3.0 Structure and Route Options

BEPC evaluated structure design and transmission line alignment options to identify those most appropriate for the Proposed Project and those that would minimize environmental impacts. The reader should note that while these BEPC-developed alignment options are described and evaluated in this EA, they do not constitute "alternatives" as defined by NEPA as they are not alternatives to Western's defined Federal action. They are discussed to demonstrate BEPC's reasoned process to develop their Proposed Project with full consideration of environmental resources and landowner preferences, in order to minimize impacts on both.

3.1 Structure Options

BEPC applied engineering, cost, and environmental analyses to evaluate various transmission line structure designs and materials. Structure design options included single-pole, H-frame, and lattice. Materials considered included steel (galvanized and self-weathering), wood (wood pole), and laminated wood. Factors considered included durability, cost of installation, cost and frequency of periodic maintenance, and potential environmental impacts.

BEPC selected single-pole structures based on comments from landowners. Single-pole structures were considered preferable over H-frame structures because they would greatly reduce potential conflicts with agricultural machinery operations, allow placing structures near property lines (thereby reducing impacts to any one property owner), and reduce the amount of land needed for any one structure. Non-tillable land between H-frame structure legs (approximately 60 square feet) also was eliminated through the use of single-pole structures.

3.2 Route Options

Land use and land ownership patterns within the Proposed Project area are defined by the Public Land Survey System, which resulted in Townships and Ranges comprised of one-mile square sections. In North Dakota, section lines have designated 66-foot-wide ROW centered on the section lines. Approximately 420 linear miles of public ROW within the Project area provided BEPC with considerable opportunities to access adjacent properties for transmission line construction. Potential routing constraints, such as residential structures, farmsteads, irrigated lands, wildlife management areas, recreational areas are relatively few and of low density. State-listed exclusion areas, such as designated local, State, and Federal historic and land use resources were avoided in their entirety. Other routing opportunities and constraints are largely contingent upon balancing individual landowner concerns and optimizing alignments from engineering and cost perspectives. Achieving a balance between landowner concerns and those related to engineering and cost fell largely on BEPC engineering and ROW acquisition staff and negotiations with local landowners. Routing adjustments made during negotiations with landowners included off-setting structures from fencelines to allow movement of crop sprayers and similar equipment. Off-setting structures from fencelines allows access around structures. Additional routing opportunities and constraints that are unique to the Project area, including sensitive environmental resources, are addressed in **table 3-1**.

BEPC's route selection criteria, the selection process, and land requirements for the Preferred Route and two transmission line Route Options, are described in the following sections. The remaining text provides the rationale for permanent and temporary land requirements for transmission line construction. Detailed affected environment information and impacts analyses are provided in chapter 4.0.

3.2.1 Routing Selection Criteria

BEPC assembled a multidisciplinary Project team including specialists in NEPA compliance, transmission line routing, PSC permitting, transmission line and systems engineering, ROW acquisition, and public involvement. Routing analyses were carried out to meet requirements of NEPA and the NDPSC. Major elements in BEPC's routing process include the identification and analysis of routing opportunities and constraints as described in the following subsections.

Table 3-1 Project-specific Routing Criteria

Routing Opportunities	Comments
Maximize use of existing linear features, such as roads, section lines, and mid-section lines.	Use of linear features generally reduces the amount of new disturbance needed for transmission line construction and maintenance. Routing near roads and trails can reduce the need for new access road construction. Routing along section lines generally avoids land severance. Use of mid-section lines can reduce visual impacts and impacts to agriculture.
Maximize co-location with existing or planned facilities.	Overall minimization of potential impacts. Minimize land use requirements. Maximize use of existing access roads and trails, when such actions would result in a reduction of impacts.
Maximize use of routes along (unoccupied) section line trails.	Use of existing trails along section lines (rather than developed roads along section lines) should minimize visual impacts to sensitive receptors and should facilitate access for construction and maintenance and minimize the need for new access roads.
With consent of landowners, route lines through remote rangeland areas.	Use of rangeland can provide opportunities to place the transmission line in relatively remote locations, which could provide opportunities to route cross-country with minimal impacts to agriculture and potentially minimal visual impacts to sensitive receptors. However, routing within rangeland could result in a higher potential for impacts to biological, cultural, and water resources. Such routing would be considered on a case-by-case basis and with the consent of landowners and consideration of potential environmental consequences.
Routing Constraints	**Comments**
Avoid population centers.	Overall avoidance/minimization of visual, land use, and construction/maintenance impacts.
Avoid proximity to airports and landing strips.	Apply Federal Aviation Administration airspace criteria when routing transmission lines to determine structure height vs. aircraft takeoff and approach requirements.
Avoid disruption to agricultural activities (crossing of cultivated fields, structure type selection).	To the extent possible, avoid crossing cultivated lands and splitting of parcels. Avoid proximity to irrigation systems. Route along existing section lines, to the extent practicable.
Minimize impacts to prime or unique farmland.	Apply reasonable methods to minimize direct or indirect use of prime or unique farmland.

Table 3-1 Project-specific Routing Criteria

Routing Constraints	Comments
Avoid land severance, when practicable.	Avoid splitting parcels that are under single ownership, unless an opportunity exists where such routing would be acceptable by the landowner and beneficial to the Project.
Avoid extreme topographic areas (i.e., buttes and badlands).	Avoid steep slopes and highly erodible soils. Construction on steep slopes can result in erosion problems, engineering and construction difficulties, and visual impacts.
Avoid designated or registered national: parks, memorial parks, historic sites and landmarks; monuments; and wilderness areas.	These are exclusion areas, as mandated by the NDPSC.
Avoid designated or registered State: parks, historic sites; monuments; historical markers; archaeological sites; and nature preserves.	These are exclusion areas, as mandated by the NDPSC.
Avoid county parks and recreational areas; municipal parks; and parks owned or administered by other governmental subdivisions.	These are exclusion areas, as mandated by the NDPSC.
Avoid areas that are critical to the life stages of threatened or endangered animal or plant species.	These are exclusion areas, as mandated by the NDPSC.
Avoid areas where animal or plant species that are unique or rare to the State would be irreversibly damaged.	These are exclusion areas, as mandated by the NDPSC.
Avoid designated or registered national: historic districts; wildlife areas; wild, scenic, or recreational rivers; wildlife refuges; and grasslands.	These are avoidance areas, as mandated by the NDPSC.
Avoid designated or registered State: wild, scenic, or recreational rivers; game refuges; game management areas; management areas; forests; forest management lands; and grasslands.	These are avoidance areas, as mandated by the NDPSC.
Avoid historic resources that are not specifically designated as exclusion or avoidance areas.	These are avoidance areas, as mandated by the NDPSC.
Avoid areas that are geologically unstable.	These are avoidance areas, as mandated by the NDPSC.
Avoid locations closer than 500 feet from houses, community centers, schools, daycare facilities, and healthcare facilities. Avoid farmsteads (minimum of 500 feet from inhabited rural structures).	These are avoidance areas, as mandated by the NDPSC. Overall avoidance or reduction of visual, land use, and construction/maintenance impacts.
Avoid reservoirs and municipal water supplies.	These are avoidance areas, as mandated by the NDPSC.
Avoid water sources for organized rural water districts.	These are avoidance areas, as mandated by the NDPSC.

Table 3-1 Project-specific Routing Criteria

Routing Constraints	Comments
Avoid irrigated land.	These are avoidance areas, as mandated by the NDPSC. Avoid induced current potential within linear facilities.
Avoid areas of recreational significance that are not designated as exclusion areas.	These are avoidance areas, as mandated by the NDPSC.
Avoid areas that have been designated as "critical habitat" under the ESA.	Minimize impacts on listed species.
Maximize structure set-backs at road crossings, to the extent practicable.	Minimize visual impacts.
Maintain uniformity of structure types (design and materials), to the extent practicable.	Minimize visual impacts.
Avoid and/or span wetlands, streams, drainages, and rivers.	Avoid and/or reduce impacts to biological and hydrological resources from line and access road construction.
Avoid flood prone areas.	Avoid impacting floodplain function. Also, avoid flood damage to power transmission facilities from flooding.
Perpendicular crossings of rivers, streams, and drainages.	Avoid and/or reduce impacts to biological and hydrological resources from line and access road construction.
Use temporary culverts to allow access, when necessary.	Reduce potential impacts to drainage patterns.
Other Considerations	**Comments**
Consider local and regional land use plans.	Minimize or avoid conflict with land use plans, goals, and objectives.
Minimize overall transmission line lengths.	Cost and maintenance considerations.
Minimize number of angle structures.	Cost and maintenance considerations.
Minimize number of transmission line crossings.	Cost, maintenance, and reliability considerations.
Avoid paralleling major transmission lines closer than 2,000 feet.	Reliability consideration. Western's criteria, designed to reduce the potential for single event catastrophic power outages.

3.2.1.1 Routing Opportunities

Routing opportunities were identified within Project area. Linear features provide opportunities that can be paralleled, such as roads, trails, and section lines. The use of linear features typically minimizes temporary and permanent impacts associated with access needed for construction and periodic maintenance. Using local roads and trails reduces the need for new road or trail construction and, therefore, minimizes potential impacts to currently undisturbed land. Although paralleling existing transmission lines provides routing opportunities, they were avoided due to North American Electric Reliability Council requirements for system reliability. For example, adverse weather conditions (i.e., tornado, high winds) that could affect an existing transmission line also could affect a parallel line, resulting in the loss of two major electrical supply lines at one or more locations during a single event.

BEPC considered existing trails (rather than improved roads) along section lines to be features that were preferable for paralleling. Section line centerlines are within a 66-foot-wide (33 feet from each edge) public ROW. Single-pole structures could be placed along private property lines and at the edge of the public ROW by using short spur temporary access extending from the trail to the structure site. Benefits of single-pole structures (over H-frame structures) are identified in section 2.1. If spur roads were to be used to gain access to structure locations, each spur road would temporarily occupy 0.009 acre, mostly within the public ROW. BEPC also considered paralleling section line trails to be preferable over paralleling local improved roads and highways because residential structures are generally located along well-defined (all weather) local roads and highways. Visual impacts to local motorists and landowners also would be minimized by locating transmission lines adjacent to trails (unimproved roads) because these areas are infrequently visited by area residents and even less frequently by non residents.

Mid-section lines also were considered to be a possible routing opportunity by BEPC because they often differentiate property ownership, particularly within areas where properties are sold in 160-acre (quarter-section) tracts. Difficulties associated with the use of mid-section lines include relatively high potential for interference with agricultural activities (i.e., cropland cultivation) and separation of property parcels. Construction along mid-section lines could result in separation of parcels within large tracts (e.g., 640 acres) that are under single ownership. However, in some cases mid-section alignments were preferable as they tend to avoid farmsteads and residences that are largely located on section line roads.

3.2.1.2 Routing Constraints

The NDPSC specifies routing exclusion and avoidance areas that directly relate to routing constraints. BEPC also routinely identifies and implements Project-specific mitigation measures to avoid and/or minimize environmental impacts, mitigate impacts that cannot be fully avoided, minimize construction costs, and benefit system reliability.

Project-specific routing criteria that BEPC applied to the Williston to Tioga Transmission Line Project are summarized in **table 3-1** (section 3.2).

3.2.2 Route Selection Process

BEPC initially identified approximately 23 transmission line segments within the area between Williston Substation and Tioga Substation and presented them at the public scoping meetings in Williston and Tioga. Two transmission line alignment options (designated as Route Options A and B) were selected by BEPC from combinations of the 23 line segments that were presented during public scoping. A 60.7-mile-long alignment was subsequently identified by BEPC engineers and lands specialists that responded to comments received during public scoping. The 61.1-mile-long alignment was designated as Route Option C and is BEPC's preferred alignment.

All three Route Options are similar in length and extend northeast from Williston Substation approximately 24 miles before turning to the east. Route Options A and B extend north and east along local roads before reaching Tioga Substation. Route Option C (Preferred Option) parallels U.S. Highway 2 and turns to the north, near Tioga Substation. Transmission line Route Options A, B, and C are shown on **figures 3-1, 3-2**, and **3-3**, respectively. Detailed routing performed by BEPC's engineers and ROW agents is provided in **appendix C**.

Permanent land requirements for each Route Option are nominal and contingent upon structure numbers. Temporary land requirements are contingent upon structure work site numbers, access road requirements, pulling and tensioning site numbers, and splicing site requirements. Temporary and permanent land requirements for each Route Option are shown in **table 3-2**.

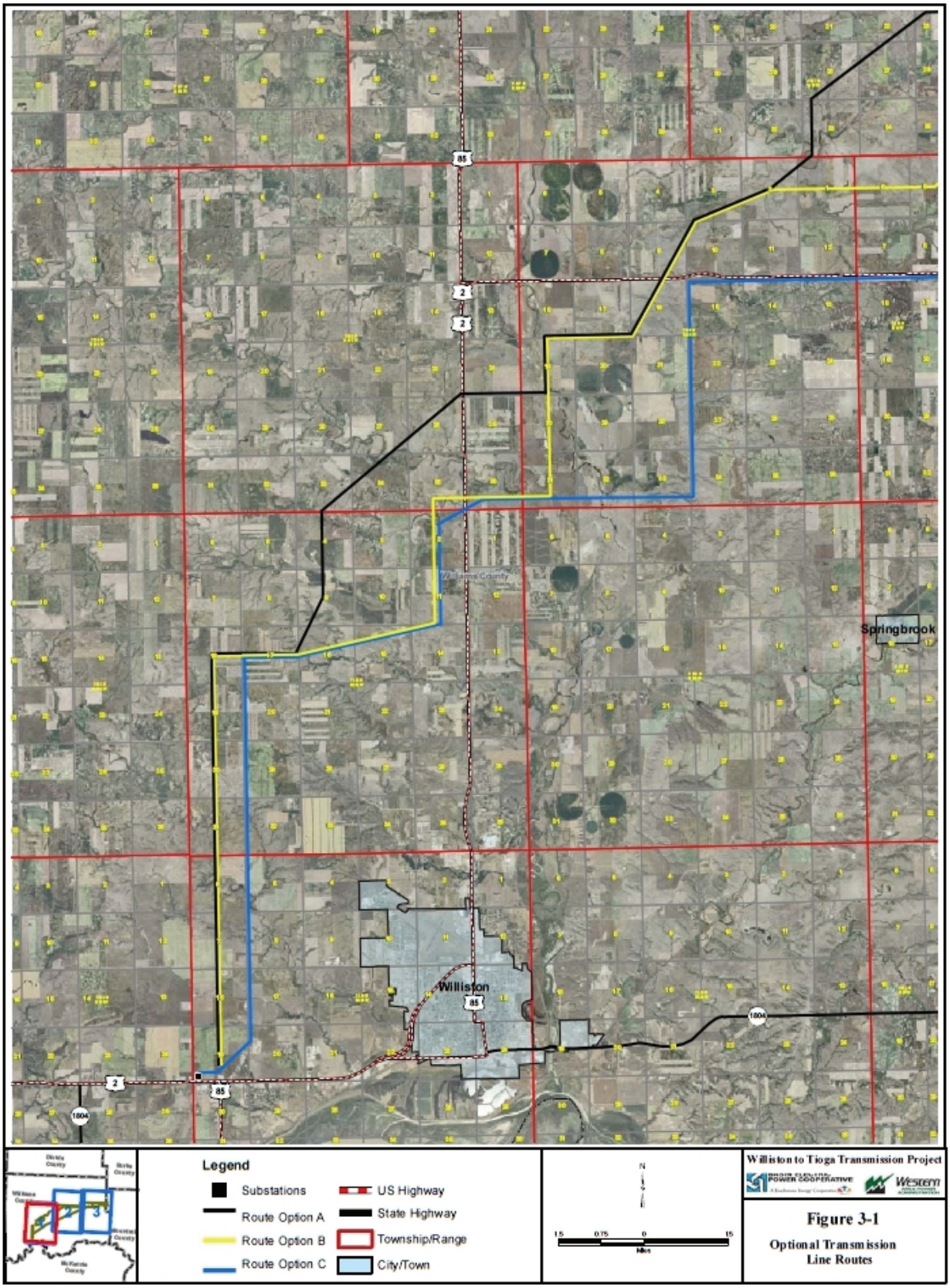

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Figure 3-1 Optical Transmission Line Routes

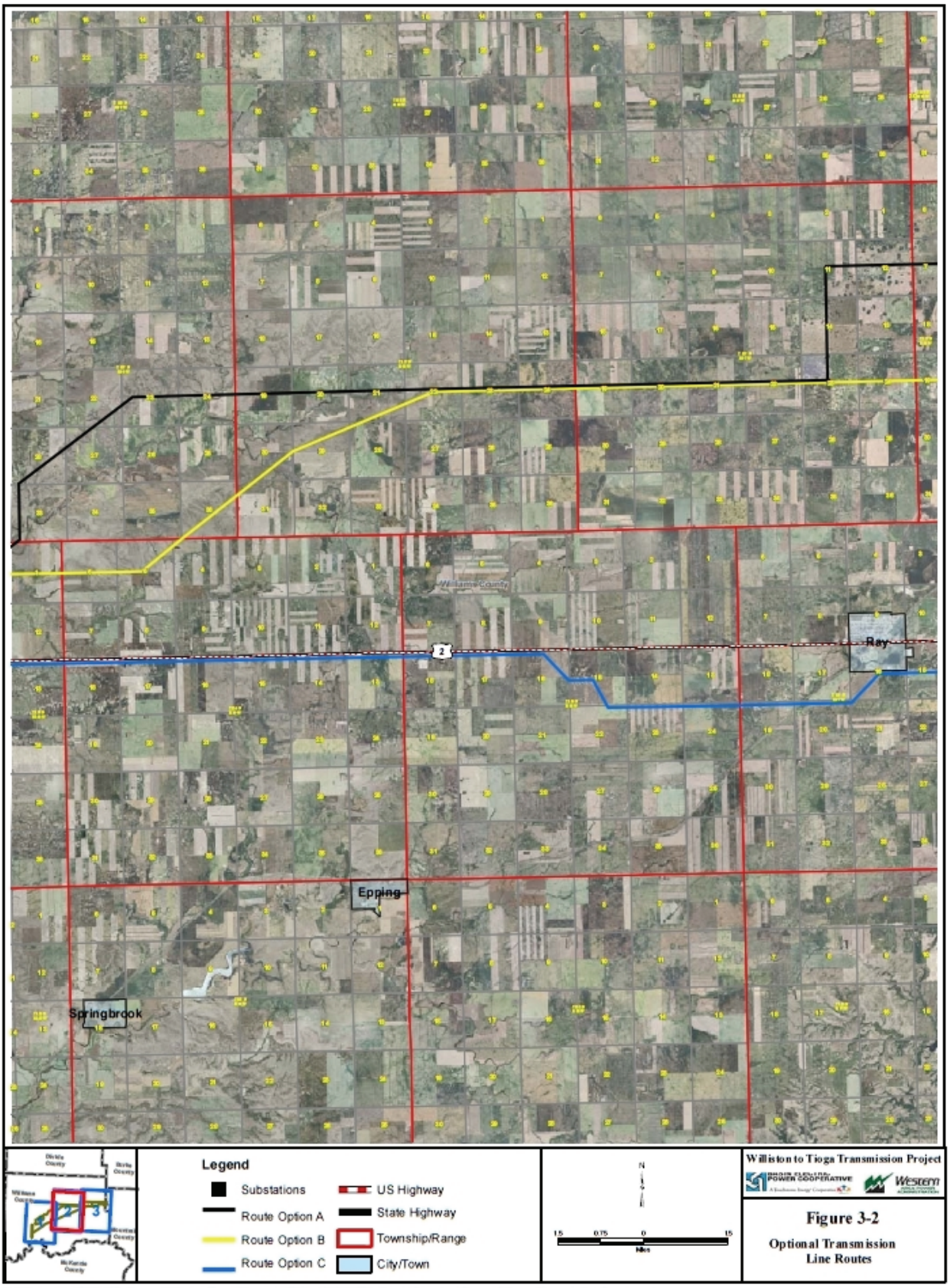

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Figure 3-2 Optical Transmission Line Routes

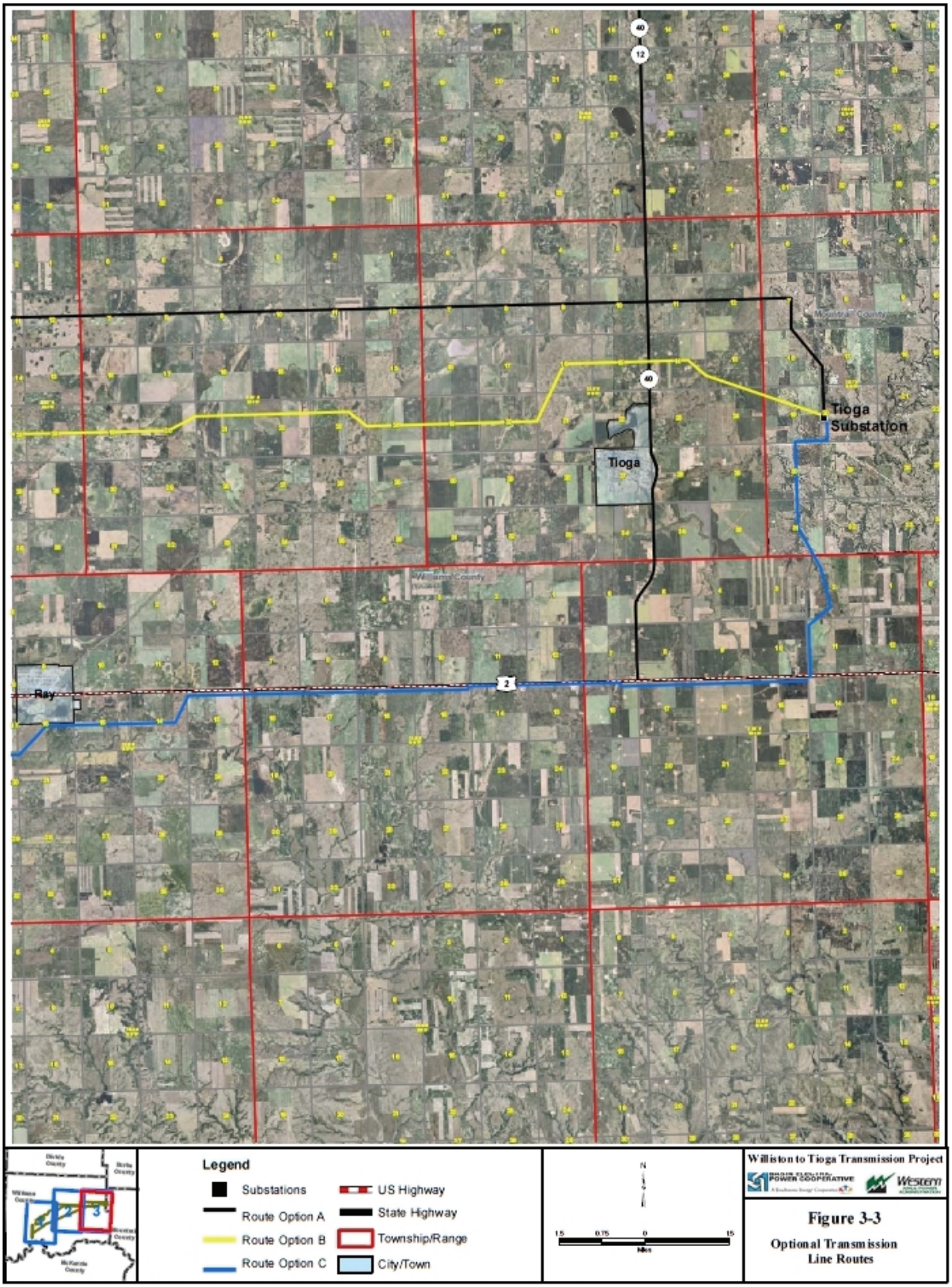

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Figure 3-3 Optical Transmission Line Routes

3.2.3 Permanent Transmission Line Land Requirements

Permanent land disturbance has been estimated for self-supporting tangent structures, self-supporting dead-end structures, and self-supporting turning structures. Each tangent structure would require directly imbedding one 3-foot-diameter pole at each structure location, thus occupying a total of 7.1 square feet per structure. Turning structures and dead-end structures would be larger, with a 5-foot-diameter, thus each occupying approximately 19.6 square feet. Approximately 50 turning and dead-end structures would be required for the transmission line. Tangent, dead-end, and angle structures would be self-supporting, and would not require guy wires. Permanent transmission line land requirement is calculated to be less than 0.2 acre.

3.2.4 Temporary Transmission Line Land Requirements

A 100-foot x 125-foot (12,500 square feet) temporary work site would be located at each structure location and within the ROW. The area would be graded, if required, to ensure safe movement and operation of heavy equipment. Route Options A, B, and C would require approximately 104 to 115 acres for structure installation, as shown in **table 3-2**. Although access to structure work sites that are adjacent to section lines can be accessed (in many cases) by spur roads, BEPC made an assumption that a 12-foot-wide trail would be used between structure work site locations within the ROW. Assuming that the trail would extend approximately 750 feet between structures, it would temporarily impact approximately 75 to 83 acres, as shown in **table 3-2**.

Pulling and tensioning sites and splicing sites would result in temporary disturbance to lands within and outside of the ROW. Pulling and tensioning areas would temporarily disturb a total of 75,000 square feet (1.7 acres) at each angle structure location. Approximately 26 to 32 pulling and tensioning sites would be needed at angle structure locations, totaling approximately 45 to 55 acres. The pulling and tensioning sites would partially extend beyond the designated ROW. The landowner would be compensated for disturbance of land outside the ROW. Additional areas would be needed along long straight-line expanses of tangent structures. Approximately 10 to 16 pulling and tensioning sites would be required along stretches of tangent structures. In this case each pulling and tensioning site would occupy approximately 37,500 square feet entirely within the ROW. Pulling and tensioning in areas of tangent structures would result in temporary impacts to approximately 9.5 to 14 acres within the designated ROW.

Splicing sites, measuring approximately 12,500 square feet (0.3 acre), also would be required at approximately 10,000-foot-increments within the transmission line ROW. Approximately 29 to 32 splicing sites would be required for construction, resulting in temporary impacts to eight to nine ROW acres; however, many pulling and tensioning sites also are likely to serve as splicing sites. The conceptual configuration of temporary work sites, 12-foot-wide access trail, structure locations, pulling and tensioning sites, and splicing sites is shown on **figure 3-4**. BEPC would site temporary laydown areas at three locations of approximately 15 acres each on previously disturbed land. Site locations are within one mile of the Proposed Project, as described in section 2.3.2.

BEPC required approximately 40 borings for geotechnical analyses. Each boring temporarily affected as much as 400 square feet within the proposed ROW and at designated structure sites. The geotechnical surveys were conducted during low precipitation conditions during the late fall through early spring, which minimized impacts to the soils and crops. An Interim Action Determination was approved by Western on June 8, 2009, for geotechnical boring

Estimated temporary and permanent land requirements identified in **table 3-2** were used as the basis for calculating temporary and permanent acreage impacts to land uses, prime and unique farmland and farmland of statewide importance, vegetation types, and wetlands. Linear distance data developed through routing were converted to estimate acreage impacts. As noted in **table 3-2**, temporary impacts associated with Route Option A would affect approximately 253.8 acres. Temporary impacts associated with Route Options B and C would affect approximately 242.6 and 272.7 acres, respectively. Permanent impacts would be similar among the three Route Options essentially limited to areas occupied by the single-pole structure bases.

Table 3-2 Temporary and Permanent Land Requirements for Route Options A, B, and C

	Transmission Line Optional Routes		
	A	**B**	**C (Preferred)**
Total Length (miles)	57.2	55.0	61.1
Total Number of single-pole Structures[1]	378	363	403
Temporary Land Requirements			
Structure Pads (acres)[2]	108.5	104.2	115.6
Access Road within ROW (acres)[3]	78.1	75.0	83.3
Pulling & Tensioning Sites at Angle Structures (number)[4]	26	27	32
Pulling & Tensioning Sites at Angle Structures (acres)[5]	44.8	46.5	55.1
Pulling & Tensioning Sites along Tangent Locations (number)[6]	16	10	11
Pulling & Tensioning Sites along Tangent Locations (acres)[7]	13.8	8.6	9.5
Splicing Site Locations (number)[8]	30	29	32
Splicing Sites (acres)[9]	8.6	8.3	9.2
Total Temporary Disturbed Area (acres)	253.8	242.6	272.7
Permanent Land Requirements			
Permanent Land Requirements for Structures (acres)[10]	<0.2	<0.2	<0.2
Additional Temporary Land Requirements			
Three material staging sites	approximately 15 acres each		
40 geotechnical boring sites (within ROW)	approximately 400 square feet each[11]		

1 Approximate number, based on an average 800-foot spacing.
2 Number of structures x 100 x 125 feet (12,500 square feet).
3 750 linear feet between structure sites, number of structures, 12-foot-wide access trail.
4 Estimated number, based on number of angle structures.
5 Angle point locations x 125 feet x 300 feet (37,500 square feet) x two directions (75,000 square feet).
6 Estimated number along areas with tangent structures.
7 Tangent structure locations x 125 feet x 300 feet (37,500 square feet).
8 10,000-foot spacing between splicing sites.
9 Splicing site locations x 125 feet x 100 feet (12,500 square feet).
10 Number of structures, three-foot-diameter single-pole structure.
11 Temporary disturbance areas previously accounted for in temporary disturbance for angle structures.

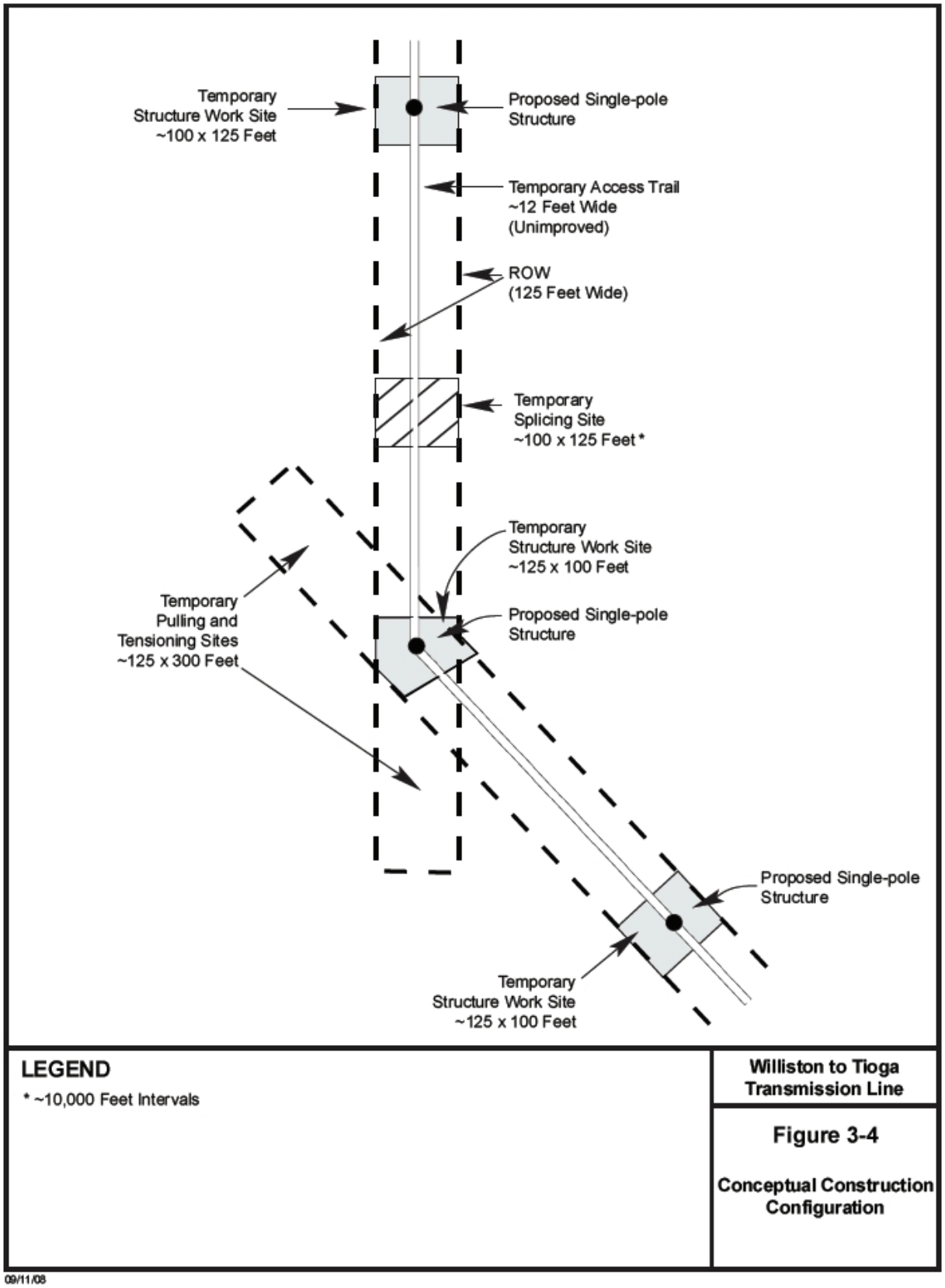

Figure 3-4 Conceptual Construction Configuration