FEASIBILITY STUDY FOR INSTALLATION OF COOLING TOWERS AT SAN ONOFRE NUCLEAR GENERATING STATION

Prepared for Southern California Edison Company

Prepared by:

Enercon Services, Inc.
500 TownPark Lane, Suite 275
Kennesaw, GA 30144

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EXECUTIVE SUMMARY

The Southern California Edison Company is majority owner and sole operator of the San Onofre Nuclear Generating Station (SONGS), which could potentially be mandated by the United States Environmental Protection Agency and the California State Water Resources Control Board to retrofit to a closed-loop cooling water system. This feasibility study was conducted to determine if closed-loop cooling could be engineered for SONGS given the site-specific constraints and, if closed-loop cooling was possible, to provide a comprehensive description of the major elements necessary to retrofit SONGS Units 2 and 3 to closed-looped cooling. It should be noted that no nuclear stations designed solely for once-through cooling have been converted to closed-loop cooling; any closed-loop conversion design would be unprecedented and would present inherent uncertainties.

Retrofitting SONGS with a closed-loop cooling system would be challenged with insuperable permitting obstacles, unparalleled – "one of a kind" – engineering challenges, adverse environmental impacts likely greater than those imposed by once-through cooling, and initial costs exceeding $3.0 billion. The closed-loop cooling system would be thermodynamically inferior to the present system which would result in a significant reduction in generating capacity up to 191 MWe. The potential for decreased electrical output from a non-carbon emitting source would only serve to undermine the State's ability to meet its greenhouse gas emissions reduction goals under California Assembly Bill AB 32.

Several studies on the possibility of converting SONGS to closed-loop cooling were completed prior to this assessment, with each study concluding that a retrofit of SONGS to closed-loop cooling would be feasible; however, these studies neglected to identify or resolve site-specific land use constraints, environmental impacts (in particular air emission limitations), or conversion cost issues. This feasibility study identifies the substantial land use constraints, initial costs exceeding $3.0 billion dollars and annual costs exceeding $85 million, considerable losses in generation during conversion and during post-retrofit operation, significant adverse environmental impacts, and likely insurmountable permitting obstacles which would be encountered if SCE were to attempt to retrofit SONGS with closed-loop cooling. Each of these issues is summarized below.

Land Use Constraints

The land use issue represents a significant obstacle to the conversion of SONGS to closed-loop cooling. The conversion would involve tunneling beneath Interstate 5, construction of six hybrid cooling towers at the Mesa Complex east of Interstate 5, and the creation of hot and cold water reservoirs immediately adjacent to each unit's turbine building. The feasibility of obtaining the permitting necessary for construction of cooling towers is questionable at best. If permitted, conversion of SONGS Units 2 and 3 to closed-loop cooling would have initial costs exceeding $3.0 billion and would include a construction period spanning a minimum of 66 months.

Cooling tower selection at SONGS is constrained by the limited site available area, the site's proximity to the California coastline and Interstate 5, and by the need to limit visible plume formation. While no cooling tower option could completely satisfy these constraints, hybrid cooling towers are the only technology available with a relatively low industrial profile that provides the cooling required with limited visible plume formation[1]. Since the size of a cooling tower is directly proportional to the amount of heat that must be rejected, and the heat loads at SONGS are relatively large, the cooling towers required for closed-loop cooling would need to be relatively large. Given the SONGS site constraints, meteorological conditions, and the necessary use of saltwater for makeup, SPX Cooling Technologies sized a linear hybrid cooling tower design with three 15 cell linear hybrid cooling towers per unit. Sufficient space for the six required towers is not available in the area of the SONGS facility located between Interstate 5 and the Pacific Ocean (i.e., the SONGS Coastal Complex); therefore, the towers would have to be located on the southwest corner of the Mesa Complex.

The location of the hybrid cooling towers would require large diameter piping to be tunneled beneath Interstate 5 from the SONGS Coastal Complex to the Mesa Complex. From the tunnel, closed-loop circulating water would be routed beside the seawall and would draw suction from a hot water reservoir and provide cooled water from the cooling tower back to a cold water reservoir. Due to the size constraints of the cold water reservoir, three new vertical wet pit circulating water pumps would be needed to pass cooling water through the condenser. Additionally, three new high volume / high head vertical wet pit pumps would be required to pump circulating water from the hot water reservoir up to the cooling towers. It should be noted that operation of cooling towers at a nuclear power plant with such a large degree of elevation change between the cooling towers and the condenser is unprecedented, and additional engineering design would be required to ensure public safety would not be compromised by the discharge of cooling water across the SONGS seawall during a loss of power event.

Cost Estimate

A cost estimate and an associated construction schedule were developed for the selected wet hybrid cooling towers assuming that all required permits could be obtained for the conversion to closed-loop cooling. The cost of closed-loop conversion would include the initial capital costs, construction outage costs, and continuous operational, parasitic, and maintenance costs. The design, construction, construction outage power production losses, and start-up of closed-loop cooling at SONGS would exceed $3.0 billion, of which approximately $2.4 billion is based on 21.1 months of construction outage per unit. For comparison, $3.0 billion is approximately 50% of the actual capital costs for the construction of both SONGS Units 2 and 3[2]. In addition to these one-time costs, SONGS would incur continuous operational costs for the remaining plant life due to net power losses from the increased circulating water temperature and parasitic losses from the new equipment required for closed-loop cooling, totaling an average annual power generation loss of approximately 143 MWe. The cost of this lost power generation coupled with the maintenance costs for the new equipment would exceed $85 million per year.

Environmental Impacts / Permitting Requirements

Drift impacts due to the operation of cooling towers would be significant, where a total of between 827.8 and 837.2 tons[3] of PM_{10} would be emitted per year by SONGS in closed-loop operation. San Diego County is currently designated by the California Air Resources Board as

[1] Hybrid cooling towers would reduce visible plume occurrence to less than 1% of the year; however, any decrease in driver visibility on Interstate 5 would reduce public safety.
[2] The actual cost of constructing SONGS Units 2 and 3 in the early 1980s was approximately $6.1 billion.
[3] PM_{10} emission variability dependent on the local salinity of the Pacific Ocean.

non-attainment for PM_{10} and $PM_{2.5}$. A major-source Title V air permit would be required from the San Diego County Air Pollution Control District. It is unlikely that SONGS could locate and purchase a sufficient number of PM_{10} emission credits to cover these emissions. Conversion of SONGS to closed-loop cooling would be infeasible if the required drift offsets were not available. It should be noted that due to the limited availability of PM_{10} emission credits and large variability in price, a cost for obtaining the necessary PM_{10} credits has not been included in the cost estimate. If PM_{10} credits were to be available, the $3.0 billion initial cost of converting SONGS to closed-loop cooling would increase significantly to include their purchase.

Additionally, approximately 165 tons of salt would be deposited downwind (south-southwest) of the proposed cooling towers extending across the SONGS Coastal Complex area. This salt deposition would create the need for significant additional maintenance requirements for the existing equipment and facilities and the potential for unplanned unit outages from electrical arcing in the switchyard. Salt deposition may also occur across the nearby Camp Pendleton housing areas to the northeast. Salt deposition across the coastal scrubland habitat could cause adverse impacts to vegetation and habitat.

The conversion from once-through cooling to closed-loop cooling would result in an annual average loss of power generation of approximately 143 MWe at SONGS. If that generating capacity was assumed to be replaced by a natural gas facility, an estimated additional 227,000 tons per year of CO_2 would be emitted to the atmosphere.

Various permits, including a Coastal Development Permit, would be required for the conversion of SONGS to closed-loop cooling. All of these permits would be acquired in accordance with regulatory public participation requirements, which would likely incur intense public opposition due to project cost, adverse aesthetic/visual impacts, air emissions, traffic, and potential ecological impacts. California Public Utilities Commission approval would also be required for recovery of the closed-loop cooling system conversion cost from the ratepayers as well as for ongoing annual costs. Additionally, it should be noted SCE does not own the land on which SONGS is located, and as such, all construction activities necessary for conversion to closed-loop cooling would need to be approved by Marine Corps Base Camp Pendleton. Failure to receive approval from any of these agencies would render the construction and operation of closed-loop cooling at SONGS infeasible.

Conclusion

While conversion of SONGS to closed-loop cooling could be engineered, several significant open issues would need to be addressed before conversion to closed-loop cooling could be considered feasible. First, conversion to closed-loop cooling would require permission to be granted by several local, state, and federal agencies, any of which would have the ability to deny approval. Second, while this report provides a conceptual design for closed-loop conversion, a final detailed design of closed-loop cooling conversion and its resulting effect on SONGS operation would be required. Third, closed-loop cooling would remove an annual average of approximately 143 MWe and a summer daylight peak of approximately 191 MWe of baseload generation from the California electrical system which could decrease grid reliability and increase reliance on carbon-emitting power sources.

1 Background and Introduction

The Southern California Edison Company (SCE) is the majority owner and sole operator of San Onofre Nuclear Generating Station (SONGS). The United States Environmental Protection Agency and the California State Water Resources Control Board are considering adopting regulations which would require SONGS Units 2 and 3 to implement a closed-loop circulating cooling water system. The feasibility of conversion to closed-loop cooling has been investigated by several studies, with each study concluding that a retrofit of SONGS to closed-loop cooling would be feasible; however, these studies neglected to identify or resolve site-specific land use constraints, environmental impacts (in particular air emission limitations), or conversion cost issues. A comprehensive feasibility study is presented in this report, along with an evaluation and comparison of previous studies.

1.1 Regulatory History

The Federal Water Pollution Control Act, 33 U.S.C. §§1251-1387, aims to restore and maintain the chemical, physical, and biological quality of the receiving waters of the United States. During 1977 the Congress enacted the Clean Water act, which establishes a comprehensive regulatory program administered by the United States Environmental Protection Agency (EPA). In 2004, the EPA issued final regulations to implement Section 316(b) of the CWA as it applies to Phase II facilities [Ref. 8.88]. Section 316(b), 33 U.S.C. §1326(b), addresses cooling water intake structures:

> *Any standard established… shall require that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.*

As defined in the EPA's Phase II regulations, Phase II facilities are existing power generating facilities with generating capacity factors greater than 15 percent (i.e., baseload facilities) that have the design capacity to withdraw at least fifty million gallons of water per day (MGD) from waters of the United States and use at least 25 percent of the water they withdraw exclusively for cooling purposes. With regard to the adverse environmental impacts associated with cooling water intake structures (CWIS) at Phase II facilities, the EPA selected "reductions in impingement and entrainment as a quick, certain, and consistent metric for determining performance" [Ref. 8.88]. As defined in the Phase II regulations, impingement takes place when organisms are trapped against intake screens by the force of the water being drawn through the CWIS and entrainment occurs when organisms are drawn through the CWIS into the cooling system. The Phase II regulations require that impingement mortality be reduced by 80 to 95 percent and that entrainment be reduced by 60 to 90 percent from the calculation baseline. The calculation baseline for impingement and entrainment mortality is based on a CWIS designed without consideration of environmental impacts (i.e., located at the shoreline near the surface of the waterbody, having a standard 3/8 inch mesh screen size, and operating at design flow rates). Facility water intake flow is assumed to be directly proportional to impingement and entrainment effects. Therefore, reductions in intake flow rate are considered equivalent to reductions in impingement and entrainment. Conversion of the cooling systems at Phase II facilities to closed-loop cooling would satisfy the performance standards of the Phase II regulations and is used as the benchmark to evaluate other alternatives. Ultimately, the EPA did not recommend closed-loop cooling as the best technology available (BTA) due to significant financial, operational, and environmental impacts.

The Phase II regulations would be implemented through National Pollutant Discharge Elimination System (NPDES) permits [Ref. 8.1]. The Phase II regulations were remanded by the 2nd Circuit Court back to the EPA and subsequently suspended on March 20, 2007 [Ref. 8.89]. On April 2, 2009, the US Supreme Court overturned the decision by the 2nd Circuit Court, allowing the EPA to reinstitute the use of cost-benefit analysis in setting standards and issuing permits under Section 316(b) of the CWA; however, at the time this feasibility study was concluded (September 2009), the Phase II regulations remained suspended.

The regulation 40 CFR §125.90(b) remains in effect, which states that permitting authorities, in the absence of nationwide standards, must implement Section 316(b) on a case-by-case, best professional judgment basis. The California State Water Resources Control Board (SWRCB) has proposed a 316(b) policy that would require the state's coastal generating stations that currently utilize once-through cooling to be either retrofitted with closed-loop cooling or provide the same level of impingement and entrainment reduction as closed-loop cooling [Ref. 8.24]. The proposed policy is based on the requirements outlined in the suspended EPA Phase II Rule and the subsequent guidance provided by court rulings on the Phase II Rule. Within one year of the effective date of the proposed SWRCB policy, existing power plants would be required to submit an implementation plan identifying the compliance alternative chosen by the plant; describing the design, construction, or operational measures that will be undertaken to implement the alternative; and proposing a schedule for implementing these measures.

SONGS Units 2 and 3 utilize once-through cooling systems with capacity factors in excess of 15 percent and use more than 50 MGD of saltwater from the Pacific Ocean for cooling purposes; therefore, SONGS Units 2 and 3 are subject to Section 316(b) impingement and entrainment regulations applicable to Phase II facilities. In the absence of nationwide standards, the SWRCB has proposed state-wide regulations in accordance with 40 CFR §125.90(b).

1.2 Comparison of Previous Studies to Current Findings

The following studies investigated retrofitting SONGS Units 2 and 3 with a closed-loop cooling water system:

- *Assessment of Marine Review Committee Recommendations for SONGS Units 2 and 3*, prepared by PLG, Inc. (formerly Pickard, Lowe, and Garrick) as part of a multi-year study by the independent Marine Review Committee (MRC) under the California Coastal Commission, February 1990 (PLG 1990) [Ref. 8.62]
- *Issues Analysis of Retrofitting Once-Through Cooled Plants with Closed-Cycle Cooling: California Coastal Plants*, prepared by Maulbetsch Consulting for the Electric Power Research Institute (EPRI), October 2007 (EPRI 2007)[Ref. 8.33]
- *Comprehensive Demonstration Study for Southern California Edison's San Onofre Nuclear Generating Station*, prepared by EPRI for SCE submittal to the San Diego Regional Water Quality Control Board, January 2008 (EPRI 2008)[Ref. 8.34]

- *California's Coastal Power Plants: Alternative Cooling System Analysis*, prepared by Tetra Tech, Inc. for California Ocean Protection Council, February 2008 (Tetra Tech 2008) [Ref. 8.83]

The bases and conclusions of each study, as well as a summary of the current findings, are summarized in Table 1.1. The closed-loop cooling analysis in EPRI 2008 is based on the results of EPRI 2007; therefore, the two studies are treated as the same with regards to analytical results.

Each of these studies considered the costs and environmental impacts of a closed-loop cooling retrofit at SONGS. Evaporative, mechanical-draft, rectilinear cooling towers were selected for consideration in all cases. In addition, Tetra Tech 2008 selected plume-abated towers. EPRI 2007 stated that plume abatement would likely be necessary, but based all analysis on basic mechanical-draft towers.

Each study concluded closed-loop cooling could be retrofitted to the SONGS facility. However, several key significant issues were identified for resolution prior to installation of a closed-loop cooling system. The closed-loop cooling installation issues include siting of the structures, air emission impacts, and cost of the retrofit:

- Cooling Tower Siting – As described further in Section 2, the SONGS facility is bounded by the San Onofre State Beach, Marine Corps Base Camp Pendleton (MCBCP), Interstate 5, a North County Transit District (NCTD) of San Diego Railway line, and old U.S. Highway 101. All previous studies assume that some portion of San Onofre State Beach could be aquired for the construction of cooling towers. However, the acquisition of protected habitat in a California State Park is uncertain at best. In addition, the previously proposed cooling tower locations would inherently decrease the efficiency of cooling towers due to the significant recirculation effects of placing the cooling towers perpendicular to the prevailing winds on site. Additionally, since the cooling towers were sited at a significantly higher elevation than the condenser, the kinetic energy in the descending circulating water would cause over-pressurization and, utlimately, failure of the condeners, turbine plant cooling water (TPCW) heat exchangers, and ancillary circulating water system equipment.

  Siting the cooling towers on the Mesa Complex, by installing circulating water tunnels under Interstate 5, the North County Transit District of San Diego Railway line, and old U.S. Highway 101 would address some of the land use issues and recirculation concerns (see Section 3.2). Additionally, reservoirs, as opposed to direct circulating water pipe tie-ins, would provide a means to dissipate kinetic energy built up in the circulating water before it is pumped through the condensers and TPCW heat exachangers.

- Air Emissions – Cooling tower drift (i.e., entrained liquid water droplets in the air stream exiting the tower) at SONGS would consist of water, salt, and dissolved/suspended solids and would be considered fine particulate emissions (PM_{10} and $PM_{2.5}$). All previous studies assume that the increase in PM_{10} and $PM_{2.5}$ air emissions due to closed-loop cooling at SONGS would result in acceptable and permittable air emission levels or could be mitigated. As described in Section 6.1, SONGS is located in an area that has already been designated a non-attainment area for several air pollutants by the EPA and the State of California.

Obtaining the necessary air emission permits or credits to operate cooling towers presents significant cost and feasibility concerns (see Sections 6.1 and 6.7). It is unlikely that SONGS could locate and purchase a sufficient number of PM_{10} credits to cover this quantity of emissions. Conversion of SONGS to closed-loop cooling would be infeasible if the required drift offsets were not available.

- Conversion Costs – Total cost estimates for the project (both units) ranged from approximately $328 million to $1.274 billion. All previous studies include capital cost and operation and maintence cost estimates. PLG 1990 and Tetra Tech 2008 also include replacement power cost estimates for power losses due to the extended outage for closed-loop cooling installation and the thermodynamic and parasitic losses associated with closed-loop cooling operation. Tetra Tech 2008 estimates that the annual cost of conversion to closed-loop cooling would be equal to 9.8% of SONGS annual gross revenue. Both PLG 1990 and EPRI 2007 conclude that conversion could be feasible, but that costs would likely increase the difficulty of the project such that conversion to closed-loop cooling could not be recommended.

  The estimated capital cost of conversion to the closed-loop cooling configuration described in Section 3 is approximately $615 million, including design/engineering, cooling towers, tunneling, construction, testing/startup, and contingency costs (detailed in Section 5.2.1 and Attachment 4). Additionally, assuming a projected cost of electricity of $73.30 per MWhr (Attachment 1, Section 5), the aggregate outage cost for conversion of SONGS to closed-loop cooling would be approximately $2.4 billion (Section 5.2.2). The estimated total one-time cost for conversion to closed-loop cooling is therefore $3.0 billion.

  After conversion to closed-loop cooling, operational and parasitic losses would cost SCE approximately $83 million per year (Sections 5.2.3 and 5.2.4). The estimated operations and maintenance costs of conversion to closed-loop cooling would be $2.8 million (years 1 to 5), $3.8 million (years 6 to 15), and $5.8 million (years 16 to 20) (Section 5.2.5). Due to the limited availability of PM_{10} emission credits and large variability in price, the cost for obtaining the necessary PM_{10} credits is not included in the conversion costs; however, if available, it is also likely that the cost of obtaining and maintaining the necessary permits to operate closed-loop cooling at SONGS would be substaintial.

Table 1.1 Comparison of Feasibility Studies on Closed-Loop Conversion at SONGS

	PLG	Basis	EPRI	Basis	Tetra Tech	Basis	ENERCON	Basis	Report Section
Technology Selection									
Heat Transfer	Evaporative	Saltwater not suitable for dry sections	Evaporative	Dry too large	Hybrid	Freeway hazards	Hybrid	Freeway hazards Visual impact	Section 3.1.1
Air Flow	Mechanical-draft	Insufficient space for natural draft	Mechanical-draft Counterflow	-	Mechanical-draft Counterflow	-	Mechanical-draft Counterflow	Space limitations Plume abatement	Section 3.1
Shape	Rectilinear (24x2 cells)	One tower per Unit	Rectilinear (~40 cells)	81 cells per Unit	Rectilinear (8 cells per tower)	6 towers per unit	Rectilinear (15 cells per tower)	3 towers per Unit 2°C recirculation allowance	Section 3.1
Cycles of Concentration	1.5	Saltwater	1.5	Saltwater	1.5	Saltwater	1.5	Saltwater	Section 4.4
Land Use									
Space (acres)	8	Towers only	Large	4,000 ft x 20 ft diameter	30.08	Areas 1 and 7	14	SPX tower dimensions 1.5 tower width spacing	Section 3.2
Location	Bluffs north and south of Power Block	Tower siting inland of I-5 assumed not feasible	Bluffs north and south of Power Block	No other option	Bluffs north and south of Power Block	Tower siting inland of I-5 assumed not feasible	South Corner of Mesa Complex	Reduced recirculation Land use concerns	Section 3.2.1
Cost									
Capital ($ million)	172	1990 Estimate by GEA Power Cooling Systems, Inc	675	Likely to exceed MCS "Difficult" estimate	593.2	Vendor estimate 'Design-and-Build'	614	Design, procurement and installation estimate	Section 5.2.1
O&M ($ million)	3	3% initial tower cost	8	3% average capital costs	6.4	Year 1 $4/gpm	2.8	Year 1 Labor and parts	Section 5.2.5
Outage ($ million)	125	60 days $0.048/kWhr	-	-	594.8	6 months per unit $72/MWhr	2,427	21.1 months per Unit $73.30/MWhr	Section 5.1.2 Section 5.2.2
Losses ($ million)	28.2	$0.048/kWhr	-	-	80	$84/MWhr	82.7	$73.30/MWhr	Section 5.2.3 Section 5.2.4
Total ($ million)	328.2		683		1,274.4		3,126.5		
Losses									
Thermal Efficiency (MWe)	49.8	Turbine manufacturer performance curves	24	PLG study	64.14	Average efficiency % losses	73.5	PEPSE plant analysis	Section 4.2.2
Parasitic (MWe)	33.6	Required pumping head and fan power	67.61	Required pumping head and fan power	58.54	Required pumping head and fan power	69.4	Required pump/fan power	Section 4.3
Total (MWe)	83.4		91.61		122.68		142.9		
Environmental									
Reduction in Water Use (%)	92	-	94	Generalized saltwater makeup estimate	95	-	95.6	Saltwater operation	Section 4.4
Visual Impact	Considerable	Towers and plume	Contentious and costly issue	Towers and plume	-	-	Low Impact	Tower visibility	Section 6.5.1
Fog	Incremental road hazard increase	High relative humidity	N/A	Plume abatement	N/A	Plume abatement	<1% of historical operating conditions	Plume abatement	Section 3.1.1
Noise (db)	above 50	1 mile from plant	-	-	-	-	Attenuated to acceptable levels	Sound attenuation required	Section 3.1.2 Section 6.5.3
Air Emmissions (lb/hr)	511	0.001% drift eliminator Salt	203 / 4054	0.0005% drift eliminator PM_{10} / Drift	210 / 3982	0.0005% drift eliminator PM_{10} / Drift	210	0.0005% drift eliminator Salt	Section 6.1.1
Conclusion	**-**		**Difficult**		**Technically and logistically feasible**		**Technologically feasible, not practicable (*Section 7*)**		

1.3 Alternative Technologies

In addition to analyzing closed-loop cooling, both EPRI 2008 [Ref. 8.34] and Tetra Tech 2008 [Ref. 8.83] evaluated alternative technologies for the reduction of entrainment and impingement mortality. EPRI 2008 determined that three alternative technologies, variable speed pumps, aquatic filter barriers, and the relocation of the cooling water intake structure were not feasible at SONGS. While fine mesh traveling screens and narrow-slot wedgewire screens were determined to be feasible at SONGS, only narrow-slot wedgewire screens were determined to be able to meet the performance standard range. However, EPRI 2008 noted that "wedgewire screens are unproven in California for use in an open ocean environment and have never been deployed in a high biofouling open ocean environment" [Ref. 8.34].

Tetra Tech 2008 evaluated the use of fine mesh modified ristroph screens, barrier nets, aquatic filtration barriers, variable speed drives and cylindrical fine mesh wedgewire screens. Tetra Tech concluded each of these technologies would either be infeasible for use at SONGS or would not be able to yield the required reductions in entrainment and impingement mortality.

1.4 Purpose of this Assessment

Given that SONGS could be mandated to retrofit to closed-loop cooling, this report presents a comprehensive feasibility study of all major elements necessary to retrofit SONGS Units 2 and 3 with a closed-loop circulating water system, including the estimated costs of conversion and the environmental impacts.

1.5 Scope and Design Objectives

This Report provides the following:

- A conceptual design, cost estimate, and construction schedule developed for the recommended closed-loop system. The assessment of economic impacts includes initial capital costs, operation and maintenance expenses, and Station capacity impacts associated with the selected configuration.
- An assessment of environmental impacts associated with the proposed changes. Negative and positive impacts are identified, and quantified on a preliminary basis. These include such issues as cooling tower plume and noise generation, site aesthetics, construction related impacts, and intake flow changes.

2 San Onofre Station and Cooling System Description

SONGS is a baseload facility comprised of two active units (Units 2 and 3) and one inactive unit undergoing decommissioning (Unit 1). SONGS is located approximately 2.5 miles southeast of San Clemente, California, occupying approximately 214 acres within the MCBCP. Units 1, 2 and 3 are located in an 83.6-acre area, referred to herein as the Coastal Complex in its entirety, to the southwest of Interstate 5, the NCTD Railway line, and old U.S. Highway 101 (collectively referred to herein as the coastal highways and railway), along the Pacific Ocean Coast. Unit 1 was permanently shut down in 1992, defueled in 1993, and is currently undergoing decommissioning. Units 2 and 3 are located southeast of and immediately adjacent to Unit 1. The remaining 130-acre area, referred to as the Mesa Complex, is located to the northeast of the coastal highways and railway. Administrative, maintenance, and support services are housed on the Mesa Complex; no power-generating activities occur there. Figure 2.1 shows an aerial view of the station layout and surrounding areas.

Figure 2.1 San Onofre Nuclear Generating Station Location

SONGS Units 2 and 3 are pressurized water reactor (PWR) nuclear steam supply systems (NSSS) that produce a net electrical output of 1070 MWe and 1080 MWe, respectively. The main condensers, the turbine plant cooling water system, and the component cooling water system reject heat to seawater drawn from the Pacific Ocean as part of a once-through cooling (OTC) system [Ref. 8.75].

2.1 Cooling Water Intake Structure Description

Two independent cooling water intake structures (CWISs) provide cooling water to SONGS Units 2 and 3. The general arrangement of the intake structures is shown in Attachment 5, Figure 5-1. Cooling water is withdrawn from the Pacific Ocean through two submerged intake conduits, each extending approximately 3100 feet offshore at a bottom depth of 30 feet. The submerged end of each conduit is fitted with a velocity cap to minimize the entrainment of motile fish into the system by converting the vertical flow to a lateral flow, thus triggering a flight response from fish. Water enters the velocity cap at an average velocity of 1.7 feet per second (fps) and with the decreasing diameter of the intake conduit the water velocity increases to 7.6 fps until reaching the exit of the offshore intake box (see Attachment 5, Figure 5-1). Upon reaching the onshore portion of each intake, the withdrawn seawater flows through vertical louvers that guide any entrained fish to a fish elevator at the far end of the intake structure. The fish elevator delivers captured live fish into the fish return line, a common conduit that returns fish unharmed to a submerged location 1800 feet offshore. Behind the louvers in each intake structure are six screen assemblies, each consisting of one traveling bar rake and one vertical traveling screen. The bar rakes remove larger debris (e.g., kelp) where the screens sift the water of small debris larger than 3/8 of an inch in diameter. The screen assemblies are angled approximately 30° to the incoming flow, which further guides fish to the fish elevator. The vertical traveling screens are fitted with 3/8-inch mesh panels and a high pressure spray that removes any debris or fish impinged on the screen face. The forebay pump pit is located downstream of the traveling bar rakes and screens. In this location four circulating water pumps (CWPs), four salt water pumps (SWPs), and two screen wash pumps take suction to provide cooling and service water which results in a 2.8 fps water velocity across the traveling bar rakes and screens [Ref. 8.75].

The four CWPs in each intake structure supply cooling water to remove heat from the main condenser and TPCW heat exchangers under all conditions of power plant loading and design weather conditions. All four CWPs are normally in operation with each CWP discharging to a quadrant of the main condenser. A portion of the flow from each CWP is combined and supplied to the TPCW heat exchangers [Ref. 8.75].

The four SWPs in each intake structure are part of the Saltwater Cooling system, an engineered safety feature (ESF) support system. The saltwater cooling system for each unit consists of two 100% capacity critical trains each containing two SWPs [Ref. 8.75].

The two full-capacity screen wash pumps each have a design capacity of 2500 gpm. These pumps supply water to the traveling bar and screen wash spray nozzles and traveling bar and screen troughs. The screen wash cycle is activated automatically by pressure differential switches when debris builds up on the traveling bars and screen. The screen wash cycle can also be run manually to prevent debris build-up [Ref. 8.75].

2.2 CWIS Flow Description

The suspended EPA Phase II regulations and proposed SWRCB policy would regulate plant cooling water, defined as follows:

> *Water used for contact or noncontact cooling, including water used for equipment cooling, evaporative cooling tower makeup, and dilution of effluent heat content* [Ref. 8.1, §125.93].

Process water, such as the water supplied to the screen wash pumps, is not regulated by the EPA or SWRCB regulations. In addition, water that is used as process water either before or after being used for cooling purposes would not be considered cooling water [Ref. 8.1].

Both EPA and SWRCB state that if nuclear facilities demonstrate that compliance would result in a conflict with a safety requirement established by the Nuclear Regulatory Commission, the Director/Water Board must make a site-specific determination of best technology available for minimizing adverse environmental impact that would not result in a conflict with the Nuclear Regulatory Commission's safety requirement [Ref. 8.88 and 8.24]. The Saltwater Cooling system is designed to automatically provide a cooling water supply for the component cooling water system heat exchangers during power generation, normal and emergency shutdown and cooldown, and during a design basis loss-of-coolant accident [Ref. 8.75]. Using closed-loop cooling water in the Saltwater Cooling system rather than Pacific Ocean water would raise nuclear safety concerns due to unanalyzed operating conditions. Additionally, in the event of cooling tower failure, adequate cooling water for the Saltwater Cooling system could not be guaranteed. Therefore, the Saltwater Cooling system would not be modified for conversion to closed-loop cooling as discussed in Section 3.6.

2.2.1 Design Intake Capacity

The licensed design intake capacity of a facility serves as the baseline for evaluating flow reductions. Licensed design flow is the expected total volume of water likely to be withdrawn from a source waterbody, used during the cooling water intake structure design, consistent with 40 CFR §125.93 and both as reflected in and consistent with the Updated Final Safety Analysis Report (UFSAR [Ref. 8.75]). In each SONGS unit, the normal operation requirements of the OTC circulation water system, with four pumps running for condenser cooling, are 830,000 gpm. Normal operating requirements of the Saltwater Cooling system may be up to 34,000 gpm with two SWPs in operation. As the relatively small capacity (2500 gpm) screen wash pumps only supply process water and operate intermittently, immediately returning much of their flow to the intake structure, the flow requirements of the screen wash system are not considered. Therefore, the total licensed design flow for each SONGS unit is 864,000 gpm. Any current or proposed flow reductions are calculated from this baseline value.

2.2.2 Flow Reductions

As discussed in Section 1.1, the Phase II regulations assume facility water intake flow is directly correlated to impingement and entrainment effects; therefore, reductions in intake flow rate are considered equivalent to reductions in impingement and entrainment. Both planned and unplanned periods of reduced power decrease the actual amount of flow entering each unit's CWIS. Flow reductions are the percent reduction from the total design intake capacity of 864,000 gpm for each SONGS unit. Five years of operational CWIS data (see Table 2.1 and Table 2.2), indicate an annual flow reduction of 7.7% for Unit 2 and 9.2% for Unit 3.

Table 2.1 SONGS Unit 2 Flow Reduction from Baseline (2003-2008)

Month	Baseline Flow (MG)	Historic Operating Flow (MG)	Flow Reduction
January	38,569	31,795	17.6%
February	35,251	25,384	28.0%
March	38,569	33,317	13.6%
April	37,325	36,561	2.0%
May	38,569	37,780	2.0%
June	37,325	36,462	2.3%
July	38,569	37,780	2.0%
August	38,569	37,780	2.0%
September	37,325	36,562	2.0%
October	38,569	37,781	2.0%
November	37,325	36,562	2.0%
December	38,569	31,722	17.8%
Annual	454,533	419,489	7.7%

*Baseline and historic operating flows listed represent an average of the total aggregate flows for each month; therefore, specific variations in flow rates between each month may be attributable to the differing number of days per month.

**Due to the two leap years occurring during the 6 year period analyzed (2003-2008), the flows for February are based on 28.33 days a month and the annual flows are based on 365.33 days a year.

Table 2.2 SONGS Unit 3 Flow Reduction from Baseline (2003-2008)

Month	Baseline Flow (MG)	Historic Operating Flow (MG)	Flow Reduction
January	38,569	32,706	15.2%
February	35,251	32,628	7.4%
March	38,569	37,780	2.0%
April	37,325	36,561	2.0%
May	38,569	37,780	2.0%
June	37,325	36,499	2.2%
July	38,569	37,779	2.0%
August	38,569	37,780	2.0%
September	37,325	36,090	3.3%
October	38,569	24,957	35.3%
November	37,325	24,930	33.2%
December	38,569	37,453	2.9%
Annual	454,533	412,942	9.2%

*Baseline and historic operating flows listed represent an average of the total aggregate flows for each month; therefore, specific variations in flow rates between each month may be attributable to the differing number of days per month.

**Due to the two leap years occurring during the 6 year period analyzed (2003-2008), the flows for February are based on 28.33 days a month and the annual flows are based on 365.33 days a year.

2.2.3 Flow Reliability

The source of cooling water for SONGS is the Pacific Ocean. The Pacific Ocean is the most reliable source of cooling water at SONGS, promoting the efficient generation of electricity and ensuring an uninterrupted supply of cooling water for nuclear safety-related systems. Although the majority of seawater entering the CWIS is pumped through the main condenser via the Circulating Water system, a smaller portion of intake cooling water also passes through the traveling water screens and flows into Saltwater Cooling system pumps. The Saltwater Cooling system provides the ultimate heat sink for the nuclear safety-related Component Cooling system. The ultimate heat sink is capable of providing sufficient cooling water to shutdown and cooldown both units, or to mitigate the consequences of an accident in one unit and shutdown and cooldown the other unit despite a design basis earthquake, tornado, flood, drought, transportation accident, oil spill, fire, or any credible single failure of any manmade structure [Ref. 8.75]. Therefore, the conceptual design for conversion of SONGS to closed-loop cooling discussed in Section 3.6 does not modify the Saltwater Cooling system.

2.3 Discharge System

After passing through the circulating water system and the saltwater cooling system, the once-through cooling water is combined with low-volume wastes generated by SONGS and discharged. The combined discharge flows through submerged conduits and is released through a diffuser section designed to dissipate the discharge heat. The discharge conduits extend 8500 feet (Unit 2) and 6000 feet (Unit 3) offshore into the Pacific Ocean. Surface water withdrawals and discharges for each unit are regulated by individual NPDES permits CA0108073 for Unit 2 and CA0108181 for Unit 3. The NPDES permit for Unit 1 expired in 2005; any remaining Unit 1 effluent is routed to the Unit 2 or Unit 3 outfalls and discharged under the respective permits [Ref. 8.22].

3 Conceptual Design

There have been no conversions of existing operating nuclear stations from once-through to closed-loop cooling[4]. Due to this uncertainty, an investigative analysis on the impact of closed-loop cooling on plant systems, operation, and electrical output must be considered. Conversion to closed-loop condenser cooling would represent a massive and difficult engineering and construction undertaking, even when site conditions are conducive to the requisite configuration changes. In contrast, the SONGS site – with substantial elevation changes, a general lack of available space, a subsurface primarily composed of sandstone, the collocation of a major interstate and the aesthetically sensitive local environment (among other factors) – poses significant additional site-specific challenges. While the total aggregate uncertainty of these factors is not determined by this conceptual design, the critical obstacles in determining the feasibility and the appropriate configuration of a theoretical closed-loop system at SONGS are discussed in the following sections. Conceptual drawings of the closed-loop cooling configuration and tie-in details are provided in Attachment 5, Figures 5-2 through 5-5.

Conversion of SONGS from a once-through to a closed-loop circulating water system would require significant changes to the circulating water equipment; in addition, numerous ancillary systems are affected either by the downstream reduction in condenser heat rejection or are impacted by the construction and placement of new circulating water equipment. As discussed in Section 3.2, cooling towers would be located on the east side of Interstate 5 and require large diameter piping to be tunneled beneath Interstate 5 from the SONGS Coastal Complex to the Mesa Complex. From the tunnel, closed-loop circulating water would be routed beside the seawall and would draw suction from a hot water reservoir and provide cooled water from the cooling tower to the cold water reservoir. Due to the size constraints of the cold water reservoir, three new vertical wet pit circulating water pumps would be needed to pass cooling water through the condenser, discharging to the hot water reservoir. Likewise, three new high volume / high head vertical wet pit pumps would be required to pump circulating water from the hot water reservoir up to the cooling towers. The circulating water would then be distributed throughout the cooling towers, cooled, and gravity fed back through the circulating water tunnel piping. Sophisticated controls would be required to maintain the necessary water inventory in each basin, and flow resistance equipment would need to be installed to control the massive inertial forces of the circulating water returning from the cooling towers. A basic flow diagram depicting the general arrangement of closed-loop cooling at SONGS is provided in Figure 3.1.

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[4] Palisades Nuclear Generating Station (PNGS) utilizes closed-loop cooling although it initially operated with once-through cooling; however, PNGS was originally designed for closed-loop cooling, and its circulating water system components were sized to accommodate the expected heat rejection capability provided by cooling towers. In this manner, it would more accurate to state that PNGS was first converted from its closed-loop design to operate with once through cooling, and then reverted to operate under it is original closed-loop cooling design.

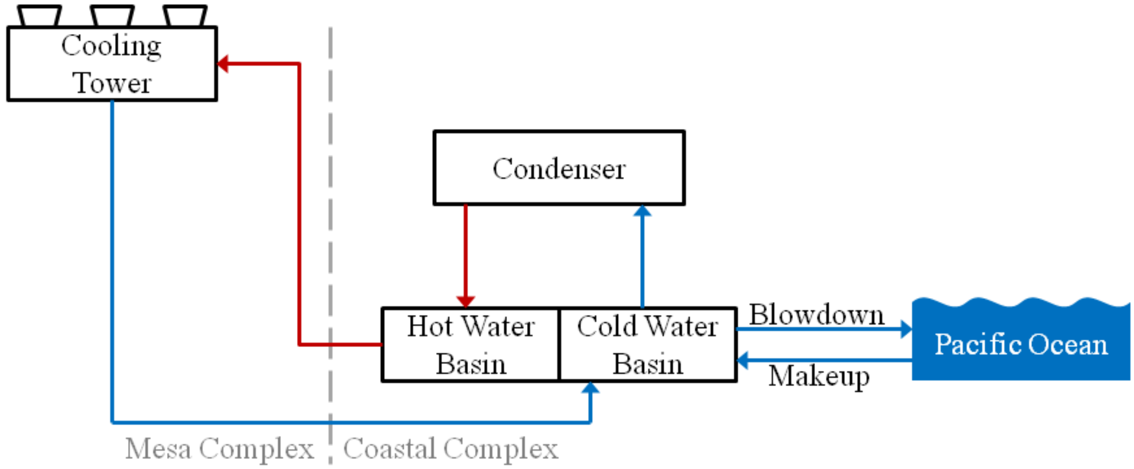

Figure 3.1 Closed-Loop Cooling Flow Diagram

3.1 Cooling Tower Selection

A variety of cooling towers are available to provide the heat rejection required by steam operated power plants. The advantages, disadvantages, and application of the different types of towers are discussed below.

Dry Cooling Towers

Dry cooling towers, which rely totally on sensible heat transfer, lack the efficiency of wet or hybrid towers using evaporative cooling, and thus require a far greater surface area than is available at the SONGS site. Additionally, due to their lower efficiency, dry towers are not capable of supporting condenser temperatures and associated turbine backpressures necessary to be compatible with the Station's turbine design, and therefore, their implementation at SONGS is not considered technologically feasible.

Natural Draft Cooling Towers

Of the available types of evaporative cooling towers, the natural draft "wet tower" offers the only passive cooling design, in that they rely on the "chimney effect" of the tower to create the required draft for cooling. As a result, natural draft cooling towers can be less costly to operate than comparably sized mechanical or hybrid cooling towers. However, since natural draft towers rely on the "chimney effect" of the tower to create the required draft the tower must be very tall, approximately 450 to 550 feet in height. Due to restrictions on both the height of the cooling tower and its discharge of a dense visible plume, and the relatively long construction schedule, natural draft cooling towers were not considered practical or capable of being permitted for use at SONGS. Figure 3.2 illustrates a typical natural draft cooling tower.

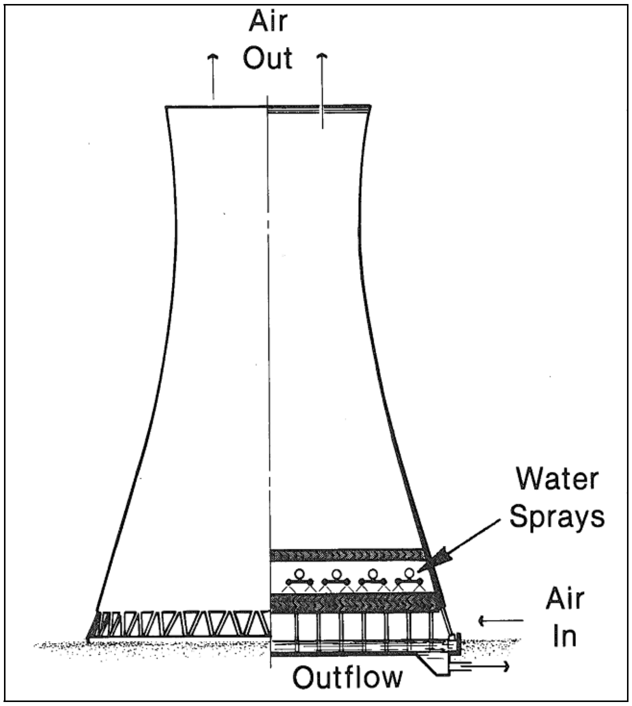

Figure 3.2 Counterflow Hyperbolic Natural Draft Cooling Tower [Ref. 8.80]

Air flow through the tower is produced by the density differential that exists between the heated (less dense) air inside the stack and the relatively cool (more dense) ambient air outside the tower. Since these towers depend on their geometric shape rather than fans for required air flow, they generally have lower operating costs.

Mechanical Draft Towers

Compared to the other types of evaporative cooling towers, a mechanical draft wet cooling tower is typically lowest in initial cost, moderate in footprint, and operates with moderate costs. Due to the need for forced draft fans, this type of tower has slightly higher noise levels than a natural draft tower, although attenuation to acceptable levels is possible at an additional cost. Mechanical draft cooling towers are considered impractical for the SONGS site, because of the risks created by the associated visible plume. In general, visible plumes would adversely impact SONGS personnel and Interstate 5 commuter safety, impede visually oriented security systems, degrade station cooling and electrical transmission equipment, and harm vegetation in the vicinity of the cooling tower plumes. Visible plumes and the necessity of plume abatement are discussed in detail in Section 3.1.1.

Figure 3.3 illustrates the air flow path through a cell of a typical mechanical draft wet cooling tower, and the applicable simplified psychrometric chart.

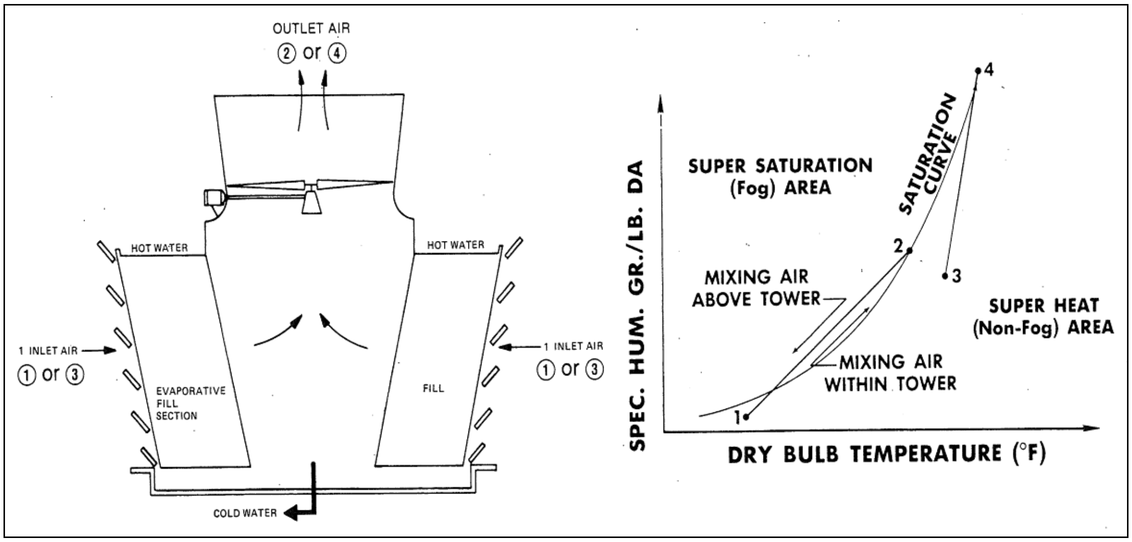

Figure 3.3 Saturation of Air in Typical Mechanical Draft Wet Cooling Tower [Ref. 8.80]

Two cases are depicted in the above figure. Case 1 - Warm ambient air enters the tower at condition 3 and exits saturated at condition 4. After leaving the tower, this saturated air mixes with the ambient air along line 4-3, most of which occurs in the invisible region below the saturation curve of the psychrometric chart. Case 2 - Cool ambient air enters the tower at condition 1, exiting saturated at condition 2 and returning to ambient conditions along line 2-1. As can be seen, most of this mixing occurs in the region of super-saturation, which causes the visible plume to be very dense and very persistent.

Hybrid Cooling Towers

A hybrid cooling tower, also referred to as a “wet/dry” or “plume abated” cooling tower, addresses some of the plume-related issues associated with the mechanical draft wet cooling tower. Basically, a hybrid cooling tower is the combination of the wet tower, with its inherent cooling efficiency, and a dry heat exchanger section used to eliminate visible plumes in the majority of atmospheric conditions. After the plume leaves the lower “wet” section of the tower, it travels upward through a “dry” section where heated, relatively dry air is mixed with the plume in the proportions required to achieve a non-visible plume. Hybrid cooling towers are slightly taller than comparable wet towers due to the addition of the “dry” section. They are also appreciably more expensive, both in initial costs and in ongoing operating and maintenance costs. A potential exists for increased noise due to additional fan load required to draw air in through the dry section, although attenuation to acceptable levels is possible, again at an additional cost.

Figure 3.4 illustrates the air flow path through a cell of a hybrid cooling tower and the applicable simplified psychrometric chart.

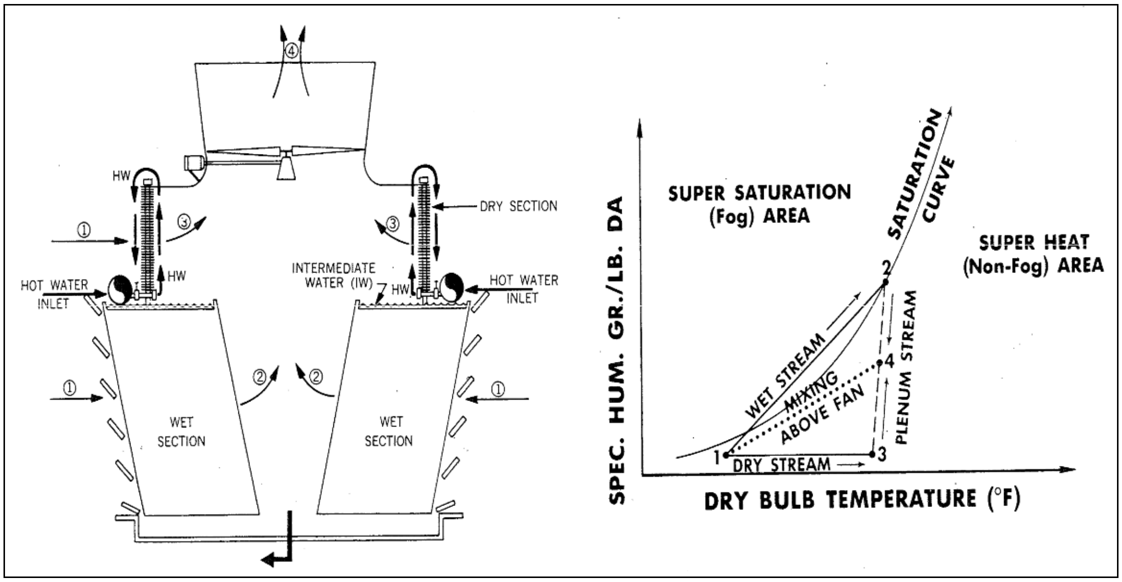

Figure 3.4 Partial Desaturation of Air in a Hybrid Cooling Tower [Ref. 8.80]

A hybrid cooling tower is designed to drastically reduce both the density and the persistency of the plume. Incoming hot water flows first through the dry heat exchanger (finned coil) sections, then through the wet (evaporative cooling) fill section. Parallel streams of air flow across the coil sections and through the fill sections, leaving the coil sections at dry condition 3, and leaving the fill sections at saturated condition 2. These two separate streams of air then mix together going through the fans, along the lines 3-4 and 2-4 respectively, exiting the fan cylinder at sub-saturated condition 4. This exit air then returns to ambient conditions along line 4-1, avoiding the region of super-saturation (visible plume) altogether in most cases.

Cooling Tower Selection

As noted in the discussions above, three cooling tower design constraints limit the selection of cooling towers for use at SONGS. First, SONGS possesses a limited site area available for cooling towers to reject approximately 7.5 billion Btu per hour per unit [Ref. 8.75]. Second, SONGS is located on the California coastline where permitting requirements limit the use of intrusive industrial equipment (see Section 6.7). Third, any visible plume emitted from the cooling tower must be as limited as possible to ensure plant personnel safety and equipment reliability in addition to commuter safety on Interstate 5. While none of the cooling tower options completely satisfies these three constraints, hybrid cooling towers are the only technology available with a relatively low industrial profile that provides the cooling required with limited visible plume formation.

Hybrid cooling towers are available in linear and round configurations. Currently, only a single comparably sized round hybrid cooling tower has been constructed at a new (not existing) facility, and that facility is not located in the United States. Although round hybrid cooling towers are generally more expensive then linear towers and have a limited historic use, the round configuration is sometimes necessary for sites with variable wind direction or where configuration of the available space does not allow favorable placement of linear cooling towers. Due to the predominate occurrence of air flow both to and from the coastline, the configuration of the available space at the Mesa Complex would suitably accommodate linear hybrid cooling towers.

The size of a cooling tower is directly proportional to the amount of heat that must be rejected from the cooling water. As the heat loads at SONGS are relatively large, the cooling towers required for closed-loop cooling at SONGS would need to be relatively large as well. Given the SONGS site constraints, meteorological conditions, and the necessary use of saltwater for makeup, SPX Cooling Technologies sized a linear hybrid cooling tower design with three, 15 cell linear hybrid cooling towers per unit (see Attachment 1, Section 1). As sized by SPX, each cooling tower cell would be 48 feet × 48 feet, have a discharge height at the top of the fan shroud of approximately 50 feet and require a 250 HP fan for operation. Sufficient space for the six required towers is not available in the Coastal Complex area of the SONGS facility; therefore, the towers would be located on the southwest corner of the Mesa Complex. Refer to Attachment 5, Figure 5-5 for a simplified site layout with the linear hybrid cooling towers.

Allowing for a certain degree of recirculation, SPX sized the cooling towers with a 15°F approach to wet bulb (see Figure 3.5 for definition of "approach"). GEA Power Cooling, Inc. was also contacted for information regarding the implementation of cooling towers at SONGS and independently confirmed the selection of hybrid cooling towers with a 15°F approach to wet bulb. The 15°F approach tower design point was considered the optimum trade-off between total capacity and performance, size, initial cost, and operating costs.

Figure 3.5 indicates the relationship between cooling tower design approach to wet bulb and tower size.

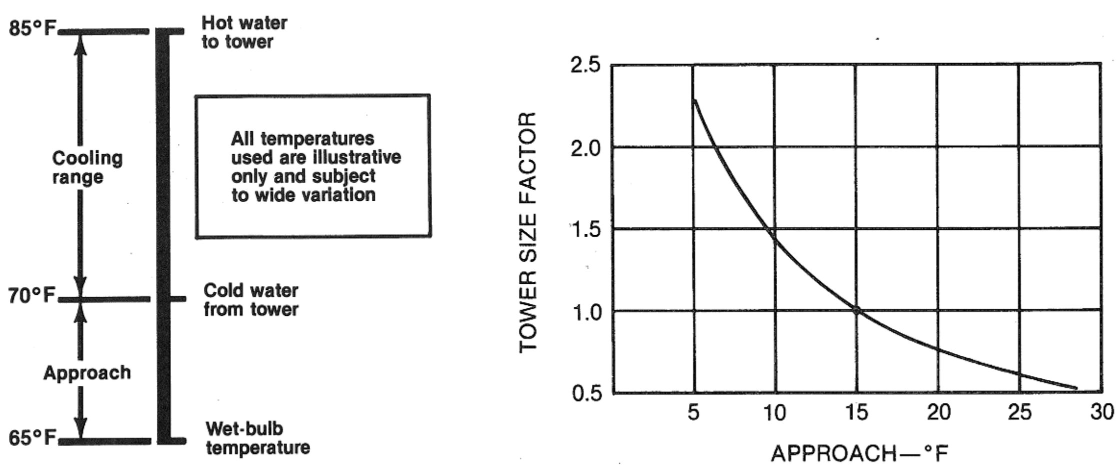

Figure 3.5 Definition of "Approach," "Cooling Range," and Relationship of Approach to Tower Size [Ref. 8.80]

The graph on the left shows the relationship of range and approach as the heat load is applied to the tower. Although the combination of range and gpm is fixed by the heat load in accordance with Heat Load = gpm x 8.33 lbs/gal water x range = Btu/min, the approach is fixed by the size and efficiency of the cooling tower.

The graph on the right indicates how, given two towers of equal efficiency, with proportionate fill configurations and air rates, the larger tower will produce colder water; i.e. have a closer approach. Important to note, from a tower cost standpoint, is the fact that the base 15°F approach tower would have had to have been twice as large to produce a 7°F approach, whereas it could have produced a 25°F approach at only 60% of its size.

3.1.1 Plume Abatement

As noted in Section 3.1, mechanical draft cooling towers were not selected due to the risks created by their associated visible plume. In particular, under specific atmospheric conditions at the site, a dense visible cloud of water vapor and entrained water droplets would be emitted from the tower that would have a significant negative effect to plant and commuter safety, along with causing plant operation and equipment reliability issues.

For background, Figures 5-6 through 5-11 in Attachment 5 include images of the plume emitted from Catawba Nuclear Station's mechanical draft cooling towers. Catawba Nuclear Station is similar to SONGS in that it is a two unit PWR producing over 2100 MWe; as such, SONGS would be expected to produce a similar plume if mechanical draft cooling towers were used under comparable meteorological conditions.

The selected cooling towers, linear hybrid towers, have specific attributes that minimize the visual impact of the tower's plume. A hybrid cooling tower generates no visible plume above its design threshold conditions. Based on the historical meteorological data (2004 through 2007) discussed in Section 4.2, hybrid cooling towers would generate a visible plume at SONGS less than 1% of the time. The selected design threshold, or "plume point", is a 32°F wet-bulb temperature coincident with a maximum dry-bulb temperature of 35°F; i.e., the plume will start to become visible when ambient temperatures decrease below the design plume point, although the plume will be much less dense and/or persistent than if generated by a non-plume abated tower. It should noted that a plume generated even 1% of the time has the potential to drift towards Interstate 5 and impact commuter visibility. Any impact to commuter visibility would decrease the public safety and increase SONGS liability.[5]

The potential physical impacts from a tower plume arise primarily from the moisture content, which can cause fogging during winter conditions, the salt content of the entrained moisture which can damage vegetation, and the heat content, which could potentially degrade Station heating, ventilating and air conditioning (HVAC) systems and affect onsite meteorological measurements. Additionally, the physical height of the cooling towers has the potential to disrupt local wind patterns, although the selection of linear hybrid cooling towers with a relatively low tower height would assist in mitigating the effect. The effect the plume would have on the operation and maintenance of SONGS equipment is included in Section 4.6, and detailed discussion the effect drift has on air pollution limits is included in Section 6.1.

3.1.2 Noise Suppression

Noise is energy transmitted through the atmosphere in the form of pressure waves and is expressed in the terms of decibels (dB). An A-scale weighted level (dBA) is often used to

[5] Historically, many severe vehicular accidents have been attributed to the effects of heavy fog on driver visibility. On January 15, 2007, a six car pile-up occurred on Texas Highway 73 due to cooling tower steam from a BASF refinery blowing across the highway, causing a thick fog and decreasing visibility [Ref. 8.48]. The accident left two people with minor injuries. On December 11, 1990, a dense fog on Interstate 75 near Calhoun, TN, caused a 99 car pile-up that killed 12 people and injured 42 others [Ref. 8.98]. The fog was attributed to nearby Bowater Paper Plant, which paid millions of dollars in settlements for the 1990 accident and several other fog-related accidents in the same location.

characterize the ambient sound pressure levels (i.e., noise levels) based on the human ear's perception of the measured sound level [Ref. 8.80]. There are several potential adverse impacts of noise, which include hearing loss, speech interference, sleep interference, physiological responses, and annoyance [Ref. 8.78].

Land uses often associated with noise-sensitive receptors include residential dwellings, mobile homes, hotels, hospitals, nursing homes, educational facilities, and libraries [Ref. 8.78]. As shown in Figure 3.6, the SONGS cooling towers would be located less than a mile away from the new housing at MCBCP. Additionally, several SONGS office buildings would be located directly next to the cooling towers on the Mesa Complex. The Noise Element of the City of San Diego's General Plan sets 65 dBA as the external noise exposure limit for office buildings and 60 dBA as the limit for residential units [Ref. 8.26]. These limits would not be enforced at SONGS, but represent reasonable noise exposure levels.

Figure 3.6 Location of MCBCP Housing near Cooling Towers

Cooling towers generate sound through the use of motors, power transmission units, fans, and cascading water, which typically produces a combined sound level of approximately 70 dBA at a horizontal distance of 50 feet [Ref. 8.80]. The sound level would diminish with distance, losing approximately 5 dBA each time the distance is doubled [Ref. 8.80]. The potential noise impact of the cooling towers on the Mesa Complex is shown in Figure 3.7. The noise levels shown are the levels that would be expected due to cooling tower operation only; noise from the ocean and coastal highways and railway would have additive effects on the total ambient noise in the area. If unmitigated, cooling tower noise would raise the ambient sound level at most Mesa Complex office buildings above the reasonable limit of 65 dBA. Cooling tower noise would fall to approximately 40 dBA before reaching the residential area at MCBCP. Though this level would be below the reasonable limit of 60 dBA, the ambient noise in the residential area would have to be determined by considering the additive noise impact from the cooling towers, ocean, coastal highways, and railway combined. It should also be noted that several endangered species and sensitive species are located on land adjacent to the Mesa Complex, and further studies would need to be conducted to determine if they would be impacted by the increased noise level. In order to mitigate the potential impacts of cooling tower noise, the hybrid cooling towers would be equipped with sound attenuators.

Figure 3.7 Noise impact of cooling towers without sound attenuation

3.1.3 Support and Maintenance

Cooling tower equipment requires extensive support to ensure continuous operation. Additional personnel would be required to perform daily and weekly maintenance routines on the cooling tower. Below is a task breakdown of the activities typically required by personnel to ensure continuous cooling tower operation.

- Check fans, motors, driveshafts, gear reducers
- Check gear reducer oil level
- Check electrical substation, transformers, switchgear

- Monitor local control panel and alarm displays
- Check water level in cold water basin and hot water distribution system
- Check booster pumps and associated instrumentation
- Sample water quality
- Inspect hot water distribution system
- Inspect fill for fouling
- Check gear reducer for leakage
- Adjust water quality

In addition, substantial maintenance would be required for long-term cooling tower operation. Below is a task breakdown of the activities typically required by personnel to ensure long-term cooling tower operation.

- Inspect drift eliminators and fill for clogging
- Check gear reducer oil seals, oil level, and oil condition
- Clean and repaint fans and drivers, drift eliminators, fill, hot water distribution system
- Rebalance fans and driveshafts
- Lighting inspection or replacement
- Inspect keys, keyways, set screws & tighten bolts for fans and drivers
- Change oil and check vent condition for gear reducers
- Check fan blade clearances
- Check for leakage in fill, basin and hot water distribution system
- Inspect general condition and repair as necessary all tower components including cranes and hoists
- Inspect general condition of basin, suction screen and tower casing
- Inspect/repair fans and drivers, and tower access components, including stairs, ladders, walkways, doors, handrails
- Transformer Inspection
- Starting at year 16, replacement of fan blades, fan motors, fan gearbox, fill, drift eliminators

As discussed in Sections 4.6.2 and 6.1.1, salt would be deposited by the cooling tower plume in the SONGS Coastal Complex area, potentially causing electrical arcing in the switchyard. This salt deposition could also adversely affect existing systems and equipment to the extent where additional preventative and correctional maintenance procedures would be required.

3.2 Cooling Tower Siting

The limited space available on the current SONGS property presents a significant challenge for siting cooling towers. The footprint of each tower would be approximately 56 feet wide, 721 feet long, and 50 feet high. Each of the six towers would be placed 1.5 tower widths spacing between parallel towers, thus creating a total impact of at least 14 acres of land. Sufficient space for the six required towers is not available in the Coastal Complex area of the existing SONGS facility; it is unlikely that protected habitat could be acquired from State Parks or used for cooling towers. Therefore, the towers would need to be located on the Mesa Complex. Attachment 5, Figure 5-5 provides an aerial view of the site and overlaying layout of the six cooling towers and the associated piping. Details on the cooling tower siting, including the selection of the Mesa Complex, the location of new closed-loop cooling equipment, relocation of existing facilities, construction spoils, and security issues are discussed in the sections below.

3.2.1 Coastal Complex / Mesa Complex Comparison

The SONGS facility currently occupies two separate areas, the Coastal Complex and the Mesa Complex, as discussed in Section 2 and shown in Figure 2.1. The Coastal Complex area is densely occupied by the Unit 2 and Unit 3 reactors and supporting structures and equipment. An employee parking lot occupies the northwest end of the Coastal Complex area. The northwest end of the Coastal Complex is bounded by the San Onofre Surf Beach area of San Onofre State Beach. The southeast end of the Coastal Complex is bounded by a protected Southern Coastal Bluff Scrub habitat in San Onofre State Beach. Installing cooling towers near the Coastal Complex area would require the relocation of the employee parking lot and the likely implementation of a parking deck and shuttling system, the acquisition of the San Onofre Bluffs and Surf Beach, and the necessary permits to construct cooling towers in the protected Southern Coastal Bluff Scrub habitat.

In addition to these land use concerns, cooling tower installation on the Coastal Complex area would present technical concerns. To minimize recirculation effects, rectilinear cooling towers should be placed with their axis in parallel with the prevailing site winds [Ref. 8.15; Ref. 8.16]. The prevailing winds at SONGS are perpendicular to the coastline (northeasterly and southwesterly, as shown in Attachment 5, Figure 5-10), making parallel placement of cooling towers with respect to the prevailing winds on the Coastal Complex area infeasible. To compensate for the thermodynamic inefficiency of significant recirculation resulting from perpendicular placement of the cooling towers with respect to the prevailing winds, the towers would need to be much larger. The cooling towers that would be required to reject the substantial SONGS heat loads, including recirculation considerations, would be too large for placement on or near the Coastal Complex area, unless large areas of the San Onofre State Beach were acquired. Since it is unlikely that SONGS would be able to obtain San Onofre State Beach land from the State of California to accommodate these towers, siting of cooling towers on the Coastal Complex area is considered infeasible.

If only Unit 2 were to construct cooling towers near the Coastal Complex area the cooling towers would be sized much larger than comparable towers sized for Mesa Complex operation and would require large diameter piping to be extended around the Independent Spent Fuel Storage Installation (ISFSI) at a length equal to or greater than that if the cooling towers were to be sited at the Mesa Complex. As there is no discernable advantage to siting only one unit's towers near the Coastal Complex area, and the recirculation effect on these towers would require much larger cooling towers be constructed than would be required at the Mesa Complex, siting of only Unit 2's cooling towers near the Coastal Complex area is not further considered.

The Mesa Complex would allow placement of the cooling towers parallel to the prevailing winds on site. However, since optimal spacing between parallel cooling towers is one tower length [Ref. 8.15; Ref. 8.16], even towers sited on the Mesa Complex would be impacted by recirculation. Therefore, the cooling towers at SONGS would be designed to account for a minimal amount of recirculation (i.e., recirculation would be present although it would be significantly less than that for towers oriented perpendicular to prevailing winds). This consideration was included in the design and pricing of the cooling towers quoted by SPX (see Attachment 1). In order to account for the cooling needs and recirculation effects at SONGS, SPX selected six linear hybrid towers for conversion to closed-loop cooling, occupying approximately 14 acres of land.

3.2.2 Location of New Closed-Loop Cooling Structures

Conversion of SONGS to closed-loop cooling would require the siting and construction of several structures ancillary to the cooling towers. Specifically, these structures can be broken down into three categories: (1) hot and cold reservoirs, (2) electrical distribution and control, and (3) booster pump skids. The hot and cold reservoir siting would be necessitated by the intake to and discharge from the main condenser, and is detailed in Section 3.3. Two electrical distribution buildings and one power and control building would be located on the Mesa Complex to support cooling tower and booster pump operation. Additionally, two electrical distribution buildings would be located near the common switchgear yard to provide power to the new recirculation pumps. All five electrical buildings are described in detail in Section 3.8.6. Finally, one booster pump skid per unit would be required to house the pumps necessary to pump circulating water from the wet suction of the cooling tower up through the dry heat exchanger. These pumps, and the new structures described above, are overlaid on an aerial view of the site shown in Attachment 5, Figure 5-5.

3.2.3 Relocation of Existing Facilities

The south corner of the Mesa Complex would best accommodate cooling towers at SONGS, due to the relatively close proximity to Unit 2 and Unit 3 when compared to the rest of the Mesa Complex area. The south corner is currently occupied by a Recreational Vehicle (RV) park, an area for security training exercises, and an area for drying kelp removed from the CWISs. These areas would need to be permanently relocated to accommodate cooling tower construction. Facility relocation would need to be evaluated during the detailed design phase; facilities would possibly be condensed to remain at the Mesa Complex or moved to an offsite location.

As noted in Sections 3.3 and 3.4, several existing facilities and equipment would be impacted by the conversion to closed-loop cooling. The siting of the cooling tower in the southwest corner of the Mesa Complex and the routing and depth of the tunneling was selected to allow for most surface structures to remain intact; however, buildings with an extensive underground footprint would need to modified or relocated to a non-impacted area of the site.

3.2.4 Construction Spoils

SONGS sits on the San Mateo Formation of massive thick, bedded sandstone [Ref. 8.75]. The San Mateo Formation is partially covered by a layer of alluvium, which is composed of a variety of loosely-packed materials (silt, gravel, clay, sand, etc.) that have been deposited by water runoff. Conversion of SONGS to closed-loop cooling would require the relocation or removal of approximately 297,210 cubic yards of sandstone and alluvium.

The cooling tower basin dimensions would be 56 feet by 721 feet at an expected depth of 5 feet (see Attachment 1), requiring excavation of approximately 44,870 cubic yards. The 12 foot diameter circulating water pipes would be grouted in place in the tunnels, requiring approximately 1 foot of additional clearance around the circumference of the pipe for a total diameter of 14 feet. The construction of eight circulating water piping tunnels, described in detail in Attachment 2, would require the excavation of approximately 195,820 cubic yards of sandstone and alluvium. The tunneling excavation would include the construction of two entrance shafts and two exit shafts. The entrance shafts would be located at the cooling tower site on the Mesa Complex. Some additional piping would be required to connect the cooling tower outlet with the tunneled piping.

On the Coastal Complex, the portion of circulating water piping running along the seawall to connect to the circulating water reservoirs would be installed by trenching. The circulating water reservoirs and trenched piping at the seawall would require the excavation of an additional 32,950 cubic yards for Unit 2 and 23,570 cubic yards for Unit 3.

The construction of six mechanical-draft, rectilinear, hybrid cooling towers, eight circulating water pipes, and four circulating water reservoirs would therefore require the excavation of approximately 297,210 cubic yards of sandstone and alluvium. For the purposes of determining cooling tower feasibility, it is conservatively assumed that these spoils would be free of pollutants and could either be stored on-site or hauled off-site for disposal. However, during detailed design, it would be necessary to assess the condition of the spoils which could lead to sampling, pollutant separation, and/or costly off-site disposal methods. The cost of spoils disposal is addressed in Section 5.2.1; however, it should be noted that these costs would increase dramatically if the spoils contained pollutants.

3.2.5 Security Issues

Currently, the Protected Area (PA) is located within the Coastal Complex area, encompassing the reactor buildings and connected structures. The existing circulating water intake pipes extend offshore from the SONGS PA into the Pacific Ocean; therefore, the implementation of closed-loop cooling and the associated cooling towers and piping outside the PA would not be expected to significantly increase any security risks. However, as the cooling towers would represent a new point of access to the PA through the new circulating water pipes, a full review of the project design and schedule by qualified security personnel would be required to identify any additional measures necessary to ensure the continued security of the plant. At a minimum, secured grating and a remote monitoring system would be required at the cooling tower collection basins on the Mesa Complex. In addition to these measures, the massive flow rates and dramatic elevation drops within the circulating water pipes inherently serve to protect the security of the plant.

3.3 Reservoir / Pump Pit Construction

To support the closed-loop cooling of each unit, two circulating water reservoirs / pump pits would be constructed between the turbine buildings and the seawall (see Attachment 5, Figure 5-2). Reservoirs, as opposed to direct circulating water pipe tie-ins, provide a means to dissipate kinetic energy built up in the circulating water as it transports through the cooling water system. In this capacity, the placement of a reservoir downstream of the cooling towers protects the condenser and TPCW system from being damaged by the energy accumulated in the circulating water as it descends from the Mesa Complex, and the placement of a reservoir upstream of the cooling towers protects the condenser and TPCW system from similar damage caused by the circulating water during a loss of power event. Additionally, reservoirs allow significant operational flexibility, whereby the reserve volume in each reservoir acts as a buffer against flow disruptions and equipment failure. One set of conceptual operating procedures is discussed in Section 3.7 to investigate the major challenges to the operation of a closed-loop cooling system of this configuration.

The Unit 2 and Unit 3 reservoirs / pump pits are detailed in Attachment 5, Figure 5-3 and Figure 5-4, respectively. For each unit, a relatively shallow (approximately 22 feet deep) hot water basin would collect heated condenser outlet water for the three recirculating water pumps that supply the cooling towers. A relatively deep (approximately 40 feet deep) cold water basin would collect cooled cooling tower outlet water for the three circulating water pumps that supply the condenser.

3.3.1 Existing Facilities and Equipment Interferences

Construction of the circulating water reservoirs / pump pits for each unit would impact nearly all existing structures between the turbine building and the seawall. In the area that would house the reservoirs / pump pits, the TPCW heat exchangers and the seawall are critical structures that should not be impacted in any way that would prevent these structures from functioning as designed after closed-loop conversion. The TPCW heat exchangers provide cooling water to equipment throughout the turbine building; relocation of the TPCW heat exchanges would require extensive rerouting, likely increasing the length of equipment supply lines and reducing the cooling capacity of the system. Figures 5-11 and 5-12 in Attachment 5 highlight those structures and equipment identified as being critical in red. Non-critical structures and equipment that would be impacted are highlighted in green and include structures and equipment which would need to be removed, relocated, or replaced. Structures that would be impacted by the construction of the reservoir / pump pit include the following:

- TPCW Pumps
- Amertap Strainer Section and Pumps
- Caustic Bulk Storage Tank

- Sulfuric Acid Storage Tank
- Bulk Ammonia Storage Tank[6]
- Dirty Lube Oil Storage Tank
- Clean Lube Oil Storage Tank
- Turbine Plant Cooling Water Storage Tank
- Sodium Hypochlorite Tank
- Circulating Water Pumps
- Maintenance Building 1

The Amertap Strainer Section and Pumps and the Circulating Water Pumps would be removed. As detailed in Section 4.5, the Amertap system has been abandoned and its removal would not impact plant operations. The four existing Circulating Water Pumps would be replaced with three new Circulating Water Pumps, located in the cold water basin (see Attachment 5, Figure 5-3 and Figure 5-4). All other identified structures would need to be relocated or replaced after construction. Several smaller structures or structures not clearly identified on the UFSAR plant drawings would also be impacted. These structures are shown in green on Attachment 5, Figures 5-11 and 5-12, but are not listed above.

After installation of closed-loop cooling the cold and hot water basins would restrict access to the intake structure, likely eliminating access needed for alternate emergency conditions and to remove the intake / discharge gates and trash baskets. It should be noted that impacts on access to the intake structure are not accounted for in this design, and while they are not likely to impact the feasibility of a closed-loop cooling retrofit, they may significantly increase the costs of maintaining the intake structure equipment.

3.3.2 Flooding Issues

The cold water basins for each unit would be connected to their respective discharge canals by a 48-inch diameter blowdown / overflow pipe (shown in Attachment 5, Figure 5-3 and Figure 5-4), which would discharge the required blowdown flow calculated in Section 4.4. An adjustable weir wall at the edge of the cooling tower basin and a throttling valve installed in the cooling tower return piping would regulate the flow of circulating water into the cold water basin. During startup and shutdown in particular, there may be some overflow to the cold water basin as the control valves are adjusted. This overflow from the cooling towers would also be discharged through the 48-inch diameter blowdown / overflow pipe. In the event of a closed-loop cooling equipment failure or loss of power, the basins would be designed to flood over the seawall rather than into the plant. It should be noted that additional engineering design would be required to ensure public safety would not be compromised by the discharge of cooling water across the SONGS seawall during a loss of power event.

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[6] Impacts to the Ammonia Storage Tank may require a revision to the SONGS California Accidental Release Prevention Risk Management Plan (CalARP RMP).

3.4 Circulating Water System Piping

Conversion to closed-loop cooling at SONGS would require eight new circulating water pipes which would be 12 feet in diameter to accommodate required operational flow. These pipes would connect the hot and cold water basins on the Coastal Complex to the cooling towers on the Mesa Complex. The substantial elevation change between the Coastal Complex and Mesa Complex areas would present a significant design challenge to the operation of large-diameter piping connecting the two areas. Each cooling tower return pipe would carry 415,000 gpm from the cooling tower basin down to the cold water reservoir, creating a significant inertial force. Flow resistance could potentially be increased by installing a nozzle and butterfly valve in each cooling tower return pipe.

3.4.1 Pipe Routing / Interferences

The routing of these pipes, shown in Attachment 5, Figure 5-5, was based on avoiding several existing structures critical to plant operation that therefore should not be affected by pipe installation.

Critical structures that served as pivot points for the pipe routing are shown in red in Attachment 5, Figures 5-11 and 5-12. These pivot points include the seawall, the diesel generator building for each unit, and the fire water storage tanks. It should be noted that while the seawall would not be relocated post conversion, the foundations would likely need to be rebuilt to ensure the integrity of the structure. Any impacts to the seawall would be addressed during construction of the cold and hot water basins.

Non-critical structures that would be impacted by the installation of the closed-loop cooling pipes are shown in green on Figures 5-11 and 5-12 of Attachment 5. The impacted structures are those that would need to be tunneled beneath. Tunneling beneath structures would be at a low enough depth that surface structures could remain intact; however, buildings with an extensive underground footprint may need to modified or relocated to a non-impacted area of the site. In particular, the soil-structure interaction analysis for the Unit 3 diesel generator building and underground fuel oil tanks would need to be evaluated for potential impact, and underground pipes near the Unit 3 diesel generator building would need to be designed for seismic II/I concerns. Additionally, since the turbine buildings for both Unit 2 and Unit 3 are designed for seismic II/I concerns, piping near each turbine building would need to be evaluated for potential impact. Impacted structures include the following:

- Sewage Treatment Plant
- Maintenance Buildings 2
- Services Building
- K 40/50 Building

Several smaller structures or structures not clearly identified on the UFSAR plant drawings would also be impacted. These structures are shown in green on Figures 5-11 and 5-12 of Attachment 5, but are not listed above. It should be noted that all underground utilities may not be precisely known and careful investigation of those areas impacted by the closed-loop retrofit would be required.

3.4.2 Tie-In Locations

The closed-loop cooling system piping would tie in to the existing condenser circulating water pipes and the discharge canal for each unit, as shown in Attachment 5, Figure 5-3 and Figure 5-4. Cooled water returning from the cooling towers would accumulate in the cold water basin before being pumped to the condenser via three new circulating water pumps. The new circulating water pumps would feed into a common header for each unit, which would tie in to the existing circulating water piping at the location of the existing circulating water pumps. The existing circulating water pumps, which would no longer be in service, would be removed to facilitate the new circulating water system tie-in. The required blowdown flow, discussed in Section 4.4, would be released through a 48-inch diameter pipe connecting the cold water basin to the existing discharge canal, as shown in Figure 5-3 and Figure 5-4 of Attachment 5. The circulating water exiting the condenser flows to the hot water basin via the existing discharge canal and a short connecting pipe between the existing discharge canal and the hot water basin.

3.4.3 Existing CWIS Abandonment

The existing CWIS would be integrated into the new closed-loop cooling system design such that only small sections of existing CWIS piping would no longer be used after conversion to closed-loop cooling, as shown in Figure 5-3 and Figure 5-4 of Attachment 5. The existing intake structure would remain in operation to provide the saltwater cooling water system flow and makeup flow to the condenser inlet through the new makeup pump installed in the existing intake pumpwell. The existing discharge structure would be utilized to discharge the blowdown released from the cold water basin. The discharge pipelines from the condensers would be extended to the hot water basin. The discharge structure between this extension of the condenser outlet pipeline and the location of the new blowdown pipe tie-in would be abandoned. Additionally, at each unit, the four existing circulating water pumps would be removed and replaced by three new circulating water pumps in the cold water basin and three new recirculating water pumps in the hot water basin.

3.5 Tunneling

The eight circulating water pipes transporting cooling water between the condensers and cooling towers would be primarily installed underground by tunneling from the Mesa Complex to the Coastal Complex area. The feasibility, cost, and schedule of tunnel construction have been evaluated by Mr. Robert A. Reseigh, a tunnel project development consultant with over forty years of experience in underground construction. Mr. Reseigh's full evaluation and credentials are included in Attachment 2.

3.5.1 Tunnel Construction with Coastal Highways and Railway in Use

The tunnels would be constructed using an Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM) as the primary tunneling method. The EPB method allows tunneling in wet, soft, or unstable ground and would be necessary for tunneling in the water-permeable San Mateo formation near the Pacific Ocean (see Attachment 2). Tunnels constructed by this method avoid surface disturbance and would not inherently require any disruption of traffic on the coastal highways and railway. Using EPB or similar trenchless tunneling technology, tunnels have been constructed under interstates and/or railroads across the country with no traffic disruption [Ref. 8.41; Ref. 8.45]. Thus, with adequate planning and coordination with transportation authorities, tunnel construction would likely be possible with Interstate 5, the NCTD Railway, and old U.S. Highway 101 in use. Since Burlington Northern Santa Fe (BNSF) Railway is the only railway currently allowed to carry freight on the NCTD Railway line [Ref. 8.75], the BNSF Railway requirements were also considered for the tunneling design.

The California Department of Transportation (CalTrans), the NCTD Railway, and the BNSF Railway would require a full engineering study and geotechnical survey before the circulating water pipeline crossings could be permitted. The estimated cost for these studies is included in the tunneling cost estimate, as noted in Attachment 2, Section 1. General guidelines provided in the CalTrans *Manual for Encroachment Permits on California State Highways* [Ref. 8.21] and the BNSF *Utility Accommodation Policy* [Ref. 8.6] were considered in the tunnel design and construction; however, the general CalTrans and BNSF tunneling guidelines are specified for up to 48-inch and 72-inch diameters, respectively. Conversations with CalTrans and BNSF permitting personnel (Attachment 2, Section 3) confirmed that the large diameter and number of pipeline crossings required for closed-loop cooling conversion at SONGS would demand significantly different tunneling requirements than described in these guidelines. Additionally, each of the eight tunnels would likely require three separate right-of-way encroachment permits for crossing beneath Interstate 5, the NCTD Railway line, and old U.S. Highway 101. Per correspondence with the CalTrans Encroachment Permits Branch Chief, a minimum spacing between pipes of twice the pipe diameter would be required for crossing beneath Interstate 5, a requirement which is incorporated in the proposed conceptual design.

3.5.2 Security Issues

Tunnel construction would require a staff of approximately 60 people (see Attachment 2). The majority of the staff would require site access to both the Mesa Complex and Coastal Complex areas (including the PA). Construction activities would likely require compensatory security measures due to tunneling from the Mesa Complex to the PA. A full review of the project design and schedule by qualified security personnel would be required to identify any additional security measures associated with tunnel construction. At a minimum, temporary remote monitoring systems would be required in the tunneling work sites and a security officer stationed at the tunnel entrance.

3.6 Intake and Discharge Structure Modification

The closed-loop cooling system would be specifically designed to replace only the portion of seawater intake that does not serve engineered safety features (ESF). Therefore the saltwater cooling system (a critical ESF) would continue to operate as currently designed, with the existing intake structure continuing operation to provide saltwater cooling system flow. The makeup water for closed-loop cooling (discussed in Section 4.4) would also be supplied through the existing intake structure, via a new makeup water pump and pipeline installed within the existing pumpwell. As noted in Section 3.3.1, the existing circulating water pumps would be removed from the existing pumpwell and replaced by new circulating and recirculating water pumps in the cold and hot water basins. The reduced flow through the intake structure, from the current 864,000 gpm to the estimated 72,000 gpm, would likely require operational modifications of the traveling screens and fish elevator. No additional structural modifications would be expected beyond the circulating water pump removal and makeup pump and pipeline installation.

The existing discharge structure would continue operation to release low volume plant effluents, saltwater cooling flow, and the blowdown of the closed-loop cooling system (as discussed in Section 4.4). The plant effluent and discharge concentrations are further discussed in Section 4.5.

The cooling towers and auxiliary components of the closed-loop cooling system would not be safety-related equipment. In the event of a failure in the closed-loop cooling system, the plant would be able to achieve safe shutdown without any modification to the current engineered safety features.

3.7 Operation of Closed-Loop Cooling

This section contains a theoretical discussion on one potential set of closed-loop cooling operating scenarios for SONGS. Retrofitting a nuclear power plant from a once-through cooling design to closed-loop cooling has not occurred; therefore, there is a large degree of uncertainty in the operation of any closed-loop cooling retrofit. The site-specific constraints at SONGS further increase the complexity and uncertainty of operational design, due to the unprecedented nature of operating cooling towers at a nuclear power plant where the condenser is significantly lower than the elevation of the cooling tower basin. One theoretical scenario of operational procedures is outlined below in an attempt to provide background on the expected complexity of operating closed-loop cooling at SONGS; however, this scenario is purely theoretical and would require significantly greater design detail than is included within this feasibility study prior to consideration as a legitimate operational scheme.

The startup, steady-state operation, and shutdown of the closed-loop cooling system would require careful consideration during the detailed design phase to resolve challenging issues associated with operating the facility in a closed-loop cooling configuration. Balancing the circulating water flow between the cooling tower basin, hot water basin, and cold water basin would dramatically increase the potential for flow variability (i.e., at times the flow rate of a circulating water pump or recirculating water pump may need to be reduced or stopped to maintain adequate inventory in each basin). The control scheme, discussed further in Section 3.8.8, would be extremely complicated, require a programmable logic control system and redundant instrumentation, and need to be capable of balancing the closed-loop cooling equipment to meet ambient environmental conditions and plant operation requirements while maintaining adequate inventory in all three basins.

3.7.1 Closed-Loop Cooling Start-up

Gradual start-up of the closed-loop cooling system would require individual pumps to be started in sequence, as shown in Figure 3.8. An adjustable weir wall at the edge of the cooling tower basin would also be required. To initiate start-up, the start-up pump and one of the three new recirculating water pumps would begin operation. The start-up pump would provide 277,000 gpm to maintain the water level in the hot water reservoir while the recirculating water pump would supply water to the cooling towers. Cooling water would accumulate in the cooling tower basins to a predetermined level, when the weir wall would be adjusted to allow cooling water to flow back to the cold water basin, where a circulating water pump would be started. A second recirculating water pump would be immediately started to accommodate the increased flow into the hot water basin. The resulting increased flow rate to the cooling towers would raise the basin inventory to an intermediate level, when the weir wall would be adjusted again and a second circulating water pump and a third recirculating water pump would be started. Again, the increased flow to the cooling towers would raise the basin inventory. When the cooling water in the basin reached the design reservoir level, the weir wall would be adjusted to allow the full design flow of 415,000 gpm through each cooling tower return pipe. The third circulating water pump would be started and the start-up pump flow would turned off, completing the startup sequence.

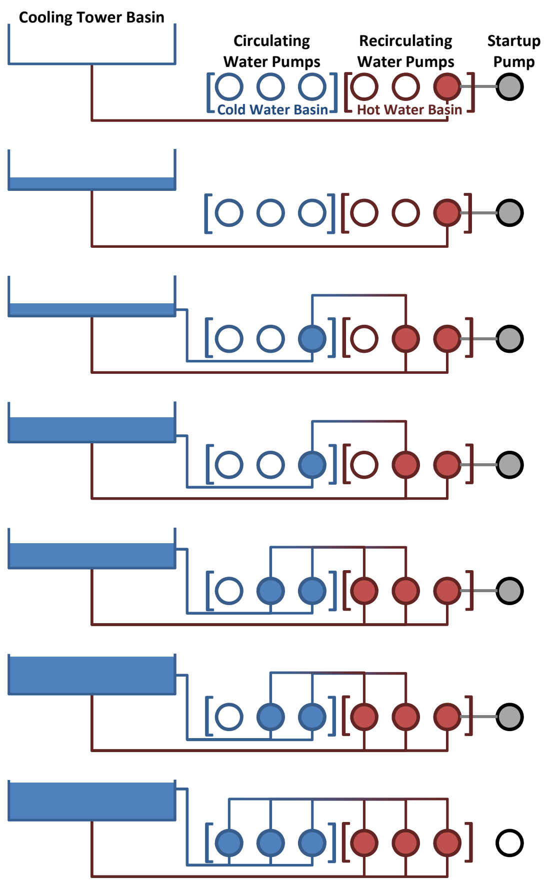

Figure 3.8 Closed-Loop Cooling Startup Sequence

3.7.2 Steady-State Closed-Loop Cooling Operation

The steady-state operation of closed-loop cooling would depend on reliable control of the pump submergence in the hot and cold water basins. Submergence would primarily be maintained by adjusting makeup or blowdown flow through throttling valve adjustments. The adjustable weir wall at the edge of the cooling tower basin and the throttling valve in the cooling tower return piping would provide a secondary method of regulating the submergence level in the cold water basin. In case of a severe loss of inventory in the hot water basin, the start-up pump would be used to provide a large influx of water. In the case of a severe loss of inventory in the cold water basin, the weir wall would be adjusted to provide a large influx of water. While the water available to the start-up pump from the Pacific Ocean is essentially unlimited, the available inventory in the cooling tower basin is finite. A detailed design study would be required to determine whether a secondary means of providing large amounts of water to the cold water basin would be necessary. For example, a spare recirculating water pump used in conjunction with the startup pump could provide the cold water basin with additional water flow. However, an additional recirculating water pump represents a significant cost increase and an additional complexity factor that would need to investigated during the detailed design phase. Likewise, a detailed design study would be required to determine the potential need for variable speed pumps in the system. If the relatively small range of flow variability provided by throttling valves would not accommodate the expected variability in the basin inventories, variable speed pumps would likely be required for at least one recirculating pump, the start-up pump, and/or the makeup pump. Again, variable speed pumps represent a significant cost increase that would need to be investigated during the detailed design phase.

The vendor minimum recommended submergence for both the circulating and recirculating water pumps is 12 feet (see Attachment 1, Section 3). If flow to the cold water basin was suddenly cut off, the minimum recommended submergence would be reached in approximately 2 to 2.5 minutes. Restricted flow to the hot water basin would occur as a result of a circulating water pump deficiency, whereby the resulting cold water basin overflow would provide sufficient submergence for the hot water basin pumps. Deeper reservoirs would provide additional margin, but would also represent additional costs and an extended construction schedule. A detailed design study would be required to determine whether the start-up pump and/or weir wall could provide sufficient emergency water flow to the basins within 2 to 2.5 minutes. If not, deeper reservoirs for additional margin could be necessary.

It should be noted that the extent of steady-state variability of the system in operation is very difficult to predict in theoretical design. Therefore, the system is reasonably expected to be highly unreliable, which could result in frequent plant shutdowns and corresponding power generation losses.

3.7.3 Closed-Loop Cooling Shutdown

Two modes of closed-loop cooling shutdown would be required: routine shutdown (e.g., scheduled outage) and emergency shutdown (e.g., pump failure). In routine shutdown, the blowdown pipe would be fully opened while the makeup pump would be turned off. As the total cooling water inventory in the system decreased, the cooling tower basin weir wall would be adjusted and the circulating and recirculating water pumps would be shut down individually. The routine shutdown sequence would be nearly the opposite of the startup sequence shown in Figure 3.8. In the case of emergency shutdown, the weir wall at the edge of the cooling tower basins would be adjusted to stop flow from the cooling towers and the blowdown pipe would be fully opened. In the event of loss of power to the circulating water pumps, the water inventory remaining in the cooling tower return pipes after the weir wall closed would likely overflow the cold water basin. The cold water basins would be designed to discharge excess flow over the rocky seawall, as described in Section 3.3.2. Check valves would be installed directly downstream of the recirculating water pumps to prevent the water inventory in the cooling tower supply piping from flooding the hot water basin. A detailed water hammer calculation would be required to properly size the check valves and ensure feasibility. In the event of a check valve failure, the hot water basin would also be designed to discharge excess flow over the seawall. It should be noted that additional engineering design would be required to ensure public safety would not be compromised by the discharge of cooling water across the SONGS seawall during a loss of power event.

3.8 Significant System Modifications

The significant equipment and structures necessary for closed-loop conversion are discussed at length in preceding paragraphs. The following section aggregates the impact each of these equipment and structures has on the existing plant systems. As conversion to closed-loop cooling would produce warmer inlet water temperatures under most conditions and thus impact nearly all plant systems, only those systems that could be significantly altered are discussed below.

3.8.1 Pumps

New circulating and recirculating water pumps would be required for closed-loop cooling, representing a significant component of the overall cooling system conversion. Whereas the existing once-through configuration requires only enough pumping head (pressure) to overcome flow losses in passing water from the Pacific Ocean through the condenser and returning to the ocean, the closed-loop cooling configuration requires increased pump head to pump the circulating water up to the elevated cooling tower spray headers on the Mesa Complex and overcome the significant internal flow losses of the cooling tower. The four existing circulating water pumps of each unit would be replaced by three new circulating water pumps and three new recirculating water pumps, as shown in Figure 5-3 and Figure 5-4 of Attachment 5. The four existing circulating water pumps were designed for 38 feet of head. The three new circulating pumps would supply the same volume of cooled water from the cold water basin through the condenser and would also be designed for 38 feet of head. The three new recirculating water pumps would pump the heated condenser outlet water from the hot water basin to the cooling towers on the Mesa Complex, requiring approximately 120 feet of head. At the cooling towers, four additional booster pumps would be required for each tower (12 booster pumps per unit) to pump the circulating water to the dry cooling section at the top of each tower. The cooled water would return from the cooling towers to the Coastal Complex by gravity-driven flow. Single speed pumps are adequate for the closed-loop cooling configuration as a constant circulating water flow rate would be required to provide a flow balance between the Coastal Complex reservoirs and cooling tower basins; Attachment 1, Sections 3 and 4 contains reference information on the proposed new pumps and necessary motors.

One start-up water pump, identical to the new circulating water pumps, would be installed in each existing intake structure to support closed-loop cooling system start-up (discussed in Section 3.7.1). The start-up pump would need to provide the full 277,000 gpm flow rate of one recirculating water pump to support closed-loop cooling start-up; therefore, the smaller capacity makeup pump could not be used for this purpose.

The makeup water pump would be sized to provide the design makeup water flow of 37,848 gpm (discussed in Section 4.4.1). A butterfly valve would be installed downstream of the makeup water pump to throttle the makeup flow across a relatively small range of flow rates. The variable makeup flow rate would be necessary to maintain a steady circulating water inventory in the hot and cold water basins, as described in Section 3.7.2. In cases where more significant basin inventory increases are required, the start-up pump or the weir wall at the edge of the cooling tower basin would be used to provide a large influx of water to the hot or cold water basins, respectively.

The new circulating and recirculating water pumps represent significant additional electrical loads. The existing circulating water pumps have 2500 HP motors. The new circulating and recirculating water pumps would each require an estimated 3400 HP and 11,000 HP, respectively. A dedicated substation, fed directly from the switchyard, would be required for each new pumphouse. Attachment 4 contains reference information on the new transformers and associated electrical switchgear for the pumphouse substations.

Maintenance of the new circulating water and start-up pumps would be similar to that required by the existing circulating water pumps; however, the new recirculating water pumps would require additional maintenance support. It would be expected that pump maintenance support for the new recirculating water pumps would include the replacement of components such as pump impellers, motors, or entire assemblies. Major equipment rehabilitation or replacement is estimated to occur every 20 to 40 years after the equipment is placed into service.

3.8.2 Main Steam Condenser

The main condensers at SONGS were designed for a stable and cold seawater source. The increased condenser water inlet temperature due to the conversion to closed-loop cooling would result in the performance losses detailed in Section 4. To offset these losses, a size increase of the condenser would be required. A condenser modification of this sort is unprecedented (i.e., implementation of a condenser redesign of this magnitude has never occurred at an operational nuclear power plant).

The orientation of the Unit 2 and Unit 3 main condensers is such that the entire turbine building is built on top of, and around, the main condenser. The net result of the main condenser location is that any significant increase to the size of the condenser would require a complete disassembly and reconstruction of the turbine building, along with the accompanying modifications/additions to the turbine building following condenser modification.

Due to the magnitude of this redesign and the lack of any history of a nuclear plant undertaking such a modification, it is concluded that the current cooling water equipment configuration could not be modified in such a way that enhances its cooling performance enough to compensate for closed-loop operational losses.

3.8.3 Saltwater Cooling System

The closed-loop cooling system would be specifically designed to replace only the portion of seawater intake that does not serve engineered safety features. Therefore, in the event of a failure in the closed-loop cooling system, the plant would be able to achieve safe shutdown without any modification to the current engineered safety features. The saltwater cooling system (a critical ESF) would continue to operate as currently designed. No modification to the saltwater cooling pumps or other equipment would be necessary.

3.8.4 Turbine Plant Cooling Water System

Saltwater for the TPCW system is currently supplied by the existing circulating water pumps. The new circulating water pumps tie in at the location of the existing circulating water pumps, requiring no modifications to the TPCW intake. The TPCW system would be affected by the temperatures produced by the new closed-loop cooling water system; however, since the water for the TPCW system is considered cooling water and is not an ESF, nor is it downstream of any ESF designated system, the water would need to be supplied by the cooling towers. The discharge of the TPCW system would be routed to the hot water basin, where it would be combined with the circulating water as it discharges from the condenser to be subsequently pumped to the cooling towers.

3.8.5 Required Mechanical Modifications

The major mechanical modifications associated with conversion to closed-loop cooling would be the installation of six hybrid, mechanical-draft, rectilinear cooling towers (Section 3.1 and 3.2) and the associated circulating water piping (Section 3.4 and 3.5). Two circulating water reservoirs (Section 3.3) would be installed at each unit for the circulating and recirculating water pumps (Section 3.8.1).

The cooled circulating water flow returning from the cooling towers would likely be controlled by a nozzle and a 144" butterfly valve near the end of each circulating water return pipe. Three check valves would be installed on the discharge of each of the three new recirculating pumps, as shown in Figure 5-3 and Figure 5-4 of Attachment 5, to prevent backflow from the cooling towers. A 48" blowdown pipe would connect the cold water basin to the existing discharge canal (Section 3.4.2 and Attachment 5, Figure 5-3 and Figure 5-4); the blowdown flow would be controlled by a 48" butterfly valve.

An adjustable weir wall would be required at the edge of the cooling tower basin to control basin inventory and regulate flow to the cold water basin.

3.8.6 Required Electrical Modifications

Extensive electrical modifications would be required to supply power to the pumps, fans, and other equipment required for closed-loop cooling operation. As shown in Attachment 4, multiple transformers would be required to convert the high capacity, high-voltage power supply to the appropriate voltage levels for necessary cooling tower equipment (i.e., pumps, fans, etc.) on both the Mesa Complex and Coastal Complex areas. Additional switchgear would need to be added to the switchyard for the recirculating pumps. Cables, conduits, and breakers would also need to be installed to connect each series of equipment to its power source. The electrical equipment, along with the material and labor required for installation, are detailed in Attachment 4.

3.8.7 Required Civil Modifications

Six cooling tower basins (Section 3.1 and 3.2) and two circulating water reservoirs (Section 3.3) would need to be constructed for each unit for the conversion to closed-loop cooling. A booster pump skid would be required to support the twelve booster pumps required by each unit's cooling towers for plume abatement operation (Section 3.2). Valve pits would be installed to allow access to the circulating water piping valves and expansion joints (Section 3.8.5). The civil structures, along with the material and labor required for installation, are detailed in Attachment 4.

3.8.8 Required Instrumentation and Control Modifications

Two controller schemes would be required for the operation of closed-loop cooling at SONGS. The interaction of the closed-loop cooling components would require a complex control scheme to ensure a balanced steady-state operation; in particular, the flow rates throughout the circulating water loop would be maintained by pump and valve controls managed by a programmable logic control (PLC) system. The second controller scheme would be required for cooling tower operation.

To manage cooling tower performance, and to safely start-up and shutdown the cooling towers, each cooling tower cell's fan and each booster pump would need to have the ability to be individually operated to control air flow rate and plume abatement for each cell. To accomplish this, the cooling tower controller scheme would be implemented to provide operators the ability to manually and/or automatically control each cooling tower cell.

The cooling tower PLC system would be utilized to reduce tower operating costs while maintaining plume abated operation. Since each cooling tower cell's fan draws air in through both the wet and dry sections, reducing fan speed would reduce the effective cooling capacity of the cooling tower, and thus decrease the net power generated by SONGS (the relationship between circulating water temperature and net power generation is discussed in Section 4.2). To avoid power losses, each cooling tower cell's fan would operate at full speed; however, each of the four booster pumps supplying each cooling tower would be capable of controlling plume abatement by either powering up or powering down each pump as ambient conditions required.

For a given ambient condition, algorithms would determine the optimum number of booster pumps to have in operation to achieve plume abatement. Ambient conditions such as wet-bulb temperature and dry-bulb temperature would be input into the cooling tower PLC. Based on the operating algorithms, the PLC would adjust the flow of hot water through the dry section by controlling the number of booster pumps in operation. Ultimately, the PLC would determine the mix of dry and wet section air such that the resulting combined effluent plume would be sub-saturated/superheated, and hence not visible.

Control equipment would be housed in the Power and Control Building, constructed near the cooling towers as shown in Attachment 5, Figure 5-5. The Power and Control Building, along with the material and labor required for installation, are detailed in Attachment 4.

4 Operational Impacts

SONGS is water-dependent – meaning both that it requires a specific quantity and temperature of water – and currently uses consistently cold seawater from the Pacific Ocean. The Pacific Ocean is the most reliable source of cooling water at SONGS, promoting the efficient generation of electricity and ensuring an uninterrupted supply of cooling water for nuclear safety-related systems. Closed-loop cooling would reduce water use from the Pacific Ocean and provide varying levels of cooling, dependent on the ambient meteorological conditions. Analysis of closed-loop cooling requires consideration of how these changes in water temperature would affect plant systems, operation, and output.

This section provides a preliminary engineering evaluation on the potential impact of converting SONGS from a once-through cooling water system into a closed-loop cooling water system. For this evaluation, the basic plant operational parameters are first defined and then applied to calculate the effects, including the expected power generation loss associated with SONGS operating under a retrofitted closed-loop cooling water design.

Conversion of SONGS to closed-loop cooling would result in a reduction in intake flow from the total licensed design flow of approximately 95.6%. However, an annual average of approximately 143 MWe and a summer daylight peak of approximately 191 MWe of generation would be lost. Additional water treatment would be required for operation of the cooling towers that would require research to identify new treatment technologies to augment the existing liquid radwaste treatment system. Although plume abated technology would be used for the hybrid cooling towers at SONGS in order to limit the visible plume, the entrained moisture and increased heat content would remain and would likely affect the operation of equipment in the vicinity of the cooling towers.

4.1 Procedural Limitations

SONGS equipment operation is governed by a set of procedural limits used to ensure adequate reliability and safety consistent with design specifications. The theoretical closed-loop operation of this equipment must be thoroughly analyzed in order to ensure these procedural limits are not exceeded. If it is expected that these procedural limits may be exceeded, SONGS may be required to operate atypically under various levels of restriction that decrease the net power generated by SONGS.

Changes to the SONGS cooling water equipment that would result in performance gains are restricted by the size and configuration of the equipment within the turbine building, particularly the condenser and the surrounding components. The main condenser for each unit was sized to reflect the use of a stable and cold seawater source. In order to maintain current operational efficiencies, a drastic modification of the condensers (through a size increase) would be required. Condenser modifications of this sort are unprecedented (i.e., implementation of a condenser redesign of this magnitude has never occurred at an operational nuclear power plant). Likewise, due to the physical constraints of the turbine building it is likely that any size increase of the condenser is not possible (see Section 3.8.2). Due to the magnitude of this redesign, the lack of any history of a nuclear plant undertaking such a modification, and the physical constraints of the SONGS turbine building, it is concluded that modification of the current cooling water equipment to compensate for the expected power generation loss is infeasible. In light of this infeasibility, condenser modifications are not considered in the scope of work for this study and thus the SONGS condenser design would be undersized for conversion to closed-loop cooling.

The main condensers are designed to function as the steam cycle heat sink, receiving and condensing exhaust steam from the main turbine and the steam generator feedwater pump turbines. The main condensers also have the capability to condense turbine bypass steam flows of up to approximately 45% of full-load main steam flow without exceeding turbine exhaust temperature limitations. The Unit 2 and Unit 3 main condensers have three steam domes (two low pressure and one high pressure) and two shells with divided water boxes. The main condensers are seawater cooled and located directly beneath the low pressure cylinders of the main turbines [Ref. 8.75]. According to the SONGS Power Operations Operating Instruction [Ref. 8.76], the Low Pressure (LP) turbine vacuum (i.e., the main condenser vacuum) has an instantaneous procedural limit of 8.1 in-Hg and a maximum 10-hr duration procedural limit of 6.0 in-Hg. A Low Vacuum Alarm occurs when the LP turbine vacuum is above the 3.5 in-Hg low vacuum alarm point.

To provide an operational margin against the procedural limit, the maximum 10 hour duration procedural limit of 6.0 in-Hg is evaluated in the performance evaluation of power system efficiency (PEPSE) analysis to ensure instantaneous ambient variations would not cause the procedural limit to be exceeded. Additionally, to evaluate the occurrence of low vacuum alarms impacting SONGS, the low vacuum alarm point of 3.5 in-Hg is evaluated.

4.2 Thermal Performance

Local meteorological data was obtained, reviewed, and analyzed for use as an input to a state-of-the-art site PEPSE model for each unit. The PEPSE model is a power plant performance modeling software that uses, among other things, cooling water intake temperature and flow rates to accurately calculate plant operational parameters and the resulting power generated.

SPX, a leading cooling tower design vendor, supplied the baseline performance of evaporative cooling towers considered here for use at SONGS. Utilizing this range of performance and taking into account the site conditions and operational restrictions present at SONGS, a tower with a 15°F approach (determined using a baseline 13°F approach design and including a 2°F allowance for recirculation) was selected appropriate for evaluation purposes.

4.2.1 Cooling Tower Efficiency / PEPSE Analysis

PEPSE is an industry accepted computer modeling software. The SONGS PEPSE model for each unit was used, along with site meteorological data, to predict performance changes as a function of cooling water inlet temperature. A diagram of the SONGS PEPSE models has been included in Attachment 3, Figures 3-1 and 3-2. Measured inlet water temperatures were combined with the sorted wet-bulb temperatures to yield one coincident data set spanning four years (2004-2007). For each hour of data, the expected gross electrical output of each unit was calculated using the PEPSE correlations for both current once-through operation and theoretical closed-loop operation. The difference between once-through and closed-loop operation was then recorded as the closed-loop operational loss.

4.2.1.1 Meteorological Data Analysis

The performance of any closed-loop cooling water system is primarily driven by the ambient weather conditions at the site and the baseline inlet water temperature values. As discussed in Section 3.1, cooling towers define their performance via an approach to wet bulb temperature. The wet bulb temperature, a meteorological measurement that incorporates both moisture content and temperature of the ambient air, is necessary for closed-loop cooling analysis, as cooling towers utilize an evaporative process to remove heat from the continuously recirculated cooling water. The approach to wet bulb is a value that is based on the size and efficiency of the cooling tower, and essentially represents the cooling ability of the equipment.

Any data set used to predict the performance of SONGS relies heavily on the presence of either wet bulb temperature measurements or a combination of values that can be used to calculate the wet bulb temperature (e.g., dry bulb temperature and relative humidity, dry bulb temperature and dew point, etc.). A thorough review was conducted to normalize the data, ensuring that a uniform data set with no erroneous data is used as the basis for analysis. Particular focus is paid to the review and acceptance of the meteorological data, as even minor errors present in the meteorological data would propagate throughout the analysis. Furthermore, there is almost always some degree of data loss associated with meteorological monitoring. This data loss may be due to a number of causes (equipment failure, biological/human error, etc.).

Wet-bulb temperature is not measured directly by site meteorological instruments; however, wet-bulb temperature was calculated using dry-bulb temperature and dew point temperature, both of which are measured onsite. Five years of meteorological data was provided (2004-2008); upon review a portion of this data contained dew point temperatures which did not correlate well with the measured dry-bulb temperature and relative humidity. The non-correlated data were spread throughout the year, but did not reoccur over the same time period during each year (i.e., non-correlated data did not occur on a particularly day each of the five years measured). These data were appropriately removed to yield a valid meteorological data set spanning all five years.

4.2.1.2 Inlet Water Data Analysis

SONGS provided five years (2003-2007) of inlet water temperatures for Units 2 and 3. These data were normalized to create a uniform hourly data set, removing erroneous data to create a valid data set for analysis. As the intake conditions are nearly identical at both units, the inlet temperatures for Units 2 and 3 were averaged across all five years to provide one complete inlet water temperature data set, regardless of individual unit maintenance outages.

4.2.2 Closed-Loop Operational Losses

SPX provided hybrid cooling tower performance curves for the cooling towers they proposed for SONGS (see Attachment 1 – Section 1). These performance curves were used across the span of wet-bulb temperatures at the necessary cooling range for SONGS to determine the potential closed-loop operational losses. The annual average operational losses for Units 2 and 3 were determined to be 36.7 MWe and 36.8 MWe, respectively.

Predicted monthly and annual closed-loop operational power losses are shown in Table 4.1 and Figure 4.1.

Table 4.1 Closed-Loop Monthly Operational Losses at SONGS

Month	Unit 2 Power Loss *(MWe)*	Unit 3 Power Loss *(MWe)*
January	31.9	32.0
February	34.9	35.0
March	35.9	36.1
April	38.1	38.2
May	39.5	39.6
June	38.8	38.9
July	39.4	39.5
August	38.6	38.7
September	37.7	37.8
October	36.1	36.2
November	33.0	33.1
December	32.2	32.3
Annual	36.7	36.8

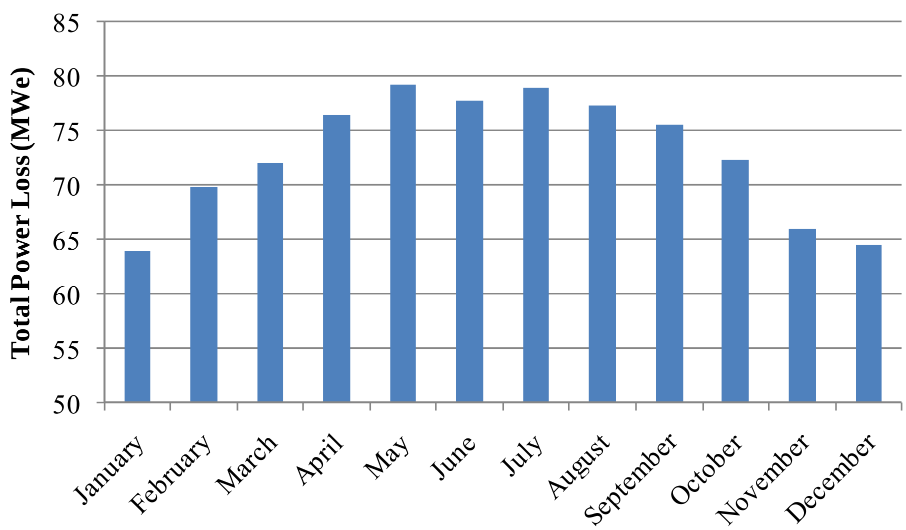

Figure 4.1 Unit 2 and 3 Combined Closed-Loop Monthly Operational Losses at SONGS

On an hourly basis, operational losses would vary significantly between daylight and nighttime hours. Figure 4.2 provides the hourly operational losses for the most impacted 24-hr period spanning July 15th and 16th, 2006, when the maximum hourly operational losses for Units 2 and 3 would have been 60.9 MWe and 61.0 MWe, respectively. These losses represent a 122 MWe loss to the power grid from the facility during the peak demand period. The comparison between the most impacted 24-hr period and the average total power losses for July illustrates the variability in power loss, whereby on any given day in July, power losses at SONGS could be in excess of 40 MWe above average.

Furthermore, these above average power losses would likely occur on the warmest days of the year, when electricity demand is at its highest.

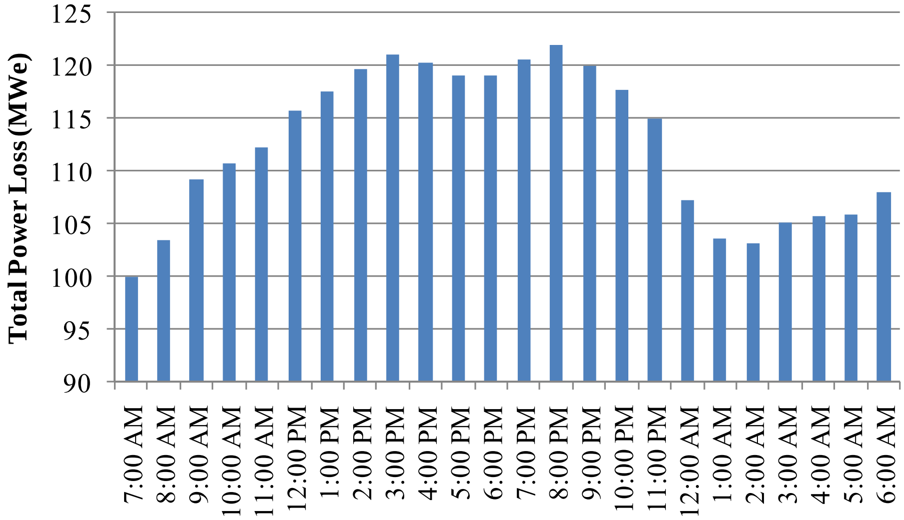

Figure 4.2 Unit 2 and 3 Combined Closed Loop Hourly Operational Losses at SONGS (24-hr period spanning July 15th and 16th, 2006)

4.2.3 Closed-Loop Impact on LP Turbine Limits

As detailed in Section 4.1, both the maximum 10-hr duration procedural limit of 6.0 in-Hg and the low vacuum alarm point of 3.5 in-Hg were evaluated to determine the frequency of excursion. Similar to the closed-loop operational losses analysis, hybrid cooling tower performance curves from SPX were used across the span of wet-bulb temperatures at the necessary cooling range for SONGS to determine the frequency of exceeding either 6.0 in-Hg or 3.5 in-Hg. The results, shown in Table 4.2, were averaged across the entire 5-year wet-bulb data set (2004-2008) to provide the average number of hours either unit at SONGS would be expected to operate beyond the listed limit.

Table 4.2 Closed-Loop Monthly Occurrence of LP Turbine Limit Exceedance (Hours)

	Unit 2		**Unit 3**	
Month	*Alarm Point (3.5 in-Hg)*	*Procedural Limit (6.0 in-Hg)*	*Alarm Point (3.5 in-Hg)*	*Procedural Limit (6.0 in-Hg)*
January	10	0	13	0
February	3	0	5	0
March	2	0	2	0
April	14	0	18	0
May	220	0	244	0
June	481	0	495	0
July	590	0	592	0
August	639	0	644	0
September	592	0	594	0
October	365	0	378	0

Month	Unit 2		Unit 3	
	Alarm Point (3.5 in-Hg)	*Procedural Limit (6.0 in-Hg)*	*Alarm Point (3.5 in-Hg)*	*Procedural Limit (6.0 in-Hg)*
November	127	0	139	0
December	7	0	9	0
Annual	3411	0	3491	0

As shown in Table 4.2, the LP turbine would be above the 3.5 in-Hg low vacuum alarm approximately 39% and 40% of the year for SONGS Units 2 and 3, respectively. Neither unit, however, breaches the maximum 10-hr duration procedural limit of 6.0 in-Hg over the five years of meteorological data. Although difficult to quantify, operation above the alarm setpoint for significant durations will certainly have a detrimental impact on affected equipment reliability and service life. Since the low vacuum alarm would be exceeded to such a great extent, reevaluation of this alarm set point and affected equipment operation would need to occur. If not changed to preclude equipment operational impacts, reliable operation of SONGS may ultimately be affected.

4.3 Auxiliary Load Reduction

All forced draft cooling towers require input electricity to perform their cooling operations. This resulting loss of electricity, referred to as parasitic loss, is extremely taxing to the net electrical output of a plant. Cooling tower parasitic losses include those losses directly attributed to the cooling tower equipment (e.g., fans) and any required additional circulating water and recirculating water pump horsepower necessary to overcome the increase in static head.

4.3.1 Parasitic Pump Losses

Three new circulating water pumps per unit would be required to pump the cooled water from the cooling tower through the main condensers. Three additional recirculating water pumps per unit would be required to pump circulating water from the hot water reservoir to the top of the wet section of the hybrid cooling tower. The circulating water pumps and recirculating water pumps would require significant electrical loads. As discussed in Section 3.8.1, the four circulating water pumps would be replaced with three new circulating water pumps; however, since these pumps would operate in a manner similar to the existing circulating water pumps, no additional parasitic losses would be incurred. Conversely, the three additional recirculating water pumps would each require an 11,000 HP motor, for a total of 33,000 HP per unit. Therefore, the new recirculating water pumps would require approximately 24.6 MWe per unit for closed-loop operation. The start-up pump used to supplement the hot water basin inventory during closed-loop cooling start-up (as described in Section 3.7.1) would require the same input power as one new circulating water pump, but would not be in use during steady-state operations and is therefore not accounted for in the parasitic loss considerations.

In addition, the dry section of each cooling tower would require two additional booster pumps per tower, each with a flow capacity of 48,400 gpm at approximately 26 feet TDH. In order to operate the dry section of the cooling tower for plume abatement, each pump would run using approximately 375 HP, for a total of 2250 HP per unit. Therefore, the dry section pumps would require approximately 1.67 MWe per unit for closed-loop plume abated operation.

A makeup pump would be required for each unit to supply 37,848 gpm makeup flow (calculated in Section 4.4). Each makeup pump would require approximately 220 HP, or 0.16 MWe.

The combined parasitic pump losses for closed-loop plume abated operation would be approximately 26.4 MWe per unit.

4.3.2 Parasitic Cooling Tower Losses

As discussed in Section 3.1, the cooling towers selected by SPX for closed-loop operation of SONGS are linear hybrid cooling towers, designed with noise and plume abatement features. In particular, hybrid cooling towers require significant additional electrical loads since they must draw air in through both the wet and dry sections of the cooling tower. Per the SPX design (see Attachment 1 – Section 1), each cell of the hybrid cooling towers would require a 250 HP motor operated fan. As there would be 15 cells per hybrid cooling tower, and 3 hybrid cooling towers per unit, a total of 11,250 HP would be required for fan operation. Therefore, the power consumed by the fans for plume abated cooling tower operation would be approximately 8.4 MWe per unit.

Summing the parasitic losses from the recirculating pumps, dry section pumps, the cooling tower fans necessary for closed-loop plume abated operation would be approximately 34.8 MWe per unit. When a SONGS unit would be online, these parasitic losses would continually draw from the net generating electricity, and, as discussed in Section 3.8.6, would require significant electrical system modification to allow for the distribution of power to the new equipment. Parasitic losses would also draw electricity under the most affected 24-hr period, which when summed together with the 122 MWe operational losses (see Figure 4.3) would result in a total power loss of 191 MWe. This worst case power loss would occur during the warmest conditions when electricity demand is at its highest.

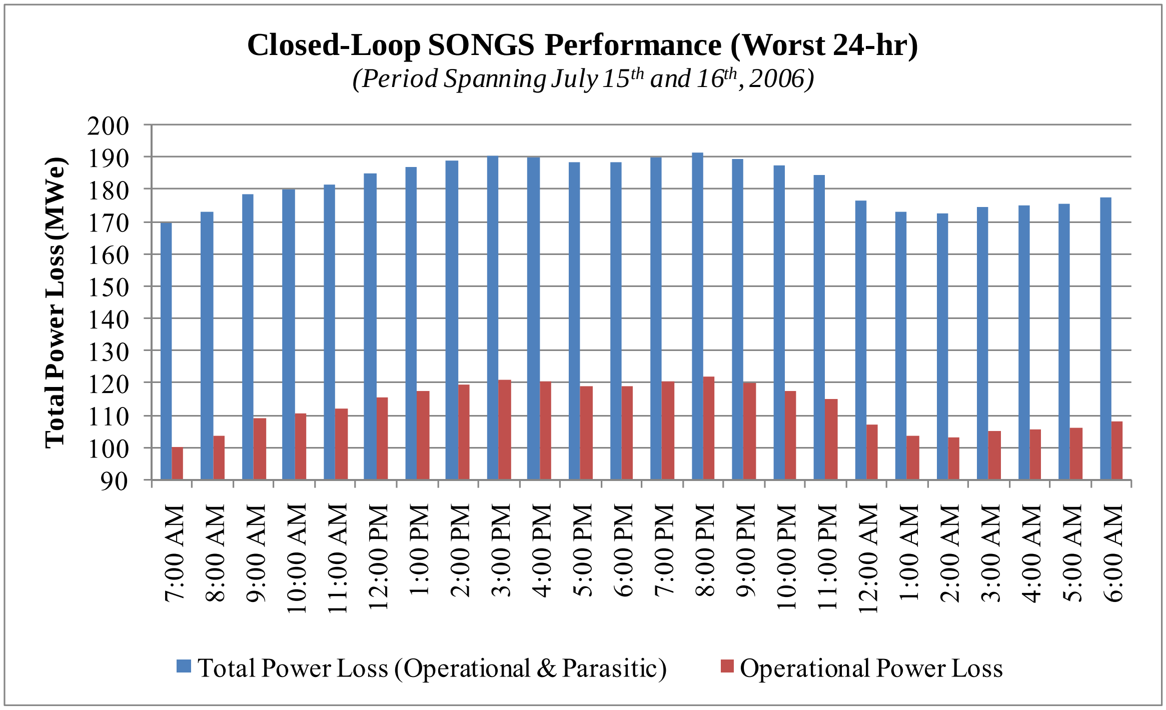

Figure 4.3 Unit 2 and 3 Combined Closed Loop Hourly Operational and Total Power Losses at SONGS (24-hr period spanning July 15th and 16th, 2006)

4.4 Water Consumption

Conversion to closed-loop cooling at SONGS would significantly reduce the water consumption currently required by the OTC system. However, a continuous supply of water would still be required for evaporative cooling tower operation. Evaporation and drift from the cooling tower represent a significant loss of circulating water that must be replenished. The evaporating water leaves the tower as a pure vapor, increasing the concentration of total dissolved solids in the circulating water. Local air quality also contributes to circulating water quality degradation, as the air is effectively washed by the water in the tower (i.e., the cascading water in the cooling tower acts as a scrubber that removes particulates from the atmosphere and concentrates them in the circulating water). To maintain the required water quality for the cooling towers sited at SONGS, a portion of the concentrated circulating water, referred to as blowdown, would be released to the ocean and replaced with sea water. Therefore, a continuous circulating water supply is required to make up the total losses from evaporation, drift, and blowdown.

4.4.1 Seawater Consumption

Saltwater from the Pacific Ocean is currently used in the OTC system at SONGS and would be used for the circulating water in a closed-loop system as well. Water quality in saltwater towers is commonly limited to 1.5 cycles of concentration, meaning that the concentration of TDS in the circulating water is 1.5 times that of the incoming saltwater.

The evaporation and drift flow rates can be estimated using the tower specifications. Evaporation can be approximated by multiplying total water flow rate (gpm) by the cooling range (°F) and 0.0008 [Ref. 8.80]. As discussed in Section 2.2.1, the total circulating water flow rate required by each SONGS unit is 830,000 gpm. The cooling range of the towers at SONGS would be the condenser inlet temperature of 90°F subtracted from the condenser outlet temperature of 109°F:

$$R = T_{\text{Supply}} - T_{\text{Return}} = 109°\text{F} - 90°\text{F} = 19°\text{F} \tag{1}$$

The evaporation flow rate from the cooling towers for each unit at SONGS is therefore estimated as follows:

$$E_{\text{Unit}} = Q_{\text{Unit}} \cdot R \cdot 0.0008 = 830{,}000\,\text{gpm} \cdot 19°\text{F} \cdot 0.0008 = 12{,}616\ \text{gpm} \tag{2}$$

The drift rate is calculated by multiplying the vendor specified drift percentage, 0.0005% in this case (see Attachment 1), times the total water flow rate (gpm):

$$D_{\text{Unit}} = \%_{\text{Drift}} \cdot Q_{\text{Unit}} = 0.0005\% \cdot 830{,}000\,\text{gpm} = 4.2\,\text{gpm} \tag{3}$$

The required blowdown to maintain 1.5 cycles of concentration, $C_{1.5}$, is estimated using the expected evaporation and drift rates [Ref. 8.80]:

$$B_{\text{Unit}} = \frac{E_{\text{Unit}} - \left[\left(C_{1.5} - 1\right) \cdot D_{\text{Unit}}\right]}{\left(C_{1.5} - 1\right)} = \frac{12{,}616\,\text{gpm} - 0.5 \cdot 4.2\,\text{gpm}}{0.5} = 25{,}228\,\text{gpm} \tag{4}$$

The makeup flow required per unit for cooling tower operation at SONGS is the sum of tower water losses due to evaporation, drift, and blowdown:

$$M_{\text{Unit}} = E_{\text{Unit}} + D_{\text{Unit}} + B_{\text{Unit}} = 12{,}616\,\text{gpm} + 4.2\,\text{gpm} + 25{,}228\,\text{gpm} = 37{,}848\,\text{gpm} \tag{5}$$

Figure 4.4 provides a per unit closed-loop flow cycle, including makeup, evaporation, drift, and blowdown flowrates.

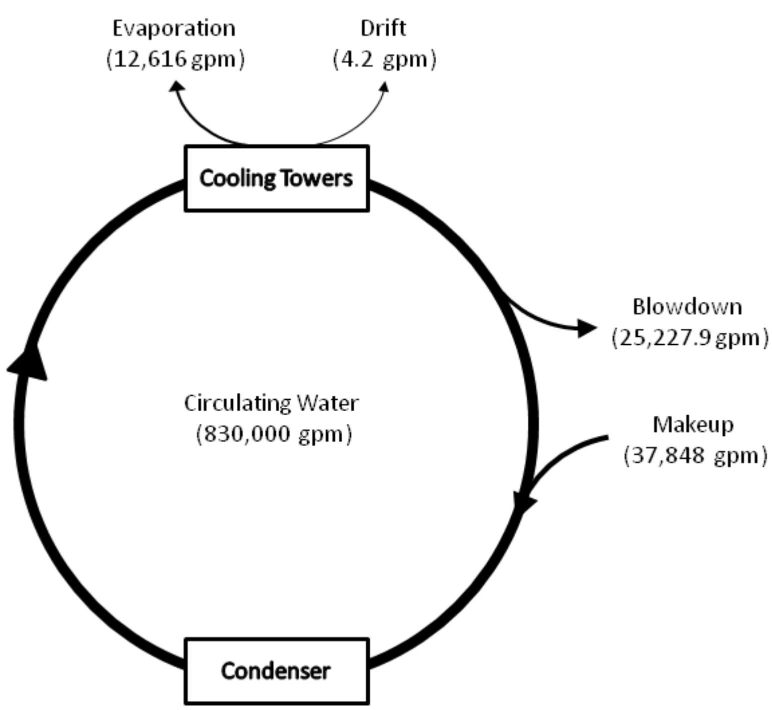

Figure 4.4 SONGS per Unit Closed-Loop Flow Cycle

The total makeup flow required by SONGS is double the makeup flow required by each unit:

$$M_{\text{Total}} = 2 \cdot M_{\text{Unit}} = 2 \cdot 37{,}848\ \text{gpm} = 75{,}696\ \text{gpm} = 109\ \text{MGD} \tag{6}$$

As described in Section 2.2.1, the total licensed design flow for each SONGS unit is 864,000 gpm. Therefore, the reduction in intake flow from total licensed design flow would be approximately 95.6%.

4.4.2 Recycled Wastewater Consumption

Consideration has been given to the use of recycled wastewater as an alternative to using seawater as makeup water for a closed-loop cooling system. The use of recycled wastewater as makeup for cooling towers at California coastal power plants has been studied [Ref. 8.35]. Consistent with the results of that study, cooling tower operation at SONGS would be maintained at six cycles of concentration, meaning that the concentration of TDS in the circulating water is 6 times that of the incoming recycled wastewater.

The estimated evaporation and drift rates are unaffected by the allowable cycles of concentration; therefore, the values are identical to those calculated for saltwater tower operation in Section 4.4.1:

$$E_{\text{Unit}} = 12{,}616\ \text{gpm} \qquad D_{\text{Unit}} = 4.2\ \text{gpm}$$

The required blowdown to maintain 6 cycles of concentration, C_6, is estimated using the expected evaporation and drift rates [Ref. 8.80]:

$$B_{\text{Unit}} = \frac{E_{\text{Unit}} - \left[\left(C_6 - 1\right) \cdot D_{\text{Unit}}\right]}{\left(C_6 - 1\right)} = \frac{12{,}616\ \text{gpm} - 5 \cdot 4.2\ \text{gpm}}{5} = 2{,}519\ \text{gpm} \tag{7}$$

The makeup flow required per unit for cooling tower operation at SONGS using recycled wastewater is the sum of tower water losses through evaporation, drift, and blowdown:

$$M_{\text{Unit}} = E_{\text{Unit}} + D_{\text{Unit}} + B_{\text{Unit}} = 12{,}616\ \text{gpm} + 4.2\ \text{gpm} + 2{,}519\ \text{gpm} = 15{,}139\ \text{gpm} \tag{8}$$

The total makeup flow required by SONGS is double the makeup flow required by each unit:

$$M_{\text{Total}} = 2 \cdot M_{\text{Unit}} = 2 \cdot 15{,}139\ \text{gpm} = 30{,}278\ \text{gpm} = 43.6\ \text{MGD} \tag{9}$$

The feasibility of the recycled wastewater option depends primarily on the distance between the plant and the nearest wastewater treatment facility able to provide adequate makeup flow.

Recycled Wastewater Availability and Feasibility

The NPDES water discharge permits for wastewater treatment facilities (WWTFs) within Orange, Riverside, and San Diego counties indicate that three facilities within 35 miles of SONGS could each provide sufficient makeup flow for closed-loop cooling towers. The 35 mile radius was chosen as the minimum distance encompassing at least two WWTFs capable of providing sufficient makeup flow to SONGS. The discharge flow rates and distance from SONGS for the three WWTFs with sufficient flow rates are shown in Table 4.3.

Table 4.3 Wastewater Treatment Facilities Discharging 50+ MGD within 35 Miles of SONGS (Based on NPDES Water Discharge Permits)

NPDES	Facility	Direct Distance [miles]	Discharge Flow [MGD]
CA8000188	**Eastern Municipal Water District Temescal Creek Discharge**	**24.9**	**58[1]**
	San Jacinto Valley RWRF	24.6	11[2]
	Moreno Valley RWRF	24.6	16[2]
	Perris Valley RWRF	24.6	11[2]
	Sun Valley RWRF	24.6	3[2]
	Temecula Valley RWRF	24.6	12[2]
CA8000408	**Orange County Water District Ground Water Replenishment System Advanced Water Treatment Facility**	**31.6**	**100[1]**
CA0110604	**Orange County Sanitation District Reclamation Plant 1 & Treatment Plant 2**	**33.1**	**232[1]**
	Outfall 001	29.9	480[3]
	Outfall 002	29.4	168[3]
	Outfall 003	29.5	130[3]

Discharge Flow Basis:

1. Average Design Flow
2. Treatment Capacity Flow
3. Outfall Capacity Flow

The NPDES permits, discharge flow rates, and distance from SONGS for all WWTFs within a 35 mile radius of SONGS are shown in Attachment 5, Table 5-2.

The total facility or outfall discharge flows are based on average design flows, treatment capacities, or outfall capacities listed in the NPDES permits, as noted in the tables. The distance from SONGS is based on either the facility address or the outfall GPS coordinates listed in the facility's NPDES permits. Thus, the discharge flows and direct distances listed may differ from the actual discharge flows and/or actual tie-in locations for transport to SONGS.

The Eastern Municipal Water District (EMWD) Temescal Creek Discharge facility and outfalls are located approximately 15 miles east of SONGS. Pipelines directly connecting SONGS and the Temescal Creek Discharge would have to be installed through the mountainous terrain of Cleveland National Forest. Tunneling through the Cleveland National Forest is likely infeasible due to the difficulty of obtaining the numerous required permits and the considerable costs for such an installation. If pipelines were rerouted around Cleveland National Forest, the required piping length would increase to over 46 miles. In addition, if the EMWD Temescal Creek Discharge consistently discharges less than 75% of the permitted flow (i.e., if the discharge flow rate is intermittent), the facility would not be a reliable source of recycled wastewater for SONGS.

The Orange County Water District (OCWD) Groundwater Replenishment System, Advanced Water Treatment Facility (AWTF) is located 31.6 miles northwest of SONGS.

The entire wastewater discharge volume of the facility is used to replenish the Orange County Groundwater Basin and seawater barrier [Ref. 8.7]; therefore the OCWD AWTF could not provide recycled wastewater for makeup flow at SONGS.

The Orange County Sanitation District (OCSD) Reclamation Plant No. 1 (RP1) and Treatment Plant No. 2 (TP2) have a combined capacity of 232 MGD. Water discharged from OCSD RP1 is pumped to OCSD TP2, to be either treated further or discharged via a combined discharge pipe to the ocean. Water treatment from OCSD is typically secondary, although a blend of primary and secondary treatment is necessary when storm flows are present. The combined discharge piping for these two plants is located approximately 30 miles from SONGS. Currently, OCSD RP1 and TP2 supply 110 MGD of treated water to the OCWD AWTF and plan to eventually supply 150 MGD. Additionally, the California Department of Health Services limits the reuse of water supplied to each of these WWTFs by the Santa Ana River Interceptor [Ref. 8.7], which eliminates an additional 30 MGD of recycled wastewater availability from the total flow. Therefore, only approximately 50 MGD or less would be available for long term supply of recycled wastewater for SONGS.

Assuming recycled wastewater could be transported through 30 miles of heavily-developed California coastline, recycled wastewater from OCSD RP1 and TP2 would need to undergo a series of further treatments to meet the cooling tower manufacturer's required water quality. This treatment would be similar to that of the 90 MGD recycled wastewater treatment plant located at the Palo Verde Nuclear Generating Station [Ref. 8.68], albeit utilizing approximately half of the flow rate (43.6 MGD). Using Palo Verde's recycled wastewater treatment plant for comparison, if recycled wastewater from OCSD RP1 and TP2 was utilized, the water treatment system required by SONGS would occupy approximately 16 acres. Additionally, cooling tower blowdown would likely need to be transported back to OCSD as the discharge of concentrated chemical contaminants (water disinfection by-products, endocrine disrupters, pharmaceuticals, etc.) is not permitted. As a result of the considerable costs, the numerous permits required, the reliability of the discharge flow rate, and the site area limitations at SONGS, using recycled wastewater from OCSD RP1 and TP2 is likely infeasible.

Due to the anticipated difficulty in obtaining sufficient wastewater flow from one WWTF, the option of combining the discharge flow of several smaller WWTFs was considered. As this option would require a network of piping connecting smaller WWTFs to SONGS, only the facilities with ocean outfalls are considered for this option as constructing a network of pipes connecting inland facilities would pose the same construction concerns discussed above. A pipe transporting recycled wastewater from the WWTFs to SONGS would likely tie in to the existing WWTF discharge lines near the coastline. As shown in Figure 4.5, a 15 mile pipeline running along the coastline to the northwest could potentially transport 63 MGD of recycled wastewater from the Aliso Creek Ocean Outfall (33 MGD) and the San Juan Creek Ocean Outfall (30 MGD) to SONGS. A 28 mile pipeline running along the coastline to the southeast could potentially transport 51 MGD of recycled wastewater from the Oceanside Ocean Outfall (23 MGD) and the Encina Ocean Outfall (28 MGD) to SONGS. As the combination of multiple outfalls would not significantly reduce the piping distance required to obtain necessary recycled wastewater for SONGS, the limitations on construction discussed for single source recycled wastewater would still apply.

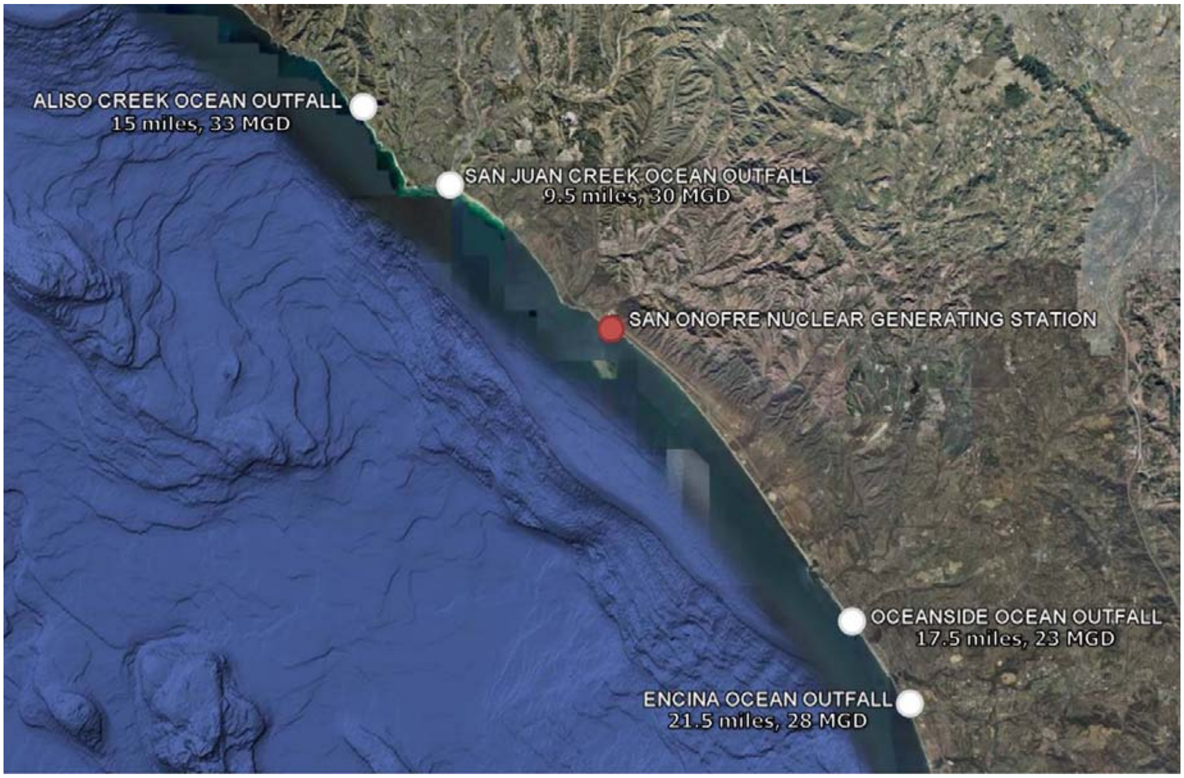

Figure 4.5 Map of Potential Recycled Wastewater Sources

4.5 Circulating Water Treatment

The existing once-through circulating water cooling system receives a minimum of chemical, mechanical, and heat water treatment. Biocides, specifically sodium hypochlorite, are added to minimize fouling of the condensers, with quantities limited by the concentrations allowed by the discharge permit. With a closed-loop cooling system, water treatment requirements are dramatically increased. The cooling tower fill is subject to fouling, as are the dry heat exchanger sections. Both the quantities and frequency of biocide injections must be increased significantly to maintain the tower fill in proper condition.

Additionally, increased water treatment is necessary due to the higher concentrations of dissolved solids, chemicals, and biological agents in the system resulting from constant recirculation of the condenser cooling water. The cooling towers act as air washers as well as distilleries, constantly evaporating large quantities of water and leaving behind the non-volatile residues. The actual concentrations of these agents are wholly based on 1.5 cycles of sea water concentration, as discussed in Section 4.4.1.

Unlike the simple injections of biocide required for the once-through configuration, a closed-loop configuration typically utilizes several chemicals, each with specific attributes requiring revision to the current business plan. Chemical treatment is broken into three subsections: deposition, corrosion, and biological.

<u>Deposition</u>

There are two forms of deposition: (1) sedimentation, which is usually mitigated through piping design, and (2) scaling. The prevention of scaling is not straightforward, and in some cases scaling may even be necessary in a piping system to prevent corrosion. For example, a thin uniform coating of calcium carbonate provides corrosion protection for internal surfaces of piping; therefore this type of scaling is desirable and should be left intact where possible. Problems arise when scaling becomes too thick and reduces heat transfer within the condenser or cooling tower. Scaling is kept under control through the use of pH control and dispersants.

Corrosion

Corrosion is the erosion of material due to chemical reactions with its surroundings. Corrosion is mitigated through proper piping design and material selection, along with an aggressive chemical treatment program using pH control and corrosion inhibitors.

Biological

Biological growth, or biofouling, is difficult to chemically treat as it attempts to inhibit a dynamic biological process. The biological process promotes corrosion through the breakdown of chemical components and the creation of localized acids. In a closed-loop cooling system, where the concentration of nutrients is increased, biofilms tend to increase on the piping internal surfaces and cooling tower fill. Control of biofilms usually involves the application of biocides and a surfactant-type biodispersant to disrupt the biomatrix, which allows better penetration of the antimicrobial. Additional chemical treatments such as biodetergents may also be necessary depending on local biological organisms and conditions.

Major closed-loop cooling water chemicals typically include:

Chemical type	Use/Function
sodium hypochlorite	biocide
surfactant	biocide aid
sulfuric acid	pH control
dispersant	scale prevention
phosphate	corrosion control

Heat treatments, similar to those conducted under once-through operation, would also be required in closed-loop operation; however, since additional chemical treatments would maintain biological growth in the closed-loop configuration, heat treatments would only need to be applied to the traveling water rakes and screens. To accomplish this, heaters would need to be placed in-line with the current screen wash system for the traveling rakes and screens, to apply heat treatments on an as-needed basis.

Condenser Cleaning and Maintenance with Closed-Loop Cooling

SONGS Units 2 and 3 were originally installed with an Amertap ball cleaning system to maintain the condenser tubes at a low level of fouling. Due to installation complications, this system was eventually abandoned in place and was not used beyond initial plant startup. To maintain condenser cleanliness, SONGS performs heat treatments by periodically increasing the condenser inlet water temperature to eliminate biological buildup. During a heat treatment, the circulating water is heated by recirculating a portion of the condenser discharge back through a portion of the intake structure. As noted previously, under closed-loop cooling nutrients in the circulating water would be concentrated, allowing for the greater potential of biological fouling in the condenser. To mitigate this risk, and following on current operating experience, SONGS would continue to perform heat treatments as necessary to maintain proper condenser cleanliness. Differing from the current procedure, the heat treatment would be administered by reducing the number of cooling tower fans in operation, thus reducing cooling efficiency and recirculating much warmer water back to the condenser.

4.5.1 Micro and Macro Fouling Control System

Each unit would require a steady state blowdown flow of approximately 25,200 gpm when running at full load. The concentration of the circulating water would be 1.5 times normal seawater. Thus, the blowdown would have a concentration of about 52,500 ppm TDS given an average seawater concentration of 35,000 ppm TDS [Ref. 8.32]. This blowdown stream would be harmful to local marine life and as such must be mixed with the seawater as it is introduced into the ocean to reduce its TDS concentration.

The blowdown would be mixed with non-concentrated Saltwater Cooling system water before being discharged out of current offshore discharge structure. As discussed in Sections 2.2.1 and 3.8.3, the Saltwater Cooling system would remain unaltered in the closed-loop cooling configuration and continue to draw in and discharge 34,000 gpm of non-concentrated saltwater from the pacific ocean. Combining this discharge with the 1.5 times concentrated blowdown would result in a combined discharge concentration of approximately 1.2 times. (25,200 gpm at 1.5 times combined with 34,000 gpm at 1.0 times results in a discharge salinity of approximately 1.2 times). This diluted discharge would then be sent through the current outfall configuration, facilitating rapid mixing by discharging through the existing series of offshore diffusers. The coupling effect of the dilution and the outfall diffusers would thus limit any adverse affects to local marine life.

4.5.2 Low Volume Waste Effluents

The San Onofre Offsite Dose Calculation Manual (ODCM) [Ref. 8.77] Table 1-1 lists the following credited radioactive liquid release points:

Batch release points:

- Primary plant makeup storage tanks
- Radwaste primary tanks
- Radwaste secondary tanks
- Miscellaneous waste condensate monitor tanks
- Blowdown processing system neutralization sump
- Full flow condensate polishing demineralizer sumps (high conductivity, low conductivity) and hold up tanks
- Component cooling water sump
- Storage tank area sump
- Steam generator blowdown

Continuous release points:

- Turbine plant sump
- Blowdown processing neutralization sump
- Steam generator blowdown bypass line
- Steam generator blowdown
- Auxiliary building sump

As required by the Unit 2 and Unit 3 NRC Operating Licenses, discharges from the ODCM-credited release points are strictly controlled in accordance with established site procedures and programs to ensure that they are well below the limits in federal NRC regulations (10 CFR 20 for instantaneous concentration limits and 10 CFR 50 for dose limits) at all times. The waste liquids are treated as necessary prior to discharge to the discharge conduit of either Unit 2 or Unit 3. Seawater used in the once-through circulating water system serves the additional function of providing dilution of the treated liquid waste to meet the concentration limits in NRC regulations (10 CFR 20).

In closed-loop operation, the waste liquids would be released to the discharge conduit of either Unit 2 or Unit 3 in a manner similar to once-through operation; however, the circulating water discharge would be reduced from a minimum flowrate of 555,000 gpm per unit during releases of the treated contents from a radwaste tank to the blowdown rate of 25,228 gpm (Section 4.4). Based on SONGS operating experience, the reduction in the circulating water discharge flowrate by more than a factor of 20 would result in concentrations of certain isotopes in the treated water from a typical radwaste primary or secondary tank that would exceed NRC 10 CFR 20 limits at the point of discharge, and would thus violate the NRC Operating Licenses. In addition, the change in operating practices would not meet the requirement to maintain dose as low as is reasonably achievable. SONGS would be required to research, identify, and install new treatment technologies (if available) to augment the existing liquid radwaste treatment system, in order to maintain and control liquid radioactive releases at the current levels. These modifications would need to be studied in further detail to determine the magnitude of impact to plant operations and project costs and schedule.

4.6 Cooling Tower Plume Emissions

As discussed in Section 3.1, while hybrid cooling towers reduce the potential for visible plume formation, they do not totally eliminate the potential for plumes to occur. Likewise, while the majority of airflow discharged from the hybrid cooling tower contains evaporated water, a small portion of drift is emitted in the cooling tower plume. As the drift droplets evaporate, the dissolved and suspended solids (in particular, dissolved salts) in the circulating water are released as airborne particles.

Cooling tower drift is defined as the emitted percentage of the circulating water from the cooling tower that is entrained in the exhaust air stream and emitted from the cooling tower. Drift droplets are any water droplets and dissolved and suspended solids they contain that are entrained in the air and emitted from the cooling tower fan shrouds.

The following section details the effect the plume and the resulting drift deposition have on the operation and maintenance of SONGS equipment. For a detailed discussion of drift and its effects on air pollution limits, see Section 6.1.

4.6.1 Plume Abatement Efficiency

The plume abatement offered by hybrid cooling towers transforms the plume from its visible state into being invisible. This process is discussed in detail in Section 3.1.1, which states that the cooling tower selected by SPX for SONGS would produce a visible plume less than 1 percent of the time. During times when a visible plume is produced, however, site operations at both the Mesa Complex and the Coastal Complex would need to account for this decrease in visibility.

The safety of plant personnel at SONGS is paramount, and such consideration must be made to notify and prepare personnel for abnormally low levels of visibility when they are to occur. While SONGS personnel are relatively accustomed to coastal fogging, meteorological conditions creating a visible plume would not necessarily align with coastal fogging and would generally occur during the morning hours where travel to and from SONGS generally occurs. Secondly, SONGS security systems that require visibility as a means of detection may be impacted to a level possibly exceeding that of natural occurring coastal fogging. Additional security impacts are discussed in detail in Section 3.5.2; however, particular attention on how the decreased visibility might impact security would need to be analyzed.

Plume abated hybrid cooling towers represent current state-of-the-art technology with respect to abatement of a visible vapor plume. These towers would greatly reduce the potential for plume formation that could impact SONGS personnel safety or security; however, since the risk of plumes impacting these areas exists, the degree to which they are impacted must be evaluated.

4.6.2 Plume Impact on Plant Systems

As discussed in Section 4.6, cooling tower drift contained within the plume has the potential to deposit dissolved solids, particularly salt, across the Mesa Complex and Coastal Complex. Additionally, even though the cooling tower plume is often rendered invisible, the entrained moisture and increased heat content remains and has the potential to affect the operation of equipment in the vicinity of the cooling tower. The following is a list of impacts to plant systems attributable to hybrid cooling tower operation:

- Interference with Station operations, safety and systems, under worst case meteorological conditions.
- Entrained moisture and increased heat content would impact SONGS meteorological measurements and HVAC equipment, requiring increased maintenance and causing degraded performance.
- Interference with plant visual-oriented security systems.

- Associated salt deposition could cause unplanned outages due to electrical arcing in the switchyard[7].
- Associated salt deposition could damage the sensitive equipment used in the SONGS meteorological monitoring system, requiring additional system maintenance and possibly the installation of a new meteorological tower.
- Associated salt deposition could cause damage to vegetation in the area.
- Long-term shadow from plume can harm vegetation.

Additional discussion on how cooling towers would affect air quality, local vegetation, and site aesthetics are detailed in Sections 6.1, 6.4, and 6.5, respectively.

[7] Closed-loop cooling at Brayton Point Power Station Unit 4, utilizing a salt water spray cooling canal, operated for less than one month before a succession of flashovers on the resistance grade insulators occurred. Resulting research on how salt deposition impacts electrical equipment indicated that salt deposition leads to arcing, causing electrical equipment to fail [Ref. 8.42].

5 Closed-Loop Cooling Conversion Cost Estimates

Included within this section are estimates of the construction and outage durations and the costs of various aspects of the conversion of SONGS Units 2 and 3 to closed-loop cooling. Due to the limited availability of PM_{10} emission credits and large variability in price, the significant cost of obtaining the necessary PM_{10} credits has not been included in the cost estimate. An estimated construction and outage schedule was developed incorporating the design and construction of each unit, discussed in Section 5.1. In order to minimize the overall construction duration and cost, the estimated schedule would allow for phasing of the various tasks in order to take advantage of labor availability, scheduled refueling outages, and allow for flexible work sequencing. It should be noted that the estimated schedule represents a shortest-case scenario, and does not take into account any impacts that could occur from outside forces such as unforeseen regulatory or licensing impacts. The duration of the required unit construction outages, based on a timeline of critical milestones that must be worked with the associated unit off-line, is discussed in Section 5.1.2, and is utilized to determine the resulting lost generating capacity, expressed in MWe.

The overall construction schedule for the conversion would extend approximately 66 months from the start date with engineering work beginning approximately 3 months prior to tunneling construction and 12 months prior to general construction. Of these 66 months, both SONGS Units 2 and 3 would require a construction outage of approximately 21.1 months.

In Section 5.2, the capital costs of the initial conversions are quantified, including design, procurement, implementation, and startup activities, based on the construction schedule for the conceptual design. The new towers and pumps would require an appreciable amount of power to operate (i.e., parasitic losses) which would effectively reduce each unit's output power to the distribution grid. Power consumption of the required new components was estimated from preliminary vendor data, and total MWe parasitic losses were determined. Likewise, the conversion would create less than optimum operating parameters for the existing turbine/condenser, resulting in reduced unit output to the grid under most operating conditions. Finally, the new cooling towers and pumps would require operations and maintenance personnel support, and service, repair, and replacement of components; based on input from potential supplying vendors, these costs are approximated.

The design, construction, construction outage power production losses, and start-up of closed-loop cooling at SONGS would cost approximately $3.0 billion, of which approximately $2.4 billion is based on 21.1 months of construction outage power production losses per unit. The total annual cost of operating closed-loop cooling at SONGS would be more than $85 million each year for the first five years of operation and the average annual costs would increase with additional years of operation. These annual costs include operations and maintenance costs, the power losses associated with the new condenser operating parameters, and the parasitic power losses due to the new equipment required for closed-loop cooling.

5.1 Construction and Outage Duration

The overall construction schedule for the conversion (see Attachment 4) would begin with tunnel construction. The total length of construction would extend approximately 66 months from the start date with engineering work beginning approximately 3 months prior to the start of tunneling construction and 12 months prior to start of general construction activities. The construction start date would be limited by the requirement of having all permitting completed and in place prior to mobilization. Likewise, the construction start date would be restricted if specifications, procurement, and design engineering were not completed as scheduled. Considering the conceptual nature of the current design parameters and the unknown effects of outside forces, the scheduling of many tasks represents a best-case scenario and could be significantly impacted.

5.1.1 Online Construction Schedule

As discussed in Section 3, the SONGS cooling towers would be sited at the Mesa Complex with tunneling to take place to connect the cooling tower with the condenser by a series of large bore circulating water pipes. To this extent, Mesa Complex activities and those activities conducted near the Coastal Complex which would not be impactive to operation could be conducted with each unit online. The following is a brief description of the major online construction activities, each of which is broken into sub-task descriptions set forth in the construction schedule (see Attachment 4).

Site Clearing and Mobilization

Construction of the hybrid tower would entail significant excavation at the Station. The area surrounding each cooling tower basin, the area near the tunneling entrance and exit, and equipment laydown areas would be cleared and excavated during the online construction. Also, several non-essential structures located on the SONGS Coastal Complex that would interfere with construction would be removed. Total site clearing and excavation would be expected to last approximately 4 months.

This construction would be limited primarily to previously impacted areas; however, the significant alteration of these areas would alter the flow pattern of runoff from precipitation events. The volume of runoff and the silt load of the runoff would likely increase due to the lack of trees and vegetation to hold the soil and slow the transport of water. Standard techniques for runoff control would be implemented, such as silt fences and grading to control the flow of runoff during construction.

Basin Construction

As discussed in Sections 3.2 and 3.8, each unit would require three 56 feet wide and 721 feet long cooling tower basins. These basins would be aligned in parallel and would have a minimum spacing of 1.5 tower widths. As shown in Attachment 4, construction of the basins for the hybrid cooling towers would be expected to last approximately 32 weeks per unit.

Cooling Tower Construction

As discussed in Section 3.1, each unit would require three 15 cell linear hybrid cooling towers (45 cells total per unit). Each cell would be 48 feet × 48 feet and have a discharge height at the top of the fan shroud of approximately 50 feet. As shown in Attachment 4, construction of the hybrid cooling towers would be expected to last approximately 20 months per unit, with construction on the Unit 3 cooling tower beginning approximately 3 months prior to the start of Unit 2 cooling tower construction.

Tunneling Construction

As discussed in Section 3.5, the eight circulating water pipes transporting cooling water between the condensers and cooling towers would be primarily installed by tunneling methods. Each concrete pipe would be installed during the excavation of each 14 feet diameter tunnel. As shown in Attachments 2 and 4, construction of the eight tunnels for the circulating water pipes would be expected to last approximately 170 weeks per unit, with construction on Unit 2's tunnels beginning 6 months prior to the start of Unit 3 tunnel construction.

5.1.2 Outage Construction Schedule

In contrast to those activities outlined in Section 5.1.1, due to the proximity of several construction activities to nuclear safety-related equipment and the impact on or removal of equipment necessary for power generation (i.e., circulating water pumps, TPCW, etc.) would require extended construction unit outages. Approximately 22.6 months of continuous outage for the construction and implementation of closed-loop cooling would be required for each unit. Beginning in 2012, each unit will have a planned refueling outage lasting 45 days occurring every two years. Subtracting the planned refueling outages from the construction outage duration, each unit would require a non-planned construction outage of approximately 21.1 months. To mitigate the effect this outage would have on the regional electrical grid, the construction schedule would stagger the start of each construction outage by 6 months. Therefore, the planned outages for each unit would coincide for approximately 16.7 months. The outage construction schedule is detailed in Attachment 4, including a breakdown of activity specific subtasks. Each of the major construction activities that would require a unit to be in an outage are described below.

Tunneling Completion

As discussed in Section 3.5, tunneling activities near the turbine and reactor buildings would require an outage. For tunneling completion approximately 2 to 3 months of outage would be required per unit.

Reservoir Construction

As discussed in Section 3.3, two circulating water reservoirs (one hot water basin and one cold water basin) would be constructed between the turbine buildings and the seawall at each unit. An outage would be required to construct these circulating water reservoirs due to the proximity of the turbine buildings and reactor buildings, as well as the necessary and frequent use of the area for plant operations. Therefore, the construction of the circulating water reservoirs would require approximately 56 weeks of outage per unit.

Circulating Water Pump Installation / Tie-in

As discussed in Section 3.4, each unit would require three new circulating water pumps installed in the cold water basin and three new recirculating water pumps installed in the hot water basin to replace the four existing circulating water pumps. Since the circulating water pumps are required for plant operation, the existing circulating water pumps could only be removed when the unit would be offline. The new circulating water pumps and recirculating water pumps that would be required to run each unit under closed-loop cooling would need to be installed during the construction of the circulating water reservoirs. In addition, the closed-loop cooling system piping and the existing condenser circulating water pipes and the discharge canal would need to be tied-in to the new circulating water reservoirs for each unit. The circulating water pump installation and tie-in of the circulating water pipes would require approximately 8 weeks of outage per unit.

Closed-Loop Cooling Plant Start-Up

Approximately 20 weeks of construction outage per unit would be required to conduct testing and start-up activities related to the new closed-loop cooling systems.

5.2 Cost of Converting to Closed-Loop Cooling

This section estimates the costs for the five major aspects of converting SONGS Units 2 and 3 to closed-loop cooling:

- initial capital costs
- construction outage costs
- costs due to new condenser operating parameters
- costs due to parasitic losses
- operation and maintenance costs, including water treatment costs

The capital costs of the closed-loop conversion are described including design, procurement, implementation, and startup activities, as detailed in Attachment 4. The duration of the required unit outages determined in Section 5.1 is used to determine the cost of lost generating capacity by applying a projected price per MWhr of $73.30 (Attachment 1, Section 5). Additionally, the price per MWhr is used to estimate both the parasitic losses associated with the pumps and cooling tower fans and the ongoing operational efficiency losses associated with operating beyond the original condenser design conditions. Finally, ongoing operation and maintenance to sustain closed-loop equipment operation is estimated over the expected lifespan of each piece of equipment.

5.2.1 Initial Capital Costs

The initial capital costs to convert SONGS to closed-loop cooling includes the cost of engineering design; the selection, procurement, and installation of major equipment (i.e., cooling towers, pumps, valves, etc.); and the costs of closed-loop construction, including the tunneling required to connect the cooling towers located on the Mesa Complex with the seaside hot and cold water reservoirs. Capital cost estimation was done in such a way as to minimize the necessary assumptions, and relied instead on well-developed conceptual designs to greatly increase the accuracy of the estimates. Attachment 4 lists the components and construction activities necessary for closed-loop operation, providing a high level of detail to the conceptual design estimation.

Three estimation techniques were used to determine the initial capital costs:

(1) Vendor provided budgetary estimates

Industry leading vendors were contacted for quotations on the major equipment and material components to allow for as accurate an estimation as possible, with the correspondence, reference material, and quotations provided in Attachment 1.

(2) Third-party detailed construction estimates

Since tunneling from the Mesa Complex to the Coastal Complex required a unique engineering solution, a nationally recognized consultant was used to determine a conceptual design, cost, and schedule for tunneling construction (Attachment 2). Spoils disposal was estimated in the tunneling evaluation at a subcontractor rate of $15/ton. The listed subcontractor rate was also used to estimate the cost of additional spoils disposal from cooling tower and circulating water reservoir excavation.

(3) Computational estimation utilizing national production rates and cost factoring

Remaining cooling equipment and construction activities were estimated using Craftsman Book Company's 2009 National Construction Estimator software. The 2009 National Construction Estimator is a construction cost estimating database that provides detailed cost estimates for the construction industry including piping, concrete, industrial equipment, electrical systems, and other heavy construction components.

The capital cost estimate contained in Attachment 4 combines these resources to produce a conceptual analysis of cost and schedule duration. The major cost centers were defined and presented in line item format in order to provide flexibility in the application of cost. Some of these line items would be equally shared by both Units 2 and 3 as several of the required construction activities would be common between both units. If separated, these common costs would not simply be cut in half. An engineering, design, and inspection cost adder of 15% was added to estimates which were not quoted for turn-key construction [Ref. 8.85].

The anticipated direct capital cost (presented in 2009 US dollars) for the conversion for both SONGS Unit 2 and Unit 3 is collectively estimated at a minimum of $492 million without contingency application or any escalation over time. Application of the recommended contingency would add an additional $123 million (based on 25% for conceptual estimates [Ref. 8.85]). The escalation of cost over the project schedule was not calculated as part of this report but would represent a significant increase when calculated over the anticipated duration of approximately 5 years. Total estimated direct capital costs for the conversion are thus $615 million.

5.2.2 Construction Outage Costs

From the construction schedule discussed in Section 5.1 and detailed in Attachment 4, SONGS Units 2 and 3 would require approximately 18.7 months of continuous outage for the construction and implementation of closed-loop cooling. Beginning in 2012, each unit will have a planned refueling outage lasting 45 days occurring every two years. Subtracting the planned refueling outages from the construction outage duration, each unit would require a non-planned construction outage of approximately 21.1 months. Since Unit 2 and Unit 3 generate a net electrical output of approximately 1070 MWe and 1080, respectively, a 21.1 month construction outage would result in approximately 16,481,000 MWhr and 16,635,000 MWhr of lost electrical generation, respectively. Assuming a projected cost of electricity of $73.30 per MWhr (see Attachment 1, Section 5), the aggregate outage cost for conversion of SONGS to closed-loop cooling would be approximately $2.4 billion.

As noted in Section 5.1.2, the estimated schedule represents a best-case scenario, and does not take into account any impacts that could occur from outside forces.

5.2.3 Costs Due to New Condenser Operating Parameters

As discussed in Section 4.2, SONGS is water-dependent, requiring a specific quantity of cooling water at a specific design temperature, here consistently cold seawater. Below this design temperature SONGS has the capability of marginally increasing its electrical production; however, above this design temperature SONGS produces significantly less electricity and could ultimately impact its low pressure turbine procedural limit. To analyze the effect closed-loop cooling would have on SONGS electrical generation a state-of-the-art PEPSE model for each unit was used. As discussed in Section 4.2, the annual average continuous operational losses for Units 2 and 3 were determined to be 36.7 MWe and 36.8 MWe, respectively.

Since closed-loop cooling performance is reliant on the ambient meteorological conditions, operational losses vary based on seasonal temperature at SONGS. Since a static standard cost of electricity is applied, the variability in operational losses does not alter the cost determination (i.e., the average cost per MWhr is applied to the average power loss). Utilizing a $73.30 per MWhr projected cost of electricity and a generating capacity factor of 90%, closed-loop cooling operational losses would cost SONGS approximately $42 million per year.

5.2.4 Parasitic Losses (Costs) Attributable to New Components

As discussed in Section 4.3, the equipment necessary to operate closed-loop cooling at SONGS would require significant input electricity, referred to as parasitic losses. Cooling tower parasitic losses would include those from cooling tower equipment and the additional recirculating water pumps and booster pumps necessary to supply circulating water to the cooling towers. Closed-loop conversion of SONGS utilizing hybrid cooling towers located on the Mesa Complex would require a continuous 34.8 MWe per unit aggregate parasitic loss. Utilizing a $73.30 per MWhr projected cost of electricity and a generating capacity factor of 90%, closed-loop cooling parasitic losses would cost SONGS approximately $40 million per year.

5.2.5 Support and Maintenance Costs

Additional operations and maintenance costs for the components necessary to convert SONGS to closed-loop cooling are estimated by identifying the major tasks for each component, and then based on operational experience and input from vendors, quantifying the estimated required man-hours and associated costs.

Due to the large number of active components, as well as the sheer size of the towers and their hot water distribution system, appreciable support would be required. The anticipated manpower required for support of each unit's cooling towers is approximately $301,000, and is detailed in Attachment 4 – Table 4-2.

In addition substantial maintenance would be required for cooling tower operation. The detailed monthly, quarterly, and annual labor and material maintenance requirements are listed in Attachment 4 – Table 4-3, and total $750,000 in years 1-5, $1,250,000 in years 6-15, and $2,250,000 in years 16-20 for each unit.

Maintenance of the new circulating water pumps are not considered an additional closed-loop cost as the new pumps would operate at the same flow rate and head as the existing pumps, and would therefore be captured by the current maintenance program. Maintenance cost of the new recirculating water and booster pumps is separated into long-term rehabilitation and replacement costs. Rehabilitation costs for major equipment are estimated to be 35 to 45 percent of replacement costs depending on the condition of the equipment. It is likely only the pumps and motors would be replaced in kind; therefore, the replacement cost should include all engineering and structural modification costs as well as the equipment costs [Ref. 8.84].

Based on an assumed operating life of 20 years, it was estimated that one of the recirculating water pumps (approximately $4,400,000/pump) and four of the booster pumps (approximately $8,000/pump) would require rehabilitation or partial replacement. Maintenance of each unit's closed-loop cooling startup and makeup pump is not accounted for due to the unknown usage factor and limited operational flowrate, respectively. Hence, on an average annual basis over the assumed 20 year life span, pumping maintenance costs would be approximately $220,000/year per unit.

As discussed in Section 4.5, additional chemicals would be injected into the makeup circulating water to prevent micro and macro fouling of the main condenser and cooling towers. The current water quality maintenance system is installed to service the main condensers periodically, and would require additional operational support to provide continuous service as well as inject other effluent streams. To control micro and macro fouling, approximately 60 gallons of commercial bulk sodium bisulfite would be required each day to adequately dechlorinate. This would result in an additional water treatment cost of $150,000/year per unit.

Summary of Additional Support and Maintenance Cost (per year, SONGS total cost)

To support the equipment necessary for continuous closed-loop operation, significant operation and maintenance would be incurred. Below is a summation of these annual costs including labor and material for the hybrid cooling towers, recirculating and booster pumps, and water treatment.

Years 1 - 5	$2,842,000/year
Years 6 - 15	$3,842,000/year
Years 16 - 30	$5,842,000/year

6 Environmental Impacts / Permitting Requirements

There would be several potential environmental impacts and regulatory challenges associated with conversion to closed-loop cooling resulting from retrofit construction activities, system modifications, disruption of operations, permitting amendments, and operation of a closed-loop cooling system. Evaluations of the closed-loop cooling issues at SONGS are provided in the following sections and briefly discuss identified regulatory issues, applicable regulations, potential impacts related to cooling system conversion, and potential costs.

Several air quality considerations would need to be evaluated with respect to the installation of cooling towers at SONGS. Direct emissions from construction would increase emissions of ozone precursors from worker vehicle emissions. Direct emissions from operation of the cooling towers would result in atmospheric salt plume drift, plume visibility impacts, emissions (i.e., PM_{10} and $PM_{2.5}$) and vapor. Indirect emissions, including criteria pollutants and greenhouse gas emissions, would result from the need to replace an annual average power generation loss of approximately 143 MWe. If that generating capacity was assumed to be replaced by a natural gas facility, an estimated additional 227,000 tons per year of CO_2 would be emitted to the atmosphere.

Cooling tower drift impacts would likely be significant as between 827.8 and 837.2 tons of PM_{10}, depending on the local salinity of the Pacific Ocean, would be emitted per year by SONGS in closed-loop operation. San Diego County is currently designated by the California Air Resources Board as non-attainment for PM_{10} and $PM_{2.5}$. A major-source Title V air permit would be required from the San Diego County Air Pollution Control District. It is unlikely that SONGS could locate and purchase a sufficient number of PM_{10} emission credits to cover these emissions. Due to the limited availability of PM_{10} emission credits and large variability in price, a cost for obtaining the necessary PM_{10} credits has not been estimated. If PM_{10} credits were to be available, the cost of converting SONGS to closed-loop cooling would increase significantly to include their purchase. Additionally, approximately 165 tons of salt would be deposited downwind of the proposed cooling towers extending across the SONGS Coastal Complex area, and may also occur across the nearby Camp Pendleton housing areas to the northeast. Salt deposition across the coastal scrubland habitat could cause adverse impacts to vegetation and occupied habitat.

Various permits, including a Coastal Development Permit, would be required for the conversion of SONGS from once-through cooling to closed-loop cooling. All of these permits would be acquired in accordance with regulatory public participation requirements, which would likely incur intense public opposition due to project cost, adverse aesthetic/visual impacts, air emissions, traffic, and potential ecological impacts. California Public Utilities Commission approval would also be required for recovery of the closed-loop cooling system conversion cost from the ratepayers as well as the ongoing annual costs. Additionally, it should be noted SCE does not own the land on which SONGS is located, and as such, all construction activities necessary for conversion to closed-loop cooling would need to be approved by Marine Corps Base Camp Pendleton. Failure to receive approval from any of these agencies would render the construction and operation of closed-loop cooling at SONGS infeasible.

6.1 Air Quality Considerations

The Federal Clean Air Act (CAA) (USC § 7401) requires the adoption of National Ambient Air Quality Standards (NAAQS) to protect the public health, safety, and welfare from known or anticipated effects of air pollution. The NAAQS are occasionally updated, and current standards are set for criteria pollutants SO_2, CO, NO_2, O_3, PM_{10}, $PM_{2.5}$, and Pb. The EPA has designated all areas of the United States as either "attainment," "nonattainment," or "unclassified" with respect to the NAAQS. An attainment designation means that the air quality of the area is better than the NAAQS. A nonattainment designation means that a primary NAAQS has been exceeded more than three separate times in three years in a given area. An area is designated as unclassified when sufficient data are not available to classify it as either attainment or nonattainment. If an area is redesignated from nonattainment to attainment, the CAA requires a revision to the State Implementation Plan (SIP), called a maintenance plan, to demonstrate how the air quality standard would be maintained for at least ten years.

The California Air Resources Board (CARB) has the authority to enforce regulations to both achieve and maintain the NAAQS. CARB has established additional standards, known as the California Ambient Air Quality Standards (CAAQS), which are generally more stringent than the NAAQS. CARB is responsible for the development, adoption, and enforcement of the state's motor vehicle emissions program, as well as the adoption of the CAAQS. CARB also reviews operations and programs of the local air districts and requires each air district with jurisdiction over a nonattainment area to develop its own strategy for achieving the NAAQS and CAAQS. The local air district has the primary responsibility for the development and implementation of rules and regulations designed to attain the NAAQS and CAAQS, as well as the permitting of new or modified sources, development of air quality management plans, and adoption and enforcement of air pollution regulations. CARB, similar to the EPA, designates areas as either "attainment" or "nonattainment" based on compliance or noncompliance with the CAAQS. CARB considers an area to be in nonattainment if the CAAQS have been exceeded more than once in three years.

The San Diego Air Pollution Control District (SDAPCD) is the agency responsible for protecting public health and welfare through the administration of federal and state air quality laws and policies within the San Diego Air Basin (SDAB). Included in the SDAPCD's tasks are the monitoring of air pollution, the preparation of the San Diego County portion of the SIP, and the promulgation of rules and regulations. The SIP includes strategies and tactics to be used to attain and maintain acceptable air quality in the county; this list of strategies is called the Regional Air Quality Strategies (RAQS). SDAPCD regulations require that any equipment that emits or controls air contaminants be permitted (Permit to Construct or Permit to Operate) prior to construction, installation, or operation. The SDAPCD is responsible for review of applications and for the approval and issuance of these permits.

The status of state and federal designations for San Diego County as of the 2007 annual report are listed in Table 6.1 [Ref. 8.2; Ref. 8.39].

Table 6.1 Air Quality Designations in San Diego County 2007

Category	Federal Designation	State Designation
Ozone (1-hour)	Attainment	Nonattainment

Category	Federal Designation	State Designation
Ozone (8-hour)	Nonattainment	Nonattainment
Carbon Monoxide	Attainment	Attainment
PM_{10}	Unclassifiable	Nonattainment
$PM_{2.5}$	Attainment	Nonattainment
Nitrogen Dioxide	Attainment	Attainment
Sulfur Dioxide	Attainment	Attainment
Lead	Attainment	Attainment
Sulfates	(no federal standard)	Attainment
Hydrogen Sulfide	(no federal standard)	Unclassifiable
Visibility	(no federal standard)	Unclassifiable

As noted in Table 6.1, the SDAB currently meets the federal standards for all criteria pollutants except 8-hour O_3 and meets state standards for all criteria pollutants except 1-hour and 8-hour O_3, PM_{10}, and $PM_{2.5}$. SDAB was designated as an O_3 attainment area on July 28, 2003, and a maintenance plan was approved. On April 15, 2004, the EPA issued the initial designations for the 8-hour O_3 standard, and the SDAB was classified as "basic" nonattainment. Basic is the least severe of the six degrees of O_3 nonattainment. The SDAPCD submitted an air quality plan to the EPA in 2007; the plan demonstrated how the 8-hour O_3 standard would be attained by 2009. The SDAB is currently classified as a state "serious" O_3 nonattainment area and a state nonattainment area for PM_{10} and $PM_{2.5}$. The SDAB currently falls under a federal "maintenance plan" for CO, following a 1998 re-designation as a CO attainment area [Ref. 8.2].

Plume visibility impacts would also need to be considered, particularly with respect to the proximity of Interstate 5, located between the SONGS Coastal Complex and the cooling tower sites on the SONGS Mesa Complex, as well as impacts on the adjacent MCBCP.

There would be no greenhouse gas emissions directly attributable to the operation of the closed-loop cooling system described in Section 3. All greenhouse gas emissions considered are based on replacing any power lost with power generated by an offsite natural gas-fired generating unit.

6.1.1 Atmospheric Salt Plume Drift

Cooling tower drift is defined as circulating water that is entrained in the exhaust air stream and emitted from a cooling tower. Air emissions typically result from entrainment of liquid water in the air stream which is carried out of the tower as drift droplets. Drift in the exiting airflow can be reduced with various types of drift eliminators.

Drift droplets are water droplets that may contain dissolved and/or suspended solids that are entrained in the air and emitted from the cooling tower stack. Generally the concentration of the dissolved solids in the drift is the same as that in the circulating cooling water. Particulate matter <10 microns in diameter (PM_{10}) forms when cooling tower drift evaporates to form salt crystals. Drift becomes regulated as the criteria pollutant PM_{10} when the liquid droplets evaporate to form crystals.

The conceptual cooling tower design for SONGS Units 2 and 3 would result in an expected 4.2 gpm of cooling water loss from each unit through drift, as calculated in Section 4.4. Since sea water would be used as the coolant, loss of coolant water to plume drift in droplet form would also result in loss of entrained salt that would impact surrounding structures and vegetation.

The following calculations have been developed to estimate the quantities of salt that would be released in cooling tower drift.

Circulating Water Quality:

Cycles of Concentration = 1.5

Salinity of Ocean Water = 33.2 to 33.7 parts per thousand (ppt) [Ref. 8.32]

Salinity of Drift = 49.8 to 50.55 ppt ≈ 0.416 to 0.422 lb/gal

Salt Loss Per Unit:

Drift Rate = (0.0005%) (830,000 gpm) = 4.2 gpm

Salt in Drift = (4.2 gpm) (0.416 to 0.422 lb/gal) ≈ 1.75 to 1.77 lb/min

Maximum Annual Salt Loss per Unit:

(24 hr/day) (60 min/hr) (365 day/yr) (90% generating capacity factor)

= (473,040 min/yr) (1.75 to 1.77 lb/min)

= 827,820 to 837,281 lb/yr

= 413.9 to 418.6 tons/year

Maximum Annual Facility Salt Loss:

(413.9 to 418.6 tons/year) (2 Units) = 827.8 to 837.2 tons/year

Wind speed and direction information collected by the onsite meteorological tower was used to evaluate potential depositional data from the conceptual design location for cooling towers. The wind rose for SONGS (Attachment 5, Figure 5-10) shows the dominant wind direction for the period 2004-2008 to be from the north-northeast and the dominant wind speed to be in the range of 2 to 4 m/s (4.4 to 8.8 miles/hour). Winds are from the north-northeast and toward the SONGS Coastal Complex area and switchyard approximately 20 percent of the time.

Given the dominant wind direction from the north-northeast, approximately 20 percent of the total calculated salt deposition, or between 165.6 and 167.4 tons of salt, would be deposited downwind (south-southwest) of the proposed cooling towers. Deposition of this drift volume would be over Interstate 5, the railroad tracks, and the SONGS Coastal Complex and switchyard.

As discussed in Section 6.4.4, there are no Critical Habitat areas within three miles of the Mesa Complex. However, the habitat surrounding SONGS that would receive most of the salt deposition is occupied habitat for endangered species such as the California gnatcatcher. In addition, the cooling towers would be located in close proximity to much of San Onofre State Beach and the new MCBCP housing.

6.1.2 Plume Visibility Impacts

As indicated in Figure 5-10 of Attachment 5, wind patterns would cause drift and vapor plume to be driven toward Interstate 5 a significant portion of the time. Section 3.1.1 discusses the plume abatement recommended for SONGS Units 2 and 3. Plume-abated hybrid cooling towers represent current state-of-the-art technology with respect to abatement of a visible vapor plume. These towers would greatly reduce the potential for plume formation that could impact traffic flow on Interstate 5 or MCBCP facilities and activities. Similarly, these towers would significantly reduce the potential visibility impacts on the adjacent (west) coastline. As noted in Section 3.1.1, a visible plume would occur less than one percent of the time when utilizing linear hybrid cooling towers at SONGS; however, a plume generated even less than one percent of the time would have the potential to drift towards Interstate 5 and impact commuter visibility. Any impact to commuter visibility would decrease public safety and increase SONGS liability.

Federal air quality regulations address visibility impairment in terms of regional haze. Regional haze is visibility impairment produced by a variety of sources and activities that emit fine particles and their precursors and that are located across a broad geographic area [Ref. 8.40]. Visibility impacts are measured in terms of deciviews, an atmospheric haze index that expresses changes in visibility [Ref. 8.40]. The referenced federal visibility regulations further require states to take steps to reduce emissions of nitrogen oxides, sulfur oxides and fine particulates, particularly with respect to emissions of these pollutants in aerosol form. Conversion of SONGS to closed-loop operation would be contingent on satisfying requests for documentation (visibility reduction expressed in deciviews) of the impact of cooling tower installation on any Clean Air Act Class I areas (national parks and wilderness areas) within 50 miles of the facility.

6.1.3 Greenhouse Gas Emissions

As discussed in Section 4, power losses from Units 2 and 3 due to operation of the closed-loop cooling system would total approximately 143 MWe (annual average) due to reduced thermal efficiency, pumping requirements, and cooling tower power requirements. Replacing this lost power would likely result in additional greenhouse gas emissions from fossil fuel powered (coal, natural gas, or diesel fuel) generating sources, including emissions of nitrogen oxides (NOx), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs) and fine particulate matter (PM_{10}). The levels of these pollutants would vary, depending on the specific fuel(s) used to generate this replacement power.

Table 6.2 summarizes indirect greenhouse emissions in the event 143 MWe were to be replaced with electricity generated by combustion of natural gas or distillate oil. Emission rates are shown on a per hour basis in pounds/hour (lb/hr) and tons/year (T/yr)[8], prior to controls. The emissions shown below are based on AP-42 emission factors [Ref. 8.87, Table 3.1-1].

[8] Short tons based on a 90% generating capacity factor.

Table 6.2 Greenhouse Gas Emissions from Replacement of Parasitic Power Loss

Pollutant	Emissions (lb/hr)	Emissions (T/yr)
Natural Gas:		
NOx	156.0	615.0
CO	40.0	157.7
SO_2	1.6	6.3
VOCs	1.0	3.9
PM	3.2	12.6
CO_2	53,633.2	211,422.1
Diesel Fuel:		
NOx	429.1	1691.5
CO	1.6	6.3
SO_2	1.6	6.3
VOCs	0.2	0.8
PM	5.9	23.3
CO_2	76,549.2	301,756.9

It should be noted that the emissions calculated in Table 6.2 do not include anticipated emissions from construction. Additional greenhouse gas emissions would be generated during the modification of the plant systems, excavation and disposal of soils and construction debris, and construction of the cooling towers and associated systems. Construction emissions would result from excavation equipment and vehicles used for material transportation, in addition to emissions from construction worker vehicles. Additional unexpected emissions could result from traffic congestion from site workers, outage workers, construction vehicles, and excavated materials transport occurring over the construction period. The emissions from these construction sources could be significant, but localized, and would cease after construction was completed; however, closed-loop conversion would be contingent on obtaining a construction air permit for these activities.

6.1.4 Permitted Emissions

The EPA has designated San Diego County as being in non-attainment status for the 8-hour ozone standard and unclassifiable for PM_{10}. The state of California classifies San Diego County as being in non-attainment status for both the 1-hour and 8-hour ozone standards, particulate matter (PM_{10} and $PM_{2.5}$) and unclassifiable for hydrogen sulfide and visibility [Ref. 8.2].

Operation of cooling towers at SONGS would result in emissions of PM_{10} and $PM_{2.5}$ (water vapor and drift) and would potentially impact visibility. If SDAPCD required SCE to obtain air quality permits for these facilities it would be necessary to conduct a New Source Review (NSR) of the impacts of particulate emissions on ambient air quality prior to construction of the cooling towers. Computer dispersion modeling conducted as part of the NSR process would likely show a localized increase in ambient fine particulate levels in the immediate vicinity of the cooling towers. As noted above, SDAPCD is already designated non-attainment by the state of California for PM_{10} and $PM_{2.5}$. Visibility issues associated with cooling tower generated plumes would also have to be addressed for permitting purposes. Additional drift offset or mitigation measures could be required by the regulatory authority, given the SONGS coastal location and surrounding cultural features. If available, drift offset costs would likely be substantial. If SONGS were required to obtain air quality permits, upon completion of cooling tower construction, an operating permit application would have to be submitted to the SDAPCD, per the District's Rule 1410 [Ref. 8.65, Regulation XIV, Rule 1410] in order to obtain an air quality operating permit.

Based on the salt loss calculations shown in Section 6.1.1, a significant tonnage of PM_{10} emission reduction credits (between 827.8 and 837.2 T/yr) would have to be purchased. Review of cost data for 2007 [Ref. 8.8] indicates that a total of 402.73 tons of PM_{10} emission reduction credits were purchased in California during that year, where costs ranged from $49/T to $1,293,151/T. The average cost was $97,442/T and the median cost was $43,000/T. Total PM_{10} purchases in the SDAPCD were 0.3 tons at a cost of $100/T. Based on this cost data and the relatively small number of tons purchased in 2007, both in the district and throughout the state, it is unlikely that SONGS could locate and purchase a sufficient number of PM_{10} credits to cover this volume of emissions. Conversion of SONGS to closed-loop cooling would be infeasible if the required drift offsets were not available. It should be noted that due to the limited availability of PM_{10} emission credits and large variability in price, a cost for obtaining the necessary PM_{10} credits has not been estimated. If PM_{10} credits were to be available, the cost of converting SONGS to closed-loop cooling would increase significantly to include their purchase.

6.1.5 Vapor

Although closed-loop cooling towers at SONGS Units 2 and 3 would be of the plume-abatement type, significant vapor loss would still be anticipated, even if plumes were rendered completely invisible. Cooling towers continuously release water vapor and a small amount of liquid into the air. This vapor loss consists of pure water and is a result of evaporation. Per Section 4.4, water vapor loss would be approximately 12,616 gpm per unit. Since the water vapor released would be in pure form it would not represent the hazard to vegetation and structures over time that losses due to drift (salt water) would represent. This vapor/fine droplet release would need to be included in $PM_{2.5}$ and PM_{10} emission calculations for air permitting purposes.

6.2 Wastewater Discharge Considerations

A basic description of the operational differences pertaining to cooling water, and more specifically, the wastewater released from the cooling systems is provided in this introduction.

In the OTC system used currently, sea water is brought in from the ocean and passes through a series of trash racks and screens that remove debris and prevent fish and shellfish from entering the cooling system. Specialized fish return systems are used to collect and return aquatic organisms to minimize the impacts on the marine ecological communities. As described in Section 2.2.1, the normal operation requirements of the OTC circulation water system, with four circulating water pumps running for condenser cooling, are 830,000 gpm for each unit. Normal operating requirements of the Saltwater Cooling system are up to 34,000 gpm, with two SWPs in operation. As the relatively small capacity (2500 gpm) screen wash pumps only supply process water and operate intermittently, immediately returning much of their flow to the intake structure, the flow requirements of the screen wash system are not considered. Therefore, the total licensed design flow for each SONGS unit is 864,000 gpm.

The NPDES permit limits pollutants and temperatures of wastewater discharges back into the ocean. In the circulating water discharge there is some plate-out of salts, minerals, and aquatic organisms which cause scale formation and fouling of heat transfer surfaces. The various chemicals injected to reduce the negative effects of fouling are minimized to comply with the release limits of the NPDES permit. As discussed in Section 4.5.2, the NPDES permit also limits whole effluent toxicity, total residual chlorine, toxic pollutants, residual heat, total suspended solids, oil, grease, wastewater flow, pH, non-carcinogenic pollutants, carcinogenic pollutants, and metal cleaning wastes. Chemicals added to the system would be required to meet the needs of SONGS's systems and also meet these limits for release, or the NPDES permit would require modification.

In a closed-loop cooling system, several operational changes would affect the cooling water returned to the ocean as wastewater. As described in Section 3.6, multiple changes to the circulating water system would be required for conversion to a closed-loop cooling system. After being sent through the condensers, the cooling water would be sent to the new hybrid cooling towers where the water would be cooled, and returned to the condensers. Since hybrid cooling towers rely on evaporative cooling to decrease the circulating water temperature, a small portion of the circulating water would evaporate in the hybrid cooling tower. As shown in Section 4.4, the evaporation rate would be approximately 12,616 gpm for each unit. Small volume losses would also occur due to tower drift; approximately 4.2 gpm per unit.

The closed-loop system at SONGS would require approximately 37,848 gpm of makeup water flow for each unit. Closed-loop cooling systems concentrate the chemicals, minerals, and salts found in the source water body (Pacific Ocean) with each cycle of concentration. The ocean water that is not sent back to the condenser for reuse or lost to evaporation and drift is discharged back to the ocean and is referred to as blowdown.

6.2.1 Cooling Tower Blowdown

Blowdown wastewater is the water returned from the cooling towers to the ocean. As shown in Section 4.4, the blowdown flow would be approximately 25,228 gpm for each unit.

With a closed-loop cooling system, water treatment requirements are dramatically increased. The cooling tower fill is subject to fouling, as are the dry heat exchanger sections. Both the quantities and frequency of biocide injections must be increased significantly to maintain the tower fill in proper condition. Additionally, increased water treatment is necessary due to the higher concentrations of dissolved solids, chemicals, and biological agents in the system resulting from constant recirculation of the condenser cooling water. The cooling towers act as air washers as well as distilleries, constantly evaporating large quantities of water and leaving behind the nonvolatile residues. The actual concentrations of these agents is based in part on the number of cycles of sea water and potential fouling conditions, as discussed in Section 4.4.1 and 4.5.

The operating conditions for the cooling towers at SONGS would limit recycle rates to 1.5 cycles of concentration. This limitation would be necessary due to the high concentration of salts and minerals found in the ocean water. With a starting salinity of 33.2 to 33.7 ppt for the ocean water and combining with 1.5 cycles of concentration, the blowdown wastewater being returned to the ocean would be approximately 49.8 to 50.55 ppt. The majority of chemicals, salts, metals, and minerals concentrate in the evaporative cooling process. Blowdown wastewater discharge to the ocean would be required to meet the NPDES limits.

Although the current NPDES permits for Units 2 and 3 do not have salinity or total dissolved solids (TDS) limits, the concentration of salinity could pose a localized impact on marine life in the immediate area around the discharge structures due to higher TDS. Plant effluent salinity increases to approximately 49.8 to 50.55 ppt could require an anti-degradation analysis and potential discharge structure modification to achieve greater dilution over a greater area of the ocean. The blowdown discharge salinity would be a factor for modification of the NPDES permit.

If converted to closed-loop cooling as described in Section 3, the blowdown discharge temperature would be dependent on the ambient wet-bulb temperature. The cooling towers were designed such that under worst case conditions (defined as a wet-bulb of 75°F) the blowdown discharge would be 90°F. The SONGS Units 2 and 3 NPDES permits require that the maximum temperature of thermal discharges from Units 2 and 3 not exceed the natural temperature of the receiving waters by more than 25°F ($\Delta T \leq 25°F$). The NPDES permit [Ref. 8.22] states that the mean surface temperature of the ocean near the site varies from 73°F in August to 56°F in January. Under worst case conditions, it is possible the $\Delta T \leq 25°F$ limit imposed by the NPDES permit could be exceeded, even if only briefly.

6.2.2 NPDES Permit Modification

NPDES permits specify the limits for release of wastewater to the ocean. The current NPDES permits for SONGS Units 2 and 3 are NPDES Permit Nos. CA0108073 and CA0108181 [Ref. 8.22]. 40 CFR 122.44(d) requires that the permits include water quality-based effluent limits. These permits are also required to use the USEPA criteria guidance provided under the Clean Water Act Section 304(a). New permit modification applications would need to be submitted to the California Water Resources Board and would need to consider system modifications, operational programs, and procedures associated with the installation and operation of cooling towers at SONGS. Additionally, the new permit modification applications would need to estimate the effluent pollutant concentrations and thermal discharge characteristics. The NPDES permits also limit whole effluent toxicity, total residual chlorine, toxic pollutants, residual heat, total suspended solids, oil, grease, wastewater flow, pH, non-carcinogenic pollutants, carcinogenic pollutants, and metal cleaning wastes. Chemicals added to the system would be required to meet the needs of the plant systems and also meet these limits for release. The feasibility of closed-loop cooling would depend on the ability of SONGS to meet these NPDES permit limits.

6.3 Solid Waste Generation

Suspended solids in the circulating water would accumulate over time in the cooling tower basins, circulating water basins, and circulating water piping. Periodically, the accumulated solids would need to be removed and disposed of at an offsite landfill. The quality of the material removed is highly dependent on the nature of the intake water, the chemicals used for cooling tower maintenance, and the materials used for construction. In addition to the solid waste sludge that would need to be periodically removed from the closed-loop cooling system, there would be a large one-time generation of waste material during construction activities. Both periodic and one-time closed-loop waste streams are discussed in this section.

6.3.1 Solid Waste Generated from Construction Activities

The site preparation and digging required for the installation of cooling tower basins and new circulating water lines would involve the disturbance and disposal of large amounts of soil. In some situations, the soil could be contaminated with oil or other organic substances from prior use. If soil contamination is present, spoils generated from conversion to closed-loop cooling would present an additional cost for retrofit operations.

6.3.1.1 Tunnel Construction

Tunnel construction is discussed in Sections 3.2.4, 3.5, and 5.1.1. The most significant solid material generated during closed-loop conversion of SONGS Units 2 and 3 would come from the construction of the eight tunnels required to circulate cooling water between the condensers and the cooling towers. As described in Section 3.2.4, tunnel construction would require the excavation of approximately 195,820 cubic yards of sandstone and alluvium. As discussed in Section 5.1.1, the material excavated from tunneling activities would likely be non-contaminated and could possibly be reused as fill or building materials (i.e., sand, gravel, rock). The material could also be spread onsite; however, due to land use constraints, transporting and disposing of the material offsite would most likely be required. The material would be expected to meet non-contaminated fill material criteria and available disposal sites would have to be found to receive the material.

6.3.1.2 Other Construction Activities

As discussed in Section 3.2.4, the total amount of excavation materials is estimated to be as much as 297,210 bank cubic yards of sandstone and alluvial material, including the tunnel spoils discussed above. As discussed in Section 6.3.1.1, some of this material could be suitable for fill, but would likely require an offsite disposal location which would need to be identified. Other types of non-hazardous solid waste would include scrap building materials, debris from the removal/relocation of existing structures/equipment that would be impacted by the conversion to closed-loop cooling, and general trash that would be generated during construction. The amount of these materials would vary during the construction but this waste stream would cease after construction was complete. A limited amount of hazardous material could potentially be generated during construction. The facility does maintain a hazardous waste permit; however, disposal under this permit would require additional cost for the proper tracking and disposal of hazardous materials.

6.3.2 Solid Waste Generated from Operations

Salt, water treatment chemicals, and other suspended solids in the circulating water would continuously accumulate in the cooling tower basins, circulating water basins, and circulating water piping throughout closed-loop cooling operation. The volume of solid waste sludge accumulated would depend on the salinity of the intake water, the cycles of concentration, and the water treatment processes used to maintain cooling tower operation and meet discharge regulations. Periodically, the accumulated solids would be removed and transported to a disposal facility. In addition to solid waste removed from the circulating water system, additional sludge may need to be removed from any required water treatment equipment, such as brine concentrators, side-stream softeners or other blowdown reduction processes.

Waste solids generated from cooling tower operations would be non-hazardous and could likely be disposed at a local offsite landfill. The material would likely be in a sludge form once removed from the basins and would either require dewatering before transportation offsite for disposal or would be solidified at the disposal facility; however, solidification would be significantly more expensive. Wastewater generated from dewatering would likely be discharged with the cooling water waste stream as part of the amended NPDES permit, discussed in Section 6.2. Solid waste generated by closed-loop cooling operation would continuously impact SONGS operations, requiring periodic offsite disposal of accumulated suspended solids over the entire lifespan of the closed-loop cooling system.

6.4 Habitat and Species Impacts

If converted to closed-loop cooling, the plant liquid effluent would be more concentrated, resulting in higher salinity and total dissolved solids. Modifications to the discharge structure to accommodate the decreased flow rate could be required to address salinity and thermal issues (see Section 3.6); however, offshore construction could disrupt aquatic resources.

In addition, closed-loop cooling would impact terrestrial resources during both construction and operations. Likewise, noise associated with construction and operation of closed-loop cooling would pose additional impacts. Utilizing cooling towers could have deleterious effects on terrestrial habitats adjacent to the site due to salt deposition. Potential impacts to species and habitat could occur to the coastal California gnatcatcher habitat immediately adjacent to the site. Additionally, arroyo toad and least Bell's vireo habitat could also be affected by salt deposition from the plume.

6.4.1 Aquatic Resources

SONGS's two generating units draw in approximately 1.7 million gallons of ocean water per minute to condense non-radioactive main steam. The SONGS once-through cooling system has existing technologies currently in place that reduce impingement mortality by an estimated 94.2% in terms of finfish numbers and 97.7% by weight. These reductions are at the high end of the 80%-95% reduction range required by the now suspended CWA 316(b) Phase II Rule. Impingement mortality reduction is achieved through the use of an offshore intake with a velocity cap combined with an on-shore fish return system (FRS). In addition to modifications to the intake structures, SCE committed to restore 150 acres of coastal wetland, costing $86 million. This acreage was determined by the California Coastal Commission (CCC) to be sufficient to offset entrainment losses of Units 2 and 3. The restoration plan was developed and approved by the CCC in compliance with conditions stated in the Coastal Development Permit for the facility [Ref. 8.70].

6.4.1.1 Construction Impacts to Aquatic Resources

SONGS currently has two functional intake and discharge systems. As discussed in Section 3.6, no modification of the cooling water intake structure would be anticipated beyond the replacement of the circulating water pumps. Discharge structure modification could be required to ensure adequate dilution of all plant effluents. The most likely impacts on the marine environment would be from dust or stormwater runoff due to construction of the cooling towers. Conversion of SONGS to closed-loop cooling would require that dust and stormwater runoff effects be mitigated through SONGS' existing programs and standard construction Best Management Practices (BMP).

6.4.1.2 Operational Impacts to Aquatic Resources

As described in Section 6.2, the cooling tower blowdown could create adverse impacts to the marine environment and aquatic resources. These identified impacts would result from higher than ambient salinity of the blowdown discharge and the potential for exceeding the NPDES thermal discharge limits.

Giant kelp is a species of marine brown alga found along the Pacific coast of North America from central California to Baja California. The closest stand of Macrocystis is the San Onofre kelp bed, 656 feet down-coast of the Unit 2 diffusers at a depth of about 40 to 50 ft. The aerial extent of a kelp bed canopy is highly variable. In 1990, canopy measurements of the kelp bed varied from zero to 76.3 hectares; however, since 1966, the canopy has averaged 11.7 hectares [Ref. 8.70]. Warmer water temperatures tend to negatively affect kelp survival as does pollution and coastal development. Human influences on giant kelp tends to be greater in southern California due to the concentration of the State's population within this region [Ref. 8.70], which may contribute to variations in the size of the kelp canopy.

Over 170 acres of artificial reef have been created in the nearby waters by SCE as mitigation for kelp losses due to increased turbidity in the area of San Onofre kelp bed resulting from discharge operations at SONGS [Ref. 8.70]. High salinity brine discharges have been indicated to be toxic to certain aquatic communities, potentially including but not limited to kelp and sea urchins. Most studies of salinity impacts on marine ecologies have focused on lower than ambient salinity impacts, but little research has been conducted on higher salinity discharges. One recent study indicated that salinity increases within 10 percent of ocean ambient appeared to have no adverse impact on kelp spores, but did have an observed adverse impact on sea urchin development [Ref. 8.79]. Thus, there would be a potential for adverse impacts of the cooling tower blowdown on marine organisms. There could also be impact from drift deposition on the near-shore area around SONGS. Both drift deposition and blowdown discharges could require additional research and modeling to ensure the impacts are localized.

6.4.2 Terrestrial Resources

Description of terrestrial vegetation near SONGS by Odgen [Ref. 8.59] indicated the portion of the San Onofre State Park immediately south of SONGS consists of disturbed coastal sage scrub habitat that occurs in small areas that have been trampled or cleared by former activities. Non-native herbaceous species such as mustard (Brassica sp.) have invaded these areas in substantial amounts. Sage scrub regeneration in these areas is evident with scattered young specimens of coyote brush and California sagebrush [Ref. 8.59].

Much of the lands on which cooling tower construction would take place have already been significantly altered. This ruderal habitat near the site contains nonnative plant species including mustard, brome grass (Bromus spp.), tocalote (Centaurea melitensis), and the naturalized giant coreopsis (Coreopsis gigantea) [Ref. 8.59].

Diegan coastal sage scrub is the predominant native vegetation association immediately south of SONGS. The association is typically found on dry sites, such as steep, south-facing slopes or clay rich soils that are slow to release stored water. California sagebrush (Artemisia californica) is the dominant shrub species onsite, forming a dense, nearly monotypic stand. Scattered specimens of coyote brush (Baccharis pilularis) and bladderpod (Isomeris arborea) also occur throughout this vegetation community onsite. The stature of this vegetation onsite is somewhat diminutive (2 to 3 ft) due to the wind-pruning effect of the moist, salty sea breezes [Ref. 8.59].

Because the actual site has limited habitat, it is not conducive to diverse wildlife utilization. Table 5-2 of Attachment 5 lists reptile and mammal species observed on the site during a survey for the SONGS Operating License Stage Environmental Report for SONGS [Ref. 8.74].

MCBCP, which occupies the majority of the SONGS vicinity, is the largest remaining tract of the land in coastal southern California that has little development or direct human influence, except for frequent military training operations. MCBCP supports several ecosystems including:

- Estuarine and beach ecosystems
- Riparian ecosystems
- Shrublands
- Grasslands
- Oak Woodlands
- Wetlands

Approximately 18 miles of undeveloped coastline exists within the borders of MCBCP. The limited area of natural coastline left in southern California makes the MCBCP shoreline of special interest. Habitats of the coast are divided roughly into four zones. The intertidal zone is regularly inundated by the ocean, while strand or beach is subject to wave action and deposition and removal of sand and gravel.

Riparian ecosystems on MCBCP contain a wide variety of habitat types including woodlands, fresh water marshes and open water areas. Within the vicinity of SONGS, waters associated with the San Mateo and San Onofre watersheds including San Mateo Creek and San Onofre Creek, respectively, provide riparian habitat. Due to the arid climate of southern California, water is a limiting factor to vegetation growth. Habitat characteristics are vastly different in riparian areas where water is more plentiful. Winter deciduous trees such as willows, cottonwoods, alders, and sycamores tend to dominate riparian habitat [Ref. 8.95].

Shrublands in the vicinity of SONGS are composed of two types. Chaparral types are dominated by evergreen species with small, thick, leathery, dark green, sclerophyllous leaves while coastal sage scrub habitat is dominated by species that lose all or most of their large, grayish-green leaves during summer months. Chaparral types are more abundant in cooler areas with higher annual precipitation consistent with higher elevations. Coastal sage scrub and specifically Diegan coastal sage scrub is common in the vicinity of SONGS as it is usually identified with warmer areas with a predominant drought season [Ref. 8.95]. Species associated with Diegan coastal sage scrub include: California sagebrush (Artemisia californica), coyote brush (Baccharis pilularis) and bladderpod (Isomeris arborea) [Ref. 8.59].

A detailed list of plant species identified near Units 2 and 3 were presented in Appendices 2A-1 and 2A-2 of the SONGS Units 2 and 3 Operating License Stage ER [Ref. 8.74]

Grasslands are also common on MCBCP. Although many grass and forb species have been introduced, grasslands cover about 30 percent of the base. They are usually located along coastal terraces and cover rolling hills with deeper soils [Ref. 8.95].

As previously mentioned, vegetation in southern California is limited by water availability. Although not typically conducive to extensive forest growth, some oak species are particularly adapted to such climates. However, oak forests in the vicinity of SONGS are only found in areas where drought is somewhat ameliorated by other characteristics. For instance, oaks woodlands are protected from the maximum intensity of the sun on north-facing slopes and have more access to water below rock faces or bouldery areas where runoff is concentrated or in areas where deep soils hold more moisture [Ref. 8.95].

6.4.2.1 Impacts Associated with Construction

Construction impacts to terrestrial resources are associated with loss of habitat due to grading and filling, storm water runoff, sedimentation, fugitive dust, and noise. Cooling towers on the SONGS Mesa Complex would be placed in a previously disturbed location which would negate the issue of habitat loss; however, erosion, sedimentation, and fugitive dust would be expected. Additional attention on mitigating these impacts would be necessary, and could be controlled by implementing BMPs.

The BMPs that would be employed at SONGS would be incorporated in a site-specific construction Stormwater Pollution Prevention Plan (SWP3) using appropriate state or local specifications prior to initiating construction. Among the general measures that would be considered for inclusion in the SWP3 are:

- Minimize the area to be disturbed and use silt fences or other sediment controls.
- Phase construction activity to minimize the duration of soil exposure and stabilizing exposed soil as quickly as possible after construction. Temporary cover BMPs include temporary seeding, mulches, matrices, and blankets and mats while permanent cover BMPs include permanent seeding and planting, placing sod, channel stabilization, and vegetative buffer strips.

- Control stormwater flowing through the site by diversion ditches or berms to direct runoff away from unprotected slopes.
- Establish perimeter controls such as vegetative buffer strips supplemented with silt fences and fiber rolls around the perimeter of the construction to help prevent soil erosion and stop sediment from mobilizing and entering the ocean.
- Control fugitive dust by watering the construction site as needed.
- Schedule periodic and regular inspection and maintenance of all BMPs put into place.

Wildlife typically avoid roadways where activity and noise increase [Ref. 8.86]. Noise and machinery activity would be expected to displace mobile species beyond the actual construction area, similar to animal movement away from areas of vehicle traffic along highway systems. Heavy equipment such as scrapers and bulldozers typically emit noise at levels within the 70 to 90 dBA range at distances of 100 feet. A small percentage of habitat at SONGS would be expected to be disturbed and ample habitat would be available adjacent to the construction site, which would provide refuge for displaced animals. Avoidance behavior surrounding construction sites would partially offset the risk of wildlife colliding with equipment or vehicles. Construction noise would not continuously impact the surrounding wildlife, but would be anticipated to impact terrestrial resources over the 66 month construction duration.

Erosion, sedimentation, fugitive dust, and noise impacts to terrestrial resources from the construction of closed-loop cooling would require additional mitigation measures by SONGS. It should be noted that while construction impacts would be considered one-time, they would last over the 66 month construction duration.

6.4.2.2 Impacts Associated with Operation

Impacts of closed-loop operation to terrestrial resources would include cooling tower noise and the vapor plume emitted from the cooling towers. Of these, the primary concern for terrestrial resources would be salt deposition caused by the cooling tower plume. Although detailed plume models have not been performed to indicate deposition rate per hectare, negative effects associated with salt deposition to some terrestrial vegetation and habitat in the vicinity of SONGS would be likely. The effect salt deposition would have on the surrounding environment would need to be investigated further to determine how severely the terrestrial resources would be harmed.

6.4.3 Threatened and Endangered Species

Twenty-three species currently protected under the Federal Endangered Species Act (ESA) have geographic ranges within the vicinity (6-mile radius) of SONGS. The vicinity includes primarily the northwest corner of MCBCP in San Diego County and the southwest corner of Orange County. Table 5-2 of Attachment 5 lists protected species and the designated protective status.

Areas of MCBCP that provide habitat for two mammalian, one amphibian, seven avian, two fish, two invertebrate, and three federally listed plant species (as well as one avian and one plant candidate species for listing under ESA) have been identified through surveys of

MCBCP. Of the 19 species identified on MCBCP, 13 protected species have been identified as residents within the vicinity of SONGS [Ref. 8.95; Ref. 8.92]. Endangered marine reptiles and mammals identified within the vicinity of SONGS are mostly transient and only migrate through the vicinity.

Terrestrial Species

Bald eagles have been federally delisted but remain listed as endangered by the state [Ref. 8.15]. In 1995 and 1996, but not since, sightings were documented on MCBCP in the Santa Margarita estuary and in Cocklebur Creek [Ref. 8.95]. Bald eagles are highly mobile and would not likely be affected by construction or operation of cooling towers.

Brown pelicans are listed endangered by the state and federal government, although it has been considered for delisting by both [Ref. 8.15]. Although brown pelicans are known to fly along the coast of MCBCP, they do not typically use MCBCP as a breeding site. The closest known nesting colony to San Diego County is on Los Coronados Islands off Tijuana, Mexico. However, pelicans have been identified feeding in estuary waters and roosting on MCBCP [Ref. 8.95].

Coastal California gnatcatchers are federally endangered and listed as a species of special concern by the state of California [Ref. 8.15]. Coastal California gnatcatchers have been identified as year round inhabitants of MCBCP in predominantly coastal sage habitat and occasionally chaparral and riparian habitats [Ref. 8.95]. The little unaltered habitat onsite consists predominantly of coastal sage community and could provide habitat for gnatcatchers. However, there are indications that gnatcatchers generally avoid crossing even small areas of unsuitable habitat [Ref. 8.58]. Interstate 5 bisects areas where gnatcatchers have been identified and the plant site. Additionally, a focused survey in 1994 failed to identify coastal California gnatcatchers immediately adjacent to the SONGS site. A possible reason credited within the study was that coastal scrub shrub vegetation onsite was denser than coastal scrub shrub vegetation in habitat that was utilized by gnatcatchers and was therefore considered to be of lower quality to the species. Although general habitat requirements for coastal California gnatcatchers appear to be located at SONGS, plant density may be such that the species does not take advantage of its existence, or habitat fragmentation may affect accessibility [Ref. 8.59].

Suitable habitat for coastal California gnatcatchers has been identified adjacent to SONGS. Noise associated with construction could affect gnatcatcher behavior and flight patterns over the 66 month construction duration. Furthermore, increased vehicular activity would increase the likelihood for collisions with gnatcatchers. Although it is not anticipated salt deposition would directly affect gnatcatchers, it is possible suitable habitat could be affected (Section 6.4.2.2).

Least Bell's vireo is a small diurnal songbird species that is federally and state listed endangered [Ref. 8.15]. They are found throughout the MCBCP in riparian habitat [Ref. 8.95]. Identified habitat includes dense brush, mesquite, willow-cottonwood forest, streamside thickets, and scrub oak in arid regions but often near water [Ref. 8.58]. Least Bell's vireo has been identified in the riparian areas along San Onofre Creek, which is approximately one mile from SONGS. Although a detailed plume analysis has not been performed, salt deposition to least Bell's vireo habitat is possible.

Southwestern willow flycatchers are listed endangered by both the federal and state government [Ref. 8.15]. The breeding range includes southern California, Arizona, New Mexico as well as parts of Nevada, Utah, and Texas [Ref. 8.93]. On MCBCP, southwestern willow flycatchers inhabit riparian woodlands consisting of willow-dominated habitats with a dense understory. They are diurnal and usually nest from June through the end of July. Southwestern willow flycatchers were identified within the plant vicinity in 2002, 2003, and 2004 bird surveys [Ref. 8.95]. However, suitable habitat is not located on the site. Furthermore, the USFWS has critical habitat mapped within 50 miles of SONGS but not within the vicinity [Ref. 8.92]. Southwestern willow flycatchers would not likely be affected by localized impacts associated with operation of cooling towers at SONGS.

Western snowy plovers are small shorebirds that are listed threatened by the federal government. Habitat for western snowy plovers consists of beaches, dry mud or salt flats, sandy shores of rivers, lakes and ponds. USFWS has critical habitat mapped about 2 miles northwest of SONGS between SONGS and San Mateo Point [Ref. 8.92] near the northwest boundary of MCBCP. USMC surveys in 1996, 1998, and 2000 reveal snowy plover nesting locations only in the southeast corner of the base [Ref. 8.95]. Western snowy plovers would not likely be affected by localized impacts associated with operation of cooling towers at SONGS.

Pacific pocket mice are listed as endangered by the federal government and as a species of special concern by the state [Ref. 8.95]. Preferred habitats include coastal strand, sand dune, ruderal vegetation on river alluvium, and open coastal sage scrub on marine terraces [Ref. 8.59]. Populations have been identified on base, northwest of SONGS [Ref. 8.95]. Trapping surveys in habitat similar to that found on SONGS property failed to identify Pacific pocket mice in 1994 [Ref. 8.59], and as such they are not anticipated onsite. Although a detailed plume analysis has not been performed, salt deposition to Pacific pocket mice habitat is possible.

Stephen’s kangaroo rat (SKR) is listed endangered by both the federal and state government [Ref. 8.15]. Suitable habitat is characterized as sparse grasslands with a high percentage of bare ground. Although SKR have been identified in the vicinity of SONGS [Ref. 8.95], suitable habitat is not located onsite.

Thread-leafed brodiaea is listed by the USFWS as a threatened species but by the California Department of Fish and Game as an endangered plant [Ref. 8.15]. The plant is a perennial herb with a flowering stem arising from an underground bulb. Thread-leafed brodiaea grows in heavy clay soil and is often in association with vernal pools and floodplains [Ref. 8.58]. NatureServe [Ref. 8.58] indicates the plant is associated with vernal pool complexes but USFWS has designated critical habitat inland of the plant [Ref. 8.15] and surveys on MCBCP have revealed thread leafed brodiaea inland of SONGS along San Onofre creek [Ref. 8.95]. Although thread-leafed brodiaea has been identified within the vicinity of SONGS [Ref. 8.95], suitable habitat has not been identified onsite. However, thread-leafed brodiaea in the vicinity of SONGS could be affected by increased salinity associated with cooling tower deposition.

Aquatic Species

Arroyo toads are federally listed endangered and listed by the state as a species of special concern [Ref. 8.15]. Sandy soil is necessary for burrowing and hibernating. However, for breeding and laying eggs, suitable habitat consists of rivers with shallow, gravelly pools adjacent to sandy terraces [Ref. 8.58]. On MCBCP, arroyo toads have been located in drainage basins throughout the base [Ref. 8.95]. It is anticipated that salt deposition from the cooling tower plume would reach San Onofre creek, which is habitat for arroyo toad populations.

Riverside fairy shrimp and San Diego fairy shrimp are listed as federally endangered species, although neither has been assigned special status by the state [Ref. 8.15]. Both fairy shrimp species share similar suitable habitat characteristics consisting of vernal pools that are temporary by nature. A base-wide survey identified 81 vernal pool complexes that contained either one or both species on MCBCP [Ref. 8.95]. Vernal pools have been mapped within a mile northwest of the site. Although changes in intake velocities and discharge composition and velocities would not affect fairy shrimp, salt deposition from the cooling tower plume could affect vernal pool salinity concentrations, thus affecting fairy shrimp habitat.

The tidewater goby is federally listed as an endangered species but considered a fish species of special concern in California [Ref. 8.15]. Tidewater gobies are found in waters 25-100 cm deep and are usually restricted to coastal brackish water habitats [Ref. 8.58] as found in many lagoons on MCBCP. One such lagoon exists within the vicinity of SONGS (approximately 1 mile northwest), but suitable habitat for tidewater gobies has not been identified onsite [Ref. 8.95]. Tidewater gobies do not have a marine life history phase [Ref. 8.58] and are therefore, not expected near the intake or discharge of SONGS. Tidewater gobies would not likely be affected implementation of closed-loop cooling at SONGS.

Steelhead trout are considered a partially anadromous salmonid. They are listed as endangered by the federal government and have been historically located in streams and rivers of Los Angeles, Orange and San Diego counties. After one to four years in freshwater, steelhead trout migrate to marine environments [Ref. 8.95]. Sexually mature steelheads migrate back to freshwater prior to spawning. The USFWS has San Mateo creek and San Onofre creek listed as critical habitat for steelhead trout [Ref. 8.15]. A single juvenile steelhead was observed in San Mateo Creek on USMCB (within the vicinity of SONGS) in 1999. Ongoing monitoring by USMC has been conducted to determine if steelhead trout routinely make use of San Mateo Creek and existing pools. As of 2005, no other steelhead trout have been identified on base [Ref. 8.95].

6.4.4 Critical and Sensitive Habitats

Critical and important habitats are those areas that are managed by a state for species that are listed at the state level as endangered, threatened, or of concern. Although MCBCP contains several uninterrupted hectares of intact habitat that is utilized by threatened and endangered species [Ref. 8.95] an amendment to the Endangered Species Act in 2004 prevents the USFWS from designating military lands as critical habitat if the areas are covered by an approved INRMP that provides a conservation benefit to the species.

MCBCP published an INRMP to aid in the management and conservation of natural resources under the Base's control in October 2001. Updates to the INRMP are ongoing, and the latest published version is from March 2007.

Section 6.4.3 indicated habitat for coastal California gnatcatchers, least Bell's vireo, thread-leafed brodiaea, arroyo toads, fairy shrimp, and the Pacific pocket mouse could be affected by salt deposition associated with the operation of cooling tower at SONGS. A detailed analysis would be required to determine the likelihood that salt deposition in these areas would be impactive. If impactive, the feasibility of operating SONGS with closed-loop cooling would need to be determined by governing regulatory agencies.

6.5 Impacts to State Parks

As described in Section 2, SONGS Units 2 and 3 are located on the Pacific coast of Southern California in northern San Diego County. The site is located entirely within the boundaries of the MCBCP near the northwest end of the 18-mile shoreline. The largest single leaseholder on MCBCP is the state of California Department of Parks and Recreation, which accounts for approximately 2000 acres, leased from the Department of Navy in 1971 for a 50-year term [Ref. 8.95, p. 2-30]. The California State Park facility created from the lease is San Onofre State Beach. Also, within a 6-mile vicinity of SONGS is San Clemente State Beach, as shown in Figure 6.1.

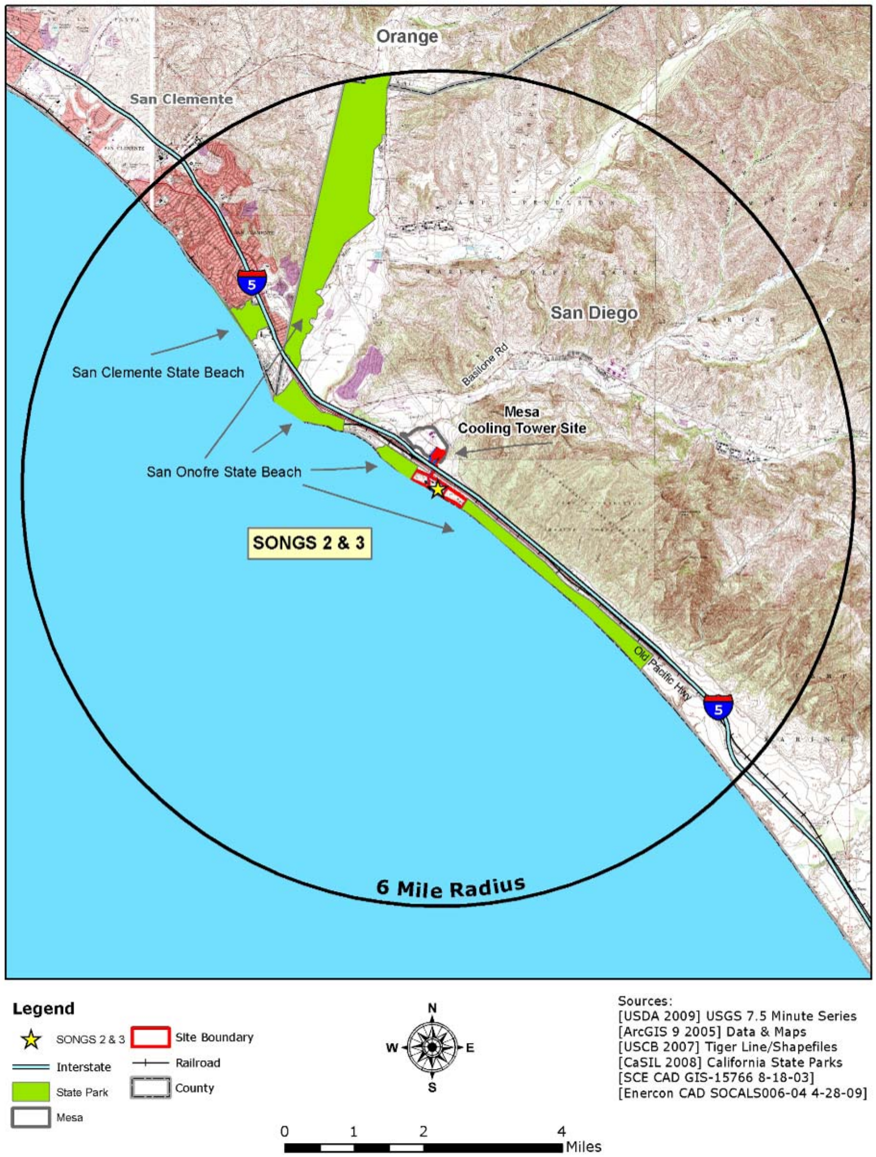

Figure 6.1 California State Parks, 6-Mile Radius

As discussed in Section 3, the cooling towers would be located in the Mesa Complex. The location of the Mesa Complex in relation to nearby San Onofre State Beach and San Clemente State Beach can be seen in Figure 6.1.

The physiography of the SONGS vicinity and San Onofre and San Clemente State Beach are typical of the region, with a rather narrow, gently sloping, coastal plain extending seaward from the uplands. The plain is terminated at the beach and forms a line of sea cliffs, which have been straightened over long distances by marine erosion. Sea cliffs in the immediate vicinity of SONGS reach a height of 60 to 100 feet above mean sea level, and are separated from the ocean by a narrow band of beach sand. In places, ephemeral streams are actively eroding gullies into the seaward portions of the coastal plain, and several deeply incised barrancas have been formed [Ref. 8.75, p. 1.2-2].

Public access to the beach adjacent to the Coastal Complex seawall is provided by an improved walkway. The walkway permits transit between open beach areas upcoast and downcoast from the site [Ref. 8.74, p. 2.1-2]. Public passage between sections of San Onofre State Beach north and south of the SONGS Coastal Complex was granted through a February 16, 1982, amendment to the coastal development permit with the CCC. This walkway is open to the public except when closure is necessary for reasons of public safety or plant security [Ref. 8.10].

The San Onofre State Beach includes 3.5 miles of sandy beaches with six access trails cut into the bluff above. The beach also contains the Bluffs Campground along Old Highway 101, the Trestle and San Onofre Surf Beaches, and the San Mateo Campground. The San Mateo campground lies inland within the San Mateo drainage, immediately adjacent to and along the north side of the creek. From July 1, 2007, to June 30, 2008, the state beach had 2,750,957 visitors with 218,750 of those camping [Ref. 8.17, p. 28].

The state beach's two campgrounds have a total of 380 campsites [Ref. 8.66]. The Bluffs Campground has approximately 221 camp sites with parking for an RV at each site. Some sites have electrical hook-ups for RV's, but no sewer hook ups. The campground has a dump station. Each site is restricted to no more than eight people. Camping is limited to no more than seven consecutive days per season, which includes off-season and peak season. Typically, the campground is closed from December to March. San Mateo Campground has approximately 157 total camp sites with electrical and water RV hook-ups at 67 of the sites. The campground also has a dump station. Each site is restricted to no more than eight people [Ref. 8.78, p. 4-93]. No person is permitted to camp at the campground for more than 30 days total in a year [Ref. 8.16, pp. 2, 5].

To the north of San Onofre State Beach is San Clemente State Beach, which stretches for a mile with two trails following scenic ravines providing access. Recreation activities include swimming, snorkeling, surfing, and fishing. The San Clemente campground sits high on the bluffs and has 160 camp sites including 72 RV sites [Ref. 8.17, p. 3]. According to the San Clemente State Beach General Plan, there are plans to expand the total number of campsites to 300 and to increase day-use parking to 1200 spaces [Ref. 8.18, p. 7]. From July 1, 2007, to June 30, 2008, the state beach had 594,693 total visitors including 160,217 campers [Ref. 8.20, p. 28].

The cooling tower structures would not be expected to affect the aesthetics at San Clemente State Beach due to the distance northwest of the potential cooling tower site, and the sea cliffs and surrounding topography (see Figure 6.1). Because of the size of the cooling towers and Mesa Complex location, the structures would be lower in height than the existing Unit 2 and 3 reactor domes. However, the size of the cooling tower structural footprint would have the potential to cause a visual impact on the immediate landscape setting. The elevation of the land surrounding the Mesa Complex is higher than most of the topography within the 6 mile vicinity, restricting the majority of aesthetic impact to the San Onofre Creek watershed. Interstate 5 travelers, North County Transit District train riders, SONGS workers, and visitors to San Onofre State Beach would be the most impacted by the aesthetics of the proposed cooling towers. This existing topography, atmospheric conditions, and structure height minimizes the potentially negative impact for the populace located in the city of San Clemente and the rest of the MCBCP.

Regarding state park aesthetics, only intermittent locations in the San Onofre Bluffs and San Onofre Surf Beach would have a line-of-site view of the structures and any possible plumes. However, the use of plume-abated hybrid cooling towers would reduce the likelihood of plume formation.

While the construction of the cooling towers would not take place within the boundaries of the San Onofre State Beach, potential impacts to State Beach areas could include diminished visual aesthetics. The San Onofre State Beach Revised General Plan describes the existing and planned land use policies for the San Onofre State Beach facilities. The scenic resources of San Onofre State Beach are of great importance. San Onofre's policy on its scenic resources is that the State Beach shall be protected from all degrading and undesirable intrusions. This policy focuses on scenic detractions due to developmental practices within the borders of the San Onofre State Beach [Ref. 8.19, p. 27]. The San Onofre State Beach policy for terrestrial habitat, specifically general vegetation management, is to preserve and perpetuate representative examples of natural plant communities common to the area and the region through mitigation practices. The mitigation plan does not address restriction of offsite sources which could degrade area resources [Ref. 8.19, pp. 22, 53].

The San Onofre State Beach is leased from the U.S. Navy and is not subject to land-use regulation by the county or the state. The Coastal Commission would review the cooling tower plans, however, to determine their consistency with the Coastal Act (see Section 6.5.2.and Section 6.7.3). Any development must be consistent with the requirements of the Federal Coastal Zone Management Act. It is the U.S. Navy's responsibility to enforce such consistency [Ref. 8.19].

During construction, areas of the San Onofre State Beach would likely be affected by increased noise (see Section 6.5.3), increased traffic, and increased dust. The affects of construction on the state beaches are discussed in Section 6.5.4.

6.5.1 View Shed Aesthetics

Aesthetics near the site could be affected by the cooling tower structures themselves, vapor plumes, increases in fog due to the cooling towers, and salt deposition.

Plume-abated cooling towers are relatively short and compact, with a height of approximately 50 feet. The cooling towers would be located on the east side of Interstate 5, in the area known as the Mesa Complex, as shown in Attachment 5, Figure 5-5. Without taking into account the change in base elevation, the cooling towers would be much shorter than the reactor buildings, which are approximately 190.8 ft tall [Ref. 8.74, Figures 3.1-2, 3.1-3, 3.1-4]. Accounting for the change in base elevation, the cooling towers would still be approximately 40 feet shorter than the reactor buildings. Current structures on the site use building and station materials complimentary to the seacoast environment where appropriate, along with the application of appropriate textural and color treatments that are integrated into the design of the facility [Ref. 8.74, p. 3.1-1]. The cooling towers could also incorporate features that are appropriate to the seacoast environment.

A view shed analysis was performed for a 6-mile and 50-mile radius based on the cooling tower location, U.S. Geological Survey National Elevation Datasets (NED), and ESRI Geographical Information System (GIS) view shed analysis processes [Ref. 8.94; Ref.

8.97]. The analysis within a 6-mile radius of the site reveals that the cooling tower structures and any emitted plumes would be most visible to viewers located on the adjacent hillsides of the San Onofre Creek drainage inside MCBCP and along Basilone Road. The view would diminish the further northeast one traveled on Basilone Road, with virtually no potential view of the structures at the bottom of the San Onofre Creek drainage. The structures and plumes would also be visible to rail traffic and vehicle occupants traveling along Interstate 5 as traffic passes west of the proposed facility. Finally, the probability of structure visibility would be high for individuals looking back toward land from the Pacific Ocean, opposite the location of the structures.

The cooling towers would be located on the Mesa Complex plateau at approximately 100 feet above the shoreline. As the distance from the cooling tower location increases, the angle of vision occupied by the cooling tower structures would decrease significantly. Because of the ocean front cliffs, angle of coastline, and inland topography, none of the San Onofre State Beach areas southeast of the San Onofre Creek drainage outlet would have a view of the proposed cooling tower structures at the level of the water. On top of the cliffs, the SONGS employee parking lot in the northwest area of the Coastal Complex but southeast of the San Onofre Creek drainage would have a direct view of the structures. Also located on top of the cliffs but southeast of the SONGS Coastal Complex, the northeast corner of the San Onofre State Beach Bluffs would have a view of the cooling towers. However, the larger portion of the San Onofre Bluffs cliff-top area located further southeast would not be in line-of-site view of the cooling towers.

Because of the angle of the coastline northwest of the cooling tower structures, viewers located along the beach front from the San Onofre Creek drainage outlet to the beginning of San Mateo Point would have an intermittent view of the cooling towers. This would include a portion of the San Onofre Surf Beach facilities. Inland locations to the north and northwest would have little or no view of the cooling towers, including the San Onofre State Beach San Mateo campground. This is due to the elevated topography of the ridgeline above the San Onofre Creek drainage. Approximately 3 miles in distance, the San Clemente State Beach and most of the City of San Clemente would have no view of the cooling towers. There is one elevated location in northeast San Clemente, approximately 4.3 miles northwest of the cooling tower location, where viewers would potentially see the structures.

For parks located along the coastline outside of the 6-mile radius but within the 50-mile region, the angle of the coastline curves to the southwest. If all atmospheric conditions are pristine at both the site of the cooling towers and at the viewer location, the nearest state beach to the southeast where viewers could potentially see the cooling tower structures or plume would be at intermittent locations in Carlsbad State Beach. Carlsbad is located approximately 22 miles in distance from the proposed location of the cooling towers. Although the structures could be visible because of the distance and angle of view, they would be difficult to see without visual aide devices. At Torrey Pines State Natural Reserve, (approximately 35 miles away), viewers could also potentially see the cooling towers but they would not be visible form Torrey State Beach. Inland from the coast, from the cities of Carlsbad to La Jolla, several elevated locations along the Interstate 5 corridor could also potentially offer views of the cooling towers. The potential would also exist from the highest points of Santa Catalina Island, approximately 40 miles distant. Finally, if atmospheric conditions and lack of vegetation cover permits, the higher elevations in Cleveland National Forest, approximately 9 miles in distance, could allow intermittent views of the cooling towers.

6.5.2 Coastline Visibility

Because of the angle of the coastline, various state park facilities within the 50-mile region located south of SONGS would have intermittent views of the cooling towers. These views would diminish with distance from the site, but the cliff tops associated with San Onofre State Beach would have the greatest view of the structures. From the Pacific Ocean looking back toward the coastline, if atmospheric conditions permitted, the potential would exist for the structures to be seen from approximately 6-miles at sea until the curvature of earth would eliminate the view of the cooling towers on the horizon.

While the conversion of SONGS to closed-loop cooling would not take place on California State Park lands, portions of the project to construct cooling towers on the Mesa Complex would be located on and traverse California Coastal Zone regulated lands. This zone also extends 3 miles offshore. The California Coastal Act of 1976 contains provisions which require protection of visual resources in coastal areas. The Coastal Act includes specific policies regarding such subjects as public access to the shore, protection of terrestrial and marine habitat, visual resources, land form alteration, and agricultural lands. These policies are the standards that are applied to the planning decisions affecting the coastal zone made by local authorities and the California Coastal Commission. Development in areas adjacent to environmentally sensitive habitat areas, parks and recreation areas should be sited and designed to prevent impacts that would significantly degrade those areas, and should be compatible with the continuance of those habitat and recreation areas [Ref. 8.83, pp. 3-3, 3-6, 3-7].

The Interstate 5 viewpoint, North County Transit District railway, and Old Highway 101 within San Onofre State Park would provide the only public views in the area. Generally, the views from Interstate 5 do not include direct views of the beach or shoreline because of obstruction by the coastal bluffs. Views from Interstate 5 to the west are over various disturbed and undisturbed open lands to the Pacific Ocean. A few canyons, such as Las Pulgas Canyon, allow limited views of the beach and shoreline. Because the cooling towers would be to the east of Interstate 5, the structures would not be expected to obstruct coastline visibility from the transportation routes in the area.

The cooling towers plumes could result in additional fogging that would decrease visibility. However, when properly operated, the hybrid cooling towers would capable of virtually eliminating visible fogging problems resulting from cooling tower operation.

6.5.3 Noise Impacts

In addition to the current noise produced by SONGS, noise would be generated in all phases of the conversion from once-through to closed-loop cooling. Noise would be produced during the construction phase as well as in the operational phase of the closed-loop cooling systems.

6.5.3.1 Current Noise Impacts of the Operational Units

SONGS is currently classified as heavy industry for noise. Routine activities at this facility are normally expected in the 65 to 75 dBA range. Based on the location of this industrial facility along Interstate 5, the Pacific Ocean, and the military activity in the area, as related to sensitive receptors, the noise levels are not significant. Currently the nearest residence is approximately 1.25 miles from the SONGS Coastal Complex, on the MCBCP. Noise at the state parks is not significantly affected by the operational units since it blends in with the Interstate 5 traffic noise and the constant noise from the ocean. Noise produced during operation is generally low level and continuous in nature, such as running pumps and spinning electrical generators. Occasional short-term noises, such as emergency siren testing or starting of emergency diesel generators, are higher in dBA but infrequent.

6.5.3.2 Construction Noise during the Change to Closed-Loop Cooling

During construction, the highest levels of noise would come from the heavy machinery that would be used to carry out activities such as moving dirt, lifting heavy objects, and drilling pipe tunnels for the circulating water pipelines. In addition, there would be an increase in vehicular traffic due to increased workforce transportation, supply trucks, and related business travel. Noise would increase during periods of shift change and during special construction activities. Increased traffic volume would impact the noise levels during the construction, but the impact would not last beyond the 66 month construction phase.

Construction noise would be influenced by some high dBA equipment such as air-driven hammers, pile drivers, emergency sirens, and outdoor loudspeaker communications. These activities would be of short-term duration and infrequently used. The use of this equipment would be scheduled to create minimal noise impacts by limiting the time of day or duration of the use. Some loud noises would be required to accomplish the work tasks and could not be eliminated.

The proposed location of the new hybrid cooling towers is at the current Mesa Complex. This location would move the construction activities closer to the sensitive receptors at the MCBCP housing area but further from the state parks. Construction in this area could increase the noise level to the sensitive receptors. Working during daylight hours and scheduling noise producing activities so that they would not occur during the normal sleep hours of the receptors would be required. As part of all activities that involve noise, the work would be required to be performed under all applicable health and safety rules and regulations. Hearing protection for workers would be a part of the required program and would be followed.

6.5.3.3 Operational Noise during Plant Operations using Closed-loop Cooling

Noise levels would increase in the vicinity of the Mesa Complex due to the operation and location of the cooling towers. As discussed in Section 3.1.2, the hybrid cooling towers would be equipped with sound attenuators in order to mitigate the noise impacts.

By maintaining the current plant availability factors, the cooling towers would be expected to be operating approximately 90 percent of the time. Most of year, the hybrid mode would be used, resulting in the loudest noise level for the majority of the year. The noise levels would fall off with distance and is consistent with expected industrial facilities located in rural to urban areas. The noise level at the state parks would not produce a noticeable increase as the traffic and ocean noise would still dominate the noise produced and heard by park guests. With the nearest resident at approximately 3800 ft away from the proposed cooling tower site, there would not be a significant change to the background noise levels that currently exist.

An actual noise survey would need to be performed to supply calculated values for noise before conversion of SONGS to closed-loop cooling. California CEQA requirements would need to be verified for the addition of the cooling tower noise and the resulting final total operational noise levels at the sensitive receptor and state parks. By regulation, the project would result in a significant impact if the installation of closed-loop cooling caused substantial, or potentially substantial, adverse changes in the ambient noise conditions within the area affected by the project (e.g., increase long-term ambient noise by 5 to 10 dBA; or short-term ambient noise by 20 dBA) and these changes affected noise-sensitive receptors [Ref. 8.78, pp. 5-68].

An increase in the long-term ambient noise level of 5 to 10 dBA is generally considered significant. This is because most people consider these noise level changes from an existing level as “substantially louder” to “twice as loud” [Ref. 8.78, pp. 5-68]. The total noise level at the sensitive receptors would be essentially the same as the current level. The operational noise level at the state parks would not be expected to change. The impact of this conversion to closed-loop cooling would not be expected to cause a significant impact due to noise.

6.5.4 Other Construction Impacts

Construction activities for the conversion of SONGS to closed-loop cooling would result in elevated noise and dust levels and traffic on roads. Additionally, the erection of cranes and buildings could affect aesthetic qualities of San Onofre State Park.

Cooling tower construction activities would require a large number of temporary employees and contractors. SONGS currently has a developed campground with approximately 250 full service camping spots at the Mesa Complex, operated specifically for temporary employees and contractors during high demand periods, such as planned reactor fuel outages. However, the cooling towers required for conversion to closed-loop cooling would be located on this campground; therefore, the campground would no longer be available for housing temporary workers.

Construction workers would likely look for commercial RV camping options within the vicinity and region for housing. The San Onofre State Beach and San Clemente State Beach restrict the number of days that visitors can stay, with no more than 30 days allowed a year. The San Clemente State Beach Campground allows no more than 7 consecutive days during peak season (March 1 through November 30) and 14 consecutive days during off-season. The Bluffs Campground and the San Mateo Campground at San Onofre State Beach allow a maximum stay of 15 consecutive days [Ref. 8.16, pp. 2, 5]. Thus, visitors to the campgrounds would not be competing for temporary housing with construction workers from the cooling tower construction.

Visitors traveling to the state parks could experience increased traffic as construction workers would commute from San Clemente and Oceanside to the SONGS site. Because interstate and state highways are constructed to support much heavier traffic loads than local roads, construction workers would likely have minimal impact on the interstate and state highways in the area.

6.6 Assessment of Cultural Resources

Conversion to closed-loop cooling at SONGS would require extensive excavation and construction activities which would need to be evaluated for potential impact to cultural resources. The review program of the California State Historic Preservation Office (SHPO) is a planning process that helps protect California's historic and cultural resources from the potential impacts of projects that are funded, licensed, or approved by federal agencies. Under Section 106 of the National Historic Preservation Act (NHPA) of 1966, the SHPO's role in the review process is to ensure that effects or impacts on properties eligible for or already listed on the National Register of Historic Places (NRHP) are considered and avoided or mitigated during the project planning process. In addition, the SHPO can review and advise communities on local preservation environmental reviews, under the provisions of the CEQA. The environmental review program includes the following:

- **Section 106 of NHPA.** The California SHPO reviews projects when a federal agency is involved with the project. It is the federal agency's responsibility to seek comments about the project from the SHPO.
- **Sections 5024 and 5024.5 of the CPRC.** These sections define the roles of state agencies in developing policies relevant to preserving and maintaining state-owned historical resources. The SHPO reviews projects when a state agency is involved with the project. It is the state agency's responsibility to seek comments about the project from the SHPO for any project with the potential to affect historical resources.
- **California Environmental Quality Act (CEQA).** Sections 21000 et seq. of the CPRC, with guidelines for implementation in the California Code of Regulations Title 14, Chapter 3, Sections 15000 et seq., require that state and local public agencies identify the environmental impacts of proposed discretionary activities or projects, and identify alternatives and mitigation measures that would substantially reduce or eliminate significant effects to the environment. Historical resources are considered a part of the environment, and a project that may cause an adverse effect to a historical resource is a project that may have a significant effect on the environment. The definition of historical resource is provided in Section 15064.5 of the CEQA guidelines.

Two historic registers track California's historical resources. The NRHP is the official federal listing of significant historic, architectural, and archaeological resources. The California Register of Historical Resources (CRHR) is the list of significant historic and prehistoric resources throughout California. In addition, some local government jurisdictions in the vicinity (6-mi radius) of SONGS maintain registers of their own. For example, SONGS is located in San Diego County, which maintains the San Diego County Local Register of Historical Resources (LRHR). Orange County does not have an LRHR.

Construction of the cooling towers, circulating water pipeline tunnels, and circulating water pipelines would be confined primarily to the onsite Coastal Complex and Mesa Complex, but the tunnels connecting these two areas would require offsite construction. The precise locations for building material laydown areas and heavy equipment parking areas have not been designated, but it is expected that they would be inside the boundaries of the Coastal Complex and Mesa Complex. As a result, the entire Coastal Complex and Mesa Complex would be defined as areas of potential effect (APE) on cultural resources. The third APE would be the offsite area slated for pipeline tunnel construction. This APE would be defined as the total width of each underground pipeline gallery plus 100 ft of clearance on each side of each gallery. Most of the offsite pipeline tunnel APE has been disturbed by past highway, railroad, and berm construction. The berm is an elongate, grass-covered strip of sloped open land that separates the Mesa Complex from Interstate 5. This man-made earthen berm was built to protect lower-lying SONGS Coastal Complex from floods or alluviation. The portion of the berm within the offsite pipeline tunnel APE has been disturbed by past excavation and fill activities [Ref. 8.63].

SCE has implemented a formal corporate screening process to protect cultural resources and other aspects of the environment from ground-disturbing activities. This screening process would apply to construction of the cooling towers and their associated pipelines, as well as any operations and maintenance activities that might intrude undisturbed soil [Ref. 8.71; Ref. 8.72].

6.6.1 Prehistoric Archaeological Sites

Several cultural resource surveys have been conducted in the Coastal Complex on the SONGS site and in its vicinity. A recent records search for these areas indicates that no prehistoric archaeological sites have been identified in the Coastal Complex APE. The entire Mesa Complex APE was surveyed for cultural resources in 1973 by Isham and Ezell [Ref. 8.44]. No prehistoric archaeological sites were identified within its boundary during this survey. The portion of the berm within the offsite pipeline tunnel APE was also examined as part of the Mesa Complex survey. The number, locations, and characteristics of prehistoric archaeological sites in the rest of the offsite pipeline tunnel APE and in the vicinity of SONGS are unknown pending access to state cultural resource records.

Two prehistoric archaeological sites (CA-SDI-1074 and CA-SDI-4916) were identified well outside of the APE boundaries but within 0.5 mi of SONGS. They are described briefly in Table 6.3. At this time, their eligibility for listing on the NRHP, CRHR, or LRHR is unknown or undetermined.

Table 6.3 Cultural Resources within 0.5 Miles of SONGS [Ref. 8.4]

Site Number	Site Type/ Constituents	Cultural/ Temporal Affiliation	Site Location	NRHP Status	CRHR Status	LRHR Status
Prehistoric Archaeological Sites						
CA-SDI-1074	Surface shell and artifact scatter	Prehistoric	Approximately 0.5 miles northwest of SONGS (Outside APEs)	UOU	UOU	UOU
CA-SDI-4916	Small surface artifact scatter of flake tools and lithics	Prehistoric	Approximately 0.25 miles east of SONGS (Outside APEs)	UOU	UOU	UOU
Historic Period Archaeological Sites						
P-37-024480	Wooden culvert beneath Amtrak railroad mainline	Historic Period (1943)	Approximately 350 feet east of SONGS (Outside APEs)	UOU	UOU	UOU
P-37-024481	Wooden box culvert beneath Amtrak railroad mainline	Historic Period (1943)	Approximately 0.25 miles northwest of SONGS (Outside APEs)	UOU	UOU	UOU

Notes:

APE - Area of Potential Effect (historical resources).
CRHR - California Register of Historical Resources.
LRHR - San Diego County Local Register of Historical Resources.
NRHP - National Register of Historic Places.
UOU - Unknown or undetermined at this time.

6.6.2 Historic Period Archaeological Sites

Several cultural resource surveys have been conducted in the Coastal Complex on the SONGS site and in its vicinity. A recent records search for these areas indicates that no Historic Period archaeological sites have been identified in the Coastal Complex APE. The archaeological survey by Isham and Ezell [Ref. 8.44] noted that the east portion of the Mesa Complex APE had been disturbed by past military operations. However, they did not identify any Historic Period archaeological sites during their survey of the Mesa Complex. No Historic Period archaeological sites have been identified in the berm portion of the offsite pipeline tunnel APE [Ref. 8.44].

Two Historic Period archaeological sites (P-37-024480 and P-37-024481) were identified well outside of the Coastal Complex APE boundary but within 0.5 miles of SONGS [Ref. 8.4]. They are described briefly in Table 6.3. At this time, their eligibility for listing on the NRHP, CRHR, or LRHR is unknown or undetermined.

6.6.3 Historic Sites

A number of cultural resource surveys have been conducted in the Coastal Complex on the SONGS site and in its vicinity. A recent records search for these areas indicates that no historic sites have been identified in the Coastal Complex APE or any other location within 0.5 miles of SONGS [Ref. 8.4].

In 1973, only two standing structures were present in the Mesa Complex APE. These were small, wood-framed buildings that military personnel had used as sanitation facilities. Both were located on the eastern side of the Mesa Complex near an unimproved dirt road that delimited the area boundary. Neither was identified as a significant historic property [Ref. 8.44]. The buildings and other man-made features completed in the Mesa Complex since that time are less than 50 years old and do not qualify as historic sites.

Isham and Ezell [Ref. 8.44] did not identify any historic sites in the protective berm portion of the offsite pipeline tunnel APE.

6.6.4 Traditional Cultural Properties

A traditional cultural property is defined "...as one that is eligible for inclusion in the [NRHP] because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community's history, and (b) are important in maintaining the continuing cultural identity of the community" [Ref. 8.60].

Several cultural resource surveys have been conducted in the Coastal Complex on the SONGS site and in its vicinity. A recent request sent to the California Native American Heritage Commission (NAHC) indicates that no traditional cultural properties have been identified in the Coastal Complex APE. However, it is unclear as to whether responses were received in regard to an NAHC request for follow-up consultations with Native American groups and individuals [Ref. 8.4]. Therefore, the presence of traditional cultural properties within the Coastal Complex APE, Mesa Complex APE, offsite pipeline tunnel APE, and the vicinity of the SONGS site remains uncertain pending consultations with the NAHC and Native American groups.

6.6.5 Impacts of Converting to Closed-Loop Cooling

As described in the previous sections, no prehistoric or historic archaeological sites, historic sites, or traditional cultural properties are known to be located in the onsite Coastal Complex and Mesa Complex APEs or in the offsite pipeline tunnel APE at SONGS. Therefore, construction and operation of the cooling towers and pipelines is not expected to have adverse impacts on such historical resources within these APEs.

In addition, past widespread construction in the Mesa Complex has resulted in extensive disturbance of the soil. The southwest portion of the offsite pipeline tunnel APE has been disturbed by past highway construction, railroad installation, and landscaping. The northwest portion of the offsite pipeline tunnel APE has been disturbed by past protective berm construction. Therefore, if any cultural resources were ever present in these areas, they would not be expected to be present today because of these past disturbances.

Although this land has previously been disturbed, the California SHPO would have to be consulted to ensure that any cultural resources in the vicinity of the construction activities (cooling towers and underground pipe tunnels) are identified and protected. A consultation letter would be prepared and submitted to the SHPO describing the potential project. SONGS would work directly with the SHPO to address any concerns related to cultural resource impacts.

Several archaeological sites (prehistoric and historic) are known to be present in the area surrounding the APEs. For these sites, adverse impacts would occur only as a result of soil-intrusive activities. For cooling tower construction and operations, SCE would not conduct soil-intrusive activities at any location outside the boundaries of the three specified cultural resource APEs. Therefore, construction and operation of the cooling towers and pipelines would result in no adverse impacts to archaeological sites in outlying areas.

6.7 Regulatory Permitting

The conversion of an existing power plant's cooling system from once-through cooling to a closed-loop cooling tower configuration would involve considerations and reviews across a range of regulatory programs. A number of state and local agencies would be involved in the review and permitting of a cooling system retrofit at an existing nuclear power plant. In addition, federal agencies would likely become involved where federal issues arise, such as endangered aquatic species, nuclear safety, navigable and harbor waters, military zones, etc. The following discussion provides an overview of the programs and agencies that would be involved and highlights the specific aspects that would need to be addressed as part of a closed-loop cooling system conversion.

The lead California agency for a power plant conversion project at SONGS would likely be the CPUC in consultation with the California Energy Commission (CEC) along with other federal agencies including the NRC. The roles of CPUC, CEC, state, and federal agencies were evaluated, and additional information was solicited from several agencies concerning the regulatory requirements for converting the current cooling system to closed-loop cooling. In addition to several regulatory agencies, input from MCBCP, CalTrans, and the NCTD Railway would be required. A list of regulatory agencies and consulted entities is presented in Attachment 5, Table 5-3. An estimated cost for documents, permits, modification of existing permits, and regulatory support for the conversion from an OTC system to a closed-loop cooling system is presented in Attachment 5, Table 5-4.

The cooling towers would be located on the Mesa Complex of the SONGS site (Attachment 5, Figure 5-5). Like the SONGS Coastal Complex area, this property is owned by the Department of Navy and controlled by MCBCP. The Department of the Navy lease requires authorization from MCBCP before SCE does any significant development at the SONGS site. After a briefing by SCE on the issue on May 8, 2009, Camp Pendleton expressed the following concerns that could result in the rejection of the construction of cooling towers on the SONGS Mesa for the following reasons: 1) salt drift from the cooling towers would adversely impact the San Onofre Base Housing complex and a new water treatment plant that MCBCP is considering constructing, 2) cooling towers would disrupt training operations in the area of the base adjacent to the SONGS Mesa where the cooling towers would be constructed, 3) cooling towers at SONGS could impact base flight operations in the San Onofre area, 4) cooling towers would likely adversely impact protected habitat on the base, and 5) construction of eight 12 ft. diameter tunnels for the cooling tower supply and discharge lines would need to go through Camp Pendleton land that is not currently leased to SONGS.

The tunneling associated with the pipelines required for conversion to closed-loop cooling would not only cross MCBCP land not currently leased to SONGS, but would also cross easements held by NCTD for the railway and CalTrans for Interstate 5 and old U.S. Highway

101 (see Attachment 5, Figure 5-5). As discussed in Section 3.5.1, a full engineering study and geotechnical survey would be required before the circulating water pipeline crossings could be permitted. Additionally, each of the eight tunnels would be likely to require three separate right-of-way encroachment permits for crossing beneath Interstate 5, the NCTD Railway line, and old U.S. Highway 101.

Proposed California State Senate Bill (SB 42) would require OTC power plants be converted to a closed-loop cooling tower configuration. Section 6 was completed to evaluate the environmental impacts and the permitting feasibility of retrofitting SONGS Units 2 and 3 in compliance with SB 42, if it is passed into law. Consultations, permits, and permit modifications could be required by several state and federal agencies. The following sections discuss each agency identified that may have jurisdiction impact or oversight on this project. In some cases, additional information/clarification from specific regulatory agencies was solicited and evaluated. These initial inputs were deemed critical in evaluating the regulatory feasibility of this potential project.

6.7.1 California Environmental Quality Act

The CEQA is a statute requiring state and/or local (jurisdictional) agencies to identify the significant environmental impacts of proposed development actions and to avoid or mitigate those impacts, if feasible.

A public agency must comply with specific environmental review requirements when it undertakes an activity defined by CEQA as a "project." This action or project undertaken by a public agency or a private proponent that may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment must first receive (discretionary) approval from an appropriate jurisdictional, governmental agency.

This required environmental review imposes both procedural and substantive requirements. At a minimum, the Lead (i.e. jurisdictional public) Agency must prepare an Initial Study (IS) of the project and its environmental effects. Depending on the potential project effects identified, either a simple Negative Declaration (ND) may be prepared – indicating no adverse environmental effects – or a more substantial, supplemental review would be required. This could either take the form of a Mitigated Negative Declaration (MND) – if anticipated project impacts are relatively minor, involve only a few issues, and can be mitigated to a “less than significant level” – or a more comprehensive Environmental Impact Report (EIR), which covers a wider range of environmental issues. A proposed project may not be approved if feasible alternatives or mitigation measures cannot be identified to substantially lessen the significant environmental effects of the project, unless the Lead Agency issues a Statement of Overriding Considerations.

As discussed in Section 6.4, conversion of SONGS to closed-loop cooling could impact the habitats for several threatened and endangered species. If impacted, additional review would be required to assess feasible alternative or mitigation measures that would substantially lessen the environmental impact. If no alternative or mitigation measure was feasible, closed-loop cooling would require the Lead Agency to issue a Statement of Overriding Consideration; otherwise conversion of SONGS to closed-loop cooling would be infeasible.

6.7.2 California Public Utilities Commission

Pursuant to Article XII of the Constitution of the State of California, the CPUC oversees the regulation of investor-owned public utilities, including SCE. Since SONGS is regulated under CPUC, reasonable costs associated with the project could be reclaimed from the CPUC through a consumer rate base adjustment. The CPUC would likely be the Lead Agency for CEQA compliance in evaluation of SCE's conversion to closed-loop cooling. The CPUC would direct the preparation of an Environmental Impact Report (EIR), which it would ultimately use in conjunction with other non-environmental information developed during the formal proceeding process to act on any SCE application for recovery of costs for implementation of the closed-loop conversion project. Under CEQA requirements, the CPUC would determine the adequacy of the Final EIR and, if adequate, would certify the document as complying with CEQA. If it approves a project with significant and unmitigable impacts, it must state the reason in a "Statement of Overriding Considerations," which would be included in CPUC's decision on the application.

In addition to the CPUC using the EIR as part of their specific approval process, this document could also be used by other California agencies as defined by CEQA Guidelines Section 15381, including the California Department of Transportation and the California Department of Parks and Recreation, as part of their respective discretionary actions and approval process.

Regulation of SONGS by the CPUC is limited by federal laws and regulations governing atomic and nuclear energy. A power plant that uses radioisotopes in the production of energy is required to comply with the federal Atomic Energy Act (42 U.S.C. Section 2011). The NRC is responsible for issuance of operating licenses under the Atomic Energy Act and for enforcing the requirements of the Act and the licenses. Federal regulations (e.g., 10 CFR Parts 20, 50, 51, 71, and 72) also govern the possession, handling, storage, and transportation of radioactive materials from a nuclear power plant.

For these reasons, the CPUC EIR would analyze solely for informational purposes project activities that are exclusively regulated by the federal government through the Atomic Energy Act and other regulations. The scope of CEQA, as stated in CEQA Guidelines [Section 15131(a)], is also limited such that the economic and social effects of a project cannot be treated as significant effects on the environment.

To comply with CEQA, SONGS would be required to prepare and submit a Proponent's Environmental Assessment (PEA) that would describe the Proposed Action, No Project Alternative, and a No Action Alternative. Estimated costs associated with PEA preparation and regulatory requirements for PEA completion are presented in Attachment 5, Table 5-4. If CPUC did not concur with SONGS CEQA, and did not allow a consumer rate base adjustment assessment to recoup closed-loop construction costs, it would be economically infeasible to retrofit SONGS to closed-loop cooling.

6.7.3 California Energy Commission

The Warren-Alquist Act grants the CEC the exclusive authority to license new power plants with capacity greater than 50 MWe or repower projects that increase the facility capacity by 50 MWe or more. As part of this process, the CEC is required to make findings regarding the project's conformance with applicable laws, ordinances, regulations, and standards (LORS). The CEC also serves as the lead state agency for CEQA compliance for new power plants or repower power projects. The Warren-Alquist Act also includes specific provisions for compliance with the California Coastal Act, including specific CEC requirements for coordination with the California Coastal Commission (CCC).

If an existing power plant was originally licensed by the CEC, a modification to the cooling system would require an amendment to the original decision, including an assessment of compliance with CEQA. If the facility was not originally licensed by the CEC, a modification to only the cooling system would not require CEC permitting or approval. SONGS Units 2 and 3 each have a generating capacity greater than 50 MWe and each unit has a CEC license.

The CEC would likely be a participant with the CPUC on the conversion to closed-loop cooling at SONGS. The CEC would not require any specific permits for this conversion, but additional costs would be incurred by SONGS to amend CEC's original decision.

6.7.4 California Coastal Commission

The Coastal Act of 1976 permanently established the CCC, which in partnership with local county and municipal planning authorities, plans and regulates development in the coastal zone. Development within the coastal zone can proceed only subsequent to issuance of a coastal development permit issued by an approved local coastal program or, in limited circumstances, by the CCC itself. Where the CCC issues a permit, the commission or the local coastal planning agency must comply with CEQA and may serve as the lead agency for a CEQA analysis; however, for conversion of SONGS to closed-loop cooling, the CPUC would likely be the lead agency. An exception to the CCC's permitting authority is provided under the Warren-Alquist Act for new power plants or those projects involving an increase of 50 MW or more. In these cases, the CCC participates in the CPUC's review process but does not have independent permitting authority. The CCC's role (under Section 30413[d] of the Coastal Act) is to provide to the CPUC a report describing what measures are necessary for the proposed project to conform to Coastal Act policies. The CPUC must then adopt those measures as part of any approval, unless it finds that the measures are infeasible or would cause greater adverse environmental harm.

6.7.4.1 California Coastal Act

On land, the coastal zone varies in width from several hundred feet in highly urbanized areas up to five miles in rural areas and it extends three miles offshore. The coastal zone established by the Coastal Act excludes San Francisco Bay, where development is regulated under the McAteer-Petris Act. The Coastal Act includes specific policies regarding such subjects as public access to the shore, protection of terrestrial and marine habitat, visual resources, land form alteration, and agricultural lands. These policies establish the standards applied to the planning decisions affecting the coastal zone made by local authorities and the CCC. The CCC is the designated coastal management agency for the purpose of administering the federal Coastal Zone Management Act, which grants regulatory control over all federal activities and federally licensed, permitted, or assisted activities to those agencies when coastal resources are affected.

Implementation of the California Coastal Act is carried out through a partnership between the CCC and local planning authorities, consisting of approximately 15 counties and 60 municipalities. These entities prepare local coastal programs (LCPs), which include land use plans (zoning maps, zoning ordinances, and other legal instruments) that are consistent with the policies established by the act and approved by the CCC. Development within the coastal zone can then proceed only subsequent to issuance of a coastal development permit by local planning authority, and for any submerged portion of a project, by the CCC itself under its retained jurisdiction.

Projects larger than 50 MWe are subject to the exclusive siting authority of the CEC. The Coastal Act includes the following statements of policy regarding development within the coastal zone. These policies could affect the conversion of a power plant from OTC to a closed-loop cooling system.

- Regarding electrical generating facilities the Coastal Act specifically states, "Notwithstanding the fact electrical generating facilities … may have significant adverse effects on coastal resources or coastal access, it may be necessary to locate such developments in the coastal zone in order to ensure that inland as well as coastal resources are preserved and that orderly economic development proceeds within the State."
- Development in the coastal zone shall not interfere with the public's right of access to the sea.
- Coastal areas that are well suited for water-oriented recreational activities that cannot be readily provided at inland water areas shall be protected for such uses.
- Upland areas necessary to support coastal recreational uses shall be reserved for such uses, where feasible. Marine resources shall be maintained, enhanced, and, where feasible, restored. Uses of the marine environment shall be carried out in a manner that will sustain the biological productivity of coastal waters.
- Development in areas adjacent to environmentally sensitive habitat areas, parks, and recreation areas shall be sited and designed to prevent impacts that would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.
- California Code of Regulations (CCR) Section 30250 establishes policy that new residential, commercial, and industrial development shall be located within, contiguous with, or in close proximity to existing developed areas able to accommodate it or, where such areas are not able to accommodate it, in other areas with adequate public services and where it will not have significant adverse effects on, either individually or cumulatively, coastal resources.
- The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views and, along the ocean and scenic coastal areas, to minimize the alteration of natural land forms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas.

- Industrial facilities shall be encouraged to locate or expand within existing sites and shall be permitted reasonable long-term growth, consistent with the policies of the Coastal Act.

Where new or expanded coastal-dependent industrial facilities cannot feasibly be accommodated in a manner consistent with the polices of the Coastal Act, such facilities may still be permitted if (1) alternative locations are infeasible or more environmentally damaging; (2) to do otherwise would adversely affect the public welfare; and (3) adverse environmental effects are mitigated to the maximum extent feasible.

The conversion of SONGS to closed-loop cooling and the addition of several new structures with a significant impact on the scenic and visual qualities of the coastal areas would be inconsistent with several Coastal Act policies. The effects of the conversion, and the overall consistency with the Coastal Act policies would have to be determined prior to conversion of SONGS to closed-loop cooling.

6.7.4.2 Closed-Loop Cooling System Permit Requirements

SCE currently maintains a CCC permit for SONGS. An amended Coastal Development Permit for SONGS Units 2 and 3 was issued by the CCC on February 16, 1982 (No. 6-81-330-A). Conversion to a closed-loop cooling system would require the modification of this permit. As the CPUC would likely be the lead agency in permitting conversion of SONGS to closed-loop cooling, SONGS would have to work directly with CPUC to address any concerns related to potential impacts and any CCC permit requirements. An estimated cost to modify the current CCC permit and provided regulatory support is presented in Attachment 5, Table 5-4. If conversion of SONGS could not be reconciled with the CPUC, conversion of SONGS to closed-loop cooling would be infeasible.

It should be noted that recent activities requiring a CCC Permit near SONGS have been rejected. The Coastal Commission voted unanimously to reject a coastal development permit in 2008 for a toll road on-ramp near San Onofre [Ref. 8.11]. The toll road on-ramp would have had significantly less aesthetic and environmental impacts than conversion of SONGS to closed-loop cooling. The Marine Review Committee has recommended, and SONGS is implementing, wetlands restoration, an offshore kelp reef, and funding for the fish hatchery in Carlsbad to compensate for impingement and entrainment impacts and offshore turbidity impacts. The CCC is on record that these mitigation measures that SONGS is taking meet the required performance standards, offsetting the offshore impacts from the plant [Ref. 8.12].

6.7.5 California Department of Fish and Game

The California Department of Fish and Game (CDFG) maintains native fish, wildlife, plant species and natural communities for their intrinsic and ecological value and their benefits to people. This includes habitat protection and maintenance in a sufficient amount and quality to ensure the survival of all species and natural communities. The department is also responsible for the diversified use of fish and wildlife including recreational, commercial, scientific and educational uses.

The CDFG may play various roles under the CEQA process. The Department is always a Trustee Agency, but under certain circumstances it may also be a Lead Agency or a

Responsible Agency. Also, by state law CDFG has jurisdiction over the conservation, protection, and management of wildlife, native plants, and habitat necessary to maintain biologically sustainable populations. The CDFG shall consult with lead and responsible agencies and shall provide the requisite biological expertise to review and comment upon environmental documents and impacts arising from project activities.

As discussed in Section 6.4, conversion of SONGS to closed-loop cooling could impact the habitats for several threatened and endangered species. If impacted, the CDFG could require additional review of each endangered and threatened species habitat to determine alternative or mitigation measures to lessen the environmental impact. If the CDFG acted as the Lead Agency, and no alternative or mitigation measure was feasible, the CDFG would have to issue a Statement of Overriding Consideration or conversion of SONGS to closed-loop cooling would be infeasible.

6.7.5.1 California Fish and Game Code – Section 2081, California Endangered Species Act, Incidental Take of Listed Species

Section 2080 of the Fish and Game Code prohibits "take" of any species that the Fish and Game Commission determines to be an endangered or threatened species. Take is defined in Section 86 of the Fish and Game Code as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." The California Endangered Species Act (CESA) allows for take incidental to otherwise lawful development projects and emphasizes early consultation to avoid potential impacts to rare, endangered, and threatened species and to develop appropriate mitigation planning to offset project caused losses of listed species populations and their essential habitats. If a proposed project could result in the catch or kill of any species listed, the project proponent is required to obtain a Section 2081 Incidental Take Permit. Should the conversion to closed-loop cooling involve a “take” of a state-listed species, the required 2081 permit should be obtainable through compliance with the MCBCP’s Integrated Natural Resource Management Plan (INRMP).

6.7.5.2 Integrated Natural Resource Management Plan

The location of the proposed cooling towers for SONGS Units 2 and 3 is on the Mesa Complex of the facility (Attachment 5, Figure 5-5). This area is not included in the NRC operating licenses for SONGS Units 2 and 3. This land utilized for the administrative operations of certain SONGS activities is within the boundaries of MCBCP and is leased through the Department of the Navy.

MCBCP maintains an INRMP, which was developed to provide the foundation of ecosystem management goals and objectives to direct management and stewardship of the lands entrusted to the Marine Corps by the American people. This INRMP documents and assists the development, integration, and coordination of natural resources management on Camp Pendleton. Further, it describes Camp Pendleton’s natural resources management programs and how those programs provide for: (1) the conservation and rehabilitation of natural resources; (2) the sustainable multipurpose use of the resources, which include hunting, fishing, trapping, and non-consumptive uses; and (3) public access to military installations to facilitate the use of these resources, subject to safety requirements and military security. MCBCP works with the CDFG, United States Fish and Wildlife Service (USFWS), and the Department of Defense (DOD) as well as local entities to ensure compliance with the INRMP is maintained [Ref. 8.95, Section 1.4]. Additional details related to INRMP and potential impacts from the conversion of SONGS to closed-loop cooling are presented in Section 6.4.

6.7.5.3 Closed-Loop Cooling System Permit Requirements

As referenced above, ecological management for MCBCP, including the Mesa Complex, is maintained through the INRMP which is reviewed on an annual basis. Based on maintaining the INRMP, no additional CDFG permits (e.g. 1602, 2081) should be needed for this project. SCE has met with MCBPC representatives concerning the implementation of closed-loop cooling at SONGS and the Marines are preparing their response to this proposed action. A consultation letter would be prepared and submitted to CDFG to inform the agency of the potential project and get feedback on any issues or questions they may have concerning this project. Impacts related to the construction and operation of the cooling towers to the INRMP would have to be evaluated and mitigation measures could be necessary to limit potential impacts. SONGS would work directly with the CDFG and MCBCP to address any concerns related to potential ecological impacts. Estimated costs associated with addressing impacts to the INRMP and regulatory support is presented in Attachment 5, Table 5-4.

6.7.6 California State Historical Preservation Office

As discussed in Section 6.7.4, the Mesa Complex has previously been disturbed including the construction of several buildings and other facilities used by SCE. Although this land has been disturbed, under CEQA the California SHPO would have to be consulted to ensure that any cultural resources in the vicinity of the construction activities (cooling towers and underground pipe tunnels) are identified and protected. Details related to the assessment of cultural resources are presented in Section 6.6.

SONGS would work directly with the SHPO to address any concerns related to cultural resource impacts. Since SHPO would provide input to the Lead Agency, the cultural resource impact recommendation would influence the Lead Agency's decision on whether alternative or mitigation measures were feasible, and whether or not the Lead Agency would issue a Statement of Overriding Consideration. If alternative measures were infeasible and no Statement of Overriding Consideration was issued, conversion of SONGS to closed-loop cooling would be infeasible.

Estimated costs associated with developing a cultural resource investigation and regulatory support are presented in Attachment 5, Table 5-4.

6.7.7 California State Lands Commission

The California State Land Commission (SLC) has jurisdiction and control over public trust lands, which can generally be described as all ungranted tidelands and submerged lands and beds of navigable rivers, streams, lakes, bays, estuaries, inlets, and straits in the state. These lands include a wide section of tidal and submerged land adjacent to the state's coast and offshore islands, including bays, estuaries, and lagoons, and are managed by the SLC under a multiple-use policy for water-related commerce, navigation, fisheries, recreation, open space, and other recognized public trust uses.

In its administration of surface leases on public trust lands, the SLC considers numerous factors in determining whether a proposed use is appropriate, including the protection of natural resources and other environmental values as well as preservation or enhancement of the public's access to state lands.

Where a lease is issued, the SLC can serve as the lead agency for CEQA analyses, but it is believed that the CPUC would be the lead agency if the decision is made to proceed with this project. The SLC also comments on Environmental Impact Reports (EIRs) for land use changes within its jurisdiction and on projects that affect state lands. The SLC also conducts a review of applications submitted to the CCC.

SONGS would work directly with the SLC to address any concerns related to visual impacts. Since SLC would provide input to the Lead Agency, the visual impact recommendation would influence the Lead Agency's decision on whether alternative or mitigation measures were feasible, and whether or not the Lead Agency would issue a Statement of Override Consideration. If alternative measures were infeasible and no Statement of Override Consideration was issued, conversion of SONGS to closed-loop cooling would be infeasible.

Estimated costs associated with regulatory support are presented in Table Attachment 5, Table 5-4.

6.7.8 California State Parks

The California State Parks (CSP) is responsible for protecting and maintaining all state owned parks in California. Currently there are hundreds of parks in the CSP system covering over 1.4 million square miles and 280 miles of coastline [Ref. 8.17]. There are four state park areas adjacent to SONGS and information on these parks is presented below.

6.7.8.1 Local Park Information

SONGS is located between San Onofre State Beach and San Onofre Surf Beach.

San Onofre State Beach is a rare 3000-acre scenic coastal-canyon park with high environmental value and recreational use. The park includes three distinct areas: San Onofre Bluffs, San Onofre Surf Beach, and San Mateo Campground.

San Onofre Surf Beach offers a world renowned and historical surf break. The beach is strictly available for day-use with no camping.

San Onofre Bluffs offers camping and day-use parking along Old Highway 101 adjacent to the sandstone bluffs. The beach below is popular with swimmers and surfers with six rugged dirt access trails cut into the bluff above. All campsites include a fire pit and picnic table.

San Mateo Campground lies a short distance inland from the 3.5 miles of sandy beaches within San Onofre State Beach. A 1.5 mile Nature Trail connects the campground to Trestles Beach, a world class surfing site. San Mateo Creek flows just east of the campground outward toward the ocean creating key riparian and wetland habitats, which host some rare and even endangered species.

6.7.8.2 Closed-Loop Cooling System Permit Requirements

Like the other California agencies, CSP must follow the CEQA requirements and could have some questions or comments on the placement and operations of cooling towers in the vicinity of four of their parks. SONGS would work with the CSP under the CEQA process to address any concerns related to potential ecological impacts. SONGS would likely continue to maintain beach access between San Onofre State Beach and San Onofre Surf Beach as required by CSP and MCBCP [Ref. 8.4].

Since CSP would provide input to the Lead Agency, their recommendation would influence the Lead Agency's decision on whether alternative or mitigation measures were feasible, and whether or not the Lead Agency would issue a Statement of Override Consideration. If alternative measures were infeasible and no Statement of Override Consideration was issued, conversion of SONGS to closed-loop cooling would be infeasible.

The estimated costs associated with regulatory support are presented in Attachment 5, Table 5-4.

6.7.9 Air Pollution Control District – San Diego

In California, the CARB develops statewide air quality standards, but authority to enforce the requirements of the CAA and its implementing regulations, as well as state and local air pollution laws and regulations, rests with the 35 regional air pollution authorities known as the Air Pollution Control Districts / Air Quality Management Districts (APCDs/AQMDs). APCDs/AQMDs are established by a county or larger regional area, issue all permits and approvals required by the CAA, and are responsible for establishing individual airshed plans.

As discussed in Section 6.1, the CARB has the authority to enforce regulations to both achieve and maintain the NAAQS. CARB has established additional standards, known as the CAAQS, which are generally more stringent than the NAAQS. CARB is responsible for the development, adoption, and enforcement of the state's motor vehicle emissions program, as well as the adoption of the CAAQS. CARB also reviews operations and programs of the local air districts and requires each air district with jurisdiction over a nonattainment area to develop its own strategy for achieving the NAAQS and CAAQS.

The local Air Pollution Control Districts / Air Quality Management Districts (APCDs/AQMDs) have the primary responsibility for the development and implementation of rules and regulations designed to attain the NAAQS and CAAQS, as well as the permitting of new or modified sources, development of air quality management plans, and adoption and enforcement of air pollution regulations. CARB, similar to the EPA, designates areas as either "attainment" or "nonattainment" based on compliance or noncompliance with the CAAQS. CARB considers an area to be in nonattainment if the CAAQS have been exceeded more than once in three years.

6.7.9.1 San Diego Air Pollution Control District (SDAPCD)

As described in Section 6.1, the SDAPCD is the agency responsible for protecting public health and welfare through the administration of federal and state air quality laws and policies within the SDAB. The monitoring of air pollution, preparation of the San Diego County's portion of the SIP, and promulgation of rules and regulations are included in the SDAPCD's tasks. The SIP includes strategies and tactics to be used to attain and maintain acceptable air quality in the county; this list of strategies is called the Regional Air Quality Strategies (RAQS). SDAPCD regulations require that any equipment that emits or controls air contaminants be permitted (Permit to Construct or Permit to Operate) prior to construction, installation, or operation. The SDAPCD is responsible for review of applications and for the approval and issuance of these permits.

The SDAB has recently been designated as an attainment area with respect to the Federal Ozone (O_3) standard. As a result of this change, the (de minimis) emissions levels for Nitrogen Oxides (NOx) and volatile organic compounds (VOC) that would trigger a full conformity analysis have increased from 50 to 100 tons. The statuses of state and federal designations for San Diego County as of the 2007 annual report are listed in Section 6.1.

6.7.9.2 Closed-Loop Cooling System Permit Requirements

Sea water would be used in the closed-loop cooling systems at SONGS, impacting vegetation in a down-wind direction with salt deposition. Plume visibility impacts would also need to be considered, particularly with respect to the proximity of Interstate 5, located between the SONGS Coastal Complex and the proposed cooling towers east of the facility, as well as impacts on the adjacent MCBCP. Salt emissions (PM_{10}) from the cooling towers (both units with a generating capacity factor of 90%) were calculated to be up between 827.8 and 837.2 tons per year (see Section 6.1 for calculations). Currently there may not be enough emission credits for PM_{10} in the San Diego region and those that are available would be very expensive. SCE contacted the SDAPCD to discuss the impacts of operating cooling towers at SONGS and how such cooling towers could be permitted as well as the availability of additional emission credits. Per conversations with SDAPCD staff, only approximately 160 tons of PM_{10} offset credits are currently available. Therefore, it is unlikely that SONGS could locate and purchase a sufficient number of PM_{10} credits to cover between 827.8 and 837.2 tons per year of emissions generated by the cooling towers. Conversion of SONGS to closed-loop cooling would be infeasible if the required PM_{10} credits were not available.

6.7.10 State Water Quality Control Board

Created by the state legislature in 1967, the five-member State Water Quality Control Board (SWQCB) protects water quality by setting statewide policy, coordinating and supporting the regional water board efforts, and reviewing petitions that contest regional board actions. The SWQCB is also solely responsible for allocating surface water rights and works in close coordination with California's nine Regional Water Quality Control Boards (RWQCB) to preserve, protect, enhance and restore water quality. Major areas of focus include:

- Stormwater

- Wastewater treatment
- Water quality monitoring
- Wetlands protection
- Ocean protection
- Environmental education
- Environmental justice
- Clean up contaminated sites, including brownfield sites
- Low-impact development

6.7.10.1 Regional Water Quality Control Boards

California's nine RWQCBs are semi-autonomous agencies, each consisting of nine part-time board members appointed by the governor and confirmed by the California State Senate. Regional boundaries are based on watersheds and water quality requirements are based on the unique differences in climate, topography, geology and hydrology for each watershed. Each RWQCB makes critical water quality decisions for its region, including setting standards, issuing waste discharge requirements, determining compliance with those requirements, and taking appropriate enforcement actions.

These RWQCBs are also responsible for implementing the requirements of the Porter-Cologne Water Quality Control Act and the U.S. Clean Water Act (CWA), including CWA Section 316(b), which governs cooling water intake structures. Each RWQCB implements the requirements of the CWA and Porter-Cologne through the issuance of NPDES permits, which include standards set forth in each RWQCB's Basin Plan as well as State Water Quality Control plans such as the Thermal Plan, Ocean Plan, and California Toxics Rule (CTR).

6.7.10.2 National Pollution Discharge Elimination System Permit

Pursuant to Section 402 of the Federal Clean Water Act (CWA) and Section 13370 of the California Water Code (CWC), the EPA approved the California state program to issue and enforce NPDES permits for pollutant discharges to surface waters of the state. The regional board is responsible for implementing the NPDES permit program pursuant to the CWA at the facility regulated under this Order. Pursuant to Section 13263, Article 4, Chapter 4 of the CWC, the Regional Boards are required to issue Waste Discharge Requirements for discharges that could affect the quality of the state's waters. Limitations, prohibitions and provisions of this Order were established pursuant to Sections 208 (b), 257, 258, 301, 302, 303 (d), 304, 306, 307, 316, 403, 405, and/or 503 of the CWA and implementing regulations in Title 40 of the Code of Federal Regulations (40 CFR), including the NPDES program implementing regulations. This action to adopt an NPDES permit is exempt from the requirements of the California Environmental Quality Act (CEQA, Public Resources Code Section 21100, et seq.) in accordance with Section 13389 of the CWC.

NPDES permits issued to power plants address the operation of cooling water intake structures that withdraw water from surface waters of the state as well as the direct discharge of cooling water and other wastewaters.

SONGS Units 2 and 3 lie within the jurisdiction of the San Diego RWQCB. This agency is responsible for issuing the facility's NPDES permits (each unit has its own permit). These permits describe the outfalls used to plant operations related to the intake and discharge of wastewaters, effluent limits of chemical concentrations in the waste stream, and monitoring / reporting requirements. It should be noted that naturally occurring metals that would be drawn in by the make-up water flow would be concentrated in the closed-loop circulating water system. Closed-loop cooling blowdown would then discharge these concentrated metals to the Pacific Ocean, and thus would need to be reviewed against the California Ocean Plan limits for each metal to ensure compliance. Due to the closed-loop cooling cycles of concentration, it is likely that several California Ocean Plan limits may be exceeded, possibly requiring additional costly treatment of blowdown prior to discharge.

6.7.10.3 Closed-Loop Cooling System Permit Requirements

Since conversion of a once through cooling system to a closed-loop cooling system would require a major modification to the facility's NPDES permit, the San Diego RWQCB would have a major role in permitting power plant conversions. The most significant issue from operating the cooling tower systems would be that it would generate elevated saline blowdown concentrations discharged to the Pacific Ocean for disposal.

Closed-loop operation of SONGs would be subject to NPDES permit requirements, such that if cooling tower blowdown concentrations did not meet the permit requirements SONGS would be forced to investigate costly additions to the closed-loop design. Estimated costs to modify the existing NPDES permits and regulatory support are presented in Attachment 5, Table 5-4.

6.7.11 United States Army Corps of Engineers

The United States Army Corps of Engineers (USACE) is responsible for investigating, developing and maintaining the nation's water and related environmental resources. The Los Angeles District encompasses 226,000 square miles in four states, protects 420 miles of Southern California shoreline from Morro Bay to the Mexican border and supports nine military bases. Established in 1898, the district has been recognized for providing engineering services for the southwest for more than 100 years.

6.7.11.1 USACE Section 404 Permit Requirements

Section 404 of the U.S. Clean Water Act regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other U.S. waters. The USACE is the federal agency authorized to issue Section 404 Permits for certain activities conducted in wetlands or "other waters of the U.S." Depending on the scope of the project and method of construction, certain activities may require this permit. Examples include ponds, embankments, and stream channelization. A Regional General Permit (RGP) is pending that would give the state the lead for most Standard Individual 404 permits, enabling this function to be handled during the state permitting process.

6.7.11.2 Closed-Loop Cooling System Permit Requirements

It is likely that the discharge structures for SONGS Units 2 and 3 would require minor diffuser modifications to accommodate the reduced discharge flow from a closed-loop cooling system. There could be some minor costs in responding to any USACE questions or comments concerning conversion of SONGS to closed-loop cooling and these costs have been included in Attachment 5, Table 5-4. It should be noted that, if significant modifications to the intake structure, discharge structure or both would be required, there would be significant cost issues related to obtaining the proper USACE permits.

6.7.12 United States Fish and Wildlife Service

The United States Fish and Wildlife Service (USFWS) issues permits under various wildlife laws and treaties at different offices at the national, regional, and/or wildlife park levels. Permits enable the public to engage in legitimate wildlife-related activities that would otherwise be prohibited by law. Service permit programs ensure that such activities are carried out in a manner that safeguards wildlife. Additionally, some permits promote conservation efforts by authorizing scientific research, generating data, or allowing wildlife management and rehabilitation activities to go forward.

Permits are handled by permitting programs in International Affairs (Management Authority), Endangered Species, Law Enforcement, and Migratory Birds.

- Endangered Species – The various USFWS regional offices administer native endangered and threatened species permits under the Federal Endangered Species Act (FESA; except permits for import and export). Permits are issued to qualified applicants for the following types of activities: enhancement of survival associated with Safe Harbor Agreements and Candidate Conservation Agreements with Assurances, incidental take associated with Habitat Conservation Plans, recovery, and interstate commerce. Permits for import and export are issued by International Affairs (Division of Management Authority).

- Migratory Birds – The various USFWS regional offices administer permits for qualified applicants for the following types of activities: falconry, raptor propagation, scientific collecting, rehabilitation, conservation education, migratory game bird propagation, salvage, depredation control, taxidermy, and waterfowl sale and disposal. These offices also administer permit activities involving bald and golden eagles, as authorized by the Bald and Golden Eagle Protection Act and migratory birds under the Migratory Bird Treaty Act [Ref. 8.57].

As discussed in Section 6.7.5, ecological management for MCBCP including the Mesa Complex is maintained through MCBCP's INRMP, which is reviewed on an annual basis. Based on maintaining the INRMP, it is expected that no additional USFWS permits would be needed for conversion of SONGS to closed-loop cooling. A consultation letter was prepared and submitted to USFWS to inform the agency of the potential project and get their feedback on any issues or questions they may have concerning this project. SONGS would work directly with the USFWS, CDFG, and MCBCP to address any concerns related to potential ecological impacts. Only minor regulatory support costs would be expected from addressing any potential USFWS questions or concerns. These estimated costs are presented in Attachment 5, Table 5-4.

6.7.13 United States Nuclear Regulatory Commission

A nuclear facility's design, such as SONGS Units 2 and 3, is understandably more complex than a typical fossil-fueled facility and incorporates additional systems that require cooling in addition to the main condenser. Auxiliary and safety systems, such as component cooling, used fuel storage, and emergency cooling, may operate in parallel with the main condenser system with dedicated pumps and supply lines. These systems may also be integrated as part of the facility-wide cooling system. In either case, special consideration must be given to ensure these systems could continue to operate as intended following conversion to closed-loop cooling.

The Energy Reorganization Act of 1974 established the NRC and tasked the agency with the oversight of commercial nuclear operations, material and waste management, and decommissioning activities. Accordingly, the NRC exercises broad regulatory authority over commercial nuclear power plants to protect public health and safety and maintains rigorous design criteria to meet these goals. The NRC has also developed environmental protection regulations under the provisions of the National Environmental Policy Act (NEPA). Any major modification proposed for an existing facility would be subject to NRC review and approval to ensure compliance with all applicable safety and environmental regulations and standards.

NRC regulations 10 CFR 50.59, 10 CFR 50.90, and 10 CFR 51 govern proposed changes to a nuclear plant. These regulations specify when prior NRC review and approval of plant changes is necessary. As part of the cooling tower retrofit, SCE would perform a 10 CFR 50.59 evaluation in accordance with the guidance provided in Revision 1 of NEI 96-07 and Regulatory Guide 1.187, both dated November 2000.

6.8 SONGS Property Restrictions

As described in Section 2, SONGS is located on the Pacific coast of Southern California in northern San Diego County. The site is located entirely within the boundaries of the MCBCP near the northwest end of the 18 mile shoreline. The property upon which the station is built is under lease and easement agreements from the Department of Navy (DoN) until May 12, 2024 [Ref. 8.95, p. 2-31]. The SONGS Coastal Complex is bounded on the west by the Pacific Ocean, on the east by Interstate 5 and the North County Transit District of San Diego (NCTD) railroad right-of-way and on the northwest and southeast by San Onofre State Beach [Ref.8.75, pp. 1.2-1 and 2.2-4]. The SONGS Mesa Complex is bounded on the southwest by Interstate 5 and the NCTD railroad right-of-way and on all other sides by MCBCP. The cooling towers and the associated pipelines would be located as shown in Attachment 5, Figure 5-5.

A number of long-term leases and easements have become part of the land use on the MCBCP. An estimated 3600 acres of leased land is no longer available for training [Ref. 8.95, p. 2-28]. Future requests for non-military projects and leases on MCBCP are evaluated, with regards to potential impacts to the base. Lease reviews require applicants to meet the following conditions:

- Proposal cannot adversely affect training.
- Proposal cannot degrade MCBCP quality of life.
- Proposals must be environmentally non-degrading.
- Proposal must ensure safety of operating forces.
- Construction must be consistent with MCBCP architecture.

Lessees are required to manage the natural resources on the lands leased for their use, consistent with the philosophies and supportive of the objectives of the MCBCP. Each lessee that manages and/or controls use of lands leased from the base is required to generate and submit a natural resources management plan for their leased lands for approval by the base within one year of establishment of their lease or renewal [Ref. 8.95, pp. 2-28 and 2-29].

SONGS's real estate rights on MCBCP are vested in nine DoN-issued easements and two leases totaling 438 acres [Ref. 8.95, p. 8]. The leased land outside the Coastal Complex, including the Mesa Complex, consists of nine parcels ranging from 1.3 to 69.3 acres [Ref. 8.31, p. 6].

The SONGS exclusion area is roughly formed by two semi-circles with radii of 1970 feet each, centered on the Unit 2 containment and a point 134 feet southeast of the Unit 3 containment, with a tangent connecting the landward arcs and the seaward arcs of the two semi-circles [Ref. 8.75, p. 2.1-1]. SCE has authority to control all activities within the exclusion area, including the exclusion or removal of personnel and property, by grant of easement from the United States made by the Secretary of the Navy pursuant to the authority of Public Law 88-82. All mineral rights in the land portion of the exclusion area are held by the United States Government [Ref. 8.75, p. 2.1-3]. As specified in SONGS Unit 2 and Unit 3 Coastal Development Permit, SCE is required to provide public access between the two parts of San Onofre State Beach around the Coastal Complex.

An easement has been granted by the DoN to CalTrans for operating Interstate 5 on MCBCP in the immediate vicinity of SONGS. This easement is used for the construction, operation, and maintenance of Interstate 5 and has been granted in perpetuity [Ref. 8.95, p. 2-31]. In addition, NCTD owns and operates a commuter rail train system that runs along the coastal area of the Base. NCTD's railroad corridor is contained within a 100-foot right-of-way easement granted to NCTD in perpetuity by the DoN [Ref. 8.95, p. 2-32].

Tunneling associated with the pipelines required for conversion to closed-loop cooling would cross MCBCP land not currently leased to SONGS, including easements held by CalTrans for Interstate 5 and NCTD for the railroad (see Attachment 5, Figure 5-5). Conversion to closed-loop cooling and the associated construction and tunneling would require additional real estate agreements from the DoN.

7 Conclusion

This feasibility study was conducted to determine if closed-loop cooling could be engineered for SONGS given the site-specific constraints and, if closed-loop cooling was possible, to create a conceptual design to estimate the cost of conversion.

As discussed in Section 3, there have been no conversions of operating nuclear stations from once-through to closed-loop cooling. Disregarding the inherent uncertainty of such a retrofit, conversion at an ideal site location would represent a massive engineering and construction undertaking. The SONGS site is not ideal for conversion, with significant elevation changes, a general lack of available space and the collocation of Interstate 5, a NCTD Railway line, and old U.S. Highway 101, thereby posing significant additional site-specific challenges. To determine feasibility, the engineering aspects and the environmental impacts of conversion to closed-loop cooling were considered.

Engineering aspects of the conversion include the selection and siting of the most appropriate cooling tower technology at SONGS. A conceptual design, cost estimate, and construction schedule was developed for the selected wet hybrid cooling towers. The costing of closed-loop conversion includes the initial capital costs, outage costs, and continuous operational, parasitic, and maintenance costs.

The environmental impacts associated with conversion of SONGS to closed-loop cooling include cooling tower plume and noise generation, site aesthetics, construction related impacts, and intake flow. It should be noted that SCE does not own the land on which SONGS resides, and as such all construction activities necessary for conversion to closed-loop cooling would need to be approved by MCBCP. Additionally, since between 827.8 and 837.2 tons of PM_{10} emissions would be discharged annually from the hybrid cooling towers, it is doubtful that SONGS could locate and purchase a sufficient number of PM_{10} emission credits for closed-loop operation. It is likely that due to permitting and land use constraints conversion of SONGS to closed-loop cooling would be infeasible.

As discussed in Section 5, the design, construction, construction outage requirements, and start-up of closed-loop cooling at SONGS would cost approximately $3.0 billion and would take a minimum of 5 years. It should be noted that due to the limited availability of PM_{10} emission credits and large variability in price, a cost for obtaining the necessary PM_{10} credits has not been included in the cost estimate. If PM_{10} credits were to be available, the $3.0 billion initial cost of converting SONGS to closed-loop cooling would increase significantly to include their purchase.

In addition to these onetime costs, SONGS would incur continuous operational, parasitic, and maintenance costs of more than $85 million per year. Closed-loop cooling would remove an annual average of approximately 143 MWe, and a summer daylight peak of approximately 191 MWe, from the California electrical system, which could decrease grid reliability[9].

[9] In 1999 and 2000, the California Independent System Operator (CA ISO) investigated the role that Diablo Canyon and SONGS play in maintaining grid reliability. The CA ISO found that SONGS provides substantial grid reliability benefits as a result of its location between the SCE and San Diego Gas & Electric (SDG&E) service territories. Moreover, significant transmission reinforcements would be needed if SONGS were shut down [Ref. 8.49].

7.1 Closed-Loop Cooling Engineering Assessment

Conversion to closed-loop condenser cooling represents a massive engineering and construction undertaking, even without the significant site constraints set forth by the considerable elevation changes, collocation of Interstate 5, a NCTD Railway line, and old U.S. Highway 101, and general lack of available space at SONGS.

To provide adequate cooling capacity while avoiding the formation of a visible plume during the majority of meteorological conditions, hybrid cooling towers would be selected for SONGS closed-loop conversion. These hybrid cooling towers would be located on the east side of Interstate 5 and would require large diameter piping to be tunneled beneath Interstate 5 from the SONGS Coastal Complex to the Mesa Complex. From the tunnel, closed-loop circulating water would be routed beside the seawall and would draw suction for a hot water reservoir and provide cooled water from the cooling tower back to a cold water reservoir. Due to the size constraints of the cold water reservoir, three new vertical wet pit circulating water pumps would be needed to pass cooling water through condenser. Additionally, three new high volume / high head vertical wet pit pumps would be required to pump circulating water from the hot water reservoir up to the cooling towers. The circulating water would then be distributed throughout the cooling towers, cooled, and gravity fed back through the circulating water tunnel piping. It should be noted that operation of cooling towers at a nuclear power plant with such a large degree of elevation change between the cooling towers and the condenser is unprecedented, and additional engineering design would be required to ensure public safety would not be compromised by the discharge of cooling water across the SONGS seawall during a loss of power event.

The closed-loop cooling system would be specifically designed to replace only the portion of seawater intake that does not serve engineered safety features. In particular, the saltwater cooling system would continue to operate as currently designed, with the existing intake structure continuing operation to provide saltwater cooling system flow.

The overall construction schedule for the conversion would extend approximately 66 months from the start date with engineering work beginning approximately 3 months prior to tunneling construction and 12 months prior to general construction. The construction start date is schedule to take place after the steam generator replacement projects at each unit have been completed. Of these 66 months, both SONGS Units 2 and 3 would require a construction outage of approximately 21.1 months. Conversion of SONGS to closed-loop cooling would be a “first-of-a-kind” construction project, and thus the current schedule would likely increase as a detailed engineering design investigates and addresses currently unknown design issues.

The cost of converting SONGS Units 2 and 3 to closed-loop cooling can be broken down into five categories: initial capital costs including engineering, procurement and construction, costs of replacement power during the construction outages, costs due to parasitic losses, and maintenance costs. The capital costs of the closed-loop conversion include design, procurement, implementation, and startup activities. In addition, a recommended contingency of 25% is included to account for the inherent uncertainty associated with any conceptual cost estimate produced before a detailed design is finalized. The outage, operational, and parasitic costs were determined by calculating the cost of lost electrical generation by applying a projected price of $73.30 per MWhr (see Attachment 1, Section 5). Finally, ongoing maintenance costs were determined by aggregating typical maintenance costs of the closed-loop cooling equipment for each year of the equipment's lifespan. Table 7.1 provides a basic summary of one-time costs associated with converting SONGS to closed-loop cooling, as well as a breakdown of the major components that comprise each cost determination. A detailed description of the costs presented in Table 7.1 is included in Attachment 4.

Table 7.1 One-Time Costs of Conversion to Closed-Loop Cooling at SONGS

Capital Costs - Design	**Estimated Cost**
Design Engineering and Modification Packages	$ 19,508,000
Capital Costs - Procurement	**Estimated Cost**
Linear Hybrid Cooling Towers (6)	$ 219,240,000
Circulating Water Pumps (6)	$ 12,960,000
Recirculating Water Pumps (6)	$ 26,400,000
Startup Pump (2)	$ 4,320,000
Subtotal	$ 262,920,000
Capital Costs - Construction	**Estimated Cost**
Tunneling	$ 122,851,000
Construction / Installation	$ 85,367,000
Field Service Testing, Commissioning, Startup and Training	$ 1,000,000
Subtotal	$ 209,218,000
Capital Costs - Total Work Scope	**Estimated Cost**
Subtotal	$ 491,646,000
Recommended Contingency (25%)	$ 122,912,000
Capital Cost Subtotal	$ 614,558,000
Construction Outage Costs	**Estimated Cost**
21.1 Month Construction Outage @ $73.30 per MWhr	$ 2,427,403,000
Total One-Time Costs	**$ 3,041,961,000**

Table 7.2 summarizes the projected annual costs associated with the ongoing operation of closed-loop cooling at SONGS. A breakdown of the major components that comprise each cost determination is included. A detailed description of the costs presented in Table 7.2 is included in Attachment 4.

Table 7.2 Annual Costs of Conversion to Closed-Loop Cooling at SONGS

New Condenser Operating Parameters Cost	Estimated Cost
Continuous 73.5 MWe Loss @ $73.30 per MWhr	$ 42,476, 000
Parasitic Losses Cost	**Estimated Cost**
Continuous 69.6 MWe Loss @ $73.30 per MWhr	$ 40,222, 000
Operations and Maintenance Costs*	**Estimated Cost**
Cooling Tower Support	$ 602,000
Cooling Tower Maintenance	$ 1,500,000
Pump Maintenance	$ 440,000
Water Treatment	$ 300,000
Subtotal	$ 2,842,000
Total Annual Costs	**$ 85,540,000**

*Costs for Years 1 – 5; for Years 6 - 15 add $1,000,000; for Years 16 – 20, add $3,000,000.

7.2 Closed-Loop Cooling Environmental / Permitting Assessment

Several significant environmental impacts and regulatory challenges would be associated with conversion from once-through cooling to closed-loop cooling at SONGS. The retrofit construction, system modifications, disruption of operations, permitting amendments, and operation of a closed-loop cooling system would transfer the predominant impacts from aquatic ecosystems to terrestrial ecosystems.

The potential environmental impacts of conversion to closed-loop cooling at SONGS would require CCC approvals and include, but are not limited to, the following:

- Land disturbance that could result in adverse impact to air quality, terrestrial ecosystems, and archeological and historic resources.
- Generation of excavation construction debris and other solid waste requiring offsite disposal and commitment of construction landfill resources.
- Transportation related impacts due to construction debris disposal, equipment and materials transport, and site workers that could cause traffic congestion and increased local air emissions.
- San Onofre State Beach aesthetics issues during construction that may be viewed as a negative to park users.

Best management practices could minimize the impacts to terrestrial habitats and species during construction due to stormwater runoff and fugitive dust emissions. A cultural resources survey would be required for the areas disturbed by construction, but there would be no impacts anticipated to sites of significant archeological concern.

The most significant construction impacts are related to the excavation and offsite disposal of soils and rock from the construction and installation of cooling towers, eight circulating water pipes, and four circulating water reservoirs. Total construction excavation debris would be approximately 297,210 bank cubic yards of sandstone and alluvial material. One or more suitable offsite construction debris disposal sites would need to be identified to receive this material which could result in additional potential impacts to terrestrial resources. In addition, assuming 20 cubic yard transport loads, this would result in approximately 20,800 truck shipments away from the site, which does not include any other equipment transportation.

This, added to additional construction vehicular traffic, could result in periods of traffic congestion on Interstate 5 and/or local roadways, particularly during weekends when high recreational use of state beaches occurs. Additional transportation related air emissions would result from construction activities throughout the 66 month construction duration, but the effects would be localized.

Impacts during cooling tower operation would be significant, especially those related to cooling tower drift. Based on the engineering estimates of drift for hybrid plume abated cooling towers, between 827.8 and 837.2 tons per year of PM_{10} would be emitted. Approximately 165 tons of salt would be deposited downwind (south-southwest) of the proposed cooling towers extending across the SONGS Coastal Complex area and switchyard, causing significant additional maintenance requirements and lead to arcing. Salt deposition across the nearby Camp Pendleton housing areas to the northeast could result in additional corrosion problems. Salt deposition across the coastal scrubland habitat could cause adverse impacts to vegetation and habitat, although these impacts would likely be minor due to the salt tolerance already existing in most of the nearby terrestrial ecosystems. The SDAPCB could potentially require SONGS to purchase PM_{10} emission reduction credits to account for the significant cooling tower PM_{10} emissions. Based on 2007 PM_{10} emission reduction credits cost data in California, it seems doubtful that SONGS could locate and purchase a sufficient number of credits to cover the expected volume of emissions, if required to do so by SDAPCD.

The conversion from once-through cooling to closed-loop cooling would result in an annual average loss of baseload power generation of 143 MWe at SONGS Units 2 and 3. If that generating capacity was conservatively assumed to be replaced by a natural gas facility, an estimated additional 227,000 tons of CO_2 per year would be emitted to the atmosphere.

Closed-loop cooling systems concentrate the chemicals, minerals, and salts found in the source water body (Pacific Ocean) with each cycle of concentration. It is likely that modification of the discharge structure diffusers would be required to address the salinity and thermal NPDES permit limits and dilute the impacts of SONGS discharges which could temporarily disrupt aquatic resources during discharge structure modification.

The construction and operation of a closed-loop cooling system at SONGS would create significant regulatory and permitting challenges. The radiological liquid waste effluent treatment system would require modification to achieve compliance with NRC liquid effluent limits under 10 CFR 20.

Various permits would be required for the conversion of SONGS from once-through cooling to closed-loop cooling. All of these permits would need to be acquired in accordance with regulatory public participation requirements, and would likely incur intense public opposition due to project cost, aesthetics, air emissions, traffic, reduced coastal access, and potential ecological impacts. In addition to the permit requirements, CPUC would have to approve the one-time costs of conversion to closed-loop cooling as well as the ongoing annual costs. Failure to receive approval from any of the governing agencies would render the construction and operation of closed-loop cooling at SONGS infeasible.

8 References

8.1 40 CFR Part 125. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 125, *Criteria and Standards for the National Pollutant Discharge Elimination System.*

8.2 Air Pollution Control District. County of San Diego. *Air Quality in San Diego County 2007 Annual Report.*

8.3 Anderson, B., J. Hunt, S. Turpen, A. Coulon, and M. Martin. *Copper toxicity to microscopic stages of giant kelp Macrocystis pyrifera: interpopulation comparisons and temporal variability.* Marine Ecology Progress Series. 68:147-156. 1990.

8.4 Aspen Environmental Group. *Final Environmental Impact Report, San Onofre Nuclear Generating Station Steam Generator Replacement Project. Volume I.* Prepared for the California Public Utilities Commission (SCH #2004101008). San Francisco, California. 2005.

8.5 Barnes, R. and R. Hughes. *An Introduction to Marine Ecology*. Blackwell Scientific Publications. Oxford, England. 361 pp. 1988.

8.6 Burlington Northern Santa Fe Railway. *Utility Accommodation Policy*. May 5, 2007. http://www.bnsf.com/tools/fieldengineering/pdf/utilacc.pdf. Accessed June 14, 2009.

8.7 Burror, Jim. Engineering Supervisor for Orange County Sanitary District. Telecon April 22, 2009

8.8 California Air Resources Board. *Emission Reduction Offsets Transaction Cost Summary Report for 2007*. December 2008.

8.9 California Coastal Commission. *Amendment to Coastal Development Permit for San Onofre Generating Station Units 2 and 3*. February 16, 1982.

8.10 California Coastal Commission. *Amendment to Public Access Walkway Permit*. Permit No: 183-73, Amendment No. 6-81-330-A. April 20, 1982.

8.11 California Coastal Commission. Minutes for Public Meeting. February 6, 2008. http://www.coastal.ca.gov/meetings/mtg-mm8-2.html. Accessed September 8, 2009.

8.12 California Coastal Commission. Status Report on SONGS Mitigation Program. December 2008. http://documents.coastal.ca.gov/reports/2009/1/W28a-1-2009.pdf. Accessed September 8, 2009.

8.13 California Department of Fish and Game. *California's living Marine Resources: A Status Report*. 2001.

8.14 California Department of Fish and Game. *Annual Status of the Fisheries Report Through 2003*. Belmont, Ca. 2004.

8.15 California Department of Fish and Game. *State and Federally Listed Endangered and Threatened Animals of California*. 2009.

8.16 California Department of Parks and Recreation. *Camping Reservation Guide*. 2009.

8.17 California Department of Parks and Recreation. *San Clemente State Beach Brochure*. 2002.

8.18 California Department of Parks and Recreation. *San Clemente State Beach General Development Plan*. February 1970. http://www.parks.ca.gov/pages/21299/files/611.pdf. Accessed May 7, 2009.

8.19 California Department Parks and Recreation. *San Onofre State Beach Revised General Plan*. June 1984. http://parks.ca.gov/pages/21299/files/663_1.pdf. Accessed June 5, 2009.

8.20 California Department of Parks and Recreation Planning Division. *The California State Park System Statistical Report: 2007/08 Fiscal Year*. March 2009.

8.21 California Department of Transportation, Headquarters Encroachment Permits Branch. *Encroachment Permits: Manual for Encroachment Permits on California State Highways*. Seventh Edition. January 2002. http://www.dot.ca.gov/hq/traffops/developserv/permits/. Accessed May 19, 2009.

8.22 California Regional Water Quality Control Board (CRWQCB). National Pollutant Discharge Elimination System (NPDES) Permits Nos. CA0108073 and CA0108181. 2005.

8.23 California Spatial Information Library. *California State Parks*. Available at http://casil.ucdavis.edu/casil/boundaries/. Accessed February 17, 2009.

8.24 California State Water Resources Control Board (SWRCB). March 2008. *Scoping Document: Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling*. Available at URL: http://www.waterboards.ca.gov/plans_policies/docs/coastal_estuarine/scope_doc031808.pdf. Accessed March 23, 2009.

8.25 Chapman, G., D. Denton, and J. Lazorchak. *Short-Term Methods For Estimating The Chronic Toxicity Of Effluents and Receiving Waters To West Coast Marine and Estuarine Organisms*. U.S.E.P.A document 600/R-95-136. 673 pp. 1995.

8.26 Council of the City of San Diego. March 10, 2008. *City of San Diego General Plan*. Available at http://www.sandiego.gov/planning/genplan/. Accessed June 25, 2009.

8.27 Department of the Interior. 1994. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Least Bell's Vireo*. Federal Register Volume 59 Number 22.

8.28 Department of the Interior. 2005. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Arroyo Toad*. Federal Register Volume 70 Number 70.

8.29 Department of the Interior. 2005. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for Brodiaea filifolia (thread-leaved brodiaea)*. Federal Register Volume 70 Number 238.

8.30 Department of the Interior. 2005. *Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the San Diego Fairy Shrimp*. Federal Register Volume 72 Number 238.

8.31 Department of the Navy. October 1, 1989. Administrative Modification No. 4 to Government Lease N6247482RP00P99.

8.32 EDAW, Inc. June 2005. *Disposition of Offshore Cooling Water Conduits, SONGS Unit 1 Final Environmental Impact Report (EIR)*. California State Lands Commission. State Clearinghouse Number SCH 2004061092.

8.33 Electric Power Research Institute. October 2007. *Issues Analysis of Retrofitting Once-Through Cooled Plants with Closed-Cycle Cooling: California Coastal Plants*. Palo Alto, CA.

8.34 Electric Power Research Institute. January 2008. *Comprehensive Demonstration Study for Southern California Edison's San Onofre Nuclear Generating Station*. Palo Alto, CA.

8.35 Electric Power Research Institute and California Energy Commission. 2003. *Use of Degraded Water Sources as Cooling Water in Power Plants*. Palo Alto, CA, and Sacramento, CA. 1005359.

8.36 ESRI. ArcGIS_9 software DVD. 2007.

8.37 Federal Register. Vol 42. No. 187. September 26, 1978. Page 43688.

8.38 Federal Register. Vol. 63, No. 170. September 2, 1998. Page 46693.

8.39 Federal Register. June 26, 2003. *Approval and Promulgation of Implementation Plans and Designation of Areas for Air Quality Planning Purposes; 1-Hour Ozone Standard for San Diego, CA.*

8.40 Federal Register. July 1, 1999. *Regional Haze Regulations: Final Rule.*

8.41 Feroz, S. Michael, Buehler, Frank S., and Britch, Michael J. 1999. *Boring and Jacking of 'The Big Pipe' Columbia Slough Consolidation Conduit in Portland, Oregon*. Rapid Excavation and Tunneling Conference Proceedings.

8.42 Gulachenski et al. March/April 1977. *Salt Water Spray Canal Contamination of Overhead Transmission Lines*. IEEE Transactions on Power Apparatus and Systems. Vol. PAS-96, No. 2. pp. 485-495.

8.43 Holbrook, S., M. Carr, R. Schmitt, and J. Coyer. 1990. *Effect of Giant Kelp on Local Abundance of Reef Fishes: The Importance of Ontogenetic Resource Requirements*. Bulletin of Marine Science. 47(1): 104-114.

8.44 Isham, D. and P. Ezell. 1973. *An Archaeological Survey of the Japanese Mesa and Units 2 and 3 of the San Onofre Nuclear Generating Station*. Report from San Diego State University to Southern California Edison Company. Rosemead, California.

8.45 Kaneshiro, J.Y., Stirbys, A.F., and Fischer, G.R. *Earth Pressure Balance tunneling for two short drives for the New Mississippi Outfall, Denver, Colorado*. Underground Space Use: Analysis of the Past and Lessons for the Future : Proceedings of the 31st ITA-AITES World Tunnel Congress, 7-12 May 2005, Istanbul, Turkey

8.46 Larry Drbal, Kayla Westra and Pat Boston. 1996. *Power Plant Engineering, 1st Edition*. Springer.

8.47 Lavenberg, R., G. Mcgowen, A. Jahn, J. Petersen, and T. Sciarrotta. 1986. *1978-1984 Abundance Of Southern California Nearshore Ichthyoplankton*. California Cooperative Oceanic Fisheries Investigations (CalCOFI) Rep., Vol. XXVII.

8.48 Meaux, M. *TCEQ launches investigation in response to six-car pile-up near BASF refinery this month*. The Orange Leader [Orange, TX]. January 27, 2007. Available at http://www.orangeleader.com/news/local_story_027014410.html. Accessed September 3, 2009.

8.49 MRW & Associates, Inc. October 2007. *Nuclear Power in California: 2007 Status Report*. California Energy Commission. http://www.energy.ca.gov/2007publications/CEC-100-2007-005/CEC-100-2007-005-F.pdf. Accessed June 24, 2009.

8.50 Multi-Agency Rocky Intertidal Network. 2004. *Egregia menziesii (Turner) Areschoug. Feather boa kelp*. www.marine.gov/egregia.htm. Accessed February 24, 2009.

8.51 Multi-Agency Rocky Intertidal Network. 2004. *Hesperophycus californicus Silva*. www.marine.gov/hesperophycus.htm. Accessed February 24, 2009.

8.52 Multi-Resolution Land Characteristics Consortium. 2001. *National Landcover Database (NLCD 2001). NLCD Zone 2 Land Cover*. http://www.mrlc.gov/multizone_download.php?zone=2. Accessed February 13, 2009.

8.53 National Oceanographic and Atmospheric Administration. 2009. *Green Turtle (Chelonia mydas)*. www.nmfs.noaa.gov/pr/species/turtles/green.htm. Accessed March 3, 2009.

8.54 National Oceanographic and Atmospheric Administration. 2009. *Leatherback Turtle (Dermochelys coriacea)*. www.nmfs.noaa.gov/pr/species/turtles/leatherback.htm. Accessed March 3, 2009.

8.55 National Oceanographic and Atmospheric Administration. 2009. *Olive Ridley Turtle (Lepidochelys olivacea)*. www.nmfs.noaa.gov/pr/species/turtles/oliveridley.htm. Accessed March 3, 2009.

8.56 National Oceanographic and Atmospheric Administration National Marine Fisheries Service. 2006. *Biological Opinion and Incidental Take Statement on the effects of the NRC's continued operation of DCPP and SONGS on threatened and endangered species in accordance with section 7 of the Endangered Species Act (ESA) of 1973*.

8.57 National Wildlife Refuge System. 2009. *Special Use Permits*.

8.58 NatureServe. *NatureServe Explorer: An online encyclopedia of life [web application]*. Version 7.1. Arlington, Virginia. http://www.natureserve.org/explorer. Accessed: April 19, 2009.

8.59 Odgen Environmental and Energy Services, Co., Inc. November 1994. *Biological Resources Report San Onofre Fence Drainage Project*.

8.60 Parker, P.L. and T.F. King. 1998. *Guidelines for Evaluating and Documenting Traditional Cultural Properties*. National Register Bulletin. U.S. Department of the Interior, National Park Service.

8.61 Perry, B. *Circulation in the Southern California Bight*. California State University at Long Beach. Long Beach, Ca. http://seis.natsci.csulb.edu/bperry/scbweb/circulation.htm. Accessed March 24, 2009.

8.62 PLG, Inc. (PLG). February 1990. *Assessment of Marine Review Committee Recommendations for SONGS Units 2 and 3*. Newport Beach, CA.

8.63 Rosen, M. 1978. *Archaeological Survey Report, San Onofre Units 2 & 3 Access Roads and Earth Borrow Sites*. Report from the University of California, Los Angeles, Archaeological Survey to the Southern California Edison Company. Rosemead, California.

8.64 RS Means Company, Inc. 2009. *RS Means Heavy Construction Cost Data 2009, 23th ed*. Construction Publishers & Consultants. Kingston, Massachusetts.

8.65 San Diego Air Pollution Control District. Regulation XIV, Rule 1410. 2004.

8.66 San Diego Convention and Visitors Bureau. *The Official Travel Resource for the San Diego Region: San Onofre State Beach*. http://www.sandiego.org/article_set/Visitors/5/27. Accessed May 7, 2009.

8.67 San Francisco Bay Conservation and Development Commission. 2007. *Shoreline Plants: A Landscape Guide for the San Francisco Bay*. http://www.bcdc.ca.gov/pdf/planning/SPLG.pdf. Accessed June 14, 2009

8.68 Schumerth, Dennis. *Gray & Impaired Water Cooling in Surface Condensers and Heat Exchangers*. Proceedings of PWR2006 ASME Power, May 2-4, 2006, Atlanta, GA, USA.

8.69 Seminoff, J., A. Resendiz, B. Resendiz, and W. Nichols. 2004. *Occurrence of Loggerhead Sea Turtles (Caretta caretta) in the Gulf of California, México: Evidence of Life-History Variation in the Pacific Ocean*. Herpetological Review, 35(1), 24–27.

8.70 Southern California Edison. January 2008. Comprehensive Demonstration Study for Southern California Edison's San Onofre Nuclear Generating Station. January 2008.

8.71 Southern California Edison. August 15, 2007. *Environmental Screening for Ground Disturbing Activities*. Corporate Environment, Health and Safety Directive EHS-EP-DR-002.

8.72 Southern California Edison. March 7, 2008. *Environmental Screening Form*.

8.73 Southern California Edison. 2005. *San Onofre Nuclear Generating Station. Steam Generator Replacement Project. Environmental Impact Report*.

8.74 Southern California Edison. 1981. *San Onofre Nuclear Generating Station 2 & 3. Environmental Report (ER).*

8.75 Southern California Edison. May 2007. *San Onofre Nuclear Generating Station Units 2 and 3. Updated Final Safety Analysis Report*.

8.76 Southern California Edison. *San Onofre Nuclear Generating Station Units 2 and 3. S023-5-1.7. POWER OPERATIONS. Operating Instructions*. Revision 38.

8.77 Southern California Edison. Offsite Dose Calculation Manual. SO123_ODCM.

8.78 Southern California Edison & URS. February 27, 2004. *Proponents Environmental Assessment for Replacement of the SONGS 2 &3 Steam Generators.*

8.79 Southern California Water Research Project. 1992. *Toxic Effects of Elevated Salinity and Desalination Waste Brine 1992-1993 Annual Report.* ftp://ftp.sccwrp.org/pub/download/DOCUMENTS/AnnualReports/1992_93AnnualReport/ar14.pdf. Accessed June 22, 2009.

8.80 SPX Cooling Technologies (SPX). 2006. *Cooling Tower Fundamentals*. 2nd Edition. Overland Park, Kansas.

8.81 Stauffer, G. 1983. *Calibration of Northern Anchovy Spawning Biomass Estimates Derived by Egg Production and Larval Census Methods*. CalCOFI Rep. Vol. XXIV.

8.82 Steneck, R.S. Graham, M.H. Bourque, B.J. Corbett, D. Erlandson, J.M. Estes, J.A. Tegner, M.J. *Kelp forest ecosystem: biodiversity, stability, resilience and future*. Environmental Conservation 29(4): 436-459. Submitted 2001; accepted September 25, 2002.

8.83 Tetra Tech, Inc. (Tetra Tech). February 2008. *California's Coastal Power Plants: Alternative Cooling System Analysis*. Golden, CO.

8.84 United States Army Corps of Engineers. 1999. *Engineering Manual 1110-2-3105, Mechanical and Electrical Design of Pumping Stations*. Changes 1 and 2.

8.85 United States Department of Energy. March 28, 1997. *Cost Estimating Guide.* Publication No. DOE G 430.1-1

8.86 United States Department of Transportation. 2004. *Synthesis of Noise Effects on Wildlife Populations*. Publication No. FHWA-HEP-06-016.

8.87 United States Environmental Protection Agency. April 2000. *Compilation of Air Pollutant Emission Factors*. Vol. I.

8.88 United States Environmental Protection Agency. July 9, 2004. *National Pollutant Discharge Elimination System – Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities*. Federal Register, Volume 69, Number 131, pp. 41576-41693. Washington, DC.

8.89 United States Environmental Protection Agency. July 9, 2007. *National Pollutant Discharge Elimination System – Suspension of Regulations Establishing Requirements for Cooling Water Intake Structures at Phase II Existing Facilities*. Federal Register, Volume 72, Number 130, pp. 37107-37109. Washington, DC.

8.90 United States Environmental Protection Agency. 2008. *Fact Sheet – Final Revisions to the National Ambient Air Quality Standards for Ozone*.

8.91 United States Fish and Wildlife Service. 2007. *National Wetlands Inventory, Wetlands Mapper*. http://wetlandsfws.er.usgs.gov/wtlnds/ launch.html. Accessed March 25, 2009.

8.92 United States Fish and Wildlife Service. *Critical Habitat Mapper*. http://criticalhabitat.fws.gov. Accessed April 23, 2009.

8.93 United States Geological Survey Colorado Plateau Research Station. *Breeding Ranges of Willow Flycatcher Subspecies*. http://sbsc.wr.usgs.gov/cprs/research/projects/swwf/wiflrang.asp. Accessed April 19, 2009.

8.94 United States Geological Survey. *Nation Elevation Dataset 2009*, http://ned.usgs.gov/. Accessed June 7, 2009.

8.95 United States Marine Corps. 2007. *Integrated Natural Resources Management Plan. Marine Corps Base Camp Pendleton, San Diego, California*.

8.96 United States Nuclear Regulatory Commission. 1996. *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437 Vol. 1 & Vol. 2)*. Division of Regulatory Applications, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission. Washington, DC.

8.97 United States Nuclear Regulatory Commission. *Sites Undergoing Decommissioning: San Onofre – Unit 1*. http://www.nrc.gov/info-finder/decommissioning/power-reactor/san-onofre-Unit-1.html. Accessed May 11, 2009.

8.98 Weiss, L. D. *Collision on I-75*. American Public Health Association. 2004.