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FLATIRON - ERIE 115KV TRANSMISSION LINE

Larimer, Boulder & Weld Counties, Colorado

Draft
Environmental Impact Statement

U.S. Department of Energy
Western Area Power Administration
Loveland Area Office - Loveland, Colorado

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ENVIRONMENTAL IMPACT STATEMENT

Flatiron-Erie 115-kV Transmission Line Project

Larimer, Weld and Boulder Counties
Colorado

U.S. DEPARTMENT OF ENERGY
Western Area Power Administration
Washington, D.C. 20585

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Chapter 1
Summary

Chapter 1 -- Summary

1.A PROJECT PURPOSE AND NEED, DESCRIPTION AND HISTORY

Western Area Power Administration (Western) proposes to uprate its existing 115-kV Flatiron-Erie transmission line. The line is located in Larimer, Weld and Boulder Counties, Colorado, and passes through the City of Longmont. The line connects Flatiron Substation and several of the substations supplying Longmont. It is a single circuit 115-kV line, 31.5 miles long, and was built in 1950-51 on a 75-foot wide right-of-way (ROW) using wood H-frame structures.

Western proposes to build 27 new structures along the line, to replace or modify 45 of the existing structures and to remove 11 of them. Many of these additions and changes would involve structures that are approximately 5 to 15 feet taller than the existing ones. The existing conductors and ground wires would remain in place. The purpose of these actions would be to allow the power carrying capability of the line to be increased and to replace deteriorating/structural members. Western would be the sole participant in the proposed project.

The project evolved from an earlier project, the Flatiron-Gunbarrel Transmission Line, that would have replaced most of the existing 115-kV Flatiron-Erie line with a double circuit 115/230-kV line. Partly because of public opposition to the project, Western conducted additional electrical systems planning studies and determined that it could be postponed, if various substation improvements and changes in procedure were made, and the Flatiron-Erie line was uprated. This led to the current proposed action.

The Flatiron-Erie line is currently operating at a rating or load capacity that is lower than the load its conductors are capable of carrying. The line was derated to prevent potential problems associated with ground clearances that do not meet current National Electric Safety Code (NESC) guidelines. The lowered rating will cause it to overload when certain other local transmission facilities are out of service. The result of this could be loss of power to the City of Longmont.

Limiting the amount of power that the Flatiron-Erie line carries was necessary to meet current NESC guidelines. As conductors carry more power, they become hotter; as they become hotter, they expand and sag closer to the ground. The NESC, in order to control the risk of electrical shocks, puts a limit on the clearance between power lines and the ground. For 115-kV lines, such as the Flatiron-Erie line, this limit is 22 feet. Western has found that in some locations, the existing Flatiron-Erie transmission line fails to meet the current NESC guidelines for minimum conductor to ground clearances. The existing clearances have been found to be as low as 20 feet during average loading periods in some locations, and would be even lower under heavy loading conditions. Spans that did not meet NESC clearance requirements for minimum and normal power flows, were raised prior to completion of this EIS because of the public safety hazard.

The proposed action will allow the line to be operated at the design rating of its conductors, which will alleviate the risk of power outages to Longmont, and ensure sufficient electrical capacity for an estimated 10 years.

Several public meetings have been held, both in connection with the earlier Flatiron-Gunbarrel project and with the Flatiron-Erie project.

1.B ALTERNATIVES, INCLUDING THE PROPOSED ACTION

Numerous actions were considered as alternatives to the proposed action. These included: "no action," conservation of energy, alternative transmission technologies, alternative electrical transmission systems, alternative structure types and alternative methods of construction. From this wide range of alternatives, three primary alternatives were developed and given detailed and equal analysis in this EIS.

1.C ANALYSIS OF STUDY AREA ENVIRONMENT AND DEVELOPMENT OF ALTERNATIVE ROUTES

The components of the study area environment that might be substantially affected by (or might affect) transmission line construction and/or operation were inventoried and mapped. This information was used to help locate the primary project alternatives.

The study area covers about 284 square miles and is centered on the existing Flatiron-Erie line. It contains, in the most general terms, three basic environmental situations. In the northwest is an area that is primarily undeveloped, though with scattered pockets of residential development. This area is moderately steep and rugged and contains several concentrations of earth and biological resources that are constraints to transmission line siting. In the center of the study area is the Longmont urban area with its concentration of land uses, primarily residential developments, that are major constraints to transmission line siting. In the remainder of the study area are extensive agricultural lands interspersed with substantial areas of residential development, both representing siting constraints. The entire study area is crossed by a number of east-flowing streams whose valleys represent moderate barriers to a north-south transmission line because of the concentrations of earth, water and biological resource values there. A network of existing transmission lines crosses the study area, and this represents an important class of opportunity for the siting of a new transmission line. Figure 4.1 illustrates the three characteristic situations in the study area.

The inventory of the affected environment was organized into the following categories:

- Earth Resources and Hazards
- Water Resources
- Biological Resources
- Land Use (existing land use, existing utilities, planned land use)
- Visual Resources
- Cultural Resources

The order in which the environmental resources are presented does not represent any relative value placed on them.

Potential landslide areas, sensitive soil/slope conditions (where erosion potential is high and/or reclamation difficult), floodplains and subsidence areas were identified in the study area as components of the Earth Resources category. These components have the potential to affect or be adversely affected by a transmission line.

The water resources that could potentially be affected by the project included ponds/reservoirs and major streams.

Numerous sensitive components of the biological environment occur in the study area. These include: wetlands; various areas designated as critical or valuable by government agencies (plant associations, rare plants, critical wildlife habitat, natural areas, rare fish habitat);, and certain habitats of various critical, sensitive or rare species (waterfowl, prairie dog/black-footed ferret, golden eagle, bald eagle, mule deer and elk, great blue heron, rare mouse species and rare insects).

Most of the study area is occupied by developed land uses, many of which are sensitive to transmission line siting. These include residential areas and sites, schools, recreation/open space, cultivated land (occasionally with center-pivot irrigation rigs), airport flight clearance zones, and a telecommunication research area (from which transmission lines are excluded). Various other developed land uses occur in scattered locations all in some degree susceptible to potential impacts from transmission lines.

Several existing electric transmission lines cross portions of the study area. These, together with the existing Flatiron-Erie line, are potential opportunities for the location of a new transmission line.

Various local authorities have developed comprehensive plans for major portions of the study area. These planned land uses, while less sensitive than existing uses of the same types, in some cases have the potential to be adversely affected by a new transmission line.

Cultural, primarily historic, resources are scattered throughout the study area. Some of these are sensitive to the siting of a new transmission line.

Land uses and areas where the visual qualities of a new transmission line could be a problem are common throughout the study area. These include existing and planned residential and recreational land uses, as well as scenic areas and areas specially designated as visually sensitive.

Each of the potentially sensitive components of the environment was assigned a value representing its constraint to our opportunity for transmission line siting. This information was then combined onto a single composite constraint/opportunity siting map (Figure 4.9), which was used to help determine the route of the three primary alternatives.

The map revealed that there appears to be no environmentally reasonable way to site a new transmission line connecting the Longmont substations other than primarily along the existing Flatiron-Erie ROW, i.e., by using the siting opportunity that the existing ROW represents. There is no evident low constraint route around the City of Longmont (either on the east or west sides), and no evident environmentally acceptable way of siting connecting spurs from the periphery of the city to its substations. Therefore, although the network of alternative routes is simple and mostly focused on the existing ROW, the relatively extensive data inventory is valuable in demonstrating the inevitability of this siting approach.

Three primary alternatives, formulated as explained above, were defined.

The first primary alternative is Western's proposed action, the uprating of the existing Flatiron-Erie transmission line. This is Alternative B, the alternative that Western believes would best and most economically satisfy the project need. It is the environmentally preferred alternative. The second primary alternative would rebuild the existing Flatiron-Erie transmission line underground for 6.1 miles through Longmont and uprate the remainder of the existing transmission line. This is Alternative C. Alternatives B and C would make no change to the existing electrical systems. The third primary alternative would remove two segments of the existing Flatiron-Erie transmission line in

Longmont, supply Longmont's substations using other existing transmission lines and a segment of new overhead transmission line, uprate the remainder of the existing transmission line, and build a new substation south of Longmont. This is Alternative D. It would make substantial changes to the existing electrical system.

1.D ASSESSMENT OF THE IMPACTS OF THE PRIMARY ALTERNATIVE ROUTES

The methodology used to assess impacts proceeded in two basic steps. First, it defined the potential, theoretical impact levels (not actual quantities) for all possible project construction actions affecting all sensitive environmental components in the study area. This process recorded and took into consideration the project's range of construction actions (from new underground construction to relatively minor modifications to an existing structure) and the standard mitigation measures that had been committed to. Second, the methodology quantified the actual impacts for the proposed system of primary alternative routes; i.e., the actual quantities of effect of various levels (moderate adverse, or beneficial) on the environmental components crossed (or approached) by the three alternatives.

1.E COMPARISON OF THE PRIMARY ALTERNATIVE ROUTES

There are no significant adverse impacts from any of the primary alternatives. The alternatives were therefore compared using moderate adverse impacts and beneficial effects.

The three primary alternatives are:

- Alternative B. The Proposed Action. Uprate the exiting 115-kV Flatiron-Erie transmission line on its existing ROW.

- Alternative C. Rebuild the existing Flatiron-Erie transmission line underground through Longmont. Uprate the remainder of the line.

- Alternative D. Remove two segments of the existing Flatiron-Erie transmission line in Longmont. Uprate the remainder of the line. Supply Longmont's substations using other existing transmission lines and a segment of new overhead transmission line on new ROW. Build a new substation south of Longmont.

There would be no impacts to earth resources from Alternatives B and D, and very small amounts of short-term moderate impacts from Alternative C.

Alternatives B and D would have no substantial adverse impact on water resources. Alternative C would cause a small amount of short-term moderate impacts on water resources and, in addition, moderate long-term impacts on streams.

Alternative B would cause relatively small amounts of short-term moderate impacts to biological resources (wetlands) from construction disturbance. Alternative C would cause slightly more of the same type of impacts; and Alternative D, very slightly more than C. However, C would also have short-term moderate impacts on two streams that are Colorado rare fish habitat and long-term moderate adverse impacts on the rare fish habitat. Alternative B would have the least, and C the most impact on this resource area.

Alternative B would cause moderate amounts of short-term moderate impacts to land uses. Alternative C would cause substantial amounts of short-term moderate impacts to land uses, but would also have substantial amounts of long-term beneficial effects from the removal of segments of the existing line and their replacement by underground construction. Alternative D would also cause substantial amounts of impacts on land uses, but it would also have long-term beneficial effects from the removal of segments of the line. Alternative B would have the least, and D the most impacts on existing land use.

Cultural resources would not be subject to impacts higher than the low level from any of the primary alternatives.

There would be no substantial adverse effects on visual resources from Alternative B. Alternative C would have small amounts of short and long-term moderate visual impacts, but substantial amounts of beneficial visual effects from the removal of segments of the existing line and their replacement by underground construction. Alternative D would cause moderate amounts of short and long-term moderate visual impacts and substantial amounts of long-term visual benefits. Alternative B would have the least and D the most impacts on visual resources.

In summary, overall comparison of moderate adverse environmental impacts, (both long and short term), for each of the three primary alternatives, shows that Alternative B ranks the best for all environmental resource areas. Alternative B, therefore is the environmentally preferred alternative.

The estimated cost of each alternative is:

B	$ 1,438,000
C	$11,168,000
D	$ 6,067,000

1.F NO ACTION, ALTERNATIVE A

Under the No Action Alternative, Western would not uprate the existing 115-kV line, but would only perform essential maintenance activities as needed. Structures and hardware would be repaired and/or replaced as required during regular maintenance operations and in response to emergency outages on the line. These repairs would have to be made with increasing frequency in the future as the line increases in age.

Implementation of this alternative would preclude most of the impacts to the environment that would be associated with the other alternatives. Insignificant impacts would occur during maintenance activities. The impacts would be of the same type as described under the above ground alternatives. Since this alternative does not increase the rating of the Flatiron-Erie line, it was not considered a viable alternative.

1.G CONSERVATION OF ENERGY AND RENEWABLE RESOURCES

As related to the transmission of power, Western's Conservation and Renewable Energy Program (C&RE) encourages the development and implementation of energy efficiency measures. Western's C&RE Program has been applied effectively for more than a decade. However, the C&RE Program has not decreased or delayed the need for transmission line improvements. Therefore, Western has determined that expanded C&RE technology applications are not a reasonable alternative to construction of this project.

1.H ALTERNATIVE TRANSMISSION TECHNOLOGIES

Several alternative transmission technologies were evaluated, including: (1) conventional overhead alternating current (AC) transmission; (2) overhead direct current (DC) transmission; and (3) underground construction. Western proposes to use conventional overhead AC transmission on the proposed action -- the uprating of the line, and also in major portions of the proposed project alternatives.

Overhead DC lines must include converter stations at either end of the line and at every point where it is interrupted to convert the DC current to AC for consumer use. Only with line segment lengths far greater than those proposed here, and transmission of much larger amounts of power, would the economic advantages of DC transmission offset the high cost of the converter stations. Direct current transmission is therefore not a viable alternative to the proposed project.

Underground construction of a 115-kV transmission line can cost five to ten times more per mile than a new 115-kV transmission line installed overhead. Other disadvantages are the need for a continuous zone of disturbance along the right-of-way. The cable system must be installed in a continuous trench approximately 2 feet wide and 3 to 5 feet deep. At any given point where a transition is made from underground construction to overhead construction, a large overhead transmission line structure must be installed. If a high pressure oil-filled pipe type cable system is used, pumping and pressurizing facilities would be required at intervals of several miles along the underground line. Underground construction through Longmont is one of the primary alternatives studied for the proposed project.

1.I SYSTEMS ALTERNATIVES

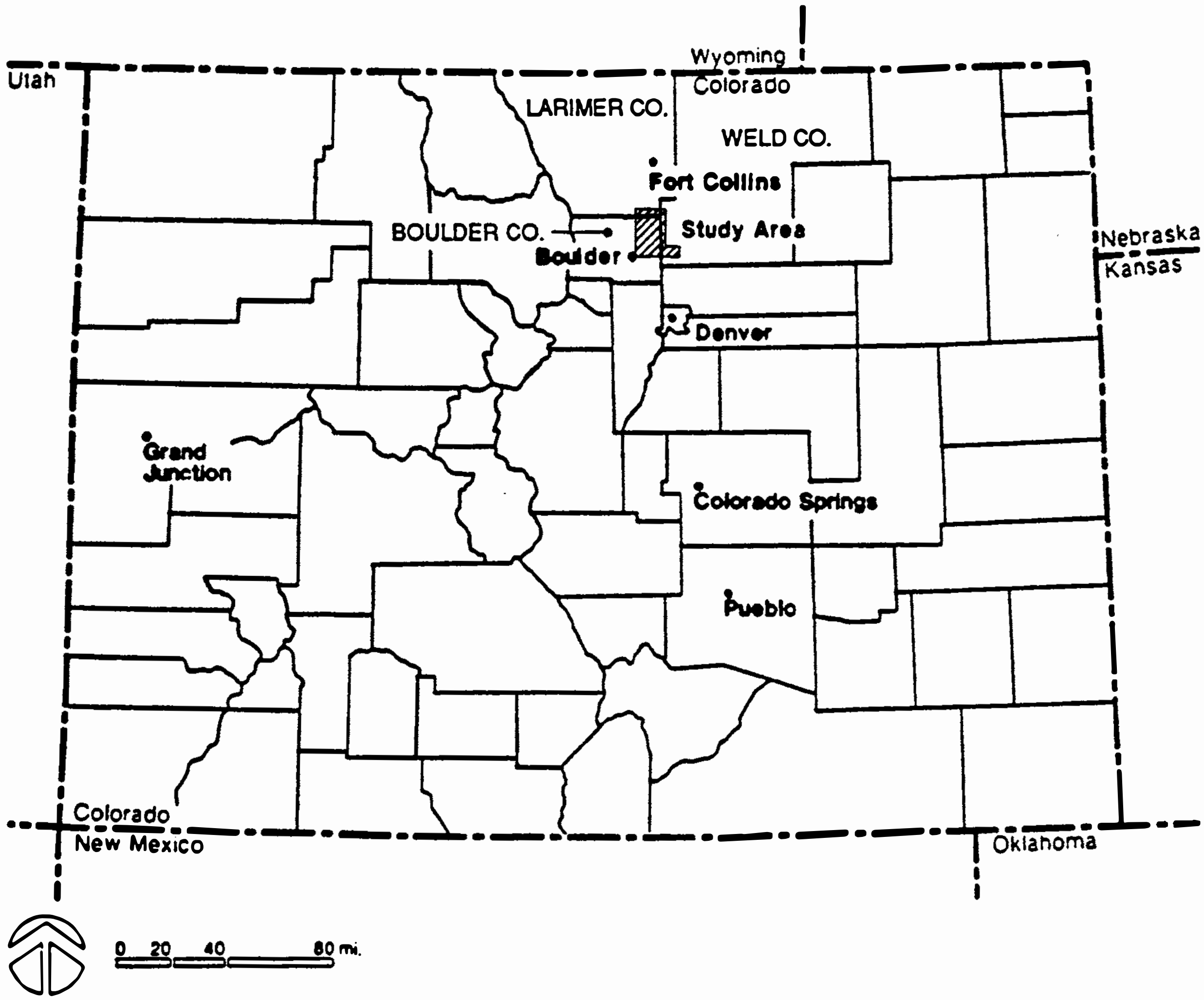
A transmission "system" refers to the electrical arrangement of and relationships between the circuits and substations by which power is supplied. Changes in routing or construction technology (e.g., overhead versus underground) do not themselves necessarily change a system. An essential characteristic of a transmission system is that each substation must be supplied by two circuits (ideally not on the same ROW) to maintain service during equipment outages. Electrical loads supplied from a substation having only one line feeding into it would be subject to frequent interruptions because of the lack of an alternative source to feed the substation. Any outage suffered on the single feed line would likewise interrupt power to any load fed from the substation.

The proposed action of uprating the existing Flatiron-Erie transmission line (primary Alternative B) would involve no change to the existing system. The underground alternative (primary Alternative C) is being considered by Western in response to public comments. It consists of reconstruction of the Flatiron-Erie line underground through Longmont. It would involve no change to the existing system. An alternative system (primary Alternative D) was formulated, in response to public comment, to explore the feasibility of removing portions of the line from densely developed areas of Longmont.

Six additional systems alternatives were considered and rejected from further study because they did not meet electrical criteria, would be very expensive, and would be associated with greater environmental impacts.

1.J AFFECTED ENVIRONMENT

The project study area (Figure 1.1) is located in north central Colorado and covers about 284 square miles.



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Location Map

Figure 1.1

Environmental resources were identified in the study area. Some resources were categorized as not requiring detailed study because the project would have no effect on them. These include Air Quality, Climate, Ground Water and Socioeconomics.

Potential landslide areas present a moderate constraint to transmission line siting. They occur in the foothills west of Longmont near Rabbit Mountain and Carter Lake. Sensitive soil/slope conditions are concentrated in the northwestern portion of the study area around Carter Lake, generally on the low hills and hogbacks of the Piedmont physiographic province.

Streams with mapped floodplains include: Little Thompson River and its tributary Dry Creek, St. Vrain Creek, Left Hand Creek, two more streams both called Dry Creek, Spring Gulch, Boulder Creek and Coal Creek.

Subsidence areas are associated with historic underground mines near Erie.

The area has many ponds and storage reservoirs of varying sizes. Carter Lake, located in the northwest portion of the study area, is the largest water body. Other large water bodies include Calkins Lake, Lonetree Reservoir, Welch Reservoir, Panama Reservoir, Ish Lake, Terry Lake, McIntosh Lake, Foothills Reservoir and a portion of Boulder Reservoir. Major streams include: Little Thompson and its major tributary Dry Creek, St. Vrain Creek and its tributaries Left Hand and Dry Creeks, and Boulder Creek and its tributary Coal Creek.

Several wetland types, including cattail marshes, riparian woodlands, willow shrublands and sedge/rush/grass meadows are present along streams and around ponds and reservoirs. The major streams in the study area are generally characterized by narrow zones of wetland vegetation on the floodplains; flood-irrigated low areas along streams have enlarged the zone of natural wetlands vegetation.

Five plant associations considered to be threatened by urban development and domestic livestock grazing are found within the study area. However, these communities are relatively common in Eastern Colorado. They include: (1) Ponderosa pine-mountain mahogany-big bluestem; (2) mountain mahogany-skunkbush-big bluestem; (3) inland saltgrass-alkali sacaton-western wheatgrass; (4) three-square bulrush; and (5) broadleaf cattail. Six rare plants have been identified within the study area. These include the Bell twinpod, Andrew's spleenwort, forktip three awn, American groundnut, and showy prairie gentian.

The study area contains eleven areas of designated critical wildlife habitat. Rabbit Mountain, northwest of Longmont, is the largest of these. Most of these areas are associated with wetlands habitats of seasonal importance to specific wildlife groups. Many of the reservoirs and ponds in the study area are used by ducks and Canada geese for nesting and rearing young. However, the magnitude of waterfowl production is low.

Numerous prairie dog towns occur throughout the project area. Two small towns are located along the existing 115-kV transmission line right-of-way. Five golden eagle nest areas are located in the northwestern portion of the study area, in the vicinity of Rabbit Mountain and Carter Lake. Bald eagles are primarily winter visitors or winter residents in the study area. They do not nest in the study area. Two small great blue heron rookeries are located in cottonwoods flanking Calkins Lake and Panama Reservoir No. 1. A large heronry occurs along Boulder Creek.

Winter range is habitat used by mule deer and elk during the winter for food, cover and local movement. These areas are very large, covering major portions of the study area and extending west through the foothills.

Additional rare animals found in the study area include Preble's jumping mouse and the grasshopper mouse; the common shiner, bigmouth shiner, Johnny darter, and Iowa darter; and the miner bee.

Residential areas are scattered throughout the study area. By far the largest area is in and around Longmont, where an area that is primarily housing extends about 4 1/2 miles north to south and about 4 miles east to west. Retail/office land use is found in and on the periphery of Longmont and on the periphery of Boulder. Institutional land uses are found primarily in and around Longmont, but also in association with some of the smaller established communities. Industrial, heavy commercial and utilities land uses are concentrated around the southern part of Longmont, but also occur in scattered locations through all but the northwest portion of the study area. Several mining operations extract sand and gravel from deposits along the major streams in the study area, especially St. Vrain Creek and Boulder Creek.

Recreation/open space land uses include golf courses; the periphery of Longmont and Boulder; and Lagerman Reservoir, Carter Lake and Rabbit Mountain. Agricultural land uses include agricultural structures, center pivot irrigation and cultivation, which is the most extensive agricultural use.

There are four active airports/landing strips in the study area: Longmont Airport, Parkland Estates Airport, Tri-County Airport and a private airstrip. A large area southwest of Longmont and north of Boulder, centered on the Table Mountain antenna field, has been designated as a telecommunications research facility protection zone. There are three radio towers in the study area. Two are located east of Niwot and one north of Erie.

Planned residential land uses of various densities are concentrated on the southern fringe of Loveland; around Longmont on its northeast, south and southwest sides; around Niwot; and southwest of Erie. Many of the units are large, a mile or more across. Most of the planned commercial land uses are around Longmont and near Niwot, and a large area southeast of Erie. Planned industrial land use areas are concentrated on the periphery of Longmont, on all sides except the northwest. Several very large areas of planned public recreation/open space are located near Rabbit Mountain, and on the periphery of Longmont.

There are numerous historic and archaeological resources in the study area. Archaeological sites include the following types: stone ring sites, open camps, lithic scatter sites, stone alignments and burials. Historic sites primarily include buildings, cemeteries, ditches and railroads.

The visual characteristics of the study area are highly varied. In the northwestern portion of the study area are scenic, natural landscapes. The heavily developed commercial and industrial urban areas of Longmont have retained relatively little evidence of the existing natural landscape, and are not generally considered visually positive. Many of the residential areas throughout the study area enjoy views of Longs Peak and other mountains in the Front Range. Visually sensitive viewers are located primarily at areas of recreational and residential land use, and along certain highways designated as visually sensitive "gateways" to Longmont.

1.K ENVIRONMENTAL CONSEQUENCES

Over 50 environmental components grouped in eight categories were inventoried and used to help locate the system of alternatives. Of these, only 15 components are affected by some part of the system of alternatives at a level that influences the comparison of the routes; i.e., at moderate adverse or beneficial levels. These effects may occur over the short-term construction period, or the long-term life of the project. Beneficial effects arise from the absence of the project rather than the construction action of removing it; therefore, beneficial effects may be considered as long-term. Table 3.3 quantifies the adverse effects and benefits of the three primary alternatives.

Table 3.4, Comparison of Environmental Impacts/Benefits and Costs of Primary Alternatives, shows the summary impacts and benefits for each alternative for each environmental resource area. It also shows the cost as an additional evaluation factor for each alternative. The table also indicates for each evaluation factor the rank -- best (1), mid-range (2), or worst (3) -- for each alternative.

There would be no substantial impacts to earth resources from Alternatives B and D. Very small amounts of short-term moderate impacts would occur to sensitive soil/slope conditions from Alternative C.

There would be no substantial impacts to water resources from Alternative B and D. Alternative C would cause relatively small amounts of short-term moderate impacts to biological resources (wetlands) from construction disturbance. Alternative C would cause slightly more of the same type of impacts; and Alternative D, very slightly more than C. However, C would also have short and long-term, moderate adverse impacts on Colorado rare fish habitat from crossing of two streams by construction equipment, and from the risk of a spill of fluid from the underground portion of the alternative.

Alternative B would cause moderate amounts of short-term moderate impacts to various land uses, including residences, a school, industry and recreation/open space. Alternative C would cause substantial amounts of short-term moderate impacts to the same land uses as Alternative B, but would also have substantial amounts of beneficial effects (mostly on the same land uses) from the removal of the existing line and its replacement by underground construction. Alternative D would also cause substantial amounts of impacts on the above land uses, plus agricultural uses, but would also have beneficial effects on developed land uses from the removal of segments of the line.

Planned land use (as explained in Section 5) would not be directly subject to impacts. Some of its environmental components are addressed under visual resources.

Cultural resources are not subject to impacts higher than the low level from any of the primary alternatives.

There would be no substantial effects on visual resources from Alternative B. Alternative C would have small amounts of short and long-term moderate visual impacts, but substantial amounts of beneficial visual effects on residential and recreation/open space land uses from the removal of segments of the existing line. Alternative D would cause moderate amounts of short and long-term moderate visual impacts on existing and planned residential and recreational land uses, but also substantial amounts of long-term benefits.

At this time, it is not clear if exposure to E&M fields presents a health risk. The consensus opinion of the majority of researchers continues to center on the need for further research. Should science establish a significant risk to public health as a result of E&M field exposure, it is Western's expectation that the issue of E&M field standards, avoidance strategies, evaluation procedures, etc., would be addressed in regulations after a careful, structured public debate that weights risk against cost. Uprating the existing Flatiron-Erie transmission line will serve Longmont's electrical capacity needs into the 21st century, thus allowing time for further research into the relationship between E&M fields and human health risk. A more detailed discussion of the health effects issue is included in Appendix C, Public Health and Safety.

The preferred Alternative B is significantly less costly than Alternatives C and D, and still provides the same reliability and capacity benefits. Alternative C, Underground through Longmont, is 7.8 times the cost of Alternative B; and Alternative D, Remove and Reroute in Longmont and Build New Substation, is 4.2 times the cost of the preferred Alternative B. Although Alternatives C and D do reduce or eliminate the E&M fields through the residential areas of Longmont, the uncertainty surrounding the E&M fields issue at the present time cannot justify expenditure of large sums of money, degradation of reliability and service, or greatly increased operating costs.

In summary, overall comparison of moderate adverse environmental impacts (both short and long-term) for each of the three primary alternatives shows that Alternative B ranks the best for all environmental resource areas. Alternative B, therefore, is the environmentally preferred alternative.

Chapter 2
Introduction

Chapter 2 -- Introduction

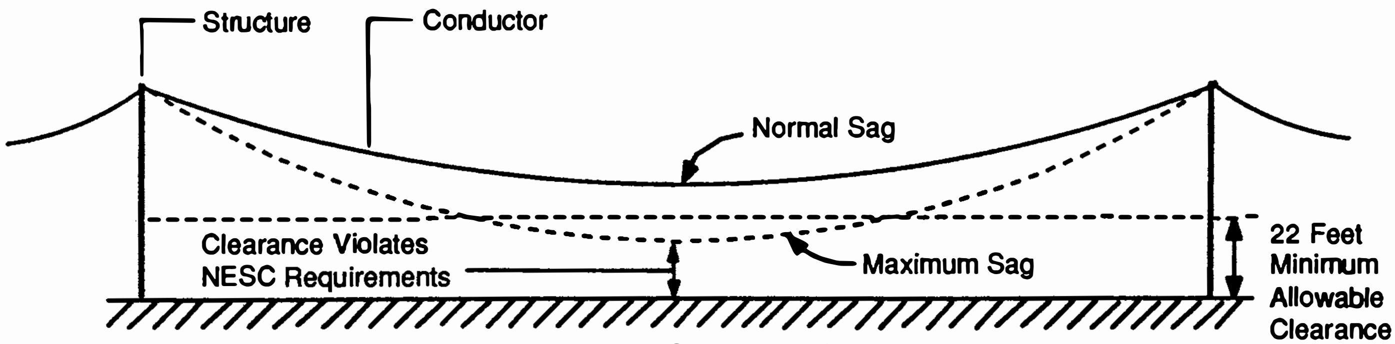
2.A PURPOSE AND NEED

The Flatiron-Erie 115-kV transmission line was constructed during 1950-1951 on wood pole, H-frame structures using 397.5 ACSR conductors. Originally designed for a conductor rating of 109 megavolt-amperes (MVA), system studies and field measurements conducted by Western determined that the actual Flatiron-Erie transmission line ratings are significantly smaller. Based on National Electric Safety Code (NESC) conductor-to-ground clearance requirements, the Flatiron-Terry Street 115-kV section of the line was rated to approximately 67 MVA and the Terry Street-Erie 115-kV line was rated to approximately 4 MVA. These ratings for the line will cause it to be overloaded for most day to day operations.

As conductors carry more power, they become hotter; as they become hotter, they expand and sag closer to the ground. The NESC, in order to avoid the risk of electrical shocks, stipulates a minimum clearance between power lines and the ground. For 115-kV lines, such as the Flatiron-Erie line, this limit is 22 feet. Using field measurement techniques, Western has found that in some locations, the Flatiron-Erie transmission line fails to meet the current NESC requirements for minimum conductor to ground clearances. The existing conductor to ground clearances have been found to be as low as 20 feet during average loading periods in some locations, and would be even lower under heavy loading conditions. This situation is shown in Figure 2.1. Spans that did not meet NESC clearance requirements for low or normal power flows, were raised prior to completion of this EIS, because of the public health hazard. Eight spans were raised in the spring and summer of 1991. This work allowed the line rating to go to 85 MVA for the Flatiron-Terry Street segment and 10 MVA for the Terry Street-Erie segment of the line. Under the proposed action, those spans that do not meet the NESC clearance requirements for peak emergency power flows would be raised after completion of the EIS.

To alleviate the overloading problems, Western has determined that the Flatiron to Longmont Northwest/Harvard portion of the line must be uprated to operate at the original rating of 109 MVA and the Longmont Northwest/Harvard to Erie segment of the line must be operated at 85 MVA. Western proposes to uprate the 31.5-mile long Flatiron-Erie 115-kV transmission line by adding, replacing, modifying and removing 83 wood pole structures. The existing line has 216 structures. The height of some of the wood pole structures would be increased by 5 to 15 feet. Section 2.A.4 (The Proposed Action) has a detailed description of these structure modifications. The voltage of the transmission line would remain at 115-kV, the existing conductor would remain in place, and the majority of the existing structure locations would remain the same.

The second situation that requires the project action is the deteriorated condition of some of the elements of the line. The line is now over 40 years old and nearing the end of the typical service life for wooden structural elements. In the fall of 1990, Western carried out systematic tests to determine the structural conditions of all poles and other structural and functional elements of the line. The results of those tests revealed the need for replacement of approximately 25 wood poles which were found to be structurally unsound because of internal rot. Replacement of these poles with new structures will also be done along with the structure modifications needed to uprate the line.



Longitudinal Section of ROW
Not to Scale

Flatiron-Erie
115kV
Transmission Line
Project

Western Area Power
Administration

Transmission Line
Conductor
Ground Clearance

Figure 2.1

2.B PROJECT DESCRIPTION

Western Area Power Administration (Western) proposes to uprate its existing 115-kV Flatiron-Erie transmission line. The location of the project is shown on Figure 2.2.

2.B.1 THE PROPOSED ACTION

There are 216 existing structures along the Flatiron-Erie transmission line. The uprating of the line would include the following types of construction activity:

- Build 27 new wood H-frame structures at new sites along the ROW.
- Replace 20 existing structures at existing sites. The structure heights would be increased by 5 feet in 6 cases, 10 feet in 9 cases, and 15 feet in 5 cases.
- Replace 22 existing structures with structures of the same height, in the same locations.
- Raise the cross arm at 3 existing structures.
- Remove complete structures at 11 sites. (These structures would be replaced by adjacent structures along the ROW, accounting for some of the 27 new structures listed above.)

The proposed action is described and illustrated in detail on Figure 3.9 in Section 3.G.1.

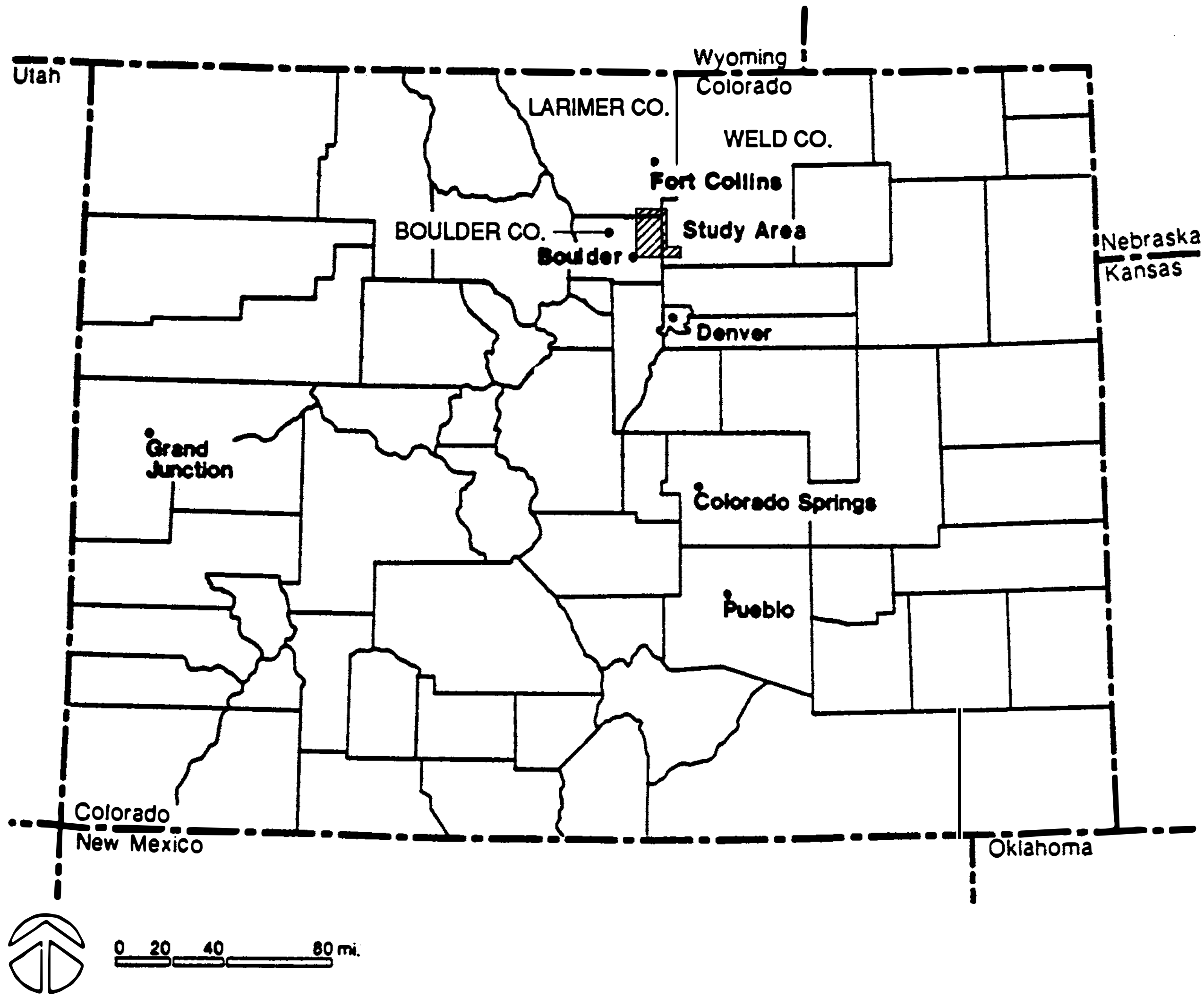
In addition, improved grounding features would be installed on all existing structures (except those being removed) and at all new and modified structures. The existing conductors and overhead ground wires would remain in place during all of the above construction operations. With changes in structure heights, the conductors might have to be resagged or reworked. The voltage of the line would remain at its present level of 115-kV. However, as explained in Section 2.B below, the power carrying capability of the line would be increased. The cost of the proposed action is estimated at $1,438,000. The action would extend the life of the line.

The reasons for the production of an Environmental Impact Statement (EIS), rather than an Environmental Assessment (EA), for this relatively minor proposed action are explained in Section 2.B below.

2.B.2 PROJECT SCHEDULE

Western published a Notice of Intent to Prepare an EIS in the Federal Register on October 6, 1989. A public scoping meeting was held on November 15, 1989, in Longmont, and preparation of the EIS began in January 1990. A planning meeting, or public workshop, was held on December 18, 1990, also in Longmont. The proposed schedule for the remaining major milestones leading to completion of the project is as follows:

- Issue Draft EIS for review and comment by agencies and the public -- Summer 1993.
- Public hearing -- Summer 1993.



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Location Map

Figure 2.2

- Final EIS Record of Decision – Spring 1994.
- Selection of construction contractor -- Fall 1995.
- Completion of construction -- Spring 1996.

2.B.3 PROJECT PROPONENT

Western would be the sole participant in the proposed project.

Western, an agency of the U.S. Department of Energy, is responsible for marketing federal electric power and for transmission service in 15 central and western states. Western markets power to 532 customers consisting of cooperatives, municipalities, public utility districts, private utilities, federal and state agencies, and irrigation districts. The wholesale power customers, in turn, provide service to millions of retail customers in Arizona, California, Colorado, Iowa, Kansas, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Texas, Utah and Wyoming. Electric power marketed by Western is generated by the Bureau of Reclamation, the U.S. Army Corps of Engineers, and the International Boundary and Water Commission. Together these agencies operate 48 hydropower generating plants in Western's marketing area. In Colorado, Western's Loveland Area Office markets 400 MW of generation capacity and has approximately 372 MW of load responsibility.

2.C PROJECT BACKGROUND AND HISTORY

Late in 1986, Western initiated the preparation of an Environmental Assessment (EA) for the Flatiron-Gunbarrel transmission line. This was a proposal to replace 23.5 miles of its existing Flatiron-Erie 115-kV transmission line with a 115/230-kV double-circuit line, from Flatiron Substation (Larimer County, Colorado) to the proposed Gunbarrel Substation located approximately six miles south of Longmont in Boulder County, Colorado. This proposal was known as Flatiron-Gunbarrel 115/230-kV Transmission Line Project. It was a joint participation project sponsored by the following power suppliers: Western, Tri-State Generation and Transmission Association, Inc. (Tri-State), Public Service Company of Colorado (PSCo), and Platte River Power Authority (PRPA). Western was designated as the project manager for this project. This environmental study proposed to locate the new double-circuit 115/230-kV line on the ROW of the existing 115-kV line using steel single pole structures. Various alternative ROW segments were also considered. The primary benefits of this project were replacement of most of the old overloaded Flatiron-Erie transmission line with a new, high-capacity double-circuit line, and provision for future load growth and transfer capability. Both circuits would initially be energized at 115-kV, but one of the circuits would be insulated for 230-kV for later conversion to 230-kV when needed. The preliminary EA for this project was completed in mid-1988.

As the environmental studies were progressing, several public meetings were held. Many comments were received from the public, generally opposing the project. Opposition was based primarily on concerns about the possible health effects of the electromagnetic fields (EMF) generated by transmission lines, the visual effects of the larger line, and the impact of the line on land values. As a result of this public input, Western formulated a proposal that involved splitting the 115 and 230-kV circuits at a point north of Longmont, routing the 230-kV circuit around Longmont (either on the west or east side), and rejoining the 115-kV line on its existing ROW at a point south of the city. (Since the 115-kV circuit serves most of the Longmont substations, it could not be routed around the city.) This proposal also considered underground construction for certain segments .of the line through Longmont and close to the Longmont Airport. Recognizing the significant public concern with this project, Western decided to consider a full range of alternatives and to prepare an EIS. Work was suspended on the EA, and EIS studies were commenced.

Simultaneously, in parallel with these expanded environmental studies, Western and the other project participants (Tri-State, PSCo and PRPA) conducted an in-depth electrical systems analysis of the project and all reasonable alternatives. A reevaluation of the projected need for the original proposal indicated that the projected electrical load growth and generation resource usage in the area did not require additional transmission circuits until the late 1990's or possibly early 2000's, if some minor power system improvements and operating procedures were implemented.

Other considerations were the economic drawbacks of constructing the Flatiron-Gunbarrel 115/230-kV project at the present time. These were:

- High initial cost for future benefits.
- Western had recently completed inspection and testing of lines comparable in terms of age and structure type to the existing Flatiron-Erie 115-kV line. This testing had suggested that the line might have more useful life left than had been anticipated, and that its entire replacement might be premature. The line has subsequently been tested, and only 11% of the poles need to be replaced because of deterioration.

The conclusions of the electrical systems engineering studies were that the proposed 230-kV line between Flatiron and PSCo's transmission system could be postponed until the late 1990s or early 2000s, provided some lesser power system improvements and operating procedures were implemented. These improvements and operating procedures were identified as (1) the addition of a second 230 to 115-kV transformer at PRPA's Longs Peak Substation (this has already been completed, and is not part of the proposed project), (2) uprating of the existing 115-kV Flatiron-Erie transmission line, and (3) removing the transmission interconnection with PSCo at Erie Switching Station.

The installation of the second transformer at Longs Peak Substation provides more capacity to the 115-kV transmission system that provides power to Longmont, and will prevent overloading the Flatiron to Erie 115-kV line. In the summer of 1992, the Erie Switching Station and the transmission interconnection with PSCo at Erie Switching Station were removed, thus reducing power flows through the system. Replacing and adding certain structures with taller structures in the Flatiron to Erie line will uprate the line to meet safety code line to ground clearances under all power flow conditions. This additional capacity in the existing Flatiron-Erie transmission line is needed to cover the increased power flows experienced for brief periods of time during peak power flows and when other area transmission lines are out of service.

Therefore, Western decided to suspend the Flatiron-Gunbarrel project and proceed with the current project -- the Flatiron-Erie 115-kV uprate. However, because Western made a commitment to prepare an EIS for the Flatiron-Gunbarrel project, Western decided to prepare an EIS (rather than the briefer and simpler EA) for the Flatiron-Erie project, although the proposed action is relatively minor (little more than a major maintenance activity) and an EIS would not normally be expected. The EIS process will also provide better opportunities for the public to comment on the project.

2.D RELATIONSHIP TO OTHER PROJECTS

The project's relationship to existing regional transmission lines is shown on Figure 2.3. The project's relationship to the existing transmission lines in its immediate vicinity is shown in more detail on Figure 4.6 in Section 4.G. Its connections to these lines are as follows:

- At Lyons Tap Switching Station (north of Longmont), the project connects to an existing 115-kV single circuit, Poudre Valley REA line that runs southwest to a large cement plant near Lyons.
- At the Longmont Northwest/Harvard Substations near the northwest edge of Longmont, the line connects to a 115-kV single circuit, PRPA line that runs east to Meadow Substation, and continues east and north to PRPA's Longs Peak Substation.
- At a point west of central Longmont, the line connects to a 115-kV double-circuit line which proceeds south to PRPA's Fordham Substation.
- At Terry Street Substation, near the south edge of central Longmont, the line connects to a 115-kV single circuit PRPA line that runs east and north to Longs Peak Substation.
- South of Longmont, the line crosses (but does not connect to) a 115/230-kV double-circuit PSCo line running east and west.
- Finally, near the Erie Switching Station site, the line connects to a 115-kV single circuit Western line proceeding east. The Erie Switching Station and the transmission interconnection with PSCo have been removed to avoid large power flows through Western's Flatiron-Erie line.

Two future projects may relate to this project. The proposed action would allow Western to continue to operate the uprated Flatiron-Erie line for about ten years. Beyond that period, the line would be retested for pole deterioration and further structural improvements would be made as necessary. After about the year 2000, a new 230-kV circuit connecting to the major regional generation resource to the north may be needed because of ongoing load growth, both locally in the Longmont area, and regionally. This could be combined with a rebuild of the Flatiron-Erie 115-kV line, could be a separate project, or could be partially combined. If and when a new line is needed, it will be treated as a new project and will comply with NEPA regulations.

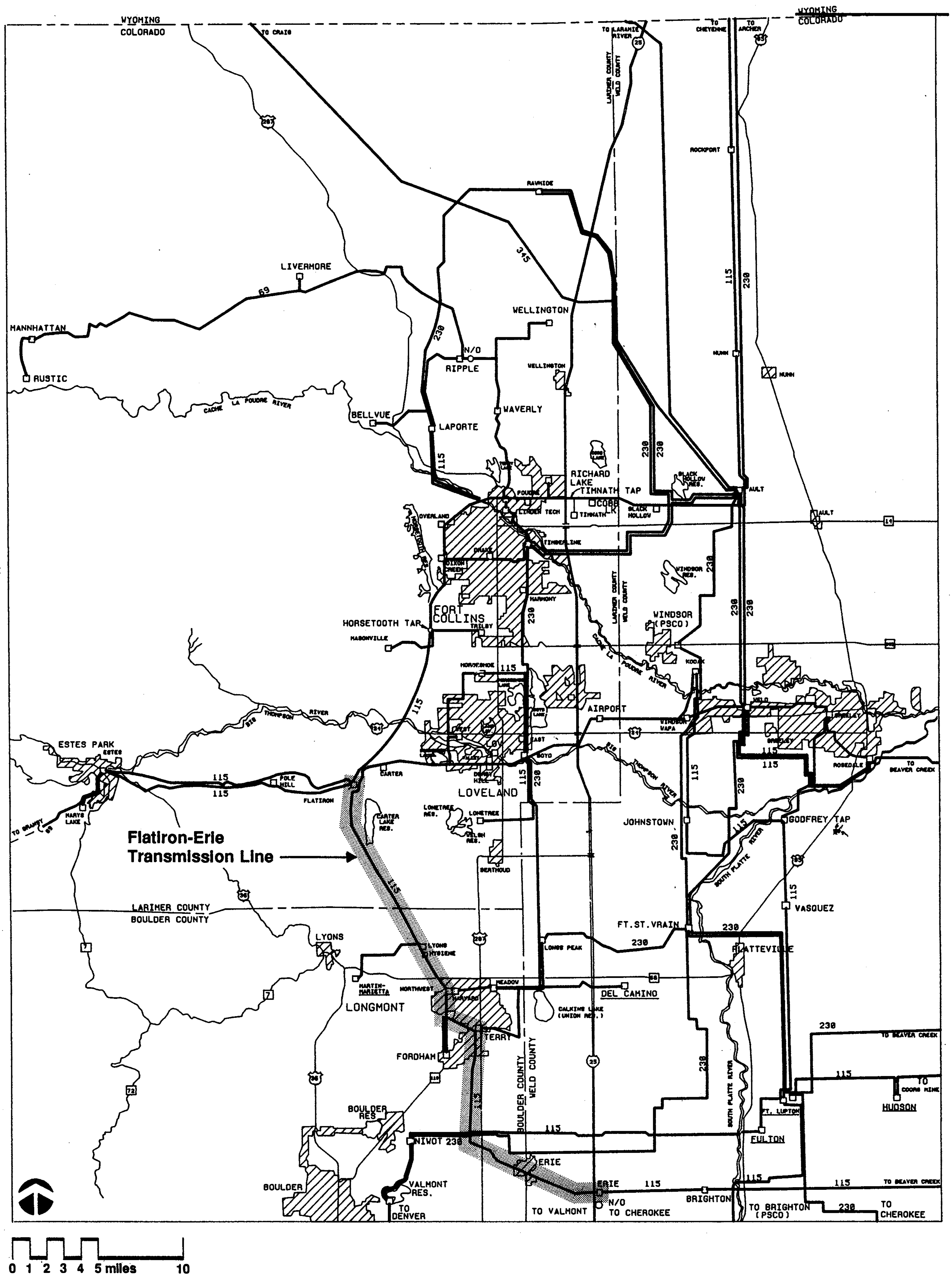
2.E JURISDICTIONS WITH AUTHORIZING ACTIONS

Table 2.1 contains a summary of the federal and state government actions that will, or may be required to implement the project.

2.F SCOPING PROCESS AND PUBLIC INVOLVEMENT

2.F.1 PUBLIC INVOLVEMENT IN EARLIER VERSIONS OF THE PROJECT

Several public meetings were held in connection with the earlier versions of the project; i.e., the Flatiron-Gunbarrel 115/230-kV double circuit transmission line EA and EIS. The following is a listing of the concerns raised by the public at these meetings that can be reasonably addressed in an



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Regional Transmission System

Figure 2.3

TABLE 2.1
FEDERAL AND STATE GOVERNMENT AUTHORIZING ACTIONS

PROJECT FEATURES	NATURE OF ACTION	AUTHORITY
	Environmental Protection Agency - Region VIII	
Environmental Analysis	Review of EIS	National Environmental Policy Act of 1969
Power Transmission System	Spill Prevention Control and Countermeasures Plan, if appropriate	40CFR112
	Department of Energy	
Power Transmission System	Review of Floodplains/Wetlands Assessment	Executive Orders 11988 and 11990
	Department of the Interior U.S. Fish & Wildlife Service	
Power Transmission System (including access)	Review of Biological Assessment. Section 7 consultation	Threatened and Endangered Species Act of 1973
	Bureau of Reclamation	
Rights-of-Way for Access Roads	Grant right-of-way across land under the jurisdiction of the Bureau, if appropriate	Reclamation Project Act of 1939 (53 Stat. 1187)
	Department of Defense U.S. Army Corps of Engineers	
Power Transmission System, including access (waterbody and wetland crossings)	Issue Section 10 or Section 404 Permit, if required.	Clean Water Act of 1977 (86 Stat. 816,884, 33U.S.C., 1251, 1344, as amended)
	Department of Transportation Federal Aviation Administration	
Power Transmission System	Issue air space permit. Provide airport-related air space determination and air space obstruction clearance for project facilities relative to the following airports/airstrips: Longmont, Tri-County, Parkland Estates Airstrip, Boulder County Municipal (near Valmont)	Federal Aviation Act of 1958, Public Law 850746, 8/23/52 (72 Stat. 749, 797; 49U.S.C. 1347, 1501; 14CFR77)
	State of Colorado Board of Land Commissioners	
Transmission Systems (including access, field offices and staging areas)	Issue right-of-way across land under the jurisdiction of the Colorado Board of Land Commissioners	Colorado Revised Statutes 25-8-101
	Department of Highways	
Transmission System	Issue utility crossing permits for State and Federal crossings	Colorado Revised Statutes 38-5-101
	Department of Health	
Transmission System (all phases of construction)	Emission permit	Air Quality Control Commission Regulations
	State Historical Society	
Access Roads, Transmission Line Rights-of-Way, Staging Areas	Cultural resources clearance	Colorado Revised Statutes 24-80.1-101 through 108; 24-65.1-104(6), 24-65.1-201(C), 24-65.1-202(3), and 24-65.1-302

EA or EIS. There were no concerns raised by government agencies at these meetings. Several general transmission line planning concerns had been brought to Western's attention by various agencies during planning for the earlier versions of the project. These concerns have been addressed, wherever appropriate, in this document.

The concerns are listed in approximate descending order of frequency of mention:

- Consider the effects of EMF on human health and provide more information on EMF.
- Build the project, either the 115-kV alone or both circuits, underground, primarily to reduce EMF strength, but also to preserve visual quality.
- Build a separate 230-kV line around Longmont to serve the Denver area.
- Build both circuits around Longmont.
- Build both circuits around Longmont and connect to the substations with radial lines.
- Build both circuits around Longmont and move the substations.
- Consider the effects on land and property values.
- Concern about visual/aesthetic effects, including views to the mountains.
- Longmont has a height ordinance; tall structures are restricted. This should also apply to transmission lines.
- Concern about the accuracy of Western's electromagnetic field strength measurements.
- Concern about the effects on TV and radio reception.
- Don't rebuild, just continue maintenance (i.e., use the "no action" alternative).
- Wildlife is given too much value versus people.
- Reroute near the Gaynor Lake development.
- Concern about shock hazard from induced currents in metal doors and windows near the project.
- Concern about the risk to persons or property from breakage of conductors.
- Concern about risks to persons from aircraft brought down by striking taller transmission line structures.
- Concern about Western's acquisition policies and restrictions of use of the easement.
- Concern about the risk of oil leaks from underground transmission lines.

Western representatives responded to some of these concerns, especially in cases where they arose from misunderstanding.

One area of misunderstanding concerns the relative costs of placing the 115-kV transmission line underground versus building it overhead. Some persons believe that a direct comparison can be made between the additional costs to place a phone line or residential distribution line underground and the additional cost to place a high voltage transmission line underground. The cost differential between placing phone lines and lower voltage residential distribution lines underground rather than placing them overhead is approximately 3 to 1. However, there is a significant cost differential between placing high voltage electrical lines underground rather than placing them overhead. This cost differential is estimated to be on the order of 10 to 1. The increased costs of underground construction result from higher material and installation costs, the need for advanced engineering design technologies, and the requirement for additional facilities such as pumping plants and special transition structures.

The proposed 115-kV circuit cannot avoid Longmont since its primary purpose is to serve Longmont. Service to Longmont must occur either by way of the existing Longmont substations or at new Longmont substations. The 115-kV line can feasibly be routed to the existing substations along existing rights-of-way, since creation of new transmission line routes through existing urban areas would cause substantial new environmental impacts. The cost of new substations would be prohibitively high, and would then require service of individual homes and businesses in Longmont by multiple new distribution lines. These would themselves cause new environmental impacts.

2.F.2 SCOPING MEETING, FLATIRON-ERIE 115-KV TRANSMISSION LINE PROJECT

A public meeting was held in Longmont in November 1989, at the beginning of the Flatiron-Erie EIS studies, to obtain public input on the scope of these studies. The meeting included presentations by Western on:

- The previous Flatiron-Gunbarrel proposal, now abandoned.
- Recent electrical systems planning activities.
- The proposed Flatiron-Erie project.
- The National Environmental Policy Act process and project schedule.
- EMF issues.

Questions and comments were then received.

The following is a list of concerns raised by the public at the meeting (or subsequently sent to Western). They are arranged in approximate descending order of frequency of mention:

- Concern about perceived risks to human health from EMF.
- Western should seek ways to lower the strength of the EMF created by the project and route the line away from people.

- There was skepticism about the accuracy of Western's EMF measurements.

- Concern about effects on property values.

- Route the line around Longmont.

- Build the line underground.

2.F.3 PLANNING MEETING, FLATIRON-ERIE 115-KV TRANSMISSION LINE PROJECT

A public meeting was held in Longmont in December 1990, after completion of the environmental inventory and formulation of a range of project alternatives (No Action Alternative, Conservation Alternative, System Alternatives, and Routing Alternatives). The purpose of the meeting was to present a project update to the public and obtain any further input. The meeting included presentations by Western and EDAW, Inc. on:

- History of the project and a description of it in its present form.

- Environmental studies completed to date and future studies.

- The project alternatives:

  - Alternative A: "No Action."

  - Alternative B: Uprate the existing 115-kV line (Western's proposed action).

  - Alternative C: Construct the line underground through Longmont (the other line segments would be identical to Alternative B).

  - Alternative D: Remove two existing line segments in Longmont. Service the Longmont substations via existing lines, including one newly constructed line (the other line segments would be identical to Alternative B).

Many members of the public then asked questions (answered by Western) or made comments. Other written comments were received at the time of the meeting or later.

The following is a list of the public's concerns. They are arranged in approximate descending order of frequency of mention:

- Concern about the possible health effects of EMF. Western should put a higher value on health and safety, even if costs increase. Western should provide more information on the field strengths generated by the project, especially how often and how long the different field strengths would occur. Western should identify the beneficiaries of the project action, i.e., the users of the power.

- Western should use higher ground clearance, larger conductors, equal line loading, and reverse phasing on the line to reduce EMF.

- What obligation does Western have to abide by the State Public Utility Commission's guidelines recommending "prudent avoidance" of EMF?

- The line should be constructed underground in populated areas (usually because of EMF concerns, also because of the overhead line's effect on visual quality). Western should provide more detailed information on burial of the line, using as a precedent the actual costs for the recent underground line supplying the IBM plant at Boulder. Some owners of land along the line might provide zero cost ROW for an underground line.
- Route the line around Longmont or in less populated areas (because of EMF concerns). Seriously consider Alternative D. Work to overcome the stated electrical system difficulties with Alternative D.

- Concern about property values.

- Concern about visual resources, particularly disruption of mountain views because of increased structure heights.

- Wildlife is valued too highly versus people.

- Concern about the effects on a person swimming at Gaynor Lake if a conductor fell in the water.

Chapter 3
Alternatives
Including the Proposed Project

Chapter 3 -- Alternatives Including the Proposed Project

Several project alternatives have been considered in response to the need for additional power carrying capability in the local transmission system, and the need to correct structural deterioration of the existing Flatiron-Erie transmission line.

3.A ALTERNATIVE A: "NO ACTION"

Under the No Action Alternative, Western would not uprate the existing 115-kV line, but would only perform essential maintenance activities piecemeal. Structures and hardware would be repaired and/or replaced as required during regular maintenance operations and in response to emergency outages on the line. These repairs would have to be made with increasing frequency in the future as the line increases in age.

Under this alternative, the present limits on the power carrying capability of the existing Flatiron-Erie transmission line would remain in place. This would cause the overloaded condition of the local (Longmont area) transmission system to continue and to become worse with time as local loads continue to rise. Consequently, power outages and service curtailment could occur and become more frequent, especially in the Longmont area, during normal and peak load periods, and when other elements of the local transmission/switching systems were out of service. In several locations, the conductor to ground clearance would continue to be in noncompliance with the National Electrical Safety Code (NESC).

Implementation of this alternative would preclude most of the impacts to the environment that would be associated with the other alternatives. Minor impacts would be associated with the increasingly frequent and extensive repair and maintenance activities. However, if Western were to adopt the No Action Alternative, actions to uprate other elements of the local electrical transmission system would eventually be required. Otherwise, the Longmont area would not continue to receive electric service of adequate reliability and quality. These other undefined actions, whether undertaken by Western or other utilities in the area, would have their own environmental impacts.

For these reasons, no action is not the proposed alternative.

3.B CONSERVATION OF ENERGY AND RENEWABLE ENERGY

As related to the transmission of power, Western's Conservation and Renewable Energy Program (C&RE) encourages the development and implementation of energy efficiency measures such as: the reduction of power losses by reconstruction and upgrading of old or overloaded transmission lines; the upgrading of generation equipment; the efficient use of existing generation facilities by the provision of interconnecting links; the application of renewable energy technology development with support from necessary transmission capacity which adjusts to irregularities in generation in local areas; the use of pilot energy conservation programs; the encouragement of energy conservation on the part of utilities (suppliers or distributors) who benefit from Federal power, through various incentives; and the development and distribution of C&RE publications for technology advancements.

The applications of these measures are most energy and cost effective during new construction. Retrofits to projects generally cost more with less net benefits. Once an efficient C&RE technology has been applied, the benefits of the actions are immediately realized and usually remain in effect for long periods. In the case of transmission lines, the benefits of transmission access and flexibility for

C&RE offers a wide variety of applications, and the possibilities are generally enhanced for even greater efficiency or resource options. This may be especially true where renewable resources are developed in areas which are not in close proximity to populated areas, i.e., where the resources exist.

In conclusion, Western's C&RE program has been applied effectively for more than a decade. The C&RE program has not decreased or delayed the need for transmission line improvements. Western's customer C&RE actions have found expanded alternatives to deferred investment in conventional generation facilities by virtue of their access to transmission options. Therefore, Western has determined that expanded C&RE technology applications are not a reasonable alternative to construction of this project.

3.C ALTERNATIVE TRANSMISSION TECHNOLOGIES

Transmission is the conveying of electrical power at very high voltages over relatively long distances, typically from a power plant or generating station where it was created to a substation from which it will be distributed, or between substations. Transmission should be distinguished from distribution, which is the conveying of electrical power at much lower voltages over relative short distances from a substation to its points of consumption.

3.C.1 CONVENTIONAL OVERHEAD ALTERNATING CURRENT (AC) TRANSMISSION

Overhead, alternating current transmission lines are the standard means of transmitting electricity locally and within regions. The electricity is carried by three-phase circuits. The conductors are suspended from tall wood or metal structures so that each conductor is separated from the other conductors and the ground by specified distances. The intervening air both cools the conductor and insulates it electrically. The conductors are attached to ceramic or polymer-fiberglass insulators to isolate them electrically from the supporting structures. In regions where lightning strikes are frequent (e.g., Colorado), ground wires stretch between the tops of the structures, above the conductors, to intercept lightning and convey it to the ground. The existing Flatiron-Erie transmission line and all the transmission lines that connect to it use this technology. Western proposes to use it on the proposed action -- the uprating of the line, and also in major portions of the proposed project alternatives. The physical elements of this type of transmission line and the operations required to construct and maintain it are described in Section 3.G.2.a.

3.C.2 OVERHEAD DIRECT CURRENT (DC) TRANSMISSION

Direct current transmission systems have only two conductors per circuit instead of the three required by the alternating current (AC) systems in normal use. Therefore, the structures required are smaller and less expensive than the structures carrying an AC line of comparable capacity. Similarly, less conductor is required and a narrower right-of-way (ROW) will suffice. In addition, the power losses of a direct current (DC) line are less than the losses of an AC line of equivalent capacity, resulting in energy conservation and economic savings. However, DC lines must include converter stations at either end of the line and at every point where it is interrupted (i.e., makes a connection to a substation) to convert the DC current to AC for consumer use. The cost of these conversion stations is extremely high. Therefore, most recent DC applications have been for lines that convey large amounts of power over extremely long distances (300 miles or more) without any intermediate connections.

Only with line segment lengths far greater than those proposed here, and transmission of much larger amounts of power, would the economic advantages of DC transmission offset the high cost of the convertor stations.

Direct current transmission is therefore not a viable alternative to the proposed project.

3.C.3 UNDERGROUND CONSTRUCTION

As reported in Section 2.F, Western received comments from the public favoring the use of underground construction through Longmont.

Underground construction is frequently used with distribution lines. With these types of relatively low voltage lines, the problems of electrically insulating each phase conductor from the others and from its surroundings, and of dissipating the heat the conductors generate are not severe. With lines of greater voltage, such as the 115-kV Flatiron-Erie line, the problems become severe. However, underground construction has been used for high voltage transmission, usually in densely developed (downtown) locations where the costs are outweighed by the costs and difficulties of getting above ground ROW.

A major reason for the public interest in underground construction is the perception that it radically reduces the electric and magnetic fields (EMF) generated by the project, and thus reduces the possibility of risks to health from them. In reality, while electric fields are eliminated, the range of magnetic field strengths (measured approximately three feet above the ground) from different types of underground construction can vary from negligible to more than the field strength of the same line built overhead. (It should be noted that a person standing in the center of the ROW is closer to an underground line than to an overhead line.) Also, a consideration with many members of the public is the improvement in visual quality that would result from burying the existing line within the Longmont area. Other advantages of underground lines are the elimination of the impacts on bird populations from collisions with overhead ground wires. The ROW for an underground line can also be narrower than for an equivalent overhead line, thus reducing certain land use impacts.

The primary disadvantage of underground transmission lines is their cost. A 115-kV underground line costs five to ten times more per mile (depending on type of underground construction used, and on soil and rock characteristics) than a new 115-kV overhead line. Other disadvantages are the need for a continuous zone of disturbance along the ROW, with potentially greater effects on soil, water, cultural resources and some biological resources. Large overhead transmission line structures are needed at any point where a transition is made from underground construction to overhead construction. Underground lines are expected to have a shorter service life than equivalent overhead lines; 25-30 years versus 40-50 years.

The reliability of underground versus overhead lines may be considered comparable. Overhead lines, being subject to the weather (particularly ice storms), may experience relatively frequent failures. However, these failures can generally be repaired within a few hours. Failures of underground systems (which may be caused by accidental dig-ins or from mechanical failure) may be less frequent, but when they occur are far more severe. A failed underground line may be out of service for several weeks or longer, depending on the extent of damage.

There are three types of underground installations that may be considered feasible for an installation like the Flatiron-Erie 115-kV line through Longmont:

- High pressure oil-filled pipe type (HPOFPT)
- Self-contained oil-filled (SCOF)
- Solid dielectric

The high pressure oil-filled pipe system carries the three insulated phase conductors of a circuit in a steel pipe filled with insulating and cooling fluid, a synthetic oil. Pumps and pumping stations are required to circulate the oil for cooling and to pressurize the oil. The high pressure oil-filled pipe system is the most popular of the various underground systems in the United States. A 1988 study (Evaluation of Alternative Undergrounding Technologies, Flatiron-Gunbarrel 230/115-kV Transmission Line Project, Power Engineers, Inc., 1988) reports over 2,500 circuit miles in existence (78% of the total underground circuits) as opposed to only a few hundred miles for any other system. This type provides the greatest opportunity to reduce EMF. This reduction is the result of the close spacing of the phases of the circuit (a trefoil configuration is ideal), which causes the fields from each phase to cancel each other. The EMFs are further canceled by fields induced in the steel pipe that contains the three cables.

The reliability of the HPOFPT system is substantially better than that of other underground systems, partly because of the resistance to damage from dig-ins afforded by the steel pipe. The cost of the HPOFPT system is in the middle of the range for underground systems. A disadvantage of this system is the possibility of oil spills in the case of failure, with the consequent risk of fire.

The self-contained oil-filled system contains each phase in a separate, fluid-filled cable laid separately in a wide trench. In 1988, less than 500 circuit miles of this system were in existence in the United States. It has so far proven less reliable than HPOFPT. The magnetic field reduction achieved is considerably less than HPOFPT and the system's cost is slightly greater. Repair times would be a little shorter than with HPOFPT.

The solid dielectric system, while popular in Europe and Japan (especially for installation in dense urban situations, often in pre-existing ducts), has not been much used in the United States. About 200 miles of solid dielectric cables were reported as being in use in the United States in 1988. The system is installed in the bottom of a relatively wide trench, with the phases separated for heat dissipation. As a result of this, the EMF cancellation is not so effective as with HPOFPT. It should be noted, however, that some utilities are beginning to experiment with solid dielectric cables in a trefoil configuration to reduce field strengths. The system is less reliable than the two described above, possibly because it is relatively susceptible to damage during accidental dig-ins. It is slightly less expensive than HPOFPT, mainly because it does not need fluid and pump facilities.

In response to public requests to put the line underground, Western evaluated an alternative that replaces the existing 115-kV line for 6.1 miles through Longmont with underground construction. The vacated ROW of the existing line, with probable minor deviations (not identifiable prior to detailed engineering design), would become the location of the proposed underground line segment. Because of the public concern about EMF and the need for the greatest possible reliability, the HPOFPT system is preferred for this alternative.

In underground HPOFPT construction, a trench about 5 feet deep is dug along the center of the ROW, and the pipe is laid in the trench and surrounded with special sand thermal fill. The remainder of the trench is backfilled. Section 3.G.4 explains underground construction in detail, and illustrates a typical cross-section of a buried HPOFPT cable system (Figure 3.13). At points where the underground line connects to overhead lines, and at substations, the three phases are attached to a special termination structure, similar to a conventional overhead steel structure, but with a greater diameter and with substantial equipment on each arm. Figure 3.14 shows a typical termination structure that could be used when a transition is made from underground to overhead construction and vice versa. At intervals of several miles along the underground line, pumping and pressurizing facilities are required. These facilities include an oil storage tank and a dual pumping plant. A combination of pump and pressure relief valves are used to maintain system pressure, and the tanks are used to store excess oil. Redundant pumps are required to provide backup in the event of a pump failure. These pumping and pressurizing facilities are installed in existing substations when possible. The average size for a pumping facility is 40 feet in length, 10 feet in width, and 10 feet in height.

In summary, underground construction has been used in densely developed (downtown) areas where construction and operation costs are less than the costs and difficulties of acquiring aboveground right-of-way. Of the three types of underground installations that may be considered as feasible alternatives of the Flatiron-Erie 115-kV line through Longmont, the HPOFPT system is preferred because of public concern about EMF and the need for the greatest possible system reliability. The physical elements of HPOFPT underground construction and the operations required to construct and maintain it are described in Sections 3.G.3 and 3.G.4..

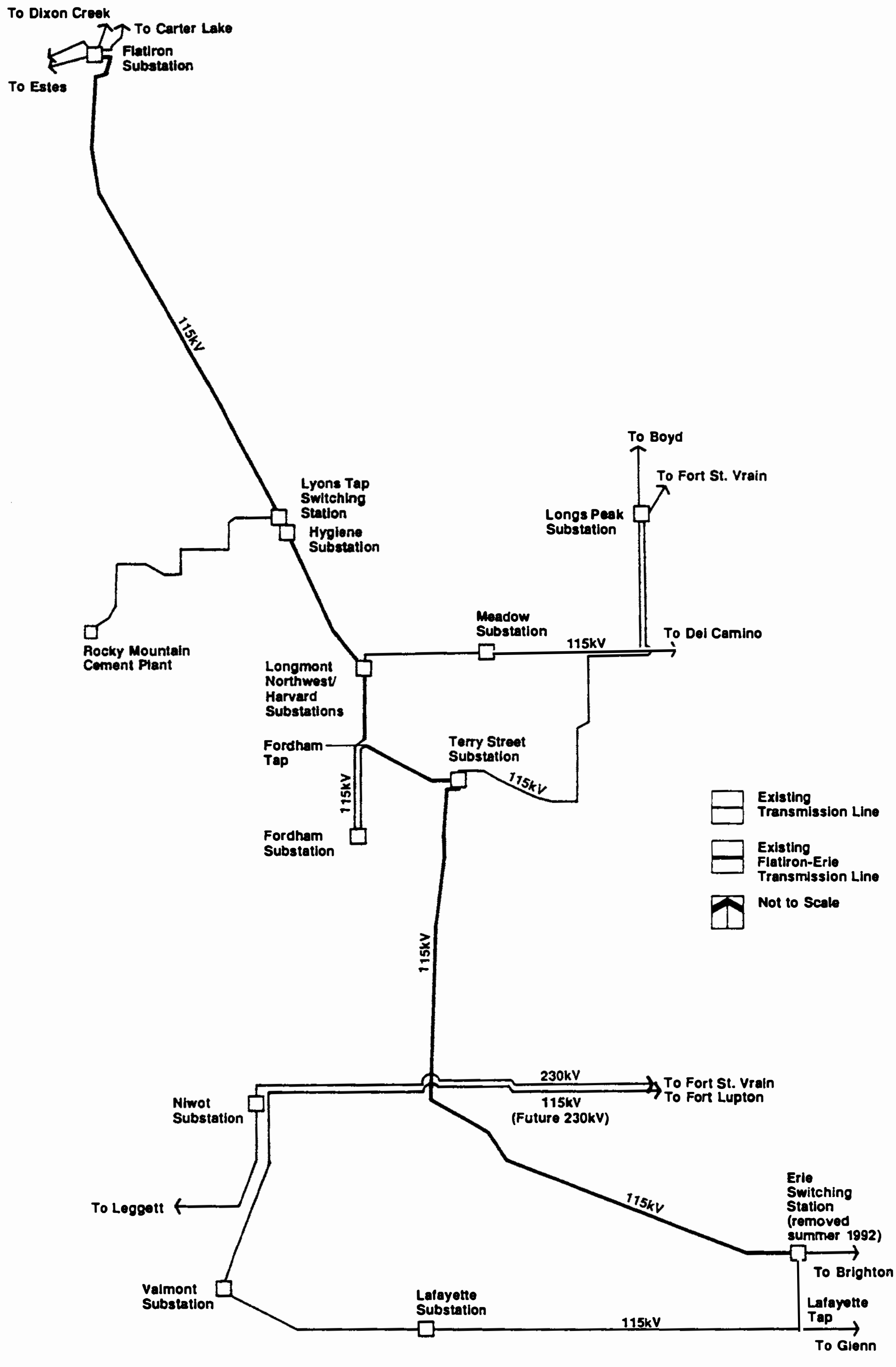
3.D ALTERNATIVE TRANSMISSION SYSTEMS

A transmission "system" refers to the electrical arrangement of and relationships between the circuits and substations by which power is supplied. Changes in routing or construction technology (e.g., overhead versus underground) do not themselves necessarily change a system. An essential characteristic of a transmission system is that each substation must be supplied by at least two circuits (ideally not on the same ROW) to maintain service during equipment outages. System criteria also require that when one of the circuits is out of service, the voltage within the remainder of the system must not drop below 92% or above 110% of the nominal voltage, and no transmission line should be required to carry more capacity than it is designed to carry, and no transformer should overload above 110% of its designed capacity rating.

3.D.1 SYSTEM ALTERNATIVE 1: THE EXISTING AND PROPOSED SYSTEM, UPRATE EXISTING FLATIRON-ERIE LINE

The existing system is illustrated on Figure 3.1. The proposed action, uprating of the existing Flatiron-Erie transmission line (primary Alternative B), would involve no change to the existing system. The underground alternative (primary Alternative C) being considered by Western in response to public comments (reconstruction of the Flatiron-Erie line underground through Longmont) likewise would involve no change to the existing system.

As Figure 3.1 shows, each of the local substations would have power supplied by at least two separate circuits located on different ROW's. This configuration meets the reliability requirements for the system. The only exception to this rule is the Fordham Substation, which is supplied by a short spurline consisting of two circuits located on the same ROW.



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Existing and Proposed Transmission System 1

Figure 3.1

3.D.2 SYSTEM ALTERNATIVE 2: REMOVE PORTIONS OF FLATIRON-ERIE LINE THROUGH LONGMONT, NEW SUBSTATION CONNECTING TO PSCO SYSTEM

An alternative system is shown on Figure 3.2 (primary Alternative D). This was formulated, in response to public comment, to explore the feasibility of removing portions of the line from densely developed areas of Longmont.

Under this alternative, an approximately 1.5-mile 115-kV line segment from the Longmont Northwest/Harvard Substation to the Fordham Tap, and an approximately 1.7-mile segment of the existing Terry Street-Erie 115-kV line, south out of Terry Street Substation, would be removed. The double-circuit structures leaving the Fordham Substation to the north would be left intact, as would be the circuit from Fordham Tap to Terry Street Substation. The Flatiron to Longmont Northwest/Harvard 115-kV line would be uprated to 109 MVA by raising and replacing various structures. A new substation with 115/230-kV (168 MVA) transformation would be constructed approximately 6 miles south of Longmont to interconnect with PSCo's 230-kV line between Niwot and Fort St. Vrain. Western's existing Terry Street-Erie 115-kV line would be connected into the new substation. Approximately 2.2 miles of new 115-kV line would be constructed from Fordham Substation to the existing Terry Street-Erie 115-kV line (the rationale for the location of this new line is explained in Section 3.G.5). Approximately 4.1 miles of existing 115-kV line (a portion of the existing Terry Street-Erie 115-kV line between the new Fordham 115-kV line and the new substation) would continue to be used and would be uprated to 109 MVA. The remaining 8.3 miles of 115-kV line between the new substation and Erie Switching Station (the remaining portion of the existing Terry Street-Erie 115-kV line) would be uprated to 85 MVA by raising and replacing various structures.

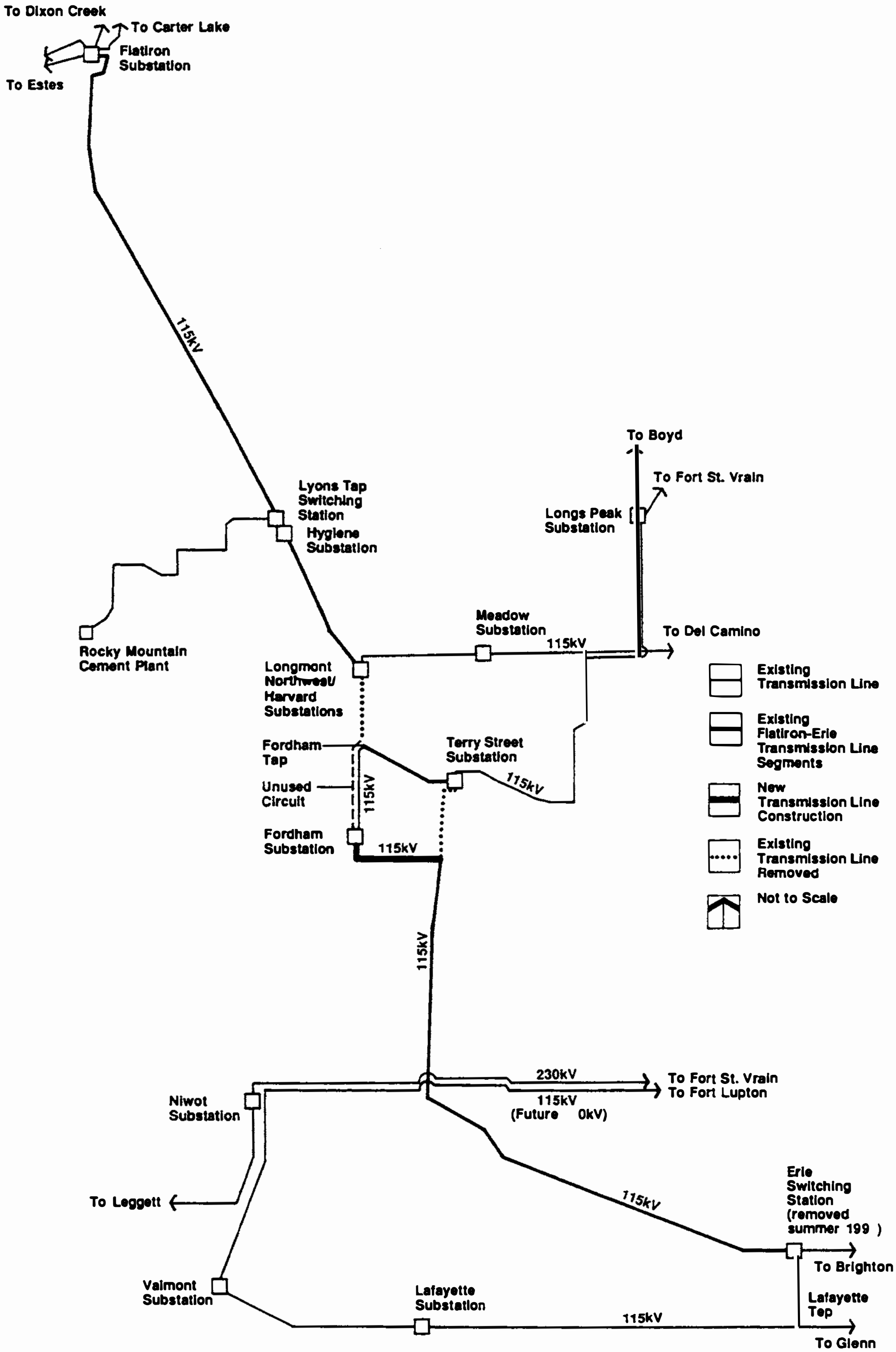
The Flatiron-Erie line would cease to exist as a direct connection. Instead, the connection between Flatiron and Erie would be via Longmont Northwest/Harvard, Meadow, Longs Peak, Terry Street, Fordham and the new substation. East and northeast of Meadow Subdivision, the circuits into and out of Longs Peak are on the same ROW. One of the two recently constructed circuits from Fordham Substation to Fordham Tap would not be used.

3.D.3 ALTERNATIVES CONSIDERED AND REJECTED

3.D.3.a <u>System Alternative 3: Remove Portions of Flatiron-Erie Line Through Longmont, Build New Substation South of Longmont, Build New Connection to Longs Peak Substation</u>

Under this system alternative (illustrated on Figure 3.3), an approximately 1.5-mile 115-kV line segment from the Longmont Northwest/Harvard Substations to Fordham Tap, and an approximately 1.7-mile segment of the existing Terry Street-Erie 115-kV line south out of the Terry Street Substation would be removed. The double-circuit structures leaving the Fordham Substation to the north would be left intact, as would be the circuit from Fordham Tap to Terry Street Substation. The Flatiron-Longmont Northwest/Harvard 115-kV line would be uprated to 109 MVA by raising and replacing various structures.

A new 115-kV substation would be constructed on the Terry Street-Erie line approximately 3.6 miles south of the Terry Street Substation. Approximately 2.2 miles of 115-kV line would be constructed from Fordham Substation to Western's existing Terry Street-Erie 115-kV line. The remaining

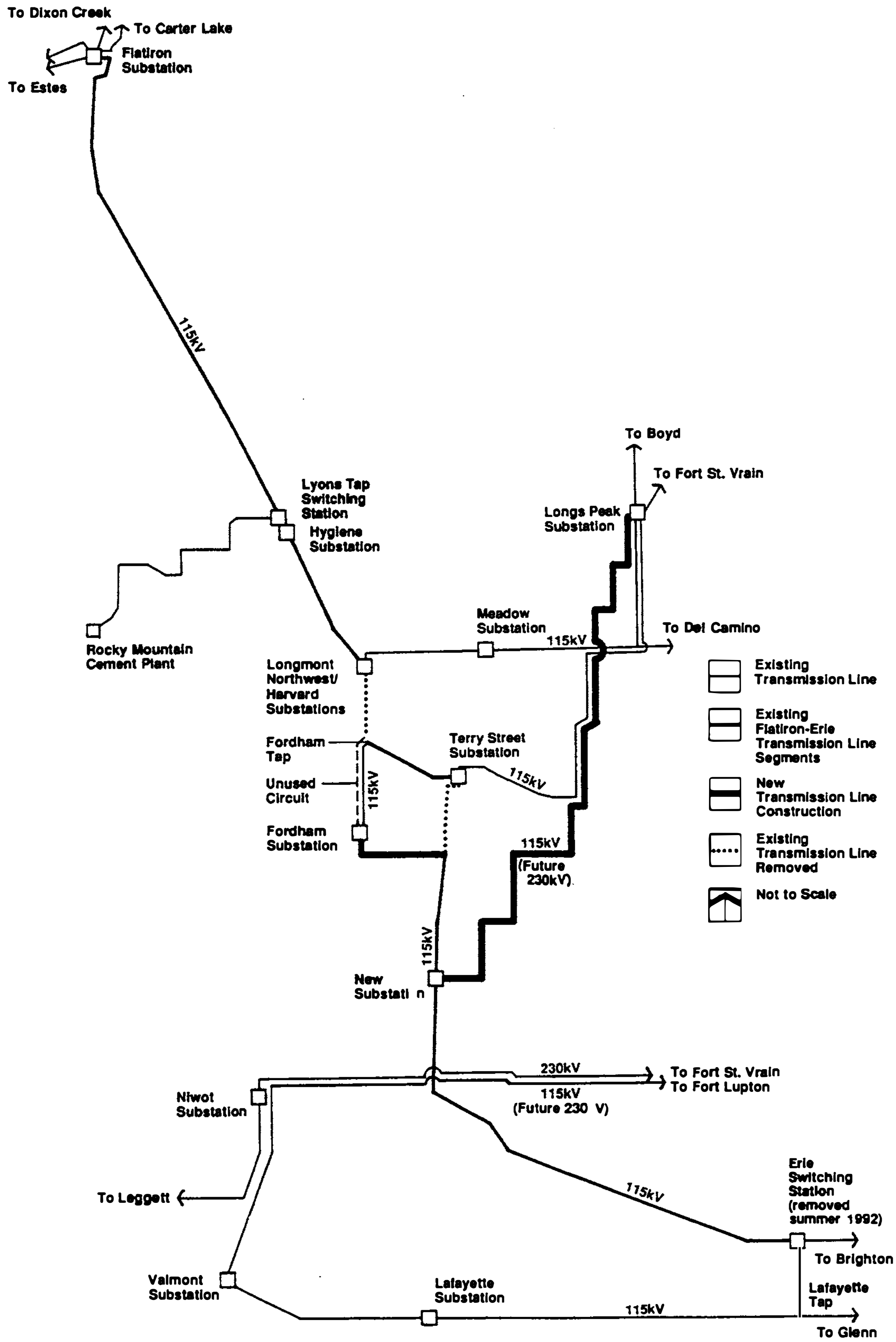


Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 2

Figure 3.2



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 3

Figure 3.3

approximately 12.4 miles of 115-kV line out of the Erie Switching Station (remaining portion of the existing Terry Street-Erie 115-kV line) would be uprated to 85 MVA by raising and replacing various structures.

A major element of this alternative would be a new line constructed from Longs Peak Substation to the new substation. Approximately 3.7 miles of the new line would be constructed to 230-kV standards from Longs Peak Substation to where the existing Platte River Power Authority's Longs Peak-Terry Street 115-kV line is strung on one side of double-circuit steel pole structures. The new line would use 3.1 miles of the unused portion of the double-circuit structures and would be insulated for 230-kV. After utilizing the existing double-circuit structures, the new line would continue on for approximately 6 miles, constructed at 230-kV standards, until it intersects Western's existing Terry Street-Erie 115-kV line. At this location, a new 115-kV substation would be constructed to terminate the Longs Peak line and the existing Terry Street-Erie 115-kV line. The Longs Peak line would be operated at 115-kV.

This system alternative has several disadvantages. From a systems planning viewpoint, it would make redundant one of the two recently constructed circuits between Fordham Substation and Fordham Tap. Costs, compared to those of System Alternatives 1 and 2, would be extremely high since the alternative would require the construction of almost 10 miles of new transmission line on new ROW, as well as a new substation.

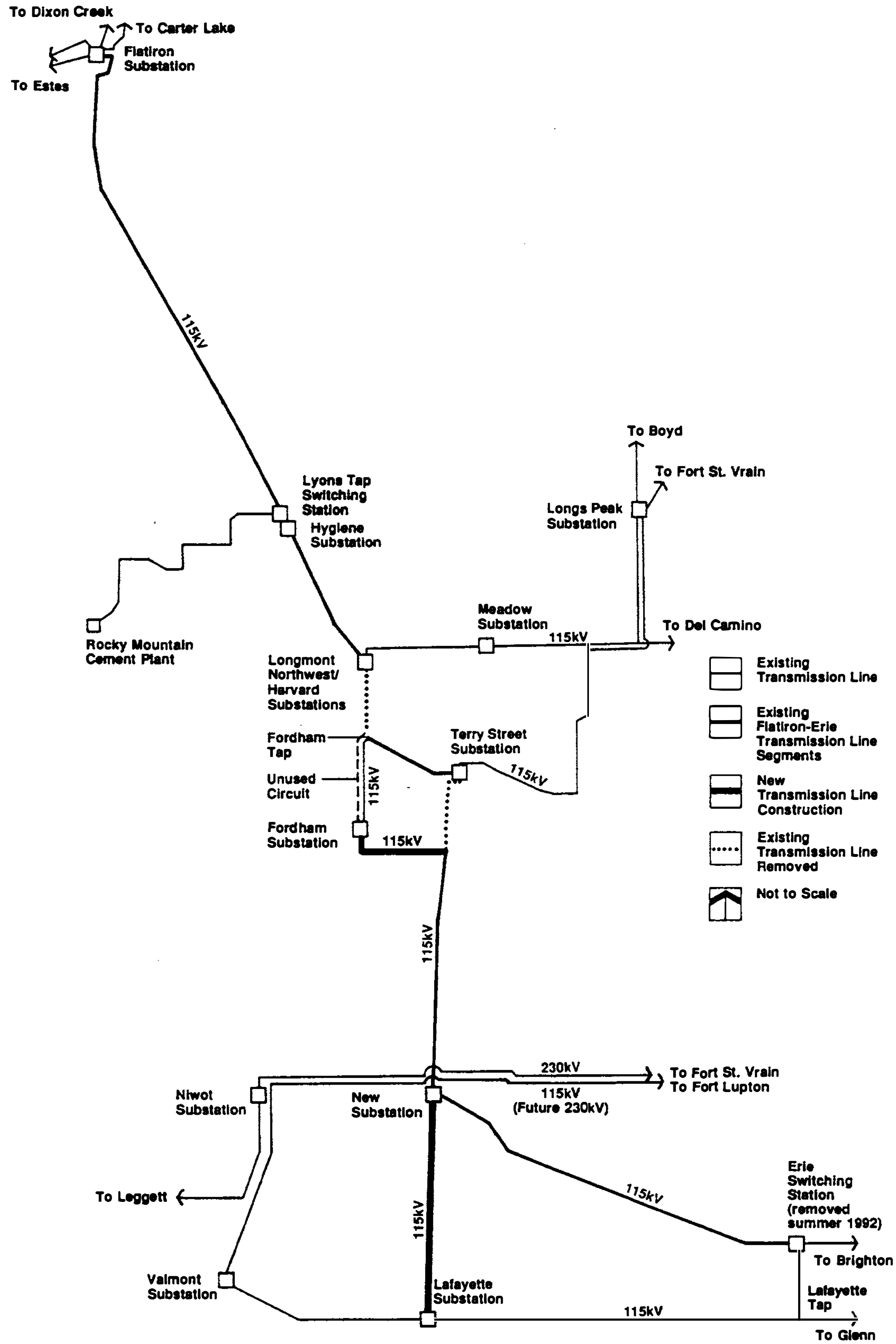
A field reconnaissance of the new line east of Longmont and an examination of Figures 4.2 through 4.9 (environmental inventory data maps) identified several environmental constraints. Along a northern segment (between Longs Peak Substation and the north end of Calkins Lake), there are residences in the area, some of which would probably be within close proximity to the line. To the south (between St. Vrain Creek and the new substation), new construction could probably avoid all residences by a reasonable margin, but would necessarily impact almost 5 miles of cultivated land. The line might cross or border a large area of public open space owned by Boulder County. This line segment would also be visible from areas south and east of Longmont.

Because of these disadvantages, this system alternative was eliminated from further study.

3.D.3.b System Alternative 4: Remove Portions of Flatiron-Erie Line Through Longmont, Build New Connection to Lafayette Substation

This alternative is illustrated on Figure 3.4. It is comparable to Alternative 2, except the new substation would be interconnected with PSCo's 115-kV Lafayette Substation and not PSCO's 230-kV line between Niwot and Fort St. Vrain. This alternative would require construction of an additional 6 miles of 115-kV line between the new substation and PSCo's Lafayette Substation. A 115/230-kV transformer would not be required for this alternative.

Alternative 4 fails to meet electrical criteria. Interconnecting Western's 115-kV line with PSCO's 115-kV transmission system at Lafayette significantly overloads PSCo's 115-kV lines between Valmont and Lafayette. Since Alternative 4 fails to meet electrical criteria, it is not considered a viable alternative and therefore was eliminated from further study.



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 4

Figure 3.4

3.D.3.c System Alternative 5: Remove Portions of Flatiron-Erie Line Through Longmont, Build New Substation South of Longmont with New Connections to Longs Peak and Lafayette Substations

This alternative is illustrated on Figure 3.5 and is comparable to System Alternative 3. This alternative would have a new line constructed between Longs Peak Substation and the new substation as described for Alternative 3. In addition, it would require approximately 8 miles of new 115-kV line constructed between the new substation and PSCo's Lafayette Substation to interconnect with PSCo's 115-kV transmission system.

Alternative 5 fails to meet electrical criteria. Interconnecting Western's 115-kV line with PSCo's 115-kV transmission system at Lafayette would significantly overload PSCo's 115-kV lines between Valmont and Lafayette. Since Alternative 5 fails to meet electrical criteria, it is not considered a viable alternative and therefore was eliminated from further study.

3.D.3.d System Alternative 6: Remove Portions of Flatiron-Erie Line Through Longmont

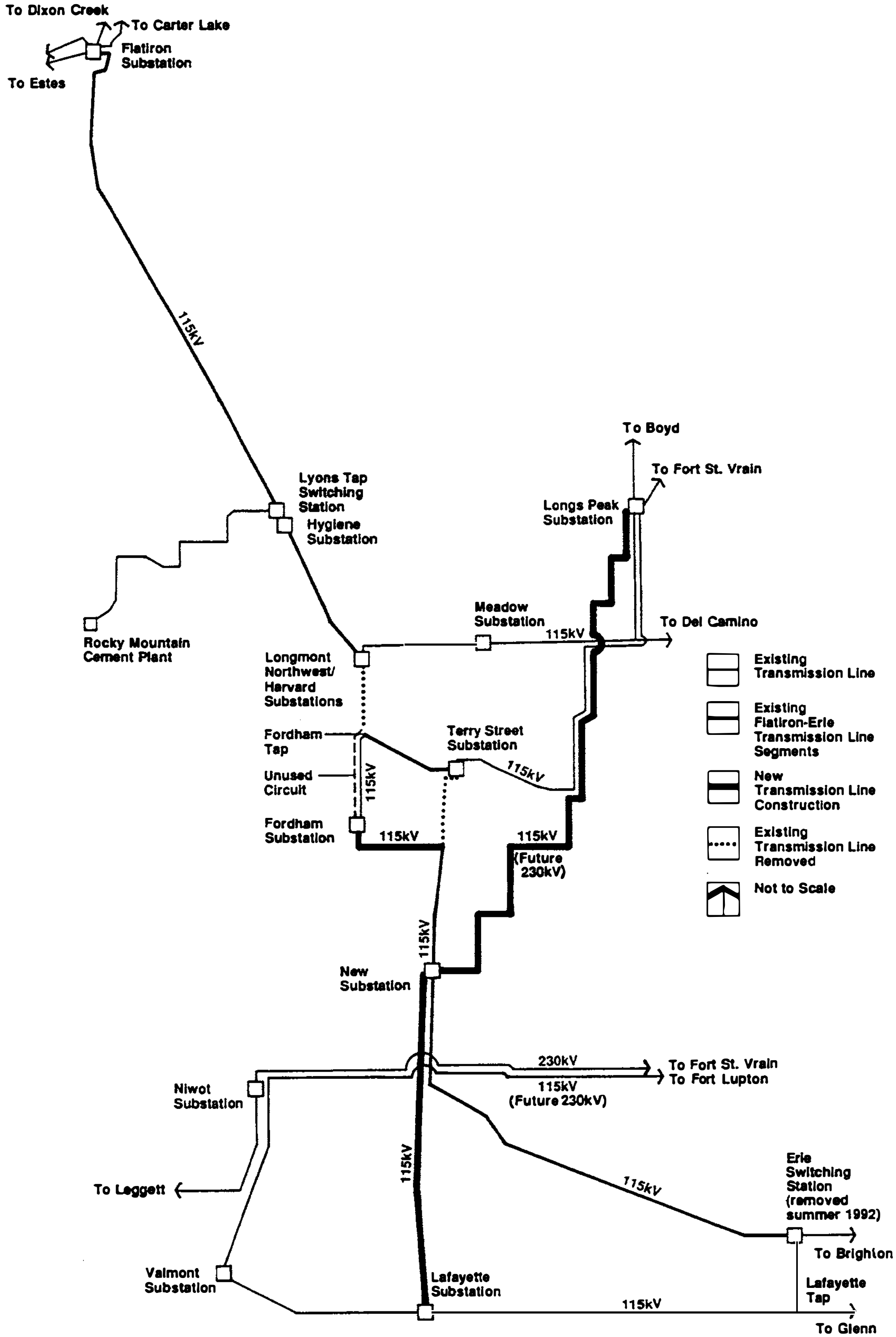
This system alternative is comparable to Alternative 2, except that there is no connection to the PSCo system south of Longmont. The system is illustrated on Figure 3.6.

Under this alternative, an approximately 1.5-mile 115-kV line segment from the Longmont Northwest/Harvard Substations to the Fordham Double-Circuit 115-kV line, and an approximately 1.7-mile segment of the existing Terry Street-Erie 115-kV line south out of Terry Street Substation would be removed. The double-circuit structures leaving the Fordham Substation to the north would be left intact as would be the circuit from Fordham Substation to Terry Street Substation. The Flatiron-Longmont Northwest/Harvard 115-kV line would be uprated to 109 MVA by raising and replacing various structures. Approximately 2.2 miles of 115-kV line would be constructed from Fordham Substation to the existing Terry Street-Erie 115-kV line. Approximately 12.5 miles of existing 115-kV line (portion of the existing Terry Street-Erie 115-kV line) between the new Fordham 115-kV line and Erie Switching Station would continue to be used, and would be uprated to 85 MVA by raising and replacing various structures.

Alternative 6 does not meet the electrical criteria that requires voltages to be maintained at a minimum of 92% with any one line out of service. For Alternative 6, the voltage drops as low as 70% at Terry Street Substation and 72% at Fordham Substation when the line from Terry Street to Longs Peak is out of service. Therefore, this alternative is considered unacceptable and was eliminated from further study.

3.D.3.e System Alternative 7: Relocate the Flatiron-Erie Line Around Longmont

An alternative system that is not feasible electrically and does not reflect good system engineering practice is illustrated on Figure 3.7. It was initially formulated, in response to public comments, to examine the feasibility of eliminating almost all of the existing Flatiron-Erie transmission line through Longmont. As the figure shows, the alternative would reroute the Flatiron-Erie line around the city without connecting to any of the Longmont substations. Longmont would then be supplied from Longs Peak Substation via a system of very long lines, all of which would have two circuits supplying each substation on the same ROW. The recently built Fordham Substation to Fordham Tap line would become redundant. The alternative would require building many circuit miles of new transmission line.

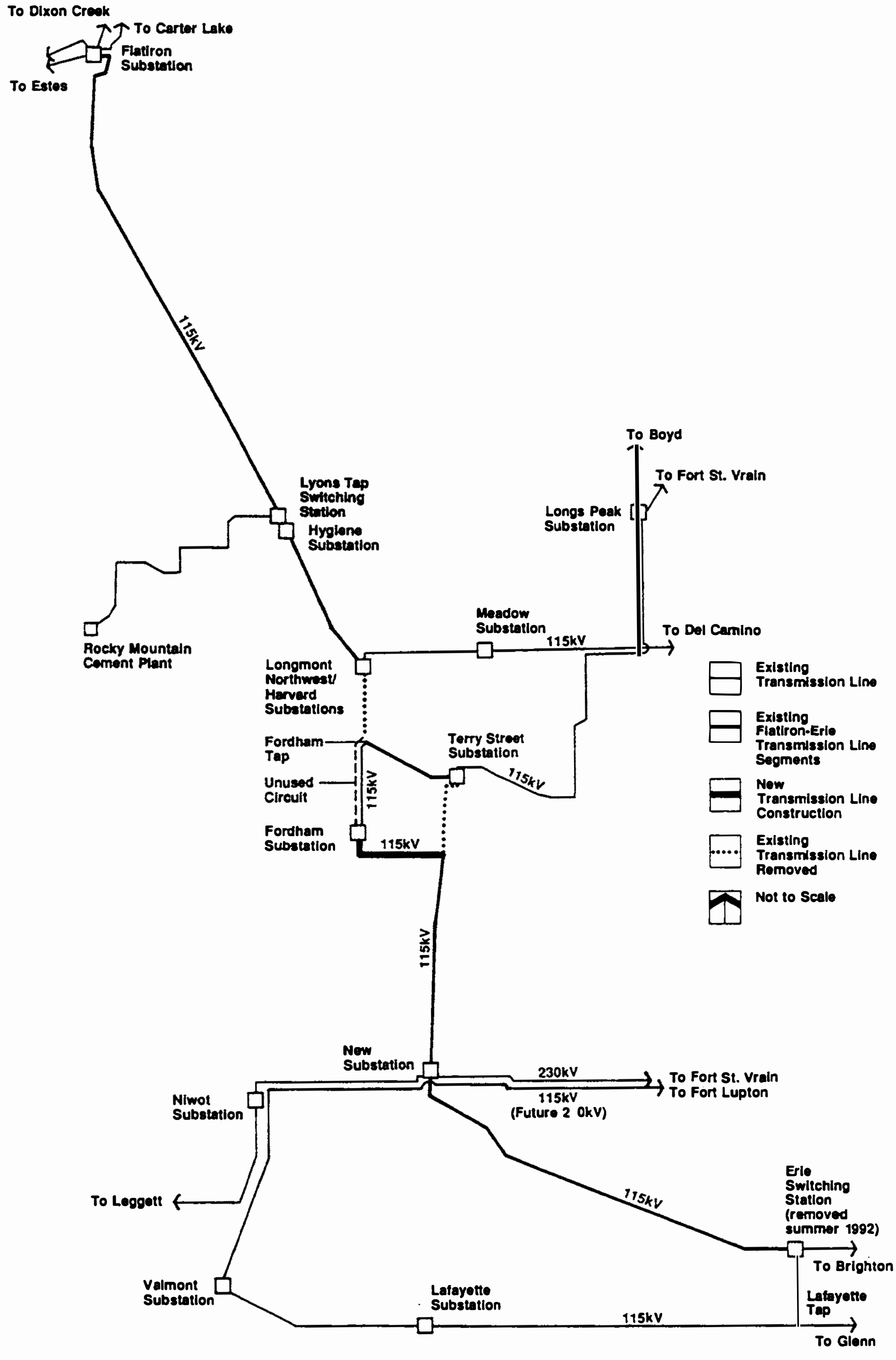


Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 5

Figure 3.5

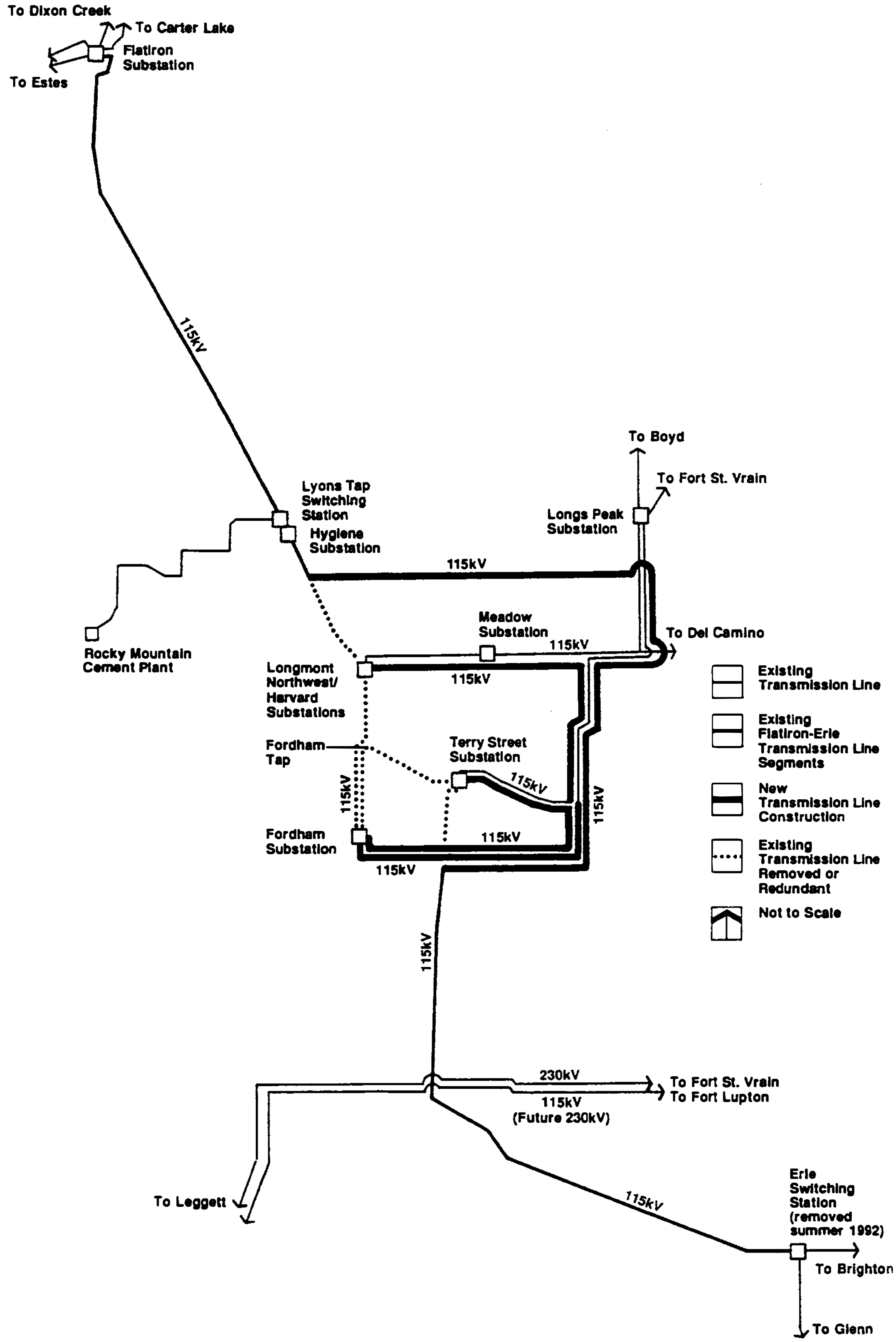


Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 6

Figure 3.6



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Alternative Transmission System 7

Figure 3.7

Under Alternative 7, Longs Peak Substation would be the only power source for the City of Longmont. A major outage at Longs Peak Substation would cause the entire City of Longmont to be without power. The extremely high dollar costs and environmental impacts of this alternative, added to its unacceptable electrical system performance, make this alternative unacceptable and, therefore, it was eliminated without further study.

3.D.3.f System Alternative 8: Relocate the Longmont Substations Outside the City

Public comments on the project have included requests to move the existing substations outside the City of Longmont. In addition to new substations, this alternative would require additional transmission lines. There would also be a need to build multiple new distribution lines from the new remote substations back to the Longmont consumers. These distribution lines would be longer than the existing distribution lines, causing excessive power losses.

Under Alternative 8, the costs and environmental impacts of relocating the substations and the new network of distribution lines would be high. The costs of power losses in the long distribution lines would be high. It should be noted that distribution lines also produce EMF, which, depending on the power flowing on the distribution line, could be higher than those produced by transmission lines. Because of additional capital costs of construction and problems with voltage regulation, this alternative was not considered viable and was eliminated without further study.

3.E ALTERNATIVE STRUCTURE TYPES

The proposed project is a single circuit 115-kV transmission line. Wood H-frame and single pole tubular steel structures are the alternative types most technically and economically feasible for such a line.

The proposed action is the uprating of the existing 115-kV transmission line, involving replacement and modifications of some of its existing wood H-frame structures. The only structure type that will preserve the technical and visual unity of the line is a wood-pole H-frame type, similar to the existing one. This is proposed. The structure type is illustrated on Figure 3.8 in Section 3.G.2. The wood-pole H-frame structure has the merits of being less tall than most other types (since the conductors are arranged horizontally) and relatively inconspicuous due to its size and coloration. It is also similar to structures used on distribution lines in the area and, therefore, would not introduce an obvious new element into the landscape.

For the required new structures that would provide the transition from underground to overhead construction, a specialized single pole steel structure is the common structure type used in this application. This structure is illustrated on Figure 3.14 in Section 3.G.2. A tubular steel H-frame structure type could also be considered in this application, with the structure being galvanized and painted brown to more closely match the existing wood H-frame structures. By utilizing a steel H-frame structure type, the transition structure would be shorter in design than the single pole steel structure. A wood H-frame structure design could probably be utilized, but there are several disadvantages to using this structure type. On a wood structure, the cables would have to be mounted on the outside of the pole and covered with a metal shield for protection, rather than installed inside the pole as is common when using steel poles. Designing a wood structure that would be flexible enough to handle ice and wind loading yet rigid enough to keep the movement from the cable-to-terminator connections to a minimum could be a difficult task. Lattice steel structures are generally considered less suitable for use in urban/suburban situations, having a more complex, industrial type of appearance.

Two alternative structure types are feasible for the new overhead portion of the alternative project action that replace some of the existing line through Longmont. These are the wood H-frame structure type, because of its advantages mentioned above, and the standard single steel pole structure. The single pole structure is taller (because the conductors are arranged vertically) and therefore more dominant visually, but because of its greater strength, allows longer spans and hence fewer structures in a given distance. The wood H-frame structure type is proposed in this situation. The single steel pole type is proposed as an alternative, and is illustrated on Figure 3.16 in Section 3.G.2.

3.F ALTERNATIVE METHODS OF CONSTRUCTION

Most conventional, overhead transmission lines are constructed in a relatively standardized way. This involves the movement of construction vehicles and equipment over the ground on a system of accessways that are either on or in reasonable proximity to the line ROW. However, access to the line ROW is required at every structure site. On terrain with less than 12 to 15 percent slope, construction vehicles and equipment can move overland without requiring the construction of an improved road. On steeper terrain, however, an accessway must be constructed by blading and grading.

Conventional construction is the logical practice in areas where access already exists or on relatively gentle or moderately sloping terrain. One of these conditions exists along most of the proposed project alternatives. In the northern third of the project area, some of the terrain is moderately steep, but accessways are generally available. These are generally the ways that were used to construct the existing Flatiron-Erie transmission line and continue to be used to maintain the line. In the remainder of the project area, the terrain is gently sloping and existing established accessways are available. For these reasons, Western proposes to use conventional construction for all overhead portions of the proposed project alternatives.

More unconventional construction methods, such as the use of a helicopter to transport crews and equipment into each structure site, are not warranted by the terrain or by the expected impacts to resources. These types of methods are employed only in inaccessible terrain or when conventional methods of site access is predicated by the presence of highly sensitive resources that would otherwise be adversely impacted.

3.G DESCRIPTION OF THE PRIMARY PROJECT ALTERNATIVES

In Sections 3.A through 3.F, a wide range of potential project alternatives has been briefly examined. These alternatives have been either rejected as infeasible, or defined as primary alternatives to be given detailed and equal analysis. In this section, three primary alternatives are described in detail.

The first primary alternative is Western's proposed action, the uprating of the existing Flatiron-Erie transmission line. It is the environmentally preferred alternative, and the alternative that Western believes would best and most economically satisfy the project need. It is Alternative B (Alternative A was the rejected, "No Action" Alternative; see Section 3.A).

The second primary alternative identified as Alternative C, would rebuild the existing Flatiron-Erie transmission line underground for 6.1 miles through Longmont and uprate the remainder of the existing transmission line. Alternatives B and C would make no change to the existing electrical systems, as shown on Figure 3.1.

The third primary alternative would remove two segments of the existing Flatiron-Erie transmission line in Longmont, supply Longmont's substations using other existing transmission lines and a segment of new overhead transmission line, uprate the remainder of the existing transmission line and build a new substation south of Longmont. This is Alternative D. It would make changes to the existing electrical system and would use the system illustrated on Figure 3.2.

The three primary alternatives (among them) account for eight different types of construction actions, varying from major to minor operations. The actions also vary widely in the degree of change they represent between the existing and the proposed condition. It is impossible to assess the impacts of the proposed project alternatives without considering the construction action that would occur along each segment of each alternative. Therefore, the construction actions are illustrated in Figure 3.8, Range of Construction Actions of the Proposed Project Alternatives. The construction actions are also indicated on the three figures in the following subsections that describe the primary alternatives (Figures 3.9, 3.12 and 3.15).

Removing a structure from the ROW (in those locations where a new structure will not be built) is an action with minor short-term adverse impacts from disturbance during the process of removal, and minor long-term beneficial impacts from the absence of the structures. The net effects are so minor that they are ignored for the purposes of route comparison. There would be a total of 11 structures removed that would not be replaced. These 11 structures would be the same for all three primary alternatives.

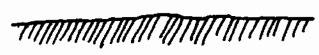
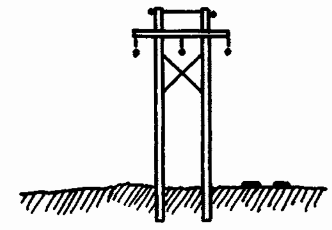
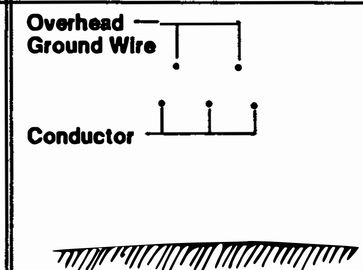
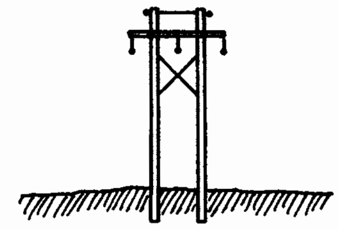
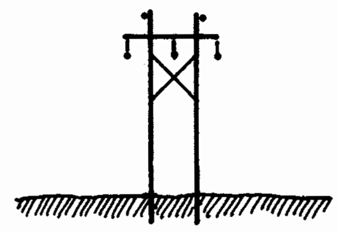
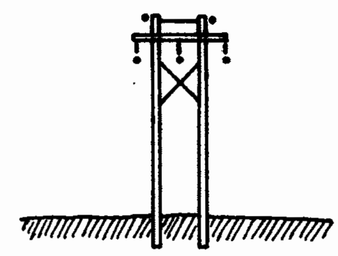
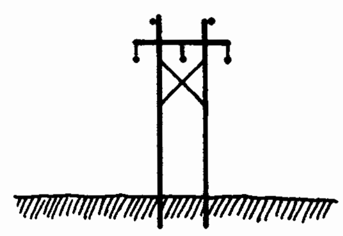
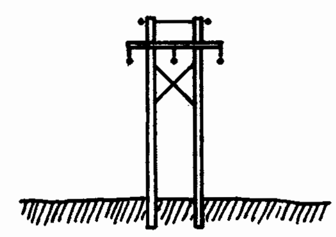
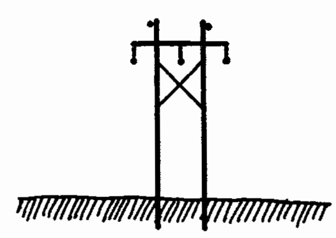
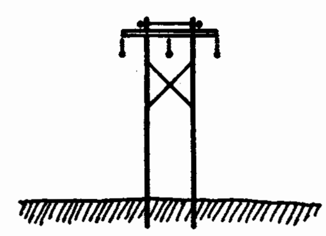
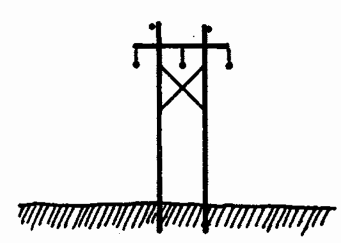
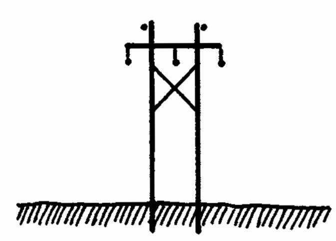
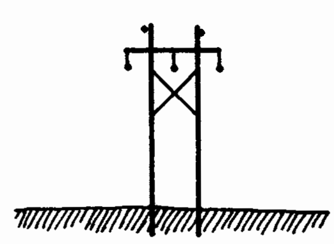
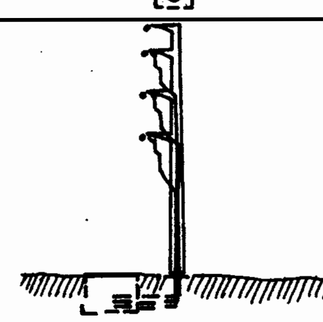
3.G.1 DESCRIPTION OF ALTERNATIVE B, THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

The proposed action alternative is shown on Figure 3.9. The construction actions involved in this alternative would be: addition of wood H-frame structures on new sites on the existing ROW, replacement of existing structures on the same site, modification of structures and removal of existing structures. The construction actions would not be continuous along the ROW with this alternative, but would occur in relatively restricted areas (no more than 200 feet long) centered on the sites of the structures that would be built or modified. The conductors and ground wires would remain in place (though in some cases, they would be raised 5 to 15 feet). Little or no new access would be required for construction, operation and maintenance of the uprated line.

All of the construction actions would occur on the existing ROW.

Construction Action Types 2, 3, 4 and 5, as shown on Figure 3.8, would be part of this alternative. The locations where each of these actions occur are shown on Figure 3.9. These actions (even Construction Action 2) would be relatively minor, and are typical of routine transmission line maintenance actions.

Construction Action 2 would involve building a new wood H-frame structure at a new site on the existing ROW. Of the construction actions associated with this alternative, 2 would involve the greatest amount of change relative to the existing condition. In the portion of the route north of Longmont, there would be 14 occurrences of this action; within the Longmont developed area, there would be no new structures at new sites; and between the south edge of Longmont and Erie Switching Station, 13 occurrences of the action are proposed, for a total of 27 between the Flatiron Substation and Erie Switching Station.

CONSTRUCTION ACTION TYPE	BEFORE PROJECT	AFTER PROJECT
1 Build New Transmission Line on New Right-of-Way (New Access)		
2 Build New Structure at New Site on Existing Right-of-Way (No New Access)		
3 Build New Structure at Existing Site on Existing Right-of-Way, Up to 15' Taller (No New Access)		
4 Build New Structure at Existing Site on Existing Right-of-Way, Same Height (No New Access)		
5 Raise Crossarm at Existing Structure (No New Access)		
6 Remove Existing Transmission Line (No New Access)		
7 Remove Existing Transmission Line, Build New Underground Transmission Line on Existing Right-of-Way (No New Access)		
8 Build Overhead to Underground Transition Structure at Existing Site on Existing Right-of-Way (No New Access)		

NOTES:
1. Construction actions 1,6 & 7- Action continuous along ROW.
2. Construction actions 2,3,4,5 & 8- Environmental effects are concentrated primarily at isolated segments of the ROW, approximately 200' long, centered on the transmission line structure.
3. New access will require little or no blading.

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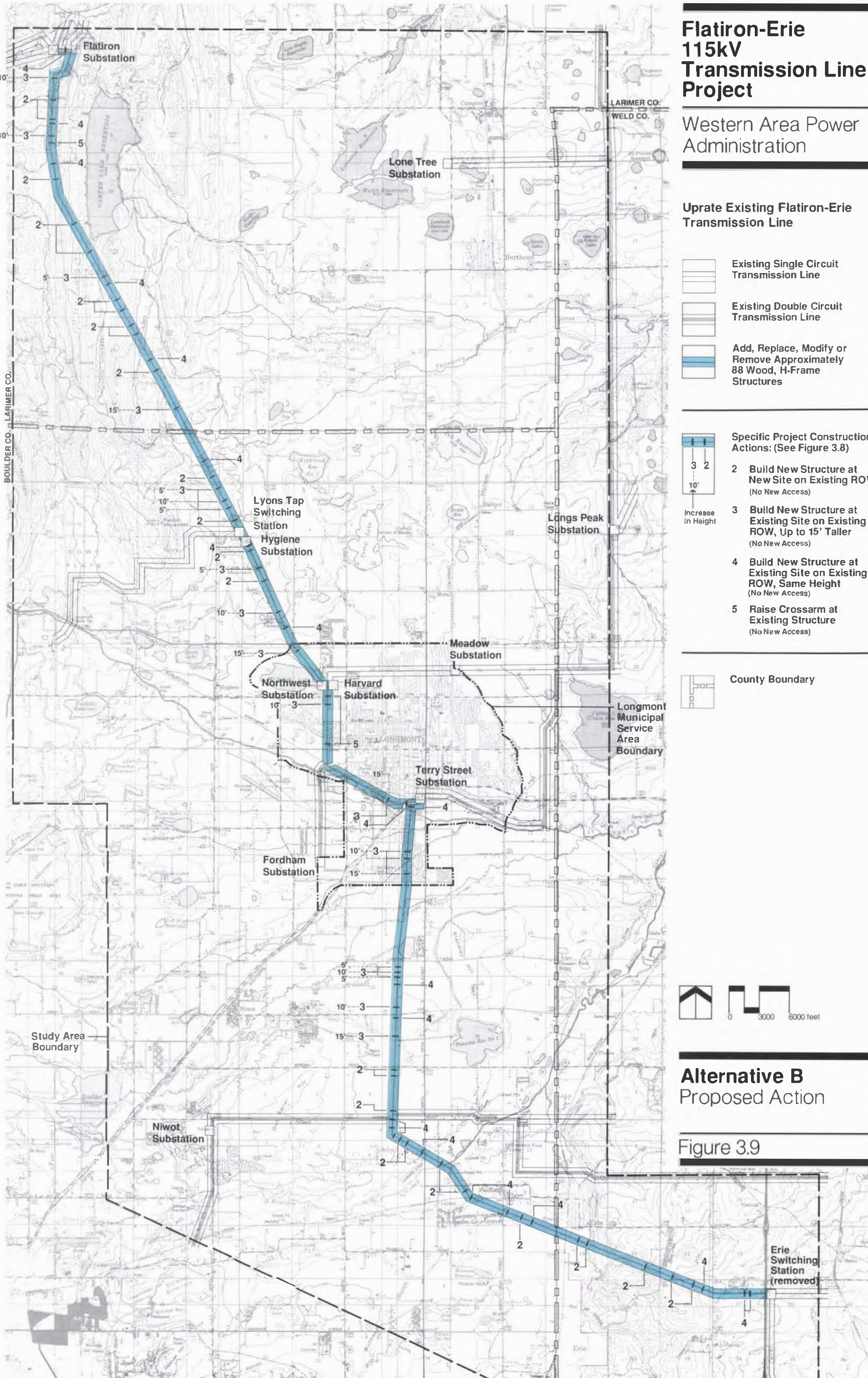
Range of Construction Actions of the Proposed Project Alternatives

Figure 3.8



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Alternative B

Proposed Action

Figure 3.9

Construction Action 3 would replace structures at their present locations; increasing their height by 5, 10 or 15 feet. North of Longmont, between the city and Flatiron Substation, there would be 9 structures replaced. Four of these would be raised 5 feet, 4 raised 10 feet, and one raised 15 feet in height. Within the Longmont area, there would be 6 structures replaced; 3 would be raised 10 feet, and 3 raised 15 feet. South of Longmont, 5 structures would be rebuilt and increased in height; 2 of them would be raised 5 feet, 2 raised 10 feet, and one raised 15 feet. Overall, between the Flatiron Substation and Erie Switching Station, 20 structures would be rebuilt in place; 6 raised 5 feet, 9 raised 10 feet, and 5 raised 15 feet.

Construction Action 4 would involve replacing an existing structure with a new one of the same height. Eight instances of the action would occur north of Longmont, two within the Longmont developed area, and 12 between the city and Erie Switching Station, for a total of 22.

Construction Action 5 would raise the cross arm at an existing structure in 3 locations: one north of Longmont and 2 within the Longmont developed area.

A total of 72 structures would be added or modified.

The locations of these construction actions are shown on Figure 3.9. There are two additional project actions that are too minor to be a factor in impact analysis and the comparison of alternatives. The first is the removal of 11 existing structures. The second is the upgrading of the electrical grounding at all structures. There are 216 existing structures along the Flatiron-Erie line.

3.G.2 DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALTERNATIVE B, THE PROPOSED ACTION

The following discussion of the design, construction, operation and maintenance of the proposed project is divided into five sections. The first of these describes project specifications and requirements, explaining the main elements of the proposed action primarily in terms of their size and area requirements. The second and third sections describe project construction and maintenance activities. The fourth section details standard committed mitigation measures; i.e, those aspects of the project's design, construction, operation and maintenance that have the potential to substantially influence its environmental impacts and that will be managed to mitigate some of those impacts. The impact analysis and route comparison assume that the standard committed mitigation measures have been appropriately and reasonably applied. The fifth section describes work at substations and taps.

3.G.2.a Project Specifications and Requirements

Electrical Design

The proposed project would be operated at 115-kV and capable of carrying up to 109 MVA of power.

Western designs, constructs, operates and maintains transmission lines, taps and substations to meet or exceed the requirements of the National Electrical Safety Code (NESC), U.S. Department of Labor Occupational Safety and Health Standards, and Western's Power System Safety Manual for maximum safety and protection of landowners, their property and the public.

The electrical grounding of all permanent structures, such as fences, metal gates and metallic structures whose electrical characteristics might be affected by the changed operation of the line, would be checked, and the grounding improved if necessary in accordance with NESC codes.

Right-of-Way Needs

The ROW width required would be 75 feet. Western currently has a 75-foot ROW along the entire length of the existing Flatiron-Erie line. Within the ROW, Western has the right to locate (construct, operate, maintain and rebuild) transmission facilities and to restrict certain land uses that would be in conflict with the line. Construction of buildings would be the main activity that would continue to be restricted. Agriculture would not be restricted, except that there would be a limit to the height of equipment that could be safely operated beneath the transmission line. The width of a ROW and the restrictions within it are determined by electrical safety codes, and may vary with structure configuration, voltage, span length and conductor sag.

Structural Elements

Table 3.1 lists the dimensions of the various project elements and the areas that would be affected by, or required for, construction. Figure 3.10 shows the typical wood pole H-frame structure that exists along the Flatiron-Erie line and that would be modified, replaced or added. Figure 3.11 shows the type of wood structure that would be used at angles in the line.

Construction Access

Access for construction vehicles and equipment would be required at every structure site (800 foot average intervals). It is anticipated that all segments of Alternative B can be accessed by the existing accessways that are currently used to maintain the Flatiron-Erie transmission line.

3.G.2.b Project Construction Activities

The necessary operations to construct the various portions of the proposed action would vary, depending on the intensity of the actions (see Figure 3.8). The following roughly sequential activities would be performed in turn by small crews progressing along a length of line.

- Surveying
- Minor clearing, blading and grading of accessways, if necessary
- Clearing and grading for structure sites and material yards
- Materials handling
- Digging holes for structure placement
- Structure assembly and erection
- Removal of existing transmission structures
- Resagging conductors
- Cleanup
- Seeding and other reclamation work

The approximate work force at one time required to construct the project would be about 30.

3.G.2.c Project Operation and Maintenance Activities

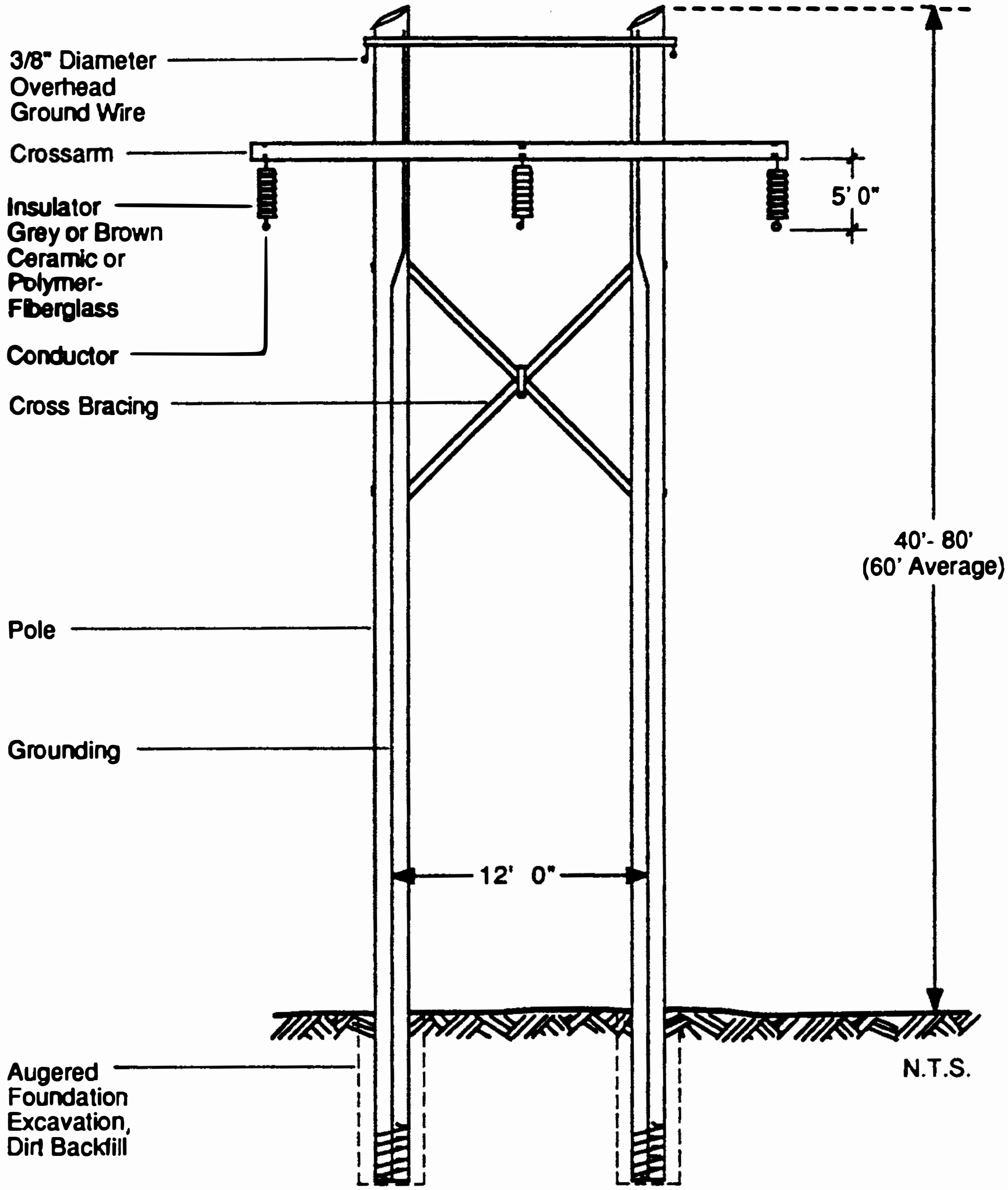
There would be no substantial changes between the operation and maintenance activities used with the proposed action and those currently in use.

TABLE 3.1

ALTERNATIVE B, PROPOSED ACTION
PROJECT ELEMENT DIMENSIONS, CLEARANCES
AND AREAS REQUIRED FOR CONSTRUCTION

(Wood H-Frame Structures)

• Structure height	
- Range	40' - 80'
- Average	60'
• Span between structures	
- Typical maximum	1,200'
- Average	800'
• Number of structures per mile (average span)	6 - 7
• Area removed from cultivation at structure base	45 sq. ft.
• Land disturbed at structure base during construction (maximum)	15,000 sq. ft.
• Material storage sites	
- Size	5 acres
- Number	1
• Minimum ground clearance beneath conductors at maximum sag	
- General	22'
- Over road	22'
• Maximum height of agricultural machinery (including antennae)	15'



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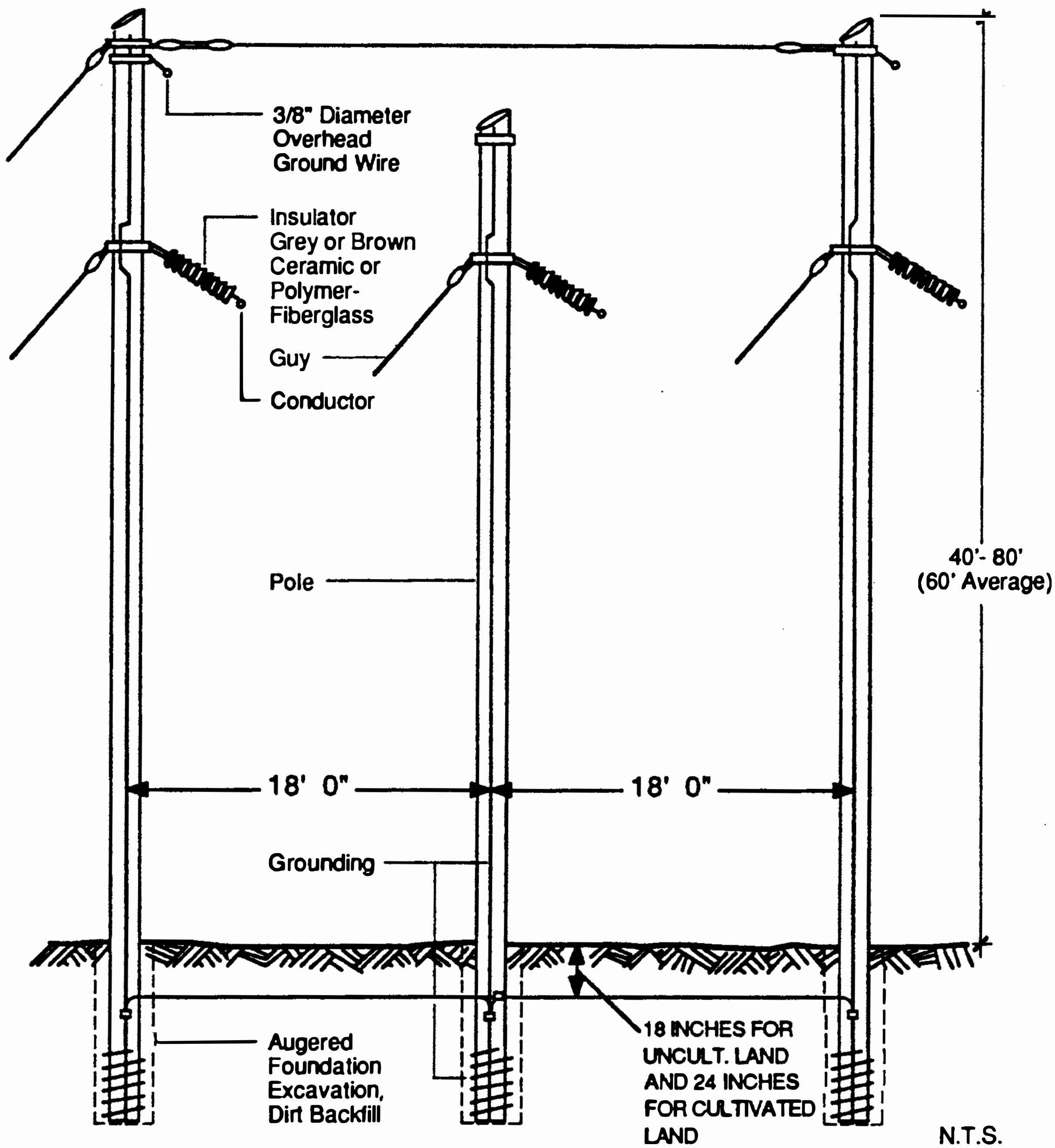
Typical Wood H-Frame Structure

Figure 3.10



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115kV Wood Angle Structure

Figure 3.11

Although permanent buildings could not be located within the ROW, any land use activity that did not interfere with the operation and maintenance of the line could continue. Normal farming activities could continue if reasonable care was taken to prevent damage to transmission line structures from farm machinery.

The day-to-day operation of the line would be directed by system dispatchers in power control centers. These dispatchers would use Western's communication facilities to operate circuit breakers that control the transfer of power through the line. These circuit breakers would also operate automatically (for example in the structural failure of a conductor) to ensure the instantaneous shut off of power in the circuit of which that conductor is a component.

The following are the maintenance operations that would be performed:

- Aerial inspection about three times per year, particularly after severe wind, ice or lightning storms when seriously damaged conductors, insulators and structures are usually detected.

- Ground inspection one time per year to detect equipment needing repair or replacement.

- Routine maintenance about once per year, or as needed, involving the inspection and repair of damaged structures, frayed or otherwise damaged conductors, and cracked or broken insulators.

- Tree topping to maintain conductor clearance about once per year, or as needed.

- Transmission lines are sometimes damaged by storms, floods, vandalism or accidents, and require repair as soon as the damage is detected (which may be during the aerial or ground surveys or at the time it occurs). Emergency maintenance would involve prompt movement of crews to repair damage and replace any equipment. If crop damage would result from repair activities, Western representatives would meet with the owner/operator to arrange for compensation. Emergency activities would be relatively infrequent and restricted in most cases to a small area.

The proposed action, uprating of the existing line, could itself be considered largely a grouping of maintenance activities. Therefore, the frequency of repair activities along the line could be expected to diminish for some years.

3.G.2.d <u>Standard/Committed Mitigation Measures</u>

The following is a description of the standard construction practices that would be part of the construction, operation and maintenance of the proposed action that have been committed to by Western, and that would mitigate some of the impacts that would otherwise occur. They would be applied on a site-specific basis following consultation with interested city and county agencies and interested private landowners. The impact assessment assumes that these mitigation measures would be applied and would be reasonably successful in mitigating some impacts.

Seasonal Restrictions

When possible, construction would be timed to avoid damage to or disturbance of:

- Growing crops (except winter wheat). Any damage to crops is compensated for by Western.

- High flows in streams

- Most critical seasons for wildlife (the bald eagle, although it is found in the study region primarily in winter, would not be measurably disturbed).

Use of Existing Construction Accessways

Western would use existing roads and accessways for construction and maintenance access wherever feasible; and if new access was required, would keep new accessways to a minimum. If project construction traffic caused excessive dust, impacting residences, recreation areas and other sensitive land uses, spraying with water would be done as necessary to mitigate the problem.

Whenever possible, construction accessways would be arranged to cross streams and washes at right angles, and would normally cross without culverts, if this could be done without damage to the stream banks. If a stream was narrow with steep, high banks, then a culvert, adequately sized to carry the heaviest construction equipment to be used and large enough to carry the highest likely projected runoff, would be installed.

After construction, access would be restricted on construction accessways. Western would install gates wherever an accessway ROW crossed an existing fence. Gates would be kept closed but not locked, unless locks were requested by landowners. If requested by the landowner, accessways not required for maintenance would be restored to the original contour and made impassable to vehicular traffic. This measure would limit potential increases in human use arising from increased accessibility. If any existing fences would be disturbed during construction, they would immediately be repaired or replaced with temporary fencing adequate to prevent straying of livestock. After completion of construction, they would be restored to their original condition.

Right-of-Way Acquisition and Use Policies

The proposed action would not require the acquisition of any new ROW, nor would it involve any change in current ROW use policies.

Specific Siting of Project Elements Prior to Construction

Before construction commences, a process of detailed siting of some of the transmission line's elements would be completed in consultation with affected landowners. The location of the existing structures along the Flatiron-Erie line is fixed. However, the location of some of the other project elements, including new overhead structures, construction accessways and materials storage sites, could be adjusted to a small degree, or in some cases, moved larger distances. Western would work with interested landowners to adjust the siting of project elements to the greatest feasible extent to reduce or eliminate potential impacts by avoiding or minimizing disturbance of sensitive environmental conditions, especially land uses.

Vegetation Removal

Removal of vegetation for construction access and clearance around new structures would be selective; i.e., the minimum necessary. Once construction is complete, vegetation would be allowed to grow back to essentially its existing condition. At the request of landowners, Western would apply herbicide around the bases of transmission line structures to prevent the growth of weeds.

Reclamation of Disturbed Areas

In all cases, the primary objective in applying reclamation measures would be the prevention of soil erosion and the stabilization of slopes and runoff channels. This would be achieved primarily by the establishment of plant cover of a density equal to or greater than that of the original cover adjacent to the specific disturbed area (ultimately consisting, wherever feasible, of the communities present before disturbance). Where required, areas that were disturbed during project construction would be reclaimed during and soon after construction by site-specific application of the mitigation measures described below. This would be done in consultation with appropriate governmental agencies and interested private landowners.

Topsoil Removal and Storage

Before construction, in any areas where a significant amount of topsoil occurred, where construction activity would be likely to disturb the soil horizons, and where revegetation might be difficult, topsoil would be stripped and deposited in storage piles separate from other excavated material.

Cleanup of Construction Materials

All waste construction materials and debris from all construction areas, including storage and construction buildings with any foundation slabs and footings, would be collected, hauled away and disposed of at approved sites.

Regrading of Disturbed Areas

After construction, areas substantially disturbed by construction operations (including those areas from which topsoil, if present, was removed), would be graded, shaped and smoothed to contours close to the original or (if this was not feasible) to natural-appearing contours. Construction accessways necessary for maintenance access and, in some cases, level crane pads at structure sites would be retained. Construction accessways would be provided with water bars as necessary to prevent erosion. If requested by landowners, construction accessways would also be regraded to contours close to the original. In all cases, cut and fill slopes would be designed to be reclaimable and stable when reclaimed.

Seeding

All previously vegetated areas disturbed by project construction, and not needed for maintenance access, would be reseeded. Seeding would normally be with suitable and appropriate grass mixes. Steep areas or other areas where soil erosion might be difficult to control would be mulched. If necessary, in severe examples of these situations, fabrics or netting would be used.

Landscaped Areas

Western would replace or pay for landscape features (plants, fences, etc.) damaged or removed during construction.

Special Treatment of Cultivated Land

On cultivated land, deep ruts and scars caused during construction which might be hazardous to farming operations would be leveled, filled and graded, or otherwise eliminated. Areas of compacted or hard-packed soil would have the soil loosened by scarifying, harrowing, discing or other approved methods. Damage to ditches, terraces, tile drains, roads or other features of agricultural land would be corrected. The land and facilities would be restored as nearly as practicable to their original condition.

3.G.2.e Project Work at Substations and Taps

The proposed action would not require expansion of the facilities at any of the substation or taps to which the Flatiron-Erie line connects. There would be no work outside existing perimeter fences at any of these facilities, except at Fordham Tap.

3.G.3 DESCRIPTION OF ALTERNATIVE C. CONSTRUCT UNDERGROUND THROUGH LONGMONT

This primary alternative would rebuild the existing Flatiron-Erie transmission line underground for 6.1 miles through Longmont, and uprate the remainder of the existing line. The alternative is shown on Figure 3.12. The uprating of the line segments north and south of Longmont would be identical to the uprating used on Alternative B. The description of the construction actions in these segments is therefore not repeated here.

There would be two construction action types involved in the underground segment of this alternative -- Actions 7 and 8 shown on Figure 3.8. Construction Action 7 would consist of the removal of the existing overhead line from the ROW and its replacement with a buried, high pressure oil-filled pipe type (HPOFPT) line. This line would be located primarily in the center of the existing ROW, but might have to make small detours in places to avoid obstacles. This construction action, unlike those associated with the uprating of the existing overhead line, would be continuous along the route segment.

Construction Action 8 would involve erection of a specialized steel structure to act as a transition between overhead and underground segments of the line. A structure would be required at each end of the underground segment, Fordham Tap, Longmont Northwest/Harvard Substation and Terry Street Substation. HPOFPT underground construction would also require two sizeable pumping/pressurizing facilities -- one at Northwest/Harvard Substation and one at Terry Street Substation. The addition of pumping facilities at Longmont Northwest/Harvard Substation may require expansion outside the existing boundaries of the substation.

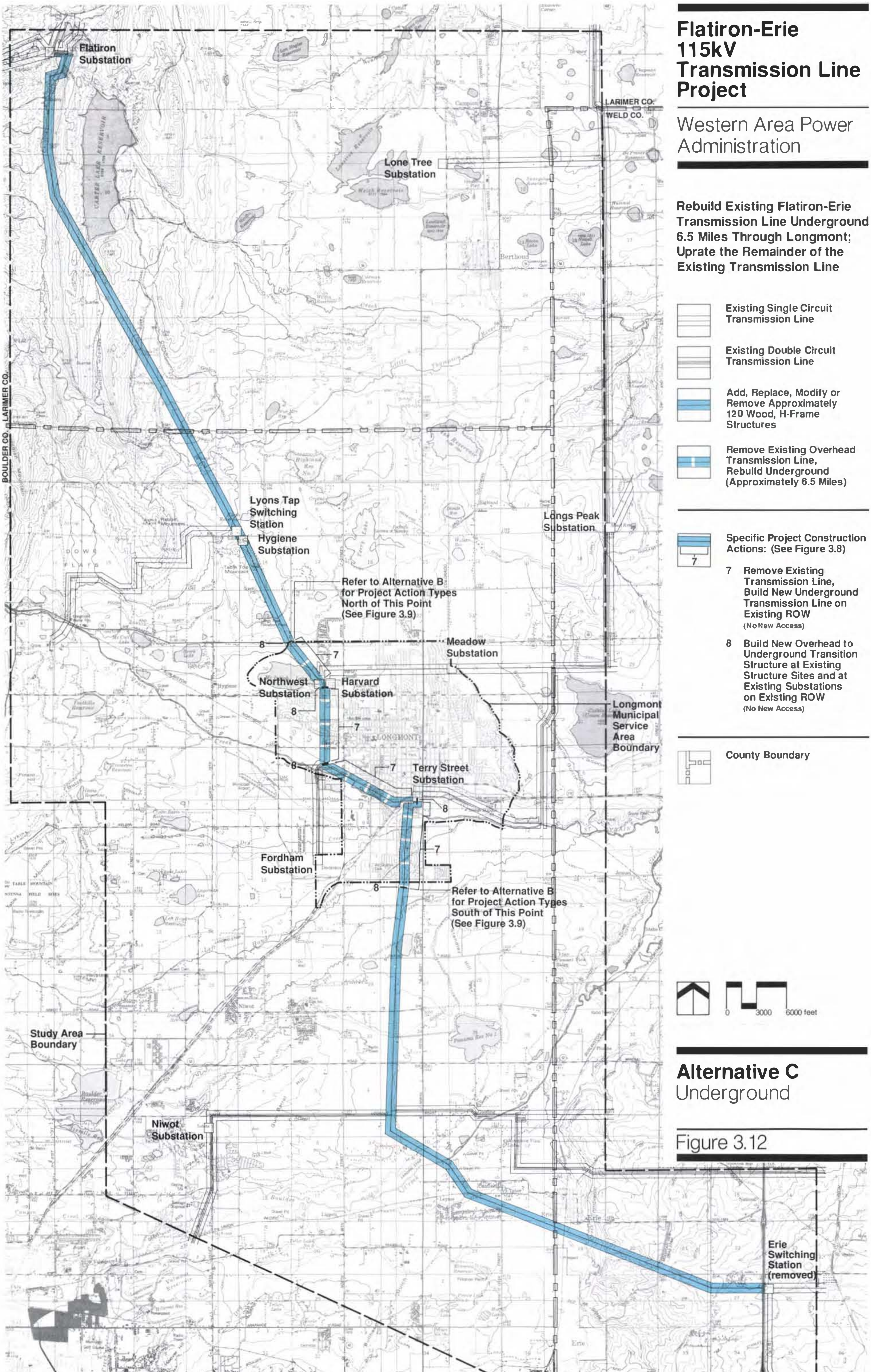

Flatiron-Erie 115kV Transmission Line Project
Western Area Power Administration
Rebuild Existing Flatiron-Erie Transmission Line Underground 6.5 Miles Through Longmont; Uprate the Remainder of the Existing Transmission Line
Existing Single Circuit Transmission Line
Existing Double Circuit Transmission Line
Add, Replace, Modify or Remove Approximately 120 Wood, H-Frame Structures
Remove Existing Overhead Transmission Line, Rebuild Underground (Approximately 6.5 Miles)
Specific Project Construction Actions: (See Figure 3.8)
7 Remove Existing Transmission Line, Build New Underground Transmission Line on Existing ROW (No New Access)
8 Build New Overhead to Underground Transition Structure at Existing Structure Sites and at Existing Substations on Existing ROW (No New Access)
County Boundary
0 3000 6000 feet
Alternative C
Underground
Flatiron Substation
Lone Tree Substation
LARIMER CO.
WELD CO.
BOULDER CO.
LARIMER CO.
Lyons Tap Switching Station
Hygiene Substation
Longs Peak Substation
Refer to Alternative B for Project Action Types North of This Point (See Figure 3.9)
Meadow Substation
Northwest Substation
Harvard Substation
Longmont Municipal Service Area Boundary
Terry Street Substation
Fordham Substation
Refer to Alternative B for Project Action Types South of This Point (See Figure 3.9)
Study Area Boundary
Niwot Substation
Erie Switching Station (removed)
BOULDER CO.
WELD CO.

Figure 3.12

3.G.4 DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALTERNATIVE C

The following discussion of the design, construction, operation and maintenance of Alternative C is divided into five sections. The first of these describes project specifications and requirements, explaining the main elements of the alternative primarily in terms of its size and area requirements. The second and third sections describe project construction and maintenance activities. The fourth section details committed mitigation measures; i.e, those aspects of the project's design, construction, operation and maintenance that have the potential to substantially influence its environmental impacts and that will be managed to mitigate some of those impacts. The impact analysis and route comparison assume that the committed mitigation measures have been appropriately and reasonably applied. The fifth section describes work at substations and taps.

The design, construction, operation and maintenance of the above-ground portions of Alternative C would be identical to that of the corresponding portions of Alternative B, the Proposed Action.

3.G.4.a Project Specifications and Requirements

Electrical Design

The electrical design of Alternative C would be identical to that of Alternative B, the Proposed Action.

Right-of-Way Needs

The ROW width required would be 75 feet for the overhead portions of Alternative C, and 40 feet for the underground portion. Western currently has a 75-foot ROW along the entire length of the Flatiron-Erie line. The surplus 35 feet would be relinquished along the underground portion of the alternative. Within the ROW, Western currently has an easement providing the right to locate (construct, operate, maintain and rebuild) transmission facilities and to restrict certain land uses that would be in conflict with the line. It may be necessary to obtain additional easement rights to accomplish the underground portion of the transmission system, including adding certain specific limitations to penetration of the ground surface, such as trenching, fencing, and certain other activities not specifically prohibited by the original easement document. Construction of buildings is and would continue to be the main restricted activity. Agriculture is not and would not be restricted, except for a limit to the height of equipment that could safely be used. The width of a ROW and the restrictions within it are determined by electrical safety codes, and may vary with structure configuration, voltage, span length and conductor sag.

Structural Elements

Overhead Construction

The above-ground portions of Alternative C would be identical to the corresponding portions of the Proposed Action, as described in Section 3.G.2.a.

Underground Construction

Figure 3.13 shows a typical cross-section of the underground transmission line trench. The underground construction type proposed and described here is the High Pressure Oil-Filled Pipe Type (HPOFPT). The cable would typically consist of: a conductor, conductor shield, laminated oil impregnated paper insulation, insulation shield, various protective wrappings, and skid wires. Three cables would be pulled into a steel pipe, coated on the inside with epoxy and on the outside with mastic. The outside coating would prevent environmental corrosion and electrically isolate the pipe. A cathodic system using sacrificial anodes would be used to protect against corrosion of the pipe from induced currents. The pipe would be surrounded with thermal fill (sand) and the trench backfilled. Sand is used as a backfill around the pipe to dissipate heat produced by the power flowing through the cables. The pipe would be filled with a nontoxic, synthetic insulating fluid, similar to medium viscosity machine oil. About two gallons per foot of pipe would be required. The fluid would be pressurized to 200 pounds per square inch. The pipe would be installed at a depth of approximately 5 feet. This is below the depth of most services, and therefore, the risk of accidental dig-ins is reduced.

Figure 3.14 shows a typical transition structure that could be used when a transition is made from underground to overhead construction and vice versa. At intervals of several miles along the underground line, pumping and pressurizing facilities are required. These facilities include an oil storage tank and a would be required at the points where underground construction makes a transition to overhead construction. In addition, the underground segment of Alternative C would require two pumping plants to maintain oil pressure. Each would occupy a building or containing structure about 41' x 10' x 11' high. Reservoirs included in these pumping stations would provide surge capacity to accommodate changes in oil volume resulting from thermal cycling, reserve oil in case of a leak, and space for a dry nitrogen blanket to prevent oil contamination. Each facility would include two pump systems, one as a backup. To accommodate the installation of these pumping facilities in existing substations, it may be necessary to expand outside the existing boundaries of the substations.

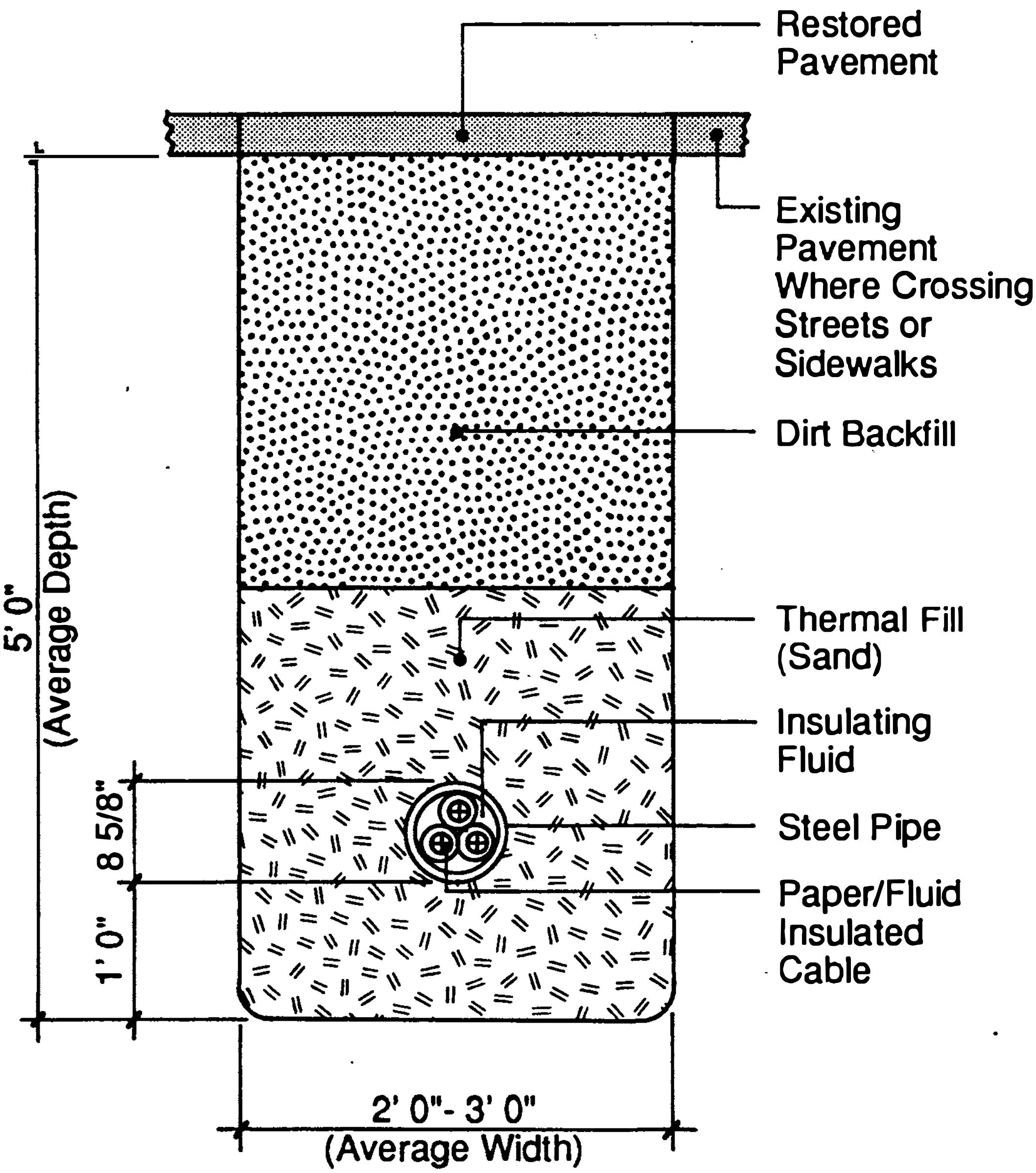
Construction Access

Access for construction vehicles and equipment would be required at every structure site with the overhead portion of Alternative C, and continuously along the length of the underground segment of the alternative. Almost all of this alternative can be accessed by the existing accessways that are currently used to maintain the line. Any required new construction/maintenance accessway would generally be located within the transmission line ROW. However, if any new access was required in steep or rough terrain, it might be necessary to locate segments outside the ROW. In these cases, a separate ROW, generally 50 feet wide, would be acquired for the accessway. Accessways would have a 12-foot running surface created by the minimum necessary amount of blading and grading. Accessways would not generally have a constructed road bed.

3.G.4.b Project Construction Activities

Overhead Construction

The necessary operations to construct the overhead portions of Alternative C would be identical to those for the corresponding portions of Alternative B.

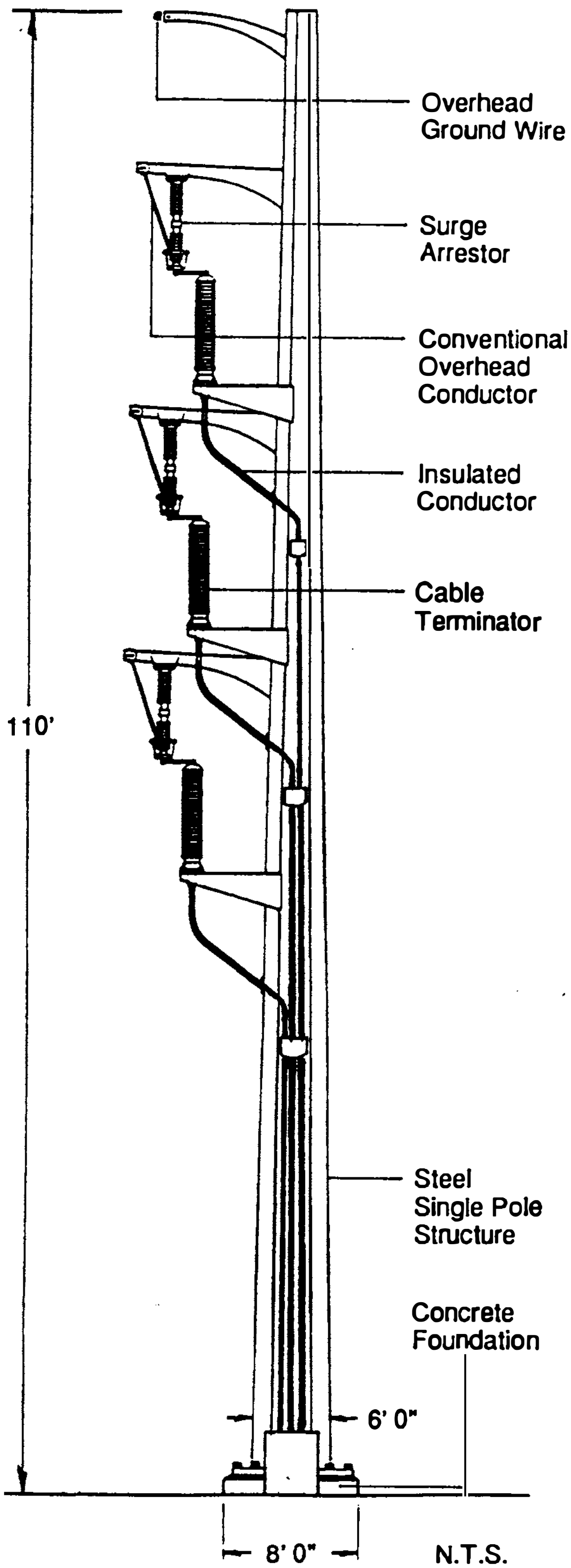


Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Typical Trench Layout for 115kV Underground Transmission Line

Figure 3.13



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Typical 115kV Overhead to Underground Transition Structure

Figure 3.14

Underground Construction

The basic sequence of construction and installation activities for the underground portion of Alternative C would include the following:

- Surveying
- Soils evaluation
- Excavation and pavement cutting
- Pipe and manhole installation
- Backfilling
- Surface restoration (streets and sidewalks crossed)
- Cable installation (pulling)
- Splice and termination installation
- Pumping facility installation
- Filling, oil pressurizing
- Testing
- Cleanup
- Seeding and other reclamation work

A 40-foot wide zone of disturbance along the ROW would be likely. The trench itself would be 2 to 3-feet wide and approximately 5 feet deep. The excavated dirt would be stored on one side of the trench occupying up to 10 feet, and a space on the other side of the trench would be used for construction equipment access and short-term storage of materials. The pipe would be bored under any operating railroad crossed, but would normally be trenched across other linear features such as streams or highways unless circumstances required boring.

The construction activities that result in significant, continuous surface disturbance along the ROW would pass a given point in about five workdays.

The transitional overhead to underground structures would be constructed using essentially the same sequence of activities as the conventional overhead construction, with the addition of installation of potheads and surge arresters by a small team of specialist workers. Manholes or vaults would be constructed at splices and at transitional structures.

A total work force of up to 35 would be required.

3.G.4.c Project Operation and Maintenance Activities

Overhead Transmission Line

The operation and maintenance activities for the above-ground portions of Alternative C would be identical to those proposed for Alternative B, and would not substantially change from those currently in use. They are described in Section 3.G.2.c.

Underground Transmission Line

Operation of the underground segment of Alternative C would require little if any operator intervention. The systems would be designed to operate automatically, and would include oil monitoring and alarm systems.

Other post-installation tasks would be essentially maintenance related. These would include inspection, monitoring, testing and preventive maintenance of oil pumping systems, cathodic protection systems cables and accessories, and replacing or repairing defective cables, accessories or oil system components.

Location of a cable fault can be a difficult and time-consuming process. No one fault-locating method would be capable of pinpointing the exact location of faults under the differing conditions encountered in the field. After the fault was located, oil-freeze techniques would be used to isolate the splice location. A splice would then be installed and the pipe section sleeved, flushed with oil and vacuum filled with oil. A manhole would usually be installed at the splice location. The outage time to locate and repair a fault would be about three weeks or longer.

3.G.4.d Standard Committed Mitigation Measures

The standard construction practices that would be part of Alternative C's design, construction, operation and maintenance, and have been committed to by Western, would be identical to those used with Alternative B, as described in Section 3.G.2.d.

Vegetation Removal

With the underground segment of Alternative C, landscaping would be permitted on the ROW. However, in the case of a cable fault, such landscaping might have to be removed.

3.G.4.e Project Work at Substations and Taps

Alternative C would require connections (not involving substantial changes) at Lyons Tap and Hygiene Substations. It would require substantial work at Harvard/Northwest and Terry Street Substations and at Fordham Tap.

Along with the transition structures at Fordham Tap (Construction Action Type 8), pumping facilities would be installed at Longmont Northwest and Terry Street Substations. The addition of pumping facilities at Longmont Northwest/Harvard Substation may require expansion outside the existing boundaries of the substation.

3.G.5. DESCRIPTION OF ALTERNATIVE D. REMOVE AND REROUTE PORTIONS OF EXISTING LINE

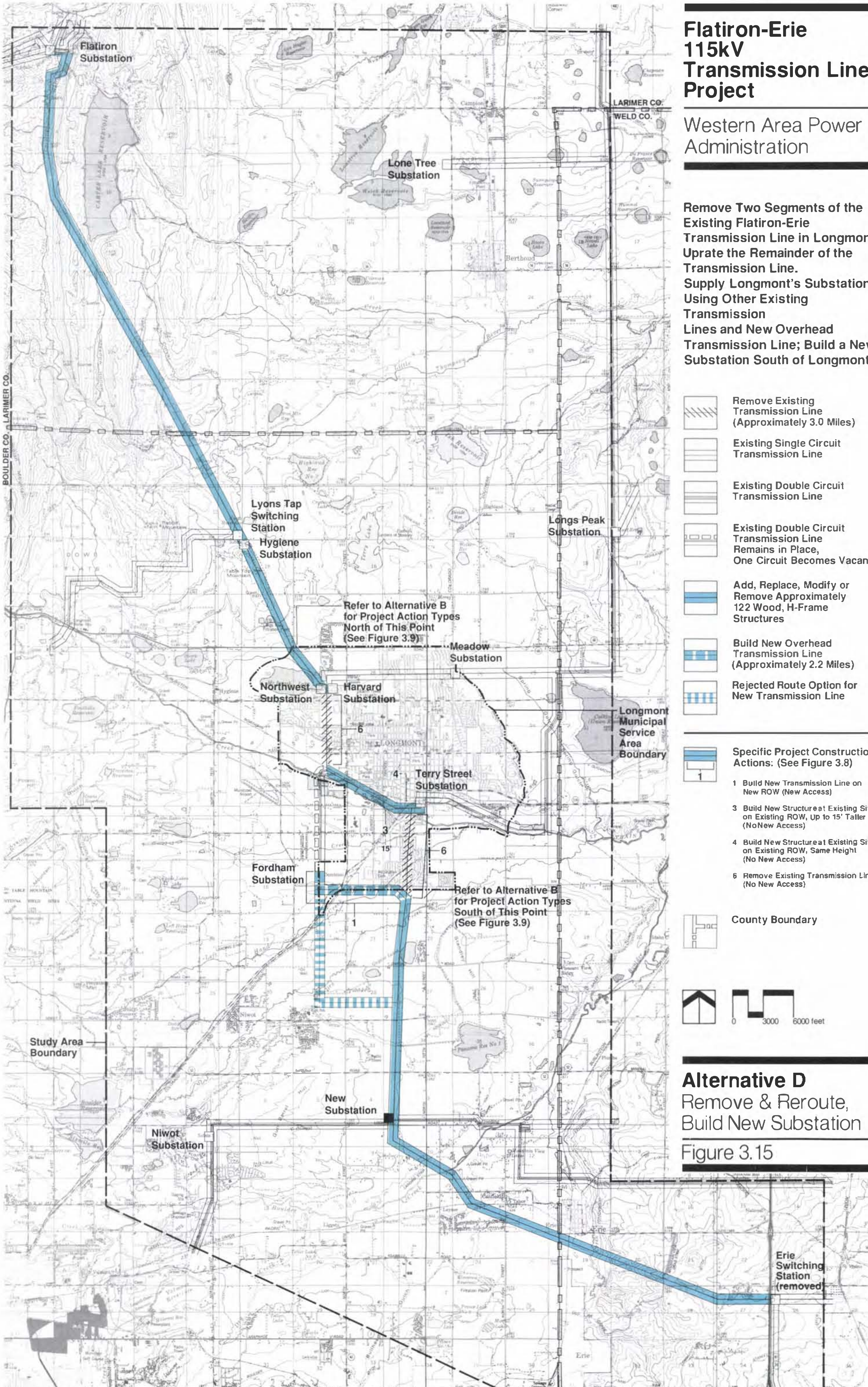
This primary alternative would remove two segments of the existing Flatiron-Erie transmission line in Longmont, supply Longmont's substations using other existing transmission lines and a new overhead transmission line, and uprate the remainder of the existing Flatiron-Erie line. It would also include a new substation about 4.4 miles south of the south edge of Longmont at the point where a major east-west PSCo line crosses the Flatiron-Erie line. The alternative is shown on Figure 3.15.

Two route options (shown on Figure 3.15) were considered for the required new connection between Fordham Substation and the Flatiron-Erie line south of Longmont. An air and ground site reconnaissance of the area and an examination of Figures 4.2 through 4.9 (the environmental inventory data maps), were conducted in order to identify the best of these route options for inclusion in Alternative D.

Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Remove Two Segments of the Existing Flatiron-Erie Transmission Line in Longmont; Uprate the Remainder of the Transmission Line. Supply Longmont's Substations Using Other Existing Transmission Lines and New Overhead Transmission Line; Build a New Substation South of Longmont.



Remove Existing Transmission Line (Approximately 3.0 Miles)

Existing Single Circuit Transmission Line

Existing Double Circuit Transmission Line

Existing Double Circuit Transmission Line Remains in Place, One Circuit Becomes Vacant

Add, Replace, Modify or Remove Approximately 122 Wood, H-Frame Structures

Build New Overhead Transmission Line (Approximately 2.2 Miles)

Rejected Route Option for New Transmission Line

Specific Project Construction Actions: (See Figure 3.8)

1

1 Build New Transmission Line on New ROW (New Access)

3 Build New Structure at Existing Site on Existing ROW, Up to 15' Taller (No New Access)

4 Build New Structure at Existing Site on Existing ROW, Same Height (No New Access)

6 Remove Existing Transmission Line (No New Access)

County Boundary

0 3000 6000 feet

Alternative D

Remove & Reroute, Build New Substation

Figure 3.15

The northern route options proceeds south and east from Fordham Substation for about one-half mile, crossing cultivated land. It then crosses the Boulder/Longmont Diagonal Highway at a point just south of a concentration of office and industrial land uses. However, the highway at this point (and for several miles to the southwest) has been categorized as visually sensitive by Boulder County. The route option then proceeds east on the south side of Pike Road (which forms the Longmont Municipal Service Area boundary) for just over a mile. In this segment, it is located primarily along the edge of a cultivated area. At the point where it approaches the existing Flatiron-Erie line, it angles southeast for a short distance to avoid a farmyard. An area a few hundred feet south of the east end of this route option contains residences under construction. The total length of new transmission line is about 2.2 miles with this option.

A second route option was considered that proceeds south from Fordham Substation for a distance of about 2 1/2 miles, crossing first about 3/4 mile of cultivated land and then the Boulder/Longmont Diagonal Highway (at a point where it is considered visually sensitive), then over 1 1/4 additional miles of cultivated land. It then turns east and crosses just under 1 1/2 miles of cultivated land before rejoining the existing Flatiron-Erie ROW. This option, in comparison to the Pike Road option described above, requires the construction of approximately an additional 2.1 miles of new transmission line on new ROW. Its one advantage is that it allows the removal of the existing line past Gaynor Lake where a few residences are relatively close to the ROW edge. Otherwise, in terms of cost and environmental impact, it is far inferior to the Pike Road option. The northern or Pike Road option was made part of Alternative D and the south option eliminated from further study.

The uprating of the line segments north and south of Longmont would be identical to the uprating used on Alternative B. The description of the construction actions in these segments is therefore not repeated here.

There would be four construction actions involved in the Longmont segment of this alternative. These are Action Types 1, 3, 4 and 6, as shown on Figure 3.8. Action 1 would be construction of a new above-ground transmission line between Fordham Substation and a point on the existing Flatiron-Erie line at the south edge of the Longmont developed area. This new transmission line segment would be very similar in specifications and appearance to the uprated Flatiron-Erie line (although it might alternatively be constructed using steel single pole structures). Construction Action 3 would be a single occurrence (within the Longmont developed area) of the replacement of an existing structure on the line with a new structure, 15 feet taller. Construction Action 4 would also be a single occurrence (within Longmont) of the replacement of one pole at an existing structure. Construction Action 6 would be the removal of segments of the existing Flatiron-Erie line from their ROW.

The new substation would be constructed on cultivated land directly adjacent to the Flatiron-Erie ROW at the point where it crosses the east-west PSCo transmission line.

3.G.6 DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALTERNATIVE D

The following discussion of the design, construction, operation and maintenance of Alternative D is divided into five sections. The first of these describes project specifications and requirements, and explains the main elements of the alternative, primarily in terms of its size and area requirements. The second and third sections describe project construction and maintenance activities. The fourth section details committed mitigation measures; i.e, those aspects of the project's design, construction, operation and maintenance that have the potential to substantially influence its environmental impacts and that will be managed to mitigate some of those impacts. The impact analysis and route comparison assume that the committed mitigation measures have been appropriately and reasonably applied. The fifth section describes work at substations and taps.

3.G.6.a Project Specifications and Requirements

Electrical Design

The electrical design of Alternative D would be identical to that of Alternative B, the Proposed Action.

Right-of-Way Needs

The ROW width required would be 75 feet for all portions of Alternative D. Western currently has a 75-foot ROW along the entire length of the existing Flatiron-Erie line, and would acquire such a ROW where new transmission line would be built (Action Type 1, see Figure 3.8). Within the ROW, Western currently has or would acquire an easement providing the right to locate (construct, operate, maintain and rebuild) transmission facilities and to restrict certain land uses that would be in conflict with the line. Construction of buildings is and would continue to be the main restricted activity. Agriculture is not and would not be restricted, except for a limit to the height of equipment that could safely be used. The width of a ROW and the restrictions within it are determined by electrical safety codes, and may vary with structure configuration, voltage, span length and conductor sag.

Structural Elements

Those portions of Alternative D that would be located on existing ROW would be identical to the corresponding portions of the Proposed Action, as described in Section 3.G.2.a and illustrated on Figure 3.9. The portion that would be on new ROW (Action Type 1) might use wood H-frame structures, in which case the structural elements used would also be identical to those used in Alternative B. However, as an alternative, steel single pole structures might be used for this portion of the alternative. The characteristics of the line, if steel poles were used, are described on Table 3.2. The steel pole structure is illustrated on Figure 3.16. It should be noted that irrespective of the structure type used on the new ROW portion of Alternative D, a one-acre conductor stringing site would be required.

Construction Access

Access for construction vehicles and equipment would be required at every structure site that is on existing ROW (800 foot average intervals). Almost all segments of the alternative can be accessed by existing accessways. The new overhead line segment in Alternative D (Action Type 1) would require the establishment of new accessways.

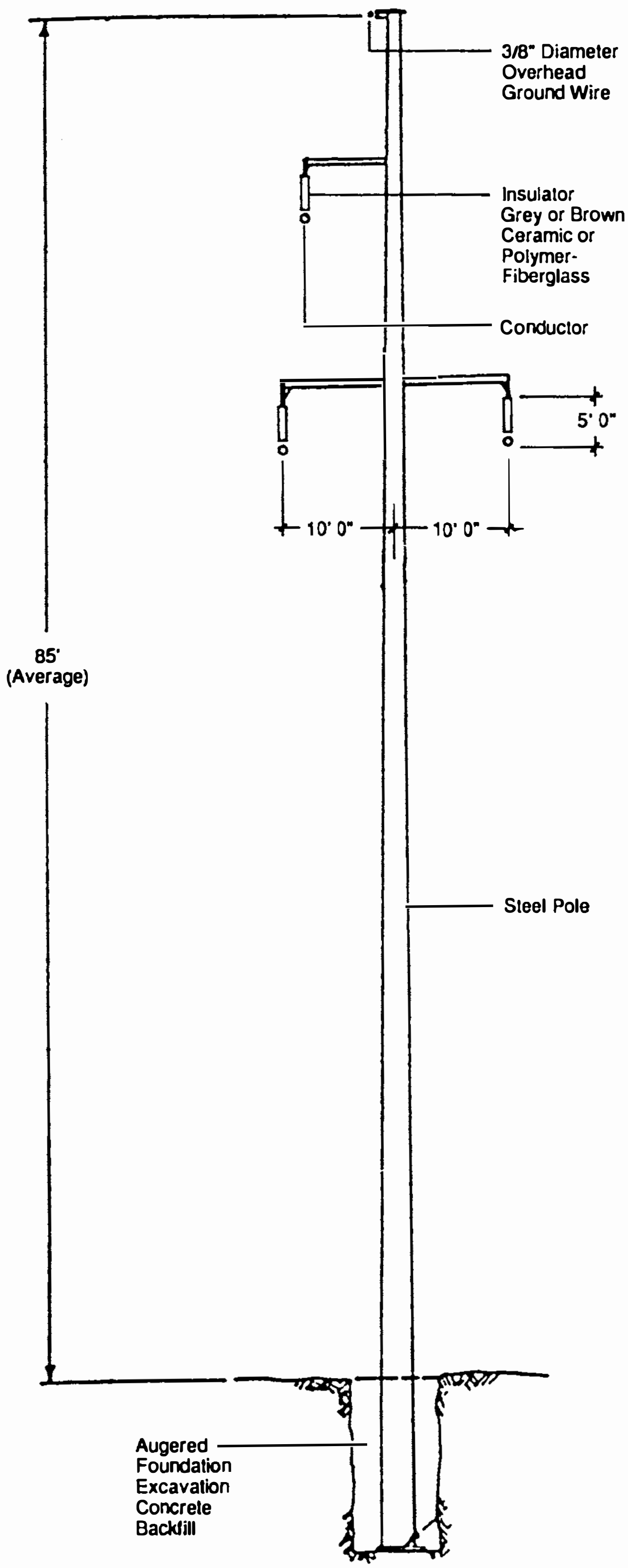
Any required new construction/maintenance accessway would generally be located within the transmission line ROW. However, if any new access was required in steep or rough terrain, it might be necessary to locate segments outside the ROW. In these cases, a separate ROW, generally 50 feet wide, would be acquired for the accessway. Accessways would have a 12-foot running surface created by the minimum necessary amount of blading and grading. Accessways would not generally have a constructed road bed.

TABLE 3.2

ALTERNATIVE D
PROJECT ELEMENT DIMENSIONS, CLEARANCES AND AREAS REQUIRED FOR CONSTRUCTION

(Steel Single Pole Structure: may be used as an alternative structure type on new ROW)

• Structure height	
- Range	75' - 125'
- Average	105'
• Span between structures	
- Typical maximum	1,375'
- Average	1,200'
• Number of structures per mile (average span)	4 - 5
• Area removed from cultivation at structure base	10 sq. ft.
• Land disturbed at structure base during construction (maximum)	15,000 sq. ft.
• Conductor stringing sites	
- Size	1 acre
- Number	1
• Material storage sites	
- Size	5 acres
- Number	1
• Minimum ground clearance beneath conductors at maximum sag	
- General	22'
- Over road	22'
• Maximum height of agricultural machinery (including antennae)	15'



Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Typical 115kV Steel Single Pole Structure

Figure 3.16

3.G.6.b Project Construction Activities

Project construction activities for the portions of Alternative D that would be located on existing ROW would be identical to those described for Alternative B, the Proposed Action. Construction activities for the portion of the alternative that would be on new ROW would also be identical, except that two additional activities would be necessary: selected topping and clearing of vegetation in the ROW (where necessary), and conductor and ground wire stringing (from a wire handling site).

The approximate work force at one time required to construct the project would be about 30.

3.G.6.c Project Operation and Maintenance Activities

The operation and maintenance activities for Alternative D would be identical to those proposed for Alternative B, and would not change substantially from those currently in use. They are described in Section 3.G.2.c.

3.G.6.d Standard Committed Mitigation Measures

The standard construction practices that would be part of Alternative D's design, construction, operation and maintenance, and have been committed to by Western, would be identical to those used with the Proposed Action, Alternative B, as described in Section 3.D.2.d.

Right-of-Way Acquisition and Use Policies

A portion of Alternative D would require the acquisition of new ROW. Western does not propose to buy any ROW outright. Instead, it would buy an easement; i.e., the right to construct, operate and maintain a transmission line there. If the line was ever abandoned, all land rights would revert to the owner.

All new land rights would be acquired in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646) and other applicable laws and regulations governing federal acquisition of property rights. Landowners would be paid fair market value for the rights acquired for their property. In addition, the easements held or acquired would provide for separate payment to the property owner for damages to property caused by the construction, operation and maintenance of the transmission line. Every effort would be made to acquire the necessary rights by direct purchase through negotiated agreement; however, if these efforts should fail, eminent domain (condemnation) proceedings would be instituted in Federal District Court to obtain the rights. Once these proceedings have been instituted, title to the required rights passes to the United States and compensation to the landowner is determined by the court at a later date. Any land temporarily required outside the ROW during the construction phase of the project (for materials storage, etc.) would be specifically arranged with affected private landowners.

3.G.6.e Project Work at Substations and Taps

Alternative D would not require expansion of the facilities at any of the existing substations or taps to which the Flatiron-Erie line connects. There would be no work outside the existing perimeter fences at any of these facilities. However, this primary alternative would require a new substation south of Longmont, located where the Flatiron-Erie transmission line crosses an east-west PSCo line. It would occupy about 4 acres of what is currently cultivated land in the northwest corner of the intersection of these lines. The land for the substation would be purchased with a fee. In appearance, it would be a "low profile" facility, and would be constructed over a period of about one year using a work force of about 20.

3.G.7 COMPARISON OF PRIMARY ALTERNATIVES

In Sections 3.G.1 through 3.G.6, three primary alternatives are described and mapped on Figures 3.9, 3.12 and 3.15. The three alternatives are:

- Alternative B. The Proposed Action. Uprate the existing 115-kV Flatiron-Erie transmission line on its existing ROW.

- Alternative C. Rebuild 6.1 miles of the existing Flatiron-Erie transmission line underground through Longmont (on its existing ROW), uprate the remainder of the overhead transmission line.

- Alternative D. Remove two segments of the existing Flatiron-Erie transmission line in Longmont, uprate the remainder of the overhead transmission line. Supply Longmont's substations using other existing transmission lines and about 2.2 miles of new overhead transmission line on new ROW. Build a new substation south of Longmont.

The process that was used to identify the routes of these three alternatives is explained in Chapter 4, and in Section B of the Environmental Support Document. The environmental effects of these alternatives on each of the environmental components were determined as explained in Chapter 5 and in Section C of the Environmental Support Document.

There are no significant adverse impacts caused by any of the primary alternatives. Moderate adverse impacts, and beneficial effects were therefore used to compare the alternatives. In accordance with NEPA Implementation Regulations, minor or low impacts were not a primary factor in the comparison. The following material compares the impacts of the routes using the information generated in the analysis process reported in Chapter 5.

The estimated cost of each alternative is:

• Alternative B, Uprate Existing Line:	$ 1,438,000
• Alternative C, Underground Through Longmont:	$11,168,000
• Alternative D, Remove & Reroute in Longmont, Build New Substation:	$ 6,067,000

Over 50 environmental components grouped in eight categories were inventoried (Figures 4.2 through 4.8) and used to help locate the system of alternatives. Of these, only fifteen components are affected by some part of the system of alternatives at a level that influences the comparison of the routes; i.e., at moderate adverse or beneficial levels. These effects may occur over the short-term construction period, or the long-term life of the project. Beneficial effects arise from the absence of the project rather than the construction action of removing it; therefore beneficial effects may be considered as long-term. Table 3.3 quantifies the adverse effects and benefits of the three primary alternatives.

TABLE 3.3

QUANTIFICATION OF ENVIRONMENTAL IMPACTS AND BENEFITS OF PRIMARY ALTERNATIVES

Environmental Resource Area	Environmental Component	Type of Impact/ Effect	ALTERNATIVE B: Uprate Existing Line	C: Underground Through Longmont	D: Remove & Reroute in Longmont, Build New Substation
Earth Resources	Sensitive Soil/Slope Conditions	Short-Term Moderate	--	500	--
		Long-Term Moderate	--	--	--
		Beneficial	--	--	--
Water Resources	Major River or Creek	Short-Term Moderate	--	2	--
		Long-Term Moderate	--	1	--
		Beneficial	--	--	--
Biological Resources	Wetland (potential)	Short-Term Moderate	1,000	1,200	1,300
		Long-Term Moderate	--	--	--
		Beneficial	--	--	--
	Colorado Rare Fish Habitat	Short-Term Moderate	--	2	--
		Long-Term Moderate	--	1	--
		Beneficial	--	--	--
Existing Land Use	Residential Area or Site	Short-Term Moderate	2,000	13,000	10,900
		Long-Term Moderate	--	--	--
		Beneficial	--	[illegible]	9,900
	Retail/Office Development	Short-Term Moderate	--	800	800
		Long-Term Moderate	--	--	--
		Beneficial	--	800	800
	Institutional Development: School	Short-Term Moderate	200	600	600
		Long-Term Moderate	--	--	--
		Beneficial	--	[illegible]	[illegible]
	Industrial/ Heavy Commercial/ Utilities	Short-Term Moderate	800	7,300	2,300
		Long-Term Moderate	--	--	--
		Beneficial	--	[illegible]	2,300
	Public Recreation/ Open Space	Short-Term Moderate	400	2,100	2,100
		Long-Term Moderate	--	--	--
		Beneficial	--	1,900	[illegible]
	Agricultural Structure/ Farmyard/ Feedlot/ Greenhouses	Short-Term Moderate	--	--	800
		Long-Term Moderate	--	--	800
		Beneficial	--	--	--
	Cultivation	Short-Term Moderate	--	--	--
		Long-Term Moderate	--	--	7,700 + 4 acres
		Beneficial	--	--	--
Visual Resources	Existing Residential Land Use	Short-Term Moderate	--	600	1,500
		Long-Term Moderate	--	600	1,500
		Beneficial	--	12,400	10,800
	Planned Residential Land Use	Short-Term Moderate	--	--	--
		Long-Term Moderate	--	--	1,000
		Beneficial	--	--	--
	Existing Recreational/ Open Space Land Use	Short-Term Moderate	--	--	--
		Long-Term Moderate	--	--	--
		Beneficial	--	1,900	1,900
	Planned Recreational/ Open Space Land Use	Short-Term Moderate	--	--	--
		Long-Term Moderate	--	--	1,700
		Beneficial	--	--	--

Note: There are no significant adverse impacts caused by any of the primary alternatives.

Legend:

- 2 (open circle) = Number of Occurrences of Moderate Short-Term Impact
- 2 (shaded circle) = Number of Occurrences of Moderate Long-Term Impact
- 500 (open box) = Length of Moderate Short-Term Impact in Feet
- 500 (shaded box) = Length of Moderate Long-Term Impact in Feet
- 500 (dark box) = Length of Beneficial Effect in Feet

Table 3.4, Comparison of Environmental Impacts/Benefits and Costs of Primary Alternatives, shows the summary impacts and benefits for each alternative for each environmental resource area. It also shows the cost as an additional evaluation factor for each alternative. The table also indicates for each evaluation factor the rank -- best (1), mid-range (2), or worst (3) -- for each alternative.

It should be noted that, in this process, there is no weighing of one environmental resource area against another. For example, a given quantity of a moderate short-term impact on wildlife is not compared against that quantity of a moderate short-term impact on existing land use (people). Each environmental resource area is considered separately in the comparison of routes. Similarly, benefits are not considered to cancel out impacts. When routes are being compared, their impacts on the various environmental resource areas, their benefits to some of these resource areas, and their dollar costs are all considered separately.

There would be no substantial impacts to earth resources from Alternatives B and D. Very small amounts of short-term moderate impacts would occur to sensitive soil/slope conditions from Alternative C.

There would be no substantial impacts to water resources from Alternatives B and D. Alternative C would cause small amounts of moderate adverse impacts. Alternative C would have, in addition, moderate long-term impacts on water resources, such as MacIntosh Lake, from the risks of a fluid leak from the underground portion of the alternative.

Alternative B would cause relatively small amounts of short-term moderate impacts to biological resources (wetlands) from construction disturbance. Alternative C would cause slightly more of the same type of impacts; and Alternative D, very slightly more than C. However, C would also have short and long-term, moderate adverse impacts on Colorado rare fish habitat from crossing of two streams by construction equipment, and from the risk of a spill of fluid from the underground portion of the alternative.

Alternative B would cause moderate amounts of short-term moderate impacts to various land uses, including residences, a school, industry and recreation/open space. Alternative C would cause substantial amounts of short-term moderate impacts to the same land uses as Alternative B, but would also have substantial amounts of beneficial effects (mostly on the same land uses) from the removal of the existing line and its replacement by underground construction. Alternative D would also cause substantial amounts of impacts on the above land uses, plus agricultural uses, but would also have beneficial effects on developed land uses from the removal of segments of the line.

Planned land use (as explained in Section 5.F) would not be directly subject to impacts. Some of its environmental components are addressed under visual resources.

Cultural resources are not subject to impacts higher than the low level from any of the primary alternatives.

There would be no substantial effects on visual resources from Alternative B. Alternative C would have small amounts of short and long-term moderate visual impacts, but substantial amounts of beneficial visual effects on residential and recreational/open space land uses from the removal of segments of the existing line. Alternative D would cause moderate amounts of short and long-term moderate visual impacts on existing and planned residential and recreational land uses, but also substantial amounts of long-term benefits.

TABLE 3.4

COMPARISON OF ENVIRONMENTAL IMPACTS/ENVIRONMENTAL BENEFITS AND DOLLAR COSTS OF PRIMARY ALTERNATIVES

	Environmental Resource Area		Primary Alternative B Uprate Existing Line	Primary Alternative C Underground Through Longmont	Primary Alternative D Revise & Reroute in Longmont Build New Substation
Moderate Adverse Environmental Impacts (Short & Long Term)	Earth	Short Term		500	
		Long Term		-- 3	
	Water	Short Term		2	
		Long Term		1 3	
	Biological	Short Term		1,200 + 2	1,300
		Long Term		1 3	-- 2
	Existing Land Use	Short Term		23,800	17,500
		Long Term		-- 2	8,500 + 4 ac 3
	Visual	Short Term		600	1,500
		Long Term		600 2	2,500 3

Impacts Legend

500 Length of ROW Causing Moderate Short Term Impacts in Feet

500 Length of ROW Causing Moderate Long Term Impacts in Feet

5 Number of Occurrences of Moderate Short Term Impacts

5 Number of Occurrences of Moderate Long Term Impacts

Ranking of Alternatives for One Evaluation Factor

	Mid-Range 2	Worst 3

		B	C	D
Environmental Benefits	Existing Land Use	--		
	Visual	--		

Benefits Legend

10,000 Length of ROW Causing Long Term Benefits in Feet

Ranking of Alternatives for One Evaluation Factor

	None

	B	C	D
Dollar Cost		$11,168,000 3	$6,067,000 2

Ranking of Alternatives

	Mid-Range 2	Highest 3

At this time it is not clear if exposure to E&M Fields presents a health risk. The consensus opinion of the majority of researchers continues to center on the need for further research. Should science establish a significant risk to public health as a result of E&M field exposure, it is Western's expectation that the issue of E&M Field standards, avoidance strategies, evaluation procedures, etc., would be addressed in regulations after a careful, structured public debate that weights risk against cost. Uprating the existing Flatiron-Erie transmission line will serve Longmont's electrical capacity needs into the 21st century thus allowing much needed time for further research into the relationship between E&M Fields and human health risk. A more detailed discussion of the health effects issue is included in Appendix C, Public Health and Safety.

The preferred Alternative B is significantly less costly than Alternatives C and D, provides the same reliability and capacity benefits as Alternative A, and provides better reliability than Alternative D. Under Alternative D, reliability to Longmont Northwest and Terry Street Substations would be reduced because one existing transmission line into each substation would be removed. Alternative C, Underground through Longmont, is 7.8 times the cost of Alternative B and Alternative D, Remove and Reroute in Longmont and Build New Substation, is 4.2 times the cost of the preferred Alternative B. Although Alternatives C and D do reduce or eliminate the E&M Fields through the residential areas of Longmont, the uncertainty surrounding the E&M Field issue at the present time cannot justify expenditure of large sums of money, degradation of reliability and service, or greatly increased operating costs.

In summary, overall comparison of moderate adverse environmental impacts (both short and long-term) for each of the three primary alternatives, shows that Alternative B ranks the best for all environmental resource areas. Alternative B, therefore, is the environmentally preferred alternative.

Chapter 4
The Affected Environment

Chapter 4 -- The Affected Environment

In this chapter, the components of the study area environment that might be substantially affected by (or might affect) transmission line construction and/or operation are described and located on a series of data maps. This information was used to help locate the project alternatives. The process is described in Section B of the Environmental Support Document that supplements this EIS.

4.A STUDY AREA DEFINITION AND DESCRIPTION

The study area covers about 284 square miles. Its northern boundary is located just north of Carter Lake and it extends approximately 25 miles to the south. The eastern boundary is located generally about 3 miles west of I-25. The study area typically extends 10 to 12 miles to the west, extending into the fringes of the foothills. The area centers on the existing Flatiron-Erie transmission line. This passes through the City of Longmont near the center of the study area and close to the community of Erie near its southern end.

The study area contains, in the most general terms, three basic environmental situations. In the northwest is an area that is primarily undeveloped, though with scattered pockets of residential development. This area is moderately steep and rugged and contains several concentrations of earth and biological resources that are constraints to transmission line siting. In the center of the study area is the Longmont urban area with its concentration of land uses, primarily residential developments, that are major constraints to transmission line siting. In the remainder of the study area are extensive agricultural lands interspersed with substantial areas of residential development, both representing siting constraints. The entire study area is crossed by a number of east-flowing streams whose valleys represent moderate barriers to a north-south transmission line because of the concentrations of earth, water and biological resource values there. A network of existing transmission lines crosses the study area, and this represents an important class of opportunity for the siting of a new transmission line. Figure 4.1 illustrates the three characteristic situations in the study area.

4.B ENVIRONMENTAL CATEGORIES AND COMPONENTS

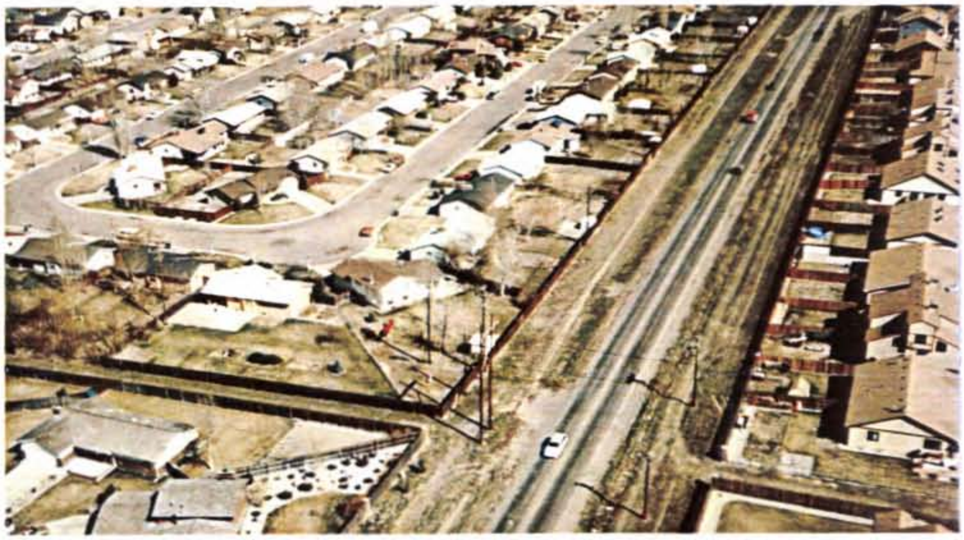
The description of the affected environment is organized into the following categories:

- Earth Resources and Hazards
- Water Resources
- Biological Resources
- Land Use (existing land use, existing utilities, planned land use)
- Visual Resources
- Cultural Resources

The order in which the environmental resources are presented within this chapter does not represent any relative value placed on them. For the purpose of developing the alternative routes, each category is given the same general value. For the purpose of impact assessment (see Chapter 5 and Section 3.G.3.b), categories are not evaluated against each other. The impacts on each category are kept separate in the analysis and comparison.

The environmental data were mapped at a scale of 1" = 3,000'. The base map used is derived from the USGS 1:50,000 scale topographic "County" Series maps, dated 1978 and 1980. These are the most recent of the alternative potential sources for a base map that were available. The mapping, as

View of Undeveloped Terrain and Residential Area South of Carter Lake



View of Typical Residential Area in Longmont. Existing Flatiron-Erie Transmission Line in Foreground

View of Typical Agricultural Land with Residence, South of Longmont

Flatiron-Erie 115kV Transmission Line Project

Western Area Power Administration

Study Area Representative Conditions

Figure 4.1

it appears in this EIS, is reduced to a scale of approximately 1" = 9,500'. The agencies that were consulted in collecting the data are listed in Section 6A. The publications and other sources that were used to inventory the data are listed in Section B of the Environmental Support Document that supplements this EIS.

Limited field checking was also performed, especially for the biological and land use components of the environment.

4.B.1 ISSUES IDENTIFIED AS NOT SIGNIFICANT AND NOT REQUIRING DETAILED STUDY

Other environmental resource areas that were considered, but are not described in detail in this analysis, include the following:

- Air Quality -- The project would have very minor, local, short-term effects on air quality, limited primarily to short-term emissions from construction vehicles and fugitive dust generated by construction activities. The transmission line would have no measurable effect on ozone levels.

- Climate -- The project would have no effect on climate.

- Ground Water -- The project would have no effect on ground water.

- Socioeconomics -- The construction of the project would have no measurable effect on population, employment or other socioeconomic factors in the region. The socioeconomic effects of the project on local communities would be production of income. Due to the small work force and the fixed availability of public services, the income effects of the work force would likely be more evident than possible impacts on public services. Income would be generated in basically three areas: income generated by the contractor for materials purchased in the local economy; income generated by the construction work force and Western staff in the form of lodging, food, retail sales and gas; and wages paid to construction work force and Western staff.

4.C <u>EARTH RESOURCES AND HAZARDS</u>

4.C.1 POTENTIAL LANDSLIDE AREAS

These areas consist of outcrops of the Dakota Group geologic formation. This contains sandstones, siltstones and shales that are subject to landslides and rockslides. The potential landslide areas are associated with low, north-south trending ridges and hogbacks. Generally, only the east sides of these ridges have exposures of the Dakota Group, the unstable material. These potential landslide areas present a moderate constraint to transmission line siting. They occur (Figure 4.2) in the foothills west of Longmont near Rabbit Mountain and Carter Lake.

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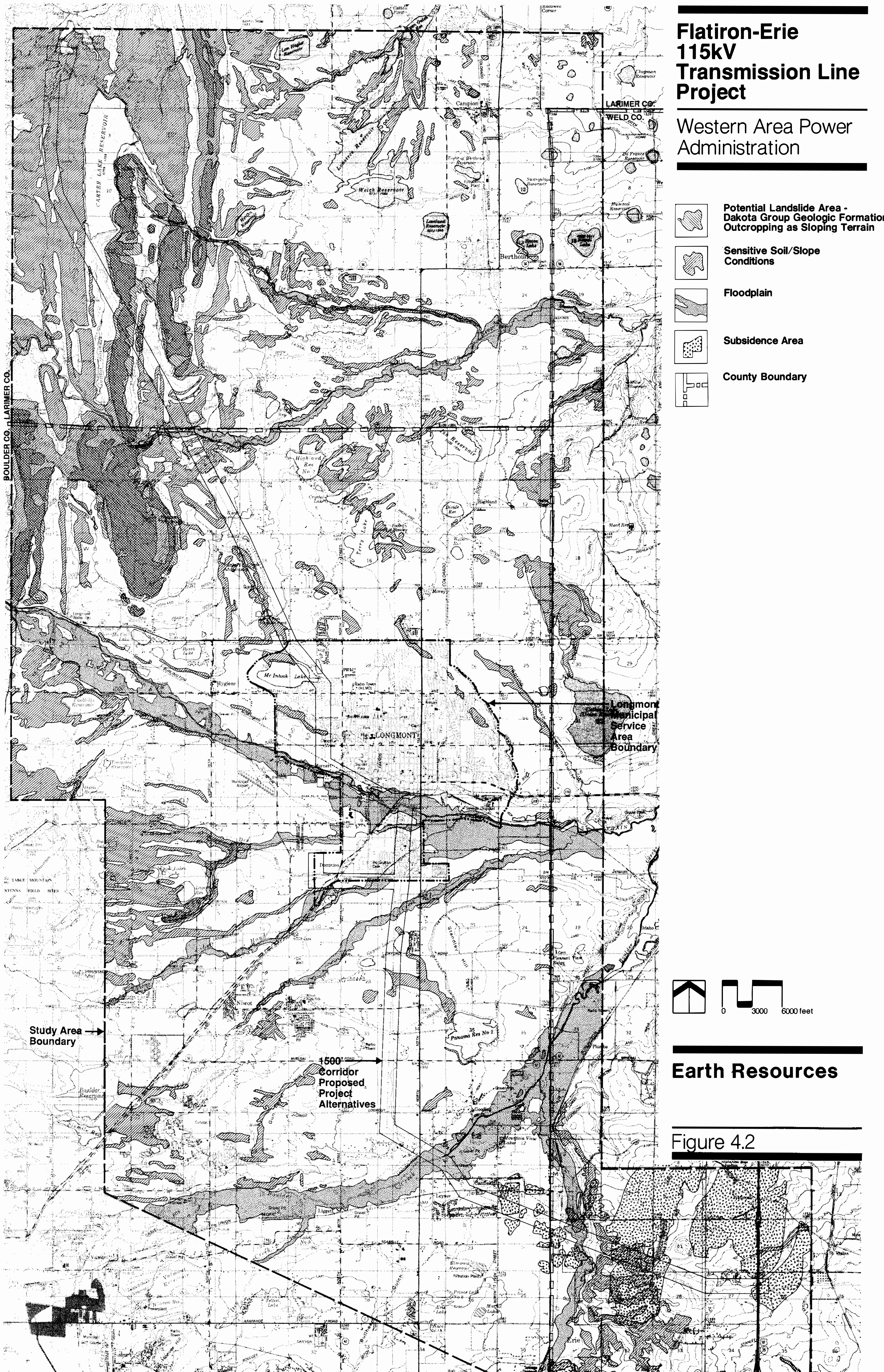

Earth Resources

Figure 4.2

4.C.2 SENSITIVE SOIL/SLOPE CONDITIONS

This mapping unit includes those soils with a high erosion potential due to steep slopes, shallow soil depth or other physical characteristics, plus those soils where reclamation would be difficult due to a high concentration of salts or strong alkalinity. Erosive areas and those soils with a low reclamation potential were mapped as a single unit, and are identified on Figure 4.2. The unit is considered a moderate constraint to transmission line siting.

Sensitive soil/slope conditions are concentrated in the northwestern portion of the study area around Carter Lake, generally on the low hills and hogbacks of the Piedmont physiographic province. Smaller patches of the mapping unit, however, occur throughout the study area.

4.C.3 FLOODPLAINS

The 100-year floodplain has been mapped for all the major and some of the minor streams of the study area (Figure 4.2). Streams with mapped floodplains, listed from north to south, include: Little Thompson River and its tributary Dry Creek, St. Vrain Creek, Left Hand Creek, two more streams both called Dry Creek, Spring Gulch, Boulder Creek and Coal Creek. (Federal Emergency Management Agency, Flood Insurance Rate Maps, Boulder, Weld and Larimer Counties.)

The width of the 100-year floodplain of the generally east-flowing streams is variable, and in places is related to channelization, roads and other urban landscape modifications. St. Vrain Creek has a floodplain width up to 4,800 feet just east of 107th Street near Longmont. The width of the Boulder Creek floodplain near its confluence with Coal Creek is over 6,600 feet. Many of the broad floodplains have elevated inclusions that are not flooded by 100-year storm events. Channelization has resulted in the confinement of the 100-year storm events to the stream channel for portions of Left Hand Creek and the northernmost Dry Creek tributary of St. Vrain Creek. Other floodplains are naturally narrow.

Unlike most types of development, transmission lines (whether overhead or underground) are relatively immune to floods. They would not typically be harmed by any but the most severe flood, and would be unlikely to substantially affect flood stage. Therefore, floodplains have a low constraint value for transmission line siting.

4.C.4 SUBSIDENCE AREAS

The subsidence areas are associated with historic underground mines near Erie. The subsidence areas west of Erie are 20 to 100 acres in size; however, those east of Erie are much larger -- up to 9,000 feet wide and over 15,000 feet long (Figure 4.2).

Subsidence areas have the potential to upset the structural stability of a transmission line and require additional maintenance work. They have been assigned a moderate constraint value.

4.D WATER RESOURCES

4.D.1 PONDS AND RESERVOIRS

The agricultural portions of the study area are characterized by a complex network of irrigation ditches and storage reservoirs. Major irrigation ditches divert water from the large streams and direct it to the storage reservoirs. Small ponds maintained only by local surface runoff are also present.

The area has hundreds of ponds and storage reservoirs of varying sizes. Carter Lake, located in the northwest portion of the study area, is the largest water body. Other large water bodies include Calkins Lake, Lonetree Reservoir, Welch Reservoir, Panama Reservoir, Ish Lake, Terry Lake, McIntosh Lake, Foothills Reservoir and a portion of Boulder Reservoir.

Figure 4.3 illustrates the streams, ponds and reservoirs of the study area. The ponds and reservoirs have been mapped in two categories: those over and those under 40 acres in size. Water bodies over 40 acres are considered to be generally not spannable by an overhead transmission line, and are therefore given a very high constraint value. Water bodies under 40 acres in size should generally be spannable and have a less severe constraint value. Because of the potential for resource damage during construction, however, the constraint value is considered high.

4.D.2 MAJOR RIVERS AND STREAMS

The study area is characterized by numerous east-flowing perennial streams, some with tributaries and some feeding water storage reservoirs up to 1,000 acres in size. Major streams, listed from north to south, include: Little Thompson River and its major tributary Dry Creek, St. Vrain Creek and its tributaries Left Hand and Dry Creeks, and Boulder Creek with its tributary Coal Creek. Numerous small ephemeral streams are tributary to these larger streams. The major streams have a moderate constraint value for transmission line siting.

4.E BIOLOGICAL RESOURCES

Important biological resources with the potential to be affected by transmission line construction and operation are distributed throughout the project area, but are concentrated in the vicinity of Rabbit Mountain and along Boulder and St. Vrain Creeks. They also occur to a lesser extent along other streams and around water bodies.

Following is a description of the important biological resources of the study area as illustrated on Figure 4.4:

4.E.1 MAJOR POTENTIAL WETLANDS

Several wetland types, including cattail marshes, riparian woodlands, willow shrublands and sedge/rush/grass meadows are present along streams and around ponds and reservoirs. However, most of the communities are too small to be identified by type and locality, i.e., they are so small that they would not be legible at the mapping scales appropriate to a regional study. Therefore, wetlands were mapped under a general category that included all wetlands types. The major streams in the study area are generally characterized by narrow zones of wetland vegetation on the floodplains; flood-irrigated low areas along streams have enlarged the zone of natural wetlands vegetation. Many of the reservoirs in the study area have zones of emergent wetland vegetation. The location of wetland areas is shown on Figure 4.4. Wetlands have a high constraint value for transmission line siting.

4.E.2 CRITICAL PLANT ASSOCIATIONS

The Colorado Natural Area Program and the Boulder County Comprehensive Plan have identified five plant associations considered to be threatened by urban development and domestic livestock grazing within the study area. However, these communities are relatively common in Eastern Colorado. They include: (1) Ponderosa pine-mountain mahogany-big bluestem; (2) mountain mahogany-

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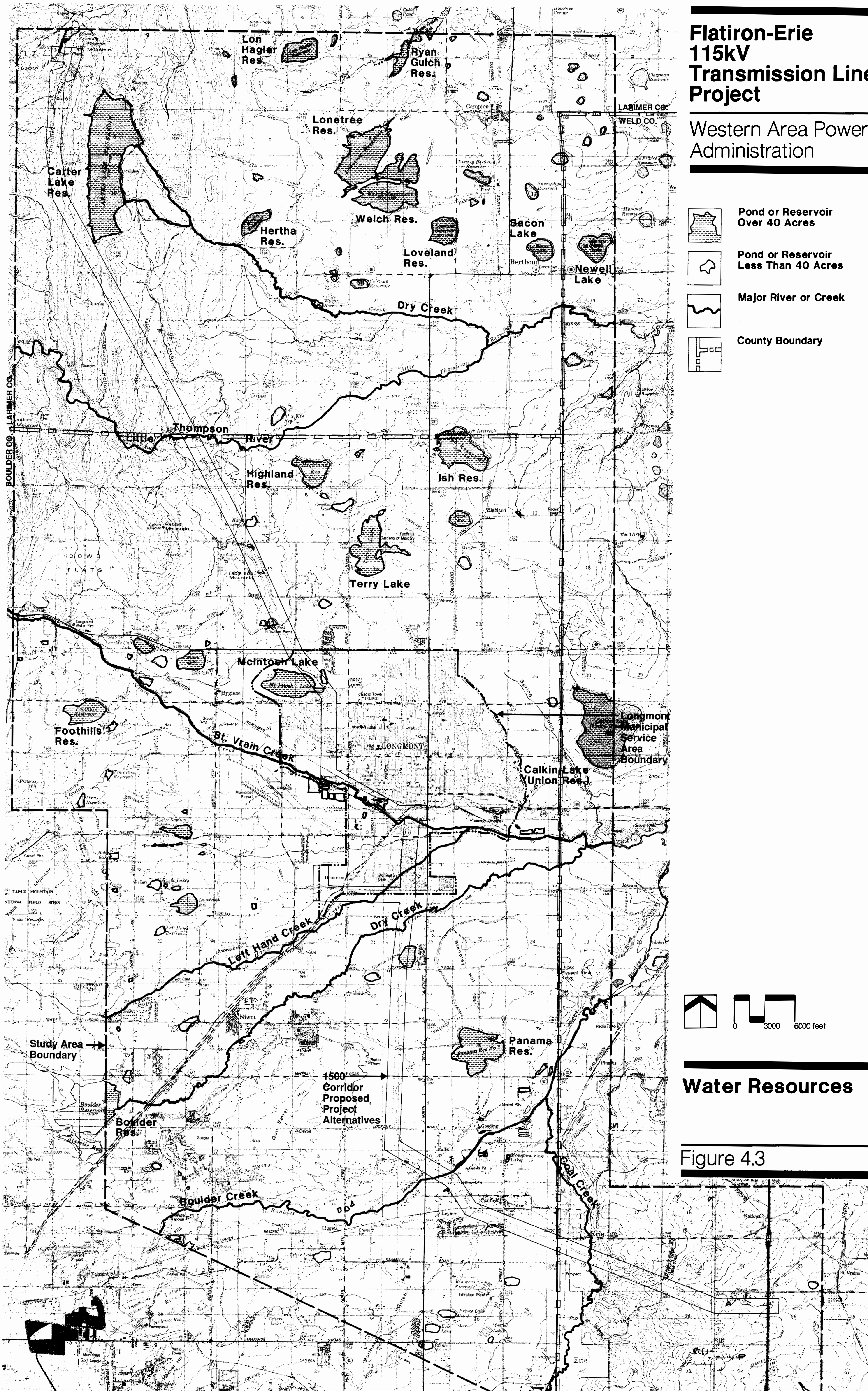

Water Resources

Figure 4.3

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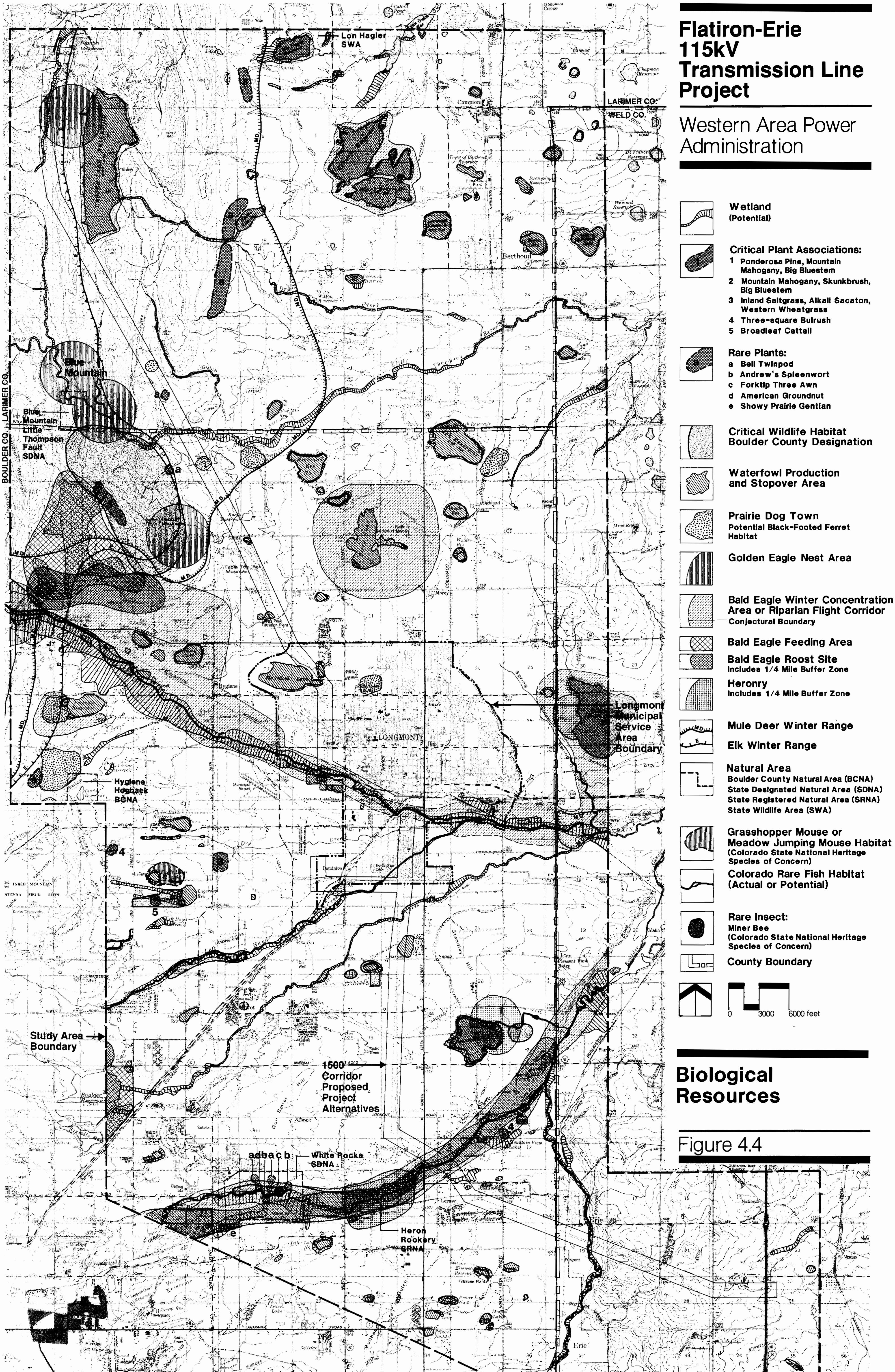

Biological Resources

Figure 4.4

skunkbrush-big bluestem; (3) inland saltgrass-alkali sacaton-western wheatgrass; (4) three-square bulrush; and (5) broadleaf cattail. The first two plant associations of concern occur in one location -- a ridge west of Rabbit Mountain. The third plant association of concern is located about two miles north of Niwot just east of 75th Street. The three-square bulrush association occurs along Boulder Creek, west of its junction with Coal Creek and near Bohn Lake. The broadleaf cattail association is at Lagerman Reservoir about two miles northwest of Niwot. These are shown on Figure 4.4. Because these are plant associations that are not rare in the region, and because of the relatively small amount of disturbance that transmission line construction would cause, the siting constraint value for critical plant associations is moderate.

4.E.3 RARE PLANTS

One plant listed as threatened on the federal species list is known to occur within the study area. A survey conducted in 1992 found the Ute Ladies' Tress Orchid (Spiranthes diluvialis) at two locations on St. Vrain Creek at a site west of the City of Longmont. Bell Twinpod (Physaria bellii), a federal candidate species, occurs at the White Rocks State Designated Natural Area and on the ridges about two miles southeast of Carter Lake, near Lon Hagler Reservoir, north of Rabbit Mountain, and near the Hygiene Hogback Natural Area.

In addition, the Colorado Natural Area Program and the Boulder County Comprehensive Plan have identified and mapped the location of four herbaceous plants in the study area that are considered to be locally rare. They include Andrew's spleenwort (Asplenium andrewsii), forktip three awn (Aristida basiramea), American groundnut (Apios americana), and showy prairie gentian (Eustoma grandiflorum). Populations of the first three species occur at White Rocks State Designated Natural Area (Boulder County Comprehensive Plan). A population of the showy prairie gentian occurs just west of White Rocks. These plant species (shown on Figure 4.4) have a high constraint value for transmission line siting.

4.E.4 DESIGNATED CRITICAL WILDLIFE HABITAT

This is habitat identified in the Boulder County Comprehensive Plan as important to wildlife. As shown on Figure 4.4, the study area contains eleven areas of critical wildlife habitat. Rabbit Mountain, northwest of Longmont, is the largest of these. Others, on a general north to south basis, include St. Vrain Creek and corridor, Lagerman Reservoir, Left Hand Canyon Cottonwood Groves, Gaynor Lakes, Panama Reservoir, B-J Acres Ranch, White Rocks, the Cottonwood Grove and the Heron Rookery along Boulder Creek, and portions of Walden and Sawhill Ponds. Most of these areas are associated with wetlands habitats of seasonal importance to specific wildlife groups. They may also support many diverse wildlife groups. Critical wildlife habitat designated by Boulder County has a high constraint value for transmission line siting.

4.E.5 WATERFOWL PRODUCTION & STOPOVER AREAS

Many of the reservoirs and ponds in the study area are used by ducks and Canada geese for nesting and rearing of young. However, the magnitude of waterfowl production is low, usually less than ten broods per reservoir, and populations average less than 50 birds per water body.

Most of the reservoirs and ponds of the study area are also used by waterfowl as resting habitat during spring and fall migrations, although the importance of individual water bodies varies. Reservoirs and other water bodies used as waterfowl production and stopover areas are common throughout the study area, and are mapped on Figure 4.4. They have a moderate constraint value for transmission line siting.

4.E.6 PRAIRIE DOG TOWNS

Prairie dog towns, active between 1987 and 1991, were mapped because of their potential to support black-footed ferrets and breeding and wintering raptors. Prairie dog populations are extremely dynamic, recently characterized along the Front Range by rapid colonization of new areas followed by bubonic plague and decimation. No observations or other indications of black-footed ferret presence have been documented within the study area, or within Colorado, in recent years. As shown on Figure 4.4, several large prairie dog towns are located in the Rabbit Mountain/Dowe Flats area. Two towns (probably too small to support a population of ferrets) are located along the existing 115-kV ROW. As explained in the Biological Assessment (Appendix E to this document), procedures are in place to protect the black-footed ferrets. Prior to construction, any areas that would be disturbed by project construction would be surveyed, probably from the air, to check for currently active prairie dog towns. If any were found, the U.S. Fish and Wildlife Service would be consulted to determine the need to survey for black-footed ferrets and to determine subsequent procedures in the very unlikely event that ferrets were found to be present. Therefore, existing prairie dog towns have been assigned a low constraint value for transmission line siting.

4.E.7 GOLDEN EAGLE NEST AREAS

Golden eagle nest areas and a surrounding buffer zone were mapped because the nests of these large raptors are protected by federal law and the species is of high conservation concern. Five golden eagle nest areas are located in the northwestern portion of the study area, in the vicinity of Rabbit Mountain and Carter Lake (Figure 4.4). Some of these nest sites are currently active, while others are inactive alternate sites. Construction of the project would not take place in any nest areas centered on active nests during the critical breeding season. Therefore, their constraint value is rated moderate.

4.E.8 BALD EAGLE USE

Figure 4.4 illustrates the areas frequently used by the bald eagle, a state and federally endangered species. Bald eagles are primarily winter visitors or winter residents in the study area. They do not nest in the study area. Their use of specific habitats varies between winters, and is related to fluctuations in the number and distribution of prairie dogs, rabbits and hares, and wintering waterfowl. Several areas utilized by wintering bald eagles occur in the study area. St. Vrain River and Boulder Creek are used as flight corridors and for hunting winter waterfowl. The upland areas, from Dowe Flats and adjacent areas south to Foothills Reservoir, are associated with active prairie dog towns, important winter prey. Many of the larger reservoirs and streams also represent feeding areas. A bald eagle roost site is located near Coot Lake approximately two miles southwest of Niwot. Another roost area is located north of the St. Vrain River near Dowe Flats. The siting constraint value assigned to the various bald eagle use areas varies depending on the susceptibility of the birds to disturbance. Winter concentration areas, roost sites and feeding areas are high constraints. The riparian flight corridor is a moderate constraint.

4.E.9 HERONRIES

The study area has three heron rookeries as shown on Figure 4.4. Two small great blue heron rookeries are located in cottonwoods flanking Calkins Lake and Panama Reservoir No. 1. One to five nests have been active here in each of these areas in the past 40 years. A large heronry occurs in a mature cottonwood stand along Boulder Creek between 95th Street and U.S. 287. The rookery is used by 70-80 pairs of herons (as well as other water birds) and has been stable for the last

30-35 years. These areas are considered critical wildlife habitat according to the Boulder County Comprehensive Plan. A buffer zone has been defined around them and given a high constraint value for transmission line siting.

4.E.10 MULE DEER & ELK WINTER RANGE

Winter range is habitat used by mule deer and elk during the winter for food, cover and local movement. The study area contains a convoluted mule deer winter range extending from the west central portion of the study area, northeast across Rabbit Mountain, and north to Lon Hagler Reservoir. A fringe of elk winter range extends along the western border of the study area, from Foothills Reservoir north to Flatiron Mountain near Carter Lake. Figure 4.4 shows the location of these winter ranges. These areas are very large, covering major portions of the study area and extending west through the foothills. Therefore, the percentage of the areas that would potentially be disturbed by a transmission line would be very small. In addition, the disturbance would be temporary and would be eliminated after reclamation. Therefore, the areas have a low constraint value for transmission line siting.

4.E.11 NATURAL AREAS

The natural area mapping unit includes Boulder County and State Natural Areas and State Wildlife Areas. Boulder County Natural Landmark sites have also been designated by the County, but these are considered to reflect primarily visual concerns and are addressed in Section 4.K, Visual Resources. From north to south, the natural areas include Lon Hagler State Wildlife Area, Blue Mountain-Little Thompson Fault State Designated Natural Area, Hygiene Hogback Boulder Canyon Natural Area, White Rocks State Designated Natural Area, and the Heron Rookery State Registered Natural Area along Boulder Creek. They are shown on Figure 4.4 and have a high constraint value.

4.E.12 RARE SMALL MAMMAL LOCATIONS

The distribution of Preble's jumping mouse, a subspecies of the meadow jumping mouse, is poorly defined in Colorado. This mouse, a federal candidate species, was collected once from a vacant field east of Niwot. The grasshopper mouse has been found near Swede Lakes in Boulder County. The locations where these species were found are shown on Figure 4.4. Although the data on these species suggest that the probability of adverse effect is low, in order to reflect local concerns, the areas are given a moderate constraint value for transmission line siting.

4.E.13 COLORADO RARE FISH HABITAT

The common shiner, bigmouth shiner, Johnny darter and Iowa darter are all fish species common in other parts of their North American distribution. Populations in Colorado represent marginal distributions and are considered locally rare by the Colorado Division of Wildlife. These species have recently been collected at several sites within the study area; however, stream reaches upstream and downstream of these sites also represent suitable habitat. Therefore, all portions of Boulder Creek, the St. Vrain River and their tributaries in the study area have been mapped as potential habitat on Figure 4.4. The creeks would all be spanned by the project. Some temporary disturbance would result from construction vehicles and equipment crossing the streams (and from trenching with underground construction), but this would occur in winter at times of low flow. Downstream sedimentation would therefore be minimal. Disturbed banks would be reclaimed after construction. Therefore, these streams are given a moderate constraint value.

4.E.14 RARE INSECT

Miner bees nest in colonies composed of individual burrows dug into near vertical Laramie Sandstone outcrops and cliffs. Because their distribution is closely associated with these geologic features, which are uncommon in the study area, the bee is relatively rare. In the study area, the miner bee is known only from the White Rocks area along Boulder Creek, as shown on Figure 4.4. Being near vertical, the habitat would almost certainly be spanned by any potential transmission line, and would not be a potential location for construction accessways. Because of this and in order to reflect local concerns, the habitat has a moderate constraint value for transmission line siting.

4.F EXISTING LAND USE

Almost all of the study area, with the exception of its northwest portion, is occupied by land uses that are (in varying degree) sensitive to the construction and operation of a transmission line. The following is a description of the important sensitive land uses in the study area, as illustrated on Figure 4.5

Land use constraint values assume that in developed (built up) areas, all routes will follow land use edges, property boundaries, roads or other ROW's. The values assume that no route would be defined that would require removal of a major building.

The visual sensitivity of existing land uses was a factor in assigning constraint values.

4.F.1 RESIDENTIAL LAND USES

Residential areas and isolated residences are mapped (primarily from aerial photography) on Figure 4.5. Residential areas, i.e., relatively large contiguous areas of housing, are scattered throughout the study area. For example, residential areas occur in Berthoud, along the Little Thompson River, in Niwot, southeast of Boulder Reservoir, in Leyner and in Erie. By far the largest area, however, is in and around Longmont where an area that is primarily housing extends about 4 1/2 miles north to south and about 4 miles east to west. Isolated residences are found in an irregular scatter over the entire study area, though with fewer in the northwest portion of the area. Residential is one of the most sensitive land uses relative to transmission line siting and has been assigned a high constraint value.

4.F.2 RETAIL/OFFICE LAND USE

This land use is found in and on the periphery of Longmont and on the periphery of Boulder. As shown on Figure 4.5, it also occurs in small areas in association with some of the older, smaller communities in the study area, particularly Berthoud and Hygiene. This land use has a moderate constraint value for transmission line siting.

4.F.3 INSTITUTIONAL LAND USES

Institutional land uses are mapped on Figure 4.5 in two categories: schools and other (hospitals, local government facilities, etc.). These land uses are found primarily in and around Longmont, but also in association with some of the smaller established communities, such as: Campion, Berthoud, Hygiene, Erie and Niwot. The constraint values applied are high for schools and moderate for others.

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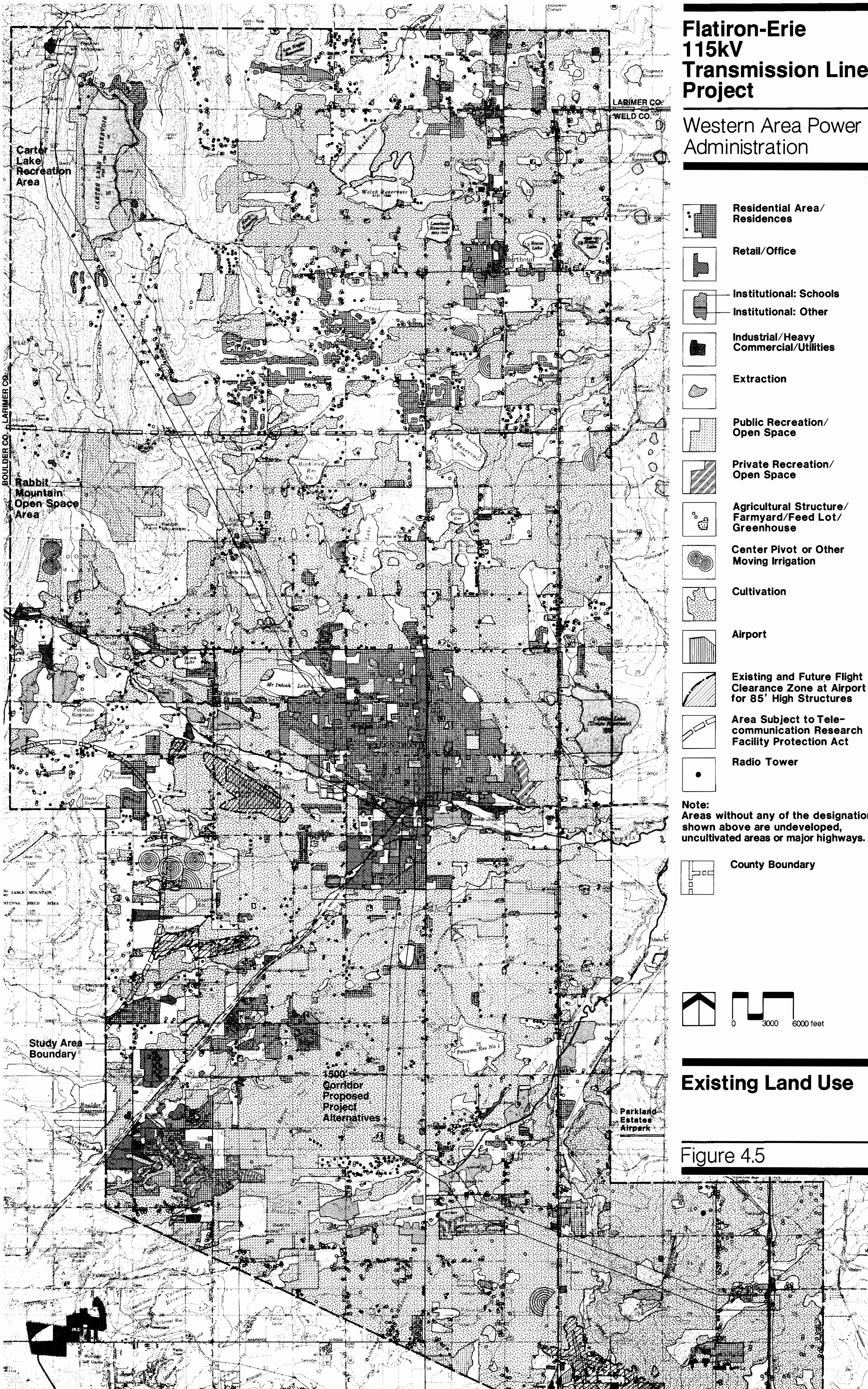

Existing Land Use

Figure 4.5

4.F.4 INDUSTRIAL, HEAVY COMMERCIAL AND UTILITIES LAND USES

These uses are concentrated around the southern part of Longmont but also occur in scattered locations, through all but the northwest portion of the study area. They appear on Figure 4.5. These isolated occurrences are frequently gravel processing plants, municipal service facilities (water treatment, etc.) and automobile wrecking operations. The heavy commercial category of land use is not always easily separable from office, but consists of those types of development judged to have a more industrial type of appearance and to be less sensitive to their visual environment. The land uses have a low constraint value.

4.F.5 EXTRACTIVE LAND USE

There are several operations extracting sand and gravel from deposits along the major streams in the study area, especially St. Vrain Creek and Boulder Creek. There is also limestone mining for cement manufacture south of St. Vrain Creek near the west edge of the study area, and in one location southeast of Carter Lake near the existing Flatiron-Erie transmission line. This land use (as shown on Figure 4.5) has a moderate constraint value for transmission line siting because of the potential for a new transmission line to prevent the extraction of the resource in the vicinity of the ROW.

4.F.6 RECREATION AND OPEN SPACE

Recreational/open space land uses are shown in two categories: public and private (see Figure 4.5). The private areas are generally golf courses. The largest units of recreation/open space land use are grouped in two locations: the periphery of Longmont and the periphery of Boulder. In addition, Lagerman Reservoir, Carter Lake and Rabbit Mountain are important large recreation areas. Public and agency perception is generally that transmission lines are incompatible with recreational/open space uses. Their constraint value is therefore high.

4.F.7 AGRICULTURAL LAND USES

Agricultural land uses (as shown in Figure 4.5) are rare in the northwest portion of the study area but common elsewhere, generally increasing in the proportion of land covered as one progresses from northwest to southeast. Three types of this use are identified. The first type consists of agricultural structures, including farmyards, feed lots and greenhouses. These are usually found in association with one or more residences which are, however, mapped separately. Agricultural structures have a moderate constraint value for transmission line siting.

Center pivot irrigation is also mapped (no moving irrigation rigs of other types were identified), and is given a very high constraint value because the usability of a center pivot rig would be seriously compromised if any part of its radius was crossed by a new transmission line. Ten instances of this land use were identified.

The great majority of agricultural land use in the study area is cultivation. This information was obtained from aerial photography and includes all land that appeared to be either cultivated or irrigated. The boundaries of this use are necessarily at times uncertain, however, because the extent of cultivation and irrigation varies from year to year. This category appears to include almost all occurrences of prime agricultural land (that has not been covered by development). Because of the inconvenience of cultivating around transmission line structure bases and because of the small amount of land removed from use, cultivation is given a moderate constraint rating.

4.F.8 AIR TRANSPORTATION USES

Active airports/landing strips are mapped on Figure 4.5. There are four of these in the study area: Longmont Airport west of the city, an airstrip north of the Longmont/Boulder diagonal highway; Parkland Estates Airport (just outside the study area northeast of Erie), and Tri-County Airport south of Erie. These areas have a moderate constraint value. All of them, however, are overlaid (wholly or mostly) by the Flight Clearance Zones for tall structures required by Federal Aviation Administration regulations (under 14 CFR, Chapter 1, Part 77, Objects Affecting Navigable Airspace). These zones have been calculated for 85-foot tall structures to reflect the probable greatest height of the proposed project (when using wood H-frame structures). These exclusion zones have been given a very high constraint value.

4.F.9 TELECOMMUNICATIONS FACILITY PROTECTION ZONE

A large area southwest of Longmont and north of Boulder, centered on the Table Mountain antenna field, has been designated as a telecommunications research facility protection zone. This zone (as shown on Figure 4.5) was set up under the Telecommunications Research Facility Protection Act of 1967. The objective of the act is to prevent the generation of certain types of electrical fields that would interfere with the research at the facility. These types of fields are generated by transmission lines, which are therefore excluded from the vicinity of the research facilities. The protection zone has a very high constraint value.

4.F.10 RADIO TOWER SITES

There are three radio towers in the study area. Two are located east of Niwot and one north of Erie. These have a high constraint value for transmission line siting.

4.G EXISTING ELECTRICAL UTILITIES

All major (69-kV and over) electric transmission lines, insofar as they represent pre-existing corridors, are potential opportunities for the location of new transmission lines. They appear on Figure 4.6, along with all major switchyards and substations. The existing Flatiron-Erie 115-kV single circuit transmission line runs northwest and southeast through the heart of the study area. Western's proposed action is the uprating of this line, and the study area was designed to accommodate any feasible alternative to it.

Seven substations/switchyards are located along the Flatiron-Erie line. At its north end is Flatiron Switchyard, an origin point for four additional 115-kV lines that run north and west. About three miles northwest of Longmont, closely grouped, are Lyons Tap (the point of origin of a west-running 115-kV line) and Hygiene Substation. At the northwest edge of Longmont are Northwest Substation, and immediately adjacent, Harvard Substation. From this location, a 115-kV line proceeds east to Meadow Substation (in Longmont), and then east and north to Longs Peak Substation. Farther south on the Flatiron-Erie line is Fordham Tap, from which a line runs south to Fordham Substation. In south-central Longmont on the Flatiron-Erie line is Terry Street Substation. From here, a 115-kV line runs east and then north to Longs Peak Substation. Between Terry Street and its termination at Erie Switching Station, adjacent to I-25, the Flatiron-Erie line does not connect to any substation. However, it does cross an east-west running 115/230-kV two circuit transmission line, the western segment of which connects to Niwot Substation. From Erie Switching Station, a 115-kV line runs east and another south. There is a separate major element of the local transmission system within the

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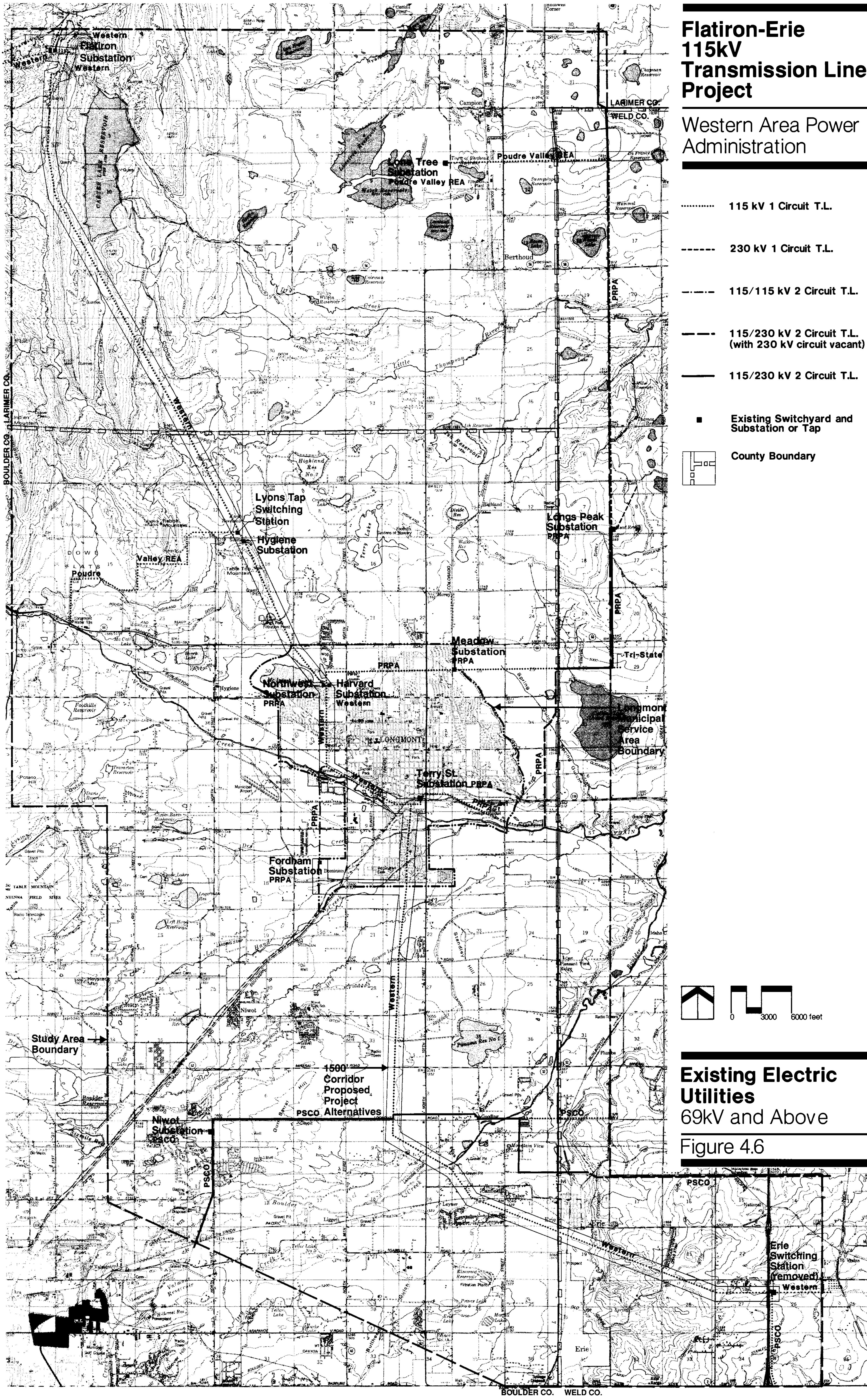
··········	115 kV 1 Circuit T.L.
- - - - - -	230 kV 1 Circuit T.L.
—·—·—	115/115 kV 2 Circuit T.L.
— — —	115/230 kV 2 Circuit T.L. (with 230 kV circuit vacant)
———	115/230 kV 2 Circuit T.L.
■	Existing Switchyard and Substation or Tap
	County Boundary



Existing Electric Utilities

69kV and Above

Figure 4.6

study area. This is a 230-kV line that runs north from Longs Peak Substation. Near Campion, it combines with a 115-kV line proceeding from Lonetree Substation to the west, to form a two circuit 115/230-kV line that runs north.

4.H PLANNED LAND USE

Portions of the study area are occupied by areas planned by various local authorities for future land uses that are (in varying degrees) sensitive to the construction and operation of a transmission line. The following is a description of the important planned land uses in the study area, as illustrated on Figure 4.7. Planned land uses are not mapped where there are already extensive areas of relatively intense, existing development. The visual sensitivity of planned land uses was considered in assigning constraint values. Planned land use constraint values are generally lower than the corresponding values for existing areas of the same uses because of the element of uncertainty that the uses will actually occur as planned, and the opportunities to design future development around a transmission line to minimize adverse effects.

4.H.1 PLANNED RESIDENTIAL LAND USES

Planned residential land uses of various densities are concentrated on the southern fringe of Loveland; around Longmont on its northeast, south and southwest sides; around Niwot; and southwest of Erie. Many of the units of these planned uses are large, a mile or more across. Other scattered areas of planned residential uses occur in rural southern Larimer County, and west and southwest of Niwot along the Boulder-Longmont diagonal highway. These planned land uses are shown on Figure 4.7, and have been assigned moderate constraint values for transmission line siting.

4.H.2 PLANNED COMMERCIAL LAND USE

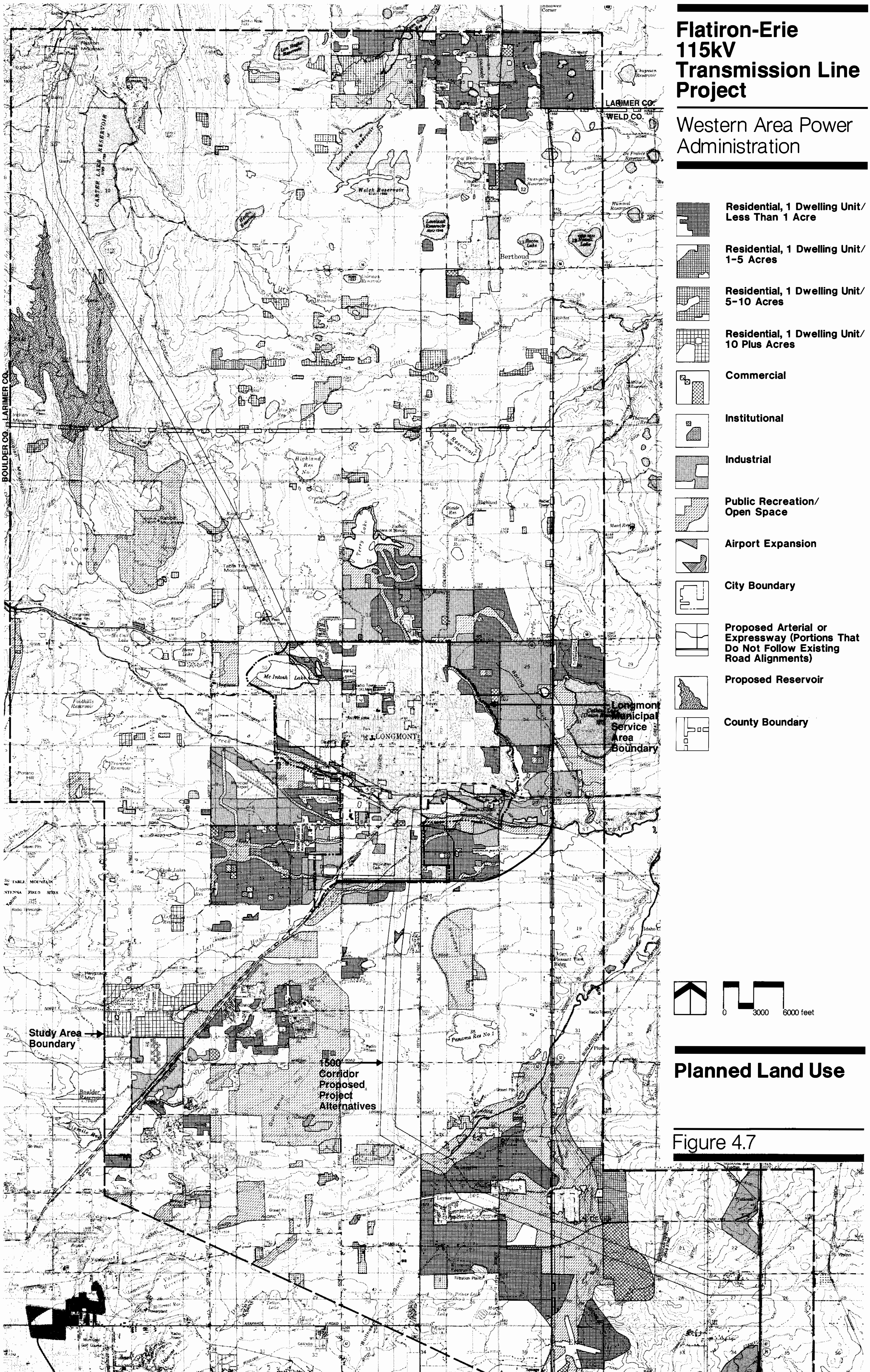
A few small areas of future commercial land use are planned in the study area and are shown on Figure 4.7. Most of these are inclusions in the planned land uses around Longmont and near Niwot. One large area of commercial land use is planned southeast of the community of Erie. Future commercial land use has a low constraint value for transmission line siting.

4.H.3 PLANNED INSTITUTIONAL LAND USE

Planned institutional land uses in the study area are mostly small inclusions in the area proposed for future development around Longmont (see Figure 4.7). However, some of the planning efforts in the study area are relatively broad and general in scope. It is probable that many planned residential areas would include pockets of institutional development. Planned institutional land use has a moderate constraint value for transmission line siting.

4.H.4 PLANNED INDUSTRIAL LAND USE

Sizeable portions of the study area (often a mile across) have been planned for future industrial use, as shown on Figure 4.7. These areas are concentrated on the periphery of Longmont, on all sides except the northwest. There are also planned industrial areas near the southern edge of Loveland, at the north edge of Berthoud, along the Boulder-Longmont diagonal highway, and adjacent to two I-25 interchanges in the southeast corner of the study area. Planned industrial land use has a low constraint value for transmission line siting. A similar planned use (also with the low constraint value) is airport expansion. Areas of this type are planned at Longmont Airport.



Planned Land Use

Figure 4.7

4.H.5 PLANNED PUBLIC RECREATION/OPEN SPACE

Very large areas of this future use have been planned (as shown on Figure 4.7). Two of these are appended to the existing open space on Rabbit Mountain. Several are on the periphery of Longmont, in places as a network of open spaces interspersed amongst future housing areas, elsewhere as bands of open space along Left Hand and St. Vrain Creeks. Several large areas of planned open space surround Niwot, particularly Gunbarrel Hill to its southeast. Two open space areas are planned along Boulder Creek: one northeast of Valmont Reservoir, the other a larger area northwest of Erie. Areas north and south of Erie, along Coal Creek and west of the community, are also planned for open space. These areas are given a moderate constraint value for transmission line siting.

4.I CULTURAL RESOURCES

This analysis of the existing cultural environment addresses recorded cultural sites. Additional cultural (especially archaeological) sites, never discovered or at least never recorded in agency files, may exist.

There are numerous historic and archaeological resources in the study area. Archaeological sites include the following types: stone ring sites, open camps, lithic scatter sites, stone alignments, and burials. Historic sites primarily include the following types: buildings, cemeteries, ditches and railroads.

The relative resource values of the recorded cultural sites in the study area vary widely. Values range from high constraint for sites on the National Register of Historic Places (NRHP), to low constraint for sites officially evaluated as not eligible for the NRHP.

Data on recorded cultural sites are made available by the State Historic Preservation Office only on the condition that the specific locations of sites must not be made public. This is to prevent vandalism and illicit excavation of sites. Therefore, the cultural resources map that was prepared to help develop a system of alternative routes for the project does not appear in this EIS.

4.I.1 CULTURAL SITES OR AREAS ON OR OFFICIALLY ELIGIBLE FOR THE NRHP

There are 12 sites/areas in this category within the study area. All are historic rather than archaeological sites. They include several churches, other buildings, a railroad and a canal. They have been assigned a high constraint value for the siting of transmission lines, primarily because of the potential for physical disturbance of a site by construction. The sites are widely scattered through the study area, but become more numerous as one moves south, with three in Longmont.

4.I.2 CULTURAL SITES OR AREAS POTENTIALLY ELIGIBLE FOR THE NRHP

These are 13 sites/areas in this category: one is in Longmont, one east, and another southeast of the city. The remainder are clustered near the southern end of the study area. They are considered a moderate constraint to transmission line siting.

4.I.3 CULTURAL SITES OR AREAS PROBABLY INELIGIBLE FOR THE NRHP

There are 106 sites/areas in this category that are recorded in the study area. They have a low constraint value for transmission line siting.

4.J VISUAL RESOURCES

The visual characteristics of the study area are highly varied. In the northwestern portion of the area are scenic, natural dominated landscapes. These include the relatively steep, rugged, north-south trending ridges and valleys to the northwest, west and southwest of Carter Lake; the upper valleys of the Little Thompson River; and St. Vrain Creek, Rabbit Mountain, and three isolated areas of steeper topography (Hygiene Hogback, Haystack Mountain and Whiterocks) rising from the more level terrain of the southwestern portion of the study area. Haystack Mountain is outside the study area boundary, but is included in the analysis because visual resources can be affected at a distance.

The heavily developed commercial and industrial urban areas of Longmont have retained relatively little evidence of the existing natural landscape, and are not generally considered visually positive. However, most of the well established landscaped residential areas of the city, as well as the other smaller communities in the study area, are considered positive visual resources. The remainder of the study area is a mixture of natural features and man-made influences. The majority of this area is agrarian in character, with pleasant views of cultivated lands and the Front Range. Many areas of scattered new development of various types, however, are at best neutral in visual quality.

Many of the residential areas throughout the study area enjoy views of Longs Peak and other mountains in the Front Range. This mountain view is a major feature in the landscape and is highly valued by many residents of the area. A number of reservoirs also add visual interest to the landscape.

Visually sensitive viewers are located primarily at areas of recreational and residential land use (including isolated residences), as shown on Figure 4.5, Existing Land Use, and Figure 4.7, Planned Land Use. They are also located along certain highways that have been designated by Boulder County and/or the City of Longmont as visually sensitive "gateways" to Longmont.

Considerations of visual quality contributed to the development of the system of alternative routes in two ways. First, the constraint values applied to existing and planned land uses included a visual component, and the designated visually sensitive highways were considered as constraints to siting transmission lines. Second, scenic landscapes where a transmission line would tend to have an adverse visual effect and where viewers would tend to be visually sensitive, were considered as constraints to transmission line siting.

Figure 4.8 shows the visual resources in the study area. (The visually sensitive land uses shown on Figures 4.5 and 4.7 are not repeated on this map.) Boulder County has designated Rabbit Mountain, and an area north and west of it, as a scenic area. This has a high constraint value for transmission line siting. Boulder County has also designated four Natural Landmarks in (or close to) the study area: Rabbit Mountain (largely enclosed within the Rabbit Mountain scenic area), Table Top Mountain, Hygiene Hogback, Haystack Mountain and Whiterocks. These also have a high constraint value.

Scenic condition landscape was defined as part of this study from a consideration of topography, vegetation and the absence of visually disruptive development. This type of landscape has a moderate constraint value.

Lastly, designated visually sensitive highway corridors were also given the moderate constraint value for transmission line siting.

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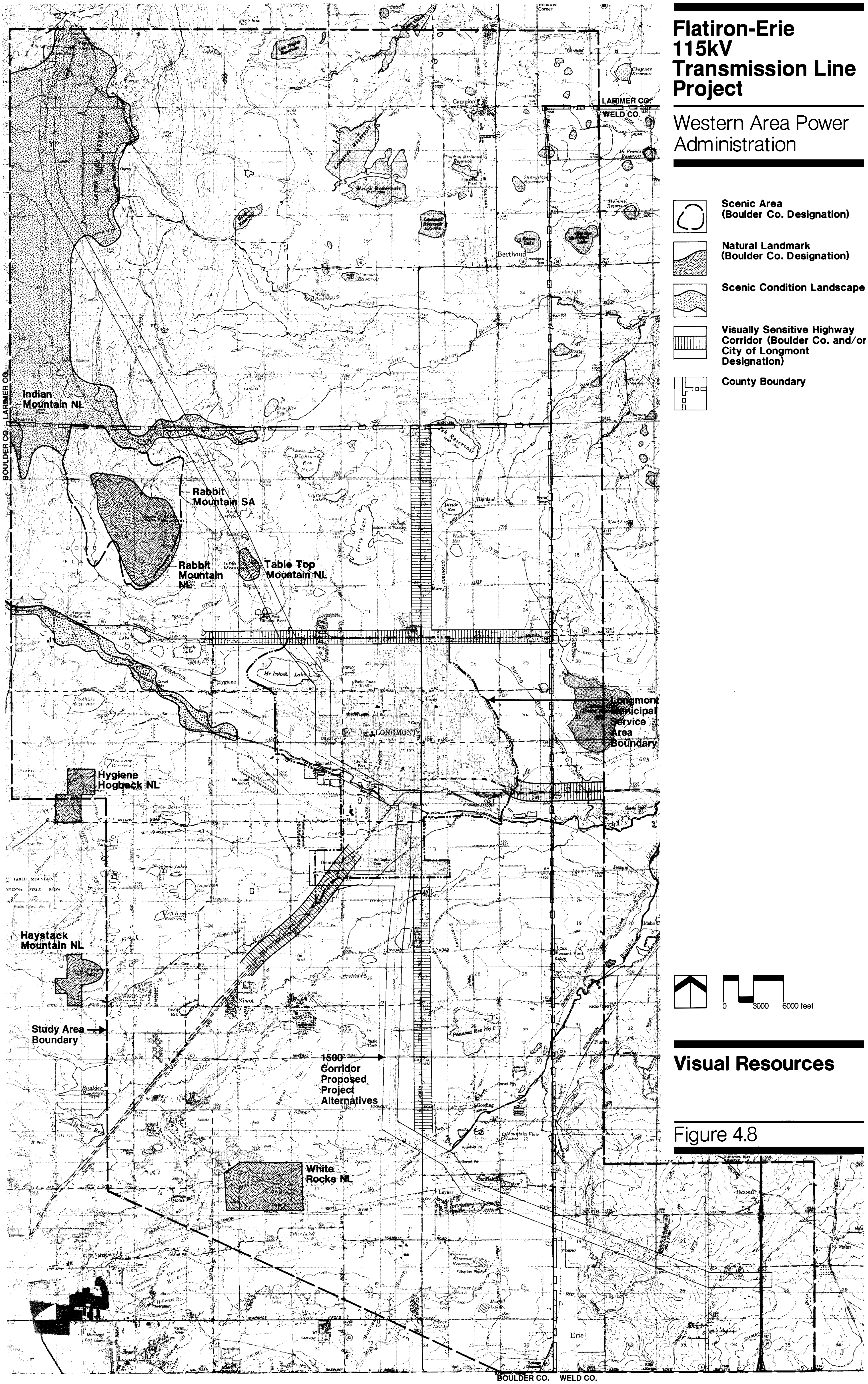

Visual Resources

Figure 4.8

4.K DEVELOPMENT OF A SYSTEM OF ALTERNATIVE ROUTES

Sections 4.C through 4.J describe the environment of the study area in terms of its constraints to and opportunities for transmission line siting. Table 4.1, below, summarizes the constraint and opportunity values that are explained in the above sections. Figure 4.9, below, graphically represents these constraint and opportunity values, and shows the alternative routes that were defined. The alternative routes are shown as 1,500-foot wide corridors, to allow for some flexibility in detailed siting of the project prior to construction. The centerlines of these corridors were the basis for quantification of the impacts that are described in Chapter 5.

The basis for the constraint and opportunity values used in Chapter 4 is explained in the Environmental Support Document that supplements this EIS and is located at the end of this document.

The basic purpose of the project is to improve the electrical transmission system that feeds the substations in the Longmont area. The composite constraint/opportunity map reveals that there is no environmentally reasonable way to do this other than primarily along the existing Flatiron-Erie ROW, i.e., by using the siting opportunity that the existing ROW's represents. There is no evident low constraint route around the City of Longmont (either on the east or west sides), and no environmentally acceptable way of siting connecting spurs from the periphery of the city to its substations. Therefore, although the network of alternative routes is simple and mostly focused on the existing ROW, the relatively extensive data inventory is valuable in demonstrating the inevitability of this siting approach.

TABLE 4.1

DEVELOPMENT OF A SYSTEM OF ALTERNATIVE ROUTES: SUMMARY CONSTRAINT/OPPORTUNITY VALUES FOR TRANSMISSION LINE SITING[1]

ENVIRONMENTAL RESOURCE CATEGORIES & COMPONENTS	VALUE				
	CONSTRAINT				POTENTIAL OPPORTUNITIES
	Very High (exclusion)	High (avoidance)	Moderate	Low to None	
EARTH RESOURCES					
Potential Landslide Area[3]	–	–	•	–	–
Sensitive Soil/Slope Conditions[2,4]	–	–	•	–	–
Floodplain	–	–	–	•	–
Subsidence Area	–	–	•	–	–
WATER RESOURCES					
Pond, Reservoir (large)	•	–	–	–	–
Pond, Reservoir (small, spannable)[2]	–	•	–	–	–
Perennial Stream[2]	–	–	•	–	–
BIOLOGICAL RESOURCES					
Wetland (potential)[2,4,5]	–	•	–	–	–
Critical Plant Association[2,4]	–	–	•	–	–
Rare Plants[4,5]	–	•	–	–	–
Critical Wildlife Habitat: Boulder County Designations[4,5]	–	•	–	–	–
Waterfowl Production & Stopover Area[4,5]	–	–	•	–	–
Prairie Dog Town (potential black-footed ferret habitat)[4,5]	–	–	–	•	–
Golden Eagle Nest Area[5]	–	–	•	–	–
Bald Eagle Winter Concentration Area	–	•	–	–	–
Bald Eagle Winter Riparian Flight Corridor	–	–	–	•	–
Bald Eagle Roost Site	–	•	–	–	–
Bald Eagle Feeding Area	–	•	–	–	–
Heronry[5]	–	•	–	–	–
Mule Deer Winter Range[4]	–	–	–	•	–
Elk Winter Range[4]	–	–	–	•	–
Natural Area (State or Boulder County designation)[4]	–	•	–	–	–
Grasshopper Mouse or Meadow Jumping Mouse Habitat[4,5]	–	–	•	–	–

Table 4.1 (continued)

ENVIRONMENTAL RESOURCE CATEGORIES & COMPONENTS	VALUE				
	CONSTRAINT				POTENTIAL OPPORTUNITIES
	Very High (exclusion)	High (avoidance)	Moderate	Low to None	
Colorado Rare Fish Habitat (actual or potential)[4,5]	–	–	•	–	–
Rare Insect: Miner Bee[4,5]	–	–	•	–	–
EXISTING LAND USE[6,7]					
Residential Area	–	•	–	–	–
Residence	–	•	–	–	–
Retail/Office	–	–	•	–	–
Institutional: School	–	•	–	–	–
Institutional: Other	–	–	•	–	–
Industrial/Heavy/Commercial/Utilities	–	–	–	•	–
Extraction	–	–	•	–	–
Publicly Owned Recreation/Open Space	–	•	–	–	–
Private and Semi-Public Recreation/Open Space	–	•	–	–	–
Agricultural Structure/Farmyard/ Feed Lot/Plant Nursery/Greenhouses	–	–	•	–	–
Center Pivot or Other Moving Rig Irrigation	•	–	–	–	–
Cultivation	–	–	•	–	–
Existing & Future Flight Clearance Zone at Airport/Landing Strip	•	–	–	–	–
Industrial/Commercial Type Development Associated with Airport/Landing Strip (excluding flight clearance zone)	–	–	•	–	–
Area Subject to Telecommunication Research Facility Protection Act	•	–	–	–	–
Radio Tower	–	•	–	–	–
EXISTING ELECTRICAL UTILITIES					–
115-kV 1 Circuit T.L.	–	–	–	–	•
230-kV 1 Circuit T.L.	–	–	–	–	•
115/115-kV 2 Circuit T.L.	–	–	–	–	•
115/230-kV 2 Circuit T.L. (w/230-kV Circuit vacant)	–	–	–	–	•
115/230-kV 2 Circuit T.L.	–	–	–	–	•
Road, Railroad, Other ROW, Land Use Edge	–	–	–	–	•
Existing Substation or Tap	–	–	–	–	–

Table 4.1 (continued)

ENVIRONMENTAL RESOURCE CATEGORIES & COMPONENTS	VALUE				
	CONSTRAINT				POTENTIAL OPPORTUNITIES
	Very High (exclusion)	High (avoidance)	Moderate	Low to None	
PLANNED LAND USE					
Residential, 1 Dwelling Unit/ Less than 1 Acre	–	–	–	–	–
Residential, 1 Dwelling Unit/1-5 Acres	–	–	•	–	–
Residential, 1 Dwelling Unit/5-10 Acres	–	–	•	–	–
Residential, 1 Dwelling Unit/10+ Acres	–	–	•	–	–
Commercial	–	–	–	•	–
Institutional	–	–	•	–	–
Industrial	–	–	–	•	–
Public Recreation/Open Space	–	–	•	–	–
Airport Expansion	–	–	–	•	–
City Boundary	–	–	–	–	–
Proposed Arterial or Expressway (Portions that do not follow existing road alignments)	–	–	–	–	–
CULTURAL RESOURCES					
Historic Site/Area on or Officially Eligible for the NRHP[2]	–	•	–	–	–
Cultural Site/Area Field Assessed as Eligible for the NRHP, Official Status Pending[2]	–	–	•	–	–
Cultural Site/Area with no, or Incomplete, Field Assessment and/or Official Evaluation[2] or Cultural Site/Area Field Assessed and/or Officially Evaluated as not Eligible for the NRHP[2]	–	–	–	•	–
VISUAL RESOURCES					
Scenic Area (Boulder Cty. Designation)	–	•	–	–	–
Natural Landmark (Boulder County Designation)	–	•	–	–	–
Scenic Landscape	–	–	•	–	–
Visually Sensitive Highway Corridor (Boulder County and/or City of Longmont Designation)	–	–	•	–	–

Notes:

1. Includes underground construction in major urban residential areas.

2. Crossings of linear features and small areal features are often of concern for specific tower location rather than corridor siting.

3. Landslide deposit areas are extensive. The probability of any one portion moving during the life of the project is estimated, on the basis of site observation, to be low. Geotechnical survey work along the ROW prior to construction may indicate specific areas of instability that would be avoided.

Table 4.1 (continued)

4. Effective reclamation work is assumed.

5. Values assume that construction would be restricted in critical wildlife breeding seasons and in seasons of high water table from irrigation, as appropriate.

6. In developed (built up) areas, all routes would follow land use edges, property boundaries, roads, or other ROWs. Constraint values assume that no route would be defined that would require removal of a major building or that would substantially restrict an existing developed land use.

7. The visual sensitivity of Existing and Planned Land Uses is considered in assigning constraint values.

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Very High Constraint

These are areas which contain resources/land uses protected by legislation and/or administrative policy, or a severe physical constraint to transmission line construction and operation. As a result, it would be very difficult to locate a transmission line in these areas and they were therefore generally avoided in the development of alternative corridors.

High Constraint

These are areas which contain resources/land uses that are considered to be of high concern (as indicated by land use plans, guidelines, etc.) and/or present a potential for impacts that could not be readily mitigated. Locating a transmission line in these areas would require careful siting and/or special design measures; they were avoided where possible in the development of alternative corridors.

Moderate Constraint

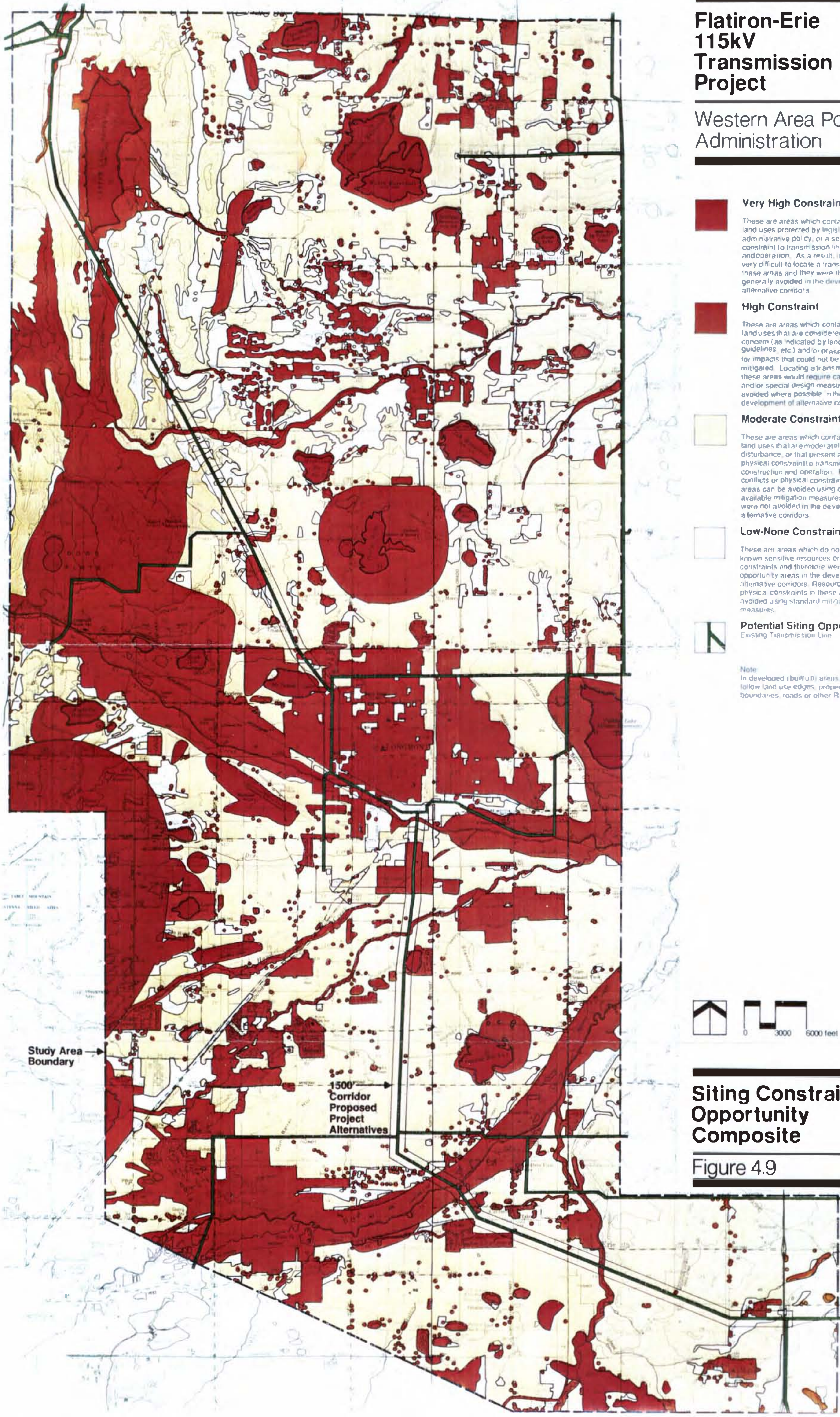
These are areas which contain resources/land uses that are moderately sensitive to disturbance, or that present a moderate physical constraint to transmission line construction and operation. Resource conflicts or physical constraint in these areas can be avoided using currently available mitigation measures; these areas were not avoided in the development of alternative corridors.

Low-None Constraint

These are areas which do not contain known sensitive resources or physical constraints and therefore were considered opportunity areas in the development of alternative corridors. Resource conflicts or physical constraints in these areas can be avoided using standard mitigation measures.

Potential Siting Opportunity
Existing Transmission Line

Note
In developed (built up) areas, all routes will follow land use edges, property boundaries, roads or other R.O.W.'s.



Siting Constraint/ Opportunity Composite

Figure 4.9

Chapter 5
Environmental Consequences

Chapter 5 -- Environmental Consequences

5A. INTRODUCTION

In this chapter, the environmental effects of constructing and operating each of the three primary alternatives are described. As explained in Chapter 3, these include Alternative B, the Proposed Action; Alternative C, Underground Through Longmont; and Alternative D, Remove and Relocate Portions of Existing Line and Build a New Substation.

The following are three basic assumptions about the impact assessment process:

- All the impacts that are quantified and used to compare routes are incremental. The assessment measures the difference (adverse or beneficial) between the existing conditions and conditions as they would be after implementation of the proposed project. Figure 3.4, Range of Construction Actions of the Proposed Project Alternatives, is the basis for judging this difference between conditions before versus after the project.

- Since none of the three primary alternatives results in any significant impacts, those effects judged to be moderate and beneficial are the means of comparing routes. Low impacts, while they may be briefly described, are not factors in the analysis.

- All impacts discussed and used to compare routes are "post-mitigation;" i.e., they assume reasonable application of the mitigation measures listed in Section 3.G.2.d., 3.G.3.d and 3.G.4.d, and described in this chapter.

The methodology used to assess impacts proceeds in two basic steps. First, it defines the potential, theoretical impact levels (not actual quantities) for all possible combinations of project construction action and environmental component. Although many environmental components are never crossed or approached by any of the project alternatives, this "check list" methodology facilitates the process of defining the impact levels by providing a frame of reference for each judgment. It also allows for efficient consideration of new alternatives, if necessary. Second, the methodology quantifies the actual impacts for the proposed system of primary alternative routes; i.e., the actual quantities of effect of various levels (significant and moderate adverse, and beneficial) on the environmental components crossed (or approached) by the three alternatives. The "frame of reference" impact levels are presented in detail in Section C of the Environmental Support Document that supplements this EIS. The actual impacts of the routes are presented in this chapter.

For reference, the actual steps that were used to define all possible, potential impact levels are outlined below:

- Define all project construction action types (see Figure 3.8) and indicate them on a map of each of the project alternatives (Figures 3.9, 3.12 and 3.15).

- For each resource category in the study area (e.g., biological resources, existing land use), formulate a list of the types and causes of potential impact that the project might induce.

- For each resource category, describe the mitigation measures that will be appropriately applied as part of the project action (all impacts are post-mitigation).

- For each resource category, list the criteria to be used to determine the significance level of impacts. (For example, it was concluded that impacts to existing urban land uses would be considered "significant" if construction and/or operation of the line would disrupt an existing activity to the extent that the activity could not practically continue.) Criteria are standards used for judging the significance of specific levels of impacts, however caused. They have no relationship to a project action.

- For each environmental component, as potentially affected by each project construction action (keeping in mind types and causes of impacts, mitigation measures and significance criteria), define a resulting impact level -- significant, moderate, low to none or beneficial. Do this for short-term and long-term impacts. Short-term impacts are those affecting a resource during the period of construction of the project. They derive from the activities required to construct the line or from the disturbance caused by these activities, and diminish after construction is completed. After two years, impacts classified as short term are not readily detectable when compared to the pre-existing baseline condition. Long-term impacts are those affecting a resource during the entire life of the project. They derive from the presence of the line and necessary accessways, the action of passing electricity through its conductors, or from the periodic or emergency maintenance operations it required.

- Tabulate results.

With this information in hand, the actual anticipated impacts (levels and quantities) of the project alternatives can be easily determined.

5.B EARTH RESOURCES

Impacts on earth resources for each of the three primary alternatives are described in this section. The methodology used to determine potential impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. Potentially impacted earth resources are shown on Figure 4.2

Impacts to earth resources would be associated primarily with land disturbance during construction. Potential effects could include initiation of mass earth movement; increased erosion; potential, very minor raising of flood stage; and damage to the line from subsidence. Mitigation measures applied would reduce or eliminate almost all of these effects. These measures would include careful siting of project elements, careful design and control of construction activities, and reclamation of disturbed areas. Potential impacts to soil/slope conditions would be considered significant if reclamation would not control erosion within two years. Impacts to other earth resources would be significant if there were substantial increases in hazards.

5.B.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows the proposed action. The construction actions included in this alternative are Numbers 2, 3, 4 and 5, as explained on Figure 3.8. These are all relatively minor actions. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place on the right-of-way (ROW) of the existing Flatiron-Erie transmission line. Therefore, little or no new construction access would be required. The construction actions include building new structures at new and existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a 200-foot long segment of the 75-foot wide ROW).

There would be no significant and no moderate impacts to earth resources from Alternative B, the Proposed Action. The level of adverse effects on (or from) potential landslide areas, sensitive soil/slope conditions, floodplains and subsidence areas would all be low to none.

North of the Longmont urban area, the proposed action would cause surface disturbance of potential landslide areas along about 400 feet of ROW (two structures). Little or no blading or grading of accessways would be required here; therefore, it would be extremely unlikely that any earth movement would be initiated. North of Longmont, the project would also disturb sensitive soil/slope conditions along a maximum of 3,200 feet of ROW (construction at 16 structures). The small amount of disturbance from new access road construction and reclamation after construction would ensure that any erosion would be minor and short term.

Within the Longmont urban area, three structures in the floodplain of St. Vrain Creek would be worked on, but this would involve no change from existing conditions relative to floodplains.

South of Longmont, there would be disturbance at three structures, i.e., along up to 600 feet of ROW with sensitive soil/slope conditions. Reclamation work here would ensure that erosion would be minor and short term. In this area, there would also be work at three structures in floodplains -- one on Boulder Creek and two on Coal Creek. This would involve no substantial change in the relationship of the project to these floodplains. Near the south end of the study area, construction activity would take place at four structures in subsidence areas. This work would not change the potential effects of subsidence areas on the project.

Overall, about 73 structures along the existing line are proposed for construction work. Assuming a conservative figure of 15,000 square feet of construction disturbance at each structure, the total area at structures temporarily disturbed and reclaimed would be at most 25 acres.

This alternative has no impacts on earth resources that contribute to route comparison (significant or moderate impacts, or beneficial effects).

5.B.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this proposed project alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two more major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. Disturbance would take place continuously along the ROW with Action 7, and on a 200-foot long ROW segment with Action 8. The actions, however, would all take place on the existing Flatiron-Erie transmission line ROW.

North and south of the Longmont urban area, this project alternative is identical to Alternative B. Therefore, like Alternative B in these segments, it is not associated with any significant or moderate adverse impacts to earth resources.

Within the Longmont area, underground construction would cross 500 feet of sensitive soil/slope conditions. Because of the greater level of construction disturbance from the underground line, it is estimated that moderate short-term adverse impacts would result in this area. After one or two growing seasons, reclamation would reduce these impacts to the low level, or eliminate them.

The total impacts on earth resources that contribute to route comparison (significant, moderate or beneficial) amount to 500 feet of moderate short-term effects on sensitive soil/slope conditions.

5.B.3 ALTERNATIVE D. REMOVE AND RELOCATE THROUGH PARTS OF LONGMONT

Figure 3.15 shows this proposed project alternative. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two different construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15. Disturbance is considered as being continuous along the ROW with Action 1.

Since this project alternative is identical to Alternative B outside Longmont, in these segments, it is not associated with any significant or moderate impacts to earth resources. Within the Longmont area, there would also be no significant or moderate impacts to earth resources from this alternative. About 500 feet of the existing line that crosses sensitive soil/slope conditions would be removed, but the adverse short-term effects of doing this would be minor. Two structures in floodplains would be modified, but this would not in any way change the project's relationship to floodplains. About 2,400 feet of the new line segment required by this alternative would be located along the edge of a floodplain (involving one to two structures in the floodplain). This would have no measurable effect on flood stage and no floodplain related impacts.

This alternative has no impacts on earth resources that contribute to route comparison (significant adverse, moderate adverse, or beneficial impacts).

5.C WATER RESOURCES

Impacts on water resources for each of the three primary project alternatives are described in this section. The methodology used to determine impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. Potentially impacted water resources are shown on Figure 4.3.

Impacts to water resources would be caused primarily by sedimentation from construction disturbance, and the risk of a spill of the cooling/insulating fluid used in underground transmission lines. Mitigation would involve control of construction activities. Impacts to water resources would be considered significant if federal or state water quality standards were violated.

5.C.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows Alternative B, the Proposed Action. The construction actions that make up this alternative are Numbers 2, 3, 4 and 5 (all relatively minor actions), as shown on Figure 3.8. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place within the ROW of the existing Flatiron-Erie transmission line; therefore, little or no new construction access would be required. The construction actions include building new structures at new and existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a maximum 200-foot long segment of the 75-foot wide ROW).

There would be no substantial adverse impacts to water resources from Alternative B, the Proposed Action. The disturbance zone at the structures being built or modified never closely approaches a major water body. Construction equipment would not likely be driven across any of the six major streams along the existing transmission line, but would use existing roads and accessways to get to the site of new or modified structures.

5.C.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this primary alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two additional major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. They would take place on the existing Flatiron-Erie transmission line ROW. Disturbance would be continuous along the ROW with Action 7, and over a maximum 200-foot long ROW segment with Action 8.

North and south of the Longmont urban area, this project alternative is identical to Alternative B. Therefore, like Alternative B in these segments, it would be have no adverse effects on water resources.

Within the Longmont area, underground construction would cross two water bodies: St. Vrain Creek and Left Hand Creek, and would closely approach McIntosh Lake. Each of the stream crossings would cause moderate short-term impacts to water resources from increased sedimentation.

Rough estimates can be made of the probability of a leak of the cooling/insulating fluid used with the HPOFPT system, affecting these three water bodies. Reliability data for HPOFPT underground transmission lines indicate 0.24 leaks/breaks annually per 100 miles of pipe (Power Engineers, Inc. 1988). It is assumed that leaked fluid would not likely travel more than about 200 feet before being detected and the problem rectified. Just under a mile of the underground line is within 200 feet of one or other of the three water bodies mentioned. Given the above assumptions, the probability of an adverse effect would be less than .0024 annually (about 1 in 400), or 0.12 (about 1 in 8) over a 50-year life of the project. The effects of a large quantity of fluid in any of the water bodies would clearly be significant. However, the amount of fluid that would be released in a failure of an HPOFPT system would vary widely depending on the type of failure. A leak resulting from corrosion would likely be slow, and would normally be detected and contained before large amounts of fluid had escaped. A leak from a dig-in would generally release more fluid, but it would typically be contained in the hole or trench that was the cause of the dig-in. Only in the case of a complete severing of a line, for example by severe seismic action (a very unlikely event), would large quantities (several thousands of gallons) of fluid would be released into the environment. (Leslie Bell, Power Engineers, Personal Communication, 1991.)

The above consideration results in an estimate of a moderate long-term impact on water resources from Alternative C.

The impacts of this alternative on water resources that contribute to route comparison amount to moderate adverse, short-term impacts at crossings of two water bodies; and moderate long-term impacts to one water body.

5.C.3 ALTERNATIVE D. REMOVE AND RELOCATE THROUGH PARTS OF LONGMONT

Figure 3.15 shows primary Alternative D. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two different construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15.

Since this project alternative is identical to Alternative B outside Longmont, in these segments it would cause no substantial impacts to water resources. The new overhead line segment would cross Left Hand Creek. However, the creek would be spanned and there would be no movement of construction equipment through the stream bed. Construction activity would not take place in or near other water bodies in this area. Therefore, within the Longmont urban area, there would likewise be no substantial effect on streams.

5.D BIOLOGICAL RESOURCES

Impacts to biological resources for each of the three primary project alternatives are described in this section. The methodology used to determine impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. Potentially impacted biological resources are shown on Figure 4.4.

Impacts to biological resources would be associated primarily with disturbance of plant communities and wildlife populations by construction disturbance and activity. Increased mortality of birds has the potential to occur due to collisions with elements of the transmission line. Mitigation of these potential impacts would consist of careful siting of project elements, timing of construction to avoid critical seasons, surveys to determine any need for avoidance of specific areas at specific times, provision of visibility markers on the overhead ground wires at critical areas, and restriction of access along the ROW to control ongoing disturbance by the public. Impacts to biological resources would be considered significant if the requirements of the U.S. Army Corps of Engineers relative to wetlands were not met; more than 1% of any rare/critical habitat in the study area was lost; the endangered black-footed ferret was in any way adversely affected; major increases in avian mortality was reasonably likely; or if mule deer, elk, bald eagles, golden eagles or herons were stressed in their most critical periods.

5.D.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows Alternative B, the Proposed Action. The construction actions that make up this alternative are Numbers 2, 3, 4 and 5 (all relatively minor actions), as shown on Figure 3.8. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place within the ROW of the existing Flatiron-Erie transmission line; therefore, little or no new construction access would be required. The construction actions include building new structures at new sites and at existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a 200-foot long segment of the 75-foot wide ROW).

There would be no significant adverse impacts to biological resources from Alternative B. There would be a number of instances of moderate short-term adverse impacts to wetlands from construction activities. All other effects on biological resources would be (at most) low.

In the route segment north of the Longmont urban area, in Chimney Hollow, west of Carter Lake, about 600 feet of the ROW that is located in wetlands would be disturbed by construction activities. This would result in moderate short-term impacts. About half a mile north of the northern edge of the Longmont developed area, at McIntosh Lake, there would be construction near a waterfowl production area; the impacts of this would be low. There would be no substantial change in the strike hazard to waterfowl.

North and south of the crossing of the Little Thompson River, two recently active prairie dog towns (probably too small to support populations of black-footed ferrets) would be disturbed by construction, over a total distance of about 600 feet of ROW (45,000 square feet maximum). Mitigation would include observation prior to construction to determine if the towns were still active. If so, the U.S. Fish and Wildlife Service would be consulted to determine whether surveys for the black-footed ferret would be necessary. In the extremely unlikely event that ferrets were found to be present, Western would work with the U.S. Fish and Wildlife Service to develop a specific mitigation plan.

West of Carter Lake, there would be construction activity near a golden eagle nest site. As part of the proposed mitigation, the nest site would be surveyed. If it is found to be active prior to construction, major activity would be avoided during the critical season.

Within Longmont, there would be construction activity within a bald eagle riparian flight corridor. Uprating the line would not increase wire strike hazards, and would not substantially decrease hunting opportunities during the construction period, again resulting in only low impacts.

South of the Longmont area, in two locations along Boulder Creek, construction would occur within wetlands over a maximum of 400 feet of ROW. This would cause moderate short-term impacts. One of these wetland areas is also a waterfowl production area; impacts to this resource would be low. Another waterfowl production area, at Gaynor Lake, would be impacted at the low level by adjacent construction. Also in the valley of Boulder Creek, construction activity would occur in a bald eagle riparian flight corridor; the impact on this would be low.

The proposed alternative is not located within the actual or potential habitat of any endangered species other than the bald eagle and black-footed ferret. Additional information on endangered species is presented in Appendix E, Biological Assessment.

As with most 115-kV lines, the design of the Flatiron-Erie line eliminates the threat of electrocution to eagles or other raptors because the distance between any two conductors, and between any perch site and any single conductor, is sufficiently large.

It is estimated that about 28 new or modified structures would be located in natural vegetation, and about 15,000 square feet maximum would be disturbed at each structure site. Construction of the project therefore would result in the disturbance of a maximum of approximately 10 acres of natural vegetation, primarily within short grass prairie and foothill plant communities. These areas would be restored to their approximate existing condition within two years of construction, thus resulting in only minor short-term impact.

The impacts from this alternative on biological resources that contribute to route comparison (significant adverse, moderate adverse and beneficial impacts) amount to 1,000 feet of moderate short-term impacts on wetlands.

5.D.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this primary alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two additional major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. Disturbance would take place continuously along the ROW with Action 7, and on a maximum 200-foot long ROW segment with Action 8.

North and south of the Longmont urban area, this project alternative is identical to Alternative B. Therefore, like Alternative B in these segments, it would not cause any significant adverse impacts to biological resources. Construction in about 1,000 feet of the ROW would cause moderate short-term impacts to wetlands.

Within the Longmont area, underground construction would also cause moderate short-term impacts to wetlands. About 200 feet of ROW would cross wetlands along St. Vrain Creek. The project's crossing of St. Vrain Creek and Left Hand Creek would cause moderate short-term impacts to Colorado rare fish habitat. There would be a moderate short-term impact at these two locations because of increased sedimentation during construction, and moderate long-term impact to the resources because of the risk of oil spills from the buried line. Other biological impacts from underground construction in the Longmont area are all low. They include 7,700 feet of construction in a bald eagle riparian flight corridor, and 2,000 feet of construction within 400 feet of a waterfowl production/stopover area. The project also parallels, but would not substantially affect a long strip of wetland along St. Vrain Creek.

Construction of the project would result in the disturbance of a maximum of approximately 10 acres of natural vegetation, primarily within short grass prairie and foothill plant communities. These areas would be restored to their approximate existing condition within two years of construction, thus resulting in only minor short-term impact.

The impacts from this alternative on biological resources that contribute to route comparison (significant adverse, moderate adverse, and beneficial impacts) amount to 1,200 feet of short-term moderate impacts to wetlands, two occurrences of short-term moderate, and one occurrence of long-term moderate impacts to Colorado rare fish habitat.

5.D.3 ALTERNATIVE D. REMOVE AND REROUTE THROUGH PARTS OF LONGMONT, BUILD NEW SUBSTATION

Figure 3.15 shows this primary alternative. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two different construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15. Disturbance is considered as being continuous along the ROW with Action 1.

This project alternative is identical to Alternative B outside of the Longmont developed area. Therefore, in these route segments, its impacts would be the same as those of Alternative B; i.e., 1,000 feet of moderate short-term impacts to wetlands.

Within the Longmont developed area, the new line segment would cause 300 feet of moderate short-term impacts to wetlands. This same new line segment would cross 400 feet of a prairie dog town, where resulting impacts would be low, and a stream that is Colorado rare fish habitat. Here, because of the defined mitigation, impacts would also be low.

Construction of the project would result in the disturbance of a maximum of approximately 10 acres of natural vegetation, primarily within short grass prairie and foothill plant communities. These areas would be restored to their approximate existing condition within two years of construction, thus resulting in only minor short-term impact.

The total impacts from this alternative on biological resources that contribute to route comparison (significant adverse, moderate adverse, or beneficial impacts) amount to 1,300 feet of moderate short-term impacts to wetlands.

5.E EXISTING LAND USE

Impacts to existing land use for each of the three primary alternatives are described in this section. The methodology used to determine impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. Potentially impacted land uses are shown on Figure 4.5.

There could be several types of potential impacts to existing land use. ROW restrictions would limit the uses that landowners could make of the ROW (most importantly, buildings could not be placed in the ROW). Cultivation could be hindered by transmission line structures in fields, and a very small area of land could be removed from use. Construction activities could cause crop damage in some seasons. Noise, dust and traffic from construction activity could affect developed uses. Noise and other electrical phenomena could affect residential and other developed land uses. There could be a risk of fire in the case of an oil spill from the underground line. Air traffic could potentially be endangered by a line (on new ROW) sited through flight clearance zones near airports and air strips. However, the potential risk to aircraft from striking tall structures outside of such zones is so remote that it is not considered in route comparison. Mitigation of land use impacts would consist of careful design and management of construction activities, including seasonal restrictions; reclamation of disturbed areas; compensation for damage; mitigation (by design or grounding) of electric phenomena (shock, radio/TV interference, noise); and restriction of access on new ROW to control increased public use. Impacts to a land use would be considered significant if the use could not continue or would be substantially restricted; any major building would have to be removed; or more than 1% of the cultivated land in the study area would be taken out of use.

Appendix C provides a discussion of the possible effects of the electrical properties of transmission lines and the latest information on their possible effects on public health and safety. The discussion includes effects such as the potential for electric shock hazards and induced voltages and currents, and includes a discussion of the potential long-term health effects. This section also provides definitions for electric and magnetic fields (E&M Fields), corona and various other related electrical parameters. These parameters are discussed in detail as they relate to the safety and health aspects of the proposed project. Estimated values for these parameters are given for the specific project alternatives.

5.E.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows Alternative B, the Proposed Action. The construction actions that make up this alternative are Numbers 2, 3, 4 and 5 (all relatively minor actions), as shown on Figure 3.8. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place within the ROW of the existing Flatiron-Erie transmission line; therefore, little or no new construction access would be required. The construction actions include building new structures at new sites and at existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a 200-foot long segment of the 75-foot wide ROW).

There would be no significant adverse impacts to existing land uses from Alternative B. There would be a number of instances of moderate short-term impacts to residential, recreational, industrial and institutional land uses from construction disturbance. All other impacts to existing land uses would be (at most) low.

In the route segment north of the Longmont urban area, there would be 600 feet of ROW subject to construction disturbance which would cause moderate short-term impacts to residences and residential areas. The long-term impacts to these residences would be low to none, since all the changes are in the existing ROW. This major segment of Alternative B would also impact 200 feet of public recreation area in the same way; i.e., moderate short-term impacts and low long-term impacts. Also, north of the Longmont area, Alternative B affects 1,600 feet of cultivation. The short-term impacts to this land use would be no higher than low because of the proposed mitigation measures, especially winter construction. Long-term impacts to cultivation would be low, because all project actions are on the existing transmission line ROW.

Within the Longmont urban area, 1,200 feet of ROW in residential areas would be subject to construction disturbance. This disturbance would cause moderate short-term land use impacts to residential land uses. Long-term impacts here would be low. Also, in Longmont, construction disturbance along the ROW would affect industrial development for 800 feet, institutional (school) land use for 200 feet, and public recreation/open space for 200 feet. All these instances of disturbance would cause moderate short-term impacts. The long-term effects in all cases would be low to none because of the minor changes from the existing conditions.

South of Longmont, there would be a single instance of disturbance affecting a residential area. About 200 feet of ROW disturbance would cause moderate short-term impacts. The long-term impacts to this residential area would be low. In this area, there would be relatively extensive amounts of cultivation affected; 7,600 feet of ROW would be disturbed in cultivated areas resulting in low short-term impacts (primarily because of the proposed seasonal restrictions), and low long-term impacts because of the minor nature of the changes brought about by the project.

The impacts from Alternative B on existing land uses that potentially contribute to route comparison (moderate adverse, or beneficial impacts) amount to moderate short-term impacts as follows: residential, 2,000 feet; industrial, 800 feet; public recreation, 400 feet; and institutional, 200 feet.

5.E.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this proposed project alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two additional major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. Disturbance would take place continuously along the ROW with Action 7, and on maximum 200-foot long ROW segments with Action 8.

North and south of the Longmont urban area, this alternative is identical to Alternative B. Therefore, in these segments, it would not cause any significant adverse impacts to existing land uses, but would cause the following quantities of moderate short-term impacts: residential areas/residences, 1,000 feet; public recreation, 200 feet.

Within the Longmont area, underground construction would affect a number of different land uses in essentially the same way. The disturbance during construction would cause moderate short-term impacts. However, the narrower ROW, in some ways. Less restrictive uses of the ROW, and reductions in established corona and field effects would have a long-term beneficial effect. The quantities of both short-term adverse impact (from construction disturbances) and long-term beneficial effect (from the absence of the former overhead line), would be as follows:

- Residential: 12,000 feet
- Industrial: 7,300 feet
- Public Recreation/Open Space: 1,900 feet
- Retail/Office: 800 feet
- Institutional (School): 600 feet

The total impacts and effects from this alternative that contribute to route comparison (significant adverse, moderate adverse, or beneficial) amount to the following:

- Residential: 13,000 feet short-term moderate; 12,000 feet long-term beneficial

- Industrial: 7,300 feet short-term moderate; 7,300 feet long-term beneficial

- Public Recreation: 2,100 feet short-term moderate; 1,900 feet long-term beneficial

- Retail/Office: 800 feet short-term moderate; 800 feet long-term beneficial

- Institutional (School): 600 feet short-term moderate; 600 feet long-term beneficial

5.E.3 ALTERNATIVE D. REMOVE AND REROUTE THROUGH PARTS OF LONGMONT

Figure 3.15 shows this proposed project alternative. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two different construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15. Disturbance is considered as being continuous along the ROW with Action 1.

Outside the Longmont urban area, this alternative is identical to Alternative B. Therefore, in these major route segments, it would not cause any significant adverse impacts to existing land uses. It would cause the following quantities of moderate short-term impacts: residential areas/residences, 1,000 feet; public recreation/open space, 200 feet.

Within the Longmont area, Alternative D would cause a variety of short-term moderate adverse impacts from construction disturbance, and long-term beneficial effects in the same areas arising from the action of removing the existing line and its subsequent long-term absence. These effects would apply as follows:

- Residential: 9,900 feet
- Retail/Office: 800 feet
- Institutional (School): 600 feet
- Industrial: 2,300 feet
- Public Recreation/Open Space: 1,900 feet

The alternative would also cause some moderate and low adverse impacts along the segment of new overhead line that is part of the alternative. These impacts would include 800 feet of moderate short-term and moderate long-term effects on a farmyard type operation, and 7,700 feet of low short-term and moderate long-term adverse effects on cultivation.

About 4 acres of cultivated land would be purchased for the new substation that is part of this alternative. This is considered to be a moderate long-term adverse impact to cultivation.

The total impacts from this alternative on existing land uses that contribute to route comparison (significant adverse, moderate adverse, or beneficial impacts) amount to the following:

- Residential: 10,900 feet short-term moderate adverse; 9,900 feet long-term beneficial

- Retail/Office: 800 feet short-term moderate adverse; 800 feet long-term beneficial

- Institutional (School): 600 feet short-term moderate adverse; 600 feet long-term beneficial

- Industrial: 2,300 feet short-term moderate adverse; 2,300 feet long-term beneficial

- Public Recreation/Open Space: 2,100 feet short-term moderate adverse; 1,900 feet long-term beneficial

- Agricultural Structure/Farmyard/Feedlot: 800 feet short-term moderate adverse; 800 feet long-term beneficial.

- Cultivated Land: 7,700 feet long-term moderate adverse; 4 acres loss, moderate long-term adverse impact.

5.F PLANNED LAND USE

The potential impacts of the proposed project on planned land use in the study area would be (in all cases) lower than the impacts for the equivalent existing land use, and in no case higher than low. This is because of the uncertainties that often exist as to the reality of specific planned uses. It is also because of the opportunity that exists to accommodate a future land use to a project.

Planned land use is shown on Figure 4.7. There would be no impacts to planned land use (exclusive of visual impacts) from any of the three proposed project alternatives that would contribute to route comparison; i.e., no significant adverse impacts, moderate adverse impacts, or beneficial impacts. All impact levels would be no higher than low.

The main value of the planned land use mapping was in its contribution to development of the system of alternative routes (see Chapter 4, Table 4.1 and Figure 4.9). Planned land uses also contribute to assessing visual impacts (see Section 5.H). Another use of the planned land use inventory was to screen for any specific, major, imminent future development that could be substantially affected by the proposed project (no such project was identified).

5.G CULTURAL RESOURCES

Impacts to cultural resources for each of the three primary project alternatives are described in this section. The methodology that is used to determine impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. A map showing all recorded cultural resources in the study area was prepared, but does not appear in this EIS. The information on recorded cultural resources was supplied by the State Historic Preservation Office, only on the condition that the information be kept confidential to avoid vandalism and illicit excavation of cultural sites.

Potential impacts to cultural resources would be associated primarily with physical disturbance during construction or disturbance of cultural artifacts by construction personnel, or by the public after construction because of improved access. Mitigation would consist primarily of a Class III survey of all previously undisturbed areas that the project might disturb, and consultation with the State Historic Preservation Office to determine any specific mitigation necessary. Construction activity would also be monitored and supervisory personnel instructed in the proper procedures for cultural resource protection. Impacts to cultural resources would be considered significant if the integrity of a site on or eligible for the NRHP was affected.

5.G.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows Alternative B, the Proposed Action. The construction actions that make up this alternative are Numbers 2, 3, 4 and 5 (all relatively minor actions), as shown on Figure 3.8. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place within the ROW of the existing Flatiron-Erie transmission line; therefore, little or no new construction access would be required. The construction actions include building new structures at new sites and at existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a 200-foot long segment of the 75-foot wide ROW).

The extensive mitigation measures proposed, particularly consultation prior to construction with the State Historic Preservation Office regarding any important cultural resources that might be affected, would reduce all potential impacts to the low level.

North of the Longmont urban area and within Longmont, there are no recorded cultural resources that would be affected by Alternative B.

South of Longmont, there are four cultural sites/areas that could potentially be affected by Alternative B. Two of these are close to existing transmission line structures that would be modified. Both of these sites are probably not eligible for the NRHP. The third is a historic district, field-assessed as eligible for the NRHP. The action here would involve a new structure on a new site (but on the existing ROW), and rebuilding of an existing structure. The fourth cultural site is a historic canal, officially eligible for the NRHP. Near it, one transmission line structure would be rebuilt.

The proposed action in this area would restrict disturbance to the already disturbed ROW, and would not change the overall appearance of the project. This, plus the mitigation measures proposed, would keep impacts at or below the low level.

Alternative B would have no impacts on cultural resources that would contribute to route comparison.

5.G.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this proposed project alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two additional major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. Disturbance would take place continuously along the ROW with Action 7, and on a 200-foot long ROW segment with Action 8.

North and south of the Longmont urban area, this alternative is identical to Alternative B. Therefore, in these route segments, it would not cause any significant or moderate impacts to cultural resources.

Within Longmont, because of the greater disturbance involved in underground construction, Alternative C would have increased quantities of impacts. None of these would exceed the low level however. Underground construction would cross two historic railroads (both with NRHP eligibility assessment incomplete, or assessed as not eligible), and would parallel one of these for 5,500 feet. Because operating railroads would be crossed by boring, and because of the mitigation measures proposed, impacts would be low.

Alternative C would have no impacts on cultural resources high enough to contribute to route comparison. All impacts would be low to none.

5.G.3 ALTERNATIVE D. REMOVE AND REROUTE THROUGH PARTS OF LONGMONT

Figure 3.15 shows this proposed project alternative. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two additional construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15. Disturbance is considered as being continuous along the ROW with Action 1.

Alternative D has impacts on cultural resources identical to those of Alternative B; i.e., all impacts would be low to none. No impacts would be severe enough to contribute to route comparison.

5.H VISUAL RESOURCES

Impacts to visual resources for each of the three primary project alternatives are described in this section. The methodology used to determine impact levels is explained in detail in Section C of the Environmental Support Document that supplements this EIS. Potentially impacted sensitive visual conditions are shown on three separate environmental data maps:

- Visual Resources (Figure 4.8), showing special visually sensitive environmental components.

- Existing Land Use (Figure 4.5), showing existing residential and recreational/open space uses as the locations of visually sensitive viewers.

- Planned Land Use (Figure 4.7), showing planned residential and recreational/open space uses as the locations of future visually sensitive viewers.

Visual impacts are primarily long term, and would arise from the presence of the project where it could be perceived as intrusive by visually sensitive viewers. Visual impacts could also occur if the project was placed in highly scenic locations. There is little mitigation that is feasible for the visual impacts of a transmission line. Normal, good, orderly design would minimize its adverse visual effects. Impacts to visual resources would be considered significant if the visual changes caused by the project would be dominant, as seen from visually sensitive viewpoints. The visual impacts of the primary alternatives are quantified and compared by measuring the distance of each project action type through or across visually sensitive land uses (residential, recreational, scenic areas and visually sensitive highway corridors). Thus, the effects on valued views from these areas, including views to the mountains, are the basis for the comparison of routes.

5.H.1 ALTERNATIVE B. THE PROPOSED ACTION: UPRATE EXISTING FLATIRON-ERIE TRANSMISSION LINE

Figure 3.9 shows Alternative B, the Proposed Action. The construction actions that make up this alternative are Numbers 2, 3, 4 and 5 (all relatively minor actions), as shown on Figure 3.8. Each occurrence of each action is mapped on Figure 3.9. The actions would all take place within the ROW of the existing Flatiron-Erie transmission line; therefore, little or no new construction access would be required. The construction actions include building new structures at new sites and at existing sites on the ROW, and replacing various elements of existing structures. The conductors and overhead ground wires would remain in place. Disturbance would not be continuous along the ROW, but would be restricted to an area centered on the structures being built, replaced or modified. The maximum extent of each of these disturbed areas is estimated at 15,000 square feet (a 200-foot long segment of the 75-foot wide ROW).

There would be no significant or moderate impacts to visual resources from Alternative B. All impacts to visual resources would be at most low.

North of the Longmont urban area, six structures would affect existing residential uses and one structure would affect existing public recreation/open space. The impact levels would be low to none because of the minor nature of the changes between existing and proposed visual conditions. Project changes would occur at 10 structures located in scenic condition landscapes, and two in a Boulder County designated natural landmark. Again, because of the minor nature of the project changes, all visual resources here would be low to none.

Within Longmont, seven structures would affect existing residential land uses and one structure would affect existing public recreation/open space. Impacts to visual resources at these locations would be at most low.

South of Longmont, four widely scattered existing residences would be affected at the low to none level.

Alternative B, in total, would not cause any impacts to visual resources that would contribute to the comparison of alternatives; i.e., significant or moderate adverse impacts, or beneficial effects.

5.H.2 ALTERNATIVE C. CONSTRUCT TRANSMISSION LINE UNDERGROUND THROUGH LONGMONT

Figure 3.12 shows this proposed project alternative. North and south of Longmont, this alternative is identical to Alternative B. Within Longmont, however, it includes two additional major construction actions. These are Construction Action 7, remove the existing transmission line and build a new transmission line underground; and Construction Action 8, build a new overhead to underground transition structure. These construction actions are explained on Figure 3.8 and mapped on Figure 3.12. Disturbance would take place continuously along the ROW with Action 7, and on a 200-foot long ROW segment with Action 8.

North and south of the Longmont urban area, this alternative is identical to Alternative B. Therefore, in these route segments, the alternative would not cause any significant or moderate impacts.

Within the Longmont area, Alternative C uses underground construction with (at five locations) substantial overhead/underground transition structures. In this route segment, 12,400 feet of existing residential land use would have long-term beneficial visual effects from removal of the existing overhead line; 1,900 feet of existing recreation/open space land use would also experience long-term beneficial effects. Small amounts (an estimated 600 feet) of existing residential land uses would be subject to short-term moderate and long-term moderate adverse impacts to visual resources from the overhead to underground transition structures.

About 6,600 feet of planned residential land use would be crossed by or adjacent to underground segments of the line. However, future land uses are not considered to be subject to measurable benefits from present actions.

The total visual impacts from this alternative that contribute to route comparison (significant adverse, moderate adverse, and beneficial effects) amount to:

- Existing Residential: 600 feet of short-term moderate impact; 600 feet of long-term moderate impacts; 12,400 feet of long-term beneficial effect

- Existing Recreation/Open Space: 1,900 feet of long-term beneficial effect

5.H.3 ALTERNATIVE D. REMOVE AND REROUTE THROUGH PARTS OF LONGMONT

Figure 3.15 shows this proposed project alternative. North and south of Longmont, it is identical to Alternative B. Within Longmont, however, it includes two different construction actions. These are Construction Action 6, remove the existing transmission line and leave the ROW vacant; and Construction Action 1, a relatively major action, build a new overhead transmission line on a new ROW. These construction actions are explained on Figure 3.8 and mapped on Figure 3.15. Disturbance is considered as being continuous along the ROW with Action 1.

Outside of the Longmont urban area, this alternative is identical to Alternative B. In these route segments, it has no significant or moderate adverse visual impacts.

Within Longmont, this alternative would have substantial beneficial effects in the segments where the existing line would be removed; 10,800 feet of existing residential development and 1,900 feet of existing recreation/open space would experience long-term benefits. Along the south edge of Longmont, existing land uses would be adversely affected by the proposed segment of new overhead line; 1,500 feet of existing residential use would be subject to moderate short-term and moderate long-term adverse effects. In this location, planned land uses would also be affected. There would be moderate adverse long-term effects on 1,000 feet of planned residential development.

The total impacts from Alternative D on visual resources that would contribute to route comparison (significant adverse, moderate adverse, and beneficial effects) would be:

- Existing Residential: 10,800 feet long-term beneficial; 1,500 feet short-term moderate adverse; and 1,500 feet long-term moderate adverse

- Existing Recreation/Open Space: 1,900 feet long-term beneficial

- Planned Residential: 1,000 feet long-term moderate adverse effects

- Planned Recreation/Open Space: 1,700 feet long-term moderate adverse

5.I ELECTRICAL REQUIREMENTS

Appendix C provides a discussion of the possible effects of the electrical properties of transmission lines on public health and safety. The discussion includes some of the more obvious effects, such as electric shocks and induced voltages and current, and includes a discussion of the potential long-term health effects. This section also provides definitions for Electric and Magnetic Fields, corona, and various other related electrical parameters. These parameters are discussed in detail as they relate to the safety and health aspects of the proposed project. Estimated values for these parameters are given for the specific project alternatives.

Potential electrical effects associated with transmission lines include ozone generation, radio and television interference, audible noise, electric and magnetic field interference, and safety concerns. The first three of these potential effects are caused by corona, which is the electrical breakdown of air into charged particles created by the electrical field at the surface of the conductors.

Corona effects are generally associated with transmission lines operating at voltages of 345-kV or above. For the proposed action (existing 115-kV line), corona effects would be negligible; ozone generation would be undetectable; and radio and television interference is not expected to be a problem. However, mitigative techniques do exist, and, if any problem occurred, Western would take corrective action. Noise may be noticeable directly under a line during foul weather. However, line noise would remain very low and would probably be masked by background storm noise during inclement weather. Audible noise (AN) is not expected to be an annoyance.

The proposed project would be designed and constructed to meet or exceed all applicable requirements of the NESC. Western will correct any induced shocks on fences or buildings associated with the line. However, persons working near the lines should exercise caution not to contact the conductors with long, metallic objects (e.g., irrigation pipe). Such contact would produce a lethal electric shock.

Much attention has focused recently on reports of health effects associated with electric and magnetic fields. This possible association between power line electric and magnetic fields (E&M fields) and human health has created a public concern that exposure to E&M fields may cause a variety of adverse human health effects. In the last 20 years, scientists have conducted a number of studies to try to determine the relationship, if any exists, of E&M fields to plant, animal and human health. Some of the studies suggest that under certain circumstances, even relatively week E&M fields can produce biologic changes. However, it is yet to be discovered whether these biologic changes represent a health risk. Although a substantial amount of research on the subject has been done, and in fact is still in progress, the body of research on health effects is still preliminary and inconclusive.

Although the consensus opinion of the majority of researchers (including DOE) regarding the existence of a link between magnetic and electric field exposure and health effects continues to center on the need for research, there are a few well known and credible epidemiologists who have taken the position that adequate evidence does indeed exist by which to conclude the presence of a cause and effect relationship. Recognizing that this diversity of opinion exists, Appendix C concludes that health effects cannot be considered as proven, and it is not clear whether biological effects can lead to health effects. If health effects exist, epidemiology indicates that they are likely to be small. Study results have not indicated a cause for immediate alarm. Because of our limited knowledge of the exposure parameters involved and the non-linearity of the dose/effect relationship, there is currently no scientific basis for regulatory action or mitigation. Therefore, the E&M fields associated with the proposed transmission line project are not anticipated to cause adverse impacts on property values nor adversely effect public health and safety. A more detailed discussion of the health effects issue is included in Appendix C, Public Health and Safety.

5.J ADDITIONAL IMPACT CONSIDERATIONS

5.J.1 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Resources committed to the proposed project would be material and nonmaterial, including financial. "Irreversible and irretrievable commitment of resources" is interpreted here to include resources that are committed throughout the life of the project. It is assumed that those resources used, consumed, degraded or destroyed during construction, operation or maintenance of the project would not be retrieved or replaced for the life of the project or beyond. Irreversible or irretrievable commitments of resources for the proposed project are summarized on Table 5.1.

5.J.2 SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

A project may have characteristics that require it to be analyzed as a trade-off between a proposed short-term use of the environment and the maintenance of long-term productivity. The National Environmental Policy Act requires that every EIS address the issue. A typical project where such a trade-off could be of prime importance might involve, for example, extraction of a mineral resource (a short-term use) from beneath an area of productive farmland (a long-term productive system). Environmental systems that are productive in the long term (i.e., self-sustaining) are here assumed to include natural geologic, hydrologic, biologic and agricultural systems. A typical transmission line project would have a very minor effect on long-term productivity.

As shown in Section 3.G.3, Alternative B of the proposed project, the uprating of an existing transmission line, would have no effect at all on long-term productivity; Alternative C would have (at most) a minute effect on long-term productivity. This would be related to its very small amount of long-term impacts on water and biological resources. It would have no effect on agriculture. Alternative D would have no long-term effect on earth, water or biological systems, but would take an extremely small amount of agricultural land out of production.

5.J.3 CUMULATIVE IMPACTS

Much of the project is located in an urban fringe area, parts of which are experiencing (and are likely to continue to experience) moderately rapid growth. This ongoing urbanization will undoubtedly cause substantial future impacts to the earth, water, biological, cultural and visual resources of the study area. The project itself would constitute an extremely small fraction of these anticipated future area impacts. Other proposed transmission lines in the area (described in Section 2.D) would likely have more impacts than the Flatiron-Erie 115-kV transmission line, since some of their length would be on new ROW. However, their impacts would almost certainly still be seen as very minor in the context of the developing study area. Transmission lines have not generally been considered to facilitate or induce urban growth.

TABLE 5.1

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Resource Category	Type of Potential Resource Commitment	Irreversible and Irretrievable?
Earth Resources	Soil loss from erosion in areas disturbed by construction.	No. Effects would be minor and primarily for the construction period only.
Water Resources	Sedimentation from construction of underground line across stream, risk of water pollution from oil spill from underground line.	No. Sedimentation would be minor and restricted to construction period. Fluid spill potentially affecting water quality would probably involve relatively small amounts of fluid, and is estimated to have about a 1 in 8 chance of occurrence in a 50-year project life.
Biological Resources: Wetlands	Construction disturbance.	No. Disturbance would be temporary and very minor in extent.
Rare Plant Communities	Construction disturbance.	No. None affected.
Wildlife Habitat	Loss from conversion of land to project uses.	No. Land occupied by the project would be very minor.
Wildlife	Disturbance by construction activity.	No. Most sensitive wildlife seasonally avoided. Other disturbance very minor.
Birds	Collision mortality.	None from Alternative B. Overall improvement from Alternative C and to a lesser extent D.
Developed Land Uses	Land occupied.	No. Existing conditions unchanged with Alternative B. Net minor decrease in amount of land occupied with Alternative C and to a lesser extent D.
Agricultural Land Uses	Land occupied. Cultivation restricted.	No. Existing effects on agriculture unchanged with Alternatives B and C. Minor increase in agricultural land occupied and restricted with Alternative D.
Land Use Plans	Land occupied. Future development options affected.	No. Existing conditions unchanged with Alternative B. Net minor decrease in amount of land occupied with Alternative C, and to a lesser extent D.

TABLE 5.1 (continued)

Resource Category	Type of Potential Resource Commitment	Irreversible and Irretrievable?
Cultural Resources	Disturbance of valuable sites.	No. No disturbance anticipated.
Visual Resources	Lowering of scenic quality.	No. Existing conditions unchanged with Alternative B. Net minor improvements with Alternatives C and D.
Construction Materials	Materials used.	Yes. Partially salvageable after ultimate abandonment of the project.
Energy	Expenditure of energy.	Yes. Fossil fuels irretrievably lost during construction and maintenance.

Chapter 6
Consultation and Coordination

Chapter 6. Consultation and Coordination

6.A LIST OF AGENCIES CONTACTED

- Advisory Council on Historic Preservation
  Golden, Colorado
  Claudia Nisley, Chief, Western Division of Project Review

- Boulder County
  Department of Parks and Open Space
  Dave Hallock, Rich Koopman

- Boulder County
  Department of Planning
  Rob Hellmick, Pete Fogg

- City of Boulder
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- City of Boulder
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- City of Longmont
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  Gene Kraning

- City of Longmont
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- City of Loveland
  Department of Parks and Recreation
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- City of Loveland
  Department of Planning
  Larry Gamble

- Colorado Archaeological Society, Lyons Chapter
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  Sharon Pay

- Colorado Division of Parks and Outdoor Recreation
  Colorado Natural Areas Program
  Denver, Colorado
  Janet Coles, Researcher II

- Colorado Division of Wildlife
  Denver, Colorado
  Dave Weber, Wildlife Biologist

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  Fort Collins, Colorado
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  Gerald Craig

- Colorado Office of Archaeology and Historic Preservation
  Colorado Historical Society
  Mary Sullivan

- Larimer County
  Parks and Recreation
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- Larimer County
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  Jerry White, Jill Bennet

- Larimer County
  Public Works Department
  Ed Woodward

- Longmont Airport Manager
  Reid Walker

- Mountain Ute Tribe
  Towac, Colorado
  Tribal Council Chairman

- National Oceanic and Atmospheric Administration
  U.S. Department of Commerce
  Teresa Maraia

- Northern Arapahoe Tribe
  Fort Washakie, Wyoming
  Tribal Council Chairman

- Southern Cheyenne Tribe
  Anadarko, Oklahoma
  Tribal Council Chairman

- State Historic Preservation Office
  Denver, Colorado
  Barbara Sudler, State Historic Preservation Officer

- Town of Berthoud
  Public Works Department
  Earl Sterkel

- Town of Erie
  Town Administrator
  Scott Hahn

- U.S. Fish and Wildlife Service
  Denver, Colorado
  Perry Olsen, Regional Director

- U.S. Fish and Wildlife Service
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  Bill Noonan, Project Leader, Endangered Species Office
  Leroy Carlson, Colorado State Supervisor
  Bill Noonan, Fish and Wildlife Biologist

- U.S. Forest Service, Routt National Forest
  Steamboat Springs, Colorado
  Robert Nycamp, Archaeologist

- Weld County
  Department of Planning Services
  Rod Allison, Brian Bingle

Note: Some of the agencies listed here were first contacted during studies for an earlier version of the project; i.e., the Flatiron-Gunbarrel EA and EIS studies. Sometimes, several contacts were made over a period between late 1986 and January 1991.

6.B LIST OF AGENCIES, ORGANIZATION AND PERSONS TO WHOM COPIES OF THE EIS ARE SENT

(List will appear in Public Draft EIS and subsequent versions)

6.C PUBLIC HEARINGS

(Transcript will appear in Preliminary Final EIS and Final EIS)

6.D LIST OF PREPARERS

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Appendix A
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Appendix A. Bibliography

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Appendix B
Glossary, Acronyms, and Abbreviations

Appendix B. Glossary, Acronyms and Abbreviations

ACSR: Aluminum conductor steel reinforced.

Alternating current (a.c.): An electric current that reverses its direction of flow at regular intervals and has alternately positive and negative values. The standard for transmission lines of the Flatiron-Erie type.

Ampere (A): The unit of measurement of electric current. It is proportional to the quantity of electrons flowing through a conductor past a given point in one second.

Circuit: A system of conductors (three with alternating current lines) through which electric current flows.

Circuit breaker: Generally, any switching device that is capable of interrupting an electrical circuit under overload or short-circuit conditions, as well as under normal load conditions.

Conductor: A wire cable strung between transmission structures through which the electric current flows.

Current: A measure of the flow of electrons through a conductor. In general, it is expressed in amperes. Current is analogous to flow rate in a water system.

Direct current (d.c.): A unidirectional current having a magnitude that does not vary, or that varies only slightly.

Easement: The right or privilege obtained to construct, maintain and operate transmission facilities within a right-of-way.

Electric field: An electric field is created in a vicinity of transmission lines by the electric charges on the conductors. This field decreases rapidly and non-uniformly from the conductor surface to the ground surface and to objects in the area. It is influenced and shaped by the objects in the area. The strength of an electric field at a point is defined as the force that would occur on a unit electric charge at that point. Field strength is expressed in a voltage per distance ratio, such as kilovolts/meter (kV/m).

Endangered species: Any species which is in danger of extinction throughout all or a significant portion of its range.

Gauss: A unit of measurement of magnetic field intensity. The Gauss indicates the number of lines of magnetic force (attraction) per unit area. For transmission lines, this is a large unit and often the milligauss is used.

Ground: Any conducting connection made between an energized electrical circuit and the earth (zero voltage potential).

Insulator:	A low conductive support for a conductor, typically of glass, porcelain or polymer-fiberglass. It prevents the normal flow of current from the conductor to earth or another conductor.
Kilowatt (kW):	The electrical unit of power which equals 1,000 watts.
Load:	The amount of electric power delivered to a given point on a system.
Magnetic field:	Region of magnetic influence or attraction -- similar to the effect near a magnet. The field that is formed around the conductors of a transmission line is caused by the current flowing in the conductors.
Overhead ground wires:	Grounded wires placed in close proximity to an energized transmission line. Overhead ground wires are used to protect the transmission line from lightning.
Phase:	One wire of a 3-wire alternating current circuit.
Riparian:	Pertaining to, living or situated on, the banks of rivers and streams.
Single circuit:	The placing of one single electrical circuit (consisting of three phases) along a row of towers. In tower design, any tower capable of supporting only one circuit.
Substation:	An assemblage of equipment designed for switching, changing or regulating the voltage of electricity.
Threatened species:	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Volt:	The unit of electromotive force or electric pressure analogous to water pressure in pounds per square inch. It is the electromotive force which, if steadily applied to a circuit have a resistance of one ohm, will produce a current of one ampere.

Appendix C
Public Health and Safety

APPENDIX C

PUBLIC HEALTH AND SAFETY

ENVIRONMENTAL IMPACT STATEMENT

Flatiron-Erie
115-kV Transmission Line Project

Larimer, Weld and Boulder Counties
Colorado

U.S. DEPARTMENT OF ENERGY
Western Area Power Administration
Washington, D.C. 20585

APPENDIX C.
PUBLIC HEALTH AND SAFETY

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Appendix C.

Public Health and Safety

Western Area Power Administration (Western) is committed to programs and policies that ensure a safe and healthy environment. Safety and health are not an obscure set of rules or a collection of generalized standards. At Western safety and health are an essential part of the working culture and are demonstrated daily by each employee and contractor as integrated actions in everyday work practices. Safety is a way of life at Western, a condition of employment. Western is committed to programs that ensure an equitable distribution of a public resource, electric energy, to the people of the Western United States in a safe, efficient, reliable, and environmentally healthful manner.

This appendix provides a discussion of the possible effects of the electrical properties of transmission lines and the latest information on their possible effects on public health and safety. The discussion includes effects such as the potential for electric shock hazards and induced voltages and currents, and includes a discussion of the potential long-term health effects. This section also provides definitions for electric and magnetic fields (E&M Fields), corona, and various other related electrical parameters. These parameters are discussed in detail as they relate to the safety and health aspects of the proposed project. Estimated values for these parameters are given for the specific project alternatives.

C.1 TRANSMISSION LINE SAFETY PROVISIONS

Powerlines, as with residential electrical wiring, can cause serious electric shocks if certain precautions are not taken. These precautions include building the lines to minimize the shock hazard. All of Western's lines are designed and constructed in accordance with the National Electrical Safety Code (NESC) standards. NESC specifies the minimum allowable distance between the lines and the ground or other objects. These requirements basically determine the edge of the right-of-way (ROW) and the height of the line, i.e., the closest point to the line that houses, other buildings, and vehicles are allowed, to limit electrical effects to acceptable levels.

People must also take certain precautions when working or playing near powerlines. It is extremely important that a person not bring anything, such as a television (TV) antenna or irrigation pipe, too close to the lines. Western provides a free booklet that describes safety precautions for people who live or work near transmission lines. It is entitled, "Living and Working Around High Voltage Power Lines" and is available from the Loveland Area Office. To obtain a copy call (303) 490-7200.

Transmission lines can also induce voltages into objects near the lines. This effect can lead to nuisance shocks if a voltage is induced on something like wire fencing which is on wood posts, and therefore, insulated from ground. Usually, however, this becomes a problem only with lines of voltages above 230-kilovolt (kV). Should problems develop with either high- or low-voltage lines, they can be corrected by simple grounding techniques. For all of Western's lines, grounding of certain objects near the lines is a routine part of the initial construction process.

C.2 POTENTIAL HAZARDS

The following sections discuss specific potential safety hazards and related activities that are of particular concern.

C.2.1 Direct Electrical Contact. The greatest hazard from a transmission line is direct electrical contact with the conductors. In fact, contact is more likely with lower voltage transmission lines, because of their lower clearance requirements. Physical contact between a grounded object and the high voltage conductors is not necessary for electrical contact to be made because under certain circumstances arcing can occur across an air gap, especially if an object is brought too close to the line or if dust or smoke provides a conductive path.

The following precautions indicate the care that must be taken near a high voltage line to avoid direct electrical contact. Extreme caution must be used when operating tall equipment, such as cranes or drilling equipment, near the line. Irrigation pipes and systems cannot be tipped up near the line. Trees near the transmission line should not be felled onto the conductors. Kites should not be flown near transmission lines and only nonmetallic string and kites should be used. The wind should carry the kite away from the transmission line. Towers should not be climbed.

If there is adequate clearance to the conductors of a transmission line, then normal agricultural and other activities can be carried on safely. Vehicles and large equipment up to 15 feet in height (including antennas, etc.) can normally travel safely under all Western lines. Lines owned by other utilities may have different height limitations. If there is any doubt whatsoever, contact Western or your local utility to review the situation before proceeding.

C.2.2 Irrigation. Both fixed and mobile irrigation systems can be operated safely near transmission lines. However, certain precautions are necessary to minimize the hazards involved. The hazards associated with irrigation near transmission lines fall into three categories: direct contact, induced shocks, and transferred potentials. With appropriate precautions all can be minimized as a source of danger.

Direct contact is the most dangerous and, unfortunately, the most likely to occur without special precautions. Irrigation pipes are often long enough to reach within flashover distance of the conductors. Therefore, pipes should never be tipped up to remove dirt or small animals when in proximity to an overhead line. Equipment used to install irrigation systems can be tall; therefore, precautions should be taken to maintain adequate electrical clearance during installation. When moving a high pressure system with long booms, such as a Vermeer mobile system, special precautions should be taken to insure that it does not tip.

Steady streams of water contacting the energized conductors can provide a direct path to ground for leakage current or a flashover. Therefore, precautions should be taken to prevent steady water streams from striking the conductors. If this does happen, one should avoid contacting or being near the irrigation system. Thus, when a steady stream of water reaches a conductor, the water should be turned off at its source before attempting to correct the problem. Nozzle risers in the vicinity of transmission lines should be equipped with spoilers or automatic shutoffs. High volume, high pressure systems have the potential to send a steady stream considerable distances. Safe operating distances for this type of equipment are based on several factors, including nozzle diameter and line voltage. Information is available to determine safe distances for this type of equipment (67, 70).

Both electric-field and magnetic-field coupling can occur on irrigation systems. The former is easily reduced or eliminated by unloading and handling pipes away from the transmission line and by attaching only short lengths of pipe to a grounded header or riser. Potentially hazardous, magnetically induced voltages can occur in long irrigation pipelines and maintenance of long pipes such as pivot systems should be done with the pipe perpendicular to the transmission line. In the event this orientation cannot be achieved, then the system should be grounded at each end. If the pipe is cut into sections, then each section should also be grounded.

To avoid the possibility of a transferred potential from the power system to the irrigation system during an electrical fault, buried portions of the irrigation system, or any pipeline, should not be too close to the tower or the tower grounding system.

In summary, irrigation near transmission lines can be hazardous if certain precautions are not taken. Cooperation between the landowner and the operator of the line is essential for safe operation.

C.2.3 Refueling. In a high electric field it is theoretically possible for a spark discharge from the induced voltage on a large vehicle to ignite gasoline vapor during refueling. However, the probability for exactly the right conditions to occur for ignition is extremely small. According to results obtained from studies conducted by Johns Hopkins University, the ignition of fuel under a transmission line would require that an individual be standing on damp earth or vegetation and that the vehicle to be refueled must be exposed to the maximum intensity of the electric field. The vehicle must also be insulated. Finally, the air-fuel mixture must approach optimal flash-point conditions. Therefore, the number of precise conditions to be met to achieve fuel ignition reduces the likelihood of the occurrence. The report points out that "even if spark energies were sufficient to ignite fuel, then the person making the attempt would likely experience uncomfortable sparks, which would serve as a healthy warning of a potentially hazardous situation" (71). For the existing line the maximum electric field is low enough that it is very doubtful the right conditions could ever be achieved.

Because of the theoretical possibility of ignition, some utilities recommend that refueling not be done near transmission lines unless necessary (61, 62). In the event refueling must be done under a line, proper grounding procedures are recommended.

C.2.4 Fires. Large fires near transmission lines represent a potential electrical hazard. The hot gases and smoke can create a conductive path to ground. If a flashover occurs along this path, then people near the fire could possibly experience dangerous shocks. Flashovers also cause outages and jeopardize the reliability of the transmission system.

Because of the hazards associated with fires, storage of flammables, construction of flammable structures, and other activities which have the potential to cause or provide fuel for fires on Western's right-of-way (ROW) are prohibited.

C.2.5 Explosives. Use of explosives on or near the ROW can be affected by electrical interference from the power line to the circuits used for detonation. There is also a potential for damage to the transmission system.

C.2.6 Lightning. Transmission line structures, wires, and other tall objects are the most likely points to be hit by lightning during a thunderstorm. Western's transmission lines are designed with overhead ground wires and grounded structures to protect the system from lightning. When the overhead ground wire or structure is hit, the lightning strike is conducted to ground at the structure. Since it is hazardous to be in the area where lightning enters the ground, it is advisable to stay away from the transmission line structures (and all tall objects such as trees) during electrical storms.

C.3 POWER TRANSMISSION FACILITES AND PUBLIC CONCERN

C.3.1 Introduction

The following sections summarize the vast amount of information that has been published regarding the assertion that exposure to 60 hertz (Hz) E&M Fields may cause a variety of adverse human health effects. Media coverage regarding this possible association has created a general public concern. The interest shown and concerns expressed during public scoping meetings and at public hearings and in public comment letters have encouraged Western to address this issue in depth.

First, we define and describe the various electrical parameters associated with power transmission facilities which are known and whose characteristics are predictable using the laws of physics and engineering. For this project these parameters are summarized in the tables of the following section. Then we discuss the more abstract and unknown features associated with the human health issue. These discussions and the associated reference sources do not present every scientific assessment and popular press article published on the subject. These discussions present the major evaluations of the issue and the publications that form the core of our present knowledge and understanding of the E&M Field issue. The scientific panels and government agencies that have evaluated the E&M Field question (See Section C.6.1) have reviewed and considered virtually all publications, studies, evidence, assessments, points of view, and opinions on the issue. These sections summarize the reviews that have taken place and the conclusions that have been reached to date.

C.3.2 Project Specific Analysis Tables

Both current and voltage are required to transmit electrical energy over a transmission line. The current is a flow of electrons measured in amperes or amps (A) and is the source of a magnetic field. The voltage (the force that drives the current) is expressed in units of volts (V) or kilovolts (kV) and is the source of an electric field.

Since power in the United States is transmitted by current and voltage that changes their strength and direction with a frequency of 60 Hz, or cycles per second, the frequency of the magnetic and electric fields produced is also 60 Hz. The fields extend out from the conductors and decrease rapidly in intensity as distance from the transmission line increases. These fields are an important consideration associated with the design of transmission lines. First, the electric field at the surface of the conductors is responsible for the phenomenon known as corona (corona is discussed in greater detail in Section C.4.1). Corona is the electrical breakdown of the air very near an electrically energized object into charged particles which can result in audible noise (AN), electromagnetic interference, and the production of various oxidants. Second, the electric and magnetic fields near ground level are responsible for induced currents and voltages.

Analysis of the specific electrical characteristics and parameters of the proposed Flatiron-Erie Transmission Line Project was conducted for each primary alternative configuration and are shown in Tables C-1, C-2, and C-3 (see sections C.4.1.7, C.4.2.4, and C.5.2). Tables C-1, C-2, and C-3 show the various values for audible noise, radio and television interference, ozone levels, and the magnetic and electric fields for each primary alternative configuration for the Flatiron-Erie Transmission Line Project. These primary alternatives are described in section 3.G of the EIS.

Figure C-1 is a comparison of magnetic fields for overhead and underground transmission lines. Figure C-1 is not intended to reflect projected field values for the Flatiron-Erie Project, but is intended to demonstrate the relative magnetic field levels associated with hypothetical overhead and two types of underground lines each carrying a load current of 700 amps. As exhibited, underground transmission does not necessarily mitigate magnetic fields. However, the underground high-pressure oil-filled pipe-type transmission cable proposed in alternative "C" would significantly reduce the magnetic field.

TABLE C-1
Calculated Load Conditions for the Flatiron-Erie Transmission Line Project

ALTERNATIVE AND LINE SEGMENTS	VOLTAGE (kV)	STRUCTURE TYPE	CONDUCTOR (Kcmil)	LOADING(MW/AMPS) MAXIMUM (OUTAGE) (Note 1)	PEAK LOAD	AVERAGE LOAD	MINIMUM LOAD
				(Note 3)			
ALTERNATIVE B: (PROPOSED ACTION)							
FLATIRON-LYONS-HYGIENE	115	WOOD H	397.5	93.0/457.8	71.4/355	46.0/228.6	32.6/162.2
HYGIENE-LONGMONT NW	115	WOOD H	397.5	63.6/318.4	42.7/214.4	27.5/137.8	19.5/97.8
LONGMONT NW-FORDHAM	115	WOOD H	397.5	38.4/217.2	17.0/86.4	11.0/55.6	7.8/39.5
FORDHAM-TERRY	115	WOOD H	397.5	24.0/120.9	2.3/14.8	1.5/9.5	1.1/6.8
TERRY-ERIE	115	WOOD H	397.5	11.6/74.4	5.9/43.8	3.8/28.2	2.7/20.0
ALTERNATIVE C: (NOTE 2)							
FLATIRON-LYONS-HYGIENE	115	WOOD H	397.5	93.0/457.8	71.4/355	46.0/228.6	32.6/162.2
HYGIENE-LONGMONT NW	115	WOOD H/UG	397.5/ HPOFPT	63.6/318.4	42.7/214.4	27.5/137.8	19.5/97.8
LONGMONT NW-FORDHAM	115	UG	HPOFPT	38.4/217.2	17.0/86.4	11.0/55.6	7.8/39.5
FORDHAM-TERRY	115	UG	HPOFPT	24.0/120.9	2.3/14.8	1.5/9.5	1.1/6.8
TERRY-ERIE	115	WOOD H	HPOFPT/ 397.5	11.6/74.4	5.9/43.8	3.8/28.2	2.7/20.0
ALTERNATIVE D							
FLATIRON-LYONS-HYGIENE	115	WOOD H	397.5	90.7/447.4	69.8/347.9	45.0/224.1	31.9/159.0
HYGIENE-LONGMONT NW	115	WOOD H	397.5	61.5/306.9	41.2/206.8	26.5/133.2	18.8/94.5
FORDHAM-TERRY	115	WOOD H	397.5	86.6/436.5	27.6/138.9	17.8/89.5	12.6/63.5
FORDHAM-NEWSUB	115	WOOD H/ SGL. STEEL	397.5/795	71.5/364.3	12.8/74.4	8.2/47.9	5.9/34.0
NEWSUB-ERIE	115	WOOD H	397.5	26.9/157.0	13.4/87.5	8.6/56.4	6.1/40.0

1) The maximum flow is given for worst case system outage condition with the overall area's system stressed at 775 MW.
2) Alternative C (underground through Longmont) is assumed to have the same loading conditions as Alternative B.
3) Each loading condition was used to calculate the electric and magnetic fields for the associated line section and alternative (See Table C-3, C-3.1 Maximum, C.-3.2 Peak, C-3.3 Average, C-3.4 Minimum).

UG = underground
HPOFPT = High pressure oil-filled pipe type underground construction.

TABLE C-2
Calculated Corona Effects for the Flatiron-Erie Transmission Line Project

ALTERNATIVE AND LINE SEGMENT	Voltage, kilovolts (kV)	ROW Width (feet)	Average Wet-weather Audible Noise at Edge of ROW, decibels A-weighted (dBA)	Average Fair-weather Audible Noise at Edge of ROW, decibels A-weighted (dBA)	Average Wet-weather Radio Interference (RI) at Edge of ROW, decibels above 1 microvolt per meter (dBDV/m)	Average Fair-weather Radio Interference (RI) at Edge of ROW, decibels above 1 microvolt per meter (dBDV/m)	Television Interference (TVI) at Edge of ROW, decibels above 1 microvolt per meter (dBDV/m)	Maximum Incremental Ozone-levels at Ground Level, parts per billion (ppb) (Note 3)
Alternative B:								
FLATIRON-LYONS-HYGIENE	115	75	25.2	0.22	43.6	26.6	5.1	0.0182
HYGIENE-LONGMONT-NW	115	75						
LONGMONT NW-FORDHAM	115	75			See Note 1			
FORDHAM-TERRY	115	75						
TERRY-ERIE	115	75						
ALTERNATIVE C								
FLATIRON-LYONS-HYGIENE	115	75						
HYGIENE-LONGMONT-NW	115	75						
LONGMONT NW-FORDHAM	115	75			See Note 1,2			
FORDHAM-TERRY	115	75						
TERRY-ERIE	115	75						
ALTERNATIVE D:								
FLATIRON-LYONS-HYGIENE	115	75						
HYGIENE-LONGMONT-NW	115	75						
FORDHAM-TERRY	115	75			See Note 1			
FORDHAM-NEW SUB	115	75						
NEWSUB-ERIE	115	75						

1 Since corona effects are produced as a result of system voltage, the corona effects will be essentially the same for all system currents (loads), line segments, and alternatives.
2 Corona effects for the underground portion of Alternative C would be negligible.
3 Calculation assumes a 1.0 mph perpendicular wind and a 0.05 inch/hr rain.

TABLE C-3

CALCULATED FIELD EFFECTS FOR THE FLATIRON-ERIE TRANSMISSION LINE PROJECT

C-3.1 MAXIMUM LOAD CONDITION FROM TABLE C-1

MAXIMUM (OUTAGE)	ELECTRIC FIELD (Max within ROW)	ELECTRIC FIELD (at edge of ROW)	MAGNETIC FIELD Max within ROW	MAGNETIC FIELD (at edge of ROW)
ALTERNATIVE B:	kV/m	kV/m	mG	mG
FLATIRON-LYONS-HYGIENE	1.69	0.86	125.4	42
HYGIENE-LONGMONT NW	1.59	0.85	82.8	28.6
LONGMONT NW-FORDHAM	1.55	0.84	55.1	19.3
FORDHAM-TERRY	1.51	0.84	30.1	10.7
TERRY-ERIE	1.51	0.84	18.6	6.6
ALTERNATIVE C:				
FLATIRON-LYONS-HYGIENE	1.69	0.86	125.4	42
HYGIENE-LONGMONT NW	1.59	0.85	82.6	28.6
LONGMONT NW-FORDHAM	(Note 1)	(Note 1)	(Note 1)	(Note 1)
FORDHAM-TERRY	(Note 1)	(Note 1)	(Note 1)	(Note 1)
TERRY-ERIE	1.51	0.84	18.6	6.6
ALTERNATIVE D:				
FLATIRON-LYONS-HYGIENE	1.69	0.86	122.3	41
HYGIENE-LONGMONT NW	1.59	0.85	80	27.6
FORDHAM-TERRY	1.63	0.86	119.3	40
FORDHAM-NEWSUB (Note 2)	1.59	0.85	94.5	32.7
NEWSUB-ERIE	1.55	0.84	40	14

C-3.2 PEAK LOAD CONDITION FROM TABLE C-1

PEAK	ELECTRIC FIELD (Max within ROW)	ELECTRIC FIELD (at edge of ROW)	MAGNETIC FIELD Max within ROW	MAGNETIC FIELD (at edge of ROW)
ALTERNATIVE B:	kV/m	kV/m	mG	mG
FLATIRON-LYONS-HYGIENE	1.59	0.85	92.2	31.9
HYGIENE-LONGMONT NW	1.55	0.84	55.1	19.3
LONGMONT NW-FORDHAM	1.51	0.84	21.4	7.6
FORDHAM-TERRY	1.51	0.84	3.7	1.3
TERRY-ERIE	1.51	0.84	10.7	3.8
ALTERNATIVE C:				
FLATIRON-LYONS-HYGIENE	1.59	0.85	92.2	31.9
HYGIENE-LONGMONT NW	1.55	0.84	55.1	19.3
LONGMONT NW-FORDHAM	(Note 1)	(Note 1)	(Note 1)	(Note 1)
FORDHAM-TERRY	(Note 1)	(Note 1)	(Note 1)	(Note 1)
TERRY-ERIE	1.51	0.84	10.7	3.8
ALTERNATIVE D:				
FLATIRON-LYONS-HYGIENE	1.59	0.85	90.1	31.2
HYGIENE-LONGMONT NW	1.55	0.84	52.6	18.4
FORDHAM-TERRY	1.51	0.84	34.5	12.3
FORDHAM-NEWSUB (Note 2)	1.51	0.84	18.8	6.6
NEWSUB-ERIE	1.51	0.84	21.9	7.8

C-3.3 AVERAGE LOAD CONDITION FROM TABLE C-1

AVERAGE	ELECTRIC FIELD (Max within ROW)	ELECTRIC FIELD (at edge of ROW)	MAGNETIC FIELD Max within ROW	MAGNETIC FIELD (at edge of ROW)
ALTERNATIVE B:	kV/m	kV/m	mG	mG
FLATIRON-LYONS-HYGIENE	1.55	0.84	57.9	20.3
HYGIENE-LONGMONT NW	1.51	0.84	34.3	12.2
LONGMONT NW-FORDHAM	1.51	0.84	13.9	4.9
FORDHAM-TERRY	1.51	0.84	2.5	0.9
TERRY-ERIE	1.51	0.84	7	2.5
ALTERNATIVE C:				
FLATIRON-LYONS-HYGIENE	1.55	0.84	57.9	20.3
HYGIENE-LONGMONT NW	1.51	0.84	34.3	12.2
LONGMONT NW-FORDHAM	(Note 1)	(Note 1)	(Note 1)	(Note 1)
FORDHAM-TERRY	(Note 1)	(Note 1)	(Note 1)	(Note 1)
TERRY-ERIE	1.51	0.84	7	2.5
ALTERNATIVE D:				
FLATIRON-LYONS-HYGIENE	1.55	0.84	56.9	19.9
HYGIENE-LONGMONT NW	1.51	0.84	33	11.7
FORDHAM-TERRY	1.51	0.84	21.9	7.8
FORDHAM-NEWSUB (Note 2)	1.51	0.84	11.9	4.2
NEWSUB-ERIE	1.51	0.84	13.9	4.9

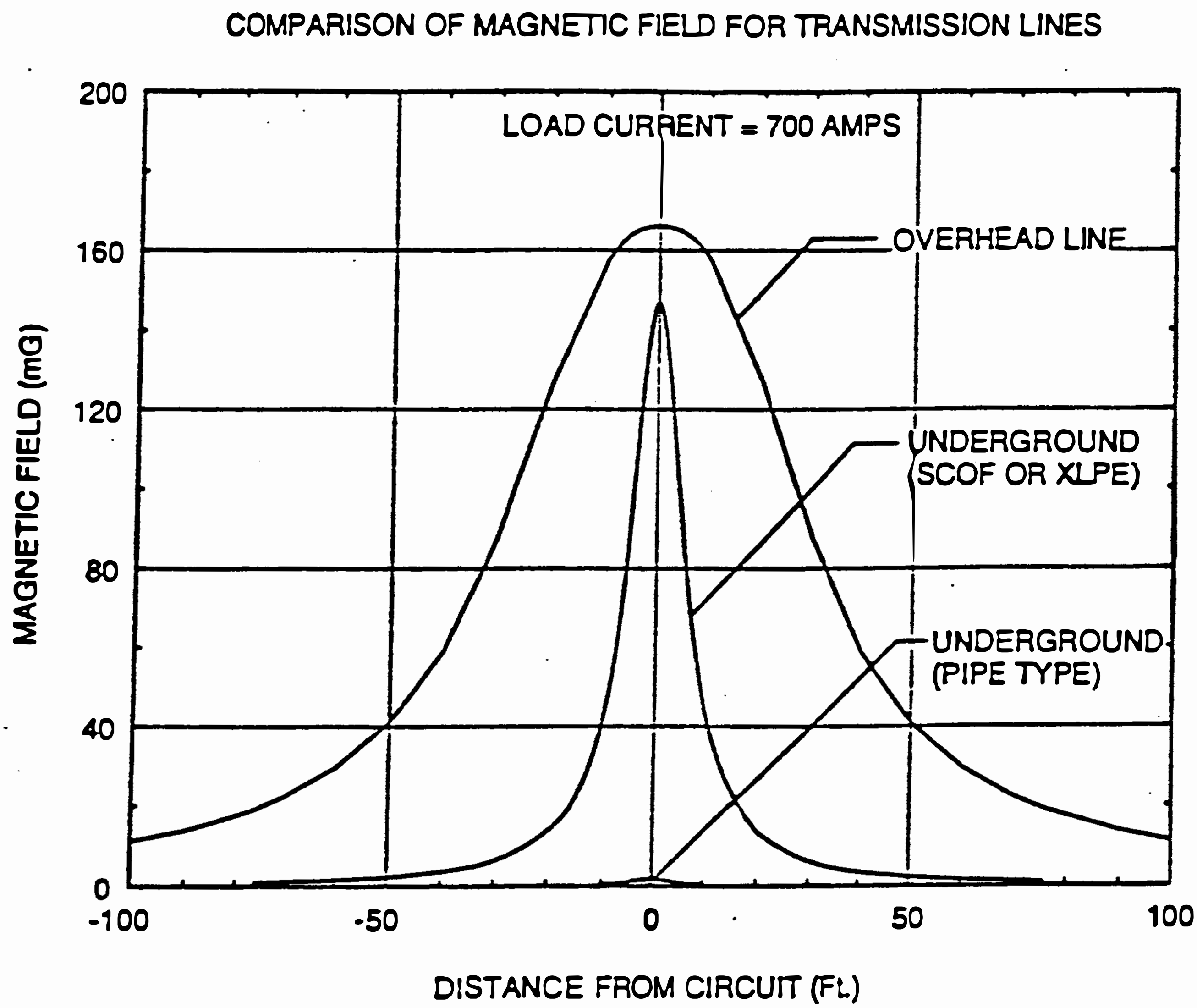
C-3.4 MINIMUM LOAD CONDITION FROM TABLE C-1

MINIMUM	ELECTRIC FIELD (Max within ROW)	ELECTRIC FIELD (at edge of ROW)	MAGNETIC FIELD Max within ROW	MAGNETIC FIELD (at edge of ROW)
ALTERNATIVE B:	kV/m	kV/m	mG	mG
FLATIRON-LYONS-HYGIENE	1.55	0.84	41.2	14.4
HYGIENE-LONGMONT NW	1.51	0.84	24.4	8.7
LONGMONT NW-FORDHAM	1.51	0.84	9.9	3.5
FORDHAM-TERRY	1.51	0.84	1.7	0.6
TERRY-ERIE	1.51	0.84	5	1.8
ALTERNATIVE C:				
FLATIRON-LYONS-HYGIENE	1.55	0.84	41.2	14.4
HYGIENE-LONGMONT NW	1.51	0.84	24.4	8.7
LONGMONT NW-FORDHAM	(Note 1)	(Note 1)	(Note 1)	(Note 1)
FORDHAM-TERRY	(Note 1)	(Note 1)	(Note 1)	(Note 1)
TERRY-ERIE	1.51	0.84	5	1.8
ALTERNATIVE D:				
FLATIRON-LYONS-HYGIENE	1.55	0.84	40	14
HYGIENE-LONGMONT NW	1.51	0.84	24.3	8.6
FORDHAM-TERRY	1.51	0.84	15.9	5.7
FORDHAM-NEWSUB (Note 2)	1.51	0.84	8.5	3
NEWSUB-ERIE	1.51	0.84	9.9	3.5

1) ALTERNATE C: THE MAGNETIC FIELDS ASSOCIATED WITH HIGH PRESSURE PIPE TYPE CABLE IS NEGLIGIBLE, (SEE FIG. C-1) AND THE ELECTRIC FIELD IS ZERO ABOVE GROUND.

2) ALTERNATE D: THE WOOD H-FRAME TYPE STRUCTURE WILL PRODUCE THE HIGHEST MAGNETIC AND ELECTRIC FIELDS, BOTH AT CENTER LINE AND AT THE EDGE OF ROW

FIGURE C-1



Source: Electric Power Research Institute

C.4 ELECTRIC FIELD EFFECTS - LINE CHARACTERISTICS

C.4.1 CORONA

C.4.1.1 DEFINITION AND DESCRIPTION

One of the electrical phenomena associated with all energized devices, including high voltage transmission lines, is corona. This is the physical manifestation of energy loss and can transform energy into very small amounts of light, sound, radio noise, chemical reaction, and heat. Because power loss is uneconomical, corona has been studied since the early part of this century. Consequently, it is well understood by engineers, and steps to minimize corona are major factors in line design. Corona can be controlled through design practices, and it is usually not a problem for transmission lines rated at 230-kV and lower.

Corona is caused by the voltage gradient (electrical pressure) at the surface of a conductor. When the stress is great enough, it can exceed the insulating capability of the surrounding air, and some electrons can be forced off the wire, something like a garden hose leaking at weak points because the pressure is too high. The electrons can then collide with air molecules up to a fraction of an inch away. The air molecules become ionized (positively or negatively charged). Ionized air molecules may then join other ionized oxygen atoms to form ozone, which in turn can produce nitrogen oxide; or the air molecules may re-stabilize by capturing an electron and returning to an uncharged state. This return to the normal condition releases energy in the form of light and electromagnetic radiation (radio noise).

There are many variables that contribute to the presence and degree of corona: line voltage, number and diameter of conductors, nicks and scratches on the conductor surface, and weather, to name a few. Foul weather affects the insulating properties of the surrounding air and also leaves water droplets on the line which serve to concentrate electrical stress and make it easier for corona activity to occur. In the same way, scratches and defects on the conductor surface and even the sharper curvature of a smaller cable can lead to corona. Corona does not only occur on powerlines, it can happen anywhere electricity is used, such as in appliances and electrical machinery, or in nature.

Saint Elmo's fire is the best known example of natural corona. It is caused by the electric charge between overhead clouds and the earth acting through the mast of a sailing ship. It usually happens at a period of high electrical activity, such as during a thunderstorm. Natural corona can occur on airplanes where friction between the moving plane and air molecules can build up a static charge. It can occur naturally in, for example, mountain tops near clouds, dust storms, tornadoes, and around the tops of erupting volcanoes.

When corona occurs on transmission lines it is usually on high voltage lines of 345-kV and above, and then mostly during foul weather. The effects are local and are a nuisance rather than a serious problem or a hazard. For example, although radio noise in the AM range can be generated by corona discharge, it is usually of such small intensity that it should not be a significant problem outside of the ROW. The same is true of television interference and audible noise. These topics will be dealt with in later sections.

Power loss due to corona is an important factor in transmission line design. However, corona on lines below 345-kV has generally not been a major problem with proper design. Corona can be minimized by using larger diameter or multiple conductors, but at the cost of more and heavier conductor material. It is economically and physically impractical to design totally corona-free power lines, but experience and research have produced design techniques that can reduce corona and its effects to low levels. It should be expected that the proposed project would have little or no corona activity under most operating conditions, and some corona activity during foul weather conditions.

C.4.1.2 AUDIBLE NOISE

During corona activity, electric transmission lines (mainly 345-kV and above) generate a small amount of sound energy. This audible noise from the line can barely be heard in fair weather conditions on the higher voltage lines (345-kV and above) and usually not at all on lines of 115-kV. During foul weather, water drops collect on the conductor and increase corona activity so that a crackling or humming sound may be heard near the line. This noise is caused by small electrical discharges from the water drops.

The sound is not hazardous and does not indicate an abnormal operating condition. Rather, the sound is due to corona on the line. The audible noise would disappear when the conductors become dry. Background noise caused by falling rain usually "masks" or covers audible noise; but in certain conditions, noise may be detectable near the ROW during a period of rain or fog.

Audible noise decreases with distance away from the line. Noise levels on most 115-kV lines have not been a problem, and audible noise is almost never reported for lines of this voltage. Table C-4 compares some common levels with calculated values for the proposed project.

TABLE C-4
COMMON NOISE LEVELS

Environmental Conditions	dBA (Decibels)	Response
Carrier Deck Jet Operation	140	Painfully Loud
Discotheque	120	Maximum Vocal Effect
Alarm Clock	80	Annoying
Air Conditioner at 20 feet	60	Intrusive
Typical Office	50	Quiet
Library	40	
Soft Whisper	30	Very Quiet
Proposed Project-Wet Weather (ROW edge)	25.2	
Broadcast Studio	20	Just Audible
Proposed Project-Fair Weather (ROW edge)	0.22	

Sound is physically measured in decibels (dB), but the human ear detects different loudness levels at different pitches (frequencies). Therefore, an adjusted "A" scale has been developed, and noise (unwanted sound) is almost always measured in dBA. Because the decibel scale is logarithmic, a difference of 20 dB indicates a factor of 10 in perceived loudness. In other words, an automobile horn at 3 feet (about 110 dBA) is 10 times as loud as the inside of a New York subway train (90 dBA), which in turn is 10 times as loud as average street corner traffic (70 dBA), etc.

The audible noise levels at the proposed project's ROW edge that are reported in Table C-4 would be far below 52 dBA, an audible noise level reported by the Electric Power Research Institute as causing "no complaints" (6), and also well below the similar noise level below which the EPA believes no effects on public health and welfare will occur (7). Residences and buildings adjacent to the ROW would be exposed to these low levels.

The state of Colorado has adopted regulations which prohibit noise levels in residential, commercial, light industrial and industrial areas which exceed certain levels at a distance of 25 feet or more from the property line. For example, during the 36 hour interval from 7 a.m. to the next 7 p.m. the maximum allowable level in a residential area is 55 dBA. Noise from the Flatiron-Erie Line will be well below the applicable Colorado regulations.

C.4.1.3 RADIO AND TELEVISION INTERFERENCE

Although overhead transmission lines generally do not interfere with normal radio or television reception, there are two potential sources of interference from transmission lines - corona and gap discharges. Corona may affect AM radios, while gap discharge can affect television, as well as radio reception.

As described in Section C.4.1.1, corona activity would be minimized due to proper design and is therefore unlikely to be a source of interference. However, if a person stands under a 345-kV or larger line in a rain storm with an AM radio, they will most probably detect static interference from the transmission line. This level of static interference is much lower on 115-kV lines. Corona generated interference decreases with distance, and beyond the ROW edge it decreases to very low values. For the proposed 115-kV line, the calculated radio noise level at the ROW edge for fair weather is shown in Table

C-2 and is about 26.6 dBDV/m and for wet weather is about 43.6 dBDV/m (decibels above 1 microvolt per meter reference value). This level would meet the Federal Communications Commission guidelines for satisfactory service (6). The design of the 115-kV line is such that TV interference levels will be very low.

Gap discharges are a very different problem. They are due to electrical discharges between broken or poorly fitting hardware (i.e., insulators, clamps, brackets). Hardware is designed and installed to be problem-free, but gunshot damage, wind motion, corrosion damage, etc., sometimes can create a gap discharge condition. When this condition develops, intermittent gaps at connection points between hardware items allow small electrical discharges to occur across the gaps. This phenomenon is not limited to transmission lines and can often be found on low voltage distribution lines. The discharges act as small "transmitters" at frequencies that may be received on some radio and TV receivers. Gap discharge sources would be located and repaired by trained Western personnel.

The severity of any interference depends upon the strength and quality of the transmitted radio or TV signal, the quality of the radio or TV set and antenna system, and the distance between the set and interference source. It is often the case that radio and TV sets are influenced more by interference sources in the home itself than by transmission lines because of the proximity of these sources. The large majority of interference complaints are found to be attributable to sources other than transmission lines, e.g., poor signal, poor antenna, heating pad, door bell, sewing machine, freezer, ignition system, aquarium thermostat, appliances, fluorescent lights, etc. (8).

The frequency content of corona discharge interference does fall within the range of AM radio receivers, but the interference intensity also decreases with distance so that it should normally not be noticeable beyond the ROW edge. Of course, this also depends on the signal strength of the station. An automobile passing under some transmission lines in foul weather may pick up interference (static) on an AM radio while beneath the line. (Sometimes this also occurs in fair weather, but it is due to gap discharge on poorly fitting or damaged hardware.) The upper limit or frequency range affected by the corona phenomenon is normally too low to influence FM receivers or CB radios.

Typical transmission line engineering practice is to design all transmission lines to be as free from corona and other sources of interference as possible. Radio interference complaints would be recorded and investigated when necessary by Western, and corrective measures taken as required. Western has a formal procedure for evaluating and responding to interference complaints, and this procedure would be implemented for any complaints received on the proposed project.

C.4.1.4 Visible Light. Corona can be dimly visible as a bluish glow or as bluish plumes. On the proposed line, corona on the conductors would be observable only under the darkest and/or rainiest conditions, when the corona is most intense, and probably would be visible only with the aid of binoculars. Without a period of adaptation for the eyes, and without intentionally looking for the corona, it would probably not be noticeable.

C.4.1.5. Photochemical Oxidants. When corona is present, the air surrounding the conductors is ionized and chemical reactions may take place producing extremely small amounts of ozone and other oxidants. Measurements in the laboratory and near transmission lines have shown that the amount of oxidants produced by operating transmission lines is usually not measurable and of no environmental consequence.

C.4.1.6 OZONE

Ozone (O_3) is another possible by-product of the higher voltage transmission lines that has raised some concern. As mentioned before, charged air molecules can combine with each other. Ozone can be formed this way, by combining three oxygen atoms. It is a paradox that the 15-mile high ozone layer shields life from ultraviolet radiation, and yet ozone can be harmful to life upon contact due to its powerful oxidizing effect. The concern has been that transmission lines can potentially produce a harmful amount of ozone. Research has revealed that ozone has not been a problem, even for very large lines up to 765-kV. The amounts of ozone generated are extremely small compared to naturally occurring background levels.

Ozone generation by electricity is very inefficient; commercial generators of ozone can only convert about 4 to 8 percent of their electrical input to ozone. Generation by transmission lines is even more inefficient because lines are designed to minimize energy loss and corona activity. There are several other manmade sources of ozone: welding operations, high voltage spectrographic equipment, copying machines, and even air fresheners. By far the largest ozone problem is caused by the action of sunlight on industrial and automobile pollution.

The quantity of ozone produced by the largest 765-kV transmission line can be almost impossible to measure because it is so small. As far as health is concerned, the important parameter is concentration. Concentration is determined by the amount of mixing between the newly formed ozone and the air surrounding the conductor. It is a function of the amount of ozone being generated, local weather conditions, wind speed and direction, local air turbulence, and the natural ozone decay rate.

Estimating ozone concentration is a complex problem but it can be handled adequately by modern air pollution models. Ozone concentration is usually measured in terms of parts of ozone per billion parts of air (ppb). Ambient ozone is ozone that is already in the air from other sources, such as dispersion from the natural ozone layer, automobile emissions reacting with sunlight, and electrical storms. Ambient ozone may also be depleted by dispersion back to the upper atmosphere, spontaneous decay, and contact with oxidizable materials. Ambient ozone levels in rural areas are typically around 10 to 30 ppb at night and may peak during the day at around 100 ppb. In urban areas, concentrations greater than 100 ppb are common. Cities like Los Angeles may peak at 500 ppb. The National Ambient Air Quality Standard for Oxidants (of which ozone is usually 90 to 95 percent) is 120 ppb, not to be exceeded as a peak concentration on more than one day a year. Under "worst case" conditions a high-voltage power line will still only contribute a very small percentage to the total ambient ozone concentrations.

One important factor is an evaluation of the ozone level increase that could be expected in the vicinity of a transmission line. A theoretical "worst case" would be provided by the following conditions: heavy rains, light winds blowing exactly parallel to the line, and 10 or more continuous hours of these conditions. Close to the proposed project, calculated ozone levels would be well below 0.1 ppb as shown in Table C-2. Concentrations below about 1.0 ppb are impossible to measure with todays most sensitive instrumentation.

Nitrogen oxides can also be generated by transmission lines but on a much smaller scale than ozone, and therefore the problem is even less significant.

Therefore, both ozone and nitrogen oxide are not a problem with 115-kV transmission lines, because levels are so small as to be undetectable.

C.4.1.7 Project Specific Effects

In summary, the corona generated levels of audible noise, radio and television interference, and ozone produced by the proposed transmission line project are expected to be well below accepted standards or of such small amounts as to be considered negligible. The calculated values for audible noise, radio and television interference, and ozone for each alternative configuration associated with the Flatiron-Erie Transmission Line project are presented in Table C-2.

C.4.2 ELECTRIC FIELDS

C.4.2.1 DEFINITION AND DESCRIPTION

Electric fields arise from the voltage (electrical pressure) on an object. Any object with an electric charge on it has a voltage (or electric potential) at its surface, caused by the accumulation of more electrons on that surface as compared to another object or surface. The voltage effect is not limited to the surface but exists in the space surrounding the object. The change in this voltage over a distance is known as the electric field. The units describing an electric field are volts per meter (V/m) or kilovolts per meter (kV/m). A field measured in volts per meter expresses the difference in electrical potential or voltage between two points that are one meter apart. The electric field becomes stronger near a charged object and decreases rapidly with distance away from the object.

Electric fields are a very common phenomenon. Static electric (or DC) fields can result from taking off a sweater or walking across a carpet. Body voltages have been measured as high as 16,000 volts due to walking on a carpet (9). The earth creates a natural static field in fair weather of about 150 V/m (0.15 kV/m) at ground level due to the 300 to 400,000 volt potential between the ionosphere and the earth (10, 11). This means that a 6-foot tall person would have a static potential of about 275 volts between the top of the head and the bottom of the feet.

The normal fair weather potential gradient of the earth varies from month to month, reaching a maximum of about 20 percent above normal in January, when the earth is closest to the sun, and falling to about 20 percent below normal by July, when the earth is farthest from the sun. Much stronger static electric potentials can exist underneath clouds, where the electric potential with respect to earth can reach 10 to 100 million volts. Natural static electric fields under clouds and in dust storms can reach static field levels as high as 3 to 10kV/m (11, 12).

Almost all household appliances and other devices that operate on electricity create electric fields. The electric field is due to the voltage on the appliance and the field decreases rapidly with distance away from the device. The field due to point source household appliances generally attenuate more rapidly with distance than fields from line sources, such as power lines. Appliances need not be operated to create an electric field, but just plugged into an electrical outlet. Typical values measured 12 inches away from some common appliances (13) are shown in Table C-5.

Sometimes, a person holding a fluorescent light tube directly underneath a transmission line (on a dark night) can demonstrate the presence of an electric field when the tube glows dimly. However, this same phenomenon will occur near many television sets, near an automobile ignition system, and near some CB radios. This phenomenon is unlikely for lines below 345-kV due to their lower electric field levels.

TABLE C-5
Typical Electric Field Values for Household Appliances
(at 12 inches)

Appliance	Electric Field (kV/m)
Electric Blanket	0.25[1]
Broiler	0.03
Stereo	0.09
Refrigerator	0.06
Iron	0.06
Hand Mixer	0.05
Phonograph	0.04
Coffee Pot	0.03

[1] 1-10kV/m in the region adjacent to the blanket wires (14)

C.4.2.2 CARDIAC PACEMAKERS

One electric field concern for high voltage transmission lines has been the possibility of interference with cardiac pacemakers. However, pacemaker interference from the proposed project would be an improbable event. The electric fields at the ROW edge associated with the proposed project (Table C-3) are below levels that are reported as capable of affecting pacemaker operation (about 2-9 kV/m) and would therefore pose no hazards for pacemaker wearers (15, 16).

There are two general types of pacemakers: asynchronous and synchronous. The asynchronous pacemaker pulses at a predetermined rate. It is practically immune to interference since it has no sensing circuitry and is not exceptionally complex. The synchronous pacemaker only pulses when its sensing circuitry determines pacing is necessary. Interference may result from a transmission line electric field causing a spurious signal on the pacemaker's sensing circuitry. However, when these pacemakers detect a spurious signal, such as a 60 Hz signal, they are programmed to revert to an asynchronous or fixed pacing mode of operation.

Prolonged asynchronous pacing is not considered a problem; some pacemakers are designed to operate that way. A common procedure when testing implanted synchronous pacemakers for battery strength, etc., is to put the pacemaker into the asychronous mode. So, while transmission line electric fields could interfere with the normal operation of some pacemakers, the result of the interference would be of short duration and not considered harmful.

C.4.2.3 ELECTRIC FIELD INDUCTION

Electric fields can induce a charge on nearby objects and cause a small electrical current to flow. For a grounded person (standing in wet grass), this current will be about 0.016 milliamperes (mA) (0.000016 amps) (one thousandth of an ampere is equal to one milliampere) for each kV/m of electric field strength. For the proposed project, the maximum induced current at the peak value of electric field (1.69 kV/m) would be about 0.027 mA. To put this in perspective, most household appliances have a small amount of electricity that can leak through the appliance insulation and flow into the body of the operator (this is called leakage current). This leakage current can increase as the insulation ages in appliances. The maximum amount of leakage current for portable household appliances allowed by the American National Standards Institute (ANSI) is 0.5 mA, and for fixed or built in appliances, the allowable increases to o.75 mA (17). In other words, it would take a transmission line electric field of about 32 kV/m (much higher than that generated by the proposed project) to induce a current in the body of a person greater than that allowed by household appliance safety standards.

The median threshold of perception (i.e., that humans can start to detect) for electric fields is about 7 kV/m and for electric currents is about 1.0 mA (6). The electric field values for the proposed project are below these perception threshold levels.

Electric charge induction on objects adjacent to the proposed project would be minimized by grounding practices, where necessary. Grounding of certain objects near the line is a routine part of the initial construction process. Charges usually do not develop on buildings since they are generally grounded through plumbing, electric service connections, metal sheeting, or frame. Most fences very near to a line will normally have little or no noticeable charges induced since fences are often grounded by metal posts, as well as by contact with vegetation (plant tissue in its normal, healthy green state is composed of nearly 85 percent water, indicating it to be quite a good electrical conductor). Western would evaluate grounding requirements on a site-specific basis and implement corrective measures where necessary to ensure public safety. In general, induced voltages on fences and structures would be reduced to very low levels by site-specific grounding measures.

Vehicles do not usually build up noticeable electric charges in the vicinity of transmission lines because most modern tires contain carbon black, a substance used in their manufacture that makes the tire able to conduct electric charges to ground. However, as a general safety measure, most utilities recommend that no refueling of vehicles be done within the ROW of 345-kV and larger transmission lines. Many typical farming operations such as discing or plowing automatically ground farm equipment to earth.

Metal irrigation systems near transmission lines pose a potential shock hazard. Caution must be exercised when handling lengths of metallic pipe near any type of overhead conductors. The pipe should be kept in a horizontal position to avoid approaching or contacting the conductors. Most irrigation equipment is naturally grounded due to contact with soil and induced charge effects can be minimized by providing contact with the earth.

Another area of possible concern is the proper functioning of electronic equipment used in modern farming machinery when operated in proximity to high voltage power lines. This has apparently not been a problem due to shielding of the electronics and the fact that equipment manufacturers understand the nature of the environment where the equipment is operated (i.e., sometimes near powerlines).

C.4.2.4 PROJECT SPECIFIC EFFECTS

Electric field values were calculated for the proposed project using the various alternative configurations (see Tables C-1 and C-3). The most important parameters for determining the ground level electric field of a transmission line are conductor height above ground, line geometry, and line voltage. Because of practical considerations, measured values of the electric field can, and do, deviate from calculated values. It is therefore common practice to calculate the electric fields for a line under a specific extreme condition.

The NESC states the condition for evaluating electric-field-induced currents is with the conductors at 176° F and at a final unloaded sag. The computed electric-field profiles at one meter (3.3 feet) above ground for typical 700 foot spans at high and low conductor clearances for line loadings of 10, 70, and 109 MW are shown in Figures C-2, C-3 and C-4 respectively for the preferred alternative (Alternative B).

FIGURE C-2

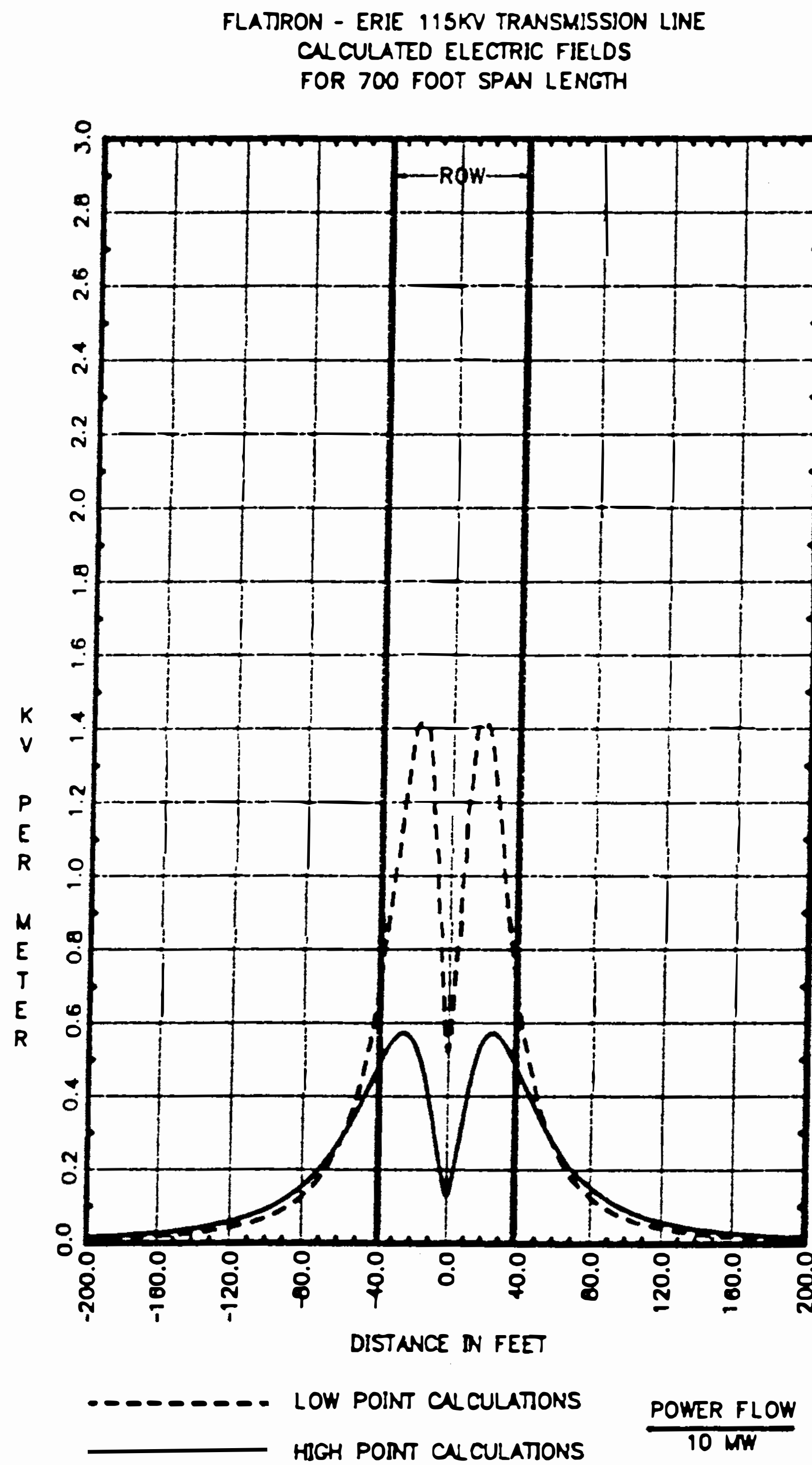

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED ELECTRIC FIELDS
FOR 700 FOOT SPAN LENGTH
KV PER METER
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
ROW
-200.0
-160.0
-120.0
-80.0
-40.0
0.0
40.0
80.0
120.0
160.0
200.0
DISTANCE IN FEET
LOW POINT CALCULATIONS
HIGH POINT CALCULATIONS
POWER FLOW
10 MW

FIGURE C-3

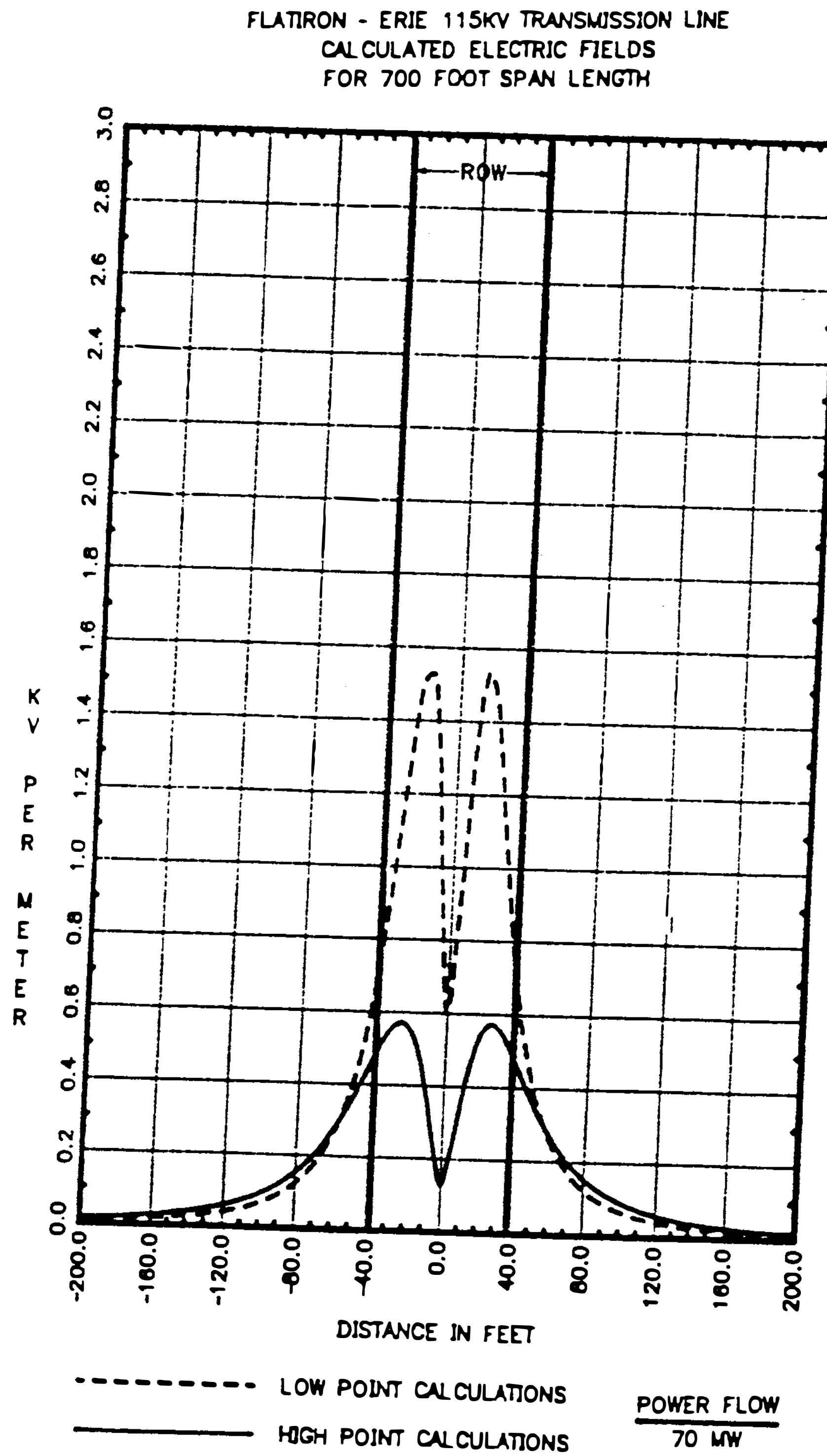

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED ELECTRIC FIELDS
FOR 700 FOOT SPAN LENGTH
ROW
KV PER METER
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
-200.0
-160.0
-120.0
-80.0
-40.0
0.0
40.0
80.0
120.0
160.0
200.0
DISTANCE IN FEET
LOW POINT CALCULATIONS
HIGH POINT CALCULATIONS
POWER FLOW
70 MW

FIGURE C-4

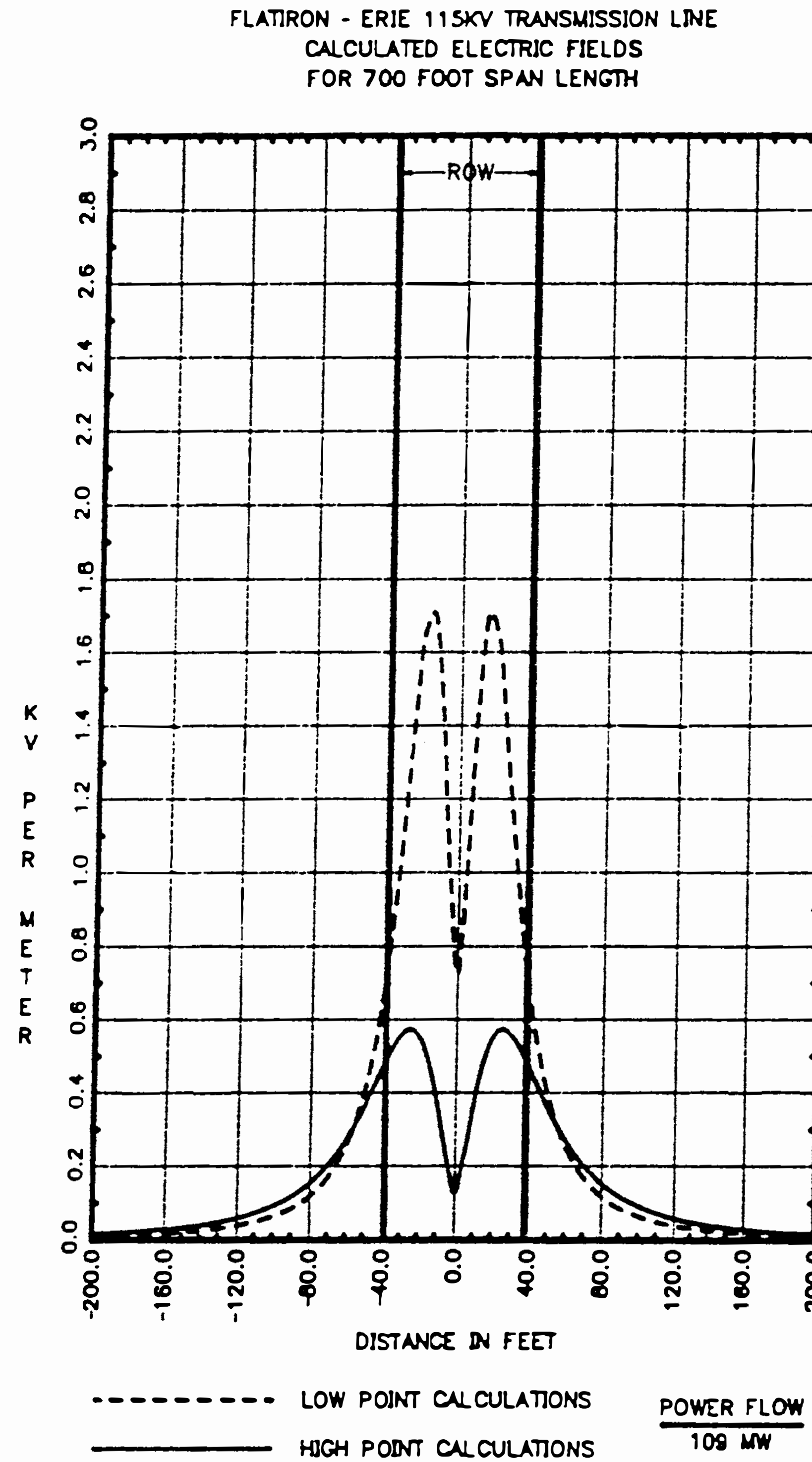

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED ELECTRIC FIELDS
FOR 700 FOOT SPAN LENGTH
ROW
KV PER METER
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
3.0
-200.0
-160.0
-120.0
-80.0
-40.0
0.0
40.0
80.0
120.0
160.0
200.0
DISTANCE IN FEET
LOW POINT CALCULATIONS
HIGH POINT CALCULATIONS
POWER FLOW
109 MW

Figure C-5 provides a pictorial representation of what is ment by the terms "High Point" and "Low Point" in the field calculation figures. High point is the insulator to ground height at the structure and low point is the conductor to ground height at maximum conductor sag.

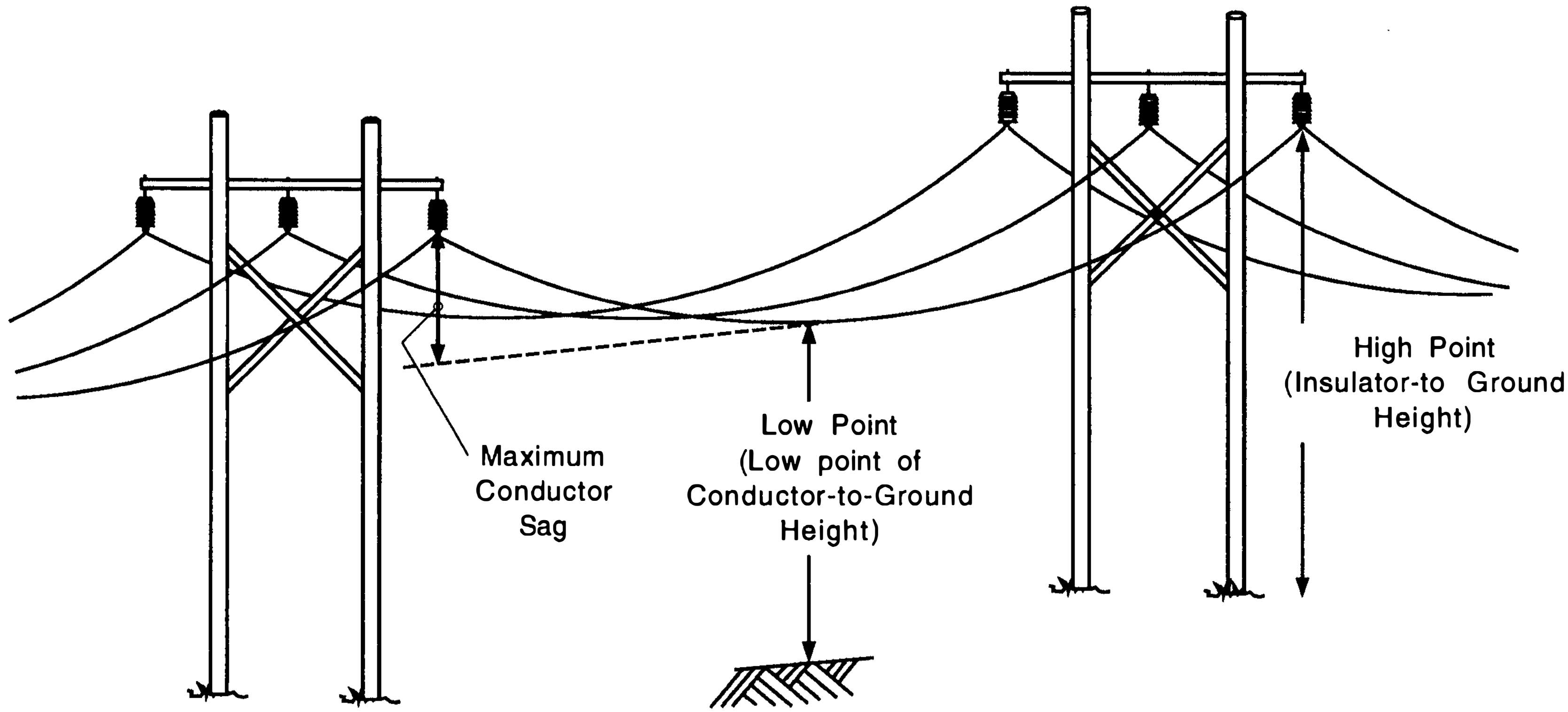

Maximum
Conductor
Sag
Low Point
(Low point of
Conductor-to-Ground
Height)
High Point
(Insulator-to Ground
Height)

FIGURE C-5

Field values calculated for the proposed project would vary from a high of approximately 1.7 kV/m directly under the conductor at midspan to about 0.8 kV/m at the ROW edge. On ROWs where the proposed project would be the only line in service, the 0.8 kV/m field would be expected at both ROW edges. Where existing lines are in service, electric field values at ROW edges adjacent to existing lines would be expected to be lower than 0.8 kV/m.

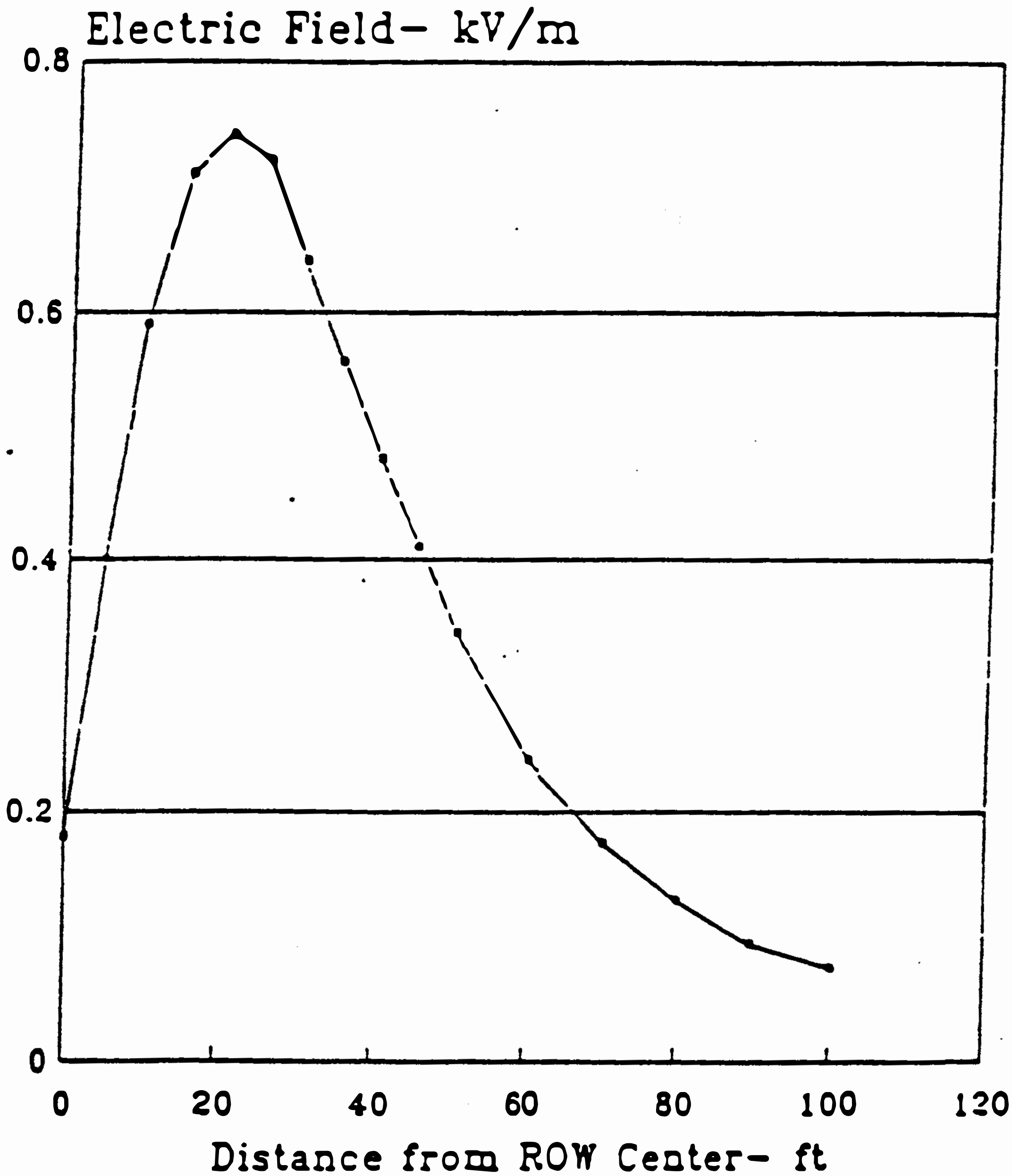
The maximum field strength for the electric field values occurs within a relatively small area of the ROW (about 5 percent of the total area) near the location where the conductors sag closest to the ground. Additional attenuation of fields would be realized as distance from the ROW edge is increased.

Electric fields are generally measured at a point one meter (3.3 feet) above the ground, and at right angles to the conductors at mid-span (the point closest to the overhead conductor, and furthest from the structures) to establish a cross section or maximum lateral profile measurement of the field. The highest readings will be obtained under the outside conductors of the line, with the electric field readings falling off to either side in relation to the distance from the conductor. Actual measured readings may be much lower than expected however, due to the shielding effects of nearby vegetation or objects as discussed earlier.

Figure C-6 shows the results of electric field measurements for the existing Flatiron-Erie 115-kV transmission line in Longmont. The measurements were made on April 14, 1988, in the period 5:20 p.m. to 5:47 p.m. at mid-span on the first full span north of Highway 119. Electric field lateral profiles were measured starting underneath the center phase using the EFM Model 113 Meter ("Denometer"). Table C-6 presents the actual measured values on which Figure C-6 is based.

FIGURE C-6

Existing 115-kV Transmission Line Measured Electric Field Lateral Profile



Location: Longmont, CO Date: 4/14/88

Table C-6

Existing 115-kV Transmission Line

Measured Electric Field Values

(First Full Span North of Highway 119, Longmont, Colorado, April 14, 1988)

DISTANCE FROM CENTERLINE (FEET)	MEASURED ELECTRIC FIELD (kV/M)
0	0.180
5	0.400
10	0.590
15	0.710
20	0.740
25	0.720
30	0.640
35	0.560
40	0.480
45	0.410
50	0.340
60	0.240
70	0.175
80	0.130
90	0.095
100	0.075

Most states have not established maximum electric field levels within the ROW or at the ROW edge, nor have Federal standards been established. Table C-7 gives a summary of existing and proposed state standards and guidelines for transmission line electric field strength limits.

Table C-7 Summary of Existing and Proposed State Standards and Guidelines for Transmission Line Electric Field Strength Limits 1/

AGENCY	JURISDICTION	60-Hz ELECTRIC FIELD LIMIT, kV/M		COMMENTS
		Within Right-of-way	At Edge of Right-of-way	
Florida Department of Environmental Regulation	69 kV and above, including substations	8 (≤ 230 kV) 10 (500 kV)	2	Codified regulation, adopted after a public rulemaking hearing in 1989
Minnesota Environmental Quality Board	200 kV and above	8	———	
Montana Board of Natural Resources and Conservation	Above 69 kV, except for lines 230 kV and below that are 10 miles or less 3/	7 4/	1 2/	Codified regulation adopted after a public rulemaking hearing in 1984
New Jersey Commission on Radiation Protection	(No formal transmission line routing process)	———	3	Use only as a guideline for evaluating complaints
New York State Public Service Commission	125 kV and above and 1 mile or longer, or 100-125 kV and 10 miles or longer	11.8 7 or 11 4/	1.6	Electric field limits are interim policies
North Dakota Public Service Commission	115 kV and above	9	———	
Oregon Energy Facility Siting Council	Above 230 kV, more than 10 miles, and routed through two or more political subdivisions 3/	9	———	Codified regulation, adopted after a public rulemaking hearing in 1980
Bonneville Power Administration Guidelines	All voltage classes owned by Bonneville	9 5 4/ 3.5 5/ 2.5 6/	5 ——— ——— ———	

1/. Applied on a case-by-case basis unless otherwise noted.
2/. Landowner may wave limit.
3/. Exclusions/exemptions not specified.
4/. At highway crossings.
5/. Maximum for shopping center parking lot.
6/. Maximum for commercial/industrial parking lot.
kV/m = kilovolts per meter

If the lines were constructed with underground cables, no electric fields caused directly by the transmission lines would be detected at ground level. Other impacts associated with placing transmission lines underground are discussed in the main body of the EIS in Section 3.G.4.

C.4.3 EFFECTS ON VEGETATION AND LIVESTOCK

Electric field levels associated with the proposed project would not have an adverse effect on crops, gardens, or natural vegetation beneath the line due to low electric field values (18). No adverse effects have been revealed on agriculture, livestock or wildlife, with the possible exception of honeybees.

C.4.3.1 Honeybees

Effects of transmission line fields on honeybees have been studied extensively (Wallenstein, 1973; Rogers et al., 1982; Greenberg et al., 1981; Greenberg and Bindokas, 1980; Greenberg et al., 1984). When hives are placed in electric fields of 2 to 4 kV/m behavioral effects can occur in honeybees. Fields of 7 to 12 kV/m can result in a variety of problems, including mortality. Intensive studies of the nature of the problem and its causation have demonstrated that bees are not harmed by electric fields per se of 10, 50, or even 100 kV/m even when exposed for 800 hours. Hence, foraging and other activities are not likely to be affected. However, when honeybee hives are placed in strong electric fields, currents and voltages are induced in the hive which are dependent on field strength, hive characteristics, and moisture conditions. If the field is high enough, there is a significant voltage difference across the dimensions of a bee's body. This "step potential" results in a shock to the bee when it takes a step. These shocks, and not the electric field per se, are a source of irritation for bees and can cause physiological damage, including death (Greenberg et al., 1984). Not surprisingly, honey production falls off and other activities become erratic. Fortunately, there are two simple solutions to the problem. One is to avoid keeping bees in high field regions on transmission line rights-of-way, and the other is to place grounded metal cages or screens over the hives (shield the hives).

The fact that no behavioral effects have been seen in shielded hives under operating transmission lines indicates that 60-Hz magnetic fields are not sufficient to cause the shock conditions that exist from electric field induction. These effects were attributable to shocks the bees received within the hive, rather than to any subtle effects of the electric fields (19, 20).

Beekeepers with hives located on the final right-of-way of the proposed line will be advised of the possible adverse effects to bees and compensated fairly to assist in relocation of hives. The maximum fields for the proposed line 1.69 kV\m, does not exceed the threshold levels where effects on bees have been observed. Therefore, there should not be any impact to the honeybees or to honey production from the proposed line.

C.4.3.2 Crops

High electric fields (15 kV/m) have been observed to induce corona on the uppermost parts of plants (47,48). The induced corona causes minor damage to leaf tips. Studies of the effects of electric fields on crops and other plants have been conducted under controlled greenhouse conditions and under transmission lines.

The most extensive analysis on effects of 60-Hz electric fields on living plants has been done by McKee and coworkers at the Pennsylvania State University (47). In initial studies, several thousand plants from 85 different species were exposed to fields from 0 to 50 kV/m in a very controlled greenhouse environment. "Damage" to plants was associated with sharp, or pointed, leaf tips and amounted to self-limiting corona damage to a few millimeters of these pointed plant parts. Tip damage began for some species at fields of 15 to 20 kV/m. The damage was less than that seen due to routine drying under normal field conditions and, even at 50 kV/m, never threatened the overall growth, viability, yield, or reproduction of exposed plants.

In followup studies, McKee (18) exposed five types of plants - alfalfa, tall fescue, sweetcorn, and two types of wheat - to 60-Hz electric fields for extended periods.

Plants were extensively analyzed for chemical element content and for an extremely wide species-specific array of size and mass parameters. There were "no statistically significant effects on seed germination, seedling growth, plant growth, phenology, flowering, seed set, biomass production, plant height, leaf area, plant survival, and nodulation." The only consistent effect that resulted from exposure was the expected occasional damage to a few millimeters of the terminal tip of plant parts exposed to fields of 30 kV/m or greater.

Studies of peas and barley conducted over several years under a BPA 1200-kV test line indicated no consistent adverse effects attributable to exposure to about 12 kV/m (48). In this same study, conifers growing close to a 1200-kV test line exhibited corona at the tips of needles and corona damage to the growing tips of some trees closest to the line. Right-of-way management practices normally limit tree growth in the immediate vicinity of the conductors, and there is no suggestion that forest growth or timber production adjacent to power lines would be affected by electromagnetic fields.

Electric fields up to 12 kV/m under operating lines and up to 16 kV/m under a test line had no noticeable effects on growth or productivity of corn and other crops commonly grown in Indiana (49, 50). However, some crops growing in the maximum field area exhibited minor damage from induced leaf-tip corona.

In summary, the effects of 60-Hz electric fields on plants is limited to corona damage at sharp terminal plant parts. This effect is too limited to be noticeable under field conditions found under operating transmission lines and does not result in crop damage. The electric fields associated with the proposed line are well below levels where the leaf-tip corona phenomenon has been observed. No damage or harm to crops will occur due to the fields under the proposed line.

C.4.3.3 Livestock

Numerous studies have investigated the performance of livestock in the electrical environment of high voltage ac transmission lines. Over a 2-year period, Amstutz and Miller (63) studied livestock, including beef and dairy cattle, on 11 farms located near a 765-kV ac transmission line in Indiana. Typical maximum electric fields were 8.5 kV/m with levels up to 12 kV/m. Magnetic flux densities of .056 G (56 mG) were measured with higher values expected during periods of higher current flow. Short-circuit currents for cows were 0.1 to 0.2 mA in a 6 to 8 kV/m field. Cows seemed to react to induced currents of about 0.7 - 0.8 mA from an insulated feed trough. The authors concluded that "neither health, behavior, nor performance were affected by the electric and magnetic fields created by the 765-kV line."

Williams and Beiler (64) investigated 55 dairy farms located within 1/2 mile of 765 kV lines in Ohio. Herd performance was evaluated from milk production records, farm records, and interviews for a six-year period - 3 years before line energization and 3 years after. Milk production did not appear to be affected by the presence of the 765-kV lines. After the lines had been constructed, the incidence of calf mortality and birth defects per farm increased. However, the investigators felt these changes may have been due to larger hard sizes after the line was constructed, to changes in farm management and to bias in reporting. Farmers involved in the study did not believe there was any significant change in the performance of their herds following line energization. The study indicated that there were no obvious effects of the 765-kV transmission line. The data suggested that the largest factors in herd performance were farm management, quality of feed and, on occasion, change in ownership.

A Swedish study of 106 farms, located under 400-kV ac transmission lines, found that herds exposed to 400-kV lines for more than 15 days per year did not have decreased fertility relative to other herds (65). There was also no relationship between exposure and the number of cows slaughtered on each farm because of reduced fertility. All herds used artificial insemination. Exposure days for each herd were estimated from the percent of pasture occupied by the transmission line and the number of days animals were in the pasture. No field measurements were made in this study, but the maximum electric field strength measured under 400-kV lines on 11 farms in Sweden was 5 kV/m (66).

In another Swedish study to obtain fertility information, researchers placed 58 cows in pens crossed by a 400-kV, 50-Hz transmission line (72). Another 58 cows were maintained in control areas away from the line. During the 120-day exposure period, the electric field averaged 4kV/m, and the average magnetic field was 20 mG. Breeding was done with artificial insemination. None of the fertility parameters studied were affected by exposure to the 400-kV line. These included the estrous cycle, number of inseminations per pregnancy, and conception rates.

In a behavioral study conducted underneath the BPA 1200-kV prototype ac line in Oregon for 5 years (1977-1981), cattle showed no reluctance to graze or drink beneath the line (67). The maximum electric field was 12 kV/m. A refined statistical analysis of the 1980-81 data indicated the cattle spent somewhat more time near the line when it was deenergized (48). This may or may not indicate a transient effect of audible noise and/or the electric field.

Exposure of swine to a 345-kV ac transmission line in Iowa resulted in no observable effects in exposed animals relative to control animals (68, 69). Body weight, carcass quality, behavior, feed intake, pregnancy rate, frequency of birth defects, birth weight or weight gain of young were investigated. Electric field exposures ranged from 3.5 to 4.1 kV/m. Magnetic field was not measured.

There are no indications that exposures to the fields beneath operating transmission lines affect livestock behavior or productivity. However, both ac and dc currents can cause definite behavioral responses in dairy and beef cattle. For this reason metal water and feed troughs, like all conducting objects under the proposed line, should be grounded to eliminate the possibility of nuisance shocks.

Although not a transmission line field effect, microshocks to livestock from so-called "stray" or neutral-to-earth voltages have given rise to problems of animal health and production (41). Voltages between a grounded-neutral system and true earth can produce low level current shocks in and around barns. These shocks can affect livestock, particularly dairy cows, which can apparently perceive a voltage as low as 0.75 to 1 V across parts of the body. The results of these low level shocks can be a significant loss in production.

Neutral-to-earth voltages have been observed from both on-farm and off-farm sources. The sources are generally related to current flow in the primary distribution and farmstead neutral systems and not to field induction from transmission lines. Similarly, the mitigation of neutral-to-earth voltages involves modifications to the primary neutral system, the farmstead neutral system, the farmstead electrical load, or the conducting surfaces in the affected area (41). Mitigation is done on a case-by-case basis. The effects of "stray" voltages are considered an electrical distribution system problem and not a transmission line problem.

C.5 MAGNETIC FIELD EFFECTS - LINE CHARACTERISTICS

C.5.1 DEFINITION AND DESCRIPTION

An electric current flowing in any conductor (e.g., electric equipment, household appliance, power line) creates a magnetic field. Several different units are commonly used to report the strength of magnetic fields. One of the most common units is the Gauss, which is a measure of the magnetic flux density (intensity of magnetic field attraction per unit area). The Gauss is a fairly large unit so magnetic field strength is often reported in thousandths of a Gauss or "milli" Gauss (abbreviation mG). One Gauss = 1000 mG and 1 mG = 0.001G. This report uses mG to report magnetic field strength. As a reference, the earth has a natural static magnetic field of about 550 mG in northern Colorado. Another natural source of high intensity magnetic fields is lightning.

The magnetic field near electric transmission lines is relatively low in comparison with measurements near many household appliances and other equipment. The magnetic field near a point source, such as an appliance, decreases rapidly with distance away from the device. The magnetic field also decreases with distance away from linear sources, such as powerlines, but not as rapidly as with appliances. Since the magnetic field is caused by the flow of an electric current, a device must be turned on to create a magnetic field.

The magnetic field of a large number of typical household appliances was recently measured by IITRI for the U.S. Navy (21) and by Enertech Consultants (22) for EPRI. Typical values are given on Table C-8 in units of milliGauss (mG) or thousandths of a Gauss.

TABLE C-8

Magnetic Field From Household Appliances

Summary of Domestic Appliance Magnetic Field Measurements

	Magnetic Field - milliGauss (1 mG = 0.001 G)	
Appliance Type	Typical Range	Maximum Value
Range	1-80	175-625
Refrigerator	1-8	12-187
Microwave Oven	3-40	65-812
Can Opener	30-225	288-2750
Oven	1-8	14-67
Toaster	2-6	9
Coffee Maker	1-2	4-25
Freezer	1-3	4-6
Mixer	2-11	16-387
Clothes Dryer	1-24	45-93
Dishwasher	1-15	28-712
Garbage Disposal	1-5	8-33
Ceiling Fan	1-11	125
Electric Blanket	3-50	65
Waterbed Heater	1-9	20-27
Blow Dryer	1-75	112-2125
Computer	1-25	49-1875
Typewriter	1-23	38
Make-up Mirror	1-29	44-125
Shaver	50-300	500-6875
Aquarium	1-40	50-2000
Sewing Machine	1-23	26-1125
Electric Drill	56-194	300-1500
Circular Saw	19-48	84-562

Source (22)

C.5.2 PROJECT SPECIFIC EFFECTS

Magnetic field values were calculated for the proposed project using the various alternative configurations (see Tables C-1 and C-3). The line current loadings used to make these calculations are presented in Table C-2. Magnetic field strengths are directly related to, among other factors, the amount of current in the conductor; the greater the current flow, the higher the magnetic field. Therefore, unlike electric fields, magnetic fields can vary significantly over time, fluctuating with system loads.

Magnetic fields associated with transmission lines behave similarly to electric fields in that they are most intense very near the conductors and fall away relatively quickly as the distance from the conductor increases. The partial cancellation effect of adjacent conductors also occurs with magnetic fields, as it does with electric fields. However, where electric fields are rather easily shielded, magnetic fields penetrate structures and soil with little decrease of field strength. Physical distance thus becomes a very important factor in limiting magnetic field exposure.

The actual level of magnetic field will vary with current loading, conductor temperature, and ground clearance. The calculated 60 Hz magnetic field profiles at one meter (3.3-feet) above ground for typical 700 foot spans at high and low conductor clearances for line loadings of 10, 70, and 109 MW are shown in Figures C-7, C-8, and C-9 respectively for the preferred alternative (Alternative B).

FIGURE C-7

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED MAGNETIC FIELDS
FOR 700 FOOT SPAN LENGTH

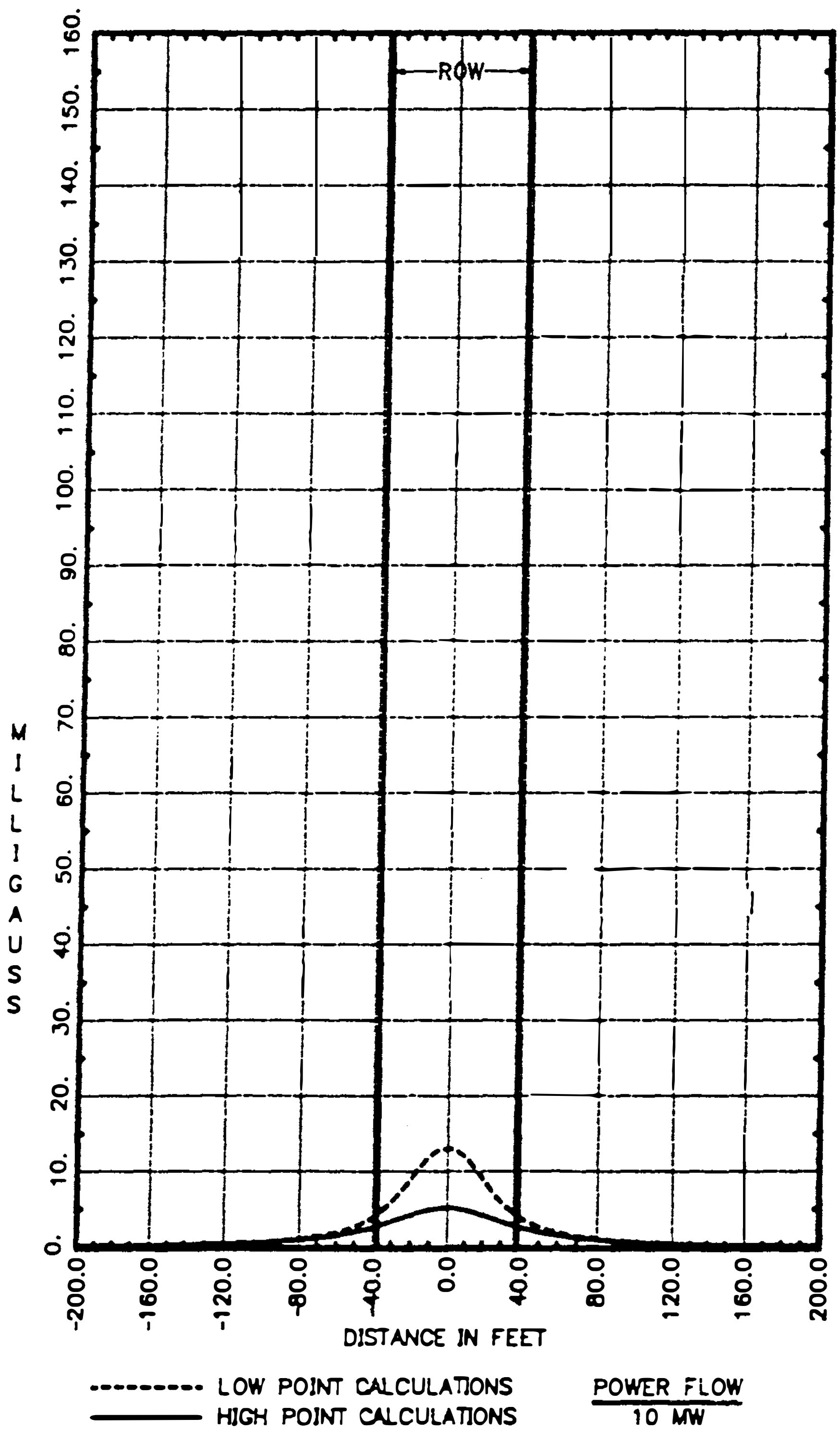


FIGURE C-8

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED MAGNETIC FIELDS
FOR 700 FOOT SPAN LENGTH

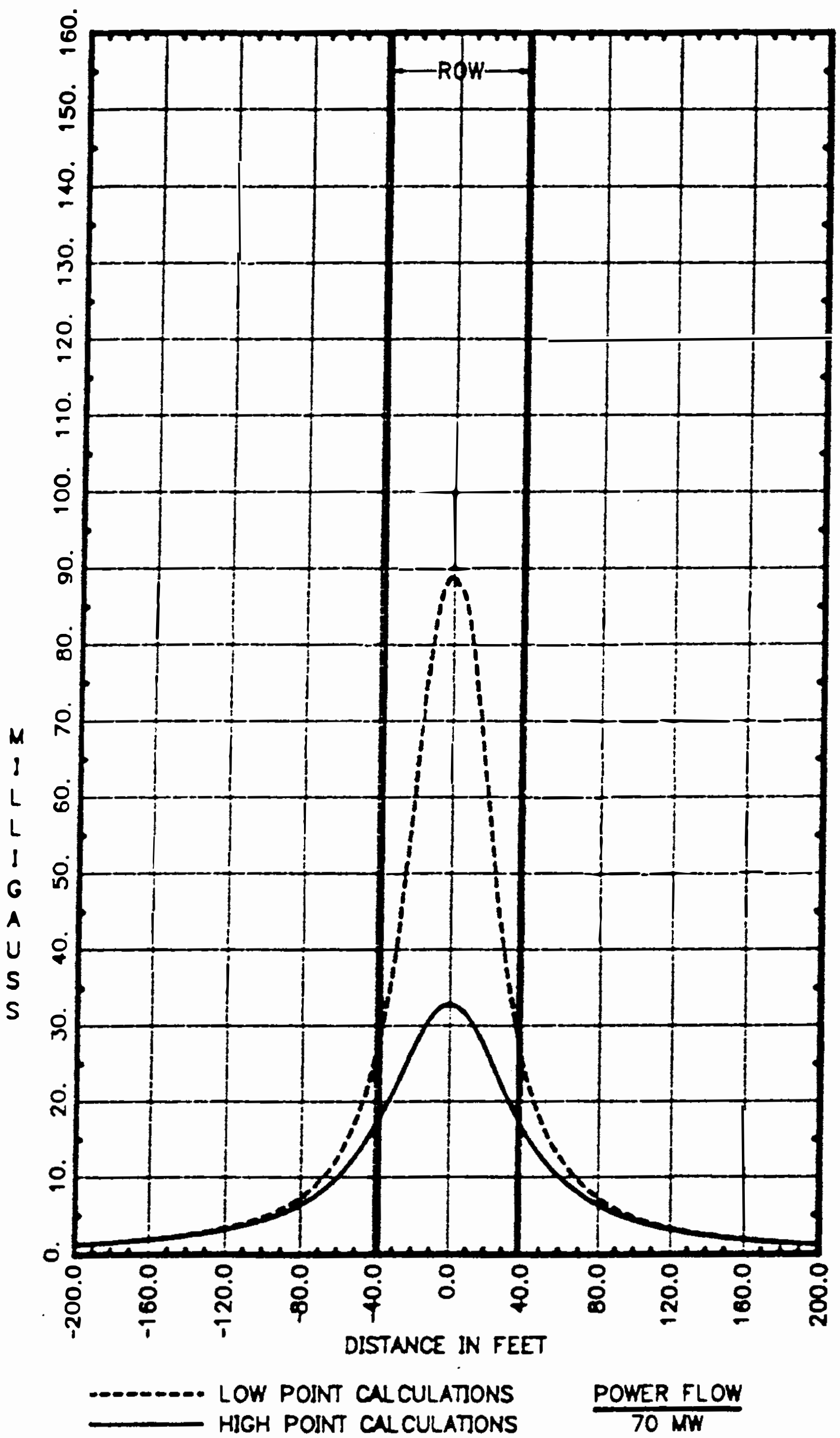
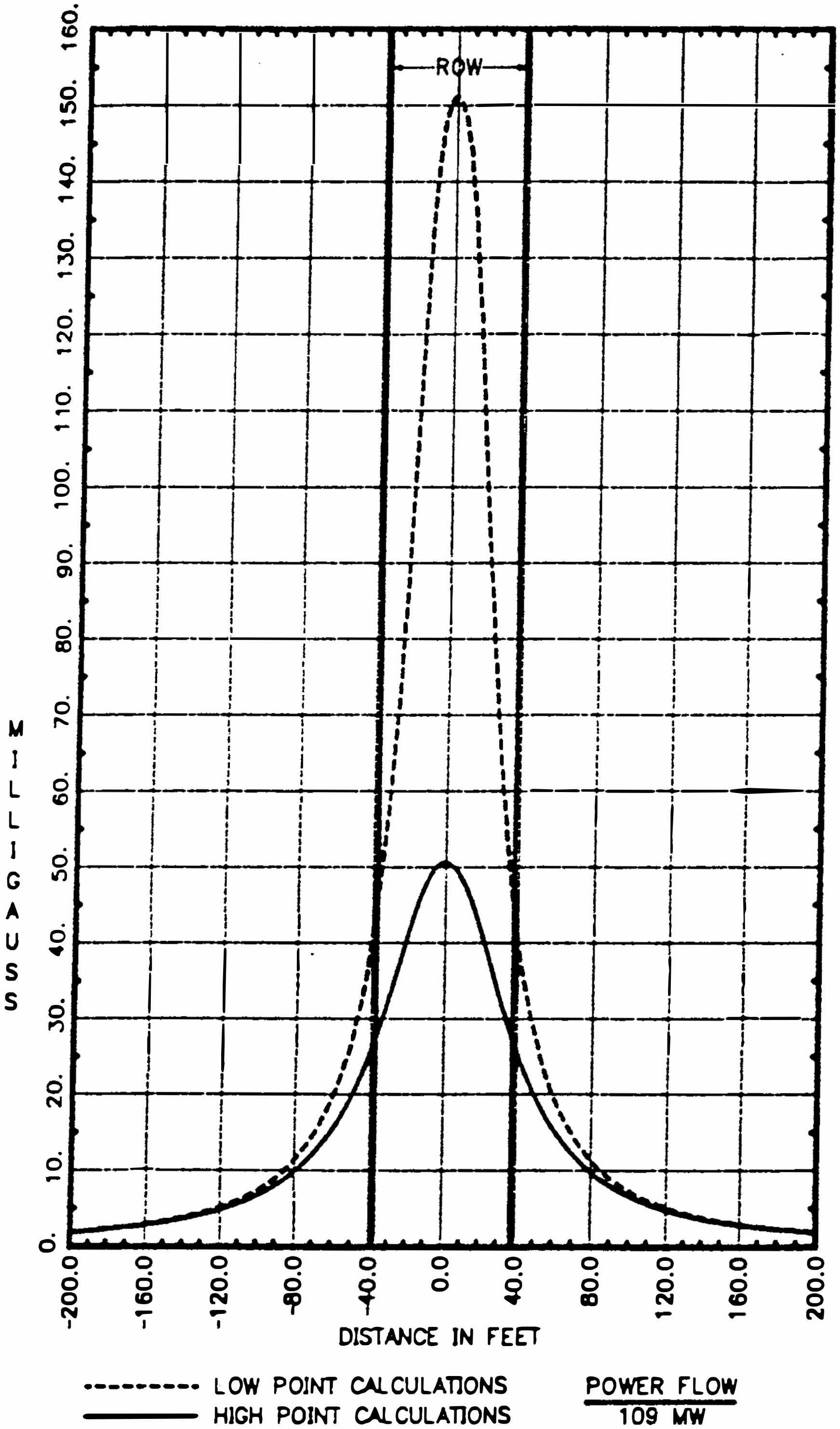


FIGURE C-9

FLATIRON - ERIE 115KV TRANSMISSION LINE
CALCULATED MAGNETIC FIELDS
FOR 700 FOOT SPAN LENGTH



Maximum magnetic field values calculated for the proposed project under peak line loading (71.4MW, BL C-3.2) would vary from a high of approximately 92 mG directly under the conductors near midspan to approximately 32 mG at the ROW edge. Additional attenuation of fields would be realized as distance from the ROW edge is increased. Most states have not established maximum magnetic field levels within the ROW or at the ROW edge, nor have Federal standards been established.

Florida has established regulations that set magnetic field limits as follows:

- 150 milligauss at edge of right-of-way for 230 kV line or smaller

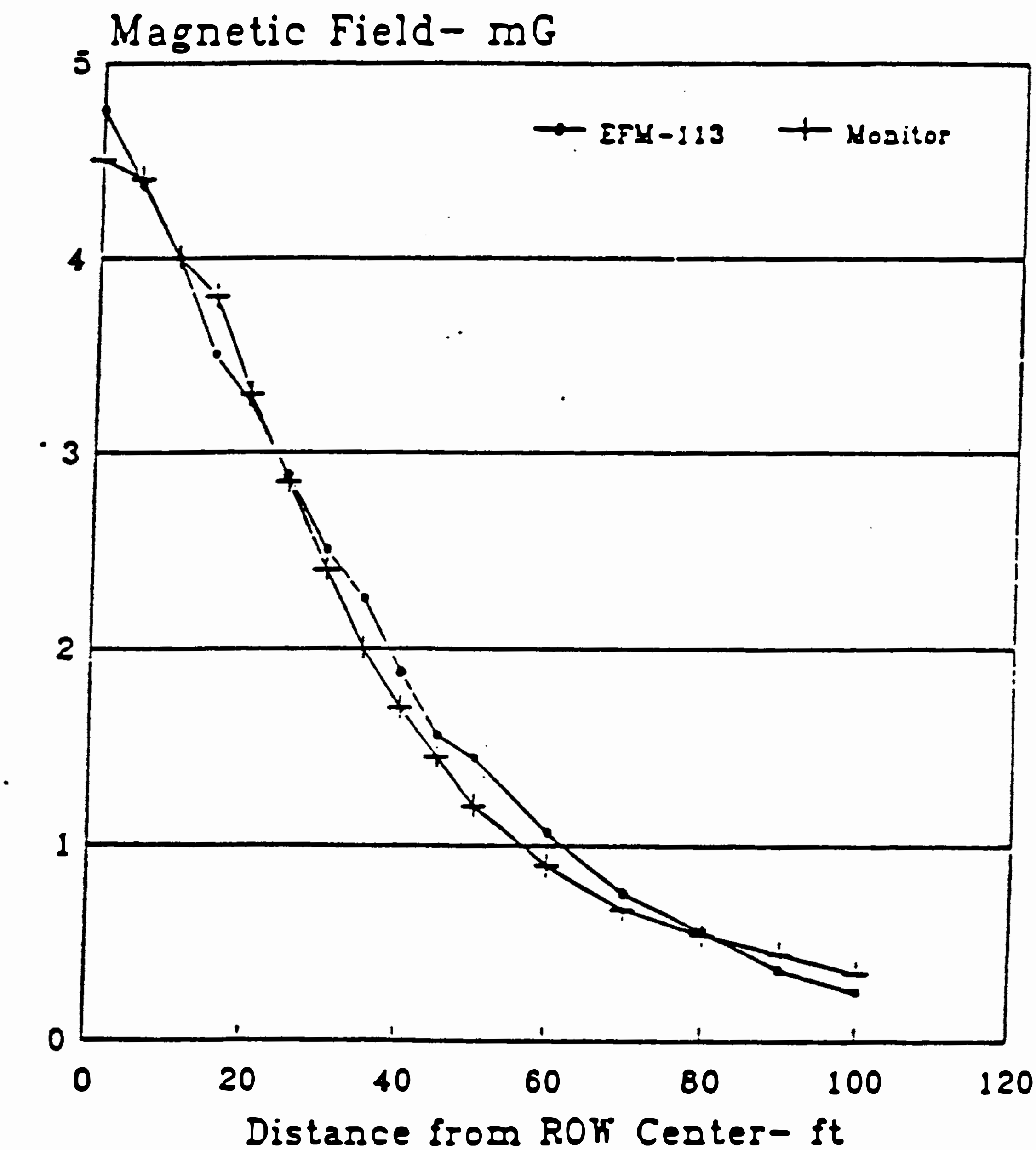
- 200 milligauss for 500 kV line

- 250 milligauss for 500 kV double circuit line

To date, New York is the only other state to establish magnetic field limits, New York's limits are not regulations, but are interim policies and set a maximum limit of 200 mG at the edge of the ROW for lines 125 kV and above and 1 mile or longer, or lines of 100-125 kV and 10 miles or longer.For unusual situations, the proposed 115-kV line could operate under an emergency loading that would temporarily increase magnetic field values at the ROW edge to about 42 mG, depending on line configuration and location. Under emergency (outage) conditions, the maximum value on the ROW, under the conductors near midspan, would then be about 125 mG (TBL. C-3.1). For transmission lines, these conditions are usually rare and of short duration. Figure C-10 shows the results of magnetic field measurements for the existing Flatiron-Erie 115-kV transmission line in Longmont. The measurements were made on April 14, 1988, in the period 5:20 p.m. -5:47 p.m. at mid-span on the first full span north of Highway 119. Magnetic field lateral profiles were measured starting underneath the center phase using the EFM Model 113 Meter ("Denometer"). Another profile was measured with the Monitor Industries Model 42 ("Leepermeter"). Table C-9 presents the actual measured values on which Figure C-10 is based.

FIGURE C-10

Existing 115-kV Transmission Line Measured Magnetic Field Lateral Profile



Denometer: EFM-113 /Leepermeter:Monitor

Date: 4/14/88

Table C-9

Existing 115-kV Transmission Line
Measured Magnetic Field Values

(First Full Span North of Highway #119, Longmont, Colorado, April 14, 1988)

DISTANCE FROM CENTERLINE (FEET)	MEASURED MAGNETIC FIELD EFM-MODEL 113 (DENOMETER) mG	MONITOR INDUSTRIES (LEEPERMETER) mG
0	4.75	4.5
5	4.38	4.4
10	4.00	4.0
15	3.50	3.8
20	3.25	3.3
25	2.88	2.85
30	2.50	2.4
35	2.25	2.0
40	1.88	1.7
45	1.56	1.45
50	1.44	1.20
60	1.06	0.90
70	0.075	0.68
80	0.563	0.55
90	0.375	0.45
100	0.250	0.35

Measurements are generally taken at right angles to the conductor at mid-span, one meter above the ground. Measurements directly under the line at mid-span would be expected to be maximum values for the transmission line due to the proximity of the conductors.

Magnetic field measurements were also made near two Longmont residences located near the transmission line. Measurement profiles were made perpendicular to the transmission line in the street in front of one house, and up the driveway to the second house. The magnetic fields in the street ranged from 6.9 mG directly under the line to 1.0 mG and less 80 feet from the line. A buried electric distribution line was located under the sidewalk in front of the home; the magnetic field reading directly over this buried line was 5.6 mG at a height of one meter above the ground. It is suspected that the magnetic fields from the buried distribution line had some affect on the magnetic field readings from the overhead transmission line. The fields could either somewhat enhance or partially cancel each other, depending on their orientation with respect to one another and electrical phasing.

The magnetic fields in the driveway of the second home ranged from 6.5 mG near the line to 3.1 mG near the house 60 feet away. No contributing magnetic fields from distribution lines were identified.

Magnetic field measurements were made inside both homes. In the first home, located 62 feet from the nearest conductor, magnetic fields in upstairs rooms facing the line ranged from 1.9 to 2.7 mG, with no apparent electrical devices operating in the rooms. In one room, measurements were taken about 2 feet from an operating TV, and a 5 mG reading was recorded. In the other home, magnetic fields of 1.2 mG were recorded in the basement area, and a field of 8 mG was measured near the furnace fan motor. On the patio, a magnetic field of 1.5 mG was present.

If the lines were constructed with underground cables, the magnetic field strength at the edge of the ROW would be greatly reduced, as compared to the overhead lines at the same location. This reduction would be due primarily to the close proximity of the three phases of the underground circuits, which causes the magnetic fields from the phases to cancel each other more effectively. Refer to Tables C-1 and C-3 and Figure C-1 for comparisons of overhead and underground line construction. Other impacts associated with placing transmission lines underground are discussed in the main body of the EIS in Section 3.G.4

C.6 HUMAN HEALTH ISSUES

Much research has been conducted in response to questions that have been raised over the past two decades as to whether exposure to electric and magnetic fields in the extremely-low-frequency (ELF) range (less than 300 Hz) may produce adverse health effects. Particular interest has been expressed in electromagnetic fields of power frequency, which are 60 Hz in North America and 50 Hz in Europe. During this period, research has addressed a wide range of possible adverse biological and health effects that are relevant to assessing whether exposure to electric and magnetic fields presents a health risk to the general population or to specific occupational groups.

From 1977 to 1990, eight highly qualified independent scientific panels and agencies evaluated the relevant scientific literature to consider whether exposure to electric and magnetic fields, at or near power frequencies, is associated with effects on human health. Each group reviewed both the laboratory and epidemiologic studies available. Summaries of these major reviews are presented below in Section C.6.1. A discussion of potential health risks posed by E&M Field exposure based on an assessment of the information that is available as of August 1992 is presented in the subsequent section. As was stated in the introduction to the health issue section (Section C.3), the following discussions do not specifically reference every publication on E&M Field health issues. However, the independent panel and agency reviewers and DOE have considered the available evidence as well as differing (and sometimes contradictory) interpretations of the health implications of the evidence in reaching the conclusions that are presented.

C.6.1 INDEPENDENT PANEL AND AGENCY REVIEWS OF THE ELECTRIC AND MAGNETIC FIELD HEALTH ISSUE

Since the mid-1970s, several independent panels of scientists have been convened in this country and abroad to review the health and scientific literature on electric and magnetic fields, and to offer evaluations regarding potential adverse health effects of such fields. The specific issues that prompted the formation of these panels varied and included concerns about AC transmission lines, an extremely low frequency (ELF) naval communication system, and the generic question of exposure to ELF electric and magnetic fields regardless of the source. None of the panels has had an adversarial interest in the outcome of its deliberations, and each panel has been multidisciplinary, composed of individuals from the biological, physical, and health sciences. In each case, the purpose was to provide technical support and input to a public organization or agency faced with the problem of determining whether field exposures create unacceptable risks to human health, safety, and welfare. In several cases, the panels considered the issues related to cancer, while in others they did not. These panel and agency proceedings are briefly reviewed below.

C.6.1.1 AC TRANSMISSION: THE FLORIDA COMMISSION.

In 1983, the Florida legislature gave the Florida Department of Environmental Regulation (DER) the authority to promulgate rules that could limit electric and magnetic field levels from overhead transmission lines. The DER established the Florida Electric and Magnetic Fields Science Advisory Commission, a group of six qualified scientific experts, to conduct an independent assessment of the biological and health literature relevant to questions of potential human risks from exposure to 60-Hz electric and magnetic fields produced by AC transmission lines. In addition, the Commission was charged with recommending regulatory guidelines, if deemed necessary. The Florida Commission opted not to evaluate the question of carcinogenesis, perhaps reflecting a tacit assumption about the quality of the available data.

The Florida Commission released its report (23) in March 1985, and specifically did not recommend regulatory control of electric or magnetic fields in its conclusion:

> "The Commission unanimously believes that the scientific evidence now available supports the conclusion that it is unlikely that human exposures to 60-Hz electric and magnetic fields from high voltage transmission lines can lead to public health problems. Although the commission believes that such problems are unlikely, but (sic) ambiguities in the currently available scientific knowledge preclude the conclusion that there is no chance that a public health problem exists. Thus, the Commission believes that:
>
> - From time to time the State should monitor new developments in this area. However, once an initial decision has been made in Florida that public health problems are unlikely, reopening the area for further consideration would not be justified unless a significant new body of experimental evidence becomes available."

As a result of the Commission's findings, the DER adopted an approach to consider decisions on new transmission projects on an individual case basis. Thus, in August 1985, when faced with a certification decision for Florida Power Corporation's (FPC) proposed 500-kV Lake Tarpon-Kathleen transmission line, the DER specified the condition of a 190-foot wide ROW along the line's route. This decision took into account uncertainties about health effects, the potential anxiety of abutters, and the fact that 190 feet is a normal ROW width for 500-kV lines within the state. In January 1986, a Florida hearing examiner rejected DER's requirement for this condition, stating that no evidence of adverse health effects was presented, and the DER's preference was "not contained in a DER existing or proposed rule and no standard for magnetic fields or other evidence of known adverse health effects from magnetic fields was offered during the course of this proceeding." Shortly thereafter, in March 1986, the Florida Siting Board, which consists of the Governor and his cabinet denied FPC's bid for certification of the line, not on the basis of health effects per se, but because the DER had not promulgated rules limiting field strength.

At this point, the DER embarked on an effort to comply with the Siting Boards requirement for a field standard, and appointed a scientific advisory panel from within the state to consider the state-of-the-science and recommend standards that would protect the public health. By September 1987, the panel had prepared its recommendations. Ironically, shortly after the panel's recommendations were available, the First District Court of Appeal for the State of Florida overturned the Siting Board's order to deny certification for the Lake Tarpon-Kathleen line. Apparently, the DER's policy of proceeding on an individual case basis was appropriate. However, by this time the initiative for setting a standard in Florida had gathered sufficient momentum, and the Florida Environmental Regulation Commission, empowered to set standards, considered the scientific panel's recommendations.

On March 1, 1989, the Commission filed standards for regulating the strength of electric and magnetic fields produced by utility transmission and distribution lines and equipment. Thus, the State of Florida became the first governmental authority in the world to set standards for both types of fields (42). Existing lines will be allowed to operate as they are currently installed. New lines must meet the following standards:

- For 230-kV Lines or Smaller. 8 kV/m maximum electric field within the ROW, 2 kV/m maximum electric field at the edge of the ROW, and 150 mG maximum magnetic field at the edge of the ROW.

- For 500-kV Lines. 10 kV/m maximum electric field within the ROW, 2 kV/m maximum electric field at the edge of the ROW, and 200 mG maximum magnetic field at the edge of the ROW.

- For Double Circuit 500-kV Lines. Electric field standards the same as for single circuit 500-kV lines and 250 mG maximum magnetic field at the edge of the ROW.

It is important to note, that although Florida has promulgated edge-of-ROW magnetic field standards, these standards are not based directly on any known health risk information, but rather are designed so that future transmission lines will not produce edge-of-ROW fields higher than any lines in operation at the time of enactment. The Florida regulations, therefore, assure the maintenance of the status quo while further research into possible E&M Field health effects is ongoing.

Member utilities of the Florida Electric Power Coordinating Group, which accounts for about 99 percent of the state's transmission lines, have said that the rules are achievable and have not planned to challenge them (42). The field strengths for Western's proposed project would be below all of the Florida standards.

C.6.1.2 THE WORLD HEALTH ORGANIZATION (WHO) EVALUATIONS OF ELF ELECTRIC FIELDS (24) AND MAGNETIC FIELDS (25).

Under a United Nations mandate, the WHO Environmental Health Criteria Program was initiated in 1973 to assess the effects of environmental chemicals and physical factors and to issue criteria documents. WHO issued a health criteria document in 1984 concerned primarily with ELF electric fields, and in 1987 issued a document focused only on ELF magnetic fields. Unlike the other panel reviews discussed here, the WHO documents did not apply to a specific source or kind of exposure, but rather dealt with the effects of electric and magnetic fields from a generic standpoint.

The 1984 document on electric fields concluded:

> "Adverse human health effects from exposure to ELF electric field levels normally encountered in the environment or the workplace have not been established." (Page 88)

and

> "Whilst it would be prudent in the present state of scientific knowledge not to make unqualified statements about the safety of intermittent exposure to electric fields, there is no need to limit access to regions where the field strength is below about 10 kV/m. Even at this field strength, some individuals may experience uncomfortable secondary phenomena such as spark discharge, shocks, or stimulation of the tactile sense." (Page 2)

The 1984 WHO document briefly considered the epidemiologic literature on cancer then available, concluding:

> "The epidemiological studies suggesting a relationship between childhood or adult cancer and residence in houses at various distances from high current flow due to external electrical wiring configurations, can only be considered as preliminary because of the many criticisms that have been leveled at the studies." (Page 87)

The principal evaluations of the 1987 WHO document (Criterion #69) on non-carcinogenic effects of magnetic fields were expressed in terms of the levels of magnetically-induced currents that may be associated with adverse effects. The current density quantity, "1 mA/m^2" that appears in the excerpt that follows corresponds to a 60-Hz magnetic field exposure level of about 3 Gauss (3,000 mG), which is about 94 times greater than the maximum field that would be encountered at the edge of the proposed project's ROW, during normal loading (peak), and about 71 times greater than during emergency loading conditions (See Table C-3). The WHO report states:

> "It can be assumed that a current density of less than 1 mA/m^2, induced by an external magnetic field should not produce adverse neurological or behavioral effects, since naturally flowing currents in the brain are of the same order of magnitude." (Page 121)

and

> "For human exposure to time-varying magnetic fields, it seems reasonable to assume that a health risk assessment

can be made on the basis of significant perturbations of biological functions caused by electric currents induced by the fields. Available data suggest that, when current densities less than 10 mA/m^2 [equivalent to about 30 G at 60 Hz] are induced in tissues and extracellular fluids, the induction of adverse health effects is unlikely. However, the possibility of some perturbing effects occurring following long-term exposure cannot be excluded." (Page 126)

The 1987 WHO document considered the epidemiologic literature, which included several studies published since 1984, and acknowledged the existence of both negative and positive reports. With reference to the positive reports, the WHO document offered the following opinion:

"These associations cannot be satisfactorily explained by the available theoretical basis for carcinogenesis by ELF electromagnetic fields. The preliminary nature of the epidemiological evidence, and the relatively small increment in reported incidence, suggest that, although these epidemiological data cannot be dismissed, there must be considerable further study before they can be accepted." (Page 22)

C.6.1.3 THE ELF COMMUNICATION SYSTEM: NATIONAL ACADEMY OF SCIENCES (NAS) (26) AND AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES (AIBS) (27).

The U.S. Navy has twice commissioned reviews of the biological and health science literature pertinent to the fields produced by its proposed ELF antenna system, formerly known as Project Sanguine and then as Project Seafarer. The antenna system is designed for land-based communication with the United States submarine fleet, and operates at 76 ± 4 Hz. In 1977, an NAS Committee (26) produced a report, and in 1985 the AIBS (27) reviewed the literature published since 1977. In the interval between the two reviews, the antenna was redesigned (for engineering reasons) from its original underground configuration to an overhead design; it is now called Project ELF.

Although the antennas transmit at 76 ± 4 Hz, the 1977 and 1985 assessments both considered studies performed at other ELF frequencies, including 60 Hz, as highly relevant to their objectives. This follows from the fact that the physical mechanisms of electric and magnetic field interactions that induce electric currents and fields within exposed subjects appear to be similar over the ELF range (less than 300 Hz). The research performed at 60 Hz to investigate AC transmission line environments served in many instances as significant source material for both the NAS and AIBS panel judgments concerning the ELF antennas' fields. It is appropriate, therefore, to consider the two expert evaluations of the Navy antenna system as highly relevant to the health questions concerning 60-Hz AC transmission. Neither the NAS nor AIBS reviews explicitly considered issues concerned with cancer. The NAS review was published prior to more recent studies on cancer, which are discussed on the following pages (for Wertheimer-Leeper, Savitz, and Peters). The AIBS decision not to consider questions of carcinogenesis may have reflected the inadequacy of the data-base on cancer that existed at the time their review was conducted.

The NAS concluded in 1977:

"A number of concerns raised over the years that Seafarer ELF fields might constitute a source of dangerous--even catastrophic--environmental contamination have been raised and found invalid and unwarranted. The Committees' considered opinion is that such fields will not cause a significant and adverse biologic disturbance, except in the event of electric shock, which is of serious concern. In fact, apart from the possible result of electric shock, the Committee cannot identify with certainty any specific biologic effects that will definitely result from exposure to the proposed Seafarer fields."

In the preface to the 1985 report, the AIBS Project Director, Donald R. Beem, Ph.D., concluded as follows:

"The AIBS Committee members are in agreement with the conclusions of the 1977 Academy report, and based on their finding in this study, the Committee believes that it is still unlikely that exposure of living systems to ELF electric and magnetic fields in the range of those associated with the Navy's ELF Communications System can lead to adverse public health effects or to adverse effects on plants or animals. However, because of certain ambiguities in the scientific literature, the Committee recommends that the Navy continue to monitor the literature and respond appropriately to any significant new information."

C.6.1.4 <u>THE NEW YORK STATE POWER LINES PROJECT (28)</u>.

The New York State Power Lines Project (PLP) consisted of 17 separate biological and health investigations concerned with the electric and magnetic fields that transmission lines produce. The PLP was conducted under a 1978 order from the New York Public Service Commission to the utilities within the state to support a $5 million electric and magnetic field biological effects research program. The order resulted from public hearings concerning the health and safety aspects of two proposed 765-kV AC transmission lines. An independent Scientific Advisory Panel developed the research program and monitored and reviewed the studies.

The PLP was initiated in 1982, and the research projects included in the program were chosen specifically to address high priority scientific questions regarding the electrical environment produced by 765-kV transmission lines. Following a careful consideration of the scientific literature, this broadly-based program supported research projects in the following areas: reproduction and development; cancer, including both laboratory studies and two epidemiologic studies (one of childhood cancer and the other of adult cancer); cell biology; and neurobiology and behavior. In almost every laboratory study, the experiments used electric and magnetic fields at least as large in strength as those found in a 765-kV ROW, which generally exceed those found in association with lower transmission voltages. Also, the exposure time that the animals, tissues, or cells tested received were very long in duration (chronic exposures). Typically, people spend relatively little time within ROWs, and the cumulative exposures in the laboratory far exceeded those that people typically receive (29). The PLP studies showed that electric and magnetic fields do not affect genetic material, which indicates that magnetic fields would not cause cancer through mechanisms related to genetic or chromosomal mutation. Also, in multi-generational experiments using rodents (i.e., successive generations of animals mated and reared throughout the exposure period), electric and magnetic field exposure produced no effects on reproduction, fertility, litter size, fetal mortality, or generation time. Although several of the PLP studies reported biochemical changes, as well as effects on cell function and whole animal behavior, neither the investigators nor the Scientific Advisory Panel concluded that these observations were indicative of an adverse effect of field exposure on public health.

The major concern of the panel was with the results of the epidemiologic study of childhood cancer conducted by Savitz in Denver (30), which reported a possible association between electric utility wiring configurations and cancer, and thus suggested a magnetic field effect (31). This study was intended as a replication of a study published by Wertheimer and Leeper (32). The latter had presented data that described an association between the incidence of childhood cancer (including leukemia) and the type of utility wiring normally found outside homes (these are almost entirely distribution rather than transmission lines). These wire code classifications (not to be confused with building codes) were originally developed by researchers Wertheimer and Leeper as a nonintrusive surrogate method of estimating indoor magnetic fields in their 1979 study of childhood cancer in Denver. Based on accepted principles of how magnetic fields levels are related to the levels of current in a conductor and the distance from the conductor, the code classifications take into account the number of lines present, the thickness of the conductors, how far out on a distribution circuit a house is located, and how far the house sits from the line. Thus the outdoor wires were coded according to their apparent current-carrying-capacity and distance from the home. The wiring configuration or coding for each home was assigned as a surrogate for the magnetic field strength predicted for each home; however, actual in-home measurements were not conducted. The implication that Wertheimer and Leeper drew from their data was that the size of the magnetic field produced by the utility wiring was associated with disease rate.

Unlike the Wertheimer and Leeper study, however, the Savitz study included measurements of magnetic fields inside the homes of the study subjects. When measured magnetic fields were used as the index of exposure, the associations with disease were weak to nonexistent, and none was statistically significant. Savitz did find, however, that magnetic field strength in the home was weakly correlated with wiring configuration, and disease was slightly but statistically significantly associated with utility wiring configuration.

Study results are often expressed in terms of the probability of observing the results if they were due to random chance. A commonly used convention is that, when this probability (or p-value) is less than 5 percent (often written $p<0.05$), the observed findings are "statistically significant." If a study reports a p-value of 0.05, this means that 5 times out of a hundred a result at least as large as that reported would have occurred solely due to random chance. The selection of 5 percent as a cutoff value for significance is arbitrary, and some investigators select 1 percent as a more stringent criterion for significance. In this discussion, the reader should assume that the term "significance" refers to the 5 percent value.

It is very important for the reader to understand that a "statistically significant association" as shown in the Savitz study does not prove causation. The Scientific Advisory Panel was careful to point out that a causal relationship between magnetic fields and cancer had not been demonstrated, and that causality was only a hypothesis. The basis for this opinion at the time was: 1) we still have only one well-designed [positive] study [the Savitz study], 2) there are unresolved questions in the Savitz study, and 3) there is no basic mechanism known to explain a causal relationship. (As an aside to this PLP discussion, there are now only two well-designed [positive] studies, the Savitz and the Peters (45) Study. Both of which have raised many as yet unsolved questions and neither study has demonstrated a mechanism to explain how E&M Fields could influence human cells.)

The other epidemiologic study in the PLP examined the relationship between both wire codes and measured magnetic fields with adult leukemia in the Seattle, Washington area (33, 34). In this study, neither wiring codes nor measured magnetic fields were found to be associated with the incidence of leukemia. Other epidemiologic studies have been conducted in community settings and the results have been mixed; some have failed to detect an association between proximity to magnetic field sources and cancer (35, 36, 37, 38), while others have reported positive associations (39, 40). The results of the PLP showed that, under carefully controlled laboratory conditions, field strengths characteristic of 765-kV AC transmission lines do not produce effects on the general health or vitality of exposed subjects, or produce cellular effects indicative of transformation to a cancerous state; the effects that were observed failed to suggest that field exposures from transmission lines were associated with adverse effects on health. Neither of the two epidemiology studies produced data linking measured magnetic fields with cancer, but one produced an association with an exposure surrogate, namely wiring codes.

In July 1987, the Public Service Commission (PSC) of the State of New York appointed a Power Lines Project Evaluation Task Force to evaluate the Scientific Advisory Panel's final report and develop recommendations for the PSC to consider. The Task Force in its report to the PSC (issued in January 1988) stated:

"Although biological effects were noted in the research, the research findings themselves do not readily translate into concrete regulatory recommendations for establishing a magnetic field standard because the research revealed no evidence that magnetic fields pose a health hazard" (p. 28, NYS Public Service Commission, 1988).

Nonetheless, it recommended actions that would be in the public interest. Included among the recommendations was that the utilities should survey all fields associated with power delivery in the state and consider means to reduce field levels. Another was that "the Chairman and Commissioners should encourage the National Association of Regulatory Utility Commissioners to establish a committee to spearhead a joint state research effort similar to the New York State Power Lines Project."

The Task Force also recommended an interim magnetic field standard according to the philosophy that, "an interim magnetic field standard should ensure that magnetic fields at the edge of future transmission line rights-of-way are no greater than the fields typical of the many existing 345-kV lines operating through the state." The Task Force further stated, "If a magnetic field limit is adopted, it should be made clear that magnetic fields have not been shown to be hazardous and that the purpose of the limit is to ensure that exposures to magnetic fields in future transmission line designs would be no greater than those which society has implicitly accepted for the 345-kV lines operating for many years throughout New York State."

In February, 1988, the PSC approved the Task Force report and recommendations. Following the completion of a state-wide survey of 345-kV lines, the PSC proposed an edge of ROW magnetic field limit of 200 mG, winter normal conductor rating, for future transmission facilities over 1 mile long operating at 125-kV or above, or over 10 miles long operating at 100 to 125-kV.

C.6.1.5 THE OFFICE OF TECHNOLOGY ASSESSMENT (OTA) REPORT (43).

A background paper on "The Biological Effects of Power Frequency Electric and Magnetic Fields" was prepared in 1989 by a group from Carnegie Mellon University for the U.S. Congress (43). The OTA report discusses the present information on the health effects of extremely-low-frequency electric and magnetic fields. It also describes various research programs in progress and provides information on regulatory activity, including existing and proposed field exposure standards.

The Carnegie Mellon group prepared the OTA report as a compendium of the available science rather than a critical review. At its conclusion, the OTA report considers various approaches to deal with the issue of electric and magnetic fields. It does point out that there are no firm policy statements it can make because the science is not complete enough to support them. To say any more would go beyond science and involve judgments and values. Nevertheless, it does present a general framework to think about the available approaches for regulators. The three general policy options are: 1) Do Nothing, 2) Prudent Avoidance, and 3) Aggressive Regulation.

The OTA report seems to direct the reader toward the prudent avoidance option. Prudent avoidance is taking modest steps to limit or reduce exposure that can be done with small investments of money and effort. Examples given of prudent avoidance include: 1) modest engineering design changes that reduce field levels and 2) actions that make exposure comparable, such as making field levels from new transmission lines similar to those levels for existing lines. The report does not recommend doing anything drastic or expensive until research provides a clearer picture of whether there is any risk and, if there is, how big it is. It also gives examples of excessive steps that, in the opinion of the authors, go beyond prudence and are, "At the least they would be foolishly expensive, at the worst, signs of serious paranoia." (43)

C.6.1.6 THE U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA) DRAFT REPORT (44).

In December 1990, the EPA released a Review Draft Report entitled "Evaluation of the Potential Carcinogenicity of Electromagnetic Fields" (EPA/600/6-90/005B). The report, dated October 1990, reviews and evaluates the available literature on the potential carcinogenicity of electromagnetic fields including extremely low frequency magnetic fields such as those produced by power lines. Though widely reported and quoted in both the print and electronic media, EPA has issued this report as a preliminary draft only, and cautions against citation, quotation, or characterization of the report as formal agency policy. Since this is the second draft of this document to contain substantially the same information, and public familiarity with its issuance and findings is relatively high, the report is briefly summarized below. The reader is cautioned, however, that this is a Draft report, issued for comment.

The EPA report reviewed available literature pertaining to human epidemiologic studies relating to carcinogenesis, chronic exposure animal studies, and in vitro studies. The purpose of the document was to "evaluate the likelihood that exposure to nonionizing electromagnetic radiation poses a risk or is a risk factor for the development of cancer in humans."

With respect to human epidemiologic studies, the EPA found that the strongest link between exposure to 60 Hz magnetic fields and human cancer comes from childhood cancer studies. In examining seven case-control studies of childhood cancer, EPA found consistent, modest elevations of cancer risk for leukemia, cancer of the central nervous system, and lymphoma in children whose exposure to magnetic fields has been estimated by the types of wires near their homes (wiring codes are discussed in Section C.6.1.4) or where magnetic field measurements indicated fields of 2 mG or higher. However, measured dose response relationships were found to be contradictory and could not be substantiated. Particularly, EPA cites studies by Wertheimer and Leeper (32) and Savitz (30), as presenting the fewest difficulties with respect to bias, confounding, or other methodological problems. These studies estimate a potential one and one half to threefold increase in cancer risk from elevated magnetic field exposure as defined by wiring codes.

Studies of residential adult exposure to magnetic fields, EPA concludes, provide somewhat mixed evidence of a risk of leukemia, and can neither be reliably used to assert or deny a possible association. One adult cancer study, however, does support an association between wiring codes and central nervous system cancer and lymphoma. Additionally, EPA found weak evidence of an association between leukemia and cancer of the central nervous system and employment in certain jobs characterized by high potential magnetic field exposure. EPA did caution, however, that misclassification of job function or other biases appears to be a distinct possibility in occupational studies.

EPA further stated that while no lifetime animal carcinogen studies of extremely low frequency electric and magnetic fields have been reported in the literature, evidence from a large number of biological test systems shows that such fields induce biological effects that are consistent with several possible mechanisms of carcinogenesis. However, none of these processes has been experimentally linked to tumors in either animals or humans, and the methods by which electric or magnetic fields may cause these events are not known. Additionally, the report points out:

> Most of the effects have been observed at field strengths that are many times higher than the ambient fields which are the putative cause of the childhood cancers in residential situations; as a consequence, many of the candidate mechanisms may not be really involved in the response to low environmental fields.

In summary, the EPA concluded:

With our current understanding, we can identify 60-Hz magnetic fields from power lines and perhaps other sources in the home as a possible, but not proven, cause of cancer in humans. The absence of key information... makes it difficult to make quantitative estimates of risk. Such quantitative estimates are necessary before judgment about the degree of safety or hazard of a given exposure can be made. This situation indicates the need to continue to evaluate the information from ongoing studies and to further evaluate the mechanisms of carcinogenic action and the characteristics of exposure that lead to these effects.

Panel Reviews of EPA Report

Science Advisory Board Review

Since the EPA draft report was issued in December 1990, it has undergone thorough review by the public and various other groups. One group providing comments was EPA's Science Advisory Board (SAB) which includes the Nonionizing Electric and Magnetic Fields (NIEMF) Subcommittee, The Radiation Advisory Committee, and the SAB Executive Committee. The SAB was requested to provide a peer review of EPA's draft report "Evaluation of the Potential Carcinogenicity of Electromagnetic Fields." The charge to the board was to review the document as to the accuracy and completeness of the information provided, as well as the interpretation of the scientific data. The advisory group released their comments in a January 29, 1992, letter to the EPA Administrator William K. Reilly. The letter summarizes the Subcommittee's comments on the EPA draft report on E&M Field carcinogenicity and presents these primary conclusions:

1) The EPA document has serious deficiencies and needs to be rewritten and then re-reviewed by the SAB;

2) Some epidemiologic evidence is suggestive of an association between surrogate measurements of magnetic-field exposure and certain cancer outcomes;

3) The EPA document does not present a holistic model of carcinogenesis within which the strength of existing evidence concerning the carcinogenic properties of electric and magnetic fields can be assessed;

4) Currently available information is insufficient to conclude that electric and magnetic fields are carcinogenic.

5) There is insufficient information to designate specific values of magnetic-field strength that may be hazardous to human health.

Committee on Interagency Radiation Research and Policy Coordination

Another panel providing review comments of the EPA draft report was the Federal Committee on Interagency Radiation

Research and Policy Coordination (CIRRPC). CIRRPC is a subcommittee of the Federal Coordinating Council for Science, Engineering, and Technology, and reports to Dr. D. Allan Bromley, White House Science Advisor. CIRRPC received comments on the EPA report from the Department of Commerce, Defense, Energy, Health and Human Services, Labor, and Transportation. CIRRPC released its review comments on the EPA draft report on E&M Field carcinogenicity on August 5, 1991, in a letter to EPA Assistant Administrator Eric W. Bretthauer. CIRRPC's letter concluded that "the evidence presented in the report does not provide a scientifically sound basis for linking cancer to exposures to electric and magnetic fields. We recommend that the 'review draft be substantially revised,' if not rewritten, to address not only the summary of interagency comments, but also the enclosed comments received from individual agencies." The letter is very critical of EPA report and views the report as unbalanced and lacking in rigor and completeness.

C.7 CURRENT ASSESSMENT OF POTENTIAL HEALTH RISKS

In assessing whether exposure to electric and magnetic fields, whether from transmission lines or other sources, poses a human health risk, it is first necessary to demonstrate that such exposure results in biological effects to cells, tissues, organs, or organisms. Next it is necessary to demonstrate that any established biological effects translate into health effects, i.e., an increase in disease or a decrease in well being. Finally, it is necessary to demonstrate the frequency with which health effects occur, or the health risk.

C.7.1 HIGHLIGHTS OF CURRENT RESEARCH.

During the last dozen years, extensive experimental work on the interaction between electric and magnetic fields and biological systems has been carried out. During this period, DOE established a research program to investigate possible health hazards. The funding level for this program was approximately $3 million in 1990, $3.5 million in 1991, and is estimated to approach $5 million in 1992. The Electric Power Research Institute (EPRI) has also maintained a similar program, vastly accelerated in recent years. Organizing efforts are under way for a proposed Cooperative National Electric and Magnetic Field Research Program involving Government agencies, State Regulatory Authorities, and public and private sector power interest. International support and involvement in health research is likewise widening. The number of countries sponsoring research has about doubled, to 25, and estimated annual spending has nearly doubled, to about $25 million worldwide, in just a few years. Research spans the entire spectrum from humans, primates, and rodents to tissues, cells, and DNA. After the early screening studies, many of which were negative, effects have now been identified for a considerable number of systems.

It must be noted that many of the observed effects are not very robust. Moreover, most studies have not been extensively replicated. In part, this may be due to the fact that appropriate exposure parameters have not yet been fully identified.

In human research, male volunteers were exposed for 6 hours to mixed electric and magnetic fields which they could perceive (46). Of some 50 blood, urine, physiological, and psychological variables investigated, only 3 showed significant changes due to the fields: 1) changes in certain brain waves; 2) a slowing of motor responses; and 3) in particular, a slight slowing of heart rate (3 out of 70 beats per minute). These effects were consistent. However, they were present only at 9 kV/m and 200 mG and not at fields above and below these values. There appears to be a "window" effect quite unlike the usual dose/effect relationship. Moreover, when fields were intermittent (on-off 4 times per minute), the effect becomes stronger. Both of these features had previously appeared in cellular work.

Melatonin is an important hormone produced in the pineal gland that regulates the thyroid gland, adrenal gland, and reproductive organs. Reduction of melatonin production is strongly correlated with breast cancer in rats as well as human females. Exposure of rats to electric fields for 3 weeks has resulted in depression of daily melatonin production by some 50 percent (46). Continuing experiments have shown that this effect can be elicited with fields ranging from 3.5 kV/m to 120 kV/m. Currently, effects of mixed electric and magnetic fields are being explored. Preliminary results show that intermittent magnetic fields yield stronger effects (46).

Cellular work has shown varied responses to exposure such as irregular firing of neurons and reduced killing capacity of white blood cells (thus reducing effectiveness of the immune system). It has become clear, largely through DOE work, that the cellular basis of many bio-effects seems to be a disturbance of the flux of biologically important ions through the cell membrane. These ions, particularly calcium, serve as messengers telling cells how to respond to external stimuli. It was found, for example, that exposure causes changes in the intra-cellular hormones, ornithine-decarboxylase and parathyroid, which are similar to changes caused by known cancer promoters (46).

Although extensive experimentation has revealed no direct effect of electric and magnetic fields on DNA, recent results (46) reveal a more subtle effect. DNA transcription and translation into messenger RNA is apparently affected by exposure. Put simply, this means that DNA is not affected directly, but the way DNA works may be changed by fields.

All these effects are biological effects; currently they cannot be characterized as health effects. They do, however, present cause for future concern.

C.7.2 DOSE AND EFFECT.

Most toxic agents found in the environment have a fairly simple dose/effect relationship. Basically, this relationship is linear, at least for small doses; twice the dose gives twice the effect. Often there is some saturation, when further increases in dose do not increase the effect.

The situation for bio-electromagnetic effects is completely different. Both human and cellular work indicate the existence of intensity "windows." An effect only seems to occur within a certain range of the parameter. Certain phenomena, in fact, appear to be restricted to narrow resonance-like bands. Non-linearity also seems to be characteristic of the frequency dependence. Furthermore, intermittency emerges as an important factor. The magnitude of the field may not be as important as fluctuations in exposure. Finally, other factors such as timing and even the local geo-magnetic field seem to play a role as well. In other words, the possible existence of intensity windows argue that more may not be worse when considering bio-effects from electric and magnetic fields. It may be some time before researchers are able to understand why certain distinct exposure ranges, resonant (or pulsing) characteristics, or exposure durations provide an observable effect, while others, even though greater in intensity, do not.

While extremely interesting from a scientific point of view, this situation makes any evaluation of "exposure" quite difficult. An extensive program of exposure measurement is not warranted at this time, since the parameters to be measured are not yet known. Finding the dose/effect relationship for biological effects must be the prime scientific objective. Once such a relationship is found, one will be in a much better position to look for possible health effects, either through epidemiology or through animal experiments.

C.7.3 EPIDEMIOLOGY.

Since human experimentation involving toxic agents is usually not possible, epidemiology (the study of the occurrence and distribution of disease) can offer a useful alternative. There have been some 40 epidemiological studies on potential health hazards of electric and magnetic fields. Roughly half of these studies are residential and half are occupational. Twenty studies are ongoing.

Epidemiological studies look for statistical correlations between the occurrence of disease and other factors. When a significant correlation is identified, the health risk is described in terms of a risk factor. A risk factor of 2 indicates that a disease occurs twice as often in a study population (or group of people) exposed to a certain factor as compared to a control population which is not exposed to the factor being considered. Table C-10 provides examples of confirmed and potential cancer risk factors reported for various factors, i.e., smoking.

TABLE C-10

Examples of Confirmed and Potential Cancer Risks Reported for Various Factors.

Factor (Cancer Type)	Relative Risk	Reference
Smoking (Lung Cancer)*	10 - 40	Wynder and Hoffman, 1982
Workers Exposed to Benzene (Leukemia)	1.5 - 20	Sandler and Collman, 1987
Workers Exposed to Carbon Tetrachloride (Leukemia)	12 - 18	Sandler and Collman, 1987
Environmental Tobacco Smoke (Lung Cancer)*	2 - 3	Ammann et al., 1987
High-Current Power Lines (Childhood Cancer)	1.3 - 2.6	Ahlbom, 1988
Radium Contamination of Drinking Water (Leukemia)	2	Lyman et al., 1985
Use of Hair Dye (Leukemia)	1.8	Cantor et al., 1988
Workers Exposed to Electric and Magnetic Fields (Acute Myelogenous Leukemia)	1.2 - 1.8	Savitz and Calle, 1987

* Generally considered as confirmed cause-and-effect associations.

In general, risk factors for residential studies of electric and magnetic fields are in the vicinity of 2, while occupational studies yield higher risk factors (e.g., 8). However, in many cases, studies showing statistically significant correlation with exposure are matched by other studies which do not. Also, the diseases involved are fortunately rare and the total number of cases is orders of magnitude smaller than those involved in accepted correlations such as lung cancer and smoking.

Among the most often quoted studies, the Savitz study (30) investigated cases of childhood leukemia in Denver. Disease incidence was associated with wiring codes, but generally not with measured magnetic field strengths. However, Savitz found that houses with fields of about 3mG have a slightly higher, though statistically insignificant, correlation with the disease than those with only 1mG. While the study itself was carefully conducted, certain facts have to be kept in mind: 1) the risk factor involved is only 2, 2) the total number of cases was about 135, and 3) there was no correlation to adult leukemia. While the study indicates potential effects, it is certainly not proof that leukemia is caused by power line fields. After the release of his study in 1987, Savitz, in an open memorandum to "persons concerned about reports of electromagnetic fields and childhood cancer," addressed the inquiries he had received concerning the study's results. He stated: "It should be kept in mind that we have not proven that magnetic fields cause cancer. Subsequent research will indicate whether we are on the right track or whether our results are in error."

Results released in 1990 from studies of telephone linemen conducted at Johns Hopkins University by researcher Genevieve Matanowski have shown elevated risks of leukemia, brain cancer, and male breast cancer (51, 52). In one study, Matanowski found that the association between leukemia and E&M Field exposure was strongest in workers, such as cable splicers and central office technicians who were exposed to higher peak E&M Field doses than other workers. Although Matanowski's work lends support to the theory of an E&M Field - cancer link in occupationally exposed populations, it does not prove a cause and effect relationship, and Matanowski continues to emphasize the need to identify the precise mechanisms by which E&M Field could influence human cells.

Finally, the most comprehensive study to date (45) of childhood leukemia and exposure to E&M Fields was published in the November 1991, issue of the <u>American Journal of Epidemiology</u>. The five-year, $1.7 million study was funded by the Electric Power Research Institute and conducted by Dr. John M. Peters, M.D. and professor of preventative medicine at The University of Southern California. The study examined 232 cases of childhood leukemia which occurred in children ages 10 and younger between 1980 and 1987 in Los Angeles. Researchers interviewed parents of leukemia victims by telephone, measured electric and magnetic fields in their homes, conducted like examinations of a control group of 232 children who did not have leukemia, and evaluated power lines outside the children's homes using wiring codes similar to the previous Denver studies (30, 31, 32).

The study results support five preliminary conclusions:

(1) Magnetic field measurements correlate weakly but significantly with wiring configurations.

(2) Wiring configurations were associated with risk of childhood leukemia, as previously found in two studies in Denver.

(3) Measured magnetic fields are not consistently related to leukemia risk.

(4) Based on parental responses to the questionnaire, use of some appliances was associated with increased risk of childhood leukemia.

(5) The risk of childhood leukemia was not associated with electric field exposure.

The Peters findings, though generally consistent with earlier studies such as the Wertheimer - Leeper and the Savitz work, continued to present further research needs. Particularly of interest are the reasons why wiring configuration is again observed to correlate better with leukemia risk than measured exposure. The question of an apparent appliance use correlation with leukemia also bears further examination.

Epidemiology studies are easier for the general public to understand than work on cellular biology. However, such studies also lend themselves to facile (and misleading) interpretations. It is sometimes difficult for the public to remember that statistical associations that may be shown in an epidemiology study do not prove causation. Therefore, these studies are particularly prone to lead to alarmist reports in the press and to general confusion. Actually, a wide variety of activities lead to risk factors of approximately 2, without arousing any notable public concern. Table C-10 provides examples of risk factors that are approximately 2 or greater.

C.7.4 BIOLOGY - HEALTH RISK.

A decade ago, a substantial number of scientists may have doubted whether electric and magnetic fields could interact with biological mechanisms. Today, the existence of "biological effects" is accepted by a majority of scientists. However, such biological effects do not necessarily imply that there are "health effects". Experiments are made under carefully controlled laboratory conditions, which may have little relevance to realistic exposure environments. For example, small amounts of light can essentially negate the effects of the melatonin experiment. Furthermore, body mechanisms are able to take care of most other biological perturbations. Proof of health effects will need extensive and costly animal experimentation. Until there is better understanding of the dose/effect relation, such work will not be conclusive.

While biological effects can be considered as established, health effects of electric and magnetic fields must be considered as unproven. Only if there are health effects, will the question of risk become relevant. Because of the apparent nature of the dose/effect relationship, one might conclude that the special exposure conditions which result in effects might be comparatively rare. On the other hand, because electricity is virtually ubiquitous, one could say that even very small health effects will result in major risks.

There are several arguments against pursuing vigorous programs of regulation and mitigation. It is not known whether, and to what degree, there really are health effects. More importantly, one does not know what to mitigate against. In a usual toxicological situation, one could simply conclude that any reduction in field strength would be commendable. But because of possible "window effects," as discussed above, it is possible that more exposure may not necessarily be worse than less, and reduction of field levels may actually be counter-productive. If it turns out that only certain frequencies are biologically active, then it may be much more important to decrease contributions of that specific component rather than lowering field strengths in general.

C.7.5 OTHER POINTS OF VIEW.

Although the consensus opinion of the majority of researchers (including DOE), regarding the existence of a link between magnetic and electric field exposure and health effects, continues to center on the need for further research, there are well known and credible epidemiologist who have taken the position that adequate evidence does indeed exist by which to conclude the presence of a cause and effect relationship.

Perhaps most prominent among these researchers is Dr. Nancy Wertheimer, whose early work with Dr. Ed Leeper in 1979 (32) is often referenced as the beginning of the current credible research into possible E&M Field health effects. Since that time, Wertheimer and Leeper have published several other studies examining possible relationships between electrical wiring and adult cancers and possible effects of electric blankets on fetal development (53, 54, 55). In all of these studies, Wertheimer and Leeper have observed a consistent correlation between high E&M Field exposure situations, often represented by surrogates such as wiring codes or electric blanket use, and negative health effects such as cancer or fetal loss. Wertheimer and Leeper's work has also attempted to control for confounding variables such as age, neighborhood, or socioeconomic levels in the case of the adult cancer studies and thermal effects in the case of electric blanket users. In both cases, the authors feel that their results are able to isolate electric and magnetic fields as the likely causal mechanism for the observed health effects.

In the area of occupational exposures, in addition to the work of G. M. Matanowski referenced above, Dr. Sam Milham, Jr. has published several studies (56, 57, 58, 59, 60) between 1982 and 1988. Dr. Milham examined mortality from leukemia and non-Hodgkin's lymphomas in workers involved in "electrical" occupations (including electricians, power station operators, and aluminum workers) and amateur radio operators who are exposed to electric and magnetic fields as a result of their hobby. Dr. Milham has consistently concluded that elevated risks, as represented by significant excess deaths correlate positively with elevated occupational exposures.

C.8 CONCLUSIONS.

It is becoming apparent that biological effects of electric and magnetic fields occur with frequencies between 15 and 150 Hz. However, health effects cannot be considered as proven, and it is not clear whether biological effects can lead to health effects. If health effects exist, epidemiology indicates that they are likely to be small.

There is, however, much room for research to improve our understanding of this complex area. And indeed, research to investigate or replicate previous studies involving electric and magnetic field exposure is continuing. There are nearly 50 studies on biological effects currently being funded in the United States; 18 of these studies are being funded by DOE. The work involves more epidemiologic investigation and basic laboratory work. DOE is currently conducting research on the effects of electric and magnetic fields on humans, baboons, small mammals (melatonin, stress, circadian rhythms), cell membranes, and cell and tissue physiology. Future studies will investigate the effects of mixed electric and magnetic fields, long-term effects on cell growth, and cell membrane interactions with electric and magnetic fields. Powerline epidemiological studies are continuing in the United States, as well as in Sweden and Great Britain. The National Cancer Institute is considering a large-scale childhood cancer study in the United States to investigate several environmental factors, including exposure to E&M Field. EPRI has also recently begun studies of cancer among electrical workers. Unlike previous studies, this research will include actual measurement of occupational E&M Field exposures. A large study of Canadian and French workers on high-voltage facilities is also just beginning. The approximate 1992 budget for the programs in the United States is approaching $11 million.

In conclusion, study results have not indicated a cause for immediate alarm. During the series of public meetings on this project, strong concerns were raised about the possible biologic effects of electromagnetic fields as related to the proposed plan or even the continuation of operation of the existing line. Although a substantial amount of research on this subject has been done and is continuing, the body of research on health effects is still preliminary and inconclusive. A growing number of studies suggest that under certain circumstances even relatively weak electric and magnetic fields can produce biologic changes. It is a widely held view that while the emerging evidence no longer allows the categoric assertion that there are no risks, there is no basis for asserting that there is a significant risk. In light of this possibility of a potential risk to human health, Western, as a responsible and concerned utility, can factor E&M Field avoidance strategies into its transmission design and construction activities if those strategies can be accomplished at modest cost and are compatible with other environmental concerns. However, because of the uncertainties surrounding the E&M Field issue at present, the expenditure of large sums of money, degradation of reliability and service, or greatly increased operating costs cannot be justified.

Therefore, the E&M Fields associated with the proposed transmission line project are not anticipated to cause significant adverse public health or biological effects nor adversely effect public safety. Should science establish a significant risk to public health as a result of E&M Field exposure, it is Western's expectation that the issue of E&M Field standards, avoidance strategies, evaluation procedures, etc., would be addressed in statue and implemented in regulations after a careful, structured public debate that weighs risk against cost. Western will continue to monitor and financially support research on the biological effects of E&M Field with the hope for an early resolution of the issue. Western will also participate in public education efforts to make certain that an evenhanded dissemination of information can be accomplished. Western continues to be committed to providing a safe and healthy environment for its employees and to provide safe, reliable, and economic electric energy to its customers and communities.

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Appendix D
Floodplains/Wetlands Assessment

Appendix D. Floodplains/Wetlands Assessment

This Floodplains/Wetlands Assessment addresses only the Proposed Action, Alternative B. The Proposed Action consists of constructing, replacing, or modifying 73 structures along the existing 31.5 mile Flatiron-Erie transmission line. Disturbance is not continuous along the ROW with this alternative, but is restricted to the vicinity of certain new or rebuilt structures.

In accordance with Executive Orders 11988 and 11990 and U.S. Department of Energy procedures, floodplains and wetlands were identified, mapped, and integrated into the planning and alternatives analysis process.

Floodplains, associated wetlands, and riparian habitat occur along the existing transmission line in association with an unnamed stream in Chimney Hollow, Little Thompson River, St. Vrain Creek, Left Hand Creek, Dry Creek, Boulder Creek, and Coal Creek. However, only the unnamed stream in Chimney Hollow, St. Vrain Creek, Boulder Creek, and Coal Creek would be affected by the project.

Potential wetlands are illustrated on the Biological Resources Map, Figure 4.4, in the Environmental Impact Statement. The potential wetlands map is based upon aerial photography and limited field reconnaissance. The wetlands mapping used to produce this floodplain/wetlands assessment, however, is based upon a field inventory of the locations where construction would take place in or adjacent to wetlands. It is therefore more precise.

The impacts of the Proposed Action on the floodplains, wetlands, and riparian habitat of the study area are described below.

D.1 CHIMNEY HOLLOW STREAM

A small ephemeral tributary to the Big Thompson River drains the Chimney Hollow area. The 100 year floodplain for this stream has not been mapped, but is likely confined close to the channel. A very small zone of riparian and potential wetlands vegetation occurs along the stream channel. It is characterized by plains cottonwood (Populus sargentii), peachleaf willow (Salix amygdaloides), sandbar willow (Salix exigua), and herbaceous grasses and forbs.

Two new structures would be placed along the stream in the area of the potential 100 year floodplain and in riparian and potential wetlands vegetation. These structures will not significantly affect the flow of storm water in the stream floodplain. Impacts to potential wetlands are insignificant and not regulated by the U.S. Army Corps of Engineers.

D.2 ST. VRAIN CREEK

The existing Flatiron-Erie transmission line traverses about 4,500 feet of the 100 year floodplain. Riparian vegetation occurs on both banks of the 150 foot long crossing of St. Vrain Creek in a zone 10 feet wide on the north bank and 25 feet wide on the south bank, but only that portion of the riparian habitat near the margin of the stream is a wetlands. The riparian habitat here consists of a few scattered plains cottonwoods with a grassy understory dominated by quackgrass (Agropyron repens). Sandbar willow thickets with an understory of reed canarygrass (Phalaris arundinacea) dominate the lowest floodplain while broadleaf cattail (Typha latifolia) stands occur in the shallow water zones. The sandbar willow and cattail stands are wetlands. The plains cottonwood forest, however, is not likely to meet the technical soils, hydrology, and vegetation criteria requirements of a wetlands.

Three existing structures located in the 100 year floodplain will be replaced with new structures in the same locations. None of these structures is located in wetlands. These changes will not significantly alter the flow of flood water across the 100 year floodplain.

D.3 BOULDER CREEK

The existing Flatiron-Erie transmission line crosses approximately 4,500 feet of the Boulder Creek floodplain. Boulder Creek has been channelized here and is about 20 feet below the surrounding landscape. At this location, the Boulder Creek floodplain is dominated by agricultural lands to the north and active sand and gravel operations and agricultural lands to the south. A narrow zone of riparian habitat occurs on both sides of the stream channel. On the north side, the zone is about 50 feet wide, whereas, on the south side, the zone is about 10 feet wide.

The riparian community here along Boulder Creek is probably not technically a wetlands. It is characterized by a rather open plains cottonwood stand with occasional peachleaf willow and elm (Ulmus pumila) trees. The understory is dominated by grasses and weedy forbs. Major grasses include sand dropseed (Distichlis spicata), and cheatgrass (Bromus tectorum). Conspicuous forbs include yarrow (Achillea lanulosa), prickly lettuce (Lactuca serriola), gumweed (Grindelia squarrosa), and musk thistle (Carduus nutans).

One new structure will be placed in the 100 year floodplain in riparian vegetation. Addition of this structure to the 100 year floodplain will not significantly alter the flow of water in the floodplain or cause adverse impacts to the riparian vegetation.

Just south of the crossing of the 100 year floodplain for Boulder Creek, a new structure will be placed on the edge of a small herbaceous wetlands. Impacts to the potential wetlands are insignificant and not regulated by the U.S. Army Corps of Engineers.

D.4 COAL CREEK

The existing Flatiron-Erie transmission line crosses 1,200 feet of the Coal Creek 100 year floodplain. At this location, Coal Creek is incised 10 feet and surrounded by agricultural land which extends to the edge of the stream channel. A few feet of riparian vegetation occurs on the banks of the stream and elements of a wetlands community occur at the margin of the stream.

The crossing area includes a few scattered plains cottonwoods amid a cover of grasses and weedy forbs. Common grasses include Canadian reedgrass (Elymus canadensis) and smooth brome (Bromus inermis). Forbs present include curly dock (Rumex crispus), kochia (Kochia scoparia), Russian thistle (Salsola kali), and dogbane (Apocynum cannabinum). This habitat is not technically a wetlands. The margins of the stream channel have sandbar willow and broadleaf cattail, a technical wetlands.

Two new structures will be placed in a portion of the 100 year floodplain that does not have wetlands vegetation. These new structures will not have wetlands vegetation. These new structures will not significantly alter the flow of storm water across the floodplain.

Appendix E
Biological Assessment

Appendix E. Biological Assessment

This Biological Assessment addresses only the Proposed Action, Alternative B. Disturbance is not continuous along the ROW with this alternative, but is restricted to the vicinity of certain new or rebuilt structures.

The existing Flatiron-Erie 115-kV transmission line is a single circuit wood H-frame line constructed in 1950-1951. In order to rectify local electrical system deficiencies and preserve the structural integrity of the line, Western proposes to uprate the line by adding 27 new structures, replacing or modifying 45 of the existing wood structures, and removing 11 structures.

Section 7(c) of the Endangered Species Act, as amended, requires federal agencies to determine if their proposed action "may affect" any federally listed threatened or endangered species. In response to a letter from Western Area Power Administration (Western) to the U.S. Fish & Wildlife Service (FWS) requesting a list of federally listed threatened and endangered species potentially present in the project area, the FWS identified the bald eagle (Haliaeetus leucocephalus), whooping crane (Grus americana), black-footed ferret (Mustela nigripes), and seven candidate species as potentially present in the study area. This assessment considers potential impacts resulting from the preferred alternative on the aforementioned species.

E.1 PROJECT DESCRIPTION

The transmission line upgrade area extends southeast from the Flatiron Substation through Longmont to the Erie Substation site, a distance of 31.5 miles. Within the right-of-way (ROW), certain land uses would be restricted, particularly the construction of buildings. Other uses, such as agriculture, could continue.

Construction of the project would be accomplished by small crews; the approximate work force at one time would be about 30. The project is scheduled to be in service by Spring of 1996. Routine maintenance activities would include periodic surveillance by helicopter and ground crews and tree trimming. Emergency repairs would also be required at times.

E.2 THREATENED & ENDANGERED SPECIES

E.2.1 BALD EAGLE (Haliaeetus leucocephalus)

The bald eagle is listed as an endangered species by the FWS (1987). Currently 18 pairs of bald eagles nest in Colorado, exceeding the states' recovery plan goals of 10. On the eastern slope, bald eagles nest at Barr Lake and along the Platte River. Although bald eagles have not nested in the project vicinity for many years, the species is of concern due to the regular occurrence of small numbers of winter residents, and spring and fall migrants along portions of the local river systems and around large prairie dog towns.

The level of wintering and transient bald eagle use has varied in and around the study area in recent years. This has been primarily due to drastic fluctuations in black-tailed prairie dog (Cynomys ludovicianus) colonies as bubonic plague spread through colonies along the Front Range. During the 1985/86 winter, up to 40 bald eagles were reported at a prairie dog town 4 miles west of Niwot (7 miles west of the proposed action). However, since the plague decimated that town, only a few transients were reported flying through the area during the 1986/87 and 1987/88 winters. This reduced winter prey base correspondingly reduced bald eagle numbers in the local area. Prairie dog distribution is again expanding in several towns within the study area and bald eagle use may increase correspondingly. The largest eagle concentration within the study area occurs in Dowe Flats, east of Rabbit Mountain, where up to a dozen eagles roost and hunt adjacent prairie dog towns. Bald eagles also occur occasionally near Carter Lake. Eagles also utilize other prairie dog towns within the study area. They also hunt wintering waterfowl along open creeks, waterbodies, and canals.

The three major components of bald eagle winter habitat are (1) hunting areas with prey base; (2) diurnal perches; and (3) communal roosts. Hunting areas generally consist of ice-free stretches of water and adjacent open terrain. Principal food items include fish, waterfowl, lagomorphs (rabbits and hares), large rodents, and carrion. Diurnal perches generally are not limiting, but they do affect distribution (Steenhof, 1978). Communal roosts are important areas for wintering bald eagles and often are used for several consecutive years. The roosts are used both at night and during periods of inclement weather. Perches and roosts generally are large trees, often with dead branches. The most frequently used trees within the study area are riparian cottonwoods or conifers.

A potentially significant, adverse impact of a transmission line on bald eagles is direct mortality from wire strikes, collision with towers, and electrocutions. The electrocution risk is low for transmission lines of 115 KV, (the voltage of the Flatiron-Erie line), because of the distance between conductors (Olendorff et al., 1986). The risk of wire strikes and tower collisions is greatest where a line crosses a flight route, such as a river, or is close to a communal roost. The problem with line proximity to roost sites arises because the roosts receive the greatest use during periods of poor visibility, such as at dusk and during storms. To reduce the risk of accidental electrocution of eagles resulting from connecting power lines, tower design should follow recommendations made in Raptor Research Foundation (1981). The project action will not change the risk to bald eagles of wire strikes or electrocution. A second type of potentially adverse impact is the risk that construction or maintenance activities too close to communal roosts could cause disturbance and/or abandonment.

The only communal roosts occur near the mouth of Dowe Flats where eagles use decadent and mature cottonwoods along irrigation ditches. The existing transmission line does not approach within 0.75 miles of the boundary of this roosting/ hunting area.

As noted, bald eagles are occasionally observed around Carter Lake Reservoir in late fall and early spring when the lake has open water and when migrating eagles and waterfowl are passing through the area. Observations of wintering eagles have also been reported around the reservoir. With the exception of a segment where the transmission line tangentially approaches within 0.25 mile of the southern end of the lake, the line parallels the lake, but is isolated from it by a 400 vertical foot hogback, Flatiron Mountain. The transmission line diagonally crosses a shallow valley at its closest approach to Carter Lake. This valley would appear to provide likely flight routes off the reservoir to areas to the south. There would be no increase in the risk of wire strikes or electrocution.

As discussed above, only two communal roosts occur near the line within the study area and the distance the line occurs from these areas minimizes the probability that construction or maintenance activities would adversely affect their use. Disturbance of diurnally roosting eagles by construction activities should not occur since suitable roost trees are infrequent along the proposed action.

The proposed action should not significantly affect the prey base, the availability of hunting habitat, or the availability of diurnal perches. Upgrading sections of access roads could temporarily and minutely reduce the area of local burrowing mammal colonies, a potential prey source; however, the level of anticipated upgrading and consequent habitat loss would, at most, only temporarily affect prey populations.

E.2.2 WHOOPING CRANE

The whooping crane is listed by the FWS (1987) as an endangered species and is one of the rarest of all North American species. Colorado has historically been out of the normal range of the species, except for stragglers during migration between breeding grounds in Canada and wintering grounds in Texas. Whooping cranes characteristically engage in low level flights between roost sites (primarily wetlands) and feeding areas (agricultural fields). Power lines transecting these habitats may increase the risk of bird collisions, resulting in injury and/or death. There have been a total of 4 verified stops for resting and feeding in northeastern Colorado, one in 1979, two in 1985, and one in 1986 (V. Sheppard, Colorado Division of Wildlife (CDOW); R. Drewien, FWS, personal communication). This area is approximately 200 miles east of the Gray's Lake flock's normal migration route (R. Drewien, FWS, personal communication). In September, 1979, a whooping crane was sighted at Sand Bar Reservoir, south of Mead and approximately 7 miles northeast of Longmont.

In the fall of 1985, two whooping cranes established temporary residence in Weld County, Colorado (the county east of Boulder and Larimer Counties) during their annual migration between Idaho and New Mexico. A 1986 sighting near Hudson (approximately 26 miles east-southeast of Longmont) was assumed to have been the same birds from 1985 (V. Sheppard, CDOW, personal communication).

The more frequent, recent appearances of whooping cranes in Colorado has resulted from an experimental program to aid the recovery of the species in which whooping crane eggs are "cross-fostered", i.e., put in the nests of greater sandhill cranes (Grus canadensis tabida) at Gray's Lake National Wildlife Refuge (NWR) in Idaho. The eggs are hatched and the chicks raised by the sandhill cranes. Young whooping cranes then migrate toward wintering grounds in southern New Mexico (Bosque del Apache NWR). The migration route includes a major rest stop at the Monte Vista National Wildlife Refuge in south-central Colorado and irregular minor stops along the way. Brief stops for resting and feeding probably account for the recent northeastern Colorado sighting in suitable habitat, such as small grain fields, irrigated meadows and reservoirs. None of the areas has yet been listed by the CDOW as critical or essential habitat, however.

Since 1965, eight whooping crane mortalities and three injuries resulting from power line collisions have been reported (Halvorson, 1984). Many of these collisions occurred with power lines that crossed agricultural lands. It is believed that many of the collisions occurred with overhead ground wire lines, which are thinner and less visible than the conductors.

The existing and proposed uprated alignment of the Flatiron-Erie transmission line crosses several linear wetlands corridors and agricultural lands dominated by irrigated and unirrigated pastures and irrigated haylands, including a few grain fields (wheat). Although the location, spatial distribution, and quality of these habitats is relatively suboptimal as stopover areas for cranes, one cannot dismiss their potential use by wayward migrants. The proposed, upgraded transmission line would not provide a greater risk of collision than the existing line. The proposed upgrading of the existing line should not jeopardize the existence of the whooping crane.

E.2.3 BLACK-FOOTED FERRET

Black-footed ferrets, listed as endangered by the FWS (1985) have historically been associated with the range of prairie dogs (Cynomys spp.) throughout the Great Plains, semi-arid grasslands, and mountain basins of North America (Hillman & Clark, 1980). Prairie dog towns are used by ferrets as a source of food and shelter (Hillman, 1968; Henderson et al., 1969; Linder et al, 1972). Changes in land use practices and poisoning programs over the last century have reduced prairie dogs to one-seven hundredth of their former distribution (K. Fagerstone, FWS, personal communication). As a result, all active prairie dog towns or complex of towns, large enough to support ferrets, are considered potential black-footed ferret habitat (Clark et al. 1983; FWS, 1986). The only known extant population, before ferrets were brought into captivity, was near Meeteetse, Wyoming; although there may still be unknown, remnant populations in parts of their historic range (Clark et al., 1983). In the fall of 1991, ferrets were re-introduced into Wyoming's Shirley Basin. The study area occurs within the general historic range of the black-footed ferret (Bissell, 1978); however, no black-footed ferret sighting have been confirmed in Colorado in recent years.

The proposed action, uprating of the existing transmission line along the existing ROW, only crosses two small isolated prairie dog towns northeast of Rabbit Mountain. Other unidentified towns may also occur within the corridor. Present prairie dog populations are especially dynamic in the study area, with bubonic plague spreading along the Front Range in recent years. Impacts associated with transmission line construction and maintenance on prairie dog towns would primarily be confined to short-term habitat loss as a result of access road use. At present, it appears unlikely that any prairie dog towns will be adversely affected by power line upgrading or activity along the existing corridor. Black-footed ferrets should, therefore, not be jeopardized by construction or operation of the power line. If construction activities associated with the proposal will disturb any active prairie dog towns, the FWS will be contacted to assess the need for black-footed ferret surveys.

E.2.4 AMERICAN PEREGRINE FALCON (Falco peregrinus)

The American peregrine falcon is listed as a breeding species in Latilongs 4, 11 and 12, but the given habitats for breeding birds are at higher elevations (6,000 - 9,000+) than what generally occurs within the study area (Colorado Bird Distribution Latilong Study, 1987). The only potential area that meets the breeding habitat type for this species is the cliffs at and near Carter Lake. No cliffs in the Carter Lake area will be disturbed by the proposed project.

In Latilong Block 5 (primarily Weld County), the American peregrine falcon is listed as a migrant species. Migrant falcons utilize a variety of habitat types, including grasslands, deciduous forests, shrublands and aquatic. Given its migrant status, the American peregrine falcon should not be adversely affected in the study area portion within Latilong 5.

E.2.5 ESKIMO CURLEW (Numenius borealis)

The Eskimo curlew has not been sighted in Colorado since 1965, and is also only known as a migrant species. Eskimo curlew breeding grounds are known to occur in Alaska and the Hudson Bay area in northern Canada. The Gulf Coast off Florida and Texas, and the Pacific Coast are known wintering locations.

It is unlikely that the proposed project would have any effect on this rare species.

E.2.6 DILUVIUM LADIES' TRESSES (Spiranthes diluvialis)

This plant is listed by the FWS as threatened. Diluvium ladies' tresses is a tall (20-50 cm) perennial forb with white or ivory flowers (Sheviak, 1984). This large orchid usually flowers the third to fourth week of July and continues flowering into October (Jennings, 1987). Diluvium ladyies' tresses reproduces by seed (Sheviak, 1984).

The habitat of Diluvium ladies' tresses is moist areas along meandering streams or old oxbows in both wooded areas and meadows (Jennings, 1987).

The major threats to populations of Diluvium ladies' tresses are cattle grazing and haying. This orchid, which is palatable to cattle, is often grazed by cattle as grazing pressure increases. Haying in moist meadows can destroy populations of this orchid often before seeds mature. Also the cessation of flood irrigation at existing populations is a threat to continuity (Jennings, 1990).

Diluvium ladies' tresses occur in Colorado, Utah, Arizona, and Nevada at approximately 11 different sites (Sheviak, 1984; Jennings, 1987). The Colorado sites include two populations in Jefferson County along Clear Creek west of Golden, one population south of Boulder along South Boulder Creek, and a historic site along the South Platte River, somewhere between Greeley and Brush (Sheviak, 1984; Jennings, 1987). A survey conducted in 1992 identified two plants at a previously unrecorded location on St. Vrain Creek west of Longmont (Western Resource Development, 1992). This site is approximately 2.5 miles west of the point where the proposed project crosses the St. Vrain.

The existing Flatiron-Erie transmission line crosses the floodplains of the unnamed ephemeral stream in Chimney Hollow, Little Thompson River, St. Vrain Creek, Left Hand Creek, Dry Creek, Boulder Creek, and Coal Creek. Wetlands, the potential habitat of Diluvium ladies' tresses, occur at these floodplain crossings but the only project actions that would affect these wetlands are two new structures in the unnamed ephemeral stream in Chimney Hollow and one in a small wetlands just south of the Boulder Creek 100 year floodplain and adjacent riparian vegetation. None of the floodplain crossings is known to contain populations of Diluvium ladies' tresses. However, a survey will be conducted at any potential habitat areas that might be disturbed by project activities following consultation with FWS.

E.3 CANDIDATE SPECIES

Limited site-specific information is available for any of the candidate species addressed below because no field surveys oriented towards these species have been conducted in the project area, and information obtained from resource agencies and other sources was often generic.

E.3.1 WHITE FACED IBIS (Plegadis chihi)

White-faced ibis are considered likely breeders in latilong block 4 (Fort Collins; latitude 40 - 41 degrees, longitude 105-106 degrees) by Colorado Field Ornithologists (1982). White-faced ibis nest in colonies, usually in a large stand of bulrushes or reeds, but they have also nested in heronries (Bent, 1926). They also migrate through the study area and are typically associated with mudflats and the littoral zone of ponds and lakes. At present, no site-specific information is available on the location of any colonies, or their occurrence near the existing line or elsewhere in the study area. White-faced ibis are present on the ponds and lakes in the Boulder area during migration. While the proposed action would closely approach several small lakes and ponds, there is no evidence of any ibis (or waterfowl) line strikes in the area and it is not expected that the upgraded line would increase this potential hazard.

E.3.2 FERRUGINOUS HAWKS (Buteo regalis)

Ferruginous hawks are most commonly associated with native or relatively undisturbed western plains, although they may use adjacent agricultural haylands during winter in the study area. Call (1978) considers this species to be the most adaptable of any raptor in the selection of nest sites, which range from ground nests to tree nests to a wide variety of manmade structures. Ferruginous hawks are considered nonbreeding residents in the Fort Collins latilong block (Colorado Field Ornithologists, 1982).

No nest sites have been identified in the transmission line corridor. Heavy winter ferruginous hawk use occurs locally in the study area focusing on prairie dog colonies. Transmission line upgrading should not affect the ferruginous hawk or its prey base.

E.3.3 WESTERN SNOWY PLOVER (Charadrius alexandrinus nivosus)

Western snowy plovers inhabit the Pacific coast inland to eastern Colorado. In interior North America, the species is associated with the shores of salt or alkaline lakes where it feeds on insects such as beetles and flies (Terres, 1980).

Snowy plovers are considered migrants in the Fort Collins latilong block, which encompasses the study area (Colorado Field Ornithologists, 1982). Because of habitat unsuitability and the paucity of observations documenting this species in the vicinity of the existing power line corridor, it is unlikely that transmission line upgrading and operation would adversely affect this species.

E.3.4 MOUNTAIN PLOVER (Charadrius montanus)

Mountain plovers are migrants in latilong block 4, probably because habitats in the block lack sizeable, suitable, short-grass prairie, such as the Pawnee Grasslands, where plovers breed in fairly large numbers. Indeed, that area, whose southwestern edge is located approximately 53 miles northeast of Longmont, is considered the "present stronghold of the species" (Graul, 1973). There is no evidence that mountain plovers breed in the study area or that line upgrading would adversely affect the species.

E.3.5 BLACK TERN (Chlidonias niger)

The Black Tern is listed as a Category 2 species by the USFWS. This species is known to breed near the study area north of Louisville (Latilong 4, 5, 12), but its abundance rating as a breeding species here is unusual (Colorado Bird Distribution Latilong Study, 1987). Breeding Black Terns utilize marsh habitat areas. Potential marsh habitat may be found along the various streams, lakes and reservoirs scattered across the study area.

South of the Louisville area (Latilong 11), the Black Tern is listed as a migrant species that ranges from unusual to fairly common in abundance. Migrant birds occur in marsh and open water (lakes and reservoirs) habitats.

Marsh and wetland areas have been avoided and no disturbances to wetland areas are anticipated. Therefore, the proposed project will have little or no impact on the Black Tern.

E.3.6 LOGGERHEAD SHRIKE (Lanius ludovicianus)

The Loggerhead Shrike is listed by the USFWS as a Category 2 species. It has been identified as a breeding species in Latilongs 4, 5, 11 and 12 (Colorado Bird Distribution Latilong Study, 1987). Their abundance status as breeding species is fairly common to common. Habitats associated within the study area include shortgrass-prairie, shrubland and riparian lowlands. Potential shortgrass-prairie areas are limited in the study area to undisturbed landscape areas in the Rabbit Mountain vicinity, stream corridors and scattered, noncultivated land. Shrubland areas would most likely occur in the Carter Lake to Rabbit Mountain vicinity and along stream corridors. Riparian lowland areas are scattered across the study area and associated with stream corridors, lakes and reservoir.

As migrants and wintering birds, they are also known to occur in other grassland areas, agricultural land and urban areas.

The proposed project may disturb a very small amount of the Loggerhead Shrike's habitat, but these areas will be revegetated with appropriate plant species to negate any adverse effects to this bird species.

3.E.7 BAIRD'S SPARROW (Ammodramus bairdii)

The Baird's Sparrow is rare and only a migrant species in Colorado (Colorado Bird Distribution Latilong Study, 1987). Grassland is the habitat associated with this bird species. Grasslands disturbed by construction of the proposed project will be revegetated with appropriate grass species. Due to the small amount of disturbance, mitigation measures, and the rare and migrant status of this bird species, the proposed project is unlikely to have any adverse effect on the Baird's Sparrow.

E.3.8 PREBLE'S JUMPING MOUSE (Zapus hudsonicus preblei)

Preble's jumping mouse is a subspecies of the meadow jumping mouse (Z. hudsonicus) and is considered by Krutzch (1954) to be a well-marked, isolated geographic race. This species is poorly understood in Colorado and known only from the western edge of the Colorado Piedmont, in the South Platte drainage southward to the Denver area (Armstrong, 1972). The study area lies on the western periphery and on the eastern flank of the known distribution. Preble's jumping mouse is poorly known throughout its distribution, as records in the state are marginal for the species, and Armstrong (1972) considers the population to be relict. Preferred habitats are moist lowlands, although irrigation may locally expand its distribution (Armstrong, 1972).

There are several records of the subspecies within the study area (Armstrong, 1972). Based on habitat preferences and the distribution of suitable habitats along the existing power line corridor, the most likely areas of occurrence would be along St. Vrain Creek, Left Hand Creek, Dry Creek, Boulder Creek, and Coal Creek, as well as any tributaries and adjacent irrigated areas. Because habitat destruction in riparian and other habitats would be minimal from power line upgrading, impacts to this species, if present, should be minimal and biologically insignificant.

E.3.9 SWIFT FOX (Vulpes velox velox)

The swift fox formerly occupied most of the Great Plains, from western Texas northward to Alberta (Armstrong, 1972). However, as the prairies were settled, the fox declined due to trapping, hunting, predator control, rodent control programs, and loss of native prairie (Bailey, 1926). More recently, Robinson (1953) suggested that species similar to the swift fox were vulnerable to "coyote getters" and to the poison "1080" used for coyote control. As a result, swift fox populations were severely depleted from the early 1800's until recently. Their numbers are now starting to rebound and they are apparently returning to their original range (Samuel and Nelson, 1982).

The southern half of the transmission line corridor lies within the former distribution of the swift fox, but approximately 40 miles west of what is considered to represent the present distribution of swift fox in Weld County (CDOW Wildlife Resource Information System (WRIS) data, 1979). However, even if present, it is unlikely that they would be adversely affected by transmission line upgrading, local prey base reductions, or other associated impacts. Construction access improvements would be limited to minor upgrading of existing accessways and would be very unlikely to measurably increase access by the public, including trappers.

E.3.10 PLAINS TOPMINNOW (Fundulus sciadicus)

The Plains Topminnow is a native fish of Colorado. Its distribution in Colorado includes Larimer, Weld and Boulder Counties. Populations of this fish are only found in isolated colonies in foothills streams and the lower mainstem of the South Platte River. Spawning for this species occurs in late spring and early summer. They require a specialized habitat of still, clear water where there is abundant filamentous growth (Colorado's Little Fish, 1985). Potential populations of the Plains Topminnow in the study area may occur along the Little Thompson River, St. Vrain River, Left Hand Creek, Dry Creek, Boulder Creek and Coal Creek. The project is not expected to disturb or affect any of these aquatic habitats. Therefore, the project should have no adverse impacts on the Plains Topminnow.

E.3.11 FRINGED-TAILED MYOTIS (Myotis thysanodes pahasapensis)

This bat species it is known to occur mostly in the foothills zone and lower mountain areas of Colorado (personal communication, Francie Pusateri, CDOW, 10/92). Considering the small amount of disturbance associated with the project, no adverse effects to this species are anticipated.

E.3.12 STEVEN'S TORTRICID MOTH (Decodes stevensi)

The Steven's Tortricid Moth is extremely rare in Colorado. It is known from several areas north of the study area, including the vicinity of Owl Canyon, Rist Canyon and the Brackenberry State Wildlife Area (Colorado Natural Heritage Program, 11/92). Given the above stated occurrence data, the proposed project is unlikely to have any impact to the Steven's Tortricid Moth.

E.3.13 COLORADO BUTTERFLY PLANT (Gaura neomexicana ssp. coloradensis)

This plant is listed by the FWS (1980) as Category 1, i.e., under review for protective status. The Colorado butterfly plant is a tall (up to 120 cm) biennial or short-lived perennial forb with white to reddish or pinkish petals (Lichvar, 1987; Clark et al., 1981; Raven, et al., 1972). The butterfly plant usually flowers in July, however, it may flower as late as September (Lichvar, 1987).

The habitat of the butterfly plant is humic soils of wet meadows in plains environments usually at elevations between 5,000 and 6,000 feet (FWS, 1978). Specifically, the plant is generally found in moist meadows in the transition zone between wet stream bottoms and drier uplands (USFWS & USBLM, 1980). Other plant species associated with this habitat include thistle (Cirsium flodmanii), Missouri iris (Iris missouriensis), Nuttall's sunflower (Helianthus nuttallii), black-eyed Susan (Rudbeckia hirta), and Kentucky bluegrass (Poa pratensis) (USFWS & USBLM, 1980).

The Colorado butterfly plant is apparently endemic to northeastern Colorado and southeastern Wyoming. Historical collections were from Laramie County, Wyoming to Douglas and Larimer Counties, Colorado (Wyoming Natural Heritage Program, 1983; USFWS, 1978). Today, there are two known populations in Larimer County, Colorado; one in Weld County, Colorado; and about twenty populations in Laramie County, Wyoming, in the vicinity of Cheyenne (Lichvar, 1987; Colorado Natural Areas Program, 1987; Nature Conservancy, 1986). A recent study by Popp (1983) concluded that the Colorado butterfly plant no longer occurs in Colorado.

Man-induced habitat modifications have resulted in impacts to native populations of the Colorado butterfly plant. Often the habitat of this plant is cut for native hay. The butterfly plant is a short-lived perennial and would not necessarily be killed by such activities. However, depending on the time of mowing, seed maturation could be prevented. Herbicide spraying for the control of Canada thistle (Cirsium arvense) and other noxious weeds common to wet meadows also often kills the broad leaved Colorado butterfly plant. Activities which either dry or excessively inundate moist meadows can adversely affect populations of the Colorado butterfly plant.

The transmission line crosses the floodplains of the unnamed ephemeral stream in Chimney Hollow, Little Thompson River, St. Vrain Creek, Left Hand Creek, Dry Creek, Boulder Creek, and Coal Creek. Wetlands, the potential habitat of the Colorado butterfly plant, occur at these floodplains crossings but the only project actions that would affect these wetlands are two new structures in the unnamed ephemeral stream in Chimney Hollow and one in a small wetlands south of the Boulder Creek 100 year floodplain and adjacent riparian vegetation. None of the floodplain crossings or the small wetlands south of Boulder Creek is known to contain populations of the Colorado butterfly plant.

E.3.14 BELL TWINPOD (Physaria bellii)

This plant is listed by the U.S. Fish and Wildlife Service as Category 2, under review for protective status (Colorado Natural Area Program, 1991). Bell twinpod, is a perennial with a rosette growth form and a perennial root stock. This low (5-13 cm) plant produces showy four-petaled yellow typical mustard flowers from mid-April into early June (Jennings, 1990).

The habitat of Bell twinpod is endemic to the limey shales and limestones of the Niobrara Formation in the plains near the foothills of Boulder, El Paso, Jefferson, and Larimer Counties, Colorado. Most populations occur on bare black shale, eroded limestone outcrops, roadcuts, or other disturbances where there is little competition (Jennings, 1990). Most frequently associated plants include skunkbrush (Rhus trilobata), ricegrass (Oryzopis spp.), and mountain mahogany (Cercocarpus montanus). Other common associates include one-sided penstemon (Penstemon secundiflorus), verbena (Verbena ambrosifolia), spike gilia (Ipomosis spicata), purple flowered ground cherry (Physalis lobata), copper mallow (Sphaeralcea coccinea), green violet (Hybanthus verticillatus), shortstyle onion (Allium brevistylum), prairie sunflower (Helianthus pumilis), caraway (Carum carvi), and prickly rose (Rosa acicularis) (Peterson & Harmon, 1981). The major threat to populations of Bell twinpod is urbanization of the habitat.

Bell twinpod occurs in about 18 known populations in Boulder County, 22 populations in Larimer County, two populations in Jefferson County, and one population in El Paso County, Colorado (Jennings, 1990). It is known to occur in six populations in the study area, including one population that is partly on the ROW of the existing Flatiron-Erie transmission line east of Rabbit Mountain. No project action is proposed within 1,000 feet of this population. Any increased vehicular use of the ROW by construction vehicles and equipment would use existing accessways. Therefore, any adverse effect on the population would be extremely unlikely.

E.3.15 ROCKY MOUNTAIN CINQUEFOIL (Potentilla effusa ssp. rupinicola)

This plant is listed by the USFWS as a Category 2 species. The habitat of the Rocky Mountain Cinquefoil is granitic soil and/or granite rock areas (personal communication, Janet Coles, Colorado Natural Areas Program, 10/92). Granite rock areas and granitic soils are generally not present within the study area, and it is not likely that this plant occurs either.

E.4 SUMMARY

The study area potentially contains three federally endangered wildlife species, eight candidate wildlife species, and three candidate plant species.

The federally endangered species include the bald eagle, whooping crane, and black-footed ferret. Bald eagles winter in the region, concentrating along streams and reservoirs and preying on prairie dogs. Any risk to bald eagles of line strikes or electrocution would not be increased by the project.

Whooping cranes migrate through Colorado in the fall and spring on the way between breeding in Canada and wintering habitat in Texas and characteristically stop briefly in Colorado to rest and feed. Whooping cranes feed in agricultural grain fields, irrigated meadows, and reservoirs. The quality of the nesting and feeding habitat in the study area is suboptimal as stopover areas. The proposed transmission line upgrade will not provide a greater risk of collision than the existing line.

Black-footed ferrets are potentially present in the larger prairie dog towns, the location of their major food source. However, no ferrets have been documented in Colorado in recent years. The proposed transmission line crosses two small isolated prairie dog towns. Potential impacts to these towns will be short term and minor. Impacts to black-footed ferrets would be avoided via consultation with the Fish & Wildlife Service (FWS) if any prairie dog towns would be impacted.

Five federal candidate avian species are potentially present in the study area.

White faced ibis nest in colonies in emergent vegetation of ponds and migrate through the area feeding in the littoral zones of ponds. No nesting colonies occur in the study area, but they are seasonally present in some of the ponds. Ferruginous hawks winter in the study area and feed on prairie dogs. Western snowy plovers are infrequent migrants that feed in alkaline lakes. Mountain plovers occur in large expanses of short grass prairie northeast of the study area, but not in the natural but hilly, highly agricultural or urban study area. Likewise, the long-billed curlew, also a species of native prairie, is an infrequent migrant in the study area. Potential impacts to these avian species would be considered low. Aquatic and wetlands habitat will be impacted minimally and only in the short term. The long term impact to native prairie will also be minimal.

Impacts to two federal candidate mammals, Preble's jumping mouse and the swift fox, will be low or non-existent. Historically, these two species were present in the study area, but today known populations are outside the study area. The Preble's jumping mouse is a species of moist lowlands and the swift fox occurs in the short grass prairie.

Three federal candidate plants are potentially present in the study area. The Colorado butterfly plant and Diluvium lady's tresses occur in wetlands and riparian habitat along streams. However, neither plant has been documented in the study area. Potential impacts to these two species is low due because wetlands and riparian habitat will be affected by the transmission line only minimally and in the short term.

Bell twinpod, a species of limy shales and limestone, occurs in six populations in the study area, including one population partially under the existing transmission line. However, this population will be avoided during construction activity.

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