LOAD CENTER
&
TRANSMISSION COST STUDY
for
SIERRA PACIFIC POWER COMPANY
SPANISH SPRINGS SERVICE AREA

Prepared For

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"Engineering with Distinction"
ECI ELECTRICAL CONSULTANTS, INC.
BILLINGS, MONTANA

ENGINEER'S CERTIFICATION
Load Center and Transmission Cost Study
For
The Spanish Springs Service Area
Tetra Tech

I certify that this engineering study was prepared by me or under my direct supervision and that I am a duly registered professional engineer in the State of Nevada.

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1.0 INTRODUCTION AND PURPOSE

Electrical Consultants, Incorporated (ECI) was retained by Tetra Tech, Incorporated to perform a load center analysis for a new substation to be located in the Sierra Pacific Power Company (SPPC) Spanish Springs Service Area. Tetra Tech is currently preparing an Environmental Impact Statement (EIS) for the substation siting, as well as routing for associated transmission lines. Local residents have expressed concern over the location selected for the substation, as well as the transmission routing proposed by SPPC. ECI has been retained to perform an independent study of the Spanish Springs Service Area load center; this process provides the ideal loci for the new substation, hereinafter referred to as the ECI Substation. It should be noted that ECI's analysis of the Spanish Springs Area load center was made through use of locale planning and zoning maps showing use and density as discussed in Section 3.2 of this report, without consideration of existing or proposed transmission routing.

This report also addresses comparative costs for overhead and underground transmission line that must be extended to provide service to the new substation. Several transmission routes are proposed, portions of which could be considered for underground construction. It was decided that this report should address the general cost of underground vs. overhead construction based upon a *typical* 3-mile line segment. This approach is preferred in lieu of attempting to estimate costs for entire line routes, where their siting and location(s) cannot be defined at this time. ECI believes that the typical construction cost data furnished in this report can be used to extrapolate costs for alternatives once the length and construction characteristics have been determined through the siting process.

Throughout this report, certain terms common to the electric industry will be used. The following list gives a definition of these terms:

Feeder A feeder is an electric distribution line extending from the substation to serve distribution consumers. The operating voltage of feeders in this report is 24.9 kV (24,900 volts) line-to-line.

Open An open is a point on a feeder or between two feeders that can be disconnected by means of a switch. When a feeder is open, power is discontinued to all customers down line from this point. Closing an open point between feeders allows customers to be served from different feeders.

2.0 EXECUTIVE SUMMARY

This section of the report summarizes ECI's evaluation of load center and 120 kV transmission construction costs to support Tetra Tech's environmental report for the SPPC Spanish Springs electric service area. The preceding section addresses the ongoing EIS process being completed in conjunction with the Bureau of Land Management (BLM). This report is a continuation of the Electrical System Study prepared by ECI in January 2002. Subsequent to our previous report, the BLM and Tetra Tech have undertaken an environmental impact study process that will define proposed and alternate transmission routes, as well as alternatives for siting of the substation. The purpose of this report is to provide an independent opinion of the electric system load center for a new substation service area, as well as typical costs for 120 kV transmission line construction.

The existing Spanish Springs Substation serves load in the Spanish Springs Valley from two (2) feeders, designated SPA273 and SPA275. The Spanish Springs Valley has experienced a 15.63% growth rate compounded annually over the past ten (10) years. It is expected that this growth rate will continue over the 2003-2012 study period used as a basis for this report. Rapid growth is anticipated as a consequence of available land and housing development in the Reno area. During the summer peak of 2002, Feeders SPA273 and SPA275 were over 80% of conductor loading, a level that is representative of the need for additional expansion for the power delivery and distribution system.

Before any new load center can be determined, the most practical service area boundary between the existing Spanish Springs Substation and a new substation to the north needed to be established. These service areas were defined by the projected loads in 2012 at the end of the study period. Using least squares analysis, it is projected that the Spanish Springs Valley will exhibit an approximate 100 MW electric peak in year 2012. Land use maps from Washoe County and the City of Sparks were used to assign a kW/acre to each area according to their zoning. Based on planning and engineering judgment, zoned areas forecast to develop over the next ten (10) years were added to the model to obtain the projected 100 MW demand for the Spanish Springs Valley. Using the projected electrical system computer models, open points were defined to limit conductor loading for Spanish Springs Substation feeders not to exceed a peak 80% conductor loading. The new Substation would then serve the balance of the area.

Results obtained using the distributed kW for each land parcel and a *center of mass* calculation place the load center approximately 1.0 mile north of La Posada Road and 0.40 mile east of Pyramid Lake Highway. The theoretical location of this load center is within an existing subdivision, making this precise location impractical for the substation site. The nearest practical location for a substation is due west of the load center adjacent to Pyramid Highway (ECI Substation). The proposed action location is approximately 2.4 miles to the northwest of this location (Sugarloaf Substation). In comparison, the alternate substation at La Posada Road and Pyramid Highway presently addressed in the draft EIS is within 1.0 mile of the theoretical load center (alternate substation). In summary, the load center for the projected service area correlates well with both the proposed Sugarloaf Substation and Alternate Substation sites. *Figure 2-1* is an excerpt from Tetra Tech's planning map showing the load center and ECI substation location, determined by ECI in relation to the proposed Sugarloaf Substation location and the Alternate Substation location.

ECI performed a load flow analysis to verify whether loads could adequately be served from this location. The ECI Substation was placed near the calculated load center along Pyramid Highway, with seven feeders exiting the substation. Two of these feeders would be lightly loaded and would be able to pick up loads served by the Spanish Springs Substation. All voltage levels were within planning criteria.

Feeders SPA273 and SPA275 can be transferred to the ECI Substation during a N-1 contingency (planning criteria term meaning loss of any single line segment or system element). During conditions when service from this new substation is lost, only 22.9% of the projected ten-year loads can be transferred to Spanish Springs and Tracy Substations. The ECI Substation would be a dual transformer substation with either transformer typically capable of serving the distribution loads. Therefore, complete loss of the substation would generally occur only as a result of loss of the incoming transmission line. This statement applies equally to the Sugarloaf or alternate sites. The first phase of the transmission project extends the line from Tracy to the ECI Substation. Until such time that the transmission line is extended to Silver Lake, completing the transmission loop, there would be no backup for the ECI Substation.

The second key issue addressed in this report is comparative estimates for overhead and underground transmission line construction. These estimates were based on ECI's past experience with other similar projects, as well as considerations unique to the Reno area and SPPC's construction practices. There are many factors that can impact the cost of construction that are not included or covered in these estimates. Generally speaking, underground transmission construction is typically placed in public rights-of-ways, including the actual roadway, or between the edge of pavement and the right-of-way boundary. The preferred placement would be in the shoulder, reducing the cost of installation. Placement of facilities in public rights-of-ways requires coordination of placement location with other existing and proposed utilities, a fact that can dramatically impact the difficulty and cost of construction.

In preparing the overhead cost estimate, the following assumptions were made:

- All poles would be wood poles
- Right-of-way could be acquired for the guying of line angle and deadend structures
- All construction would be single pole wood with horizontal post insulators

Table 2-1 summarizes cost estimates for underground and overhead construction. The additional cost of construction with underbuild is included as a line item in this table. Estimates do not include costs of rights-of-way and permitting, or the cost of environmental studies.

Table 2-1
120 kV Transmission Line Costs Per Mile

Type of Construction	Cost Per Mile
Underground 120 kV Transmission	$1,685,389
Overhead 120 kV Transmission	$223,996
Additional Cost for Distribution Underbuild	$53,154
Double Circuit 100/120 kV Transmission	$405,889

3.0 SYSTEM EVALUATION

This section of the report evaluates the existing system for Spanish Springs Valley and determines the load center for the new ECI Substation. The following approach was used to determine the electrical load center:

- Ten-year loads (2003-2012) for Spanish Springs Valley were projected
- The kW usage based on area zoning maps was allocated
- Add projected loads to existing system model
- The most practical service area to be served by the Spanish Springs Substation was determined
- The load center for the new service area was determined

3.1 Existing Distribution System

ECI's report titled "Electric System Study for the Spanish Springs Service Area" issued in January 2002 evaluated the need and timing for a substation in the Spanish Springs service area. Since completion of this study, an EIS report has been undertaken to study impacts of the electrical system expansion. Subsequent to issue of our previous report, the Spanish Springs Valley has experienced an increase in summer peak load of 15% (year 2002). This service area is presently served by the Spanish Springs Substation via two feeders serving the length of the Spanish Springs Valley. *Figure 3-1* shows the substation location and feeder layout.

Both SPA273 and SPA275 are currently at maximum capacity. The line conductor for Feeder SPA273 was recently upgraded to a 900-amp rating; this feeder recorded a peak of 780 amps in 2002. Correspondingly, Feeder SPA275, which has an ampacity rating of 575 amps, exhibited a 500-amp peak in 2002. Additional improvements since issue of our previous study include replacement of a Spanish Springs Substation 47 MVA transformer with a larger 60 MVA unit to address short-term load growth. This capacity increase provides only an interim solution for growing distribution system loads; a new substation must be constructed in the near future to address long term electrical system reliability.

Figure 3-1

3.2 Load Forecast

Load projections for the Spanish Springs Valley needed to be established in order to define the load center. Prudent and practical engineering judgment dictated that a ten-year load projection should be used. ECI used actual demand and energy consumption data to develop a ten-year forecast. *Table 3-1* provides a history of the substation MW demand and feeder loading summary.

Table 3-1
Substation MW Demand & Feeder Loading Summary

Year	Substation Peak (MW)	Feeders (Amps)	
		SPA273	SPA275
1991	49.6		100
1992	50.57		200
1993	62.4		170
1994	67.8	60	210
1995	68.4	108	190
1996	74.1	132	240
1997	72.7	240	310
1998	75.9	280	360
1999	72.3	420	390
2000	87.6	504	420
2001	74.0	408	490
2002	96.0	780	500
1991-2002 Annual Compounded Growth	6.19%	18.83%	12.76%

The yearly load peaks were analyzed for the period 1991 through 2002 to provide a more accurate method of forecasting load growth. Using a least squares regression technique, monthly peak load data was used to derive a trend line. The arithmetic trend defines the average rate of load growth over the entire 11-year period, effectively leveling high and low system peaks. This historical growth rate was assumed to be indicative of average future growth, absent of any other known local or economic indicators that suggested a change from past performance. *Figure 3-2* through *Figure 3-5* provide graphs of historical and projected loading for Spanish Springs Transformer 1 (SPA#1) and Transformer 2 (SPA#2), along with Feeders SPA273 and SPA275. Feeder SPA273 showed a 2002 peak load of approximately 33.7 MVA; correspondingly, the peak for Feeder SPA275 was 21.6 MVA. Projected loads are 62.64 MVA and 36.72 MVA for

Feeders SPA273 and SPA275, respectively. These projected loads equate to a growth rate of 18.83% and 12.76%, compounded annually for Feeders SPA273 and SPA275, respectively. The combined growth rate of these two feeders, which represent the Spanish Springs Valley, is 15.63%.

Figure 3-2

Figure 3-3

Figure 3-4

Figure 3-5

SPPC completed a study for the South Meadows area kW usage per acre for various types of zoning within their service area. A copy of this report was provided to ECI for the allocation of loads in the Spanish Springs Valley. The kW usage levels from the South Meadow Study were compared to those published in the Electrical Transmission and Distribution Reference Book and were found to be within reason. *Table 3-2* lists kVA per acre values from the Electrical Transmission and Distribution Reference Book.

Table 3-2
Typical Load Densities for Various Types of Areas

Type of Area	Construction	kVA/Acre
Urban	Dense, High Rise Low Rise Office/Prof. Retail Residential – Dense	600-3000 50-750 50-300 10-60
Suburban	Retail Office/Industrial Park Residential	10-100 5-50 2-25
Rural	Residential Agricultural – Non-Irrigation Agricultural - Irrigation	3-15 005-0.1 25-3

SPPC provided ECI with Washoe County and City of Sparks land use maps that were used to calculate acreage for each type of zoning. *Table 3-3* lists the kW per acre values assigned to each zoned area by ECI along with kW per acre values provided by SPPC. The exhibit map titled *Spanish Springs Valley and Surrounding Area* included at the end of this report, shows the assigned kW values. Calculated kW per acre values were assigned to the model for areas of potential growth in the ten-year period.

Determination of which zoned areas to add to the model was necessary to achieve the projected ten year loads. Although the land use map shows zoning for all of Spanish Springs Valley, excluding some of the existing subdivision, this land use map does not indicate lots currently occupied by homes. The area along Calla De La Plata Drive shows residential lots, but does indicate which of these have been built out, and the model provided by SPPC indicated that there is approximately 700 kW of load in this area. It is assumed that the residential lots along Calla De La Plata Drive are built out and are not

included in the projected ten year loads. Zoned lots away from Calla De La Plata Drive were added to the model to represent future build out of this area. The same assumptions are made for lots along Pyramid Highway, north of Calla De La Plata Drive. Undeveloped zoned areas north of Spanish Springs Substations were pro-rated and added to the model.

Table 3-3
Typical Load Densities for Various Types of Areas

Description	Allocated kW/Acre	SPPC kW/Acre
Commercial	60.0	60.0
General Rural	0.60	0.10
High Density Suburban	14.0	14.0
High Density Urban	84.0	84.0
Industrial	80.0	80.0
Low Density Rural	0.60	0.30
Low Density Suburban	3.00	3.00
Low Density Urban	20.0	20.0
Medium Density Rural	1.20	0.60
Medium Density Suburban	6.00	6.00
Medium Density Urban	42.0	42.0
Open Space	0.00	0.00
Parks and Recreation	1.00	1.00
Public and Semi-Public	25.0	25.0

Total commercial kW for the Spanish Springs Valley is over 100 MW based on the land usage maps and the projected ten-year loads (2012) is 100 MW. Due to the large amount of kW allocated for commercial areas, kW values for some of these areas were reduced, while others were used at fully allocated values, and some areas zoned commercial were not included. The *Spanish Springs Valley and Surrounding Area* map included at the end this report highlights each of the areas added to the existing system. The *Load Density per Square Mile* map at the end of this report provides data based on zoning and does not include existing loads.

3.3 System Planning Criteria

In the preparation of any electrical system study, planning criteria consistent with standard industry practices must be established to use as a criteria in the selection and evaluation of options for improvements. ECI used the following criteria for SPPC system evaluation in performance of this study:

- The continuous current in any overhead or underground circuit during peak conditions shall be no more than 80% of rated ampacity,
- Maintain a continuous rating of substation transformers that will not result in measurable loss of life,
- Normal operating voltage at transmission levels shall be no less than 0.985 per unit.
- A maximum of seven volts drop shall be allowed from the first distribution transformer to the last transformer on the primary distribution circuit. Assuming a nominal sending end voltage of 125 volts at the substation bus, minimum distribution system voltage for normal operating conditions shall be 118 volts.

The above criteria apply to all normal system operating conditions. It should be noted that the SPPC system is dual peaking in characteristic. In other words, peaks normally occur in both summer and winter during maximum high and low ambient temperature periods. Presently, the Spanish Springs area is a winter peak, however, it is anticipated to move toward a typical dual peak characteristic as additional commercial load develops. Therefore, projected loads were considered to represent both summer and winter peak.

For N-1 contingency conditions (outage of any single line or other circuit element), the following criteria, consistent with SPPC engineering practice, was used:

- The continuous current in any overhead or underground circuit during emergency conditions shall be no more than 100% of rated ampacity
- Allowable overload for substation transformers shall be 110% of upper FA rating for four hours without loss of life below 104°F ambient temperature
- Transmission voltage within 90% of pre-emergency operating voltage at transmission voltage levels
- A maximum of thirteen volts drop from the first distribution transformer to the last transformer on a distribution circuit. Assuming a nominal sending end voltage of 125

volts at the substation bus, minimum distribution voltage during contingency conditions such as back feed shall be 114 volts

SPPC has confirmed that they can transfer loads on the feeders south of Spanish Springs Substation to other substations during contingency conditions, but are unable to transfer feeders north of Spanish Springs Substation. For reliability, the new substation should be located to allow load transfers of all loads in the Spanish Springs Valley north of Spanish Springs Substation.

The above criteria apply to all single outage conditions. In addition, contingencies conditions can result in overloads of lines and transformers that can cause tripping of system protective devices and a subsequent d*ouble contingency* condition

3.4 Existing System Summary

SynerGee™ load flow software was used to model the distribution system in the Spanish Springs Valley. Load flow analysis was completed after projected ten-year loads were added to the model. Initially, the load flow analysis would not converge with all projected loads added. SynerGee typically will not converge when voltage levels fall below 90 volts. To obtain baseline results, some of the projected loads were open or disconnected from the model, allowing the load flow to converge. This resulted in loading less than the projected load, clearly emphasizing the lack of transfer capability of the distribution system to serve future load growth without a new substation in the Spanish Springs area. Feeder SPA273 conductor loading was 141% with the reduced project loads. The SynerGee maps at the end of this report show voltage drop for both the existing system and existing system with projected loads.

New open points for Feeders SPA273 and SPA275 were determined at actual projected load levels to define a new service area for the new substation. The open points were placed such that conductor loading did not exceed 80% during normal system operations. An open point was placed at Pyramid Lake Road and La Posada Road for Feeder SPA273, and another open point was placed along Vista Boulevard on Feeder SPA275. Projected ten year loads on Feeders SPA273 and SPA275 are 11.3 MVA and 18.67 MVA, respectively, with opens at the above-mentioned locations. These open points

establish the area that Feeders SPA273 and SPA275 will serve, as well as the area that will be served by the new ECI Substation.

3.5 Load Center Evaluation

The load center for the ECI Substation was determined once the open point locations were established. The substation should ideally be located near the load center of the service area. Placing the substation near its load center enables the utility to extend feeders in all directions from the new substation. Ideally, the substation should also be placed in a location that will allow load to be transferred from one substation to the other during an outage condition.

The load center for the new ECI Substation was determined using a *center of mass* calculation. By definition, the center of mass is located at (X_{CM}, Y_{CM}) where:

$$X_{CM} = (M_1X_1 + M_2X_2 + \ldots)/(M_1 + M_2 + \ldots)$$
$$Y_{CM} = (M_1Y_1 + M_2Y_2 + \ldots)/(M_1 + M_2 + \ldots)$$

The XY coordinates of the existing and projected ten-year loads for the new ECI service area were used to determine the XY coordinate for the load center. Results placed the load center approximately 1.0 mile north of La Posada Road and 0.40 mile east of Pyramid Lake Road. This location is within the existing subdivision, making this precise location impractical for a substation site.

A load flow analysis was performed with the substation placed along Pyramid Lake Highway near the calculated load center. The projected ten year load (2012) for this substation is approximately 75.9 MW. The ECI Substation was modeled with seven (7) new feeders exiting the substation. Feeder loads ranged from 3.6 MW to 18.7 MW. New feeders would be required in all directions from the substation, with the two feeders to the south typically having less loading in order to allow for load transfer between the ECI Substation and Feeders SPA273 and SPA275. All loads could be served with voltage levels within planning criteria from this location. The map at the end of this report shows the ECI Substation service area, along with the proposed feeders.

Load could be served adequately with the Alternative Substation located near Pyramid Lake Highway and La Posada Road. A substation located south of La Posada Road would make it more difficult to serve new loads as they develop north of La Posada Road, although transfer of load served by Spanish Springs Substation is made easier. Locating the substation several miles north of La Posada Road will make load transfer of Feeders SPA273 and SPA275 more difficult. However, the use of voltage regulators will allow load to be served with adequate voltage levels.

Allocated loads for this analysis were based on the existing land use maps. It can be assumed that some of the areas that are currently zoned as general rural adjacent to existing subdivisions will be re-zoned and developed at a higher density. It is ECI's opinion that this is particularly likely along the eastern slope of the Spanish Springs Valley. Although a change in zoning from general rural to medium rural may shift the load center to the east by adding additional kW per acre, the largest impact would result from areas zoned commercial. It should also be noted that if the allocated kW for the unassigned residential lots along Calla De La Plata Drive and Pyramid Highway north of Calla De La Plata Drive is approximately 3000 kW. Existing load in this area is approximately 840 kW. This amount will have little affect on moving the load center. Areas zoned commercial have the largest kW per acre usage, resulting in the largest impact on the *center of mass* calculation. Allocating commercial zones at full kW values shifts the load center closer to the proposed action location, i.e., Sugarloaf Substation. As noted in Section 3.2, Load Forecast, not all of the commercial kW values were added to the model. The commercial acreage included in the model was the more southerly areas, which places the load center more southerly.

4.0 TRANSMISSION COST

This section of the report provides construction estimates for overhead and underground 120 kV transmission line. The purpose of these estimates is to establish a base cost to evaluate each of the three basic transmission routes proposed for this area. All three routes follow the same route from Tracy north to a point where each route turns and continues west through Spanish Springs Valley toward Stead. The three basic routes consist of the following:

- The primary route, which skirts the north edge of the City of Sparks, then continues north to the proposed Sugarloaf Substation and west to Stead.
- Alternately, a northerly route would basically loop north of the Reno Sparks Indian Colony and would have a radial tap to feed the proposed Sugarloaf Substation.
- The third route would be a southerly route across Spanish Springs Valley, and would follow the proposed route, or Calla De La Plata Drive. Continuing west to Stead, this route would use the existing 100 kV line right-of-way, which would be rebuilt to double circuit.

Other options being considered include using the existing transmission corridors. The purpose of this section is not to evaluate which route should or should not be the preferred transmission route, but to establish cost guidelines for construction of the different routes.

In preparing the transmission estimates, ECI considered standard costs from other similar construction projects and included costs specific to the local area. Specific costs include impacts associated with local labor, taxes and additional charges imposed by local municipalities.

ECI obtained pricing for materials based upon SPPC's construction standards. These specific material items include such things as underground cable and insulators.

4.1 Underground Cost Estimate

A minimum length of three miles was assumed as representative in preparing underground cost estimates although actual section length may be shorter or longer. This costing basis results in more realistic (lower) estimate than for a single mile of line. Additionally, cost estimates were based on the following assumptions:

- Splice vaults were added near the riser poles.

- A spare reel of cable (2500') was included in the estimate, but no spare splices or terminations were used.

- Cable cost was reduced somewhat based on figures obtained from the manufacturer.

- Terrain would suggest that the installation could be accomplished with minimal pavement damage. However, based upon input from SPPC, it was assumed that the entire cable route would require pavement cutting and a substantial "pavement cutting penalty" was included in the estimate in addition to the pavement cutting and replacement costs. A 4' patch was assumed in this estimate (2' trench). If the cable can be installed in the shoulder or ditch, the overall cost of the project will be reduced by eliminating some of the associated cost of cutting and patching pavement.

- The estimates do not include stores or "clearing" material handling charges.

- Specific direct SPPC labor charges were not included, with the exception of engineering, inspection charges and overheads.

- The estimates do not include costs for right-of-way, permitting or environmental tasks.

Table 4-1 on the following pages lists the underground cost estimate by line item for material and labor. The cost per mile per this estimate is $1,685,389.

TABLE 4-1
120 kV UNDERGROUND TRANSMISSION DETAILED ESTIMATE OF COST
Line Length = 15840 feet

MATERIAL	QUANTITY	UNIT	UNIT COST	TOTAL COST
CONDUIT & ACCESSORIES				
CONDUIT, PVC, 6", SCHEDULE 40	63360	LF	$1.80	$114,048.00
CONDUIT, PVC, 4", SCHEDULE 40	15840	LF	$0.95	$15,048.00
COUPLING, CONDUIT, PVC, 6"	64	EA	$4.25	$272.00
PLUG, CONDUIT, EXPANDING, 6", PVC, SCHEDULE 40	18	EA	$9.63	$173.34
SPACER, BASE, PLASTIC, 6" PVC CONDUIT, 1-1/2" SPACING	12000	EA	$1.00	$12,000.00
LUBRICANT, PULLING, CABLE, MILD WEATHER, 5 GALLON PAIL	87	EA	$40.75	$3,545.25
URD, MARKER TAPE, 2000 ft Roll	16	EA	$25.00	$396.00
CONCRETE	1887	CU YD.	$88.00	$166,056.00
CABLE SPLICE VAULTS & MANHOLES				
VAULT, CONCRETE, PRECAST, 8’ X 16',FULL TRAFFIC COVERS	8	EA	$12,575.00	$100,600.00
CONDUCTOR				
2000 KCMIL AL PER SPPC SPEC	52396	LF	$23.00	$1,205,108.00
4/0 COPPER GROUNDING CONDUCTOR	17424	LF	$1.50	$26,136.00
CONDUCTOR ACCESSORIES				
138kV PREMOULDED CABLE SPLICE	24	EA	$6,000.00	$144,000.00
LINK BOX AND GROUNDING HARDWARE	8	EA	$2,000.00	$16,000.00
138kV UG CABLE TERMINATOR	6	EA	$7,200.00	$43,200.00
138kV STATION CLASS ARRESTER	6	EA	$2,400.00	$14,400.00
UG CABLE CLAMP NON-MAGNETIC	120	EA	$45.00	$5,400.00
TERMINATION STRUCTURES & HARDWARE				
STEEL DEAD END STRUCTURE	2	EA	$24,000.00	$48,000.00
CONCRETE	28	CU YD.	$88.00	$2,464.00
INSUL, SUSP, 10"DISC	60	EA	$15.63	$937.86
LINK SOCKET CLEVIS	6	EA	$18.81	$112.86

LINK OVAL EYE BALL	6	EA	$11.43	$68.57	
SHACKLE, ANCHOR, 5/8	6	EA	$5.59	$33.53	
LINK SOCKET CLEVIS	6	EA	$18.81	$112.86	
Y CLEVIS EYE 90, 30k	6	EA	$3.26	$19.54	
STN CL Iron 0.20 - 0.55	6	EA	$12.60	$75.57	
TOTAL ESTIMATED MATERIAL COST					**$1,918,207.38**
PAVEMENT CUTTING, REMOVAL & RESTORATION	63360	SF	$5.00	$316,800.00	
PAVEMENT CUTTING PENALTY	1	EA	$200,000.00	$200,000.00	
TRENCHING (6’ DEPTH)	7040	CY	$32.00	$225,280.00	
6"/4" PVC DUCT INSTALLATION	79200	LF	$3.20	$253,440.00	
BACKFILL AND SPOIL REMOVAL	7040	CY	$4.85	$34,144.00	
SPLICE VAULT INSTALLATION	8	EA	$10,800.00	$86,400.00	
CABLE INSTALLATION	47520	LF	$3.00	$142,560.00	
CABLE SPLICING	24	EA	$7,200.00	$172,800.00	
CABLE TERMINATION	6	EA	$4,800.00	$28,800.00	
4/0 GROUND CABLE	15840	LF	$1.00	$15,840.00	
LINK BOX AND VAULT GROUNDING	8	EA	$2,000.00	$16,000.00	
ARRESTER INSTALLATION	6	EA	$600.00	$3,600.00	
POLE FOUNDATION	2	EA	$15,600.00	$31,200.00	
TECH SUPPORT	16	WKS	$5,000.00	$80,000.00	
MOBILIZATION/DEMOBILIZATION	1	Lot	$25,000.00	$25,000.00	
TOTAL ESTIMATED LABOR					**$1,631,864.00**
ENGINEERING/INSPECTION					
DESIGN ENGINEERING	3000	HRS	$80.00	$240,000.00	
FIELD SUPERVISION/INSPECTION	2000	HRS	$60.00	$120,000.00	
TOTAL ESTIMATED ENGINEERING/INSPECTION					**$360,000.00**
ESTIMATED CONSTRUCTION COST					**$3,910,071.38**
CONTINGENCY	10.0%	of	$3,910,071.38		**$391,007.14**
TOTAL ESTIMATED CONSTRUCTION COST					**$4,301,078.52**
CONSTRUCTION OVERHEAD					
PROJECT SUPERVISION	10.00%	of	$4,301,078.52	$430,107.85	

CONSTRUCTION OVERHEAD	5.25%	of	$4,301,078.52	$225,806.62	
AFUDC (0.3843% PER MONTH)	6	month	$4,301,078.52	$99,174.27	
TOTAL CONSTRUCTION OVERHEADS					**$755,088.74**

PROJECT SUMMARY

MATERIAL	$1,918,207.38
LABOR	$1,631,864.00
ENGINEERING/INSPECTION	$360,000.00
CONTENGENCY	$391,007.14
CONSTRUCTION OVERHEAD	$755,088.74
TOTAL ESTIMATED COST	**$5,056,167.26**
COST PER MILE	**$1,685,389.09**

4.2 Overhead Cost Estimate

The cost estimate for the overhead 120 kV line was based on a 10 mile section of line. Estimates do not include right-of-way, permitting or environmental issues/costs. The following assumptions were made for the 10 miles of line:

- There would be seven (7) running angle structures.
- Three double dead-end corners.
- All structures would use wood poles.
- Additional, right-of-way could be acquired for guying and anchors.

Table 4-2 outlines the material and labor costs for the overhead 120 kV transmission estimate. The estimated cost per mile is $223,996, based on building a line in a new right-of-way. *Table 4-3* details additional cost for underbuilding distribution on the transmission line, which is estimated at $53,154 per mile.

The estimated cost detailed in *Table 4-4* to rebuild the 100 kV line to a double circuit 100 kV/120 kV line is $405,889 per mile. This cost includes approximately $34,094 per mile to transfer existing circuit to the new pole line and remove all poles. The cost of rebuilding the 100 kV transmission line to double circuit would increase, if the existing line is required to remain energized. This additional cost can vary from 2.5 to 5 times the base cost. Factors affecting the cost include:

- Voltage of the energized line;
- Configuration of the existing transmission line; and
- Whether the new line is located 10' from the existing line, or on the same center line.

Cost estimates are based on building a line in rural area. Constructing the same transmission line through a suburban area would increase the cost by approximately 1.2 times the per mile cost. Other factors affecting the cost include attaching cable TV or telephone to the line.

TABLE 4-2
OVERHEAD 120 kV TRANSMISSION DETAILED ESTIMATE OF COST
Line Length = 52800 FEET

MATERIAL	QUANTITY	UNIT	UNIT COST	TOTAL COST	
POLES (85' H2)	138	EA	$2,300.00	$317,400	
CONDUCTOR (954 MCM AA)	54000	CKT FT	$3.90	$210,600	
STATIC	54000	FT	$0.30	$16,200	
HARDWARE (TANGENT, 3 PHASE WITH INSULATORS)	128	EA	$1,337.00	$171,136	
HARDWARE (RUNNING ANGLE, 3 PHASE WITH INSULATORS)	7	EA	$2,246.00	$15,722	
HARDWARE (DE, 3 PHASE WITH INSULATORS)	3	EA	$4,673.00	$14,019	
TOTAL ESTIMATED MATERIAL					**$745,077**
LABOR					
POLES (85' H2)	138	EA	$1,400	$193,200	
CONDUCTOR (954 MCM AA)	52800	CKT FT	$4.50	$237,600	
STATIC	52800	FT	$0.60	$31,680	
TANGENT, 3 PHASE WITH INSULATORS	128	EA	$2,500	$320,000	
RUNNING ANGLE, 3 PHASE WITH INSULATORS	7	EA	$5,425	$37,975	
DE, 3 PHASE WITH INSULATORS	3	EA	$8,025	$24,075	
ROAD/ACCESS CONSTRUCTION	10	MI	$2,500	$25,000	
MOBILIZATION/DEMOBILIZATION	1	LOT	$25,000	$25,000	
TOTAL ESTIMATED LABOR					**$894,530**
ENGINEERING/INSPECTION					
DESIGN ENGINEERING	2500	HRS	$80	$200,0000	
FIELD SUPERVISION/INSPECTION	1500	HRS	$60	$90,000	
TOTAL ESTIMATED ENGINEERING/INSPECTION					**$290,000**
ESTIMATED CONSTRUCTION COST					**$1,929,607.00**
CONTINGENCY	5.0%	of	$1,929,607		**$96,480.35**
TOTAL ESTIMATED CONSTRUCTION COST					**$2,026,087.35**

CONSTRUCTION OVERHEAD					
PROJECT SUPERVISION	10.00%	of	$2,026,087.35	$60,782.62	
CONSTRUCTION OVERHEAD	5.25%	of	$2,026,087.35	$106,369.59	
AFUDC (0.3843% PER MONTH)	6	month	$2,026,087.35	$46,717.52	
TOTAL CONSTRUCTION OVERHEAD					**$213,869.73**

PROJECT SUMMARY

MATERIAL	$745,077.00
LABOR	$894,530.00
ENGINEERING/INSPECTION	$290,000.00
CONTENGENCY	$96,480.35
CONSTRUCTION OVERHEAD	$213,869.73
TOTAL ESTIMATED COST	**$2,239,957.08**
COST PER MILE	**$223,995.71**

TABLE 4-3
DISTRUBUTION OVERBUILD DETAILED ESTIMATE OF COST
DISTRIBUTION COSTS ONLY
Line Length = 52800 FEET

MATERIAL	QUANTITY	UNIT	UNIT COST	TOTAL COST	
HARDWARE (TANGENT, 3 PHASE)	166	EA	$200	$33,200	
HARDWARE (RUNNING ANGLE, 3 PHASE)	7	EA	$586	$4,102	
HARDWARE (DOUBLE DE, 3 PHASE)	3	EA	$786	$2,358	
MATERIAL CONTINGENCY	30	%	$11,898	$11,898	
TOTAL ESTIMATED MATERIAL					**$51,558.00**
LABOR					
TANGENT, 3 PHASE	166	EA	$845	$140,270	
RUNNING ANGLE, 3 PHASE	7	EA	$2,340	$16,380	
DOUBLE DE, 3 PHASE	3	EA	$3,276	$9,828	
REMOVE FACILITIES	176	EA	$468	$82,368	
REMOVAL CONTINGENCY	30	%	$74,653.80	$74,653.80	
TOTAL ESTIMATED LABOR					**$323,499.80**
ENGINEERING/INSPECTION					
DESIGN ENGINEERING	300	HRS	$80	$24,000	
FIELD SUPERVISION/INSPECTION	200	HRS	$60	$12,000	
TOTAL ESTIMATED ENGINEERING/INSPECTION					**$36,000.00**
ESTIMATED CONSTRUCTION COST					**$411,057.80**
CONTINGENCY	10.0%	of	$411,057.80		**$41,105.78**
TOTAL ESTIMATED CONSTRUCTION COST					**$452,163.58**
CONSTRUCTION OVERHEAD					
PROJECT SUPERVISION	10.00%	of	$452,163.58	$45,216.36	
CONSTRUCTION OVERHEAD	5.25%	of	$452,163.58	$23,738.59	
AFUDC (0.3843% PER MONTH)	6	month	$452,163.58	$10,425.99	
TOTAL CONSTRUCTION OVERHEAD					**$79,380.93**

PROJECT SUMMARY

MATERIAL	$51,558.00
LABOR	$323,499.80
ENGINEERING/INSPECTION	$36,000.00
CONTENGENCIES	$41,105.78
CONSTRUCTION OVERHEAD	$79,380.93
TOTAL ESTIMATED COST	**$531,544.51**
COST PER MILE	**$53,154.45**

TABLE 4-4
OVERHEAD 100/120 kV TRANSMISSION DETAILED ESTIMATE OF COST
Line Length = 52800 FEET

MATERIAL	QUANTITY	UNIT	UNIT COST	TOTAL COST	TOTAL
POLES (90' H2)	138	EA	$2,800	$386,400	
SELF SUPPORTING STEEL CORNER POLE (INC. HARDWARE)	7	EA	$20,000	$140,000	
SELF SUPPORTING STEEL DE CORNER POLE (INC. HARDWARE)	5	EA	$35,000	$175,000	
POLE FOUNDATION CORNER	7	EA	$12,000	$84,000	
POLE FOUNDATION DE CORNER	3	EA	$13,000	$39,000	
CONDUCTOR (954 MCM AA)	54000	CKT FT	$7.80	$421,200	
STATIC	54000	FT	$0.30	$16,200	
HARDWARE (TANGENT, 3 PHASE WITH INSULATORS)	138	EA	$2,487	$343,206	
TOTAL ESTIMATED MATERIAL					**$1,605,006**
LABOR					
POLES (90' H2)	138	EA	$1,400	$193,200	
SELF SUPPORTING STEEL CORNER POLE	7	EA	$6,500	$45,500	
SELF SUPPORTING STEEL DE CORNER POLE	5		$10,000	$50,000	
CONDUCTOR (954 MCM AA)	52800	CKT FT	$9.00	$475,200	
STATIC	52800	FT	$0.60	$31,680	
TANGENT, 3 PHASE WITH INSULATORS	138	EA	$2,500	$345,000	
TRANSFER TANGENT	138		$1,345	$185,610	
TRANSFER CORNER	7		$2,540	$17,780	
TRANSFER DE CORNER	5		$3,776	$18,800	
REMOVE POLES	186		$638	$118,668	
ROAD/ACCESS CONSTRUCTION	10	MI	$2,500	$25,000	
MOBILIZATION/DEMOBILIZATION	1	LOT	$25,000	$25,000	
TOTAL ESTIMATED LABOR					**$1,531,518**

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ENGINEERING/INSPECTION					
DESIGN ENGINEERING	3000	HRS	$80	$240,000	
FIELD SUPERVISION/INSPECTION	2000	HRS	$60	$120,000	
TOTAL ESTIMATED ENGINEERING/INSPECTION					**$360,000**
ESTIMATED CONSTRUCTION COST					**$3,496,524.00**
CONTINGENCIES	5.0%	of	$3,496,524		**$174,826.20**
TOTAL ESTIMATED CONSTRUCTION COST					**$3,671,350.20**
CONSTRUCTION OVERHEAD					
PROJECT SUPERVISION	3.0%	of	$3,671,350.20	$110,140.51	
CONSTRUCTION OVERHEAD	5.25%	of	$3,671,350.20	$192,745.89	
AFUDC (0.3843% PER MONTH)	6	month	$3,671,350.20	$84,653.99	
TOTAL CONSTRUCTION OVERHEAD					**$387,540.38**

PROJECT SUMMARY

MATERIAL	$1,605,006.00
LABOR	$1,531,518.00
ENGINEERING/INSPECTION	$360,000.00
CONTENGENCY	$174,826.20
CONSTRUCTION OVERHEAD	$387,540.38
TOTAL ESTIMATED COST	**$4,058,890.58**
COST PER MILE	**$405,889.06**