CONSULTANT REPORT

TRANSMISSION OPTIONS AND POTENTIAL CORRIDOR DESIGNATIONS IN SOUTHERN CALIFORNIA IN RESPONSE TO CLOSURE OF SAN ONOFRE NUCLEAR GENERATING STATION (SONGS)

ENVIRONMENTAL FEASIBILITY ANALYSIS

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ABSTRACT

This consultant report provides a high-level assessment of the environmental feasibility of a number of electric transmission alternatives under consideration by the California Independent System Operator in response to the closure of the San Onofre Nuclear Generating Station in June 2013. These alternatives may be considered by California Energy Commission staff for potential electric transmission corridor designation. While the alternatives examined may provide electrical solutions for addressing challenges arising from the closure of the San Onofre Nuclear Generating Station, this report presents and examines the likely siting constraints that may have to be considered during the environmental permitting process for each potential alternative.

Both alternating current and direct current corridor alternatives were examined, along with several potential submarine high-voltage direct current alternatives.

The alternatives were ranked on a qualitative four-step scale that ranges from possible, possible but challenging, challenging, to very challenging.

Keywords: California Energy Commission, San Onofre Nuclear Generating Station, environmental assessment, electrical transmission, onshore transmission alternatives, offshore transmission alternatives, siting constraints, AC, HVDC, submarine HVDC technology

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EXECUTIVE SUMMARY

Introduction

Aspen Environmental Group prepared this feasibility analysis in response to a request from the California Energy Commission staff to inform the Energy Commission staff and California Independent System Operator about environmental feasibility concerns related to potential electric transmission options under consideration by the California Independent System Operator in response to the closure of the San Onofre Nuclear Generating Station. These options may be considered by the Energy Commission staff for potential transmission corridor designations.

Under the direction of the Energy Commission staff, Aspen worked with an external team that included representatives of Southern California utilities in the study area (San Diego Gas & Electric Company [SDG&E] and Southern California Edison [SCE]); state and federal agencies with permitting authority in the study area (U.S. Bureau of Land Management, U.S. Forest Service, California Public Utilities Commission, California State Parks, and the San Diego County Planning Department) and the California ISO.

The group held an initial WebEx meeting to introduce and discuss the work, and several follow-up meetings with subsets of this external team were held to gather more specific input. This report is the result of Aspen's assessment of the information gathered throughout this process under the direction of the Energy Commission staff.

Purpose

Aspen studied potential corridors for two basic types of transmission options. First, the report describes and evaluates a series of potential onshore transmission alternatives, including both alternating current (AC) and direct current (DC) systems and substation upgrades. Second, the report describes and evaluates the technology, viability, and potential to develop offshore corridors for a high-voltage direct current (HVDC) submarine cable between the SCE and SDG&E territories. The studied alternatives include:

- Alternative 1, Submarine HVDC Cable.
- Alternative 2, Alberhill to Suncrest.
- Alternative 3, Enhanced Talega-Escondido/Valley-Serrano (Forest Route).
- Alternative 4, Enhanced Talega-Escondido/Valley-Serrano (Talega-Serrano Route).
- Alternative 5, Imperial Valley to Inland (Overhead AC and Overhead/Underground DC).
- Alternative 6, Valley to Inland (Overhead AC or Underground DC).
- Alternative 7, Imperial Valley Expansion.

- Alternative 8, Mesa Substation Loop-In.

Conclusions

This work presents an early-stage evaluation of the potential transmission corridors in the Southern California study area. Developing any of the transmission options would require viable project sponsors with experience and access to sufficient resources to establish an optimum route and design. The considerations identified here provide an overview of requirements stemming from regulatory agency oversight, environmental issues, and technical or construction engineering concerns. Comprehensive environmental and technical studies would still need to occur before any agency could approve a project within any of the corridors.

Table ES-1 is the key to the colors used in the summary table of transmission alternatives and major constraints. Table ES-2 (Transmission Alternatives – Descriptions and Major Constraints) summarizes the results of this study. This analysis finds that permitting the submarine cable HVDC and five of the onshore transmission alternatives would be possible but challenging. Furthermore, the Mesa Substation Loop-In alternative could be implemented in a shorter time frame than the other onshore transmission alternatives.

Table ES-1 Key to Summary Table: Likelihood of Successful Permitting and Construction

■ **Green**: Possible	No major obstacles to permitting or construction
■ **Yellow**: Possible but Challenging	Siting constraints but likely can be overcome
■ **Orange**: Challenging	Serious siting challenges that may not be resolvable
■ **Red**: Very Challenging	Very serious siting challenges that may make routes infeasible

Source: Aspen Environmental, 2014.

Table ES-2: Transmission Alternatives – Descriptions and Major Constraints			
Alternative Name	**Description**	**Constraints**	**Likelihood of Successful Permitting**
Alternative 1. Submarine Cable HVDC	Alamitos or Huntington Beach, to San Onofre or Encina	• Steep seafloor slopes and canyon crossings • High risk of seafloor instability, seismic ground movement, and fault rupture • Securing the cable to the seafloor would impact to benthic habitat, hard-bottom areas, rocky substrate, or bedrock • Laguna Beach marine conservation areas • Huntington Beach State Park	**Possible but Challenging**
Alternative 2. Alberhill to Suncrest	500 kV Alberhill to Suncrest I-15 Corridor to SR 79	<u>Alberhill to Inland (Riverside County)</u> • Dense development in Temecula • Longitudinal encroachment in Caltrans I-15 ROW <u>Inland to Suncrest</u> • Cleveland National Forest to Suncrest proposed wilderness designation • Scenic, low-density areas in northern San Diego Co. • Small airport near Warner Springs	**Very Challenging**

Table ES-2: Transmission Alternatives – Descriptions and Major Constraints			
Alternative Name	**Description**	**Constraints**	**Likelihood of Successful Permitting**
Alternative 3. Enhanced Talega-Escondido/ Valley – Serrano (TE/VS) (Forest Route)	500kV Alberhill to Inland	• Expansion of Talega Substation • TE/VS through Cleveland National Forest, Trabuco Ranger District • Expansion of ROW through Santa Margarita Ecological Reserve • Expansion of ROW through Camp Pendleton	**Challenging**
	500 kV Inland to Suncrest	• ROW across La Jolla Reservation • Cleveland National Forest to Suncrest proposed wilderness designation • Scenic, low-density areas in northern San Diego Co.	**Very Challenging**
Alternative 4. Enhanced Talega-Escondido/ Valley – Serrano (TE/VS) (Talega-Serrano Route)	500 kV Serrano to Inland	• Expansion of facilities through residential area in Mission Viejo and other communities • Expansion of Talega Substation • Expanded ROW into Talega Substation • Expansion of ROW through Santa Margarita Ecological Reserve • Expansion of ROW through Camp Pendleton	**Challenging**
	500 kV Inland to Suncrest	• ROW across La Jolla Reservation • Cleveland National Forest to Suncrest proposed wilderness designation • Scenic, low-density areas in northern San Diego Co.	**Very Challenging**

Table ES-2: Transmission Alternatives – Descriptions and Major Constraints			
Alternative Name	**Description**	**Constraints**	**Likelihood of Successful Permitting**
Alternative 5, 1A. Imperial Valley to Inland 500 kV Overhead	Overhead 500 kV Imperial Valley Sub to eastern boundary of Anza-Borrego Desert State Park (ABDSP)	• Overhead construction across BLM land and private agricultural land • Special status species mitigation required; loss of productive agricultural land	**Possible but Challenging**
	Overhead 500 kV through Anza-Borrego Desert State Park (ABDSP)	<u>Anza-Borrego Desert State Park:</u> • Overhead construction in Anza-Borrego Desert State Park • Inadequate ROW through ABDSP Wilderness • Angelina Springs Cultural Reserve <u>Santa Rosa-San Jacinto National Monument Option:</u> • Monument; National Forest Roadless Areas; Santa Rosa Reservation; ABDSP Wilderness	**Very Challenging**
	Overhead 500 kV west of ABDSP	<u>Northern San Diego County:</u> • ROW across La Jolla Reservation • Scenic, low-density areas in northern San Diego Co.	**Very Challenging**

Table ES-2: Transmission Alternatives – Descriptions and Major Constraints			
Alternative Name	**Description**	**Constraints**	**Likelihood of Successful Permitting**
Alternative 5, 1B. Imperial Valley to Inland HVDC Overhead and Underground	Overhead HVDC Imperial Valley Sub to eastern boundary of ABDSP	• Overhead construction across BLM land and private agricultural land.	**Possible but Challenging**
	Underground HVDC through ABDSP	• Construction disturbance and traffic in ABDSP • Disturbance of bighorn sheep and seasonal construction constraints • Construction challenges (bedrock and Earthquake Valley Fault)	**Challenging**
	Overhead **or** underground west of ABDSP	• ROW across La Jolla Reservation • Scenic, low-density areas in northern SD Co.	**Challenging**
Alternative 6, 2A. Valley to Inland 500 kV Overhead	All Overhead 500 kV Through Temecula and environs	• Must avoid Pechanga Reservation and Agua Tibia Wilderness • Dense development in Temecula • Southwestern Riverside County Multispecies Core Reserve • Temecula Bike Path	**Very Challenging**
Alternative 6, 2B. Valley to Inland HVDC All Underground	All underground DC Through Temecula and environs	• Existing buried utilities in road ROW • Engineering considerations in design	**Possible but Challenging**

Table ES-2: Transmission Alternatives – Descriptions and Major Constraints			
Alternative Name	**Description**	**Constraints**	**Likelihood of Successful Permitting**
Alternative 7. Imperial Valley Sub. Expansion	Expand Imperial Valley Substation	• Flat-tailed horned lizard habitat • BLM Yuha Desert Wildlife Management Area	**Possible but Challenging**
Alternative 8. Mesa Substation Loop-In	Expand SCE Mesa Substation	• SCE states that expansion is possible	**Possible**

Source: Aspen Environmental, 2014.

CHAPTER 1:
Opportunities and Constraints for Onshore Transmission Siting in Study Area

This chapter describes the opportunities and constraints related to the onshore alternatives being considered in this report. The section "Previous Studies" summarizes the previous major studies that considered transmission routes in the study area. The section "Opportunities for Transmission Siting" describes the opportunities for transmission siting in the study area, and the section "Constraints for Transmission Siting in Study Area" describes the constraints and challenges that exist in this region. The section "Regulatory Requirements for Potential Land Based Transmission" is a summary of the existing regulations that govern transmission line siting.

Previous Studies

The onshore transmission alternatives studied are located in Imperial, San Diego, Riverside, and Orange Counties. Two major studies of high voltage transmission lines have been published by the California Public Utilities Commission (CPUC) in the past 13 years: first for the San Diego Gas & Electric Company (SDG&E) proposed Valley-Rainbow project and second for the SDG&E Sunrise Powerlink project. Each study is summarized below.

Valley-Rainbow

On March 23, 2001, SDG&E proposed to construct an approximately 30-mile-long, 500 kilovolt (kV) transmission line that would connect the Southern California Edison Company (SCE) Valley Substation (in southern Riverside County) with the proposed Rainbow Substation in northern San Diego County. In addition, the proposed project included a second 230 kV circuit to the Talega-Escondido transmission line and modifications of several SDG&E substations.

The CPUC's assigned administrative law judge determined that alternatives to the proposed project be evaluated before initiating the California Environmental Quality Act (CEQA)/National Environmental Policy Act (NEPA) process. Therefore, in November 2002, the CPUC published the *SDG&E Valley Rainbow 500 kV Interconnect Project, Interim Preliminary Report on Alternatives Screening*. This comprehensive report identified and evaluated about 45 alternatives. The alternatives are illustrated on Figure 1 on page 22; they were divided into the following categories:

- New 500 kV transmission alternatives between the Valley and proposed Rainbow Substation, or existing Pala Substation.
- New 500 kV route through the Cleveland National Forest (CNF) Trabuco or Palomar Districts.

- New 500 kV transmission alternatives connecting other SDG&E substations in Orange and Riverside Counties and Imperial Irrigation District substations in Imperial and San Diego Counties.

- 500 kV transmission alternatives that would use or parallel existing utility rights-of-way in Orange, Riverside, Imperial, and San Diego Counties.

- Alternative transmission system designs, voltages, and nonwires alternatives.

Ultimately, SDG&E withdrew its application to the CPUC, and no environmental impact report (EIR)/environmental impact statement (EIS) was prepared.

As part of the CPUC's assessment of Valley-Rainbow alternatives, an engineering study was prepared to consider the transmission line corridor between the SDG&E Talega and the SCE Serrano Substations (Commonwealth, 2002). This report evaluated design options in several segments of the Talega-Serrano corridor, and concluded that the installation of a new 500 kV line on the existing rights-of-way (ROWs) from Serrano to Talega would be feasible, but that it would require substantial reconfiguration of the existing lines in the corridor, including installing one line underground.

Sunrise Powerlink

The route originally proposed by SDG&E is shown in Figure 2 on page 23; it included an overhead segment passing through Anza-Borrego Desert State Park (ABDSP) that was highly controversial. The alternative that was ultimately approved and constructed was one of the Southern Route alternatives, illustrated in Figure 3 on page 24. The final route avoided ABDSP but did pass through portions of the Cleveland National Forest.

Proposed Route and Approved Route

The route originally proposed by SDG&E is shown in Figure 2; it included an overhead segment passing through ABDSP that was highly controversial. The alternative that was ultimately approved and constructed was one of the Southern Route alternatives, illustrated in Figure 3. The final route avoided ABDSP but did pass through portions of the Cleveland National Forest.

Alternatives Studied

The EIR/EIS evaluating the proposed Sunrise Powerlink project included a broad analysis of alternatives, covering the same geographic range as the alternatives studied for the Valley-Rainbow analysis. The Sunrise alternatives screening process culminated in the identification and preliminary screening of more than 100 potential alternatives. These alternatives range from minor routing adjustments to SDG&E's proposed project location, to entirely different transmission line routes, to alternative energy technologies, as well as nonwire alternatives. Figure 3 illustrates the alternatives evaluated.

Opportunities for Transmission Siting

In seeking routes for new overhead transmission lines, the primary opportunity for lower impact routes is an existing transmission corridor. The Garamendi Principles are encouraged for transmission siting. As described in the California Energy Commission's *Energy Aware Facility Permitting and Siting Guide* (California Energy Commission, 2010), a new law was passed to recognize the value of the transmission system and need for effective long-term transmission corridor planning (Senate Bill 2431, Garamendi, Chapter 1457, Statutes of 1988). The law declared that it is in the best interests of the state to:

- Encourage the use of existing ROWs by upgrading existing transmission facilities where technically and economically justifiable.
- When construction of new transmission lines is required, encourage expansion of existing rights-of-way, when technically and economically feasible.
- Provide for the creation of new ROWs when justified by environmental, technical, or economic reasons, as determined by the appropriate licensing agency.
- Where there is a need to construct additional transmission, seek agreement among all interested utilities on the efficient use of that capacity.

However, in densely populated areas like Southern California, residential development is often located immediately adjacent to existing corridors, so the proposed use of these corridors for more and higher voltage lines can result in strong and organized opposition to proposed projects. Examples of this opposition have occurred in:

- Sunrise Powerlink. The proposed coastal segment would have required installation of new towers in an existing ROW with adequate existing space for new towers. Numerous neighbors submitted comments stating that they already bore the impacts of an existing corridor and that it was unfair to increase that burden.
- Tehachapi Renewable Transmission Project (TRTP), Chino Hills segment. SCE proposed installation of single- or double-circuit 500 kV towers in an existing ROW previously occupied by a 220 kV line. The CPUC initially approved a double-circuit overhead 500 kV line, and SCE began installation of the towers. After intense and persistent opposition, the CPUC later reconsidered its approval and ordered SCE to install the line underground, as well as to remove the newly constructed towers.

Constraints for Transmission Siting in Study Area

The Valley-Rainbow and Sunrise Powerlink alternative studies document the substantial geographic and land-use constraints associated with attempts to design a successful transmission line route through the region. Figure 4 on page 25 presents an overview of land uses in the study area, including the land uses that are most challenging for transmission line siting. The most significant constraints are described below.

Anza-Borrego Desert State Park

Anza-Borrego Desert State Park extends from only 3 miles north of the Mexican border roughly 65 miles north to its northern border at the Santa Rosa-San Jacinto National Monument. Given the north-south extent of the park, there are three potentially feasible ways of routing a 500 kV transmission line from Imperial County into San Diego and Riverside Counties, unless considering a transmission line route as far north as the Interstate 10 (I-10) corridor (Devers Substation and west). Figure 5 on page 26 illustrates these locations. Each is described as follows:

South of the Park

The existing Southwest Powerlink (SWPL) and Sunrise Powerlink 500 kV lines now pass south of the ABDSP boundary.

Through the Park, Grapevine Canyon/Highway 78

In 2005, SDG&E proposed the 500 kV Sunrise Powerlink to pass through the center of the park, following an existing Imperial Irrigation District (IID) and SDG&E 92/69 kV line along State Route (SR) 78, then through Grapevine Canyon. The feasibility of the proposed installation of a 500 kV line through the park was questionable due to the narrow width of the existing ROW (which runs between designated Wilderness Areas). In addition, in 2012, the park designated a portion of Grapevine Canyon (through which the existing 69 kV line passes) as a "cultural preserve," which would almost certainly prohibit future consideration of another transmission line through Grapevine Canyon. The remaining option through this part of the park is underground in SR 78, an alternative considered in the Sunrise Powerlink EIR/EIS and discussed further in Alternative 5 (in Chapter 2).

Immediately North of the Park, Highway 74

This route would generally follow the "Pines to Palms Highway" (designated as a National Scenic Byway by the San Bernardino National Forest [SBNF]) and an "eligible" scenic highway by the California Department of Transportation (Caltrans). An overhead transmission line route through this area would require passing through about 15 miles of the Santa Rosa-San Jacinto National Monument, which includes portions of the SBNF. There are several major constraints in this area, as illustrated on Figure 6 on page 27:

- A portion of the area immediately north of ABDSP is designated as "Cactus Springs-B Inventoried Roadless Area;" however, the U.S. Forest Service (USFS) is in the process of redesignating this land with a proposed use of "Backcountry Non-Motorized." This new designation would prohibit utility use.
- Immediately west of the SBNF is the Santa Rosa Indian reservation.
- Immediately south of the reservation is ABDSP designated wilderness.

Based on these constraints, it appears that the remaining route through the area may be to install an HVDC line underground within Highway 74. This route would be feasible only in the following circumstances:

- If the USFS and the U.S. Bureau of Land Management (BLM) allow an overhead high-voltage direct current (HVDC) transmission line within the National Monument boundaries (but outside wilderness and roadless areas).
- If the HVDC line can be installed underground starting just east of the roadless areas and ending at the western boundary of the Santa Rosa Indian reservation.

Santa Rosa -San Jacinto National Monument

The Santa Rosa-San Jacinto National Monument was designated by Congress in Public Law 106-351 in October 2000. Within its boundaries are BLM land, USFS land (within the SBNF), and private land. It was designated " … in order to preserve the nationally significant biological, cultural, recreational, geological, educational, and scientific values found in the Santa Rosa and San Jacinto Mountains and to secure now and for future generations the opportunity to experience and enjoy the magnificent vistas, wildlife, land forms, and natural and cultural resources in these mountains and to recreate therein." The BLM approved the Management Plan for the Monument in 2004 (BLM, 2004).

The monument's location and its boundaries are illustrated in Figure 6 on page 27. The Pacific Crest Scenic Trail also passes through the monument. The BLM describes the monument as follows:

> The National Monument's boundary encompasses about 272,000 acres, including 65,000 acres within the San Jacinto Ranger District of the San Bernardino National Forest, and 89,500 acres within the Bureau of Land Management's California Desert Conservation Area. The National Monument includes two federal Wilderness Areas: the Santa Rosa Wilderness which contains 61,600 acres of BLM and Forest Service lands, and 19,470 acres of the Forest Service's San Jacinto Wilderness. Its boundary also surrounds lands owned and administered by the Agua Caliente Band of Cahuilla Indians, California Department of Parks and Recreation, California Department of Fish and Game, other agencies of the State of California, and private landowners.

The management plan is silent on utility use (but defers to BLM or USFS land-use restrictions, as appropriate), but Public Law 106-351 addressed potential use of Monument lands for utilities as follows:

> (e) UTILITIES.— […] The management plan prepared for the National Monument shall address the need for and, as necessary, establish plans for the installation, construction, and maintenance of public utility rights-of-way within the National Monument outside of designated wilderness areas.

There has not yet been a proposal to construct a transmission line through the monument, but given its purpose and scenic value, such a proposal would likely be met with vocal opposition.

National Forest Lands

San Diego and Riverside Counties include large areas of National Forest System lands, including portions of the CNF and the SBNF. Figure 4 (overview map on page 25) illustrates the locations of these dispersed Forest Service units. USFS lands can be challenging for siting major

transmission lines because the lands are protected with a variety of land-use categories, many of which are restrictive as to development of utilities.

For this study, there are three USFS areas of most concern: the CNF Boulder Creek area between the Suncrest Substation and the town of Santa Ysabel, the CNF area around Mount Palomar (Highway 79 on the north and Highway 76 on the south), and the SBNF area between Temecula and the Coachella Valley (following Highway 74). Constraints for each area are described briefly below.

1. **CNF Boulder Creek Area** (Alternative 2, Alberhill to Suncrest, and Alternatives 3 and 4, Enhanced Tallega-Escondido/Valley-Serrano (TE/VS): The currently designated Inventoried Roadless Areas are proposed for being redesignated as "Proposed Wilderness." In addition, a new "Proposed Wilderness" area has been proposed. The combination of these areas would likely make it impossible for the Forest Service to permit a transmission line.

2. **CNF Mount Palomar Area** (Alternatives 2 and 3): Highways 79 and 76 bound the Mount Palomar area on the north and south, and because the Forest Service land crosses the highways, a transmission line through this midsection of San Diego County would pass through small areas of Forest Service land.

3. **CNF Trabuco Ranger District** (Alternative 3, TE/VS Forest Route) would include more than 46 miles of Forest Service land, requiring a new 500 kV line along the eastern ridgeline of the Santa Ana Mountains overlooking Lake Elsinore. This is an area with intense recreational use, including hang gliding, and scenic views.

4. **SBNF land within the monument**: As described above (see "Immediately North of the Park, Highway 74"), there are lands of the SBNF within the monument. Transmission line siting through these areas would have to comply with both the national monument and the Forest Service regulations.

Tribal Land

The study area, as shown on Figure 4 on page 25, includes many large areas of land under the control of many tribal entities, including:

- Viejas Reservation
- Capitan Grande Reservation
- Santa Ysabel Reservation
- Mesa Grande Reservation
- La Jolla Reservation
- Rincon Reservation
- Pala Reservation
- Riverside County
- Pechanga Reservation
- Cahuilla Reservation
- Santa Rosa Reservation

While some processes on tribal land are overseen by the Bureau of Indian Affairs, the ability of utilities to cross tribal land is entirely controlled by the tribal governments. If the tribal members do not accept a utility's terms for an easement across tribal land, there is no appeal.

The Pechanga reservation, located at the southern boundary of Riverside County adjacent to Temecula, has expanded substantially since the Valley-Rainbow project was proposed, so the tribal government controls access to San Diego County across a stretch of land of nearly 6 miles from east to west.

Agua Tibia Wilderness

Agua Tibia Wilderness is a 15,933-acre protected area in southern Riverside and northern San Diego Counties. While it is mostly within the Palomar Ranger District of the Cleveland National Forest, it is managed by the BLM and the CNF. It was designated as wilderness in 1975. The wilderness is immediately adjacent to the Pechanga reservation, so the two properties together block north-south access between San Diego and Riverside Counties along a 12-mile stretch of the county line.

Highly Developed Temecula and Southern Riverside County

The northern portion of the study area has experienced dramatic growth in residential development over the past 15 years. This includes the Riverside County area around the City of Temecula (communities of Murrieta, Menifee, Winchester, Sun City, Lake Elsinore, and Hemet). When the Valley-Rainbow transmission line (500 kV overhead) was proposed through this area 13 years ago, it was strongly opposed by the southern Riverside County communities. The community expressed concerned about the winery industry, recreational lakes and parks, and residential development.

Since the Valley-Rainbow proposal, many proposed residential communities have been constructed, making it exceptionally challenging to find an overhead route through this area.

Rural Residential Areas: Scenic Values and Regional Parks

The northern half of San Diego County and the southern segment of Riverside County include scenic open spaces where undeveloped views are valued and protected.

Scenic Highways and Scenic Areas

Two types of scenic highways exist in the study area. State Route 78 is a designated scenic highway, passing through ABDSP. State Routes 76 and 79 are both designated as "eligible" for designation as scenic. These designations reinforce the local and regional concerns about maintenance of views, undeveloped areas, and open space, making transmission line siting difficult.

Electric and Magnetic Fields From Transmission Lines and Potential Health Concerns

One consideration when planning or siting new transmission lines is the public interest and concern regarding potential health effects from exposure to electric and magnetic fields (EMFs). There are three primary electrical parameters associated with the environment in the vicinity of transmission lines: 1) the electric field, 2) the magnetic field and 3) air ions (for DC lines). Additional detail is provided in Appendix B, Electric and Magnetic Fields From HVDC Transmission Lines and Potential Health Concerns.

- Both high-voltage alternating current (HVAC) and HVDC lines generate an electric field surrounding the conductors, with the magnitude of the electric field dependent on the voltage of the line. The strength of the static electric field decreases rapidly with distance from the source. Electric fields are shielded by trees, walls or other objects and, if shielded, do not penetrate the body, and adverse health effects have not been scientifically established. Some fish and marine organisms use electric fields to detect prey, find mates, and possibly to orient themselves, but there is limited evidence of specific effects of EMF.
- Both HVAC and HVDC lines generate magnetic fields. The magnetic field for a DC line is a static field that does not change over time much like the Earth's magnetic field. Static magnetic fields have been studied extensively at strengths significantly higher than for HVDC transmission lines due to their use in medical diagnostics. The available information does not indicate a significant increase or decrease in the prevalence of the diseases evaluated or conclude that exposure to DC magnetic fields affects health. Generally, conclusions surrounding the human health impacts of EMF also apply to potential impacts on marine species.
- *Air ions* are charged air molecules produced by corona, the partial electrical breakdown of the air surrounding conductors. A result of corona is both positive air ions that have lost an electron and negative air ions that have picked up the excess electrons. For HVDC lines air ions with the same polarity of the conductor migrate toward the opposite pole of the HVDC circuit, and a significant portion of the air ions migrate to the ground and away from the transmission line. Natural background air ion densities range from 1,000 ions per cubic centimeter in open areas to 80,000 ions per cubic centimeter in urban areas. Directly below HVDC

transmission lines air ion densities are in the range of 100,000 ions per centimeter. Air ions have been studied for more than a hundred years; research has not provided any reliable evidence that air ions produce any harmful effects.

Regulatory Requirements for Potential Land-Based Transmission

Table 1 lists the federal, State, and local permits and authorizations that may be required prior to constructing and operating a new high voltage transmission line within Imperial, San Diego, Riverside, Los Angeles, and/or Orange Counties.

Table 1: Permits That May Be Required for Overhead or Underground High-Voltage Transmission Line			
Agency	Jurisdiction	Requirements	Applicable Alternative(s)
Federal Agencies			
Council on Environmental Quality, National Environmental Policy Act	Environmental review of major federal actions	▪ Compliance with NEPA: preparation of EIS	All
U.S. Fish and Wildlife Service	Endangered Species Act 16 USC 1531-1544 Migratory Bird Treaty Act and Eagle Protection Act Fish and Wildlife Coordination Act	▪ Biological Assessment, Section 7 Consultation, Biological Opinion ▪ Enforcement of the Migratory Bird Treaty Act (MBTA) ▪ Habitat Conservation Plans (HCP) – Riverside County	All for Section 7 Consultation and MBTA Enforcement; Alternative 6 for HCP
U.S. Army Corps of Engineers	Clean Water Act, 33 USC 1341 Section 10, Rivers and Harbors Act Permit	▪ Individual or Nationwide Section 404 Permit	All
U.S. Department of Transportation, Federal Highway Administration		▪ Encroachment Permits ▪ Review of obstruction and objects affecting airspace	All
U.S. Department of the Treasury, Bureau of Alcohol, Tobacco and Firearms	Where blasting may be required	▪ Explosive User's Permit	All
Federal Aviation Administration		▪ Helicopter Lift Plan ▪ Form 7460-1	All
Federal Communications Commission (FCC)	Licenses/permits related to FCC frequencies and paths	▪ Telecommunication Permit (as required)	All
U.S. Bureau of Indian Affairs, Pacific Regional Office	Section 106 of National Historic Preservation Act of 1966	National Historic Preservation Act (NHPA), Section 106 consultation	All
Advisory Council on Historic Preservation	National Register of Historic Places	NHPA, Section 106 consultation	All
U.S. Department of Agriculture - United States Forest Service		▪ Forest Plan amendment and Special Use Permit (SUP) authorization Easements or other real property conveyances ▪ Timber settlement sale	Alternatives 2, 3, 4, 5

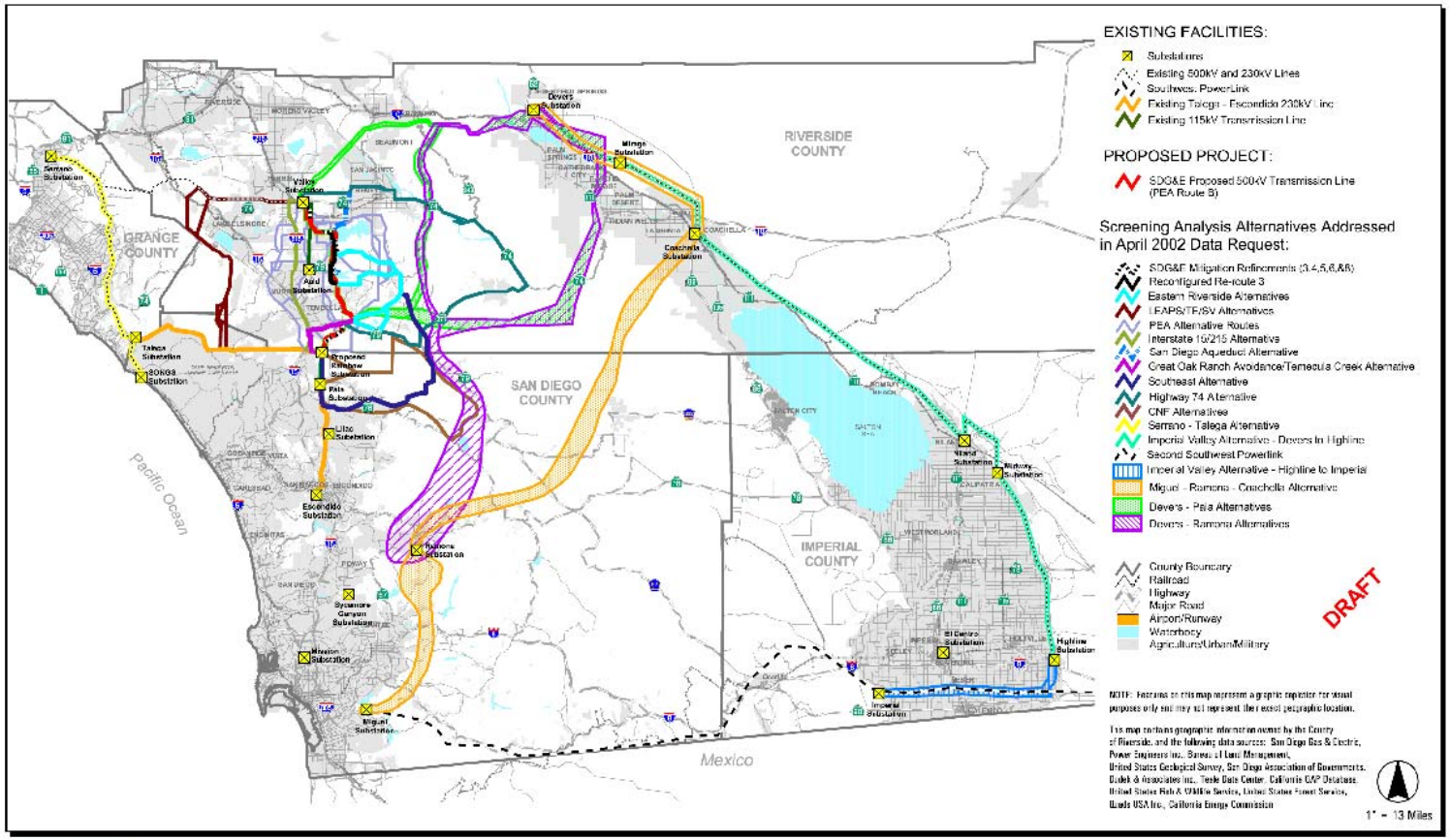
Table 1: Permits That May Be Required for Overhead or Underground High-Voltage Transmission Line			
Agency	Jurisdiction	Requirements	Applicable Alternative(s)
Bureau of Land Management	FLPMA, 43 USC 1701 et seq. 43 USC 1701 et seq.	▪ ROW Grant / Record of Decision ▪ Temporary Use Permit ▪ Antiquities and Cultural Resources Use Permit ▪ Plan of Development ▪ Notice to Proceed ▪ California Desert Conservation Area Plan Amendment ▪ Clean Air Act Conformity ▪ Fire Prevention Control Plan	Alternative2 2 through 6
U.S. Department of Defense (DOD)	If on DOD lands	▪ Federal Aviation Regulation (FAR) Part 77 Request (via FAA) ▪ Secretary of the Navy Instructions (SECNAVINST) 11011.47A (access road outside of easement)	Alternatives 3 and 4
Marine Corps Base (MCB) Camp Pendleton	Construction on MCB Camp Pendleton	▪ FAR Part 77 Request (via FAA) ▪ SECNAVINST 11011.47A (access road outside of easement) ▪ License for non-federal use of real property	Alternative 3 and 4
La Jolla, Pala	Section 106 of National Historic Preservation Act of 1966	▪ Section 106 consultation	Alternative 3, 4, 5
State Agencies			
California Public Utilities Commission	Transmission, substation, generation projects 50 kV and above	▪ CPCN ▪ Likely Lead Agency for CEQA and certification of EIR	All
California Independent System Operator	Purpose and Need for new transmission, substation and generation projects	▪ Interconnection approval	All
California Department of Fish and Wildlife	Manage fish, wildlife, plant resources and habitats; California Endangered Species Act (ESA), California Native Plant Protection Act, California Fish and Game Code Section 1601	▪ Streambed Alteration 1601 Permit ▪ Section 2061 Incidental Take Permit ▪ Mitigation agreement/plan ▪ Certification of EIR ▪ Easement	All
California Department of Transportation (Caltrans) Districts 7, 8, 11, and 12	State-owned streets and highways Code 660-711.21 Cal. Code of Regs. 1411.1-1411.6	▪ Encroachment/Crossing Permits ▪ Traffic Control Plans ▪ Oversize Load/Special Load Permit ▪ Temporary Helicopter Landing Site Permit	All

Table 1: Permits That May Be Required for Overhead or Underground High-Voltage Transmission Line			
Agency	Jurisdiction	Requirements	Applicable Alternative(s)
California Department of Toxic Substances Control (DTSC)	Hazardous Waste Control Act of 1972	▪ EPA Hazardous Waste Generator Identification Number ▪ Permit for hazardous waste treatment, storage and disposal ▪ Hazardous Material Business Plan	All
California State Historic Preservation Office	Any archaeological or paleontological work	▪ Cultural Resources Use Permit, Field Use Authorization, or an Archaeological Resources Protection Act (ARPA) Permit (if required) ▪ Consultation for Section 106 of the National Historic Preservation Act	All
California Air Resources Board	Statewide	▪ Portable Engine Registration for specified non-mobile portable engines.	All
California State Water Resources Control Board	Clean Water Act, Section 401	▪ 401 Certification	All
California Department of Industrial Relations Division of Occupational Safety and Health		▪ Construction activities permit ▪ Tower cranes permit ▪ Helicopter operations permit and tunneling permit	All
California State Lands Commission	State lands	▪ Right-of-Way Easement	Alternatives 2 through 5
California Department of Parks and Recreation	State Park Lands (Anza-Borrego Desert State Park)	▪ Easement	Alternative 5
California Park and Recreation Commission	State Park Lands (Anza-Borrego Desert State Park)	▪ Plan Amendment ▪ Change in Wilderness Designation	Alternative 5
Department of Water Resources	Water crossings	▪ Encroachment/Crossing Permit (as required)	All
Regional Agencies			
Regional Water Quality Control Board ▪ Region 4 (Los Angeles) ▪ Region 7 (Colorado River Basin) ▪ Region 8 (Santa Ana) ▪ Region 9 (San Diego)	Clean Water Act, Section 401	▪ 401 Certification ▪ Storm Water Construction General Permit 99-08-DWQ ▪ National Pollutant Discharge and Elimination System (NPDES) Permit ▪ Waste Discharge Requirements (WDRs)	All

Table 1: Permits That May Be Required for Overhead or Underground High-Voltage Transmission Line			
Agency	Jurisdiction	Requirements	Applicable Alternative(s)
South Coast Air Quality Management District (SCAQMD); San Diego Air Pollution Control District (SDAPCD); or Imperial County Air Pollution Control District (ICAPCD)	South Coast Air Basin; San Diego Air Basin; or Salton Sea Air Basin	Portable Equipment Registrations; Authority to Construct and Permit to Operate backup diesel generator for black start capability (if required).	All
Imperial Irrigation District (IID)	District irrigation/drainage channels	▪ Encroachment/Crossing Permit ▪ Easements and ROW Grant	Alternative 5
Local Agencies, Municipalities, and Other Entities			
Counties ▪ Imperial County ▪ Los Angeles County ▪ Orange County ▪ Riverside County ▪ San Diego County	County roads and highways, flood control/drainage channels	▪ Road/Highway Encroachment/Crossing Permit ▪ Grading and Wall Permits ▪ Traffic Control Plans ▪ Temporary Street/Land Closure Permit ▪ Explosives Permit ▪ New or expanded ROW Grant ▪ Flood Control/Drainage Channel Encroachment/Crossing Permit ▪ Excavation Permit ▪ Tree Removal Permit (if required)	All
Cities ▪ San Diego ▪ Poway ▪ Escondido ▪ Encina ▪ Lake Elsinore ▪ Wildomar ▪ Menifee ▪ Grand Terrace ▪ Ontario ▪ Rancho Cucamonga ▪ Redlands	City roads and highways, flood control/drainage channels, lands	▪ Road/Highway Encroachment/Crossing Permit ▪ Flood Control Channel ▪ Encroachment/Crossing Permit ▪ Temporary Use/Occupancy Permit – Material and Storage Yards ▪ Regional Water Quality Control Board – Storm Water Pollution Prevention Plan ▪ Tree Removal Permit (if required)	All
Riverside County Habitat Conservancy Agency (RCHCA)	Construction on RCHCA lands	▪ Crossing Permit	Alternatives 2 and 3

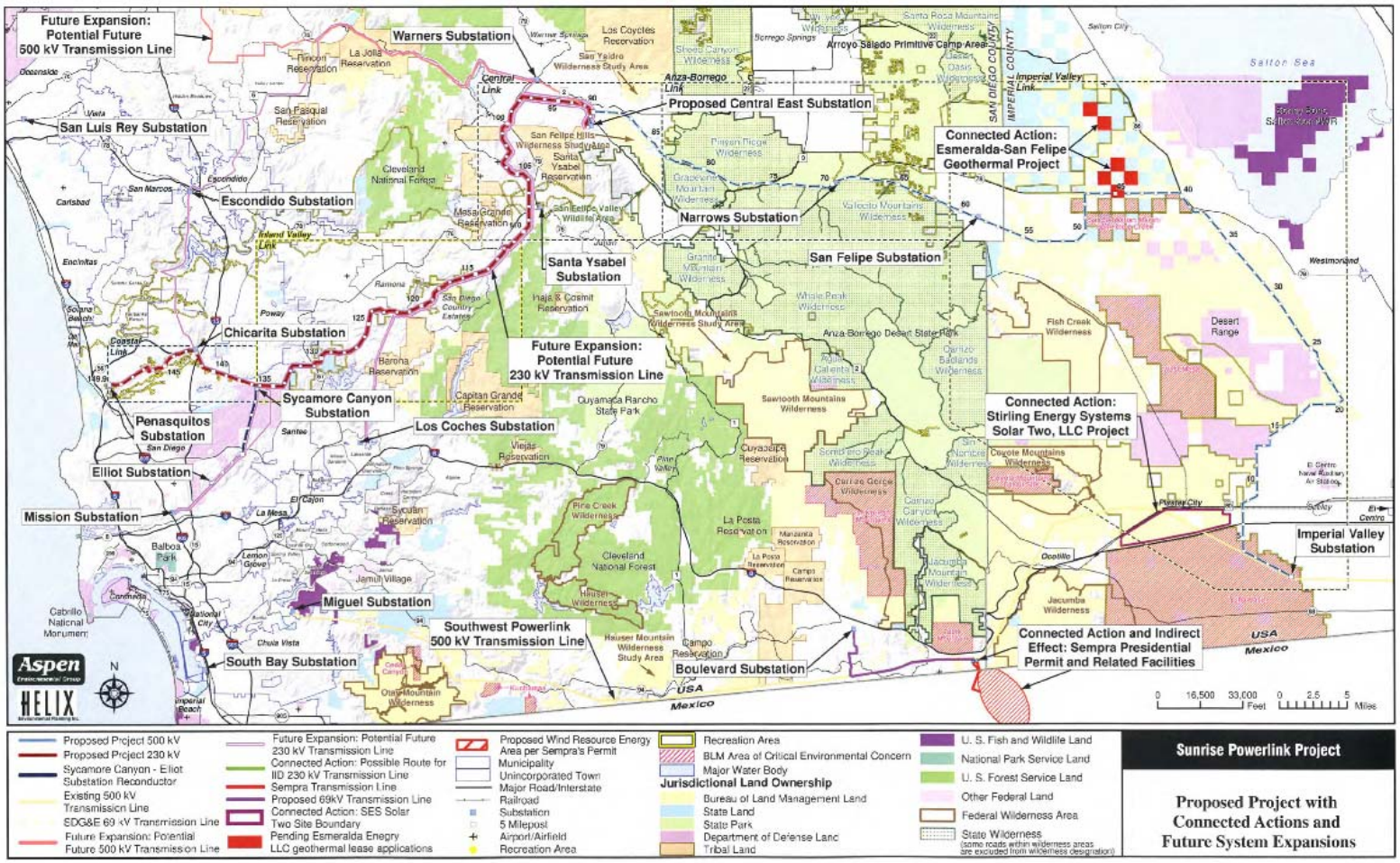
Source: Aspen Environmental, 2014

Figure 1: CPUC Valley-Rainbow Alternatives Evaluated



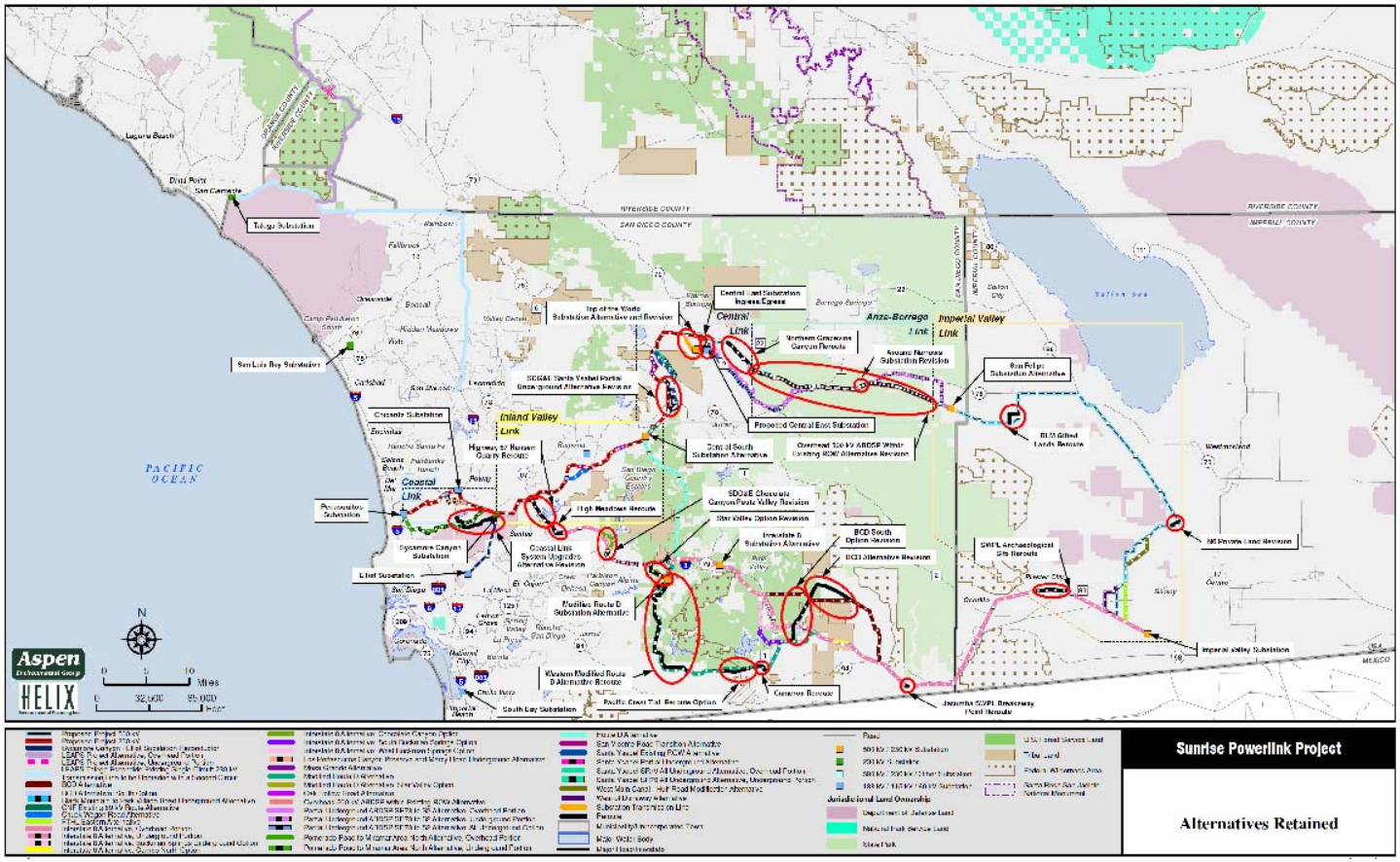
Source: http://www.cpuc.ca.gov/environment/info/dudek/valleyrainbow/V2R/fig_es-3.gif

Figure 2: Proposed Project With Connected Actions and Future System Expansions



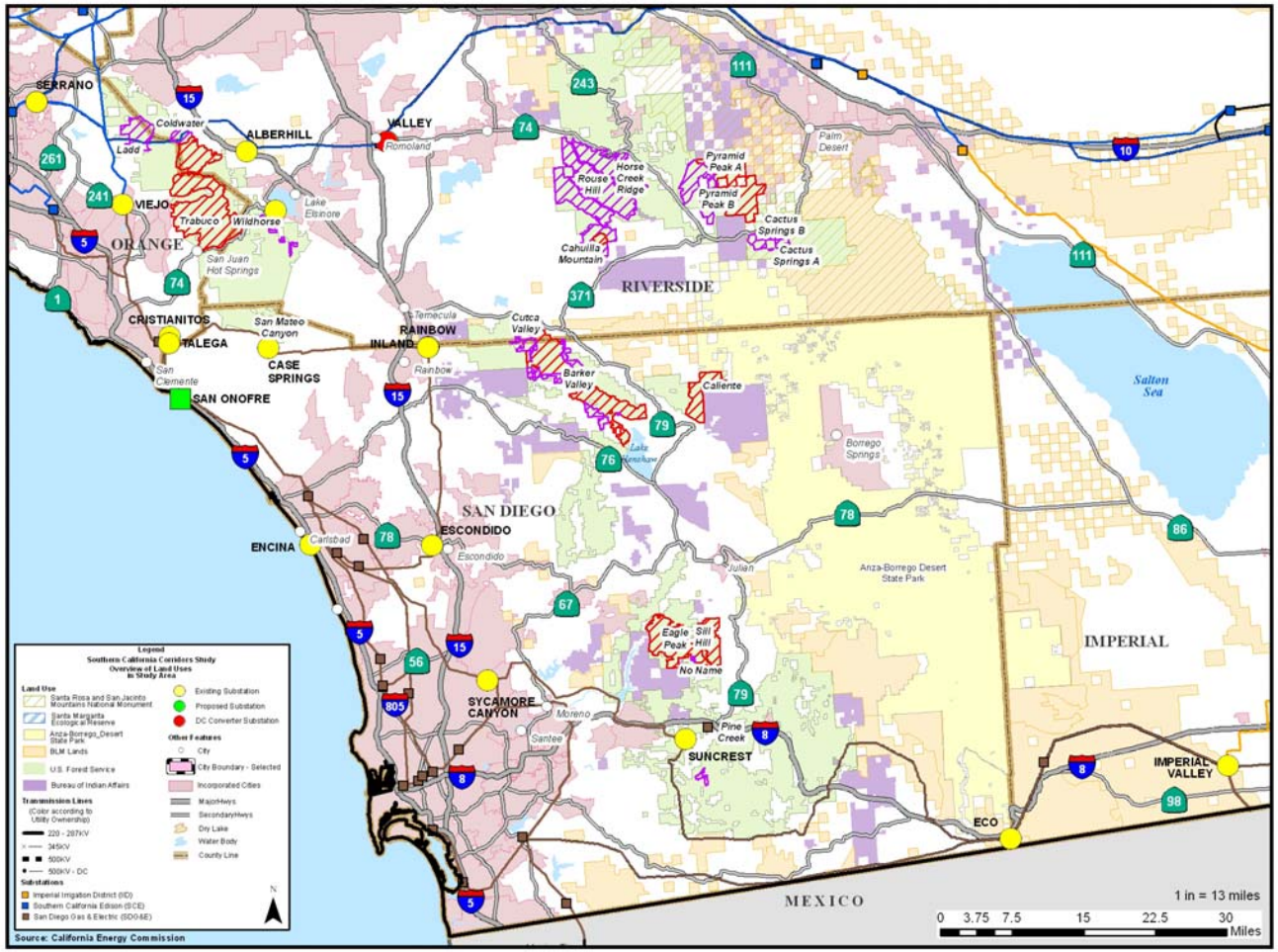
Source: CPUC and US BLM, 2008: http://www.cpuc.ca.gov/Environment/info/aspen/sunrise/toc-feir.htm

Figure 3: Alternatives Retained



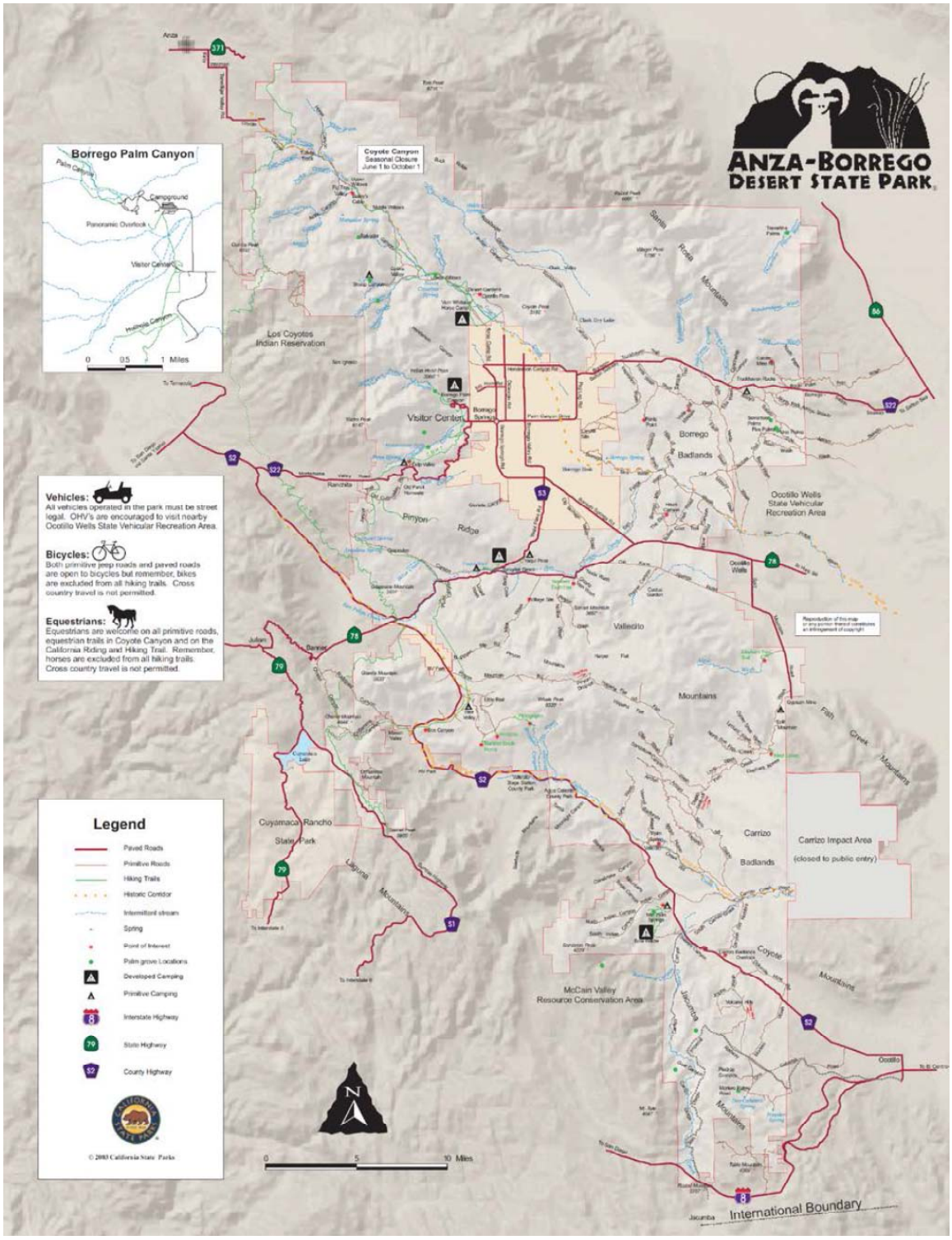
Source: CPUC and US BLM, 2008: http://www.cpuc.ca.gov/Environment/info/aspen/sunrise/toc-feir.htm

Figure 4: Overview of Land Uses in Study Area



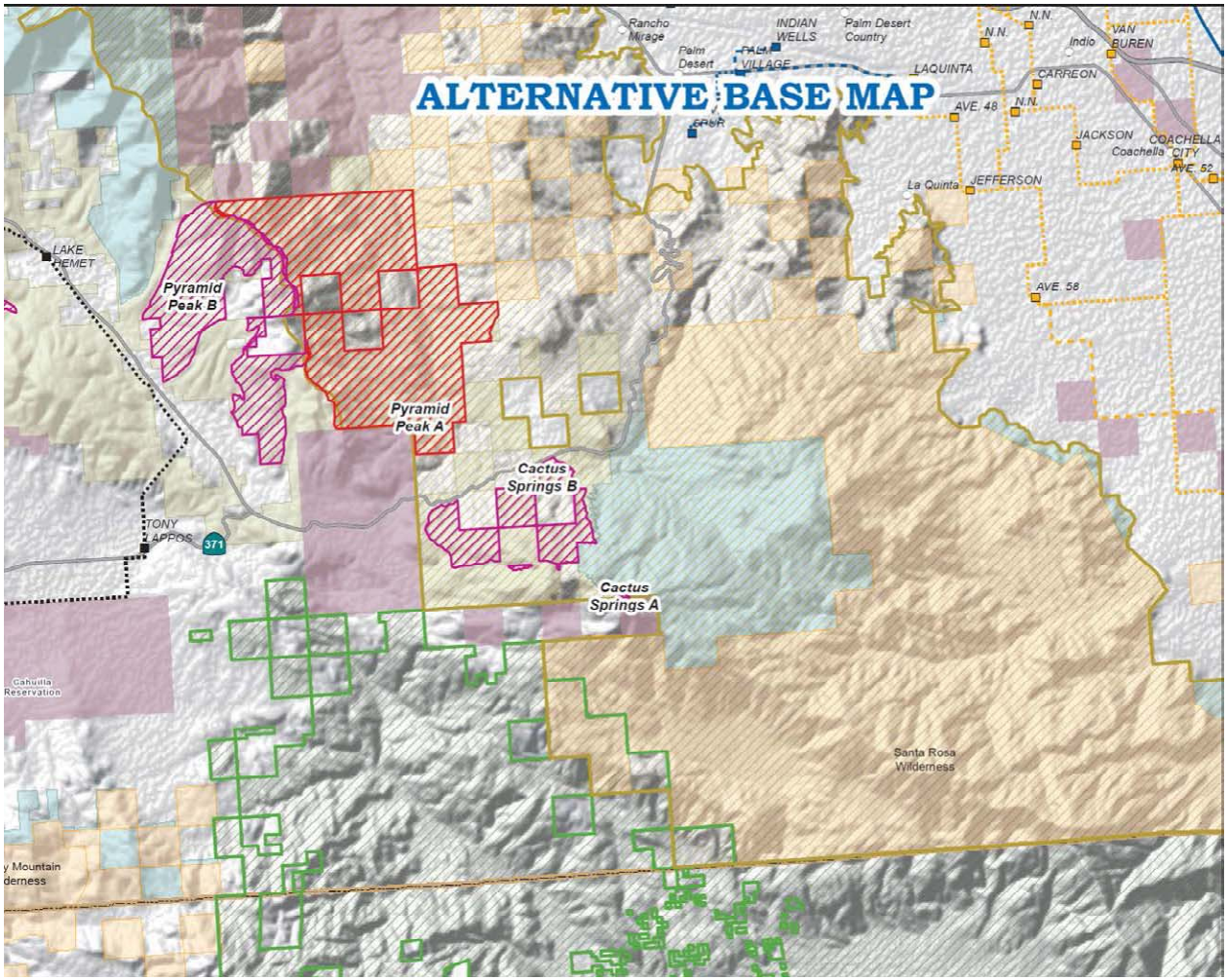
Source: California Energy Commission, 2014

Figure 5: Potential Transmission Line Crossings of Anza-Borrego Desert State Park



Source: California State Parks, 2014.

Figure 6: Santa Rosa-San Jacinto Mountains National Monument



Source: Aspen Environmental, 2014

CHAPTER 2:
Onshore Transmission Alternatives − Description of Potential Routes and Constraints

Chapter 1 of this report describes the siting challenges that exist in the study area. This chapter describes each of the onshore alternatives and summarizes the major constraints and land-use challenges for each route. Appendix A details the potential routes that were developed to allow assessment of routing constraints.

This chapter addresses onshore routes only; Alternative 1, the submarine HVDC alternative, is addressed in Chapters 3, 4, and 5. Additional technical information about HVDC lines is addressed in Section 3. This chapter is organized as follows:

- Overview of Alternative Corridors and Segments.
- Alternative 2, Alberhill to Suncrest.
- Alternative 3, Enhanced TE/VS (Forest Route).
- Alternative 4, Enhanced TE/VS (Talega-Serrano Route).
- Alternative 5, Imperial Valley to Inland (Overhead AC and Overhead/Underground DC).
- Alternative 6, Valley to Inland (Overhead AC or Underground DC).
- Alternative 7, Imperial Valley Expansion.
- Alternative 8, Mesa Substation Loop-In.

Overview of Onshore Alternative Corridors and Segments

The five onshore transmission routes (Alternatives 2 through 6) that are evaluated in this study have some transmission segments in common and also interconnect a variety of substations.

Table 2 shows the transmission segments that each alternative would use, and Table 3 shows the substations with which each alternative would interconnect. Figure 7 on page 61 is a map showing, in a schematic manner, all the substations and segments that would be affected by the onshore alternatives. All figures are presented at the end of Chapter 2.

Table 4 presents an overview of transmission line length and jurisdictions for each of the onshore alternatives. The first two rows present the length of each alternative; the length provided in the original route descriptions differs from the length of each route based on the routing defined in this report. The routes were not mapped in the original descriptions, so it is not possible to explain the differences between the original miles and those described and illustrated in this report.

Table 2: Transmission Segments for Onshore Alternatives					
	Alt 2 Alberhill to Suncrest	**Alt 3 TE/VS (Forest)**	**Alt 4 TE/VS (Talega–Serrano)**	**Alt 5 Imperial Valley–Inland**	**Alt 6 Valley–Inland**
500 kV – Alberhill to Warner	x				
500 kV – Alberhill to Case Springs		x			
500 kV – Talega to Case Springs to Inland		x			
500 kV – Inland to Warner		x	x		
500 kV – Warner to Suncrest	x	x	x		
500 kV – Serrano to Talega			x		
500 kV – Talega to Inland			x		
500 kV – Imperial Valley to Inland				x	
HVDC Option – Imperial Valley to Inland				x	
500 kV – Valley to Inland					x
HVDC Option – Valley to Inland					x
2 x 230 kV – Inland to Escondido (new double circuit)		x	x		
230 kV – Talega to Escondido (reconductor; upgrade to double circuit; loop into Inland Sub.)				x	x

Source: Aspen Environmental, 2014

Table 3: Substations by Alternative					
	Alt 2 Alberhill to Suncrest	**Alt 3 TE/VS (Forest)**	**Alt 4 TE/VS (Talega–Serrano)**	**Alt 5 Imperial Valley–Inland**	**Alt 6 Valley–Inland**
Alberhill (New 500/115 kV)	x	x			
Case Springs (New 500 kV)		x			
Inland (New 500 kV)		x	x	x	x
Suncrest (Existing 500/230 kV)	x	x	x		
Talega (Add 500 kV to 230/138 kV)		x	x		
Talega (Existing 230 kV)				x	x
Serrano (Existing 500/230 kV)			x		
Escondido (Existing 230 kV)		x	x	x	x
Imperial Valley (Add 500 kV or HVDC)				x	
Valley (Add 500 kV or HVDC)					x
San Onofre and Huntington Beach (Synchronous Condenser Sites)		x	x		
Japanese Mesa (SDG&E San Onofre Nuclear Generating Station (SONGS) Mesa 69 kV) (Phase Shifter Site)				x	x

Source: Aspen Environmental, 2014

Table 4: Routing Details and Land Jurisdiction by Alternative							
	Alt 2 Alberhill to Suncrest	**Alt 3 TE/VS (Forest)**	**Alt 4 TE/VS (Talega–Serrano)**	**Alt 5, 1A Imperial Valley–Inland (500 kV)**	**Alt 5, 1B Imperial Valley–Inland (HVDC)**	**Alt 6, 2A Valley–Inland (500 kV)**	**Alt 6, 2B Valley–Inland (HVDC)**
Length in Original Description Provided	65.0	137.2	n/a	145	145	35	35
Length of New 500 kV or HVDC based on potential routing presented in this report	105.3	138.6	142.4	140.0	142.2	40.0	30.0
Length of Underground Segment(s)	0	0	0	0	36.3	0	29.9
BLM Land	0.4	0.3	0.3	33.3	32.8	0	0
Forest Service Land	17.7	46.3	21.9	2.2	2.2	0	0
Military Land (Pendleton)	0	10.0	10.2	0	0	0	0

Table 4: Routing Details and Land Jurisdiction by Alternative							
	Alt 2 Alberhill to Suncrest	**Alt 3 TE/VS (Forest)**	**Alt 4 TE/VS (Talega–Serrano)**	**Alt 5, 1A Imperial Valley–Inland (500 kV)**	**Alt 5, 1B Imperial Valley–Inland (HVDC)**	**Alt 6, 2A Valley–Inland (500 kV)**	**Alt 6, 2B Valley–Inland (HVDC)**
State Lands Commission	0.8	2.0	2.0	0.7	5.1	0	0
State Parks	0	0	0	19.6	19.9	0	0
Tribal Land	0	3.6	3.6	3.6	3.6	0	0
Unincorporated County	61.5	76.0	88.8	80.6	78.2	32.0	11.2
Incorporated City	24.7	0	15.2	0	0	6.5	18.7

Source: Aspen Environmental, 2014

Alternative 2: Alberhill to Suncrest

ALTERNATIVE 2 DESCRIPTION
SCE Alberhill – SDG&E Suncrest 500 kV

- Construct 105 miles of new 500 kV line (70 percent compensation) from SCE's Alberhill to SDG&E's existing Suncrest substation. Alberhill Substation is located between SCE's existing Valley and Serrano Substations, at the northwest corner of the intersection of Temescal Canyon Road and Concordia Ranch Road in unincorporated western Riverside County. This substation is expected to be in service in 2015.
- Convert either one of San Onofre generating units to 700 MVAR synchronous condensers or install one new 700 million volt-amperes (MVAR) static reactive volt-amperes (VAR) compensator (SVC) to be connected to San Onofre 230 kV switchyard.

Note: The original description of Alternative 2 estimated 65 miles for new 500 kV line, but there are about 80 miles between Alberhill and Suncrest Substations as the crow flies. The 105-mile-long potential route defined in this report follows existing transmission line ROWs and highways.

In terms of evaluating potential routing constraints, the most significant component of this alternative is the following:

- New 500 kV transmission line from SCE's proposed Alberhill Substation in Riverside County to SDG&E's Suncrest Substation in San Diego County.

The San Onofre Substation components described above have no major siting or permitting challenges, so they are not addressed in this report.

Alternative 2 Routing Summary

Appendix A presents details on the potential route for each alternative, including a description of the route itself and the land uses along the route. This section presents a brief overview of the route as background for the discussion of routing constraints.

There are few options for a potentially feasible 500 kV overhead high-voltage line between Alberhill and Suncrest Substations. Figure 8 illustrates the general route defined for this study; this potential route would face likely insurmountable obstacles in the first and third segments defined below.

- Riverside County segment: Alberhill through Temecula. Densely developed with homes and commercial buildings.
- North San Diego County segment: Following Highways 76 or 79. Low density of homes, but requires passing through USFS or tribal land and scenic inland North County.
- South San Diego County segment: Into Suncrest Substation from the north. USFS land with restricted land-use designations. West of Suncrest the density of residential development is too high for a 500 kV line to be installed.

Alternative 2 consists of a single-circuit 500 kV overhead transmission line between SCE's proposed Alberhill Substation, near Interstate 15 in Riverside County, and SDG&E's existing Suncrest Substation, south of Interstate 8 in San Diego County. The line would require acquisition of new ROWs along nearly the entire route and would not interconnect with other substations between Alberhill and Suncrest.

As shown in Figure 8 on page 62, the route would begin at the SCE Alberhill Substation site, just east of the city of Lake Elsinore and near I-15. For this potential route, the 500 kV transmission line would follow the Caltrans I-15 freeway corridor south for roughly 24.5 miles into Temecula. It would then turn east to follow Highway 79 for about 38 miles to near Warner Springs in San Diego County. Then the route would turn south, staying west of Highway 79 for 15 miles to Santa Ysabel, where it would turn southeast and parallel Highway 78 (Julian Road) for approximately 3.5 miles before turning south into the CNF for approximately 12 miles, crossing I-8 and terminating at Suncrest Substation east of the community of Alpine.

Much of this overhead route would be easier to site assuming use of tubular steel poles (TSPs) rather than lattice towers. As described in Appendix C (Right-of-Way Requirements), the narrower base of the TSPs allows construction in a more constrained space.

Alternative 2 Constraints

The major constraints on the Alternative 2 route are those listed below. Each issue is described in more detail in the following paragraphs.

1. Dense development in Temecula.
2. Longitudinal encroachment within Caltrans I-15 ROW.

3. U.S. Forest Service lands with restricted land-use designations.

4. Scenic and low-density residential areas in northern San Diego County.

5. Glider and small aircraft airport near Warner Springs.

Constraint 1: Routing through Temecula

The strong opposition of Temecula residents to the SDG&E proposed Valley-Rainbow 500 kV line was instrumental to the ultimate failure of that project, which was cancelled after CPUC analysis of alternatives in 2002. Between 2000 and 2010, the Temecula population increased from about 58,000 to more than 100,000. The city is densely populated east of I-15, and the development of a viable overhead high-voltage route through the city is unlikely.

The two possible options for routing a 500 kV line through Temecula would be to follow the edge of the Temecula River or to follow Highway 79 (Temecula Parkway). It would likely be very challenging to find adequate ROW for an overhead route for either option. An underground route along Temecula Parkway may be feasible (as is being demonstrated in Chino Hills for the TRTP), but the high cost and disturbance required for installation of a 500 kV AC line underground should make that technology a last resort for very unusual situations. Appendix C addresses ROW requirements for overhead and underground high-voltage transmission lines.

Constraint 2: Use of I-15 Caltrans ROW

There are two possible north-south transmission options between the general areas of the Alberhill and Inland Substations. Alternative 3 considers a route from Alberhill to Suncrest that does not affect the Caltrans ROW, following the proposed TE/VS (Lake Elsinore Advanced Pumped Storage Project) transmission route along the eastern edge of the CNF. The route presented for Alternative 2 through this part of Riverside County would use the space remaining in the I-15 Caltrans ROW. Appendix D presents the Caltrans regulations; relevant sections are excerpted in Table 5 (California Department of Transportation, 2013). The regulations explain that exceptions to the prohibition of utility installations within controlled-access roadways can be made only where it is "impossible or unreasonably costly to locate utilities outside of the controlled right of way." Exceptions for encroachments on freeway ROWs must be submitted to the Division Chief of the Division of Design, who has decision-making authority. While overhead transmission and distribution lines commonly cross Caltrans ROWs around the state, no longitudinal encroachments have been approved.

Table 5: Caltrans Regulations: New Utility Longitudinal Encroachments
With the exception of special cases permitted under strictly controlled conditions, **new utilities will *not* be permitted to be installed longitudinally within the access control lines of any freeway or expressway**—including installations on structures that cross major valleys or rivers and installations through tunnels. Utilities will not be allowed to be installed longitudinally within the median area. Utilities that transport hazardous materials will not be allowed in a vehicular tunnel under any circumstances. These provisions were established to provide for the maximum degree of safety and to preserve the traffic-carrying capacity, both of which are warranted by the large public fund investment in freeways. **Exceptions can be made at locations where circumstances make it impossible or unreasonably costly to locate utilities outside of the access controlled right of way.** To the extent feasible and practicable, any utility installations allowed within access controlled rights of way should be located so that they can be serviced and maintained from outside the right of way. [**emphasis** added]
Source: California Department of Transportation, Project Development Procedures Manual, 06/21/2013, http://www.dot.ca.gov/hq/oppd/pdpm/chap_pdf/chapt17.pdf

As part of the CPUC's assessment of the TE/VS Project, a preliminary assessment of use of the I-15 corridor as a transmission route was prepared by Commonwealth Associates (Commonwealth Associates Inc., 2002). The review determined that it was feasible to install a 230 kV circuit in the I-15 corridor entirely on Caltrans ROW. Constraints were identified near some residential and commercial areas that would require taller poles and restrained insulators.

A cursory review of a 500 kV option also was performed. Commonwealth concluded that due to the required support structures and ROW width, it was unlikely that a 500 kV line could be constructed along this corridor. Ideal ROW widths for 500 kV lines are in the range of 160 feet or more, and Commonwealth concluded that the I-15 corridor could not accommodate traditional construction of this type of ROW. However, this study assumed that the line would be exclusively in the Caltrans ROW. No evaluation was made of whether a 500 kV line would be feasible using a combination of Caltrans ROW and adjacent properties. Based on a review of aerial photography, potential routes through the general area using both Caltrans ROW and other properties may exist. In this case, the route would be on or adjacent to Caltrans ROW in largely undeveloped areas and would diverge from the freeway into undeveloped mountainous terrain to skirt developed areas.

While it may be technically feasible to use a combination of Caltrans ROW and other properties in the I-15 corridor for construction of a 500 kV line, it is unknown whether or under what conditions Caltrans would permit installation of structures in its ROW.

Constraint 3: Crossing CNF Lands With Restricted Land-Use Designations

The southernmost segment of this alternative would have to pass through the CNF Palomar Ranger District and cross the San Diego River. The route would pass through the No Name roadless area, crossing into the CNF Descanso Ranger District. The CNF has proposed to convert the "Inventoried Roadless Areas" to "Proposed Wilderness" and to designate additional land along the San Diego River canyon as wilderness. A Draft Record of Decision presenting the Forest Service's preliminary decision on this action was issued in January 2014 but until it is signed the "Inventoried Roadless Areas" designation remains in place. The proposed installation of a high-voltage transmission line through these land designations would almost certainly be prohibited by the CNF.

Constraint 4: Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County

The inland valleys of southern Riverside and northern San Diego Counties are generally open landscapes characterized by grazing, agriculture, and scattered homes. There are many large areas of tribal land in the region, and while the potential route for Alternative 2 does not pass through tribal lands, there would be concerns about effects on Native American resources and values.

Constraint 5: Small Airport Near Warner Springs

A landing strip used by small aircraft and gliders is located west of Warner Springs next to the highway. Continued use of the landing strip would be threatened by an adjacent 500 kV transmission line. There is extensive open space on Vista Irrigation District land that could accommodate a ROW reroute to address this issue and avoid going through Warner Springs.

Alternative 3: Enhanced TE/VS (Forest Route)

ALTERNATIVE 3
Enhanced Talega-Escondido/Valley-Serrano (TE/VS) 500 kV Transmission, Option 1 (Forest Route)

- Construct 30.3 miles of new 500 kV line from SCE's Alberhill Substation to new Case Springs Substation (located south of new Lake Elsinore Advanced Pumped Storage [LEAPS] Substation).
- Construct 12.4 miles of 500 kV line from new Case Springs Substation to SDG&E's Talega Substation.
- Construct 17.6 miles of new 500 kV line from new Case Springs Substation to new Inland 500 kV Substation in northern San Diego County.
- Construct 66.7 miles of new 500 kV line from new Inland Substation to SDG&E existing Suncrest Substation; this line will be 70 percent compensated (in other words, series caps are needed).
- Total new 500 kV line is 127.0 miles long.

Upgrades:

- Upgrade the existing Talega Substation from 230/138 kV to 500/230/138 kV.
- Construct 21.7 miles of two new 230 kV lines (double-circuit tower line) from new Inland to SDG&E's existing Escondido Substation.
- Reconfigure the existing San Onofre–Santiago (2) 230 kV lines, San Onofre–Serrano 230 kV, San Onofre–Viejo 230 kV to have these become Talega-Santiago (2), Talega-Serrano (1), Talega-Viejo (1) 230 kV lines. The other existing lines terminating at Talega are Talega–San Onofre (3) and Talega-Tap-Capistrano 230 kV lines.
- Convert either one of San Onofre generating units to 700 MVAR synchronous condensers or install one 700 MVAR SVC to be connected to San Onofre 230 kV switchyard.
- Retain Huntington Beach Units 3 and 4 as synchronous condensers in the event that AES does not have PPA or other means of financing to proceed with repowering of these units.
- Convert HB Units 1 and 2 to synchronous condensers in the event that AES does not have PPA or other means of financing to proceed with repowering of these units.

In terms of evaluating potential constraints, the most significant components of this alternative are:

- New 500 kV transmission line 127 miles long, from SCE's proposed Alberhill Substation in Riverside County to SDG&E's Suncrest Substation in San Diego County (via Lake Elsinore Advanced Pump Storage [LEAPS], Case Springs, Inland Substations).

- Expansion of Talega Substation from 230/138 kV to 500/230/138 kV.

- New 500 kV transmission line connecting new Case Springs Substation to SDG&E's Talega Substation.

- Addition of a second 230 kV circuit to existing Talega to Escondido 230 kV towers (only between Inland and Escondido).

The constraints associated with the first three items listed above are presented in this section. The existing Talega-Escondido 230 kV transmission line heads east from Talega, then turns south to reach Escondido. At that turn, a proposed new Inland Substation is shown on the maps. The existing Talega-Escondido 230 kV line has a vacant position for a second 230 kV circuit between the proposed Inland Substation and Escondido. No environmental or permitting constraints have been identified for this potential upgrade given that the poles already exist and only the conductors and insulators would need to be added. The other components described above have no major siting or permitting challenges, so are not addressed in this report.

Alternative 3 Routing Summary

Appendix A presents details on the potential route for each alternative, including a description of the route itself and the land uses along the route. This section presents a brief overview of the route as background for the discussion of routing constraints.

Figure 9 illustrates the potential route for Alternative 3. Overall, a 500 kV route from Alberhill Substation through CNF to Inland Substation would be roughly 60 miles long. From Alberhill Substation, the new 500 kV line would extend about 32 miles to a new Case Springs Substation and then an additional 18 miles to Inland Substation. A 500 kV line would extend west from Case Springs for about 14 miles to Talega Substation. From Inland Substation, the 500 kV line would continue south to near Lilac Substation, then head east to Warners Substation before heading south to Suncrest Substation. In addition, two new 230 kV lines would be installed in the ROW between Inland and Escondido Substations

This alternative suggests a 500 kV interconnection between SCE's 500 kV Valley-Serrano line and SDG&E's 230 kV Talega-Escondido ROW, following the route proposed by The Nevada Hydro Company as part of its LEAPS Project (The Nevada Hydro Company, 2011; Federal Energy Regulatory Commission, 2007). Because the 500 kV line would connect the Talega-Escondido line with the Valley-Serrano line, the interconnection was referred to as the "TE/VS" project. The TE/VS interconnect was proposed to extend from SCE's Valley-Serrano transmission line by way of a new switchyard near I-15 at Corona (Lee) Lake, about 2 miles northwest of SCE's Alberhill Substation site, to a 500/230 kV Case Springs Substation, where it would loop in SDG&E's existing Talega-Escondido 230 kV line. It is assumed that the Alternative 3 alignment would begin at Alberhill Substation, extend north along I-15, then follow the TE/VS alignment. Currently, there is no active application before the CPUC for the TE/VS project.

This potential alternative follows Highway 76, based on SDG&E's suggestion of this route as part of a potential "500 kV Full Loop" during the Sunrise Powerlink EIR/EIS process. However, Highway 76 passes through the Rincon and La Jolla reservations, which would be avoided by following Highway 79 to the north. The alternative route, Highway 79, passes through central Temecula, as described for Alternative 2. Both routes face serious challenges.

The 500 kV project segments would include the following segments:

- New ROW using the TE/VS route from Alberhill to Case Springs.
- New 500 kV adjacent to the existing Talega-Escondido ROW from Case Springs west to Talega.
- New 500 kV from Case Springs east to Inland.
- South from Inland Substation to Lilac. The 500 kV circuit would share the same ROW as the existing single circuit 230 kV Talega-Escondido line and the new double circuit 230 kV Inland-Escondido line.
- The remainder of the unincorporated San Diego County route in the new ROW.

The 230 kV upgrade segments of the Talega-Escondido line would be developed in various line configurations:

- The two new 230 kV circuits could be developed as a new double-circuit line, adjacent to the existing Talega-Escondido line.
- One new circuit could be added to the existing 230 kV Talega-Escondido line on the vacant side and a new single-circuit 230 kV line be added in the ROW.
- One new circuit could be added to the existing 230 kV towers, and the second new circuit could be installed on new towers that also carry the new 500 kV circuit.
- Depending on design considerations, the existing 69 kV circuit between Pala and Lilac Substations could remain on the spare position on the original 230 kV towers, be installed on the same towers (as an "underbuild"), or be moved to separate poles.

Alternative 3 Constraints

The major constraints on the Alternative 3 route are those listed below. Each constraint is described in more detail in the following paragraphs, except where they are described for Alternative 2 (in that case, the discussion in Chapter 2, "Alternative 2 Constraints" is referenced).

1. ROW across La Jolla reservation
2. Expansion of Talega Substation

3. TE/VS route through CNF Trabuco Ranger District; CNF concerns
4. Expansion of ROW through Camp Pendleton
5. Crossing CNF lands with restricted land-use designations
6. Scenic and low-density residential areas in northern San Diego County
7. Expansion of ROW through Santa Margarita Ecological Reserve

Constraint 1: ROW Across La Jolla Reservation

Because tribes are independent of the federal or state governments, their land is not subject to eminent domain, and transmission lines must be sited with full agreement of the tribal government and members. For this reason, transmission line siting normally avoids all tribal land. However, Alternative 3 would cross tribal lands because:

- SDG&E has existing ROWs for 69 kV line across the La Jolla reservation, and SDG&E defined this as a potential route for its "500 kV Full Loop" in the Sunrise Powerlink evaluation process.

Constraint 2: Expansion of Talega Substation

Alternative 3 would require expansion of the Talega Substation to allow the addition of a 500 kV interconnection. This substation is located between San Clemente and Camp Pendleton. Portions of the substation are within Marine Corps boundaries, and expansion would require Marine Corps approval. The substation upgrades would enlarge the substation footprint to accommodate additional circuits and equipment. The substation may double in size to accommodate these changes, although its size might be reduced through the use of gas-insulated rather than air-insulated equipment. The design and construction of the line configurations would require coordinated planning and cooperative use of the adjacent ROWs by SCE and SDG&E. Additional land for ROW and substation expansion would be on either private property or at Camp Pendleton.

The land needed for additional ROW and an enlarged substation is on a corner of Camp Pendleton as well as on private land. Use of additional Camp Pendleton land would require an agreement with the Department of the Navy. Roughly half of the substation is on Camp Pendleton property, with the rest extending north into Orange County. Immediately north of the substation is San Clemente and unincorporated Orange County. San Onofre State Park is south of the substation on land leased by the state from Camp Pendleton through 2021. The park extends from the substation south along the county line to Interstate 5 (I-5).

Figure 10 on page 64 presents the topography and an aerial photo of the substation. It appears to be located on the top of a graded hill, with downward slopes to the east, west, and south. Expansion of the substation boundaries does not appear to be feasible without major grading and earth moving.

One option to consider is the expansion of the Cristianitos Substation, located about 3,500 feet north of Talega. This small substation is not adjacent to Camp Pendleton and is sited on more level topography. If the 500 kV system could use this substation as its point of interconnection, this appears to be a more feasible site. Cristianitos Substation is in unincorporated Orange County, east of Cristianitos Canyon Creek. The land immediately adjacent to this substation is vacant in all directions. Conceivably, the Cristianitos Substation could be expanded and replace Talega Substation or be integrated electrically with Talega, with rerouted lines.

It would be necessary to develop an agreement between SCE and SDG&E on how to configure the lines in and out of the Talega Substation and enlarge and configure the substation to meet their respective needs. SDG&E likely would need to underground its 69 kV line and to allow use of 10 to 20 feet of its ROW width to accommodate the 500/230 line.

Constraint 3: TE/VS Route Through CNF Trabuco Ranger District; CNF Concerns

The Federal Energy Regulatory Commission (FERC) published a final EIS in 2007 that evaluated the TE/VS route through the CNF, and the CNF issued a record of decision approving the project. However, this decision and the EIS are now more than 6 years old, and they may no longer be valid. If a new impact analysis is required for the CNF, the assessment would be much more rigorous, given the Forest Service processes that have been implemented since 2007. It is not certain that the prior approval for this route segment would be granted in 2014.

CNF's Trabuco Ranger District has a history of serious wildfires. Fires can be started during major construction, and high-voltage lines can create hazards to firefighters. The Forest Service has indicated a concern about fire risk related to this line segment. In addition, this segment has habitat for a number of biological species of concern.

Constraint 4: Expansion of ROW Through Camp Pendleton

The new 500 kV line following the existing Talega-Escondido corridor between Case Springs and Talega would be on land owned by Camp Pendleton. The undeveloped land in the vicinity of the ROW is used for military training and exercises but is largely undisturbed. An agreement between the Navy and SDG&E provides for use of the ROW and a portion of the Talega Substation site. The current easement document would require an amendment by the parties to expand the ROW. Concerns may arise regarding to the height and location of towers and spans relative to existing towers and spans, and the risk they may pose to military aircraft. The existing ROW grant would have to be examined to determine if a line larger than 230 kV is allowed, and if taller towers would be permitted. Additional concerns would relate to the potential for igniting a fire and for impacts on firefighting. The landscape along much of the ROW is undisturbed and has the potential to provide habitat for various special status species.

The existing ROW may not be sufficiently wide to support both the existing 230 kV and a new separate 500 kV line. If additional ROW is needed, this would have to be negotiated with the Navy.

In a preliminary rights analysis, SCE concluded that the language in its agreement allowing a ROW through Camp Pendleton "does not allow additional towers or additional lines in the existing ROW. Construction of a new 500 kV line would require an amendment or new

easement document. Even with an amendment to allow construction of a new tower, [the] current ROW is not large enough for both the existing 230 kV lines and a new 500 kV line and would require expansion."

Constraint 5: Crossing CNF Lands With Restricted Land-Use Designations

See discussion of Constraint 3 in the discussion of Alternative 2, "Use of I-15 Caltrans ROW."

Constraint 6: Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County

See discussion of Constraint 4 in Alternative 2, "Scenic and dispersed residential areas and tribal concerns in northern San Diego County."

Constraint 7: Expansion of ROW Through Santa Margarita Ecological Reserve

The Case Springs-to-Inland segment may require additional ROW. Construction of the Case Springs Substation would be constrained by terrain and by access road requirements, potentially affecting Camp Pendleton or an ecological reserve. This segment passes through the Santa Margarita Ecological Reserve, most of which is in Riverside County north of the ROW. However, south of the county line, parts of the existing Talega-Escondido ROW near the Santa Margarita River fall within the Reserve boundary. Adding a new 500 kV line between Case Springs and Inland likely would require mitigation for affected special status species.

Alternative 4: Enhanced TE/VS (Talega-Serrano Route)

ALTERNATIVE 4
Enhanced TE/VS 500 kV Transmission , Option 2 (Talega-Serrano Route)

- Convert the existing Serrano–San Onofre 230 kV and Talega-Serrano 230 kV line to 500 kV line to terminate at Talega substation.
- Construct 17.6 miles of new 500 kV line from new Case Springs Substation to new Inland 500 kV Substation in northern San Diego County.
- Construct 12.4 miles of new 500 kV line from Case Springs Substation to Talega Substation on Camp Pendleton lands.
- Construct 66.7 miles of new 500 kV line from new Inland Substation to SDG&E existing Suncrest Substation; this line will be 70 percent compensated (that is, series caps are needed).
- Total new 500 kV line would be 130.8 miles long.

System Upgrades:

- Upgrade the existing Talega Substation from 230/138 kV to 500/230/138 kV.
- Construct 21.4 miles of two new 230 kV lines (double-circuit tower line) from new Inland to SDG&E's existing Escondido Substation.
- Reconfigure the existing San Onofre-Santiago (2) 230 kV lines, San Onofre-Viejo 230 kV to have these become Talega-Santiago (2), Talega-Viejo (1) 230 kV lines. The other existing lines terminating at Talega are Talega-San Onofre (3), and Talega-Capistrano 230 kV lines.
- Convert either one of San Onofre generating units to 700 MVAR synchronous condensers or install one 700 MVAR SVC to be connected to San Onofre 230 kV switchyard.
- Retain Huntington Beach Units 3 and 4 as synchronous condensers in the event that AES does not have a PPA or other means of financing to proceed with repowering of these units.
- Convert HB Units 1 and 2 to synchronous condensers in the event that AES does not have PPA or other means of financing to proceed with repowering of these units.

In terms of evaluating potential constraints, the most significant components of this alternative are:

- Conversion of the Serrano–San Onofre and San Onofre–Talega 230 kV lines to 500 kV in existing SCE ROW (The corridor between Talega and Serrano does not include an existing circuit directly between these two endpoints).

- New 500 kV transmission line connecting Talega to SDG&E's Suncrest Substation (via Case Springs site and Inland Substation).

- Expansion of Talega Substation from 230/138 kV to 500/230/138 kV.

The other components described above have no major siting or permitting challenges, so are not addressed in this report.

Alternative 4 Routing Summary

Appendix A presents details on the potential route for each alternative, including a description of the route itself and the land uses along the route. This section presents a brief overview of the route, as background for the discussion of routing constraints.

Alternative 4 is illustrated in Figure 11 on page 65 and includes 140 miles of new 500 kV transmission line. The route east and south of the Case Springs location is the same as that of Alternative 3, so is not described here. The unique portion of this route is the conversion of two existing transmission circuits (Serrano–San Onofre and San Onofre–Talega) to a new 500 kV line, terminating at Talega substation. The existing ROW between Talega and Serrano passes through the densely developed cities of San Clemente and Mission Viejo for about 5 and10 miles, respectively, before turning into the hills.

Alternative 4 Constraints

The major constraints on the Alternative 4 route are those listed below. Each constraint is described in more detail in the following paragraphs.

1. ROW across La Jolla reservation
2. Expansion of facilities in existing ROW through Mission Viejo and other cities; transmission congestion north and west of Talega Substation
3. New ROW to accommodate 500 kV and 220 kV lines terminating in Talega
4. Expansion of Talega Substation
5. Expansion of ROW through Camp Pendleton
6. Crossing CNF lands with restricted land-use designations
7. Scenic and low-density residential areas in northern San Diego County
8. Expansion of ROW through Santa Margarita Ecological Reserve

Constraint 1: ROW Across La Jolla Reservation

See discussion of Constraint 1 in Alternative 3, "ROW Across La Jolla Reservation."

Constraint 2: Expansion of Facilities in Existing ROW Through Mission Viejo and Other Cities; Transmission Congestion North and West of Talega Substation

Figure 12 on page 66 illustrates two areas of very dense residential neighborhoods through which the Talega-Serrano corridor passes. In all, four additional circuits would terminate at Talega Substation: one 500 kV and three 220 kV circuits. The existing SCE Serrano–San Onofre single-circuit 220 kV line would be replaced with a single-circuit 500 kV line between Serrano and Talega. For much of its length, the 220 kV line shares towers with SCE's 220 kV Chino-

Viejo–San Onofre line. The replacement 500 kV circuit and the Chino-Viejo–San Onofre 220 kV circuit would be accommodated on new towers built to accommodate the two lines, and the existing 220 kV towers would be removed.

Except in the immediate vicinity of the Serrano Substation, for about 17 miles east and south from the substation, much of the ROW is in open land through the Irvine Ranch Conservancy. Most of this area is designated as part of the National Natural Landmarks program. This designation is by way of voluntary agreements with the landowner(s). The existing ROW predates the designation, and the program does not appear to pose any restrictions on upgrading the existing 220 kV structures to 500/220 kV structures in the ROW.

SCE conducted a preliminary rights analysis and concluded, "The northern portion of this corridor passes through both the Irvine Ranch as well as the Cleveland National Forest. The results of a preliminary rights analysis highlighted several places along the corridor where the existing rights would be insufficient as they contain language which does not allow additional towers or circuits. These areas would require newly negotiated agreements to install or upgrade facilities."

At Mission Viejo and in the cities to the south, the ROW is used extensively for active and passive recreation and parking. Compatible uses such as ball fields, trails, parking, nurseries, and landscaping often are colocated with transmission ROWs in developed areas. New towers for the 500/220 kV circuits would be larger than the existing towers that would be removed, creating a visual impact to facility users and neighboring properties. Depending on tower spacing, reconfiguration of other uses in the ROW might be required. It its preliminary rights analysis, SCE concluded that, "The central portion of this corridor passes within less than 150 feet from numerous residential communities for several miles. Although the corridor is 200 feet wide, installation of a double circuit 500 kV tower would be significantly taller than the existing 230 kV tower and have visual impact to the residents of this area. Successful construction of underground through this area would be unlikely due to the outage requirements for the 230 kV lines which pass overhead. These facilities would need to be de-energized and temporary structures constructed in order to maintain service during the construction. Where the corridor joins with the additional 230 kV lines coming from Santiago, the ROW is not large enough for both the existing 230 kV lines and a new 500 kV line and would require expansion."

From San Juan Hills High School to Talega Substation, SCE and SDG&E have abutting ROWS. SCE's Serrano–San Onofre ROW is on the south side of the corridor, and SDG&E's ROW between Talega Substation and the utility's southern Orange County service area is on the north side. Each ROW is about 200 feet wide.

As part of its ongoing South Orange County Reliability Enhancement (SOCRE) Project, SDG&E proposes replacing a single-circuit 138 kV line in the ROW with 7.5 miles of double-circuit 230 kV line. If the existing SDG&E 69 kV circuit were placed underground, it appears that there would be sufficient corridor width to accommodate the replacement SCE 500/220 kV line.

Constraint 3: New ROW to Accommodate 500 kV and 220 kV Lines Terminating in Talega

Terminating the two San Onofre–Santiago 220 kV circuits, the San Onofre–Viejo-Chino 220 kV circuit, and the new 500 kV circuit at Talega Substation would require inserting four new circuits into the congested area immediately west of the substation and accommodating them in the substation as well.

Based on the current width of the ROWs here and the SOCRE Project, additional ROW would be needed for the addition of four SCE lines to terminate at the substation. There is vacant land both south and north of the existing corridor that could accommodate the ROW expansion. Given the variety of line crossings west of the substation, it is likely the four new terminating lines would be on the north side of the ROW in Orange County.

Constraint 4: Expansion of Talega Substation

See discussion of Constraint 2 in Alternative 3, "Expansion of Talega Substation."

Constraint 5: Expansion of ROW Through Camp Pendleton

See discussion of Constraint 4 in Alternative 3, "Expansion of ROW Through Camp Pendleton."

Constraint 6: Crossing CNF Lands With Restricted Land-Use Designations

See discussion of Constraint 5 in Alternative 3, "Crossing CNF Lands With Restricted Land-Use Designations."

Constraint 7: Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County

See discussion of Constraint 6 in Alternative 3, "Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County."

Constraint 8: Expansion of ROW Through Santa Margarita Ecological Reserve

See discussion of Constraint 7 in Alternative 3, "Expansion of ROW Through Santa Margarita Ecological Reserve."

Alternative 5: Imperial Valley to Inland (AC or HVDC)

ALTERNATIVE 5
San Diego High-Voltage Transmission Options 1A and 1B

Imperial Valley to Inland – Option 1A (500 kV AC)

- New proposed 500 kV AC transmission line between the existing SDG&E Imperial Valley Substation and the new SDG&E Inland Substation within northern San Diego County. This alternative is proposed as an overhead line that would be nearly 140 miles in length.
- In addition to the new transmission line, the new 500/230 kV Inland Substation would be constructed at a new north inland location, as well as the upgrade/construction of a 500/230 kV substation at the existing Imperial Valley Substation.
- The proposed option may include provisions for the installation of two 500 MVA +/- 45° phase shifters at the new SONGS Mesa 230 kV Substation (that is, expand the existing Japanese Mesa Substation) to optimize network flow through the San Diego transmission system and into the Los Angeles load center.

Imperial Valley to Inland – Option 1B (HVDC)

- New proposed HVDC transmission line between the existing SDG&E Imperial Valley Substation and the new SDG&E Inland Substation within northern San Diego County. This alternative is proposed as an overhead and underground line that would be roughly 142.2 miles in length, with an underground segment of 36.3 miles.
- In addition to the new transmission line, the new Inland Substation would be constructed at a new north inland location as well as the installation of DC converter stations at this new substation and the existing SDG&E Imperial Valley Substation. This project will include provisions for integrating the proposed DC terminal at Imperial Valley with a DC flow control device to improve network flow across the ISO, IID, and CFE transmission systems.

System Upgrades for Both Options 1A and 1B

- Reconductor Escondido-Talega transmission line (TL 23030) to a minimum rating of 1175/1175 MVA normal/emergency and loop-in to the new Inland Substation. Construct a new 230 kV transmission line on the vacant side of the existing tower line supporting TL 23030 between Escondido and Talega Substations and loop-in to the new Inland Substation.

This alternative is described in two parts. The first section below presents Imperial Valley to Inland, Option 1A (500 kV AC), and the second section presents Option 1B (HVDC, overhead and underground). For each option, the major component addressed is the proposed new transmission line between the Imperial Valley Substation (Imperial County) and the new Inland Substation (northern San Diego County).

Appendix A presents details on the potential route for each alternative, including a description of the route itself and the land uses along the route. This section presents a brief overview of the route, as background for the discussion of routing constraints.

Imperial Valley to Inland, Option 1A (500 kV)

Figure 13, Alternative 5, on page 67 illustrates a potential route for this 500 kV line. The potential route is assumed to be all overhead. It follows much of the originally proposed 500 kV Sunrise Powerlink Transmission Project, combined with the SDG&E "500 kV Full Loop" proposed during the Sunrise proceeding. This route is not considered likely to be feasibly permitted, as described in the section below on constraints. However, it is described briefly here to illustrate the challenges of crossing ABDSP.

Imperial Valley to Inland, Option 1A: Routing Summary

In Chapter 1, the section "Anza-Borrego Desert State Park" describes three possible routes for crossing ABDSP. This alternative follows the existing 69/92 kV transmission lines through the park. Starting from the Imperial Valley Substation, the route follows the originally proposed Sunrise Powerlink route north through Imperial County, then west along Highway 78 into ABDSP.

Upon leaving the park at its western boundary, the potential route would diverge from the Sunrise route and instead would follow the Highway 76 route defined by SDG&E's "500 kV Full Loop." This route segment in northern San Diego County is common with that described for Alternatives 3 and 4. When the route meets the Talega-Escondido corridor (just north of the Lilac Substation), the 500 kV line would turn north and parallel the Talega-Escondido line (in new ROW) to the Inland Substation.

Imperial Valley to Inland, Option 1A: Constraints

The major constraints on the Alternative 5, Option 1A route are those listed below. Each constraint is described in more detail in the following paragraphs.

1. Overhead passage through Anza-Borrego Desert State Park
2. Inadequate ROW through ABDSP Wilderness
3. Passing through Angelina Spring Cultural Preserve area and potential direct and indirect effects on numerous cultural resources
4. Diminishing the recreational and scenic value of ABDSP
5. ROW across La Jolla reservation
6. Scenic and low-density residential areas in northern San Diego County

Constraint 1: Overhead Passage Through Anza-Borrego Desert State Park

As documented extensively in the Sunrise Powerlink EIR/EIS, an overhead 500 kV line through ABDSP would result in numerous significant and unmitigable impacts and very substantial opposition from the State Parks Department, members of the public, and organizations. The most important impacts would result from the following concerns:

- Loss of visual quality in and around ABDSP's central and heavily visited scenic region and designated wilderness areas.
- Effects on desert bighorn sheep and numerous other sensitive species.
- Construction noise and traffic.
- Corona noise in remote and quiet areas.

Constraint 2: Inadequate ROW Through ABDSP Wilderness

The required ROW width is not available through Grapevine Canyon between two ABDSP wilderness areas. Therefore, the State Parks Commission would have to reverse the wilderness designation of a segment along the ROW for the State Parks Department to permit the transmission project.

Constraint 3: Passing Through Angelina Spring Cultural Preserve and Potential Direct and Indirect Effects on Numerous Cultural Resources

In 2012, park officials completed their review of the valuable cultural zones and designated several of them as "cultural preserves." One of these, Angelina Spring, is traversed by the existing 69 kV line through Grapevine Canyon. This new designation as a preserve presents an additional reason for the infeasibility of an overhead route through the park.

According to the 2012 *Anza-Borrego Desert State Park Cultural Preserve Management Plan,*[1]

> A cultural preserve is an internal unit of an existing State Park, State Recreation Area or State Vehicle Recreation Area. It is a delineated zone where the primary goal is for focused management based on preservation. These designations incorporate park lands that contain rich and outstanding prehistoric and historic resources which include archaeological sites, village locations, burial grounds, rock art panels, trails, ranches, structures and cultural landscapes.[2]

The Legislature provided for the cultural preserve subclassification in the Public Resource Code:

> Cultural Preserves consist of distinct non-marine areas of outstanding cultural interest established within the boundaries of other state park system units for the purpose of protecting such features as sites, buildings, or zones which represent significant places or events in the flow of human experiences in California. Areas set aside as cultural preserves shall be large enough to provide for the effective management and interpretation of the resources. **Within cultural preserves, complete integrity of the cultural resources shall be**

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1. http://www.parks.ca.gov/pages/21299/files/FINAL_ABDSP_Cultural_Preserve_Management_Plan_112612.pdf

sought, and no structures or improvements that conflict with the integrity shall be permitted." (P.R.C. 5019.74; emphasis added)

Constraint 4: Diminishing the Recreational and Scenic Value of ABDSP

Based on detailed comments provided by officials of the ABDSP and the State Parks Department on the proposed Sunrise Powerlink Project and the route through ABDSP, a 500 kV transmission line along Highway 78 and through Grapevine Canyon would have severe adverse effects on the use and value of the park. The EIR/EIS for the Sunrise Powerlink also identified significant and unmitigable visual and recreational impacts.

Constraint 5: ROW Across La Jolla Reservation

See discussion of Constraint 1 for Alternative 3, "ROW Across La Jolla reservation."

Constraint 6: Scenic and Dispersed Residential Areas and Tribal Concerns in northern San Diego County

See discussion of Constraint 4 for Alternative 2, "Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County."

Imperial Valley to Inland, Option 1B (HVDC)

As illustrated in Figure 14, Alternative 5, Option 1B has the same substation endpoints as Alternative 5, Option 1A, but is an HVDC alternative, so it can more easily be installed underground. See Appendix C on ROW requirements for AC and DC transmission lines. Because this option is an HVDC line, it would require construction of AC/DC converter stations at the Imperial Valley and Inland Substations. The potential route for Alternative 5, Option 1B is illustrated in Figure 14 on page 68.

Imperial Valley to Inland, Option 1B: Routing Summary

The route of Option 1B is very similar to that described in Option 1A except that this option is suggested to be installed underground through ABDSP, within the ROW of Highway 78. Because this is not a controlled-access highway, the Caltrans restrictions described in Alternative 2, Constraint 2 ("Use of I-15 Caltrans ROW") would not be applicable.

This all-underground option was studied and found to be feasible in the Sunrise Powerlink EIR/EIS. It was considered because it would eliminate the visual impacts in the park of the overhead transmission line, it would eliminate corona noise, and it would avoid the Angelina Spring Cultural Preserve.

Imperial Valley to Inland, Option 1B: Constraints

While an underground line would not be visible, there remain several challenges and constraints to installation of an underground line, even HVDC, through the park. The major constraints on the Alternative 5, Option 1B route are those listed below. Each constraint is described in more detail in the following paragraphs.

1. Construction disturbance and traffic obstruction through Anza-Borrego Desert State Park.

2. Construction challenges related to bedrock and crossing of the Earthquake Valley Fault.

3. Disturbance of desert bighorn sheep and likely seasonal construction constraints.

4. ROW across La Jolla reservation.

5. Scenic and low-density residential areas in northern San Diego County.

Constraint 1: Construction Disturbance and Traffic Obstruction Through Anza-Borrego Desert State Park

While this route would be entirely underground within ABDSP, the construction within the narrow and winding Highway 78 would likely require road closures. With Highway 78 closed, access between the Imperial Valley and northern San Diego County would be extremely time-consuming. Construction would likely require blasting to construct the trench in bedrock, so construction noise within the park would be severe.

Constraint 2: Construction Challenges Related to Bedrock and Crossing of the Earthquake Valley Fault

This option would cross the Earthquake Valley Fault and would parallel the fault for several miles along County Highway S2. The crossing of major faults is not recommended for high-voltage transmission lines when installed underground, due to the risk of cable rupture and the time required for repair. However, due to the extremely high value of the protected open space in ABDSP and the San Felipe Valley, and the unknown frequency of major earthquakes in this area (likely substantially less frequent than once in 100 years), the underground line is considered to be feasible and a worthwhile trade-off for elimination of visual and other severe impacts.

Construction in County Highway S2 would be likely feasible, but State Route (SR) 78 is narrow (as narrow as 23 feet in width) and winding with rocky slopes on both sides of the roadway. This would make construction challenging and costly in this portion, but it is likely to be feasible. A job hazard analysis prior to the start of construction would be required to evaluate the risk of falling rock due to vibration from construction equipment. The job hazard analysis would identify the hazard and would propose solutions to mitigate or eliminate the risk of falling rocks.

Constraint 3: Disturbance of Desert Bighorn Sheep and Likely Seasonal Construction Constraints

This route through the park passes through a significant population of desert bighorn sheep. The sheep are protected during their lambing season, so construction would likely be prohibited during this season. Other seasonal constraints on construction may also be imposed for different species or during major park visitation periods. This could result in an extremely long construction time frame.

Constraint 4: ROW Across La Jolla Reservation

See discussion of Constraint 1 for Alternative 3 (“ROW Across La Jolla Reservation”).

Constraint 5: Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County

See discussion of Constraint 4 for Alternative 2 ("Scenic and Dispersed Residential Areas and Tribal Concerns in Northern San Diego County").

Alternative 6: Valley to Inland (AC or HVDC)

ALTERNATIVE 6
San Diego High-Voltage Transmission Options 2A and 2B

- **Valley–Inland, Option 2A (500 kV AC)** – New proposed 500 kV AC transmission line between the existing SCE Valley Substation and the new SDG&E Inland Substation within northern San Diego County. This alternative is proposed as an overhead line that would be roughly 40 miles in length. In addition to the new transmission line, the new 500/230 kV Inland Substation would be constructed at a new north inland location. The proposed option may include provisions for the installation of two 500 MVA ±45° phase shifters at the SONGS Mesa 230 kV substation to improve network flow through the San Diego transmission system and into the Los Angeles load center.
- **Valley–Inland, Option 2B (HVDC)** – New proposed underground HVDC transmission line between the existing SCE Valley Substation and the new SDG&E Inland Substation within northern San Diego County. This alternative is proposed as an underground line that would be about 30 miles in length. In addition to the new transmission line, the new Inland Substation would be constructed at a new north inland location, as well as the installation of DC converter stations at this new substation and the existing SCE Valley Substation.

System Upgrades for Both Options 2A and 2B

- Reconductor TL 23030 (Escondido-Talega) to a minimum rating of 1175/1175 MVA normal/emergency and loop-in to the new Inland Substation. Construct a new 230 kV transmission line on the vacant side of the existing tower line supporting TL 23030 between Escondido and Talega Substations and loop-in to the new Inland Substation.

This alternative is described in two parts. The first section presents Valley to Inland, Option 2A (500 kV AC), and the second section presents Option 2B (HVDC underground). The system upgrades (Reconductor Escondido-Talega) are described for Alternatives 2, 3, and 4 above and present no significant constraints. The major components analyzed here are:

- New transmission line routes between Valley Substation and a new Inland Substation.
- Expansion of Valley Substation for DC Converter Station or additional 500 kV connection.

Valley Substation and the proposed Inland Substation sites are about 22 miles apart, as the crow flies. There is no existing high-voltage transmission between these two substations. The Valley Substation is located at the intersection of Menifee Road and State Route 74 in Menifee,

Riverside County. The Inland Substation would be located on undeveloped land near Rainbow Heights Road in unincorporated San Diego County, just south of the San Diego-Riverside County border.

Appendix A presents details on the potential route for each alternative, including a description of the route itself and the land uses along the route. This section presents a brief overview of the route as background for the discussion of routing constraints.

Valley to Inland, Option 2A (500 kV AC)

Valley to Inland, Option 2A: Routing Summary

The Valley-to-Inland area is heavily constrained by existing homes. While it would be theoretically possible to design a 200-foot ROW between these two substations, the route would be located immediately adjacent to existing homes and follow an existing bike path and levee to avoid the take of existing homes.

A new overhead 500 kV transmission line would require a new 200-foot ROW; however, for this study the authors considered corridors that would be wider than 200 feet whenever possible to provide flexibility for siting should it be needed. The overhead route described here and illustrated in Figure 15 is considered very likely to be infeasible, due to the density of existing development in the area and the lack of existing transmission corridors. However, a route is described here that would like present the least constraints possible.

The potential Valley-Inland overhead route would exit the Valley Substation to the southeast, make a wide eastward loop around the cities of Menifee, Murrieta, and Temecula before turning west toward the I-215 freeway north of the Pechanga Indian reservation and the Agua Tibia Wilderness. It would then parallel the freeway south to the Talega-Escondido transmission corridor and turn east to follow that corridor to the Inland Substation location. To avoid the constraints outlined above, the potential Valley-Inland route would remain entirely east of the I-215 and I-15 freeways.

Direct Overhead Route: Considered but Eliminated. The most direct route between the Valley and Inland Substations would parallel the I-215 freeway, cross the freeway into the City of Murrieta and arrive at the Inland Substation from the west. This route would be 10 miles shorter than the potential route but was eliminated from consideration for the following reasons:

- The route would be located within less than 200 feet from homes for several miles and near several existing schools.
- The route would be located in a riparian corridor for 3 miles to avoid homes.
- The route would have to run directly over existing commercial and industrial development or require the removal of several existing buildings.

- The route would cross the Santa Margarita Ecological Reserve. The 4,344-acre reserve is a field station for San Diego State University and provides protected sites for research and education of Southern California ecosystems (San Diego State University, 2013). The BLM manages 1,247 acres of the reserve as an Area of Critical Environmental Concern (ACEC), and portions of the Santa Margarita River within the ACEC are eligible for classification as a "wild river," the most restrictive of the Wild and Scenic River classification (U.S. Bureau of Land Management, 2012).

Valley to Inland, Option 2A: Constraints

The major constraints on the Alternative 6, Option 2A route are those listed below. Each constraint is described in more detail in the following paragraphs.

1. Pechanga reservation
2. Agua Tibia Wilderness
3. Density of residential and commercial development
4. Southwestern Riverside County Multiple Species Core Reserve
5. Temecula Bike Path

Constraint 1: Pechanga Reservation

The potential route completely avoids tribal land of the Pechanga reservation because this tribe's land acquisition 10 years ago effectively prevented the development of a viable Valley-Rainbow transmission line route. The Pechanga Indian reservation is east of the I-15 corridor and extends roughly six miles east to west. During the evaluation of the Valley-Rainbow 500 kV Interconnect Project, the Pechanga Band of Luiseño Mission Indians stated that consent must be given to have access to their lands for any environmental study or for any proposed route through the reservation (California Public Utilities Commission, 2001). The Nation of the Pechanga Band of Luiseño Mission Indians did not give its consent for a route through the Pechanga Indian reservation, and there is no indication that it would do so at this time (California Public Utilities Commission, 2001). As such, the route avoided the Pechanga Indian reservation to avoid feasibility constraints.

Constraint 2: Agua Tibia Wilderness

The potential route avoids the Cleveland National Forest Agua Tibia Wilderness, which is located immediately east of the Pechanga Indian reservation. This area extends about 4.8 miles eastward. A transmission corridor would not be compatible with wilderness lands, so the constraint has been avoided.

Constraint 3: Density of Residential and Commercial Development

The result of the avoidance of both the Pechanga reservation and the Agua Tibia Wilderness is that the potential route must jog west just north of those two jurisdictions, passing through central Temecula along a route that is not likely to be permittable.

As can be seen in the route presented in Figure 15, the potential route includes a broad sweep around the eastern side of the Menifee/Temecula area to avoid as many homes as possible. However, even with that routing, the potential route would affect many locations between the Valley and Inland Substations that are heavily developed with suburban homes, especially near the boundary between Menifee and Temecula. In addition, numerous rural residential areas are located outside Temecula, further complicating the corridor route. Portions of the potential route have sufficient land available to accommodate a 500 kV line ROW, but some locations would require the corridor to be within 150 feet of homes.

Constraint 4: Southwestern Riverside County Multiple Species Core Reserve

The corridor would potentially conflict with the Southwest Riverside County Multi-Species Reserve. A route through the reserve would require approval from the Reserve Management Committee made up of the Metropolitan Water District (MWD), Riverside County Habitat Conservation Agency, U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Wildlife (CDFW), and Riverside County Regional Parks and Open Space District. Ten local government agencies have permits that rely on the integrity of the reserve. Regulatory feasibility, as well as environmental criteria, depends on whether a new 500 kV line would jeopardize permits in place.

Constraint 5: Temecula Bike Path

To traverse Temecula and avoid take of any residential or commercial development, the route would follow an existing bike path along a riparian area. This riparian corridor is about 500 feet wide and could technically accommodate a 200-foot ROW. The potential route would require removal of some existing riparian vegetation and would conflict with the existing bike path use.

Valley to Inland, Option 2B (HVDC Underground)

Valley to Inland, Option 2B: Routing Summary

The Valley-to-Inland underground HVDC transmission line between the existing SCE Valley Substation and the new SDG&E Inland Substation would be underground within existing roads. The permanent access right-of-way requirements for an underground HVDC route would be about 13 feet (TransÉnergieUS, 2004). As described in Appendix C (ROW Requirements), construction of an underground HVDC would require an underground duct bank roughly 2 feet wide and buried at least 3 feet deep. Larger vaults would be located along the route at nearly 1,600 feet apart.

All underground construction of transmission lines requires a continuous trench in which to install duct banks that would carry the electrical cables. If not constructed with appropriate best management practices, this amount of trenching could create soil erosion and could affect buried cultural or paleontological resources. To minimize other effects on natural resources, the potential route would follow existing roads from Valley Substation until a point about 2 miles west of the new Inland Substation. This southernmost 2-mile stretch is essentially roadless, and it is the route of the existing Talega-Escondido 230 kV transmission line, so in this segment, the route would transition to overhead until reaching the Inland Substation.

Substation Expansion for Converter Station

The HVDC route would require two AC/DC converter stations: one at the Valley Substation and one at the Inland Substation. The converter stations would require 5 acres of land. At both the Valley Substation and the proposed Inland Substation, there is sufficient vacant land such that 5 acres would be available for construction of the converter stations. Near the Valley Substation, the available land is existing agriculture. Near the proposed Inland Substation, the land is either undeveloped or open space.

Valley to Inland, Option 2B: Constraints

The major constraints on the Alternative 6, Option 2B route are those listed below. Because the HVDC underground route would follow existing roads, it would be less constrained by adjacent land uses or natural resources that would be affected by an overhead line in undisturbed areas. Each constraint is described in more detail in the following paragraphs.

1. Existing utilities in the road ROW
2. Engineering considerations
3. Electric and magnetic fields

Constraint 1: Existing Utilities Within the Road ROW

The underground HVDC construction ROW would require about 13 feet of space parallel to the trench, but the trench itself would be only about 3 to 6 feet wide. In some instances, roadways, in particular older roadways, may be congested due to existing utilities located beneath the surface. For example, while much of the underground route has distribution facilities above ground, some of the newer development may require distribution lines to be underground. Typical underground utilities include water lines, sewer pipes, and natural gas pipelines.

Separation from existing utilities would be required to ensure safety of all utilities during both construction and operation.

Constraint 2: Engineering Considerations

The HVDC route follows straight roads wherever possible as this would ease the construction of an underground road where trenching is required. The bending radius for underground cables and vaults along this route would need to be carefully engineered, in particular in locations where the road width is limited. Special construction methods (horizontal boring and/or directional drilling) may be required in areas where open trench construction is not feasible. These areas would include railroad tracks (such as along Case Road), large utility crossings, roads, drainage crossings, and environmentally sensitive areas.

Constraint 3: Electric and Magnetic Fields

The Chapter 1 section, "Electric and Magnetic Fields from Transmission Lines and Potential Health Concerns," describes EMF as one of the potential concerns about underground transmission lines. In some projects that undergo substantial public scrutiny, especially where the lines would be located near homes, a major issue of concern tends to be regarding potential

health effects from exposure to electric and magnetic fields (EMFs). Generally, providing information and educational materials on these fields can resolve many concerns.

There are three primary electrical parameters associated with the environment in the vicinity of HVDC transmission lines: 1) the electric field, 2) the magnetic field and 3) air ions.

- Both HVAC and HVDC lines generate electric fields surrounding the conductors, with the magnitude of the electric field dependent on the voltage of the line. The strength of the static electric field decreases rapidly with distance from the source. Electric fields are shielded by trees, walls, or other objects and, if shielded, do not penetrate the body. Adverse health effects have not been scientifically established.

- Both HVAC and HVDC lines generate magnetic fields. The magnetic field for a DC line is a static field that does not change over time, much like the Earth's magnetic field. Static magnetic fields have been studied extensively at strengths significantly higher than for HVDC transmission lines due to their use in medical diagnostics. Studies found no significant increase or decrease in the prevalence of the diseases evaluated, and the data do not allow a conclusion that exposure to DC magnetic fields affects health.

- *Air ions* are charged air molecules produced by corona, the partial electrical breakdown of the air surrounding conductors. A result of corona is both positive air ions that have lost an electron and negative air ions that have picked up the excess electrons. For HVDC lines air ions with the same polarity of the conductor migrate toward the opposite pole of the HVDC circuit, and a significant portion of the air ions migrate to the ground and away from the transmission line. Natural background air ion densities range from 1,000 ions per cubic centimeter in open areas to 80,000 ions per cubic centimeter in urban areas. Directly below HVDC transmission lines air ion densities are in the range of 100,000 ions per centimeter. Air ions have been studied for more than a hundred years; research has not provided any reliable evidence that air ions produce any harmful effects.

Alternative 7: Imperial Valley Substation Expansion

ALTERNATIVE 7
Imperial Valley Expansion
High-Voltage Flow Control Between ISO Balancing Authority Area (BAA) to Other BAAs

- Expand the existing Imperial Valley 500/230 kV Substation to accommodate the following installations:
  - Back-to-back DC installation that includes AC-DC and DC-AC converters
  - Additional 230 kV bus structure to relocate and connect 230 kV lines to IID and Comisión Federal de Electricidad in Mexico.

Alternative 7 would expand the Imperial Valley Substation to include infrastructure that would improve the flow control between the California ISO and other balancing authority areas (such as IID and Mexico). The converter stations would facilitate grid stabilization between the United States and Mexican grid systems. Assuming use of the latest technology of voltage-source converters, the footprint for a single converter station is roughly 4 acres. Because the 4 acres includes the footprint of the AC substation yard and infrastructure, around 1.5 to 2 acres would be required to incorporate the converter into an existing AC substation, such as the Imperial Valley Substation. The back-to-back converters described in this alternative would require 3 to 4 acres total.

Because the existing Imperial Valley Substation includes numerous facilities, it is unlikely that two converter buildings could be located within the existing fence line, and an expansion of the fence line is likely required. There is sufficient undisturbed land surrounding the Imperial Valley Substation that could potentially be used to expand the substation; however, several projects have been proposed that could preclude use of some of this area. The projects include the Ocotillo Sol solar PV farm, located on 100 acres immediately south of the substation, and the IID Liebert Substation, located 400 feet north of the substation. Several existing transmission lines run east of the Imperial Valley substation connecting the substation with power generation in Mexico.

Existing agriculture lands are located nearly 1,800 feet north of the substation. Locating the converters at this distance from the existing substation would likely not be feasible because the converters would need to be connected to the HVAC buses in the existing Imperial Valley Substation. However, it may be possible to build the HVAC buses as overhead transmission lines across the 1,800 feet to reach the converter stations.

Description of Existing Imperial Valley Substation

The Imperial Valley Substation is an existing major substation that serves SDG&E, IID, and merchant generators and provides an intertie to the Comisión Federal de Electricidad in Mexico. The lines served by this substation include the 500 kV SWPL and the 500 kV Sunrise Powerlink, two 230 kV interties with generators at Mexicali and Rosita to the south and an interconnection with the IID transmission system. It is located on 64 acres on BLM-administered land.

Imperial Valley Substation – Regulatory Setting

The Imperial Valley Substation is located on BLM-administered lands in Imperial County in an area identified as Limited Use by the California Desert Conservation Area Plan. Under this classification, electrical infrastructure is an allowed use in designated utility corridors. The Imperial Valley Substation is located within the BLM Utility Corridor "N."

The substation is also located within the boundaries of the BLM's Yuha Basin Area of Critical Environmental Concern (ACEC) and within the Yuha Desert Management Area for the flat-tailed horned lizard. The Yuha Basin ACEC was designated to provide protection to unique cultural and natural resources in the region, including the flat-tailed horned lizard, prehistoric resources, and historical resources (U.S. Bureau of Land Management, 2013). The Yuha Desert

Management Framework Plan contains an energy- and transmission-related goal and action; the action is to permit the traversing of the ACEC by proposed lines and associated facilities if environmental analysis demonstrates that it is environmentally sound to do so.

The nearest location outside the Yuha Desert Wildlife Management Area is existing agriculture land 1,800 feet north of the substation. Parcel APN 051 350 010 is 1.5 acres, and APN 051 350 011 is 3.6 acres. Both are zoned A-3, heavy agriculture.

Constraints to Expansion of Imperial Valley Substation

Expansion of the substation would require BLM approval with respect to two resource concerns, each described in more detail below.

1. Flat-tailed horned lizard habitat
2. Yuha Desert Wildlife Management Area

Constraint 1: Flat-Tailed Horned Lizard Habitat

The *Flat-tailed Horned Lizard Rangewide Management Strategy, 2003 Revisions: An Arizona-California Conservation Strategy* encourages surface-disturbing projects to be sited outside flat-tailed horned lizard management areas whenever possible but does not preclude such projects. If a project must be sited within a management area, the BLM encourages projects to be sited in a previously disturbed area or in an area where the habitat quality is poor and construction could be timed to minimize potential mortality. New ROW may be permitted along the boundaries of the management area, but only if impacts can be mitigated to avoid long-term effects and if the cumulative disturbance area per management area from all projects does not exceed 1 percent.

Constraint 2: Yuha Desert Wildlife Management Area

The Yuha Desert Wildlife Management Area is 57,304 acres. A 1 percent disturbance cap would comprise 573.04 acres. According to the BLM, as of July 2013, almost two-thirds of the 1 percent habitat disturbance allowance had been accounted for either through existing or authorized projects (167 acres) or proposed projects (207.6 acres) (U.S. Bureau of Land Management, 2013). As such, while not encouraged, additional disturbance could be approved by the BLM in the Yuha Desert Wildlife Management Area. Appropriate mitigation would be required, as calculated using the Flat-tailed Horned Lizard Rangewide Management Strategy formula that considers adjacent habitat impacts, growth-inducing effects, existing disturbance on site, and the duration of effects.

Alternative 8: Mesa Substation Loop-In

ALTERNATIVE 8
Transmission Upgrade Option in the LA Basin – Mesa Substation Loop-In Transmission Project

- Expand SCE's existing Mesa 230/66/16 kV Substation to include 500 kV service.
- Include three 500/230 kV and four 230/66 kV transformer banks.
- Loop in the new Vincent–Mira Loma 500 kV line (part of Tehachapi Renewable Transmission Project, scheduled to be in service in 2015).
- Loop in existing Laguna Bell–Rio Hondo 230 kV, and Goodrich–Laguna Bell 230 kV lines into the expanded Mesa Substation.

This proposed alternative includes three 500/230 kV transformer banks (bays), four 230/66 kV transformer banks (bays), and other line routing and rework. It is assumed that most of this work would require an expansion to the existing Mesa Substation facility. SCE stated that it anticipated a Mesa 500/230/66/16 kV Substation would require roughly 70 acres of land (Southern California Edison Company, 2013).

Description of Existing Mesa Substation

The 220/66/16 kV Mesa Substation is located on 23 acres. It was upgraded as a part of the Tehachapi Renewable Transmission Project with 12 new foundations for 220 kV circuit breakers and disconnect switches. Some existing 220 kV lines were relocated as part of the project. An approximately 19-acre laydown yard was constructed on a separately fenced portion of SCE property immediately southwest of the Mesa Substation.

Land Uses Around Mesa Substation

The Mesa Substation is located on land designated as general commercial in the *Los Angeles General Plan.*[3] The surrounding land uses are also identified as general commercial with some residential land uses further away. Nineteen acres of land southwest of the Mesa Substation is being used as a laydown area for the Tehachapi Renewable Transmission Project but could potentially be used for substation expansion. SCE also owns about 27 acres of land southeast of the Mesa Substation.

Constraints to Expansion of Mesa Substation

According to SCE, there is sufficient land available to expand the Mesa Substation (Southern California Edison Company, 2013). The land to the southwest of the substation is a laydown area, and SCE could expand the substation on this parcel. There are multiple existing transmission lines that would potentially be realigned to accommodate this expansion.

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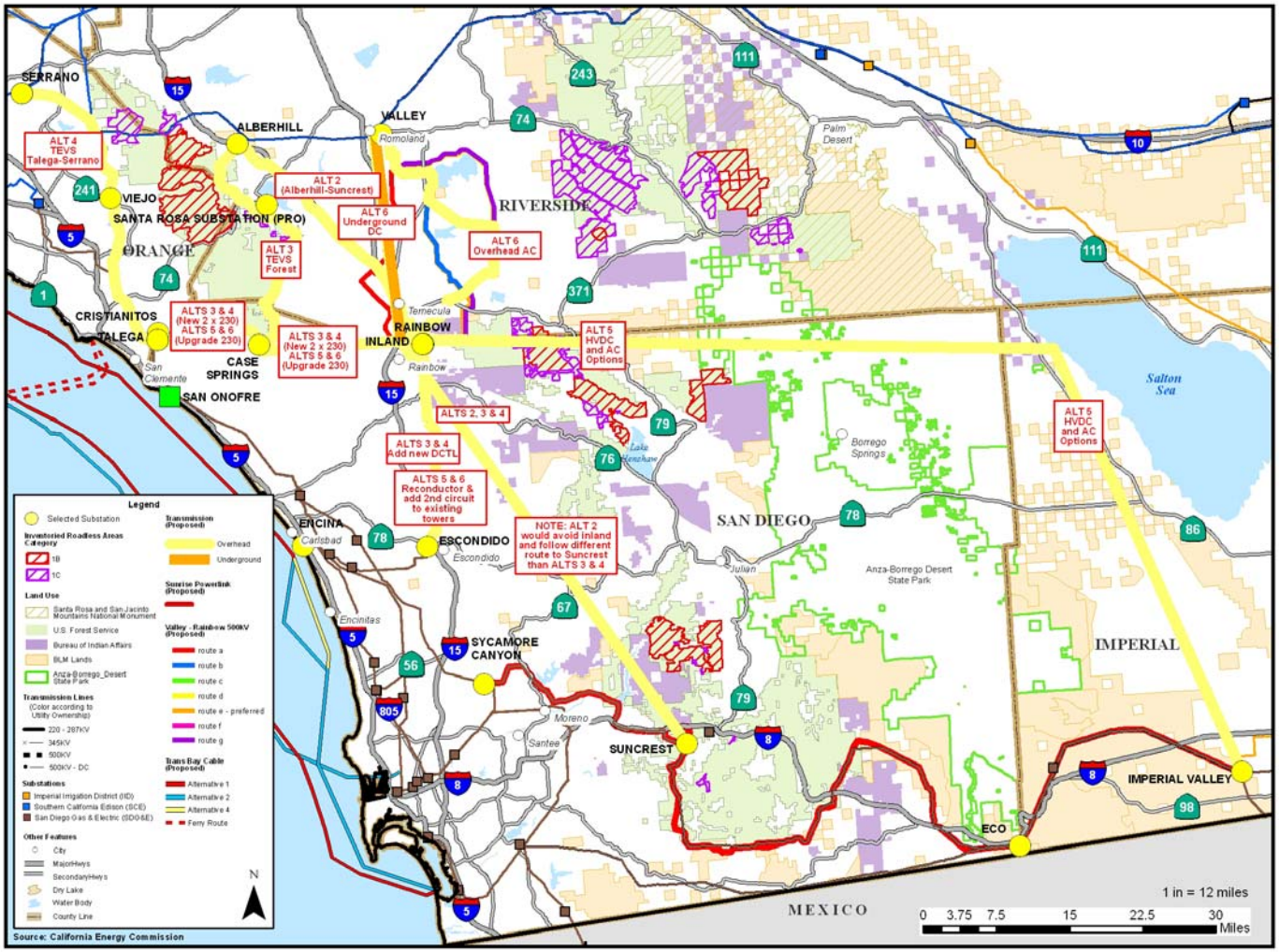
3. Los Angeles General Plan, <http://www.blm.gov/pgdata/etc/medialib/blm/ca/pdf/cdd/cdcaplan.Par.15259.File.dat/CA_Desert_.pdf>

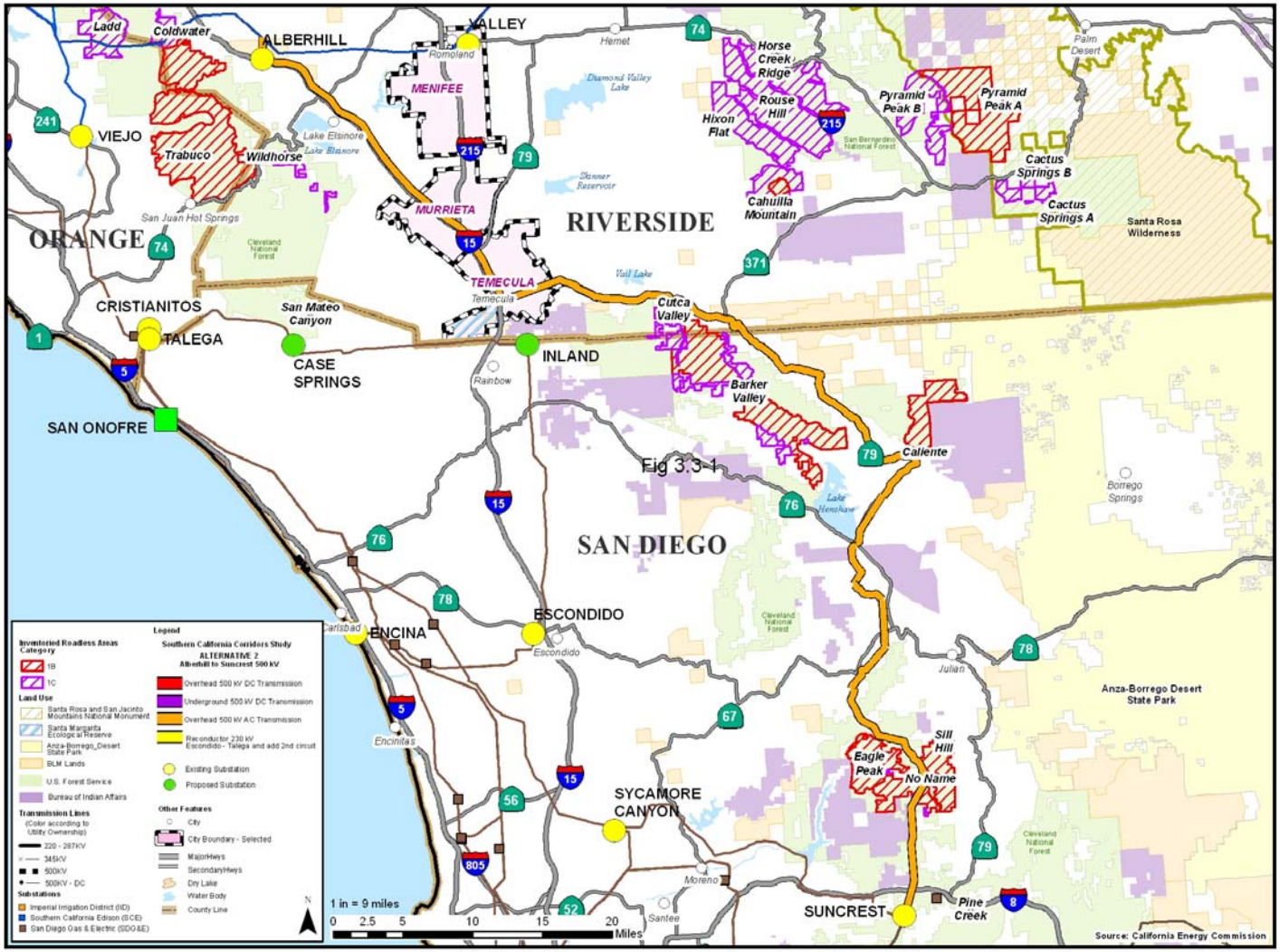
The 27-acre parcel of land located to the southeast of the Mesa Substation is an undeveloped area owned by SCE. The substation could also expand onto this parcel of land. California gnatcatcher nests were present at the 27-acre parcel during construction of the Tehachapi Renewable Transmission Project, and expansion onto this site would require mitigation for impact to the species. There are multiple existing transmission lines that would potentially be realigned to accommodate this expansion.

Figure 7: Schematic Map of Onshore Substations and Segments



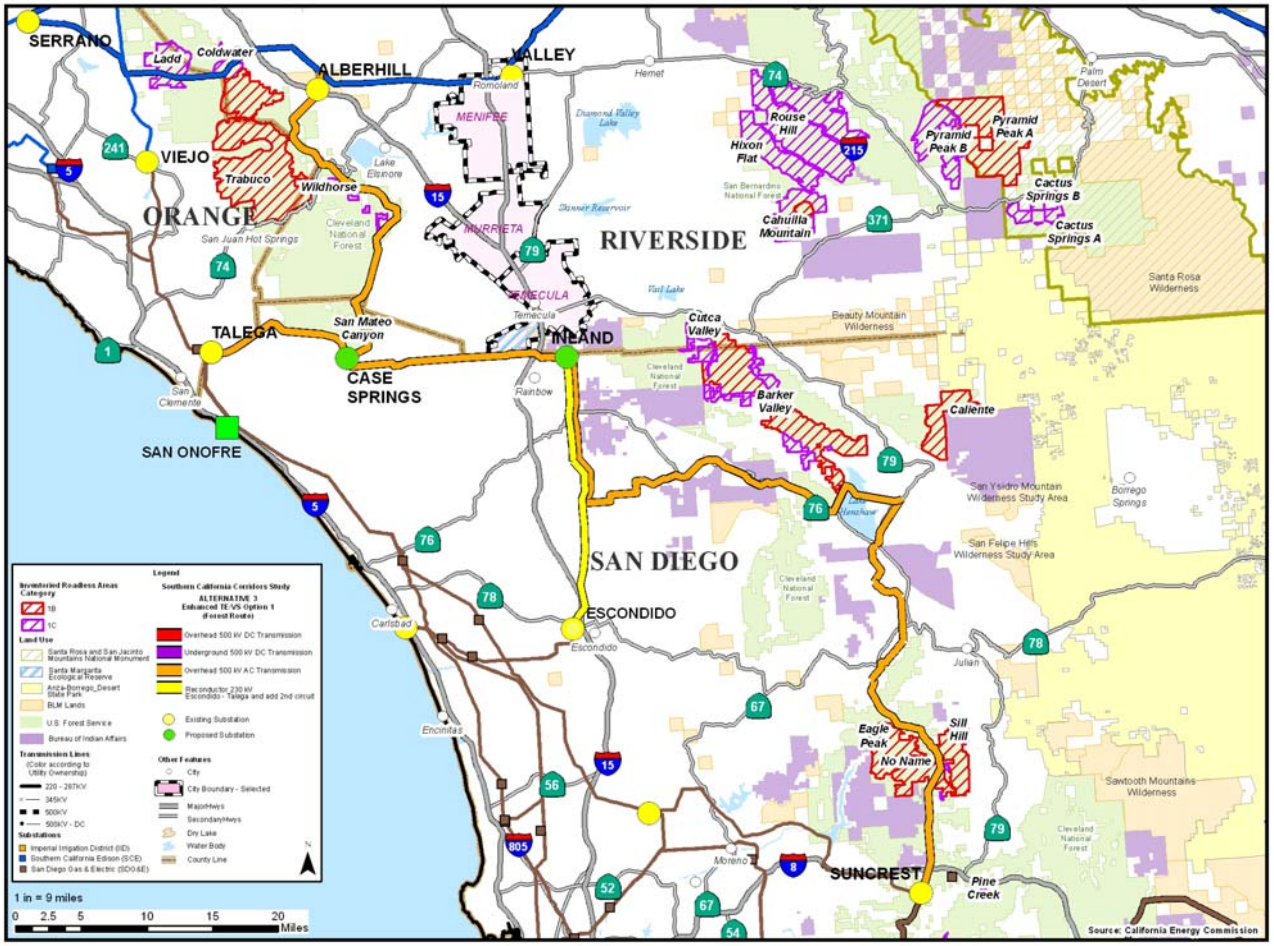
Source: California Energy Commission, 2014

Figure 8: Alternative 2 (Alberhill to Suncrest)



Source: California Energy Commission, 2014

Figure 9: Alternative 3 (Enhanced TE/VS, Forest Route)



Source: California Energy Commission, 2014

Figure 10: Talega Substation

Talega Substation - Talega Substation Topography

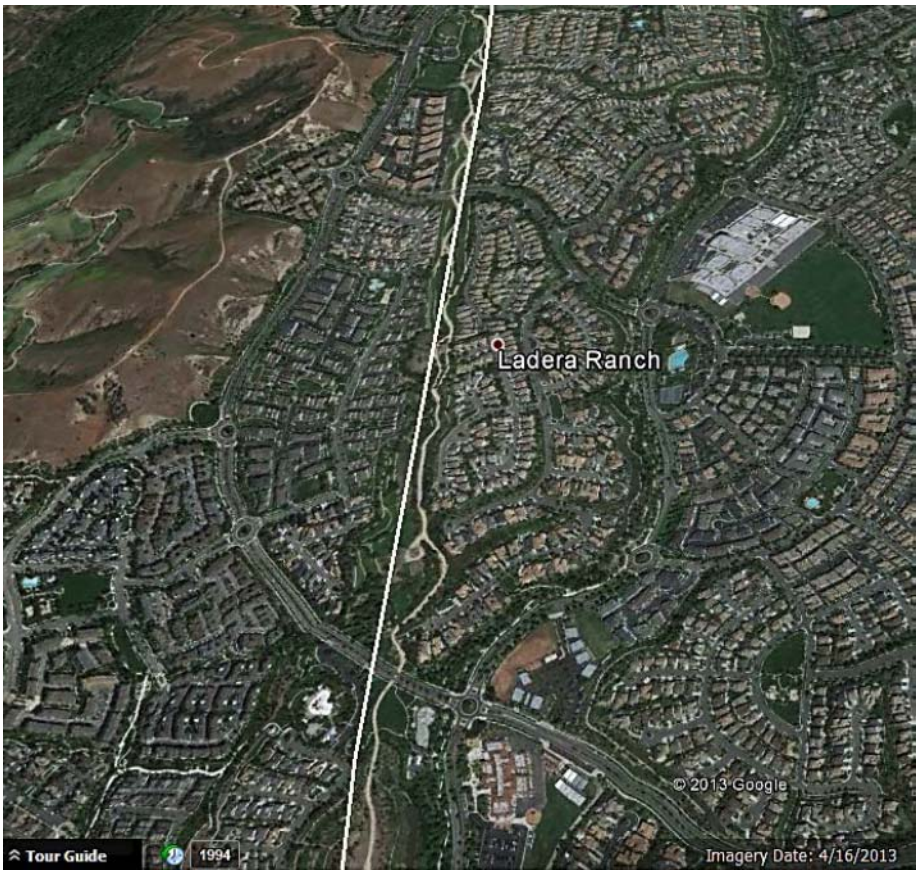
Talega Substation – Aerial Photo

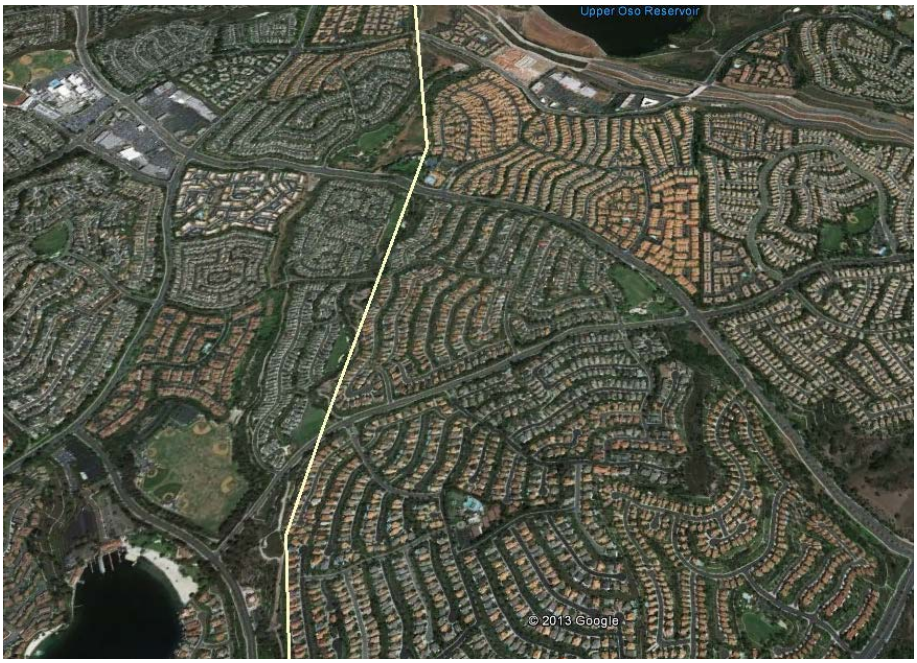
Source: Obtained from Google Earth

Figure 11: Alternative 4 (Enhanced TE/VS, Tallega-Serrano Route)

Source: California Energy Commission, 2014

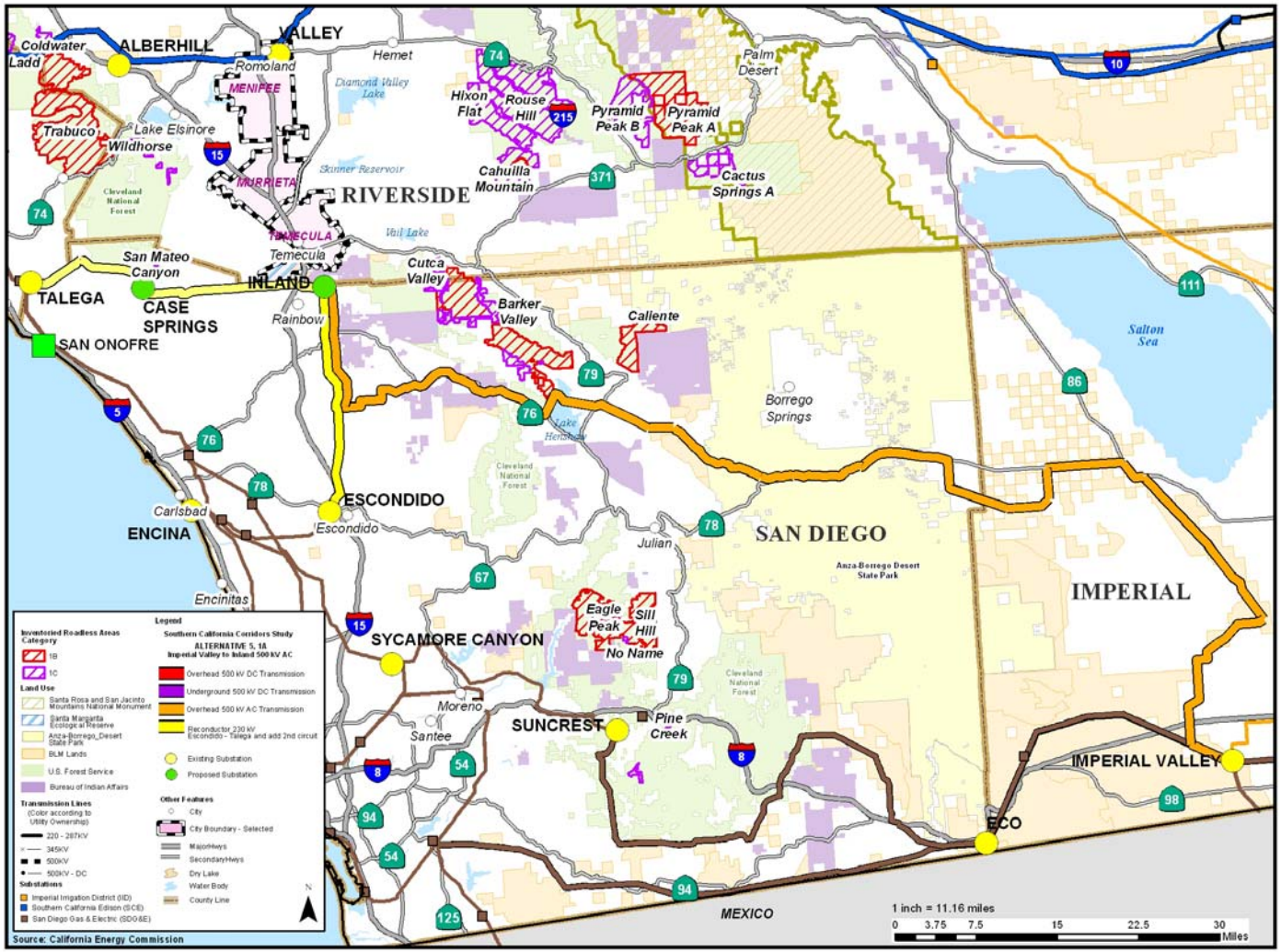
Figure 12: Detail of Talega-Serrano Corridor Through Mission Viejo





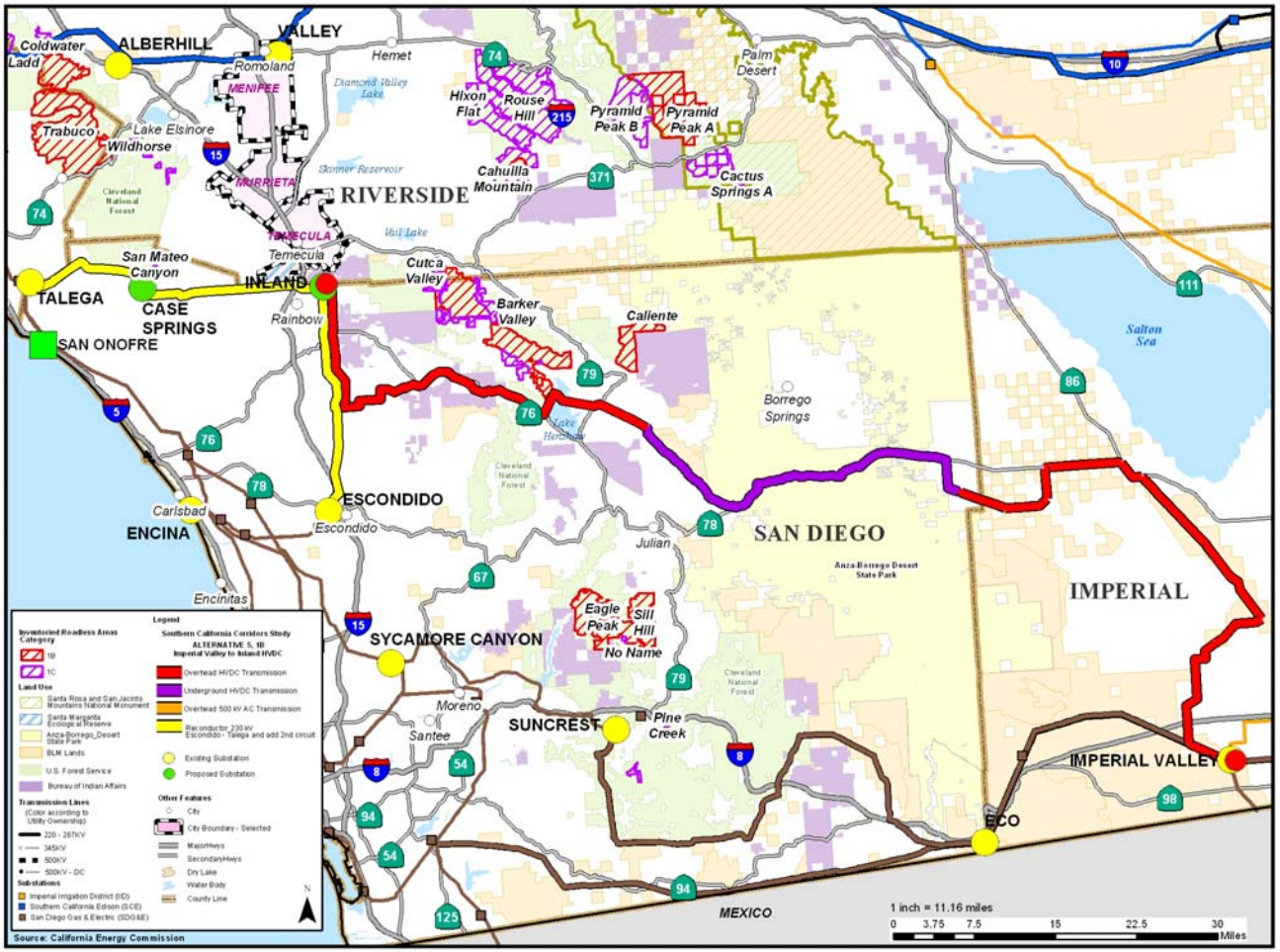
Source: Obtained from Google Earth

Figure 13: Alternative 5, Option 1A (Imperial Valley to Inland, 500 kV Overhead)



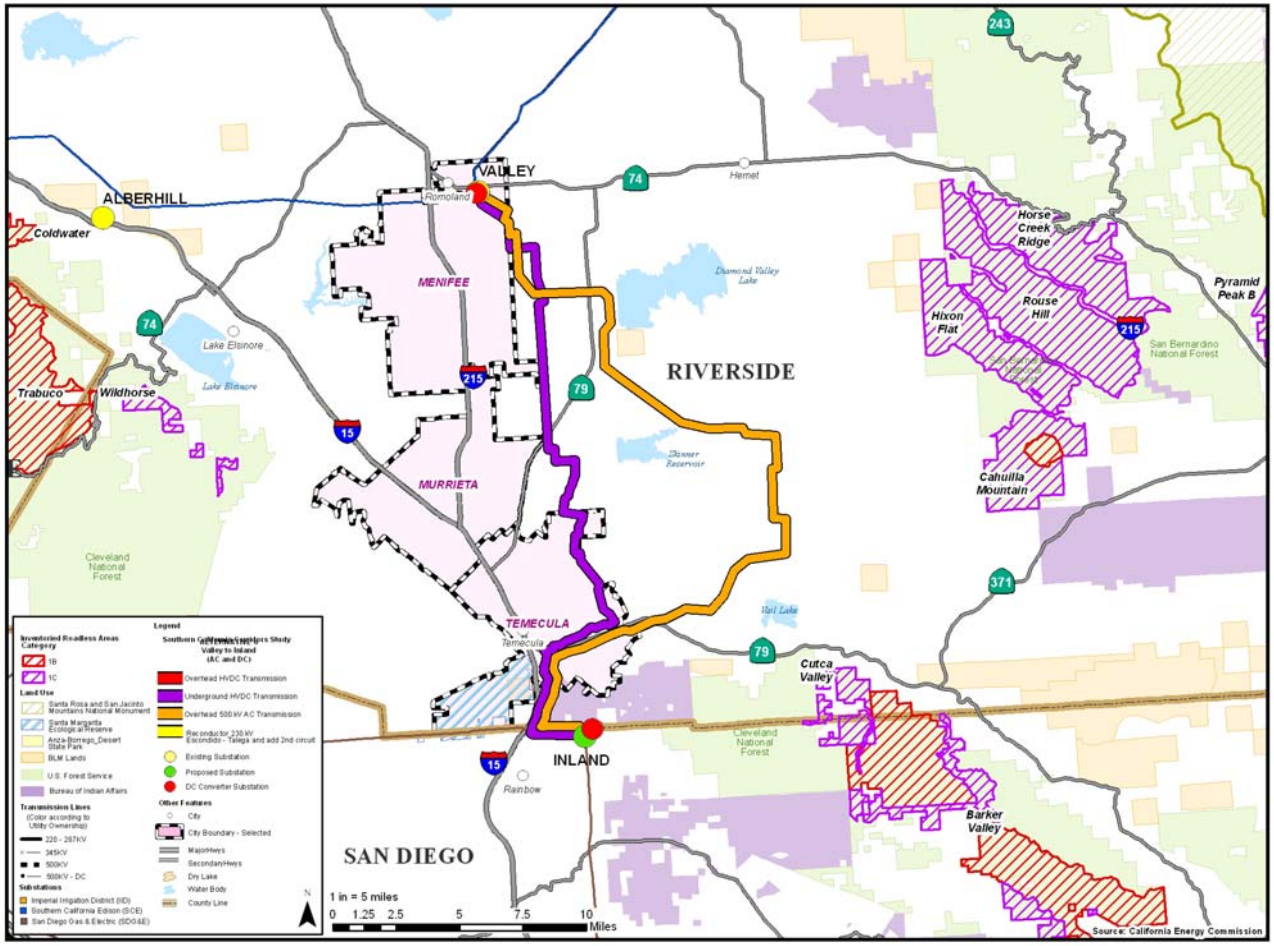
Source: California Energy Commission, 2014

Figure 14: Alternative 5, Option 1B (HVDC Overhead and Underground)



Source: California Energy Commission, 2014

Figure 15: Alternative 6 (Overhead and Underground Options)



Source: California Energy Commission, 2014

CHAPTER 3:
Background on Submarine HVDC Technology

Review of HVDC Systems and Successful Submarine Installations

This chapter provides an overview of high-voltage submarine technology, describes major systems that are installed, and describes the Trans Bay Cable Project as an example of the HVDC technology in use in California today.

High-Voltage Submarine Transmission

Typical applications for offshore high-voltage electric transmission systems include interconnecting isolated grids, importing power from offshore generation (for example, wind power), and providing power to offshore facilities (for example, oil and gas production).

High-voltage alternating current power systems are the prevalent technology used to deliver electricity from power sources to consumers throughout the world. These are used because voltage levels on AC systems can be easily transformed from one voltage level to another and multiple AC transmission lines can be readily connected to each other using relatively simple equipment, switching, and protective devices. However, AC power systems incur power losses in several ways, including resistive losses and reactive losses. For underground or submarine cables in AC systems, additional losses occur in the form of cable charging and sheath losses. For AC systems to be configured in a manner that allows them to operate in a stable fashion, the system must be able to return to a synchronized equilibrium following a transient disturbance. Long AC underground or submarine transmission lines have attributes that can negatively impact electric system stability. Both of these factors, system stability and additional losses, explain why DC systems are most often used for underground and submarine transmission lines of notable length.

In contrast to typical AC power systems, HVDC systems are better suited for interconnecting isolated or unsynchronized networks over long distances. An HVDC system avoids or minimizes certain problems associated with AC systems (such as the charging current necessary due to cable capacitance in long conductors, and the higher thermal losses on AC systems). Although control and communications within an HVDC system can be more complex, HVDC systems can be operated to insulate connected AC systems from system stability issues and allows for more precise control of the power flow in either direction.

Transmission over an HVDC line reduces the required number of conductors when compared to AC transmission. Where AC transmission systems operate in a three-phase configuration, requiring three conductors (one per phase), DC systems may use a monopole or bipole configuration. (See discussion below on HVDC Transmission Configurations.) Monopole DC lines are vulnerable to loss of capability with the loss of any component. Common long-distance DC lines are in a bipole configuration with two conductors, one for each “pole” of the circuit (the positive pole and negative pole). Because fewer conductors are used for an HVDC system, a narrower footprint is needed and conductor costs are reduced. Equipment for converting AC

to DC and back to AC is costly, however, on long transmission lines this cost is offset by the lower conductor cost.

General Comparison of AC and DC Power Systems

General advantages and disadvantages of using HVDC technology instead of an AC transmission line between two transmission systems (National Renewable Energy Laboratory, 2011) would include:

HVDC Advantages

- Long-distance transmission with lower costs and losses.
- Ability to connect unsynchronized and weaker grids.
- No high capacitance effect on DC (no reactive losses).
- More power per conductor, with two conductors only.

HVDC Disadvantages

- High cost of converter stations.
- Complexity of control, communications, and so forth.
- Maintenance costs higher than for AC, unique spare parts needed.
- HVDC circuit breaker reliability issues.

Relative Costs

HVDC lines require construction of converter stations at each end of the line to connect with the AC transmission system. The high costs of the HVDC converter stations is a major factor limiting the use of HVDC technology to long-distance applications. An AC system would generally be less expensive than a DC system at distances of fewer than 250 miles overhead or less than 30 miles submarine (National Renewable Energy Laboratory, 2011). The HVDC converter stations require sufficient space (from 5 to 8 acres), seismic protection, and transportation infrastructure allowing construction access by large equipment.

Literature reviewed for this study indicates that each converter station would cost between $100 million to $200 million each, depending on capacity and configuration, and installing the submarine cable itself between the SCE and SDG&E territories could cost an additional $300 million to $600 million, for a project cost ranging up to roughly $1 billion.

Basic Submarine HVDC System Components

The two primary components of an HVDC transmission system are the AC/DC converter stations at each end of the HVDC line and the transmission line itself. Each of these components has subsystem technology choices for how to configure an HVDC system.

HVDC Converter Stations

Converting between a grid-based AC system power and a DC system occurs at converter stations. HVDC is a proven technology with systems in operation for more than 60 years. (A section below presents details on major HVDC installations that exist around the world.) The two technologies for conversion between AC and DC are either the original *current source converters* (CSC), also referred to as *line-commutated converters* (LCC), or the more recently developed *voltage source converters* (VSC).

LCC/CSC systems have some limitations related to the inability to commutate during electrically close fault conditions without nearby dynamic voltage support. The direction of current flow cannot be readily changed on LCC/CSC systems; therefore, these HVDC systems are best suited for interconnections where only unidirectional power flow is desired. In addition, since LCC/CSC systems rely on the connected AC system to provide the commutating voltage, it is not possible to feed power into the AC system unless synchronous machines (generators) are operating on the AC system. For this reason, an LCC/CSC HVDC system cannot provide black-start power into the AC system it interconnects.

VSC systems are highly controllable and address several issues associated with transmission systems. Since VSC systems do not require the dynamic voltage support from the AC system, these converters can be used to interconnect weak AC systems. VSC systems are also more compact than LCC/CSC systems. CSC systems are much easier to connect into a multiterminal HVDC system. Because the current flow direction can be reversed on these systems, they can provide for bidirectional power flow and are suited to interconnecting AC systems where power exchange in either direction is desired. VSC systems are self-commutated, giving them the capability to feed power into a passive AC system with loads but no operating synchronous machines (generators), thereby providing potential black-start power into the AC system.

HVDC converter stations include a variety of equipment in addition to the conversion equipment. DC converter stations also include AC and DC filters, cooling systems, switches, HVDC transformers, breakers, instrumentation, and communication equipment. The conversion equipment needs to be housed in a clean, controlled environment and, therefore, is enclosed in a building. The HVDC transformers differ from AC transformers in that they handle both AC and DC voltage stresses and are subject to high levels of harmonics.

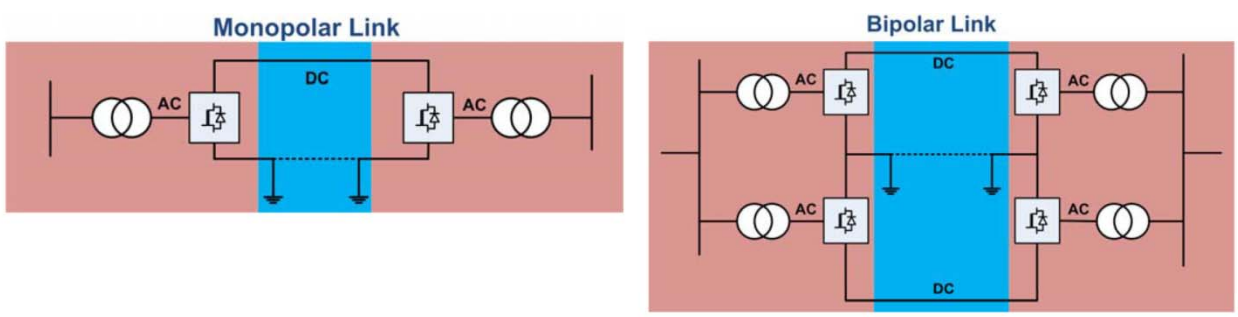
Installing new HVDC converter stations at each terminating point would involve developing each site of about 5 to 8 acres to accommodate the VSC equipment, depending on the voltages of the systems and the power transfer capacity. Normally, the station would be housed within a structure with height between 40 and 80 feet; the footprint of the building would be from 400 to 600 feet on each side. Each converter station would also include an electrical yard and a fence enclosing the site.

HVDC Transmission Configurations

HVDC transmission lines include the energized conductors for transmitting power and include some form of current return path using either earth electrodes or a lower voltage ground cable. When using earth electrodes, they are located at some distance (about 10 miles) from the converter stations and require a medium voltage overhead line to interconnect them to the system. Earth electrodes have a significant land requirement, and the use of earth return may have problems related to corrosion of long-buried metal objects, such as pipelines. Commonly HVDC submarine systems use a metallic return path by installing a lower-voltage ground cable. For an HVDC interconnection between the SCE and SDG&E transmission systems, the use of an earth return is not considered due to the added environmental concerns of installing the earth electrodes.

There are three primary ways to configure a HVDC transmission line between converters: monopole, symmetrical monopole, and bipole. Figure 16 shows the schematic configurations of monopolar and bipolar DC systems.

Figure 16: Monopolar and Bipolar DC Systems



Source: National Renewable Energy Laboratory, 2011

The choice of configuration type results in different numbers of subsea cables, which directly influence costs. The selection of a specific configuration also affects the power transfer capacity and reliability of the HVDC system.

- For a monopole configuration, one full-rated cable is installed as the "pole," and a second lower-voltage ground cable is installed as the return path. In the event that one cable is not operational, the system is out of service. (Examples are the existing Neptune Cable and Trans Bay Cable.)

- For a symmetrical monopole configuration, two full-rated cables are installed and operated at opposite voltage levels (plus/minus). A high-impedance ground is used, and a separate return path is not required. In the event that one cable is not operational, the system is out of service. (An example is the existing Cross Sound Cable.)

- For a bipole configuration, two full-rated cables are installed and operated at opposite voltage levels (plus/minus polarities), and a third lower-voltage ground cable is installed as the return path. In the event that one cable is not operational, the system can remain service at a 50 percent power transfer level.

Cable Types

There are three primary types of power cable used for HVDC submarine cables: fluid-filled cable, mass-impregnated cable, and extruded dielectric cable.

- *Self-contained fluid–filled* (SCFF) cables use a paper-tape type of insulation around the current carrying conductor. The insulating tape is impregnated with a low-viscosity synthetic fluid that is maintained in place by keeping the cable under pressure by oil-pumping stations at one or both ends of the cable.

- *Self-contained mass-impregnated* (MI) cables use a paper-tape type of insulation around the current carrying conductor. The insulating tape is impregnated with a very high-viscosity oil-based dielectric fluid that is substantially nondraining, even when installed at significant water depths, thereby avoiding the need for oil-pumping stations.

- *Self-contained extruded dielectric* cable used for HVDC uses a modified, cross-linked polyethylene (XLPE) insulation around the current carrying conductor.

- Generally SCFF cables have only been used for relatively short routes with MI cables accounting for more than 75 percent of installed HVDC cable. Considered a relatively new development, the modified XLPE-type cable has seen more recent use at lower voltage levels (150 kV DC).

Cable Components

Regardless of the type of insulation used, there is no standard design for submarine cables, and they tend to be custom-designed and fabricated to the specific requirements of each project. Submarine cables for high-voltage power transmission may typically contain multiple subcables and generally include the following typical components:

- Conductor. Usually copper due for high conductivity, although aluminum is sometimes used due to its lighter weight.

- Conductor screen. Semiconducting tape to maintain uniform electric field.

- Insulation. MI tape or modified XLPE around each conductor.

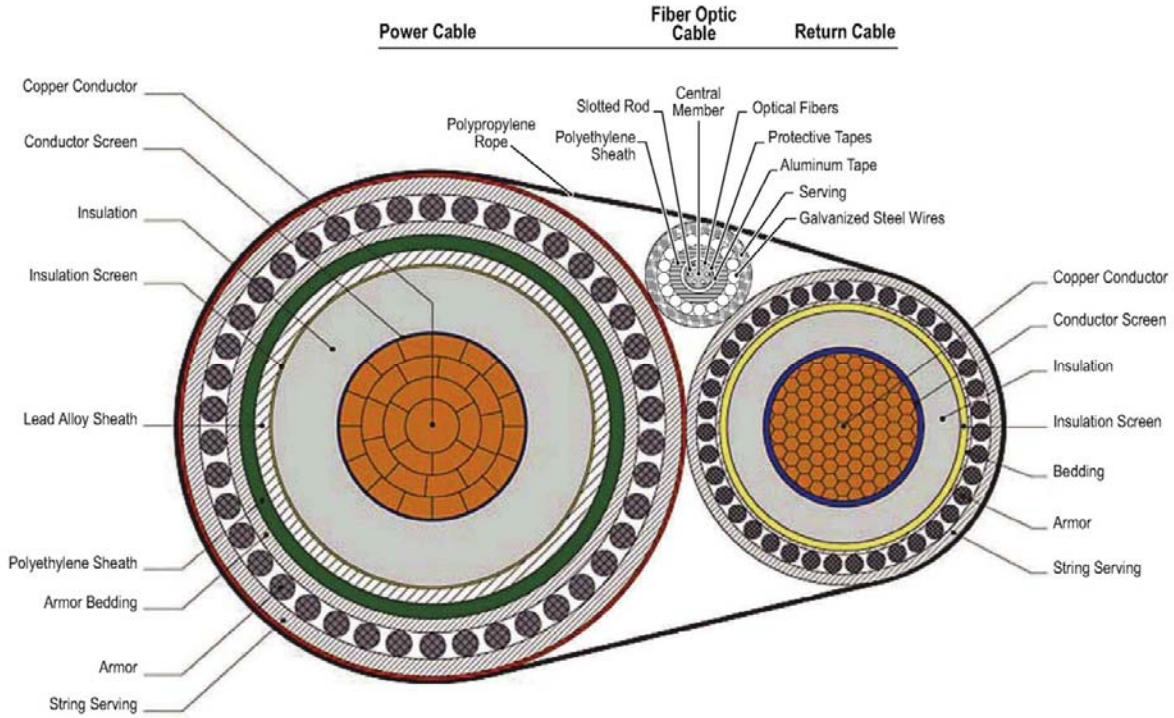
- Insulation screen. Extruded semiconducting material around each conductor cable to maintain uniform electric field.

- Sheath. Extruded lead alloy or conductive tape, copper or aluminum, around each conductor cable used as a path for fault and leakage currents.

- Anticorrosion jacket. Extruded polyethylene jacket over each conductor cable to insulate the metallic sheath from ground and to act as an impermeable water barrier.
- Fiber optic cable. Optionally used for communication.
- Fillers. As needed for voids between components.
- Binder tapes. Helically applied tape to maintain subcomponents in position within the overall cable.
- Armor bedding. Polypropylene or polyethylene material around the overall cable for mechanical protection and to bed the metallic armor.
- Armor. Helically wrapped galvanized steel wires for mechanical protection.
- Outer sheath. Continuously extruded polymer sheath or helically wrapped polypropylene.

The cross-section of a typical monopole HVDC configuration with one ground return cable in a bundle is shown in Figure 17.

Figure 17: Cross-Section of HVDC Cable Bundle



Source: Trans Bay Cable, 2006

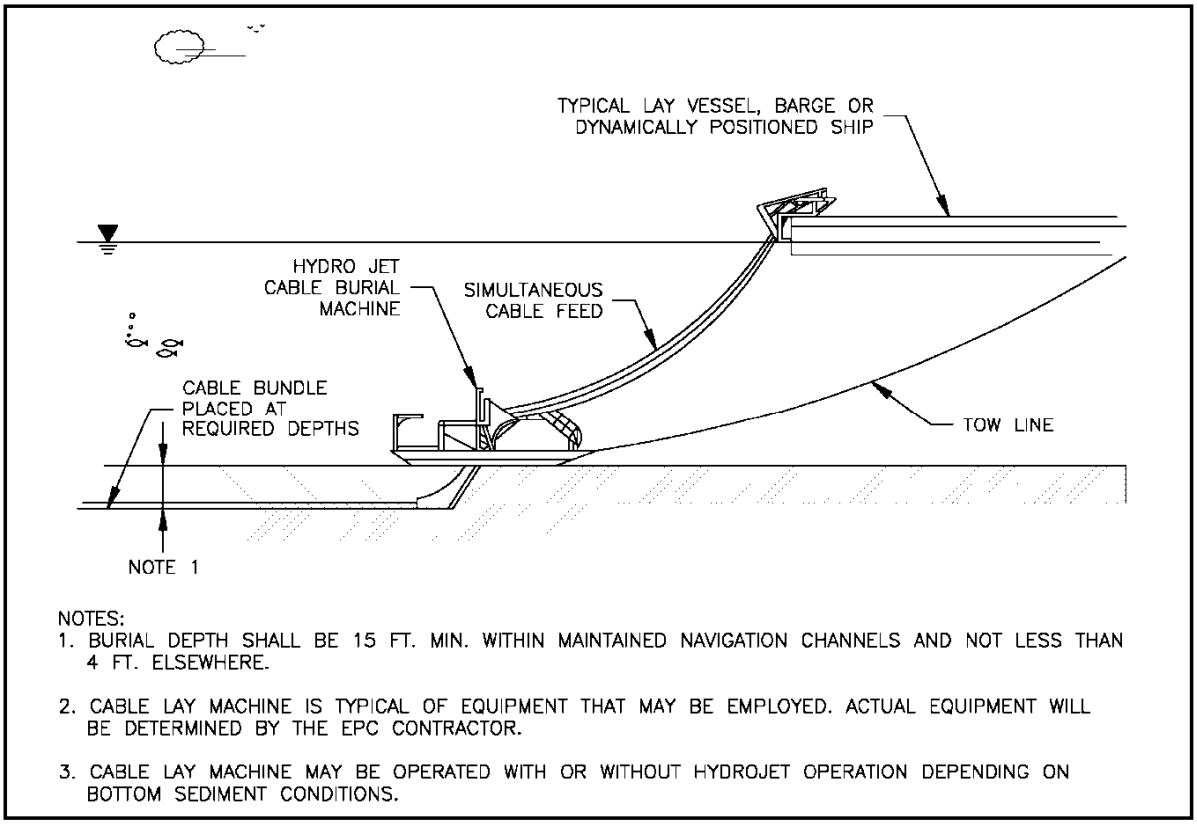
Submarine Cable Configuration

Similar to AC transmission lines, to transfer large amounts of power over an HVDC line, it may necessary to use more than one conductor/cable per voltage pole. In these instances the conductors may be "bundled" within a single submarine cable or they may be laid as separate cables. Similarly, the poles for an HVDC line may be bundled or laid separately. The determination of whether to bundle the poles of an HVDC line depends on project specifics and several factors, such as size of the conductors, cost, and reliability.

Submarine HVDC cables may be placed in a couple of ways, including direct laying on the bottom or trenching into the bottom. Directly laid cables may be left exposed on the bottom or there are a variety of coverings that can be used to protect the cables from currents and or mechanical damage from fishing or anchor dragging. Cable covering may employ rock coverage, concrete mattress placement, or split pipe covering. Trenching or plowing the cable into the seafloor provides simultaneous lay and burial. For trenched cables they may be buried using hydrojetting at the time of laying or they can be laid on the bottom and then trenched in after the initial cable lay. Post-lay burial may involve use of a remotely operated vehicle (ROV). The cable trench results in a disturbed area roughly a meter wide. The depth of cable trenching depends on the composition of the bottom, and cable can be buried at depths up to 10 meters.

The submarine cable installation process is illustrated in Figure 18.

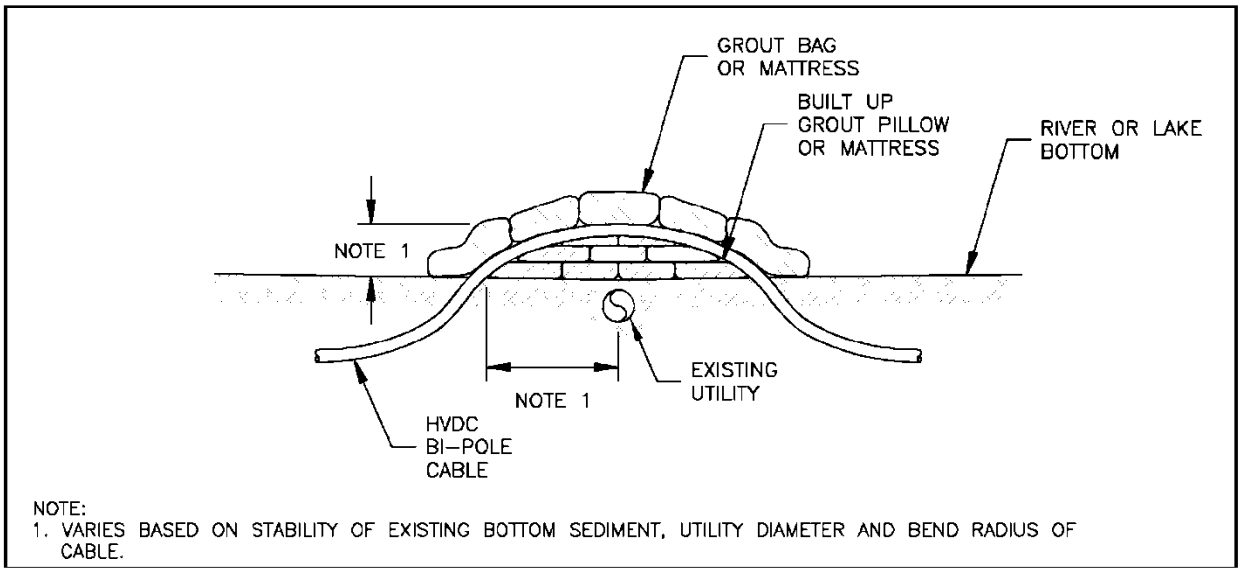
Figure 18: Submarine Cable Installation Process



Source: Champlain Hudson Power Express, 2013

Cable covering and armoring for providing protection for crossing existing utility pipelines or cables may use flexible concrete blankets or mattresses lowered into place around the existing utilities and over the submarine cable, as illustrated in Figure 19.

Figure 19: Submarine Cable Protection Measures



Source: Champlain Hudson Power Express, 2013

Precisely placing the submarine cable on the sea floor depends upon the water depth and positioning systems used on the cable-laying ship. Sophisticated monitoring and control systems can control cable placement to within 5 to 10 percent of the depth of water where the cable is being placed. When more than one cable is being placed, they may be horizontally positioned relatively close to each other. Horizontal spacing of a bipole, two-cable system would need to provide a sufficient buffer so that the second cable does not disturb or impinge on the first cable. The degree of control in placing the cables may dictate spacing on the order of 5 to 10 meters, increasing as water depths become greater. In addition, the potential future need to grapple one of the cables to raise it for repair may also require some minimum spacing.

Routing/laying of submarine cable also needs to consider the slope of the seafloor and/or the need for gradual turns. Cable routing should minimize traversing underwater slopes, because installation on steep slopes requires anchoring the cables to the sloping seafloor. Cable anchorage may be necessary for direct laid cable on slopes greater than 30 degrees. Slopes of 45 degrees or steeper should be avoided to the greatest extent possible, as these areas would require more complex anchorages and pose additional risks to the cable. The alignment generally cannot follow course changes that vary more frequently than the length of cable that is suspended from the back of the cable laying ship. The alignment should follow gradual course changes (no more than 30 degrees).

Coastal Landings

Coastal landings of the submarine cables would normally be housed within a durable conduit or pipe to add protection as the cables cross between the coastal zone and the onshore underground.

Coastal landings of the cables may be installed using either a direct lay approach or horizontal directional drilling (HDD). The direct lay approach requires soil or sandy bottom that allows the cables to be installed using conventional excavation methods, such as jetting or trenching. To directly bury the cable across a beach or sandy bottom, it may be suspended by floats from the offshore vessel and lowered into a trench, as shown in Figure 20.

Figure 20: Coastal Landing of Buoyed Cable

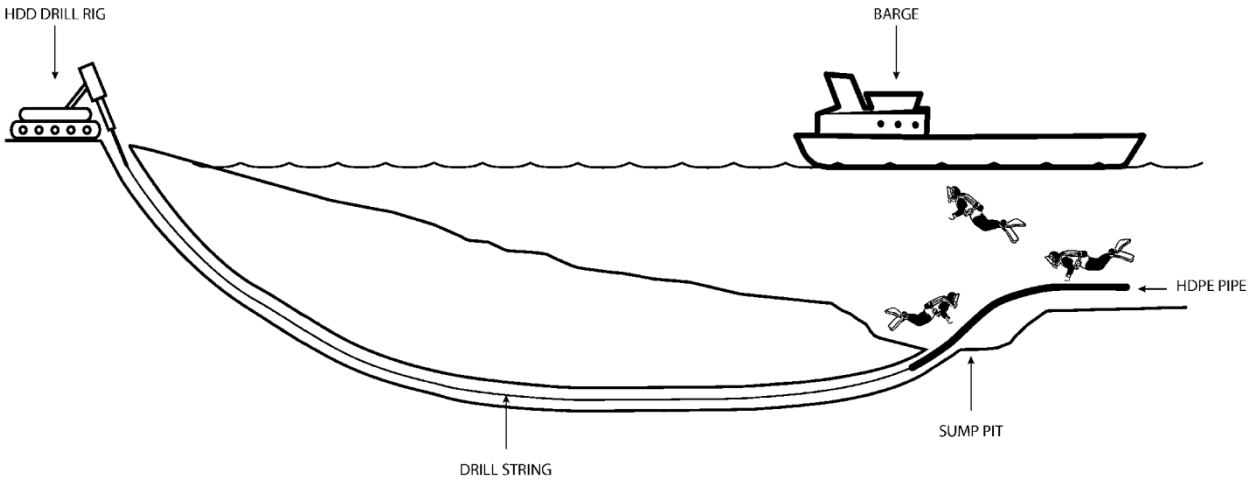
Source: Sharples, 2011

Where a steep slope occurs, HDD may be used to bring the submarine cable onto land areas. HDD can be characterized as drilling a microtunnel through the ground and installing a protective pipe into this microtunnel. The submarine cable is then installed within the pipe. HDD can be used in soils or bottom conditions that are not conducive to jetting or trenching. HDD can also mitigate construction in environmentally sensitive shore areas by passing beneath tidal zones, coastal features, dunes, or other shoreline critical habitat. The protective pipe installed via HDD generally ends once reaching water depths of 70 to 100 feet or a distance of up to 2,500 feet. This 2,500-foot limit is not dictated by HDD technology, but rather is due to

the limitations on the maximum distance that a submarine cable could be pulled through a pipe due to cable characteristics and strength. HDD construction methods require a work area onshore of roughly one to two acres for pipe laydown, drilling pads, and cable pulling equipment. This work area can be set back from the shore area as necessary, but the setback is limited by the 2,500-foot cable pulling distance.

Figure 21 shows the arrangement of a coastal landing constructed by HDD.

Figure 21: Coastal Landing of Cable Installed by HDD



Source: Pacific Gas and Electric Company, 2012

Terrestrial Underground Cable Configuration

Once a submarine cable makes landfall, there is typically a transition from a submarine-type cable to an underground-type cable. The transition point is installed in a large underground vault 15 to 20 feet wide, 30 to 40 feet long, and 10 feet high. The underground cable has a similar configuration to the submarine cable, but without the armoring that protects the cable in the marine environment. Removing the armoring reduces the weight of the cable and facilitates placing it in an underground trench or pulling into an underground duct bank.

Between coastal landings and the converter stations, underground cable would be placed in a trench and/or duct bank. There are several considerations for placing underground high-voltage cables. In general, it is preferred to place the cable in lengths as long as possible and to minimize the number of cable splices, as these can be a source of cable failure. When placing underground cables, there are also limitations on the bending radius that can be used for turns in the cable route and, in the case of cables pulled into duct banks in lieu of being laid in an open trench, pulling tensions need to be kept within an allowable range. The pulling tension when placing cables is a function of the cable weight and the friction within the duct the cables are pulled into. Of these two factors, the cable weight is the factor that varies the most from project to project and depends upon the specific electrical characteristics required for the cable.

The choice between placing underground cable as direct bury in an excavated trench or in an underground duct bank is dictated mostly by the nature of the area the cable route passes through.

The use of direct bury is most common and practical in rural or open areas, where there are few man-made obstructions or conflicting land uses that would preclude opening long sections of open trench and having a large amount of cable laying and trench excavation equipment along the cable route for extended periods. When direct bury methods are used, the cable route frequently is adjacent to or in close proximity to a roadway as these roads represent an existing linear corridor or right-of-way and they greatly facilitate movement of equipment. In cases where direct bury can be used, the dimensions for a trench with two HVDC cables would generally be a depth of at least 3 to 4 feet and of similar width. In this form of construction, the cables would be placed within the trench and surrounded by some type of homogeneous thermal backfill. It is also common to place a thin concrete cap above the cables and thermal fill as a physical barrier to protect the cable from unintended dig-ins. Native soils are then used as backfill to final grade. For direct bury cable, the distance between cable splices is generally dictated by the length of cable that can be manufactured and placed on a cable reel for shipping. Again, the length of cable on a reel will be project-specific, depending upon the size and characteristics of the cable and any transportation limits, but generally several thousand feet and as much as a mile or more of cable can be placed on a cable reel.

When splices are made in direct bury cable, these can be placed either in a cable pit or cable vault. During construction the cable splice area needs to be a controlled environment to manage contamination and limit exposure to the elements during splicing. Since cable splices can be a source of cable failure, there is a higher probability of a potential need to access the cable splices after construction is complete and the cables are in service. This presents a choice of whether to use a cable vault that provides immediate access to the splices or to use a cable pit that is much less costly but would require additional repair time for careful excavation to expose the splices. In any event, greater physical separation is provided between the cables in splice areas to provide working room so for a short distance a cable pit or cable vault will require a wider footprint of 10 to 20 feet.

The use of a cable duct bank and vault system is most common and practical in developed suburban and urban areas where there are many man-made obstructions or conflicting land uses that make it impractical to open long sections of trench and have a large amount of cable laying and trench excavation equipment along the cable route for extended periods. In this environment, securing a continuous linear right-of-way is extremely difficult, meaning that when duct banks methods are used, the cable route is most often beneath city streets or other disturbed rights-of-way. Placing the cables within a conduit provides protection against external damage and heat management. A backfill of low thermal resistivity material is typically placed around the conduits to aid in transferring heat away from the conductors. This form of construction also allows the construction of the duct bank and placement or pulling of the cable to occur as two construction activities.

The excavation of a trench to construct a duct bank holding two HVDC cables in an urban environment would need to address other existing underground utilities or facilities and could generally be a depth of 8 to 12 feet and a width at the surface of 4 to 6 feet. However, if individual duct banks are used for each cable in a bipole configuration, the duct bank for individual cables could be as few as two feet wide and as shallow as three feet. Along underground portions of the HVDC route, underground vaults would also need to be installed. Based on cable-pulling limitations, these vaults could be spaced roughly anywhere from every 1,200 to 2,000 feet apart. The distance between underground vaults would be dictated by the specific cable design. Cable vaults may also be required at a smaller spacing as needed where the cable route makes significant turns or changes in alignment. From the foregoing it can be seen that a cable duct bank and vault system can have a substantial amount of variance from one project to the next as dictated by the specifics of the urban environment and the design of the HVDC cable. Underground vaults would be similar to the vault where the transition from submarine cable to terrestrial cable occur. Vaults containing cable splices and their sizes would again depend upon the cable design but are typically 15 to 20 feet wide, 20 to 30 feet long, and 10 feet deep.

HVDC System Suppliers and Manufacturers

HVDC systems and high-voltage power cables (submarine and underground) rely upon very specialized technologies, for which there are a limited number of manufacturers and installers. Worldwide there may be a half-dozen to a dozen companies that can manufacture and install projects of this type. For this reason, it is most common that a turnkey or design-build approach is used to complete HVDC and submarine cable projects.

Major HVDC Installations Reviewed

Worldwide HVDC Installations

The earliest major HVDC systems came on-line in the 1950s and 1960s. Some of the original applications in Sweden and New Zealand were for submarine crossings, and these have remained in service, although many early HVDC systems have been upgraded in recent decades. About 100 systems are in use globally, with the lengths of the lines, service voltages, and power rating capacities growing steadily over the years. Among the largest, completed in 2010, are overhead HVDC systems completed in China ranging up to distances of more than 1,000 miles and more than 5,000 MW capacity. (Electric Power Research Institute, 2008; University of Idaho, 2012)

California is served by three major HVDC transmission lines: the 3,100 MW Pacific Intertie; the 2,400 MW Intermountain Power Project (Path 27), and the 400 MW Trans Bay Cable. The Pacific Intertie and Intermountain Project are long-distance overhead lines for importing out-of-state power to Southern California. The only HVDC transmission line within the California bulk transmission system is the submarine Trans Bay Cable in the San Francisco Bay, which was placed into service in late 2010.

Table 6 includes a sampling of HVDC installations illustrating the range of voltages, capacities, and distances crossed. The table identifies projects that have included significant lengths of

submarine cable, although for some projects, the length may be a combination of submarine and terrestrial segments. Table 7 provides a broader overview of worldwide HVDC projects.

Table 6: Notable Recent HVDC Projects and Successful Submarine Installations					
Name of Project (Technology)	**Location**	**Year Online**	**Maximum Depth of Water (feet)**	**Power Rating (MW)**	**Length of HVDC Submarine**
Trans Bay Cable	USA, San Francisco Bay	2010	100	400	53 mi underwater
Neptune Cable	USA, New Jersey–New York	2007	80	660	50 mi underwater; 64 mi total
Cross Sound Cable	USA, Connecticut–New York	2002	115	330	24 mi underwater
Cross Channel	UK-France	2011	140	2,000	29 mi underwater; 45 mi total
New Zealand Inter Island	New Zealand	1992	760	1,240	379 mi total
Grita	Greece-Italy	2001	N/A	500	196 mi total
Estlink	Estonia-Finland	2006	N/A	350	65 mi total
Basslink	Australia, Victoria-Tasmania	2006	N/A	500	180 mi submarine; 217 mi total
Norned	Norway-Netherlands	2008	450	700	360 mi total
Jindo-Jeju	Korea, Mainland-Jeju	2011	N/A	400	65 mi total
Britned	UK-Netherlands	2011		1,000	161 mi total
Murraylink	Australia, S. Australia–Victoria	2002	N/A	200	110 mi underground

Source: Aspen, 2014

Table 7: Overview of Worldwide HVDC Projects					
Name of Project (Technology)	**Location**	**Online**	**Power Rating (MW)**	**DC Voltage (kV)**	**Length of HVDC Line/Cable (miles)**
Konti-Skan 1 (Merc)	Denmark-Sweden	1965	250	±250	112
New Zealand Hybrid Inter Island Link (Merc)	New Zealand	1965	600	±250	378
Sacoi 1 (Thy)	Italy	1965	200	200	239
Pacific Intertie (Merc)	USA	1970	1,440	±400	844
Nelson River 1 (Merc)	Canada	1973	1,854	±463	552
Skagerrak I (Thy)	Norway-Denmark	1976	275	±250	149
Skagerrak II (Thy)	Norway-Denmark	1977	275	±250	149
Square Butte (Thy)	USA	1977	500	±250	464
Nelson River 2 (Thy)	Canada	1978	900	±250	583
Hokkaido-Honshu (Thy)	Japan	1979	150	125	104
Hokkaido-Honshu (Thy)	Japan	1980	300	250	104
Pacific Intertie (Merc)	USA	1982	1,600	±400	844
Gotland II (Thy)	Sweden	1983	130	150	62
Itaipu 1 (Thy)	Brazil	1984	1,575	±300	487
Itaipu 1 (Thy)	Brazil	1985	2,383	±300	487
Nelson River 2 (Thy)	Canada	1985	2,000	±500	583
Pacific Intertie Upgrade (Thy)	USA	1985	2,000	±500	844
Des Cantons–Comferford (Thy)	Canada-USA	1986	690	±450	107
Intermountain Power Project (Thy)	USA	1986	1,920	±500	487

Itaipu 1 (Thy)	Brazil	1986	3,150	±600	487
Gotland III (Thy)	Sweden	1987	260	±150	64
Itaipu 2 (Thy)	Brazil	1987	3,150	±600	499
Konti-Skan 2 (Thy)	Denmark-Sweden	1988	300	285	93
Pacific Intertie Expansion (Thy)	USA	1989	3,100	±500	844
Gesha (Gezhouba-Shanghai) (Thy)	China	1990	1,200	±500	620
Rihand-Delhi (Thy)	India	1991	750	500	505
New Zealand Inter Island (Thy) *[Depth: 760 feet]*	New Zealand	1992	1,240	+270/-350	379
Rihand-Delhi (Thy)	India	1992	1,500	±500	505
Hokkaido-Honshu (Thy) *[Depth: 780 feet]*	Japan	1993	600	±250	104
Sacoi (Codrongianos and Suvereto) (Thy)	Italy-Corsica-Sardinia	1993	300	±200	239
Skagerrak III (Thy)	Norway-Denmark	1993	500	±350	149
Baltic Cable (Thy)	Sweden-Germany	1994	600	450	162
Kontek (Thy)	Denmark-Germany	1995	600	400	106
Sylmar East (Valve Reconstruction) (Thy)	USA	1995	550	500	744
Haenam-Cheju (Thy)	Korea	1997	300	±180	63
Leyte-Luzon (Thy)	Philippines	1998	440	350	282
Gotland HVDC Light (Tra)	Sweden	1999	50	±60	43
Kii Channel (Thy) *[Depth: 190 feet]*	Japan	2000	1,400	±250	63
Swepol Link (Thy)	Sweden-Poland	2000	600	±450	157
Grita (Thy)	Greece-Italy	2001	500	400	196
Thailand-Malaysia (Thy)	Thailand-Malaysia	2001	300	±300	68

Tian-Guang (Thy)	China	2001	1,800	±500	595
Cross Sound (Tra)	USA	2002	330	±150	25
Murraylink (Tra)	Australia	2002	200	±150	110
East-South Interconn. II (Thy)	India	2003	2,000	±500	899
Three Gorges–Changzhou (Thy)	China	2003	3,000	±500	533
Celilo (Valve Replacement) (Thy)	USA	2004	3,100	±400	744
Gui-Guang I (Thy)	China	2004	3,000	±500	608
Three Gorges–Guangdong (Thy)	China	2004	3,000	±500	583
Konti-Skan 1 (Thy)	Denmark-Sweden	2005	250	±250	112
Basslink (Thy)	Australia	2006	500	400	217
Estlink (Tra)	Estonia-Finland	2006	350	±150	65
Three Gorges–Shanghai (Thy)	China	2006	3,000	±500	558
East-South Interconn. II Upgrade (Thy)	India	2007	2,500	±500	899
Gui-Guang II (Thy)	China	2007	3,000	±500	744
Neptune (Thy)	USA	2007	660	500	65
Cahora-Bassa (Thy)	South Africa–Mozambique	2008	1,920	±533	880
Norned (Thy) [depth: 450 feet]	Norway-Netherlands	2008	700	±450	360
Ballia-Bhiwadi (Thy)	India	2010	2,500	500	496
Caprivi (Tra)	Namibia	2010	300	350	589
Hulunbeir (Inner Mongolia) – Shenyang (Thy)	China	2010	3,000	± 500	570
Intermountain Power Project Upgrade (Thy)	USA	2010	2,400	± 500	487

Storebaelt (Thy)	Denmark	2010	600	400	35
Three Gorges–Shanghai 3 (Thy)	China	2010	3,000	±500	620
Trans Bay Cable (Tra)	USA	2010	400	200	55
Xianjiaba-Shanghai (Thy)	China	2010	6,400	±800	1,228
Yunnan-Guangdong (Thy)	China	2010	5,000	±800	879
Britned (Thy)	UK-Netherlands	2011	1,000	±400	161
Fenno-Skan II (Thy) *[Depth: 300 feet]*	Finland-Sweden	2011	800	500	188
Jindo-Jeju (Thy)	Korea	2011	400	±250	65
Ningdong-Shangdong (Thy)	China	2011	4,000	±660	828

Source: U. Idaho, 2012 (abridged); CIGRE, 2009. Converter Technology: Mercury (Merc), Thyristor (Thy), or Transistor (Tra).

Domestic HVDC Proposals Under Development

Other major HVDC projects that are under development elsewhere in the United States are briefly described below. Aside from the Hawaii proposal, these projects are sponsored by investment companies that aim to develop a transmission interconnection that may be used by others to exchange power, for a fee, similar to how a toll road may be paid for by users. Development timelines typically extend up to 10 years.

Port Angeles–Juan de Fuca Transmission Project. The U.S. Department of Energy (DOE) released a final EIS in October 2007 and issued a decision in May 2008 to implement this 34-mile international HVDC line from the greater Victoria area, British Columbia, Canada, across the Strait of Juan de Fuca (depths up to about 500 feet) to the United States at Port Angeles, Washington. The application was made in December 2004 by Sea Breeze Olympic Converter LP (under Sea Breeze Power Corp.) to secure approvals from DOE for the cable that would be capable of carrying up to 550 MW in either direction. The DOE's Bonneville Power Administration (BPA) offered the terms for interconnection with the federal Columbia River Transmission System, which is owned and operated by BPA, and the DOE's Office of Electricity Delivery and Energy Reliability issued a Presidential permit to Sea Breeze for the border crossing. Approvals from the Canadian National Energy Board remain pending.

Champlain Hudson Power Express Transmission Line Project. The U.S. DOE, Office of Electricity Delivery and Energy Reliability, released a draft EIS in September 2013 for an international submarine and overland HVDC line from the Canadian border about 336 miles through New York State, under Lake Champlain (with water depths approaching 400 feet) and in the Hudson River. The application for a Presidential permit was made in January 2010 by Champlain Hudson Power Express, Inc. (under Transmission Developers, Inc.) for the line, which would deliver 1,000 MW to the New York City grid. Any decisions or approvals for this project would occur after release of a final EIS.

Hawaii Inter-Island Renewable Energy Program (HIREP). The Hawaii Department of Business, Economic Development and Tourism and Hawaiian Electric Co. (HECO) have jointly studied the feasibility of a third party developing a 400 MW HVDC cable system in the ocean (depths up to about 2,600 feet) between Oahu and other islands with abundant renewable energy resources. The HIREP studies were triggered by a statewide renewable energy goal being set in 2008, and the DOE initially announced and then amended its notice of preparing a programmatic EIS in 2010 and 2012, respectively. Although various planning-level studies have been commissioned by the State of Hawaii (Navigant Consulting, Inc., 2011) and prepared for DOE by the National Renewable Energy Laboratory (NREL), no project application has yet been filed.

Description of Trans Bay Cable

Trans Bay Cable LLC (TBC) owns and maintains the Trans Bay Cable, a 400 MW HVDC transmission line that includes 53 miles of underwater cable in the San Francisco Bay and Carquinez Straits from Pittsburg, in Contra Costa County, to Potrero Point in San Francisco. The project was developed in cooperation with the City of Pittsburg and Pittsburg Power Company (a municipal utility). In early 2004, TBC started the environmental review process, and the

project came on-line in late 2010. The City of Pittsburg acted as the lead agency under CEQA and certified the final environmental impact report in November 2006. Allowing one year for feasibility studies prior to starting the environmental review, the development timeline for TBC was about seven years.

The transmission line includes an onshore HVDC converter station at each endpoint, each with a footprint of about 5.5 acres, within sites that are smaller than 8 acres. Short (0.3 mile) AC cable and overhead transmission lines connect the HVDC converter stations to the PG&E Pittsburg and Potrero substations.

During cable installation most of the cable alignment, except at utility crossings, was buried to a depth of 3 to 6 feet in the San Francisco Bay floor using a hydroplow. At utility crossings the cable was laid on top of existing pipelines and cables, which are protected from the overlying cable by concrete mattress or rock riprap. The cable bundle, which consists of a power transmission cable and a return cable with a fiber-optic cable for communication between the converter stations, is about 10 inches in diameter.

Since coming on-line, the line has achieved a high level of service. The owner of the system filed for subsequent environmental review of submarine maintenance. The owner also recently proposed to add black start capability. The black start capability, or "dead bus energization," would improve the functionality of the existing line if it is tripped out of service. Each of these changes is described below.

Maintenance Requirements

To conduct maintenance along the areas where the cable is exposed, TBC applied to the U.S. Army Corps of Engineers (USACE) to allow in-water activities needed to protect the cable over a 10-year period. Over the next 10 years, TBC would need to add protection to locations that coincide with areas where the cable could not be buried or where the current has exposed the buried utilities. TBC seeks approval for placing concrete mattresses and rock fill in areas surrounding the exposed cable. The maintenance activities include hand jetting to increase the depth of the burial of the cable in sand and sediment, placing additional protective mattresses, and adding rock fill to support an eroded area where the cable crosses over a pipeline. These activities would mitigate environmental impacts by adhering to seasonal work windows, slowly moving the concrete and rock fill into position, and using low-pressure jets to minimize disturbance and turbidity (U.S. Army Corps of Engineers, 2013).

Upgrading to Provide Black Start Capability

TBC plans to modify the existing HVDC line to allow energizing the Potrero 115 kV bus in the event of a loss of power in San Francisco coinciding with a loss in service of the cable. The California ISO approved the Dead Bus Energization Project in early 2013. This project would allow TBC to energize the HVDC cable so it could quickly supply power from Pittsburg to Potrero to foster restoring service to a portion of San Francisco. The upgrade would install fast-ramping generation, potentially two 1.5 MW units, at TBC's Potrero substation to establish bus voltage and frequency allowing power to flow from Pittsburg. TBC hopes to place this feature into service in 2015 (California Independent System Operator, 2013). Depending on the final

design, the new generation could cause environmental impacts as a minor emergency-use-only stationary source of air pollution and mechanical noise.

Perspective on the Trans Bay Cable

The TBC project and other projects worldwide demonstrate that the HVDC technology is proven and viable. The TBC project achieved commercial operations in November 2010, with about nine months of delays, and it was the first use of VSC technology supplied by Siemens (called HVDC Plus) (Navigant Consulting, Inc., 2011). The technology has become more common, and a 2010 survey of potential developers for the Hawaii Inter-Island cable project found that a VSC HVDC system would be the likely choice of technology for that application, which involved radially connecting remote wind farms. However, the potential developers at that time held concerns with the commercial status of the VSC technology. As a competing manufacturer of similar technology, ABB (called HVDC Light) has commissioned at least 10 other VSC HVDC facilities elsewhere in the world (ABB, 2013). During the subsequent years of operation, relatively minor submarine maintenance activities have been necessary, and the proposal to add black start capability indicates an ongoing interest in investing in the TBC to improve its capabilities.

Regulatory Requirements for Submarine-Based Alternative

This section summarizes the regulatory requirements for submarine cables in general and identifies permits or approvals potentially required for a new submarine HVDC cable between the SCE and SDG&E territories. Table 8 on page 97 lists the permits that may be required for the submarine HVDC cable. Applicable agency jurisdictions and laws are also described below.

Lead Agencies for NEPA and CEQA

The lead agencies carry the primary burdens for conducting the environmental impact assessment, preparing environmental documentation, ensuring the appropriate level of public review, and coordinating consultation with every involved agency.

The USACE has jurisdiction over structures and work in navigable waters, and the USACE would be the likely federal lead agency in the NEPA process.

Either the California Coastal Commission or the California State Lands Commission would be likely to take the role of lead agency in the CEQA process.

In Chapter 4, the section on "Environmental Considerations" elaborates on agency jurisdiction and highlights the timelines for the environmental review process and other issues that may influence the viability of installing a new submarine cable system.

Ocean Jurisdiction

In general, offshore construction activities are under State of California jurisdiction if they occur within 3 nautical miles of the shoreline, and federal jurisdiction applies to construction activities more than 3 nautical miles from shore.

Federal Submerged Lands Act (43 United States Code (U.S.C.) § 1301 et seq.) granted ownership of lands and resources within 3 nautical miles (5.6 kilometers) of the shore to California (and other coastal states).

Outer Continental Shelf (OCS) Lands Act (43 U.S.C. § 1331 et seq.), passed in coordination with the Submerged Lands Act, confirmed federal jurisdiction over the resources beyond 3 nautical miles from shore and created a legal process for developing those resources. Section 4(f) of the OCS Lands Act requires a permit for the construction or artificial islands, installations, and other devices on the seabed to the seaward limit of the outer continental shelf.

The Bureau of Ocean Energy Management (BOEM), within the U.S. Department of the Interior, administers activities related to development on the OCS and conducts environmental studies, including NEPA analyses for offshore energy development. The OCS Lands Act establishes the authority of the U.S. Department of the Interior (DOI) to grant rights-of-way for pipelines and other facilities for transmission of energy through the OCS. The submarine HVDC cable would not require a lease or easement from BOEM because the project would not qualify as an activity that supports development or production of energy on the OCS (30 CFR 585).

Federal Requirements

Clean Water Act (CWA). The purpose of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." Clean Water Act Section 404 and the Rivers and Harbors Act of 1899 Section 10 define waters of the United States and wetlands. The definition of "waters of the United States" includes rivers, streams, estuaries, the territorial seas, ponds, lakes, and wetlands. Wetlands are defined as those areas "that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 Code of Federal Regulations (CFR) 328.3 7b). Section 404 of the CWA prohibits fill of and dredging of waters of the United States without prior authorization from the USACE. Section 401 requires California (via the nine Regional Water Quality Control Boards) to issue Water Quality Certifications (WQC) for licenses or permits issued for, among other things, the discharge of dredged or fill materials to federally jurisdictional waters, or waters of the United States.

Rivers and Harbors Act (33 U.S.C. § 403) addresses effects to navigable waters and regulates "excavation, fill, or alterations or modifications to the course, location, condition, or capacity of any port, …harbor, canal, lake, …or enclosure within the limits of any breakwater, or of the channel of any navigable water of the United States, unless the work has been recommended by the Chief of Engineers." Under Section 10 of the Rivers and Harbors Act, the USACE has the authority to regulate the navigable capacity of any of the waters of the United States.

USACE Nationwide Permit Program (NWP). Nationwide Permit No. 12 for Utility Line Activities, if applicable, could be used to satisfy Section 404 of the CWA and Section 10 of the Rivers and Harbors Act. The NWP covers limited activities, including those "...required for the construction, maintenance, repair, and removal of utility lines and associated facilities in waters

of the United States, provided the activity does not result in the loss of greater than 1/2-acre of waters of the United States for each single and complete project."

Coastal Zone Management Act (CZMA). The CZMA outlines two national programs, the National Coastal Zone Management Program and the National Estuarine Research Reserve System. The 34 coastal programs aim to balance competing land and water issues in the coastal zone. The overall program objectives of CZMA remain balanced to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." The National Oceanic and Atmospheric Administration's (NOAA) Office of Ocean and Coastal Resource Management (OCRM) administers the CMZA.

Marine Mammal Protection Act (MMPA). The 1972 MMPA established a federal responsibility to conserve marine mammals. The Department of Interior has jurisdiction over sea otters, walruses, polar bears and manatees, and the Department of Commerce is responsible for cetaceans and pinnipeds other than the walrus. Under the MMPA of 1972 (as amended in 2007), it is unlawful to take or import marine mammals and marine mammal products. The MMPA defines "take" as "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." (16 U.S.C. §1362(13).) Under Section 101(a)(5)(D) of the MMPA, an Incidental Harassment Authorization (IHA) Permit may be issued for activities other than commercial fishing that may affect small numbers of marine mammals. An IHA covers activities that extend for periods of no more than one year and that will have a negligible effect on the impacted species. If the potential for serious injury and/or mortalities exists, and there are no measures that could be taken to prevent this form of "take" from occurring, a Letter of Authorization (LOA) must be obtained.

Federal Endangered Species Act (ESA). The federal ESA is implemented by U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NMFS, also known as NOAA Fisheries). The federal ESA protects plants and wildlife that are listed as endangered or threatened by USFWS and NMFS. Section 9 of the ESA prohibits the take of listed fish and wildlife, where "take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in such conduct" (50 CFR 17.3). For plants, this statute governs removing, possessing, maliciously damaging, or destroying any listed plant on federal land and removing, cutting, digging up, damaging, or destroying any listed plant on nonfederal land in knowing violation of state law (16 U.S.C. 1538).

Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §§ 1801-1884). The Magnuson-Stevens Act of 1976 (as amended in 1996 and reauthorized in 2006) applies to fisheries resources and fishing activities in federal waters, which extend to 200 miles offshore. The act is intended to facilitate conservation and management of U.S. fisheries, development of domestic fisheries, and phasing out of foreign fishing activities. Sections 305(b)(2) to (4) of the Magnuson-Stevens Act outline a process for NMFS to comment on activities proposed by federal action agencies that may adversely impact areas designated as Essential Fish Habitat (EFH). Specifically, federal action agencies are required to consult with NMFS on any action authorized, funded, or undertaken that may adversely impact EFH.

Migratory Bird Treaty Act (16 U.S.C. §§ 703–711). The MBTA of 1918 protects all migratory birds. Birds protected under the MBTA include all native waterfowl, shorebirds, hawks, eagles, owls, doves, and other common birds such as ravens, crows, sparrows, finches, swallows, and others, including their body parts (for example, feathers and plumes), active nests, and eggs. A complete list of protected species is found at 50 CFR 10.13. The USFWS is responsible for enforcing the provisions of the MBTA.

National Historic Preservation Act. Section 106 of the National Historic Preservation Act requires consultation regarding cultural resources listed in or eligible for inclusion in the National Register of Historic Places. The regulations implementing Section 106 (36 CFR 800) specify a consultation process to assist in satisfying this requirement. Consultation with the appropriate State Historic Preservation Office, the Advisory Council, Native American tribes, the public, and state and federal agencies is required by Section 106 of the National Historic Preservation Act. The State Historic Preservation Office would be responsible for reviewing all project-related reports.

Abandoned Shipwreck Act. The Abandoned Shipwreck Act establishes government ownership over the majority of abandoned shipwrecks located in waters of the United States and creates a framework within which shipwrecks are managed. It affirms the authority of state governments to claim and manage abandoned shipwrecks on state submerged lands. The Abandoned Shipwreck Act protects any wreck that is claimed by the government from open-sea laws of salvage and finds and preserves shipwrecks as multiple-use resources. Additional protections are provided by the Sunken Military Craft Act, which does not allow any person to possess, disturb, remove, or injure any sunken military craft.

Clean Air Act (42 U.S.C. §7401-7626). Section 176(c) of the federal Clean Air Act requires federal agencies to ensure that actions undertaken in nonattainment or maintenance areas are consistent with federally enforceable air quality management plans. General conformity requirements apply to those aspects of the federal action that involve ongoing federal agency responsibility and control over direct or indirect sources of air pollutant emissions. Compliance with the conformity rule can be demonstrated in several ways. Compliance is presumed if the net increase in direct and indirect emissions from a federal action would be less than the relevant *de minimis* levels for the nonattainment area. If net emissions increases exceed a *de minimis* value, a formal conformity determination process must be followed. Federal agency actions subject to the general conformity rule cannot proceed until there is a demonstration of consistency with the local State Implementation Plan.

State Requirements

California Coastal Act. The California Coastal Act is intended to protect the state's 1,100 miles of coastline. The policies of the Coastal Act form the standards by which the California Coastal Commission approves coastal development permits (CDP) and the Local Coastal Programs (LCP) developed by local agencies. Development activities within 1,000 yards of the mean high tide are generally subject to the Coastal Act and would require a CDP.

Coastal Act Section 30108.2 defines "fill" as "earth or any other substance or material, including pilings placed for purposes of erecting structures thereon, placed in a submerged area." Coastal Act Section 30233(a)(5) allows the filling of open coastal waters for "incidental public service purposes, including but not limited to, burying cables and pipes or inspection of piers and maintenance of existing intake and outfall lines." The two tests that must be met to qualify under this subsection are that (1) the use must be for incidental purposes, including the burying of cables, and (2) the use must offer a public service.

California State Lands Commission. The California State Lands Commission has jurisdiction over the state's tidal and submerged coastal lands from the mean high tide line to 3 nautical miles offshore, including filled lands formerly covered with water, offshore islands, bays, estuaries, and lagoons. Determinations made by the State Lands Commission on the need to permit or agree to lease facilities on submerged lands must consider whether the lease is in the best interest of the State (2 California Code of Regulations [CCR] 2802).

Unified Port District of San Diego. The Port District manages roughly 33 miles of San Diego shoreline and has been granted 5,483 acres of tidelands on the San Diego Bay and submerged lands that were conveyed to the Port District by the California State Lands Commission. The Port District is governed by the San Diego Unified Port District Act, San Diego Port District Code, and the Unified Port of San Diego Port Master Plan.

California Endangered Species Act (CESA) (CFGC §§ 2050-2098). Sections 2050-2098 of the California Fish and Game Code (CFGC) prohibit the take of state-listed endangered and threatened species unless specifically authorized by CDFW. The state definition of "take" is to hunt, pursue, catch, capture, or kill a member of a listed species or attempt to do so. CDFW administers the California Endangered Species Act (CESA) and authorizes take through permits or memoranda of understanding issued under Section 2081 of CFGC or through a consistency determination issued under Section 2080.1. A consistency determination allows CDFW to authorize a project to proceed if that agency agrees with terms and conditions developed for a federal Biological Opinion and Incidental Take Permit. Section 2090 of CFGC requires state agencies to comply with threatened and endangered species protection and recovery and to promote conservation of these species.

Marine Protected Area (CFGC §§ 2852[c]). Marine protected areas (MPA) are designated by law, administrative action, or voter initiative to protect or conserve marine life and habitat. The Marine Life Protection Act of 1999 required CDFW to redesign its system of MPAs to increase coherence and effectiveness. MPA classifications include Marine Life Reserves (the equivalent of the State Marine Reserve classification); State Marine Parks, which allow recreational fishing and prohibit commercial extraction; and State Marine Conservation Areas, which allow for specified commercial and recreational activities, including fishing for certain species but not others, fishing with certain practices but not others, and kelp harvesting, provided that these activities are consistent with the objectives of the MPA and relevant California Fish and Game Code. MPA classifications are described in more detail below:

- **State Marine Reserve**: Prohibits all take and consumptive use (commercial and recreational, living or geologic). Scientific research and nonconsumptive uses are allowed.

- **State Marine Park**: Prohibits commercial take but may allow select recreational harvest to continue. Scientific research and nonconsumptive uses allowed.

- **State Marine Conservation Area**: May allow select recreational and commercial harvest to continue. Scientific research and nonconsumptive uses are allowed. Some state marine conservation areas are designated as "no-take."

- **State Marine Recreational Management Area**: Provides subtidal protection equivalent to an MPA, while allowing legal waterfowl hunting. Scientific research and nonconsumptive uses are allowed.

- **Special Closure**: An area designated by the Fish and Game Commission that prohibits access or restricts boating activities in waters adjacent to the sea bird rookeries or marine mammal haul-out sites.

MPAs are a subset of marine managed areas (MMAs), which are broader groups of named, discrete geographic areas along the coast that protect, conserve, or otherwise manage a variety of resources and uses, including living marine resources, cultural and historical resources, and recreational opportunities. MMA classifications include state water quality protection area, state marine cultural preservation area, and state marine recreational management area. There are 50 MPAs in the South Coast Region, which covers the California coast from Point Conception in Santa Barbara County south to the California/Mexico border; these MPAs include 19 State Marine Reserves (SMR), 21 State Marine Conservation Areas (SMCA), 10 No-Take SMCA, and 2 Special Closure Areas.

Table 8: Permits That May Be Required for the Submarine HVDC Cable		
Agency	**Jurisdiction**	**Requirements**
Federal Agencies		
Council on Environmental Quality, National Environmental Policy Act	Environmental review of major federal actions	Compliance with NEPA: preparation of EIS
U.S. Army Corps of Engineers (USACE), Los Angeles District	Waters of the United States	▪ Permit (i.e., a federal action) and Environmental Assessment for marine cable installation in open waters under the Clean Water Act Section 404 and the Rivers and Harbors Act Section 10. ▪ Determination of applicability of Nationwide Permit (NWP) No. 12 for Utility Line Activities. ▪ Likely lead agency for the NEPA process and agency consultation. ▪ Determination of General Conformity applicability under Clean Air Act Section 176.
U.S. Coast Guard (USCG) - Los Angeles-Long Beach Sector; San Diego Sector; 11th Coast Guard District (Alameda)	Navigable waterways	▪ Establish Vessel Traffic Safety zone ▪ Issuance of appropriate Notice to Mariners
U.S. Department of Defense	Marine Corps Camp Pendleton for SONGS; San Diego Bay for Old Town, Silvergate, or South Bay	Consultation

Table 8: Permits That May Be Required for the Submarine HVDC Cable		
Agency	**Jurisdiction**	**Requirements**
Marine Corps Base (MCB) Camp Pendleton	Construction on MCB Camp Pendleton	▪ Federal Aviation Regulation (FAR) Part 77 Request (via FAA) ▪ Secretary of the Navy Instructions (SECNAVINST) 11011.47A (access road outside easement) ▪ License for nonfederal use of real property
U.S. Fish and Wildlife Service (USFWS), Sacramento, Ventura, and Carlsbad Field Office	Pacific Ocean	▪ Biological Assessment, Section 7 Consultation, Biological Opinion ▪ Enforcement of the Migratory Bird Treaty Act (MBTA)
Federal Communications Commission (FCC)	Licenses/permits related to FCC frequencies and paths	Telecommunication permit as required
U.S. Bureau of Indian Affairs, Pacific Regional Office	Section 106 of the National Historic Preservation Act of 1966	National Historic Preservation Act, Section 106 consultation
Advisory Council on Historic Preservation	▪ National Register of Historic Places ▪ Abandoned Shipwreck Act	National Historic Preservation Act, Section 106 consultation
National Marine Fisheries Service/National Oceanic and Atmospheric Administration Fisheries, Southwest Regional Office	Marine fisheries, special-status species and habitats	▪ Consultation or technical assistance under Section 7 of the Endangered Species Act (ESA) regarding USACE permit; ▪ Potential impact to Essential Fish Habitat (EFH); ▪ Potential Incidental Harassment Authorization (IHA) permit under Marine Mammal Protection Act (MMPA)
United States Fish and Wildlife Service	Special-status species and habitats, migratory birds	▪ Consultation under Section 7 of the Endangered Species Act (ESA); ▪ Enforcement of the Migratory Bird Treaty Act (MBTA)

State Agencies, Regional Agencies, and Port Districts		
California Coastal Commission	Development activities within 1,000 yards of the mean high tide	▪ Coastal development permits ▪ Consistency with California Coastal Act ▪ Consistency with the federal Coastal Zone Management Act (CZMA) ▪ Likely Lead Agency for CEQA and certification of EIR
California State Lands Commission (CSLC)	Tidal waterways and submerged lands below the mean high tide line	▪ Alternative acting lead agency or responsible agency for CEQA process ▪ Residual and review authority over actions managing lands legislatively granted to City of Long Beach, which owns Port of Long Beach lands, and the San Diego Unified Port District.
Port of Long Beach	Long Beach Harbor District	Not applicable. Eastern limit of Harbor District is at the Los Angeles River.
Port of San Diego	San Diego shoreline and tidelands on the San Diego Bay	Consultation regarding consistency with the Port Master Plan
California Department of Fish and Wildlife (CDFW)	Special-status species and habitats, including Marine Protected Areas	▪ California Endangered Species Act coordination, Section 20801 Incidental Take Permit or Consistency Determination under California Fish and Game Code Section 2080.1 ▪ Native Plant Protection Act, and other provisions of the Fish and Game Code as applicable ▪ Marine Life Protection Act and rules for Marine Protected Areas
California Department of Water Resources	Water crossings	Encroachment/crossing permit (as required)

California State Water Resources Control Board, and Regional Water Quality Control Board (RWQCB) – Los Angeles Region; Santa Ana Region; San Diego Region	Clean Water Act, Section 401	▪ National Pollution Discharge Elimination System (NPDES); ▪ General Construction Storm Water Pollution Prevention Plan (SWPPP); ▪ Water Quality Certification under Section 401 of the Clean Water Act
California Department of Industrial Relations Division of Occupational Safety and Health		Construction activities permit
California Department of Transportation (Caltrans)	State-owned streets and highways Code 660-711.21 CCR 1411.1-1411.6	Encroachment permit and design review
South Coast Air Quality Management District (SCAQMD); or San Diego Air Pollution Control District (SDAPCD)	South Coast Air Basin; or San Diego Air Basin	Portable Equipment Registrations; Emissions Standards for Marine Vessels; Authority to Construct and Permit to Operate backup diesel generator for black start capability (if required).
Local Agencies: Alamitos		
City of Long Beach	City streets and sidewalks	ROW Acquisition and/or establish utility franchise area
City of Seal Beach	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit
Local Agencies: Huntington Beach		
City of Huntington Beach	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit

Local Agencies: San Onofre, Japanese Mesa, or SONGS Mesa		
Marine Corps Base (MCB) Camp Pendleton (see Federal Agencies)	See above.	See above.
Local Agencies: Encina or Cannon		
City of Carlsbad	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit
Local Agencies: Penasquitos		
City of San Diego	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit
Local Agencies: South Bay or Bay Boulevard		
Port of San Diego	San Diego Bay	See Port Districts, above.
City of Chula Vista	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit
Local Agencies: Old Town		
Port of San Diego	San Diego Bay	See Port Districts, above.
City of San Diego	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit
Local Agencies: Silvergate		
Port of San Diego	San Diego Bay	See Port Districts, above.
City of San Diego	City streets and sidewalks	▪ Traffic Management Plan; ▪ Excavation Permit

Source: Aspen Environmental, 2014

CHAPTER 4:
Submarine Transmission Considerations

Developing a submarine HVDC submarine cable connecting the SCE and SDG&E electrical transmission systems would be an extremely complex project. In-depth surveys and evaluations would need to be conducted by viable project sponsors with experience and access to sufficient resources to establish an optimum route and design. This work presents an early stage evaluation of installing a submarine HVDC power cable in the Southern California study area

This effort reviews publicly available reports, presentations, and studies of impacts or feasibility of comparable concepts to assess the state of the industry and highlight some of the unique limitations or concerns (Gevorgian, 2011; Bureau of Ocean Energy Management, 2007; Sharples, 2011).

The considerations identified here provide an overview of requirements stemming from regulatory agency oversight, environmental issues, and technical or construction engineering concerns. Comprehensive environmental and technical studies would still need to occur before any agency could approve a project of this nature.

Feasibility Metrics for Submarine HVDC Cable

Successful completion of a submarine HVDC cable project could be threatened by several considerations summarized here. This list highlights the issues that represent potential fatal flaws. Proper project route selection and design should be able to address each of these issues so that they do not fatally affect the feasibility or viability of building new submarine transmission in the study area.

Ensuring Project Viability

Table 9 summarizes the primary early stage concerns and how an electric transmission project in the submarine corridor could address the issues.

Table 9: Early Stage Concerns for Submarine Corridor

Consideration	Potential Solutions
Submarine Cable	
Avoid hard-bottom areas, rocky substrate, or bedrock.	▪ Geophysical (geological and geotechnical) survey during route assessment. ▪ Conduct post-lay surveys to determine as-built impacts and restoration plans, and fund payments into a Hard Bottom Mitigation Fund.
Avoid slopes greater than 30 degrees.	▪ Bathymetry and sonar survey during route assessment.

Table 9: Early Stage Concerns for Submarine Corridor	
Consideration	**Potential Solutions**
Route cable crossings of faults in the direction of the fault lines.	▪ Geophysical survey during route assessment. ▪ Study of seismic activity and history during route assessment to determine seafloor instability, seismic ground movement, and fault rupture. ▪ Provide excess slack of cable in fault areas where large displacements could occur.
Avoid suspensions or free spans of cable.	▪ Secure the cable to the seafloor through the installation of bolts or anchorage systems in the rock, although this could result in unavoidable impacts to hard bottom habitat. ▪ Geophysical survey during route assessment.
Avoid State Marine Conservation Areas.	▪ Requires specific authorization by CDFW. ▪ Conduct early CDFW staff consultation.
Avoid State Marine Reserves.	▪ Activities within a marine reserve should be avoided, as they are generally restricted to research, restoration, or monitoring. ▪ Conduct early SMR and CDFW staff consultation.
Avoid routing along length of a navigable or marked channel, and avoid areas used for anchoring.	▪ Identify anchorage areas and normal navigable routes during early-stage study. ▪ Increase burial depth and add armoring to increase protection.
Route cable or pipeline crossings as near a 90-degree perpendicular angle to the existing cable as practicable.	▪ Identify existing cables and pipelines during early stage study. ▪ Magnetometer survey during route assessment. ▪ Install a protective conduit for existing utilities or post-lay armoring.
Avoid known shipwrecks and mapped archaeological resources.	▪ Identify known wrecks, protected cultural resources, and debris during early stage study. ▪ Magnetometer survey during route assessment. ▪ Follow a treatment plan for unanticipated and unavoidable discoveries.

HVDC Converter Stations	
Site converter stations with compatible existing land uses.	▪ Choose converter station locations with adequate transportation infrastructure for 100-ton transporter capacity. ▪ Select Alamitos or Huntington Beach for northern HVDC terminal point. ▪ Select San Onofre or Encina for southern HVDC terminal point.
Coastal Landings and Underground Cable	
Site coastal landing zones and terrestrial underground cable with compatible existing land uses.	▪ Choose coastal landing to occur through an existing conduit or pipeline, such as one of the power plant cooling water intake structures, if available and well-maintained. ▪ Underground route selection should avoid creating disruptions to existing sensitive, nonindustrial land-use types.
Avoid placing HDD through permeable geologic formations.	▪ Install casings or conduits during the HDD process to seal off permeable formations.
Avoid placing underground cable through contaminated sites.	▪ Adhere to applicable site management plans or risk management plans established for purposes of subsurface remediation.

Source: Aspen Environmental, 2014

Tools for Route Selection

Recent federally sponsored review (Sharples, 2011) of the state-of-the-art for submarine power cable burial shows the wide range of interrelated considerations for route selection and the various phases of study. The route depends on:

- Considerations of cable design, installation, burial depth, and lifetime.
- Considerations of installation vessel based on water depth, geological information, permissible cable stresses, and burial depth/cable protective measures.
- Weather for installation.
- Potential cable protection from scour and navigation risk.

Refining the understanding and requirements along the route can be accomplished by a sequence of studies, data gathering, and surveys.

Desktop Study

This level of study helps to design and plan the subsequent field surveys. The range of information gathered would include:

- Bathymetric information, such as charts and surveys from harbors.
- Anchorage areas, shipping fairways, normal shipping routes, buoy areas, and others.
- Geological information, including rock outcrops and mudslide areas.
- Existing geotechnical (soils) data and information from other geological surveys.
- Information on existing cables, pipelines, and so forth.
- Meteorological and oceanographic information, including tides, currents, and wind and wave regimes.
- Information on wrecks and debris on seabed, for example, from NOAA databases including Automated Wreck and Obstruction Information System (AWOIS).
- Seismic activity maps and any records of seismic activity.
- Archeological and chemosynthetic communities that may be necessary to avoid.
- Information from USCG databases of incidents and near misses of shipping in the area, dropped equipment.
- Information on military activities including restricted military activity areas and so forth.

Route Assessment Field Survey

After desktop studies, the initial field work to determine suitability of the route includes:

- Bathymetry survey to confirm and refine the detail of information from charts.
- Sonar survey to understand the bottom and subbottom profile, potential sand waves, and information on evidence of bottom currents.
- Magnetometer survey to provide information on metal objects including debris, existing pipelines, and cables.
- Geophysical survey to provide soil type, strength, temperature, and temperature absorption capability.
- Survey of currents and surf action.

Burial Assessment Survey

After preliminary route selection and before installation, a burial assessment survey would provide input to design of armoring, confirmation of the potential burial depth, data to determine the speed with which the cable can be laid and the risk of hang-up of the burial methods and methods to facilitate the selection of installation vessels and burial equipment. This may involve running an assessment plow along without a cable present to confirm the route or using an instrumented sled to conduct final electronic surveys of the route.

Environmental Considerations

Agency Jurisdiction

Federal Agencies

Coastal waters are granted to the State of California, and federal jurisdiction of the Outer Continental Shelf (OCS) lands includes resources beyond 3 nautical miles (5.6 kilometers) from shore.

The USACE has jurisdiction over structures and work in navigable waters, and the USACE would be the likely federal lead agency in the NEPA process. The authority of the USACE stems from Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The site-specific circumstances and construction methods dictate the permitting requirements. For example, jet plowing would not generally be subject to a Section 404 permit because it would not represent a discharge of dredged or fill material. Work in navigable waters would generally be subject to the Section 10 permit requirements. Although not all trenching for installation of a submarine cable may require a Section 404 permit, the USACE Los Angeles District Engineer has the authority to specify the cable burial depth and separation distances. Typically, the USACE burial requirements would be 3 to 6 feet below the seabed and up to 15 feet buried in an anchorage area or in a channel (Sharples, 2011). Obtaining a permit from ACOE and completing the NEPA process may take about two years.

Although the Outer Continental Shelf Lands Act establishes the authority of the U.S. Department of the Interior and Bureau of Ocean Energy Management to grant rights-of-way for energy facilities through the OCS, the submarine HVDC cable would not require BOEM approval because the project would not qualify as an activity that supports development or production of energy on the OCS (30 CFR 585).

Other federal agencies that would need to be consulted during the NEPA process, which could alternatively serve as NEPA lead agency, depending on the level of interest, include the U.S. Coast Guard, Department of Energy, Department of Defense, Fish and Wildlife Service, and National Marine Fisheries Service/National Oceanic and Atmospheric Administration. Other permitting requirements are shown in Chapter 3, Regulatory Requirements for Submarine-Based Alternatives.

FERC could be involved with economic regulation of the new electric transmission infrastructure, but FERC would not conduct environmental review for this project.

The study area does not include any waters that are within a National Park or a National Monument located on the OCS or in National Marine Sanctuaries or National Wildlife Refuges located on the OCS.

State Agencies

Either the California Coastal Commission or the California State Lands Commission would be likely to take the role of lead agency in the CEQA process. The State Lands Commission has jurisdiction to permit or establish a lease for facilities within the state's tidal and submerged coastal lands from the mean high tide line to 3 nautical miles offshore. Development activities within 1,000 yards of the mean high tide are generally subject to the Coastal Act and would also require a CDP from the California Coastal Commission. Completing the CEQA process through either lead agency may take about two years.

Other state or local agencies could serve as CEQA lead agency, depending on specific development proposals. For example, a municipal utility district may serve as a lead agency if it has a partnership or ownership interest with the development team. Alternatively, the CPUC may serve as lead agency if the developer seeks a CPCN for CPUC rate recovery or to obtain eminent domain authority. Other permitting requirements are shown in Section 4.2.

State Marine Protected Areas

No federally protected marine sanctuaries are within the study area between Long Beach and San Diego. The following National Wildlife Refuges occur nearby but outside the corridor:

- Seal Beach NWR (onshore).
- San Diego Bay NWR (near Chula Vista).
- Tijuana Slough NWR (south of the study area).

The following state-managed marine protected areas (State Marine Reserves and State Marine Conservation Areas) occur along the corridor:

- Crystal Cove SMCA, north of Laguna Beach.
- Laguna Beach SMR and Laguna Beach SMCA (No-Take) – extends to State Water Jurisdiction.
- Dana Point SMCA.
- Swami's SMCA, near San Elijo Lagoon, San Diego County – extends to State Water Jurisdiction.
- South La Jolla SMCA and South La Jolla SMR – extends to State Water Jurisdiction.

Installing the cable near the shoreline may require specific authorization by the CDFW for establishing a new nonconsumptive use or commercial activity potentially within a marine

protected area. An SMCA generally allows certain commercial purposes as long as the CDFW determines the activity would not compromise protection of the resource. An SMR is more restrictive because activities in these areas are generally restricted to research, restoration, or monitoring for resource protection.

- Early surveys of habitat and cultural resources including hard substrate would be necessary to establish the potential for take within the marine protected areas.
- CDFW staff consultation would clarify the potential for take.
- Routing through an SMR should be avoided.

Marine Biology and Coastal Habitat

Marine Habitat and Wildlife

The cable-laying vessel, cable-trenching equipment, and excavation of an HDD containment area would have direct contact impacts to marine benthic species, incidental contact with fish, and limited or unlikely contact with marine mammals. Ship presence, noise, and vessel wakes could temporarily disturb sea birds, including migratory birds and colonies. Activities would need to adhere to seasonal work windows established by resource agencies and to avoid areas designated as EFH.

Hard-Bottom Areas

Cable-laying could damage hard-bottom habitats and rock substrate. Vessels anchoring near shore for construction of coastal landings for the cable system may damage the seafloor. Similarly, if the route of the submarine cable system must traverse steep slopes or across canyons, the cable may need to be secured to avoid suspensions or free-spans. Securing the cable to the seafloor could result in unavoidable impacts to hard bottom habitat due to the installation of bolts or cable anchorage systems in the rock. Detailed mapping may be available in the areas of existing oil and gas resources licensed by BOEM in San Pedro Bay, but project-specific bathymetry and sonar surveys would likely be necessary to assess the benthic habitats along the full length of the power cable route. Natural kelp beds would need to be avoided, as well as one known artificial rock reef. Offshore near the San Clemente pier, SCE installed an artificial rock reef called the Wheeler North Reef for improving giant kelp habitat in the area.

Turbidity and Suspension of Contaminants

Turbidity would impact benthic or slow moving species and, to a lesser extent, fish and marine mammals. Seafloor disturbance could cause suspension of low-level contaminated sediments that may bio-accumulate in species within the food chain.

Underwater Noise

Underwater noise levels from ship and equipment could impact fish and mammals (avoidance of work vicinity, possible disruption of communications, migration, and feeding behaviors), and potentially disrupt benthic species behaviors, including filter feeding and foraging. Noise

levels near the plowing or trenching activities could be considered to be harassment to marine mammals and fish by the National Marine Fisheries Services.

Heat Dissipation

The power cable would dissipate heat, and this dissipation could affect the marine environment, especially for areas where cable could not be buried. Operation of the cable in the marine environment could increase water temperatures immediately near the sediment surface, generally for the water within about 4 inches of the seafloor above the cable. If hard-bottom areas cannot be avoided, the cable bundle could lie on the ocean floor. In some areas this unburied cable would be covered by concrete mattresses or protective sleeves. In other areas the cable could be exposed. Marine species could come in contact with the exposed cable or the protective covering. The 2007 environmental study for the Port Angeles–Juan de Fuca 550 MW underwater DC cable[4] found that the cable surface would be about 140°F (60°C), and water temperatures over the sediment covering the cable could increase by about 1.8°F (1°C). Species could be injured or startled if they settled on the unburied cable. Unburied cable would not be in one continuous length. This means that creating a migration barrier would be unlikely.

Potential Solutions

- Conduct appropriate presiting surveys (bathymetry and bottom profile) to identify and characterize potentially sensitive seafloor habitats and geological information related to natural rock outcrops.
- Adhere to seasonal work windows established by resource agencies and avoid areas designated as EFH.
- Avoid locating facilities near known sensitive seafloor habitats, such as kelp reefs, coral reefs, hard-bottom areas, and chemosynthetic communities.
- Avoid hard-bottom habitats, including seagrass communities and kelp beds and restore any damage to these communities (Bureau of Ocean Energy Management, 2007).
- Vessels should travel reduced speeds when assemblages of cetaceans are observed and maintain a reasonable distance from whales, small cetaceans, and sea turtles (Bureau of Ocean Energy Management, 2007).
- Minimize potential vessel impacts to marine mammals and sea turtles by requiring project-related vessels to follow the NMFS Regional Viewing Guidelines while in transit. Operators should be required to undergo training on applicable vessel guidelines (Bureau of Ocean Energy Management, 2007).
- Minimize construction activities in areas containing anadromous fish, during migration periods (Bureau of Ocean Energy Management, 2007).

4. http://energy.gov/sites/prod/files/nepapub/nepa_documents/RedDont/EIS-0378-FEIS-2007.pdf

- Minimize disruption and disturbance to marine life from sound emissions during construction (Bureau of Ocean Energy Management, 2007).
- If hard-bottom cable installation is not avoidable, post-lay surveys via a remotely-operated-vehicle (ROV) may be necessary to determine as-built impacts and restoration plans for hard-bottom habitats and rock substrate.
- If hard-bottom cable installation is not avoidable, postlay surveys may be necessary to determine the scope of payments into a Hard Bottom Mitigation Fund, subject to oversight by the California Coastal Commission.
- Minimize turbidity during construction (Bureau of Ocean Energy Management, 2007).
- Minimize impacts to wetlands by maintaining buffers around wetlands, implementing erosion and sediment control, and maintaining natural surface drainage patterns (Bureau of Ocean Energy Management, 2007).
- Minimize potential conflicts with commercial and recreational mariners and fishing interests.
- Use submarine cables that have proper electrical shielding to reduce electromagnetic fields and bury the cables in the seafloor, where practicable (Bureau of Ocean Energy Management, 2007).
- Implement an invasive marine species control plan for controlling ballast water of construction vessels that originate outside Southern California.

Geologic, Geotechnical, and Seismic Hazards

On the continental shelf, the most likely geologic hazards would be scouring, irregular topography, faulting, and the effects of tsunamis occurring anywhere in the Pacific Basin. The study area includes a portion of the continental shelf in a physiographic region known as the California Continental Borderland (Bureau of Ocean Energy Management, 2007). The continental shelf is fairly narrow in this region and typically occurs within five miles from shore. In the vicinity of Newport Beach, Laguna Beach, and Dana Point, the edge of the shelf is only one to two miles offshore.

Topography, Water Depth, and Slopes

The seafloor within the corridor of study remains relatively shallow at a depth of less than 150 feet for most locations very near shore or within one-half to three-quarters mile. Generally following the state-federal water boundary three miles from shore, a steep wall of the continental shelf drops an additional 1,000 to 1,500 feet. Within 10 miles from shore, depths up to 2,600 feet are encountered. Although some submarine power cables have been successfully installed at depths of up to 5,000 feet (National Renewable Energy Laboratory, 2011), this study anticipates that the cable design would dictate avoiding water depths greater than 3,000 feet.

Major canyons would be encountered offshore near the historical Newport Pier, at the Santa Ana River, and at the La Jolla Canyon.

Crossing the underwater canyons and steep offshore walls may leave portions of the cable suspended, exposed, or in free-span, which would increase risks of damage and entanglements.

Potential Solutions

- Routing near the shoreline (within one-half to three-quarters mile) would generally avoid steep offshore walls, but this would increase exposure of the cable to wave energy and the scouring action of ocean currents.
- Secure the cable to the seafloor through the installation of bolts or anchorage systems in the rock, although this could result in unavoidable impacts to hard bottom habitat.
- At Newport Canyon, hydroplow or jet cable installation should be investigated near the shore (roughly 200 feet offshore), where depths less than 100 feet would be encountered. However, this would increase potential impacts to the coastal zone, near-shore habitat and potentially to the historical Newport Pier, which would increase the need for cable protection from anchor dragging and fishing gear.
- Burial of the submarine cables along the steep offshore walls at La Jolla Canyon may not be feasible and could leave portions suspended.

Cable anchorage may be necessary for direct laid cable on slopes greater than 30 degrees, and slopes of 45 degrees should be avoided to the greatest extent possible as these areas would require more involved anchorages and pose additional risks to the cable.

Cable burial along the steep walls of the shelf or submarine canyons, portions of the cable may be exposed to unacceptably high risk of damage or entanglements by remaining suspended, exposed, or in free-span.

Subsurface Geology, Scouring Action, and Seafloor Instability

Installing the cable within the hard bottom, rocky substrate, or bedrock would be problematic and would need to be avoided for minimizing impacts to biological resources. For hard bottom conditions, a plow would not be usable, and a rock saw or excavator would need to be used to create a shallow trench in the bedrock before laying a duct. Then the duct would need to be pinned to the floor of the trench before placing the cable (Sharples, 2011).

Vigorous tidal circulation and storm waves have an important effect on the transport of sediments on the surface of the continental shelf. Episodic sediment movement caused by ocean currents and waves can undermine offshore structures and lead to failure. The energy of currents and waves also poses a risk to submarine cables (Bureau of Ocean Energy Management, 2007). Introducing hard scour-protection structures should generally be avoided because the structure can induce increased erosion over time.

Potential Solutions

- Conduct seafloor surveys in the early phases of a project to ensure that the project is sited appropriately to avoid or minimize potential impacts associated with seafloor instability or other hazards (Bureau of Ocean Energy Management, 2007).

- Conduct appropriate presiting surveys to identify and characterize potentially sensitive topographic features (Bureau of Ocean Energy Management, 2007).

- Hazards posed by scouring to underwater cables could be mitigated by building the cable system with sufficient excess slack to reduce the risk of breakage due to increased tension caused by irregular topography or seafloor displacement as a result of mass movement or faulting (Bureau of Ocean Energy Management, 2007).

- Where burial of the cable in sediment is not possible, secure the cable to the seafloor through the installation of bolts or anchorage systems in the rock, although this could result in unavoidable impacts to hard bottom habitat.

- Surveying the cable route every one to two years during the life of the project should verify that the cable has remained buried consistent with an agency-approved cable burial plan. The survey may be conducted with an ROV equipped with video and still cameras. If a survey shows that any segment of the cable is no longer buried consistent with the cable burial plan, repairs would be needed to rebury those cable segments.

Cable burial in shallow areas of vigorous scouring due to tidal circulation and storm waves may warrant an unacceptably high level of maintenance or protective repairs.

Seismic Hazards

The undersea transmission cable system would be especially vulnerable to earthquake-induced displacement and slope failure, including slumping and mudslides. Known faults through Southern California traverse the terrestrial and submarine areas of study. Notably, the Newport-Inglewood fault that is parallel to and along the Orange County coastline is a feature capable of causing roughly 3 to 10 feet of surface rupture offshore. Crossing a fault at 90 degrees may not be optimal for minimizing the effects of displacement of the cable system during a fault rupture (Sharples, 2011).

Tsunami effects are primarily a concern in the shallow water of coastal areas where the bottom causes the tsunami wave height to increase, which increases scour. Increasing the burial depth may protect the cable from the scour of the tsunami wave (Sharples, 2011).

See also the section "Technical Considerations" below.

Potential Solutions

- The cable route and coastal landing locations would need to be determined through geologic and geotechnical evaluation of the formations.

- Seafloor mapping and study of seismic activity conducted during the early phases of project development would help establish an appropriate route to avoid or minimize potential impacts and the hazards associated with seafloor instability, seismic ground movement, and fault rupture.

- Avoid direct fault areas where a large displacements could occur when selecting the submarine cable route.

- Hazards posed by fault rupture could be mitigated by laying the cable in the direction of the fault line, not crossing at 90 degrees, and by building the cable system with sufficient excess slack to reduce the risk of breakage as a result of faulting.

- The cable system should include a submarine earthquake monitor and a detailed earthquake emergency repair plan.

- The cable system specifications may include improved tensile strengths and deformation capabilities through the design of the submarine cable armoring.

Previous study of this issue (Sharples, 2011) reveals that for extreme earthquakes where ground upheaval is significant, there are no reasonable mitigations that can completely avoid damage. For smaller quakes where ground displacement is an issue, the mitigation of laying excess cable parallel to the direction of the fault line can minimize the probability of damage.

Submarine Archaeology and Known Obstacles

Coastal areas are usually especially sensitive due to a long history of human settlement resulting in a high density of historical and prehistoric buried resources, including archeological resources or human remains. Shipwrecks are often in known locations and, therefore, could be avoided, but many would be unknown and may be identified during cable routing studies. Other resources would include prehistoric sites covered by water and sediment. Highly degraded or deteriorated cultural resources, including shipwrecks, may exist undetected buried within unconsolidated sediments, which could be damaged or destroyed during cable burial.

Route selection would be conducted in a manner to avoid areas of known cultural resources. Shipwrecks would need to be avoided as protected resources under the Abandoned Shipwreck Act and Sunken Military Craft Act. Early stage study helps to identify known wrecks and debris on seabed, for example, from NOAA databases; however, other wooden or metallic debris on the seafloor or in the sediment can obstruct cable installation. All reports that consolidate the information on cultural resources or potential resources would need to be reviewed by the State Historic Preservation Office during the agency consultation process.

Potential Solutions

- Conduct side scan sonar and magnetometer tows using 30-m (100-ft) line spacing in areas where there is a high potential for shipwrecks.

- Develop and implement a worker cultural resources training program for educating construction crews on standards for resource avoidance and handling of unanticipated discoveries.

- Before route selection, a qualified marine archaeologist would analyze available side scan sonar and magnetometer data and prepare a report for agency review and approval.

- Avoid known and potential shipwreck locations.

- Follow a treatment plan for unanticipated and unavoidable discoveries of cultural resources.

Air Pollutant Emissions and Air Quality Attainment

Vessels used for construction could temporarily cause emissions exceeding local thresholds for ozone precursors or particulate matter. Construction, installation, or maintenance in federal waters would be subject to a determination of applicability of the General Conformity Rule for air quality impacts in the South Coast ozone and PM2.5 federal nonattainment area or in the San Diego ozone nonattainment area.

Potential Solutions

- Minimize emissions from construction and maintenance activities by maintaining all construction equipment properly in accordance with manufacturer's specifications, and ensure that equipment is checked by a certified visible emissions evaluator.

- Offroad construction diesel engines should be registered under the California Air Resources Board (ARB) Statewide Portable Equipment Registration Program or meet at a minimum the Tier 2 California Emission Standards for Off-Road Compression-Ignition Engines, as specified in CCR Title 13, Chapter 9, Sec. 2423(b)(1).

- All marine commercial harbor craft, except gasoline-powered small craft, should meet at a minimum the Tier 2 Marine Engine Emission Standards (CCR Title 17, Sec. 93118.5).

Marine Vessel Traffic and Military Use Areas

Submarine cables, especially telecommunications, are prone to damage from fishing gear or ship anchor dragging. Power cables that are buried and armored are less susceptible to damage. Additional discussion of protection to avoid cable damage appears under the section below, "Technical Considerations."

The study area falls outside and to the east of the Port of Long Beach area. However, recreational mariners, fishermen, and military activities are common in the corridor. Navy Fleet and Marine Corps amphibious training occurs nearly every day along the Southern California coastline to the San Diego Bay. The level of activity varies from unit-level training to full-scale Carrier/Expeditionary Strike Group operations and certification (Bureau of Ocean Energy

Management, 2007). Although power cable construction and maintenance would involve small-scale commercial vessel activity within offshore military areas, coordination with the appropriate military authorities will be necessary.

Potential Solutions

- Site facilities to avoid unreasonable interference with ports, marinas, and USCG-designated traffic separation schemes.
- Coordinate with the USCG Vessel Traffic Service, Los Angeles-Long Beach, to establish a vessel safety zone for construction and maintenance so that USCG can provide information for the appropriate notices to mariners for cable-laying work.
- Department of Defense consultation and coordination would be necessary to identify the stipulations necessary to avoid or eliminate potential conflicts with military use.
- Cable corridors landing at or near San Onofre would require a license from the U.S. Marine Corps Base Camp Pendleton, which has discretion over any proposal that may disrupt military activities. Following approval by Camp Pendleton, cable construction and maintenance could become part of the Marine Corps' operations.

HVDC Converter Stations

The HVDC converter stations require sufficient space (from 5 to 8 acres), seismic protection, and transportation infrastructure allowing construction access by large equipment (Chapter 3, section "High-Voltage Submarine Transmission"). The converter stations would introduce an additional new industrial land use to the two endpoints. The converter station transformers, two per station, would be the largest pieces of equipment at about 100 tons each. To avoid traffic impacts, these transformers could require transport at night from the barge landing via truck trailer to the site (Navigant Consulting, Inc., 2011).

Potential Solutions:

- Select converter station locations with adequate transportation infrastructure for 100-ton transporter capacity.
- Select converter station locations to avoid conflicts with sensitive, nonindustrial land-use types (for example, residential, recreational, hospitals, schools) that may be incompatible with the aesthetics and noise of the industrial-type converter station facilities, including the switchgear, a large array of cooling fans, and standby power generators.

Coastal Landings

Coastal landings of the cables may be installed using either a direct lay approach or horizontal directional drilling (HDD). The direct lay approach requires a soil or sandy bottom that allows the cables to be installed using conventional excavation methods such as jetting or trenching. (See Chapter 3, section "High-Voltage Submarine Transmission.")

Potential Solutions:

To avoid impacts caused by direct burial of the cable across a beach or sandy bottom, shore landings could occur through one of two optional approaches:

- Pulling the cable to the cable-laying vessel through an existing conduit or pipeline, such as one of the power plant cooling water intake structures, if available and well-maintained.

- Using an HDD to install a pipe as a conduit to create a landing for the cable from the cable-laying vessel.

HDD construction methods require a work area on shore of roughly one to two acres for pipe laydown, drilling pads, and cable-pulling equipment. This work area can be set back from the shore area as necessary, but the setback is limited by the 2,500-foot cable-pulling distance. Installing the HDD in near-surface geological formations could result in an accidental bedrock or soil fracture, during which drilling fluids or cuttings could be released into the ocean.

Potential Solutions:

- HDD work areas should be sited to avoid potential conflicts with sensitive onshore land-use types.

- Steps would need to be taken to avoid accidental release of drilling fluids or cuttings during the HDD process due to bedrock or soil fracture.

- Drilling could be slowed if a loss of drilling mud volume or pressure is detected. If a fracture occurs, increasing the viscosity of the drilling mud may be able to seal the fractures and stabilize the bore hole.

- Casings or conduits could be installed during the HDD process to seal off permeable formations.

Terrestrial Underground Cable

Ground Disturbance

Construction of underground HVDC duct banks could require continuous trenching, along with excavation of rock, blasting, and stockpiling and removal of spoils. Underground construction and trenching would involve new ground disturbance and construction-related impacts (traffic, air quality and dust, and noise). There is also a potential to encounter contaminated soils and cultural resources and to impact biological resources as a result of the ground disturbance.

Construction and Repair Time

Maintenance and restoration time in the event of an outage of submarine or underground HVDC cables would be difficult and could result in longer outages and repair times when

compared to an overhead AC system. Accessing underground components and vaults could require intensive traffic control. In addition, duct bank repair could require rock excavation, traffic control, and possible roadway closure.

EMF and Static Discharge

Operation of the transmission line would produce electric and magnetic fields (EMF). The electric field strength, measured in volts per meter (V/m), would be reduced by shielding or by burial of the line, which would effectively eliminate the potential for exposure to the electric field. Unlike the electric field, the magnetic field, measured in milligauss (mG), would not be reduced by intervening objects. Field levels fall off with distance from the source; however, locations immediately along the cable would be exposed to increased magnetic fields due to the cable. A typical DC circuit employs two conductors per circuit. Another environmental consequence of this configuration is static discharge in the area around the converter terminals. See Appendix C for additional information on EMF due to HVDC transmission systems.

Potential Solutions:

- Implement typical best practices for protection of natural and cultural resources during trenching or cut-and-cover activities necessary for installation of on-land electric transmission and linear infrastructure.
- Route selection should avoid creating disruptions to existing sensitive, non-industrial land-use types (for example, residential, recreational, hospitals, and schools).
- Coordinate with local authorities and agencies to minimize conflicts with existing transportation systems and underground utility systems.
- Avoid contaminated sites and, where unavoidable, adhere to applicable site management plans or risk management plans established for subsurface remediation.

Technical Considerations

Technical Challenges of Submarine HVDC

The range of technical factors to be evaluated in assessing the feasibility of a HVDC submarine transmission interconnection falls into two broad categories; constraints related to electric transmission system operation and physical challenges related to installation, maintenance, and upkeep of the HVDC submarine cable system.

System Operation

Electric system modeling of the interconnected transmission system, including the HVDC converter stations and submarine link, will establish necessary parameters to determine the AC portion of the system filtering and protection, as well as converter type and harmonic conditioning for the DC portion of the power system. A major component of the system modeling will be to determine the communication and control requirements for an HVDC interconnection. Cable system sizing would also be determined based on this modeling.

Development of the electric system requirements for an HVDC transmission interconnection, including submarine cable components, does not represent a technical limitation as has been demonstrated by the significant range of HVDC submarine systems that have been developed and installed worldwide. (See Chapter 3, "High-Voltage Submarine Transmission.")

Installation and Maintenance Challenges

The primary physical challenges that need to be considered include the maximum depth of the cable installation, the subsea topography and bottom materials, as well as other external threats to the cable integrity. The integrity of submarine cables can be impacted by both natural phenomenon as well as human activity.

Maximum cable-laying depth is dictated primarily by the strength of the submarine cable itself in terms of its ability to withstand the tensile stresses from the length of cable suspended between the laying ship and the seafloor. A review of installations to date indicates it is feasible to place power cables in water depths of 3,000 feet.

The topography along the route of a submarine cable needs to be evaluated in terms of slopes to be traversed. There are a couple of concerns related to sloping topography. For cables laid across steep slopes, a concern is that gravitational forces pulling the cable downslope that may cause cable movement, resulting in excessive longitudinal or torsional stresses after placement. Limiting the steepness of slopes traversed, burying, or anchoring the cables can mitigate slope concerns.

Another slope-related concern is the potential for submarine landslides or sediment movement that would stress or damage the cable. This concern is accentuated in seismically active areas. Evaluating the stability of the seafloor and the cable route selection process helps to identify the most appropriate mitigation for this issue. However, if it is not feasible for cable routing to avoid areas exhibiting evidence of historical earth movement, the topography and geologic hazards may pose an unacceptably high risk of damaging a submarine cable.

Hard substrate or exposed rock outcroppings along the route of a submarine cable are also of concern. These conditions can result in significant discontinuities that could lead to the cable being suspended above the sea bottom or the cable may rest upon hard or sharp points. Under these conditions the cable may experience excessive and cyclical bending stresses. If the cable is suspended in notable water currents, the currents may induce vibrations that lead to cable damage and failure.

Submarine cables are also susceptible to damage from human activities. This damage can occur from physical contact due to ship anchor dragging or fishing operations. Again, route selection to avoid areas with seafloor disturbing activities is the best mitigation for avoiding cable damage. Cable routing can be accomplished in areas with ship traffic or fishing activities as there are several options that can be considered for protecting and armoring cables from physical intrusion.

Cable and Pipeline Crossings

No major underwater telecommunication cables would be crossed in the corridor of study. Other power cables may be present for oil and gas operations in San Pedro Bay although none appear in BOEM databases.

Pipelines to or from the BOEM oil and gas platforms in the San Pedro Bay would be crossed by the project, if Alamitos is selected as a termination point. Selecting Huntington Beach as a termination point may allow the project to avoid crossing existing pipelines to oil and gas platforms.

Potential Solution:

- Cable and pipeline crossings, if necessary, would need to occur as near a 90-degree perpendicular angle to the existing cable or pipeline as practicable, and crossings could require installation in a protective conduit or postlay armoring by a remotely operated vehicle (ROV).

Burial and Protection of the Submarine Cable

Reliability of the system depends on its protection, and the power cable should be expected to experience occasional faults due to outside damage. During 15 years of study by CIGRE, 49 faults were reported for 7,000 circuit-kilometers (4,350 circuit-miles) of submarine power cables, resulting in a fault rate of 0.8 faults per year per 1,000 circuit-miles (National Renewable Energy Laboratory, 2011). The most common risks of damage to submarine cables are from fishing gear (52 percent), anchors (18 percent), and suspensions (5 percent). Earthquakes caused relatively few of the reported faults (3 percent) (National Renewable Energy Laboratory, 2011).

Techniques are available to armor and protect the cable, and assessing the effectiveness of the techniques can be accomplished through the use of a "burial protection index" (Sharples, 2011).

Potential Solutions:

- Burial within seafloor between 1 to 5 meters reduces the risk of damage.

- Periodically during project operation, for all buried portions of the cables, the owner would need to ensure that adequate coverage has been maintained to avoid interference with fishing gear/activity (Bureau of Ocean Energy Management, 2007).

- The USACOE would generally prohibit installing a buried cable along the length of a marked channel, and areas known to be used for vessel anchoring would need to be avoided. Outside of known vessel anchoring areas, burial alone would not completely avoid the risk of an anchor strike, and a high risk of an anchor strike would violate a primary underwriting standard for cable insurance (Navigant Consulting, Inc., 2011).

Other Mechanical and Electrical Considerations

There are no standard designs for submarine cable systems. Water depths and routing details may dictate cable strength requirements, and the cable-laying vessel equipment and layout of the vessel and installation equipment should also be considered in cable design (Sharples, 2011).

Cable specifications would need to be established to address the following details:

- Cable strength
- Bending radius
- Thermal requirements
- Water penetration
- Fault-protection, lightning protection
- Splicing
- Repair procedures
- Quality control

Other Installation and Maintenance Considerations

- Limited global availability of cable-installation vessels
- Quantity, mass, and transport of cable
- Availability of mechanical plow or jet plow equipment
- Need for postlay burial in sediment or postlay cable protection and armoring through the use of ROV.

CHAPTER 5:
Submarine Transmission Route Alternatives

Alternative 1: Submarine HVDC Cable

ALTERNATIVE 1
Submarine High-Voltage Direct Current Cable – connecting SCE and SDG&E system

a. Build converters at Alamitos or Huntington Beach switchyard.

b. Connect Alamitos East and Alamitos West 230 kV buses together (this may require upgrading 230 kV circuit breakers to withstand higher fault duty at Alamitos Substation).

c. Build converters at the following terminating point at one of the following potential sites (four options).

   i. San Onofre 230 kV switchyard or vicinity location near SONGS.

   ii. Encina 230 kV switchyard.

   iii. Terminating at the existing Penasquitos Substation.

   iv. Terminating at South Bay, Old Town, or Silvergate

d. Common upgrades to the above item (c):

   i. Converter station at Encina 230 kV switchyard.

   ii. Install dynamic reactive supports at the following locations:

      - 700 MVAR to be connected to San Onofre 230 kV switchyard.
      - 500 MVAR at Alamitos East 230 kV switchyard (this could be part of the converter's dynamic reactive support capability).
      - 300 MVAR at Alamitos West 230 kV switchyard.
      - 300 MVAR at Del Amo 230 kV Substation.
      - Retain existing Huntington Beach dynamic reactive supports for Units 3 and 4 (if these two are not repowered by AES due to lack of PPA).
      - Install a 225 MVAR SVC at Penasquitos Substation (for options that terminate the submarine cable at Encina or Penasquitos; if connecting at Penasquitos, this could be part of the dynamic reactive support of the converter).

e. Potential future upgrade to San Onofre–San Luis Rey 230 kV #1 line (under 1.c.i above) for terminating submarine cable at San Onofre 230 kV switchyard.

f. Upgrade Encina Tap–San Luis Rey 230 kV line (TL 23011A) from 2x1033 ACSR to 2x1033 ACSS to gain more emergency rating; ACSS conductors could be strung on the same tower without requiring additional rights-of-way. This is required for Option 1.c.ii above (i.e., terminating at Encina 230 kV switchyard).

g. Lay XLPE undersea cable connecting L.A. Basin to San Diego areas (that is, Alamitos to termination points under 1.c.).

Description of Submarine Options

Submarine options involve establishing a new HVDC transmission line to connect the service territories of SCE and SDG&E inside the Los Angeles Basin and San Diego local capacity areas. Each submarine option includes establishing new transmission line interconnections at one northern and one southern terminating point at existing SCE and SDG&E switchyards, respectively. Each submarine HVDC option would also include two new converter stations near the existing SCE and SDG&E switchyards, coastal landings for the cable, and laying the new cable offshore.

In terms of evaluating potential constraints, the primary considerations for this alternative are:

- Siting the HVDC converter stations with compatible existing land uses.
- Siting the cable system coastal landing zones and terrestrial underground cable with compatible existing land uses.
- Routing the cable to avoid slopes greater than 30 degrees.
- Routing the cable crossings of faults in the direction of the fault lines.
- Routing the cable to avoid State Marine Conservation Areas and State Marine Reserves.

Many other routing considerations must also be balanced, such as avoiding impacts to hard-bottom benthic habitats and avoiding mapped archaeological resources, but proper route selection and design should be able to address these issues.

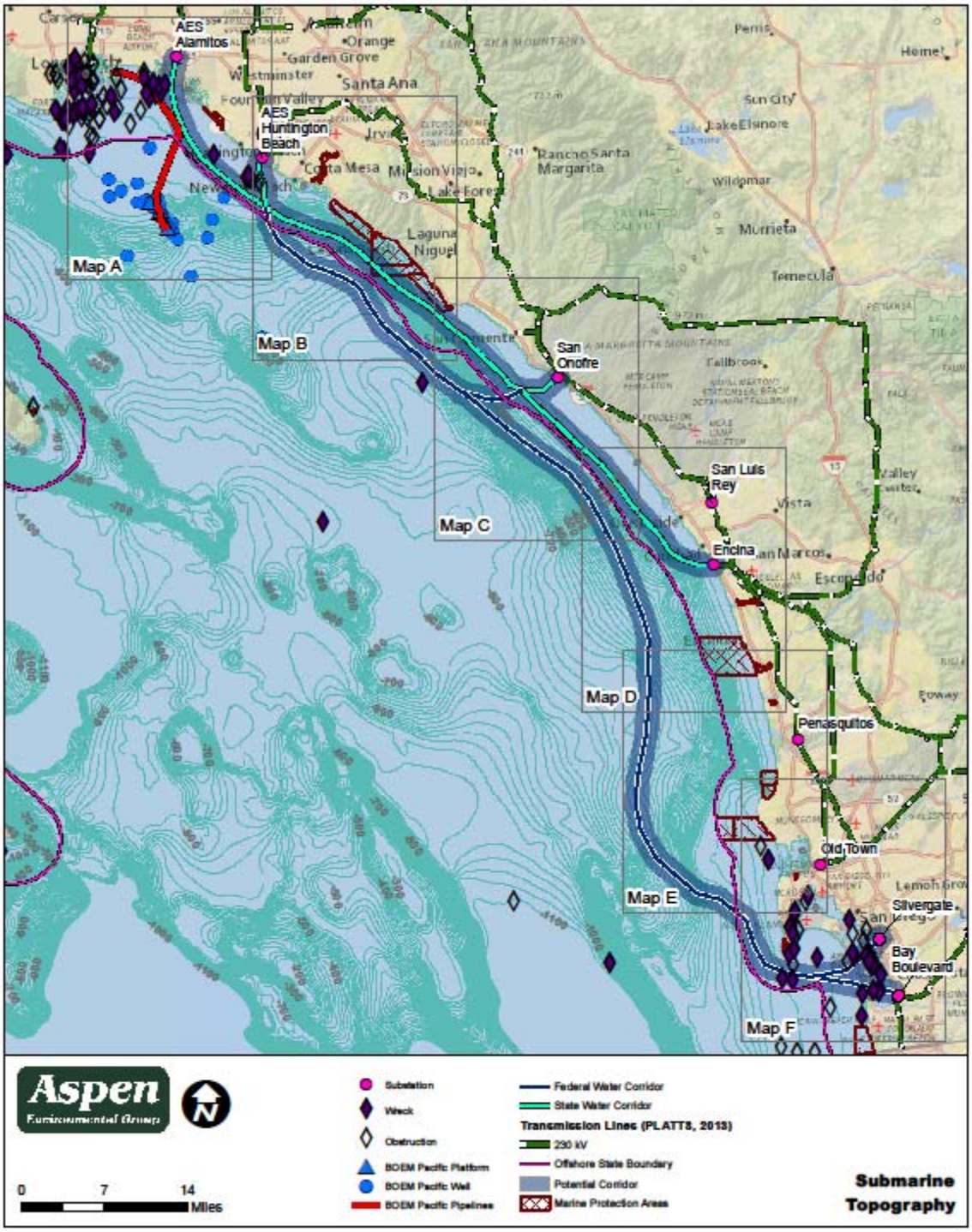
Figure 22 shows the underwater topography along the submarine corridors, and Figure 23 shows the slopes of the topography. Figure 24 shows known faults in the study area. Appendix E (Detailed Submarine Corridor Maps) contains six higher-resolution maps for each of these figures.

HVDC Converter Station Locations and Coastal Landings

New terminating points for interconnection would be established for the new submarine HVDC transmission line at two of the switchyards/substations listed in Table 10. The northern terminating point would either by at Alamitos or Huntington Beach, and the southern terminating point would be at one of the six southern locations listed in Table 10.

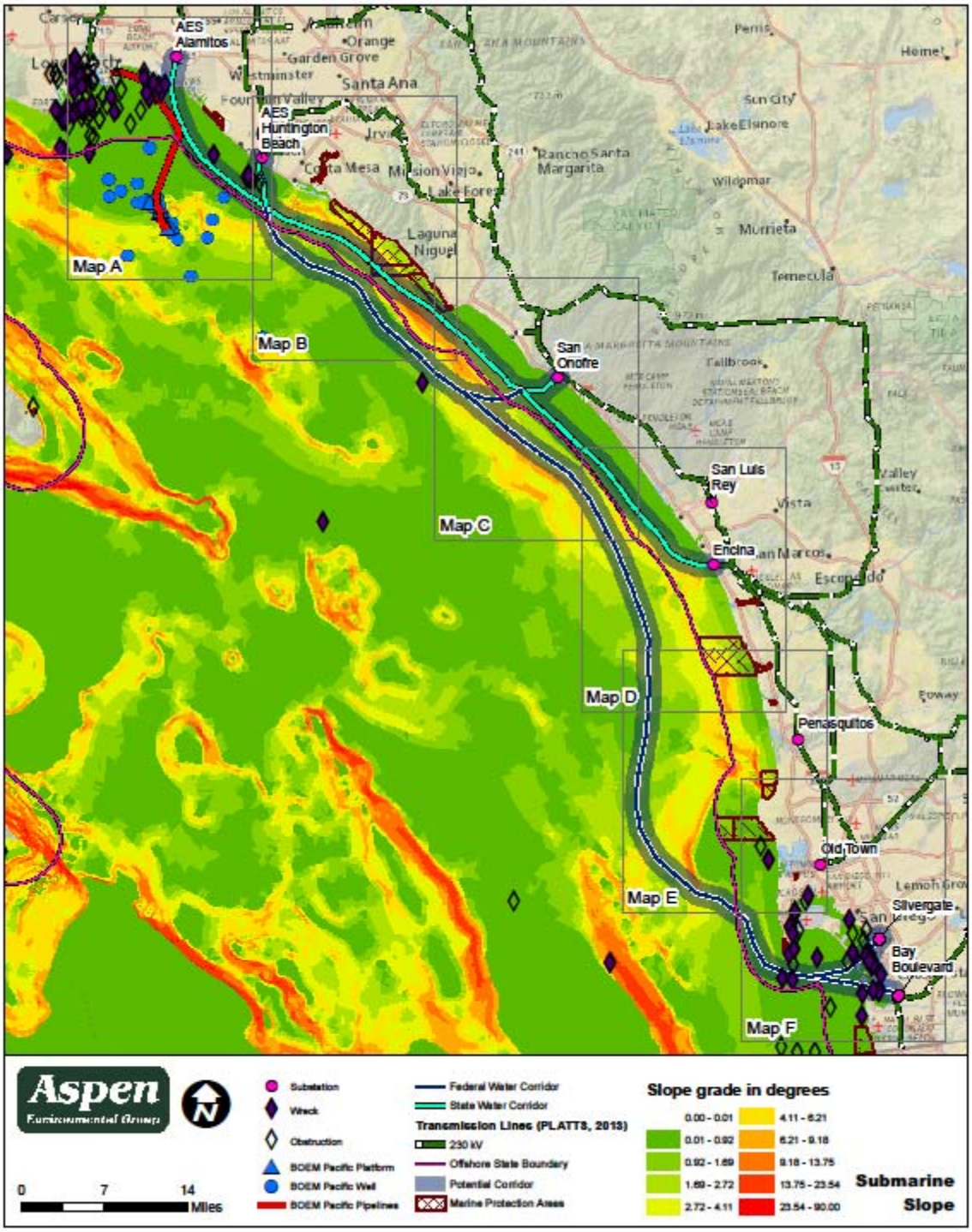
Table 10: Possible Terminating Points for New Submarine HVDC Transmission Line		
Northern Substations	**Jurisdiction, Location**	**Constraints**
North 1. Alamitos	City of Long Beach City of Seal Beach	Dense coastal development. Potential conflicts with commercial and recreational mariners. Channelized and navigable waterways.
North 2. Huntington Beach	City of Huntington Beach	Coastal landing would require long HDD or beach traverse through Huntington Beach State Park. Site planned for redevelopment.
Southern Substations	**Jurisdiction, Location**	**Constraints**
South 1. San Onofre	Marine Corps Base Camp Pendleton	Requires ROW on Camp Pendleton.
South 1 Option: Japanese Mesa or SONGS Mesa	Marine Corps Base Camp Pendleton	Requires ROW on Camp Pendleton.
South 2. Encina or Cannon	City of Carlsbad	Site planned for redevelopment.
South 3. Pensaquitos	City of San Diego	Incompatible surrounding existing land uses. Not viable: no suitable coastal landing site.
South 4. South Bay or Bay Boulevard	U.S. Department of Defense, San Diego Bay City of Chula Vista	Requires routing cable in navigable waterways of San Diego Bay or crossing Coronado Island near or through Silver Strand State Beach.
South 5. Old Town	U.S. Department of Defense, San Diego Bay City of San Diego	Incompatible surrounding existing land uses. Not viable: no suitable coastal landing site.
South 6. Silvergate	U.S. Department of Defense, San Diego Bay City of San Diego	Requires routing cable in navigable waterways of San Diego Bay or crossing Coronado Island near or through Silver Strand State Beach.

Figure 22: Submarine Topography



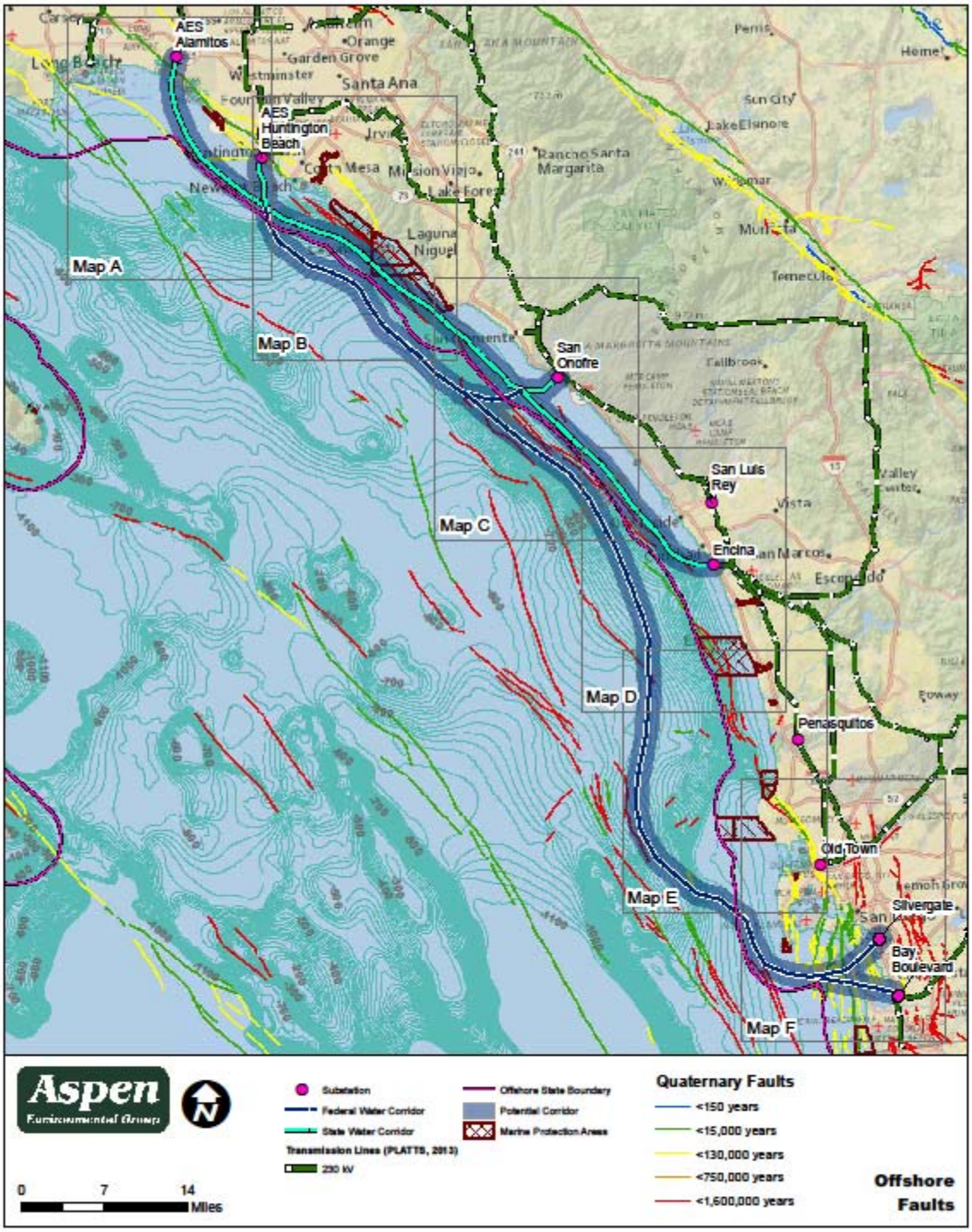
Source: Aspen Environmental, 2014

Figure 23: Submarine Slope



Source: Aspen Environmental, 2014

Figure 24: Offshore Faults



Source: Aspen Environmental, 2014

Submarine Corridor Descriptions

Figure 22 shows the potential submarine transmission corridors identified in this analysis based on the following goals:

- Avoid slopes greater than 30 degrees.
- Route cable crossings of faults in the direction of the fault lines.
- Avoid State Marine Conservation Areas and State Marine Reserves.
- Avoid known shipwrecks and mapped archaeological resources.

Federal Water Corridor

The Federal Water Corridor, a corridor far enough offshore to be under federal jurisdiction, would allow the cable system to avoid the Laguna Beach marine conservation areas and would allow the greatest flexibility in the route selection process in avoiding steep slopes or canyon crossings.

For interconnection points south of Encina, routing through federal coastal water would allow the cable to bypass other State Marine Conservation Areas, Swami's SMCA, and South La Jolla SMCA and SMR.

The maximum water depth along the Federal Water Corridor is about 2,000 feet (600 meters).

State Water Corridor

The State Water Corridor, a corridor within California state jurisdiction, leaves little flexibility for the route selection process in avoiding steep slopes or canyon crossings. For the route to avoid traversing steep slopes, the route may be forced to cross the Laguna Beach marine conservation areas. The corridor shown in this analysis minimizes the crossing of the Laguna Beach conservation areas, although this increases the likelihood of forcing the route to traverse steep slopes. To remain within state waters, the cable may need to be secured to the seafloor to avoid suspensions or free-spans, which could increase benthic habitat impacts.

Interconnection points south of Encina are not considered to be viable with a State Water Corridor because routing through state coastal water would force the cable to cross the Swami's SMCA and South La Jolla SMCA and SMR.

The maximum water depth along the State Water Corridor is about 1,000 feet (300 meters).

Supporting Analysis of Interconnection Locations

Alamitos (North 1)

The Alamitos Generating Station (AGS) is at 690 North Studebaker Road on the eastern side of Long Beach in Los Angeles County. AGS includes six conventional steam turbine units with a total generating capacity of 1,950 MW (California Ocean Protective Council, 2008). The AGS facility covers 120 acres of a 230-acre industrial site along the west back of the San Gabriel River, 2 miles northeast of the entrance to Alamitos Bay and the Long Beach Marina (California Ocean

Protective Council, 2008). The switchyard is in the northern portion of the site near East 7th Street.

The AGS site is bounded by East 7th Street (Highway 22) to the north, the San Gabriel River to the east, Westminster Avenue to the south, and North Studebaker Road and the Los Cerritos Channel to the west. The city of Seal Beach is adjacent to the eastern edge of the facility across the San Gabriel River. The Los Angeles Department of Water and Power Haynes Generating Station is directly opposite AGS on the east bank of the San Gabriel River.

Land Use: The land use in the vicinity of the Alamitos Generating Station includes power generation, open space, and residential. The immediate area of the generating station is zoned for planned development (PD-1) as part of the Southeast Area Development and Improvement Plan (SEADIP), Subarea 19, by the City of Long Beach and residential low density (RLD) and residential high density (RHD) by the City of Seal Beach. The land use at the generating station is mixed uses (7). Subarea 19 is fully developed by the existing permitted industrial uses, that is, Alamitos and adjacent power generation stations (City of Long Beach, 1999). Rosie the Riveter Charter High School is located on the AGS site.

Jurisdiction/Plans*:* City of Long Beach General Plan, Southeast Area Development and Improvement Plan, City of Seal Beach General Plan. The site is not in the California Coastal Commission's designated coastal zone.

Figure 25: Alamitos: Potential Coastal Landing

Source: Obtained from Google Earth, 2014

Site Analysis for Alamitos

Figure 25 shows the potential Alamitos landing. The switchyard is adjacent to the San Gabriel River and two miles northeast of the entrance to Alamitos Bay and the Long Beach Marina. There are open space, industrial, and residential land uses between the site and the Queensway Bay. In 2008, the site was evaluated for conversion to closed-cycle wet cooling (California Ocean Protective Council, 2008). The evaluation determined that there would not be space for wet cooling towers if land owned by Pacific Energy could not be secured for use.

Huntington Beach (North 2)]

The existing Huntington Beach Generating Station (HBGS) is at 21730 Newland Street, just north of the intersection of Pacific Coast Highway (U.S. Highway 1) and Newland Street. In

2012, AES Southland, LLC submitted an application to the Energy Commission to demolish the HBGS and replace it with the Huntington Beach Energy Project (HBEP). The HBEP would be air-cooled, which would eliminate the need for large quantities of once-through cooling seawater currently used by the HBGS. HBEP would be a natural gas-fired, combined-cycle, 939 MW electrical generating facility consisting of two independently operating, combined-cycle gas turbine power blocks. Huntington Beach is in Orange County. An optional endpoint in this area would be the SCE Ellis Substation, located about three miles northeast of the power plant, near the intersection of Garfield Avenue and Ward Street, also in Huntington Beach.

Land Use

The HBGS/HBEP site covers 28.6 acres in a largely industrial area of Huntington Beach. The area is designated as Public (P) in the Huntington Beach General Plan; this designation allows for development of public utilities. The HBGS/HBEP site is zoned public-semi-public (PS) and is included in the Coastal Zone Overlay District (CZ), and the Oil Production Overlay District (O). The areas surrounding the site include the following land uses:

- **North:** Between Edison Drive and the Huntington Beach Channel, there are an animal hospital and auto wrecking and recycling centers. Beyond the Huntington Beach Channel there are mini-storage facilities, warehouses, and then residential neighborhoods, including parks and schools.

- **South:** The Wetlands and Wildlife Care Center is adjacent to the existing HBGS site on a narrow strip of land between the HBGS boundary and Pacific Coast Highway. Huntington Beach State Park and the Pacific Ocean are across Pacific Coast Highway from the site.

- **East:** The Huntington Beach Channel runs along the eastern boundary of the HBGS/HBEP site. The Huntington Beach Wetland Preserve/Magnolia Marsh Restoration Project Area is adjacent to the southeast HBGS boundary and southwest of the Huntington Beach Channel. There is another tank farm (Plains All American Tank Farm) to the east of the Channel and the Ascon/Nesi Landfill is to the northeast (within the Magnolia Pacific Specific Plan Area).

- **West:** The Huntington-By-The-Sea Mobile Home and RV Park and Cabrillo Mobile Home Park are across Newland Street to the west. There is a partially completed new subdivision, Pacific Shores, to the northwest.

Jurisdiction/Plans

City of Huntington Beach General Plan, Huntington Beach Zoning and Subdivision Ordinance.

Figure 26: Huntington Beach: Potential Coastal Landing

Source: Obtained from Google Earth, 2014

Site Analysis for Huntington Beach

Figure 26 shows the potential Huntington Beach landing. The southwest boundary of the HBGS/HBEP site is about 1,200 feet from the Pacific Ocean. This site may be able to provide a landing point, possibly using retired once-through cooling facilities once the HBGS is closed. In addition, there may be space on the reconfigured HBEP site for a converter station. Coastal landing would require a long HDD (more than 2,000 feet) or beach traverse through Huntington Beach State Park.

San Onofre (South 1)

The San Onofre Nuclear Generating Station (SONGS) site is in northwestern San Diego County, two miles south of San Clemente. It is just south of I-5 and the Pacific Coast Highway along the coast. The SONGS site is under the jurisdiction of the MCBCP. The switchyard is in the northern portion of the site near Pacific Coast Highway. Offshore and north of SONGS, near the San Clemente pier, SCE installed an artificial rock reef for improving giant kelp habitat in the area, called the Wheeler North Reef.

SCE announced plans to permanently retire SONGS on June 7, 2013. Within two years of shutdown, SCE must submit a detailed decommissioning plan, including activities and schedules, cost estimates, and potential environmental impacts, to the Nuclear Regulatory Commission and to state officials. The final closure date for the SONGS has not been determined, but SCE is required to complete decommissioning within 60 years.

Land Use. The SONGS site is characterized by industrial land uses, such as office structures, warehouses, paved equipment years, and paved parking lots. The site is also surrounded by designated open space and recreational areas managed by California State Department of Parks and Recreation and MCBCP.

Jurisdiction/Plans. MCBCP (DOD), San Onofre State Beach (California State Department of Parks and Recreation), U.S. Marine Corps Base Camp Pendleton *Integrated Natural Resource Management Plan* (2001), *San Onofre State Beach Revised General Plan* (1984).

Japanese Mesa or SONGS Mesa (South 1 Option)

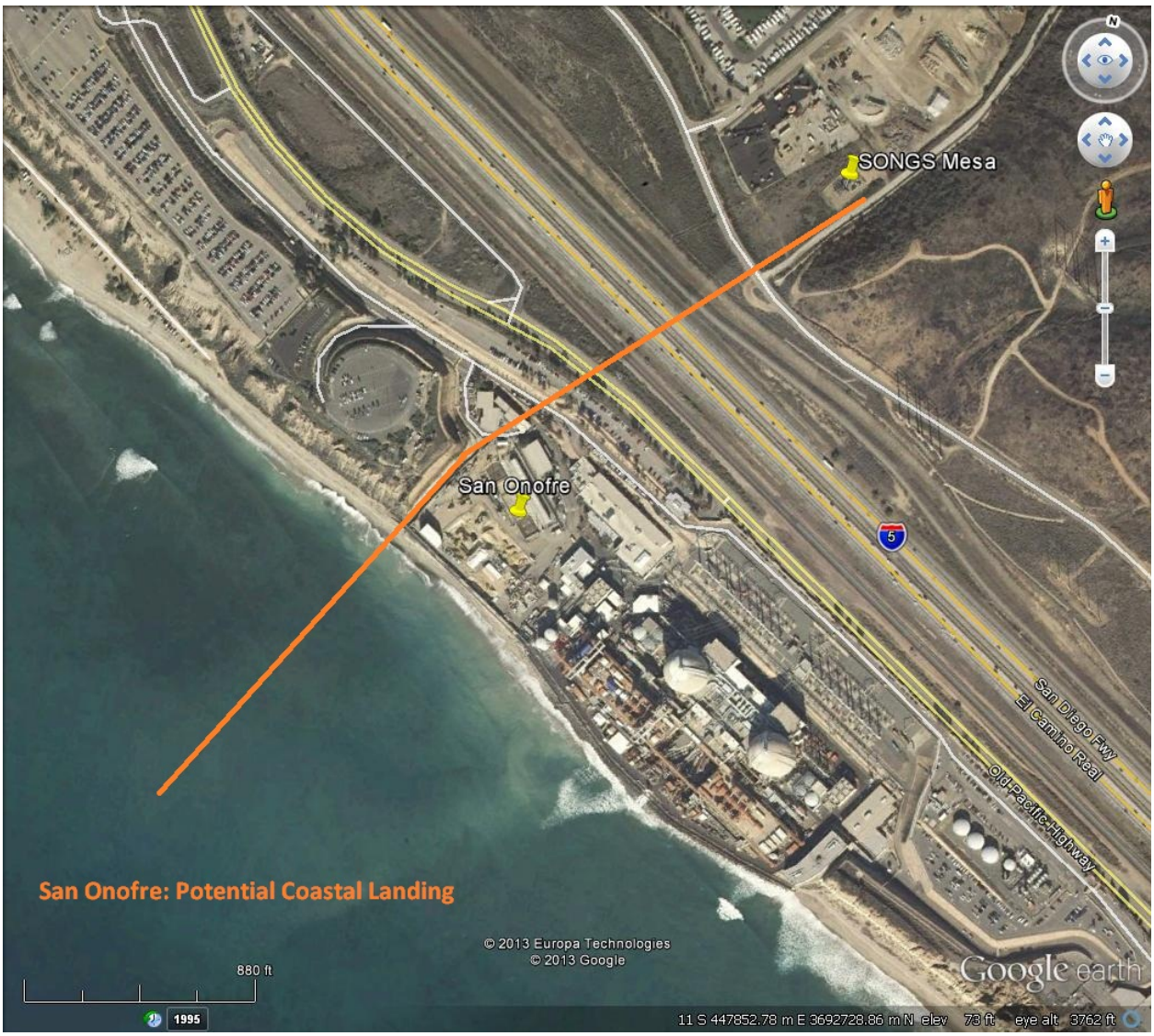
The existing SDG&E Japanese Mesa 69 kV (also known as SONGS Mesa) substation on Camp Pendleton is south of the San Onofre Gate and east of I-5, within Area 51 of the base. Area 51 is used by the Pendleton's Heavy Equipment Facilities Maintenance Department. Japanese Mesa substation occupies a roughly 0.3-acre site within a 3-acre parcel situated immediately south and east of land used by the Marines for bulk materials storage (sand/gravel) and other low-density activities. Southeast of the substation is an approximately 70-acre area through which power lines from the SONGS switchyard pass before diverging north and south to SCE and SDG&E substations. About 30 acres of this area appear sufficiently flat to be graded to accommodate new electricity facilities such as switchyards and substations. Subject to Department of Defense approval, it appears feasible to replace substation and switchyard facilities at SONGS with new facilities at this location. This move would eliminate high-voltage lines crossing over I-5 and consolidate facilities closer to the existing north-south transmission corridor on Camp Pendleton. The area also has the potential for construction of a substation that would be an alternative to using the Talega Substation as a hub for various transmission line interconnection alternatives.

Land within the base includes breeding habitat for birds such as the western snowy plover and California gnatcatcher. Rare mammals on base include the Pacific pocket mouse and Stephens' kangaroo rat. Based on Pendleton's Integrated *Natural Resources Management Plan,* the area around Japanese Mesa includes California gnatcatcher habitat (U.S. Marine Corps Base Camp Pendleton, 2012). Presence of these birds during nesting season potentially would restrict

construction activities for that part of the year. Also, mitigation may be required if habitat is taken.

Site Analysis for San Onofre. Figure 27 shows the potential San Onofre landing. The SONGS site is within 100 feet of the ocean. Based on aerial review it may be able to provide a landing point and space for a converter station. To avoid colocation of the cable system with the decommissioning activities at SONGS, the Japanese Mesa or SONGS Mesa option would be preferred.

Figure 27: San Onofre: Potential Coastal Landing



Source: Obtained from Google Earth, 2014

Encina or Cannon (South 2)

The Encina Power Plant and the SDG&E Cannon Substation are in Carlsbad in northern San Diego County. In 2012, the Energy Commission approved NRG's application to construct the Carlsbad Energy Center Project (CECP) on the Encina Power Plant site.[5] The 23-acre CECP is planned for the northeast section of the 95-acre Encina Power Plant site (currently occupied by a tank farm). The SDG&E Cannon Substation is located immediately south of the CECP site. The Encina Power Plant/CECP site is north of Cannon Road and west of I-5, roughly 1,500 feet from the shoreline. An option to this endpoint would be the SDG&E San Luis Rey Substation near Highway 76 in Oceanside, although this site is farther from the coast and closer to residential areas.

Land Use. The CECP is site surrounded by a variety of industrial and commercial land uses including:

- **North:** Agua Hedionda Lagoon to the north and northeast.
- **South:** Cannon Boulevard and single family residences south side of Cannon Boulevard.
- **East:** I-5 to the east, with Car Country Park south and adjacent to west side of I-5 (private greenbelt).
- **West:** Carlsbad Boulevard (Community Scenic Corridor) to the west and Carlsbad State Beach west of Carlsbad Boulevard; single-family residences to the southwest (west of Carlsbad Boulevard).

The Encina Power Plant site is designated public utilities (PU) under the city's general plan. There is designated open space to the north and south. There are also residential low-medium density, travel/recreational commercial, and planned industrial designations to the south.

Jurisdiction/Plans. Encina Specific Plan (SP 144) covers 680 acres of Encina Power Plant and adjacent beach and lagoon. Carlsbad General Plan, Carlsbad Zoning Ordinance, Encina Specific Plan, Encina Power Station Precise Development Plan (PDP 00-02), Carlsbad Local Coastal Program/Agua Hedionda Land Use Plan (1982), North County Multiple Habitat Conservation Plan (MHCP) and the Carlsbad Habitat Management Plan (HMP) for Natural Communities, South Carlsbad Coastal Redevelopment Project Area Plan. The City of Carlsbad has a certified Local Coastal Program, but the proposed CECP is within the Coastal Commission's retained jurisdiction.

Site Analysis for Encina. Figure 28 shows the potential Encina landing. The site is in an industrial area that borders the Agua Hedionda Lagoon. The site is relatively close to the shore (~1,500 feet), and based on aerial review, there may be adequate space for a landing point and converter station.

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5 According to the City of Carlsbad, it is not clear when the CECP would be built. http://news.carlsbadca.gov/proposed-power-plant

Figure 28: Encina: Potential Coastal Landing

Source: Obtained from Google Earth, 2014

Penasquitos [South 3]

The Penasquitos Substation is in San Diego near the intersection of Carmel Mountain Road and East Ocean Air Drive.

Land Use. The land use designations surrounding the substation are commercial and office, parks and recreation/open space, public facilities and utilities, and residential. Torrey Hills Park is to the west, and the Torrey Corner Shopping Center is to the northeast.

Jurisdiction/Plans. City of San Diego, City of San Diego General Plan.

Site Analysis for Penasquitos. Figure 29 shows the surroundings for Penasquitos. The site is surrounded by open space, recreational, commercial, and residential land uses, and it is more than 2 miles from the shoreline. Based on aerial review this site does not appear feasible for a coastal landing point or a converter station.

Figure 29: Peñsaquitos: Surrounding Land Uses

Source: Obtained from Google Earth, 2014

South Bay or Bay Boulevard (South 4)

The existing South Bay Substation is in Chula Vista in southwestern San Diego County. In October 2013, the CPUC voted to allow SDG&E to develop the South Bay Substation Relocation Project. This project involves demolition of the existing South Bay Substation (near Bay Boulevard and L Street) and the construction of the Bay Boulevard Substation 0.5 miles to the south on the site of a former liquefied natural gas (LNG) plant. The Bay Boulevard Substation site would be 2 miles within Chula Vista, 7 miles southeast of downtown San Diego.

Land Use. Both the South Bay Substation site and the future approved Bay Boulevard Substation site are adjacent to industrial and commercial uses and designated open space. According to the draft Port Master Plan amendment, the proposed substation site is designated as Industrial Business Park, and land uses surrounding the substation site include habitat

replacement to the immediate east, park/plaza to the north, and open space to the east. North of the site, there is industrial land associated with previous LNG facility. To the west there are salt crystallizer ponds associated with Western Salt Works (commercial salt producer). To the south there are industrial and office uses, and to the east there are an SDG&E utility corridor/easement, San Diego and Arizona Eastern Railway tracks, and commercial and industrial uses east of Bay Boulevard. The Bay Boulevard substation site is adjacent to the boundary of San Diego Bay National Wildlife Refuge.

Jurisdiction/Plans. Bayfront coastal area of the City of Chula Vista Coastal Zone, lands under the jurisdiction of the Unified Port District of San Diego and under the jurisdiction of the city, the city's LCP Land Use Plan area (Figure D.10-2a [Bayfront Jurisdictional Boundaries]), California Coastal Act Policy, Chula Vista Bayfront Master Plan, Unified Port District of San Diego – Port Master Plan, Chula Vista Local Coastal Program – Land Use Plan, Bayfront Specific Plan, City of Chula Vista General Plan, Chula Vista Bayfront Master Plan (CVBMP).

Site Analysis for South Bay. Figure 30 shows the potential South Bay landing. The Bay Boulevard site is roughly 0.4 mile from the bay across the existing salt works. Fourteen acres of the former LNG site would not be developed for the relocated substation, which may leave room for a converter station. Access to San Diego Bay may require routing the cable system across Coronado Island near or through Silver Strand State Beach.

Figure 30: South Bay: Potential Coastal Landing

Source: Obtained from Google Earth, 2014

Old Town (South 5)

The Old Town Substation is in San Diego at 5525 Gaines Street.

Land Use. The Old Town Substation site is bordered by four city streets: Gaines Street to the south, Benicia Street to the east, Azusa Street to the west, and Riley Street to the north. The San Diego County Animal Services Department is across Azusa Street to the west. There are homes across Riley Street to the north, commercial areas to the south, and residential areas to the west.

Jurisdiction/Plans. City of San Diego, City of San Diego General Plan.

Site Analysis for Old Town. Figure 31 shows the surroundings for Old Town. This substation site is 3 miles (through largely residential areas) from the nearest inlet to the ocean near Sea World Drive. There is an approximately 1-acre, apparently vacant, lot south of the substation,

but otherwise space is constrained by adjacent residential and commercial development. Based on aerial review, this site is unlikely to provide a feasible coastal landing point or space for a converter station.

Figure 31: Old Town: Surrounding Land Uses

Source: Obtained from Google Earth, 2014

Silvergate (South 6)

The SDG&E Silvergate Substation is located at Harbor Drive and Sampson Street in the Barrio Logan community in San Diego. The site vicinity is entirely paved and developed. The site is surrounded by industrial development to the northwest, Harbor Drive to the northeast, Sampson Street to the southeast, and East Belt Street to the southwest. There are homes 500 feet to the north. The harbor is roughly 700 feet southwest of the substation site. The Naval Station San Diego, National Steel and Shipbuilding Company, and other military-associated facilities are in the project vicinity.

Land Use. The substation site is designated as industrial land in the San Diego County General Plan. There are areas designated for multiple uses across Harbor Way.

Jurisdiction/Plans. City of San Diego General Plan, San Diego Unified Port District, Barrio Logan Community Plan and Local Coastal Program, Barrio Logan Planned District Ordinance.

Site Analysis for Silvergate. Figure 32 shows the potential Silvergate landing. The Silvergate Substation is separated from the San Diego Bay by about 700 feet of industrial development. There may be some vacant industrial sites in the vicinity that could be used for siting a converter station. Access to the San Diego Bay may require routing the cable system across Coronado Island near or through Silver Strand State Beach.

Figure 32: Silvergate: Potential Coastal Landing

Source: Obtained from Google Earth, 2014

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ACRONYMS

ABDSP	Anza-Borrego Desert State Park
AC	alternating current
ACEC	Area of Critical Environmental Concern
AGS	Alamitos Generating Station
ARB	California Air Resources Board
ARPA	Archaeological Resources Protection Act
AWOIS	Automated Wreck and Obstruction Information System
BLM	U.S. Bureau of Land Management
BNSF	Burlington Northern Santa Fe
BOEM	Bureau of Ocean Energy Management
BPA	Bonneville Power Administration
Cal FIRE	California Department of Forestry and Fire Protection
California ISO	California Independent System Operator
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CDP	coastal development permits
CECP	Carlsbad Energy Center Project
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFGC	California Fish and Game Code
CFR	Code of Federal Regulations
CIGRE	Council on Large Electric Systems
CNF	Cleveland National Forest
CPCN	Certificate of Public Convenience and Necessity
CPUC	California Public Utilities Commission
CSC	Current Source Converters
CSLC	California State Lands Commission
CVBMP	Chula Vista Bayfront Master Plan
CWA	Clean Water Act
CZ	Coastal Zone Overlay District
CZMA	Coastal Zone Management Act
DC	direct current
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of Interior
DTSC	Department of Toxic Substances Control
EFH	essential fish habitat
EIR	environmental impact report
EIS	environmental impact statement
EMF	electric and magnetic fields

ESA	Endangered Species Act
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCC	Federal Communications Commission
FERC	Federal Energy Regulatory Commission
FLMPA	Federal Land Management Policy Act
HBEP	Huntington Beach Energy Project
HBGS	Huntington Beach Generating Station
HCP	Habitat Conservation Plans
HDD	horizontal directional drilling
HECO	Hawaiian Electric Co.
HIREP	Hawaii Inter-Island Renewable Energy Program
HMP	Habitat Management Plan
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
ICAPCD	Imperial County Air Pollution Control District
IHA	Incidental Harassment Authorization
IID	Imperial Irrigation District
kV	kilovolt
LADWP	Los Angeles Department of Water and Power
LCC	line-commutated converters
LCP	Local Coastal Programs
LEAPS	Lake Elsinore Advanced Pumped Storage
LNG	liquefied natural gas
LOA	Letter of Authorization
MBTA	Migratory Bird Treaty Act
mG	milligauss
MCB	Marine Corps Base
MCBCP	Marine Corps Base Camp Pendleton
Merc	mercury
MHCP	Multiple Habitat Conservation Plan
MI	mass-impregnated
MMAs	Marine Managed Area
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Areas
MRI	magnetic resonance imaging
MWD	Metropolitan Water District
MVA	million volt-amperes
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge and Elimination System
NREL	National Renewable Energy Laboratory

NWP	Nationwide Permit Program
O	Oil Production Overlay District
OCRM	Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
OH	overhead
P	public
PDP	precise development plan
PEA	proponent's environmental assessment
PPA	power purchase agreement
PRC	Public Resources Code
PU	Public Utilities
RCHCA	Riverside County Habitat Conservancy Agency
RHD	residential high density
RLD	residential low density
ROV	remotely operated vehicle
ROW	right-of-way
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SBNF	San Bernardino National Forest
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison Company
SCFF	self-contained fluid–filled
SCR	Selective Catalytic Reduction
SDG&E	San Diego Gas & Electric
SDAPCD	San Diego Air Pollution Control District
SEADIP	Southeast Area Development and Improvement Plan
SEIS	supplemental environmental impact statement
SMCA	State Marine Conservation Areas
SMR	State Marine Reserves
SOCRE	South Orange County Reliability Enhancement
SONGS	San Onofre Nuclear Generating Station
SP	specific plan
SR	State Route
SUP	special use permit
SVC	Static VAR Compensator, where VAR means reactive volt-amperes
SWPL	Southwest Powerlink
SWPPP	Storm Water Pollution Prevention Plan
TBC	Trans Bay Cable LLC
TE/VS	Talega-Escondido/Valley-Serrano Interconnect
Thy	thyristor
TNHC	The Nevada Hydro Company
Tra	transistor
TRTP	Tehachapi Renewable Transmission Project

TSP	tubular steel pole
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
VAR	volt ampere reactive
VID	Vista Irrigation District
V/m	volt per meter
VSC	Voltage Source Converters
WDR	waste discharge requirement
WQC	water quality certifications
WSA	wilderness study area
XLPE	cross-linked polyethylene

APPENDICES

APPENDIX A: Detailed Route Descriptions

APPENDIX B: Electric and Magnetic Fields from HVDC Transmission Lines and Potential Health Concerns

APPENDIX C: Right-of-Way Requirements for AC and DC Transmission Lines

APPENDIX D: California Department of Transportation Policies

APPENDIX E: Detailed Submarine Corridor Maps