 230 kV line. Fill slopes have stabilized and vegetative recovery was, in most cases, complete.

B. PROPOSED OR COMPLETE SEEDING AND PLANTING PROGRAMS FOR 1972-1973 GROWING SEASON

1. Diablo-Midway kV Transmission Access Roads

a. Towers 1 - 3:

Hand seed tower pads with assorted grass species.

b. Pullsite Tower 10:

Cultivate soil and hand seed with assorted grass specied. Fertilizer application required.

c. Pullsite Tower 29:

Cultivate and hand seed.

d. Towers 29 - 32:

Seed fill slopes on spur road and Tower Sites 31 and 32.

e. Tower 37:

Hand seed with special grass mixture on road bed and tower pad after winterizing.

f. Towers 35 - 38:

Seed fill slopes, spur roads, and tower pads after winterizing.

g. Towers 52 - 66:

Hydroseed road and cut and fill slopes.

2. Diablo - Gates 500 kV Transmission Access Roads.

a. Pullsite Tower 22:

200 Bishop pine and assorted grass species.

b. Towers 1 - 7:

Hand seed tower pads with assorted grass species and tree lupin.

c. Towers 52 - 60:

Hand seed fill slopes with assorted grass species.

d. Towers 60 - 96:

Hydro seed with assorted grass species.

e. Towers 257 - 266:

Apply fertilizer during hand seeding. Special seed mix used.

C. COMMENTS AND RECOMMENDATIONS

1. It is evident from the review of new construction that the blanket application of the out-sloped road has been modified. Insloped or engineered (balanced cut and fill) roads are used in selected areas to minimize visual impact and to reduce erosion off fill slopes. The in-sloped road is generally used on inside turns which may accumulate considerable water volume. The out-sloped road is generally used most effectively on gentle terrain requiring a minimum of cutting or soil movement. This modification must be observed periodically to see whether maintenance problems may develop.

Ridge top roads have been located where possible to reduce visual impacts and unsightly overcasting. Through road cuts were used effectively to keep roadside disturbance to a minimum.

The use of soil compactants has significantly reduced dust and has stabilized the road surfaces during rainfall. The soil compactants have also reduced the need for frequent maintenance.

Seeding programs carried over from last year were marginally successful. Areas receiving significant rainfall were the most successful. The recent October rains have provided sufficient moisture to stimulate germination. The timing of this report was too early to determine full results.

2. The problems of erosion of road cuts and fill slopes have not been fully corrected. There has however, been a significant improvement during the past six months, and the amount of erosion and its frequency of occurrence is considerably less.

means to reduce. Several test programs were initiated in first excavations around the plant site to determine specie adaptability to pit planting on near-sterile soils. To determine how various tree species would react in a low rainfall area with disturbed soils, test plantings were set out in 1970. As a result of these test programs, 8,000 one-year old Bishop Pine and 2,000 one-year old Monterey Pine were planted along and adjacent to the right of way roads. In addition, two-year old Coast Live Oak seedlings were pit-planted near Gates Tower 7. Further tests were made on handseeding tree lupine on selected tower pads to supplement natural revegetation. Generally, the results of all programs are encouraging and additional tests are recommended to include the Diablo-Midway right of way and roads.

Subsequent six-month reports will be submitted, to include all programs initiated, and additional conditions identified on existing and newly constructed roads. Interim inspections will be conducted to review suggested programs and report on their progress, and to inspect construction activity to insure compliance with recommendations.

* * *

PACIFIC GAS AND ELECTRIC COMPANY

62-6724

COPY

December 8, 1972

Public Utilities Commission
of the State of California
State Building
350 McAllister Street
San Francisco, California 94102

Re: Hartzell v. Pacific Gas and Electric Company, and Related Matters, Cases Nos. 9075, 9115, 9182 and 9189, Decision No. 79726

Gentlemen:

Enclosed is one copy of Pacific Gas and Electric Company's second report required by Ordering Paragraph No. 5 in Decision No. 79726. This second report supplements and is submitted in the same format as, the company's first report filed June 1, 1972. Maps showing new construction and photopoints are enclosed.

Very truly yours,

MALCOLM H. FURBUSH
JBBunnin/jk

SECOND REPORT

BY

PACIFIC GAS AND ELECTRIC COMPANY

on Existing Access Roads for the

Diablo Transmission Lines

in Compliance with

Decision No. 79726 of the

CALIFORNIA PUBLIC UTILITIES COMMISSION

December 8, 1972

The Commission's Decision No. 79726, in Case No. 9015 (Hartzell v. PGandE) and related matters, required Pacific Gas and Electric Company to conduct a survey of 500 kV transmission line access roads leading from Pacific Gas and Electric Company's Diablo Canyon Nuclear Power Plant Site to its Midway and Gates 500 kV substations. The objective of the survey was to observe, record, and document conditions of existing or potential erosion, siltation, or visual change resulting from road construction; and to recommend corrective and rehabilitative measures which can reasonably be applied by Pacific Gas and Electric Company to promote soil stabilization and vegetative recovery.

A committee was formed to conduct the review of all existing access roads; to observe and note conditions; and to suggest, where necessary, a suitable rehabilitative program. The committee included three Line Construction representatives and a representative from the Land Department.

The field survey was initiated March 27 and completed April 7, 1972, with periodic trips to review or rephotograph a photopoint. Line Construction personnel drafted onto 1" = 200' contour maps all existing roads and individual photopoint locations. (A set of these maps is submitted as part of this report.) This portion of the survey was completed on May 5, 1972. During this period, photopoints were recreated from composite photographs and combined with individual data sheets to form the basis of the written report. Information obtained from the maps, photographs, and data sheets was evaluated and analyzed to report results of the survey and to recommend corrective measures. The results are contained in two binders, one for each line.

Photopoints located in the field are documented on the maps and recorded on the bound data sheets which accompany this letter. The photopoints are located along the roads and are established with 1/4" x 2" x 2' lath labeled "Environmental" and marked with pink and yellow flagging. Photopoint numbers are located on the reverse side of the lath. Criteria for establishing photopoints were as follows:

1. Provision of a panoramic view of representative conditions, existing or potential.

2. Ease of relocating photopoints.

3. Protection from road maintenance and other disturbances.

Limitations on this study were as follows:
1) The time to establish survey procedures and to complete study was short. 2) Normal, corrective maintenance of roads was completed on a major portion of the Midway line prior to this survey.

A. DIABLO-MIDWAY 500 KV TRANSMISSION ACCESS ROADS:

1. Road Survey:

a. Access roads existing at the time of survey served:

1) Towers 1 through 20

2) Towers 20 through 28 (end haul not entirely completed)

3) Towers 67 through Midway Substation

b. Access roads not included in survey:

Towers 28 through 67 (access roads not constructed)

c. Maintenance:

1) Towers 1 through 20: Maintenance performed and in most cases corrective measures initiated were in compliance with recommended corrective action (Midway photopoints 1 and 2)

2) Towers 67 through Midway Substation: Maintenance completed to Tower 180 (3-31-72). Remaining portion to be completed by 4-1-72.

3) General: A continuing maintenance program is in effect for all access and spur roads. Manpower and equipment fluctuates as other commitments arise.

2. Vegetation:

a. Hydroseeding - Major portions of the Midway line have been hydroseeded (twice in some areas) with results ranging from poor to fair. Allowing for the minimal rainfall this past winter, the observation period should be extended through next winter to determine more meaningful results from the seeding program.

b. An inspection team will submit interim reports and recommendations for additional programs as needed. New road construction will be included on interim reports and entered on the following six-month report required by the CPUC order. All new seeding programs will be done reasonably prior to winter rains to insure full exposure to normal precipitation.

c. Native vegetation is establishing itself on construction sites. Percent of cover is presently minimal but will improve with time. (Midway photopoints 7, 10-14a, 16, 18, 19-24, 33, 35).

B. DIABLO-GATES 500 KV TRANSMISSION ACCESS ROADS:

1. Road Survey:

a. Access roads existing at the time of survey served:

1) Towers 1 through 67

2) Tower 75 (a spur road)

3) Towers 81 through 88

4) Towers 100 through 247 (over-built existing access for 230 kV)

b. Access roads not included in the survey:

1) Towers 67 through 74 (not constructed)

2) Towers 88 through 95 (main roads privately built to developers' specifications - spur roads to PGandE specifications)

3) Towers 95 through 100 (not constructed)

4) Towers 247 to Interstate 5 (not constructed)

5) Interstate 5 to Gates Sub (roads have already been obliterated by agriculture use)

c) Maintenance: An inspection team has recommended corrective measures (generally corresponding to the survey team's) for all existing portions of the road. Maintenance has been completed to Tower 22 and emphasis is now on those portions of the right of way under construction.

1) Towers 79 through 88 - roads graded. Existing roads utilized for access were graded.

2) Towers 100 through 160 - foundations being constructed with periodic maintenance for heavy equipment.

3) Towers 160 through 201 - interim state, minimum road use. Existing roads were utilized for access.

4) Towers 201 through 247 - new road construction with overbuilding of existing roads where practical.

2. Vegetation:

a. Hydroseeding - From plant site to Tower 22 extensive hydroseeding has been done. Results are poor to fair in general (Gates photopoints 3, 5, 7, 7a, 8, 9a), and good in specific areas (photopoint 2). Poor rainfall, soil conditions, and grazing impact contributed to the indicated results.

b. Pine and Oak Seedlings Program - Selected sites along the Gates access and spur roads were planted with Bishop and Monterey Pines and Coast Live Oak. (See reference maps LT-2-212-1 and 2; P1906-(13-15)). Present mortality in the pine may average 20-30% with greater mortality expected by next fall. The program should be monitored to determine results. Oak seedlings are doing much better than expected.

c. Native Seed: Tree lupine was handseeded at selected sites. Natural recovery of tree lupine is excellent. This plant should be considered for further seeding programs.

d. An inspection team will submit interim reports and recommendations for additional programs as needed. New road construction will be included on interim reports and entered on the following six-month report. All new seeding programs will be done reasonably prior to winter rains to insure maximum exposure to normal precipitation.

e. Native vegetation has revegetated most fill slopes to an acceptable level. As anticipated, cut slopes are bare except at toe where soil accumulation has stimulated regrowth. Tree planting programs will enhance screening for visual improvement of cut slopes.

C. GENERAL COMMENTS AND RECOMMENDATIONS:

1. Erosion and Siltation: Improper drainage led to most of the existing erosion and siltation off of the roads. The most efficient and economical program to reduce erosion should be concentrated on improving and expanding existing measures to effectively control water runoff.

The applied erosion control measures, in principle, will minimize soil erosion if consistently and correctly done. Water checks designed to carry water off into undisturbed areas are essential. If this is not possible, over-side drains are an effective means to carry water off of fill slopes.

The principal of outsloped roads to provide uniform sheeting of water off the road is sound if the road is not used after maintenance. However, excessive use of a road, especially during and immediately after a storm, creates channels for runoff which tend to by-pass constructed controls. This is especially critical on inside turns, extensive fills, or live and intermediate drainages with culverts. As a general recommendation, the road bed should be insloped under these conditions and drained to a culvert or dipped to an over-side drain. This method is efficient as long as the road is periodically maintained. Upon conclusion of use, the road bed can be outsloped, seeded and "put to bed".

2. Vegetation: Vegetation is another means to aid in soil stabilization. Natural species should be encouraged to revegetate disturbed areas either by fertilizer applications or seeding and planting programs. The use of native species, especially those adapted to nearly sterile soil, is recommended.

   All vegetative rehabilitation programs should be completed reasonably prior to the winter rains to insure full exposure to the area's normally low precipitation levels. Seeding should be coordinated with road building to prevent surface glazing before seed application. Seedlings should be planted on selected fill slopes to break slope continuity and to provide screening.

3. Visual Effects: Visual awareness of roads has become a primary consideration in determining road locations, construction standards and techniques, and revegetation programs. The degree of influence is exemplified by the "end-haul" road currently under construction between Midway Towers 20 through 28. Although exposed to Avila Beach, the impact of that road is lessened by the absence of long fill slopes, and the screening provided by the undisturbed vegetation.

   Future road building, especially between the Diablo plant site and Highway 101, should consider the end-haul technique, along with others, to minimize visual impacts. The limitations to this road standard include the additional time to engineer road locations, areas to deposit spoil material, and the added time and expense to construct the road.

   Visual impact can be reduced by proper route selection before construction and by close supervision during construction to insure that recommended procedures are carefully implemented. However, existing roads, especially between the plant site and Gates Tower 22, have created a visual problem which vegetation screening offers the only suitable

Appendix 5-1

INTERNAL DOSE TO BIOTA AND CALCULATION OF BIOACCUMULATION FACTORS FOR WATERFOWL

The annual internal dose, D_i (in millirads per year), from radionuclide i to biota deriving all of its food from water in which the concentration is W_i μCi/ml with which it is in equilibrium is written:

$$D_i = 1.87 \times 10^7 \, C_i^b \, W_i E_i , \qquad (1)$$

where

1.87×10^7 = a constant to convert microcuries per gram of biota to dose,

C_i^b = bioaccumulation factor for radionuclide i for the biota (the index $b = m$ to designate waterfowl, f to designate fish, i to designate invertebrates, and a to designate aquatic plants), given by the ratio of the concentration (in microcuries per gram) in the biota to the concentration in the water, and

E_i = the effective absorbed energy (MeV) of radionuclide i in the biota.

The maximum effective absorbed energies in man (30-cm-diam organism) were used in calculating doses to biota in the general categories of aquatic plants, invertebrates, and fish, whereas the effective absorbed energies corresponding to a 10-cm-diam organism were used for waterfowl.[1] Therefore, for most biota other than waterfowl, the internal dose will be considerably overestimated, because the effective absorbed energy will be less than that for a 30-cm diam organism.

Bioaccumulation factors for waterfowl (total body) were calculated by estimating the body burden that would result at equilibrium from consuming aquatic plants growing in water containing 1 μCi/cm^3 of each radionuclide. The rate of change of body burden, B_i (μCi), of radionuclide i with respect to time is given by the following differential equation:

$$\frac{dB_i}{dt} + \lambda_i B_i = S_i , \quad (2)$$

where

S_i = source of radioactivity of radionuclide i to the waterfowl (μCi/day) and

λ_i = effective elimination constant (days^{-1}) of radionuclide i in the total body.

Solution of this equation for an equilibrium body burden, B_i^{eq} (i.e., $dB_i/dt = 0$), gives

$$B_i^{eq} = S_i/\lambda_i \ . \quad (3)$$

We can further define the source of radioactivity of radionuclide i to the waterfowl as:

$$S_i = W_i C_i^a \, g \, F_i \ , \quad (4)$$

where

W_i = concentration of radionuclide i in water (μCi/ml),

C_i^a = bioaccumulation factor for radionuclide i in aquatic plants relative to water,

g = grams of aquatic plants consumed per day, and

F_i = fraction of the intake of radionuclide i retained in the total body (dimensionless).

When Eq. (4) is substituted into Eq. (3) and divided by m, the mass of the animal, the result is a bioaccumulation factor, C_i^m, for waterfowl:

$$C_i^m = 1.44 \ T_i W_i C_i^a F_i \ \text{g/m} \quad (5)$$

where

T_i + ln $2/\lambda_i$.

In calculating values for C_i^m, the following assumptions were made:

W_i = 1 μCi/ml,

g = 100 g of aquatic plants per day, and

m = 1000 g.

In Eq. (5), g and m are related as a ratio, g/m, and the above assumptions fix this ratio at 0.1. This is probably a reasonable ratio for animals covering a range of body weights of 500 g to 1500 g; therefore, Eq. (5) should be applicable to a range of body weights, even though m is 100 g in the calculation of the bioaccumulation factors for Table 5.23. The numerical values used for T_i and F_i are those listed as T and f_w, respectively, in ICRP Publication 2. Although the values listed by the ICRP were intended to apply to man, they probably can be applied to waterfowl without excessive error, because most of the studies on which the values are based were conducted with rats and mice, not man. In the case where such effective half-times were determined for man, use of these numbers for waterfowl would most likely result in an overestimate of the concentration factors. Data based on experiments with waterfowl are not available.

REFERENCE FOR APPENDIX 5-1

1. International Commission of Radiological Protection, *Report of Committee II on Permissible Dose for Internal Radiation,* ICRP Publ. 2, Pergamon Press, Oxford, 1969.

Appendix 5-2

CALCULATION OF THE DOSE DUE TO RADIONUCLIDES DEPOSITED ON A BEACH FROM THE WATER

The concentrations of radionuclides deposited on the shore areas of the ocean were estimated by the empirical equation,

$$C_{\text{Shore}} = 100\ C_{1/2}\ C_{\text{water}}\ , \qquad (1)$$

where C_{water} is the concentration of the radionuclide in picocuries per liter of water at the specified location, $T_{1/2}$ is the half-life of the radionuclide in picocuries per square meter deposited on the shore by sedimentation from the water. Equation (1) was determined empirically for the Columbia River area and is assumed to hold true for deposition from salt water.

The use of Eq. (1) may result in estimates of radionuclide concentrations that are larger than are actually present[1] since wave action on beaches generally results in well-sorted sediments with relative large size.[2]

The fraction, f, of the infinite plane dose received from a semi-infinite plane of width W from 4 to 60 m (about 10 to 200 ft) is given by

$$f = 0.067 + 0.167\ \ln W$$

One then needs only a standard table for the infinite plane dose, D_{infinite}, and the semi-infinite plane dose $D_{\text{semi-infinite}}$ is given by

$$D_{\text{semi-infinite}} = (0.067 + 0.167\ \ln W)\ D_{\text{infinite}}$$

Values for the infinite plane dose were obtained from a computer code.[3]

REFERENCES FOR APPENDIX 5-2

1. A. M. Freke, *Health Phys*. 13: 743 (1966).

2. E. K. Duursma and M. G. Gross, "Marine Sediments and Radioactivity, *Radioactivity in the Marine Environment*, National Acaemy of Sciences, (1971.

3. W. D. Turner, S. V. Kaye, and P. S. Rohwer, *EXREM and INREM Computer Codes for Estimating Radiation Doses to Populations from Construction of a Sea-Level Canal with Nuclear Explosives*, report K-1752, Oak Ridge National Laboratory (1968).

Appendix 12-1

ENVIRONMENTAL CONSIDERATIONS: ALTERNATE EFFLUENT COOLING SYSTEMS

Wet cooling towers require large amounts of chemicals in the recirculating water to inhibit biological growths and to prevent corrosion. Salt concentrations also build up in the tower water due to extensive evaporation and the blowdown must be bled off and discharged. In addition to blowdown and evaporation losses drift containing chemicals in essentially the same concentration as in the recirculating water escapes from the towers along with the vapor plume. Chemicals added to tower water thus find their way directly into surrounding aquatic or terrestrial ecosystems.

The following discussion of cooling tower chemicals was taken from a draft manuscript by S. H. Hale, R. S. Carlsmith, and C. C. Coutant, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Corrosion and Scale Inhibitors

Corrosion inhibitors used for open recirculating systems usually are mixtures of zinc, chromate, phosphate, sodium silicate, nitrate, borate, and organic inhibitors. The following corrosion and scale-inhibiting chemicals (with their concentrations) are commonly used in cooling tower waters.[1]

	ppm
1. Chromate plus zinc	5 to 30 CrO_4 1 to 15 Zn
2. Chromate plus zinc plus phosphate	5 to 30 CrO_4 1 to 15 Zn 1 to 5 PO_4 (inorganic) 1 to 5 PO_4 (organic)
3. Zinc plus inorganic phosphate	10 to 30 PO_4 2 to 10 Zn
4. Zinc plus organic phosphate	1 to 10 Zn 3 to 15 PO_4 (organic)

5. Organic phosphate scale inhibitor 1 to 18 PO_4 (organic)

6. Specific copper corrosion inhibitor 1 to 5 sodium mercapto-benzothiazle or benzo-triazole

Chromate, zinc, and phosphate are often used together because of the very synergistic anticorrosive effects when they are combined.

Biocides

Of the commonly used biocides, chlorine or hypochlorite or non-oxidizing organic compounds such as chlorophenols, quaternary amines, and organometallics such as organotin compounds, organo-sulfur, and organothiocyanate are most frequently employed. They are all used to prevent deterioration of tower wood, loss of heat transfer efficiency, general fouling or plugging arising from microbial growthsm and corrosion that results from microbial attack.[2] Organotin must be formulated with quaternary ammonium and other complex amines to produce a synergistic effect and to be dispersible. Chlorophenols, as soluble potassium and sodium salts, are more persistent than free chlorine and remain in systems longer. Common chlorophenols include: 2,4,5-trichlorophenate; 2,4,6-T; 2,3,4,6-T; tetrachlorophenol; and pentachorophenol. Organosulfurs are noted for low toxicity to animals yet effective action against bacteria, fungi, and especially sulfate-reducing bacteria. Quaternary and complex amines are effective wetting agents and destroy microbial agents by surface-active properties; these are the least toxic of all antimicrobial compounds to animals although they may form and so cause aesthetic problems. The organothiocyanates, the most modern of the nonoxidizing biocides, are widely effective. Oils, organic chemicals, water hardness, and other materials seem to cause little reduction in their effectiveness, especially if they are combined with chlorophenols. The nonoxidizing biocides are used whenever the problems are rather severe and where the use of free chlorine is not acceptable. Typical concentrations for continuous use are 1 to 25 ppm; higher (200 ppm or so) if applied in periodic treatments. Elemental chlorine is an oxidizing agent and can cause rapid deterioration of wood. The use of free chlorine as a biocide is usually restricted to 1.0 ppm as free residual Cl_2 and to 1 to 2 hr per day.[1]

The use of biocides that contain mercury, arsenic, lead, or boron is limited by stringent regulations on their release to the environment than do most of the compounds previously discussed, because of their extreme toxicity.[3]

Corrosion Inhibition

Chromate ion is one of the most effective corrosion inhibitors. It is effective where it can react with iron-containing alloys to form alpha ferric oxide and chromic oxide film on the iron surface. Usually this treatment is most effective when a high concentration of chromate is circulated throughout the system until the film forms; then maintenance of a low concentration of chromate is sufficient to maintain the protective film.

Phosphate acts both as a corrosion and a scale inhibitor and may be found as sodium tripolyphosphate, sodium hexametaphosphate, and several types of "glassy" phosphates of high molecular weight. The compounds also form a protective film on metal, mostly on cathodic areas. However, at high temperature, low pH, or high calcium concentrations, the polyphosphates revert to orthophosphates of low molecular weight or react with iron or water hardness salts to form an insoluble sludge.

Zinc ion alone is a relatively weak corrosion inhibitor but has strong synergistic qualities. It is a cathodic inhibitor that forms a deposit of zinc hydroxide on cathodic areas, thereby diminishing the cell potential.

Sodium silicate forms a thin protective gelatinous film over the first layer of corrosion product on the metal surface. High concentrations of chloride or sulfate ions may disturb the protective layer.

Organic inhibitors aid in developing protective layer of insoluble material or by creating a surface-active barrier.

Nitrite is a passivator for steel that makes the steel effectively a more noble metal. A similar passivation is provided by tin alloys; copper is a bit weaker. High concentrations of chlorides reduce the effectiveness of nitrites; for example, about 4000 ppm of NO_2 is required in a 3% NaCl solution, as compared with only 50 ppm in distilled water to achieve the same effect.

Borax is often included in nitrite-based inhibitors to maintain a pH of 8 to 10 in the water. It has not been demonstrated to be effective as an inhibitor.

Antifoulant Polymers

Antifoulant polymers are of three types.[2] Flocculants agglomerate individual particles so that they remain suspended and are easily bled off. Dispersants interfere with the agglomeration of colloidal particles that are attracted to metal surfaces, often modify their crystallization, and allow them to slough off. Chelating agents react with certain metal ions to form stable, soluble complexes; calcium, magnesium, iron, aluminum, and manganese ions may be chelated to prevent their precipitation, but the reaction is stoichiometric, and chelation of water hardness ions is generally uneconomical.

TOXICITY

General

In Table 12-1.1 are listed some elements which have historically been used in cooling towers, along with their concentration factors by plankton and brown algae.[4] The concentration factors may signify increased toxic effects of various elements through a food chain and suggest that even low concentrations of some contaminants in water may be harmful by the third or fourth trophic level. Some high concentration factors, such as those exhibited by Foraminifera and Porifera for silicon, are normal. Some elements, not toxic to aquatic life, may unbalance the ecosystem by overstimulating the growth of certain plants or animals. It is well established that nitrogen and phosphorus, particularly in combination, cause massive algal blooms under conditions where these elements were previously the limiting factors. While the accumulating poisons mercury and lead are no longer marketed for use in cooling towers, any of the heavy metals (e.g., chromium, zinc, or tin) may cause environmental problems by remaining in sediments or by concentrating in some forms of aquatic life. Establishment of the potential threat to the environment becomes extremely difficult because the different forms and valence states of the element may vary greatly in toxicity — as with sulfur, chlorine, and mercury. Factors contributing to the change from one state to another and synergistic toxic effects must be known before cooling tower chemicals can be ranked in order of potential environmental threat.

The effect of chemicals released in the shoreline effluent has been discussed in section 5. In order to estimate the impact of

Table 12-1.1. Toxicity and concentration factors of elements once or presently used in cooling towers

Element	Concentration factor[a]		Functions	Environmental toxicity[b] (not injected)
	Plankton	Brown algae		
As[c]		2,500		Carcinogenic; moderately toxic to plants, highly to mammals – especially as AsH_3
B		6.6	Essential for green algae, angiosperms	Moderately toxic to plants, slightly to mammals
Br[c]		2.8	Essential for marine organisms; amino acids	Br_2 is very toxic; Br^- is relatively harmless to organisms
Cl[c]	1	0.062	Essential for mammals and angiosperms	Cl^- is relatively harmless; Cl_2, ClO^-, ClO_3^- are highly toxic
Cr[c]	17,000	6,500	May serve some physiological function	Cr(III) is moderately toxic; Cr(VI) is highly toxic to organisms and is probably carcinogenic (by inhalation)
Cu[c]	17,000	920	Essential to all organisms	Very toxic to algae, fungi, and seed plants; highly so to invertebrates; moderately so to mammals
Hg[c]		250		A cumulative poison in mammals; very toxic to fungi and green plants; highly to mammals in some forms
N	19,000	7,500	Essential as structural atom	Relatively harmless; concentrations higher in plankton and fish
P[c]	15,000	10,000	Vital in many ways	
Pb[c]	41,000	70,000	None	Very toxic to most plants, moderately so to mammals; cumulative poison
S[c]	1.7	3.4		S_2 highly toxic to bacteria and fungi, relatively harmless to green algae, seed plants, and mammals; H_2S is highly toxic to mammals, SO_2 moderately to highly; SO_4^{2-} is relatively harmless
Si[c]			Essential to some plants	Scarcely toxic, but large amounts in mammalian lung harmful, used by foraminifera, porifera, etc.
Sn[c]	2,900	92	None	Very toxic to plants and green algae
Zn[c]			Essential to all organisms	Moderately toxic to plants; slightly toxic to mammals; uptake by plant roots not linked to metabolic process

[a]Ppm in fresh organism divided by ppm in seawater.

[b]Toxicity terms: very, 1–10 ppm; highly, 10–100 ppm; moderately, 10–1000 ppm; slightly, over 1000 ppm (as 24-hr median tolerance limit in moderate-sized organisms – e.g., fish).

[c]Accumulator species or genera known.

chemicals from cooling tower blowdown and drift, similar information on the expected concentrations to be released need to be provided.

Salt deposition (0.46 lb/ft^2/day) from either natural or mechanical draft towers would be expected to have an effect on plant communities within the 1/2 mile radius area.

Various plants have differing salt tolerances, and additional salt added to the environment may influence the plant community structure. Plant community changes could also result in altered vertebrate communities. As an example, in areas where weeds have been controlled by the use of herbicides, changes in insect populations.[5] Another study indicates that salinity, as a factor influencing vertebrate populations, is probably most important as it affects the distribution of plants.[6]

Research conducted at Island Beach State Park indicates that the position of plant populations in the ecological community is determined by a salt spray gradient.[7] Shure[8] has reported on the relationships of small mammals on Island Beach. The distribution of these vertebrates on Island Beach is related to the topographically controlled pattern of environment and vegetation.

Little is known about the exact levels of tolerance to ingested sodium chloride for the land dwelling vertebrates which occur in the Diablo Canyon area, however that the white footed mouse *(Peromyscus leucopus)* has been reported to tolerate drinking solutions of up to 0.3 molar sodium chloride for ten days without changes in body weight or significant mortality.[9]

The temperature and salinity characteristics of undiluted cooling tower blowdown are similar to those of the desalination plant effluents. The cooling tower blowdown at Diablo would be discharged through an offshore diffuser to minimize the adverse effects of the warm water brine.[10] The undiluted warm water brines (20° to 26°F temperature increase at 50 to 60 parts per thousand salinity) from desalting plants can eliminate or retard many benthic species in the discharge region. A desalination plant at Key West, Florida (producing 8 cfs of 55 ppt brine at about 20°F above ambient) caused algae, tunicates, and snails to be eliminated, and bryozoans to be retarded in the vicinity of the discharge. Other effects were the elimination of sensitive benthic species within 140 ft of the discharge and a considerable reduction within 200 ft of the discharge.[11]

While an *offshore discharge* would still use a once through cooling system, the thermal effluent would be mixed into the vertical water column, thus reducing the condenser Δt more rapidly in the vicinity of the discharge.

Both an offshore horizontal point discharge and the offshore diffuser will increase the travel times of organisms carried through the condenser cooling water system. This would increase the temperature-dose received by zooplankton, fish eggs, and fish larvae, and should cause a higher mortality than the shoreline discharge.

Warm water "replacement" flora and fauna would not be anticipated since temperature fluctuations of less than 4°F will fall within natural seasonal fluctuations for nearshore areas of the California coast. However cold water biota can become reduced or absent in such areas during warm summers. Canopy deterioration in kelp beds (*Macrocystis* spp.) frequently occurs when temperatures 2°F or more above normal summer levels appear for several weeks.[13]

A decrease in the bull kelp (*N. luetkeana)* canopies has been predicted in the areas exposed to surface isotherms greater than 4°F (see section 5.3). The loss of bull kelp could be avoided or minimized by constructing an offshore discharge beyond the canopies, at a depth approaching 60 ft.

Ecological investigations at several generating plants with offshore submerged discharges have not revealed any adverse effect on the marine ecology. The San Onofre Nuclear Generating Station, surveyed by the California Department of Fish and Game in 1969, had a lush and diversified biota.[14] The coolant water discharge did not appear to have an adverse effect on the marine life in the nearshore ocean environment. The California Department of Fish and Game also surveyed the Redondo Beach Power Plant in 1968.[15] The biota was healthy, and similar to other small boat harbors in southern California. Although algae in the harbor were limited, the invertebrate fauna was generally lush and diversified, especially near the discharge in the outer harbor.

The use of *dry towers* would eliminate many of the problem areas associated with once-through cooling and evaporative type cooling towers. As a large source of cooling water would no longer be necessary, intake problems of impingement and entrainment would disappear as well as the discharge problem of thermal pollution. They would also eliminate the fogging and icing problem inherent with wet cooling towers.

REFERENCES FOR APPENDIX 12-1

1. Final Environmental Statement, William B. McGuire Nuclear Station, Units 1 and 2, Docket Nos. 50-369 and 50-370, October 1972, USAEC Directorate of Licensing, p. H-2.

2. R. Silverstein and S. Curtis, "Cooling Water," *Chem. Eng.*, Aug. 9, 1971, p. 93.

3. W. L. Marshall, *Thermal Discharges: Characteristics and Chemical Treatment of Natural Waters Used in Power Plants*, ORNL-4652, Oak Ridge National Laboratory, Oak Ridge, Tenn. (1970).

4. H. J. M. Bowen, *Trace Elements in Biochemistry*, Academic Press, New York, N.Y., 1966.

5. N. W. Moore, "Toxic Chemicals and Birds: The Ecological Background to Conservation Problems," *Brit. Birds* 55: 428-435 (1962).

6. A. M. Woodbury, "Animals and Salinity in the Great Basin," *Amer. Naturalist* 82: 171-187 (1948).

7. William E. Martin, "The Vegetation of Island Beach State Park, New Jersey," *Ecol. Monogr.* 29: 1-46 (1959).

8. D. J. Shure, Ecological Relationships of Small Mammals in a New Jersey Barrier Beach Habitat," *J. Mammal.* 51: 267-278 (1970).

9. L. L. Getz, "Influence of Water Balance and Macroclimate on the Local Distribution of the Redback Vole and White-Footed Mouse," *Ecology* 49: 276-286 (1968).

10. Pacific Gas and Electric Company, *Supplement No. 2 to Environmental Report, Units 1 and 2 — Diablo Canyon Site*, vols. 1 and 2, July 28, 1972.

11. W. D. Clark, J. W. Joy, and R. J. Rosenthal, "Biological Effects of Effluent from a Desalination Plant at Key West, Florida," Project No. 1805 ODIA, Contract No. 14-12-470, Federal Water Quality Administration, February 1970.

12. M. A. Zeitoun, E. G. Mandelli, and W. F. McLinney, *Disposal of the Effluents from Desalinization Plants into Estuarine Waters*, U.S. Department of Interior, Research and Development Progress Report No. 415, 1969.

13. W. J. North and J. R. Adams, "The Status of Thermal Discharges on the Pacific Coast," Proceedings of 2nd Workshop on Effects of Thermal Additions in the Marine Environment, Solomons, Md. (November 1968), *Chesapeake Sci.* 10(3-4): 139-144 (1969).

14. M. M. Duffy, "The Marine Environment in the Vicinity of the San Onofre Nuclear Generating Station," California Department of Fish and Game, *MPR Ref.* 70-1, February 1970.

15. J. M. Duffy, "Redondo Beach Harbor Biological Monitoring," California Department of Fish and Game, *MRO Ref.* 69-1, 1969, 55 pp.

Appendix 13-1

ECONOMIC ANALYSIS METHOD

The cost figures in Table 13.3 were obtained by using costs supplied by the applicant and estimates made by the staff. All costs are based on a 30 year plant life and an interest rate of 8.75%.

The $665 x 10^6 "plant cost" and the $29 x 10^6 "annual fuel" cost were taken from reference 1 of Section 13. The "operation and maintenance" cost of $12 x 10^6 was calculated by the staff from an operating and maintenance cost supplied by the applicant in Reference 1 of Section 13 and does not include taxes. For salt-water towers a $400,000 annual operating cost and a $40 x 10^6 capital expenditure was estimated by the staff. The offshore discharge was estimated by the staff at $17 x 10^6 as discussed in Section 13.

The "Annual operation cost" in Table 13.3 is the sum of the "fuel" plus the "operation and maintenance" costs. The present worth of this cost at 8.75% for 30 years is the "30-year present worth of operation." The "30-year present worth of operation" plus the "Plant cost" is the "Present worth of Generating Cost" in Table 13.3. The "annualized generating cost" was then obtained by applying the capital recovery factor for 30 years at 8.75 percent to the "Present worth of generating cost."

Appendix 13-2

BIOLOGICAL ENTRAINMENT LOSSES

13-2.1 ENTRAINMENT (ONCE-THROUGH SYSTEM)

Total flow = 3864 cfs = 109.417 m^3/sec (Sect. 3.3.3)

31,536,000 sec = 1 year

Total flow (100% load factor) = 31,536,000 sec/year x 109.417 m^3/sec

= 3,450,574,500 m^3/year = 3.4506 x 10^9 m^3/year

Densities

Phytoplankton	= 17.3 g/m^3	(IV-E-57, ER)
Zooplankton	= 0.305 g/m^3	(XII-D-7, ER)
Larval fish	= 1.1102/m^3	(IV-E-62, ER)
Larval rockfish	= 0.0326/m^3	(IV-E-66, ER)

Total entrainment

Phytoplankton = 3.4506 x 10^9 m^3/year x 17.3 g/m^3
= 59.69 x 10^9 g/year

Zooplankton = 3.4506 x 10^9 m^3/year x 0.305 g/m^3
= 1.052 x 10^9 g/year

Larval fish = 3.4506 x 10^9 m^3/year x 1.1102/m^3
= 3.8308 x 10^9 fish/year

Larval rockfish = 3.4506 x 10^9 m^3/year x 0.0326/m^3
= 0.1124 x 10^9 fish/year

13-2.2 ENTRAINMENT THERMAL LOSSES (ONCE-THROUGH SYSTEM)

Direct losses, phytoplankton: None

Direct losses, zooplankton: 1.052×10^9 g/year entrained
Mortality of 3.39% occurs 88.97% of the time
Mortality of 8.44% occurs 11.03% of the time

$$\begin{aligned}\text{Mortality} &= (0.0339 \times 0.8897)\ (1.052 \times 10^9 \text{ g/year}) \\ &+ (0.0844 \times 0.1103)\ (1.052 \times 10^9 \text{ g/year}) \\ &= (0.0317 + 0.0098) \times 10^9 \text{ g/year} \\ &= 0.0415 \times 10^9 \text{ g/year} = 41.5 \times 10^6 \text{ g/year} \\ &= 9.14 \times 10^4 \text{ lb/year}\end{aligned}$$

Direct loss, larval fish: 4×10^9 fish/year entrained.

Mortality assumed to be 70% between discharge temperature of 76°F (24.4°C) and 82.5°F (28.1°C) (September to November) and 35% at or below 76°F (the remainder of the year) (see reference 72, Sect. 5).

$$\begin{aligned}\text{Mortality} &= (4 \times 10^9)\ (0.25)\ (0.7) + (4 \times 10^9)\ (0.75)\ (0.35) \\ &= 1.8 \times 10^9 \text{ fish/year}\end{aligned}$$

13-2.3 TOTAL ENTRAINMENT LOSSES FOR ALTERNATIVE PLANT DESIGNS

Entrainment losses for the alternative plant designs are given in Table 13-2.1. The losses due to chlorine and defouling for the once-through system are computed in Sect. 5.3.2. Losses in the cooling tower are computed in Sect. 12.3.1.

Table 13-2.1. Entrainment losses for alternative plant designs

100% power factor

	Unit	Once-through proposed	Diffuser	Salt-water cooling towers
Phytoplankton	lb/year			
Thermal		None	None	
Chlorine		9.12×10^5	$>9.12 \times 10^5$	
Defouling		2.25×10^5	$>2.25 \times 10^5$	
Total		11.37×10^5	$>11.37 \times 10^5$	6.33×10^6
Zooplankton	lb/year			
Thermal		91.4×10^3	$>91.4 \times 10^3$	
Chlorine		16×10^3	$>16 \times 10^3$	
Defouling		3.97×10^3	$>3.97 \times 10^3$	
Total		111.4×10^3	$>111.4 \times 10^3$	1.116×10^5
Total primary producers and consumers	lb/year	1.2×10^6	$>1.2 \times 10^6$	6.4×10^6
Fish larvae	Fish/year			
Thermal		1.8×10^9	$>1.8 \times 10^9$	
Chlorine		27×10^6	$>27 \times 10^6$	
Defouling		6.56×10^6	$>6.56 \times 10^6$	
Total		$\sim 2 \times 10^9$	$\sim 2 \times 10^9$	184×10^6

Appendix 14-1

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT FOR THE DIABLO CANYON UNITS 1 AND 2

The staff's responses to the comments can be found at the locations indicated in the margins of the comments.

50-275
50-323

DVISORY COUNCIL
N
ISTORIC PRESERVATION
ASHINGTON, D.C. ~~20040~~ 20005

January 26, 1973

niel R. Muller, Assistant Director
for Environmental Projects
rectorate of Licensing
ited States Atomic Energy Commission
shington, D. C. 20545

ar Mr. Muller:

response to your request of December 12, 1972, for comments on the vironmental statement for the Diablo Canyon Reactor Units 1 and 2, d pursuant to its responsibilities under Section 102(2)(C) of the tional Environmental Policy Act of 1969, the Advisory Council on storic Preservation has determined that your draft environmental atement is inadequate regarding our area of expertise as it does not ntain sufficient information. To enable the Advisory Council to mment, please furnish additional data indicating:

a. That the most recent listing of the National Register has been consulted and that no National Register properties are affected by the proposed project.

1. Although your environmental statement contains evidence of having consulted the National Register of Historic Places, there is no indication that the most current listing was utilized or whether any properties would be affected. The National Register is published in the Federal Register of March 15, 1972, and monthly supplements are published on the first Tuesday of each month. In the supplement for August, 1972 a new property was listed in the San Luis Obispo County area, the Hearst San Simeon State Historic Park. The Advisory Council would like to know what effect, if any, your project will have on this property as well as the three noted in the statement.

Sect. 2.3

b. The effects on the archeological sites in the area.

1. A letter from Richard B. Hastings, the State Park Archaeologist, appears on page A2-1-2 of your draft statement indicating that three archeological sites have been found in the area of your project. The Advisory Council would like to know what effects, if any, your project will have on these sites and what steps will be taken to assure their preservation and enhancement.

Sect. 14.2

73.

Should you have any questions on these comments or require any additional assistance, please contact Jim Cardwell of the Advisory Council staff.

Sincerely yours,

Ken Tapman
Compliance Officer

A14-1-5

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

RECEIVED FEB 5 1973 U.S. ATOMIC ENERGY COMMISSION

FEB 2 1973

50-275
50-323

Mr. Daniel R. Muller
Director of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental statement for the Diablo Canyon Reactor Units 1 and 2, Pacific Gas and Electric Company, reviewed in the relevant agencies of the Department of Agriculture, and comments from Economic Research Service and Forest Service, both agencies of the Department, are enclosed.

Sincerely,

T C Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosures

ECONOMIC RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Draft Environmental Statement, Diablo Canyon Reactor Units 1 and 2, Pacifi Gas and Electric Company

1. A significant adverse environmental impact is erosion resulting from some methods of constructing maintenance roads for the transmission line systems (p. 4-9). The Statement says that most of the impact wil
App. 4-1 be temporary since revegetation will be rapid (p. 8-1). However, the AEC staff concluded that rapid revegetation is difficult in Diablo Canyon (p. 4-17). In light of the rather severe impact that could result (pp. 4-10 and 11), we feel that the Applicant should include in the final environmental statement their plan for redress of the trans- mission line impact with its associated costs and benefits (see p. 12- para. 3).

Sect. 4.2.2 Consonant with the apparent public concern in this area, we strongly feel that the support information on which Section 12.3.7 must be based (although little, if any, is presented in the draft statement) should be included in Section 4.2.2 to complement that discussed on pp. 4-9 and 10.

2. The visibility of transmission towers and roads will create an advers
Sect. 14.10 aesthetic impact for many (p. 8-1). We feel that the environmental statement should discuss the alternative transmission line locations which were proposed by the complainants referenced on p. 12-22. The
Fig. ~~3-14~~ costs and benefits of each major alternative should be briefly displayed. Finally, a map, such as fig. 2.4, noting alternative routes would be a desirable addition to the report.

3. The discussion of the Diablo-Midway transmission line's impact on the California condor (p. 4-11) is exceedingly brief and merits further attention. Although not mentioned, this bird is on the endangered species list and hence has a high social value. Although the nesting area is some 40 miles to the south, the bird's range overlaps the
Sect. 4.2.2 project area. According to the National Audubon Society, most of the reduction in its numbers comes from private game hunters. Hence, the building of access roads into the Los Padres National Forest coul have a significant adverse effect. The final environmental statement should include any plans the Applicant may have to minimize this effe For example, the Applicant might consider measures to restrict the us of these access roads.

- In this regard, the effect of the transmission lines and access roads should be considered in Chapter 5, Environmental Impacts of Station Operation. Sect. 5.3.1

- Section 2.2.2 discusses the present and future recreational use of the Diablo Canyon Area. We feel that the statement should also consider recreational uses of land traversed by the three transmission lines and the environmental impact of the latter upon them. Sect. 14.10

- The Applicant basically justifies the Diablo Canyon Units on existing and projected growth rates of electricity consumption. Inasmuch as the production of electricity consumes natural resources and results in environmental change, we feel that the Statement should include a discussion of measures that the Applicant, and, possibly, the system service area within which it has intertie agreements, have under consideration to encourage more efficient utilization of electricity. Some measures which could have a significant impact on demand projections might include the reduction of demands for costly peak power through special metering, implementation of rate structures designed to promote more efficient consumption, and the revision of present utility promotional efforts. Such a discussion would be compatible with NEPA Guidelines for environmental impact statements which require evaluation of alternatives to the proposed action. It would be properly included in Chapter 12. Sects. 14.19, 14.21

  The Applicant only discusses the implementation of such measures in terms of reacting to the crisis situation which would occur if the alternative of "no additional capacity" were chosen over construction of the two Units. (Section 12.1.4). However, recent interpretation of section 102 (2) (c) of NEPA held, in essence, that the range of alternatives required to be considered were those "reasonably available." None were to be ruled out, "merely because they do not offer a complete solution to the problem." NRDC v. Morton (D.C. Cir. 1972). Sect. 14.21

- The inclusion of indirect benefits relating to "Air Quality" in Table 13.2 is not acceptable. The proper comparison, and the one consistent with other items in the table, would be between the conditions existing with and without the project. Sect. 14.22

UNITED STATES DEPARTMENT OF AGRICULTURE
Forest Service

Re: AEC Draft Environmental Statement - Diablo Canyon Reactor Units 1 and 2

Forest Service comments on the subject draft Environmental Statement are primarily concerned with the environmental effect of the transmission lines and necessary access and constructior roads which cross the Los Padres National Forest at two locatic The Diablo-Gates Route crosses a narrow section of the Forest near State Highway 41 northeast of Morro Bay; the Diablo-Midway Route crosses the Forest further to the south and east. (The locations are indicated on the attached Forest map.)

Sect. 3.7.1 The right-of-way for the Diablo-Midway Route within the Los Padres National Forest is 400 feet, not 350 feet, as indicated on page 3-44. The access roads constructed in the Los Padres National Forest, under Forest Service supervision, total appro› mately 16.0 miles, not 11.5 as indicated at the top of page 3-4

Sect. 2.7.1 (This correction should be made in the middle of page 2-46 als We suggest rewriting the last two sentences of the first paragı on page 3-46 to read:

Sect. 3.7.2 "Some turns are as much as twice the width of straight portions on the National Forest roads. Further, in most cases the roads on National Forest lands were required to be much les steep than those which Pacific Gas and Electric built on lands outside the Los Padres National Forest."

Sect. 4.2.2 Section 4.2.2, starting on page 4-8, covers impacts on the terrestrial environment from the construction of transmission lines and associated access roads. The following information could make this section more complete in regard to effects on Los Padres National Forest resources. The first paragraph in Section 4.2.2 states that the forest resources of the region will not be significantly altered as a result of the necessary clearing. We suggest adding:

"Primary uses of these National Forest lands are for graz: watershed protection, and wildlife production."

Sect. 4.2.2 The right-of-way for the Diablo-Gates transmission line covers about 22.4 acres, and for the Diablo-Midway transmission lines 311.0 acres. Impact to the terrestrial environment from the transmission lines themselves is minimal. Of more importance are the longer-term effects of access road construction. Access roads within the Los Padres National Forest for the Diał

Gates transmission line covers about 12.6 acres, and for the Diablo-Midway lines, 63.6 acres. Thus, about 76.2 acres of National Forest land will be converted into service roads by the project.

We note that on page 4-17 hydroseeding of cut and fill slopes is mentioned as one of the methods to be used to promote revegetation. On steep slopes hydroseeding does not provide adequate soil cover and does not do an adequate job of holding and stabilizing the soil compared to the punched-in straw mulch method. Sect. 4.4.1 App. 4-1

Benefits expected to occur from transmission line construction (third paragraph, page 13-9) mention that the "roadways are expected to provide access to heretofore inaccessible areas of the Los Padres National Forest," and that they will serve as fire lanes. These roadways will be used for access for administrative purposes only, including fire suppression, not for public access. Also, similar high-tension powerlines have been known to interfere with aerial tanker operation on wildland fires. Sects. 13.5.1, 14.23

It is recognized that transmission line construction is nearly complete and that most of the environmental damage from transmission line and access road construction has already occurred. On page 5-1 it is noted that Pacific Gas and Electric intends ultimately to install six units at the site. Should this future expansion require additional transmission lines to be built, much of the road construction and environmental damage discussed in this environmental statement can be avoided by utilization of helicopters in construction of transmission towers. This would also be true for construction of transmission lines in similar terrain on other projects. However, the Los Padres National Forest feels that National Forest resources in the project area are adequately protected by the existing special-use permits issued to Pacific Gas and Electric Company.

We have also reviewed the section on the life history of the condor, pages A2-6-17 and A2-6-18. The first sentence of the second paragraph would more correctly summarize current understanding of condor life history if changed to read: App. 2-6

"They do not make a nest but choose a place in some inaccessible area - normally a cave in the face of a rocky ledge."

Two recent publications to which the AEC staff may want to refer are:

USDI, Bureau of Sport Fisheries and Wildlife, 1969. Effects of the Sespe Creek Project on the California Condor. August 1969, Laurel, Maryland.

USDA, Forest Service, 1971. Habitat Management Plan for the California Condor. (Available at Forest Service offices in San Francisco, Santa Barbara, and Ojai, California).

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
630 Sansome Street, Room 1216
San Francisco, California 94111

50-275
50-323

REPLY TO
ATTENTION OF:

SPDPD-R

23 February 1973

RECEIVED MAR 1 1973

Mr. Daniel R. Muller, Assistant Director
for Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your request for Corps of Engineers review and comments on the draft environmental statement for Diablo Canyon Reactor Units 1 and 2 by Pacific Gas and Electric Company. In accordance with our review procedures, this letter shall serve as the consolidated response of the District Engineer, Los Angeles, and the Division Engineer, South Pacific.

The proposed plan does not conflict with existing or authorized plans of the Corps of Engineers. We have no comments concerning the environmental statement for this proposed action but appreciate the opportunity to review it.

Sincerely yours,

Everett E Love Col CE
for DAVID N. HUTCHISON
Colonel, CE
Deputy Division Engineer

A14-1-13

THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

January 24, 1973

50-275
50-323

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for Diablo Canyon Reactor Units 1 and 2 which accompanied your letter of December 12, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

Pages 3-17 - Figure 3.8 is a graphical representation of the high and low surface temperatures recorded in Diablo Cove in 1968. It is unclear from the graph or the text exactly what the highs and lows represent. If the highs and lows are diurnal temperature fluctuations, this fact should be clearly indicated. Fig. 3.8

Pages 5-21, Paragraph 2 - The statement is made in the section on <u>Effects of Temperature</u> that "the cooling water discharge from Units 1 and 2 at Diablo Canyon can be expected to raise the surface water temperature 10° F above ambient over an area of 7.4 acres." However, according to information provided in paragraphs 3 and 4 on page 3-22, the figure 7.4 acres represents the revised estimate of the portion of Diablo Cove to be enclosed by the 10° F isotherm. If this is, in fact, the case then the temperature of much of the 7.4 acres will be raised considerably more than 10° F above ambient for the following reasons: Sect. 5.3.2

Only at the perimeter of the 10° F isotherm will the ambient temperature be elevated just 10° F. At any point within the 10° F isothermal boundary the ambient temperature will range from 20° F above ambient to 10° F above ambient depending on the distance from the original point of discharge, which is itself 20° F above ambient.

Sect. 5.3.2

The same situation may also be applied to the 40° F and 2° isotherms. Within the 4° F isotherm, which is predicted t enclose 92 acres of surface water, temperatures will range from 10° F above ambient to 4° F above ambient. This shou be clarified in the final environmental statement.

Sect. 5.3.2

Pages 5-21, Paragraph 3 - Based on the isothermal surface areas predicted in paragraph 2 of pages 5-21, and on the maximum ambient surface temperature of 63.5° F for Diablo Cove, the statement concludes that "Therefore the water temperature at the point of discharge may become 83.5° F during normal operation. Another 7.4 acres may be heated 73.5° F, and from 90 to 100 acres will be elevated to 67.5

Sect. 5.3.2

These predictions are evidently based on surface water tem peratures at the individual 10° F and 4° F isothermal boun aries. Based on our comments above, the paragraph should be revised to indicate that the water temperature at the p of discharge may become 83.5° F during normal operation, t another 7.4 acres may have temperatures ranging from 83.5° to a low of 73.5° F, and that from 90 to 100 acres may hav temperatures from 73.5° F to a low of 67.5° F.

Sect. 5.3.2

If the figures we suggest are correct, then all assessment of thermal impacts on the aquatic environment must be reev ted. On the other hand, if the Staff concludes that the assessments presented in the draft environmental statement remain valid, then an explanation in support of this concl should be presented.

Sect. 5.3.2

Page 5-27, Paragraph 1 - The phytoplankton doubling rates presented are taken from data collected off La Jolla in Southern California during the spring and summer months. Although no better information may be available, we questi the applicability of the data to the situation at Diablo C The surface waters off La Jolla are generally several degr Fahrenheit warmer than those found in Diablo Cove at any given time, and it might be suspected that phytoplankton doubling rates would be increased accordingly. A statemer should be made whether the phytoplankton doubling rates would be expected to be significantly different at the two locations.

Sect. 14.15

Page 6-12 - Table 6.2 omits aquatic sediments from the lis of samples to be analyzed for radioactivity. Sediments within 500 feet of the effluent outfall and at two other locations should be sampled and a complete description of species to be analyzed and the sampling locations included the final environmental statement.

We conclude from the discussion on pages 3-33 and 3-34 and table 3.6 that the major portion of gaseous vent release to the open atmosphere during normal operation of one plant is as follows: Sect. 3.4.2

1000 Curies Xe-133, once per week
1500 Curies Xe-133, continuously
970 Curies Kr-85, 45 days holdup

Without more precise information on the duration and time (night or day) of release involved in the containment purge and in the waste gas processing system and the number of storage tanks used, we cannot judge whether the annual relative concentration values listed in table 5.27 are appropriate. For example, a containment purge, one hour per week and a gas storage tank release over a 10-hour period, assuming 2 tanks with 45-day hold-up capacity, would be a total release period of about 132 hours per year. The values listed in table 5.27 would be inappropriate in such a case.

For the accidental release as discussed on page 7-4 the assumptions should be stated specifically rather than by reference to proposed Annex to Appendix D, 10 CFR 50.

We have noted in the appendices the commentary by the Air Resources Laboratories of NOAA with respect to dispersion conditions under Pasquill Categories C, D, and F. We have also noted that the applicant's program includes meteorological measurements from a 250 foot tower near the plant location and from a 100 foot tower on top of a 914 foot hill on the site and similar measurements at 4 other locations.

Dispersion characteristics of accidental radioactive releases under stable conditions have been commented on above however, we take note of the location of the site on a spit due west of U. S. Route 101 and the Los Padres National Forest. We are somewhat concerned that with all the meteorological data available to the applicant, that some sort of study, either deterministic or statistical, has not been made with regard to the possible increased fogging or production of mist or light rain during marine inversion conditions. Sect. 5.2.2

The marine inversion is particularly intense in the area of the site during the fall and early winter. At this time, there is a relatively high frequency of low level winds from the northwest. Therefore, without going into laborious

computations, one can surmise that the mixing of the warm moist air discharged from the plant at a temperature of 20°
Sect. 5.2.2 above ambient with the marine layer (which normally extends 1 to 1.5 kilometers) can be advected southeastward with a potential for increased fogging and/or light precipitation over a heavily traveled roadway(U. S. 101). It appears to us that the impact of this phenomenon can be simulated to some extent.

The Arkansas Nuclear One draft environmental impact statement recently reviewed contained a computer study of the impact fogging from a once through cooling system. We feel that
Sect. 14.11 the simulation work done by the Arkansas applicant should viewed as a precedent for other draft environmental impact statements where fogging or other important weather modification situations have a potential for impact on the environment.

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

50-275
50-323

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

FEB 21 1973

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of December 12, 1972, wherein you requested comments on the draft environmental impact statement for the Diablo Canyon Reactor Units 1 and 2, Pacific Gas and Electric Company, Docket Numbers 50-275 and 50-323.

This Department has reviewed the health aspects of the above project as presented in the documents submitted. The following comments are offered:

1. Page 5-57, paragraph 2, indicates that "gonads have the restrictive numerical dose limits" and references NCRP #39. Table 6 on page 106 of NCRP #39 gives Population Dose Limits of 170 mrem average per year for both genetic and somatic. Sect. 14.3.1

2. Page 5-57, paragraph 1 states that ". . . the dose estimated to the thyroid of a two-year-old child from radioactive iodine in milk is 10 times that for an average adult." FRP Report #4 (page 23) also points out that "It has been estimated that a small number of infants (6-18 months) in localized areas conceivably could receive doses from 10 to 30 times the average." Sect. 14.3.2

3. Page 5-55, paragraphs 3 and 4, indicates that the estimated dose to the thyroid for processed and raw milk consumption is respectively for the adult, 0.60 mrem and 3 mrem. These values can be considered to be within a few percent of average exposures from natural background radiation and within a small fraction of the radiation protection guides. Could further data be provided on the estimated thyroid dose for the child under two years of age? Sect. 14.3.3

4. Although not always stated, it is assumed that the radiation doses specified are for a period of one year or an annual rate. Sect. 14.3.4

Page 2 -- Mr. Daniel R. Muller

Sect. 3.4.1

On page 53 of the Pacific Gas and Electric Company's report, it indicates the estimated liquid waste activity released with the condenser cooling water to be 7.6 curies per year from Units 1 and 2. The AEC report indicates, on page 3-31, that the anticipated release of radioactive materials in liquid effluent of Units 1 and 2 to be 28 curies. Appendix I of the proposed amendment of 10 CFR, part 50, indicates that the estimated annual total activity of radioactive material in liquid effluents to be released should not exceed 5 curies.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Richard L. Seggel
Acting Assistant Secretary
for Health

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
2500 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA 90057

AREA OFFICES:
Los Angeles, California
San Francisco, California

REGIONAL IX
REGIONAL OFFICE
FRANCISCO, CALIFORNIA

FEB 16 1973

50-275
50-323
IN REPLY REFER TO:
9.2PP

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

Subject: Draft Environmental Impact Statement for Proposed Diablo Canyon Electrical Energy Generating Units

The subject proposal is for the continuation of construction permits issued previously. Included in the proposal is also a request for an operating license upon completion of the project.

Construction on the two Units was started in June 1968. In mid-1972, Unit I was estimated to be 45.6 percent complete. Unit II was approximately 13 percent (12.8) complete. The earliest commercial operation of Unit I is planned for March 1, 1975. Unit II is expected to be operating one year later. The Units are designed to convert nuclear power into electrical energy. The power plant is being constructed on the Pacific Coast in San Luis Obispo County. The 750-acre site is located in an undeveloped section of the coastline. The nearest town is Avila Beach, approximately 400 in population, which is about 7 miles away. The closest residence is about 1½ miles from the site.

The service area for the proposed plant encompasses most of northern and central California. Agreement has also been made to exchange power with Southern California utility service companies.

Our review of your proposal indicates one area which if included, would make for a more complete Final Environmental Impact Statement. Some responsibility for the indirect effects of population growth in service areas should be assumed by the applicant. An action such as that proposed very directly, affects the growth potential in the service area. That is, as the capacity to provide electrical energy is increased, so is the potential for growth in the service area. Sect.14.14

Another concern we have relates to the coordinating mechanism among the firms providing utility services in a given service area. More specifically, we think the Final EIS should include a comment on how the applicant coordinates the provision of its services with those provided by other utility companies. Sect. 11.1

Daniel R. Muller
Washington, D. C.

As noted in our letter to you dated February 8, 1973, we realize our comment will be late. However, we hope they will be useful to you and thank you for requesting our participation.

Sincerely,

~~Area~~ Director

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

50-275
50-323

In reply refer to:
ER 72/1427

MAR 28 1973

Dear Mr. Muller:

This is in response to your letter of December 12, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated December 1972, on environmental considerations for Diablo Canyon, Units 1 and 2, San Luis Obispo County, California.

Our comments are presented according to the format of the statement or according to specific subjects.

Summary and Conclusions

Paragraph 7, page iv indicates that the action called for is the issuance of construction permits for the facilities. This appears to be inconsistent with Appendix 1-1 which indicates that the AEC issued construction permits for Units 1 and 2 in April 1968 and December 1970, respectively. Sect. 14.1

Historic and Natural Landmarks

The aerial photograph on page 4-7 reveals that most of the environmental impacts of site preparation and facility construction have already been experienced. However, this work did not affect any existing or proposed unit of the National Park System, nor any site eligible for registration as National Historic, Natural or Environmental Education Landmarks.

Chapter 4, entitled Environmental Impacts of Site Preparation, Station Construction, and Construction of Transmission Facilities, does not discuss the impacts on the three archeological sites identified by State Park Archeologist Hastings in his letter of May 12, 1971, and mentioned on page 2-25 of the statement. According to Mr. Hastings' letter the construction of the plant directly involves three prehistoric sites. The statement should assess the impact of plant construction on the archeological resources identified and discuss steps that will be taken to preserve or salvage archeological values. It does not appear that the applicant has acted to mitigate damage to these important archeological sites. Sect. 2.3 and 14.2

Also it does not appear that full compliance with Executive Order 11593 of May 13, 1971, has been accomplished. A dire professional survey of the site should have been made to locate and identify cultural resources so that they could b properly considered during planning and construction. Consequently, the impact of the development on cultural resour may never be known.

Geology

The brief description of the geology presented in the draft statement is inadequate for an independent assessment of th geologic environment relevant to proposed construction of t plant. The statement should indicate the measures that wer taken in the design of the facility to assure long-term structural integrity and mitigate possible hazards to the structure arising from geologic or hydrologic conditions. Although estimates are given for potential ground accelerat the use of these figures is covered only by the assertion t the proposed plant will withstand safely the earthquakes di cussed in the Safety Evaluation Report.

We suggest that, as a minimum, a more comprehensive summary the geologic and seismologic analysis section of the prelim
Sect. Safety Analysis Report be included in the final environment
14.3 statement with adequate cross references to appropriate par of the statement to indicate how this data have been utiliz for purposes of design and construction of the facility.

As a result of procedures previously established between th AEC and this Department, the Geological Survey has previous reviewed the Preliminary Safety Analysis Report. Comments this Report were transmitted to the AEC Director of Regulat on August 18, 1969, and were made part of the public record the AEC licensing procedure.

Thermal Dissipation

Sect. The initial momentum mixing of the plume is affected by the
14.4 constriction presented by Diablo Cove which will limit the water available for dilution. The AEC staff's analysis
Sect. recognizes this to some extent, as shown in figure 3.9 by t
3.3.3 eddy within the cove on the south of the plume. However, t temperature shown within this eddy of 4 degrees above ambie

would still require a sizeable inflow of diluting water into this portion of the cove. We believe that this magnitude of inflow is doubtful and expect that the water temperatures within the cove will be higher than those predicted by the analyses presented in the statement.

The environmental impacts of this plant when combined with other thermal-electric plants on the California coast does not appear to have been properly considered. We think that the final environmental statement should discuss the contribution of environmental effects from the proposed plant in relation to the cumulative effects on coastal waters from all existing and proposed powerplants.

Impacts from the Construction of Transmission Lines and Associated Access Roads

According to pages 4-9 and 4-10, extensive erosion has occurred
in some areas. The Public Utilities Commission of the State App.
of California has required the applicant to develop written 4-1
standards and policies for the design, construction, and main-
tenance of access roads which would give reasonable considera-
tion to aesthetic values and the conservation of natural resources,
and the environment. We suggest that the final environmental
statement contain a factual and complete evaluation of the
erosion impacts from construction and operation of the plant and
transmission lines. Mitigating measures should also be included.

Breakwater Construction in South Cove

The statement recognizes on page 4-15 that some of the sites
used by harbor seals as haul-out areas were removed during
construction of the breakwater in the South Cove. Although Sect.
there is an implication that some of the seals will return to 4.3.2
he area after construction is over, no effort is made in the
tatement to evaluate the population of seals existing prior
o construction and that expected to exist when construction
s completed.

he deposition of silt in South Cove as a result of intake
onstruction activities and the biotic degradation of the cove
hould be described and quantified to the extent possible. The
bservation of the presence of silt during the reconnaissance Sect.
tudy on April 3, 1972, should be related to other prior 4.3.3
bservations given in the report of D. Clifton, entitled,
The Effect of Construction on the Harbor Seal in Diablo Cove,
an Luis Obispo County, California." This would serve to

further quantify the impacts on these animals.

Aquatic Impact

Sect. 4.4.2 The survival of 15,129 abalone that were removed from the intake and discharge areas and transplanted to other areas should be indicated on page 4-17.

Metals

The effects of copper, nickel and chromium should be more thoroughly investigated. The possibility of concentration of certain metals by plankton or other marine life and the synergistic effects of some metals in combination with other metals, chemicals and increases in water temperatures should be evaluated.

Sect. 5.3.2

Sect. 6.3

Although levels in excess of 400 ppb of nickel are found in marine organisms, insufficient data have been included to provide assurance that an unacceptable level of damage to marine organisms will not occur. The statement should indica that additional information is required to determine the effe of nickel releases on the marine environment of Diablo Canyon Haydu's investigations, cited on page 86 in Water Quality Criteria," April 1, 1968, indicate that low levels, 10-12 ppb of chromium, molybdenum, and nickel are toxic to oysters and that toxicity is increased with increases in temperature. We also think that insufficient data have been provided to lead to a determination that the chromium releases from Diabl Canyon will not damage marine organisms.

Effects of Temperature

Sect. 5.3.2 The use of data in tables 5.14 and 5.15 to show the thermal tolerance of certain species of phytoplankton can only serve as an indication since none of the species listed in these tables are found in Diablo Cove according to Appendix table 2 Therefore, we question the use of these data for determinatio possible damage to marine organisms in Diablo Cove. For exam Valonia and Penicillus are tropical Atlantic genera. It sho be noted that important algae, such as Nereocystis, Macrocyst Pterygophora, Distyoneurum, Desmarestia, Botryoglossum, and Calliophyllis, which occur at Diablo Canyon are not listed in Table 5.14.

mperature tolerance of Macrocystis pyrifera is discussed on ge 5-27 for southern California. It should be indicated at Macrocystis pyrifera is not abundant in the vicinity of ablo Cove. The distribution of Nereocystis and Macrocystis at does occur in the vicinity of the thermal discharge should described. The temperature tolerances of Nereocystis utkeana should be documented. We do not consider the ference to Macrocystis pyrifera suitable for describing ssible damage to Nereocystis Leutkeana. Investigations may dicate that the upper thermal tolerance of N. Leutkeana is low 68°F. Sect. 5.3.2

is indicated on page 5-28 that since the 10°F isotherm fects only a small area occupied by N. Leutkeana there is strong possibility that no direct impact will occur. Since e of the largest kelp beds in the area is found directly front of and near the discharge, we think an element of certainty should be reflected as to the significance of the pacts. Postoperational monitoring may show that impacts e substantially different than those anticipated at this time. Sect. 5.3.2

do not consider the comparison of Morro Bay flora and fauna th that of Diablo Canyon as meaningful. For example, crocystis sp., Nereocystis sp., and Haliotis sp. are not found the vicinity of the Morro Bay discharge canal according to ble 5.18. Also, the volume of heated effluent at Diablo nyon will be many times that at Morro Bay. For these reasons, recommend that this section be deleted and no attempt be de to compare these two very different situations. Sect. 5.3.2

nce no direct evidence exists concerning fish eggs and larvae Diablo Cove or South Cove, an acceptably accurate assessment of the possible effects of entrainment cannot be made. -cove fish larvae densities computed from off-the-coast nples are not acceptable, nor are figures for computed losses sed on such hypothetical densities. We do not believe that e discussion on page 5-41 is sufficient to draw the conusion that no impact is expected from the discharge plume. Sect. 5.3.2

is stated on page 5-43 that analysis of species present, esented in Table 5.21, and their thermal tolerances, presented Table 5.22, indicates that no fish mortality would be pected from the discharge plume at Diablo Cove. This analysis nands explanation since only one of the 40 most important shes recovered during sampling in the Diablo area is included Table 5.22. Sect. 5.3.2

Plant Accidents

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airborne
Sect. emissions. However, the environmental effects of releases
14.17.1 to water is lacking. Many of these postulated accidents lis in Table 7.1 could result in releases to the Pacific Ocean and should be evaluated.

We also think that Class 9 accidents resulting in both air a water releases should be described and the impacts on human life and the remaining environment discussed as long as ther is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Pacific Ocean which could persist for centuries.

Adverse Environmental Effects Which Cannot Be Avoided

It is indicated on page 8-1 that the major adverse impact is the loss of grazing land. The aesthetic impact created by t
Sect. transmission line and access roads is covered with a single
4.2.2, sentence; however, we think that the disturbance rendered by
5.1, the project on the natural qualities and scenic values of th
8.1 coastal landscape will be quite significant. For example, substantial erosion difficulties and resulting vegetation damage have already occurred in hilly areas. This general concern for such values is shared by State and conservation groups. Recent coastal control legislation enacted by the State of California attests to the widespread public concern for the protection of the natural qualities of the coastal zone. Therefore, we urge that the final statement recognize and address the significant values inherent in non-developme of coastal areas and indicate that these values are foreclos by project construction and operation.

Biological Resources

We think that the section on irreversible and irretrievable
Sect. commitments of resources should contain an estimate of the
10.4 annual loss of fish and wildlife resources due to the constr tion and operation of the project.

Benefit-Cost Analysis

Section 13.5 shows savings in air pollutants in terms of SO_2, NO_x and particulates. Since emissions of SO_2, NO_x and particulates depend on a variety of parameters, background data Sect. upon which the savings in pollutants were calculated should 14.22 be given either in the Benefit-Cost Analysis section or in the Alternative section of the statement.

Conclusions and Recommendations

The variety, importance, and production of marine life in the ocean off California have been documented in several reports. Operation of this project will cause damage to aquatic resources, but the magnitude of those damages is uncertain.

he statement states or implies that the resource losses will ot be serious; however, appropriate documentation is not iven in many cases. We did not have an opportunity to participate adequately in the completed environmental studies nd have not been appraised sufficiently of the objectives, lanning, and progress of ongoing studies. Therefore, we are oncerned that construction and operation of the project may amage terrestrial wildlife resources and the thermal, chemical, nd other effluents may damage marine resources to a greater xtent than that indicated in the statement. It is imperative hat this project be constructed and operated in a manner that ill assure adequate protection of the fish and wildlife resources hat the applicant demonstrate conclusively that this will be ccomplished, and that if monitoring studies indicate that nacceptable damage is occurring, adequate measures will be aken to reduce such damage to acceptable levels.

ccordingly, we recommend that the operating license for nits 1 and 2 contain stipulations to accomplish the following n addition to those given on pages iv and v.

. Postoperational environmental studies developed in consultation with appropriate Federal and State natural resource agencies, shall be conducted continuously for not less Sect. than 4 years following project release of more than 50 14.15 percent of the design heated effluent from the project. Annual programs reports shall be prepared by the licensee and submitted to the previously mentioned Federal and State natural resource agencies for their review and comment.

Within 6 months following the close of the 4-year study period, the licensee shall prepare and submit to these agencies a final report of findings for their review and comment. The licensee shall submit this final report, with appropriate corrections or changes, and the comment of and their responses to the Federal and State agencies involved, to the Atomic Energy Commission. If this repo indicates that unacceptable damage has occurred or that there is a question as to the acceptability of the impac AEC, in consultation with the applicant and appropriate agencies, shall decide whether to continue with the studies along established lines or design new studies to be carried out during a subsequent 3-year period. If significant adverse environmental effects occur, appropriate action shall be taken to alleviate the impacts within the shortest practical period of time.

Sect. 14.15

2. No new units shall be added to the project until it has been demonstrated conclusively that operations of Units and 2 have had no significant adverse effects on marine resources.

Sect. 14.1

3. The applicants or their consultants shall meet with participating agencies when necessary to discuss any studies and effect any modifications deemed necessary to the well-being of the natural resources.

We hope these comments will be helpful to you in the prepara tion of the final statement.

Sincerely yours,

Acting Deputy Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (GWS/83)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 426-2262

8 JAN 1973

50-275
50-323

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of 12 December 1972 addressed to Mr. John E. Hirten, Assistant Secretary for Environment and Urban Systems, regarding the draft environmental impact statement and other pertinent papers on the Diablo Canyon Nuclear Reactor Units 1 and 2, San Luis Obispo County, California.

The concerned operating administrations and staffs of the Department of Transportation have reviewed the material submitted. It is our determination that the impact of the project on transportation is fairly minimal. We have no comments to offer and we have no objection to the project.

The opportunity for this Department to review the draft statement for the Diablo Canyon Project is appreciated.

Sincerely,

J. D. Mc[illegible]
Captain, U. S. Coast Guard
Acting Chief, Office of Marine
Environment and Systems

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

50-275
50-323

OFFICE OF THE ADMINISTRATOR

15 FEB 1973

RECEIVED
FEB 16 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental statement for the Diabló Canyon Nuclear Plant Units 1 and 2 and our detailed comments are enclosed.

Our principal concern is with the appropriateness of this draft statement for the consideration of both the continuation of the previously issued construction permit and the issuance of an operating license. The current review should be adequate for considering the potential impact of the continuation of construction. We believe, however, that substantial additional information will be developed by the time the plant is ready for licensing, on which a more accurate final assessment of the environmental impact can be based. The AEC should evaluate such additional information as it becomes available and should determine whether a supplemental review is necessary.

We are pleased to note that the AEC will require the applicant to improve the plant's capabilities to treat steam generator blowdown and to reduce the radioiodine discharges, even though the calculated dose consequences at the receptors are within the guidelines of the proposed Appendix I. We agree with the AEC staff that the potential discharges of radionuclides would be excessive without the indicated improvements and would not be "as low as practicable" since many other similar PWRs have treatment systems which control or reduce these discharges.

We were unable to assess the thermal impact of the once-through cooling system due to the inadequate information presented. We therefore could not determine whether or not the proposed discharges will meet present water quality standards. A more accurate analysis should be presented in the final statement.

Because of the lack of sufficient information in the draft statement to assess the full impact of the proposed Diablo Canyon facility, we have rated the statement "Category 3" in accordance with our review procedures (see category explanation enclosed). We recommend that the additional information identified in the enclosed detailed comments be furnished in the final statement. If you have any questions concerning our comments, we will be pleased to consult with you or members of your staff.

Sincerely,

Sheldon Meyers
Director
Office of Federal Activities

Enclosures

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

FEBRUARY 1973

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Diablo Canyon Nuclear Plant Units 1 and 2

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for the Diablo Canyon Nuclear Plant Units 1 and 2 prepared by the U.S. Atomic Energy Commission (AEC) and issued on December 12, 1972. Following are our major conclusions:

1. We noted in our review that this draft statement has been submitted in support of two proposed actions: (1) the continuation of the construction permit and (2) the issuance of an operating license. It is expected that substantial additional information, which will enable a more accurate assessment of the environmental impact, will be developed by the time the plant is ready for licensing. This additional information is expected to include final system design details,

Sect. 14.1 operating experience at similar large nuclear power reactors, and results of environmental studies. While the current review is adequate for consideration of the continuation of the construction permit, prior to plant operation the AEC should assess the best information then available to determine if the conclusions reached during the current review are still valid, and to determine whether a supplemental environmental review is necessary.

2. We are pleased to note that the AEC will require the applicant to improve the plant's capabilities to treat steam

Sect. 14.6 generator blowdown and to reduce the radioiodine discharges, even though the calculated dose consequences at the receptors are within the guidelines of the proposed Appendix I. We agree with the AEC staff that the potential discharges of radionuclides would be excessive without the indicated improvements and would not be "as low as practicable," since many other similar PWRs have treatment systems which control or reduce these discharges. Sect. 14.6

3. Because of the inapplicability of the thermal modeling procedures used by the applicant and the AEC as described in the draft statement, we are unable to assess the thermal impact of the proposed once-through cooling system. The information presented is inadequate to evaluate whether or not the proposed discharge will meet present water quality standards. We recommend that a more adequate projection of the impact of thermal pollution on the water and the biota be developed. The applicant should be aware of the water quality standards, effluent guideline and intake structure requirements of the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500). Sect. 14.4, 5.5

RADIOLOGICAL ASPECTS

Radioactive Waste Management

Except for the radionuclide discharges resulting from the steam generator blowdown, the radioactive liquid effluents that will be released from Diablo Canyon Units 1 and 2 are expected to be within the guidelines of the proposed Appendix I to 10 CFR Part 50. As indicated in the draft statement, the anticipated radionuclides discharged from the steam generator blowdown systems are excessive (26 Ci/year) and exceed the levels proposed in Appendix I. We are pleased to note that the AEC has implemented the concept of "as low as practicable" through the indicated requirement to improve the radwaste treatment capability for waste associated with the steam generator blowdown, even though the calculated doses, which would result from the estimated discharges, are within the Appendix I guidelines. Thus in consideration of the excessive levels currently predicted and the available technology and present industry practices, we believe that the Diablo Canyon radioactive waste treatment systems should be improved to allow treatment of the steam generator blowdown.

Sect. 3.4.1

The draft statement did not include estimates of the quantities of radionuclides which might be discharged from the turbine building drains in the event of significant primary-to-secondary steam generator leakage in combination with reactor fuel failures. While the concentrations of radioactivity can be expected to be small,

Sect. 3.4.1

ompared to other sources, operational experience has indicated the eakage may be significant - in the range of a few gallons per inute. The final statement should provide estimates of the adionuclides expected from this leakage and the bases for these stimates. Furthermore, the final statement should provide ssurance that the releases from these drains will be monitored and ampled prior to release to the environment.

Sect. 3.4.1

Sect. 14.15

The doses from noble gas discharges from Diablo Canyon should be ithin the dose guidelines of the proposed Appendix I to 10 CFR Part 0. The iodine-131 releases, however, could conceivably result in ff-site concentrations as much as two orders of magnitude (at 2,800 eters) greater than those given by Appendix I, which are for pplication at the site boundary (800 meters). The concentration at he site boundary would be substantially greater than at 2,800 eters. We agree with the AEC that design changes to reduce the otential radioactive iodine discharges from the auxiliary building nd the steam generator blowdown vent are warranted. We note that any similar modern PWR facilities have provisions for treating nd/or eliminating the iodine discharges from these sources; thus, pparently such control measures are practicable.

Sects. 5.4.4, 5.4.5

ose Assessment

The draft statement failed to present the calculated potential ose consequences at the site boundary. We agree that it is ealistic to calculate the consequences at the nearest receptor or

Sect. 14.13.5

from critical pathways where they occur. However, if credit is allowed for atmospheric dispersion of the gaseous effluents, as would be attainable for doses calculated at the receptor beyond the site boundary, then reasonable measures should be implemented to document, periodically, that the actual critical receptor or pathway does not move closer to the point of maximum potential dose. This has not been addressed in the draft statement. The final statement should discuss a surveillance program which will document any changes that occur in the dose pathways and should provide dose estimates at the point of maximum off-site dose. If no such surveillance program is contemplated, the limiting doses should be applied at the critical site boundary.

Sect. 14.15

In making an independent estimate of the gaseous discharges of radioiodine from this facility, we could neither resolve the differences between our estimates and those of the AEC nor justify some of the assumptions made by the AEC staff. The differences in the estimated releases may be associated with the source terms; however, since the draft statement does not provide the primary coolant concentrations assumed by the AEC as a starting point, it is not possible to verify this. The two major sources of radioiodine appear to be from evaporator vents and the steam generator blowdown tank vent. The assumptions used in estimating the iodine release from plant evaporators are not provided, and furthermore, since this source has not been included in previous environmental statements,

Sects. 3.4.1, 3.4.2

he assumptions are not available from previous reviews. Similarly, he rationale for assuming a 50% removal of the radioiodine by the team generator blowdown sample cooler is apparently unique to this lant. Yet, it is not apparent that the steam generator blowdown ystem for Diablo Canyon is different from those for similar PWRs. Sects. 3.4.1, 3.4.2

Based upon a 2 Ci/year iodine-131 source term and a X/Q of 1.9 x 0 $^{-7}$ sec/m ^{3} at 5 miles NNW of the site, we arrive at a higher hild's ingestion dose rate than the estimate presented in the tatement. We assumed that cows were on pasture for only 6 months f the year and estimated a dose rate to a one-year-old child's hyroid of approximately 20 mrem/year at a location 5 to 6 miles NNW f the site. Since our calculations for other distances were in lose agreement with those of the AEC, we suggest that the AEC eview their dose estimate for this distance. Assurance should be iven that an individual thyroid dose rate will not exceed 5 rem/year for any individual located beyond the plant property oundary. Sects. 5.4.4, 5,4.5

The final statement should address these points and provide the dditional information and/or clarification requested. While the nformation will probably not result in any change in our onclusions as to the acceptability of the environmental impact from he plant operations, we expect that possibly the desirability of dditional iodine control systems will be reinforced by the nformation.

Transportation and Reactor Accidents

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: (1) those involving transportation of spent fuel and radioactive wastes and (2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants required as a result of the investigations could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course. make our concerns known.

The statement concludes "... that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

Environmental Monitoring

Little information is given on the preoperational radiological monitoring program and nothing is mentioned about the planned operational program. EPA has recently published a document entitled "Environmental Radioactivity Surveillance Guide" which contains detailed information which should assist the applicant in planning and conducting a minimum level of environmental surveillance. Our Sect. 14.15
review indicated that the existing program has several deficiencies, if it is to be used as an operating program: (1) the air particulate stations do not include provisions for iodine monitoring; (2) the milk samples are taken only quarterly at two dairies, neither being the one assumed to be most sensitive (on page 5-60 of the draft

statement); (3) at present the milk samples often are not gamma scanned until several weeks following collection; thus, detection sensitivity is reduced; and (4) no edible meat samples are taken from animals grazing on nearby range land.

The operational monitoring program should correct these deficiencies. Also, TLD stations should be established at locations which could measure radiation from waste shipments, particularly at the railroad transfer location. Beach sand samples should be taken annually or biennially at Avila Beach to see if buildup of long-lived radioactivity is occurring.

NON-RADIOLOGICAL ASPECTS

Thermal Effects

Diablo Canyon Units 1 and 2 consist of two pressurized water reactors which will produce an electrical output of 2300 MWe. Condenser cooling will be accomplished by means of a once-through system with a shoreline intake (1,734,000 gpm) and a shoreline discharge. The intake and discharge structures are located in adjacent coves on the coast of California.

We do not believe that the thermal models of either the applicant or the AEC adequately predict the characteristics of the thermal discharge plume. The modeling procedures used by both the applicant and the AEC assume an infinite quantity of unheated dilution water at the point of discharge, but we do not think this requirement will be satisfied. According to the draft statement, the tidal currents produce relatively little flushing action in the discharge cove, and the volume change of water in the cove due to tidal action is only about four percent of the condenser discharge of 1,734,000 gpm. As a result, we expect the water temperature of the entire cove to build up considerably above that of the ambient ocean temperature. Under such conditions, the cove might be regarded as a continuation of the cooling water discharge system with the final outfall at the mouth of the cove. Therefore, all analyses based on the assumption of infinite cooling water being

Sects. 3.3.3, 14.4

available at the point of thermal discharge within the cove become inapplicable.

Since the validity of the plume analyses are seriously

Sect. 5.5 questioned, we do not feel that we can adequately evaluate the extent to which the thermal discharge conforms to applicable water quality standards.

We recommend that the applicant develop an adequate model of the

Sect. 14.4 thermal discharge. It is most likely that a physical model will be necessary to properly predict the impact of the thermal discharge. This should be discussed in detail in the final statement.

The thermal modeling in the draft statement is also the basis for the determination of the environmental effects which in turn

Sect. 14.4 influence the evaluation of alternative cooling systems. We recommend that reevaluation of alternative cooling systems be conducted on the basis of adequate thermal discharge studies and discussed in the final statement.

Information is inadequate to evaluate whether or not the proposed discharges will meet present water quality standards.

Sect. 5.5 However, the applicant should be aware of the water quality standards, effluent guidelines, and intake structure requirements of Public Law 92-500.

Biological Effects

Until adequate analysis has been made of the thermal discharge, it will not be possible to determine the impact of this discharge on the marine biota.

The intake structure should be described in more detail with specific emphasis on the velocity of water entering the intake cove. In addition, further information should be supplied in the final statement to support the AEC contention that less than 10 pounds of fish will be lost annually at the intake structure. Sects. 3.3.2, 5.3.2

Chemical Effects

The projected chemical effluent concentrations of the plant are well under the maximum concentrations permitted by the applicable, federally approved water quality standards. There is every indication that these standards will be satisfied.

According to the draft statement, condenser defouling will be accomplished by chlorination and thermal shock (recirculation of hot condenser cooling water). Alternatives to these methods are "on-load" tube cleaners such as circulating plastic balls (example: Amertap) and plastic bristle brushes which shuttle through the condenser tubes by reversal of water flow. The draft statement does not explain why the "thermal shock" and chlorination procedures are chosen in preference to the mechanical procedures. The final statement should more fully explain the rationale of the choice of these defouling procedures. Sect. 12.3.4

<u>Air Quality Effects</u>

The draft statement does not indicate what type of unit will be utilized to provide start-up pressure and/or space heating; therefore, the final statement should provide the following information:

Sects. 3.3.4, 5.2.2

1. type of unit;
2. type of fuel including where applicable, sulfur content, BTU rating and fuel use rate;
3. number of hours per annum of operation;
4. estimated emission of air pollutants (particulates, SO_2 and NO_x); and
5. location and duration of peak downwind concentrations.

Also, the final statement should describe the methods which will be employed to control particulate emissions from the on-site concrete batch plants.

Sect. 5.3.1

The AEC staff's position that ozone produced by high voltage transmission lines will not lead to any significant adverse ecological effects is premature. There is not enough information available concerning ozone production by high voltage transmission lines and the interaction of ozone with the environment to justify concluding that there is no problem. Due to the generic nature of the potential problem of ozone produced by high voltage transmission lines, the details of our concerns are being prepared for transmission to the AEC under separate cover. Efforts to evaluate the potential environmental effects of ozone produced by high voltage transmission lines should be pursued by the AEC and the results applied to each facility, recognizing that the severity of potential effect may be very dependent on the existing air quality.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the draft statement did not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Diablo Canyon Nuclear Plant Units 1 and 2. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following topics were discussed in the final statement.

1. The draft statement estimates that 1000 drums/year of solid waste will be produced but it is unclear whether the quantity of radioactivity included is 5 Ci/year (as stated) or 5 Ci/drum, which is more typical. Also, the draft statement uses the applicant's estimate of the number of shipments/year (2) which is based on their estimate of 300 boxes and 40 barrels per year for both units. These discrepancies may have a significant effect on the calculated population doses and need to be clarified. Also, the bases for the AEC estimates should be presented including all pertinent details regarding sources. Sect. 3.4.3

2. The estimated doses to workers involved in loading the shipments onto railroad cars appear reasonable. However, there is no discussion of the location of this transfer point (it is apparently in San Luis Obispo), its proximity to populated areas, or whether it is appropriate to carry out such an Sect. 14.18

Sect. 14.18 operation at this location. Also, the population dose at this transfer point should be estimated.

3. The transient population apparently was not included in the dose estimates for immersion in the radioactive plumes. There are about 3 million visitor days at parks within 10 miles of the site, which may be equivalent to a permanent population of

Sect. 14.13.7 several thousand (depending on the assumptions used). Also, the dose to on-site construction workers (for Unit 2) was not considered. For the latter, the direct radiation sources should be included.

Sect. 14.13.8 4. The draft statement did not discuss possible population doses from crops. While this pathway is probably not very important, it warrants some mention.

Sect. 5.3.2 5. A determination should be made of any impact that the thermal plume might have on the migrating habits of the abalone.

Sect. 5.3.2 6. A discussion of the entrainment of abalone and macroalgae in the cooling water intake should be included.

Sect. 14.9 7. The final statement should specify whether or not demineralizer regenerants will be neutralized prior to discharge or whether the seawater has sufficient buffering capacity to prevent large variations in pH of the thermal plume due to these unneutralized regenerants.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

APR 11 1973

r. Daniel R. Muller
ssistant Director for
Environmental Projects
irectorate of Licensing
. S. Atomic Energy Commission
ashington, D. C. 20545

ear Mr. Muller:

This is in reference to your letter dated December 12, 1972, requesting omments on the AEC Draft Environmental Statement related to the proposed ontinuation of the construction permits and the issuance of an operating icense to the Pacific Gas and Electric Company for the Diablo Canyon nits No. 1 and No. 2 (Docket Nos. 50-275 and 50-323).

Pursuant to the National Environmental Policy Act of 1969, and the pril 23, 1971, Guidelines of the Council on Environmental Quality, these omments review the need for the facilities as concerns the adequacy and eliability of the affected bulk power systems and matters related thereto.

In preparing these comments, the Federal Power Commission's Bureau of ower staff has considered the AEC Draft Environmental Statement; the Applicant's nvironmental Report and Supplement thereto; related reports made in response o the Commission's Statement of Policy on Reliability and Adequacy of lectric Service (Order No. 383-2); and the staff's analysis of these documents ogether with related information from other sources. The staff bases its valuation of the need for a specific bulk power facility upon long-term onsiderations as well as the load supply situation for the peak load period mediately following the availability of the facility.

ed for the Facility

The Pacific Gas and Electric Company's Diablo Canyon Nuclear Generating ation Units No. 1 and No. 2 are substantially identical 1,060-megawatt ressurized-water reactor generating units. Unit No. 1, originally scheduled r commercial operation in May 1972, has been delayed and is presently heduled for March 1975. The 34-month delay will make the unit unavailable r the 1972-74 summer peak load periods. It is now expected to be available time to assist in meeting the 1975 summer peak loads. Unit No. 2, originally heduled for commercial operation in July 1974 has also been delayed and is esently scheduled for March 1976. The 20-month delay will make the unit unavailable for the 1974 and 1975 summer peak load periods, but it should be available for the 1976 summer loads. The following report of the Bureau of Power staff considers the need for Unit No. 1 to meet the 1975 summer peak load responsibility and for both Units No. 1 and No. 2 to meet the 1976 summer peak load responsibility.

Within the Pacific Gas and Electric Company's (PG&E) service area boundaries are power system facilities owned by others. These facilities, together with the PG&E system, form what is referred to as the PG&E area system. Data for the PG&E area system is reported by the Western Systems Coordinating Council's (WSCC) Pacific Southwest Power Area - D (IV-D) in the WSCC Response to Commission Order 383-2. This area system includes the Sacramento Municipal Utility District (SMUD), the U. S. Bureau of Reclamation's Central Valley Project (CVP), excluding its pumping loads served from Bureau lines and the generation capability used to serve such loads, part of California's State Water Project, the City and County of San Francisco system and, in part, the Modesto and Turlock irrigation districts. All of these agencies have generati and transmission facilities. SMUD, Modesto and Turlock also have distributio systems. The area system also includes agencies and districts that sell the entire output of their generating facilities to PG&E. These include East Bay Municipal District, Placer and Yuba County water agencies, and the Merced, Nevada, Oroville-Wyandotte, Oakdale and South San Joaquin irrigation district The area system also includes Municipal Systems and other entities that have only distribution systems; their power is supplied by the area system. Hence the effect of a delay in the completion of Diablo Canyon Units No. 1 and No. must be considered from the area standpoint since all electric utilities in northern California are interconnected and PG&E is the area's major supplier.

PG&E estimates loads, plans resource additions, and conducts operations for the entire area system. Resource additions planned by other agencies wit the area for their load requirements are taken into account by PG&E in determining the amount of additional resources and type of capacity that must be constructed to meet area system load and reserve requirements.

The current generation expansion program of the PG&E area system through 1977 is tabulated below:

Mr. Daniel R. Muller

GENERATION EXPANSION PROGRAM
PG&E AREA SYSTEM

Estimated Commercial In-Service Date	Station	Type 1/	Capability
Summer 1973	Geysers No. 9	G	53.0
Fall 1973	Geysers No. 10	G	53.0
Fall 1973	Rancho Seco No. 1 2/	N	830.0
Summer 1974	Geysers No. 11	G	106.0
Fall 1974	Melones (Retired)	H	(13.3)
Fall 1974	S.F. (G.T.) No. 1	GT	50.0
Spring 1975	S.F. (G.T.) No. 2	GT	50.0
Spring 1975	Diablo Canyon No. 1	N	1,060.0
Summer 1975	Geysers No. 12	G	106.0
Spring 1976	Diablo Canyon No. 2	N	1,060.0
Summer 1976	Geothermal	G	106.0
Fall 1976	Geothermal	G	106.0
Fall 1976	S.F. (G.T.) No. 3	GT	50.0
Spring 1977	S.F. (G.T.) No. 4	GT	50.0
Summer 1977	Geothermal	G	106.0
		TOTAL	3,772.7

1/ Type: G - Geothermal, GT - Gas Turbine, F - Fossil, H - Hydro, N - Nuclear

2/ Owned by Sacramento Municipal Utility District.

The PG&E area system load is the total electric demand measured at the generating units of all entities within the area system with adjustments for the net interchange of power with interconnected systems outside the area system. The area system total capacity resources are estimated for the critical peak load month of August on the basis of the water supply of the most adverse year to date.

The following tabulation shows the electric system loads to be served by the PG&E area system, and the relationship of the electrical output of the Diablo Canyon Units No. 1 and No. 2 to the available reserve capacities on the summer-peaking Applicant's area system at the time of the 1975 summer and 1976 summer periods. These are the anticipated initial service periods of the units but the life of each unit is expected to be some 30 years or more, and they are expected to constitute a significant part of the Applicant's total generating capacity throughout that period. Therefore, these units will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

Mr. Daniel R. Muller

FORECAST 1975 SUMMER PEAK LOAD-SUPPLY SITUATION

	PG&E Area System
Conditions with Diablo Canyon Unit No. 1 (1060 Megawatts)	
Net Dependable Capacity - Megawatts	15,566
Net Peak Load - Megawatts	12,849 1/
Reserve Margin - Megawatts	2,717
Reserve Margin - Percent of Peak Load	21.1
Conditions without Diablo Canyon Unit No. 1	
Net Dependable Capacity - Megawatts	14,506
Net Peak Load - Megawatts	12,849 1/
Reserve Margin - Megawatts	1,657
Reserve Margin - Percent of Peak Load	12.9
Reserve Margin Needs Based on 20 Percent Criterion - Megawatts	2,570
Reserve Margin Deficiency - Based on 20 Percent Criterion - Megawatts	913

1/ Reduced by 550 megawatts net firm purchases from Pacific Northwest.

FORECAST 1976 SUMMER PEAK LOAD-SUPPLY SITUATION

	PG&E Area System
Conditions with Diablo Canyon Units No. 1 and No. 2 (2,120 Megawatts)	
Net Dependable Capacity - Megawatts	16,780
Net Peak Load - Megawatts	13,731 1/
Reserve Margin - Megawatts	3,049
Reserve Margin - Percent of Peak Load	22.2
Conditions without Diablo Canyon Units No. 1 and No. 2	
Net Dependable Capacity - Megawatts	14,660
Net Peak Load - Megawatts	13,731 1/
Reserve Margin - Megawatts	929
Reserve Margin - Percent of Peak Load	6.8
Reserve Margin Needs Based on 20 Percent Criterion - Megawatts	2,746
Reserve Margin Deficiency - Megawatts	1,817

1/ Reduced by 543 megawatts net firm purchases from Pacific Northwest.

The resources of the utilities in the PG&E area system are planned to meet both of the following reserve criteria:

1. Reserves after scheduled maintenance must be greater than the two largest units in service.

2. A probability analysis of the loads and resources under pooled operation must provide reliability such that load will not exceed capacity more than one day in ten years. The corresponding reserve has been calculated to be approximately 20 percent of peak load.

In the foreseeable future, the 20 percent reserve criterion will govern.

The availability of Diablo Canyon Unit No. 1 for summer 1975 would provid the Applicant with an expected system reserve margin of 2,717 megawatts or 21. percent of peak load. However, should additional delays result in the unavail ability of Diablo Canyon Unit No. 1 for the 1975 summer peak period, reserves would be reduced to 1,657 megawatts or 12.9 percent of peak load, resulting in a reserve margin deficiency of 913 megawatts based on the minimum reserve criterion of 20 percent of peak load.

With respect to the 1976 summer peak load period, the availability of the Diablo Canyon Units No. 1 and No. 2 would provide a reserve margin of 3,049 megawatts or 22.2 percent of peak load. If the capacity of the Diablo Canyon Units No. 1 and No. 2 is not available as scheduled, system reserves would be reduced to 929 megawatts or 6.8 percent of peak load, or an overall deficiency of 1,817 megawatts based on the minimum reserve criterion of 20 percent of peak load.

PG&E is currently purchasing 833 megawatts from utilities in the Pacific Northwest. These purchases will decrease to 550 megawatts and 543 megawatts i 1975 and 1976 respectively, because the power will be needed in the Northwest PG&E is currently negotiating for additional summer-peaking capacity from the Northwest, and reports that without the Diablo Canyon units as scheduled in the period 1975-76, even with an additional 300 megawatts of emergency suppor the system's reliability does not meet the reserve margin criterion as stated

The adequacy and reliability of the PG&E area's system in 1975 and beyon is not only dependent upon the timely operation of the Units at Diablo Canyon but also upon the scheduled installation and continued operation of other generating units. In the PG&E area system there are approximately 225 generating units.

Transmission Facilities

The Applicant states the necessary transmission line additions required for the Diablo Canyon Plant include: a single-circuit 500-kilovolt transmission line, approximately 79 miles in length from the station to the existing Gates Substation; two single-circuit 500-kilovolt transmission lines approximately 84 miles in length from the Station to the existing Midway Substation; and a double-circuit 230-kilovolt transmission tap line from the Station to the existing Morro Bay-Mesa 230-kilovolt transmission system. The transmission line additions will deliver the output of Diablo Canyon Station to the PG&E transmission system.

The Applicant states the routes of the transmission lines associated with the Diablo Canyon Station have been approved by the California Public Utilities Commission and by the counties crossed by the lines. The Applicant also states the existing right-of-way and tower structures were carefully selected to minimize their resulting impact on the environment.

Alternates to the Proposed Facilities

The Applicant, in determining the need for additional generation to meet its projected loads, considered a number of alternatives including, location, type (base-load and peaking), fuel (nuclear, coal, oil or gas), geothermal, purchases of power, environmental effects, and economics. Much of PG&E's hydroelectric capacity is low capacity factor power which is used principally for peaking service. System requirements and economic considerations led to the selection of a nuclear-fueled station to provide baseload generation. The Applicant did not provide comparative cost studies of alternative plants. The nuclear-fueled plant serves to conserve fossil fuel resources, some of which are in short supply, and eliminates the problems of air pollution associated with fossil fuels.

A geothermal source equivalent to the Diablo Canyon Units would have to provide energy averaging approximately 14,860,000 megawatt-hours annually for 30 years at a rate of some 2,120 megawatts. In addition to decisions regarding the significant environmental aspects involved in the exploration of such a source, if it were to be found in the Applicant's service area, a number of engineering tests, evaluations, and decisions would be required. At present the effects of such large-scale depletion of underground steam sources are unknown. The Bureau of Power staff realizes that the geothermal resources are depletable and that until further reliable data concerning geothermal resources and their utilization are available, it would not be prudent to depend on geothermal energy to meet the baseload requirements indicated.

Mr. Daniel R. Muller

Conclusions

The staff of the Bureau of Power concludes that the electric power output represented by the Diablo Canyon Units No. 1 and No. 2 is needed to implement the PG&E area systems generation expansion program for meeting projected loads and to provide some reasonable measure of reserve margin capacity for the 1975 and 1976 summer peak load periods.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

LIVERMORE, JR.
RETARY

nservation
ish and Game
avigation and
ment
arks and Recreation
ater Resources

RONALD REAGAN
GOVERNOR OF
CALIFORNIA

A14-1-57

50 - 275
50 - 323

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

Air Resources Board
Colorado River Board
San Francisco Bay Conservation and Development Commission
State Lands Commission
State Reclamation Board
State Water Resources Control Board
Regional Water Quality Control Boards

THE RESOURCES AGENCY OF CALIFORNIA

SACRAMENTO, CALIFORNIA

APR 3 1973

Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Attention: Mr. Daniel R. Muller

Gentlemen:

The State of California has reviewed the Draft Environmental Statement related to the continued construction and proposed issuance of an Operating License for the Diablo Canyon Units 1 and 2 for Pacific Gas and Electric Company, Dockets Nos. 50-275 and 50-323, which had been submitted to the Office of Intergovernmental Management (State Clearinghouse) within the Governor's Office. This review fulfills the requirements under Part II of the U. S. Office of Management and Budget Circular A-95 and under the National Environmental Policy Act of 1969.

The Draft Environmental Statement was reviewed by the State Departments of Commerce, Conservation, Fish and Game, Food and Agriculture, Housing and Community Development, Justice, Navigation and Ocean Development, Parks and Recreation, Public Health, Public Works (Division of Highways), and Water Resources; State Water Resources Control Board; Reclamation Board; Air Resources Board; and Public Utilities Commission. The State's general comments are given in the following paragraphs, and specific comments are attached.

The Statement gives the impression that the conclusions were based on well-studied environmental impacts. Additional evidence must be presented to support some of the conclusions. Modification of the Statement is necessary in order to set forth clearly the predicted effects of the discharge and to identify areas where additional data are needed to quantify completely the impact of the proposed plant operation.

Principal sections that should be presented with more precise information are: the thermal plume predictions, including the temporal and spatial effects in the receiving waters during both normal operation and heat treatment for the control of fouling organisms; the impact of entrainment in terms of number of biomass of marine fauna killed; the effect of chemical additions on aquatic life; and an assessment of the cost of the project in terms of modification in marine life.

The staff should recognize that many predicted conclusions on ecological costs are not really known and that the entire problem needs to be examined with appropriate onsite studies and all data requirements identified.

Therefore, we recommend that the Statement be redrafted to take into account our comments and recommendations.

The attached pages of specific comments are an integral part of this letter. Thank you for the opportunity to review this Draft Environmental Statement.

Sincerely yours,

N. B. LIVERMORE, JR.
Secretary for Resources

By Paul L. Clifton

Airmail
Attachment

SPECIFIC COMMENTS
DRAFT ENVIRONMENTAL STATEMENT
Diablo Canyon Units 1 and 2

e 2-29, Item: Seismology. It is said that the maximum earthquake that ht disturb the Diablo Canyon Nuclear Reactor Powerplant site could cause round acceleration of 0.20 g at the site. A 1:1,000,000 scale map showing imum peak accelerations to be expected in bedrock throughout California prepared in December 1972 by the California Division of Mines and Geology the request of the Division of Highways. This generalized map indicates aximum peak acceleration of 0.28 ± 0.10 g for the Diablo Canyon area. The 0 g ground acceleration used in the Draft Environmental Report thus appears be an appropriate order of magnitude of ground shaking to be expected at reactor site. Sect. 14.3

e 2-49, Paragraph 3. The first sentence should be clarified as follows: ch of the bottom deeper than 20 feet is composed of flat bedrock, boulders, ble, and sand in all mixtures, and therefore does not provide the necessary lone habitat". It should be emphasized that the areas within the cove ch are less than 20 feet in depth provide extremely important habitat for lone. Sect. 2.7.2

e 2-51, Figure 2.16. It was stated that this figure presents a list of h commonly taken in rocky bottom habitats in the Diablo Canyon area. ever, this figure was quoted from a Department of Fish and Game publication, h Bulletin 130, where it was intended as a general description of species ompassing many areas along the coast. The following species changes need be made if this figure is to apply to the Diablo Canyon area: Fig. 2.16

Shallow Rock - Remove jacksmelt and walleye surfperch; insert striped perch and black perch.

Kelp Bed - Remove jacksmelt, insert pile perch, striped perch, black perch, and vermilion rockfish.

Shallow Reef - Remove canary rockfish, brown rockfish, rosy rockfish, yellowtail rockfish, and turkey-red rockfish.

In addition, juvenile rockfish of several species extend from the Shallow Rock through the Shallow Reef zones. Those species listed for the Deep Reef should be considered as a general list because specific information on their presence in the Diablo Canyon area is not available. This figure should be referenced as "modified from California Department of Fish and Game, Fish Bulletin 130". Sect. 2.7.2

s 3-20 and 3-21, Item: Staff's Thermal Model and Maximum Thermal Plume. egard to the area of the 10°, 4°, and 2° isotherm plumes, the first sentence he second paragraph states: "The staff believes that these results are onable for average conditions". We would like clarification as to what considered an "average" condition. It was further stated that no allowance made for ocean currents because the currents of the region are entirely Sect. 14.4 and 14.5

unpredictable. This statement is not entirely correct; currents in the regi are somewhat predictable during the Oceanographic Seasons.

In assuming the "worst case" of a southerly current (southerly direction), i appears that part of the basis for this assumption is the attendant danger c recirculation in the south cove. However, there is no prediction of a condi
Sect. tion for a current in the northerly direction bending the plume into the nor
14.5 cove. This condition could occur during the Davidson Season. We would like
and to see thermal plume predictions for both north and south currents together
3.3.3 with tidal and wind conditions. While the maximum thermal plume as shown in Figure 3.9 may occur under completely calm conditions with no current, wind or tidal action, we feel it is an unrealistic prediction of the actual exten of the plume for all conditions. The extent of the various isotherm plumes extending along the nearshore areas needs to be presented in the thermal model, and appropriate figures prepared.

Page 4-15, Item: Breakwater Construction in South Cove. With regard to the statement that "the harbor seals will return to the area when construction i
Sect. completed", it should be pointed out that construction of the breakwater has
4.3.2 been completed for quite some time and no significant return of the harbor seals has occurred to date. The possibility that the displacement of harbor seals may be permanent should be recognized.

Page 4-17, Item: Aquatic Impact (Marine Environment). The second sentence stated that 'some siltation has been observed; however, the small amount of silt observed during a subtidal survey on April 3, 1972, suggests that wave action has carried most of the silt out of South Cove and dispersed it in
Sect. the adjacent ocean area". Information from a diving survey by the state
4.4.2 personnel during March and April 1972 did not support this statement. (See Final Report, Burge and Schultz, "Marine Environment in the Vicinity of Diablo".) Their analysis indicated that the sloughing and siltation from the coffer-dam had badly degraded the environment. Sediment buildup of up to 16 inches was noted in some areas, while the rocky reefs had up to 4 inches of silt. It was concluded that the siltation from the breakwater construction was still apparent and that it had caused a major effect throu destruction of habitat. This impact should be recognized.

Page 5-14, Item: Chlorine. The first paragraph discusses the effect of ex sive use of chlorine where chlorine levels of 5.0 ppm have been measured in discharge. However, other studies have shown the same effects at concentra similar to those proposed at Diablo. For example, chlorine when used at co
Sect. trations considerably below those required to control fouling had deleteric
5.3.2 effects on entrained phytoplankton. (See Carpenter, Peck, and Anderson, 19 "Cooling Water Chlorination and Productivity of Entrained Phytoplankton", Marine Biology 16, 37-40.) Phytoplankton are apparently very sensitive to the action of chlorine.

The chlorine toxicity information presented in Table 5.8 indicates that mar organisms are highly variable in their response to chlorine. In the refere to Waugh (1964), it was not listed in the table that a concentration of 0.5 for a 10-minute exposure caused heavy mortality for barnacle nauplii. No information is available on the effect of chlorine on abalone adults or lar on other invertebrates common to the Diablo Canyon area. In addition, orine toxicity to marine fish and their larvae has not been studied ensively. Recent information indicates that a concentration of 0.01 ppm the level where fish in the receiving water are no longer affected.

itional information in the literature indicates that the concentrations chlorine used at Diablo Canyon may be lethal to some forms of marine life. itional onsite studies will be necessary in order to determine the acute chronic impacts on both the entrained and receiving water marine life. appears that chlorine at concentrations necessary for the control of anic growths could have adverse effects. This should be recognized in Statement. Sect. 6.3

e 5-14 through 5-17, Item: Copper. It was stated that the staff expects adverse effects from releases of copper into the environment. This conclu- n was based on the information presented concerning natural occurring per concentrations in Florida and the effect of copper on marine organisms ble 5.9). If natural concentrations are to be quoted, values for the ocean er off California should be used, rather than those off Florida where natural els could be higher. It also appears that the green abalone, as well as er species, are sensitive to the effect of copper. The data presented in le 5.8 for marine invertebrates are based on relatively short-term tests in which only mortality was considered. The long-term chronic effects of levels of copper are not well documented, and the potential for buildup the food chain should be considered. This potential impact should be ognized. Sect. 5.3.2

long-term effects of copper, as well as other heavy metals, in the environ- t cannot be adequately assessed with the information presented. Additional ite monitoring in the environment for copper and the other heavy metals eased by the plant should be included in the monitoring program. Sect. 6.3

e 5-24, Figure 5.2. This figure shows the anticipated discharge plume in ation to zones of plant growth. This projection appears to be for calm litions, as were the previous projections for isotherms. Under varying rent, wind, and tidal conditions, the anticipated plume may extend to ferent areas, including the important nearshore abalone zone. At times 4°F isotherm could encompass the entire cove. Sect. 14.5 and 3.3.3

icipated plumes under other conditions should be presented. In addition, ification should be provided as to how and where natural sea surface peratures will be determined in order to predict the various isotherm zones. Sect. 14.4

e 5-25, Table 5.14. This table should be titled "Thermal Tolerance Limits Various Marine Phytoplankton, Algae, and Marine Plants". Eleven species of e and marine plants are listed in the table. Sect. 5.3.2

e 5-27, Item: Periphyton. In discussing the intake cove temperatures at blo Canyon, the expected daily lows of 45°F during March and highs of 63.5°F the late summer and fall may be infrequent. These were the recorded minimum maximum temperatures and may not occur daily during these periods. In tion, localized temperatures may vary and at times may be below or above emes recorded to date. Sect. 5.3.2

If the assumptions that only a small area of bull kelp would be affected or that no impact would be seen were based on the anticipated plumes presented previously, we question these projections unless currents, wind, and tidal action are included.

Page 5-28, Item: Invertebrates, (a) Zooplankton. In discussing the studies
Sect. of delayed mortality to zooplankton, it should be noted that the results were
5.2.3 from one 24-hour test. We feel that additional studies are necessary before
conclusions about delayed mortality to zooplankton can be made.

The conclusion of the staff that the impact on zooplankton will be insignifi-
cant needs to be clarified. The impact on pelagic holoplankton that have shor
Sect. generation times may be insignificant. However, this may not be true for
5.2.3 meroplankton (eggs and larvae of fish and invertebrates). Species that spawn
only once during the year would have eggs and larvae only during certain seas
Large numbers of meroplankton could become entrained during these periods,
which could result in a significant impact for some species.

Page 5-34, Item: Benthic Communities. In the first paragraph it was stated
that "the staff concludes that the impact on benthic communities at Diablo
Canyon will be similar to that at Morro Bay, where an increase in warm water
tolerant forms was observed in the small transition area". We agree that the
Sect. will be a replacement in the transition zone; however, many species listed in
5.2.3 Table 5.18 for Morro Bay were not found at the Diablo Canyon site. This was
true not only for benthic species, but also for fish and algae. For example,
not one species of Sebastes was listed in Table 5.18 for Morro Bay, while at
Diablo Sebastes were the most abundant. Several of the more important brown
algae, serving as food for abalone, were not found at Morro Bay. The differ-
ence between the two sites and the possibility of different types of impacts
should be recognized.

The last paragraph on Page 5-34 gives the impression that Burge and Schultz
suggested that intermediate depths from 10 to 50 feet might be the most
Sect. important for red abalone. This was not true. Burge and Schultz suggested
5.2.3 that the nearshore area from 0 to 20 feet was the most important area for the
red abalone and that smaller beds were found in depths of 20 to 50 feet. It
should be noted that Station 16 was representative of the 5- to 10-foot zone.

Page 5-39, Paragraph 2. In discussing the loss of 70,000 abalone from the
cove, we assume this estimate was based on transect data of visible abalone.
Sect. Juveniles and those hidden from view could increase this estimate substan-
5.2.3 tially. In addition, this estimate was based on the assumption that half
the cove would be altered. If the entire cove were altered, losses would be
considerably greater. Additional thermal plume projections should be done
to provide information for assessment of the impact of the cove and adjacent
areas.

Sect. This projected loss only considers direct mortality from high temperature an
6 losses through reduction in algae. Other aspects, such as the effect on
reproduction or physiology, have not been considered.

ge 5-41, Item: Fish, (a) Fish Eggs and Larvae. The use of data from CalCOFI ations to compare with Diablo Cove can be questioned. Because CalCOFI staons are offshore stations, the species involved would be different. A comrison of Tables 5.20 and 5.21 shows that the northern anchovy is the only rectly comparable species. While Sebastes are common to both, the larval sh from the open ocean station may be species inhabiting the deeper waters. st of the Sebastes listed for the Diablo area spawn nearshore. In addition Sebastes, which produce live young, others such as the cabezon have adhesive gs that attach to nearshore rocks. Direct qualitative and quantitative mparisons cannot be made between the nearshore and offshore areas.

addition, we question the mortaility figures for entrainment based on the timates of zooplankton. Eggs and larvae of fish are softer than crustacean oplankton. Mortality from abrasion, turbulence, or changes in pressure uld be much greater for the softer forms. A recent study indicated that rvival of entrained young fish was zero at 30°C, while at temperatures of °C, and 22°C, 50 percent and 35 percent mortalities were recorded. arcy, B. C., Jr., 1971, "Survival of Young Fish in the Discharge Canal a Nuclear Power Plant, J. Fish Res. Bd. Canada, 28: 1057-1060.) Sect. 5.3.2

do not agree with the evaluation of the expected loss of larval fish as esented. The impact on eggs and larvae of fish could be much greater and y affect recruitment to local populations of fish in the Diablo Canyon area. site studies on entrainment will be necessary in order to adequately assess e losses. The discharge plume may also alter the nearshore nursery areas r some species. We recommend that this entire section be reevaluated. Sect. 6.2.2

ge 5-43, Item: Fish, (b) Juvenile and Adults. The reference to the species Table 5.22 as being representative of those at Diablo Canyon (Table 5.21) not true. The thermal tolerance of the species at Diablo Cove has not been aluated. For example, nine species of Sebastes were listed from Diablo Canyon ile the only Sebastes species in Table 5.22 was not found at Diablo Canyon. comparison of the two lists shows few similarities, and it should be recogzed that the thermal tolerances for species in the Diablo area are not known. Sect. 5.3.2

ne adverse effects would be expected through the entrainment of small fish le to pass through the intake screen. (Reference is again made to Marcy, 71.)

eference to the statement that jacksmelt would become more abundant should given. This species is not presently found in the area, and other species ht be expected to become more abundant than jacksmelt. Those attracted to Morro Bay discharge (Table 5.18) should be considered for the Diablo yon area. Sect. 5.3.2

ge 5-43, Item: Heat Treatment for Defouling the Conduits. We would like rification and documentation on the expected loss of "3.57×10^3 lb/yr of plankton and 5.9×10^6 larval fish/yr within the cove", and on how these ues were derived. Sect. 5.3.2

Page 5-48, Item: Mechanical Effects. Documentation is needed for the stat that "losses less than 10 pounds per year will result from mechanical damag the intake". Differences in swimming ability should be considered when mak estimates using data from other powerplants. Anadromous fish may be more successful in escaping intake velocities than many nearshore marine fish. Mortalities for nearshore marine fish could be higher than the estimate presented.

Sect. 5.3.2

Page 6-2, Item: Preoperational Aquatic Surveys. We do not feel that all studies have been adequate to provide baseline information or predictive assessments. Additional work should be done on the effects of current dire tion, winds, and tidal influence on the predicted plume areas. This inforn tion is necessary in order to adequately assess the expected environmental impact.

Sect. 3.3.3 and 6.3

The biological baseline information is adequate for providing the relative abundance of animals. Postoperational monitoring will only determine gros effects such as the disappearance of species. The more subtle effects, su as changes in food habits, growth, or reproduction, cannot be assessed wit out additional baseline information on life history and biology of the spe in the area. This should be recognized in the Statement.

Sect. 6.2

Page 6-2, Item: Studies Planned by California Fish and Game. The studies performed by California Fish and Game can provide a relative baseline and be used as indices for gross changes induced by plant operation. However, these studies did not define the population sizes of the major sport and commercial species. This section should be revised accordingly.

Sect. 6.2

Page 6-7, Item: Operational Thermal and Chemical Monitoring Programs. Un this is related to chlorine, we would like more information on the pH of t discharge during chemical cleaning of equipment. No mention was made in t statement on this aspect of the operation and on the chemicals to be used, other than chlorine.

Sect. 6.3

A monitoring program for heavy metals in the environment associated with t discharge should be included. This program should mention uptake by both and animals. Background levels should be determined prior to operational start-up.

Sect. 6.3

Page 10-3, Item: Biological Resources. We do not agree with the statemer that "In general, the effect on biological resources is too small to regar any of them as committed". There will be a definite commitment of resourc as a result of the project, and these should be recognized. The loss of abalone and other species in the cove has been mentioned. Mortalities thr entrainment, heat treatment, and addition of chemicals have been recogniz and should be stated as a commitment of resources. Because the purpose o the environmental impact statement is to assess the impact of the project resource commitments should be considered, regardless of their magnitude.

Sect. 10.4

ge 13-10, Item: Costs - Environmental. The assessment of environmental sts was a judgment based on the conclusions arrived at in the Statement. e impression given in the Statement was that these conclusions were based well-studied impacts and adequate information. In many instances, this s not been the case. The environmental cost of the breakwater construction ould be revised. The loss of abalone and other species should be recognized. also feel that the comparisons and data presented on the impact of entrain-nt, heat treatment, and addition of chemicals, were not adequate to conclude at these would not have serious consequences to the environment.

Sect. 13

A14-1-66

ATE OF CALIFORNIA—RESOURCES AGENCY RONALD REAG

EPARTMENT OF PARKS AND RECREATION
). BOX 2390
CRAMENTO 95811

50-275
50-323

January 24, 1973

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in reference to your request for review and comment of the Environment Impact Statement for Diablo Canyon, Docket Nos. 50-275 and 50-322.

We have completed our review and we believe that the project will have no adve effect on our state parks.

Sincerely,

James B. Hommon, Supervisor
Project Design and Construction Section

O-1a/6

A14-1-67

GEOTHERMAL ENERGY INSTITUTE
11 EAST 47TH STREET
NEW YORK, NEW YORK 10017
TEL.: (212) 758-5338

nuary 30, 1973

ited States Atomic Energy Commission
shington, D.C.

Re: Draft Environmental Statement prepared by the Directorate of Licensing in respect of proposed Diablo Canyon Nuclear Reactor Power Pants to be located on the California coast
Docket Nos. 50-275, 50-323.

ntlemen:

We submit the following comments in response to the aft environmental impact statement furnished to us on January , 1973:

1. The staff fails to present any adequate qualitative alysis of the environmental impact which will result from the plicant's operation of liquid radioactive waste system, dioactive gaseous waste system and radioactive solid waste stem. Sect. 14.12

2. The staff fails to present any adequate qualitative alysis of the environemental impact which will result from the scharge of chemicals to the environment by the proposed power ant. The staff purports to calculate projected 'dilution' of the pected chemical wastes but does not evaluate the impact of those stes or reactor coolant chemical 'leaks'. Sect. 3.4

3. The staff fails to present any qualitative evaluation the environmental impact which will result from the transport of clear fuel from South Carolina, or the transport of irradiated el back to South Carolina where it may be reprocessed, or the ansport of solid radioactive wastes to a "burial site" (which has yet been disclosed by the applicant). Sect. 14.12

4. No evaluation is given with respect to the the vironemntal impact which may arise as a result of theft of dioactive materials. See "Preventing Nuclear Theft", Ed., R.B. chman and P. Althoff (1972); Safeguard Report of the Institute Nuclear Materials Mnagement (May, 15, 1970). Sect. 14.16

5. The staff's evaluation of alternative sources (p.12-f) is vague, unspecific, unfactual and lacking in substantive tent. Sect. 14.20

- The staff refers to a "vendor of the geothermal steam". this we assume the staff refers to Union Oil Company which is operator of a joint venture (composed of Thermal Power Company, ma Power Company and Union) which is delivering geothermal steam 8 turbine-generator sets owned by the applicant at the Geysers thermal field in Sonoma County, CALIFORNIA.

The staff ignores the fact that Union has accelerated the rate of development on the 15,000 acres controlled by the joint venture. A third drilling rig has been placed into operation on that property, so that three rigs will be operating continuousl

In addition, the staff fails to refer to the fact that Magma and Thermal are proceeding independently of Union to develop additional geothermal steam sources. At the Geysers Therma and Magma are planning a new unit which will be built on top of a large geothermal well heretofore permitted to exhaust to atmosphere and considered merely as a 'rogue bore'.

Magma recently established a substantial geothermal fie in the Suprise Valley of Northern California.

The California Dvision of Oil and Gas estimates of August 1972 are substantially in conflict with the staff's proven reserve figure of 750 MW. See Oil and Gas Journal, January 29, 197

The staff ignores the vast proven reserves established at the Geysers by Pacific Energy Corporation, which controls about 20,000 acres within the Geysers KGRA (known geothermal resource area) and the reserve report published in respect thereto. See letter of DeGoyler & MacNaughton attached hereto. PEC has successf drilled two additional geothermal steam wells since that report wa written.

The staff ignores the proven reserves established by Signal Oil & Gas Company at the Geysers and the continuing develop program that company and Sun Oil Company are engaged in.

The staff ignores the development program at the Geysers undertaken by Cinta Oil Company of San Francisco.

The staff ignores the geothermal potential at Mono Lake.

The staff ignores the vast geothermal potential of Southern California where Standard Oil Company of California, Phillips Petroleum Corporation and others have exploration program underway; the staff once agaain fails to evaluate the fact of the establishment of a 75,000 kw geothermal power plant at Cerro Priet just south of El Centro, California and the fact that drilling operations north of Cerro Prieto have resulted in further geotherm steam discoveries.

The staff suggests that "subsidence" may be a problem in geothermal operations. In New Zealand, where subsidence occured for some years - no difficulties were experienced, no undue environmental impact took place - and the subsidence stopped in 19 In Iceland where geothermal operations have been conducted for a number of years, no subsidence has occured. At the Geysers in northern Calfiornia, no subsidence has occured.

The staff refers to considerations of land use. It's estimates of land use are erroneous. They are apparently based on the assumption that geothermal steam wells are placed on 20 or 40 acre spacing. PEC has demonstrated that 5 acre spacing is adequate Signal Oil Company and Phillips Petroleum Corporation are preparin to drill directionally from one position and eliminate several drilling positions. In addition, new technology now in development will permit small generation units to be placed directly on the well-head and eliminate the need for large plant areas.

We might point out that the applicant is nonetheless building larger units. It has ordered a single 140,000 kw unit for use at the Geysers.

In our opinion, the staff is not qualified to make an adequate evaluation of geothermal energy as a viable energy alternative to nuclear power plants and is clearly biased in favor of nuclear power. The staff's recent competitive activities bear this out.

We therefore find the draft environmental statement to be wholly inadequate in the above respects and as failing to meet the standards required by the National Environmental Protection Act.

Very truly yours,

Donald F.X. Finn

Donald F.X. Finn
Executive Director

PLEASE NOTE OUR NEW ADDRESS:

ROOM 429
680 Beach Street
San Francisco, California 94109

Tel.415-885-6663

cc: Environmental Protection Agency
Council On Environmental Quality

P.S. I am particularly concerned over the total lack of consideration demonstrated by the staff evidenced by its total failure to evaluate the obvious geothermal potential of San Luis Obispo County — information readily [illegible]

A14-1-71

Kenneth B. Kilbourne
Post Office Box 813
1548 Lisa Street
Carpinteria, Calif. 93013

RECEIVED
FEB 2 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

January 26, 1973

50-275
50-323

Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Reference: Comments on Draft Environmental Statement
Dockets #50275 and #50323

Gentlemen:

The enclosed comments are directed to some of the more basic shortcomings in the Diablo installation. The comments are not inclusive in that time did not permit discussion of some areas which seem to need more muscle.

As a senior member of the American Society for Quality Control, with extensive experience in this field, and as the president of a small industrial manufacturing company, it is almost unbelievable that your report doesn't delve further into reliability and quality assurance. I am left with the impression that priorities may be mixed.

Very truly yours,

K. B. Kilbourne

K:ho

Encl.

Kenneth B. Kilbourne
Post Office Box 813
1548 Lisa Street
Carpinteria, Calif. 93013

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT BY THE DIRECTORATE OF LICENSING, UNITED STATES ATOMIC ENERGY COMMISSION

DIABLO CANYON UNITS #1 AND #2
PACIFIC GAS AND ELECTRIC COMPANY

Submitted to:

Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Docket Nos. 50275 and 50-323

Submitted by:

K. B. Kilbourne

January 26, 1973

K B Kilbourne

CONTENTS

GENERAL

These comments on the draft environmental statement are concerned with the following:

1. Are the definitions of normal plant operation reasonable?
2. Are the possibilities of plant failures properly considered?

NORMAL PLANT OPERATIONS

The extent to which the power reactor conforms to the normal operations defined in the draft environmental statement will determine adverse environmental effects. In the short term, adverse effects may be mitigated. However, the long term, cumulative effects of "acceptable" levels of radioactive and other contamination that the plant will release are not well known. Anything other than trivial departure from the defined operating conditions could be serious and destructive in the short term, or the long term, or both.

The plant design, equipment and proposed controls are not sufficiently detailed in the draft report so that they may be evaluated. Consequently, these comments are not intended to judge whether the plant is safe or unsafe. At the same time, it should be noted that the limited description of the primary and secondary cooling systems, the proposed effluent discharge system, and the environmental evaluation of effects can in no way be considered confidence builders.

Primary and Secondary Cooling Systems The draft leads to the following conclusions:

1. There is no redundant cooling for the primary system, and presumably such is impossible, not feasible or uneconomic.

2. While the primary and secondary cooling systems are independent, radioactive and other contamination is possible between them. No radioactive or chemical inspection is provided from the turbine condenser.

3. The primary cooling liquid, after processing through the radioactive waste system, dumps into the secondary cooling system discharge line. There is no indication how this operates under emergency conditions.

4. Radiation monitoring is not operationally defined in the draft statement. It is not apparent whether radiation monitoring is informational sampling or provides to shut-down discrepant effluent flow, and in such cases, how rapidly the system will respond.

5. Chemical sampling of effluent will be after the fact (after discharge) and not from the discharge conduit, or at the radiation monitor stations.

Effluent Discharge System Outside of control of effluent from the turbine condenser, the steam generator blowdown tank, the boron recycle system and the waste disposal system, the environmental impact will depend upon the heat level of the discharge and various assumptions as to the characteristics of the discharge plume.

Draft report data and its interpretation on the discharge plume is unconvincing, theoretical and speculat The size and shape of the cove, the average depth of sixte (16) feet, the discharge velocity and turbulence and the discharge volume (five acre feet per minute) makes the da improbable. Other variables as wave and tidal action, the contour of the cove bottom, offshore and eddy currents, proximity to the South cove inlet, and variation in weathe conditions raise real doubts that the discharge plume wil in any respect approximate the geometrical form in the dr

Sect. 3.3.3 and 14.4

The discharge plume is more likely to encompass the entire cove and to tilt southerly to South cove most of the time. The temperature rise and level of contamination will necessarily, then, be a function of the daily temperature of the water in the cove, the temperature and volume of the discharge, the rate of change of water in the cove, and the heat dissipation to the ocean and to the atmosphere.

Sect. 3.3.3 and 14.4

To assume that no substantial part of the plume will recirculate through South cove, and thereby changing temperature and contamination estimates, is sheer optimis

Sect. 3.3.3 and 14.4

The draft claims a two-fold dilution in 8 acres of water with an average depth of less than 16 feet. Usin 16 feet for depth, eight acres is 128 acre feet of seawate The discharge from two power reactors will equal 128 acre in twenty four minutes. While the dilution may be two-fol

Sect. 3.3.3 and 14.4

the first hour, it will be substantially less for succeeding hours...unless it can be established that a hundred (100) percent change of water occurs in the eight (8) acres every half hour...a very unlikely occurence.

Offshore Discharge Line An offshore discharge line into the ocean rather than discharging into the cove was lightly considered and rejected. The arguments against appeared to be basically cost and not environmental. Loss of kelp and abalone and other adverse effects on the marine biota were accepted. Evaluation of the discharge plume data was uncritical or not accomplished, and comparisons beteen the proposed plant and one with an offshore discharge are not valid except for cost differences. Sect. 14.4

Environmental Effects The actual characteristic of the discharge plume and the percentage of effluent recirculated through the secondary cooling system will lead to a significantly higher water temperature and more contamination in Diablo cove than the draft report indicates. Marine biota will disappear from the cove, except for a few hardy survivors and some migrants that can stand the cold water between their home and this heated paradise. Requiring an offshore discharge line would eliminate these adverse effects. Sect. 3.3.3, 5.2.3 and 13

CONSIDERATION OF PLANT FAILURES

Probability of Failure Section 7 of the draft Sect. 14.17.2

statement discusses environmental impact of postulated accidents (failures). However, it gives no information as to what is meant by "probability of occurrence." Reference is made to "low" and "high" occurrence rates without explaining what "low" and "high" is in numerical data and how it was obtained. Lacking such data, it must be assumed that "probability of occurrence" refers to engineering value judgements and not to statistically determined probabilities with appropriate confidence limits. As such, the conclusions of Section 7 may or may not be correct and have very limited value in evaluating the environmental impact of the reactor plant.

From a system standpoint there may be no available meaningful and reliable data which can be used to predict probability of failure. Treating all operating water cooled power reactors as a universe from which to draw probability data, or citing a no failure record on this basis, would be a specious and questionable procedure. In any case, with 28 power reactors in operation since the first went on stream in New Jersey in 1963, 52 under construction and some 70 on order, there simply are not enough facilities (too small a sample) upon which to establish a valid probability of failure from a system standpoint.

As the oil companies discovered with their platforms (a simple, safe technology compared to reactor plants) it is unrealistic and incredible to predict no failures where men, materials and machines are involved. The probability of minor and major failures exists, but objective measure of the level of probability does not. It can be assumed, however, that potential failure will increase with the number of plants constructed and their years of operation. A major failure in a water cooled reactor is more certain than uncertain, and the questions are mostly where, when and the consequences.

The draft statement does not deal adequately with the matter of failure, in particular the consequences and appropriate corrective action. A similar glaring omission is the lack of any description of the quality assurance program for operation of the plant.

Safety Considerations Section 7 of the draft refers to the staff's Safety Evaluations dated January 23, 1968 and November 18, 1969 and eight categories ranging from trivial to major postulated accidents.

No mention is made, or discussion of, AEC publication, "Water Reactor Safety Program Plan," (1970), which outlines 139 safety questions with water cooled power reactors, 44 of which are considered "very urgent, key problem areas, the solution of which would clearly have great impact, either directly or indirectly, on a major critical aspect of reactor safety."

Many of these 139 safety questions, including the 44 urgent and critical safety questions, remain unsolved. This report with appropriate response should be incoporated in the environmental statement.

Table 7.2, Summary of Radiological Consequences of Postulated Accidents, lists under Class 8.1 loss-of-coolant accidents with an estimated dose to population in 50-mile radius of 120 man-rems. The draft states, "The probability of occurrence of large Class 8 accidents is very small."

Sect. 14.17.2

The environmental statement should include a statement of the consequences and the corrective action for Class 8 accidents, particularly when it is considered that other doses listed in the table range from 0.1 to 12 man-rems.

CONCLUSION

The draft environmental statement is not adequat to properly evaluate the environmental impact of Diablo Canyon power reactors #1 and #2.

The definitions of normal plant operation are not reasonable. The possibilities of plant failures have not been sufficiently considered.