3. ALTERNATIVES ANALYSIS

3.1 INTRODUCTION

The no-action alternative, six system alternatives, and several route alternatives for the proposed Miguel–Mission 230kV #2 Project were studied during the development of the project description. The proposed project was selected as the preferred alternative because it would have the potential for reduced environmental impact, would cost less than the other alternatives to build, would meet the required project schedule, and would provide a more efficient solution to the project's purpose and need (refer to Chapter 2).

3.2 PROJECT ALTERNATIVES CONSIDERED AND ELIMINATED

3.2.1 No-action Alternative

CEQA requires consideration of the no-action alternative. Under the no-action alternative, the project would not be built. This means the transmission delivery capability north of Miguel Substation would remain limited by 560 MW. Without this project, SDG&E/CAISO imports would remain constrained and require transmission system congestion management to maintain power system reliability. The cost of transmission system congestion is significant. The economic analysis prepared by Henwood[1] shows that in the absence of the project SDG&E and CAISO ratepayers would incur 33 million and 181 million dollars, respectively, in increased annual energy costs. Also, the no-action alternative could discourage new generation from developing in southern California and Baja Mexico, resulting in less opportunity for a competitive energy marketplace. As a result, the no-action alternative was determined to be not in the best economic interest of customers in San Diego and California.

3.2.2 System Alternatives

The proposed project is an economically driven endeavor that would relieve overloads on various existing 69kV and 138kV transmission lines and existing 230kV/69kV and 230kV/138kV transformers north and west of Miguel Substation during high power flow into Miguel Substation. SDG&E conducted several facility studies for proposed merchant generation where the project was identified as a preferred alternative to support increased power flow north of the Miguel Substation.

SDG&E looked at and eliminated from further consideration the alternative of constructing a new transmission line in a new right-of-way between the Miguel and Mission Substations. This potential alternative was eliminated because it would unreasonably increase project costs associated with land acquisition for new rights-of-way, equipment, and materials and would result in unnecessary, potentially significant environmental impacts.

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[1] CPUC Order Instituting Investigation into Assembly Bill 970 Regarding the Transmission of Electric Transmission and Distribution Constraints, Actions to Resolve Those Constraints, and Related Matters Affecting the Reliability of the Electric Supply, dated November 2, 2000.

Therefore, SDG&E proposes to construct the project within the existing right-of-way in order to utilize, to the maximum extent feasible, existing utility facilities and access roads, to avoid and minimize potentially significant environmental impacts, to minimize project costs, and to streamline project permitting and construction.

Six transmission upgrade alternatives, including the proposed project, were studied. The other five options were a 69kV/138kV system upgrade alternative, three conceptual 230kV transmission alternatives, and a RAS alternative. The following sections and Table 3-1 fully discuss and compare each alternative.

Transmission System Upgrade Alternatives

Upgrading Existing 69kV/138kV System

The 69kV/138kV upgrade alternative includes the addition of two new transformers and various bundling and reconductoring of existing 69kV and 138kV transmission TLs. This alternative would include the following transmission system upgrades.

- Install new 230kV/138kV 392 mega-volt-ampere (MVA) transformer at Miguel Substation
- Install new 138kV line (two 636-kcmil ACSR) from the new 138kV transformer terminal at Miguel Substation to the Proctor Valley Substation (1.4 miles)
- Loop-in 138kV TL 13824 (South Bay to Los Coches) into Proctor Valley Substation and install two new breakers with 2200A breaker rating or higher
- Bundle 138kV TL 13824 from Proctor Valley Substation to Los Coches Substation to two 636-kcmil ACSR (15.3 miles)
- Reconductor portion of 69kV TL 631 (El Cajon to Los Coches) to one 636-kcmil ACSR (7.7 miles)
- Install new 138kV/69kV 224 MVA transformer at Main Street Substation and tap TL 13815 on the 138kV side of the new transformer
- Install motorized switch on the South Bay Substation to Main Street tap line at the Main Street Substation
- Reconductor 69kV TL 606 (Division Street Substation-Naval Station Metering Facility) to two 636-kcmil ACSR (1 mile)
- Reconductor southeast and northeast main bus at South Bay Substation with bundled 1,033-kcmil ACSR

This 69kV/138kV system upgrade alternative would cost approximately 10 percent more than the proposed project and also would take up to a year longer to design and construct. In addition, this 69kV/138kV upgrade alternative would not provide a long-term solution because more thermal overloads on the transformers at Miguel Substation and various 69kV circuits would exist as load grows and power flow increases into Miguel Substation, resulting from more generation interconnection south and east of Miguel Substation.

Table 3-1: Alternatives Analysis Summary

Alternative	System Performance	Relative Cost (compared to project)	Construction Issues	Environmental Impacts
69kV/138kV upgrade system	• Accommodates less new generation south of Miguel Substation	• Approximately 1.1 X "COST"	• New 230kV/138kV 392 mega-volt-ampere (MVA) transformer at Miguel Substation • New 138kV/69kV 224MVA transformer at Main Street Substation (transformers have long lead times) • Requires 3.5 to 4 years to license and construct • Modify existing structures (higher loads) for 138kV line from Proctor Valley to Los Coches Substations (15.3 miles) • New 138kV structure line from Miguel to Proctor Valley Substations (1.4 miles) • 69kV transmission line reconductorings required (8.7 miles)	• No new right-of-way required • Requires approximately 9 new poles • Requires modification of approximately 90 existing structures • Requires approximately 13 pulling and tensioning sites • Requires approximately 149 work areas • Requires approximately 3 staging areas • Requires approximately 9 new spur roads

Alternative	System Performance	Relative Cost (compared to project)	Construction Issues	Environmental Impacts
New 230kV circuit between Miguel Substation and Main Street Substation, and a new 230kV Main Street Substation	• Overloads occur at transmission facilities at low levels of generation south of Miguel Substation • Requires many more system reinforcements than the project or the 138kV upgrade alternatives	• Approximately 2.8 X "COST" • Additional SDG&E system reinforcement costs would exist beyond the cost of the transmission line	• New 230kV Substation at Main Street (components have long lead times, and great expense would be required) • New land acquisition would be a great expense (through public areas) • Construction would be difficult where it runs parallel to the existing Trolley Line • Requires at least 4 years to license and construct • New 230kV structure line from Miguel to South Bay Substations • Modify existing structures for 230kV line from South Bay to Main Street Substations	• No new right-of-way required • Requires approximately 70 new poles • Requires modification of approximately 48 existing structures • Requires approximately 8 pulling and tensioning sites • Requires approximately 118 work areas • Requires approximately 3 staging areas • Requires approximately 70 spur roads • Requires installation through environmentally sensitive areas, such as coastal wetlands, between South Bay and Main Street Substations • Requires new land acquisition for substation • High visual impact (taller structures than those in parallel circuits) • Associated reconductoring or other system modifications would result in additional pull sites and work areas (mileage unknown)

Alternative	System Performance	Relative Cost (compared to project)	Construction Issues	Environmental Impacts
New 230kV circuit between the Miguel Substation, and a new 230kV substation in the vicinity of the existing Los Coches Substation	• Overloads occur at transmission facilities at low levels of generation south of Miguel Substation • Requires many more system reinforcements than the project or the 138kV upgrade alternatives	• Approximately 2.5 X "COST" • Additional SDG&E system reinforcement costs would exist	• New 230kV Substation at Los Coches Substation (components have long lead times, and great expense would be required) • Requires at least 4 years to license and construct • Modify existing structures for 230kV line from Miguel to Los Coches Substations (14.6 miles) • New structure line needed for 69kV/138kV circuit relocation from Miguel to Los Coches Substations (14.6 miles)	• No new right-of-way required • Requires approximately 100 new poles • Requires modification of approximately 65 existing structures • Requires approximately 165 work areas • Requires approximately 14 pulling and tensioning sites • Requires approximately 3 staging areas • Requires approximately 100 new spur roads • Hillside excavation required for substation • Additional grid reinforcements would result in added impacts

Alternative	System Performance	Relative Cost (compared to project)	Construction Issues	Environmental Impacts
New 230kV circuit Miguel to Sycamore Substations	• Requires many more system reinforcements than the project or the 138kV upgrades alternatives	• Approximately 1 X "COST" • Additional SDG&E system reinforcement costs would exist	• Requires 3.5 to 4 years to license and construct • Modify existing structures for 230kV line from Miguel Substation to Fanita Junction • Vacant position exists on existing 230kV structures from Fanita Junction to Sycamore Substation • New structure line needed for 69kV/138kV circuit relocation from Miguel Substation to Fanita Junction	• No new right-of-way required • Requires approximately 130 new poles • Requires modification of approximately 45 existing structures • Requires approximately 21 pulling and tensioning sites • Requires approximately 175 work areas • Requires approximately 3 staging areas • Requires approximately 130 new spur roads • Associated reconductoring or other system modifications would result in additional pulling sites and work areas

Alternative	System Performance	Relative Cost (compared to project)	Construction Issues	Environmental Impacts
Remedial action scheme (RAS)	• Fails to accommodate increased transmission capacity to enable more new generation • Requires at least 630MW generation restriction at South Bay and 230MW generation restriction at Encina 138kV • Additional operator actions required to dispatch gas turbines and shift generation from South Bay to Encina Substations after a single contingency	• Initial cost: approximately 100,000 dollars (not including costs of imports to customers) • Increased cost to ratepayers (generator tripping schemes) • Discourages new generation (less competitive marketplace)	• No transmission upgrades required beyond Miguel Substation • Requires up to 1 year to design, obtain required approval, and implement	• Not applicable
Miguel–Mission 230kV #2 Project	• Supports future increase in power injection at Miguel Substation • Requires no minimum generation dispatch • Supports future load growth at Los Coches and Sycamore Canyon Substations • Same real power loss as 138kV upgrade	• "COST"	• Requires approximately 3 years to license and construct • Modify existing structures for 230kV line from Miguel Substation to Fanita Junction. Vacant position exists on existing 230kV structures from Fanita Junction to Mission Substation. • New structure line needed for 69kV/138kV circuit relocation from Miguel Substation to Fanita Junction	• No new right-of-way required

<u>Other 230kV Alternatives</u>

Among the other transmission alternatives considered were:

- a new 230kV circuit from the Miguel to Main Street Substations and construction of a new 230kV substation at Main Street,
- a new 230kV circuit from the Miguel to Los Coches Substations and construction of a new 230kV substation at Los Coches, and
- a new 230kV circuit from the Miguel to Sycamore Substations.

These 230kV alternatives would require significantly more system reinforcements, such as various 69kV/138kV transmission line upgrades and transformer additions, than either the project or the 69kV/138kV reinforcement alternative. The 230kV alternatives were eliminated from further study because they would be unreasonably greater in cost than the project due to the need for substation land acquisition, would require greater amounts of equipment and materials, and would result in more environmental impacts and their associated mitigation requirements.

<u>Use of Congestion Management and Remedial Action Scheme</u>

This alternative does not include transmission reinforcement beyond Miguel Substation. It would require implementing an automatic protection system in the form of RAS, generators increasing minimum generation dispatch requirement at South Bay and Encina power plants, and various automatic post-contingency operating actions (including generator dropping) to meet the CAISO reliability criteria. These implementations would result in operating inflexibility, complex operation, and higher probability of loss of generation and load. Congestion management and RAS, as proposed by the CAISO after the completion of the facilities study for the Otay Mesa Generation Project, was eliminated from further consideration. Use of congestion management and RAS fail to meet the purpose and need of providing increased transmission capacity to enable more new generation in California and Mexico to serve load in San Diego and California. In fact, this alternative potentially would expose new generation and existing generation in Mexico to tripping and generation output reduction schemes, thus increasing energy costs to customers because economic generation is removed (tripped) from the system. This alternative also discourages new generation from developing in Southern California and Baja Mexico, resulting in less opportunity for a competitive energy marketplace.

3.2.3 Energy Conservation and Load Management Alternatives

SDG&E, under the direction of the CPUC, offers a number of energy conservation programs for customers including financial incentives for installing specific, energy-efficiency measures. SDG&E also provides programs, such as online energy profiling and in-home energy audits, to make customers more aware of their energy usage and of ways to conserve, as well as a variety of free brochures on improving energy efficiency. These programs play an important role in energy savings. However, even with these programs, these savings are far from what would be needed to meet forecasted load in coming years. The average on-peak demand savings between 1984 and 2000 were 37 MW per year. The lifecycle savings from individual conservation programs range from 7 to 20 years. These demand savings from energy-efficiency programs are largely accounted for in the forecasted load.

In addition, the future nature of these programs is uncertain. Although Public Goods Charge funding has been extended, the programs will be developed according to CPUC policy directions, which are subject to change. This occurred in 1997, when the CPUC's objective for the programs changed to "market transformation," with less emphasis on energy and demand savings. This change in objective resulted in lower savings results for 1998 to 2000 programs than had been achieved in preceding years. Uncertainty in future program policies and directions means uncertainty in program savings.

Load management programs are defined as those that reduce electric peak demand or have the primary effect of shifting electric demand from peak to non-peak time periods. SDG&E currently offers no load management programs, except for curtailable/interruptible rate programs. However, the CPUC and the CAISO are promoting load management activities for utilities to implement.

An example of the CPUC efforts is contained in its March 27, 2001 Decision on the Implementation of Public Utilities Code Section 399.15(b), Paragraphs 4–7; Load Control and Distributed Generation Initiatives.[2] In this Decision, the CPUC authorized SDG&E to administer a pilot program designed to test the viability of a new approach to residential load control and demand-responsiveness through the use of Internet technology and thermostats that affect central air conditioning use. The CAISO is also promoting load management initiatives. For example, the CAISO implemented the Summer 2001 Demand Relief Program (DRP) and is also pursuing a new demand response program called the Discretionary Load Curtailment Program (also referred to as the Voluntary Load Curtailment Program).

For purposes of transmission system planning, load reduction that results from load management programs can be considered neither reliable nor long term. Load management programs inherently lack persistence, because the participant may drop out at any time by forgoing the incentive payment. This can occur if the opportunity to the customer is greater to operate equipment than is the incentive to not operate. Load management programs also depend on funding each year to pay incentives to customers who reduce load. Without incentives, no load reduction occurs at all. For example, in the CAISO's DRP, incentives were funded only for the summer 2001 (June through September). The DRP produced no load reduction at any other time of the year, even if system peak occurred in May or October. Moreover, the DRP was clearly defined as a one-year program. Participants committed only to reducing load for a given incentive during one summer. It is unclear what, if any, program will exist in the future, or what it would produce in terms of actual load reduction. The average benchmark price for the CAISO's 2001 DRP was 140,000 dollars per MW per year.

The CAISO's proposed Discretionary Load Curtailment Program would allow participants to choose when and whether they are curtailed on a daily basis. With this voluntary structure, and without specific previous history, SDG&E cannot depend on such load curtailment mechanisms as a project alternative. Furthermore, as with the CAISO's 2001 DRP, it is a costly alternative. Although an accurate cost forecast for this type of CAISO program has not yet been established, a range of 200 to 250 dollars per megawatt hour has been suggested, based on recent price caps.

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[2] CPUC, Rulemaking 98-07-037, Decision 01-03-073, March 27, 2001.

Thus, as a stand-alone project alternative, energy conservation and load management programs were considered and eliminated. The savings from these programs represent a fraction of the capacity the project would supply. In addition, uncertainty surrounds future program policies and directions and, as a result, potential savings from energy conservation and load management activities. Therefore, energy conservation and load management programs were eliminated from further consideration as a viable project alternative.

3.3 ROUTE DESIGN ALTERNATIVES

This section describes the route design alternative for the relocated 69kV/138kV component of the project occurring within SDG&E's existing right-of-way. As discussed in Section 3.2.2, there are no feasible route alternatives for the new 230kV circuit component of the project other than the preferred alternative detailed in Chapter 1. Therefore, the alternative route design analysis in this section[3] describes the relocated 69kV/138kV component, which is divided as follows:

- Subsection A: Miguel Substation to Tower #28
- Subsection B: Tower #28 to Tower #5
- Subsection C: Tower #5 to Los Coches Substation
- Subsection D: Los Coches Substation to Tower #37
- Subsection E: Tower #37 to Fanita Junction

Refer to Chapter 1 and Figure 1-5 for a description and map, respectively, of these subsections, the existing facilities, and the proposed additions and modifications. CPUC General Order 95 served as the basis for selecting structure locations for the relocation of the existing 69kV/138kV pole line discussed within these subsections. The following sections fully describe the preferred transmission design and the alternatives considered.

3.3.1 Subsection A: Miguel Substation to Tower #28

From Miguel Substation to Tower #49, SDG&E proposes to install the relocated 69kV/138kV circuits onto a new pole line on the west side of the existing right-of-way. The west side of the existing right-of-way was chosen because relocation of the new 69kV/138kV pole line on the east side of the existing right-of-way does not provide sufficient line clearance due to the presence of the two existing 69kV circuits (TL 627 and TL 643) located on the east side of the existing right-of-way. Relocation of the existing 69kV/138kV circuit on the east side would require a complete rebuilding of the two existing 69kV circuits with steel poles instead of wood poles, creating greater potential environmental impacts and increased costs. This subsection of the existing right-of-way lies mostly within rural areas. North of Tower #49, SDG&E proposes to cross the new pole line to the center of the right-of-way between the two existing steel lattice tower lines and then crossing to the east side of the existing right-of-way at Tower #40. This results in increasing the distance to housing on the west side of the right-of-way. And because housing on the east side of the existing right-of-way is generally closer to the route than the

[3]This route design analysis is based on the status of engineering studies completed to date. Engineering changes and /or modifications to the preferred route may occur as a result of the final design. However, the changes or modifications are not expected to significantly alter the project benefits, project scope, or potential project impacts.

housing on the west side between Towers #49 and #40, the preferred alternative along a centered position before crossing to the east side of the existing right-of-way has the potential for less impact to the community.

However, locating a new 69kV/138kV structure line in the center of the two existing steel lattice tower lines, for long distances, is not preferred because it reduces the reliability of the existing 230kV circuits and the proposed 230kV circuit within the existing right-of-way because of reduced line clearances. In addition, maintenance of the relocated 69kV/138kV pole line would be difficult to perform safely without an outage on both of the nearby existing 230kV circuits. Locating the line between existing towers would necessitate steel pole construction to accommodate required clearances between circuits, thus increasing costs. Construction of the new 69kV/138kV pole line would also require outages of the existing 230kV, 138kV, and 69kV circuits within the existing right-of-way. For these reasons, it would not be reasonable to remain in a centered position for extended distances.

3.3.2 Subsection B: Tower #28 to Tower #5

North of Tower #28, SDG&E proposes to install the relocated 69kV/138kV pole structure line 12 feet from the east edge of the existing right-of-way. In addition to avoiding housing developments on the west side of the right-of-way starting at Tower #27, location to the east side would allow positioning the tap of TL 632 to utilize existing poles on TL 6914 to cross the existing right-of-way and head west toward Granite Substation. Crossing over from the east side of the existing right-of-way between Towers #12 and #11, SDG&E proposes to install the new pole line in the center of the two existing steel lattice tower lines.

Installation of the relocated 69kV/138kV circuit on the west side of the existing right-of-way does not allow for sufficient line clearance due to the presence of the two existing 69kV circuits (TL 632 tap and TL 6914) located on the west side of the existing right-of-way. Therefore, no feasible solution exists to place the new structure line on the west side of the existing right-of-way north of Tower #28.

Alternatively, locating a new 69kV/138kVstructure line in the center of the two existing steel lattice tower lines prior to Tower #12 may cause reliability and maintenance issues like those described for Subsection A. Because more housing developments occur on the west side of the right-of-way than on the east side, a major housing community lies north of Tower #15, and a roadway exists between the housing developments and the right-of-way along the east side of the right-of-way from Tower #9 to Tower #5, the preferred alternative of locating the circuit away from the west side has less potential for impact on existing land uses. In addition to avoiding housing on the east side near Tower #10, crossing the new pole line to the center of the two existing steel lattice tower structures would require no modifications to the two existing 69kV circuits (TL 6914 and TL 678), which would otherwise require new structure lines causing additional environmental impacts.

3.3.3 Subsection C: Tower #5 to Los Coches Substation

SDG&E proposes to install the relocated 69kV/138kV pole structure line to a centered position between the two existing tell lattice tower structures within the existing right-of-way, from Tower #5 to Los Coches Substation.

Installation of the relocated 69kV/138kV circuit on the east or west side of the existing right-of-way does not allow for sufficient line clearance due to the presence of the two existing 69kV circuits (TL 631 and TL 6914) located on the west side of the existing right-of-way, and single existing 69kV circuit (TL 678) located on the east side of the existing right-of-way. Therefore, no feasible solution exists to place the new structure line on the east or west side of the existing right-of-way without initiating significant costs and environmental impacts associated with the relocation of the existing 69kV structure lines.

Placement of existing structures does not provide adequate clearance for an alternative alignment through this subsection.

3.3.4 Subsection D: Los Coches Substation to Tower #37

From Los Coches Substation to Tower # 37, SDG&E proposes to construct the 69kV/138kV pole structure line 12 feet from the west edge of the existing right-of-way. Location of the new 68kV/138kV steel pole support structures would match the relative span for span positioning of the existing 138kV steel lattice tower structures. This span for span positioning is required to maintain adequate clearances to adjacent circuits within the existing right-of-way and to minimize the potential impact of new access and/or spur road construction.

The existing 69kV circuit (TL635) currently occupying the east side of the existing 138kV steel lattice tower structures would be relocated onto new single-circuit steel pole structure line within the existing right-of-way and centered between the 138kV and 230kV towers for a short distance (two spans). This transition to the center of the existing right-of-way can be accommodated because of the very short distance, approximately three poles. Location of the new steel pole support structures would match the relative span for span positioning of the 138kV steel lattice tower structures.

The wood pole support structures along the existing 69kV circuit proposed for relocation currently occupy sensitive wetlands Using a span for span design for the new double-circuit 69kV/138kV line would minimize the need to enter the wetland areas to relocate the line, except to remove the existing wood pole structures. Placement of existing structures does not provide adequate clearance for an alternative alignment through this subsection.

3.3.5 Subsection E: Tower #37 to Fanita Junction

Because of the existing narrow right-of-way in this subsection, SDG&E proposes to install the relocated 69kV/138kV pole line approximately 12 feet from the south edge of the existing right-of-way from Tower #37 to Fanita Junction. The relocated 69kV/138kV circuit would be constructed on steel pole support structures in this subsection.

The existing 150-foot-wide right-of-way from Tower #37 to Fanita Junction allows for few relocation options, except for undergrounding or obtaining additional right-of-way width. Both options pose much greater environmental, technical, and financial impacts than the proposed relocation alternative.

3.4 ALTERNATIVE TECHNOLOGIES

3.4.1 Underground High-Voltage Transmission

SDG&E has significant experience designing and installing underground high-voltage transmission cable up to 138kV and has studied the design, manufacture, and installation of underground cable systems at a voltage level of up to 230kV.

Design, manufacture, installation, and operation of long-distance 230kV underground transmission lines have yet to be implemented within the SDG&E transmission system. Reliability issues for long-term operation remain unresolved. Repairing a failed underground cable can take weeks or months due to the complexity of specialized cable, splices, and equipment and personnel required. Installation of underground trench and 230kV cable would result in much more significant ground disturbances compared to overhead construction. Finally, because underground systems can cost up to five times as much as overhead systems, this alternative is not beneficial to the consumer rate base. For these reasons, underground installation of 230kV cable is not feasible to meet the purpose and need identified in Chapter 1, and was eliminated from further consideration.

3.4.2 Underground Versus Overhead Line Construction Impacts

The impacts of ground-disturbing construction activities to wildlife and other resource values resulting from undergrounding a transmission line would be much greater than for building an overhead transmission line. Other impacts of underground construction typically would result from hazardous material leaks in fluid-filled cables, land-use compatibility, and aesthetics. Impacts that typically need to be considered are discussed in the following sections.

Right-of-way

One of the benefits of this project is maintaining all line construction activities within an existing right-of-way. Typically, overhead construction requires wider right-of-way widths (e.g., 150 feet to 250 feet along the Miguel–Mission right-of-way) than underground construction (about 40 feet for a single circuit in a rural area). However, if two underground circuits are required to reduce restoration time and increase reliability, a right-of-way width of 60 to 80 feet may be required to maintain thermal capacity, provide adequate access for construction and maintenance, and as a safety buffer. Overhead construction requires greater right-of-way width for clearances between electrical conductors and for the potential sag and swing in wind of the conductors. Underground right-of-way widths can be limited to the area containing the line and an area on each side of the line for access and to protect against unintentional excavation damage.

Perpendicular underground street crossings can occur, but would require special protection to prevent damage from other construction or repair excavations. Access to the underground cable substructure (i.e., conduits) would be required along the entire length of the underground cable system, whereas overhead transmission lines would require access only at each steel lattice tower structure or pole location. Additional space for access and grading would be required at splice vaults. Underground installations also would require larger areas to accommodate possible overhead equipment and inductive reactor stations, and to protect the underground cable from high-voltage excursions that can damage the insulation material and cause failure.

In undeveloped areas, underground transmission line construction requires the right-of-way to be totally cleared of trees, brush, and ground cover to allow for construction. Overhead construction requires permanent clearing only in the areas of the proposed structures (i.e., poles or steel lattice tower structures), access roads, and removal of trees to provide for required electrical conductor clearance and maintenance. Both overhead and underground construction would require new spur roads off existing access roads. Impacts to biological and cultural resources would be considerably greater with an underground alternative.

Ground Disturbance

Ground disturbance for overhead line construction would occur in structure locations, tensioning sites, and access roads, while underground construction would involve extensive ground disturbance (trenching) for the entire line length. Extensive street repair or ground restoration also would be required. Extensive disruption to traffic patterns can also result during underground construction in a street right-of-way.

Overhead construction has the flexibility to span sensitive features, such as wetlands. Underground construction does not have this type of flexibility and would require construction through sensitive features. Directional drilling or boring can be used for cross-linked polyethylene (XLPE) underground construction. However, it would be very expensive and would come with its own set of technical problems.

Replacement or repair activities along underground cables would result in significant ground disturbance when compared to repair of overhead lines. Overhead line repair work usually involves much less impact, typically only at the existing structure locations. In addition to excavations, secondary off-site ground-disturbing impacts may occur during repair of underground lines if selective trench backfill is required for heat dissipation of underground cable. Off-site material source sites must be excavated to obtain this select trench backfill material, which then must be trucked to the trench site.

For self-contained, fluid-filled cable installations, a loss of fluid could occur and result in contamination of the surrounding soil. A fluid leak can be caused by several means, including thermal expansion and contraction of the cable due to power cycling, ground movement, splice breakage, termination movement, improper installation, and a cable fault. A leak of pressurized fluid can spread.

Land Use and Aesthetics

Overhead construction can be visually intrusive in sensitive visual environments. Underground construction typically is considered to have lower visual impacts. However, ground-disturbance impacts of underground transmission line construction would be highly visible because vegetation clearing is required along the right-of-way. Underground cable installation would require cable poles at each end of an underground cable section to transition from underground to overhead. Figure 3-1 illustrates a typical cable pole installation.

In addition to the cable poles, reactor stations may be required along underground lines to control voltage rise. An additional constraint associated with construction of underground lines is that length of cable sections is limited by voltage rise along the cable, due to self-capacitance. Reactor stations would need to be inserted along the line at regular intervals to maintain the cable voltage rise within acceptable limits. For an underground Miguel–Mission 230kV line, it is estimated that reactor stations would be required every 10 to 15 miles and would encompass an area of 1 acre.

At each reactor station, the underground cable would be brought to the surface, terminated, and transferred to an overhead bus. Equipment in each reactor station would include the reactors, 230kV circuit breakers, and disconnect switches, control and protection equipment. In addition to land use impacts, each reactor station would create additional potential failure points along the line and further compromise circuit reliability. These reactor stations also would have the appearance and impact of a small electric substation. Figure 3-2 illustrates a typical reactor station.

In agricultural areas, underground construction may be much more disruptive than overhead construction. Farming usually can be conducted under overhead lines (except for structure locations), but it would be prohibited over underground lines to allow continual access to the underground cable and to avoid damaging the line during cultivation.

Costs

Depending on topography, underground lower voltage (69kV to 138kV) and high-voltage (230kV) electric cable construction typically costs four to six times more than overhead line construction. Costs for a 230kV underground cable alternative would be particularly high because of the project's length and the potential post-project costs for maintenance and reliability.

The length of an underground line alternative would require the installation of approximately two reactor stations along a 35-mile route, as described, which are not installed in the typically shorter underground cable installations. Additionally, to minimize potential outage times, a spare cable or circuit would need to be installed during initial construction of the project. A spare cable would increase the cost of an underground project by approximately 25 percent.

3.5 CONCLUSION

Compared to other alternatives considered, the proposed project was chosen because it is the most feasible, lowest cost alternative that achieves the prescribed purpose and need. In particular, the proposed project would provide superior net economic benefits by achieving the greatest reduction of transmission constraints and congestion costs, as well as enhancement of competition among suppliers, and would not result in significant environmental impacts.

The route design (based on current engineering studies) was chosen because it:

- utilizes existing utility facilities and rights-of-way to the greatest extent feasible to reduce potential for adverse environmental impacts;
- provides the most feasible engineering design, complying with General Order 95 guidelines; and
- provides superior transmission system performance.

Figure 3-1

Typical Cable Pole Installation

(see link on contents page)

Figure 3-2

Typical Reactor Station

(see link on contents page)