6.5 WATER RESOURCES

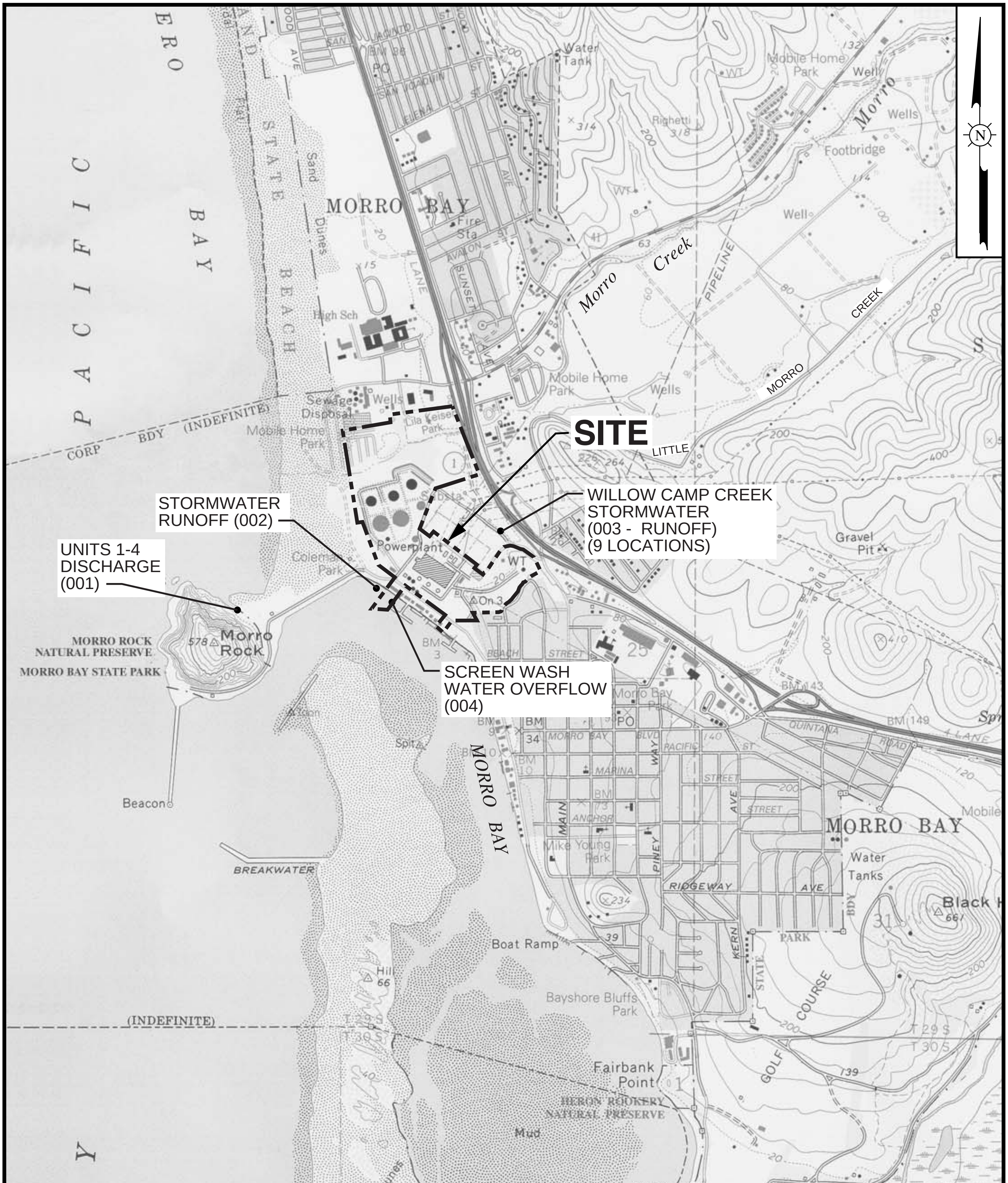
This section evaluates water resources utilized by the Morro Bay Power Plant (MBPP) and the effects of the Project on those resources. The Project will continue the use of seawater for once-through cooling at the same location where it has occurred for over 40 years (see Figure 6.5-1, Surface Water Bodies and Facility Discharge Locations and Figure 6.5-2, Cooling Water Flow Comparison). Both maximum design and actual cooling water flow rates will be reduced compared to present plant operations. This section also evaluates the effects of Project construction, operation and maintenance on ground water, surface drainage, and potential flood damage and related issues.

The use of seawater for cooling has been periodically evaluated at MBPP and has been found, in the issuance of each five-year term National Pollutant Discharge Elimination System (NPDES) permit by the California Regional Water Quality Control Board - Central Coast Region (RWQCB), to be consistent with the protection of beneficial water uses in the area. This present assessment is based on historical and recent studies performed during plant operating conditions comparable to those which will occur with the Project. As discussed in Section 6.5.2, the extent and thermal effects of the discharge from MBPP with the Project will be less than those that are presently occurring.

Using the existing Units 1 through 4 permitted intake and discharge structures without significant functional modification eliminates potential construction-related environmental impacts in shoreline and offshore areas.

In the development of this evaluation, there has been ongoing coordination with agencies including, but not limited to, the RWQCB, the California Energy Commission (Commission), the California Coastal Commission (CCC), and the California Department of Fish and Game (CDFG). The purpose of this coordination has been to assure that adequate data and working assumptions are used for this Application for Certification (AFC), and will continue to be used for the ongoing NPDES permitting and Commission certification processes for the Project.

As part of the coordination with the RWQCB, study plans for the Project at MBPP have been developed in conjunction with representatives of the above listed agencies and independent consultants chosen by the Commission and the RWQCB. The Morro Bay Power Plant Modernization Project Thermal Discharge Study Plan is one of two study plans (the other one covering studies related to operation of the cooling water intake system), and is provided in Appendix 6.5-1. This study plan is established to provide the Commission and the RWQCB with



0 2,000 4,000 FEET

SCALE: 1: 24,000

REFERENCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP OF MORRO BAY NORTH AND MORRO BAY SOUTH, CALIFORNIA, DATED 1993 AND 1994.

SURFACE WATER BODIES AND FACILITY DISCHARGE LOCATIONS

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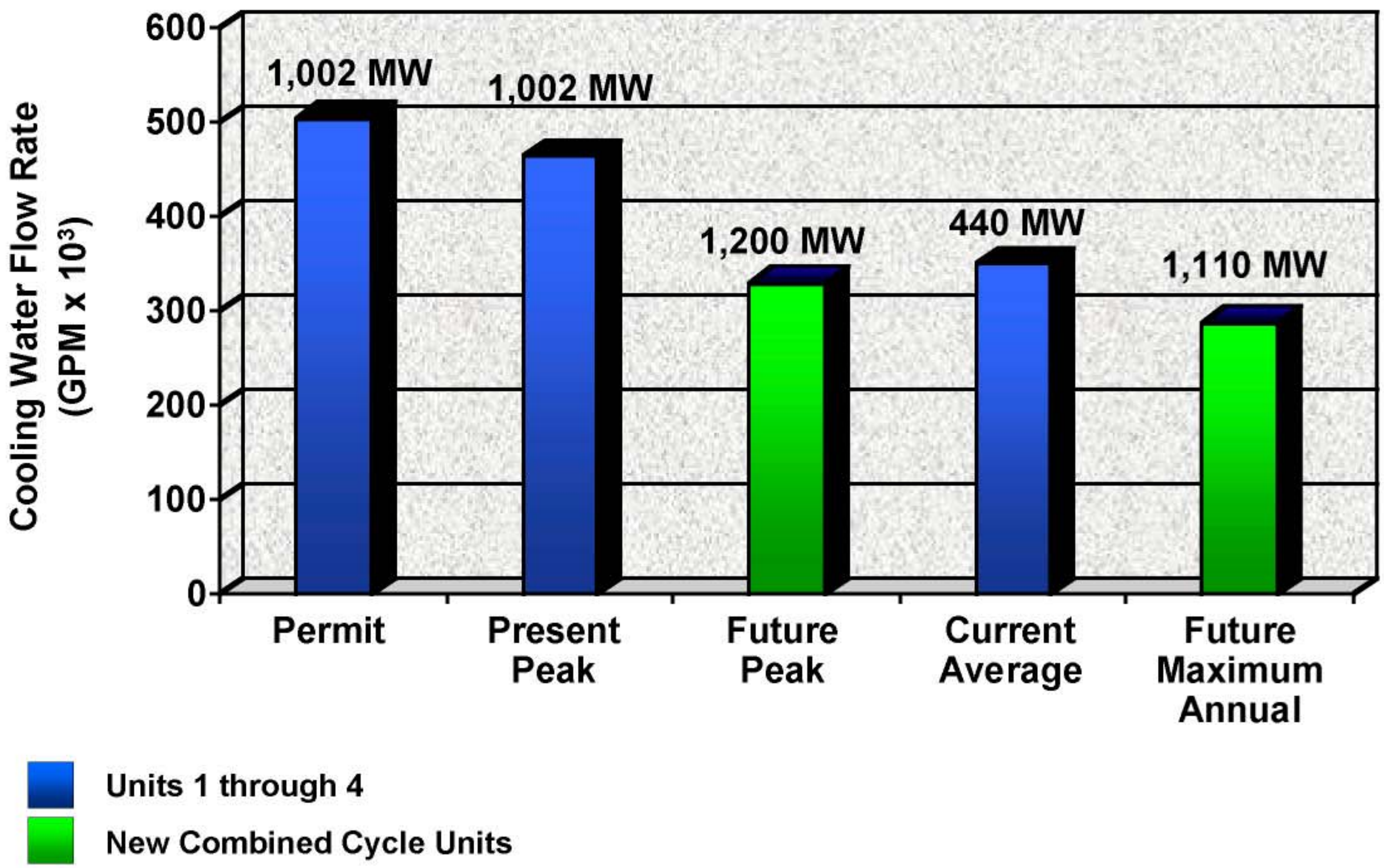
FIGURE 6.5-1



NOTES:

(1) "PRESENT PEAK" DENOTES MAXIMUM PRESENT CAPACITY OF UNITS 1-4.

(2) "CURRENT AVERAGE" DENOTES AVERAGE MBPP PLANT PERFORMANCE DURING THE PERIOD JULY 1999 THROUGH JUNE 2000.

(3) "FUTURE PEAK" DENOTES NEW COMBINED CYCLE UNITS AT MAXIMUM OPERATION.

(4) "FUTURE MAXIMUM ANNUAL" DENOTES MAXIMUM PROJECTED ANNUAL OPERATING SCENARIO FOR COMBINED CYCLE BASED ON 4,000 HRS PEAK POWER AND 4,400 HOURS BASE LOAD PER YEAR.

COOLING WATER FLOW COMPARISON

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MORRO BAY POWER PLANT

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FIGURE 6.5-2

information necessary to evaluate conditions in the area of the discharge of the facility and to project future conditions under modernized Project operations. The study plan addresses studies to gather, analyze, and interpret information related to both the physical characterization and biological effects of the discharge. Study results will provide information to the RWQCB to establish compliance with the California Thermal Plan and Section 316(a) and (b) of the federal Clean Water Act (CWA), providing a basis for the Project's NPDES permit. In conformance with the Memorandum of Understanding between the Commission and the State Water Resources Control Board, the AFC and the Application for an NPDES existing permit modification will proceed on parallel tracks.

Benefits of Project

Beneficial aspects of the Project related to the physical aspects of water resources include the following, which in many cases relate to benefits to marine biological resources as discussed in Section 6.6A - Marine Biological Resources:

- Generation of 20 percent more electricity, while utilizing less cooling water, and rejecting about 25 percent less heat to the ocean than existing Units 1 through 4 at full capacity, and 47 percent less heat at non duct firing base load levels.
- Optimizing use of water (reducing the total by about 29 percent at full plant loads, and by 41 percent the amount of cooling water used per megawatt [MW] of generation at full plant load).
- With its smaller flows and heat loads, the discharge plume will mix more rapidly, become buoyant and separate from the ocean bottom and shoreline substrate areas at shorter distances from the outfall, resulting in reduced exposure to marine organisms in these habitats. Consequently, the Project's discharge will continue to assure protection of the beneficial uses of the receiving waters.
- Using multiple cooling pumps for the new units, enabling reduced cooling water flow rates at less-than-peak operation by shutting off one or more pumps.
- Reducing approach velocities to the intake structures for Units 1 through 4 by 10 to 40 percent, depending on intake bay and operating level.
- Consistency with state water resources policies favoring the use of marine, rather than inland waters for power plant cooling.
- Avoiding impacts on limited local potable water supply by continuing use of seawater for power plant cooling.
- Using existing intake and discharge structures without significant modification, thereby eliminating potential marine construction impacts and avoiding the construction of large, visually obtrusive onshore cooling systems.

6.5.1 EXISTING CONDITIONS

6.5.1.1 Water Resources Policies

The MBPP is located on the coast of California about halfway between San Francisco and Los Angeles, about 14 miles northwest of the City of San Luis Obispo in San Luis Obispo County in the City of Morro Bay. The plant is situated west of Highway 1, near Morro Bay Harbor and east of Estero Bay. The area includes light industry, commercial operations and marine, residential and recreational areas.

The existing operations at MBPP are consistent with the water use preference hierarchy of the California State Thermal Plan policy by virtue of location and the use of once-through seawater cooling water. The policy establishes a preference for coastal power plants, using the ocean as a source of cooling water, rather than inland sites that require the use of limited supplies of fresh water. This State Water Resources Control Board Power Plant policy provides guidance in the planning and permitting of new power plants using inland waters for cooling and suggests methods for keeping the consumptive use of freshwater to a minimum (State Water Resources Control Board, 1975).

The principles contained in the Thermal Plan policy describe the preference:

> It is the Board's position that from a water quantity and quality standpoint the source of power plant cooling water should come from the following sources in this order of priority depending on site specifics such as environmental, technical and economic feasibility consideration: (1) wastewater being discharged to the ocean, (2) ocean, (3) brackish water from natural sources or irrigation return flow, (4) inland wastewaters of low total dissolved solids (TDS) and (5) other inland waters.

The basis for this preference is explained in the policy as follows:

> Although many of the impacts of coastal power plants on the marine environment are still not well understood, it appears the coastal marine environment is less susceptible than inland waters to the water quality impacts associated with power plant cooling. Operation of existing coastal power plants indicates that these facilities either meet the standards of the State's Thermal Plan and Ocean Plan or could do so readily with appropriate technological modifications. Furthermore, coastal locations provide for application of a wide range of cooling technologies which do not require the consumptive use of inland water and therefore would not place an additional burden on the State's limited supply of inland waters.
>
> These technologies include once through cooling which is appropriate for most coastal sites, potential use of saltwater cooling towers, or use of brackish waters where more stringent controls are required for environmental considerations at specific sites.

6.5.1.2 Overview of Beneficial Uses

The water resources of Morro Bay and Estero Bay have been and continue to be used beneficially for fishing, boating, water supply, habitat and water-related recreation (such as surfing and swimming) and tourist activities at Morro Strand State Beach and Morro Rock City Beach. Recreational boating activity is one measure of these uses. Morro Bay is home to 50 permanent slips – subject to a waiting list - and 70 moorings for home-ported vessels. The City of Morro Bay also operates the North and South "T" piers for visitors on a first-come, first-served basis. The Morro Bay Yacht Club has an additional 15 slips to assist transient boaters. Assuming that each of the local slips and moorings is used in any given boating season, the current level of use is about 10,000 boat-days per 180-day summer season.

Commercial and recreational fishing are important biologically-related beneficial uses of Morro Bay. See Section 6.6A - Marine Biological Resources, for further discussion of these resources and potential Project effects on biological resources.

6.5.1.3 Uses of Water at MBPP

The surface water bodies in the vicinity of MBPP are Morro Bay, Estero Bay, Willow Camp Creek, and Morro Creek. Seawater for once-through cooling and boiler makeup is withdrawn from Morro Bay and, after use, returned to Estero Bay. The source of water to Morro Bay and MBPP is primarily the Pacific Ocean, with minor seasonal contributions from Chorro and Los Osos Creeks. The operation of MBPP does not deplete the water volume in any of the water bodies.

MBPP typically uses around 10,000 gallons of freshwater per day from its onsite wells for routine operation of the facility. Currently, during maintenance periods, more than 80,000 gallons per day may be used for such short term activities as stack washing, boiler fireside washing, and boiler air preheater washing. Seawater obtained from Morro Bay is used as a noncontact once-through cooling water source to condense steam used to generate electricity at the facility. Additionally, the cooling water flow serves as a source of makeup water to the boilers after appropriate in-plant treatment in the seawater evaporation system. These uses are shown in the MBPP water balance flow schematic diagram for the existing facilities (see Figure 6.5-3). Table 6.5-1 shows current and proposed Project cooling water system flows and related plant loads.

Surface water run-off which accumulates from rainwater that falls on the Pacific Gas and Electric Company (PG&E) switchyard area adjacent to the MBPP is collected from drains located behind shutoff valves. This storm water, which is collected in spill containment areas, is checked for compliance with the SPCC requirements prior to being discharged to Willow Camp Creek or Morro Bay. Runoff collected from the industrial portions of MBPP is collected in impoundments and inspected prior to release, or collected in catchment areas and routed to the oil-water separator in accordance with the NPDES permit prior to discharge. Runoff from parking lots, roads, and other non-industrial areas is collected in storm drains which flow into Morro Bay. The pattern of runoff will not be affected by this Project. These discharges are described further in the Storm Water Pollution Prevention Plan (SWPPP) provided in Appendix 6.5-2. The relevant water bodies and discharge locations are shown in Figure 6.5-1.

6.5.1.3.1 Existing Once-Through Seawater Cooling System

The MBPP is located on an abundant source of cold ocean water which dissipates the heat from the once-through cooling water system at MBPP. Pacific Ocean currents supply enormous quantities of cold ocean water to the Morro and Estero Bay areas. Nearshore current patterns, due to gravitational and tidal flows, induce a high degree of circulation in the Estero Bay area, particularly in concert with the daily tidal flows in and out of Morro Bay and Estero Bay. Cold water reaches the power plant cooling water intakes located at the northeast bank of Morro Bay. After passing through the Units 1 through 4 primary steam condensers, the cooling water is discharged to Estero Bay via three subsurface discharge conduits as shown in Figure 6.5-4. One conduit for Units 1 and 2, and one each for Units 3 and 4, discharge to an outfall canal.

The MBPP consists of four generating units with a combined net capacity of 1,002 MW and a combined cooling water flow of approximately 464,000 gallons per minute (gpm), when all four units are operating. The configuration of the plant cooling water system is shown in Figure 6.5-5. Specifications of the Units 1 and 2, and Units 3 and 4, cooling water systems are listed in Table 6.5-2.

<u>Intake Structure for Units 1 Through 4</u>

The intake system for Units 1 through 4, which will be used essentially as is for the Project, is shown schematically in Figures 6.5-4 and 6.5-5. Design specifications are presented in Table 6.5-2. The common cooling water intake structure for Units 1 through 4 is located on the eastern shore of Morro Bay. Water is drawn through bar racks and then passes through traveling

TABLE 6.5-1

CURRENT AND PROPOSED COOLING SYSTEM DESIGN LOADS AND FLOWS

	HISTORIC (Design)	CURRENT (Actual)	PROJECTED[1] (Design)
Units 1 and 2 Intake Structure			
Intake Flow Rate (gpm)	197,200[2]	184,000	165,000
Approach Velocity at Bar Rack (fps)	0.5[3]	0.37[4]	0.33[5]
Units 1 and 2 Discharge			
Total Flow Rate (gpm)	197,200	184,000	165,000
Maximum Temperature Increase (° F)	16	17	20
Net Generating Capacity (MW)	326	326	600
Heat Load at Maximum Capacity (Million BTU/min)	26.3	26.3	27.5
Units 3 and 4 Intake Structure			
Intake Flow Rate (gpm)	293,600[6]	280,000[7]	165,000
Approach Velocity at Bar Rack (fps)	0.5[3]	0.51[4]	0.3[5]
Units 3 and 4 Discharge			
Total Flow Rate (gpm)	293,600	280,000	165,000
Maximum Temperature Increase (° F)	19	20	20
Net Generating Capacity (MW)	676	676	600
Heat Load at Maximum Capacity (Million BTU/min)	46.5	46.5	27.5
Combined Discharge			
Total Flow Rate (gpm)	490,800	464,000	330,000[8]
Maximum Temperature Increase (° F)	19	20	20
Average Temperature Increase at Maximum Capacity (° F)	17.8	22	20
Net Generating Capacity (MW)	1,002	1,002	1,200
Heat Load at Maximum Capacity (Million BTU/min)[9]	73	73	55

98-710/Rpts/AFC(text)/Tbls&Figs/Sec 6.5 (10/19/00/mc)

(1) Units 1 through 4 will be replaced by the new combined-cycle units, the values shown are for the maximum duct-fired operation (maximum of 4,000 hours per year).

(2) Original capacity for Units 1 and 2, determined from design specifications.

(3) Original design values at mean lower low water (MLLW) (PG&E 1983).

(4) Average velocity at curtin wall opening in front of bar racks measured in 1999. The water level during the Units 1 and 2 intake measurement was 2.64 to 2.51 feet above MLLW; the corresponding water level for the Units 3 and 4 intake measurement was 3.63 to 3.22 feet above MLLW. (DE&SI, January 2000)

(5) Estimated average velocity at curtin wall opening in front of bar racks based on 1999 measured data, prorated for maximum flowrate for combined cycle units.

(6) The original Westinghouse cooling water pumps for Units 3 and 4 were rated at 73,400 gpm, each (two pumps per unit, 4 total).

(7) Units 3 and 4 cooling water pumps were replaced in 1988-1989 with new Kubota pumps rated at 70,000 gpm, each.

(8) The water usage figures presented in this AFC are based on a discharge temperature minus intake temperature differential of 20˚ F. The use of a 20° differential will minimize the entrainment and impingement effects from the use of cooling water at the MBPP. Should the RWQCB determine that an adjustment is required to consider the warmer waters in Morro Bay compared to Estero Bay, then it will be necessary to increase the flows to allow full operation of the combined cycle units.

(9) The total heat discharged to Estero Bay at maximum plant capacity will be reduced from about 73 million Btu/min to about 55 million Btu/min.

TABLE 6.5-2
SPECIFICATIONS OF THE EXISTING COOLING WATER SYSTEMS

SPECIFICATION(1)(2)	UNITS 1 AND 2	UNITS 3 AND 4
BAR RACKS		
Number	4	6
Location	Shoreline	Shoreline
Spacing On-Center, in. (cm)	4 (10.2)	4 (10.2)
Bar Size, in. (cm)	3 x 3/8 (7.6 x 0.9)	3 x 3/8 (7.6 x 0.9)
TRAVELING SCREENS		
Location	Shoreline	Shoreline
Number	4	6
Manufacturer	Envirex	Envirex
Mesh Size, in. (cm)	3/8 (0.9)	3/8 (0.9)
PUMPS		
Location	Shoreline	Shoreline
Number (per unit)	2	2
Manufactuer	Westinghouse	Kubota
Type	Vertical single-stage mixed flow	Vertical single-stage mixed flow
Capacity, cfs (Each Pump)	102	156
m^3/sec	2.9	4.4
gpm	46,000	70,000
PRESSURE CONDUITS TO CONDENSER		
Number	2	2
Diameter, ft (m)	4.5 (1.4)	5.5 (1.7)
Length, ft (m)	650 (200)(3)	900 (275)(4)
CONDENSER		
Number of Tubes	9,550	10,342
Tube Material	Copper Nickel	Copper Nickel
Tube Outside Diameter, in (cm)	7/8 (2.2)	1 (2.5)
Design delta-T, °F (°C)	15.5 (8.6)	18.9 (10.5)
DISCHARGE CONDUITS		
Number	1	2
Size, ft (m)	7 x 10 (2.1 x 3.0)	7.25 x 7 (2.2 x 2.1)
Length, ft (m)	3,450 (1,050)(5)	3,775 (1,150)(5)
APPROXIMATE TRAVEL TIMES, sec	(7)	(8)
Bay to Pumps	60	64
Pumps to Condenser	89 (+22)	130 (-3)
Through Condenser	5	5
Condenser to Discharge	522 (+8)	537 (+45)
Total Through Plant	676 (+30)	736 (+42)
Total Heated	527 (+8)	542 (+45)
DESIGN WATER VELOCITIES, fps (cm/sec)		
Approach to Bar Racks	0.5 (15)	0.5 (15)
Through Bar Racks	0.5 (15)	0.5 (15)
Approach to Screens	0.7 (21)	0.6 (18)
Through Screens	1.4 (43)	1.4 (43)
Pump to Condenser	7.3 (220)	6.9 (210)
Through Condenser	7.0 (215)	7.0 (215)
Condenser to Discharge	6.6 (200)	6.5 (200)

(1) Units 1 and 2 share bar racks, traveling screens and a discharge tunnel; Units 3 and 4 share bar racks and traveling screens.
(2) Except as noted, specifications for the two units in a unit pair are identical.
(3) Unit 1; for Unit 2 add 160 ft. (50 m).
(4) Unit 3; for Unit 4 add 25 ft. (8 m).
(5) Unit 1; for Unit 2 subtract 55 ft. (17 m).
(6) Unit 3; for Unit 4 add 290 ft. (90 m).
(7) Unit 1; for Unit 2 add number in parentheses.
(8) Unit 3; for Unit 4 add number in parentheses.

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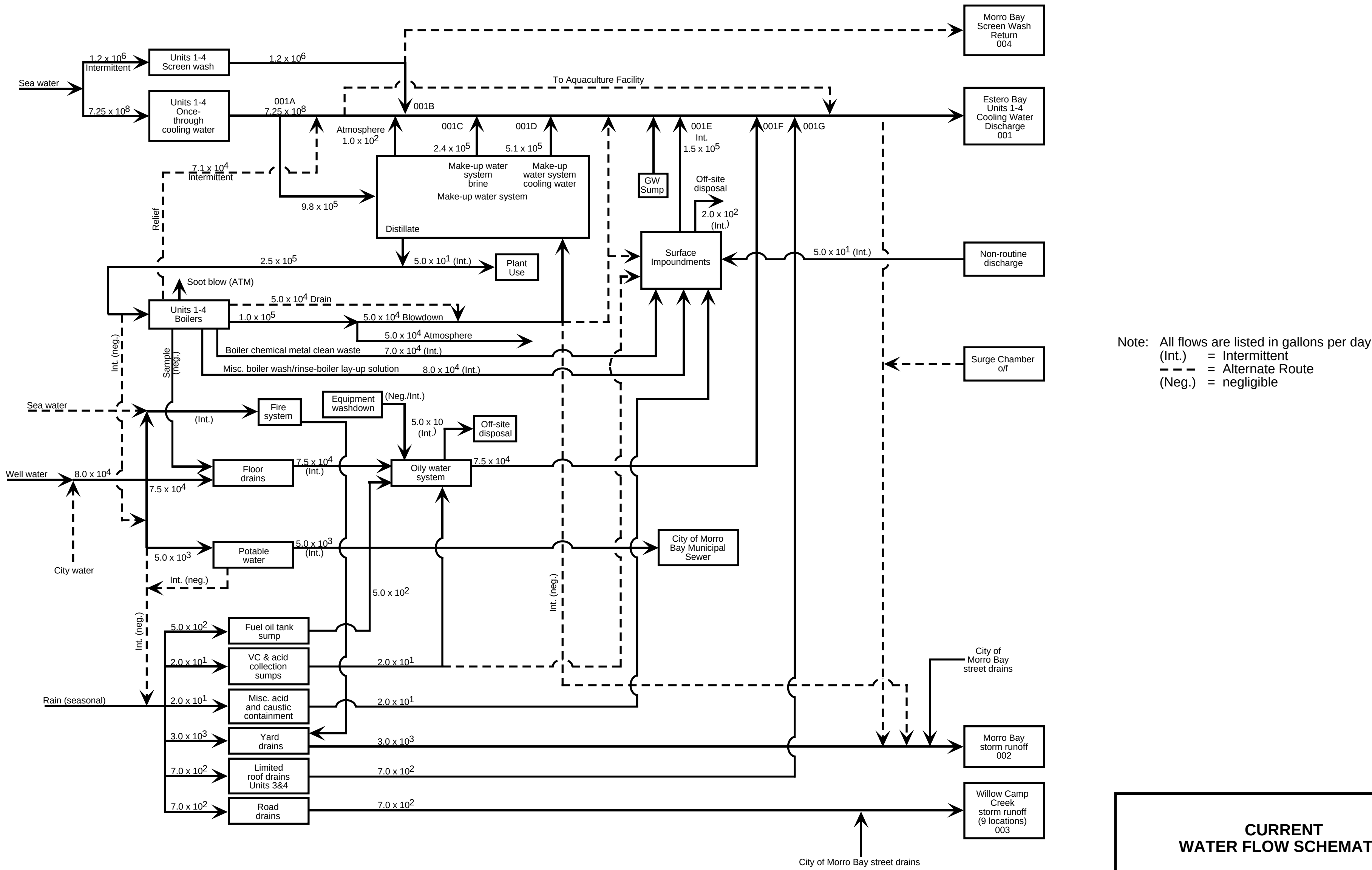

SOURCE: NPDES PERMIT CA0003743 1995 (AS CORRECTED).

CURRENT
WATER FLOW SCHEMATIC

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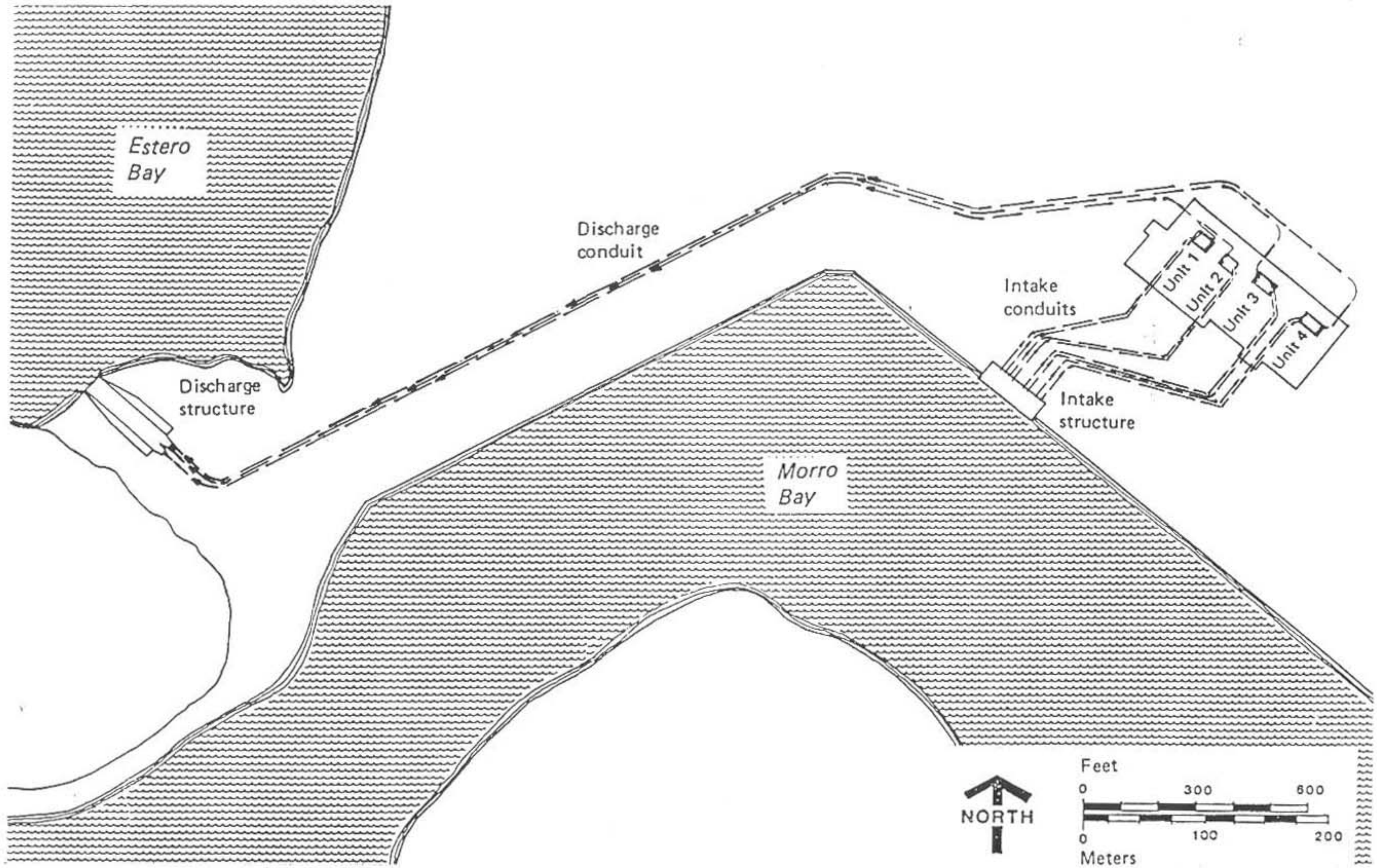
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-3



SOURCE: *MORRO BAY POWER PLANT COOLING WATER INTAKE STRUCTURES REPORT 316 (B) DEMONSTRATION* BY ECOLOGICAL ANALYSTS, INC., 1983

GENERAL CONFIGURATION UNITS 1-4 COOLING WATER SYSTEM

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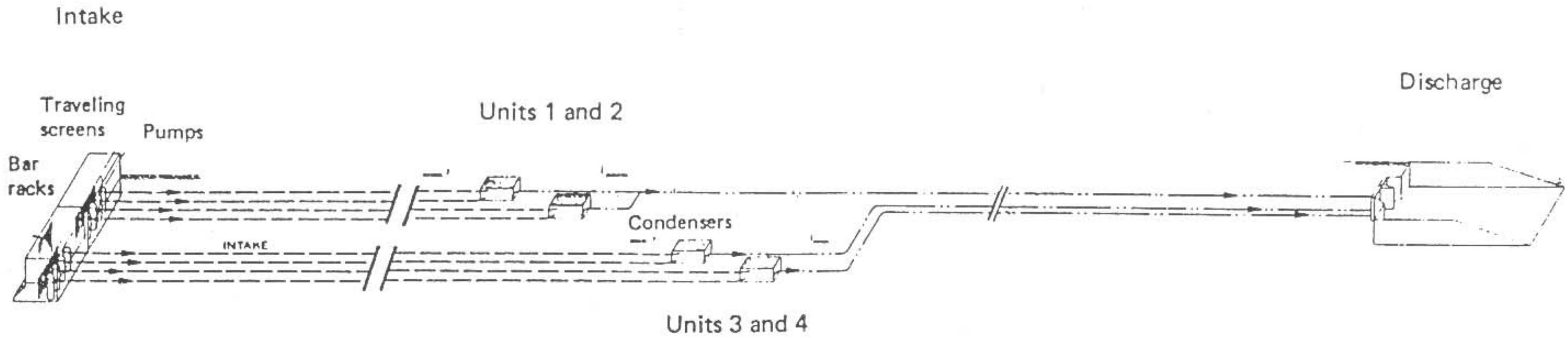
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-4



SOURCE: *MORRO BAY POWER PLANT COOLING WATER INTAKE STRUCTURES REPORT 316 (B) DEMONSTRATION* BY ECOLOGICAL ANALYSTS, INC., 1983.

SCHEMATIC DIAGRAM UNITS 1-4 COOLING WATER SYSTEM

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-5

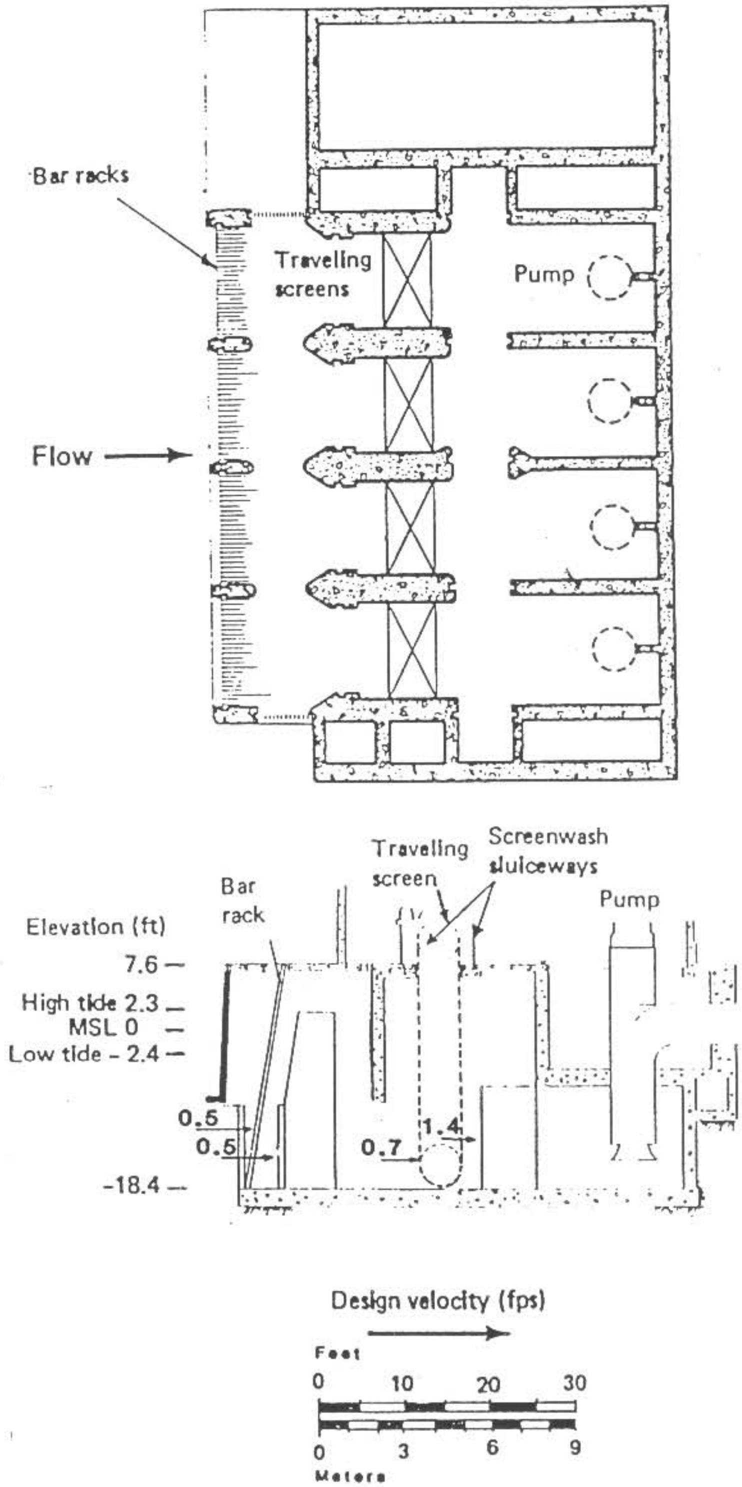
screens to circulating water pumps located downstream of the screens. Each of the four existing generating units has two circulating water pumps that pump cooling water to the condensers through two conduits, one serving each condenser half. Figure 6.5-6 and Figure 6.5-7 show the major features of the two intake bays of the current intake structure. The design seawater approach velocity to the bar racks is 0.5 feet per second (fps). Periodic removal of sediment which builds up around the intake structures, and which has the effect of reducing the cross sectional area of the intake opening, maintains the approach velocity to design levels. Yearly measurements are taken at the intake structures and maintenance activities (such as removal of silt and or debris) are conducted as required to maintain the design approach velocities.

Each pair of circulating water pumps at Units 1 and 2 has a combined operating capacity of 92,000 gpm; and each pair serving Units 3 and 4 has a combined capacity of 140,000 gpm. Under full operating conditions, the combined design flow rate of Units 1 through 4 is 464,000 gpm (see table above). Each pair of pumps provide a relatively constant flow rate of cooling water when the associated generation unit is on line, regardless of the level of power generation. For example, the Unit 3 cooling water pumps will pump about 140,000 gpm whenever Unit 3 operates, whether it is generating at a reduced load of 150 MW or at the maximum capacity of 338 net MW.

6.5.1.3.2 Units 1 and 2 Cooling Water System

As shown in Figures 6.5-4 and 6.5-5, cooling water is provided to the Unit 1 and 2 condensers from the intake structure described in the previous section. The discharge from the Units 1 and 2 condensers is combined in a single discharge conduit that runs approximately 3,500 feet to a short outfall canal on Estero Bay. Specifications of the system are presented in Table 6.5-2.

Figure 6.5-6 shows the major features of the intake bay for Units 1 and 2. Bar racks, spaced 4 inches on center and located about 20 feet in front of the vertical traveling screens, prevent the entry of large objects into the cooling water system. The vertical traveling screens, with a mesh size of 3/8 inch, retain smaller objects. Material retained by the screens, is removed during screen rotation and washing, which is initiated either by a timer at approximately 4-hour intervals or when the across-screen hydraulic differential exceeds a predetermined maximum. During screen washing, spray nozzles wash the material into a surrounding sluiceway. The sluiceway empties into a screenwash wet well equipped with a large diameter pump that drains the wet well and discharges into the common condenser discharge conduit of Units 1 and 2.



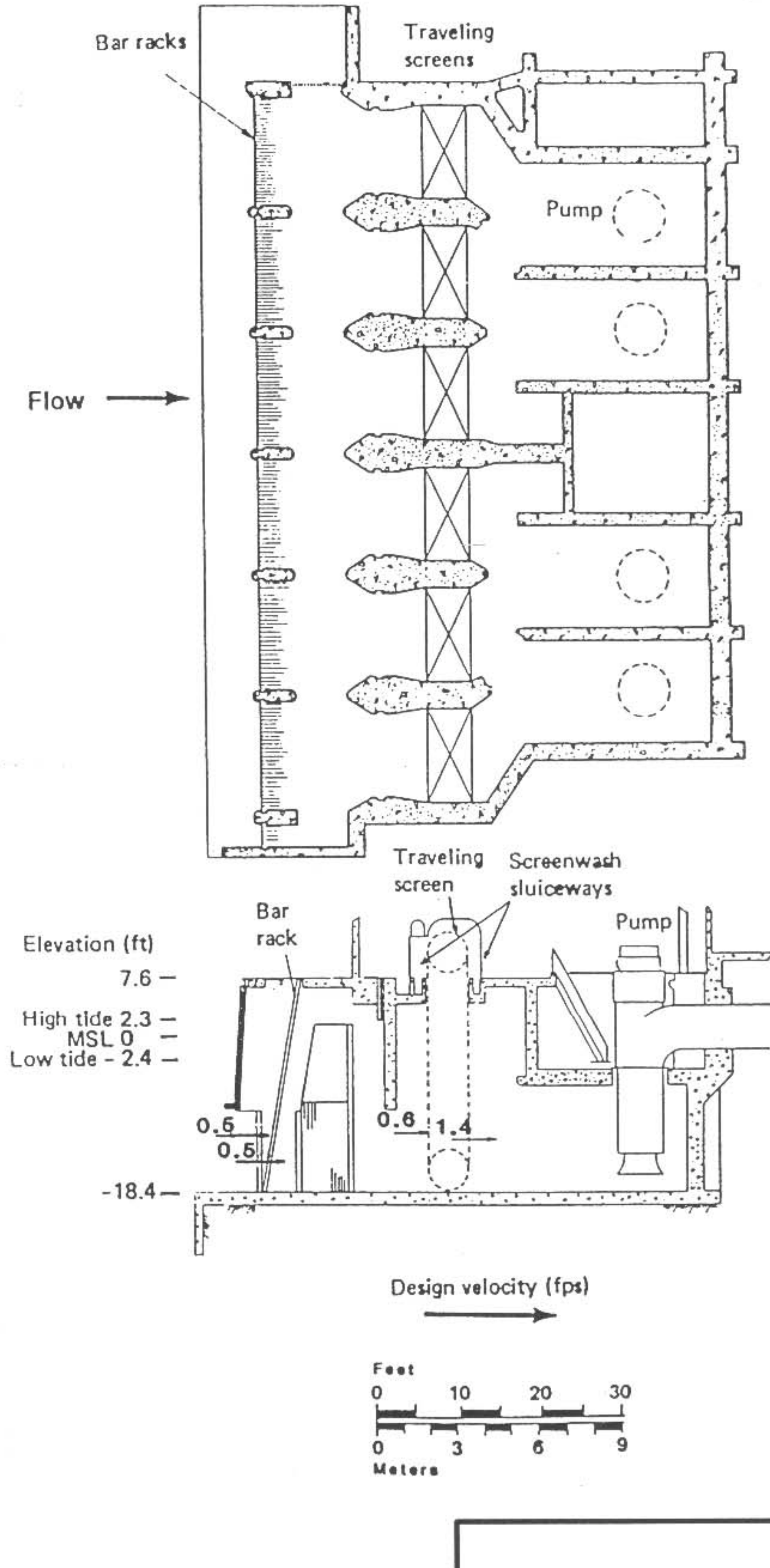
SOURCE: *MORRO BAY POWER PLANT COOLING WATER INTAKE STRUCTURES REPORT 316 (B) DEMONSTRATION* BY ECOLOGICAL ANALYSTS, INC., 1983.

PLAN AND SECTION DIAGRAMS UNITS 1 AND 2 INTAKE STRUCTURE

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-6



SOURCE: *MORRO BAY POWER PLANT COOLING WATER INTAKE STRUCTURES REPORT 316 (B) DEMONSTRATION* BY ECOLOGICAL ANALYSTS, INC., 1983.

PLAN AND SECTION DIAGRAMS UNITS 3 AND 4 INTAKE STRUCTURE

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-7

For micro-fouling of the condensers, each unit is chlorinated at the condensers for about 90 minutes (45 minutes for each condenser half) one time per day, for a total for Units 1 through 4 of 6 hours, with a maximum total residual chlorine (TRC) of less than 70 ppb measured at the outfall canal. This is in accordance with NPDES Permit requirements for chlorination, which state "TRC may not be discharged from any single generating unit for more than 2 hours per day. Simultaneous multi-unit chlorination is permitted." See Chapter 8.0 - Engineering, and Appendix 8-2 for additional information on the operation of the cooling water system.

Periodic heat treatment (demusseling) of each cooling water system is used to remove mussels and minimize the growth of other macro-fouling organisms on the piping and heat exchangers. The required frequency of this operation varies seasonally. Demusseling of the circulating water intake tunnels is typically performed once per quarter. Historically, the discharge tunnels were treated approximately once per year, but this practice was discontinued around 1990. Durations of heat treatments are a function of maximum temperature reached. Normally each heat treatment lasts about three hours, with the maximum temperature held for one hour. See Chapter 8.0 - Engineering, and Appendix 8-2, for additional information on periodic heat treatment.

6.5.1.3.3 Units 3 and 4 Cooling Water System

The cooling water system serving Units 3 and 4 is shown schematically in Figure 6.5-5. The intake bay for Units 3 and 4 is located adjacent to the intake bay for Units 1 and 2 and consists of bar racks, traveling screens, a chlorinator, and circulating water pumps. Four separate intake conduits deliver cooling water to Units 3 and 4 condenser halves, which then combine into a single discharge tunnel for each unit. The cooling water flows from the two units through separate, parallel 4,000-foot-long discharge tunnels which discharge into Estero Bay through the common discharge canal. Cooling system design specifications are presented in Table 6.5-2.

Figure 6.5-7 shows the major features of the intake bay for Units 3 and 4. Bar racks, spaced 4 inches on center, are located about 20 feet in front of the vertical travelling screens. The traveling screens have 3/8-inch mesh. Material retained by the screens, is removed during screen rotation and washing, which is initiated either by a timer at approximately 4-hour intervals under operating conditions or when the across screen hydraulic differential exceeds a predetermined maximum.

During screen washing, spray nozzles wash the retained material into a surrounding sluiceway which empties into a common screenwash wet well. The screenwash is sent to Estero Bay by a large diameter pump which empties into the discharge conduit of Units 3 and 4.

Heat treatment and chlorination procedures at Units 3 and 4 are similar to those described for Units 1 and 2. (See Chapter 8.0 - Engineering and Appendix 8-2 for additional information.)

Plant Operation

The design specifications for the generating units at the MBPP apply primarily to operation under full load conditions, i.e., continuous maximum circulating water pump operation and generation at full capacity. Because these generating units are usually operated to respond to seasonal and daily fluctuations in demand for electrical energy, the actual load is generally below operating capacity when expressed as an average over a month or a year. A convenient statistic for description of plant operational status is the plant or unit capacity factor, the ratio of actual gross generation to maximum possible generation over a specified interval, expressed as a percentage.

A summary of the average monthly generation capacity factors for Units 1 through 4 for July 1999 through June 2000 is given in Table 6.5-3. Monthly generation capacity factors for this period range from a low of 0 percent for Units 1 and 2 and up to almost 74 percent for Unit 3. The average overall generation capacity factor for that period was about 44 percent. The MBPP participates in the California Power Exchange (PX) and each unit is dispatched from the California State Independent System Operator (CAISO) as necessary to meet the system electric power demand.

Percentage operating time is a second statistic used to describe operating history. It consists of the ratio of the hours that a unit operates (regardless of generation amounts) to the total hours in a period, expressed as a percentage. Percentage operating time for each unit by month for July 1999 through June 2000 is summarized in Table 6.5-4. For this period the percentage of operating time for the four generating units ranged from 0 to 100 percent, with an average for all units of about 71 percent.

Monthly average intake and discharge water temperatures for 1994 through 1999 are shown in Figure 6.5-8. Monthly average intake temperatures ranged from 52 to 64° F, and monthly average discharge temperatures ranged from 59 to 78° F. The average temperature differential during the July 1999 through June 2000 period, representative of present operating conditions, was 13.7° F.

TABLE 6.5-3

RECENT CAPACITY FACTORS FOR MORRO BAY POWER PLANT (PERCENT)

PERIOD	UNIT 1	UNIT 2	UNIT 3	UNIT 4	ENTIRE PLANT
July 1999	45.03	44.56	46.46	17.81	36.31
August 1999	15.40	35.18	31.09	42.93	33.14
September 1999	27.39	42.61	46.23	44.74	42.02
October 1999	60.42	66.22	51.76	54.78	56.59
November 1999	23.56	40.09	65.23	58.42	51.92
December 1999	0	55.14	44.85	59.78	44.15
January 2000	46.58	64.67	62.60	61.89	60.06
February 2000	49.45	36.10	60.96	54.31	52.73
March 2000	0	0	48.49	40.07	29.66
April 2000	0	1.8	29.67	12.52	14.43
May 2000	44.02	40.37	20.96	51.73	38.28
June 2000	70.15	68.26	73.85	67.94	70.34
Averages	**31.83**	**41.25**	**48.51**	**47.24**	**44.18**

Note: Unit capacity factors shown in percent.

6.5.1.4 Surface Water

6.5.1.4.1 Physical and Hydrodynamic Characteristics

Morro Bay - Setting

This, and the following subsections describing physical and hydrodynamic characteristics of Morro Bay, are extracted from a more detailed report on this subject which is attached as Appendix 6.5-3. Morro Bay is a shallow estuary, approximately 4.3 miles long and 1.8 miles wide. It opens onto Estero Bay, which extends about 19 miles along the California Coast between Pt. Buchon and Pt. Estero. The mouth of Morro Bay is south of the mid-point of Estero Bay, and is located about 14 miles northwest of San Luis Obispo. Morro Rock, a 578-foot stone monolith which marks the entrance to the bay and harbor, dominates the bay's landscape and is visible from any point in Estero Bay and the surrounding coastal plain (see Figure 6.5-1).

Morro Bay has been designated a State and National Estuary. The bay became part of the National Estuary Program (NEP) in 1995. The NEP was established in 1987, by amendments to the Clean Water Act, to identify, restore and protect the nationally significant estuaries of the United States.

TABLE 6.5-4

RECENT OPERATING TIME FOR MORRO BAY POWER PLANT (PERCENT)

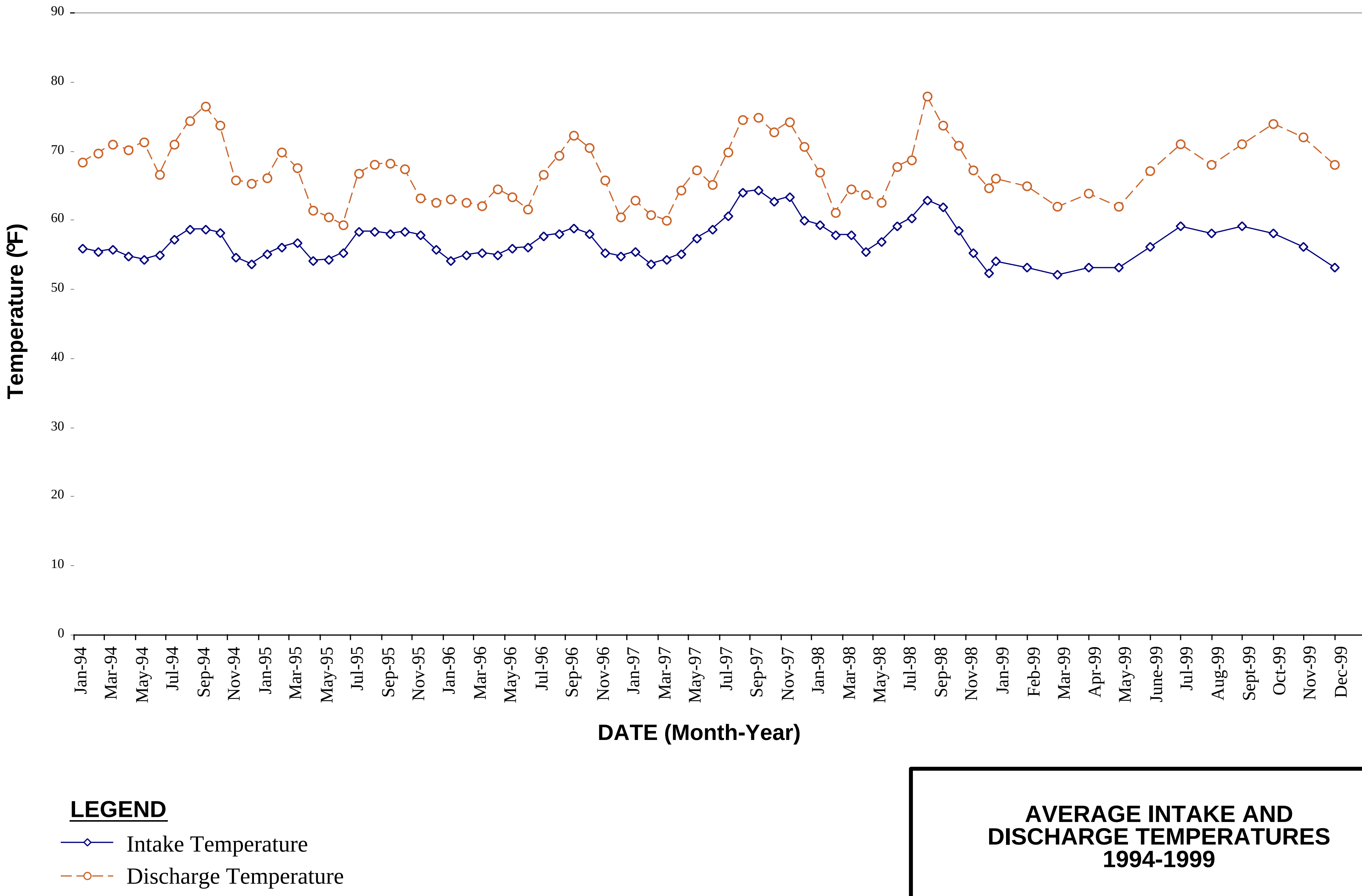
PERIOD	UNIT 1	UNIT 2	UNIT 3	UNIT 4	ENTIRE PLANT
July 1999	90.33	90.59	100	41.30	80.56
August 1999	35.74	75.16	67.5	100	69.6
September 1999	45.23	83.65	100	100	82.22
October 1999	85.51	96.03	88.19	93.94	90.92
November 1999	32.63	63.13	100	98.52	73.57
December 1999	0	79.77	81.9	100	65.42
January 2000	66.38	100	91.52	99.22	89.28
February 2000	84.93	62.31	100	84.47	82.93
March 2000	0	0	93.88	73.55	41.86
April 2000	0	4.54	58.39	23.44	21.59
May 2000	63.13	56.87	31.34	83.6	58.74
June 2000	92.50	91.71	100	100	96.05
Averages	**49.70**	**66.98**	**84.39**	**83.17**	**71.06**

Note: Values shown are percentage of time when units operated.

Morro Bay - General Characteristics

Morro Bay is a shallow, seasonally hyper-saline bar-built estuary, a type of system often referred to as a lagoon or barrier-lagoon (Orme, 1991). It is formed behind a barrier sand spit formed by littoral transport north from the vicinity of Pt. Buchon. This natural (south) barrier spit separates the bay and the delta of Chorro and Los Osos Creeks from the more open waters of Estero Bay. The south spit is cut off from Morro Rock by the present entrance channel. This modern entrance is one of two original entrances. A smaller (north) sand spit connects Morro Rock to the mainland. This spit is artificial, and was constructed to close a second natural entrance to the bay north of Morro Rock.

Morro Bay is of recent (Holocene) origin. It has assumed approximately its present form since the relative stabilization of sealevel around 6,000 to 7,000 Years Before Present (YBP). Orme (1991) estimates that the barrier spit likely formed between 3,500 and 5,000 YBP. Like most estuaries,



SOURCE: MORRO BAY POWER PLANT NPDES MONITORING REPORTS, 1994-1999.

AVERAGE INTAKE AND DISCHARGE TEMPERATURES 1994-1999

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-8

Morro Bay is a transient feature in geological terms, and it is quite vulnerable to filling by dredged material disposal, sedimentation from tributary creeks, migration of its sand spit, tectonic changes, and global sealevel rise.

The total surface area of Morro Bay is approximately 3.3 square miles. Much of the Bay is intertidal, so that the area of open water at low tide (the subtidal area) is considerably smaller - less than 1 square mile (Tetra Tech, 1999). The subtidal volume is around 4,400 acre feet, giving an average depth of the subtidal part of the bay of 8.4 feet below Mean Lower Low Water (MLLW) or 11.3 feet below Mean Tide Level (MTL). The area of the system below Mean High Water (MHW) is about 11,470 acre feet., yielding an average depth for the system as a whole of about 3.8 feet below MTL. This very shallow average depth and the contrast between the depths of the subtidal and intertidal areas reflects the presence of relatively narrow channels through a considerable expanse of intertidal flats and marsh.

One of the more notable features of Morro Bay is that its freshwater supply is not at its head or most distant point from the entrance, as is typical for an estuary. Instead the primary freshwater sources, Chorro and Los Osos Creeks, enter the middle of the bay, between Baywood Park and White Point. This geometry is reflected in flushing time and salinity patterns in the bay.

<u>Morro Bay - Oceanographic Perspective on Habitats</u>

The surface area of the bay can be described in terms of habitat in several ways. The simplest division is perhaps between open water (subtidal) habitats, and intertidal habitats. The subtidal surface area below MLLW is about 650 acres, of which about 350 acres is always submerged because it is below Extreme Low Water (ELW); ELW is around 2.5 feet below MLLW. The remaining intertidal area is made up of about 980 acres of tidal mud flat in the low intertidal and 470 acres of high intertidal salt marsh (Gerdes et al., 1974).

The system can also be described in terms of physiographic zones (Chipping, 1979; Haltiner and Thor, 1991). There are four such zones:

- <u>Zone 1: Entrance channel and upper bay.</u> This zone is characterized by rapid tidal flow, active sediment movement and shoaling/filling related to navigational development. Most of this zone is subtidal, and it contains most of the subtidal habitat. The Morro Bay Power Plant is in this zone. However, power plant effects are secondary to those associated with navigational development. The high energy levels of this zone do not allow accumulation of fine sediments from tributary creeks to the degree that occurs in the rest of the bay.

- Zone 2: Central bay. The area south of Fairbank Point is transitional between the mouth, with its active circulation, and more interior regions where flows are usually weak. There is a mix of subtidal, tidal flat and marsh habitats. Coarse silts are found in some areas. This zone has been impacted by navigational and marina development, and by land use on its shorelines and within the tributary drainage basins to Chorro and Los Osos Creeks. Shoaling has been less than in the rest of the bay. Some subtidal areas have actually increased their depth, e.g., the Fairbank Hole.
- Zone 3: Southernmost reaches of the bay. This is the area with the longest flushing time in the system. It consists of mud flats, with limited marsh and open water areas. It accumulates fine sediments (fine silts and clays) supplied by Chorro and Los Osos Creeks. Sediment-attached pollutants may also reach this area from the drainage basin of the tributary creeks. Aeolian sediment transport is, moreover, causing the barrier spit to encroach on this part of the system. Local and remote land use impacts are strong; 30-40 percent of the volume has been lost.
- Zone 4: The deltas of Chorro and Los Osos Creeks. These areas are mudflats upon which marsh has been encroaching as the deltas are supplied with sediment, resulting in elevation increases. Although there is accumulation of fine sediment in this area, energy levels are briefly high during high flow periods. These periods supply sediment to the remainder of Morro Bay and to the ocean as well. The material supplied by these tributaries consists primarily of silt and clay, but some sand and coarser material also present. Most of the coarse fractions are likely trapped on the delta, with only limited supply of coarse material to the rest of the bay. This zone is very highly impacted by land use in the watershed of the two tributary creeks; 60 percent of the volume below 4 feet above MLLW has been lost. Damage to the channel network in and above the delta has had severe effects on the native steelhead run.

Morro Bay - Navigational Development

The mouth of Morro Bay has been highly altered in support of navigation, and navigation has had a very large overall impact on the system. There were originally two mouths to the bay, one on either side of Morro Rock. The northerly entrance was closed initially in 1911 and finally in 1936, with the intention of creating a self-scouring, southerly entrance (Wiegel, 1967; Tetra Tech, 1999). This hope was not, however, totally fulfilled, leading to construction of the existing channel and navigation works in the early 1940s. The Morro Bay entrance, developed on an emergency basis during World War II, was one of the last coastal harbors in the entire US constructed without the benefit of modern wave refraction analyses, which were just being developed about the time that the Morro Bay entrance was built. This fact, along with a severe open coast wave environment, likely accounts for the safety hazards of the entrance and repeated need for modifications to, and repair of, the project.

Two breakwaters form the present entrance to the bay. These were constructed during 1941-1943, with periodic repairs between 1946 and 1964. The first extends 1,800 feet in a south-southwesterly direction from the base of Morro Rock. The second extends a similar distance to the west from the sand spit that separates Morro Bay from Estero Bay. The ends of the breakwaters are separated by approximately 800 feet. There is a third, smaller groin at the end of the spit, to the south of the channel. This was constructed in 1956 to correct a spit erosion problem. A navigation channel is maintained by the U.S. Army Corps of Engineers (COE) from the bay's entrance to White Point, a distance of approximately 2.5 miles. The channel is dredged every 3 to 4 years to a nominal depth of 15 feet below mean lower low water (MLLW) (COE, 1991). The average dredging volume required to maintain this navigation channel has been around 88,000 cubic meters per year (115,000 cubic yards per year) since 1949 (COE, 1991).

Construction and maintenance of a navigation channel has had major effects on the bay, in part because of the considerable contrast between the small natural channel and the much larger dredged cross section. The dredged channel has about three times the cross-sectional area of the natural channel, and the natural channel depth was often only 7-9 feet (Wiegel, 1967).

Morro Bay - Freshwater Inflow

An estuary is traditionally defined as a semi-enclosed coastal water body where seawater is diluted by freshwater derived from land drainage (Dyer, 1997). Freshwater inflow is, therefore, a vital part of any estuarine system. Morro Bay receives freshwater input from the seasonally variable drainage flows of Chorro and Los Osos Creeks. Total watershed of the creeks encompasses approximately 48,000 acres, only about 23 times the total surface area of the bay. This small ratio of watershed to estuary area marks Morro Bay as a marine-dominated system. Because of the small catchment area, average flows for these tributaries are quite small, and peak flows are of more importance to the system.

In addition to providing freshwater inflow to the bay during winter and spring, these creeks are a source of sediment, nutrients, and pollutants. Freshwater inflow also plays a major role in determining flushing time during periods when flow is moderate to high. Although the freshwater flow is quite small compared to the tidal prism (except during high-flow periods), this inflow sets up a two-layer estuarine flow that flushes the system, at least from the delta area to the mouth.

Morro Bay - Sediment Input

The sediment budget (balance of supply and export) for Morro Bay is not well understood. In general, however, three primary processes are active and have tended over time to reduce the volume of the bay:

- Fluvial sediment supply - the input of sediment from Chorro and Los Osos Creeks.
- Aeolian transport - wind blown sediment supply along and from the barrier sand spit.
- Littoral transport - the supply of material to the bay by alongshore sand transport caused by waves and near-shore currents.

As is typical of many highly altered estuaries, dredging is a dominant term in the sediment budget, removing a large amount of sediment from the system. Haltiner and Thor (1991) provide a summary of the effects of these processes, indicating a net increase in shoaling of 37,000 cubic yards per year.

Another point is the importance of large events -- a single 100 year storm is estimated to provide as much sediment as 10 typical years of flow. Given the relatively short flow record available, the importance of extreme events, the strength of climate fluctuations with periods from about 3 to 50 years, and the difficulties in predicting sediment loads, sediment loading remains quite uncertain.

Morro Bay - Climate Effects

Climate influences on West Coast estuarine processes are very important, especially that of the El Niño- Southern Oscillation (ENSO) cycle, with a typical period of 3 to 7 years. In the Morro Bay area, La Niña years are usually drier than average, whereas El Niño years may be either very wet (1982-83 and 1998) or very dry (1977). On the average, however, El Niño years have above normal precipitation, especially during December to February (*www.nws.mbay.net/cal_enso. html*). These climate cycles influence, through their effects on precipitation, the estuarine annual salinity cycle, and seasonal patterns of estuarine circulation may be quite different in a dry and wet years. Moreover, fluvial sediment transport usually varies with a power greater than two of river flow, and El Niño years also typically exhibit high sealevel and littoral transport. Sediment transport and shoaling, therefore, may also exhibit strong climate cycles.

There is also a longer climate cycle active in the Northeast Pacific Ocean, known as the Pacific Decadal Oscillation or PDO. The PDO cycle is typically 40 to 50 years in duration. Because there is a strong correlation between precipitation, river flow and sediment transport, PDO climate phases may (relative to long-term average) cause more or less rapid shoaling to occur in the interior of the bay for several decades at a time.

Morro Bay - Tidal Regime

Morro Bay is flushed twice daily by the tidal influx from Estero Bay. Tides at Morro Bay, as along the entire coast of California, are of the mixed semidiurnal type with two highs and lows per 24.8 hour period. The two high tides each day and the two low waters each day are not, however, equal. There is a higher and a lower high water, and a lower low and higher low water also. The difference between the two tides each day is known as the diurnal inequality. The mean values of these heights (averaged over a long period) are known as: Mean Higher High Water (MHHW), Mean Lower High Water (MLHW), Mean Lower Low Water (MLLW) and Mean Higher Low Water (MHLW). The tidal range (distance between MLLW and MHHW) is 5.3 feet near the entrance to the bay; this represents the greater daily or diurnal tidal range. The difference between MLHW and MHLW is 2.31 feet; this represents the lesser daily tidal range. Extreme predicted tides within the bay range from 0.8 feet below MLLW to 5.6 feet above MLLW.

The present Morro Bay tidal range is normal for coastal ports from Los Angeles to Monterey. The fact that the tidal range in Morro Bay has increased from about 4.7 to about 5.3 feet (a difference about 0.6 feet or 11 percent) since navigational development suggests that the system was severely choked before construction of the entrance channel. That is, the small entrance channel cross section limited tidal exchange with the ocean to a substantial, and probably seasonally variable, degree. Exchange with the ocean has increased since 1941-43, when the channel was constructed.

It is a typical property of tides in shallow, strongly convergent embayments like Morro Bay that the tidal range remains constant or increases somewhat toward the head of the bay. In contrast, the tidal current velocities are strong at the entrance but weaken toward the head of the bay (Jay, 1991). Thus, water velocity at mid-tide within the boat channel can reach 3.6 knots (6 feet per second, or fps) (PG&E, 1983), but are weaker in the interior of the bay. At spring ebb tide, peak outflow from Morro Bay has been estimated to be as large as 24.5 million gpm (54,000 cfs).

Tidal exchange provides the strongest currents in the system and plays an important role in sediment transport, flushing pollutants from the bay, and maintaining the estuarine morphology. The fact that there is little freshwater inflow to provide flushing for much of the year means that concern is merited regarding the declining size of the tidal prism, the primary agent of flushing in a system with little river inflow. Sediment transport processes are, moreover, quite complex, as indicated by the fact that tidal asymmetry has allowed channels to maintain themselves and (in a few instances) even increase in length or depth despite overall shoaling trends. Because of the complexity of estuarine processes, it is necessary to focus clearly on transport mechanisms to understand historical changes to the system and the role of the Morro Bay Power Plant in those changes.

Morro Bay - Definition of the Tidal Prism

The tidal prism is the volume of water that goes both in and out of an estuary during a tidal cycle. On the West Coast where tides are mixed diurnal and semidiurnal, it is normally taken as the volume associated with an elevation change between mean lower low water (MLLW) and mean higher high water (MHHW). The tidal prism should not be confused with the total flux on a flood or an ebb tide. The total ebb or flood flux is made up of the tidal prism volume plus or minus any net flows, such as river flow and, in this case, the plant intake flow rate. Because of the presence of various types of mean flow, natural or man-made, the ebb or flood flux alone will differ from the tidal prism volume.

Determination of the tidal prism volume is important for several reasons. The tidal prism to estuary volume ratio (greater than 1 in this case) is an indicator of tidal distortion, and the fluxes that fill and empty the tidal prism are an important means for flushing the embayment. Loss of tidal prism is, therefore, a possible indicator of water quality problems, loss of sediment transport capacity and habitat degradation. There is another point in the present case - the ratio of the volume of water withdrawn by MBPP to the tidal prism is a simplistic measure of plant effects. It is a naïve measure in that: a) it says nothing about the location of any possible effects; and b) it does not clarify whether the effects are positive or negative, especially when considered in combination with other human alterations.

As discussed in Appendix 6.5-3, and depicted graphically in Figure 1 of that appendix, the tidal prism is about 8,130 acre-feet, given the established datum levels. This is 102 percent of the total volume below MLLW, and 65 percent of the volume of the bay at MHHW. These comparisons emphasize how shallow most of the seabed of the bay is. A more detailed discussion of tidal prism, including the rationale for basing it on the volume difference between the MHHW and MLLW planes, is given in Appendix 6.5-3.

Morro Bay - Effects of the Power Plant on the Tidal Prism

It is also important to clarify the relationship of the Morro Bay Power Plant intake volume to the tidal prism. This understanding is needed for the calculations of source water volumes for proportional entrainment mortality estimates in the 316(b) resource assessment. The understanding is also important in addressing some local concerns expressed about the potential effects of the power plant of the tidal prism and potential related effects on sedimentation in the bay. Oceanographers distinguish carefully between tidal currents and mean flows (the currents after the tides are averaged out). The MBPP is a mean-flow process, because it is a steady intake that has no tidal variation. It has, by definition then, no direct effect on the tidal prism - the same tidal flow will go in and out of the bay, whether the intake operates or not. To argue that the plant impacts the tidal prism is to say that there is a change, due to the intake, in the volume of bay filled and emptied on each tide. Clearly this is incorrect. The volume of water between MLLW and MHHW (whose filling and emptying by tidal fluxes is the tidal prism) remains the same whether or not the plant intake is in operation. Thus, there is no direct effect of the plant intake on the tidal prism.

The plant intake volume of 464,000 gpm (or about 1,030 cfs) may be compared to the tidal prism volume. The intake over a 6.2 hour period of flood or ebb is 23 million cubic feet. The equivalent tidal prism volume is 8,130 acre feet, or 354 million cubic feet. Thus, the plant intake flow rate is on average about 6.5 percent of the tidal prism. This means that flux of water at the mouth of the bay is increased by 6.5 percent on flood and decreased by 6.5 percent on ebb. Tidal fluxes landward of the plant intake are, however, not affected.

Salinity Intrusion and Temperature/Salinity Distributions Within the Bay

Estuarine circulation patterns, pollutant and sediment transport, habitat value and estuarine productivity are all closely related to temperature and salinity. In particular, many California embayments have an annual cycle related to weather patterns and river inflow. They are positive estuaries, with salinity decreasing toward the head of the bay, in winter and spring. In positive estuarine circulation, the surface layer flows seaward (averaging over the tidal cycle) and the bottom layer has a net landward movement. Morro Bay and other small California estuaries often become negative or hypersaline systems in late summer and fall. That is, the salinity in the bay is higher than in the adjacent ocean and increases toward the head of the bay, because evaporation within the bay exceeds freshwater input from rain and river flow.

Salinity in the vicinity of the MBPP cooling water intakes tends to be similar to that of the open waters of Estero Bay. During the period from August 1971 to July 1972, salinity at the MBPP intake ranged from 33.3 to 34.2 (PG&E, 1973). As one moves further into the back bay, away from the moderating influence of the open ocean, fluctuations in salinity become more extreme. An area of decreased salinity exists in the vicinity of the delta formed by Chorro and Los Osos Creeks. The extent of this freshwater influence is dependent upon the discharge volumes of the creeks and is, therefore, quite seasonal. Runoff is at its highest during the rainy season which runs from November through March. Salinity near the mouth of Chorro Creek was measured to be as low as

22.4 (Gerdes et al., 1974). During the late summer when the freshwater input is at a minimum and evaporation is high, salinity within pools in the salt marsh has been measured at 38.2 (Gerdes et al., 1974). Thus, the head of bay can exhibit a substantial degree of hypersalinity.

The salinity distribution in Morro Bay has been impacted by several factors, including consumptive water use in the drainage basin and changes to the entrance channel configuration. The latter effect is likely to have been the most important, because it strongly affects both the mean (estuarine) circulation and the salinity intrusion regime produced by the mean circulation. The mean, density-driven circulation in an estuary is very sensitive to channel depth -- the strength of the mean flow varies as the square or cube of the depth. The salinity distribution is even more sensitive; top-to-bottom salinity differences increase with the fourth or fifth power of maximum channel depth. This means that, during periods of positive estuarine circulation, landward bottom currents are substantially stronger, due to the presence of the navigation channel, than they would be otherwise. Seaward bottom currents are stronger than in the prechannel system during periods of negative estuarine circulation.

The strongest impacts of navigational development would be expected to occur during high flow periods, when salinity gradients are strong and sediment is supplied to the system from the watershed. Strong gravitational circulation is very effective at trapping sediment in the landward parts of a system, and the navigation channel extends to the middle of the bay, where some shoaling has occurred. The effects of the power plant intake are, in contrast, confined to the entrance area.

Thus, the Morro Bay Power Plant may interact with the seasonal salinity cycle to a limited degree, but in no manner that would have negative effects.

<u>Temperature</u>

Due to its proximity to the entrance of Morro Bay, water conditions at the MBPP cooling water intake tend to approximate those found in the open ocean waters of Estero Bay for most of the year. Monthly average seawater temperature measured at the MBPP intake structure ranged from 52 to 64° F during the period from January 1994 through December 1999 (Figure 6.5-8, PG&E and Duke Energy MBPP NPDES Monitoring Reports, 1994-1999). The yearly average ambient seawater temperature during this period ranged from 56 to 59°F; the highest yearly and daily averages for the period of 1994 to 1999 occurred during the El Niño event of 1997. Water temperatures within Morro Bay become more variable and extreme, due to climatic heating and cooling, as one progresses to the shallow waters of the back bay. The warmest temperatures are found in shallow water when the bay is hypersaline.

The power plant intake flow likely moderates temperatures near the mouth in Morro Bay to a limited degree, by promoting exchange with Estero Bay, where the annual temperature range is less than it is inside Morro Bay.

Sediment Transport and Habitat Changes

Shoaling of the bay and resultant loss of habitat and tidal prism have emerged as a point of public concern. Historic changes in Morro Bay depth, area and tidal prism have been examined in several reports, including Haltiner and Thor (1988, 1991), Josselyn et al. (1989) and Tetra Tech (1999). It is clear, despite methodological difficulties, that a substantial loss of tidal prism, likely about 25 percent, has occurred. Given that the tidal prism is now about 8,130 acre feet, it must have been in excess of 10,000 acre feet in 1884, a loss of at least 2,000 acre feet. This loss of tidal prism is related to changes in aeolian transport, hydrodynamic processes in the bay, and land use changes in the watershed. It may also be influenced by climate and tectonic processes not presently understood. There is no mechanism for the plant to have caused shoaling or loss of tidal prism landward of the plant.

Morro Bay - Summary of Changes in Hydrodynamic and Physical Habitat Processes

Morro Bay is a highly altered system. That the ecosystem has deteriorated over the last century is obvious, but the causes are not. This reflects the fact that ecosystem dynamics are very non-linear, and relating cause and effect in estuaries is notoriously difficult, when multiple alterations are present. In the present case, MBPP has played a rather small role in the large habitat changes that have occurred. The following factors have played much larger roles in the observed historical changes in physical processes than has the MBPP intake:

- Changes in entrance topography related to navigational development, including the closure of one of the original mouths of estuary (North of Morro Rock), channel and jetty construction, dredging, and dredged material disposal. Because the navigation channel is now deeper than it was, the mouth of the estuary does not close or almost close as it historically must have in some years. The changes in channel depths and seawater intrusion have in turn changed the seasonal salinity cycle and transitions to and from a hypersaline state. Navigational development may also have contributed to loss of tidal prism through dredged material disposal and jetty construction.
- Habitat and tidal prism loss through diking, filling, agricultural and urban development.

- Loss of freshwater input from the watershed, due to consumptive use, likely coupled with an increase in sediment supply and pollutants related to land use and fires, as seen with the fire of August 1994 and the subsequent floods in 1995 (MBNEP, 2000). These appear to have caused a substantial increase in tidal marsh and loss of tidal prism between around 1895 and 1951.
- Water quality impairment related to watershed and urban development and agriculture.

Within this larger context of historical changes, the effects of the MBPP intake flow are minor and restricted to the entrance area. In particular, the role of the intake flow on circulation and sediment transport landward of the plant is small, and the plant operation does not affect the tidal prism at all. Enhanced exchange of water with the ocean caused by the plant may have a minor but positive impact on water quality during late summer.

Estero Bay

Estero Bay is a shallow, sandy bottom bay that lies between Estero Point to the north and Point Buchon to the south. The bay is a little over 15 miles in length and arcs inland a distance of about 5.5 miles. The gently sloping bottom of the bay has a maximum depth of about 300 feet (50 fathoms), and the 120-foot (20-fathom) depth contour lies 1 to 3 miles offshore. The majority of the bay is characterized by a subtidal sand bottom. The center of the bay's shoreline is a broad sandy beach that decreases in width, and transitions into a rocky intertidal zone as one approaches either of the points defining the northern and southern boundaries of the bay. Cooling water from the MBPP is discharged into Estero Bay from a short (275-foot) canal situated adjacent to the northeast edge of Morro Rock.

Water transport along the northern and central portions of the California coast, including Estero Bay, is primarily driven by the California Current. The California Current is generally characterized as a broad, shallow, slow moving southerly current. During the winter the California Current is occasionally displaced by the northerly moving Davidson Current. The near shore manifestations of the California Current can, however, be quite variable in both speed and direction (Lynn & Simpson, 1987). Localized conditions can be dramatically altered by winds, tides and surf conditions. Winds along this section of the California coastline are predominantly from the northwest, and tend to establish a counterclockwise gyre (circular current) within Estero Bay (SOCAL, 1973). Net water movement in the vicinity of the MBPP discharge tends to be northward while the gyre is established. Wave generated currents can accentuate the northward along shore water movement, particularly in response to swells generated from the south.

In addition to their role in controlling temperature and nutrient levels in the marine habitat, oceanic currents and wind driven waves create highly dynamic conditions of water movement and exchange. The California current transports water and free-drifting life forms southward along the coast from northerly locations during much of the year. During winter months, the Davidson Current intermittently transports water and organisms north along the coast. Major onshore-offshore exchange of water also occurs in association with the upwelling process that occurs regularly along the central California coast. The narrow continental shelf and straight coastline north of Point Conception expose the rocky coast to continuous and sometimes intense wave action.

Nearshore ocean temperatures along the California coast north of Point Conception are largely regulated by the California and Davidson currents and the seasonal upwelling of deeper ocean water (see Figure 6.5-9). Surface water temperatures measured from January 1996 through December 1997 at a location immediately south of Estero Bay, ranged from 49 to 68° F with a mean value of 57° F (J. Lindsey, Tenera, Inc., pers. Comm.). Temperatures within the shallow, sandy bottomed portions of the bay are reported by local residents to exceed the upper reading during calm windless periods. Temperatures in the bay tend to be highest in the late summer and lowest in the late winter and spring when the prevailing northwesterly winds are the strongest. The winds promote the offshore movement of the surface water mass and its subsequent replacement by the upwelling of cold, nutrient rich water from deeper layers. Seasonal upwelling plays an important role in temperature and nutrient cycling within the bay and along the entire coast of California. Upwelling is not, however, restricted temporarily, and can occur at anytime during the year when the necessary wind conditions persist.

Morro Creek and Willow Camp Creek

Morro Creek traverses the northwestern portion of the MBPP site west of the onsite tank farm. Willow Camp Creek flows westward into Morro Creek near the north end of the tank farm (see Figure 6.5-1). After the confluence of Willow Camp Creek with Morro Creek, Morro Creek continues to the ocean along the borders of MBPP. It empties into the ocean at the southern end of Atascadero State Beach north of Morro Rock. Stormwater discharge from MBPP takes place under the NPDES Permit into Willow Camp Creek at nine locations designated 003-A to 003-I.

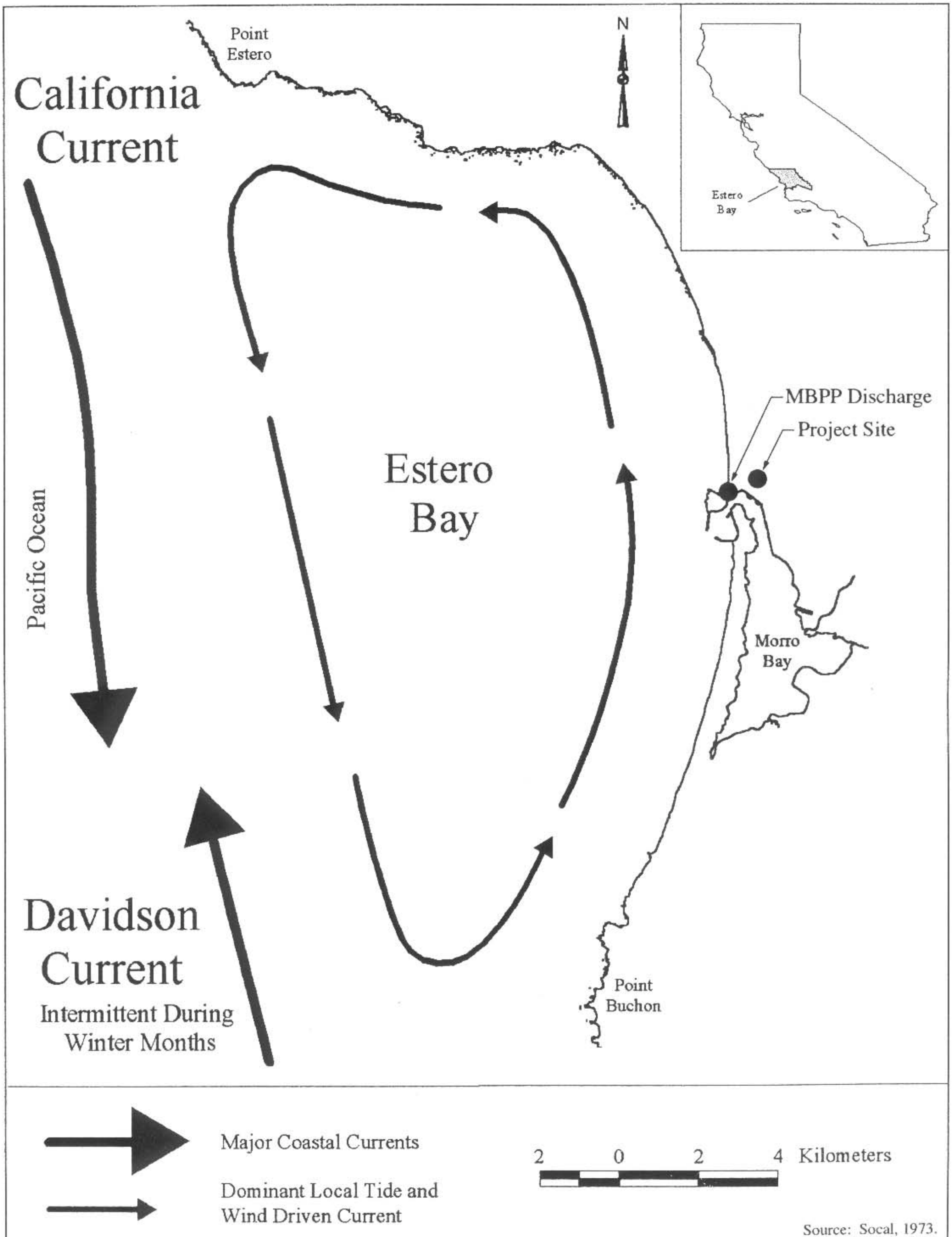


Figure 6.5-9. Schematic View: Typical Current Patterns in the Area of MBPP Discharge.

6.5.1.4.2 Water Quality

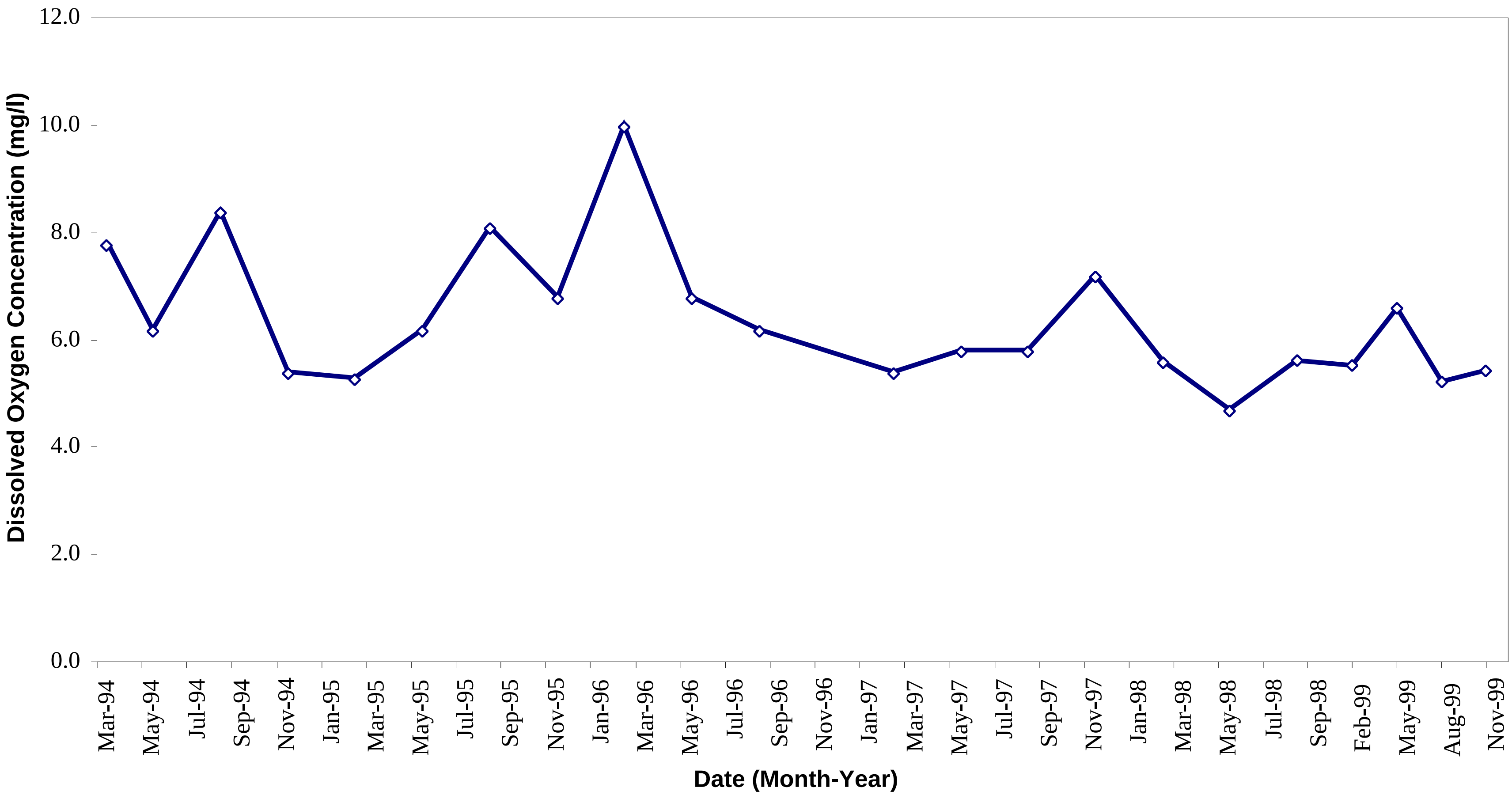
The physical and chemical character of water passing through the MBPP cooling system on most portions of the tidal cycle is essentially similar to that of the nearshore Pacific ocean water, because of the vast daily tidal exchange of water between Morro Bay and the Pacific Ocean. The exception is at the end of an outgoing tide, when (usually) warmer inland water originating in Morro Bay provides much of the source of intake water for MBPP.

Overall, the seasonal variability in temperature, salinity, and dissolved oxygen is low, reflecting the limited variation in the marine nearshore environment of Morro Bay, and the adjacent coastal waters. For example, during the 1971 to 1972 study reported by PG&E (1973), the range of nearshore Estero Bay ambient water temperatures was only from 52 to 60° F. The minimum was observed in January and the maximum in September. Salinity during the same period only varied from 33.4 to 33.8. Ambient dissolved oxygen ranged from 6.6 to 10.8 mg/L. No seasonal trends were observed in dissolved oxygen (see Figure 6.5-10).

Several of the "priority problems" that led to Morro Bay's inclusion in the EPA's National Estuary Program are specifically related to water quality. These problems include contamination by pathogens, suspended sediment, nutrients and heavy metals. In addition, the Morro Bay estuary is considered "impaired waters" for sediment, pathogens, and metals under Section 303(d) of the federal Clean Water Act. Chorro and Los Osos creeks are listed for sediment and nutrients. Chorro is also listed for metals, and Los Osos is listed for priority organics. This designation requires the RWQCB to determine pollutant loadings and develop attainment strategies for these water bodies. Pursuant to Section 303(d), a water is listed as "impaired" if evidence exists that a violation of a water quality standard has occurred, or there is a potential for a future violation. Sediment and sediment transport have been discussed above in Section 6.5.1.4.1 and in more detail in Appendix 6.5-3. Bacteria, nutrients, heavy metals and other toxics, are discussed below.

Bacteria

High levels of bacteria, including fecal coliform, have been detected in Morro Bay, generally in the southern half of the bay (MBNEP 2000). These elevated levels of bacteria present a potential health threat to those who utilize the bay for recreational purposes and economic threats to those who depend upon the resources of the bay for their livelihood. In recent years, sections of the bay's oyster beds have been closed or subject to restricted harvest due to high fecal coliform levels. At times, concentrations of bacteria in waters along the shorelines of Los Osos and Baywood have exceeded safe water body-contact standards as defined by the RWQCB.



SOURCE: MORRO BAY POWER PLANT NPDES MONITORING REPORTS, 1994-1999.

DISSOLVED OXYGEN
1994-1999

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FIGURE 6.5-10

Known sources for bacteria include run off from agricultural operations (cattle) in the watershed; urban runoff from Los Osos and the City of Morro Bay; and illegal dumping from "live-aboard" vessels (MBNEP 2000). Bacteria levels vary over time and appear to be highest after "first flush" rainfall events. Bay water in the location of the Morro Bay Power Plant tends to have low bacteria levels due to the proximity of the harbor entrance and tidal flushing.

Nutrients

Nutrient enrichment, primarily nitrogen and sometimes phosphorous, has been identified as a problem in both the back-bay and the fresh water creeks flowing into Morro Bay (MBNEP 2000). Impacts of nutrient enrichment include increased algal growth, decreased water clarity, toxicity, and reduced dissolved oxygen levels. When excessive nutrients are present, alga growth can become excessive and eutrophication can result as the alga dies and decays and robs the water of oxygen. Fish kills and losses of sea grass beds are common consequences.

Monitoring by the National Monitoring Program (RWQCB, 1999) shows a strong correlation between nutrient contamination and the presence of irrigated agriculture. In addition, surface run-off from urban areas contains nutrients from homeowner applications. The effects of nutrient contamination are more prominent in the creeks and back-bay where low-flow conditions and limited tidal exchange allow for nutrient build up. Consequently, nutrient contamination is not considered to be a water quality issue in the area of the power plant.

Heavy Metals and Other Toxics

Inactive mines in the upper Morro Bay watershed are believed to have contributed to high levels of heavy metals, particularly chromium and nickel, found in sediments eroding from these areas. Other possible heavy metal contamination concerns include copper and lead, which were both once used in "antifouling" paints for marine vessels, and copper from brake pad dust (MBNEP 2000).

Heavy metal contamination appears to be most prevalent in the creek sediment and back-bay mud. According the RWQCB, recent sediment samples from Chorro Creek show levels of chromium and nickel that exceed RWQCB Basin Plan Water Quality Objectives (RWQCB, 1999). Sediment in the area of the MBPP is predominantly ocean sediment transported by the long shore current and has little or no heavy metal contamination. Water quality samples collected annually by MBPP personnel show intake water concentrations of metals such as chromium, cadmium, nickel, arsenic, zinc, lead, and mercury are typically below limits of detection.

Various sampling events, in various locations within the Bay and watershed, show concentrations for other toxics, such as pesticides and polychlorinated biphenyl (PCB), to be low, especially when compared to data from other coastal creeks and estuaries (MBNEP 2000).

6.5.1.5 Ground Water Bodies and Related Geologic Structures

Hydrogeologic conditions have been evaluated at the site as far back as 1958, and more recently in reports completed in 1987, 1997 and 1998. MBPP lies in the southwestern portion of the Morro Hydrologic Subarea of San Luis Obispo County (see Figure 6.5-11). The Morro Hydrologic Subarea is bordered by the Los Padres National Forest on the east, north and south and Morro Bay on the west. The water-bearing formations from oldest to youngest are the upper pleistocene old dune sands (Qso), recent quaternary alluvium (Qal), and recent dune sand (Qs). Underlying the water bearing formations is the essentially nonwater-bearing Jurassic Franciscan Formation (Department of Water Resources [DWR] 1972). A summary of the water-bearing characteristics of the regional geologic formations is shown in Table 6.5-5.

6.5.1.5.1 Hydrogeologic Units

The Qso attains a maximum thickness of 150 feet, and extends inland from the coastline a maximum of 0.75 mile (Figure 6.5-12). It is composed of primarily arkosic sands with some interbeds of clay, silt and gravel and is moderately permeable (DWR, 1972).

The Qal attains a maximum thickness of 150 feet. It extends along the tributaries of Morro Creek to within 0.25 mile of the mouth of Morro Creek where it interfingers with the Qs. The Qal is composed primarily of sand and gravel with some thin interbeds of silt and clay and is highly permeable (DWR, 1972).

6.5.1.5.2 Hydrogeologic Conditions

The primary source of ground water in the Morro Hydrologic Subarea is infiltration of precipitation. Precipitation over the basin falls on the Jurassic Franciscan Formation (Jf) and either infiltrates through joints and fractures, runs off into the tributaries of Morro Creek, or is lost by evapotranspiration. Infiltrating precipitation in the Jf recharges the ground water body by migrating along joints and fractures which intersect the Qal along Morro Creek. Most of the recharge to the ground water body occurs from surface run-off which infiltrates along Morro Creek. Infiltration also occurs where rainfall falls directly on the Qso, the Qs and the Qal along Morro Creek.

TABLE 6.5-5

REGIONAL GEOLOGIC UNITS AND THEIR HYDROGEOLOGIC DESCRIPTIONS AND PROPERTIES

FORMATION	MAXIMUM THICKNESS (in feet)	GENERALIZED LITHOLOGY
HOLOCENE Recent Dune Sand - Qs	25 +	Very fine- to medium-grained sands. Insignificant ground water production; moderate permeability when saturated.
Alluvium - Qal	70 +	Sand and gravel separated by relatively thin interbeds of silt and clay. Water-bearing; data indicate high permeabilities.
UPPER PLEISTOCENE Old Dune Sand - Qso	150 +	Very fine- to medium-grained arkosic sands with thin interbeds of clay, silt, and gravel. Water-bearing; limited data indicate moderate permeabilities.
LOWER PLEISTOCENE Paso Robles - Qpr	290	Interbedded marine sediments composed of clays, silts, sands, and gravels. Water-bearing; limited data indicate coarse material exhibits high permeabilities.
TERTIARY Monterey - Tms	Unknown	Undifferentiated marine sedimentary deposits. Predominantly shales which grade into siltstones. Nonwater-bearing; capable of transmitting water only through joints, fractures, and bedding planes.
Volcanics - Tmv		Andesite-dacite intrusives. Nonwater-bearing; capable of transmitting water only through fractures and joints.
JURASSIC TO CRETACEOUS Franciscan - Jf	1,500 +	Predominantly composed of sandstones interbedded with shale, siltstone, and chert layers. Essentially nonwater-bearing; capable of transmitting water derived from precipitation.

98-710/MorroBay/Reports/AFC(text)/Tbls&Figs (8/12/99/jb)

Source: Department of Water Resources 1972.

The Qs attains a maximum thickness of 25 feet and is limited to areas within 0.25 mile of the coastline. It is saturated only during high water conditions, and does not yield significant quantities of water. It is moderately permeable when saturated.

SOURCE: RCRA PART B PERMIT APPLICATION VOLUME 3 HYDROLOGICAL ASSESSMENT REPORT BY KINTR, 1985.

REGIONAL MAP OF GROUND WATER RECHARGE AND DISCHARGE AREAS, AND PERENNIAL GROUND WATER FLOW DIRECTION

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FIGURE 6.5-11

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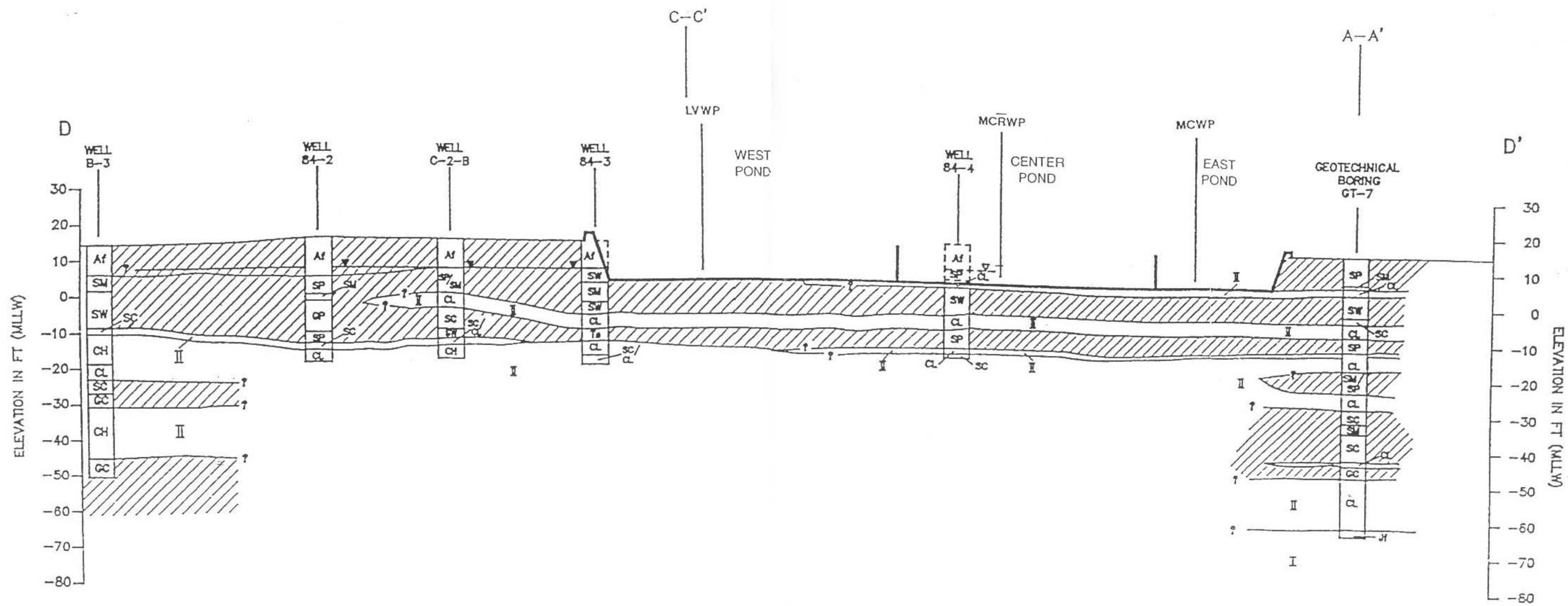


WELLS PROJECTED INTO SECTION

WELL	DISTANCE AND DIRECTION	
B-3	130 FT	NW
84-2	45 FT	NW
C-2-B	55 FT	NW
84-3	110 FT	NW
84-4	105 FT	NW
GT-7	0 FT	NW

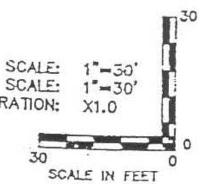
HYDROSTRATIGRAPHIC UNITS (DISCUSSED IN TEXT)

- I — FRANCISCAN FORMATION (BEDROCK)
- II — DISCONTINUOUS LOW PERMEABILITY UNIT
- III — PERMEABLE AQUIFER UNIT

LEGEND

- SW — UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL
- ▼ — POTENTIOMETRIC SURFACE ELEVATION (MEASURED 5/18/87)

VERTICAL SCALE: 1"=30'
HORIZONTAL SCALE: 1"=30'
VERTICAL EXAGGERATION: X1.0



Source:
Mittelhauser Corporation
PG&E Morro Bay Power Plant Report
December 8, 1992.

SOURCE: PHASE II ESA REPORT BY PG&E, JULY 1997

HYDROSTRATIGRAPHIC CROSS SECTION D-D'

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FIGURE 6.5-12

Under natural or nonpumping conditions, ground water moves from the recharge source provided by Morro Creek in the northeast to the southwest portion of the Morro Hydrologic Subarea, where it discharges into Estero Bay and Morro Bay. During rare periods of increased pumping of the Morro Bay municipal well field near the coast, the hydraulic gradient reverses locally allowing seawater intrusion to move landward in the alluvial aquifer. The maximum extent of seawater intrusion in the Morro Hydrologic Subarea is believed to be 1.5 miles inland (DWR, 1972). The perennial direction of ground water flow is westward towards the Pacific Ocean (Figure 6.5-11).

6.5.1.6 Site Ground Water Regime

The water-bearing units at the site consist primarily of an alluvial aquifer with interbeds of silt and clay. The aquifer varies in thickness from approximately 72 feet at the eastern edge of the site to a thickness of 63 feet at the western edge of the site. The contact between the alluvium and the sandstones and shales of the Jf generally defines the vertical extent of the water-bearing formations (Figure 6.5-12). The Jf underlies the site at a depth of about 75 feet, or 60 feet below mean sea level (MSL).

The depth to ground water generally varies from 3 to 15 feet below the ground surface across the site. The regional ground water gradient across the site is from northeast to southwest, following the trend of the floodplain of Morro Creek. The ground water elevation varies from about 12 feet above MSL at the eastern edge of the site to about 3 feet above MSL at the western edge of the site.

The site ground water system is generally unconfined. Review of available boring logs shows the discontinuous nature of the clay layers underlying the site and indicates that the clays are probably not capable of inducing confined ground water conditions.

Water-bearing zones beneath the site appear to be contiguous with the regional ground water system. The deposits at the east and southeastern portion of the site which contain larger amounts of silt and clay are part of the Qal. The deposits at the western edge of the site are part of the Qso and Qs. Ground water moves through Qal into the Qso and Qs, and discharges into Morro Bay and Estero Bay.

Onsite ground water is recharged by infiltration from precipitation and by offsite ground water flow from the northeast. Onsite ground water generally flows toward the southwest, and is locally influenced by ground water pumping and tidal fluctuations.

6.5.1.7 Aquifer Parameters

Review of site investigations performed by others, specifically the Comprehensive Groundwater Monitoring Evaluation (CGME) by Mittelhauser in 1995 determined an estimate of the principal hydraulic parameters (i.e., hydraulic conductivity and storage coefficient), the seepage velocity in the uppermost permeable unit, the vertical hydraulic gradients in the upper, middle, lower, permeable units, and the hydraulic connection between the three permeable units, as determined from nine slug tests and two pump tests. Figure 6.5-13 shows the monitoring well locations.

The following hydrogeologic data results and conclusions were presented by Mittelhauser in the CGME report (1995), and are summarized below:

- Nine slug tests were performed on monitoring wells 88-3, 88-4, 92-1, 92-2, 92-3, C-2-A, C-2-B, C-3-B and 94-1-M (Table 6.5-6). Falling and rising head data were evaluated for the wells. The hydraulic conductivity values for the upper member of the upper permeable unit ranged from 0.002 to 0.040 feet per minute (ft/min). Slug test hydraulic conductivity values for the lower portion of the upper permeable unit were 0.027 and 0.105 ft/min in well C-2-B and 0.004 ft/min in well C-3-B. The estimated storage coefficient was 6×10^{-4} for well C-2-B. The hydraulic conductivity of the middle permeable unit was 0.0459 and 0.118 ft/min, with a storage coefficient of 1.0×10^{-8}. The storage coefficient values indicate that the middle permeable unit is distinctly isolated from the upper permeable unit, and representative of a confined aquifer.
- A 48-hour pump test (Pump Test 1) was performed on the upper member of the upper permeable unit. Monitoring well 88-3 was used as the pumping well and wells 88-4, 92-1, 92-2, 92-3, C-2-A, C-2-B and C-3-B were used as observation wells. Drawdown and recovery data were collected and evaluated for the observation wells. The results show that the upper member of the upper permeable unit has a hydraulic conductivity of 13.11 ft/min at well C-2-A at 0.3 ft/min at well 92-2. The average drawdown observed was 1.63 ft/min and an average of 0.47 ft/min for recovery. The hydraulic conductivities for the lower member were 1.01 and 9.73 ft/min with an average of 2.86 ft/min. The data indicate that when the upper member is heavily stressed from pumping, the two units of the upper permeable zone have some hydraulic connection.
- A 48-hour pump test (Pump Test 2) was performed on the middle permeable unit. Monitoring well 94-1-M was used as the pumping well and 88-2, 88-3, 88-4, 92-2, 92-3, C-2-A, C-2-B and C-3-B were used as observation wells. Drawdown and recovery data were collected and evaluated for the observation wells. Using the Papadopoulos-Cooper method for analyzing a pumped well under

TABLE 6.5-6

GROUND WATER MONITORING WELL AND PIEZOMETER SUMMARY

WELL IDENTITY	WELL LOCATION	WELL POSITION	CASING DIAMETER (in)	GRADE ELEVATION (ft, MLLW)	SCREEN LENGTH (ft)	ELEVATIONS OF TOP AND BOTTOM OF SCREEN (ft, MLLW)	HYDROSTRATIGRAPHIC UNIT(S) SCREENED	STATUS
84-1	157' N MCWI	N	3	16.09	25.5	9.09, -16.41	II, III	ABN
88-1	188' N MCWI	N	4	15.95	13.3	9.95, -3.30	III	GLM
84-2	95' W MCWI	D-MCWI	3	16.62	27.5	9.62, -17.88	II, III	GLM
88-3	25' S MCWI	D-MCWI	4	15.79	13.4	9.79, -3.61	III	GQM
88-4	32' S MCWI	D-MCWI	4	15.54	12.0	9.54, -2.46	II, III	GQM
92-1	111' SE MCWI	U-MCWI	4	16.00	15.0	11.00, -4.00	III	GQM
92-2	18' NE MCWI	U/C-MCWI	4	17.00	15.0	12.00, -3.00	III	GQM
92-3	4' SW MCWI	C-MCWI	4	15.90	15.0	10.90, -4.10	III	GQM
84-5	60' S OWSS	U/D-OWSS	3	16.37	49.5	10.87, -38.63	III	ABN
84-6	60' OWSS	U/D-OWSS	3	14.65	44.1	9.65, -34.45	III	ABN
84-7	42' S OWSS	U/D-OWSS	3	14.73	44.3	4.73, -39.57	II, III	ABN
84-8	91' E OWSS	U/D-OWSS	3	14.26	38.3	8.26, -30.74	III	ABN
85-9	81' W OWSS	D-0WSS	3	15.35	40.0	5.35, -34.65	III	ABN
85-10	70' N OWSS	D-OWSS	3	15.36	40.0	5.36, -34.64	III	ABN
85-11	25' S OWSS	U/D-OWSS	3	15.14	35.0	5.14, -29.86	III	ABN

WELL LOCATION
OWSS = Oil Water Separator System
MCWI = Metal Cleaning Waste Impoundments
G = General Plant Area

WELL POSITION
D = Downgradient
U = Upgradient
N = Neither U or D
C = Cross Gradient

SCREENED HYDROSTRATIGRAPHIC UNIT
II = Discontinuous Low Permeability Soils
III = Aquifer Soils

STATUS
GLM = Ground Water Level Monitoring
GQM = Ground Water Quality Monitoring

TABLE 6.5-6

GROUND WATER MONITORING WELL AND PIEZOMETER SUMMARY (Continued)

WELL IDENTITY	WELL LOCATION	WELL POSITION	CASING DIAMETER (in)	GRADE ELEVATION (ft, MLLW)	SCREEN LENGTH (ft)	ELEVATIONS OF TOP AND BOTTOM OF SCREEN (ft, MLLW)	HYDROSTRATIGRAPHIC UNIT(S) SCREENED	STATUS
C-1-C	35' W MCWI	U/D-OWSS	4	15.11	10.0	-17.89, -27.89	III	GLM
C-2-A	35' W MCWI	D-MCWI	4	16.14	5.0	8.14, 3.14	III	GLM
C-2-B	35' W MCWI	D-MCWI	4	16.06	5.0	-6.94, -11.94	II, III	GLM
85-P-1	G	N	1.5	15.72	20.0	5.72, -14.28	III	GLM
85-P-2	G	N	1.5	15.20	9.0	5.2, -3.8	III	GLM
P-5	G	N	2	16.04	5.0	10.54, 5.54	III	GLM
P-6	G	N	2	16.62	10.0	2.62, -7.38	II, III	GLM
P-7	G	N	2	15.46	10.0	3.46, -6.54	II, III	GLM
P-8	G	N	2	33.45	10.0	7.45, -2.55	III	GLM
P-9	G	N	2	21.21	10.0	8.21, -1.79	III	GLM
P-10	G	N	2	20.37	10.0	1.57, -8.43	II, III	GLM
P-11	G	N	2	22.12	5.0	4.12, -0.88	II, III	GLM
P-12	G	N	2	21.86	15.0	6.56, -8.44	II, III	GLM
P-13	G	N	2	40.33	10.0	13.33, 3.33	III	GLM

98-710/ AFC(text)/Tbls&Figs (10/11/00/rw)

WELL LOCATION
OWSS = Oil Water Separator System
MCWI = Metal Cleaning Waste Impoundments
G = General Plant Area

WELL POSITION
D = Downgradient
U = Upgradient
N = Neither U or D
C = Cross Gradient

SCREENED HYDROSTRATIGRAPHIC UNIT
II = Discontinuous Low Permeability Soils
III = Aquifer Soils

STATUS
GLM = Ground Water Level Monitoring
GQM = Ground Water Quality Monitoring

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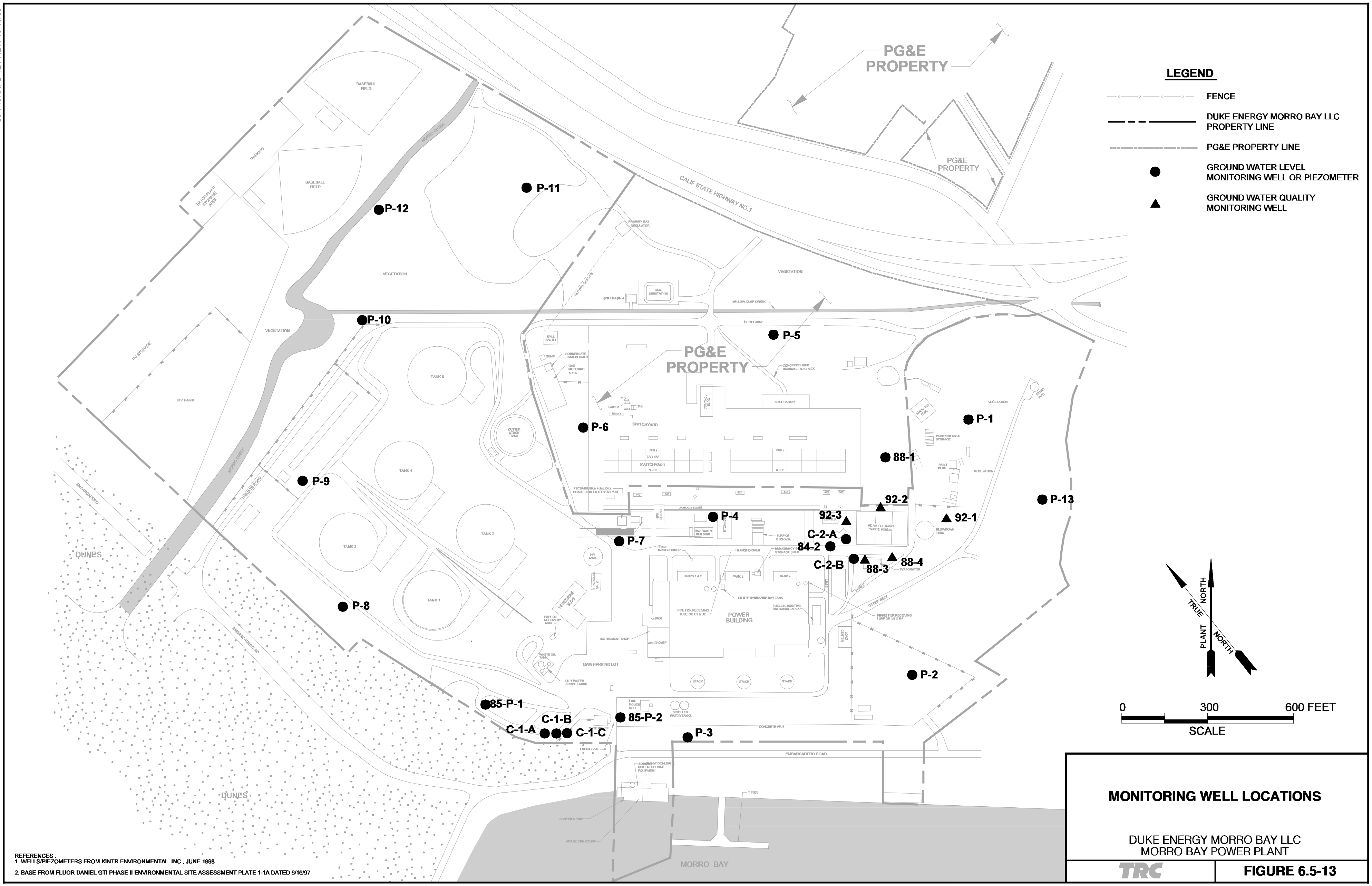

REFERENCES :
1. WELLS/PIEZOMETERS FROM KINTR ENVIRONMENTAL, INC., JUNE 1998.
2. BASE FROM FLUOR DANIEL GTI PHASE II ENVIRONMENTAL SITE ASSESSMENT PLATE 1-1A DATED 6/16/97.

MONITORING WELL LOCATIONS

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FIGURE 6.5-13

confined conditions, the results indicate a transmissivity of 3.78 x 102 ft/min and a storativity of 0.01. Recovery data analysis by the Recovery Method indicates a transmissivity value of 0.00422 ft/min and a hydraulic conductivity of 4.168 x 10-03 ft/min was calculated for this unit. The overall hydraulic conductivity is 3.974 x 10-03 ft/min for the middle permeable unit. The results of the drawdown data analysis show that pumping of the middle permeable unit has no effect on wells in the upper permeable unit. Therefore, the upper and middle permeable units are not hydraulically connected.

- A vertical gradient of 0.084 feet per foot (ft/ft) was calculated between the upper and lower member of the upper permeable unit. In addition, a vertical gradient of 0.154 ft/ft was calculated between the lower member of the upper permeable unit and the middle permeable unit.
- Seepage velocities for both the upper member and lower member of the upper permeable unit were calculated using data derived from both pump tests, laboratory analysis for effective porosity, and the hydraulic gradient. The seepage velocity for the upper member is 3.3×10^{-3} ft/min (4.75 feet per day). The seepage velocity for the lower member is 9.53×10^{-3} ft/min (13.73 feet per day [fpd]). The units are separate and distinct from each other.

6.5.1.7.1 General Ground Water Quality

General ground water quality for MBPP has been evaluated from data collected as part of the site ground water monitoring program from August 1984 to August 1985, by Fluor Daniel GTI during Phase II Environmental Site Assessment (ESA) field work in 1997, and from data from PG&E production wells. A total of 11 monitoring wells and two piezometers comprised the ground water monitoring system at the site for the 1984-1985 program. Eight monitoring wells in the vicinity of the surface impoundments were installed by PG&E during May through August 1984. Monitoring wells 84-1 to 84-4 are located near the metal cleaning waste impoundments and monitoring wells 84-5 to 84-8 are located near the oil water separator impoundments. Monitoring wells 84-1 and 84-5 were intended to serve as upgradient background monitoring locations. Three additional monitoring wells (85-9 to 85-11) and two piezometers (85P-1 and 85P-2) were installed during April 1985 in the vicinity of the oil water separator impoundments. In November 1985 an additional 13 piezometers were added throughout the general plant area as indicated in Figure 6.5.13. Currently there are 5 ground water quality monitoring wells (88-3, 88-4, 92-1, 92-2, 92-3) and 22 ground water level wells and piezometers at the site. Monitoring well construction details are summarized in Table 6.5-6.

Quarterly sampling of monitoring wells is performed on a regular basis as provided in the Ground Water Monitoring Plan. Chemical analyses are performed for ground water suitability parameters (40 Code of Federal Regulation [CFR] 265.92 [b] [1]), ground water quality parameters (40 CFR 265.92 [b] [2]), indicator parameters (40 CFR 265.92 [b] [3]) and chemical parameters selected by PG&E on the basis of their suspected presence in wastes discharged to the impoundments. Ground water monitoring parameters and sampling frequencies are listed in Table 6.5-7.

Ground water quality at the site has remained stable for the past 5 years as shown in Appendix 6.5-4. Most constituents remain below the federal criteria for the monitoring wells. The constituents which do not have an associated federal criteria have also remained stable in their concentrations for the past 5 years.

As was previously noted, salt water intrusion occurs up to 1.5 miles inland in this area which can be seen in the few constituents which exceed the federal criteria. Chloride, and sodium and manganese exceed the federal criteria on a regular basis. In comparing these ground water values to those obtained in the period of 1984-1985 the ground water quality appears to be approximately the same. Since this water is not used for potable service and the quantity of ground water use is projected to be the same with the new units, the project is not expected to affect the ground water quality.

6.5.1.8 Water Inundation Zones

As shown in Figure 6.5-14, the base flood elevation (100-year floodplain), denoted as Zone A14, extends into the northerly portion of the Project Area [See Federal Emergency Management Agency ("FEMA") Flood Insurance Rate Map ("FIRM"), entitled City of Morro Bay, (Panel No. 060309 0005C, Revised November 1, 1985)]. The balance of the Project area falls between the 100-year base flood and 500-year flood elevations denoted as Zone B on the FIRM and Figure 6.5-14. The Project area does not fall within a coastal flood zone, and does not fall within a regulatory floodway. As noted by FEMA's Flood Insurance Study, (FIS) supporting the FIRM: "[t]here is no history of noted by FEMA's Flood Insurance Study, (FIS) supporting the FIRM: "[t]here is no history of serious flood problems from the streams that flow through Morro Bay." (Flood Insurance Study for the City of Morro Bay, page 4 (Nov. 1, 1985). The only specific flooding information in the Morro Bay area is anecdotal reports of flooding in 1973 in the adjacent City (Id. at 4). However, no flooding has ever been reported or experienced on the MBPP site.

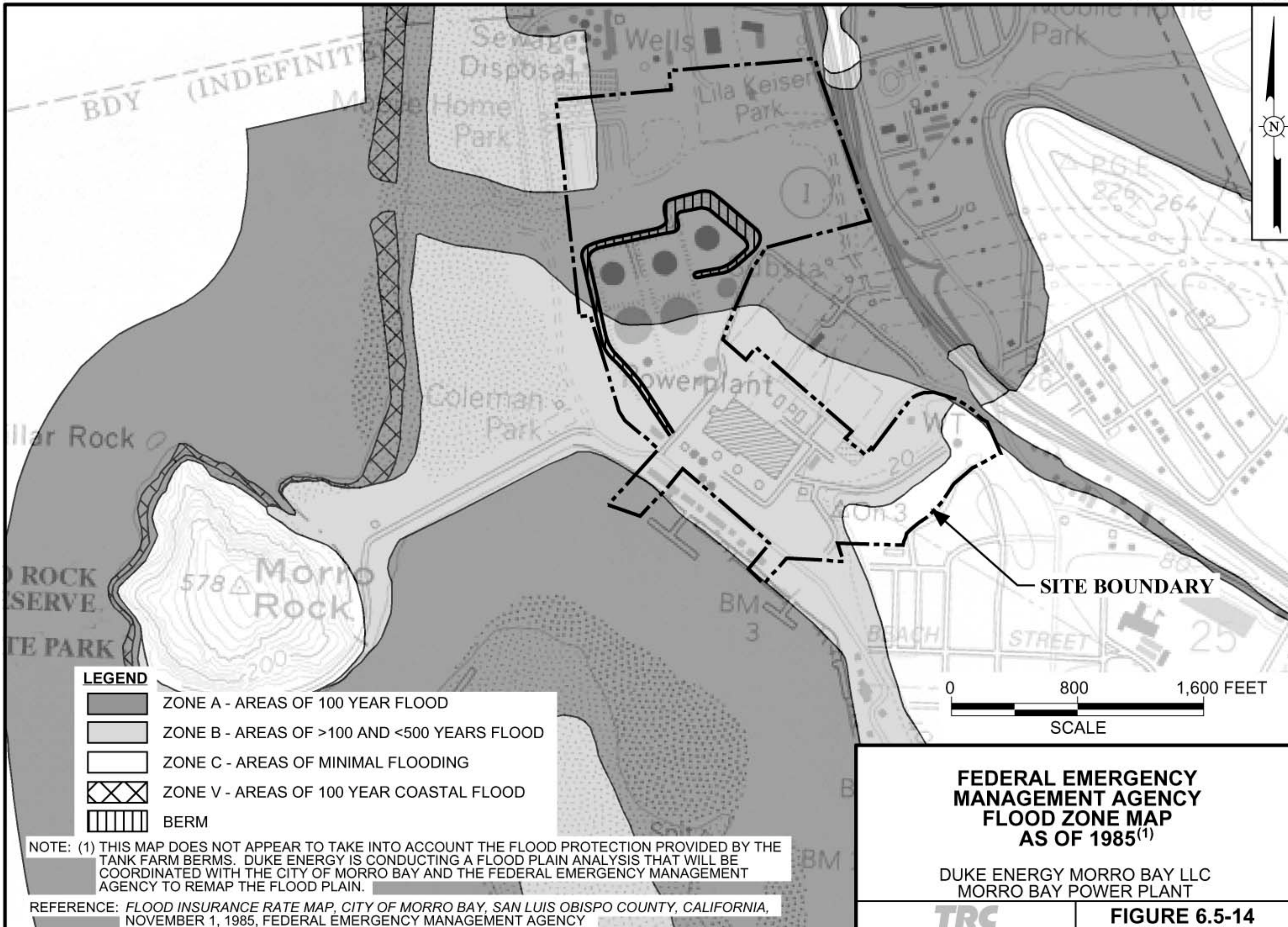
TABLE 6.5-7

MONITORING PARAMETERS
MONITORING WELLS 92-1, 92-2, 88-3 AND 88-4

ANALYTES[1]	MONITORING PARAMETER QUARTERLY SAMPLING STATISTICAL ANALYSIS	CONSTITUENTS OF CONCERN QUARTERLY/ANNUAL SAMPLING[2] STATISTICAL ANALYSIS	WATER QUALITY PARAMETER QUARTERLY/ANNUAL SAMPLING[3] NO STATISTICAL ANALYSIS
Ammonia	X		
Arsenic		X	
Bromide	X		
Barium		X	
Calcium			X
Chloride			X
Total Chromium		X	
Cobalt		X	
Copper	X		
Fluoride	X		
Iron		X	
Magnesium		X	
Manganese			X
Nickel		X	
Oil and Grease			X
Potassium			X
Sodium			X
Silver			X
Sulfate	X		
Vanadium		X	
Zinc		X	

(1) Samples from all ground water monitoring wells will be analyzed for the same analytes as designated above.
(2) Quarterly sampling for 2 years (8 quarters), then annual sampling.
(3) Quarterly sampling for 2 years, then biennial sampling (recently changed back to Annual Sampling).

The FIRM and related FIS show that the 100-year base flood elevation at Zone A14 in the northern portion of the Project area is at 21 feet (1929 NVGD). The 1929 NVGD is 2.73 feet higher than elevation data developed by Bestor Engineers, Inc based on the USGS benchmark (2298 C 1978) located in the median of Embarcadero Road in Morro Bay and having a MLLW of 15.19 feet as the reference point. Thus, based on MLLW, the 100-year base flood elevation would be 23.73 feet MLLW while the 500-year flood elevation varies between 24.73 and 25.73 feet MLLW (22 - 23 feet NVGD). The FIRM depiction of the 100-year base flood area does not reflect the presence in the



NOTE: (1) THIS MAP DOES NOT APPEAR TO TAKE INTO ACCOUNT THE FLOOD PROTECTION PROVIDED BY THE TANK FARM BERMS. DUKE ENERGY IS CONDUCTING A FLOOD PLAIN ANALYSIS THAT WILL BE COORDINATED WITH THE CITY OF MORRO BAY AND THE FEDERAL EMERGENCY MANAGEMENT AGENCY TO REMAP THE FLOOD PLAIN.

REFERENCE: *FLOOD INSURANCE RATE MAP, CITY OF MORRO BAY, SAN LUIS OBISPO COUNTY, CALIFORNIA,* NOVEMBER 1, 1985, FEDERAL EMERGENCY MANAGEMENT AGENCY

FEDERAL EMERGENCY MANAGEMENT AGENCY FLOOD ZONE MAP AS OF 1985(1)

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FIGURE 6.5-14

Project area of the existing berm and dike (levee) system surrounding the tank farm. This berm and dike system has been in place since the 1940's to 1950's, well prior to the development of the 1985 FIRM.

The top of the berm surrounding the tank farm is approximately at elevation 33.2 to 33.9 feet (MLLW). Thus, the berm and dike system is well above the 23.73 foot MLLW 100-year base flood elevation. The elevation at the base of the tanks within the berm and dike system is approximately 22.2 feet MLLW. Thus, under existing conditions, the Project area, although partially mapped on the relevant FIRM panel as being within zone A14 (within the 100 year flood plain) is, due to the long-standing presence of the berm and dike system, effectively elevated above the FEMA-calculated 100-year base flood elevation. For the new Project, all standards applicable to construction occurring within a mapped 100-year base flood elevation, will be met, or action will be taken to ensure that the FIRM is revised or amended to reflect the presence of a levee system (dike and berm) or grade elevations above the 100-year base flood elevation, or a combination of the above.

6.5.1.9 Cooling Water System Discharge Area Structures and Locations

Figure 6.5-15 shows the coastal area in the vicinity of the discharge from MBPP on the north side of Morro Rock. As indicated in the figure there are five pipelines on the ocean floor within 12,000 feet (2 nautical miles) to the north of the MBPP once-through-cooling discharge location. They are:

- Oil transfer line to MBPP storage tanks (inactive).
- Publicly Operated Treatment Works (POTW) discharge line from City wastewater treatment plant.
- Three transfer lines to the Chevron facility (inactive).

Discharge to Estero Bay from the POTW treated effluent line is allowed under an NPDES Permit. The end of this discharge line is located approximately 6,000 feet north-northwest of the discharge from MBPP. It is located at 35°23'11" north latitude and 120°52'29" west longitude in approximately 50 feet of water. The line is 27 inches in diameter and is equipped with 33 diffusers. The wastewater is treated at the POTW for conventional parameters removal such as biological oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids (TSS). The wastewater discharge flow capacity is 1.3 mgd (approximately 900 gpm). The negligible interaction of this discharge with the MBPP cooling water discharge plume is discussed under cumulative impacts, below. This is the only continuous discharge to Estero Bay in the vicinity of MBPP.

Additionally, there is a permitted stormwater discharge from the MBPP into Morro Bay located just west of the intake structure designated at Discharge 002 (see Figure 6.5-15).

6.5.2 IMPACTS

Significance criteria were determined based on California Environmental Quality Act Guidelines (CEQA), Appendix G, Environmental Checklist Form (approved January 1, 1999) and on performance standards or thresholds adopted by responsible agencies. An impact may be considered significant if the Project results in:

- Violation of RWQCB water quality standards or waste discharge requirements.
- Substantial depletion of ground water supplies or substantial interference with ground water recharge such that there would be a net deficit in aquifer volume or a lowering of the local ground water table.
- Substantial alteration of the existing drainage pattern of the site or area in a manner that would result in substantial flooding, erosion or siltation on or offsite.
- Substantial adverse change in physical conditions creating run-off water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional polluted run-off.

6.5.2.1 Construction Impacts

During construction activities, including onsite oil tank demolition, plant construction, and the demolition of the existing power plant and stacks, temporary berms, silt fences, and containment will be provided to control stormwater run-off and will comply with the requirements of an erosion control plan which will be prepared to ensure that construction activities utilize best management practices and conform to the applicable regulatory requirements**.** Work will be performed under an approved construction permit which requires the above plans and control measures to be in place.

Prior to utilizing or closing the surface areas of the site exposed by the tank demolition and plant demolition activities, the subsurface soils must be examined and remediated if contamination is found. During the time soil sampling and analysis is being performed, the exposed soil area will be protected by covering it with a plastic material to prevent potential contamination of the ground water by percolation through impacted soils.

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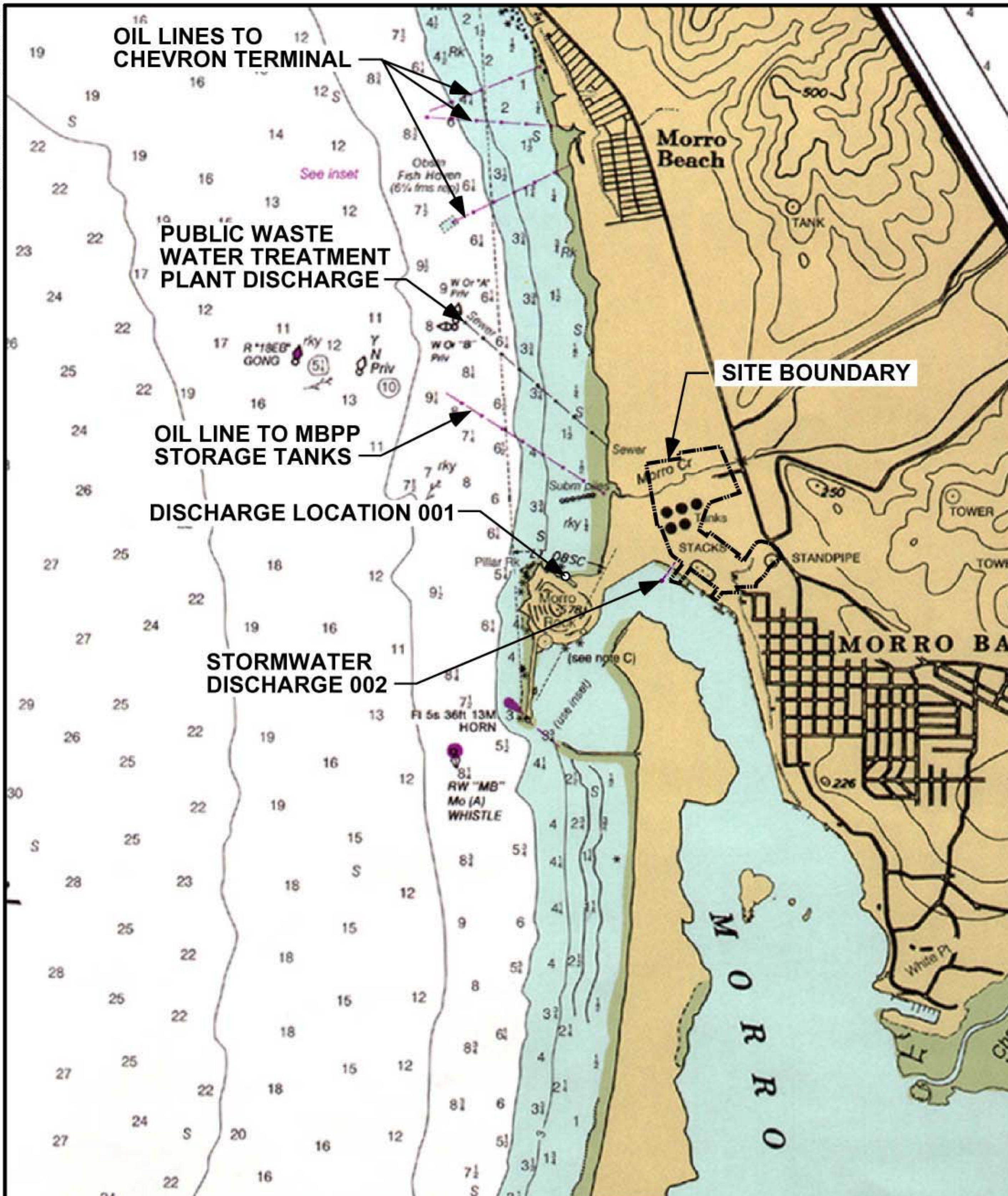

0 3,000 6,000 FEET

SCALE

DISCHARGE LOCATIONS IN VICINITY OF MBPP

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FIGURE 6.5-15

Although the building housing the cooling water intakes will be upgraded, no structural alterations are required in the water to the existing Units 1 through 4 cooling water intake and discharge structures for utilization by the Project. Therefore, no construction or related impacts will occur to Morro Bay or Estero Bay water resources.

During construction, the use of potable water at the site is expected to increase to serve the needs of construction workers. This demand will be accommodated with water brought in for the construction workers. Onsite showering will not be available to the construction crews. The use of portable toilets will also assure that the Project construction will not impact the City of Morro Bay's sanitary sewer system. Therefore, no significant adverse impacts on potable water or sanitary use are projected.

MBPP typically uses around 10,000 gallons of fresh water per day from its onsite wells for routine operation of the facility, and, during maintenance periods, more than 80,000 gallons per day may be used for short term activities. During construction of the Project, these same short term peak usages will occur, primarily for dust control during grading activities and while implementing initial landscaping plans.

As required by BMP, dust control activities will be performed during both demolition and construction activities. This water will be provided from the site raw water wells which currently supply water for plant washdown and other nonpotable sources. It is anticipated that total site water use during tank demolition will require approximately an average of 30,000 gpd. This would be increased to approximately 40,000 gpd during peak plant construction activities and 42,000 gpd during the demolition of the existing plant after new unit construction is completed. This projected water use is shown in Figure 6.5-16.

The NPDES permit allows for 80,000 gpd to be removed from the onsite ground water wells for use in the plant. Recently the plant has been averaging 10,000 gpd from the wells. During peak project activities the amount of water withdrawn from the wells is only expected to be 50 percent of permitted levels except for a brief period during peak construction activities, and no adverse impact is projected. (See Table 6.5-8).

The location of the onsite ground water wells is shown in Figure 6.5-17. As indicated, these wells are located cross gradient from four well used by the city. The distance from the north well used by the power plant to the closest city well (No. 15) is approximately 150 feet. The maximum pumping

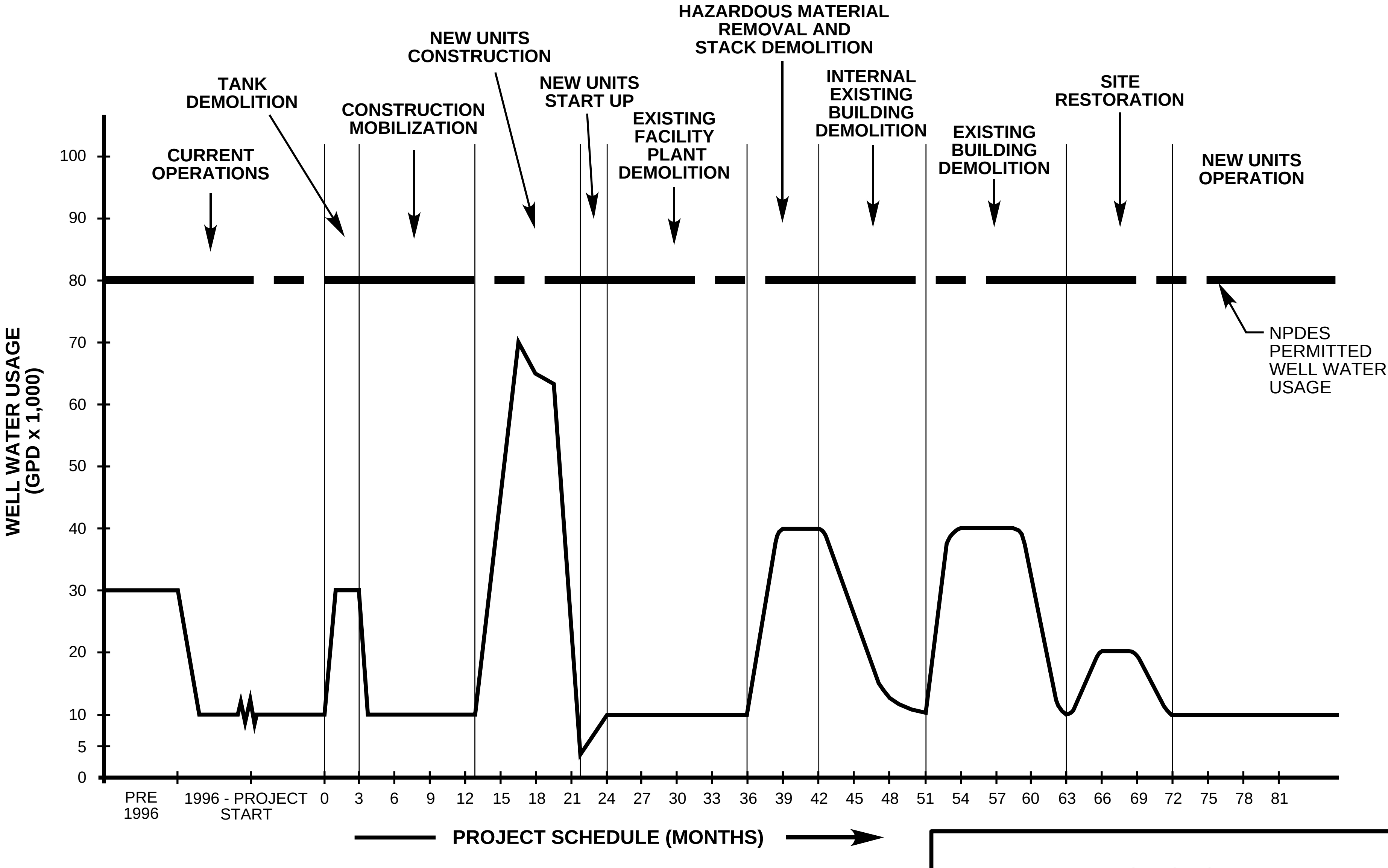
TABLE 6.5-8

PROJECTED WATER WELL DEMAND

ACTIVITY	TANK DEMOLITION		UNIT NEW CONSTRUCTION		OLD PLANT DEMOLITION		NEW UNIT OPERATION		SEAWATER		
	Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum	Peak (gpm)	Average (gpm)	Annual (gpy)
Dust Control	20,000	32,000	30,000	55,000	32,000	40,000			464,000[1]	250,000[1]	1.31E+11[1]
Current Plant Operation	10,000	15,000	16,000	15,000					405,000	253,000	1.18E+11
New Plant Operation	--	--	--	--	10,000	15,000	10,000	15,000			
Total	30,000	47,000	40,000	70,000	42,000	55,000	10,000	15,000			
NPDES Permit	80,000	80,000	80,000	80,000	80,000	80,000	80,000	80,000			

(1) There is no construction use of sea water. This is once-through cooling water for Units 1 through 4 that will continue to operate during construction of the new combined-cycle unit.

gpm = gallons per minute
gpy = gallons per year



NOTE: THE WATER PUMPED FROM THE ONSITE WATER WELLS AT MORRO BAY POWER PLANT IS NONPOTABLE DUE TO NATURALLY OCCURRING CONSTITUENTS.

AVERAGE ONSITE WELL NONPOTABLE WATER HISTORICAL AND PROJECTED USAGE

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TRC | **FIGURE 6.5-16**

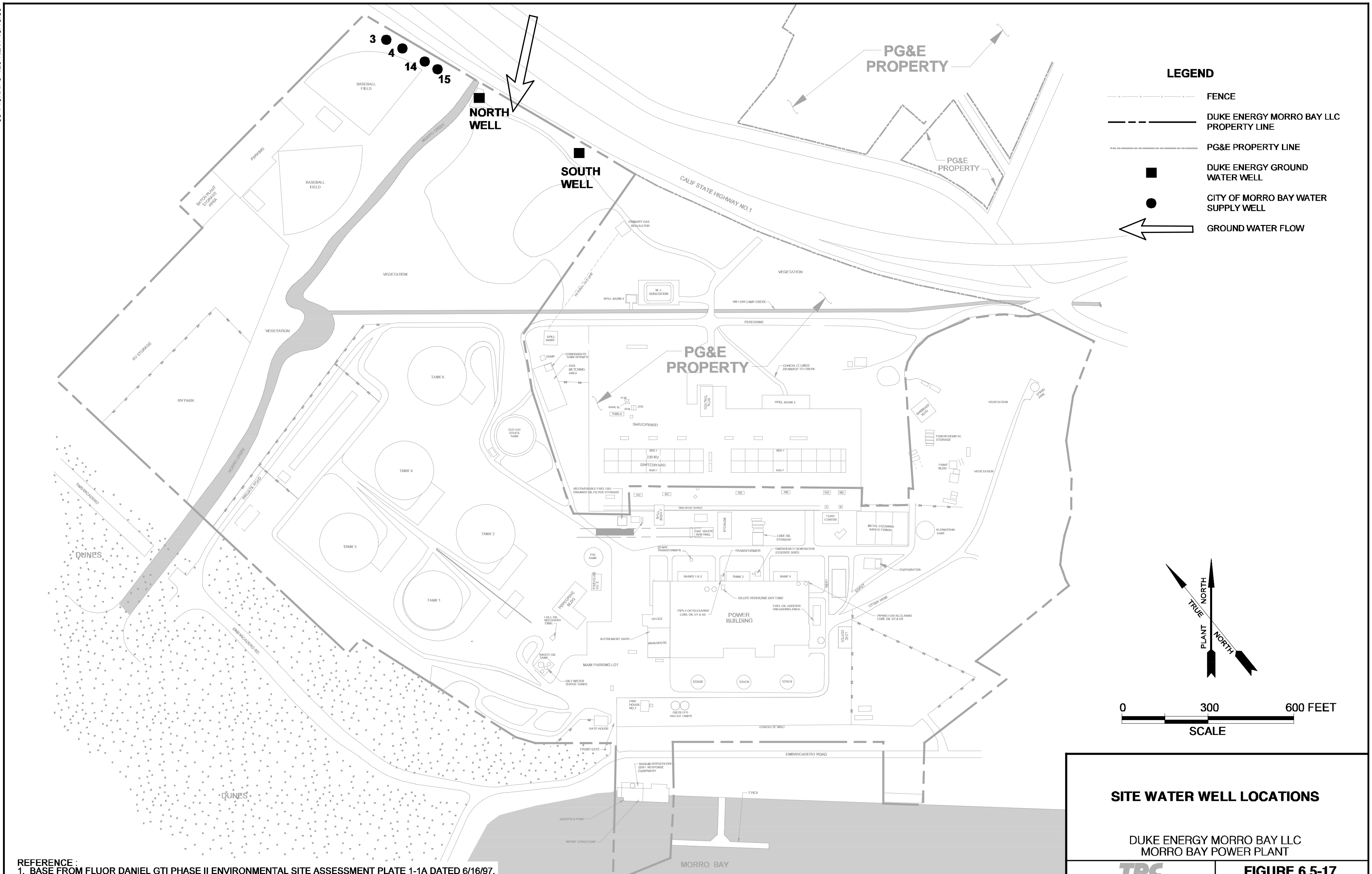
rate allowed by the permit is 55 gpm. Based on the nature of the water bearing zones shown in Table 6.5-5 the permeabilities of the aquifer are medium to high. Under these conditions a very small zone of influence of a well pumping at 55 gpm is expected. Since this well is cross gradient to and outside the zone of influence of the city well, no effect is expected at the closest city well.

6.5.2.2 Operation and Maintenance Impacts

MBPP operations and maintenance with the Project will reduce the presently permitted use of ocean cooling water at the site. A major body of information on the water resources, marine biological resources and beneficial uses of the MBPP area was developed in the 1970s and 1980s in support of the NPDES permitting and renewals for the once-through cooling water system. This information includes studies of major components of the cooling water intake-discharge system that will continue to be used by the Project at levels similar to those studied previously. The maximum flow rate into the intake structure for Units 1 through 4 will be reduced from the current capacity of approximately 464,000 gpm for Units 1 through 4 to approximately 330,000 gpm for the new combined-cycle units (a decrease of 29 percent at full load). At base load, the flows will be reduced by 47 percent. There will be corresponding reductions in the intake structure water approach velocities of 10 to 40 percent, depending on the intake bay and plant operations. Regular maintenance and monitoring activities at the intake structures will be utilized to maintain the lower approach velocities. This decreased volume of water and lower approach velocities will reduce both impingement and entrainment.

As discussed in Section 6.5.1.4.1 (Physical and Hydrodynamic Characteristics), and in more detail in Appendix 6.5-3, and in Section 6.5.1.4.2 (Water Quality), Morro Bay is a highly altered system. The following factors have played much larger roles in the observed historical changes in physical processes than has operation of the MBPP cooling water intake: disturbance patterns related to changes in entrance topography due to navigational development; dredging, and dredged material disposal; tidal prism loss through diking, filling, agricultural and urban development; loss of freshwater input from the watershed due to multiple causes; and water quality impairment related to watershed industry and mining, urban development and agricultural operations.

In this larger context, operation of the existing MBPP has had very limited or negligible effects on the physical/water quality environment and the mechanisms that control it. The effects of MBPP intake flows are small and restricted to the entrance area. The plant operations do not affect the tidal prism at all. Increased exchange of water with the ocean caused by the plant may have a minor but positive impact on water quality during late summer. Since the proposed Project will result in the reduction



REFERENCE :
1. BASE FROM FLUOR DANIEL GTI PHASE II ENVIRONMENTAL SITE ASSESSMENT PLATE 1-1A DATED 6/16/97.

SITE WATER WELL LOCATIONS

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FIGURE 6.5-17

of 29 percent or more in the flows withdrawn from Morro Bay and discharged into Estero Bay, any small effects that the existing plant could have will be reduced accordingly with the Project .

As discussed in more detail below and in Section 6.6A - Marine Biological Resources, prior and presently underway NPDES permitting related studies for MBPP have found that beneficial uses of water resources are protected, including commercial and recreational fishing, boating, commercial withdrawals, and other recreational uses as well as the maintenance of balanced populations of marine and estuarine organism communities. Since the effects of proposed MBPP operations will be less than those from previous operations, this protection of beneficial uses of water will be maintained with the Project.

6.5.2.2.1 Cooling Water System Modifications

Figure 6.5-18 shows a preliminary postproject MBPP water flow schematic. Generating Units 1 through 4 will be permanently replaced as a result of the Project, and the existing Units 1 through 4 intake structure, located on the shoreline of Morro Bay, will be used essentially as is (with architectural treatment enhancements - see Section 6.13) to provide once-through cooling water supply to the new combined-cycle units. The eight existing Units 1 through 4 cooling water pumps in the intake structure will be replaced with eight new pumps, each with an operating capacity of approximately 41,250 gpm, to serve the new units. New pipelines will be installed onsite to connect the combined-cycle units to the existing Units 1 through 4 cooling water supply and discharge conduits. No further modifications to the existing cooling water system are planned. The cooling water return flow from the new units will utilize the existing Units 1 through 4 discharge tunnels, which extend from the MBPP to the existing discharge canal structure adjacent to Morro Rock. Cooling water from the new units will flow through the existing discharge tunnels to the discharge channel and into Estero Bay. A detailed description of the modifications to the existing Units 1 through 4 cooling water system is provided in Chapter 8.0 - Engineering.

6.5.2.2.2 Operational Changes

The combined-cycle units will require a cooling water flow of about 330,000 gpm at maximum operation with a maximum temperature increase of 20° F. The combined-cycle units will generate more electricity, utilize less cooling water, and reject about 25 percent less heat to the ocean than existing Units 1 through 4 at full capacity. Discharge of up to 503,000 gpm of once-through cooling water to Estero Bay is currently permitted under NPDES permit CA 0003743 at a temperature increase of up to 30° F above the temperature of the intake.

The new combined cycle units will be capable of both peak power operation (duct firing of Heat Recovery Steam Generators, HRSGs) and base load, or non-peak power (no duct firing), operation. Cooling water flow rates and thermal loads for the peak power combined cycle operation and maximum operation of the existing units are compared in Table 6.5-1. During base load operation of the combined cycle units, the power generation of the new plant will slightly exceed the current capacity of existing Units 1 through 4. However, since in a combined cycle plant only a portion of the total electricity generated is produced in the steam cycle, the cooling water flow rates and heat loads for the new plant will be dramatically reduced as compared to the 100 percent steam cycle design of the existing units. The following table illustrates this point.

Units	Net Power Generation (MW)	Cooling Water Flow Rate (gpm)	Temperature Rise (° F)	Heat Load (million Btu/min)
Existing Units 1 through 4	1,002	464,000	22	73
New Combined Cycle - base load	1,030	247,500	19.3	40
New Combined Cycle - peak load	1,200	330,000	20	55

As shown in the table, base load operation of the new combined cycle units will generate more power than the existing units with only slightly more than half the cooling water usage and thermal discharge to Estero Bay. At these base load levels, which are expected to occur more than half the time for the new units, the modernized plant will use 48 percent less water than required by the existing plant per MW of generation. Also at these base load levels, the modernized plant will reject 47 percent less heat into the cooling water than required by the existing plant per MW of generation. Even though more cooling water is needed for peak power operation of the new units compared to base load operation, since duct firing produces additional power by generation of additional steam, peak operation will also result in significantly reduced cooling water use as compared to the existing units.

The use of multiple cooling water pumps for the new units (four pumps per unit) will provide flexibility to reduce cooling water flows during certain operating conditions, unlike Units 1 through 4 which must run both cooling water pumps for each operating unit, even at significantly reduced operation. It is expected that each of the new combined cycle units will operate with only three of the four cooling water pumps in operation at base load (non-duct fired), which should be the most

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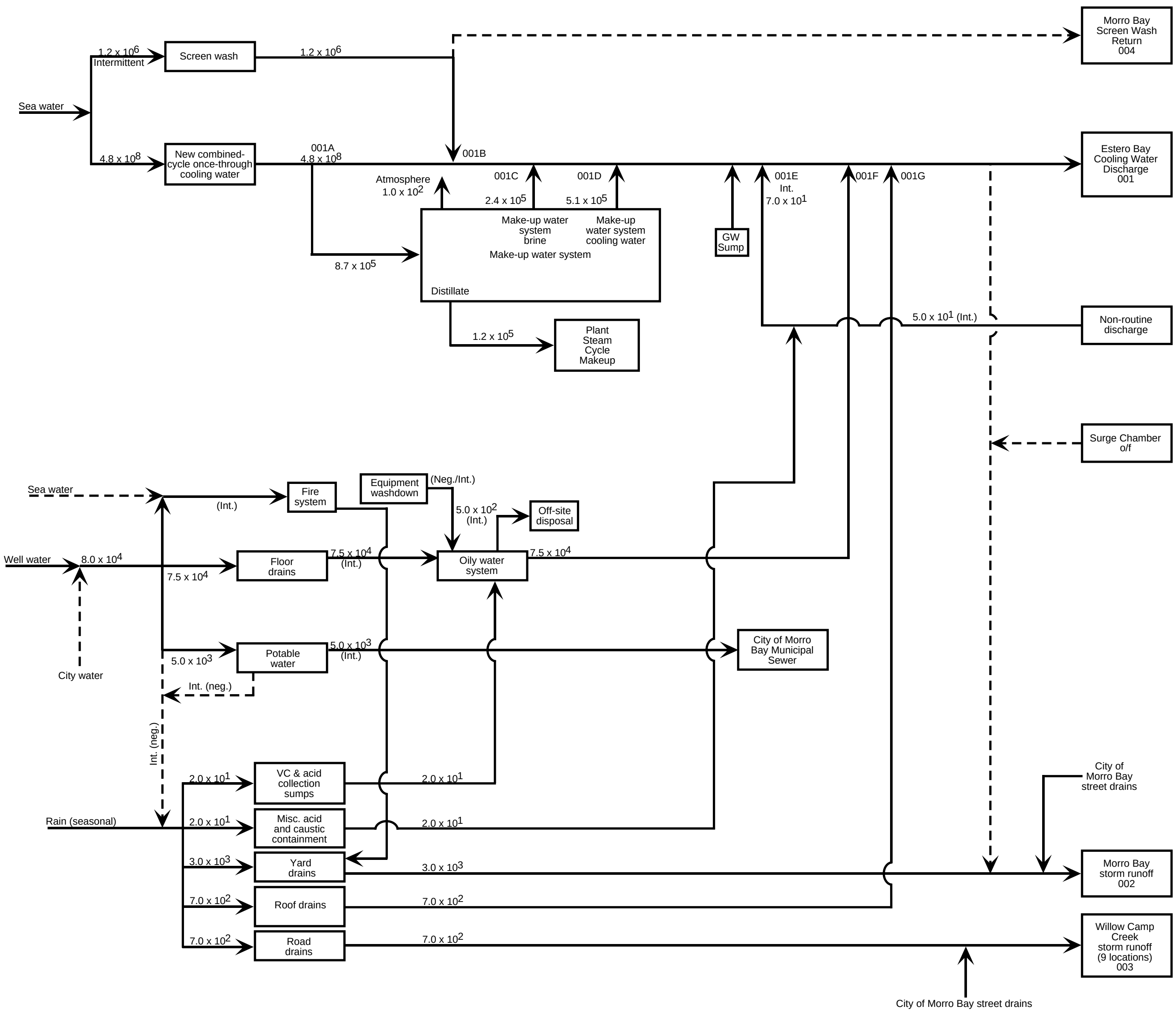

Note: All flows are listed in gallons per day
(Int.) = Intermittent
- - - = Alternate Route
(Neg.) = negligible

PROPOSED
WATER FLOW SCHEMATIC

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FIGURE 6.5-18

common operating mode. The preceding table comparing the new and existing units includes this reduced flow for the new units at 1030 MW (i.e., a total of six out of the eight cooling water pumps in operation).

The ability to operate the new combined cycle units with reduced cooling water flows at less than maximum loads will significantly reduce the intake structure approach velocities, as shown in the following table.

Operation	Cooling Water Flow (gpm)	Approach Velocity to Bar Racks (fps)
Units 1 and 2 Intake Structure		
Existing Units 1 and 2 @ full load	184,000	0.37
New combined cycle @ peak load	165,000	0.33
New combined cycle @ base load	123,750	0.25
Units 3 and 4 Intake Structure		
Existing Units 3 and 4 @ full load	280,000	0.51
New combined cycle @ peak load	165,000	0.30
New combined cycle @ base load	123,750	0.23

Approach velocities at curtin wall opening based on 1999 measurements - see Table 6.5-1

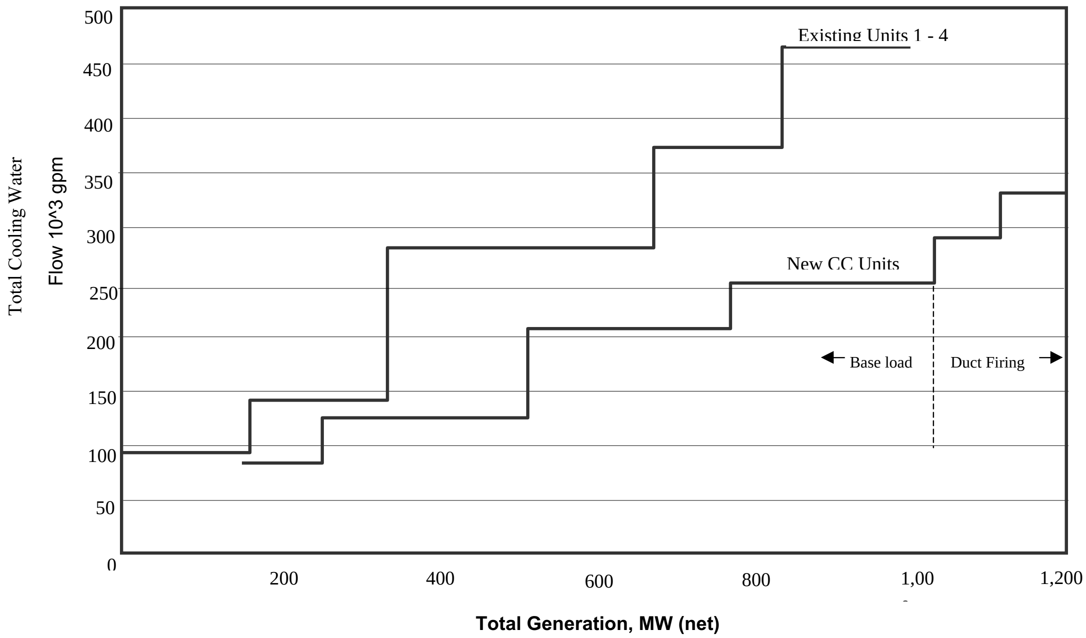
Duke Energy proposes to limit peak power, duct fired operation to no more than 4,000 hours per year. Assuming that base load, non-duct fired operation occurs for an additional 4,400 hours per year, the annual average cooling water flow rate for this maximum combined cycle operations scenario would be about 287,000 gpm. By comparison, the actual average cooling water flow for Units 1 through 4 for the 12-month period ending in June 2000, based on plant records maintained for the RWQCB, was more than 350,000 gpm.

Figures 6.5-19 and 6.5-20 show a comparison of cooling water use in gpm and heat load (quantity of heat in Btus discharged to the ocean) related to both the existing units and the new combined-cycle units at various power generation loads. As shown in these figures, the new combined-cycle units will utilize significantly less sea water for cooling and reject significantly less heat to Estero Bay than the existing units, for all power generation levels.

Figure 6.5-19 graphically compares the present maximum and average cooling water flows from the existing units to those projected after the Project. This figure also shows that the peak use of water for the post-Project MBPP is expected to be less than 67 percent of the maximum allowable use under the current NPDES permit.

FIGURE 6.5-19

COOLING WATER FLOW COMPARISON



Notes for Figure 6.5-19

1) Existing units generation and cooling water flows based on following scenarios:

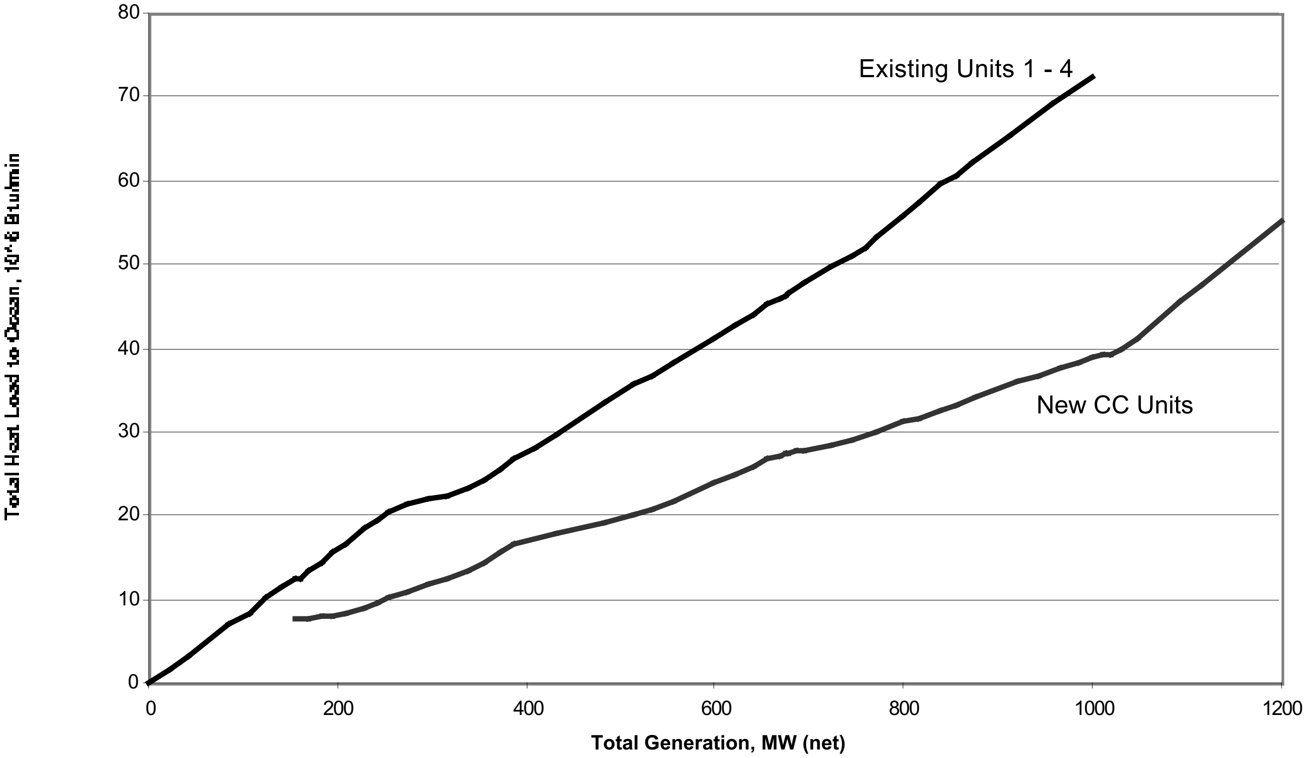
Units on line	Generation, MW (net)	CW Flow, 10^3 gpm
1 or 2	0 -163	92
3 or 4	163 - 338	140
3 and 4	338 - 676	280
1 or 2 plus 3 and 4	676 - 839	372
1 - 4	839 - 1002	464

2) New combined cycle units generation and cooling water flows based on following scenarios:

Units on line	Generation, MW (net)	CW Flow, 10^3 gpm
1 CTG @ 50-100% load	153 - 255	82.5
1 CTG @ 100% load plus 1 CTG @ 50-100% load	255 - 516	124
2 CTGs @ 100% load plus 1 CTG @ 50-100% load	516 - 773	206
3 CTGs @ 100% load plus 1 CTG @ 50-100% load	773 - 1032	247.5
2 CTGs @ 100% load w/df plus 2 CTGs @ 100% load w/o df	1032 - 1116	289
4 CTGs @ 100% load w/df	1116 - 1200	330

CTG denotes combustion turbine generator
df denotes duct firing

Figure 6.5-20
Heat Load Comparison



Notes:

1) Figure depicts total heat absorbed from plant condensers and coolers and discharged to ocean by the cooling water return flow.

2) Operating scenarios are the same as described for Figure 6.5-x, Cooling Water Flow Comparison

As previously explained, the cooling water temperature increase for the new combined-cycle unit will be less than or equal to 20° F over the expected range of operating conditions. Data collected over the period of June 29 to July 19, 1999, under varying load and tide conditions, indicate the water temperature in the MBPP discharge canal was generally between 65 and 80° F (i.e., within 20° F above the receiving water temperature) prior to reaching the point at which mixing with ambient ocean water occurs. Therefore, the combined cycle cooling water discharge temperature from the post-Project MBPP is expected to be in essentially the same range as measured today, within the California Thermal Plan guideline of 20° F temperature increase.

6.5.2.2.3 Physical Extent of Thermal Plume

After discharge, the thermal plume from MBPP enters the nearshore waters of Estero Bay. The buoyant warm water spreads northward, thinning and dissipating heat as it spreads, over distances of hundreds to thousands of feet, depending on the thermal loading from MBPP and on environmental conditions related to tides, winds, and waves. Unlike substance constituents of a discharge, heat is not dependent on dilution to be reduced in its levels. Heat dissipates to the atmosphere from the water surface beginning at the point of discharge. Since this mechanism is continuous, there is no build-up of heat in the receiving waters with continued discharge of heated water at any given level.

Direct and remote measurements of the thermal plume were made by PG&E in August 1972. A much more complete characterization program is currently underway (see Appendix 6.5-1), and, as described below, preliminary findings are consistent with earlier findings. Additionally, findings from biological thermal effects studies are found in Section 6.6A - Marine Biological Resources. As discussed in Section 6.6A, there is no evidence of adverse water quality impacts in the distribution and/or abundance of organisms present in the surrounding area. The historical thermal plume information is useful, because it provides a basis for planning the contemporary sampling program.

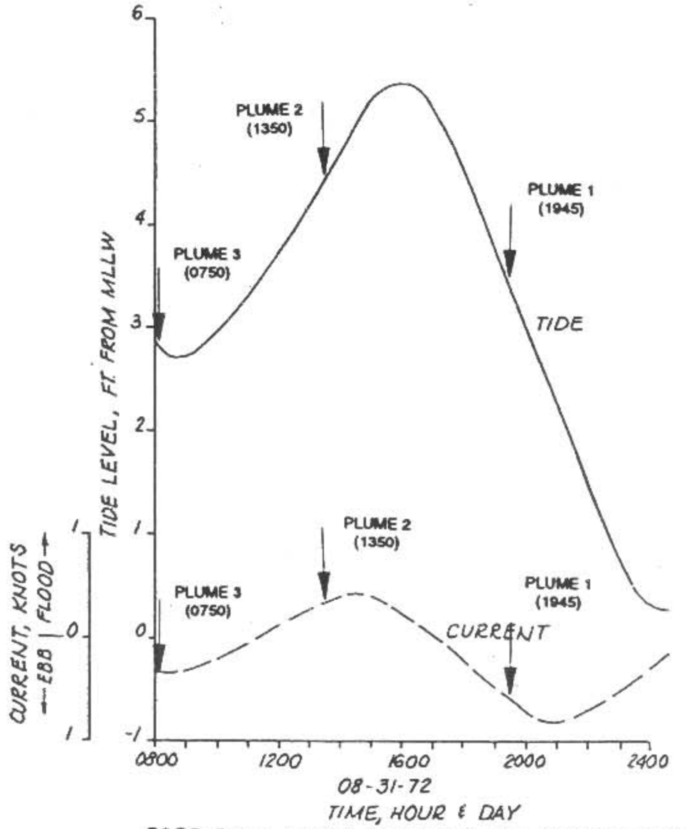
The PG&E plume mapping took place on August 31, 1972 over a range of tidal conditions. During most of the survey period, MBPP operated at close to the maximum net power generation rate of 1,002 MW (1,030 gross). As shown in the preceding section, the maximum operation of the new combined cycle units will result in significantly less cooling water and heat load discharge to the ocean than occurred during this survey. Thus, the results of the 1972 survey probably over-predict the peak extent and effects from operation of the new combined cycle units.

The tidal and plant load conditions during the 1972 survey are shown in Figure 6.5-21. The maximum thermal effects at the surface were observed at the start of the stronger of the two daily ebb tides (between high and low tide). The maximum plume spread is illustrated in Figure 6.5-22 (Plume 1, Maximum Impact). Under other tidal conditions, the surface distribution of the portion of the plume that is 4-6 °F above ambient ocean temperature is far less extensive, covering generally about one-tenth to one-third the area covered during the stronger ebb tide. This is illustrated in the thermal images obtained (at maximum load) during a rising tide in Figure 6.5-23 (Plume 2, Rising Tide) and approaching low tide in Figure 6.5-24 (Plume 3, Low Tide).

The historical thermal images also give examples of the manner in which the discharge plume contacts the shoreline. During the surveys, the plume consistently contacted about 600 feet of shoreline on the north face of Morro Rock, along the extended alignment of the discharge canal, at temperatures ranging from 10 to18 °F above ambient. The extent of other shoreline contacted by plume waters that were at least 4 °F above ambient was limited to the sandy intertidal area within about 2,000 feet east and northeast of the discharge and was greatest during rising tide (Figure 6.5-23, Plume 2). In addition to the aircraft-derived thermal images, the 1972 surveys included a limited number of surface and subsurface temperature measurements from a boat operating in and around the plume. These data were used to calibrate the thermal images and to provide some indication of the vertical extent (i.e., depth) of the thermal plume.

Preliminary data from the contemporary thermal plume characterization study support the historical interpretations. Data from the boat survey on July 7, 1999 are shown in Figures 6.5-25 and 6.5-26. Due to the rough surf conditions, the survey was limited to areas beyond 1,000 feet from Morro Rock and the breakwater and 1,500 feet from the sandy beach to the north of the discharge canal.

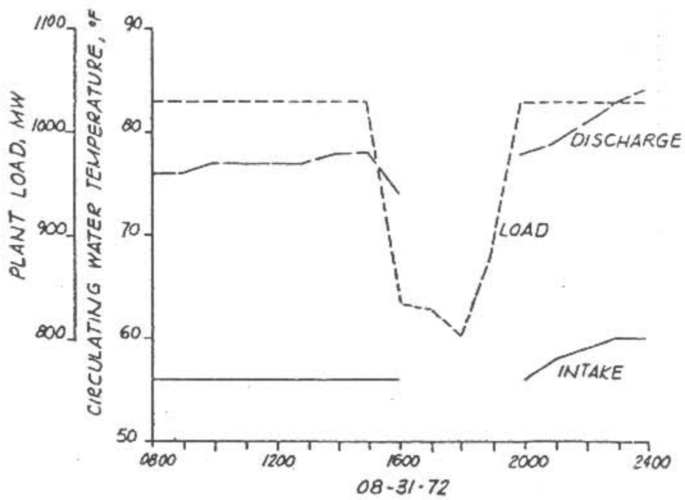
At the surface, the plume is elongated in the north-south direction over distances of about 3,000 feet, comparable to what was observed in August 1972. Below the surface, the thermal plume is confined to a much smaller area just northwest of Morro Rock and to depths above 20 feet. The inshore edge of the survey data is in water depths of 25-40 feet. Hence, these data do not provide information about shoreline contact. Ongoing surveys are being conducted using two boats working simultaneously, with the smaller vessel operating closer to shore, combined with aerial plume mapping.



PREDICTED TIDE & CURRENT FOR SURVEY PERIOD

NOTES:

1. COOLING WATER FLOW IS 397,000 GPM.
2. NO TEMPERATURE DATA AVAILABLE FOR 1700 TO 1900.
3. CIRCULATING WATER TEMPERATURES ARE WEIGHTED AVERAGES OF ALL UNITS.



COOLING WATER & PLANT LOAD DATA FOR SURVEY PERIOD

SOURCE: MORRO BAY POWER PLANT ENVIRONMENTAL SURVEY AUGUST 31, 1972 BY PG&E.

TIDE LEVELS AND TIMES OF PLUME SURVEYS; MBPP LOAD AND DISCHARGE TEMPERATURES

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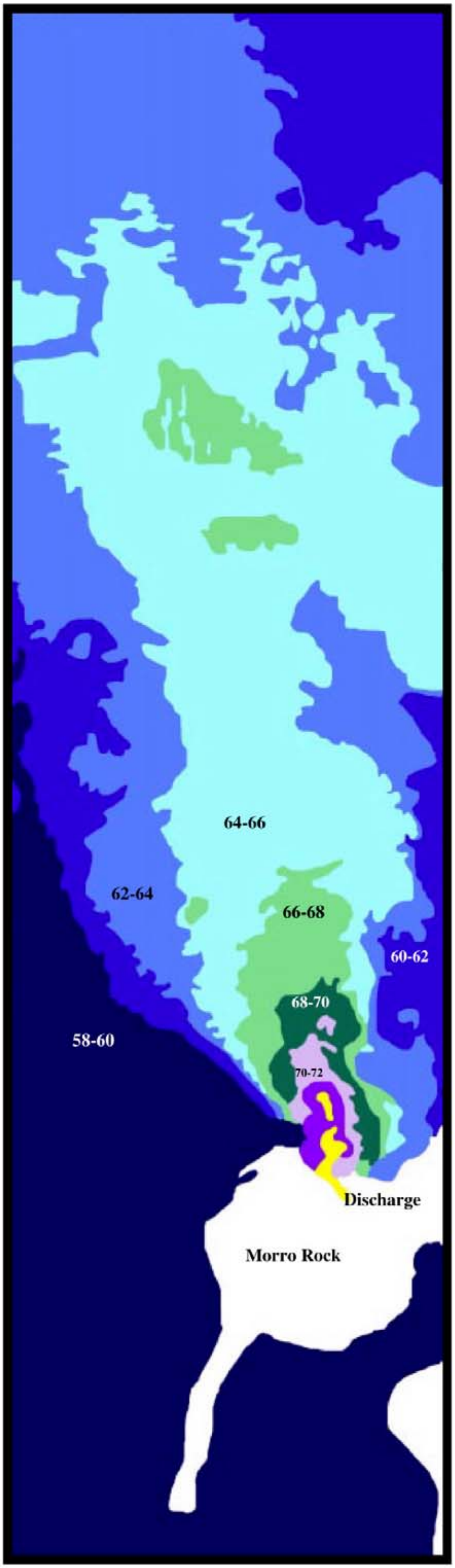
FIGURE 6.5-21



This figure illustrates historic maximum MBPP thermal impacts on surface temperatures in Estero Bay from thermal imagery taken after the high tide at the beginning of the low tide (i.e., 3 hours after high tide) with all Units (1-4) operating at high load in 1972. The extent of the plume was reduced about 50-75% on other tides.

Surface Water Temperature F°
58.00
60.00
62.00
64.00
66.00
68.00
70.00
72.00
74.00
76.00
78.00

Date/Time:	8/31/72; 1945 PM
Plant Load:	~ 1000 MW
Thermal Load:	69.57 Million Btu/min
Cooling Water Flow:	397,000 gpm

Data scanned from IR Thermal Image

0 1,000 2,000 FEET

SCALE

PLUME 1
EXAMPLE OF MAXIMUM THERMAL IMPACT ON SURFACE TEMPERATURES

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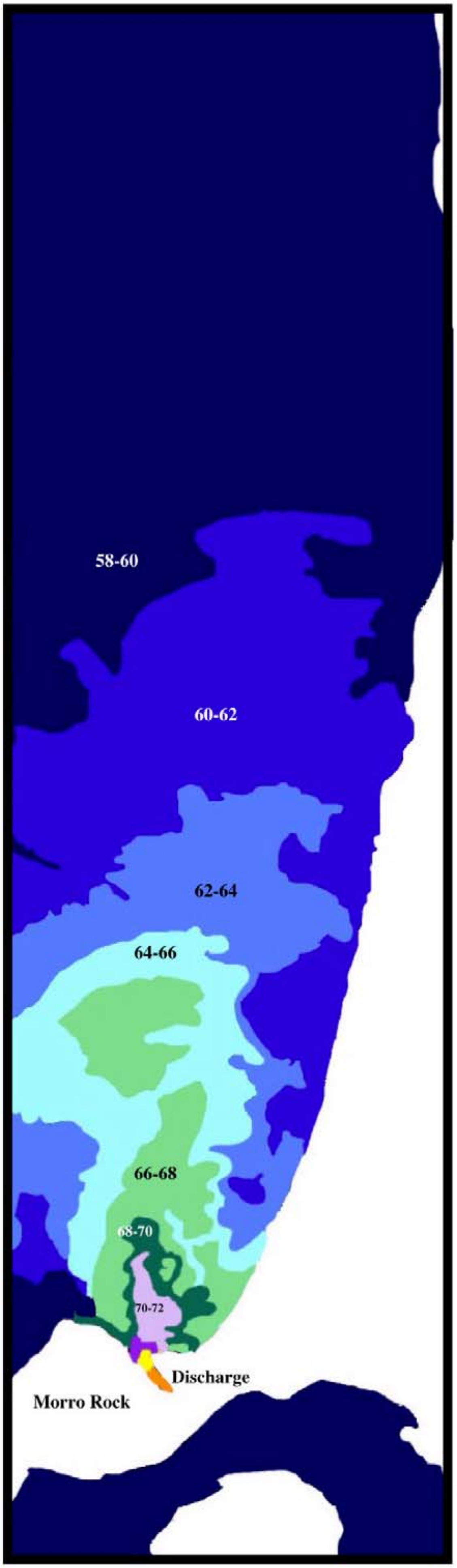
FIGURE 6.5-22



This figure illustrates historic MBPP thermal impacts on surface temperatures in Estero Bay from thermal imagery taken late on a flood tide (i.e., 2 hours before high tide) with all Units (1-4) operating at high load in 1972.

Surface Water Temperature F°
58.00
60.00
62.00
64.00
66.00
68.00
70.00
72.00
74.00
76.00
78.00

Date/Time:	8/31/72; 1350 PM
Plant Load:	~ 1000 MW
Thermal Load:	69.57 Million Btu/min
Cooling Water Flow:	397,000 gpm

Data scanned from IR Thermal Image

0 1,000 2,000 FEET

SCALE

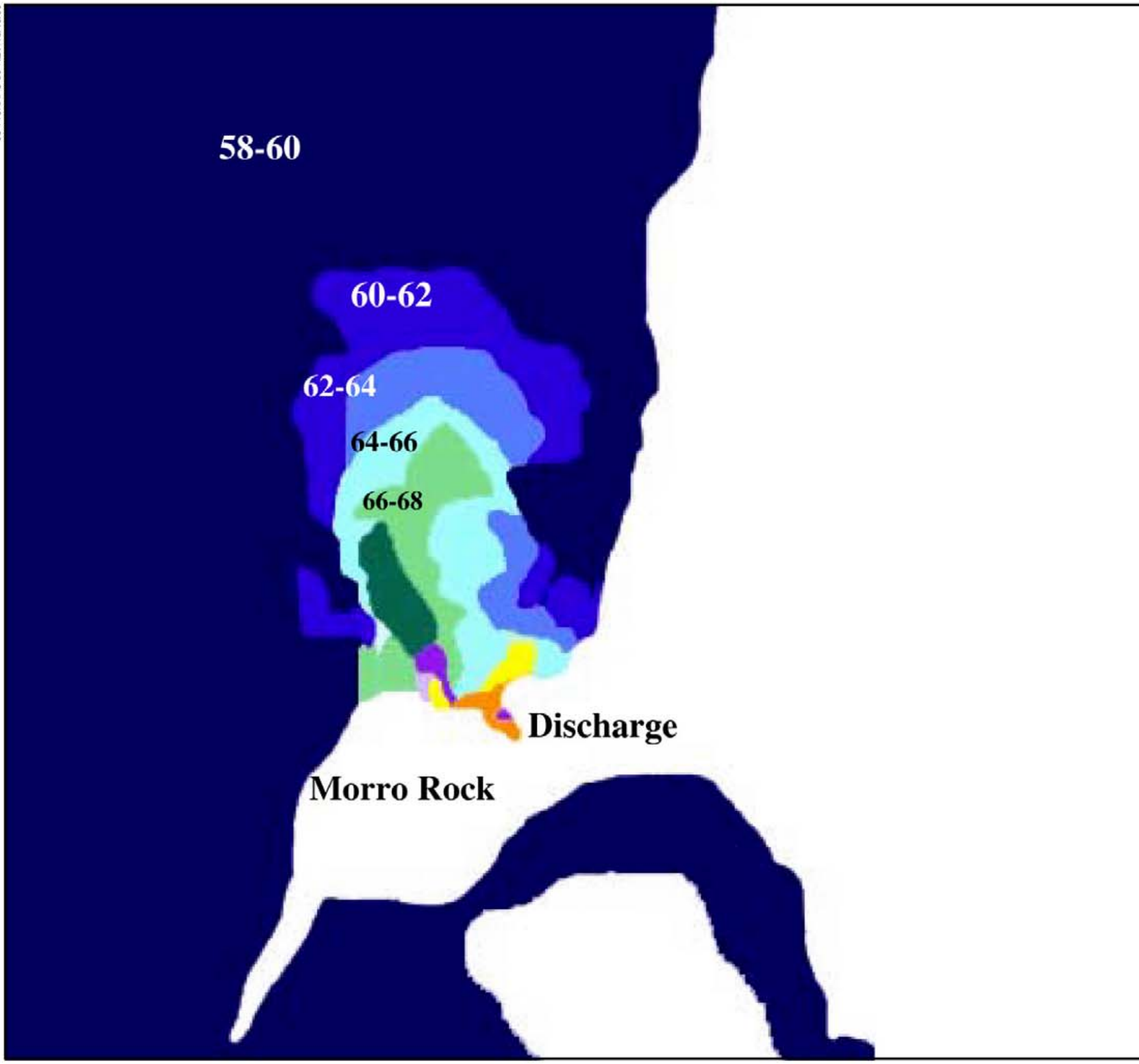
PLUME 2
EXAMPLE OF MAXIMUM RISING TIDE THERMAL IMPACT ON RECEIVING WATERS

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

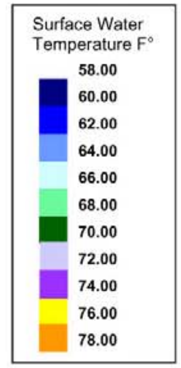
TRC

FIGURE 6.5-23

98-710RAFC-99 REV 10/10/00

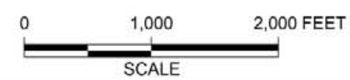


This figure illustrates historic maximum MBPP thermal impacts on surface temperatures in Estero Bay from thermal imagery taken near low-tide (i.e., 1 hour before minimum low tide) with all Units (1-4) operating at high load in 1972.



Date/Time:	8/31/72; 0750 AM
Plant Load:	~ 1000 MW
Thermal Load:	69.57 Million Btu/min
Cooling Water Flow:	397,000 gpm

Data scanned from IR Thermal Image



PLUME 3
EXAMPLE OF MAXIMUM LOW-TIDE IMPACT ON SURFACE TEMPERATURES

DUKE ENERGY MORRO BAY LLC
MORRO BAY POWER PLANT

TRC

FIGURE 6.5-24

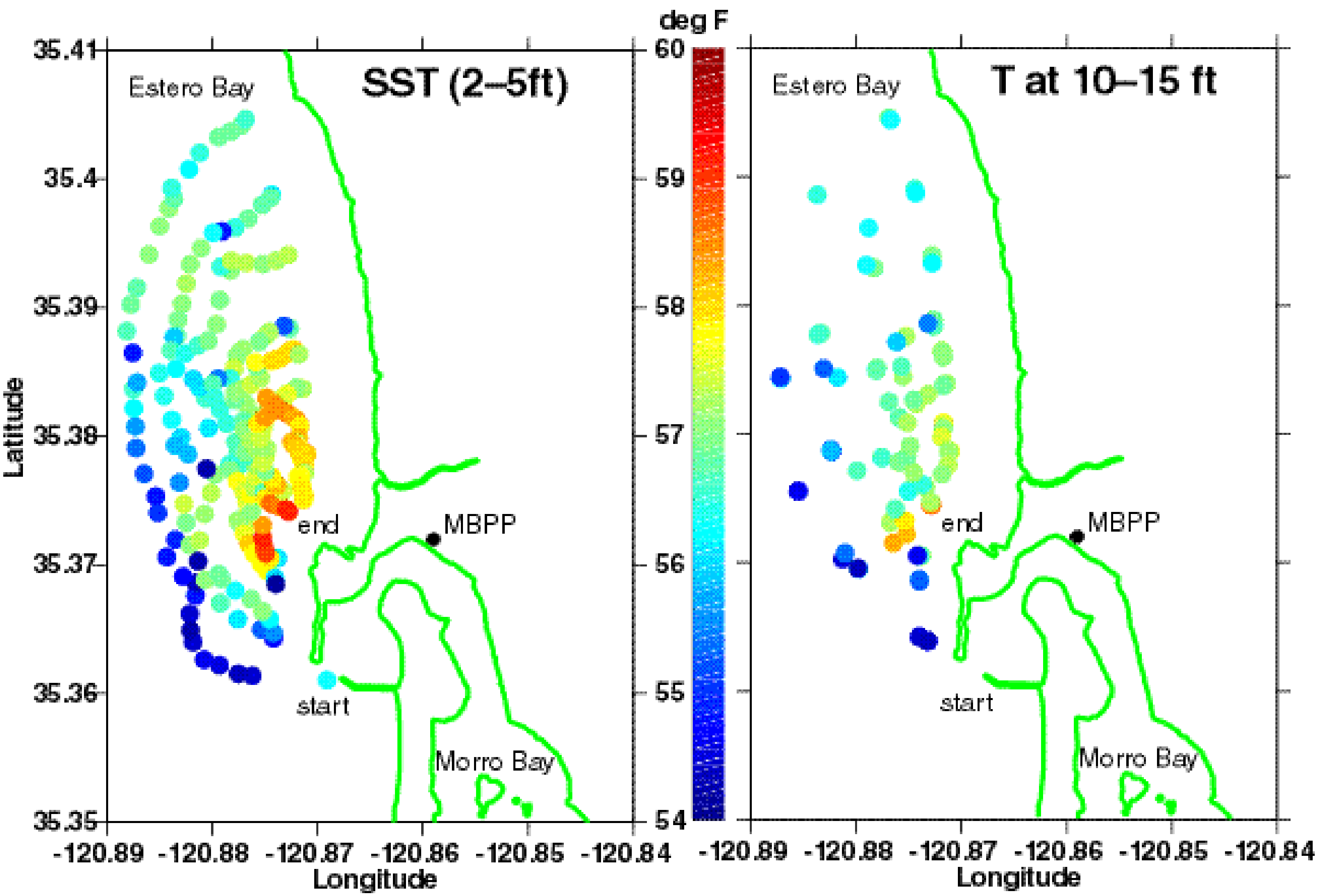


Figure 6.5-25. Temperature from the boat survey on July 7, 1999 near the surface (left) and at depths between 10 ft and 15 ft (right).

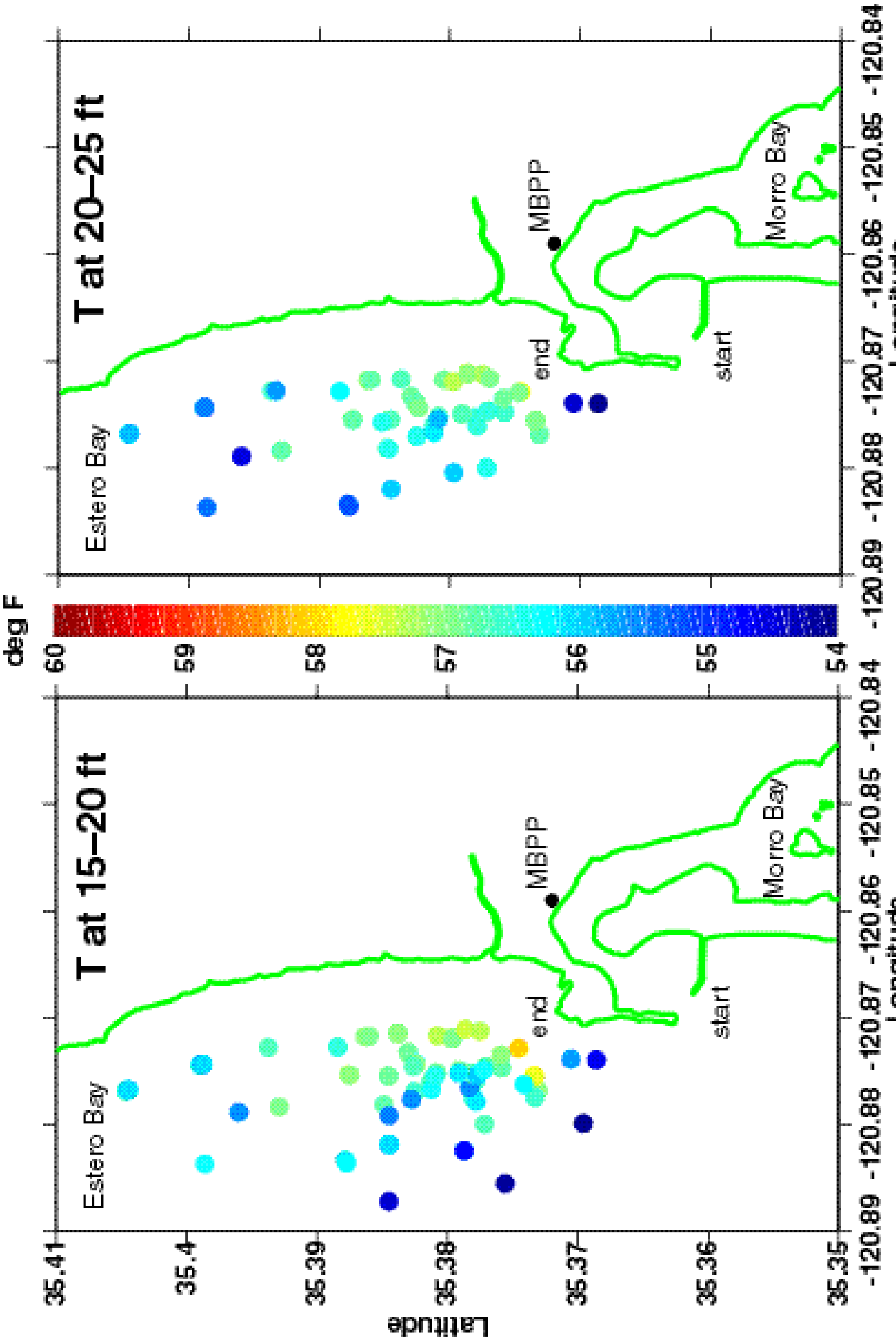


Figure 6.5-26. Temperature from the boat survey on July 7, 1999 at depths between 15 ft and 20 ft (left) and at depths between 20 ft and 25 ft (right).

In addition to the improved survey techniques and frequency, the ongoing thermal plume study will take advantage of months-long temperature time series data collected at a number of points around the discharge canal, along Morro Rock, inside Morro Bay, and in the ambient waters of Estero Bay. These data, particularly the measurements extending outward from the discharge canal, will help to define the extent of the thermal signature from MBPP under a wide variety of environmental and plant load conditions. A sample of the time series data that have been collected so far are shown in Figure 6.5-27 for the period of January 2000. These data provide a good overview of the fluctuations related to the MBPP discharge during a month with relatively high heat loading (60 percent capacity factor yielding around 600 MW monthly averaged power generation). Temperatures within the discharge canal are a function of the daily variations in MBPP load.

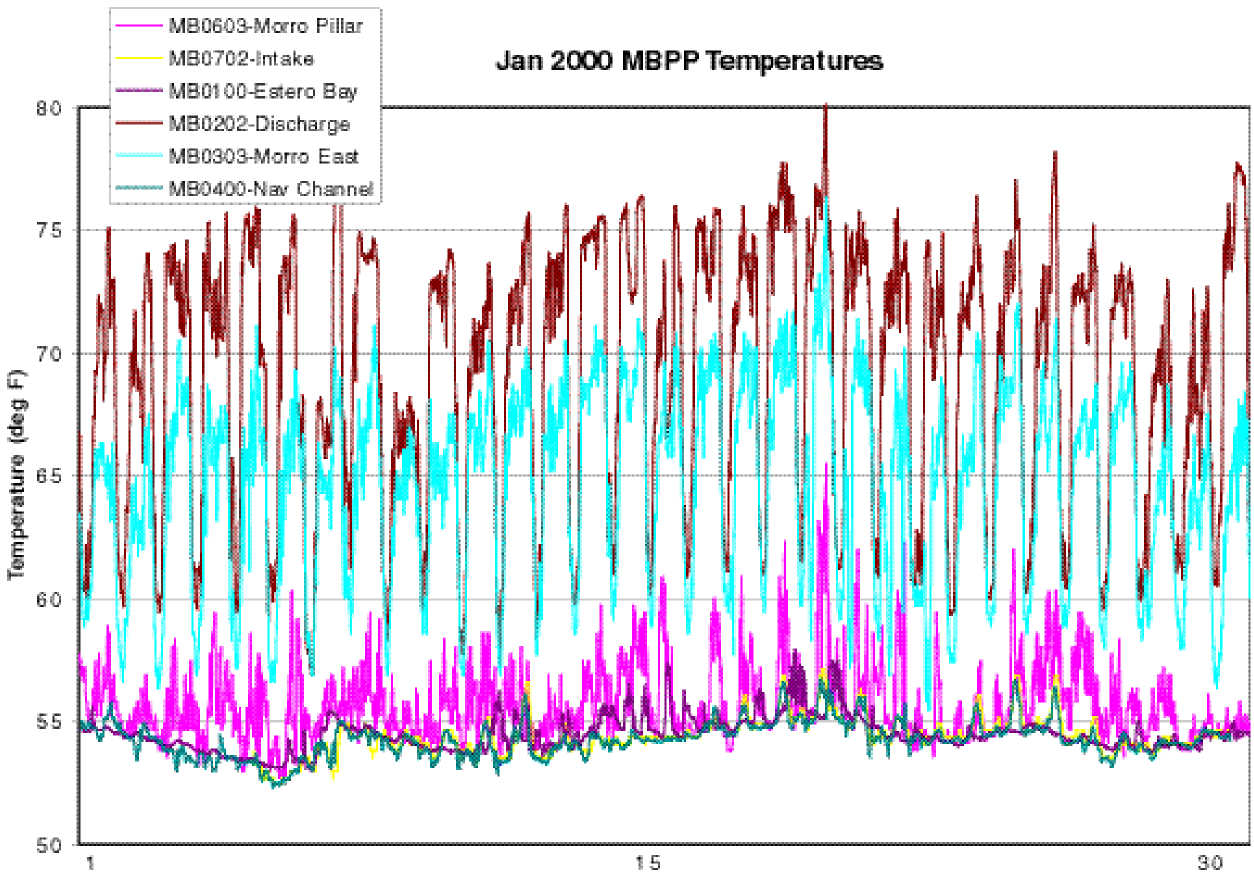


Figure 6.5-27. MBPP temperature records collected in January 2000.

The data in Figure 6.5-27 also provide an indication of the range of the MBPP plume with respect to the shoreline of Morro Rock. At the Morro Rock East Transition location, about 360 feet northwest from the discharge, the receiving water experiences about two thirds of the maximum temperature increase due to the discharge, or 10-15º F. At the Pillar Rock location, about 800 feet from the discharge, the water experiences warming related to the discharge that is typically 2-5º F. On some days, no warm water reaches the Pillar Rock location.

The contemporary thermal plume characterization study that is underway (See Appendix 6.5-1) is using the combination of aerial images, boat-based measurements, and a large number of fixed temperature recording stations. The role of the program is to place the inferences made from historical and preliminary data on a firm statistical basis. Data from repeated surveys will be combined with time series data to produce frequency-of-occurrence maps for various elevated temperature values at the surface as well as vertical temperature sections indicating the depth of the plume under peak load and variable tidal conditions. These empirical, data-based descriptions of the thermal plume will be more accurate than would be output from a hydrodynamic model of the complex open ocean environment in the vicinity of the discharge.

As previously discussed, the maximum cooling water flow will be reduced by 29 percent, and the maximum heat loading will be reduced by 25 percent, with the Project. As will be further clarified as more results of the thermal plume characterization study become available (Appendix 6.5-1), the extent and effects of the MBPP thermal plume will change accordingly. As discussed in Section 6.6A - Marine Biological Resources, there is no evidence of adverse water quality impacts in the distribution and/or abundance of organisms present in the surrounding area.

Compliance With Objectives of the California Thermal Plan

The Water Quality Control Plan for Control of the Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan) is based on the protection of beneficial uses and areas of special biological significance of thermal discharge receiving waters. The information analyzed and reported in Section 6.6A - Marine Biological Resources, concludes that the California Thermal Plan objectives of protection of beneficial uses have been achieved and are expected to continue to be achieved under the reduced cooling water flow discharge and heat loading conditions going forward with the Project.

As previously described, cooling water to one of the 600 MW Units of the Project will be provided using seawater from the existing intake structures used for Units 1 and 2. Cooling water to the second 600 MW Unit will be provided using seawater from the existing intake structure used for Units 3 and 4. This Project is more thermally efficient and will require 29 percent less water at full capacity, and 41 percent less water per megawatt, than the existing Units 1 – 4. Units 1 and 2 currently use 184,000 gallons per minute (gpm) and Units 3 and 4 use 280,000 gpm whereas the combined-cycle units only use a maximum 165,000 gpm each for a decreased water usage of 134,000 gpm, a 29 percent reduction. Moreover, the intake flow velocities from Morro Bay harbor will decrease 10 to 40 percent for the combined-cycle units due to the lower cooling water requirements. The proposed efficient combined-cycle units will reject 25 percent less heat per MW at full load, and 48 percent less heat per MW at base loads.

The cooling water discharge to Estero Bay will occur at the same location as the existing discharge. The cooling water discharge for the proposed combined-cycle units will maintain a temperature differential of 20° or less from the receiving water temperature. The existing NPDES permit allows for a 30° temperature differential between the intake and cooling water discharge temperature. After completion of the Project, the cooling water discharge through the outfall canal will be about 330,000 gpm under duct fired operations and 248,000 gpm without duct fire. Duct fire operations will be limited by air emission standards and are expected to occur less than half the time of operations. A discharge of 503,000 gpm is allowed under the existing NPDES permit.

In summary, the existing intake and discharge structures for the modernization will be maintained and continued to be used for the Project. The volume of cooling water discharge will be significantly reduced, the total heat loading will be significantly reduced, and more importantly, the temperature differential of the cooling water discharge will be lowered from a maximum of 30° to 20°.

Duke Energy believes that the MBPP discharge should be treated as an "existing discharge" under the Thermal Plan. Relevant provisions of the Thermal Plan describe an "existing discharge" to be any discharge which is presently taking place (at the time of Plan adoption), a discharge for which waste discharge requirements have been established and construction commenced prior to adoption of the Plan, or any material change in an existing discharge for which construction has commenced prior to adoption of the Plan. A "new discharge" is any discharge which is not presently taking place unless waste discharge requirements have been established and construction commenced prior to adoption of the Plan or any discharge which is presently taking place and for which a material change is proposed but no construction has commenced prior to adoption of the Plan.

As this discharge from MBPP has been taking place since the early 1950s, it is a discharge that is "presently taking place." Moreover, the modernization as described will result in less discharge with reduced temperature than is presently taking place. Consequently, the most relevant question would appear to be whether the proposed Project constitutes a "material change" which would cause the Project to become a "new discharge" under the Thermal Plan (See Craig M. Wilson's Legal Interpretation Memo to David Maul of the California Energy Commission dated March 24, 1999, Question #2 & Response, p.5).

As is indicated in the above referenced Legal Interpretation Memo, the definition of the term "material change" in the Thermal Plan must be interpreted to have the same meaning as that contained in the State Water Board's regulations. In that the Project involves substantially less than complete replacement of the existing plant, the above referenced Memo notes that the discharge from the upgrade should be considered "new" if the construction results in a material change in the discharge from the existing plant. It further suggests that this must be decided on a case-by-case basis.

The State Water Resources Control Board's regulations regarding "material change" are contained in Cal. Code Regs., Title 23, section 2210, and provide that a material change in the character, location, or volume of the discharge includes, but is not limited to, five specific criteria. The first criterion relates to the addition of a new process or product by an industrial facility resulting in a change in the character of the waste. As indicated above, more efficient combined-cycle generating units will replace the existing units. This is not a new process or product and will not change the character of the waste. Cooling water will continue to be discharged. The second criterion relates to significant change in the disposal method. The disposal method will remain the same - cooling discharge through the outfall canal to Estero Bay. The third criterion relates to a significant change in the disposal area. As indicated, the disposal area will remain the same - Estero Bay north of Morro Rock. The fourth criterion relates to an increase in flow beyond that specified in the waste discharge requirements. The proposed flow will decrease, not increase. Thus, this criterion does not apply to the Project. The final criterion relates to an increase in area or depth to be used for solid waste disposal beyond that specified in the waste discharge requirements. This does not apply to the Project.

In summary, this analysis of State Water Resources Control Board regulations indicates that the MBPP Project should be viewed as an "existing discharge." Under the Thermal Plan and the above-mentioned Interpretation Memo, the proposed discharge would not constitute a "material change" under State Board regulations and the discharge therefore would not be considered a "new discharge." The bottom line is that this Project will result in reduced cooling water intake volume and velocity, and reduced temperatures and heat loading to waters of the state, resulting in environmental benefits to water resources.

Although the discharge occurs at the shoreline, no significant effects on marine biological communities are anticipated (See Section 6.6A - Marine Biological Resources). Several factors mitigate against adopting alternatives to continued use of the discharge canal by the Project, including:

- The alternative of constructing a new discharge tunnel offshore would result in direct environmental impacts to the shoreline area around Morro Rock, and in Estero Bay. Such a discharge structure would require up to a 12-foot-diameter by 3,000-foot-long offshore tunnel at significant environmental and socio-economic cost.
- Historic thermal effects studies, as well as those currently underway, of key marine environment habitats (including rocky intertidal, sandy beach and ocean bottom habitats) have demonstrated no significant impacts. Prior NPDES permits concluded that historic discharges from MBPP at higher levels of water flow and heat load discharge assured protection of beneficial uses. Existing and ongoing studies, as part of the RWQCB Technical Working Group Study Plan for MBPP, have similar findings (see Section 6.6A - Marine Biological Resources , and its Appendices 6.6A-4, 6.6A-6, and 6.6A-7.

For additional discussion of alternative cooling technologies, see Section 5.7 - Alternative Cooling Technologies.

<u>Other Operation or Maintenance Impacts</u>

Since no new cooling water structure operational facilities are planned except for the replacement of pumps as previously described, no changes during operations are anticipated. Maintenance and cleaning activities around the intake structure for Units 1 through 4 to remove sediment, eelgrass and debris are currently performed and will continue regularly in the future. However, with the lower intake velocities and volume of water required by the combined-cycle units, these maintenance activities may be required on a less frequent basis.

6.5.2.2.4 Operational Impacts on Ground Water

An estimated total of approximately 10,000 gpd of fresh water from onsite wells has been used historically for plant operations. This water was used mainly for sanitary water and plant washdown activities. During certain maintenance activities such as (a) boiler fire side washing, (b) air preheater washing, and (c) stack washing, this usage could reach as high as 80,000 gpd. It is estimated that this will not change after the Project is completed, as the washdown of the new units will be offset by the elimination of the washdown at Units 1 through 4. Upon commercial operation of the Project, potable water usage and sanitary sewer flow to the City of Morro Bay sewer system is expected to be slightly reduced, since Project staffing requirements are slightly less than staffing requirements for the existing MBPP. Once the landscape plan has been implemented, use of drought tolerant plants will assure use of freshwater for irrigation is minimized. The projected water demands during construction and operation are shown in Table 6.5-8.

Freshwater supplies on the Central Coast are limited. A typical 1,200 MW power plant can evaporate approximately 11,000 to 14,000 acre-feet per year of freshwater as a result of larger wet cooling towers that create large visible plumes. By using seawater for cooling, the Project avoids the consumption of 11,000 to 14,000 acre-feet per year of freshwater (14,000 acre-feet per year is equivalent to about 8,700 gallons per minute). The use of seawater cooling also avoids the disposal and the environmental effects of wastewater and solids that would be generated by the use of a closed freshwater system. These negative affects are completely avoided by the continued use of once-through seawater cooling.

6.5.2.2.5 Impacts on Surface Drainage

Runoff collected from the industrial portions of MBPP is collected in impoundments and inspected prior to release, or collected in catchment areas and routed to the oil-water separator in accordance with the NPDES permit prior to discharge. Runoff from parking lots, roads, and other non-industrial areas is collected in storm drains which flow into Morro Bay. The current runoff from MBPP into Willow Camp Creek will be halted with the Project.

As noted in section 6.5.1.8 and Figure 6.5-11, a portion of the 100-year base flood elevation (Zone A14) extends into the northerly portion of the site, notwithstanding the presence of a long-existing dike and berm system that effectively protects the Project area from the 100-year base flood. Protection of the combined-cycle units from 100-year flood events will be provided by grade elevation and improvement of the existing dike and berm system, as may be necessary to meet FEMA standards. In addition, assuming that portions of the Project continue to fall within the 100-year base flood elevations, development in the Project area and corresponding analyses will be conducted pursuant to Morro Bay development permit requirements to ensure that: a) relevant construction standards are met; b) that the development is reasonably safe from flooding; and c) that the development does not result in an increase in the water surface elevation of the base flood by more than one foot at any point. Site erosion controls will be continued and no substantial changes are proposed.

6.5.2.2.6 Impacts of 100-Year Flood

The existing berm and dike system surrounding the tank farm is approximately 18 feet in height, with the tops of the berms at an approximate elevation of 33.2 to 33.9 feet (MLLW). As noted in Section 6.5.1.8, the tops of the berms well exceed the FEMA estimated 100-year base flood elevation of 23.73 feet (MLLW), and the 500-year flood elevation of 24.73 to 25.73 feet (MLLW). However, the Flood Insurance Rate Map does not reflect the presence of this berm and dike system and, instead, the northerly portion of the Project area is mapped as falling within the 100-year base flood area (Zone A14).

The existing berm elevations are sufficient to prevent floodwaters from inundating the site during a base flood event. Nonetheless, the berm and dike system will, if necessary, be modified to meet current FEMA construction and maintenance standards for levees (44 C.F.R. § 65.10[b]). All standards applicable to construction occurring within a mapped 100-year base flood elevation will be met, or action will be taken to ensure that the FIRM is revised or amended to reflect the presence of a levee system (dike and berm) or grade elevations above the 100-year base flood elevation. With the berm and dike system improvements necessary to meet FEMA construction and maintenance standards for levees and grade elevation, the Project will not be subject to flooding during a base flood event (will effectively be above zone A14) and will qualify for a Letter of Map Amendment or Revision.

Depending on the results of flood studies, it may be necessary to undertake actions to ensure that the dike and berm (levee) system meet FEMA standards. If grading and construction result in filling portions of the A14, compensatory actions may be required to achieve the result of no increase greater than a 1 foot rise in the base flood elevation in any area, and to ensure that the development is safe (e.g., that appropriate construction methods and materials are used and that standards are achieved, if the northerly portion of the Project area still falls within the mapped Zone A14 100-year base flood elevation).

In summary, all standards applicable to construction occurring within a mapped 100-year base flood elevation will be met, or action will be taken to ensure that the FIRM is revised or amended to reflect the presence of a levee system (dike and berm) or grade elevations above the 100-year base flood elevation, or a combination of the above.

6.5.2.3 Cumulative Impacts

No cumulative impacts on water resources in the area are expected to result from operating the modernized MBPP's cooling water intake and discharge. The same structures that are now in place will be used, and both the flows through them and the heat loading in the discharged water will be less than at present. The current discharge plume occasionally reaches the vicinity of the City of Morro Bay Wastewater Treatment Plant outfall, which is located approximately 6,000 feet from the MBPP discharge, with a maximum discharge flow rate of approximately 900 gpm. At this distance from the MBPP discharge, the thermal plume is a thin surface phenomenon. The sewer discharge is diffused 50 feet below the surface and infrequent interaction at very low differential temperatures could be expected to take place between the plumes. As discussed in Section 6.6A - Marine Biological Resources, there is no evidence of adverse water quality impacts in the distribution and/or abundance of organisms present in the surrounding area.

Cumulative impacts analysis also includes demolition of the existing generating units and tank farm. The demolition of these facilities is not expected to have any significant effects on water resources in the area. There will be a temporary increase in the use of raw well water to control dust emissions; however, this use is expected to be within the NPDES Permit limit and transient in nature and is therefore considered to be negligible (See Air Quality Section 6.2.8 for a discussion of this measure.

6.5.2.4 Design Features to Avoid Impacts

The following are design and/or operational water resource related aspects of the Project that avoid potentially significant environmental impacts that have been incorporated into the Project:

- Use of the existing cooling water intake and discharge infrastructure systems for the new units avoids construction impacts and marine habitat disturbance within Morro Bay and Estero Bay.
- Use of efficient combined-cycle technology, thereby reducing water usage and thermal loads compared to the existing generating units. At base load, the new efficient combined cycle units will require 48 percent less water per MW of electrical generation compared to the existing units, and at full load, 41 percent less.
- Multiple cooling water pumps for the new units, which will allow reduced cooling water flows at less than maximum capacity operation.
- Reduction in cooling water flows, and the velocities at the intakes, will directly reduce both entrainment and impingement at the intakes.
- Continued use of seawater cooling at Morro Bay avoids consumptive use of precious freshwater supply and avoids the visual and environmental impacts of cooling towers.

6.5.3 MITIGATION MEASURES

Because the beneficial uses of water resources in the vicinity of MBPP are expected to continue to remain protected as described above, no significant adverse impacts on water resources are projected. No construction activities will occur in fresh or marine water environments, and the Project operation will result in significantly reduced cooling water flows and heat loads. Therefore, no water resource related mitigation measures are proposed for the Project.

6.5.4 SIGNIFICANT UNAVOIDABLE ADVERSE IMPACTS

No significant unavoidable adverse impacts are projected to occur to water resources due to construction, operation or maintenance of the Project. As described above, no construction activities will occur in fresh or marine water environments, and the Project operation will result in significantly reduced cooling water flows and heat loads.

6.5.5 LAWS, ORDINANCES, REGULATIONS AND STANDARDS (LORS) COMPLIANCE

A summary of LORS related to local surface and ground water resources is provided in Section 7.5.5. The Project will be in compliance with LORS related to fresh and ocean water resources during Project construction and operation, principally through the RWQCB permitting process. The LORS so covered include:

- National Pollutant Discharge Elimination System (NPDES) discharge permit under Federal Clean Water Act, and Storm Water Pollution Prevention Plan (SWPPP) program.
- Regulation of thermal discharges under California State Thermal Plan and State Ocean Plan
- Spill Prevention Control and Countermeasures (SPCC) Plan and release reporting requirements.
- State Water Use Regulations (General and specific to Power Plant Cooling).

Compliance with the LORS related to operation of the cooling water system and other discharges from the site will be accomplished by applying for and obtaining a new NPDES permit from the RWQCB. The Project will also update current SWPPP and SPCC Plans.

The Commission review of this AFC covers the other applicable LORS, including:

- Information concerning water resources protection in Appendix B under 20 California Code of Regulations (CCR).
- CEQA Guidelines 14 CCR §15000, Appendix G.

Principal Federal, State, and Local regulations related to water resources follow.

6.5.5.1 Federal Authorities and Administering Agencies

6.5.5.1.1 Clean Water Act (CWA) of 1977 (including 1987 amendments)

Section 311; 33 USC §1321; 40 CFR Parts 110, 112, 116, 117

These sections of the CWA include provisions for spills into navigable waters of the United States. An SPCC Plan is currently in place at MBPP, and will be updated every three years. The administering agency is the Central Coast RWQCB, with oversight provided by EPA.

Section 316(a); 33 USC §1326; 40 CFR part 401

This section of the CWA requires point source discharges with effluent limitations for the control of the thermal component to be stringent enough to assure the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife that rely on the water where the discharge is made. The administering agency is the Central Coast RWQCB, with oversight provided by EPA.

Section 316(b); 33 USC §1326(b); 40 CFR part 401

This section of the CWA requires that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing environmental impact. The administering agency is the Central Coast RWQCB, with oversight provided by EPA.

Section 320; 33 USC § 1330; 40 CFR part 35 - National Estuary Program

This section establishes the National Estuary Program (NEP) under which the Governor may nominate an estuary lying within the State as an estuary of national significance and request a Comprehensive Conservation and Management Plan (CCMP) for the estuary from the EPA. Morro Bay has been accepted into the NEP and has in place a Draft CCMP that is expected to be final in October 2000. The MBPP will not have any environmental impacts addressed by the NEP, and the CCMP established pursuant to it. This program is administered cooperatively by the California EPA, the Morro Bay Management Plan Task Force, and the Central Coast RWQCB.

Section 402; 33 USC §1342; 40 CFR Parts 122-136

The CWA requires a general construction activities permit for discharge of stormwater from construction sites that disturb 5 acres or more. Project construction activities will be performed in accordance with a SWPPP and associated monitoring pursuant to the NPDES General Permit for

Storm Water Discharges Associated with Construction Activity. This federal permit requirement is administered by the Central Coast RWQCB, with oversight provided by the SWRCB and the EPA.

6.5.5.1.2 Rivers and Harbors Act

Section 10, 33 USC §401; 33 CFR parts 114, 115, 116, and 321

This section provides that no bridge, causeway, dam or dike may be built over any navigable water unless the plans are submitted to and approved before construction is commenced. The administering agency is the U.S. Army Corps of Engineers.

6.5.5.1.3 National Flood Insurance

42 USC § 4101 et. Seq.; 44 CFR Part 70

These sections of the National Flood Insurance statute provides for mapping areas subject to flooding and revisions to those maps. The administering agency is the Federal Emergency Management Agency (FEMA).

Executive Order No. 11988

Each Federal Agency has the responsibility to evaluate the potential effects of any action it may take on a floodplain.

6.5.5.2 <u>State Authorities and Administering Agencies</u>

6.5.5.2.1 California Porter-Cologne Water Quality Control Act 1972; California Water Code §13000-14957; 23 CCR

This Act establishes the SWRCB and the RWQCB as the principal state agencies with primary responsibility for the coordination and control of water quality. Discharges of waste must comply with the ground water protection and monitoring requirements of the Resource Conservation and Recovery Act of 1976, as amended (RCRA) (42 USC Sec. 6901 et seq.), together with any more stringent requirements necessary to implement this revision or Article 9.5 (commencing with §25208) of Chapter 6.5 of Division 20 of the Health and Safety Code (see Section 7.5.4.2). The administering agency is the Central Coast RWQCB.

6.5.5.2.2 California Constitution, Article 10 §2

This article prohibits the waste or unreasonable use of water and regulates the method of use and method of diversion of water. The administering agency is the SWRCB.

6.5.5.2.3 California Water Code §13269; 23 CCR Chapter 9

The code requires the filing of a report of waste discharge and provides for the issuance of waste discharge requirements with respect to the discharge of any waste that can affect the quality of waters of the state. The waste discharge requirements may incorporate requirements based on the Clean Water Act §402(p) and implementing regulations at 40 CFR Parts 122 seq., as administered by the Central Coast RWQCB.

6.5.5.2.4 State Water Resources Control Board Resolutions

SWRCB Resolution 75-58

This resolution gives priority to the use of ocean waters for power plant cooling purposes. The administering agency is the Central Coast RWQCB.

SWRCB Resolution 74-43

This resolution contains a number of prohibitions against waste discharges including chemical, biological and petroleum related waste. The administering agency is the Central Coast RWQCB.

6.5.5.2.5 Water Quality Control Plan for Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan), Appendix A-3

This plan sets specific water quality objectives related to temperatures allowed for receiving waters, to assure protection of beneficial uses. The plan was established in conjunction with 40 CFR 316(a) for thermal discharges. It is administered by the Central Coast RWQCB.

6.5.5.2.6 California Ocean Plan, California Water Code §13170.2

This provision requires the State Water Resources Control Board to formulate and adopt a water quality control plan for the ocean waters of California. In formulating the plan, the SWRCB is to evaluate the effect of municipal and industrial waste discharges on the ocean marine environment.

6.5.5.2.7 California PRC §25523(a) and §25523(b); 20 CCR §1752, 1752.5, 2300-2309, and Chapter 2 Subchapter 5, Article 1, Appendix B, Part (l)

These code sections provide for the inclusion of requirements in the Commission's decision on an AFC to assure protection of environmental quality and require submission of information to the Commission concerning proposed water resources and water quality protection. Under Section 25523(b), the Commission is to ensure that a project located in a coastal zone complies with the requirements of the California Coastal Act and report recommendations prepared pursuant to that Act submitted by the California Coastal Commission as an advisory agency. The administering agency is the Commission.

6.5.5.2.8 Morro Bay Management Plan, PRC §28000 et seq.

Establishes Morro Bay as a State Estuary and was the precursor to its acceptance into the National Estuary Program (NEP). Morro Bay has in place a Comprehensive Conservation and Management Plan (CCMP) which calls for Federal, State, local, and private collaboration in addressing the environmental problems facing the Morro Bay estuary. The MBPP will not have any environmental impacts addressed by the NEP and the CCMP established pursuant to it. This program is administered cooperatively by the California EPA, the Morro Bay Management Plan Task Force, and the Central Coast RWQCB.

6.5.5.3 Local Authorities and Administering Agencies

6.5.5.3.1 City of Morro Bay; Municipal Code Chapter 14.17 – Flood Damage Prevention Ordinance

Under delegation from FEMA, the City of Morro Bay performs the first level analysis and provides approval for revision to the City flood maps. The City also specifies building requirements and analysis for building in the flood zone. In order to participate in the National Flood Insurance Program ("NFIP") administered by FEMA, local communities must adopt and enforce flood hazard prevention ordinances. The City of Morro Bay has adopted a Flood Damage Prevention Ordinance (Morro Bay Ordinance No. 477, codified at Ch. 14.72 MBO). As a Commission licensed power plant, the otherwise required development permit is subsumed in the Commission siting process under PRC §25500. The administering agency is the City Public Services Department.

6.5.5.4 Industry Codes and Standards

No LORS or codes are applicable.

6.5.6 REFERENCES

Asquith, D. O., 1991, Evolution of Morro Bay Tidal Channels, 1884 to present, Sedimentation and Physical Processes, ASCE Coastal Sediment Conference, Seattle, WA, pp. 7-2.21- 7-2.38.

California Central Coast Regional Water Quality Control Board, 1999. Annual Report 1997-98. "Nonpoint Source Pollution and Treatment Measure Evaluation for the Morro Bay Watershed." Prepared for the U.S. Environmental Protection Agency. Fifth Annual Report for the Morro Bay Section 319(h) National Monitoring Program.

California Central Coast Regional Water Quality Control Board. Order No. 95-22 *Waste Discharge Requirements for Pacific Gas and Electric Company*. Morro Bay Power Plant, San Luis Obispo County. NPDES No. CA 0003743. March 10, 1995.

California Coastal Act of 1976.

California State Water Resources Control Board. Water Quality Control Plan for Control of Temperature in Coastal and Interstate Waters and Enclosed Bays and Estuaries of California; Appendix A-3 (Thermal Plan). 1975.

California State Water Resources Control Board. Water Quality Control Plan for the Ocean Waters of California (California Ocean Plan) adopted 1972. Last amended 1997.

California State Water Resources Control Board. *Water Quality Control Policy on the Use and Disposal of Inland Waters Used for Power Plant Cooling*. June 1975.

California Water Code Porter-Cologne Water Quality Control Act. Division 7, Sections 13142.5 and 13391. 1998.

Chipping, D. H., 1979, Chorro delta, a birdfoot delta, California Geology (March).

Duke Engineering and Services, Inc (DESI). Morro Bay Power Plant 1999 Intake Area Hydrographic Survey and Intake Structure Approach Velocity Measurements. January 2000.

Dyer, K. R., 1997, Estuaries, a Physical Introduction, 2nd Ed, Wiley, New York.

Ecological Analysts, Inc. Moss Landing Power Plant Cooling Water Intake Structures. On file, Moss Landing Power Plant. 1983.

Ecological Analysts, Inc. Moss Landing Power Plant Units 1 Through 5, 316(a) Demonstration Supplement. On file, Moss Landing Power Plant. 1981.

Federal Water Pollution Control Act, As Amended by the Clean Water Act of 1977 (commonly referred to as Clean Water Act) last amended by PL-104-324. Sections 301, 303 and 316. October 19, 1996.

Gerdes, G. L., E. R. J. Primbs, and B. M. Browning, 1974, Natural Resources of Morro Bay - Their Status and Future, California Department of Fish and Game, Coastal Wetland Series #8.

Haltiner, J. and D. Thor, 1988, Sedimentation processes in Morro Bay, California, Phillip Williams and Associates, various paginations.

Haltiner, J. and D. Thor, 1991, Sedimentation processes in Morro Bay, California, Sedimentation and Physical Processes, ASCE Coastal Sediment Conference, Seattle, WA, pp. 7-1.1-7.1.21.

Jay, D. A. and Flinchem, E. P., 1997, Interaction of fluctuating river flow with a barotropic tide: A test of wavelet tidal analysis methods, J. Geophys. Res. 102: 5705-5720.

Jay, D. A., 1991, Green's law revisited: tidal long wave propagation in channels with strong topography. J. Geophys. Res. 96: 20,585-20,598.

Johnson, J. W., 1973, Characteristics and behavior of Pacific Coast tidal inlets, J. Waterways, Harbors, Coast. Engin. Div. ASCE (August).

Josselyn, M. L., M. Martindale, and J. Callaway, 1989, Biological resources of Morro Bay as impacted by watershed development in Los Osos and Chorro Creek watersheds, Romberg Tiburon Center for Environmental Studies, San Francisco State University, various paginations.

Metcalf and Eddy, Inc. Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition. McGraw Hill, Inc. 1991.

Morro Bay National Estuary Program (MBNEP). 2000. "Characterization Report." Volume II to the Comprehensive Conservation Management Plan.

Noda, E. K., and Y. Jen, 1975, Sand Transport Analysis, Morro Bay, Tetra Tech Inc., Pasadena, CA, various paginations.

Orme, A. R., 1991, Evolution of the Morro barrier-lagoon system: a synthesis, ASCE Coastal Sediment Conference, Seattle, WA, pp. 7-3.39-7.3.48.

Pacific Gas and Electric, 1973, An Evaluation of the Effect of the Cooling Water Discharges on the Beneficial uses of Receiving Waters at Morro Bay Power Plant, various paginations.

Pacific Gas and Electric. *An Evaluation of Cooling Water Discharge on the Beneficial Uses of Receiving Waters at Morro Bay Power Plant.* July 1973.

Pacific Gas and Electric. NPDES Monitoring Reports, Moss Landing Power Plant. 1994 through 1998.

Tetra Tech, Inc., 1998, Morro Bay National Estuary Program Sediment Loading Study, Lafeyette, CA., various paginations.

Tetra Tech, Inc., 1999, Morro Bay National Estuary Program Hydrodynamic Circulation Model, Lafeyette, CA., various paginations.

US Army Corps of Engineers, 1991, Morro Bay, California, Feasibility Report, Volume II, Los Angeles District.

Wiegel, R. L., 1967, An Ocean Engineering Study of Morro Bay, California (unpublished special study), UC Berkeley, various paginations.