United States of America
Before the

Department of Energy

Public Service Company of New Mexico Docket No PP-197

Application For
Presidential Permit

Introduction

The Public Service Company of New Mexico ("PNM" or "Company"), is a company organized under the laws of the State of New Mexico, engaged in the business of providing natural gas service at retail and electric utility service at both wholesale and retail. The Company also provides water and waste water management services to third parties. PNM is authorized to conduct business in the states of New Mexico, Arizona, California and Illinois.

Exact Legal Name

PNM's exact legal name is "Public Service Company of New Mexico."

Exact Legal Name of all Partners

At the present time, PNM does not have any partners in the project for which this application is made. Partners may be invited to join the project in the future, at which time PNM will provide the DOE with appropriate notice, including the exact legal name of all partners.

Name, Post Office Address and Telephone Number of the Person to Receive Correspondence

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Albuquerque, New Mexico 87103
(505) 241-2570

Foreign Ownership of PNM or its Facilities

Neither PNM nor its transmission lines are owned wholly or in part by a foreign government or directly or indirectly assisted by a foreign government or instrumentality thereof. At the present time, PNM does not have any agreement pertaining to such ownership or assistance from any foreign government or instrumentality thereof. However, PNM has had several discussions with both the Comisión Federal de Electricidad (CFE) as well as other private parties in Mexico regarding the potential for such ownership or assistance. Should these discussions result in contracts for foreign ownership or assistance, PNM will provide the DOE with appropriate notice, including the exact legal name of all participants.

Existing Contracts with Foreign Governments or Foreign Private Concerns

At the present time, PNM has two contracts in effect with the CFE which provide for the sale or purchase of economy energy at delivery points in the United States or in the Mexican states of Baja California and Chihuahua. While these contracts do not directly relate to the interconnection facilities that are the basis of this application, PNM could potentially export electricity to Mexico under either or both of those contracts, subject to obtaining the appropriate Export Permit from the DOE.

Showing of Legal Capacity

As shown in the attached signed Opinion of Counsel (see appendix A), the construction, connection, operation, and maintenance of the proposed facility is within the corporate power of PNM, and PNM has complied with or will comply with all pertinent Federal and State laws.

A Description of the Transmission Facilities through which the Electric Energy Will be Delivered to the Foreign Country, Including the Name of the Owners and the Location of Any Remote Facilities

PNM proposes to construct two high voltage transmission circuits, within a single right-of-way, to interconnect the existing electrical systems of the United States and Mexico. The proposed in-service date for these facilities is June, 2002. The two circuits may be constructed as one double circuit or two individual lines and, depending on economic and other business conditions at the time, however, the individual circuits may actually be constructed based on a phased timing approach. Both of the proposed transmission circuits would originate at the Palo Verde Nuclear Generating Station (PVNGS) High Voltage Switchyard located approximately 50 miles west of Phoenix, Arizona. In Mexico the facilities would connect with complimentary transmission facilities of the Comisión Federal de Electricidad (CFE), the national electric utility of Mexico, at an existing substation named Santa Ana, located some 60 miles south of the international border. Participant Owners in the PVNGS Switchyard are Arizona Public Service Company, Salt River Project, Southern California Edison Company, Los Angeles Department of Water and Power, El Paso Electric Company, The Sacramento Municipal Utility District and Public Service Company of New Mexico.

At present the choice of technology (alternating current or “AC” versus direct current or “DC”) and the routing for the line(s) remain open options. The decision regarding the technology for this project is the subject of ongoing discussion with the CFE and will be heavily influenced by technical and business considerations. Such technical and business considerations include potential differences in interaction of the DC conversion equipment with generating facilities in either system as well as potential limitations in ultimate transfer capability between the technologies. Nevertheless, PNM desires to consider this decision in consultation with the DOE and in light of the results of the environmental review process which the DOE will conduct as a result of this application. At this time PNM has narrowed the range of alternatives to the two technical options (AC vs. DC) and three routing alternatives as discussed below. However, it is anticipated that additional routing alternatives may be identified during the environmental review process. Typical structure types for the two technical alternatives are shown in Appendix B. The three routing alternatives are shown on the routing map in Appendix C.

As referenced above, the two high voltage transmission line(s) and stations which are the subject of this application may be designed either for alternating current (AC) or for direct current (DC) operation. Depending on the ultimate design choice, at one or more points along these line(s), equipment would be installed to convert the line(s) from AC to DC and then back to AC operation.

This conversion of operating modes is required for technical reasons to provide for asynchronous operation of the systems on both sides of the interconnection. Should the line(s) be designed for AC operation, this conversion equipment would be located in a single station, commonly referred to as back-to back converter station, located at a point close to the existing international border. This choice of location is strongly favored for technical reasons, since due to differences in relative electrical strength of the two systems being interconnected this location would optimize the operation and transfer capability between the two systems. Other locations may be considered for the AC option back to back station, if environmental or other concerns prevail, but they would be less than optimal technically. The line(s) between the PVNGS Switchyard and this new converter station would be operated at 345 kV (345,000 volts), while the line(s) between the new converter station and the interconnection point with the Mexican system would be operated at 230 kV. Each of these AC line(s) would be expected to be rated for a transfer capability of approximately 400 MWs.

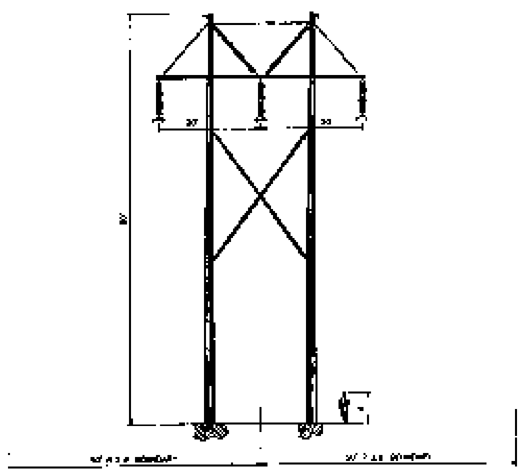
Should the ultimate design call for the transmission line(s) to be operated as DC circuits, the conversion equipment would be split into two separate stations, one on each end of the new line(s). If constructed using a phased approach, the DC line(s) between these stations would initially be operated as a mono-pole DC line operating at a nominal voltage of 400 kV, and would be expected to be rated for an approximate transfer capability of between 400 and 500 MWs, depending on final system design studies. With the addition of the second circuit the system would be upgraded to bi-pole ±400 kV operation and the transfer capability doubled to between 800 and 1000 MWs accordingly.

The discussion and the map in appendix C indicate three current routing alternatives: 1) the Western Tohono O’odham, 2) the Eastern Tohono O’odham, and 3) the Palo Verde to Nogales corridors. Any of the corridors depicted could be used for either the alternating current (AC) or direct current (DC) technical alternatives. No proposed locations for the new substation required by the AC alternative are shown on the map, since a precise location will depend on both technical and environmental considerations. However, the AC to DC to AC back-to-back conversion facilities would fit easily within the width of the two-mile wide corridors depicted and would generally be located near the international border for the corridor selected.

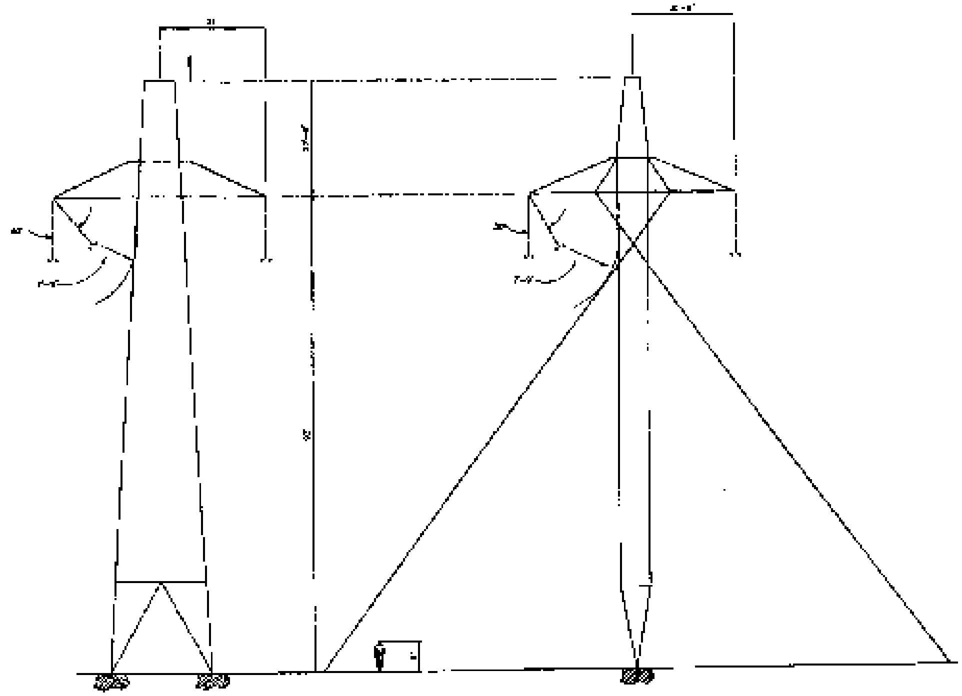
PNM anticipates that the process of narrowing the routing alternatives to a single corridor and finally to the 150 to 200 foot right-of-way for the transmission line(s) as well as the process of selecting the AC or DC technical alternative will depend on parallel evaluation and approval processes in the United States and Mexico. The concurrent environmental processes in both countries will determine whether use of any one route would create unacceptable environmental impacts and whether any of the routes is clearly favored on the basis of lowest potential impacts. Parallel technical studies will further define potential operation and reliability impacts of the technical options on the electrical systems of the United States and Mexico. A final selection of technology and routing will require the information from all of these analyses.

Potential Environmental Impacts of the Proposed Route Alternatives

The potential environmental impacts of the proposed route alternatives are discussed in Appendix C. The information provided in Appendix C is intended only to indicate the general character of the environment in the project area and to provide a preliminary basis for assessing the potential of the proposed project to affect the environment. It is anticipated that the Department of Energy will prepare the level of National Environmental Policy Act (NEPA) review required under 10 CFR 1021.



230 kV WOOD STRUCTURE



DC

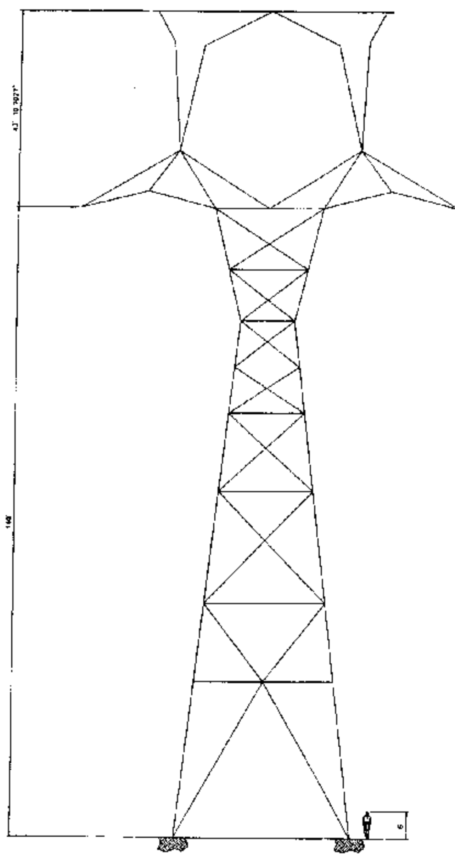
DEC 01 1991

"PENDING APPROVAL"

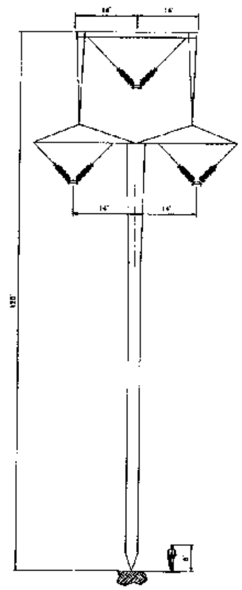
PNM

STATEMENT

STRUCTURES



345 kV TANGENT
SCALE: 1"=10'



345 kV GUYED LATTICE STEEL TOWER
SCALE: 1"=10'

DEC 07 1998

"PENDING APPROVAL"

PROPRIETARY STATEMENT

[illegible]

ASSOCIATED LAYERS	
LAYER NAME	DESCRIPTION
0	STANDARD
TBBL	TITLE BLOCK
DRAW	LINE WORK
TEXT	ALL TEXT

PNM PUBLIC SERVICE COMPANY OF NEW MEXICO

PNM TRANSMISSION STRUCTURES
345kV
SYSTEM STRUCTURES

DR: C.BENALLY	TR:	DATE: 11/12/98
CKD:	OK:	SCALE: AS NOTED
APP:	ACAD FILE: DBD'54'	DBD-1541
REV. NO. 0		

Appendix C
Statement of Environmental Impacts of the Proposed Facility

Summary

PNM has conducted a preliminary routing analysis for the facilities described in this Application and has gathered preliminary information on biological resources (including Threatened and Endangered Species), cultural resources (not including Traditional Cultural Properties), soils and hydrology. This information is intended only to satisfy the requirements of 10 CFR 205.322 and to provide general background information on the character of the environment in the project area and potential impacts to environmental resources. The level of detail is predicated on an assumption that the United States Department of Energy (DOE) will apply the criteria set forth in 10 CFR 1021 to determine the level of NEPA review required prior to granting a Presidential Permit for this project. The DOE will determine the appropriate studies to support the level of NEPA review determined to be necessary and supervise preparation of them.

General Character of Expected Impacts to the Environment

Impacts to environmental resources will generally occur during five stages of project implementation: 1) survey work required to physically locate and appropriately mark the locations for each structure required to support the powerline conductor, 2) erection of the powerline supporting structures, 3) stringing and tensioning the powerline conductor, 4) construction of new substations and 5) maintenance of the powerline. Expected impacts for each of these activities is briefly characterized here.

Structure Location Survey

Physically locating and appropriately marking the locations for each structure that will support the powerline conductor requires that a survey crew, generally consisting of two to three individuals, access each location and transport survey equipment to the location. This generally entails driving a light four-wheel drive vehicle to the location in order to transport both the survey crew and their equipment. Environmental impacts are created by the light vehicle, the crew walking about the location and by driving wooden stakes or other devices into the ground to mark the location and to provide datum points for use during construction.

It is generally feasible to avoid impact to sensitive resources, such as archaeological sites, threatened or endangered species or habitat, fragile soils or other resources, by selecting a route to the structure location that avoids such areas. As discussed in greater detail below, the structure locations themselves will generally have been selected to avoid impact to such environmental resources. In cases where such complete avoidance strategies are not feasible, other measures, such as accessing the locations on foot or by helicopter, may be available.

Structure Erection

Erection of the structures to support the powerline conductor is generally the most impact intensive aspect of any interconnection project that requires powerline construction. A number of construction methods are technically feasible and any or all of these methods could be employed for the present project.

One method involves delivering the materials for the powerline structure to each location, assembling the materials on site and erecting the structure by use of a crane. This method will generally entail constructing a temporary road to each structure location, preparing a level pad for the crane at the structure location and extensive foot traffic at the location. Depending on structure design, it may also be necessary to excavate one or more areas for a concrete foundation and to deliver concrete to each structure location. Using this method, the main impacts consist of extensive ground disturbance in an area of about 150 by 150 feet (45 by 45 meters) at the structure location and along the temporary access road.

Alternatives to the method described above involve the use of a helicopter to replace the crane for erecting the structures, use of pre-fabricated pads, guy wires and anchors for structure foundations and assembling the structures at a smaller number of staging areas, then delivering the completed structures to the required location for erection. Use of a prefabricated pad, guy wires and anchors is generally characteristic of steel transmission tower, while wooden structures are generally direct buried and anchored. Pre-assembly of structures is generally associated with helicopter construction, which can also minimize the need for temporary access roads.

Stringing and Tensioning Conductor

Stringing and tensioning the electrical conductor (the “wires”) creates impacts that are generally incremental to those experienced during erection of the structures, although this activity may require accessing points along the centerline of the powerline corridor that are not accessed during other phases of construction. It is generally feasible to access those points using a light four-wheel drive vehicle or even on foot, in the case of particularly sensitive areas. Helicopters can also assist in avoiding impacts during this phase of construction.

Substation Construction

If the direct current (DC) alternative is selected for the Sonora – Arizona Interconnection Project, substations at a previously undisturbed site will not be required and all substation construction will occur at or near the existing substations on each end of the interconnection, as an expansion or extension of existing facilities. The alternating current (AC) alternative will most likely require construction of a totally new substation at a previously undisturbed location. In either case, substation construction will totally disturb the surface of the relatively limited area that the substation occupies. Since there will be a reasonable degree of flexibility in selecting the exact location for any new substation and since existing substations occupy areas that have already been substantially disturbed, it should be feasible to avoid impact to sensitive environmental resources, even if the alternating current (AC) alternative is selected.

Maintenance after Construction

Maintenance after construction is also a potential source of environmental impacts, although these impacts are generally less substantial than those experienced during construction. Maintenance inspections may entail driving a light four-wheel drive vehicle along the powerline route, although this activity can also be carried out from a helicopter. If a structure sustains damage or the conductor becomes detached from the supporting structures, it may be necessary to carry out activities similar to those conducted when initially erecting the structures or stringing and tensioning the conductor.

Mitigation of Potential Impacts to Environmental Resources

Potential mitigation measures during specific phases of construction have been addressed above. The remainder of this section discusses potential mitigation measures that may be available during project design. Any or all of these measures might be applied to the present project, depending on the character of the environmental resources identified during the NEPA process and other environmental compliance processes (such as the studies required for compliance with Section 106 of the Historic Preservation Act or the Endangered Species Act).

It should be noted that the selection of mitigation measures is conducted in consultation with the state, federal and other agencies responsible for granting required permits and managing the lands used by the project. In all cases, the selection of mitigation measures should achieve a balance between the nature of the environmental resources and the cost of implementing mitigation measures. In some cases, it may be determined that specific environmental resources values do not reach a level where highly costly mitigation measures must be implemented. In other cases, such implementation may be required.

The selection of the technology for this project, whether a direct current line connecting stations at the two ends or an alternating current line with a converter station along the line, will be determined in part by the technical requirements of the project and in part by the assessment of potential environmental impacts. The selection of a corridor for placement of the powerline is a crucial mitigation measure, which may be applied even before selecting a technical design for the project. The two-mile wide corridors proposed in this Application are preliminary and it is fully expected that it may be advisable to study additional alternatives during the NEPA compliance process. The results of the NEPA process itself will be critical in selecting the final corridor to be used for siting of the actual powerline right-of-way. Since the right-of-way will most likely utilize no more than 150 to 200 feet of the corridor finally selected and the actual physical location of powerline facilities lies within an even more restricted area, this selection of a final alignment allows many additional opportunities to avoid impacts to critical environmental resources.

The placement of individual structures also presents opportunities to avoid impacting environmental resources. While engineering concerns dictate the spacing of structures to some extent and it is desirable to limit the number of Points of Intersection (places where the line turns an angle), there is also considerable flexibility in structure placement. Flexibility may also exist in choosing the Points of Intersection. Employing these two sources of flexibility, it is often feasible to place structures so that both the structure location and any access road that may be needed for that location avoid environmentally sensitive areas.

When it is not feasible to mitigate impacts through avoidance, other mitigation measures may be available. Such measures are highly specific to the character of the resources and to the nature of the impact and it is, therefore, difficult to predict in advance which measures may be found to be appropriate for this project. However, mitigation measures commonly applied to similar projects include re-grading and re-vegetation to mitigate impacts to soils and flora, timing of activities to avoid impacts to fauna and programs of data recovery prior to construction to mitigate impacts on archaeological sites. To the extent that such measures and other measures are deemed appropriate to mitigate any environmental impacts of the Sonora – Arizona Interconnection Project, they will be applied.

Discussion of Environmental Resources on Individual Proposed Corridors

General Discussion

This section of Appendix C to the Application discusses the known environmental resources of the project area for each of the corridors currently proposed. These corridors have been identified through a preliminary routing analysis conducted in-house by PNM and it is considered likely that additional alternatives will emerge the EIS process. It is also possible that still further routes may emerge later in the EIS process.

The discussion here is intended to provide the level of information required for this Application and as a starting point for consideration of routing alternatives. The need for more through analysis may be identified during the NEPA environmental review process. The discussion treats the resource types individually and presents the information for each corridor separately. The methodology used to produce the summary characterization for each resource type is also presented.

The corridors discussed here are depicted and labeled on the accompanying map. No proposed locations for the new substation required by the AC alternative are shown, since a precise location will depend on both technical and environmental considerations. However, the AC to DC to AC back-to-back conversion facilities would fit easily within the width of the two-mile wide corridors depicted and would generally be located near the international border for the corridor selected, in the case where the AC alternative is determined to be the preferred technical alternative. This proposed location is based upon the expected technical performance of the substation equipment and the ability of the interconnection project to provide critical electrical support in northern Sonora. Other locations may be considered due to other evaluation factors, including environmental impact, but such alternative locations would not be optimal in terms of technical performance or project cost.

The discussion and the map indicate three preliminary routing alternatives: 1) the Western Tohono O'odham, 2) the Eastern Tohono O'odham and 3) the Palo Verde to Nogales. Each of the corridors is potentially appropriate for either the AC or the DC technical alternative. PNM anticipates that any additional routing alternatives that might be identified and proposed would also begin at Palo Verde, terminate at Santa Ana and provide for construction of two electrical circuits, either AC or DC.

The detailed information on environmental resources was provided to PNM by Lone Mountain Archaeological Services, with John Taschek and Associates subcontracted to provided the information on soils, biotic resources and hydrology. Those contractors were originally asked to look at a larger number of alternatives and PNM has extracted information on the routes proposed in this Application from that more extensive body of information. PNM has also reviewed the information for completeness and has edited the written material provided for consistency in terminology with respect to the powerline alternatives and flow of information in this document. All data presentations and conclusions with respect to resource characterizations are as stated by the providing contractors.

Soil Types

Methodology

Soil information on the corridors was assembled from the soil surveys for the project area, using soil surveys obtained from the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS). The routing of each corridor was established on the soil maps. For each corridor the primary and secondary soil types were recorded. The primary soil types represent the predominate soils located within each corridor. The secondary soil types represent other common soils that occur to a lesser extent within each corridor. Information on specific primary and secondary soil types for each corridor is on file at the Public Service Company of New Mexico. The following discussions summarize soil types for each corridor, progressing from north to south by county.

Western Tohono O'odham

The predominate soil types identified for the portion of this corridor located in Maricopa County range from gravelly fine sandy loam to extremely gravelly course sandy loam. The soils are generally deep and well drained to somewhat excessively drained with slopes ranging from 1 to 15 percent. These soil types are found on fan terraces dissected by narrow flood plains (washes).

The predominate soil types identified for the portion of the corridor located in Pima County range from extremely gravelly sandy loam to fine sandy loam. The soils are generally deep and well drained to somewhat excessively drained with slopes ranging from 1 to 15 percent. These soil types are found on stream terraces and fan terraces dissected by flood plains (washes).

Eastern Tohono O'odham

The predominate soil types identified for the portion of this corridor located in Maricopa County range from gravelly fine sandy loam to extremely gravelly course sandy loam. The soils are generally deep and well drained to somewhat excessively drained with slopes ranging from 1 to 15 percent. These soil types are found on fan terraces dissected by narrow flood plains (washes).

The predominate soil types identified for this section of the corridor located in Pima County range from sandy loam to gravelly sandy loam. The soils are generally deep and well drained with slopes ranging from 0 to 3 percent. These soils are found on flood plains, alluvial fans, valley plains, and old terraces.

Palo Verde to Nogales

The predominate soil types identified for the portion of this corridor located in Maricopa County range from extremely gravelly sand loam to very gravelly course sandy loam. The soils are generally deep and somewhat excessively drained to excessively drained with slopes ranging from 1 to 15 percent. These soil types are found on fan terraces dissected by narrow flood plains (washes).

The predominate soil types identified for the portion of this corridor located in Pinal County range from sandy loam to sandy clay loam. The soils are generally deep and somewhat excessively well drained with slopes ranging from 1 to 3 percent. These soil types are found on fan terraces.

The predominate soil types identified for the portion of this corridor located in Pima County range from gravelly to very cobbly loam. The soils are generally very shallow and poorly drained with slopes ranging from 5 to 60 percent. These soil types are found on lower mountains and pediment surfaces.

The predominate soil types identified for the portion of this corridor located in Santa Cruz County range from gravelly loam to gravelly sandy loam. The soils are generally deep and well drained with slopes ranging from 10 to 35 percent. These soils are found on piedmont surfaces.

Based upon this characterization of the soils within the project area, PNM concludes that it should be feasible to mitigate impacts created during construction and maintenance of the powerline and any substation facilities through re-grading and re-vegetation. Special measures may be required near drainages, but the character and extent of such measures cannot be identified with precision until design of facilities is nearing completion.

Habitat and Threatened and Endangered Species

Methodology

A description of the general habitat within each corridor was assembled using text and mapping from *Biotic Communities of the Southwest,* David E. Brown, 1994. State and Federal listings of threatened and endangered (T&E) species were also obtained from the US Fish and Wildlife Services and the Arizona Game and Fish Department. Federal and State threatened and endangered species listings were obtained for Maricopa, Pima, Pinal, Santa Cruz, and Cochise Counties. The complete T&E listings for the routing alternatives are on file at the Public Service Company of New Mexico. Detailed information on the occurrences of threaten and endangered species in the corridors will require more intensive investigation and field surveys which will be conducted for the corridor selected for actual construction. The following provides a summary of the general habitat/vegetation found in each corridor.

Western Tohono O'odham

The Western Tohono O'odham corridor consists of two subdivisions of the Sonoran Desert Scrub vegetation type, the Lower Colorado River subdivision and the Arizona Upland subdivision (Brown, 1984). Of these, approximately three fourths of the corridor is the Lower Colorado River subdivision.

The Lower Colorado River subdivision is a sparse desert shrubland containing vast areas of desert pavement, which is unvegetated, unconsolidated gravel and soil. The most common, exemplary shrub association of this habitat type is creosote-white bursage. Saltbush is another dominant shrub in this subdivision, which is quite extensive. Several species of small trees grow along intermittent drainages within this habitat including western honey mesquite, ironwood, blue palo verde, and smoke tree.

The Arizona Upland subdivision is a multi-layered scrubland or woodland with leguminous trees, low shrubs, large cacti, and low growing succulents. It usually has a varying canopy with small clearings and openings. This habitat type is the most picturesque in the Sonoran Desert with saguaro and organ pipe cacti and is frequently found on rolling terrain. Common species within the Arizona Upland habitat include creosote, palo verdes, ironwood, mesquites, catclaw acacia, crucifix thorn, saguaro, organ pipe, chollas, barrel cacti, and jojoba.

Because approximately three-fourths of this corridor crosses a rather low diversity, widespread desert shrubland community, the Lower Colorado River subdivision of the Sonoran Desert, it has relatively low potential for involvement with threatened and endangered species listed for the region. The large areas of unvegetated desert pavement in the Lower Colorado River vegetation community do not provide suitable habitat for large numbers of sensitive species. This corridor may involve crossing the Gila River, which contains a number of rare, threatened, and endangered fish species. This alignment has the potential to impact a relatively low number of threatened, endangered or sensitive species, provided Gila River crossings do not cause a considerable impact. The measures discussed above may also reduce the potential impact of any required river crossings.

Eastern Tohono O'odham

The Eastern Tohono O'odham corridor contains the same habitat types as its western counterpart. The difference, however, is in the proportions within each subdivision. This corridor is made up of half Lower Colorado River and half Arizona Upland. The Arizona Upland community is more southeasterly occurring than the Lower Colorado River community. The species makeup and structure of these habitats are as described for the Western Tohono O'odham corridor.

This corridor crosses equal amounts of the Lower Colorado River desert shrubland and Arizona Upland. The Arizona Upland community type is rather complex with multi-layered trees and shrubs, large saguaro and organ pipe cacti, and an understory of succulents. As such, the Arizona Upland supports a relatively high number of sensitive cacti, birds, and mammals. For this reason this alignment has a moderate potential to impact threatened and endangered species. This alignment may also involve crossing the Gila River, which could impact sensitive fish species.

Palo Verde to Nogales

This corridor also contains by majority the Lower Colorado River and Arizona Upland divisions of Sonoran Desert Scrub, but also lesser amounts of semi-desert grassland, Madrean evergreen woodland, and Plains and Great Basin grassland.

Semidesert grassland is a desert grassland with small amounts of shrub cover. Common shrubs found in this habitat are honey mesquite, creosote, and four-wing saltbush. Common grasses found in this community are grama grasses, dropseed, tobosa, and three-awn.

Madrean evergreen woodland is a southwestern woodland found in mountain ranges in this region around the Sierra Madre of Mexico. It is typically open on lower slopes, becoming more dense as elevation increases. Evergreen oaks are a namesake constituent of this community and are very prevalent. Common oak species here are gray oak, emory oak, Arizona white oak, and Mexican blue oak. Pine and juniper are also common in this woodland, including Apache pine, Arizona pine, Chihuahua pine, and Durango pine, and alligator and one-seed juniper.

The Plains and Great Basin grassland is a community made up of a combination of cold season Great Basin species with Great Plains distributed species. Dominant grasses in this vegetation community are Indian ricegrass, blue grama, plains lovegrass, other grama grasses, and dropseed grasses.

This is the longest of the corridors considered, and it also crosses the most habitat types. This alignment may involve crossing the Gila River and multiple crossings of the Santa Cruz River, both of which are habitat for several threatened and endangered fish species. Because of its length, multiple river crossings, and highest number of habitat types this alignment has the potential to impact the highest number of threatened and endangered species. The mitigation measures discussed above will be available to reduce the level of actual impacts that may be identified.

Based upon the information available at this point, PNM believes that it should be feasible to avoid or mitigate impacts to threatened and endangered species and their habitats through application of the measures discussed earlier in this Appendix C to the Application.

Hydrology

Methodology

Information pertaining to the hydrology of the corridors was assembled by reviewing United States Geological Survey (USGS) maps of the project area. The number of water bodies within each corridor was counted to estimate the number of crossings that might be necessary for the interconnection facility. The names of water bodies designated on the USGS maps were also recorded to estimate the number of more significant water resources in each corridor. The following sections provide a summary of the water bodies and the number of crossings identified in each corridor.

Western Tohono O'odham: This corridor crosses approximately 95 bodies of water consisting of streams, canals, washes, and rivers. No lakes were identified in the corridor. The northern portion of the corridor follows the Gila River for approximately 20 to 25 miles between the Gillespie Dam and Gila Bend. In this area, the interconnection facility may involve multiple crossings of the Gila River and its tributaries. Based on an approximate length of 130 miles for the corridor, and crossings with 95 bodies of water, the interconnection facility would result in an average of 0.7 crossings per mile. Approximately 13 of the 95 crossings are named on the USGS maps of the corridor. The remaining crossings consist of minor tributaries, unnamed streams, creeks, canals, and washes. A listing of the named rivers, canals and washes, progressing from north to south through the corridor, is on file at the Public Service Company of New Mexico.

Eastern Tohono O'odham

This corridor crosses approximately 240 bodies of water consisting of streams, canals, washes, and rivers. The northern portion of the corridor is located in the Rainbow Valley, which receives runoff from the Sierra Estrella, Maricopa and other mountains. An extensive network of drainages is present in the southern portion of the corridor. These washes generally originate in the Comomabi and Baboquivari Mountains east of the corridor and drain westward toward the Vamori Valley. Two small lakes were also identified in the southern portion of the corridor, 1) Bird Nest Lake, located approximately 6 miles northwest of Sells, and 2) a small unnamed lake located approximately 7 miles north of the international border. Based on an approximate length of 160 miles for the corridor, the interconnection facility would result in an average of 1.5 crossings per mile with water bodies. Approximately 23 of the 240 crossings are named on the USGS maps of the corridor. The remaining crossings consist of minor tributaries and unnamed canals and washes. A listing of the named rivers, canals and washes, progressing from north to south through corridor is on file at the Public Service Company of New Mexico.

Palo Verde to Nogales

This corridor crosses approximately 170 bodies of water consisting of streams, canals, washes, and rivers. The northern 50 miles of this corridor follows the same alignment as the Eastern Tohono O'odham. This portion of the corridor is located in the Rainbow Valley, which receives runoff from the Sierra Estrella and the Maricopa Mountains. At the Maricopa/Pinal County line, the corridor diverges to the southeast past Tucson. Near Tucson, the corridor follows the Santa Cruz River. The interconnection facility may involve multiple crossings with the river and its tributaries in this area. The southern portion of the corridor winds through the Santa Rita and Patagona Mountains crossing numerous drainages. Several springs are also located in this area. North of Nogales, the corridor again crosses the Santa Cruz River.

Based on an approximate length of 250 miles for the corridor, and an estimated 170 crossings, the interconnection facility would result in an average of 0.7 crossings per mile. Of the 170 crossing locations, 27 are named water bodies. The remaining crossings consist of minor tributaries and unnamed canals and washes. A listing of the named rivers, springs, canals and washes, progressing from north to south through corridor is on file at the Public Service Company of New Mexico.

Based upon this characterization of the hydrology along the routes currently proposed, PNM believes that it should be feasible to avoid all but temporary impacts to the water bodies in the course of this project. Mitigation measures may also be available to reduce the extent of even short term impacts that might be unavoidable during construction and maintenance activities.

Archaeological Resources

Methodology

Lone Mountain Archaeological Services has gathered information on known archaeological sites within the routing alternative corridors from the archaeological site files at the Arizona State Museum (ASM) in Tucson, consulting the comprehensive ASM archaeological site record maps (7.5' and 15' U.S.G.S. quadrangles) and obtaining photocopies of the corresponding ASM archaeological site cards. A summary of this site information on an Excel spreadsheet is on file at the Public Service Company of New Mexico, along with a complete set of site card photocopies.

The three routing alternatives are discussed in turn below, with comments on relative densities of known archaeological sites and the potential for unidentified sites. The ASM archaeological site files include both prehistoric and historic archaeological sites as well as standing historic architectural properties. All three kinds of sites were recorded in the file search and are considered in the discussions below. The information provided here does not include research into archaeological investigations which may have been conducted in the project area but are not included in the site files of the ASM.

A number of linear features, designated by ASM as archaeological or historic sites and having ASM site cards, are located within the limits of the alternatives. These features include historic roads, historic and prehistoric canals, and early electrical transmission lines. Because calculating the areal extent of such features is impractical, the spreadsheet on file at PNM does not provide total area for them. Similarly, the UTM coordinates provided on the site cards for such features often correspond to points distant from the point where the feature and a given alternative intersect. In these cases, no UTMs are provided in the spreadsheet; a note is added in the final column of the spreadsheet that the site is an extensive linear feature with multiple UTM coordinates.

The quantity and quality of locational information on an ASM archaeological site card varies considerably, most notably according to the period when the card was originally filed. The earliest site cards often provide only limited information of any kind and may lack precise locational data. During the ongoing computerization of the ASM files, UTM coordinates have been added to some site cards by the ASM staff when a location could be determined from other information on the card or from the plot of the site on a quadrangle. If a site in the spreadsheet lacks UTMs, its site card lacked UTMs, and the precise location of the site may not be known. The location of the site somewhere within the indicated alternative(s) is based on its appearance on the corresponding quadrangle, however tentative its original plotting may have been.

Many site cards provide only a centerpoint UTM. Others provide the UTMs either of two points (usually the limits of an elongate site or a linear feature) or four or more points (different points on the perimeter of a site). When a site card provides multiple UTMs, all are recorded in the spreadsheet and a centerpoint is automatically calculated by averaging the northings and eastings.

During the search, a site was assumed to fall within an alternative if any part of the site crossed the boundary of an alternative depicted in the PNM maps. Note that the centerpoint UTM of a site may actually fall outside the limits of a proposed alternative, while some portion of the site falls within it (as determined while examining the ASM maps). Also, it was sometimes impossible to determine precisely where the boundary of an alternative fell on the ASM quadrangles. In equivocal cases, sites were assumed to be within the alternative.

A total of 546 archaeological sites within the limits of the three routing alternatives presented in this Application have been recorded in the ASM site files, including some minor overlap in the maps PNM provided to Lone Mountain. All of these sites have been entered into the spreadsheet on file at PNM. Of the 546 sites, the site cards of 14 were not available at ASM. For these sites, the only information included in the spreadsheet is the alternative(s) in which the sites fall.

The total number of sites in each alternative, the length of each alternative (as measured on the PNM overall project area map) and the average number of sites per mile in each alternative are given below. Note that because some of the alternatives are partially coterminous, many sites fall in more than one alternative. The limited numbers of sites in minor mapping overlaps are not included in these calculations:

Corridor	Total Sites	Length	Sites per Mile
Western Tohono O'odham	62 sites	128 miles	0.48 sites per mile
Eastern Tohono O'odham	63 sites	160 miles	0.39 sites per mile
Palo Verde - Nogales	421 sites	234 miles	1.80 sites per mile

Western Tohono O'odham
A total of 62 archaeological sites have been recorded within the limits of the Western Tohono O'odham Alternative. This is the lowest number of sites in any of the alternatives. The relatively low number of sites owes in large part to a relative lack of archaeological survey within the alternative, although it probably also relates to a relatively low density of prehistoric and historic settlement. The Western Tohono O'odham Alternative crosses the hottest and most arid portion of the study area, where large, permanent settlements were relatively less common in prehistoric times. At the same time, more ephemeral but no less significant archaeological sites may occur anywhere in the alternative.

One cluster of sites within the alternative bears special mention. Near its northern end, the alternative encompasses a section of the Gila River at Gila Bend. As expected, recorded site density increases in this area, a product of both survey coverage and actual site density. Of particular interest is the variation in site density across a short section of the alternative where it crosses the Gila River floodplain. The quadrangle map at ASM corresponding to this area (Cotton Center 7.5') shows that a linear survey of thirteen miles carried out directly on the floodplain discovered just one site. Immediately east of this survey, on the terrace just above the floodplain, a parallel linear survey of the same length discovered 31 sites. This dramatic difference in site density may owe in part to the low visibility of sites on the floodplain, but it probably also results from a settlement pattern that favored the terrace over the floodplain. A careful consideration of such small-scale distinctions in settlement pattern can be used in the selection of a precise route for the interconnection if it passes through the archaeologically sensitive Gila Bend area.

Eastern Tohono O'odham Alternative

A total of 63 archaeological sites have been recorded within the limits of Eastern Tohono O'odham Alternative. As with Western Tohono O'odham Alternative, the relatively low number of sites owes in large part to a lack of archaeological survey, though perhaps also to a relatively low density of sites. Large, permanent settlements were relatively uncommon in prehistoric times, but more ephemeral sites may be numerous.

Three clusters of sites within the alternative bear mention. The first is in the immediate vicinity of the town of Topawa, near the southern end of the alternative. The area has been the subject of a fair amount of archaeological survey and numerous prehistoric sites have been recorded. The most notable concentration is along Fresnal Wash, a seasonal drainage running east-west through Topawa and intersected by the alternative. A linear survey along Fresnal Wash, plotted on the corresponding quadrangle at ASM (Topawa 7.5'), identified an average of eight sites per mile.

A second cluster of recorded sites occurs just west of the town of Ko Vaya, in the immediate vicinity of the Ko Vaya Hills. Although there has been little systematic survey in the area, eight sites have been recorded within the alternative where it passes through and adjacent to the hills. Several miscellaneous features depicted on the original U.S.G.S. quadrangle (Ko Vaya 7.5'), such as cemeteries, old well sites, mines, and prospects, suggest that historic archaeological resources may be of particular concern in the vicinity of the hills.

A third cluster of recorded sites occurs near the town of Santa Rosa, where the alternative passes through the Santa Rosa Valley, west of the Santa Rosa Mountains. Eleven sites have been recorded within the alternative in this area, including both prehistoric and historic sites. There has been only limited systematic survey coverage in the area. A single linear survey of 1.25 miles identified two archaeological sites.

Palo Verde - Nogales Alternative

A total of 421 archaeological sites have been recorded within the limits of the Palo Verde - Nogales Alternative. This is the largest number of recorded sites in any of the alternatives.

The primary reason for the large number of recorded archaeological sites within the Palo Verde - Nogales Alternative is its route through the Tucson Basin, an important focus of both prehistoric and historic settlement. In particular, the Palo Verde - Nogales Alternative passes directly through the heart of the historic district of downtown Tucson, where historic archaeological site density and historic architectural property density is very high. It also passes immediately adjacent to a substantial segment of the Santa Cruz River Valley north and west of Tucson, an area of concentrated Hohokam and Archaic-period settlement.

A measure of the Tucson area's contribution to the site count can be had by reference to a single ASM quadrangle (Tucson 7.5'), where 114 recorded sites fall within the limits of the Palo Verde – Nogales Alternative. Because a large amount of archaeological survey has been carried out in the Tucson area, much of it associated with development, the rate of discovery of archaeological sites has been much higher than for any other alternatives. Regardless of this survey bias, the archaeological potential of the Tucson Basin is very high.

Apart from the immediate vicinity of Tucson, the portion of Palo Verde - Nogales Alternative extending from Nogales to Tucson is another area of moderately high site density. Again, a fair amount of previous survey coverage in this portion of the alternative is partly responsible for the substantial number of recorded sites, but the archaeological potential of this area is undoubtedly higher than most of the Eastern and Western Tohono O'odham Alternatives.

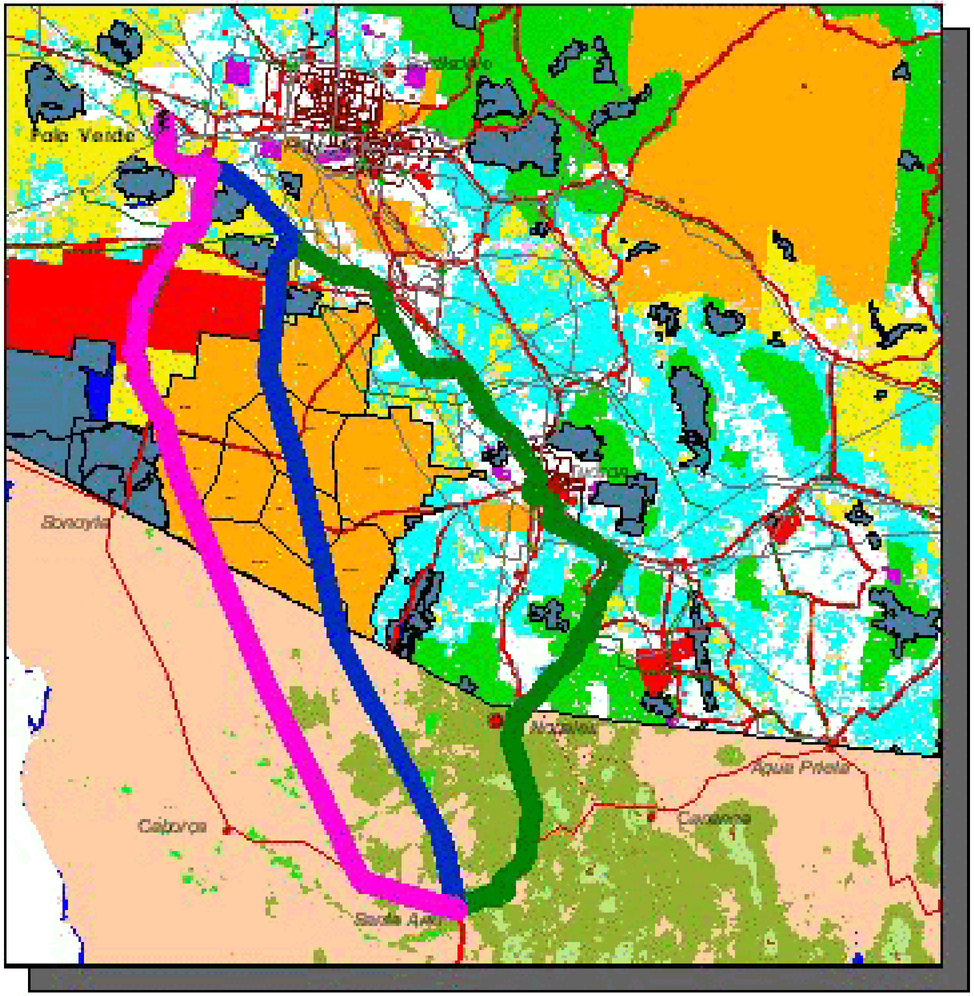
North and west of the Tucson Basin, where the Palo Verde - Nogales Alternative heads more westerly toward the Palo Verde Mountains, the density of recorded sites drops dramatically. Although this area does not have the archaeological potential of the Tucson Basin proper, the relative lack of recorded sites undoubtedly owes in large part to a lack of previous survey. After merging with Eastern Tohono O'odham Alternative near the Palo Verde Mountains, the combined route continues westward through another area of very low recorded site density. Archaeological survey coverage in this area is again very limited. It is likely that archaeological potential declines as the combined route heads west, but without actual survey the rate of decline is impossible to specify.

PNM's Conclusion

While the quantity and character of archaeological resources appears to vary considerably among the alternatives, based upon an inventory of known sites, no alternative appears to be precluded from further consideration based upon the data available at this time. The mitigation measures discussed above may be reasonably expected to substantially reduce all impacts to archaeological sites, due to the fact that they generally occur within discrete areas that are relatively limited in extent.

General PNM Conclusion

While the assessment of environmental resources presented here is preliminary, it has not uncovered indications that any of the corridors identified to date is precluded from further consideration as a potential route for the Sonora - Arizona Interconnection Project. The process, therefore, appears to be free to proceed through the steps that DOE may identify as required prior to approval of PNM's permit application.



Sonora - Arizona Interconnect Project