Appendix D
Mechanical Equipment List

Mechanical Equipment					
System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
Reactor Coolant Pumps	Pump Motor		Yes	Yes	Yes
	Oil Lift Pumps	Operating and Backup	Yes	Yes	Yes
	Other	Anti-Reverse Rotation Pumps	Yes	Yes	Yes
		ARRP Motor	Yes	Yes	Yes
		Motor and Seal Heat Exchangers	Yes	Yes	Yes
Pressurizer Relief Discharge System	Quench Tank		Yes	Yes	Yes
	Valves		Yes	Yes	Yes
Demineralized Water Makeup System	Demineralized Water Storage System	Makeup Demineralized Water Tanks	No	No	No
Ultimate Heat Sink	Main Offshore Intake Structure		Yes	Yes	Yes
	Intake Conduit	From One Pipe Section Beyond Auxiliary Intake Structure to Main Offshore Intake Structure	Yes	Yes	Yes
	Outfall Conduit	West End Box Conduit Seaward	No	No	No
Condensate Storage Facility	Condensate Storage Tank T-120		Yes	Yes	Yes
	Pumps		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Nuclear Service Water System	Storage Tank		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Other		Yes	Yes	Yes
Turbine Plant Cooling Water System	Tanks		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Heat Exchangers		Yes	Yes	Yes

Mechanical Equipment					
System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Filters		Yes	Yes	Yes
Compressed Air System	Receivers		Yes	Yes	Yes
	Compressors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Aftercoolers		Yes	Yes	Yes
	Dryers		Yes	Yes	Yes
	Filters		Yes	Yes	Yes
Chemical and Volume Control System	Tanks	Volume Control Tank	Yes	Yes	Yes
		Boric Acid Batching Tank	Yes	Yes	Yes
	Pumps	Primary Plant Makeup Pumps	Yes	Yes	Yes
	Motors	Primary Plant Makeup Pump Motors	Yes	Yes	Yes
	Piping and Valves	Letdown Portion (From Letdown Back Pressure Control Valve to Radwaste Diversion Valve)	Yes	Yes	Yes
		Volume Control Tank (Between Isolation Valves)	Yes	Yes	Yes
	Letdown Heat Exchanger		Yes	Yes	Yes
	Purification Ion-Exchanger		Yes	Yes	Yes
	Delithiating Ion-Exchanger		Yes	Yes	Yes
	Purification Filter		Yes	Yes	Yes
Normal Operation—Containment Building Ventilation Systems	Containment Normal Cooling Units	Air Handling Units	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Chillers	Yes	Yes	Yes
		Chilled Water Pumps	Yes	Yes	Yes
		Compression Tanks	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes

Mechanical Equipment					
System	**Item/Subsystem**	**Description/Breakdown**	**Anchorage Satisfactory?**	**Free From Known Seismic Vulnerabilities?**	**Free From Seismic Interaction?**
	Strainers		Yes	Yes	Yes
	CEDM Cooling System	Cooling Coils	Yes	Yes	Yes
		Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Reactor Cavity Cooling System	Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	MSIV Enclosure and Penetration Area Cooling System	Supply Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
Normal Operation–Auxiliary Building Ventilation Systems	Control Room System	Air Handling Units	Yes	Yes	Yes
		Fan Coil Units	Yes	Yes	Yes
		Computer Room Fan Coil Units	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
		Exhaust Fans	Yes	Yes	Yes
		Transfer Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Radwaste Area System	CEDMCS Room Fan Coil Units	Yes	Yes	Yes
	ESF Switchgear Room Systems	Air Handling Units	Yes	Yes	Yes
		Exhaust Fans	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Non-Class 1E Switchgear Room Systems	Exhaust Fans	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Prefilters	Yes	Yes	Yes
	Chiller Room Systems	Air Handling Unit	Yes	Yes	Yes

Mechanical Equipment					
System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
		Exhaust Fan	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Battery Room Systems	Air Handling Unit	Yes	Yes	Yes
		Exhaust Fan	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Normal Chilled Water System	Chillers	Yes	Yes	Yes
		Pumps and Motors	Yes	Yes	Yes
		Air Separator	Yes	Yes	Yes
		Compression Tank	Yes	Yes	Yes
		Piping and Valves	Yes	Yes	Yes
	Continuous Exhaust System	*Fans*	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Plant Vent Stacks	Yes	Yes	Yes
Turbine Building Ventilation System	Switchgear Room and D6 Battery (Elevation 7') Room Systems	Supply Air Units	Yes	Yes	Yes
		Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
	Lube Oil Room System	Supply Air Units	Yes	Yes	Yes
		Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
	Steam Air Ejector Exhaust System	Piping and Valves	Yes	Yes	Yes
	Main Generator Iso-Phase Bus Connection Enclosure Ventilation System	Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork	Yes	Yes	Yes
	D7 Battery and Battery Charger	Supply Air Units	Yes	Yes	Yes

Mechanical Equipment					
System	**Item/Subsystem**	**Description/Breakdown**	**Anchorage Satisfactory?**	**Free From Known Seismic Vulnerabilities?**	**Free From Seismic Interaction?**
	Rooms (Elevation 56')	Exhaust Fans and Motors	Yes	Yes	Yes
		Ductwork and Dampers	Yes	Yes	Yes
		Electric Duct Heaters	Yes	Yes	Yes
Fire Protection System	Tanks		Yes	Yes	Yes
	Pumps and Motors		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Turbine-Generator	Turbine: High, Low Pressure		Yes	Yes	Yes
	Control and Protective Valve System		Yes	Yes	Yes
	Turbine Drains		Yes	Yes	Yes
	Exhaust Hood Spray System		Yes	Yes	Yes
	Lube Oil System	Components	Yes	Yes	Yes
		Piping	Yes	Yes	Yes
	Electric Turning Gear		Yes	Yes	Yes
	Turbine Control System		Yes	Yes	Yes
	Turbine Control Panel		Yes	Yes	Yes
	Turbine Supervisory System		Yes	Yes	Yes
	Turbine Protective Devices		Yes	Yes	Yes
	Turbine Overspeed Protection		Yes	Yes	Yes
	Turbine Monitoring Equipment		Yes	Yes	Yes
	Turbine Support Accessories		Yes	Yes	Yes
	Generator		Yes	Yes	Yes
	Seal Oil System		Yes	Yes	Yes
	Hydrogen Coolers		Yes	Yes	Yes
	Generator H_2/CO_2 System		Yes	Yes	Yes

Mechanical Equipment					
System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Stator Water System		Yes	Yes	Yes
	Exciter Switchgear and Voltage Regulator		Yes	Yes	Yes
	Exciter		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Steam Supply System	Reheaters		Yes	Yes	Yes
	Moisture Separator-Reheater Drain Tanks		Yes	Yes	Yes
	Main Steam Tube Bundle Drain Tanks		Yes	Yes	Yes
	Bled Steam Tube Bundle Drain Tanks		Yes	Yes	Yes
	Y-Strainers		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Condenser	Main Condensers		Yes	Yes	Yes
	Vent and Drain System		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Main Condenser Evacuation System	Seal Water Heat Exchanger		Yes	Yes	Yes
	Air Ejector Condenser		Yes	Yes	Yes
	Air Ejectors		Yes	Yes	Yes
	Condenser Vacuum Pump		Yes	Yes	Yes
	Seal Water Pumps		Yes	Yes	Yes
	Separator Tanks		Yes	Yes	Yes
Turbine Gland Sealing System	Gland Steam Condenser Exhaust Fan		Yes	Yes	Yes
	Gland Steam Condenser		Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
Turbine Bypass System	Piping and Valves		Yes	Yes	Yes
Circulating Water System	Pumps and Motors		Yes	Yes	Yes

Mechanical Equipment					
System	Item/Subsystem	Description/Breakdown	Anchorage Satisfactory?	Free From Known Seismic Vulnerabilities?	Free From Seismic Interaction?
	Piping and Valves		Yes	Yes	Yes
	Expansion Joints		Yes	Yes	Yes
	Strainers		Yes	Yes	Yes
	Traveling Rakes and Bar Screens		Yes	Yes	Yes
	Gates #4, 5, and 6		Yes	Yes	Yes
	Gate Operators and Accessory Equipment		Yes	Yes	Yes
Condensate and Feedwater System	Tanks	Heater Drain Tanks	Yes	Yes	Yes
		Feedwater Pump Seal Drain Tanks	Yes	Yes	Yes
		Feedwater Pump Turbine Drain Tanks	Yes	Yes	Yes
	Pumps and Motors	Condensate Transfer Pumps	Yes	Yes	Yes
		Condensate Pumps	Yes	Yes	Yes
		Heater Drain Pumps	Yes	Yes	Yes
		Feedwater Pumps	Yes	Yes	Yes
		Feedwater Pump Turbine Drain Pumps	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes
	Other		Yes	Yes	Yes
	Feedwater Heaters		Yes	Yes	Yes
Steam Generator Blowdown System	Piping and Valves		Yes	Yes	Yes
	Blowdown Heat Exchanger		Yes	Yes	Yes
Turbine Plant Chemical Addition System	Pumps and Motors	Amine Feed Pumps	Yes	Yes	Yes
	Piping and Valves		Yes	Yes	Yes

Explanation:

1. CEDM = Control Element Drive Mechanism
2. CEDMCS = Control Element Drive Mechanism Control system
3. MSIV = Main Steam Isolation Valve
4. H_2 = Hydrogen
5. CO_2 = Carbon Dioxide

Appendix E
Evaluation of Important-to-Reliability NSR Building Structures

E.1 INTRODUCTION

E.1.1 Objective

The objective of this assessment was to determine if any of the non-power block NSR buildings that house important-to-reliability NSR SSCs could cause a prolonged outage due to a seismic event.

E.1.2 Scope of Work

The scope of work involved 1) identifying the NSR buildings that house important-to-reliability NSR SSCs and 2) evaluating the extent of damage of the selected buildings in the event of a SONGS review level earthquake. This assessment was achieved by:

- Reviewing available structural and architectural drawings and calculations to form engineering opinions of the expected seismic performance of each building relative to other similar buildings of the same vintage located in the same seismic environment.
- Selecting an appropriate corresponding HAZUS model building type for each building based on the building's characteristics.
- Modifying the HAZUS fragility curves for the appropriate model building types using engineering judgment.
- Estimating the probable damage of each building in the event of a SONGS review revel earthquake.

The description of each selected building and the basis of the HAZUS building fragility evaluations are summarized in this appendix.

E.2 NSR BUILDINGS THAT HOUSE IMPORTANT-TO-RELIABILITY NSR SSCs

The buildings included in the scope of this study were constructed between the 1970s and 1990s. Three SONGS buildings were identified as housing important-to-reliability NSR SSCs:

- Mesa Warehouse.
- SCE Switchyard Relay House.
- SDG&E Switchyard Relay House.

The Mesa warehouse was selected because it houses replacement parts that may be required to repair important-to-reliability NSR SSCs following the occurrence of an earthquake. The SCE and SDG&E switchyard relay houses contain switchyard control instrumentation that is required for the transmission of the power generated at the plant.

E.3 ASSESSMENT PROCESS

E.3.1 Field Observations

As part of the assessment, a walk-through was completed at the Mesa warehouse and switchyard. The purpose of the walk-through was to become familiar with the buildings, observe the general conformance of the actual constructed facilities to the original drawings, and take representative photographs of the buildings' gravity and lateral load carrying systems.

E.3.2 Document Review

In addition to the walk-throughs, the structural, civil, and architectural drawings, as available, were reviewed for all three buildings. The SONGS structural design calculations were also examined. In many cases, the drawings available were not complete sets and / or information about the seismic details was lacking, which is important when making decisions about the quality factors (defined in Section E.4.6). The drawings were reviewed to develop an engineering opinion about the quality of the seismic design features and were compared with drawings of similar buildings of the same vintage and seismic zone (which were still in the Uniform Building Code (UBC) and in use at the time these buildings were designed). Summaries of the reviews are provided below.

E.3.3 Mesa Warehouse Building

E.3.3.1 Information Reviewed

The following drawings and calculations were reviewed in association with the Mesa warehouse:

- Drawing C-1: General Notes, March 30, 1982.
- Civil Drawing C-2: Offsite Warehouses Sections and Details, March 30, 1982.
- Structural Drawing S-6: 100,000 sq. ft Warehouse Foundation Sections and Details, March 30, 1982.
- Structural Drawings S-9, S-10: 100,000 sq. ft Warehouse Miscellaneous Sections and Details, September 14, 1983.

- Structural Drawing S-11: 100,000 sq. ft Warehouse Office Area Framing Plans, December 19, 1983.
- Structural Drawings S-12, S-13: 100,000 sq. ft Warehouse Office Area Framing Sections and Details, December 19, 1983.
- Structural Calculations for building frame and lateral bracing performed by Capitol Metal Buildings, Stockton, California, May 21, 1982 and June 11, 1982.
- Structural Calculations for building foundation and slab-on-grade performed by Engineering Department of S.C. Edison Co.,March 11, 1982.

E.3.3.2 Building Description

The Mesa warehouse consists of three interconnected structures. The warehouse is a single-story prefabricated metal building with dimensions of 400 ft by 250 ft. The adjacent office building has plan dimensions of 240 ft by 75 ft. The adjacent flammable material storage space has dimensions of 150 ft by 250 ft. The buildings were constructed circa 1982 using the seismic provisions of the 1979 UBC.

E.3.3.2.1 Gravity Load-Resisting System

The gravity load-resisting systems of the three buildings consist of gable type portal frames placed at 25 ft on center (o.c.). Eight inch (in.) deep gage metal Z purlins span between the frames and support the metal deck roofs that complete the gravity load-resisting system. The steel columns are supported by isolated footings. The reinforced concrete slab-on-grade is 6 in. thick.

E.3.3.2.2 Lateral Load-Resisting System

The lateral load-resisting systems of the three buildings consist of gable type portal frames in the transverse direction and X-braced frames in the longitudinal direction. The frames in the transverse direction are spaced at 25 ft o.c. and consist of tapered girders and columns with fully welded moment connections. The column base connection at the transverse moment frame columns was designed as a pinned connection. It includes four 1-1/8 in. diameter anchor rods embedded approximately 22 in. into the foundation. The X-braced frames consist of single-angle members. Lateral load from the roofs is accumulated along the purlins and transferred to the longitudinal bracing through a system of horizontal rod X bracing, whose location coincides with the location of the braced frame bays.

A gravity load-carrying column is located in the warehouse at the center of the bay that breaks up the span of the girders into two identical spans of 125 ft each. There are four bays of longitudinal bracing on each end bay.

The office building relies on the continuation of the frames from the warehouse for its lateral support in the transverse direction. Along the longitudinal direction, it has three bays of diagonal steel angle bracing.

A similar system exists in the flammable materials storage space as well. It has five bays of transverse frames and two bays of longitudinal bracing.

Using the terminology of HAZUS, the Mesa warehouse is a S3 – Steel Light Frame Structure.

E.3.3.3 Discussion

Although prefabricated metal buildings do not typically have a robust lateral system, they have performed relatively well in past earthquakes. Based on the review of the moment connections, it is expected that they will have a performance similar to pre-Northridge earthquake connections of similar vintage. However, due to the relatively large spans of the girders, it is likely that the building has inadequate lateral stiffness to prevent damage due to seismic loads in the transverse direction. In the longitudinal direction, the resistance is provided by ordinary single angle tension braces only, since the compression braces are expected to buckle and provide negligible lateral resistance. In addition to these deficiencies, past experience with these types of buildings has indicated that the rod bracing at the roof diaphragm level will likely not be adequate to prevent damage, thereby providing an indirect load path for the seismic loads.

E.3.3.4 Recommendations

It is recommended that a quality factor (see Section E.4.6) of 1.2 be used both for transverse loading and longitudinal loading relative to buildings similar to the vintage of the Mesa warehouse.

E.3.4 Switchyard Relay Houses

E.3.4.1 Information Reviewed

The following calculation was used to perform this review:

- Structural Calculations for San Onofre Generating Station, 220 kilovolt (kV) Switchyard, October 14, 1975 performed by Bechtel.

E.3.4.2 Building Description

The two switchyard relay houses are referred to as the SCE building and the SDG&E building. Both are roughly of equal size, rectangular in plan with major dimensions of 35 ft by 28 ft. The roof of each is about 11 ft above the finished floor. One edge of each of the buildings is buried into the sloping ground with the concrete wall acting as a retaining wall. The remaining walls of the buildings are of reinforced masonry. The buildings were constructed circa 1974 using the provisions of the 1973 UBC. However, the design calculations point out that an internal SCE criterion requiring the structures to be designed for a base shear capacity of 0.5g was used. Due to similar construction, a single assessment was applied to the two switchyard relay houses.

E.3.4.2.1 Gravity Load-Resisting System

Structural and architectural drawings of the buildings were unavailable. Design calculations show that the perimeter walls along with an open-steel, open-web joist system and the 1-1/2 in. deep metal deck with 3 in. concrete topping constitute the gravity load-resisting system.

E.3.4.2.2 Lateral Load-Resisting System

The lateral load-resisting systems of the switchyard relay houses include the perimeter reinforced masonry walls along with the concrete shear wall that also acts as the retaining wall. The masonry walls are grouted at 32 in. o.c. with a #5 bar in the cell. Remaining cells are also grouted with Zonolite masonry fill up to the bond beam level. The roof diaphragm of each structure is a 1-1/2 in. deep metal deck with 3 in. deep concrete topping.

E.3.4.3 Discussion

The switchyard relay houses have been designed to a high level of base shear, even compared to the current 2007 California Building Code (CBC). The steel deck roof diaphragm is positively attached (through welding) to the masonry walls with steel angles that are connected to the masonry walls with 7/8 in. diameter cast in place bolts placed at 16 in. o.c. These structures are expected to behave in a superior fashion in an earthquake.

Using the terminology of HAZUS, the switchyard relay houses can be classified as a C2L – Low Rise Concrete Shear Wall Building. The other possible classification as a RM2L – Reinforced Masonry Bearing Wall with Precast Concrete Diaphragms is not applicable.

E.3.4.4 Recommendations

As a result of reviewing the calculations, it is recommended that a quality factor (see Section E.4.6) of 0.8 be used for the HAZUS analysis of the switchyard relay houses.

E.4 BUILDING FRAGILITY

E.4.1 HAZUS Fragility Data

HAZUS is national consensus software developed by the FEMA to help estimate damage to the built environment as the result of future scenario earthquakes (FEMA, 2003, 2005). One of its primary purposes of the software is to help government agencies evaluate risks, and the software includes national databases embedded within. This software is described in the Technical Manual. There is also an Advanced Engineering Building Module (AEBM) Manual, which is an extension of the general methods in HAZUS intended for use in estimating individual building losses.

In developing HAZUS, fragility curves for different model building types (e.g., steel light frame buildings) were determined. An example of a fragility curve is shown on Figure E.4-1. Generally the cumulative probability of reaching a damage state for a given level of deformation (drift) or severity of shaking (e.g., PGA) is plotted. This plot is usually generated assuming a lognormal distribution of damage, with a corresponding median and beta (logarithmic standard deviation).

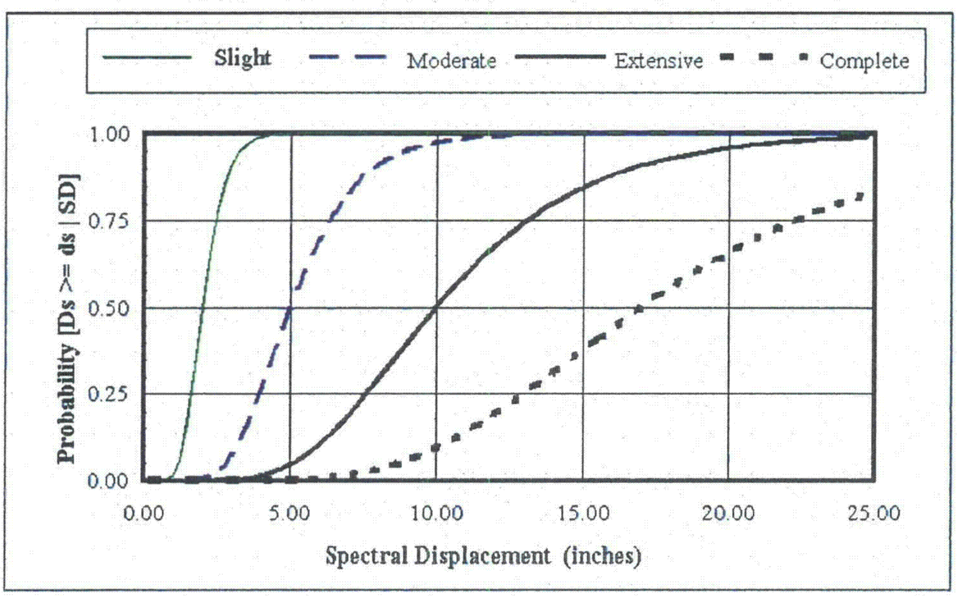

Figure E.4-1 Sample Fragility Curves

E.4.2 Displacement vs. PGA

While most of the fragility data in the HAZUS Technical Manual is based on building displacements, an alternate procedure that is based on PGA data is also presented. This alternate procedure was used is this evaluation.

E.4.3 Damage States

In the case where different damage states are defined for a building, fragility curves can be developed for each damage state. In HAZUS, the damage states defined are slight, moderate, extensive, and complete. HAZUS fragility functions are provided for each damage state.

The HAZUS Technical Manual indicates that the moderate damage state has 5 to 25% damage, and that it corresponds with a green tag after an earthquake. Moderate damage may be localized. A green tag means that the building has been inspected and that no significant weakening of the structure has occurred. Thus, there are no restrictions on occupancy.

Furthermore, the HAZUS Technical Manual indicates that the extensive damage state has 25 to 100% damage, and corresponds with a yellow tag after an earthquake. A yellow tag means occupancy is restricted but that sufficient reserve capacity exists and that collapse is not expected if an aftershock were to occur. The building cannot be occupied as it was before the earthquake occurred unless some action is taken. Some portion of the building may be unsafe. Generally occupants are permitted to remove important belongings through brief visits until the damage is mitigated, or until the likelihood of a significant aftershock decreases.

Finally, the HAZUS Technical Manual indicates that the complete damage state corresponds with 100% damage, which corresponds with a red tag. A red tag indicates that the building is unsafe and that there is a risk of collapse on its own or due to an aftershock. No entry into the building is permitted, even to conduct repairs or remove important belongings. However, the complete damage state does not necessarily correspond with the physical collapse of a building. In general, the complete damage state implies that building repair costs exceed the cost of building replacement. The HAZUS collapse rates for the various building types are not uniform and range from 3% (wood frame buildings) to 15% (un-reinforced buildings).

As indicated above, fragility curves for different model building types are included in the HAZUS documentation. Model building types of relevance for this study are concrete shear wall buildings (C2) and steel light frame buildings (S3). HAZUS also differentiates between low-rise, mid-rise, and high-rise buildings. All the buildings included in this study qualify as low-rise buildings.

For each model building type, HAZUS also provides fragility data corresponding to different seismic design levels. The fragility data was developed in the 1990s when seismic zones defined in the UBC were still in use. High-Code is intended to reflect design practice in Seismic Zone 4 after 1975; Moderate-Code is representative of the design practice in Seismic Zone 2B after 1975; and Low-Code is intended to reflect design practice in Seismic Zone 1 after 1975. The AEBM Manual indicates that for buildings constructed between 1941 and 1975 the appropriate design levels should be reduced by one. Only the switchyard relay houses fall into this category. However, the switchyard relay houses were designed for an elevated base shear capacity appropriate for High-Code classification. Buildings constructed prior to 1941 are considered pre-Code and have a different set of fragility data. Thus, there are fragility data for four seismic design levels included in HAZUS.

E.4.4 Design Level

At the time these three buildings were constructed (1970 to 1990), the region that SONGS is located in was considered Seismic Zone 4, according to the UBC. The switchyard relay houses, on the other hand, although designed per 1973 UBC, used the internal SCE guideline of 0.5g base shear coefficient for seismic design qualifying it for the High-Code seismic design level. Based on this information, it was determined that the fragility data associated with the High-Code seismic design level is appropriate for all the buildings.

E.4.5 Fragility Data for Generic Building Types

The median PGA provided in the HAZUS Technical Manual for the fragility curves is given in Table E.4-2. As noted above, these values correspond to High-Code Design.

Table E.4-2 Fragility Data for Generic Building Types

Building Type	Damage State			
	Slight	Moderate	Extensive	Complete
	PGA Median, g	PGA Median, g	PGA Median, g	PGA Median, g
C2L	0.24	0.45	0.90	1.55
S3	0.15	0.26	0.54	1.00

E.4.6 Quality Factor

HAZUS fragility data are intended to represent the average building type of a certain height and age, and are designed using specific building code provisions. However, not all buildings designed under such conditions will perform equally in an earthquake. Based on the drawing review, an assessment was made on whether a building was better or worse than the average building. A quality factor that is used to scale the median of the fragility data was used. In this study, quality factors ranged from 0.8 to 1.2, with 1.2 representing a building with a median that is 1/1.2 lower than the average. Quality factors assigned for each building were presented in Section E.3.

The quality factor not only is used to reflect the superior or inferior detailing or configurations, it also incorporates what was learned by reviewing the drawings or design criteria about the importance factors used in the design. Thus, the quality factor for the switchyard relay houses was decreased to account for the high design base shear coefficient.

E.4.7 Expected Building Fragility Levels

E.4.7.1 Moderate Damage

The fragility level for each of the three structures being in the moderate damage state is listed in Table E.4-3. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-3 Fragility Corresponding with Moderate Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.22
Switchyard Relay Houses (2)	C2L	0.8	0.56

Note: Fragilities for all buildings assume High-Code Design.

E.4.7.2 Extensive Damage

The fragility level for each of the three structures in the extensive damage state is listed in Table E.4-4. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-4 Fragility Corresponding with Extensive Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.45
Switchyard Relay Houses (2)	C2L	0.8	1.13

Note: Fragilities for all buildings assume High-Code Design.

E.4.7.3 Complete Damage

The fragility level for each of the three structures in the complete damage state is listed in Table E.4-5. The generic fragility values of Table E.4-2 are modified by dividing them by the quality factor.

Table E.4-5 Fragility Corresponding with Complete Damage State

Building	HAZUS Building Type	Quality Factor	Median Fragility, g
Mesa Warehouse	S3	1.2	0.83
Switchyard Relay Houses (2)	C2L	0.8	1.94

Note: Fragilities for all buildings assume High Code Design.

E.5 CONCLUSIONS

For the SONGS review revel earthquake, the two switchyard relay houses will sustain only moderate damage and will be green tagged after the earthquake and thus will remain functional. However, the Mesa warehouse will sustain extensive damage and will be yellow tagged following a SONGS review level earthquake and access to the building will be restricted.

The HAZUS damage states used in this evaluation correspond with the structural damage states. Nonstructural components within the building were not directly evaluated; however, they were observed during the walk-through of each building. The relay panels and equipment within the switchyard relay houses are all anchored and braced to the ceiling joists. These components were screened for the SONGS review level earthquake during the equipment walkdowns.

E.6 REFERENCES

FEMA, 2003, Department of Homeland Security and Response Directorate, Federal Emergency Management Agency, Mitigation, Division, Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR1, Advanced Engineering Building Module, Washington, D.C..

FEMA, 2005, Department of Homeland Security and Response Directorate, Federal Emergency Management Agency, Mitigation, Division, Multi-hazard Loss Estimation Methodology, Earthquake Model, HAZUS-MH MR4, Technical Manual, Washington, D.C..

Appendix 5

Building Codes and Seismic Design Standards

BUILDING CODES AND SEISMIC DESIGN STANDARDS

1 Objective

This report summarizes the evaluation of the San Onofre Nuclear Generating Station (SONGS) non-safety-related (NSR) systems, structures, and components (SSCs) as compared to the current building codes and seismic design standards for non-nuclear power plants. Additionally, a review of the seismic design standards changes was performed to determine if there are any implications to the SONGS NSR SSCs.

2 Building Code Requirements for Power Plant Construction

The original seismic design criteria for SONGS NSR components were specified in the "Project Design Criteria Manual for the San Onofre Nuclear Generation Stations Units 2 & 3." The Seismic Category II equipment was to be designed using an equivalent static seismic load of 0.2g horizontally and 0.13g vertically, applied simultaneously, with no increase in allowable stress levels (a one-third increase in allowable stress levels was a common design practice during the period of SONGS design). This was the general design criteria in use for all SCE power plant structures and equipment anchorages at the time of plant design. In general, the 0.20g lateral loading had been in use for at least two decades prior to the design of SONGS. This 0.20g design criteria had been used for many California power plants and was greater or equal to that required by Uniform Building Code (UBC) of the same vintage. SONGS Seismic Category III SSCs were designed in accordance with the UBC in effect at the time of actual design (mostly 1973-1984).

The switchyard had a 0.50g lateral force design criteria which was an SCE interim substation design criteria adopted after the 1971 San Fernando Earthquake.

Historically, the post-1971 San Fernando Earthquake time period saw major changes in the UBC. Figure 2-2 shows the development of UBC/IBC design levels for non-structural components and equipment from 1933-2006. In the 1979 UBC, force levels were specified for non-structural components and equipment as 0.3g. Prior to 1979, the non-structural loading had been 0.2g. In 1997, the UBC was changed to allow both Load Resistance Factor Design (LRFD) and Allowable Stress Design (ASD), thus the code lateral force coefficients have to be appropriately factored for the chosen design criteria. Also, in 1997, the code lateral force coefficient was made a function of site soil type, component type, and elevation within a structure. In 2000, the International Building Code (IBC) was published, with other revisions following in subsequent years. Figure 2-1 assumes ASD, Zone 4, Site Condition C, and a building elevation ratio, z/h = 0.55. As can be noted from Figure 2-1, the effective lateral force factor specified for SONGS NSR seismic design is very close to the design value required in the current 2007 California Building Code (CBC) that is based on the 2006 IBC and ASCE 7-2005.

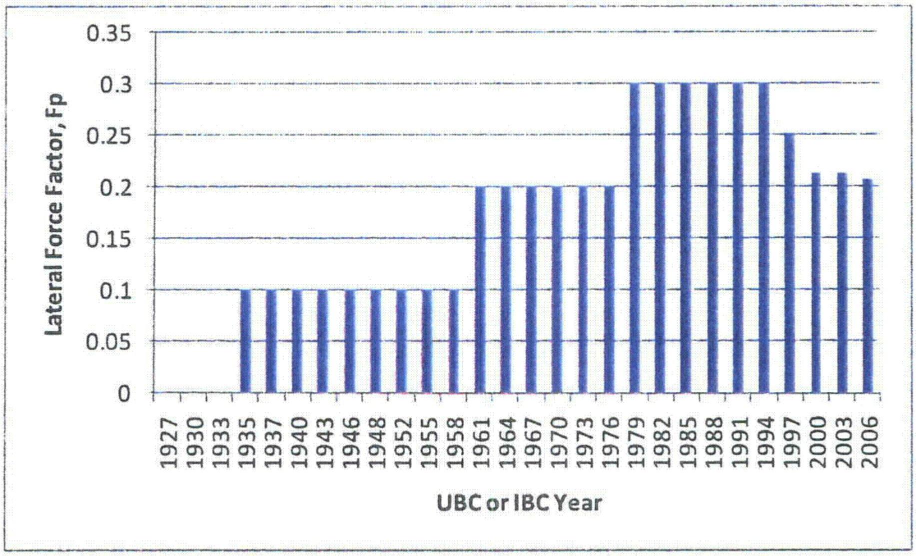

Figure 2-1. Comparison of Building Code Lateral Force Coefficient for Components (Adjusted for Allowable Stress Design and Soil Classification C for 1997-2006)

Seismic anchor loads calculations of a component located within a SONGS Turbine Building (TB) for both the original SONGS design criteria and the current CBC code are provided in Section 3 to illustrate the comparison between the design codes. The 2007 CBC horizontal design loading is about 4% higher than the original design loading. The 2007 CBC vertical design loading is less than the original SONGS design loading. Thus, the anchor loads for both the original design criteria and the current building code are essentially the same.

3 Current Code Anchor Design Comparison

The current code specified for power plant design by the CEC is 2007 California Building Code (CBC) that is based on 2006 IBC and ASCE 7-2005. For LRFD, the horizontal seismic design force for nonstructural components and equipment is calculated, as follows:

$F_{ph} = \frac{0.4 \cdot a_p \cdot S_{DS} \cdot W_p}{\left(\frac{R_p}{I_p}\right)}\left(1+2\frac{z}{h}\right)$, however, F_{ph} shall not be less than $F_{ph} = 0.3 \cdot I_p \cdot S_{DS} \cdot W$

For ASD, the horizontal seismic design force is:

$$F'_{ph} = (0.7) \cdot F_{ph}$$

Where

F_p = seismic design force for LRFD

F'_p = seismic design force for ASD

S_{DS} = short period spectral acceleration (0.2 sec or f=5 Hz)

a_p = Component amplification factor (from code table)

I_p = component importance factor (from code table)

W_p = operating weight

R_p = component response modification factor

z = height in structure of point of attachment with respect to the base

h = average roof height structure with respect to the base

For LRFD the vertical seismic design force is: $F_{pv} = 0.20 \cdot S_{DS} \cdot W$

For ASD the vertical seismic design force is: $F'_{pv} = (0.7) \cdot F_{pv}$

Seismic anchor loads calculations for a 150KVA transformer located at Elevation 43 ft in the SONGS TB for the original design criteria and the current code are provided to illustrate the comparison between the design codes.

W_p = 4450 lbs

3.1 Original SONGS Design Criteria

$F'_{ph,original} = 0.2 \cdot W_p = 0.2 \cdot 4450 = 890\text{lbs}$

$F'_{pv,original} = 0.13 \cdot W_p = 0.13 \cdot 4450 = 579\text{lbs}$

3.2 2007 California Building Code

S_{DS} = 0.882 g (from USGS web site for SONGS longitude and latitude; Site Class C)
a_p = 1.0
I_p = 1.0
R_p = 2.5
z = 36 ft (approximately 80% of all turbine support equipment is at this level (TB elev. 43') or lower)

h = 65.5 ft (TB height)

$$F_{ph} = \frac{0.4 \cdot 1.0 \cdot 0.882 \cdot W_P}{\left(\frac{2.5}{1.0}\right)}\left(1 + 2\frac{36}{65.5}\right) = 0.296 \cdot W_P$$

F_p shall not be less than $F_P = 0.3 \cdot S_{DS} \cdot \mathrm{Ip} \cdot W_P = 0.265 \cdot W_P$
For Allowable Stress Design load combination, the seismic loads are multiplied by a factor of 0.7
$F'_{ph,\ 2007\ CBC}$ = 0.7 (0.296) 4450 = 922lbs
$F'_{pv,\ 2007\ CBC}$ = 0.7 (0.2) (0.882) (4450) = 549lbs

3.3 Comparison

The 2007 CBC horizontal design loading is about 4% higher than the original design loading. The 2007 CBC vertical design loading is less than the original SONGS design loading. Thus, the anchor loads for both the original design criteria and the current building code are essentially the same.

4 Seismic Design Standards Changes

The seismic standard design changes from the original design to the present time have been reflected in the building code changes throughout this period. These changes are primarily related to the magnitude of calculated earthquake lateral and vertical forces. Sections 2 and 3 of this report show more details about changes in earthquake forces. The 2003 IAEA Safety Guide for the Seismic Design and Qualification of Nuclear Plants (NS-G-1.6) covers primarily safety-related SSCs. The standard looks at the potential of non-safety related SSCs interacting with safety-related SSCs. For this case, the standard prescribes that the non-safety-related SSCs to be designed at the same high level of earthquake as the safety-related SSCs. SONGS non-safety related SSCs whose collapse or failure could result in the loss of the safety functions of safety-related SSCs are designed at the same level earthquake as the safety-related SSCs. Since the above referenced IAEA Safety Guide and SONGS design of non-safety related are very similar, there are no seismic design implications for the SONGS non-safety related SSCs.

5 Conclusion

The report shows that the changes in building codes and associated seismic design standards from the original design to present time does not have any implications for the SONGS NSR SSCs. These SSCs were designed to seismic loads comparable to the current building code.

The 2003 IAEA Safety Guide for the Seismic Design and Qualification of Nuclear Plants (NS-G-1.6) is similar to the requirements of the SONGS design basis and it does not reveal any potential weakness in the SONGS NSR SSCs seismic design.

Appendix 6

San Onofre Nuclear Generating Station Evacuation Time Evaluation Final Report

FINAL REPORT

San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

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A31392

June 12, 2007

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EXECUTIVE SUMMARY

The Nuclear Regulatory Commission has requested that licensees of nuclear power plants provide information regarding time estimates for evacuation of the resident and transient population within a radius of about 10 miles from the nuclear reactor sites. This area is called the Emergency Planning Zone (EPZ). The evacuation time estimates are for use by those emergency response personnel charged with recommending and deciding on protective actions during an emergency.

The recommendations of NUREG-0654, Rev. 1 and NUREG/CR-6863 suggest that the evacuation time estimates should be updated as local conditions change.

The San Onofre Nuclear Generating Station (SONGS) is located in San Diego County, California, approximately four miles southeast of San Clemente and 15 miles north of Oceanside. The station is situated between Interstate 5 and the Pacific Ocean. The Southern California Edison Company, operator of SONGS, began generating electricity from Unit 1 in January 1968, from Unit 2 in August 1982, and from Unit 3 in April 1983. Unit 1 ceased generating electricity in 1992.

The previous evacuation time estimates for the SONGS area were prepared in 2000, with results documented in a 2001 study report.[1] The study included evacuation time estimates for projected 2006 area population.

Moderate population growth has occurred in the area since the 2001 evacuation time analysis. Current developer activities and plans indicate that slightly more than expected new development has occurred since the 2006 projections were prepared in 2000.

Evacuation Time Estimates for Protective Action Zones

The following table summarizes the Evacuation Time Estimates (ETE) for Protective Action Zones (PAZ) within the EPZ.

A brief description of the PAZs and the associated population follows:

- PAZ 1: SONGS facility, San Onofre State Beach, San Mateo Campground, San Onofre Bluffs Campground, and Camp Pendleton housing (5,702 people)
- PAZ 2: Pacific ocean (0 people)
- PAZ 3: Marine Corps Base Camp Pendleton (10,061 people)
- PAZ 4: San Clemente, portion of Marine Corps Base Camp Pendleton and parts of Southern Orange County (78,363 people)
- PAZ 5: Dana Point and San Juan Capistrano (90,821 people)

[1] Analysis of Time Required to Evacuate Transient and Permanent Population from Various Areas within the Emergency Planning Zone, San Onofre Nuclear Generating Station, Update for 2000-2006, prepared for Southern California Edison Company by Wilbur Smith Associates, July 2001.

SUMMARY OF TOTAL ETE FOR ALL SCENARIOS TESTED USING PAZ STRUCTURE EVACUATION TIME ESTIMATE (ETE) TOTAL HOURS TO EVACUATE

	WEEKDAY	WEEKEND	NIGHT	ADVERSE WEATHER	WEEKDAY EARTHQUAKE
PAZ 1 & PAZ 2	3.0	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 3	3.1	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 4	7.3	6.8	6.3	8.3	14.3
PAZ 1 & PAZ 3 & PAZ4	7.3	7.0	6.3	9.0	16.3
PAZ 1 & PAZ 4 & PAZ5	9.5	9.2	8.2	10.3	18.0

Source: Wilbur Smith Associates, 2006

The estimates range from 1.5 hours for the least populated areas under the most favorable of circumstances to 18 hours for the most populated areas under earthquake conditions. If the earthquake scenario is not considered, then the less populated portions could evacuate in 4 hours or less and the more populated areas in 10.3 hours or less. The range of certainty for evacuation of the EPZ is plus or minus 2 hours.

Chapter 1
EVACUATION TIME ESTIMATES FOR PROTECTIVE ACTION ZONES

An Emergency Planning Zone (EPZ) structure was developed based on prevailing wind direction at the SONGS facility and grouped large areas of population and employment for evacuation time estimates. These areas are identified as Protective Action Zones (PAZs). The EPZ was subdivided into five (5) PAZs, as summarized below:

- PAZ 1: SONGS facility, San Onofre State Beach, San Mateo Campground, San Onofre Bluffs Campground, and Camp Pendleton housing (5,702 people)
- PAZ 2: Pacific ocean (0 people)
- PAZ 3: Marine Corps Base Camp Pendleton (10,061 people)
- PAZ 4: San Clemente, portion of Marine Corps Base Camp Pendleton and parts of Southern Orange County (78,363 people)
- PAZ 5: Dana Point and San Juan Capistrano (90,821 people)

The estimates for population, employment, and vehicles within each PAZ were developed using the data described in the remaining chapters of this report. An estimate of population and employment by PAZ is provided in **Table 1.1**.

Table 1.1:
EPZ PERMANENT AND TRANSIENT POPULATION SUMMARY 2011
BY PROTECTIVE ACTION ZONE (PAZ)

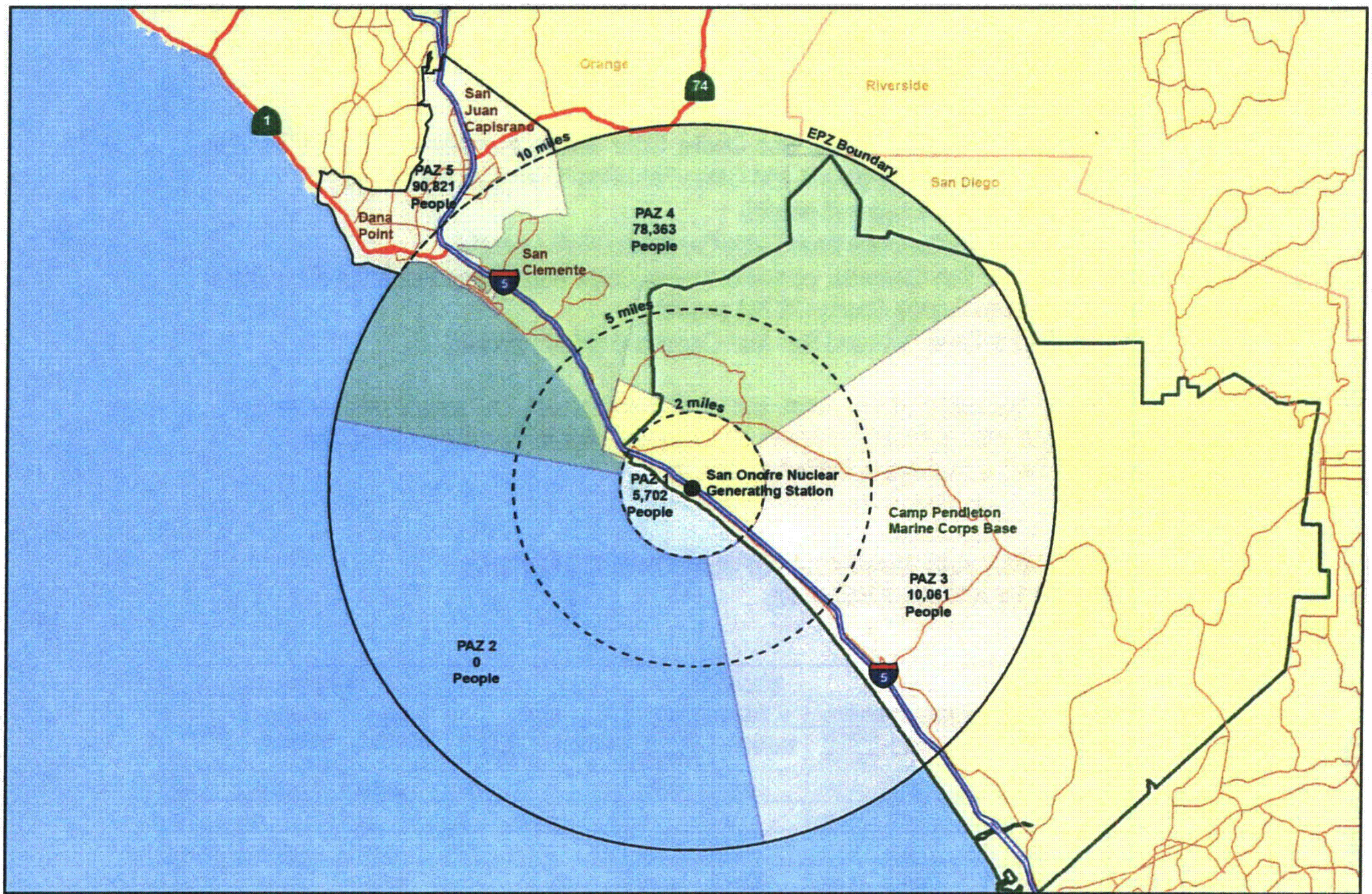
PAZ	RESIDENTS (ALL SCENARIOS)	NON-RESIDENTS						GRAND TOTALS		
		SUMMER WEEKEND		SUMMER WEEKDAY		NIGHT		SUMMER WEEKEND	SUMMER WEEKDAY	NIGHT
		WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR			
1	5,702	62	14,760	2,225	7,380	8	1,476	20,524	15,307	7,186
2*	0	0	0	0	0	0	0	0	0	0
3	10,061	0	0	0	0	0	0	10,061	10,061	10,061
4	78,363	5,636	16,468	13,851	9,166	949	1,711	100,467	101,380	81,023
5	90,821	8,334	19,560	19,713	9,956	987	1,206	118,715	120,491	93,014
TOTAL:	184,947	14,032	50,788	35,789	26,503	1,944	4,393	249,767	247,239	191,284

Source: Wilbur Smith Associates, November 2006

Note:

1. PAZ 2 is the Pacific Ocean. It is not possible to estimate the number of ocean going vessels that may occupy this PAZ under Year 2011 conditions; however, it is assumed that in an emergency situation the appropriate evacuation notice would be provided to any vessels within the EPZ and evacuation times would be within the total estimates ETE as summarized in the subsequent sections.

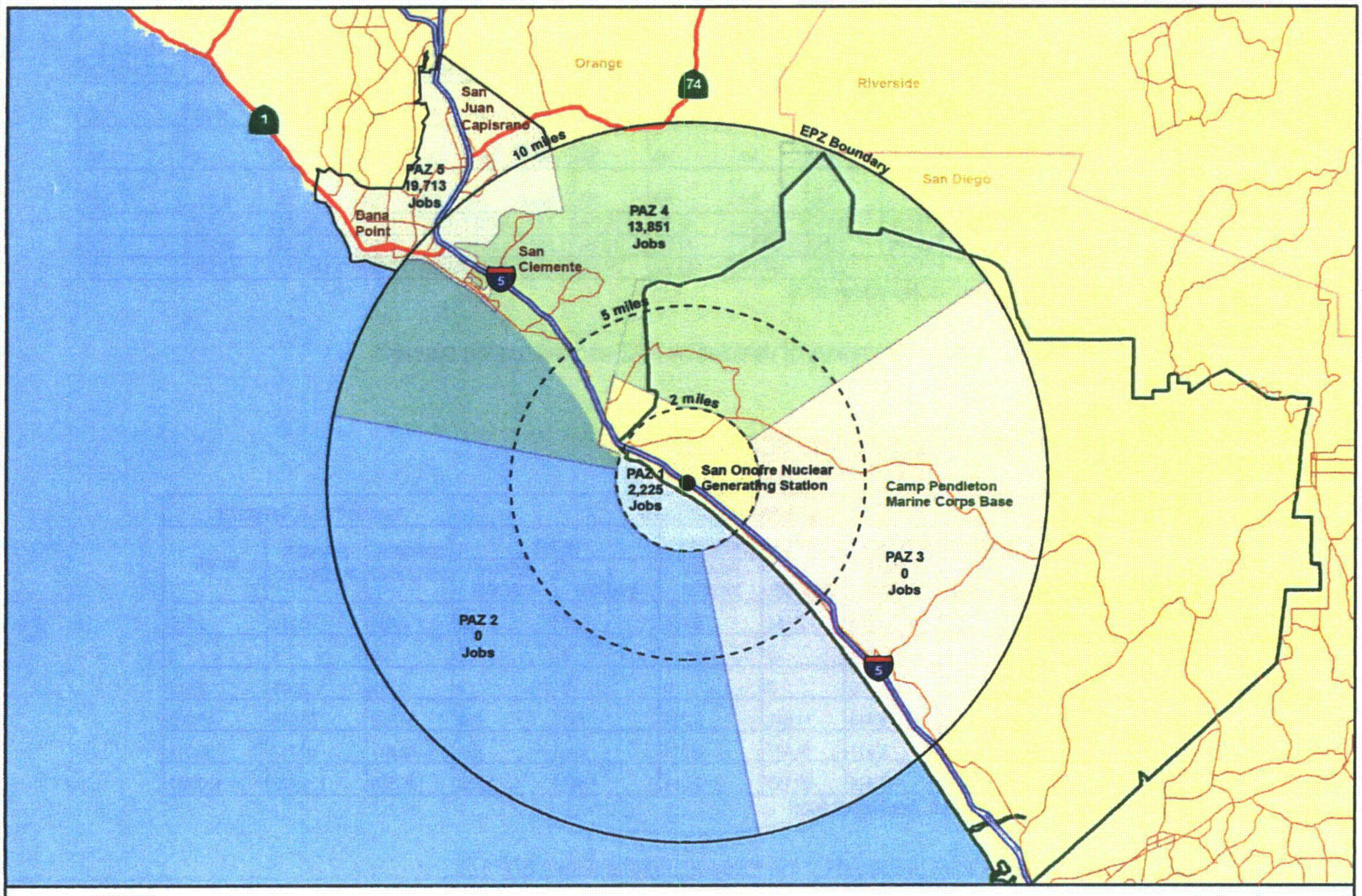
Figure 1.1 shows the population estimates by PAZ and **Figure 1.2** shows the employment estimates by PAZ.



San Onofre Nuclear Generating Station
Evacuation Time Estimate
2011 PAZ Population

WilburSmith

Figure 1.1



San Onofre Nuclear Generating Station
Evacuation Time Estimate

2011 PAZ Employment

WilburSmith Associates

Figure 1.2

Table 1.2 shows the calculation of vehicles by PAZ based on household vehicle ownership and occupancy.

Table 1.2:
ESTIMATED 2011 HOUSEHOLD VEHICLE OWNERSHIP AND OCCUPANCY SUMMER WEEKEND/WEEKDAY AND NIGHT

PAZ	RESIDENT POPULATION	PEOPLE/ HH	TOTAL HH	% HH NO VEHICLE	% HH W/ 1 VEHICLE	% HH W/ 2 VEHICLES	% HH W/ 3 OR MORE VEHICLE	HH W/0	HH W/1	HH W/2	HH W/3	VEHICLES OWNED	VEHICLES USED	VEHICLE OCCUPANCY
1	5,702	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,426	4.00
2	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	NA
3	10,061	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,515	4.00
4	78,363	2.37	33,025	2.3%	25.2%	46.5%	26.0%	773	8,326	15,347	8,578	69,102	44,207	1.77
5	90,821	2.37	38,292	3.3%	29.3%	44.3%	23.1%	1,252	11,213	16,977	8,851	76,143	48,771	1.86
Total/Ave	184,947		71,317	2.8%	27.4%	45.3%	24.5%	2,025	19,539	32,324	17,429	145,245	96,919	1.91

Source: Wilbur Smith Associates, November 2006

Table 1.3 shows the resultant summary of vehicles by PAZ and evacuation scenario:

Table 1.3:
2011 PAZ VEHICLES EVACUATED BY SCENARIO

PAZ	RESIDENTS VEHICLES (ALL SCENARIOS)	NON-RESIDENTS VEHICLES						GRAND TOTAL VEHICLES		
		SUMMER WEEKEND		SUMMER WEEKDAY		NIGHT		SUMMER WEEKEND	SUMMER WEEKDAY	NIGHT
		WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR			
1	1,426	52	5,216	2,184	2,608	8	522	6,694	6,218	1,955
2	0	0	0	0	0	0	0	0	0	0
3	2,515	0	0	0	0	0	0	2,515	2,515	2,515
4	44,207	4,696	5,819	11,542	3,239	791	604	54,722	58,988	45,602
5	48,771	6,945	6,911	16,427	3,518	822	425	62,627	68,717	50,019
Total	96,919	11,693	17,946	30,153	9,365	1,621	1,552	126,558	136,438	100,091

Source: Wilbur Smith Associates, November 2006

Evacuation estimates were prepared for the following combinations of PAZs:

- PAZ 1 and 2
- PAZ 1 and 3
- PAZ 1 and 4
- PAZ 1, 3, and 4
- PAZ 1, 4, and 5

These groupings reflect communities and areas affected based on their distance from SONGS and wind direction.

Each of the five combinations of PAZ evacuations shown above were tested for the following scenarios:

- Daytime summer weekday
- Daytime summer weekend
- Night
- Adverse weather conditions
- Earthquake conditions

In addition to the scenarios described above, sensitivity tests were run for the following conditions under the daytime summer weekday condition:

- Contra-flow on I-5
- Incident on I-5
- Delayed mobilization
- 20% shadow demand
- 80% population under earthquake conditions
- Aggressive access control on I-5

1.1 Evacuation Time Estimates

Tables 1.4a and 1.4b summarize the evacuation time results by PAZ. Data in **Table 1.4a** provides a summary of all simulations, while **Table 1.4b** provides a summary of the sensitivity tests performed against the daytime summer weekday evacuation condition.

Table 1.4a:
SUMMARY OF TOTAL ETE FOR ALL SCENARIOS TESTED USING PAZ STRUCTURE (TOTAL HOURS TO EVACUATE EPZ)

	WEEKDAY	WEEKEND	NIGHT	ADVERSE WEATHER	WEEKDAY EARTHQUAKE
PAZ 1 & PAZ 2	3.0	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 3	3.1	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 4	7.3	6.8	6.3	8.3	14.3
PAZ 1 & PAZ 3 & PAZ 4	7.3	7.0	6.3	9.0	16.3
PAZ 1 & PAZ 4 & PAZ 5	9.5	9.2	8.2	10.3	18.0

Source: Wilbur Smith Associates, 2006

Table 1.4a indicates that the combination of PAZs 1, 4 and 5 take the longest time to evacuate. These regions include southern Orange County, San Clemente, Dana Point, San Juan Capistrano, and the SONGS facility. It requires 9.5 hours to evacuate these areas on a weekday. This is more than three times the evacuation time for PAZs 1 and 3, the facility and Camp Pendleton. The fact that PAZ 4 and PAZ 5 are more populated than the other PAZs is a significant contributing factor to this trend.

PAZs 1 and 4, and PAZs 1, 3 and 4 take the same amount of time to evacuate both on a weekday and during night; each taking more than seven and six hours respectively. PAZs 1 and 2, and PAZs 1 and 3, take the same amount of time to evacuate under different scenarios.

Table 1.4b:
SUMMARY OF SENSITIVITY TESTS OF TOTAL ETE ON DAYTIME SUMMER WEEKDAY CONDITIONS USING PAZ STRUCTURE (TOTAL HOURS TO EVACUATE EPZ)

	CONTRA-FLOW ON I-5	INCIDENT ON I-5	DELAYED MOBILIZATION	20% SHADOW DEMAND	80% POPULATION UNDER EARTHQUAKE CONDITIONS	AGGRESSIVE ACCESS CONTROL ON I-5
PAZ 1 & PAZ 2	2.3	5.1	3.1	3.3	5.0	3.0
PAZ 1 & PAZ 3	3.0	5.1	3.1	3.3	5.1	3.0
PAZ 1 & PAZ 4	6.4	8.0	7.4	7.3	10.2	6.5
PAZ 1 & PAZ 3 & PAZ 4	6.5	8.2	7.5	9.0	10.2	6.5
PAZ 1 & PAZ 4 & PAZ 5	7.5	11.0	8.5	11.2	12.3	8.2

Source: Wilbur Smith Associates, 2006

Table 1.4b describes the Sensitivity Tests on a summer weekday for the different combination of PAZs. In summary:

- Contra-flow operations on I-5 would reduce the time required to evacuate all combinations of PAZ evacuations, with the greatest reduction occurring for the combination of PAZ 1, 4, and 5 of approximately two hours.
- An incident on I-5 could increase the evacuation times by nearly two hours.
- Delayed mobilization has a negligible effect for the majority of PAZ evacuation combinations; however, for the combination of PAZ 1, 4, and 5 the total evacuation time actually reduces by approximately one hour. This is assumed to be a result of the dense populations within these PAZs and the benefits of delayed mobilization as compared to available capacity on the EPZ roadway network: The roadway network does not reach capacity as quickly and therefore can move more vehicles faster out of the EPZ when the mobilization is delayed.
- When shadow demand is assumed to be at 20%, the effects are proportional to the volume evacuating the EPZ. Therefore, the effect of increased shadow demand is minimal for the PAZ evacuation combinations of lower populations. Under the combination of PAZ 1, 4, and 5, the increased shadow demand would potentially increase evacuation times by almost two hours.
- If only 80% of the population evacuates under earthquake conditions, the total evacuation time for each PAZ combination reduces substantially. The greatest reduction occurs for the PAZ combinations with the smallest populations (PAZ 1 and 2).
- Aggressive access control on I-5 will have the greatest reduction in evacuation times for those PAZ combinations with the highest total volume of evacuating population.

Chapter 7 provides graphical representation of vehicles moved beyond the EPZ boundary for the 5 combinations of PAZ evacuations.

Chapter 2
DATA COLLECTION

The Southern California Edison Company requested that the evacuation time estimates reflect resident and transient populations anticipated for the area in mid-2010. For the purposes of this study, the Year 2011 was identified for future estimates. This would provide emergency response personnel with evacuation time estimates that would continue to be useful as the anticipated new development occurs within the area. The evacuation time study includes:

1. The identification of resident and transient population within the area in 2006, based upon available information, and the estimated numbers and distribution of population by 2011.
2. Identification of existing institutions which require special evacuation assistance, as well as those known new institutions planned for construction.
3. An evaluation of the evacuation routes relative to their traffic-carrying capacity during an evacuation.
4. Estimation of evacuation time requirements for the resident and transient population, and special institutions, under normal and adverse weather conditions.
5. The assessment of evacuation time requirements if major damage occurs to the primary evacuation routes as a result of an earthquake (or similar disruptive event) occurring prior to, or during, the evacuation.
6. Review and inclusion of new NUREG elements where appropriate.

Data collection includes the following efforts:

1. Establish a study area;

2. Review Emergency Response Plans for the various jurisdictions and agencies within the EPZ;

3. Inventory existing highway facilities, including roadway facility type, number of lanes, operating speeds, and traffic controls;

4. Review available demographic data, employment data, recreational facility usage and future plans and forecasts; and

5. Assemble information for schools, and special institutions within the area.

All spatially referenced data was compiled and referenced to a Geographic Information System (GIS) database. Included in this GIS database are all the features obtained or created by the project team.

2.1 Study Area

The San Onofre Nuclear Generating Station (SONGS) is located in San Diego County, California, approximately four miles southeast of San Clemente and 15 miles north of Oceanside. **Figure 2.1** presents the regional context of SONGS.

The Nuclear Regulatory Commission stipulates that the EPZ must include land areas within 10 miles of the SONGS site[2]. **Figure 2.2** shows the 10-mile radius EPZ boundary which encompasses all of the cities of San Clemente, San Juan Capistrano, Dana Point, and a large portion of the United States Marine Corps Base, Camp Pendleton. San Juan Capistrano, Dana Point, and the Ortega area have been included in the EPZ evacuation time estimates although the 10-mile radius actually bisects these communities. This expanded planning area, or geopolitical EPZ, is here after referred to as simply the EPZ or study area.

2.2 Emergency Response Plans

Contacts were made with local and regional planning agencies, County and State transportation departments, and local and county officials responsible for emergency response planning. Appendix A provides the agencies contacted, information received, and approximated date.

The principal emergency response plans include:

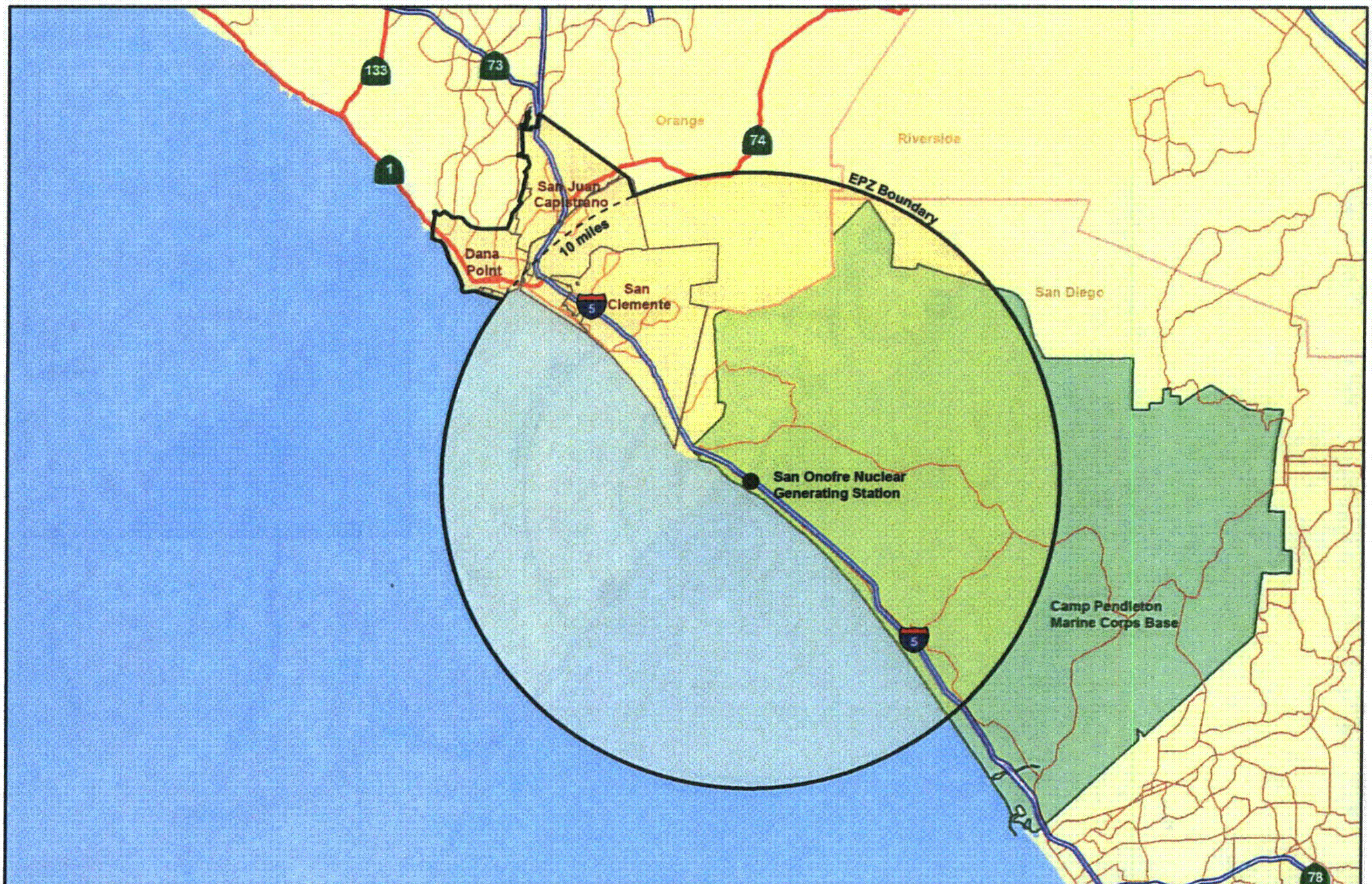
- County of Orange Nuclear Power Plant Emergency Plan for the San Onofre Nuclear Generating Station, January 2005;
- City of San Juan Capistrano Emergency Operations Plan, February 2004; San Onofre Nuclear Generating Station Emergency Response Plan, June 2004.
- City of Dana Point Emergency Plan, January 2004;
- City of San Clemente Multi-hazard Emergency Response Plan, December 2003;
- Marine Corps Camp Pendleton Force Protection Plan, Annex C (Operations), July 2004;
- Department of California Highway Patrol, Border Division Nuclear Response Plan for the San Onofre Nuclear Generating Station, March 2005;
- Capistrano Unified School District Emergency Guide, San Onofre Nuclear Power Plant, October 2005;

[2] NUREG/CR-6863 p.4

San Onofre Nuclear Generating Station
Evacuation Time Estimate

Regional Location

Figure 2.1



EPZ/Study Area

0 1.25 2.5 5 7.5 10 Miles

San Onofre Nuclear Generating Station
Evacuation Time Estimate

Study Area

Figure 2.2

2.3 Transportation Facilities

One interstate route (I-5) and two state routes (SR-1 and SR-74) currently serve the area within the EPZ limits. Interstate 5 (San Diego Freeway) is the primary north-south route serving traffic between Orange and San Diego Counties.

State Route 1 (Pacific Coast Highway) provides secondary north-south access within the northern part of the EPZ. State Route 74 (Ortega Highway) is the only regional east-west roadway within the study area. The Ortega Highway is a winding, mountain-area roadway which connects the area to Interstate 15, approximately 32 miles to the east.

State Route 73 (The San Joaquin Hills Transportation Corridor), a north-south toll roadway which connects to I-5 approximately 3 miles north of SR-74, was opened to traffic in late November, 1996. This six-lane roadway, which connects to SR-55 and State Route 405 in Costa Mesa, significantly increases the capacity for northbound evacuation traffic.

These major corridors are shown in **Figure 2.2**

2.4 Demographic/Employment Data

The numbers of evacuating persons and vehicles from the area were obtained by applying the estimated growth in each area since the 2000 census, and anticipated growth up to 2011. The 2006 and 2011 resident and transient estimates were made as follows:

1. The estimated number of 2006 residents for San Clemente, San Juan Capistrano, and Dana Point was obtained from the California State University, Fullerton (CSUF) Center for Demographic Research and from local planning agencies.
2. The geographic distribution of population increases was based on development project plans identified by local agencies; CSUF demographic data; and recent demographic information obtained from the Cities of San Clemente, San Juan Capistrano, and Dana Point planning agencies.
3. Population projections for 2011 in the Cities of San Clemente, San Juan Capistrano, and Dana Point were based on estimates provided by the local planning agencies and by CSUF. The distribution of new residents within each City was based on information provided by the local planning agencies which reflects developer proposals and/or building permit projections and CSUF demographic projections.
4. State Park Beach usage was based on peak visitation records for the 2005 summer season. According to the State Parks, beach capacity will not increase because it is limited by the amount of parking.
5. The 2006 and 2011 employment for the three cities was estimated using employment information compiled from CSUF projections. Then percentages of people that work and live in the same city were subtracted from the total employment so as to not double count people within the vicinity. This was obtained from the 2000 census.
6. Average household size and vehicle ownership statistics obtained from the 2000 census were applied to each community to estimate the number of vehicles per households and persons in households without vehicles in 2006 and 2011.

2.5 Schools and Special Institutions

Several population segments require special evacuation consideration. These segments include members of the residential population not having access to an automobile, special needs citizens, and special institutions such as schools, nursery schools, hospitals, and assisted living facilities.

2.5.1 Schools

A summary of student enrollment in public and private schools within the EPZ is presented in **Appendix B** and shown on **Figure 2.3.** Current school enrollments within the study area are approximately 19,944 students in public schools and 5,648 students in private schools.

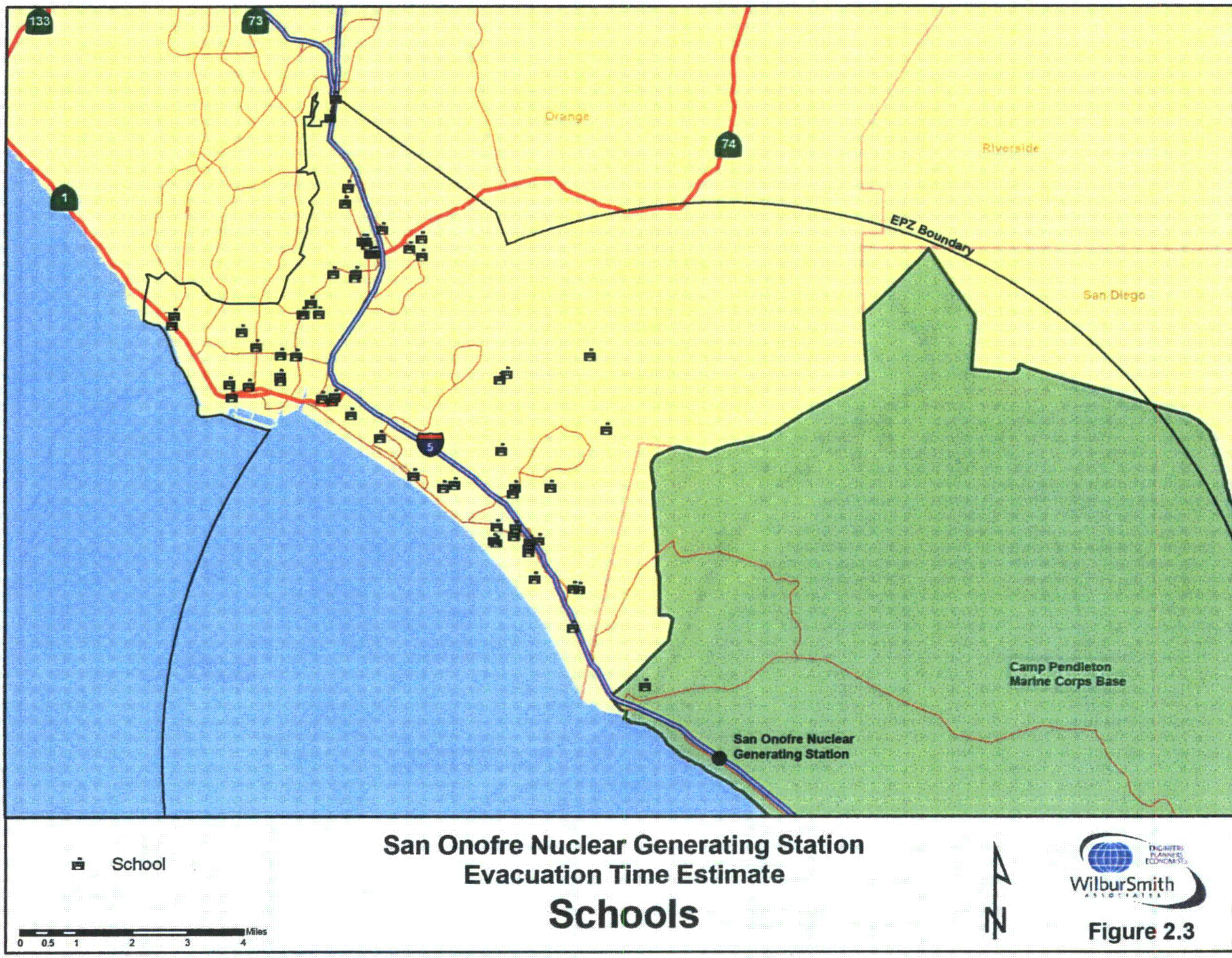
2.5.2 Special Populations

There are three types of institutions within the EPZ that would require assistance in relocation. These are hospitals, assisted living facilities, and homebound persons with special needs.

Assisted living facilities located within the EPZ are provided in Appendix C and shown on **Figure 2.4.** Health care center and hospital population figures were furnished by institutional staffs, except where noted.

One hospital is located within the EPZ: Saddleback Memorial Medical Center, San Clemente Campus; shown on **Figure 2.4**

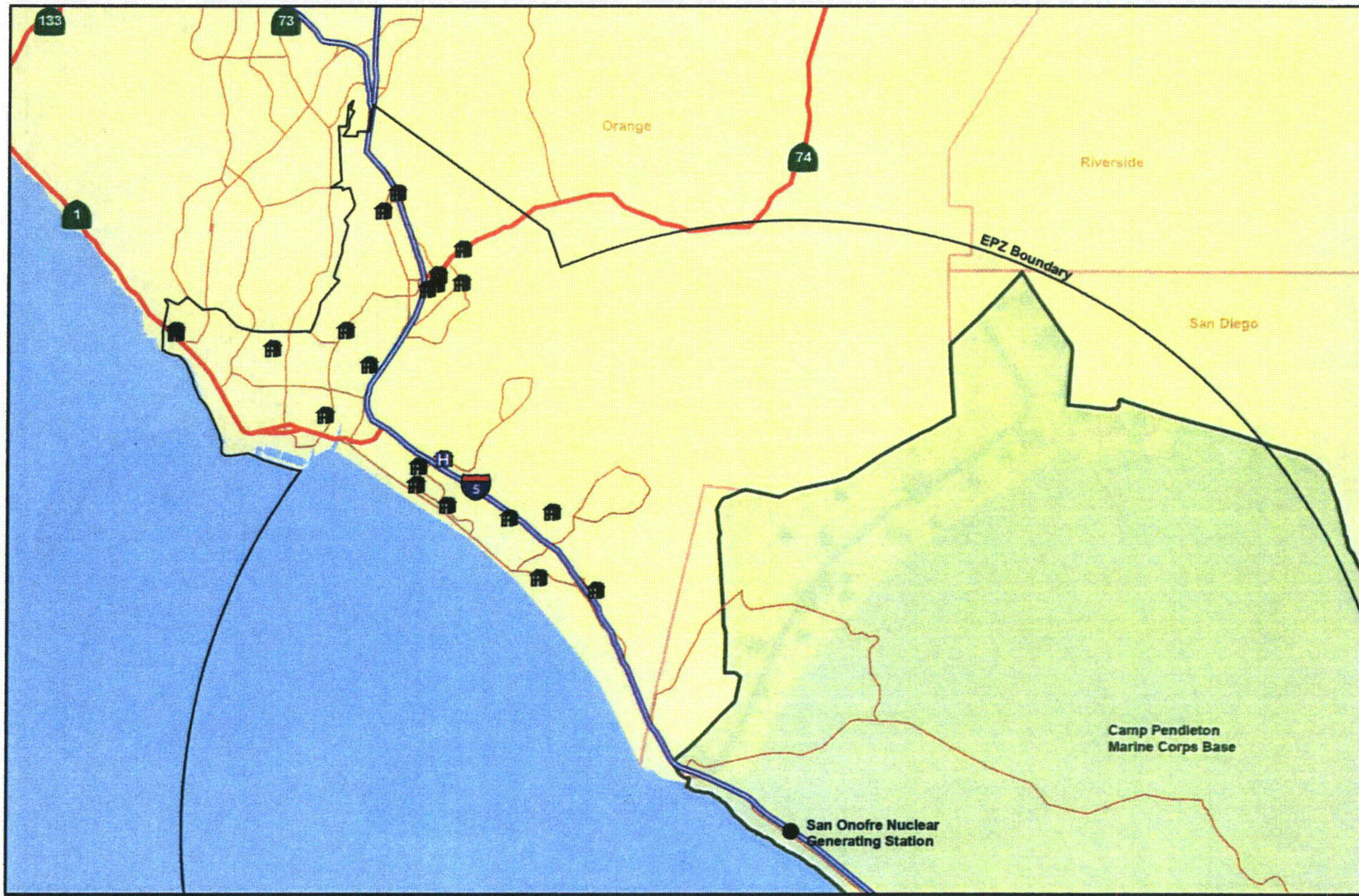
There are no civilian detention facilities within the EPZ.



San Onofre Nuclear Generating Station
Evacuation Time Estimate

Schools

Figure 2.3



San Onofre Nuclear Generating Station
Evacuation Time Estimate

Assisted Living and Hospitals

Figure 2.4

Chapter 3
SIMULATION MODEL

This study does not rely on specific evacuation route maps that unnecessarily imply the public should take routes which may not be the most ideal for the duration of the evacuation. Instead it relies on individual decisions of route selection that comply with traffic control points, access management plans, and actions coordinated through a supervisor.

The evacuation time assessment was conducted using DYNASMART-P. DYNASMART-P is a state-of-the-art dynamic route assignment model sponsored by the Federal Highway Administration and developed at the University of Maryland. This software package provides a blend of four step regional models and corridor level micro-simulation models.

Individual driver behavior is considered in selecting available routes, and the model attempts to route them in the most efficient manner possible. This model represents intersections on the arterial system, and ramp merges on freeways as significant constraining points. Its dynamic assignment capability allows each vehicle to determine its best path out of the area.

On the freeway system, it represents the stop-and-go conditions when there is overwhelming demand. Conversely, it shows that both speeds and throughput are increased when an aggressive access management plan is in place. DYNASMART-P tracks the performance of individual links, as well as reports minute by minute the number of vehicles that have successfully crossed the EPZ boundary line.

3.1 The Network

The DYNASMART-P software evaluates travel on a specific network. The evacuation route roadways are defined as a series of links and nodes. Each link represents a specific segment of roadway with common geometric features and operational characteristics. A pair of nodes identifies the limits of each link. Nodes are located wherever evacuation routes intersect, change geometric characteristics, or change operational characteristics.

Links are defined as arterials, highways, and freeways. Freeways include High Occupancy Vehicle (HOV) lanes where these facilities exist. The number of through lanes, turn lanes, link speed, maximum service flow rate, saturation flow rate and grade are defined at nodes as well as the type of control (stop sign, traffic light, etc.).

The traffic characteristics of each link and node in the evacuation network were determined through field review, aerial photos, and traffic engineering analyses. A listing of the link characteristics was prepared identifying the roadway name, the length of link, the operating speed, and the link capacity (the number of lanes multiplied by the assigned capacity per lane). The operating speeds and lane capacities reflect average operating conditions.

Sub-zones were used to define centroids. Sub-zone boundaries generally follow readily identifiable natural or man-made features, census tracts, and Southern California Association of Government

Transportation Analysis Zones (TAZ).

Trips from origin centroids were generated on various links within the EPZ. The destination was a single large area beyond the EPZ encompassing all possible evacuation routes.

Trip creation occurs at the rate which the public mobilizes. The route selected to get beyond the EPZ depends on the trip start and previous demand on the routes. Mobilization time is the combination of time to receive the warning, travel home (if necessary), and make preparations to leave.

The model evaluation information includes the total evacuation time and a distribution of trip percentages reaching the EPZ boundary from the start of evacuation. The distributions may also be produced for trips from any specified subarea. Average travel time and delay time is calculated by time increment for trips exiting the EPZ by time increment.

3.2 General Assumptions

Various assumptions were necessary in the estimation of the numbers of persons and vehicles which would evacuate and the analysis of evacuation times. All assumptions are consistent with NUREG guidance.

3.2.1 Public Information and Notification

All residents and employees in the EPZ have been provided with information regarding evacuation instructions and preferred or required evacuation routes. The community alert siren system is used to alert the EPZ population, followed by instructions through radio, television, and public address systems.

3.2.2 Evacuations Prior to General Evacuation

This estimate assumes a single point in time when there is a general notification to evacuate and all evacuations start from that point. This is a requirement of the DYNASMART-P software.

The evacuation time evaluation assumes a slow escalation of the emergency, so reality may well deviate from this single point notification for reasons such as the following:

- San Onofre State Beach authorities may evacuate the park and campgrounds as a precautionary measure.

- Individuals may voluntarily decide to evacuate before a general evacuation is issued.

Substantial pre-notification evacuation will reduce the number of individuals evacuating to the north and would logically reduce the estimates in this document. Estimates have been created for sets of PAZs. The estimates for evacuation of PAZs 1 and 2 and PAZs 1 and 3 could be applied to a site area emergency as they primarily contain populations within and immediately surrounding the SONGS facility, where the general emergency condition would include PAZs 4 and 5.

3.2.3 Traffic Controls

It is assumed that the freeway network within the EPZ is isolated from external traffic. Diversion of freeway traffic away from the affected area is assumed to begin within 30 minutes. Most traffic control officers and barricades for directing traffic are assumed to be in place within 60 to 90 minutes.

3.2.4 Number of People and Vehicles Evacuating

This ETE assumes an average auto usage of 1.3 vehicles per household even though a higher number of eligible drivers and autos exist[3]. This number is in part the result of public information efforts that educate residents about the reasons for avoiding unnecessary vehicles.

More specific calculations and assumptions are outlined below.

1. Estimates of vehicle usage are as follows:
   a. One-vehicle households would evacuate as a single unit generating one evacuating vehicle
   b. On average two-vehicle households will use 1.3 vehicles.
   c. Three (or more)-vehicle households would generate 1.75 vehicles. This recognizes that many 3 vehicle households only have 2 drivers.
2. All persons, residents and transients, evacuate.
3. The majority of the EPZ labor force (non-military) work outside of the EPZ, with almost all commuting to work by personal automobile.
   a. For estimating the number of vehicles evacuating, it was assumed that a minimum of one vehicle would be evacuated for every auto-owning household. This reflects in part that the majority of households have a second vehicle available.
   b. This also conservatively assumes that commuters from one-vehicle households would be able to return to their homes to evacuate their family.
   c. To ensure that there is sufficient bus transportation, the estimates of persons requiring transportation assistance assume that none of the residents who commute to work outside the EPZ would be able to return to evacuate their family.
4. The number of non-resident vehicles evacuating reflects the following occupancy level assumptions:
   a. Non-resident beach visitors average 3.0 to 3.5 persons per vehicle, based on statistics for each park area.
   b. Non-resident workers would average 1.2 persons per vehicle.
   c. Persons staying at area hotels/motels and visitors to areas other than the beaches would average 2.0 persons per vehicle.
   d. Because determining whether visitors are at the beach or are visiting other places is difficult, an average of 2.8 persons per vehicle is assumed for those categories.
5. Transportation capacities for those needing special assistance are:
   a. 2 persons per ambulance.
   b. 6 persons per wheelchair van.
   c. 36 persons per bus (for those in assisted living centers).

[3] Sorensen and Voght, "Interactive Emergency Evacuation Guidebook: Prepared for the Protective Action IPT, "February 2006, Oak Ridge National Laboratory <http: //emc.orn 1.gov/CSEPPweb/evac-files/index.htm>

   d. 70 persons per bus (for those who do not have auto transportation).
   e. 60 persons per bus for schools and daycares.
6. The total number of people needing to be evacuated in each of the scenarios (summer weekend, summer weekday, and nighttime) assumes all the residents are present during each of these times. Only the transient population changes for each scenario.
7. The ratio of residents who live and work within an EPZ city over the total number of workers in each EPZ city was obtained from the 2000 Census data as follows:
   a. 43% of San Clemente workers live within San Clemente.
   b. 25% of San Juan Capistrano workers live within San Juan Capistrano.
   c. 36% of Dana Point workers live within Dana Point.
   d. 20% of workers from any given EPZ city reside in a neighboring EPZ city.

3.2.5 Evacuation Route Conditions

A set of evacuation time estimates was developed for the area based on all existing evacuation routes being available.

Additional time estimates were made for adverse weather and earthquakes. Adverse weather conditions in this area would most likely be heavy rain or fog. Such weather conditions are assumed to reduce roadway capacities by 15 percent.

Assumptions regarding potential evacuation route blockages due to an earthquake event are below.

3.3 Earthquake Assumptions

This scenario could also assume any situation where the use of bridge structures is impeded. Caltrans has identified older bridges in the study area that have not been retrofitted to current seismic design standards. These locations are shown on **Table 3.1.** Locations for potential landslides are not shown; these locations exist along existing routes adjacent to cliffs (e.g. PCH and portions of I-5).

Table 3.1:
LIST OF NON-RETROFITTED BRIDGE STRUCTURES IN THE EPZ

ROUTE	DISTRICT	PM	BR. NO.	CITY	ROAD\WATERWAY OVERPASSED	LENGTH (M)	YEAR BUILT\ YEAR WID. EXT.
5	12	2.31	550204	SCLE	Avenida Presido	43.6	1960\1981
5	12	2.66	550205	SCLE	Avenida Palizada	49.7	1960\1981
5	12	3.39	550207	SCLE	Avenida Pico	42.7	1960\1981
5	12	4.97	550223	SCLE	Avenida Vaquero	53.0	1981
5	12	6.69	550226	DAPT	S.R. 1 \ Camino Las Ramblas	69.8	1960\1973
5	12	10	550230	SJCP	El Horno St	54.2	1958\1969
5	12	10.91	550231	SJCP	Junipero Serra Rd	38.1	1958\1969
5	12	11.45	550289	SJCP	Trabuco Creek	72.8	1959\1969

Source: *Caltrans District 12, Wilbur Smith Associates, 2006*

Notes:

DAPT – City of Dana Point
OCN - City of Oceanside
SJCP – City of San Juan Capistrano
SCLE – City of San Clemente

For purposes of testing a potential earthquake scenario, the following approach was taken:

1. Where landslides spill onto the I-5 mainline, one through lane will be possible.
2. I-5 Bridges identified by Caltrans that have not been retrofitted will fail. Where the bridge is part of an interchange, vehicles can go down the off-ramp and back up the on-ramp.
3. When ramps are used for rerouting the mainline, three travel lanes can be accommodated regardless of the normal striping on the ramp.
4. Traffic from the west that would normally access I-5 at that point must use an alternative path since they cannot cross under/over I-5 to the northbound ramps.
5. Pacific Coast Highway is assumed to be essentially unusable due to high potential for landslides.
6. The at-grade arterial system remains largely in-tact and available for evacuation with the exception of PCH and roadways crossing I-5 at vulnerable bridges.
7. Two sensitivity tests were tried. The first test assumes that 100% of the vehicles in a normal evacuation would be used, and the second 80% of normal evacuation vehicles. The second scenario reflects that officials are able to reduce vehicles through public awareness of the gravity of unnecessarily consuming remaining capacity.
8. All scenarios are timed beginning at first public notice to evacuate although it may take longer to order an evacuation due to officials assessing evacuation routes.

9. Modeling does not account for minor debris removal, law enforcement mobilization, and organizing rerouting (as in traffic control for the off- and on-ramps) that may be necessary before vehicles can move as the model expects. An extra hour is added to both scenarios to account for this.

3.4 Network Assumptions

The assumptions utilized in developing the link travel times and capacities are discussed in the following sections.

3.4.1 Directional Flow

All roadways will operate as they do under present conditions. Under normal conditions on a four-lane, two-way roadway, only the two outbound lanes would be utilized for evacuation.

3.4.2 Travel Speeds

In accordance with the Highway Capacity Manual 2000 (HCM 2000) procedures, starting speeds (or uncongested average traversing speeds) were assigned to each link according to the character of the roadway. Freeway free flow speeds begin at 65 miles per hour with ramp speeds at 25 miles per hour. Four-lane roadways were generally assigned speeds ranging from 25 miles per hour to 45 miles per hour depending on posted speed limits, roadway quality, and access control. Congested speeds are then calculated by DYNASMART-P.

3.4.3 Roadway Conditions

Capacities assigned to each roadway are consistent with recommendations in HCM 2000. For the purpose of this analysis, the following capacities by roadway type were assigned:

- Freeway - An average 2,200 vphpl was estimated for all freeways in the area.
- Interchange Ramps - 1,200 vphpl for on-ramps.
- At-grade arterials – Typically two and four-lane roadways were assigned capacities between 1,000 - 1,400 vehicles per lane per hour along the primary evacuation path. This is higher than normal conditions, which are attempting to serve demands in all directions. Instead, green time at the traffic signals is governed by officers and flashing yellow lights which increase the flow in the major direction. Such an increase is supported by HCM 2000 procedures.
- Capacity constraints: Receiving capacity outside the EPZ boundary was reduced on at-grade arterials for the first several hours due to competition from shadow demand.

The average lane capacities summarized above are consistent with those used in standard traffic engineering and planning studies.

3.4.4 Roadway Closures and Management Plans

A review of California Highway Patrol (CHP) plans, Orange County Sheriff plans, and local management plans indicate that within the first 30 minutes of notice to evacuate:

- I-5 will be closed to northbound traffic at SR-78 and Harbor Drive. This measure will also reduce the effects of shadow demand.
- I-5 will be closed to southbound traffic just north of the El Toro "Y".
- Between the EPZ boundary and the El Toro "Y", all access ramps – northbound and southbound – are to be closed to all but emergency vehicles.
- Southbound at-grade arterial streets entering the EPZ will remain open to allow family members who were beyond the EPZ at first notice to return and assist their families with evacuating.

Local plans do not call for closing or even metering access to northbound I-5 from within the EPZ. Rather, officers are instructed to assist with orderly loading of ramps, but there is no intention to slow the rate of entry to the mainline if it begins to fail.

Traffic generated entirely within the EPZ may be sufficient to cause I-5 to fail, and it is not uncommon for freeways to be reduced to 65-75% of their maximum throughput when this happens. Model scenarios were constructed to reflect the existing plans and to reflect limited or metered access to I-5 insuring maximum throughput.

For a description of the traffic control points, please see Appendix D.

3.4.5 Northbound – Southbound Split

Plans suggest that all vehicles north of SONGS will be required to evacuate north, and those south will be required to evacuate to the south. Due to population distributions more than 90% of all evacuating vehicles will travel northbound. The work presented here focuses on northbound evacuation unless otherwise specified.

3.4.6 Shadow Demand Characteristics

This ETE assumes as a baseline condition that there will be no significant demand on evacuation routes from the shadow ring (0% shadow evacuation assumed). In the event that a significant shadow evacuation does occur, a sensitivity test was conducted to reveal the implications that a 20% shadow demand may have on at-grade evacuation routes.

3.4.7 Background Traffic Characteristics

In this modeling, we assume access will be denied to both northbound and southbound I-5 for all background and shadow demand between the EPZ boundary and the El Toro "Y", and the only non-EPZ vehicles allowed on freeway evacuation routes are mainline southbound trips being rerouted northbound.

While shadow demand will have little impact on I-5, it will have significant impact on at-grade evacuation routes. To estimate the effects of all these factors on the evacuating traffic, the following approach was taken:

1. Assume that 100% of normal day-to-day traffic activities occur in the first 30 minutes, dropping to 75% in the 31-60 minute range, 50% in the 61-120 minute range, 25% in the 121-240 range, and finally no significant contribution to northbound movements from background traffic beyond this point.
2. Assume that 6% of the Average Daily Traffic on I-5, I-405, and SR-73 is southbound in a typical hour, as per Caltrans data.
3. Assume that the first 30 minutes of southbound freeway traffic does not have a chance to react to media warnings to avoid southbound travel.
4. Assume that in the 31-60 minute range, about half of the normal flow will receive notice to avoid southbound freeway travel toward the area.
5. Assume in the 61-120 minute range, only 10% of normal flow becomes queued in the southbound direction and rerouted to northbound movement.
6. Beyond 2 hours, there is no longer a significant entry of southbound vehicles that must be rerouted onto northbound evacuation routes.

For modeling the effects of 20% shadow demand:

1. Identify 2011 population and employment in first five miles beyond the geopolitical EPZ.
2. Assume that 20% of this population (shadow demand) would mobilize for evacuation along the same curve used within the EPZ, but delayed by 60 minutes (as they would take extra reaction time to conclude that they are sufficiently at risk to evacuate).
3. All shadow demand is excluded from using I-5, in all scenarios, except for one sensitivity test in which no restrictions are made to accessing I-5 other than officer-assisted, orderly access.

3.4.8 Traffic Signals

This modeling assumes that traffic signals on the approaches to I-5, as well as at significant intersections within the EPZ and the shadow ring, will at a minimum be set to flash mode, with the flashing yellow supporting a primary evacuation path. Ideally, officers would aid at these intersections to occasionally break the stream and allow secondary movements to enter. The agency-specific evacuation plans specify instructions for manual traffic signal control at key locations, and these locations are summarized in Appendix D.

3.4.9 Contra-Flow on I-5

One model run of the highest demand scenario allows for two contra-flow lanes on I-5. Access to and egress from the contra-flow lanes is not significant in the model, but in practice there are some redundant considerations included in the recommendations section.

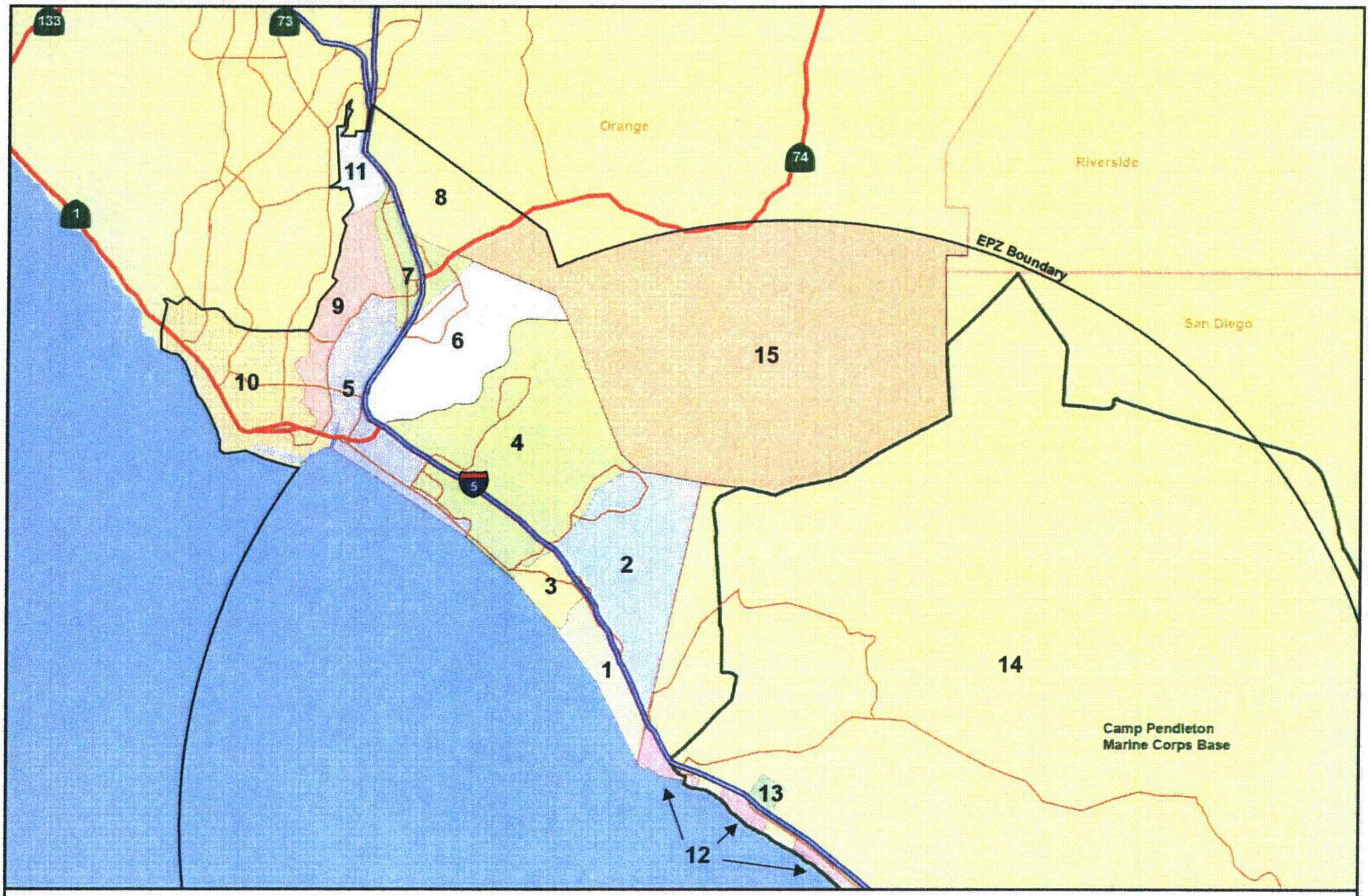
There are several issues to consider in designing the access to and egress from contra-flow lanes. Some of these are noted in Appendix E.

3.5 Centroids

The DYNASMART-P requires that a trip, in this case the evacuation trip, be loaded into the network from a point. The point is called a centroid. Sub-zones were used to define these centroids, as shown in **Figure 3.1.**

Specific sub-zones were developed to encompass existing population concentrations and easily identifiable land uses. Sub-zones were delineated to follow existing political, natural, and manmade boundaries and features, or other readily recognizable features such as the Southern California Association of Governments (SCAG) TAZ boundaries. The approximate areas of habitation were outlined as the sub-zone boundary for those areas comprised of family military housing or barracks concentrations.

A brief description of the area encompassed by each sub-zone is presented in Appendix F.



San Onofre Nuclear Generating Station
Evacuation Time Estimate

Sub-Zones

0 0.5 1 2 3 4 Miles

N

WilburSmith ASSOCIATES
ENGINEERS PLANNERS ECONOMISTS

Figure 3.1

Chapter 4
EVACUATION SCENARIOS

4.1 Time Frame Variations

The time of day at which an evacuation is initiated would affect the number of persons to be evacuated and the time interval required to respond to the evacuation warning. Both of these factors would affect the total time interval required to evacuate the area. Three common time periods were selected for the development of evacuation time estimates.

1a: Daytime on a summer weekday;
1b: Daytime on a peak summer weekend;
1c: Night, either on a weekend or weekday

4.1.1 Summer Weekday Evacuation (1a – Base for comparison)

The first scenario represents the event that an evacuation takes place during a summer weekday during work hours with many residents working outside the EPZ, and a significant number of workers within the EPZ who reside outside the EPZ. This condition would include a substantial number of non-resident workers and tourists. Recreation usage at State Parks and beaches would be moderately heavy, consistent with current park usage statistics.

The evacuation times for schools in the EPZ have also been included in the weekday time estimate for special institutions. The time estimates reflect normal school year attendance.

4.1.2 Summer Weekend Evacuation (1b)

The second case is the condition where an evacuation takes place on a summer weekend, where a significant portion of the populace would be non-residents who are in the area as workers and tourists, or for recreational purposes. Weekend resident population in the area would be higher than on a weekday when many residents would be out of the area at their place of work. Estimates of beach visitors are based on data for the July 4th holiday, which is usually one of the peak visitor days in the year. The number of visitors to most beach areas is limited by the available parking areas on this day.

4.1.3 Night Evacuation (1c)

In the event that an evacuation takes place at night, the maximum resident population and the minimum non-resident population would be in the EPZ. This scenario assumes evacuation warning would occur in the late evening when most people would be at their permanent or temporary place of residence.

4.2 I-5 Management Variations

All traffic management variants center around management of I-5. I-5 is the most significant facility available for evacuation and the most practical facility for implementing various management strategies. Four operating strategies were modeled:

1a: Moderate management of I-5 (Current local plans: Traffic from San Diego denied use of I-5, and northbound on ramps north of the EPZ boundary are closed to shadow demand and background traffic.
2a: No significant restrictions on I-5 (Same as 1a, but ramps north of EPZ boundary remain open).
2b: Aggressive traffic management of I-5 (Same as 1a, but officers meter ramp entry to ensure more efficient 50-60 mph speeds).
2c: Same as 2b, but with northbound contra-flow implemented on two southbound lanes.

4.2.1 Moderate Management of I-5 (1a Baseline)

The existing I-5 management plan calls for barricading all north-bound on ramps between the EPZ boundary and the El Toro "Y". This will eliminate competition from shadow demand and background traffic to ensure that the receiving capacity of I-5 is reserved exclusively for evacuating vehicles. This operating plan is considered a "baseline assumption" because it is the plan that local officials are prepared to implement at present. This plan is applied to the above weekday, weekend, and night evacuations. It is also applied to other sensitivity tests where noted.

While this plan is an effective strategy to ensure that receiving capacity beyond the EPZ boundary will be sufficient, it does not consider the potential for overloading the freeway (collapsing speeds are reducing throughput to just 65-75% of normal capacity) with traffic generated entirely within the EPZ. Existing plans are hence dubbed a "moderate" management plan, since it has effective elements, but also misses out on some efficiency that more aggressive plans could obtain.

4.2.2 No Significant Restrictions on I-5 (2a)

This sensitivity test is designed to reveal the benefit of the moderate management plan. In other words, what would happen if officials simply closed I-5 for through trips to and from San Diego, and still allowed unfettered northbound access for non-evacuating traffic between the EPZ boundary and the El Toro "Y"?

4.2.3 Aggressive Management of I-5 (2b)

This sensitivity test is designed to reveal additional benefit that could be realized if maximum throughput is maintained on I-5 for the duration of the evacuation. This "maximum efficiency" can be achieved by coordination with a central supervisor that has a birds-eye view of the system and can enforce actions that will improve efficiency, and if officers will slow the rate of entry if speeds are below the 50-60 mph range.

4.2.4 Aggressive Management of I-5 (2b) with Contra-Flow on I-5 (2c)

Heavy demand on I-5 northbound is expected to last nearly the entire evacuation. However, I-5 southbound may have significant ability to help move vehicles northward. This sensitivity test uses the assumptions of the aggressive management plan, but in addition assumes that where I-5 southbound has four and five lanes, two lanes could be used for northbound evacuating vehicles.

4.3 Variations in Other Conditions

Several other conditions may coincide with an evacuation. It is also possible that variation in a few critical assumptions may have an effect. The following sensitivity tests were modeled to establish the expected range of ETEs should certain conditions exist, or for the expected range of variance in major assumptions. All these use weekday moderate I-5 management but for the noted differences.

3a. Longer mobilization times than expected.
3b. Adverse weather conditions (rain or fog).
3c. Incident on northbound I-5 reduces capacity.
3d. Up to 20% shadow demand.
3e. Earthquake event, with associated bridge, structure, and slope failures.

4.3.1 Delayed Mobilization Sensitivity Test (3a)

There is reason to believe that even if the time consumed in mobilization is significantly higher than estimated, the overall evacuation time may be only minimally affected. The significant question is how quickly roadway capacity will be consumed by those who are first to mobilize. Once the roads are full those not yet mobilized may be able to take their time since they would only be entering gridlock.

A *sensitivity test using a longer than expected mobilization time distribution*, was used to test this situation.

4.3.2 Adverse Weather (3b)

Several adverse weather conditions occur in the EPZ which could potentially coincide with and impede an evacuation. The most probable would be the effects of heavy rainfall or dense fog. Heavy rainfall is used for this analysis.

HCM 2000 suggests that the affect of rain/fog is to reduce freeway speeds by 16%, and capacities by 15%. Arterials can be expected to see a 10% reduction in speed, and a 6% reduction in capacity. Once the effects of these reductions are modeled, the resulting percent change (or sensitivity) in overall ETE between the normal day and the adverse weather conditions can then be applied to weekend and night scenarios.

4.3.3 Unexpected Incident on Northbound I-5 (3c)

There is significant potential for an event to occur on northbound I-5 during the evacuation (vehicle collisions or breakdowns). This scenario assumes an incident occurs near the EPZ boundary which closes all lanes on I-5 for 45 minutes.

4.3.4 Up to 20% Shadow Demand (3d)

This scenario was developed to quantify the range of uncertainty that exists in the assessment of evacuation time should shadow demand reach 20% instead of the anticipated negligible amount (0%). Calculations suggest that 20% shadow demand, combined with background demand and demand from rerouting, would consume 75% of at-grade arterial roadway capacity during the first 120 minutes. With time, conditions improve so that 50% of at-grade capacity is available to the target population until the 240 minute mark. Shadow demand will not affect freeway capacity due to restricted access.

4.3.5 Earthquake Event (3e and 3f)

This scenario assumes that an earthquake event has compromised the SONGS facilities resulting in the need to evacuate and possible landslides and bridge failures have rendered many roadway sections unusable. This scenario could also apply to any situation where the use of bridge structures is impeded.

Chapter 5
EVACUATION NETWORK

Evacuation plans identify the area roadways to be used as evacuation routes by each community. The major roadway system and the principal evacuation routes within the EPZ sectors are depicted in **Figure 5.1.**

5.1 Major Evacuation Routes

Major roadways in the area which were examined for use as evacuation routes are described in the following paragraphs.

- Interstate 5 (San Diego Freeway) is the principal north-south roadway and passes just east of SONGS. I-5 is an eight- to ten-lane freeway. Four northbound lanes are available for evacuation use south of Camino Las Ramblas and five lanes are available north of this point. Four lanes are available in the southbound direction, south of State Route 1.

- The San Joaquin Hills Transportation Corridor (State Route 73) extends from State Route 55 in Costa Mesa to I-5 between Junipero Serra Road and Avery Parkway. The two-lane connector ramp from northbound I-5 to northbound San Joaquin Hills Transportation Corridor adds one additional evacuation lane between Ortega Highway and Junipero Serra Road and two additional evacuation lanes from Junipero Serra Road north to the SR-73 connector ramp.

- Basilone Road is a two-lane road which intersects I-5 approximately two miles north of SONGS and runs in a southeasterly direction into the interior of Camp Pendleton.

- Old Highway 101 was originally a four-lane roadway, but has been narrowed to two lanes in some areas to provide shoulder-area parking for visitors to the State Beach areas. This highway parallels I-5 from the Basilone Road interchange past the SONGS facility, with a southern connection to I-5 at the Las Pulgas interchange approximately seven miles south of the SONGS site.

- El Camino Real (State Route 1) is a four-lane undivided roadway which generally parallels I-5 from the Orange County line northward to the Avenida Pico area in northern San Clemente.

- State Route 1 continues north of Avenida Pico as the Pacific Coast Highway between Avenida Pico and Doheny Park Road. North of Del Obispo Street, Pacific Coast Highway operates as a three-lane, one-way street couple to Street of the Blue Lantern and then narrows to a four-lane (two-way) roadway and generally parallels the coastline.

- Avenida Pico is a four-lane arterial within the City of San Clemente west of I-5, with its western terminus at El Camino Real (State Route 1) near the Pacific Ocean. It is generally six-lanes east of I-5.

- Ortega Highway (State Route 74) is a generally four-lane, east-west roadway from Camino Capistrano to east of Hunt Club Road, which is located near the eastern city limits. Ortega Highway then narrows to two lanes and continues across the San Juan Creek channel to the Lake Elsinore area in Riverside County. Though it has limited capacity, it is expected to be fully utilized in an evacuation.

- Antonio Parkway is a four-lane north-south arterial which runs from Ortega Highway (SR-74) in the south, at La Pata Avenue, to Crown Valley Parkway in the north. From Crown Valley Parkway to Oso Parkway, Antonio widens to six lanes. At this point just east of the Mission Viejo city limit it continues as a six-lane arterial and runs in a northeasterly direction to connect with the Foothill Transportation Corridor (SR-241).

- Camino Capistrano begins as a two-lane arterial at its intersection with Pacific Coast Highway in northern San Clemente, and parallels the Pacific Coast Highway through the Capistrano Beach residential areas of Dana Point. At Camino Las Ramblas, it turns northward and parallels I-5 through San Juan Capistrano. At its junction with Doheny Park Road, Camino Capistrano widens to a four-lane cross-section to Del Obispo Street. From Del Obispo Street to Ortega Highway, Camino Capistrano operates as a two-lane roadway. The roadway extends north of Ortega Highway as a four-lane roadway to a point near Oso Road, where it tapers down to a two-lane roadway.

- Rancho Viejo Road extends from Calle Arroyo in the south, across Ortega Highway. Most of the roadway is four lanes wide.

- Street of the Golden Lantern is generally a six-lane arterial which extends from Pacific Coast Highway north beyond the limits of Dana Point and becomes Moulton Parkway north of Crown Valley Parkway in Laguna Niguel.

- Niguel Road is a four-lane roadway which extends from Pacific Coast Highway north beyond the limits of Dana Point and connects with Alicia Parkway immediately north of Crown Valley Parkway in Laguna Niguel.

- Crown Valley Parkway is generally a six-lane arterial which extends north through Dana Point, then northeasterly through Laguna Niguel to I-5.

Evacuation Routes

0 1 2 4 6 8 Miles

San Onofre Nuclear Generating Station
Evacuation Time Estimate

Evacuation Routes

N

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Figure 5.1

5.2 Planned Improvements to the Major Roadway Network

Near-term/on-going, medium-term, and long-term planned roadway improvements were identified through contact with responsible agencies. These are described below.

5.2.1 Near-Term/On-Going Roadway Projects

Antonio Parkway is currently a four- and six- lane arterial paralleling east of I-5 between Oso Parkway and Ortega Highway (SR-74). The road has been planned to extend south along La Pata Avenue and connect Avenida Pico near Avenida Vista Hermosa, thus providing a bypass route to the communities living east of I-5.

Currently, the La Pata Avenue Extension of Antonio Parkway extends as a two-lane road one mile south of Ortega Highway to the County Landfill site. Further extension of this road to Avenida Vista Hermosa has been deferred and is not anticipated to be completed before 2011. The potential impact of this improvement on evacuation routing and evacuation time will not be included as part of this study.

5.2.2 Long-Term Roadway Projects

There are several regional arterials being considered, in the long term and in or near the study area. Those which could ultimately increase available evacuation route capacity are summarized below:

The extension of Antonio Parkway as a high-capacity two-lane arterial along the alignment of La Pata Avenue from the County Landfill to Avenida Pico (as described above).

The Foothill-South Transportation Corridor (FSTC, or SR-241), runs between I-5 at the Orange County/San Diego County line and Oso Parkway. This roadway, if completed, would be aligned along the northern boundary of Camp Pendleton Marine Corps Base and northeast of San Clemente, providing additional capacity to the north.

SR-241 currently connects Oso Parkway near Santa Rancho Margarita to SR-91 in Santa Ana Canyon. The project construction may be anticipated to begin in 2007-2008 and may be completed by 2011. Since its earliest completion is the last year of the study, it is assumed that it will not be available during the study time frame. Antonio Parkway, an existing arterial, could be utilized as an alternate route to SR-241 and is included in the modeling network for the ETE analyses.

Thus, these projects do not anticipate their full completion before 2011, or at best near the very end of the horizon period. As such, none of the above-mentioned long-range regional arterial improvements were reflected in terms of available new evacuation roadway capacity for this evaluation time analysis.

5.3 Designated Evacuation Routes and Reception Centers

The principal northbound evacuation routes are I-5 and the Pacific Coast Highway, with Camino Capistrano, Street of the Golden Lantern, Niguel Road, Crown Valley Parkway, and Antonio Parkway as secondary routes. These are preferred routes only.

Population from within the U.S. Marine Corps Base, Camp Pendleton and San Onofre State Park have been assigned evacuation routes leading to the south. The principal routes to the south are Basilone Road and I-5. Basilone Road is primarily for evacuation of Camp Pendleton.

Nonessential SONGS personnel and visitors will be directed to evacuate north or south via I-5, depending on the safest prevailing conditions at the time.

The Orange County Fairgrounds is the assigned reception center identified in the Offsite Emergency Response Plan for those who evacuate north. Carlsbad High School is the reception center for those who evacuate to the South. Reception centers are more accurately called Reception and Decontamination Centers. These are referred to in most of this document as reception centers for ease of use.

5.4 Evacuation Route Link/Node Network

The designated evacuation routes were translated into a link/node network for input to a Dynamic Assignment Simulation Program.

5.5 Roadway Characteristics for Evacuation Network

Each roadway has an observed free flow speed and capacity that must be coded as a starting point for simulation. A brief description of these attributes is given below:

- Speed: The normal speed limit or observed speed is provided as a starting point for the simulation. The length of each link is also computed to determine average time to traverse the link. Note that this speed is not the normal peak hour observed speeds, which are typically much lower than the posted speed limit on congested arterials and freeways.

- Capacity: Capacity in vehicles per hour per lane (vphpl) identifies the number of vehicles which can traverse a typical intersection for that class of roadway. Link capacity is then simply lane capacity multiplied by the number of lanes.

Chapter 6
DEMAND ESTIMATES

6.1 Public Evacuation Time Components

For the general population, the time required to evacuate is comprised of several individual time components. The following time components during an evacuation are expected from the majority of the population:

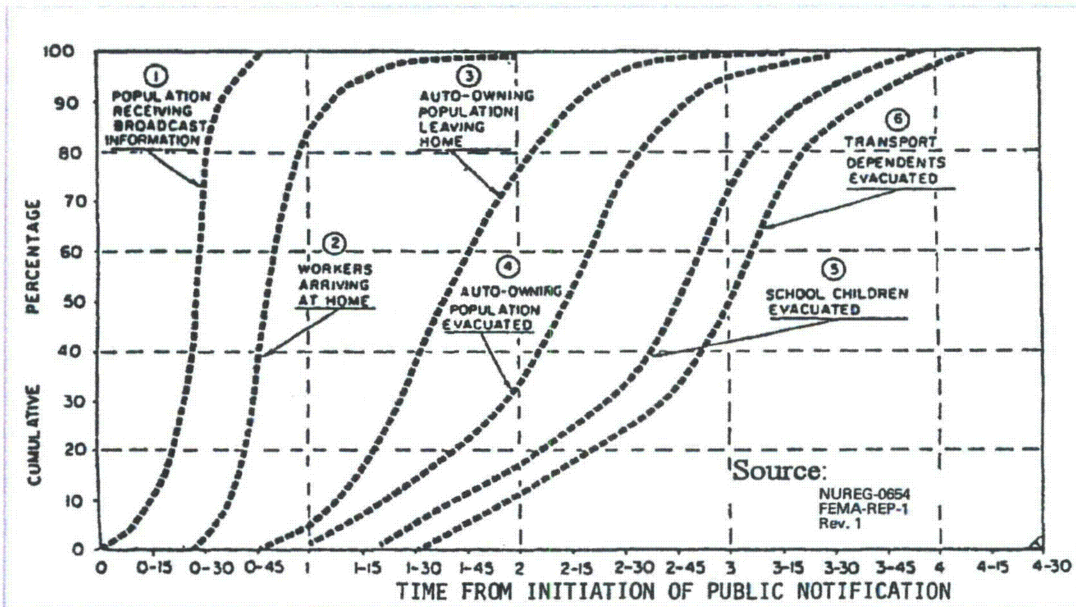
1. Receipt of Notification - The time required for the general population to receive notification of evacuation once public warning is initiated.
2. Return to Home - The time required for persons to return to their homes. This reflects the time required to close up businesses and places of work.
3. Departure from Home - The time required to assemble family members, pack essential items for the evacuation, and secure the home prior to leaving.
4. Evacuation Travel Time - The time required for the population to travel out of the affected area.

The transient population (visitors and workers who reside outside the EPZ) would skip steps two and three, mobilizing much faster than the resident population.

6.2 Mobilization Rates

Each evacuation time component can be expressed graphically as a distribution curve of the percent of population completing a public response component over time (**Figure 6.1**). Mobilization time is that period between the initial evacuation notification and the time that people leave home. In **Figure 1** this is line 3, Auto-Owning Population Leaving Home. The mobilization time distribution controls the rate at which vehicles enter onto the evacuation network.

Figure 6.1:
NUREG-0654 SAMPLES OF TIME TO COMPLETE EVACUATION PHASES

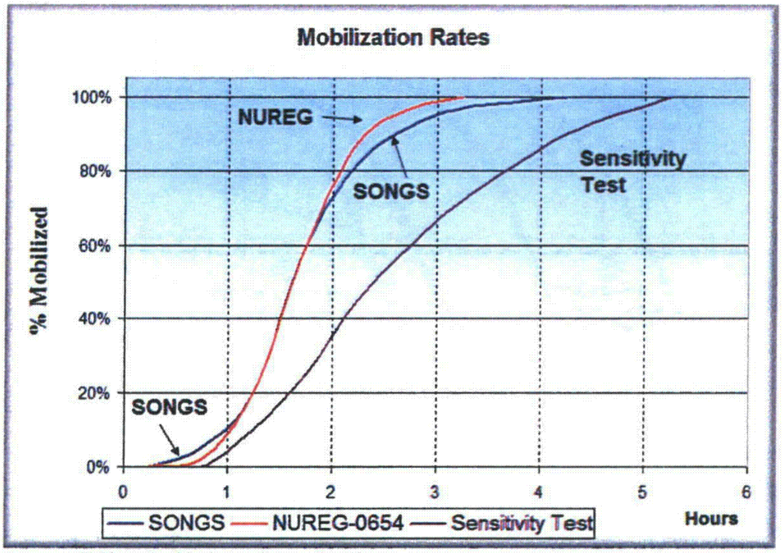


Source: NUREG-0654, Rev. 1

Visitors and people who work in the EPZ but live outside the EPZ are able to mobilize to leave the EPZ much more quickly than those who live within the EPZ. Mobilization rates of beach visitors or SONGS employees follow a curve between **Figure 6.1** curves 1 and 2 (receiving notice, and workers arriving at home). Curves 5 and 6 were used to account for schools and transport-dependent individuals. Curve 4 is an example of a final ETE.

A blending of the relevant NUREG curves applied to SONGS is shown in **Figure 6.2**. This is compared with the NUREG curve 3 which encompasses the majority of evacuees.

Figure 6.2:
MOBILIZATION RATES



Source: Wilbur Smith Associates, 2006

The mobilization rate in the first few minutes is far more important than in latter minutes. Roadway capacity is largely unused in the first few minutes. Once demand begins to overwhelm capacity it may be irrelevant whether the remainder of evacuees mobilize quickly.

A sensitivity test was conducted of a far more pessimistic mobilization rate than that recommended by NUREG-0654. The test concluded that the slower mobilization rate did not change the overall ETE in a meaningful way. The analysis is presented in Chapter 7.

6.3 Evacuation Population Elements

The populace within the EPZ has been classified into two main groups and a total of six sub-groups. The groups are:

1. Persons Evacuating By Personal Vehicle
   a. Residents who own automobiles; and
   b. Transients (visitors and non-resident workers) who have automobiles available.
2. Persons Requiring Evacuation Assistance
   a. Residents without automobiles;
   b. Transients without automobiles;
   c. School children; and
   d. Special needs populations having restricted mobility.

Projections received from CSUF and local planning agencies were used to estimate population for 2006. The evacuation time estimates reflect the 2006 demographic forecasts.

The following sections identify the population segments, the vehicle volumes, and transportation requirements.

6.3.1 Resident and Transient Population Estimates

The estimated resident and transient population which would evacuate reflects the following:

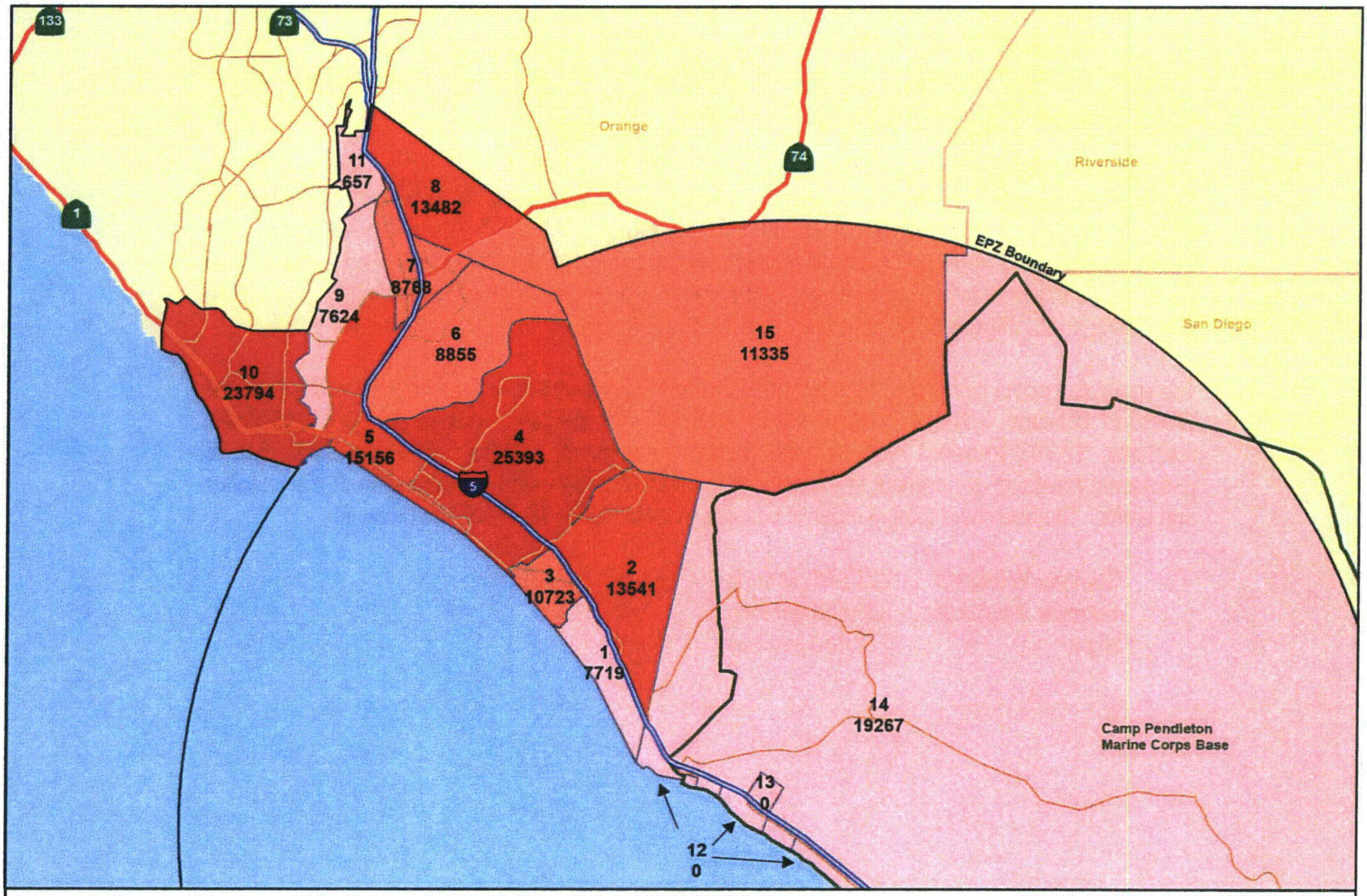
1. The resident population reflects the total number of persons estimated to reside within each zone.
2. The workers represent the estimated total number of non-resident persons (transients) employed within each zone or visiting the zone for business purposes.
3. The tourist and beach populations reflect the estimated number of recreational visitors (non-residents) within the zone.

6.3.1.1 2006 Resident and Transient Population

The estimated number of Year 2006 residents and transients who would evacuate is summarized by scenario in **Table 6.1** and shown geographically on **Figures 6.3 2006 Population and 6.4 2006 Employment**. On **Figure 6.3**, Camp Pendleton population is not shown in the legend in the highest category, as this population will evacuate to the south and not influence the modeling of populations evacuating north. **Figure 6.4** is summer weekday employment.

The maximum population which may be within the area at any one time would occur for the Summer Weekend scenario. The evacuees, which total 221,078 persons, include 166,314 permanent residents, 12,703 transient workers, and 42,061 recreational visitors. This assumes that all permanent residents are present in the area at the time of peak visitor accumulation at the beaches and parks. The estimated total number of persons evacuating for the three scenarios is:

Summer Weekend	221,078 persons
Summer Weekday	220,563 persons
Night	172,453 persons



San Onofre Nuclear Generating Station
Evacuation Time Estimate

2006 Population

Note: Population of Camp Pendleton not modeled

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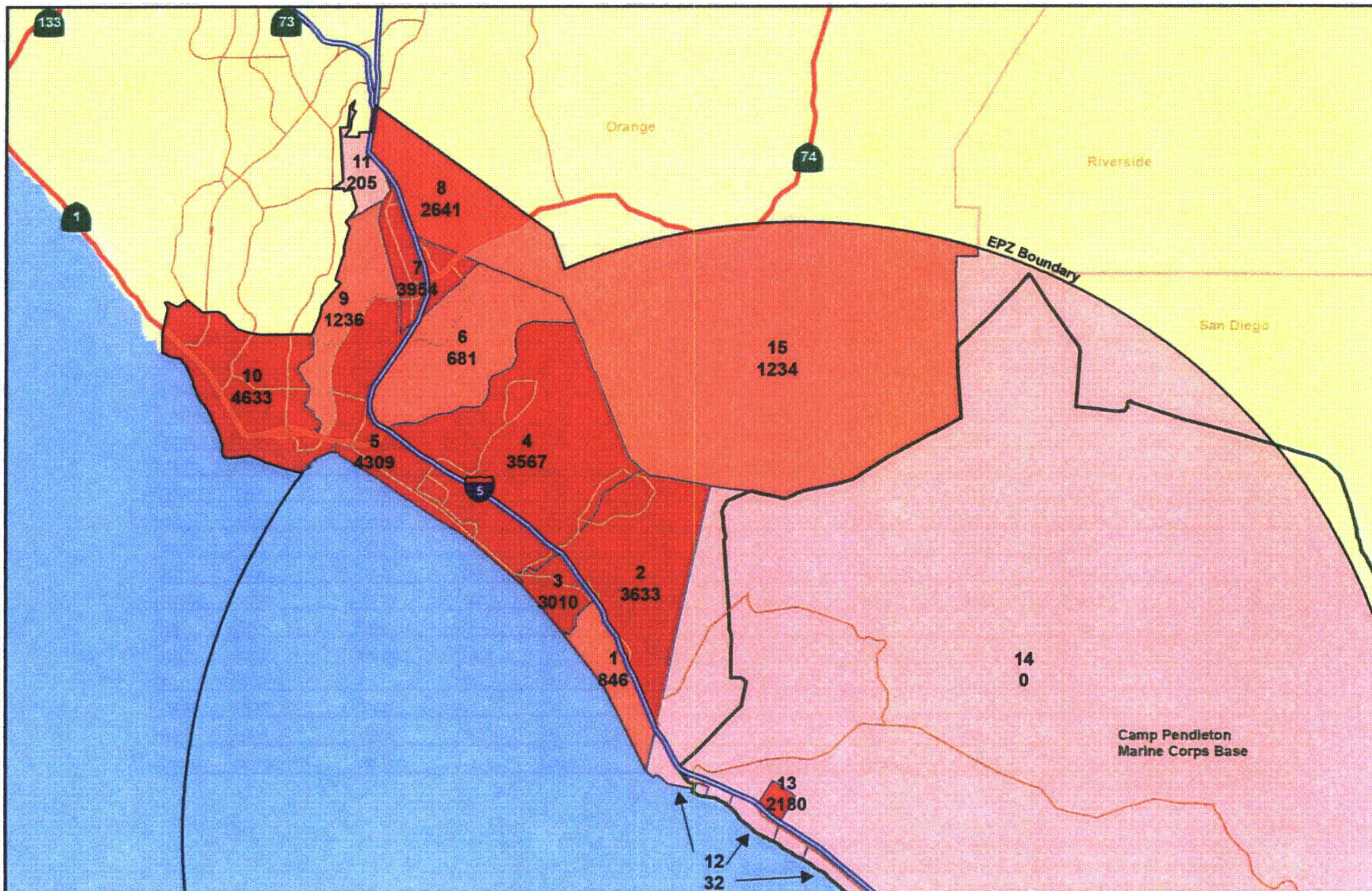
Figure 6.3



San Onofre Nuclear Generating Station
Evacuation Time Estimate

2006 Employment

Figure 6.4

Table 6.1:
EPZ PERMANENT AND TRANSIENT POPULATION SUMMARY 2006

Sub-zone	Residents (All Scenarios)	Non-Residents						Grand Totals		
		Summer Weekend		Summer Weekday		Night		Summer Weekend	Summer Weekday	Night
		Worker	Beach/ Visitor	Worker	Beach/ Visitor	Worker	Beach/ Visitor			
1	7,719	666	3,180	846	2,095	82	960	11,565	10,660	8,761
2	13,541	1,211	280	3,633	249	171	95	15,032	17,423	13,807
3	10,723	1,904	10,060	3,010	5,030	301	270	22,687	18,763	11,294
4	25,393	863	40	3,567	220	182	88	26,296	29,180	25,663
5	15,156	2,028	12,480	4,309	6,240	285	420	29,664	25,705	15,861
6	8,855	187	177	681	115	34	40	9,219	9,651	8,930
7	8,768	1,318	175	3,954	114	198	40	10,261	12,836	9,005
8	13,482	998	277	2,641	219	844	77	14,757	16,341	14,402
9	7,624	778	267	1,236	211	74	74	8,669	9,071	7,772
10	23,794	2,214	2,714	4,633	1,357	172	339	28,722	29,784	24,305
11	657	78	21	205	17	21	6	756	879	684
12	0	48	12,300	32	6,150	8	1,230	12,348	6,182	1,238
13	0	0	0	2,180	0	0	0	0	2,180	0
14	19,267	0	0	0	0	0	0	19,267	19,267	19,267
15	11,335	410	90	1,234	71	103	25	11,835	12,641	11,463
TOTAL:	166,314	12,705	42,061	32,161	22,088	2,475	3,664	221,078	220,563	172,453

Source: Wilbur Smith Associates, 2006

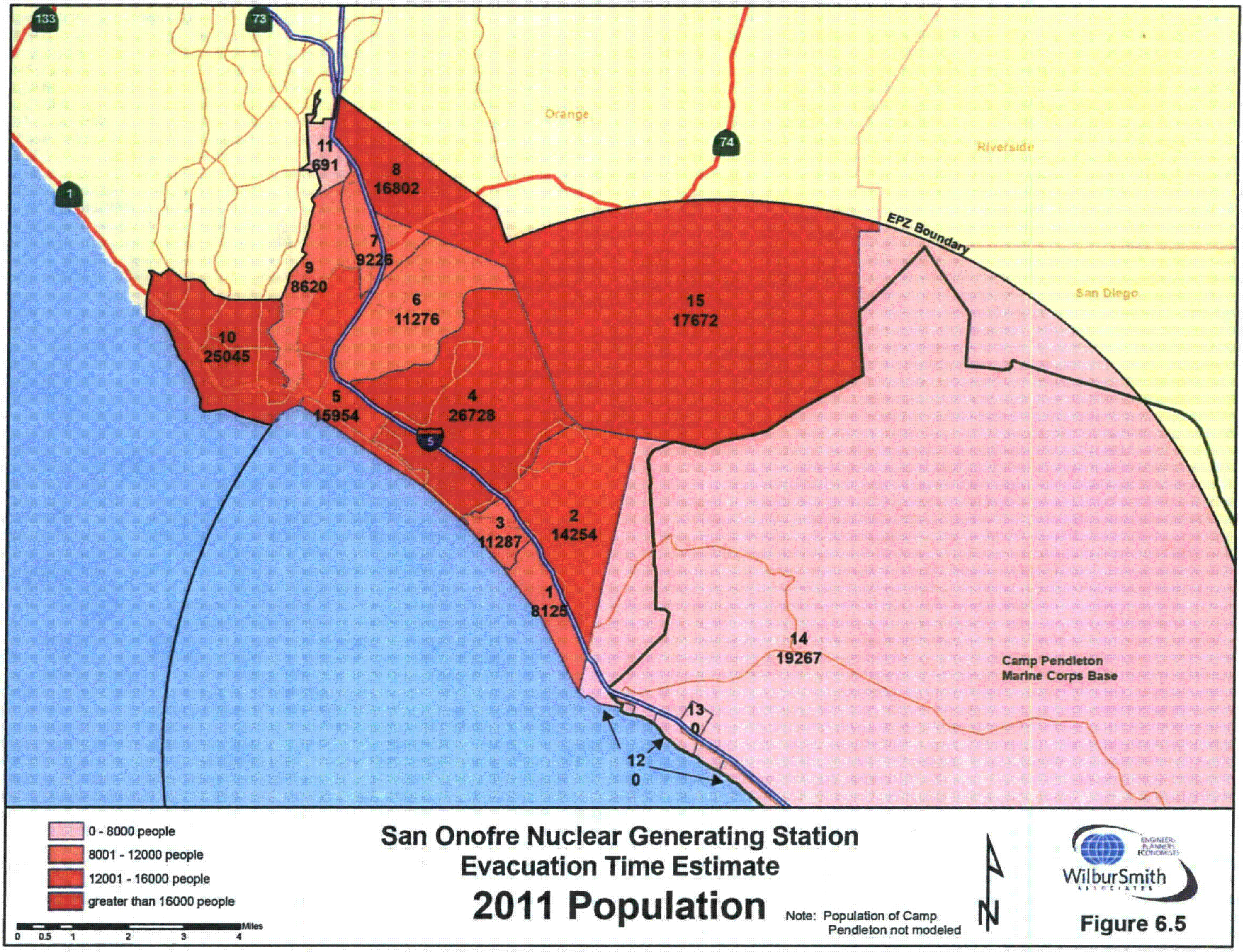
Note:

Sub-zone 13 is SONGS and only workers are counted for this sub-zone.
Sub-zone 14 is Camp Pendleton, the number stated is peak population not distinguishing between workers and residents.

6.3.1.2 2011 Resident and Transient Population

Estimated resident and transient populations for 2011 are summarized in **Table 6.2** for each evacuation scenario, and shown on **Figures 6.5 2011 Population and 6.6 2011 Employment.** Camp Pendleton population was treated in **Figure 6.5** as it was in 2006. Employment is also summer weekday employment. The total number of persons included in each scenario is as follows:

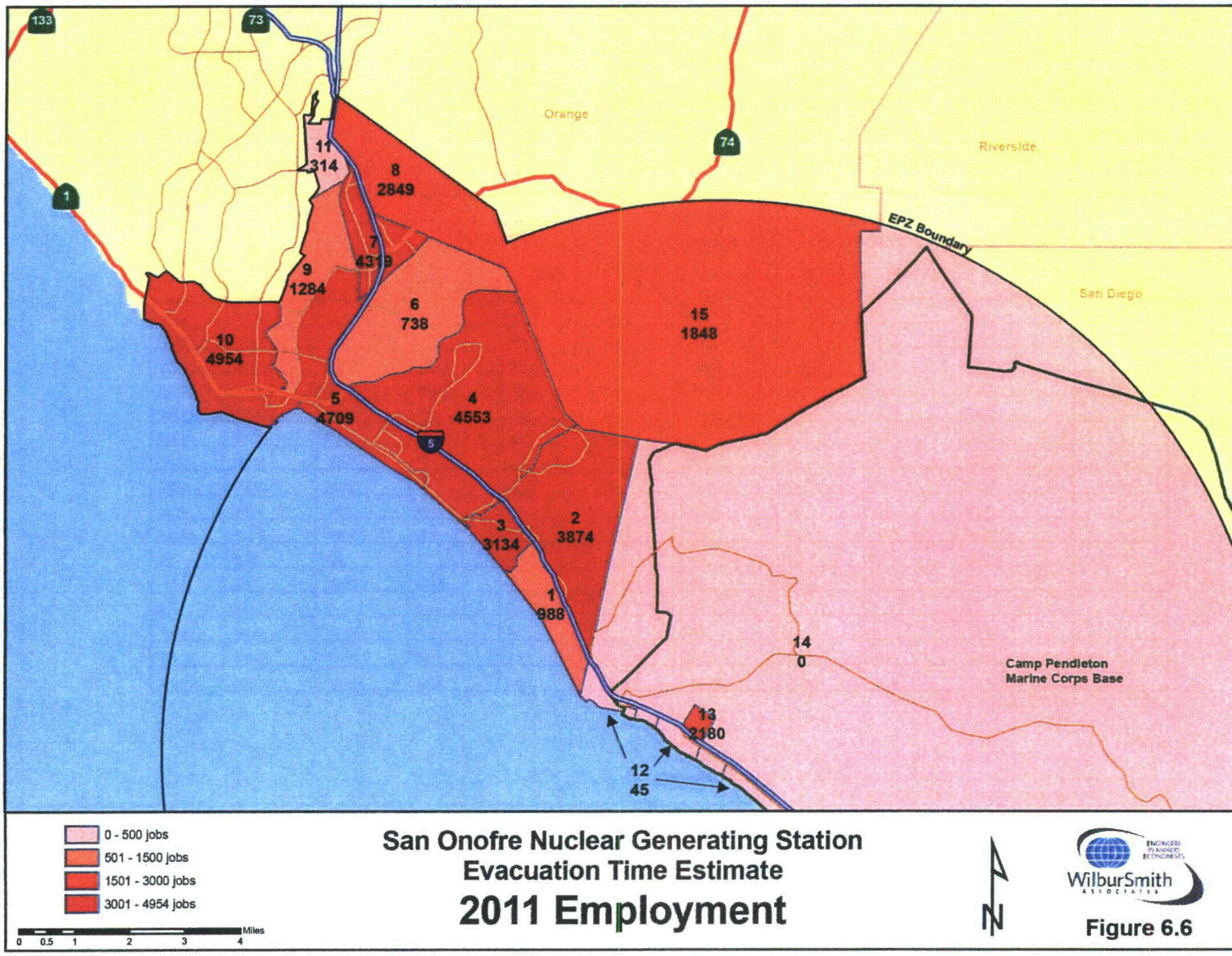
Summer Weekend	249,767 persons
Summer Weekday	247,239 persons
Night	191,284 persons



San Onofre Nuclear Generating Station
Evacuation Time Estimate
2011 Population

Note: Population of Camp Pendleton not modeled

Figure 6.5



San Onofre Nuclear Generating Station
Evacuation Time Estimate

2011 Employment

Figure 6.6

Table 6.2:
EPZ PERMANENT AND TRANSIENT POPULATION SUMMARY 2011

SUB-ZONE	RESIDENTS (ALL SCENARIOS)	NON-RESIDENTS						GRAND TOTALS		
		SUMMER WEEKEND		SUMMER WEEKDAY		NIGHT		SUMMER WEEKEND	SUMMER WEEKDAY	NIGHT
		WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR			
1	8,125	779	3,816	988	2,514	95	1,152	12,720	11,627	9,372
2	14,254	1,291	240	3,874	299	182	113	15,785	18,427	14,549
3	11,287	1,982	12,072	3,134	6,036	314	324	25,341	20,457	11,925
4	26,728	1,102	264	4,553	264	232	106	28,094	31,545	27,066
5	15,954	2,216	14,976	4,709	7,488	312	504	33,146	28,151	16,770
6	11,276	203	94	738	138	38	48	11,573	12,152	11,362
7	9,226	1,440	524	4,319	136	216	47	11,190	13,681	9,489
8	16,802	1,077	332	2,849	262	108	92	18,211	19,913	17,002
9	8,620	809	321	1,284	253	77	89	9,750	10,158	8,786
10	25,045	2,367	3,256	4,954	1,628	184	406	30,668	31,627	25,635
11	691	90	25	314	20	24	7	806	1,025	722
12	0	62	14,760	45	7,380	8	1,476	14,822	7,425	1,484
13	0	0	0	2,180	0	0	0	0	2,180	0
14	19,267	0	0	0	0	0	0	19,267	19,267	19,267
15	17,672	614	108	1,848	85	154	29	18,394	19,605	17,855
TOTAL:	184,947	14,032	50,788	35,789	26,503	1,944	4,393	249,767	247,239	191,284

Source: Wilbur Smith Associates, 2006

Note:

Sub-zone 13 is SONGS and only workers are counted for this sub-zone.
Sub-zone 14 is Camp Pendleton, the number stated is peak population not distinguishing between workers and residents.

6.3.2 Evacuation Vehicles Used by Resident Population

6.3.2.1 Resident Population

The projected 184,947 persons in 2011 residing in sections of the EPZ which would evacuate north are estimated at 71,317 households. Household automobile ownership information from the 2000 Census was used to estimate the number of households in 2011 that own one or more automobiles (68,950 households). This information is displayed in **Table 6.3.**

Household automobile ownership information from the 2000 Census was used to estimate the number of households that own zero, one, two, and three or more vehicles. Based on vehicle per family assumptions the number of vehicles taken by residents was calculated. **Table 6.3** shows the process of figuring the total number of vehicles used by residents for Summer Weekend/Weekday and Nighttime scenarios.

Table 6.3:
ESTIMATED 2010 HOUSEHOLD VEHICLE OWNERSHIP AND OCCUPANCY SUMMER WEEKEND/WEEKDAY

SUB-ZONE	RESIDENT POPULATION	PEOPLE/ HH	TOTAL HH	% HH NO VEHICLE	% HH W/ 1 VEHICLE	% HH W/ 2 VEHICLE	% HH W/ 3 OR MORE VEHICLE	HH W/0	HH W/1	HH W/2	HH W/3	TOTAL VEHICLES OWNED	TOTAL VEHICLES USED	AVERAGE VEHICLE OCCUPANCY
1	8,125	2.08	3,905	2%	26%	51%	21%	91	998	1,984	831	7,876	5,032	1.61
2	14,254	2.34	6,095	2%	25%	52%	21%	128	1,515	3,148	1,304	12,375	7,890	1.81
3	11,287	2.19	5,158	6%	45%	35%	14%	333	2,331	1,792	702	8,372	5,889	1.92
4	26,728	2.27	11,749	2%	30%	46%	22%	234	3,537	5,387	2,591	23,381	15,075	1.77
5	15,954	2.41	6,631	6%	34%	40%	19%	392	2,283	2,684	1,272	12,102	7,998	1.99
6	11,276	2.56	4,404	5%	27%	48%	20%	202	1,190	2,134	878	8,530	5,500	2.05
7	9,226	2.98	3,097	6%	35%	37%	22%	193	1,084	1,136	685	5,752	3,759	2.45
8	16,802	2.23	7,541	2%	29%	43%	25%	176	2,169	3,276	1,919	15,440	9,788	1.72
9	8,620	2.40	3,599	1%	17%	49%	33%	40	603	1,757	1,199	8,314	4,986	1.73
10	25,045	2.22	11,277	2%	30%	46%	22%	216	3,385	5,176	2,500	22,487	14,489	1.73
11	691	2.07	333	1%	22%	50%	26%	5	74	168	86	712	444	1.56
12	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	-	NA
13	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	-	NA
14	19,267	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,817	NA
15	17,672	2.35	7,528	0%	5%	49%	46%	15	370	3,682	3,462	19,904	11,254	1.57
Total/Ave	184,947		71,317	3%	30%	45%	22%	2,025	19,539	32,324	17,429	145,245	96,919	1.91

Source: Wilbur Smith Associates, 2006

The 2011 resident population would use an estimated 96,919 vehicles to evacuate. The number of resident vehicles is summarized by sub-zone in **Table 6.4**.

6.3.2.2 Transient Population

Virtually all travel of the transient population within the area occurs via private automobile. The number of vehicles used by these transient groups was derived by applying the following average vehicle occupancy factors to the estimated number of visitors within the area represented by each population centroid:

Transient Workers	1.2 persons/vehicle
Transient Beach-Goers	3.0 persons/vehicle
Campers	3.5 persons/vehicle
Other Business, Shopping, Recreational Visitors	2.0 persons/vehicle
Beach-Goers, Campers, and Other Average	2.8 persons/vehicle

The number of vehicles used by transients in an evacuation is presented by sub-zone in **Table 6.4**.

Table 6.4:
EVACUATION VEHICLES GENERATED BY SUB-ZONE 2011

SUB-ZONE	RESIDENTS	NON-RESIDENTS						GRAND TOTAL VEHICLES		
		SUMMER WEEKEND		SUMMER WEEKDAY		NIGHT				
	ALL SCENARIOS	WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR	WORKER	BEACH/ VISITOR	SUMMER WEEKEND	SUMMER WEEKDAY	NIGHT
1	5,032	649	1,348	823	888	79	407	7,030	6,744	5,519
2	7,890	1,076	85	3,228	106	152	40	9,050	11,223	8,081
3	5,889	1,652	4,266	2,612	2,133	261	114	11,807	10,634	6,265
4	15,075	918	93	3,794	93	193	37	16,086	18,962	15,306
5	7,998	1,847	5,292	3,924	2,646	260	178	15,136	14,568	8,436
6	5,500	169	33	615	49	31	17	5,702	6,163	5,548
7	3,759	1,200	185	3,599	48	180	17	5,144	7,406	3,955
8	9,788	897	117	2,374	93	90	32	10,802	12,254	9,910
9	4,986	674	113	1,070	90	64	31	5,773	6,145	5,081
10	14,489	1,973	1,151	4,128	575	154	144	17,612	19,192	14,786
11	444	75	9	262	7	20	2	527	712	466
12	0	52	5,216	38	2,608	7	522	5,267	2,646	528
13	0	0	0	2,146	0	0	0	0	2,146	0
14	4,817	0	0	0	0	0	0	4,817	4,817	4,817
15	11,254	511	38	1,540	30	129	10	11,804	12,825	11,393
TOTAL:	96,919	11,693	17,946	30,153	9,365	1,621	1,552	126,558	136,438	100,091

Source: Wilbur Smith Associates, 2006

Note:
* Resident vehicle estimates were computed in Table 6.3.

The largest number of transient vehicles would be included in an evacuation occurring on a summer weekday, when the combination of transient workers and a relatively large number of beach visitors would increase the number of transient vehicles to 39,519. This compares to 29,757 transient vehicles for a summer weekend and 3,171 vehicles for a nighttime evacuation. The evacuation time estimates assume that all transient vehicles will leave the EPZ.

6.3.2.3 Total Number of Vehicles Evacuating EPZ (Unassisted Population)

The combined number of permanent resident and transient vehicles included within the evacuation time estimate is as follows:

Summer Weekday	136,438 vehicles
Summer Weekend	126,558 vehicles
Night	100,091 vehicles

6.3.3 General Population Requiring Evacuation Assistance

A portion of the population in the EPZ will not have an automobile available to use in an evacuation. Groups which may require transportation assistance would include households which do not own an automobile, households where the family vehicles are unavailable at the time of evacuation, homebound special needs population, and persons in institutions (for example schools, hospitals and assisted living facilities). The demand for public transit is figured by estimating the number of bus loads needed to evacuate this portion of the population. These numbers are not necessarily the number of buses required, because one bus can make several trips reducing the number of buses needed and vehicles on the road at the time of the evacuation.

6.3.3.1 Residents without Automobiles

The 2000 Census reveals that between two and five percent of the households within the EPZ do not own an automobile. Applying the average household size to the number of 2011 households without autos in each community yields an estimated 4,916 residents who may require transportation assistance. In **Table 6.5** the total weekend and night population needing evacuation assistance without an auto is 4,916.

Table 6.5:
NUMBER OF BUS LOADS NEEDED TO TRANSPORT RESIDENTS WITHOUT AN AUTO

SCENARIO	PERSONS	BUS LOADS
Weekend	4,916	71
Weekday	13,597	195
Night	4,916	71

Source: Wilbur Smith Associates, 2006

This estimate includes many school-age children of no auto households who would be provided transportation through the school authorities if an evacuation occurs on a school day. A weekday scenario would drop the population of no auto households to 4,129 by excluding school children, but would include households with one vehicle that may not be available at the household.

Census data indicates that between 17 and 45 percent of the households in the various areas has access to only one vehicle. Based upon regional work trip patterns, it is estimated that approximately

25 percent of these one-car households have workers who commute more than 20 miles from home and would be beyond the traffic control/diversion perimeter.

Applying the average number of persons per household (less the driver of the absent vehicle) to the one-car households without an available auto would result in as many as 9,468 persons. The total weekday population potential requiring assistance is 13,597.

The average seating capacity of the current bus fleet is approximately 36 persons per bus. In an emergency situation standees would be accommodated therefore 70 persons per bus was used to determine bus load demand.

The permanent residents without autos produce a potential need for up to 195 bus loads under summer weekday conditions.

School children and residents of assisted living facilities are not included in the above weekday scenario. They are addressed as a separate institution requirement on weekdays.

6.3.3.2 Transients without an Automobile

Most of the non-resident workers and recreational visitors would be expected to have an automobile available for use in an evacuation. An individual dropped off at work or at the beach by someone who then travels out of the EPZ could create a transient without an automobile. The analysis assumes that two percent of transient visitors do not have a vehicle available at the time of evacuation. The number of persons and bus loads is provided in **Table 6.6.**

Table 6.6:
NUMBER OF NEEDED BUS LOADS TO TRANSPORT TRANSIENTS WITHOUT AUTOS

SCENARIO	PERSONS	BUS LOADS
Weekend	1296	19
Weekday	1246	18
Night	127	2

Source: Wilbur Smith Associates, 2006

6.3.4 Schools

The primary means of transport for children in school evacuating the EPZ would be by bus.

The evaluation of transportation requirements for school children assumes that the majority of students attending public schools would be transported outside the affected area by school district or public transit bus.

Current information obtained from the CUSD indicates that the school district has sufficient capacity to transport approximately 5,000 students at one time. OCTA advises that the average capacity of their current public transit fleet is 36 seated adult passengers. Recognizing that somewhat more pupils could be accommodated, an average capacity of 60 pupils per bus was used.

Local emergency response plans envision that many of the children attending private schools would be picked up by their parents prior to evacuating the area. For the purpose of this estimate, only private school students who take the bus to school would be evacuated by bus. Approximately 1,275 students take buses to private school[4].

Using the approximate school district bus fleet lift capacity, it is estimated that as many as 352 public transit bus loads could be required to evacuate all public and private schools within the EPZ.

6.3.5 Special Populations Having Restricted Mobility

There are three types of institutions within the EPZ that would require assistance in relocation. These are hospitals, retirement homes, and homebound persons with special needs. These persons would be relocated to hospitals, assisted living facilities, and other appropriate facilities outside the affected area.[5]

6.3.5.1 Hospitals, Assisted Living Facilities, and Retirement Homes

Saddleback Memorial Medical Center, San Clemente Campus is the only hospital located in the EPZ. The 68 patients in this facility would be transported by ambulance and wheelchair van. Of the 68 patients, 42 would be accommodated by seven wheelchair vans, while 26 would be accommodated by 13 ambulances. Transportation requirements are based on assessments made by officials representing the hospital.

Based on information provided by facility staffs, a total of 822 of the assisted living residents were assessed to be ambulatory. Assuming a seated capacity of 36 per bus, some 23 transit bus loads would be required for evacuation. The estimated total of 309 wheelchair-bound persons would require 52 wheelchair vans having an average capacity of six chairs each.

Hospital and assisted living vehicle requirements are listed in **Table 6.7** below.

Table 6.7:
ESTIMATED YEAR 2011 TRANSPORTATION ASSISTANCE REQUIREMENTS FOR HOSPITALS AND ASSISTED LIVING POPULATION REQUIRING SPECIAL ASSISTANCE

ITEM	AMBULANCES	WHEELCHAIR VANS	BUS LOADS	TOTAL
Persons	26	351	822	1199
Vehicles	13	59	23	95

Source: Wilbur Smith Associates, 2006

Note:

Assumed vehicle capacities: Ambulances (2 per unit); wheelchair vans (6 per unit); bus loads (36 passengers per bus).

6.3.5.2 Homebound Populations Requiring Special Transportation Assistance

The County of Orange maintains a Special Assistance population list of persons who live at home and have chronic disabilities that may limit their mobility. Transportation assistance for homebound persons who are members of this program would have to be assigned on an individual basis. The type of transportation required would depend on the nature of the person's disability.

4 Per discussions with Orange County Sheriffs Department (OCSD)

5 County of Orange Nuclear Power Plant Emergency Plan for San Onofre Nuclear Generating Station, coordinated by Orange County Sheriff-Coroner Emergency Management Division, Interjurisdictional Procedures #8, #9, and #18. p. V-14.

The current number of persons enrolled in the Special Assistance program requiring transportation assistance is 529. Based on current program participants, approximately 54 of the total would require ambulances and 164 wheelchair vans. The remaining 311 are ambulatory and could be transported by bus, with some minor assistance. This resulted in the estimated transportation assistance requirements that are summarized on **Table 6.8** below.

Table 6.8:
ESTIMATED YEAR 2011 TRANSPORTATION ASSISTANCE REQUIREMENTS FOR HOMEBOUND POPULATION REQUIRING SPECIAL ASSISTANCE

ITEM	AMBULANCES	WHEELCHAIR VANS	BUS LOADS	TOTAL
Persons	54	164	311	529
Vehicles	27	27	9	63

Source: Wilbur Smith Associates, 2006

Note:
Assumed vehicle capacities: Ambulances (2 per unit); wheelchair vans (6 per unit); bus loads (36 passengers per bus).

6.3.5 SONGS Workers and Visitors

The number of on-site workers and visitors present at the SONGS facility depends upon the time of the week and whether or not a generation unit is shut down for maintenance or refueling purposes. During routine shut-downs or outages there is a large increase in the number of contract personnel on site. Each of the two generating units is scheduled for shut-down once every 18 to 24 months for refueling, with the outages scheduled to avoid the summer period when demand is greatest.

Southern California Edison would mandate an evacuation of the plant upon declaration of a General Emergency. Approximately 150 essential personnel would remain on site. **Table 6.10** presents the estimated number of workers and visitor vehicles that would exit the site.

SONGS workers would evacuate either north or south depending upon the safest direction of travel at the time.

Table 6.9:
ESTIMATED NUMBER OF VEHICLE USED BY EVACUATING SONGS WORKERS

CONDITION	WEEKDAY	WEEKEND	NIGHTTIME
Total Vehicle Evacuating			
During Normal Operations	2146	0	0
During Outage Operations	2514	341	341

Source: SONGS SCE, 2006

6.3.8 U.S. Marine Corps Base, Camp Pendleton

Peak population in those base areas included within the EPZ is estimated at 19,267 persons, as shown on **Table 6.11**. The estimated number of persons that would be evacuated would total 16,665 persons for an evacuation occurring during normal work hours, and 17,698 persons if the evacuation occurs outside of normal work hours.

Transportation resources used to evacuate these areas will include privately-owned vehicles and government vehicles.[6] Estimated evacuation demand has been expressed only in terms of persons requiring transportation.

[6] Annex C (Operations) to MCP FP Plan 04, July 2004

Table 6.10:
ESTIMATED POPULATION AND TRANSPORTATION REQUIREMENTS FOR CAMP PENDLETON

AREA	ESTIMATED PEAK POPULATION FOR CAMP PENDLETON	NUMBER OF PERSONNEL TO BE EVACUATED	
		NORMAL WORK HOURS	AFTER NORMAL WORK HOURS
San Onofre Recreation Beach	200	100	50
San Onofre Family Housing	4,712	2,500	3,500
Mobile Home Park (248 Trailers)	500	300	500
San Onofre	3,000	3,000	3,000
San Mateo	3,197	3,197	3,197
San Mateo Pt. Housing	290	200	290
Horno	3,245	3,245	3,245
Talega	307	307	100
Las Flores	930	930	930
Las Pulgas	2,886	2,886	2,886
TOTAL	19,267	16,665	17,698

Source: Camp Pendleton Housing, 2005

Chapter 7
RESULTS – EVACUATION TIME ESTIMATES

7.1 EMERGENCY EVACUATION TIME ESTIMATES

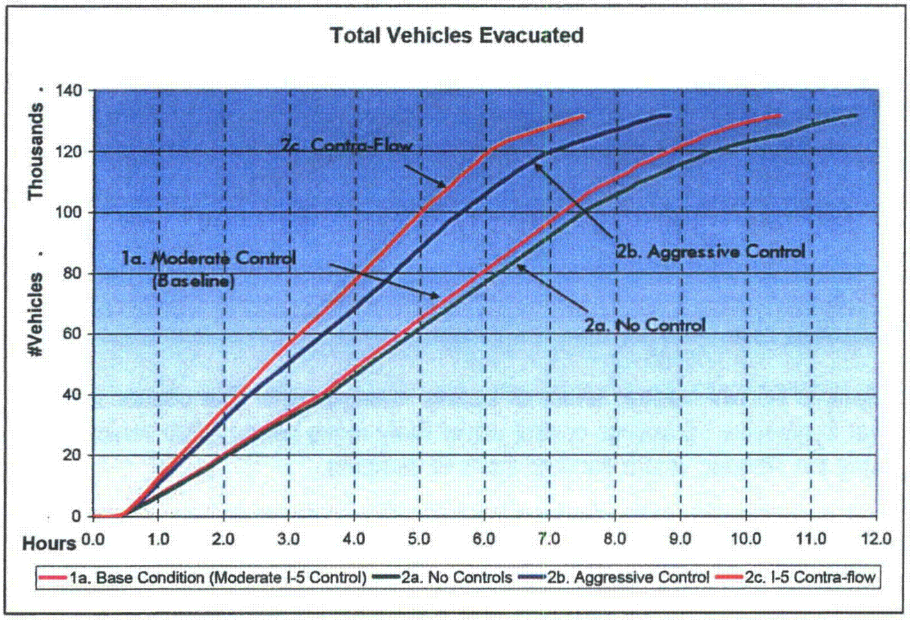
Emphasis was placed on the more densely populated areas within the northern sector in the development of evacuation time estimates. Approximately 90 percent of the total resident population within the EPZ is located in Orange County, north of SONGS. Evacuation to the South is expected to experience no capacity constraints, and will be affected only by the mobilization time.

7.1.1 Graphical Analysis of Evacuation Elements

Figure 7.1 shows how many vehicles have moved beyond the EPZ boundary at each hour for several I-5 control scenarios. The point at the upper-right of each curve represents the total ETE for the respective scenario.

Compared to the no controls alternative, the existing I-5 management plan (1a) is effective at improving the ETE. The procedural action of ensuring that I-5 operates at maximum throughput improves the estimates dramatically. The addition of two contra-flow lanes is also significant but has implementation and operational issues.

Figure 7.1:
TOTAL VEHICLES EVACUATED UNDER I-5 MANAGEMENT APPROACHES

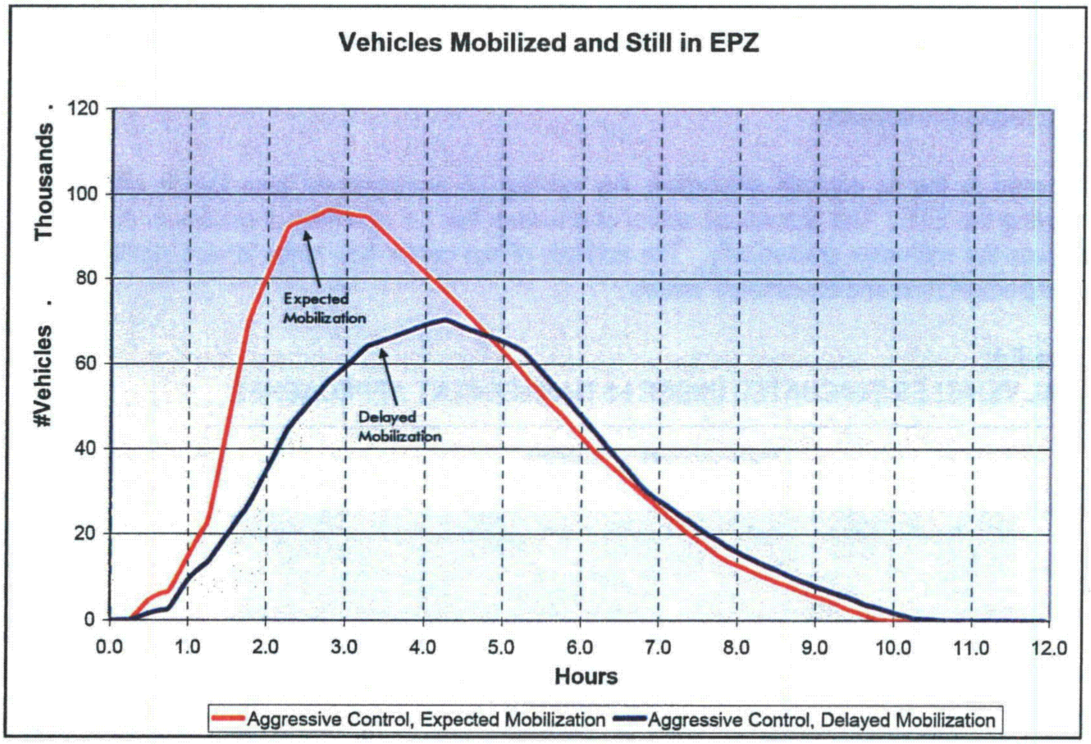


Source: Wilbur Smith Associates, 2006

Figure 7.2 shows how many vehicles have been mobilized, but are still in the EPZ over time. The highest curve has a lot more people stuck in traffic, while the bottom curve lets them stay at home a little longer. All vehicles from the bottom curve are fully mobilized in the fifth hour, at which point they enter congestion the same as if they had been sitting in their vehicles the whole time. The slight differences after hour 5 are not meaningful and can be considered noise.

Potential negative outcomes of extreme congestion may be worth considering when determining a mobilization plan. Vehicles running out of fuel, aggressive driving, and shoulder commandeering could add significant time to the evacuation and are typical of extreme congestion. Staged mobilization can reduce the potential for these negatives. While it makes no difference in the total ETE, it would make a difference to each individual.

Figure 7.2:
DIFFERENCE BETWEEN EXPECTED MOBILIZATION AND DELAYED MOBILIZATION



Source: Wilbur Smith Associates, 2006

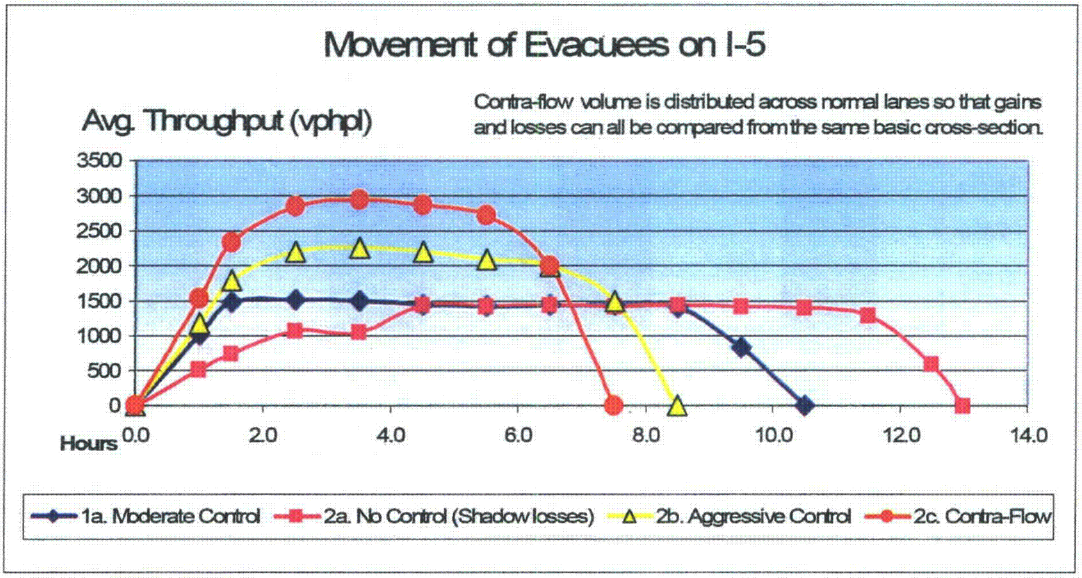
Figure 7.3 is an analysis of I-5 with various levels of access management. The second highest line (yellow) shows that aggressive I-5 access control would likely move nearly 2,200 vehicles per hour per lane until nearly the 7th hour, where demand starts to dissipate.

The base case line (1a, blue) will move evacuees at about 1,500 vphpl (about 30% loss) until nearly the 9th hour, at which point demand falls off.

The no-control line (2a) shows what occurs when shadow demand can access I-5 beyond the EPZ. For the first several hours I-5 carries less than 1,500 vphpl. In reality I-5 will still move 1,500 vphpl, but many of them are not evacuees. This figure shows only evacuees. No-control would stretch the evacuation out to nearly 13 hours.

In the contra-flow scenario, the lanes do not actually carry 3,000 vphpl each. This is theoretically impossible. The total volume from contra lanes is added to the original number of lanes to make it comparable with the other scenarios.

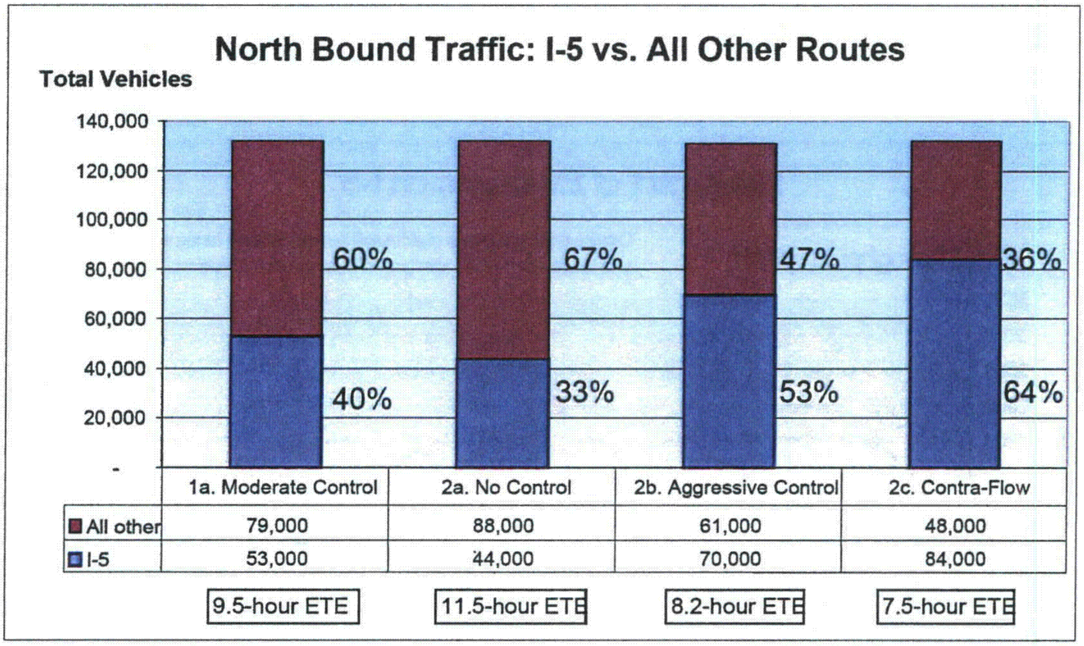
Figure 7.3:
AVERAGE THROUGHPUT OF AN I-5 LANE DURING EVACUATION SCENARIOS



Source: Wilbur Smith Associates, 2006

Figure 7.4 is a depiction of how much of the evacuation occurs on I-5 as opposed to all other roadways for the different management scenarios. In each case there are 132,000 vehicles. In the base case 40% of the traffic is moved on I-5, while in the contra-flow case up to 64% of the traffic would use I-5.

Figure 7.4:
RELATIVE SHARE OF EVACUATION TRAFFIC ON I-5 AND NON-FREEWAY ROUTES



Source: Wilbur Smith Associates, 2006.

7.1.2 Special Institutions

Special institutions, such as schools, hospitals, retirement and assisted living facilities, are expected to require significantly more mobilization time than the general public. It could take as long as four hours to mobilize these populations. The analysis has demonstrated that in most cases, the time required to dissipate queued vehicles is longer than the mobilization time, so these special institutions would still evacuate with the general public, but likely at the tail end of the queues.

7.2 Evacuation Time Estimates for Protective Action Zone (PAZ) Structure

7.2.1 Tabular Analysis of PAZ Evacuation Elements

Chapter 1 has already presented the time estimates from the analysis. The evacuation time summary **Tables 1.4a** and **1.4b** are reproduced as **7.1a** and **7.2a.** **Tables 7.1b** and **7.2b** represent relative percentage change from the baseline for each scenario.

Table 7.1a:
SUMMARY OF TOTAL ETE FOR ALL SCENARIOS TESTED USING PAZ STRUCTURE (TOTAL HOURS TO EVACUATE EPZ)

	WEEKDAY	WEEKEND	NIGHT	ADVERSE WEATHER	WEEKDAY EARTHQUAKE
PAZ 1 & PAZ 2	3.0	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 3	3.1	3.3	1.5	4.0	11.0
PAZ 1 & PAZ 4	7.3	6.8	6.3	8.3	14.3
PAZ 1 & PAZ 3 & PAZ 4	7.3	7.0	6.3	9.0	16.3
PAZ 1 & PAZ 4 & PAZ 5	9.5	9.2	8.2	10.3	18.0

Source: Wilbur Smith Associates, 2006

Table 7.1b:
PERCENT OF WEEKDAY TIME ESTIMATE FOR ALL SCENARIOS TESTED USING PAZ STRUCTURE

	WEEKDAY	WEEKEND	NIGHT	ADVERSE WEATHER	WEEKDAY EARTHQUAKE
PAZ 1 & PAZ 2	---	110%	50%	133%	367%
PAZ 1 & PAZ 3	---	106%	48%	129%	355%
PAZ 1 & PAZ 4	---	93%	86%	114%	196%
PAZ 1 & PAZ 3 & PAZ 4	---	96%	86%	123%	223%
PAZ 1 & PAZ 4 & PAZ 5	---	97%	86%	108%	189%

Source: Wilbur Smith Associates, 2006

PAZs 1/2 and 1/3 have a higher beach population on weekends reflected in the increased weekend relative ETE percentage. The increase in workers on weekdays offset the weekend recreational population. The weekend ETE percentage of the base is therefore less than 1.

As expected, adverse weather slows the evacuation. The relative impact is not related to population. It is related to available evacuation routes and distance required to leave the EPZ. The network is very restricted until PAZ 5. PAZs 1, 3 and 4 are restricted to I-5 and PCH for most of the distance in a northern evacuation. The distance and limited opportunities compound to make the evacuation of these areas more inefficient relative to the scenario's base.

This is even more evident in an earthquake scenario where the actual time it takes to evacuate a relatively small population is longer than the evacuation of a population 22 times that size on a summer weekday. PAZ combination 1/4/5 evacuates 123,812 vehicles, while the PAZ combination 1/2 evacuates 5605 vehicles. It takes these 5605 vehicles 11 hours to evacuate, while under normal circumstances the 123,812 vehicles in 1/4/5 evacuate in 9.5 hours.

Under earthquake conditions the length and number of facilities impacted compound evacuation difficulty for those PAZs located the furthest from the EPZ boundary. This results in the most significant increase in EPZ evacuation percentage relative to the base. An earthquake is essentially multiple incidents compounding the distance and limited opportunities to evacuate the population closer to SONGS.

Tables 7.2a and **7.2b** continue this examination for the sensitivity tests.

Table 7.2a:
SUMMARY OF SENSITIVITY TESTS OF TOTAL ETE ON DAYTIME SUMMER WEEKDAY CONDITIONS USING PAZ STRUCTURE (TOTAL HOURS TO EVACUATE EPZ)

	CONTRA-FLOW ON I-5	INCIDENT ON I-5	DELAYED MOBILIZATION	20% SHADOW DEMAND	80% POPULATION UNDER EARTHQUAKE CONDITIONS	AGGRESSIVE ACCESS CONTROL ON I-5
PAZ 1 & PAZ 2	2.3	5.1	3.1	3.3	5.0	3.0
PAZ 1 & PAZ 3	3.0	5.1	3.1	3.3	5.1	3.0
PAZ 1 & PAZ 4	6.4	8.0	7.4	7.3	10.2	6.5
PAZ 1 & PAZ 3 & PAZ 4	6.5	8.2	7.5	9.0	10.2	6.5
PAZ 1 & PAZ 4 & PAZ 5	7.5	11.0	8.5	11.2	12.3	8.2

Source: Wilbur Smith Associates, 2006

Table 7.2b:
PERCENT OF WEEKDAY TIME ESTIMATE FOR ALL SENSITIVITY TESTS USING PAZ STRUCTURE

	CONTRA-FLOW ON I-5	INCIDENT ON I-5	DELAYED MOBILIZATION	20% SHADOW DEMAND	80% POPULATION UNDER EARTHQUAKE CONDITIONS	AGGRESSIVE ACCESS CONTROL ON I-5
PAZ 1 & PAZ 2	77%	170%	103%	110%	167%	100%
PAZ 1 & PAZ 3	97%	165%	100%	106%	165%	97%
PAZ 1 & PAZ 4	88%	110%	101%	100%	140%	89%
PAZ 1 & PAZ 3 & PAZ 4	89%	112%	103%	123%	140%	89%
PAZ 1 & PAZ 4 & PAZ 5	79%	116%	89%	118%	129%	86%

Source: Wilbur Smith Associates, 2006

Contra-flow and aggressive access control on I-5 are two positive scenarios. Aggressive access control has no influence on PAZ 1. Since PAZ 1 will enter the network at the start, there isn't any need for access control. The ramp queue will be the access control.

Contra-flow and access control help the most with PAZ combination 1/4/5. Increasing the efficiency of the main evacuation route has its greatest impact on the scenario with the most population. Increasing the efficiency of I-5 makes the less efficient alternative evacuation opportunities less inviting.

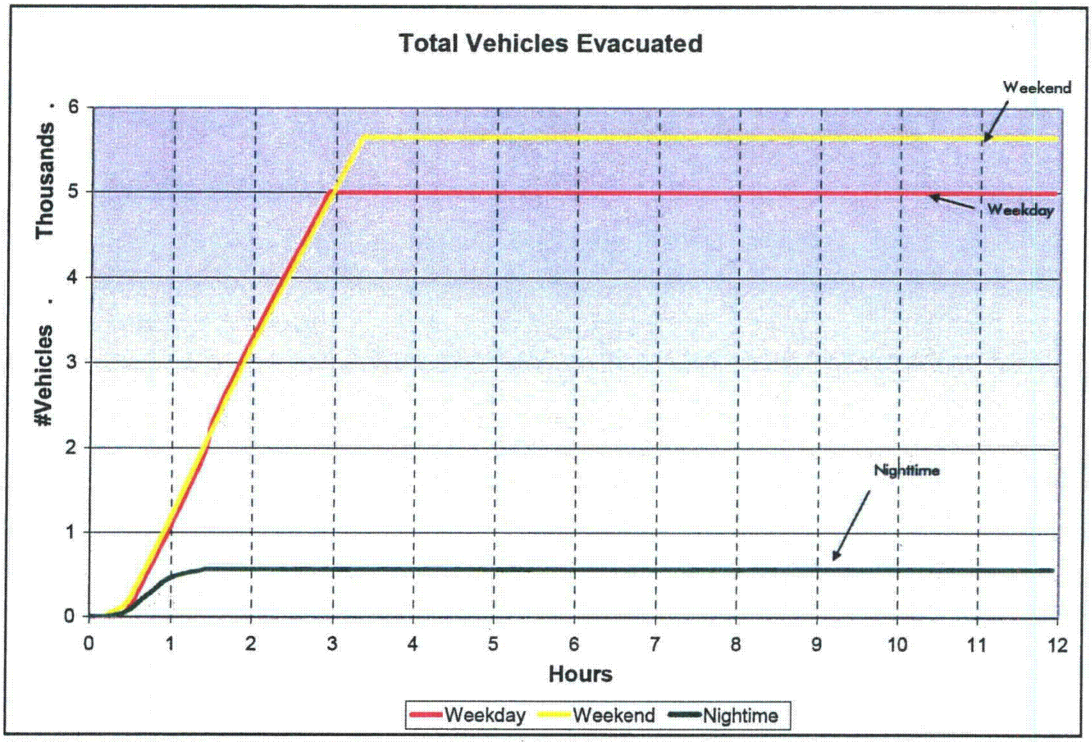
An incident on I-5 has the greatest relative impact on the PAZ combinations with the most reliance and greatest distance on I-5. The evacuation time on these PAZ combinations is also relatively small so an equivalent delay will have a greater relative impact.

Delayed mobilization was discussed in detail above in the graphical analysis of section 7.1.1. The positive impact of delayed mobilization on PAZ combination 1/4/5 further demonstrates that maintaining efficiency in the network has a positive influence on evacuation.

7.2.2 Graphical Analysis of PAZ Evacuation Elements

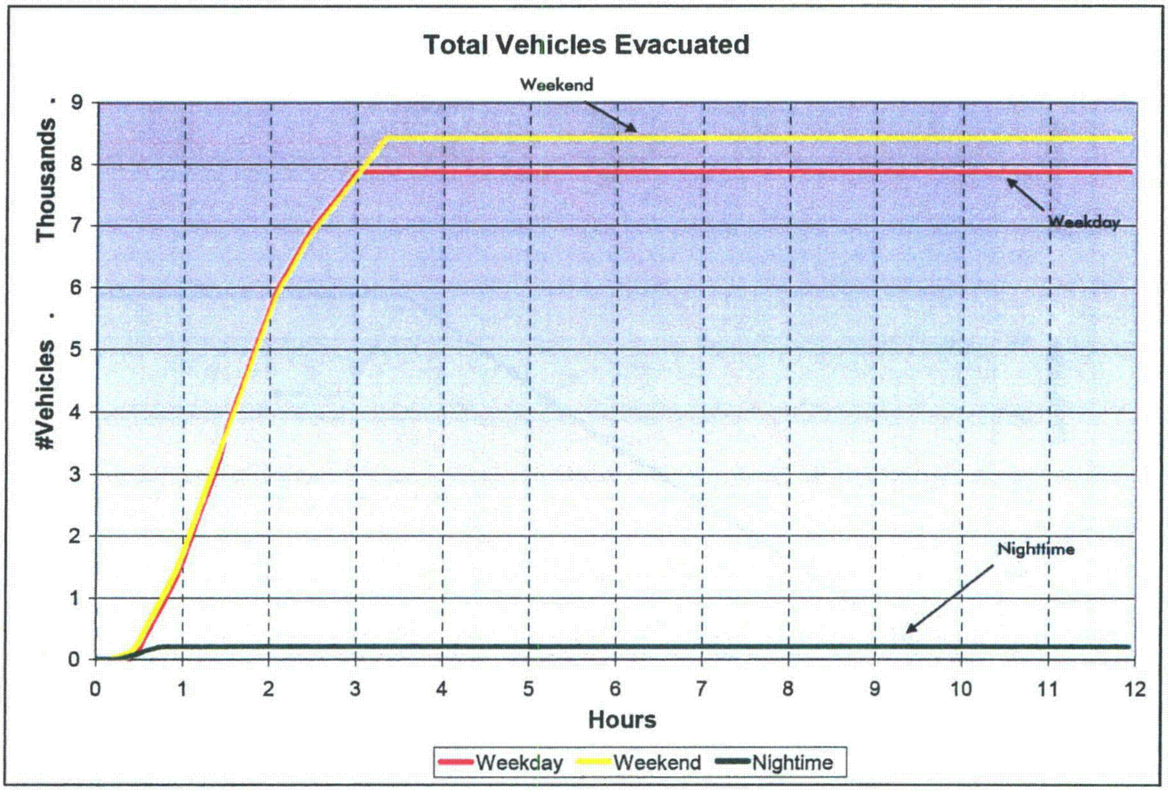
Figures 7.5 through **7.9** show how many vehicles have moved beyond the EPZ boundary at each hour for the five combinations of PAZ evacuations.

Figure 7.5:
TOTAL VEHICLES EVACUATED USING PAZ STRUCTURE PAZ 1 AND 2 EVACUATION



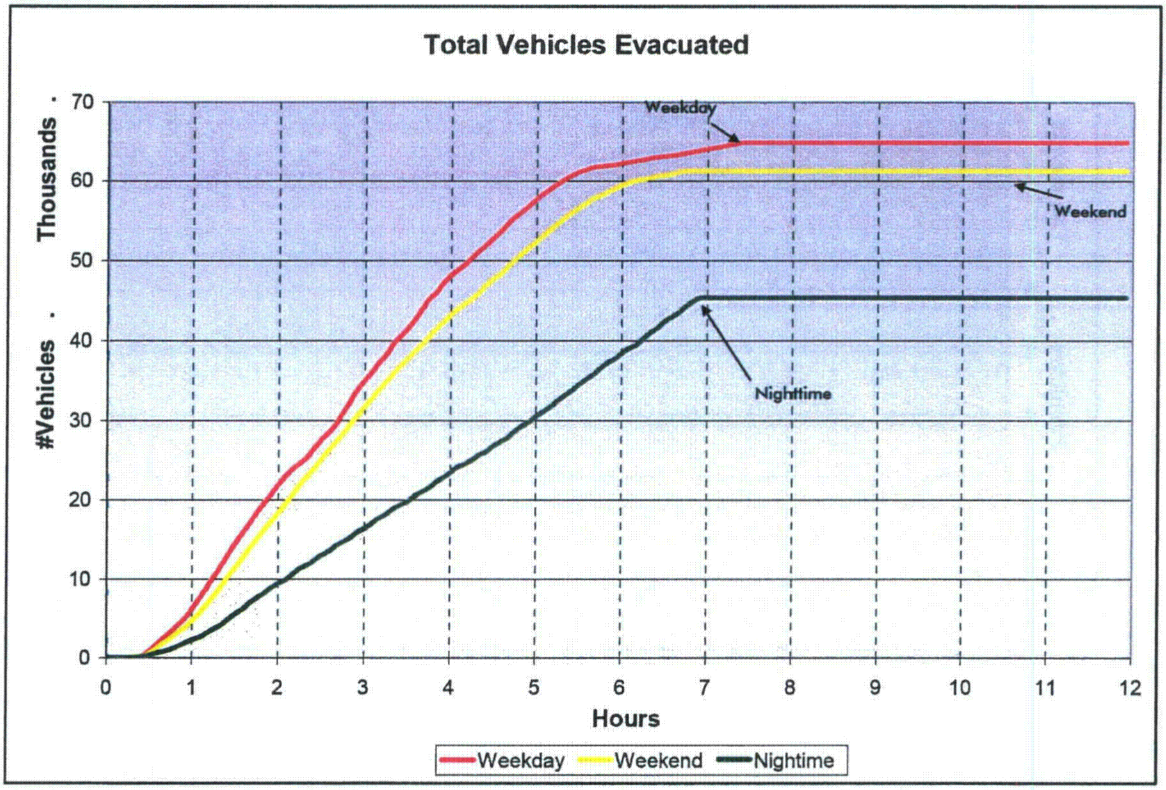
Source: Wilbur Smith Associates, 2006

Figure 7.6:
TOTAL VEHICLES EVACUATED USING PAZ STRUCTURE PAZ 1 AND 3 EVACUATION



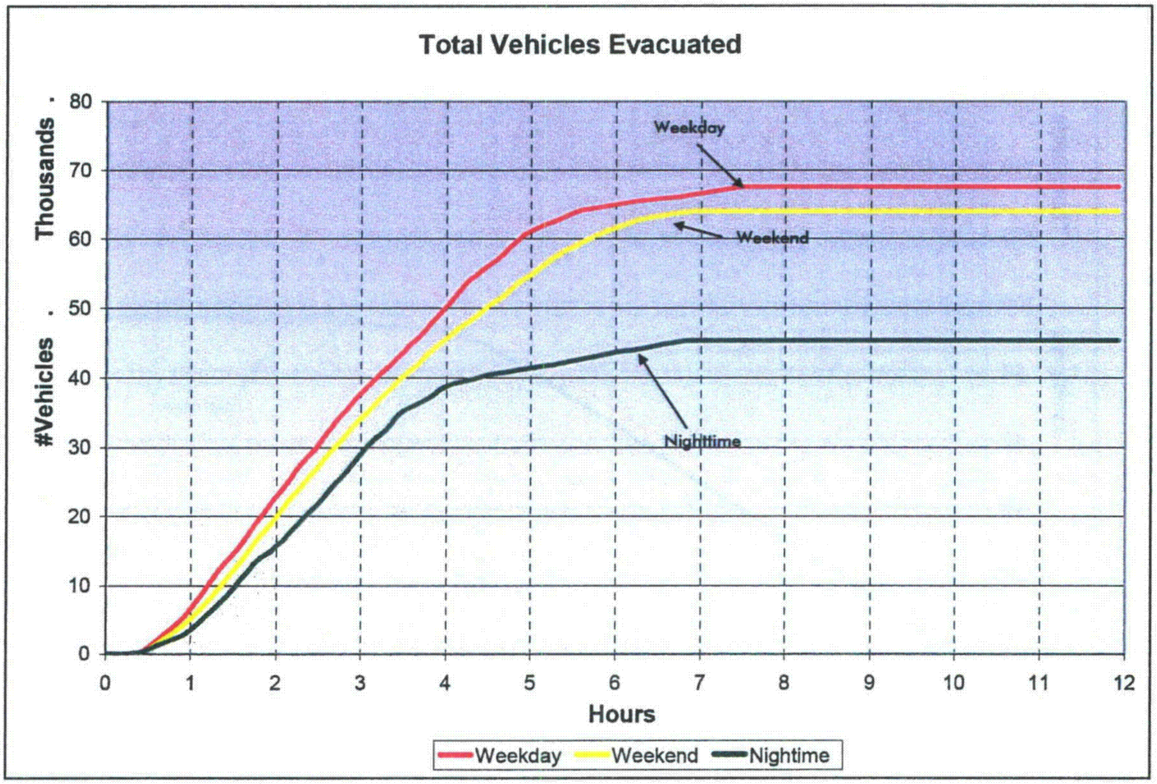
Source: Wilbur Smith Associates, 2006

Figure 7.7:
TOTAL VEHICLES EVACUATED USING PAZ STRUCTURE PAZ 1 AND 4 EVACUATION



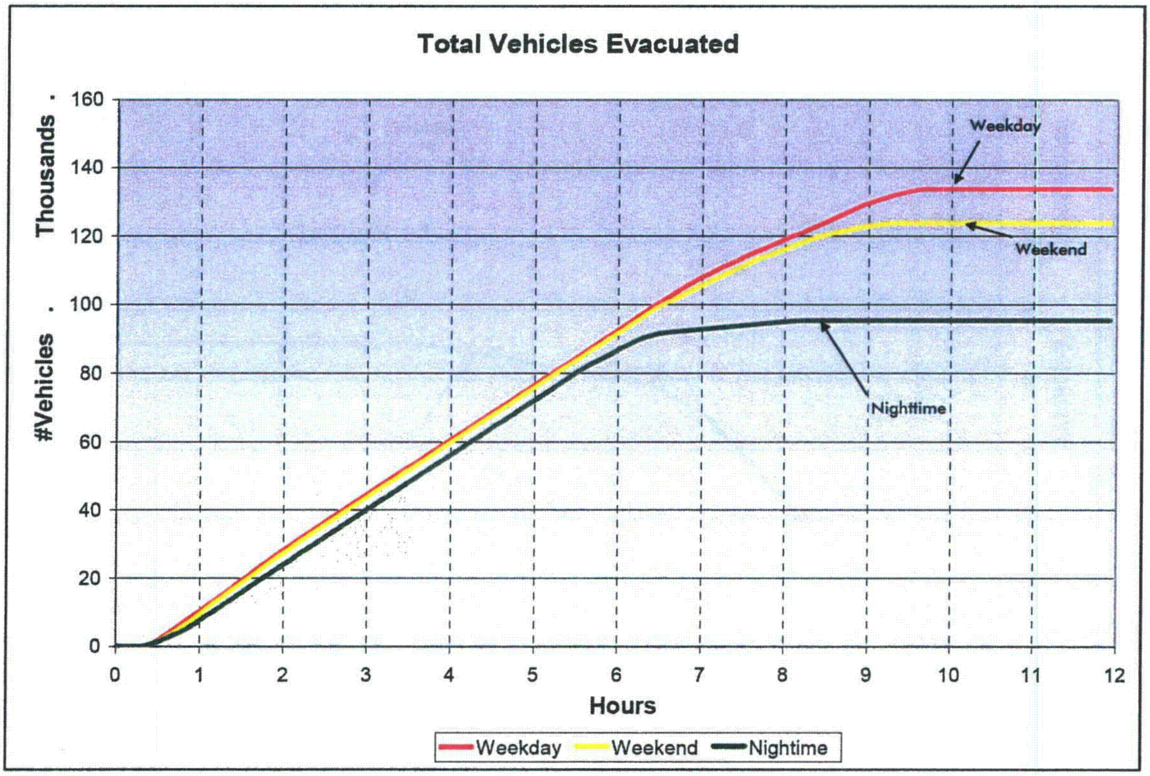
Source: Wilbur Smith Associates, 2006

Figure 7.8:
TOTAL VEHICLES EVACUATED USING PAZ STRUCTURE PAZ 1, 3 AND 4 EVACUATION



Source: Wilbur Smith Associates, 2006

Figure 7.9:
TOTAL VEHICLES EVACUATED USING PAZ STRUCTURE PAZ 1, 4 AND 5 EVACUATION



Source: Wilbur Smith Associates, 2006

7.3 Range of Certainty

There are both positive and negative factors that could influence the ETE.

1. **Shadow Demand**: Shadow demand as high as 20% could add as much as 1.7 hours to the total evacuation even if shadow demand traffic is prohibited from I-5. The effect of increased shadow demand is minimal for the PAZ evacuation combinations of lower populations.

2. **Incidents**: An incident on I-5 could add more than two hours to the total ETE.

3. **Adverse Weather**: Adverse weather could add 1.7 hours, and would increase the likelihood of an incident.

4. **Inefficiency**: No significant management of I-5 is a possibility if the existing plans for I-5 traffic management are not adhered to. Likewise, simple inefficiency or miscommunication in the execution of any critical elements could add time to the ETE.

5. **Combination of Events**: It is conceivable that all these time-adding events could coincide to produce a "worst case" scenario adding perhaps an additional 4-6 hours to the ETE. The earthquake condition is an extreme example of event combination and it increases the ETE by up to 9 hours.

6. **Total Population/Vehicles**: We have assumed a relatively low vehicle usage of 1.3 vehicles per household. If this assumption proved to be too low or high, the ETE would follow suite.

7. **Rate of Escalation**: There are varying levels of emergency classification. Should an incident progress gradually, certain population may be ordered to evacuate earlier than general evacuation. Individuals may also voluntarily evacuate under such situations. Should a general emergency evacuation eventually be declared, less people would be left to evacuate. This would improve the ETEs.

8. **Contra-Flow**: Local adoption of the use of contra-flow lanes and a more aggressive approach to managing I-5 improves the ETE by as much as 2.0 hours.

9. **Daytime Population**: Modeling conducted here for a weekday assumes that the majority of those who work north of the EPZ would desire to and be successful at re-entering to assist their families. The number of evacuating vehicles for the weekday condition is slightly over-estimated if fewer individuals return from work locations outside the EPZ.

10. **Evacuation Sooner Than 2011**: If a full-scale evacuation occurs before 2011, fewer people will reside in the area than are estimated in this analysis lowering the ETE.

11. **SR-241 Extension**: It is possible that the Foothill-South Transportation Corridor, or SR-

241, could be completed in 2010 or 2011. This would provide significant additional capacity to the area and would significantly improve expected ETEs.

Based on the items identified above, and the fact that any live event would unfold somewhat differently than expected, WSA is confident that an ETE following one of the scenarios presented here would likely be within plus or minus two hours.

FINAL REPORT

San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

APPENDIX A

Appendices

Appendix A

AGENCY CONTACTED	INFORMATION PROVIDED	APPROX. DATE
Cal State Fullerton Center for Demographic Research	Demographic Information	10-7-05
City of San Clemente	City Emergency Plan	8-31-05
City of San Juan Capistrano	City Emergency Plan & Private Schools Emergency Plan	9-14-05
City of Dana Point	City Emergency Plan	9-14-05
California Highway Patrol	CHP Emergency Plan	8-31-05
Caltrans District 12	Traffic Data, Roadway Characteristics, and Infrastructure Plans	8-31-05
Southern California Edison SONGS	Schools and Daycare Info. & SONGS Worker Info.	8-18-05 12-21-05
Orange County Sheriffs Department	County Emergency Plan, Private School Travel Survey	9-14-05
United States Marine Corps, Camp Pendleton	Camp Pendleton Population & Emergency Plan	11-7-05
SCAG	Model Information	9-22-05
SANDAG	Model Information	9-22-05
Capistrano Unified School District	School Populations, Emergency Plan, & Bus System Capacity	9-22-05
Orange County Transportation Authority	Bus Capacity	12-13-05
State Parks	Beach Capacity	9-22-05
Dana Point Visitors Bureau	Orange County Visitors Information	9-30-05

FINAL REPORT

San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

APPENDIX B: PUBLIC AND PRIVATE SCHOOL ENROLLMENT

Appendix B: PUBLIC AND PRIVATE SCHOOL ENROLLMENT

Public Schools	Address	SUB-ZONE	Teachers	Students
Palisades Elementary School	26462 Via Sacramento, Capistrano Beach, CA 92624	5	28	600
Dana Hills High School	33333 Golden Lantern, Dana Point, CA 92629	10	160	2900
R.H. Dana Elementary School	24242 La Cresta Drive, Dana Point, CA 92629	10	17	397
R.H. Dana Exceptional Needs Facility	24242 La Cresta Drive, Dana Point, CA 92629	10	15	120
Adult Education	31431 El Camino Real, San Juan Capistrano, CA 92675	7	100	1000
Junipero Serra High School & Fresh Start	31422 Camino Capistrano, San Juan Capistrano, CA 92675	7	18	200
San Juan Elementary	31642 El Camino Real, San Juan Capistrano, CA 92675	7	29	630
Harold Ambuehl Elementary School	28001 San Juan Creek Road, San Juan Capistrano, CA 92675	6	30	620
Marco Forster Middle School	25601 Camino del Avion, San Juan Capistrano, CA 92675	9	85	1600
Del Obispo Elementary School	25591 Camino del Avion, San Juan Capistrano, CA 92675	9	21	500
Kinoshita Elementary School	2 Via Positiva, San Juan Capistrano, CA 92675	6	35	720
Marblehead Elementary School	2410 Via Turqueza, San Clemente, CA 92673	4	26	600
Vista Del Mar Elementary and Middle School	1130 Avenida Talega, San Clemente, CA 92673	15	64	1300
Clarence Lobo Elementary School	200 Avenida Vista Montana, San Clemente, CA 92672	2	26	500
San Clemente High School & Upper Campus	700 Avenida Pico, San Clemente, CA 92673	2	120	3200
Shorecliffs Middle School	240 Via Socorro, San Clemente, CA 92672	4	49	1300
Truman Benedict Elementary School	1251 Sarmentoso, San Clemente, CA 92673	4	31	762
Concordia Elementary School	3120 Avenida del Presidente, San Clemente, CA 92672	1	30	660
Bernice Ayer Middle School	1271 Sarmentoso, San Clemente, CA 92673	4	31	730
Las Palmas Elementary School	1101 Calle Puente, San Clemente, CA 92672	3	30	660
Private Schools				
Capistrano Beach Calvary School	25975 Domingo Avenue, Capistrano Beach, CA 92624	5	40	200
St. Edward's Parish School	33866 Calle La Primavera, Dana Point, CA 92629	9	56	550
Saint Michael's Academy	107 West Marquita, San Clemente, CA 92672	3	11	145
Monarch Bay Montessori Academy	32920 Pacific Coast Highway, Dana Point, CA 92629	10	4	140
Mission Parish School	31641 El Camino Real, San Juan Capistrano, CA 92675	7	25	350
Our Lady of Fatima Elementary School	105 N. La Esperanza, San Clemente, CA 92672	2	14	280
JSerra High School	26351 Junipero Serra Road, San Juan Capistrano, CA 92672	7	30	300
Capistrano Valley Christian School	32032 Del Obispo St., San Juan Capistrano, CA 92675	5	90	700
St. Margaret's Episcopal School	31641 La Novia Ave., San Juan Capistrano, CA 92675	7	210	1230
StoneyBrooke Christian School	26300 Via Escolar, San Juan Capistrano, CA 92692	8	41	660
Saddleback Valley Christian Elementary School	26333 Oso Road, San Juan Capistrano, CA 92675	7	13	350
Saddleback Valley Christian Jr High/High School	26333 Oso Road, San Juan Capistrano, CA 92675	7	25	150
Our Savior's Lutheran Elementary and Preschool	200 E. Avenida San Pablo, San Clemente, CA 92672	2	13	238
Pre-schools and Daycares				
Saddleback Valley Christian Preschool	26333 Oso Road, San Juan Capistrano, CA 92675	7	5	90
Nobis Children's Center	26153 Victoria Blvd., Capistrano Beach, CA 92624	5	10	50
Wee Can Preschool	34240 Camino Capistrano, Capistrano Beach, CA 92624	5	7	60
Palisades United Methodist Preschool & Kinder.	27002 Camino de Estrella, Capistrano Beach, CA 92624	4	15	110

St. Edward's Parish Preschool	33926 Calle La Primavera, Dana Point, CA 92629	9	14	78
South Shores Christian Preschool	32712 Crown Valley Parkway, Dana Point, CA 92629	10	14	116
Gloria Dei Lutheran Preschool	33501 Stonehill Drive, Dana Point, CA 92629	9	13	75
Happy Campers Preschool	33501 Del Obispo, Dana Point, CA 92629	9	4	20
Dana Preschool	34052 Street of the Violet Lantern, Dana Point, CA 92629	10	4	30
Broderick Montessori School	24292 Del Prado Ave, Dana Point, CA 92629	10	4	60
Appletree Day Care	33061 Elisa Drive, Dana Point, CA 92629	10	3	15
KinderCare Learning Center	1141 Puerta Del Sol, San Clemente, CA 92673	15	17	80
Early Explorations	2015 Calle Frontera, San Clemente, CA 92673	4	25	200
San Clemente Presbyterian Preschool	119 Avenida De La Estrella, San Clemente, CA 92672	3	14	166
La Cristianita Preschool	35522 Camino Capistrano, San Clemente, CA 92672	4	9	125
Serra Preschool	1005 Calle Puente, San Clemente, CA 92672	3	6	25
St. Michael's Infant/Toddler Center	702 N. Ave De La Estrella, San Clemente, CA 92672	3	10	40
Saint Michael's Preschool	107 West Marquita, San Clemente, CA 92672	3	8	50
Stepping Stone Preschool	130 Avenida Granada, San Clemente, CA 92672	3	3	18
Boys & Girls Club of San Clemente	1304 Calle Valle, San Clemente, CA 92672	3	15	600
Garden Gate Childcare	207 Ave. San Pablo, San Clemente, CA 92672	2	1	6
Chris's Corner	213 Calle Tinaja, San Clementem, CA 92672	4	2	18
San Clemente Preschool	163 Avenida Victoria, San Clemente, CA 92672	1	10	60
San Clemente Montessori Preschool	189 Avenida La Questa, San Clemente, CA 92672	1	5	48
Evelyn Lobo Villegas Head Start	32204 Del Obispo, San Juan Capistrano, CA 92675	5	6	68
Childbridge Preschool	31113 Rancho Viejo Rd., San Juan Capistrano, CA 92675	7	13	130
Community Presbyterian Preschool	*32202 Del Obispo, San Juan Capistrano, CA 92675*	*5*	*14*	*200*
Capistrano Valley Head Start	31485 El Camino Real, San Juan Capistrano, CA 92675	7	9	88
Stonebridge Day School	32091 Alipaz, San Juan Capistrano, CA 92675	5	3	21
San Juan Preschool	26891 Spring Street, San Juan Capistrano, CA 92675	7	2	
San Juan Montessori Preschool	32143 Alipaz, San Juan Capistrano, CA 92675	5	5	50
Rancho Capistrano Schools	29251 Camino Capistrano, San Juan Capistrano, CA 92675	11	20	160
Aunty Jody's Childcare	27701 Paseo Esteban, San Juan Capistrano, CA 92675	7	3	12
Family Day Care	33061 Elisa Drive, Dana Point, CA 92629	10	3	7
Family Day Care	207 San Pablo, San Clemente, CA 92672	2	1	6
Capistrano Valley Christian Preschool	32032 Del Obispo, San Juan Capistrano, CA 92675	5	4	28
Total Enrollment			1,818	27,202

Source: Southern California Edison, www.dexonline.com, 2006, Interjurisdictional Planning Committee: Model Nuclear Power Plant Emergency Plan for Private Schools and Childcare Facilities, August 2004

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San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

APPENDIX C: RETIREMENT HOMES AND HOSPITALS

Appendix C: RETIREMENT HOMES AND HOSPITALS

RETIREMENT HOMES AND HOSPITALS	ADDRESS	SUB-ZONE	RESIDENTS/PATIENTS		
			AMBULATORY	NON-AMBULATORY	TOTAL
Dana Point					
Bay Side Terrace	23031 Java Sea Dr.	10	3	1	4
Palmera Terrace	24622 Jeremiah Dr.	10	6	0	6
The Fountains at Sea Bluffs	25411 Sea Bluffs Dr.	9	98	2	100
Seaside Terrace	32591 Seven Seas Dr.	10	3	3	6
San Clemente					
Pacific Breeze Home	113 Avenida Del Reposo	3	0	6	6
Wycliffe Casa De Seniors	105 Avenida Presidio	2	75	2	77
Saddleback Memorial Medical Center	654 Camino De Los Mares	4	11	8	19
San Clemente Villas by the Sea	660 Camino De Los Mares	4	31	123	154
Accent on Seniors	*273 Via Ballena*	*4*	4	2	6
San Juan Capistrano					
Capistrano Beach Extended Care	35410 Del Rey	4	15	62	77
Mirabel by the Sea	26961 Calle Granada	5	0	6	6
Aegis of Dana Point	26922 Camino De Estrella	4	50	20	70
Aegis of Laguna Niguel	32170 Niguel Rd.	10	54	20	74
ARV Assisted Living	32200 Del Obispo St.	5	75	20	95
Atria Chateau San Juan	32353 San Juan Creek Rd.	6	105	0	105
Brighton Gardens	31741 Rancho Viejo Rd.	7	15	10	25
Casa de Amma	27231 Calle Arroyo	7	17	0	17
Silverado Senior Living	30311 Camino Capistrano	7	57	20	77
Villa Paloma Senior Apartment	27221 Paseco Espada	9	97	3	100
Seasons Senior Apartments	31641 Rancho Viejo Rd.	7	102	1	103
Tessie's Place	27642 Rosedale Dr.	8	4	0	4
Total Residents/Patients			822	309	1,131

Source: www.dexonline.com, 2006

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APPENDIX D

Appendix D

City of San Clemente

SC-1.	Location:	Cristianitos Road at I-5 Interchange.
	Control:	Direct traffic from Cristianitos Road onto northbound I-5 on-ramp.
SC-2.	Location:	Avenida Del Presidente and Avenida Calafia- Southbound I-5 Ramps.
	Control:	Direct traffic northbound on Avenida del Presidente.
SC-3.	Location:	South El Camino Real at Northbound I-5 Ramps.
	Control:	Direct traffic from northbound Avenida del Presidente onto Avenida Mendocino overpass and then northbound El Camino Real. Direct traffic from south El Camino Real onto northbound I-5 on-ramp.
SC-4.	Location:	South El Camino Real at I-5 Interchange (S. El Camino Real underpass).
	Control:	Direct traffic from El Camino Real onto northbound I-5 on ramp.
SC-5.	Location:	South El Camino Real and Avenida Presidio.
	Control:	Direct traffic from El Camino Real onto eastbound Avenida Presidio (towards I-5 interchange northbound on-ramp).
SC-6.	Location:	Avenida Presidio at I-5 Interchange.
	Control:	Direct traffic from Avenida Presidio onto northbound I-5 on ramp.
SC-7.	Location:	Avenida Palizada at I-5 Interchange.
	Control:	Direct traffic from Avenida Palizada and Avenida Caballeros onto northbound I-5 on-ramp.
SC-8.	Location:	Avenida Pico at I-5 interchange.
	Control:	Direct traffic from Avenida Pico onto northbound I-5 on-ramp.
SC-9.	Location:	North El Camino Real and Avenida Pico.
	Control:	Direct traffic to the north on El Camino Real.
SC-10.	Location:	Camino De Estrella at I-5 interchange.
	Control:	Direct traffic from Camino De Estrella onto northbound I-5 on-ramps. Since the volume of evacuation traffic is projected to be greater from the east than the west, one of the westbound lanes could be directed onto the south-side

northbound I-5 on-ramp until eastside evacuation traffic has dissipated.

SC-11. Location: Pacific Coast Highway (North El Camino Real) and Camino Capistrano.
Control: Direct traffic to the north on Pacific Coast Highway.

SC-12 Location: Vista Hermosa at the I-5 Interchange and the Vista Hermosa Interchange and Calle Frontera
Control: Direct traffic from Frontera onto the northbound I-5 onramp to the freeway; if they cross over the I-5 from the southbound lanes of the freeway, just redirect them right back on to the northbound side of the I-5.

City of San Juan Capistrano

SJC-1. Location: Via California and Camino Los Ramblas.
Control: Direct traffic west on Camino Las Ramblas (towards I-5 on-ramp).

SJC-2. Location: U.S.1-Camino Las Ramblas at I-5 Interchange.
Control: Direct traffic from U.S. 1- Camino Las Ramblas onto northbound I-5 on ramps. Since the vast majority of evacuation traffic would approach from the east, traffic using one of the westbound lanes could be directed to the south-side northbound I-5 on-ramp (loop ramp).

SJC-3. Location: Alipaz Street and Del Obispo Street.
Control: Direct traffic onto eastbound Del Obispo Street.

SJC-4. Location: Camino Capistrano and Del Obispo Street.
Control: Direct eastbound Del Obispo Street traffic in left lane onto northbound Camino Capistrano. Direct eastbound Del Obispo Street traffic in right lane to continue east on Del Obispo Street (towards I-5 on-ramp at Ortega Highway interchange. Direct traffic from northbound Camino Capistrano onto eastbound Del Obispo Street.

SJC-5. Location: Camino Capistrano and I-5 Southbound Ramps (South of San Juan Creek Road).
Control: Direct traffic northbound on Camino Capistrano.

SJC-6. Location: San Juan Creek Road and Valle Road.
Control: Direct traffic from San Juan Creek Road onto southbound Valley Road (towards the northbound I-5 on-ramp at La Novia Avenue).

SJC-7. Location: La Novia Avenue and San Juan Creek Road.
Control: Direct traffic to the north on La Novia Avenue (towards Ortega Highway).

SJC-8. Location: La Novia Avenue at Ortega Highway
Control: As conditions permit, direct from La Novia to eastbound out Ortega to Antonio Parkway, or direct westbound on Ortega to Rancho Viejo Road.

SJC-9. Location: Ortega Highway and Rancho Viejo Road.
Control: Direct traffic to the north on Rancho Viejo Road.

SJC-10. Location: Ortega Highway at I-5 Interchange.

	Control:	Direct traffic from eastbound Ortega Highway onto the northbound I-5 on-ramp.
SJC-11.	Location:	Camino Capistrano and Junipero Serra Road.
	Control:	Direct traffic to continue northbound on Camino Capistrano. As conditions at the Junipero Serra Road/northbound I-5 on ramp permit, divert a portion of the northbound on Camino Capistrano Traffic to the freeway interchange on-ramp.
SJC-12.	Location:	Junipero Serra Road at I-5 Interchange.
	Control:	Direct traffic from Junipero Serra Road onto the northbound I-5 on-ramp.
SJC-13.	Location:	Rancho Viejo Road and Junipero Serra Road.
	Control:	Direct the majority of northbound traffic on Rancho Viejo Road to continue north on Rancho Viejo Road. As conditions at the Junipero Serra Road/northbound I-5 on-ramp permit, divert a portion of the northbound Rancho Viejo Road traffic to the freeway interchange on-ramp

City of Dana Point

DP-1.	Location:	Pacific Coast Highway and Doheny Park Road
	Control:	Direct traffic north on Doheny Park Road (towards Camino Capistrano).
DP-2.	Location:	Pacific Coast Highway and Del Obispo Street
	Control:	Direct traffic onto northwest-bound Pacific Coast Highway.
DP-3.	Location:	Pacific Coast Highway and Selva Road
	Control:	Direct traffic northbound on Pacific Coast Highway.
DP-4.	Location:	Street of the Golden Lantern and Camino Del Avion
	Control:	Direct traffic northbound on Street of the Golden Lantern.
DP-5.	Location:	Del Obispo Street and Stonehill Drive
	Control:	Direct traffic northbound on Del Obispo Street.
DP-6	Location:	Del Prado at Golden Lantern
	Control:	Direct southbound Del Prado northbound on Golden Lantern.
DP-7	Location:	PCH and Golden Lantern
	Control:	Route Southbound Golden Lantern traffic north on PCH. Do not allow traffic to proceed to southbound Del Prado.
DP-8	Location:	PCH and Niguel Road
	Control:	Direct all traffic northbound.
DP-9	Location:	PCH and Crown Valley Parkway
	Control:	Direct all traffic northbound.
DP-10	Location:	Niguel Road at Camino Del Avion
	Control:	Prevent traffic from traveling south on Niguel Road.
DP-11	Location:	Pacific Coast Highway at Palisades Drive.
	Control:	Block Palisades Drive on the north of Coast Highway to prevent traffic from interfering with neighborhood evacuations.
DP-12	Location:	Palisades Drive at Doheny Place
	Control	Block Palisades Drive at Doheny Place to prevent neighborhood traffic from

bottlenecking at Coast Highway.

DP-13	Location:	Las Ramblas at Interstate 5
	Control:	Block the southbound on-ramp to prevent traffic from traveling southbound on Interstate 5.
DP-14	Location:	Victoria Road at Camino Capistrano
	Control:	Block Victoria Road so as to keep Capistrano Beach residential traffic flowing north on Camino Capistrano.
DP-15	Location:	Doheny Park Road at Pacific Coast Highway
	Control:	Block on-ramp to southbound Pacific Coast Highway (Las Ramblas). Route Doheny Park Road traffic toward Camino Capistrano or to northbound Pacific Coast Highway.
DP-16	Location:	Pacific Coast Highway at San Juan Creek. Block southbound Pacific Coast Highway at the San Juan Creek cut-off to prevent southbound traffic from bottlenecking at Coast Highway.

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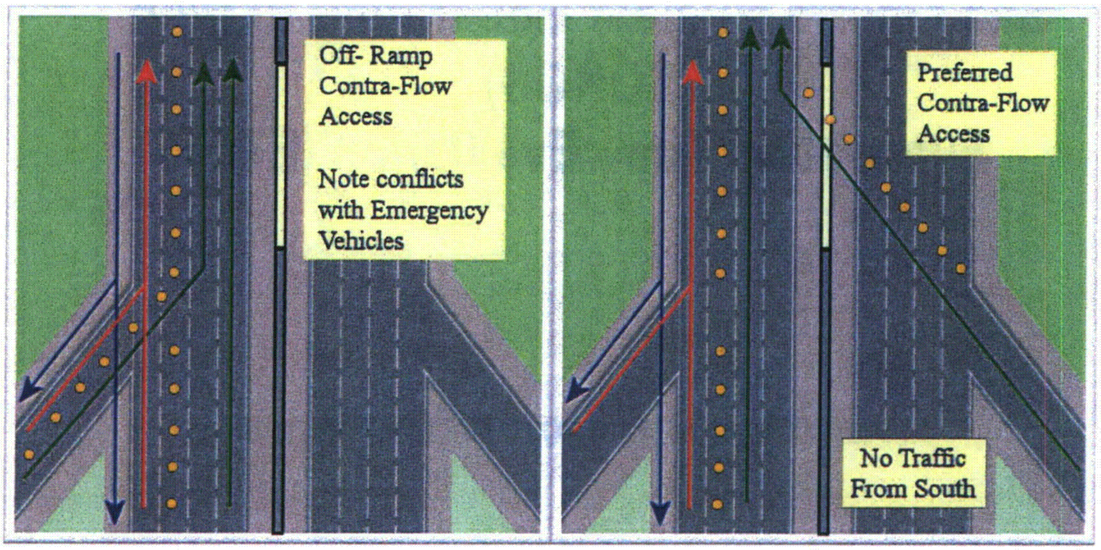
APPENDIX E: CONTRA-FLOW IMPLEMENTATION

Appendix E: CONTRA-FLOW IMPLEMENTATION

Two methods of accessing and managing contra-flow lanes are presented in the figure below along with practical steps that should be taken to help contra-flow succeed safely:

POTENTIAL CONTRA-FLOW ACCESS METHODS



The image on the left shows a means of accessing the lanes by converting an off-ramp into an on ramp. One mainline lane is consumed by cones to create separation from emergency vehicles which would be moving both directions on the shoulder and outer-most lane (shown in red and blue). Note that the green traffic stream conflicts with emergency vehicle paths. If there are large gaps between emergency vehicles, this approach can work well if officers halt the flow of traffic while emergency vehicles pass.

Contra-flow could be implemented on both I-5 and SR-73 up to the point at which southbound traffic has been rerouted. A mirror arrangement would need to be made at ramps near the barricade point to allow contra-flow vehicles to exit down on-ramps and safely transition to cross-streets.

The diagram on the right removes conflicts, and as such is a more ideal way of accessing contra-flow lanes. The approach in the image would have no traffic on the mainline from the south if it is applied at the first several interchanges nearest to SONGS. Cones would channel all traffic across the mainline through a removable barrier into the lanes. Traffic from three of the southernmost interchanges could be routed into contra-flow lanes without overloading the lanes.

Exiting the lanes outside the EPZ should be done by going down an on-ramp rather than trying to re-enter the regular northbound lanes through removable barriers. This is because outside the EPZ I-5 northbound will be running full, and trying to bring two contra-flow lanes back into an already full freeway will cause a long bottleneck that will impede the evacuation. If three ramps are used to load the flow, at least three ramps should be used to disperse the flow also.

Though well separated from emergency vehicles, driving the reverse direction on a freeway may be awkward for many, so speeds in contra-flow lanes should be restricted.

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San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

APPENDIX F: SUB-ZONE DESCRIPTIONS

Appendix F: SUB-ZONE DESCRIPTIONS

SUB-ZONE 1 - Sub-zone 1 includes all residential, commercial, and recreational (San Clemente State Beach) areas west of 1-5, south of Victoria Avenue and north of the Orange County/San Diego County boundary.

SUB-ZONE 2 - Sub-zone 2 includes all residential, commercial, and recreational areas east of I-5, north of the Orange County/San Diego County line and south of Avenida Pico.

SUB-ZONE 3 - Sub-zone 3 includes all residential, commercial, and recreational areas west of I-5, north of Victoria Avenue and south of Avenida Pico.

SUB-ZONE 4 - Sub-zone 4 includes all residential, commercial, and recreational areas north of Avenida Pico, east of Pacific Coast Highway, and south of Camino Las Ramblas.

SUB-ZONE 5 - Sub-zone 5 includes portions of San Juan Capistrano, Capistrano Beach residential, commercial, and recreational areas of Dana Point which lie west of I-5 and north between Del Obispo and I-5 in the north.

SUB-ZONE 6 - Sub-zone 6 includes all residential, commercial, and recreational areas west of La Mancha Avenue, south of San Juan Creek, north of Las Ramblas and east of I-5.

SUB-ZONE 7 - Sub-zone 7 includes the residential, commercial, and recreational areas within San Juan Capistrano which lie north of San Juan Creek, west of I-5, east of Trabuco Creek and also includes area east of I-5 to Sundance Drive.

SUB-ZONE 8 - Sub-zone 8 includes the residential, commercial, and recreational areas within San Juan Capistrano which lie north of SR-74 and east of I-5.

SUB-ZONE 9 - Sub-zone 9 includes the residential, commercial, and recreational areas of San Juan Capistano and Dana Point which lie west of Trabuco Creek, north of Del Obispo, ½ mile east of Golden Lantern, and south of San Juan Canyon. The boundary to the west aligns with the City boundary line.

SUB-ZONE 10 - Sub-zone 10 includes the residential, commercial, and recreational areas which lie ½ mile west of Del Obispo, south of Camino Del Avion and east of Salt Creek. Boundaries to the north and west align with Dana Point City boundaries.

SUB-ZONE 11 - Sub-zone 11 includes the residential, commercial, and recreational areas which lie north of Junipero Sierra, west of I-5, west of Golden Lantern, and south of Avery Parkway.

SUB-ZONE 12 - Sub-zone 12 includes the recreational areas which comprise San Onofre State Beach.

SUB-ZONE 13 - Sub-zone 13 includes all areas which comprise San Onofre Nuclear Generating Station (SONGS).

SUB-ZONE 14 - Sub-zone 14 includes all areas in Camp Pendleton Marine Corps Base that are within the 10-mile EPZ boundary.

SUB-ZONE 15 - Sub-zone 15 includes all areas which are North of Avenida Pico, South of SR-74, East of sub-zones 4 and 6, and West of County Line.

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San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE)

ACRONYMS

Acronyms

CHP - California Highway Patrol
CSUF - California State University, Fullerton
CUSD - Capistrano Unified School District
DYNASMART-P - a state-of-the-art dynamic route assignment model sponsored by the Federal Highway Administration and developed at the University of Maryland.
ETE - Evacuation Time Estimates
FSTC - Foothill-South Transportation Corridor
HCM 2000 - Highway Capacity Manual 2000
HOV - High Occupancy Vehicle
I – Interstate Highway
OCTA Orange County Transportation Authority
PAZ - Protective Action Zone
PCH – Pacific Coast Highway (California 1)
SCAG – Southern California Association of Governments
SONGS - San Onofre Nuclear Generating Station
SR – State Route (California Highway)
TAZ - Traffic Analysis Zones
vphpl - vehicles per hour per lane
WSA – Wilbur Smith Associates

Appendix 7

Annual Assessment of the San Onofre Nuclear Generating Station Evacuation Time Evaluation, dated August 23, 2010

Memorandum for File
August 23, 2010

Subject
Annual Assessment of the San Onofre Nuclear Generating Station Evacuation Time Evaluation Background

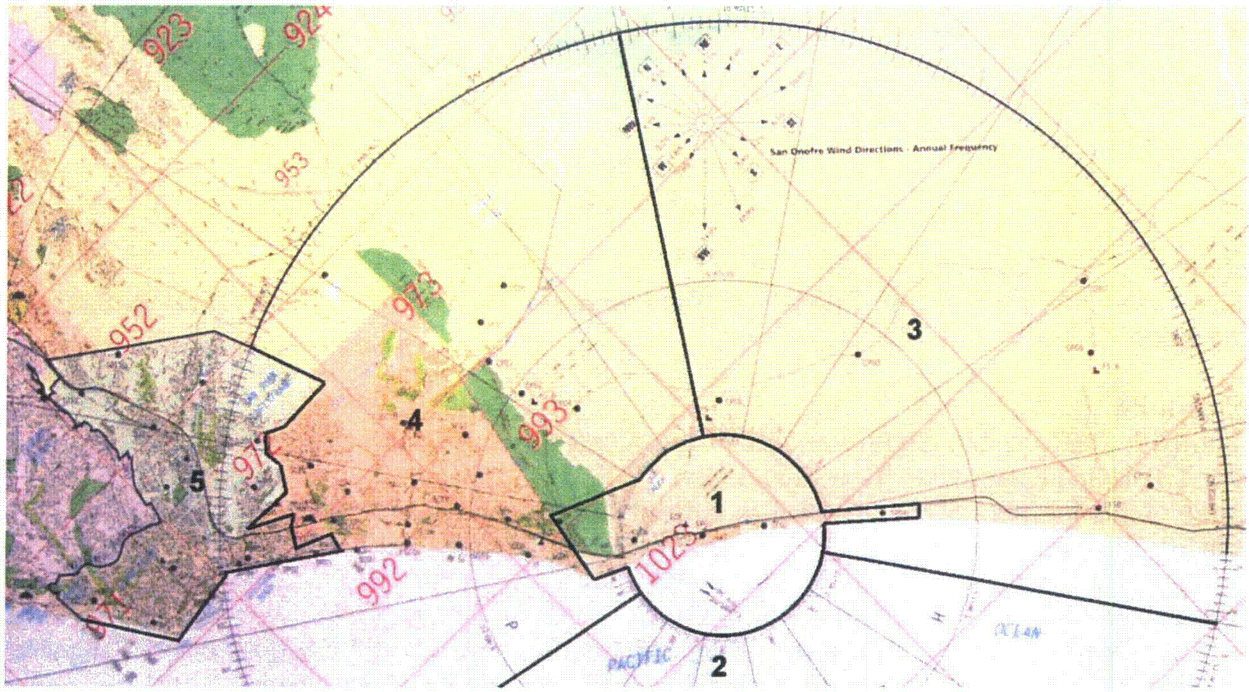
Background
On June 12, 2007, Wilbur Smith Associates produced the San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation (ETE) for Southern California Edison. The purpose of this memorandum is to review current information to determine if the 2007 ETE accurately reflects conditions in the Emergency Planning Zone

References used

1. San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation, Prepared for Southern California Edison by Wilbur Smith Associates, dated June 12, 2007
2. NUREG/CR-6863 "Development of Evacuation Time Estimate Studies for Nuclear Power Plants"
3. Center for Demographic Research, Orange County City Demographics, August 2009, http://www.fullerton.edu/cdr/city.asp
4. Camp Pendleton Base Housing 2009
5. Southern California Edison - Nuclear Organization Chart, updated August 12, 2010
6. Orange County Sheriffs Long Term Care Population 2010
7. California Department of Transportation ITS Architecture and System Plan, Final Report, dated November 3, 2004

Basis for Annual Assessment
In accordance with Reference 2, the primary elements of the Evacuation Time Study, population and roadway capacity, should be periodically evaluated to assess whether there is an impact to the Evacuation Time Estimate. The evaluation of the population should address increases in the population, changes in age demographics, and changes to the special needs population. Evaluation of the roadways should address improvements, constraints, traffic flow and changes to the transient traffic flow through the Emergency Planning Zone. Additionally, an increase in the number of special needs facilities or special events, implementation of intelligent transportation systems, or jurisdictional changes in response authority, should also be considered

Population Demographics
The permanent population was assessed for San Clemente, Dana Point, San Juan Capistrano, and Camp Pendleton located in Protective Action Zones (PAZ) 1, 3, 4 and 5 (see map next page). As shown, there is no permanent population located in PAZ 2 which is the Pacific Ocean.



According to Reference 3, the population for San Clemente, Dana Point, and San Juan Capistrano is 142,268. According to Reference 4, Camp Pendleton reports their 2009 population as 23,380. Using this data, the total population for PAZ 1, 3, 4 and 5 is 165,648.

Table 1.1 of SONGS 2007 ETE projects the population in the same area as 184,947. Since estimates are within 10% of the projected estimates listed in Reference 3, the current SONGS ETE is considered to be a valid and conservative assessment of evacuation times.

Reference 1 lists the SONGS evacuating vehicles as 2514. The SONGS 2007 ETE assumes this population has 1.2 persons per vehicle. This works out to 3017 persons being evacuated. Reference 4 lists the SONGS population as 4,139. Using the same assumptions as above, the number of vehicles exiting SONGS during an evacuation is 3449.

The population remains within the bounds of the total population estimate contained in the 2007 SONGS ETE.

Special Needs Population
The current evacuation time study lists 21 facilities with 1131 long term care residents living in the Emergency Planning Zone. For 2010, a new assessment was conducted by Orange County Sheriffs Emergency Management and SONGS staff (Reference 5). That assessment identifies 50 facilities with a long term care population of 1313.

The population remains within the bounds of the total population estimate contained in the 2007 SONGS ETE.

Roadway Assessment
As noted in the Reference 1, Antonio Parkway is currently a four- and six- lane arterial paralleling east of I-5 between Oso Parkway and Ortega Highway (SR-74). The road has been planned to extend south along La Pata Avenue and connect Avenida Pico near Avenida Vista Hermosa, thus providing a bypass route to the communities living east of I-5. As of this date, this roadway is still under construction.

As noted in Reference 1, The planned Foothill-South Transportation Corridor (FSTC, or SR-241), if completed would run between I-5 at the Orange County/San Diego County line to Oso Parkway and provide additional roadway capacity for the EPZ. This roadway project is no longer being considered in its current form.

These projects are not anticipated to be completed before 2011. As such, the existing roadway capacity noted in Reference 1 is unchanged.

New Special Facilities
Based on feedback from city contacts, there have been no new special facilities such as entertainment venues, office complexes and hospitals constructed in the EPZ that would adversely affect the evacuation times noted in Reference 1.

New Special Events
Based on feedback from city contacts, there have been no new special events (concerts, holiday events and festivals) staged in the EPZ that would adversely affect the evacuation times noted in Reference 1.

Implementation of intelligent transportation systems
Reference 7 discribes the implementation of California's intelligent transportation system. Although the SONGS 2007 ETE is silent on intelligent transportation systems, the California current system was in place at the time of this evacuation time study.

Jurisdictional Changes in Response Authority
Based on feedback from city contacts, there have been no jurisdictional changes in response authority that would adversely affect the EPZ evacuation times noted in Reference 1.

Summary
There has been no significant changes in the SONGS EPZ that would adversely affect the information contained in the San Onofre Nuclear Generating Station (SONGS) Evacuation Time Evaluation, Prepared for Southern California Edison by Wilbur Smith Associates, dated June 12, 2007.

Richard A. Garcia
Offsite Emergency Planning and External Affairs
San Onofre Nuclear Generating Station

Appendix 8

Economic Impacts of the San Onofre Nuclear Generating Station on the California Economy

Economic Impacts of the San Onofre Nuclear Generating Station on the California Economy

Prepared by IHS Global Insight
U.S. Regional Services
800 Baldwin Tower
Eddystone, PA 19022

Impacts of the San Onofre Nuclear Generating Station

Introduction

The purpose of this analysis is to estimate the impacts of the San Onofre Nuclear Generating Station (SONGS) on the California economy. This will be assessed over a five-year period from 2010 through 2014 using expenditure estimates provided by the Southern California Edison Company (SCE). The information provided by SCE for use in the impact evaluation consists of workers directly employed by the plant, employee compensation, material purchases, fixed costs, and other service expenditures needed to maintain and operate the facility. The analysis here is limited to estimating the macroeconomic impact of operations and maintenance of SONGS on the California economy. The impact estimate will show how many jobs are directly created by operation and maintenance of the nuclear plant and the macroeconomic impact associated with indirect and induced effect on other economic sectors in California. The impact results will provide an estimate of output, value added, taxes and earnings generated in the California economy. Under the SCE proposal, annual spending would range between $712 million and $862 million during the five-year period. Our computations revealed that operation and maintenance of SONGS have a significant impact on the California economy creating about 9,400 jobs and more than $3.3 billion in output per year over the period under study. Each dollar spent on the operation and maintenance of SONGS produces $1.35 of labor income in the California economy, the bulk of which (77%) is employee compensation.

Study Area

To assess the economic impacts of SONGS, IHS Global Insight defined the entire state of California as the study area. While SONGS is located in San Diego County, the economic activity generated by the plant will have significant impacts across California. Most of the labor and about half of the direct material inputs needed for SONGS operations and maintenance will be obtained in-state. California is the nation's largest state economy, accounting for 13% of gross domestic product and 12% of the population; California's 2008 gross state product of $1,846.75 billion would make it about the eighth largest economy in the world, similar in size to Russia. Due to its heavy mix of high-paying service sector jobs, median household income is over $60,000 or about 17% higher than the national average.

IHS Global Insight used the IMPLAN input/output (I/O) model to estimate the total economic impacts of SONGS because its high level of sector detail enables the final demand changes to be assigned to the appropriate economic sectors. An I/O model such as IMPLAN provides for an accounting of the effects that initial direct spending in one industry has on other sectors through the inter-industry relationships in the economy. IMPLAN contains a set of multipliers that produce estimates of the total regional increases in output, value added, employment, and income produced by direct spending. IMPLAN uses national inter-industry purchasing relationships, adjusted for the structure of the regional economy through the use of regional purchase coefficients, to derive a set of sector-specific multipliers that are unique to the regional economy being analyzed. The multipliers are used to derive indirect and induced effects, which are looked at along with the direct effects to obtain the total change in regional economic activity. The sizes of the multipliers are determined by the technical co-efficients of the production functions in the affected final demand sectors, and on the number and types of industries that supply inputs to the directly affected sectors. The construction and maintenance of energy facilities with a high output value per worker has a relatively large economic multiplier effect because of the value of inputs and the consumer spending supported by the high-wage employees.

The key assumption in this type of economic impact study is the selection of the sectors where the final demand changes will occur. In the case of SONGS employees, the sectors are detailed later in the report, which were distributed using an employee mix provided by SCE. The spending for materials was also assigned as appropriate to IMPLAN sectors in accordance with NAICS classification based on a SCE detailed material-spending breakdown. The employee compensation generated by short-term service hires was applied to the model to capture the activity supported by the disposable income.

Measurement of Economic Impacts

The maintenance and operation activity at SONGS affects a large number of sectors in the California economy. In particular, the activities create direct, indirect, and induced demand for labor leading to a high employment multiplier. When a direct increase in regional spending occurs, there are two types of economic impacts generated through backward linkages that are considered by models such as IMPLAN:

- Indirect effects are generated when a business that receives an initial, direct increase in spending purchases additional inputs from their suppliers located in the region.
- Induced effects are produced by the increase in local spending of disposable income by the newly hired workers, including both the new direct workers hired by firms receiving the initial changes in final demand (e.g., the new construction workers) and by new workers in the supplying industries (e.g., firms who sell concrete or steel to the contractor and who, in turn, have to hire new workers to meet the increased demand.)

In terms of the modeling purposes for this study, the direct purchases are based on SCE's proposed and planned expenditures. The indirect purchases are determined from within the model and are calculated utilizing a combination of IMPLAN's industry specific production functions and regional purchase coefficients[1] (RPC). Based on information provided by the SCE, it is estimated that 50% of the direct material purchases will be made within California with the rest made outside the study area. The material spending will ultimately require non-labor inputs such as steel, machinery, and equipment, some of which will be purchased within the study area, indirectly supporting employment in those activities. Additionally, the wages supported by the plant generate activity for a multitude of other service and goods-producing sectors. The backward linkages for a producing firm in a regional economy consist of the other industries from which it buys the inputs needed to make the goods and services it sells.

The higher the share of inputs that are bought from suppliers located in the regional economy, the more complete the backward linkages, which will result in larger indirect and induced effects and higher economic multipliers. When evaluating the regional economic impacts of a project, it is important that the changes in all the primary measures of regional economic activity be considered. In other words, changes in levels of output, value added, and income should be examined along with changes in employment.

[1] This is the ratio representing the portion of regional demands purchased from local producers.

We have summarized the payroll, wage, material, and other direct California expenditures estimated to be needed to maintain and operate the plant. Any expenditures or activity generated outside the state will not be included in this study. SCE expects to spend close to $4 billion from 2010 to 2014, averaging about $770 million per year. During the five-year period, general spending is highest in 2010, the first year of this plan. Jobs related to contractor work and services will vary depending on the maintenance and capital improvements scheduled each year.

Wage, Employment and Material Expenditures Estimates for SONGS
Expenditure by Asset Class (Million Dollars)

Expenditure	2010	2011	2012	2013	2014	5-Year Avg.
SCE Salaries & Payroll Adds	410.54	408.18	395.53	410.48	427.04	410.35
Contrator Wages & Salaries	164.77	83.51	56.98	53.61	77.65	87.31
Service Wages & Salaries	107.81	82.17	86.48	99.51	97.88	94.77
Other Services	70.64	53.84	56.66	65.20	64.13	62.09
Material Purchases	36.08	37.82	42.06	46.43	41.67	40.81
General/Admin Expenses	25.47	20.57	21.28	22.40	23.29	22.60
Fixed Costs	23.58	24.15	24.88	25.56	26.22	24.88
Property Taxes & Insurance	22.82	25.79	28.35	29.87	30.69	27.50
Total	861.71	736.02	712.23	753.06	788.58	770.32

Job Estimates (Full Time Equivalent)

Job Type	2010	2011	2012	2013	2014	5-Year Avg.
SCE Permanent Staffing	2,439	2,439	2,314	1,939	1,939	2,214
SCE Temporary Staffing	52	36	36	34	43	40
Contractor Staffing	1,020	506	336	308	434	521
Total	3,511	2,981	2,686	2,281	2,416	2,775

The material purchases were distributed through the IMPLAN model utilizing a detailed spending list provided by SCE. The material breakdown was then applied to each year and is relevant from the point of view of how these expenditures affect the economy of California. Investment in each material-providing industry is distributed over the entire economy due to backward linkages. Industries have different strengths in terms of creating their impact on the economy.

Since we are analyzing an existing facility, much of the impacts will be related to the jobs it supports. While material spending is significant, the bulk of SCE spending plan is allocated to wage and salary expenditures. Over the study period the plant will employ an average of 2,214 full-time workers on-site and several hundred more through contract and temporary staffing with positions that range from high-paying nuclear operators to facility support and security services. How the employees are classified in the IMPLAN model is of particular importance in this study, as the impact on output and disposable income will vary greatly between employment types. Full-time SCE employees and contract workers were classified utilizing an employment mix provided by SCE. Note that employment estimates were provided only for staff that works at the site for an extended period. For short-term services, like an elevator repairman, we used the estimated service wages to calculate the impact that it has on disposable income spending in California. Direct employment related to material spending, fixed costs, and other services expenditures by SONGS is also not included in these job estimates but are reflected in the final results.

Distribution of SONGS Employment

Sectors	2010	2011	2012	2013	2014
Electric Power Generation, Transmission, and Distribution	2,106	1,779	1,599	1,359	1,442
Security Services	492	489	464	390	392
Management, Scientific, and Technical Services	405	314	273	233	256
Facilities Support Services	293	186	147	129	155
Accounting and Payroll Services	215	213	203	170	171
Total Employment	3,511	2,981	2,686	2,281	2,416

Results

The economic activity supported by SONGS is considerable. Outlining the results, indicates, for example, that the plant directly supports $2.2-billion of output and a total output of $3.3-billion. The employment multiplier is well above 2.0, meaning that for each direct job created by SONGS-related activity, indirect and induced impacts will produce more than one additional job in the study area; in total SONGS generates an average of 9,450 jobs per year (over 2010 to 2014) on a full-time equivalent basis (FTEs). In California, average annual wages in 2010 totaled $56,000 and value added per employee is measured at about $135,000 according to IHS Global Insights latest estimates. In comparison, SONGS generates jobs with annual average wages of $84,000 and value added per employee of over $243,000 per year, which is substantially more than the state average. The economic impact of SONGS operation and maintenance is significant, each dollar spent on operation and maintenance of the nuclear plant generates a total of $4.3 in output and $3.0 in value added in the California economy. Each dollar spent on the operation and maintenance of SONGS produces $1.35 of labor income in the California economy, the bulk of which (77%) is employee compensation.

Economic Impacts of the San Onofre Nuclear Plant on California
(Millions of 2010 Dollars, Employment Full Time Equivalent)

	2010	2011	2012	2013	2014	5-Year Avg.
Expenditures	861.71	736.02	712.23	753.06	788.58	770.32
Employment						
Direct	4,442	3,801	3,631	3,436	3,444	3,751
Total	11,520	9,783	9,126	8,314	8,512	9,451
Multiplier	2.59	2.57	2.51	2.42	2.47	2.51
Output						
Direct	2,807.75	2,372.28	2,165.51	1,898.77	1,985.61	2,245.98
Total	4,123.93	3,485.22	3,187.50	2,805.20	2,927.69	3,305.91
Multiplier	1.47	1.47	1.47	1.48	1.47	1.47
Value Added						
Direct	2,125.83	1,799.07	1,635.16	1,420.29	1,489.31	1,693.93
Total	2,873.60	2,431.26	2,215.85	1,935.63	2,024.80	2,296.23
Multiplier	1.35	1.35	1.36	1.36	1.36	1.36
Labor Income						
Employee Compensation	984.32	835.07	769.06	684.92	708.23	796.32
Proprietor's Income	305.73	257.97	234.36	203.62	214.05	243.14
Total Labor Income	1,290.05	1,093.04	1,003.42	888.54	922.28	1,039.46
State and Local Taxes						
Personal Income taxes	43.19	36.59	33.55	29.65	30.81	34.76
Sales Taxes	149.28	126.13	114.28	98.72	103.98	118.48
Corporate Income Taxes	26.30	22.23	20.13	17.37	18.30	20.87
Other Taxes	91.49	77.19	69.55	59.44	63.02	72.14
Total State Taxes	310.26	262.13	237.51	205.18	216.10	246.24

Appendix 9

Letter from Peter Douglas, California Coastal Commission, dated February 4, 2010

STATE OF CALIFORNIA—NATURAL RESOURCES AGENCY ARNOLD SCHWARZENEGGER, GOVERNOR

CALIFORNIA COASTAL COMMISSION

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February 4, 2010

State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Re: Comments on "Draft Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling"

Dear Chair Hoppin and Board Members:

I am writing to add to the comments Coastal Commission staff provided to you in September and December 2009 regarding the above-referenced proposed policy. The Board's proposed policy includes provisions that would allow Southern California Edison's San Onofre Nuclear Generating Station (SONGS) to continue using once-through cooling if it met several site-specific requirements.

Over the past several decades, the Coastal Commission has reviewed the facility's operations and its adverse impacts on marine life. Through approval of several coastal development permits and amendments, the Commission has required Edison to mitigate for those impacts by restoring coastal wetlands, constructing offshore reef habitat, operating a sea bass hatchery, and other measures. The Commission has also periodically reviewed the performance and success of these mitigation measures.

Should the Board determine that SONGS may continue to operate its once-through cooling system, it is the position of Commission staff that the facility's adverse effects on marine life have been fully mitigated and will continue to be mitigated as long as the mitigation measures continue to perform as required.

Please contact me at 415-904-5200 if you have any additional questions or comments regarding this issue.

Sincerely,

PETER DOUGLAS
Executive Director

cc: Coastal Commissioners
James Boyd, Commissioner, California Energy Commission
Yakout Mansour, CEO, California Independent System Operator Corporation
Lester Snow, Secretary of Natural Resources
Michael Peevey, President, California Public Utilities Commission