Review of Options for Crossing the Narraguagus and Machias Rivers

Northeast Reliability Interconnect 345 kV Transmission Line

Prepared for:
Bangor Hydro-Electric Company
Bangor, Maine

Prepared by:
Commonwealth Associates, Inc.
Jackson, Michigan

January 12, 2005

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Prepared by:

John Guidinger
Robert Uddin, PE
Conrad Olfier, PE
Richard Collins, PE

At the offices of:
Commonwealth Associates, Inc.
Jackson, Michigan

Approved by:

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I. INTRODUCTION

This report examines the feasibility of installing an underground crossing or a specially located overhead crossing at two rivers on the proposed 84-mile 345 kV transmission line to be built between Orrington, Maine, and a point on the Canadian border near Woodland, Maine. The two rivers are the Narraguagus River and the Machias River, both of which are designated as Outstanding River Segments by the State of Maine and used by backcountry canoeists. Undergrounding a short segment of the proposed overhead line at the river crossing would remove the overhead conductors from view by canoeists and other river users. Another alternative would be to try to locate the overhead crossing so that the visibility of the line to river users would be reduced. This report investigates these options.

1. DESCRIPTION OF THE CROSSING AREAS

The location of the proposed crossing by the transmission line of the Narraguagus River is in Hancock County about 43 line miles east of the Orrington Substation. Depending on the exact alignment chosen for the crossing, the river is about 40 to 50 feet wide at the crossing location (Figure 1). The surrounding area is second-growth harvested forest land owned by International Paper Company. Stud Mill Road, a private logging road owned by the paper company, crosses the river on a bridge about 60 to 180 feet south of the proposed transmission line crossing. The Maritimes and Northeast Pipeline, a buried 24-inch natural gas pipeline, crosses the river about 60 feet south of the road bridge.

The transmission line crossing of the Machias River would be in Washington County about 57 line miles east of the Orrington Substation. Depending on the exact alignment chosen for this crossing, the crossing point would be between 250 and 650 feet north of the Stud Mill Road bridge and about 300 to 600 feet north of the north shore of First Machias Lake (Figure 2). The river varies from about 50 to 150 feet wide in this area. The surrounding land supports second-growth forest land owned by International Paper Company. The buried Maritimes and Northeast Pipeline crosses the river about 120 feet north of the road bridge.

Ownership of a corridor along the Machias River was acquired in fee by the State of Maine in 2004 from International Paper under Phase I of the Machias River Project. Acquisition of the river corridor allows the state to preserve the existing wilderness character of the river, protect important Atlantic salmon habitat, and preserve other environmental resources along the river. Along the north side of Stud Mill Road, the corridor includes the river bottom and land extending about 600 feet west from the west river bank and land extending about 1,800 feet east of the east river bank. International Paper retained a 1,000-foot-wide easement across the river for utility crossings along Stud Mill Road. Approximately 900 feet of this width is on the north side of the road. The pipeline and the proposed transmission line crossing are within the retained utility easement crossing area north of the road.

2. EHV UNDERGROUND CONSIDERATIONS

Extent of Existing Underground 345 kV Lines

Extra-high-voltage (EHV) transmission lines are often considered for undergrounding, but very few are actually placed underground. This is due to the extremely high cost, the inherent possibility of heat-induced cable failures, the difficulty of repairing failures and the long outages required, and the

limited experience with EHV underground solid dielectric cables in the United States. EHV 345 kV lines are installed underground only when absolutely necessary and then for only short distances. Typically, this is in situations where space is severely limited (such as in dense urban areas), where an overhead line would interfere with air navigation near airports, where wide and deep water bodies must be crossed, or where visual impacts would occur to significant natural or historic viewsheds. In New York State, 345 kV underground lines pass under the streets of Manhattan to deliver electrical power to some of the larger substations. In this situation the many tall buildings would interfere with overhead lines. A submarine 345 kV crossing of the Hudson River exists near Newburgh, New York. An overhead crossing of the river, which is 3,600 feet wide at the crossing location, would have been very costly and would have degraded the significant scenic aesthetics of the Hudson River Valley to thousands of residents and travelers.

Heat Dissipation Requirements

Energized transmission line conductors generate heat, which for overhead lines is dissipated to the surrounding atmosphere. When the conductors are placed underground, the heat must be dissipated through the casing pipes into the adjacent soil. The heat then rises through the soil in a fan-shaped pattern above the cable to the soil surface, where it enters the atmosphere. Failure to provide for the proper dissipation of heat can damage the conductor and can eventually cause a failure of the circuit.

Designing a reliable underground transmission line requires a proper analysis of the heat dissipation properties of the surrounding soil. The analysis begins with obtaining soil borings along the route chosen for the underground line and making field and laboratory tests to asses the thermal properties of the soil at varying levels of soil moisture content. Other design work involves identifying the electrical characteristics of the transmission line and the load to be served, and selection of the proper cable type, duct, casing pipe, pipe coating, burial depth, method of excavation, and backfill materials.

The amount of heat produced by the cables depends on the current (expressed as amperage) that the conductor is carrying and the resistance of the conductor and dielectric characteristics of the cable insulation. The amperage of most transmission lines will vary on a daily and seasonal basis as the demand for power rises and falls to satisfy the needs of human activities in residential, agricultural, commercial, and industrial settings. The amount of heat generated by the conductors will likewise vary concurrently on a daily and seasonal basis. Under normal operating conditions, conductor temperatures will generally be about 185 degrees Fahrenheit for pipe-type cable systems and about 195 degrees for solid dielectric cable systems. The estimated temperature of the exterior surface of the steel casing pipe (in which pipe-type cables are placed), or the upper surface of the concrete duct bank (in which solid dielectric cables are placed) will be about 130 degrees Fahrenheit under these operating conditions.

The heat will naturally rise upward through the soil to the soil surface. Heat from a cable under a river will rise up into the saturated soils below the river and into the river water and probably, in part, into the atmosphere. As the heat migrates upward away from the heat source into a larger volume of soil it is dissipated and temperatures are reduced.

To avoid damage to the cable, the soil above the underground line must remain capable of transferring heat to the atmosphere. Therefore the cable will always be designed to minimize heating of the covering soil. This minimization of heating will be required whether the soil has been backfilled after the cable has been installed by trenching, or where the soil was not disturbed at all because the cable was installed by directional drilling. Because heating is minimized, significant detrimental changes should not occur to surface soil temperatures, soil moisture content, winter snow

cover, river water temperatures, etc. Likewise, there should be little temperature-induced effects to the vegetation growing above the cable or to aquatic river habitats.

Principal 345 kV Underground Technologies

High-Pressure Fluid-Filled Pipe-Type Cable Systems

The oldest and most reliable technology for EHV underground applications is high-pressure fluid-filled (HPFF) pipe-type cable. Pipe-type cable systems place three paper-insulated conductor cables (three conductors are required for each three-phase circuit) in a steel pipe, which, for 345 kV, would typically be about 10 inches in diameter (Figure 3). The pipe is filled with an oil-based insulating fluid, such as synthetic oil, and pressurized to maintain insulation integrity. For longer lines, pulling and access manholes are required about every 2,000 to 3,000 feet along the line. Due to a significant bending restriction on the cables, long-radius elbows are required to accommodate bends and offsets in the line.

The HPFF pipe-type system may be installed by laying the pipe in a trench or by pulling it through a bored hole. To match the capacity of the overhead line, two sets of parallel conductors are installed in the underground segment. This means that two sets of three conductors would be installed instead of one set of three conductors. In undergrounding 345 kV lines, the conductor sets are separated about 10 to 20 feet apart to help dissipate the heat and minimize the effect of one set of conductors on the other. A small-diameter PVC pipe is normally placed alongside one of the steel pipes to carry the transmission system's monitoring communication line through the underground segment.

The benefits of HPFF pipe-type cable technology are:

- A smaller diameter cable and casing pipe can be used than for solid dielectric systems
- The technology is well proven with many HPFF cables operating for more than 50 years

The negatives of HPFF pipe-type cable technology are:

- The pipe requires a cathodic protection system to prevent corrosion damage
- The cathodic system requires regular maintenance
- A dielectric fluid (a synthetic oil) and pressurizing equipment must be employed
- The pressurization equipment requires regular maintenance
- A reliable low-voltage power source is required for the pressurizing pumps
- The dielectric fluid may cause environmental impacts in the event of a leak (although leaks are rare)
- Two trenches or two boring holes are needed.

Solid Dielectric Cable Systems

Solid dielectric cable systems are based on a newer technology that has become widely used for underground transmission systems up to 230 kV in the United States. For higher voltage 345 kV and other EHV transmission systems, solid dielectric cables have been installed on a very limited basis. Solid dielectric cables are heavily insulated and placed individually in plastic PVC pipes, normally about 6 inches in diameter. The individual PVC pipes are grouped together in a duct bank formed by pouring concrete around the pipes (Figure 4). Normally, additional spare PVC pipes are included in the duct bank. One spare pipe will contain the communications line.

For trenching construction, the concrete-encased duct bank is constructed in the bottom of a trench about 3 feet wide and normally about 5 to 6 feet deep. The depth of the trench is set so that the top of the duct bank is about 3 feet below grade. For directional boring construction, the PVC ducts are pulled into the open bore or are placed in a large polyethylene pipe, typically about 30 inches in diameter. The space between the PVC pipes inside the large pipe is typically flooded with water or filled with concrete to enhance heat transfer properties. As with all underground cable systems, longer lines require pulling and access manholes about every 2,000 to 3,000 feet along the line and the cables have very limited bending radii.

Also similar to the pipe-type system, two sets of parallel conductors will be required for the underground segment. However, unlike the pipe-type system, the two sets of three solid dielectric conductors may be placed in PVC pipes inside the same duct bank, and the need for two trenches or borings is eliminated.

The benefits of dielectric cable systems compared to pipe-type cable systems are:

- The cable requires little maintenance.
- There is no fluid pressurizing equipment to maintain.
- There is no need for low-voltage power to operate pressurizing equipment.
- There is no insulating fluid to leak.
- Only a single trench or bore is needed.
- Because steel pipes are not used, there is no need for cathodic protection equipment.

The negatives of solid dielectric cable systems are:

- There is no long-term operating experience at 345 kV.
- The estimated lifespan of the cable is lower, perhaps only 30 years.
- The termination and cable splicing technology at 345 kV is not as advanced and could cause a reliability problem.

Underground Construction Methods

There are two basic methods of installing underground transmission lines: horizontal directional drilling and open cut trenching.

Horizontal Directional Drilling

The horizontal directional drilling method utilizes a shaft to force a slurry jetting device or to power a drilling device to produce a small diameter pilot hole along a carefully controlled route to the desired destination point. A hole-opener drilling device or a reaming plug is then pulled back through the hole to enlarge it to the desired diameter. The cuttings are removed by pumping a drilling fluid through the hollow shaft. The fluid flows back through the completed hole, carrying the cuttings out of the hole into a slurry catchment pond. The geologic materials through which the bore is passing must be dense enough to maintain the drilling fluid under enough pressure to force it to flow back through the completed portion of the hole.

Directional drilling requires a staging area on each end of the bore for construction machinery, for the slurry catchment basin, and for laying out the pipe and cable. The staging area must be cleared, leveled, and reinforced as needed. For the pipe-type or the dielectric cable system, a minimum area approximately 100 by 200 feet for machinery would be needed on each side of the river. In addition,

one side of the river would need to provide a clear, level area about 500 feet in length to lay out the duct pipe and cable.

Horizontal directional drilling has difficulties with soils containing individual boulders, fractured rock, or very loose conditions. These conditions cause the drilling fluid to lose pressure and stop flowing back to the bore opening with the cuttings. In unsuitable soils the pressurized drilling fluid may flow into the surrounding soil, saturate a large area of soil, and perhaps flow out at the soil surface or into surface waters. Before drilling, soil tests are normally performed to determine if the local soils are suitable for horizontal directional drilling.

Unlike trenching, boring has the ability to go deeper if needed to pass under obstacles. However, increased depth may restrict proper heat dissipation because the deeper bore will be farther from the soil surface and atmosphere.

Open Cut Trenching

The open cut trenching method is done with self-propelled excavating equipment working from the soil surface. Direct access along the entire length of the trench is required. An area parallel to the trench or a remote area must be reserved for receiving and temporarily storing the side-cast spoil. Unlike boring, trenching is performed in the open where obstacles such as boulders can be seen and accessed for removal as needed.

The trenched right-of-way will need to be cleared of trees and stumps to provide access to construct the underground line. For the proposed 345 kV line, a cleared area at least 60 feet in width will be needed. After construction is completed, a cleared area about 40 to 50 feet wide will have to be maintained for the life of the line. Trees cannot be allowed to grow on the right-of-way and prevent access to the line for maintenance or entangle the underground line in thick roots.

After construction is completed, about 2 feet of thermally controlled cover must be placed over the underground line for security. The backfill is normally a mixture of sand, stone, and concrete. Typically, about a foot of native soil is placed on top of the thermally controlled backfill to allow the re-growth of vegetation.

Trenching across rivers is more difficult than trenching on land. Environmental concerns pertaining to water quality, aesthetics, navigational access, and contaminated bottom sediments often limit the type of trenching in rivers. The line is normally placed deeper under rivers, such as 10 to 12 feet below the river bottom to minimize heating of the river bottom. If the river is more aggressive in terms of channel development, the depth may need to be increased and more extensive excavations continued across stream terraces adjacent to the river channel. Where the line is trenched across a river and a concrete duct bank is used, the river crossing segment of the duct bank is normally placed inside a large diameter steel or PVC casing pipe. A thermally controlled cover is backfilled over the underground line to provide proper heat dissipation. Crushed rock is normally used to cover the thermal backfill to prevent washing.

Several trenching methods may be employed to cross a river depending on the size, depth, amount of flow, and navigational use of the river. Common trenching methods include trenching in the open river from a barge using a dredge or water jetting excavator with silt screen protection; placing a temporary cofferdam completely across the river and using pumps or a temporary channel to allow the river to flow past the cofferdam; or placing a cofferdam partially across the river and completing a section before moving the cofferdam to a new section. At all times constructors need to be aware of the hazard of sudden increases in river flow from seasonal or sudden precipitation events.

When trenching across a river without cofferdams, temporary silt screens are installed to minimize the amount of silt flowing downstream. Silt screens often consist of steel sheet piling that has been driven to a level below the water surface. Water can flow over the sheeting, but most of the silt is trapped at lower depths by the sheeting. However, the silt screen will not catch all of the silt, and some downstream silting will occur from trenching in the river.

Overhead/Underground Transition Stations

A 345 kV overhead/underground transition station will be required at both sides of each river crossing. These stations connect the overhead conductors through various terminators, switches, surge arrestors, and other equipment to the underground cables.

The appearance of a 345 kV transition station will resemble a substation, except large transformers and circuit breakers are not normally installed. The transition station will be fenced and the soil covered by gravel. A conceptual sketch of a proposed transition station is shown in Figure 5. A photograph some of the equipment in an existing 345 kV transition station is shown in Figure 6. The transition stations are very similar for pipe-type systems and solid dielectric cable systems, except that stations for pipe-type systems will have pressurizing pumps and related equipment for the insulating fluid.

Maintenance and Repair Considerations

Maintenance

Underground transmission lines at 345 kV do not presently exist on the Bangor Hydro transmission system. Installing these two segments of EHV underground lines will require new maintenance expertise, implementation of monitoring techniques not currently in use by Bangor Hydro staff, and warehousing of new types of spare parts.

Maintenance will be complicated by the remote location of the two river crossings from existing maintenance facilities and staff. The crossings are about 43 and 57 line miles from the existing Bangor Hydro Orrington Substation and maintenance facilities in the Bangor area. Vehicle access to the transition stations will be needed at all times and in all types of weather.

Both the pipe-type cable system and dielectric cable system would require monitoring devices and a data transmitting system to allow transmission system operators in Bangor to monitor the proper operation of the underground segments. The transmission line will be equipped with a fiber optic communication line for monitoring the operation of the overall line. The monitoring equipment at the underground segments would use this fiber optic system to send information to the system operators at Bangor.

For a pipe-type cable system, regular maintenance of the pressurization system will be required. The pressure is normally created and maintained by electric pumps. A dielectric cable system would not require pressurization pumps.

A low-voltage power source will be needed at the transition stations to provide power for the pumps, the monitoring and communication devices and perhaps station lighting. Due to the remote location of the underground segments, CAI assumes that constructing a long distribution pole line from the closest existing source would be infeasible. Therefore, propane-powered generators and batteries would be installed at each transition station to provide low-voltage power for the station.

Repairs

Once either the pipe-type cable system or the solid dielectric cable system is installed, faults should rarely occur. However, if a fault does occur, repairs will be costly and require extensive time. Because the underground segments on this line would be short, the most likely method of repair would be to remove and replace the entire cable. For the pipe-type cable system, all three cables in the faulted pipe would need to be removed, inspected, and probably all three replaced.

The cables will be manufactured specifically to meet the design requirements of the river crossing installations. Since manufacturing and delivery of replacement cables will take 2 months or longer and since outages on the proposed 345 kV transmission line must be minimized, CAI assumes that one set of pipe-type cables or one solid dielectric type cable will be obtained by Bangor Hydro and kept in storage for contingency purposes. To prevent deterioration of the cables while in storage, they will need to be held under carefully controlled storage conditions.

3. OVERHEAD DESIGN CONSIDERATIONS

The proposed 84-mile transmission line could readily cross the Narraguagus River and Machias River using the same overhead structures and conductors utilized on the rest of the line. Depending on the exact alignment chosen for the river crossing, the closest structures (Figures 7-9) would be about 200 to 500 feet from the river edge. The three conductors and two shield wires would be over the river at a height of about 28 to 30 feet (about 50 feet for Option 4).

Some flexibility exists on positioning the structures near the river banks to minimize visual impacts and take advantage of local topographic variations. Average inter-structure span lengths for the line will be about 700 to 800 feet. Longer spans could be employed to move the nearest structures farther back from the river bank. Spans up to 1,000 feet or more are possible, but (depending on the local topography) the structures will very likely need to be taller to provide adequate conductor ground clearance at mid-span. The taller structures may need guy wires (or additional guy wires) and perhaps an extra set of cross braces to provide additional support. The taller structures with additional guying and bracing may be more visible from the river and First Machias Lake.

II. DESIGN ALTERNATIVES

1. DEFINITION OF OPTIONS

CAI defined underground Options 1 and 2 and overhead Options 3 and 4 for crossing the Narraguagus and Machias Rivers. These options are summarized in Table 1, and the conceptual layout of each option is illustrated in Figures 10 through 19. The underground options would require an overhead/underground transition station on each side of each river. The options are defined as follows:

Option 1A – Trenched Crossing for Pipe-Type Cable

Option 1A (Figures 10 and 14) would employ pipe-type cable to cross under the two rivers. The cable would be installed in two parallel 10-inch-diameter pipes buried in two 3-by-6-foot trenches about 10 to 20 feet apart for the entire distance between the west transition station and the east transition station. The trench would be about 950 feet long for the Narraguagus River crossing and about 1,950 feet long for the Machias River crossing. The trench would be backfilled with a thermally controlled mixture of sand, stone and concrete with soil placed on top. Under the river, the pipes would be placed about 10 to 12 feet below the river bottom to allow for any river channel scouring and to reduce the amount of heat reaching the river bottom. The trench would be backfilled with a thermally controlled mixture of sand, stone and concrete with crushed stone placed on top to match the elevation of the existing river bottom. A profile of the river crossing is shown in Figures 13 and 18.

Option 1B – Trenched Crossing for Solid Dielectric Cable

Option 1B (Figures 10 and 14) is the same as option 1A, except that solid dielectric cable would be employed instead of pipe-type cable. Only one trench would be needed for each crossing, and the conductors would be encased in a concrete duct bank. Trench lengths would be the same.

Option 2A –Trenched and Bored Crossing for Pipe-Type Cable

Option 2A (Figures 11 and 15) would employ both trenching and boring construction techniques. Pipe-type cable would be installed in two parallel 10-inch-diameter pipes in two 3-by 6-foot trenches about 10 to 20 feet apart extending from each transition station to a point about 200 to 400 feet from the banks of the rivers. The total trenching lengths would be about 450 feet for the Narraguagus River crossing and 760 feet for the Machias River crossing. Two bores about 10 to 20 feet apart would be made under each river to carry the 10-inch pipes between the trenched segments. The pipes would be placed about 20 feet below the river bottom. The bores would be about 500 feet long for the Narraguagus River and about 1,070 feet long for the Machias River. The alignment for the Option 2A crossing of the Machias River (Figure 15) is shorter than the all trenched alignment (Figure 14). A profile of the river crossing is shown in Figures 13 and 18.

In defining this option for consideration, CAI has assumed that local geologic conditions would be suitable for conducting boring operations. However, geologic testing performed in 1997 (by S. W. Cole Engineering of Bangor, and J.D. Hair and Associates of Tulsa, Oklahoma) for the Maritimes and Northeast Pipeline crossing of the Narraguagus River and Machias River indicated that the coarse

overburden materials above bedrock were probably not suitable for drilling. The depth of the overburden was estimated to be about 80 feet at the west bank of the Narraguagus River and about 40 feet on the east bank. At the Machias River the overburden was estimated to be about 60 feet deep. For both river crossings their report states that "Possible drilling problems in the coarse overburden, considered against the relatively minimal effort involved to excavate this crossing, make open cut excavation the preferred method"…of crossing the river.

Option 2B - Trenched and Bored Crossing for Solid Dielectric Cable

Option 2B (Figures 11 and 15) is the same as Option 2A, except that solid dielectric cable would be employed instead of pipe-type cable. Only one trench and one bore would be needed, and the conductors would be encased in a single in a 30-inch diameter pipe. Trench and boring lengths would be the same. The pipe would be placed about 20 feet below the river bottom.

Option 3 – Overhead Crossing Using a Basic Alignment

Under Option 3 (Figures 12 and 16), the overhead line would be extended on a basic alignment across each river to generally follow, but not parallel, the pipeline and road. At both rivers, the alignment would seek to cross the river and adjacent stream terraces on an alignment as short as possible with a minimum number of angles. For the Narraguagus River crossing, 2 wood-pole tangent structures and about 1,300 feet of overhead conductor would be the equal of the underground crossing. For the Machias River, 2 tangent structures, 2 light angle structure, and 2,970 feet of overhead conductor would be the equal of the underground crossing options. The nearest structures would be located about 300 from the west bank and 500 feet from the east bank of the Narraguagus River and 300 feet from the banks of Machias River. The 3 conductors and 2 shield wires would cross over the river at a height of about 28 to 30 feet. A profile of the river crossing is shown in Figures 13 and 19.

Option 4 – Overhead Crossing Parallel to the Pipeline (Machias River Only)

Option 4 (Figure 17) would apply only to the Machias River crossing. This option would have the overhead line follow an alignment that is parallel and adjacent to Stud Mill Road on the west side of the river and adjacent to the pipeline right-of-way where it crosses the river. With the adjacent cleared pipeline right-of-way, some of the new clearing width needed for the transmission line could be reduced at the river by overlapping it with the pipeline clearing. For this crossing of the Machias River, 2 tangent structures, 2 light medium structures, two deadend structures, and about 3,080 feet of overhead conductor would be the equal of the underground crossing options. The nearest structures (guyed deadend structures) would be about 80 feet west and about 220 feet east of the respective river banks. The 3 conductors and 2 shield wires would cross over the river at a height of about 50 feet. A profile of the river crossing is shown in Figure 19.

2. CLEARING REQUIREMENTS

Figures 10 to 12 and 14 to 17 show the estimated areas where clearing would be required. The trenched construction (whether pipe-type or solid dielectric cable) would need a cleared area a minimum of 60 feet wide for trenching and temporary sidecasting of the excavated spoil. After the line is installed, a corridor at least 40 to 50 feet wide must be maintained in a cleared condition for the life of the line to prevent tree roots from interfering with the line and to allow maintenance vehicles occasional access to the line. For directional drilling, the first 100 feet at each transition station where the bore is in the tree root zone will be cleared the same as for the trenched installation. The remaining portion of the bored right-of-way will not need to be cleared since the bore can be angled downward as needed to pass beneath the tree root zone.

For the overhead line the cleared area would need to be about 155 to 170 feet wide for both construction and operation of the line. The purpose of this cleared area is to provide the high standard of reliability necessary for all major EHV transmission lines, by preventing trees from growing to a height where they could fall over onto the line. The roots of trees cut at ground level, small tree saplings, shrubs, and herbaceous vegetation will be allowed to remain on the right-of-way to prevent soil erosion. Utilities typically maintain cleared rights-of-way by chemically treating or cutting growing trees and tall brush on a 5-to-7-year maintenance cycle.

3. CONCEPTUAL COST ESTIMATES

Tables 1 and 2 contain a summary of a series of comparable lengths and conceptual cost estimates for Options 1 through 4 on each of the rivers. These estimates are for the overhead and underground segment of line across the Narraguagus River between "Point A" and "Point B shown on Figures 10 through 14, and across the Machias River between "Point C" and "Point D" shown on Figures 15 through 19.

The cost estimates include labor, materials, engineering, owner's costs, a 15 percent contingency applied to the total cost, a 3 percent inflation factor, and a credit for the segments of overhead line not used. These estimates are based on MEANS 2005 costs, discussions with contractors, and recent experience with underground and overhead transmission line projects with allowances for Maine construction conditions. These estimates do not take into account the specific soil characteristics or other site-specific information needed to properly design the proposed crossings of the Narraguagus and Machias Rivers. Therefore, it is very likely that the actual cost of the river crossings will vary from these conceptual estimates.

The Option 1, 2, and 3 crossings of the Narraguagus River range from 1,200 feet to 1,300 feet in length. The estimated underground cost ranges from 4.4 to 6.2 million dollars, depending on whether pipe-type or solid dielectric cable is used and whether the cable is installed by trenching or directional drilling. Option 1B, where a solid dielectric cable is installed by trenching, is the least cost underground option at 4.4 million dollars. However, this cost is still 22 times more than the estimated Option 3 overhead cost of 0.2 million dollars for this segment of line.

For the Machias River, the Option 1, 2, 3, and 4 crossings range from 2,890 feet to 3,080 feet in length. The estimated underground cost ranges from 7.3 to 9.1 million dollars, depending on whether pipe-type or solid dielectric cable is used and whether the cable is installed by trenching or directional drilling. As on the Narraguagus River, Option 1B, which is a solid dielectric cable installed by trenching, is the least-cost underground option at 7.3 million dollars. However, this cost is still 15 times the average of Option 3's estimated overhead cost of 0.4 million dollars and Option 4's estimated cost of 0.5 million dollars.

TABLE 1
COMPARISON OF RIVER CROSSING OPTIONS
Northeast Reliability Interconnect 345 kV Transmission Line

Option Number	Option	Trench Length (Feet)	Bore Length (Feet)	Overhead Length (Feet)	Total Length (Feet)	Conceptual Cost (Dollars)	Cost Per Foot (Dollars)	Under-ground Cost Multiplier (Ratio)
	Narraguagus River Crossing							
1A	Trenched Using Pipe-Type Cable	950	0	250	1,200	5,496,680	4,581	28
1B	Trenched Using Solid Dielectric Cable	950	0	250	1,200	4,393,442	3,661	22
2A	Trenched and Bored Using Pipe-Type Cable	450	500	250	1,200	6,185,701	5,155	31
2B	Trenched and Bored Using Solid Dielectric Cable	450	500	250	1,200	5,293,700	4,411	27
3	Overhead Crossing on Basic Alignment	0	0	1,300	1,300	213,477	164	1
	Machias River Crossing							
1A	Trenched Using Pipe-Type Cable	1,950	0	1,060	3,010	8,592,880	2,855	18
1B	Trenched Using Solid Dielectric Cable	1,950	0	1,060	3,010	7,278,476	2,418	15
2A	Trenched and Bored Using Pipe-Type Cable	640	1,190	1,060	2,890	9,128,650	3,159	20
2B	Trenched and Bored Using Solid Dielectric Cable	640	1,190	1,060	2,890	8,326,399	2,881	18
3	Overhead Crossing on Basic Alignment	0	0	2,970	2,970	410,829	138	1
4	Overhead Crossing Adjacent to Pipeline	0	0	3,080	3,080	539,893	175	1

Source: Measurements and conceptual cost estimates by CAI.
NOTE: THE COST INFORMATION IS CONCEPTUAL AND INTENDED FOR OPTION COMPARISON PURPOSES ONLY.

TABLE 2
ESTIMATED COST SUMMARY
Northeast Reliability Interconnect 345 kV Transmission Line

Option	Transition Stations	Underground Line					Overhead Line	Other Costs (2)	River Crossing Total
		Trenching Backfilling	Boring	River Crossing (1)	Cable Pipe, Duct Bank, etc.	Total			
Narraguagus River Crossing									
1A Trenched Crossing Using Pipe-Type Cable	$1,724,968	$742,214	$0	$85,392	$1,386,206	$2,213,812	$10,638	$1,547,262	$5,496,680
1B Trenched Crossing Using Solid Dielectric Cable	1,092,993	371,107	0	65,276	1,626,966	2,063,349	10,638	1,226,462	4,393,442
2A Trenched and Bored Crossing Using Pipe-Type Cable	1,724,968	351,575	1,016,610	0	1,334,294	2,702,479	10,638	1,747,615	6,185,700
2B Trenched and Bored Crossing Using Solid Dielectric Cable	1,092,993	175,787	956,355	0	1,569,688	2,701,830	10,638	1,488,239	5,293,700
3 Overhead Crossing on Basic Alignment	0	0	0	0	0	0	94,665	118,813	213,478
Machias River Crossing									
1A Trenched Crossing Using Pipe-Type Cable	1,724,968	1,523,491	0	85,392	2,845,371	4,454,254	79,557	2,334,100	8,592,879
1B Trenched Crossing Using Solid Dielectric Cable	1,092,993	761,746	0	65,276	3,327,006	4,154,028	79,557	1,951,897	7,278,475
2A Trenched and Bored Crossing Using Pipe-Type Cable	1,724,968	500,018	1,808,330	0	2,546,721	4,855,069	45,106	2,503,508	9,128,651
2B Trenched and Bored Crossing Using Solid Dielectric Cable	1,092,993	250,009	1,664,923	0	3,003,139	4,918,071	45,106	2,270,229	8,326,399
3 Overhead Crossing on Basic Alignment	0	0	0	0	0	0	234,630	176,198	410,828
4 Overhead Crossing Adjacent to Pipeline	0	0	0	0	0	0	326,165	213,728	539,893

(1) Cofferdam and trenching in river.
(2) Includes soil investigations, land surveying, engineering, owner's costs, AFDUC, 3 percent inflation, 15 percent overall project contingency, and (for underground options) a credit for overhead segment of line not built.
Source: Conceptual cost estimates by CAI based on MEANS 2005, discussion with contractors, and other project experiences.
NOTE: THIS IS A CONCEPTUAL COST ESTIMATE INTENDED FOR OPTION COMPARISON PURPOSES ONLY.

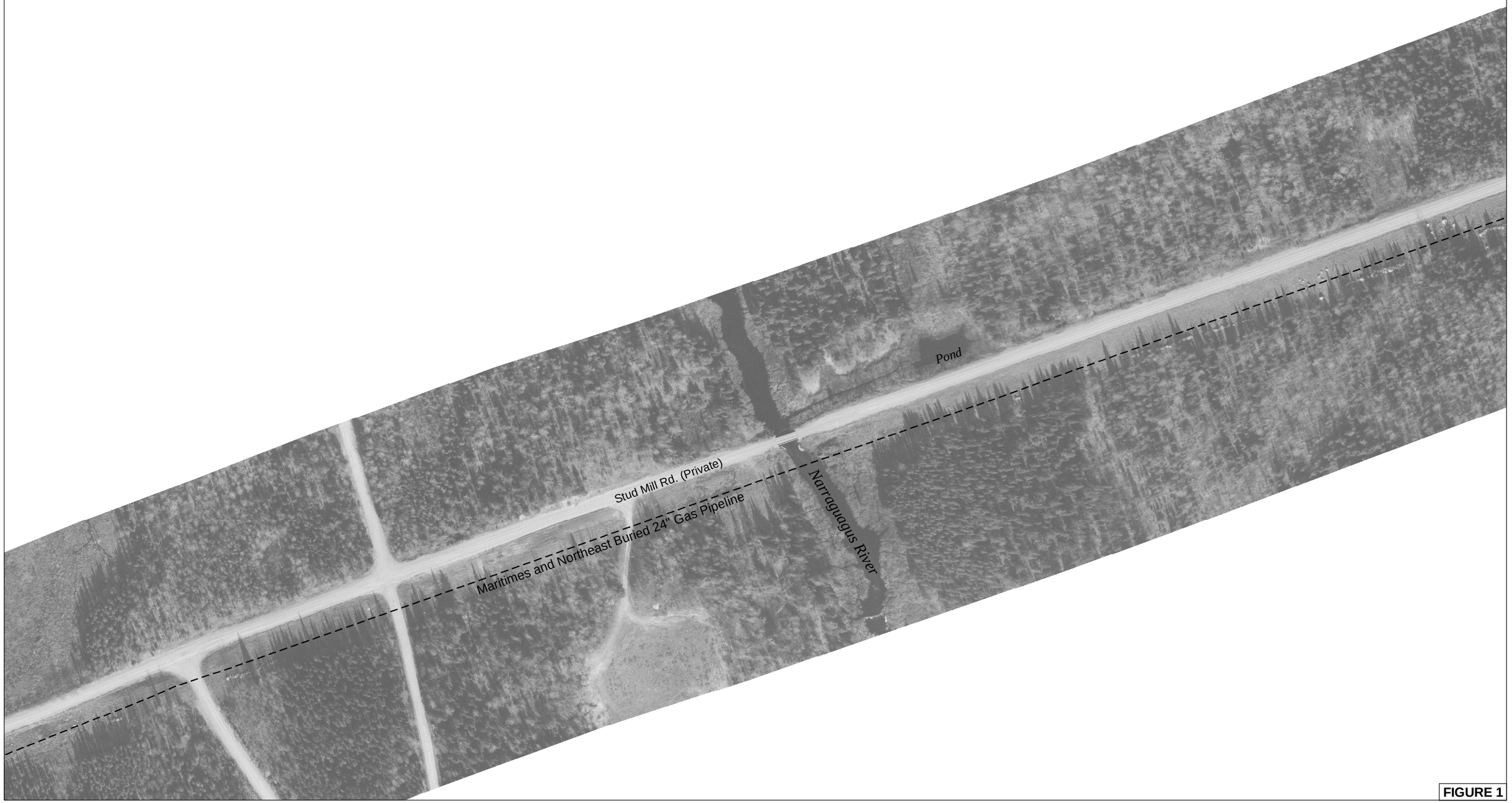


FIGURE 1

– – – – – Existing Pipeline

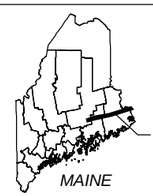
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



Project Area

AREA FOR CROSSING NARRAGUAGUS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

November 9, 2004

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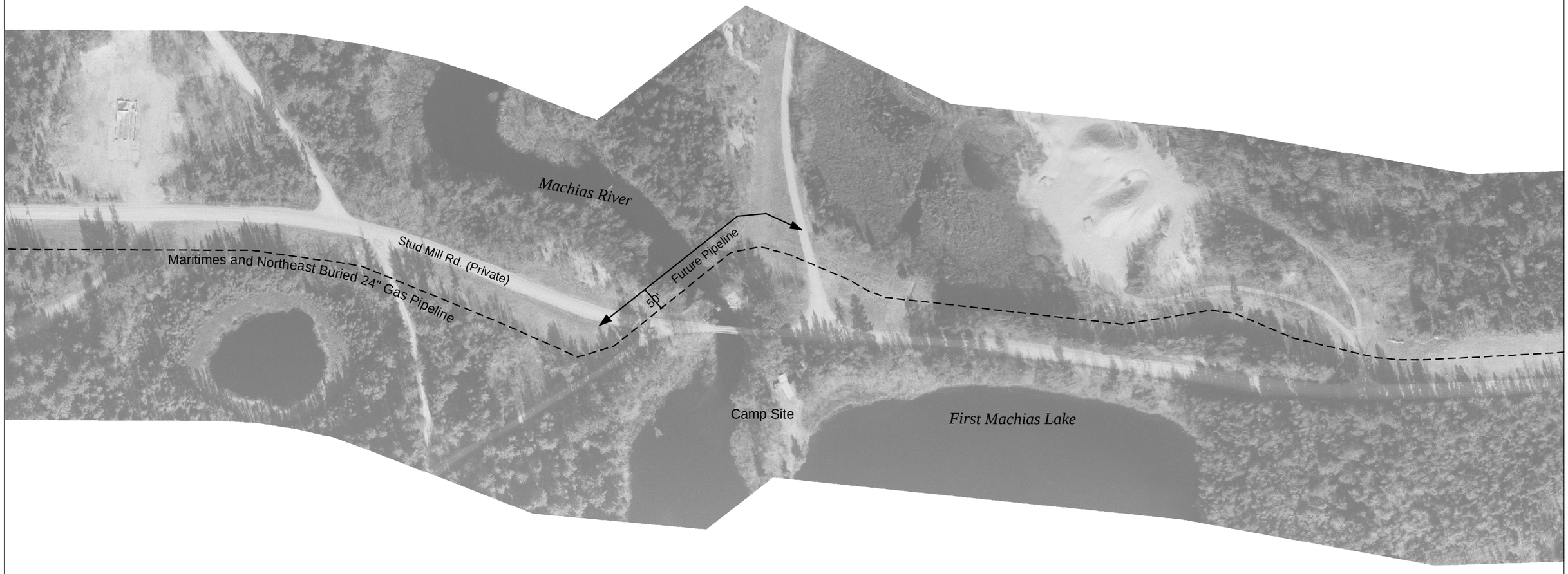


FIGURE 2

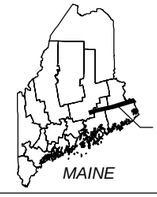
– – – – – Existing Pipeline

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



Project Area

Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

AREA FOR CROSSING MACHIAS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

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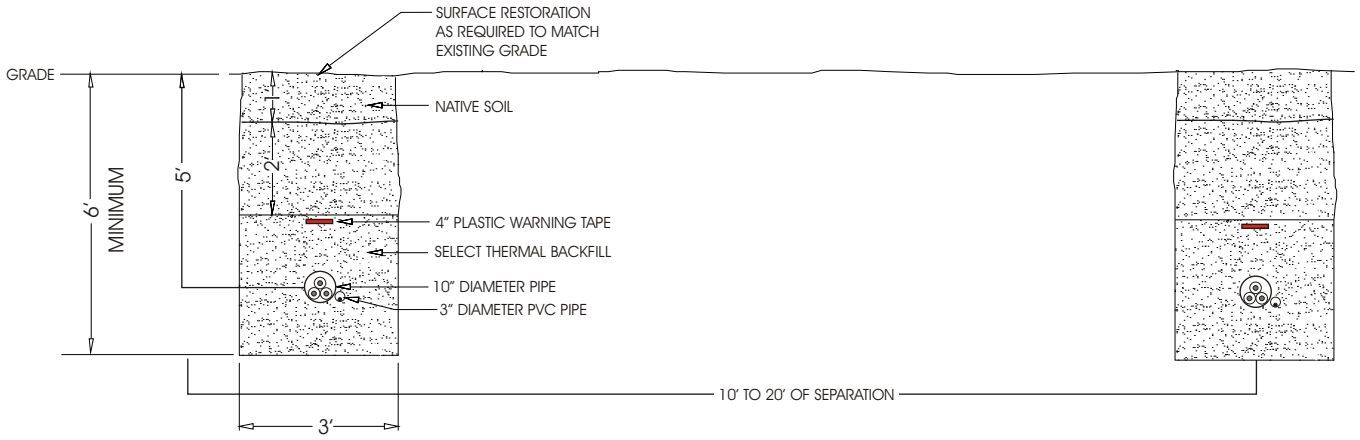
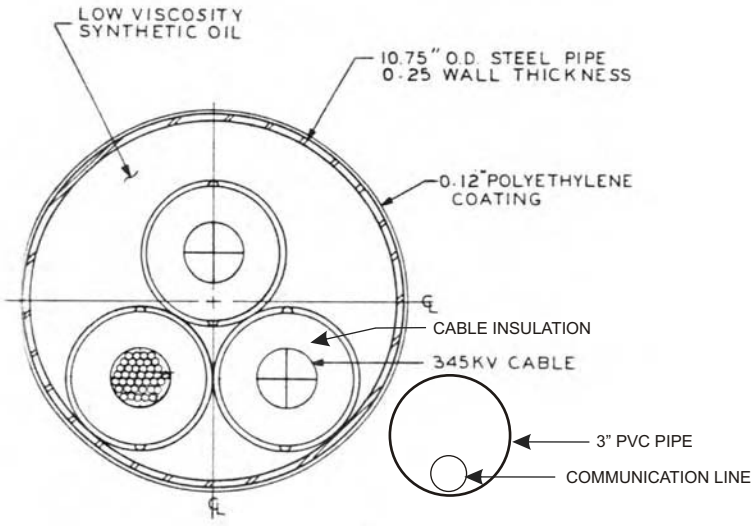


TYPICAL 345 kV PIPE-TYPE TRENCH
CONSTRUCTION CROSS SECTION



345 kV PIPE-TYPE CABLE
CROSS SECTION

FIGURE 3

TYPICAL CROSS SECTION OF OIL-FILLED UNDERGROUND 345 kV PIPE-TYPE CABLE
Northeast Reliability Interconnect
345 kV Transmission Line
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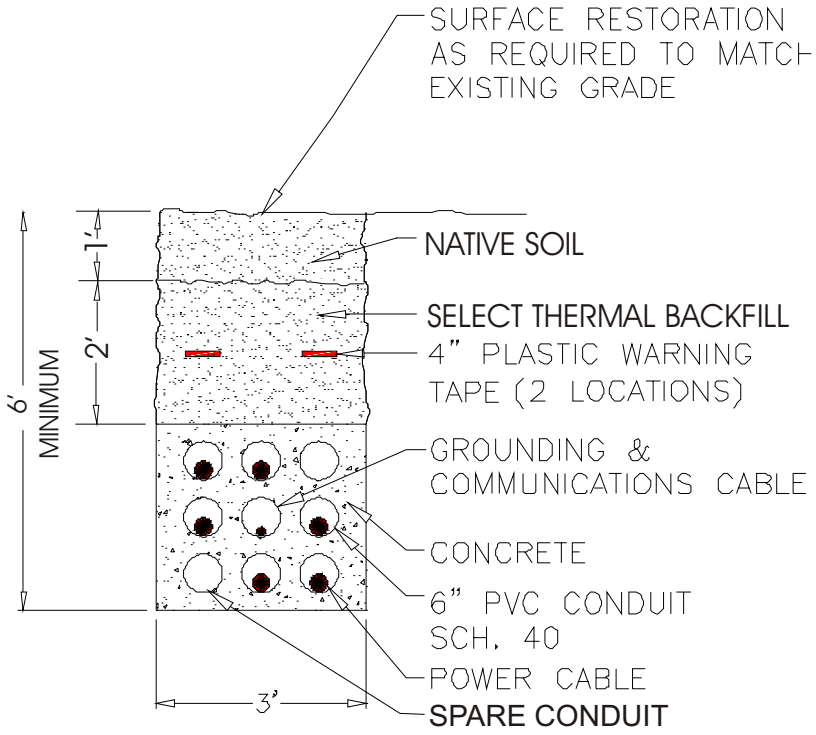
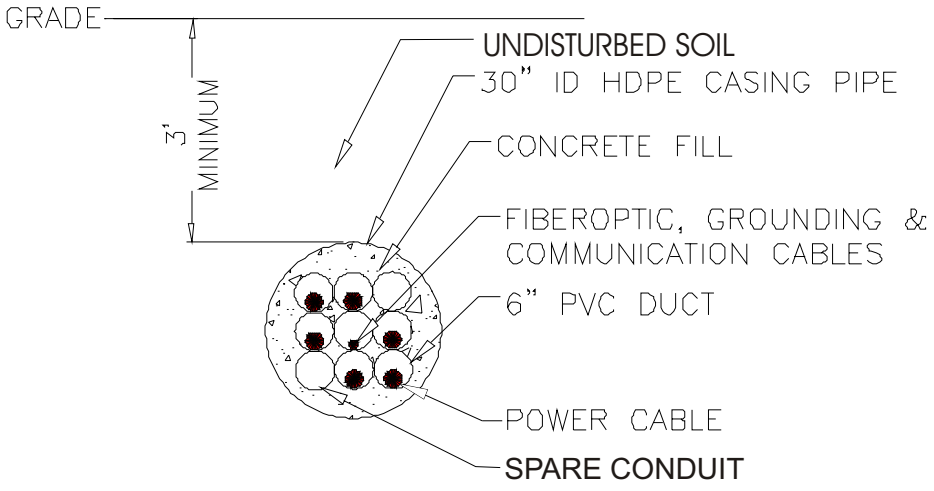


TRENCH
CROSS SECTION



DIRECTIONAL DRILL
CROSS SECTION

FIGURE 4

TYPICAL CROSS SECTION OF UNDERGROUND 345 kV SOLID DIELECTRIC CABLE DUCTWORK

Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

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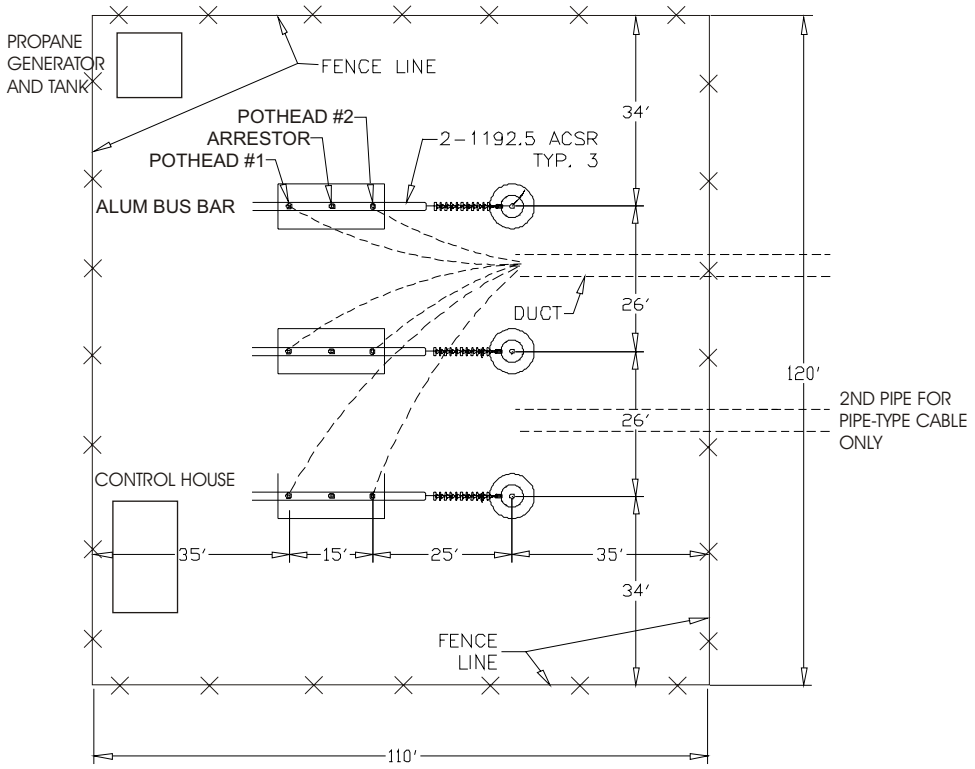
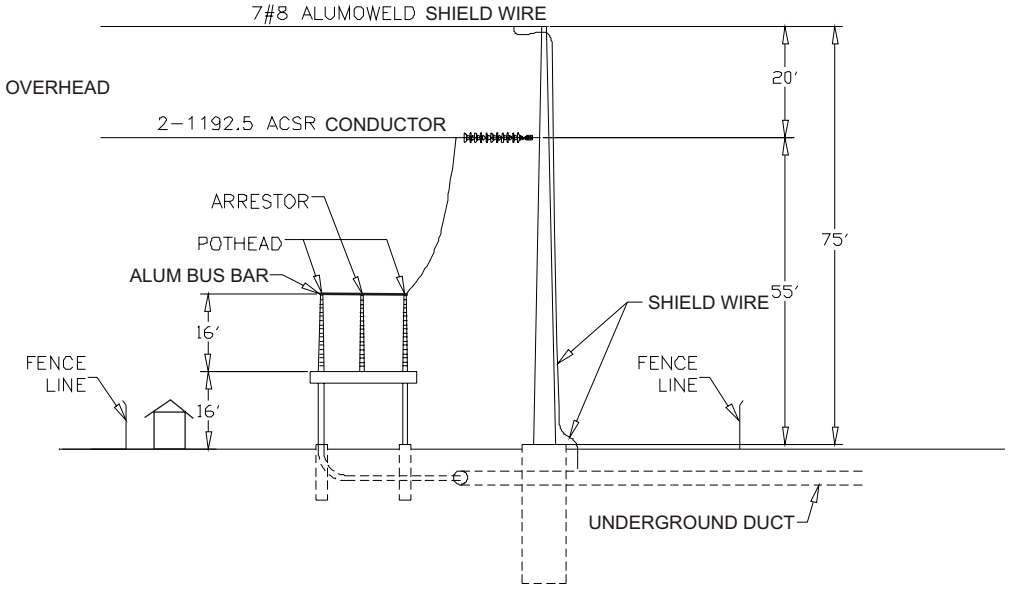
OVERHEAD TO UNDERGROUND TRANSITION STATION



PLAN VIEW

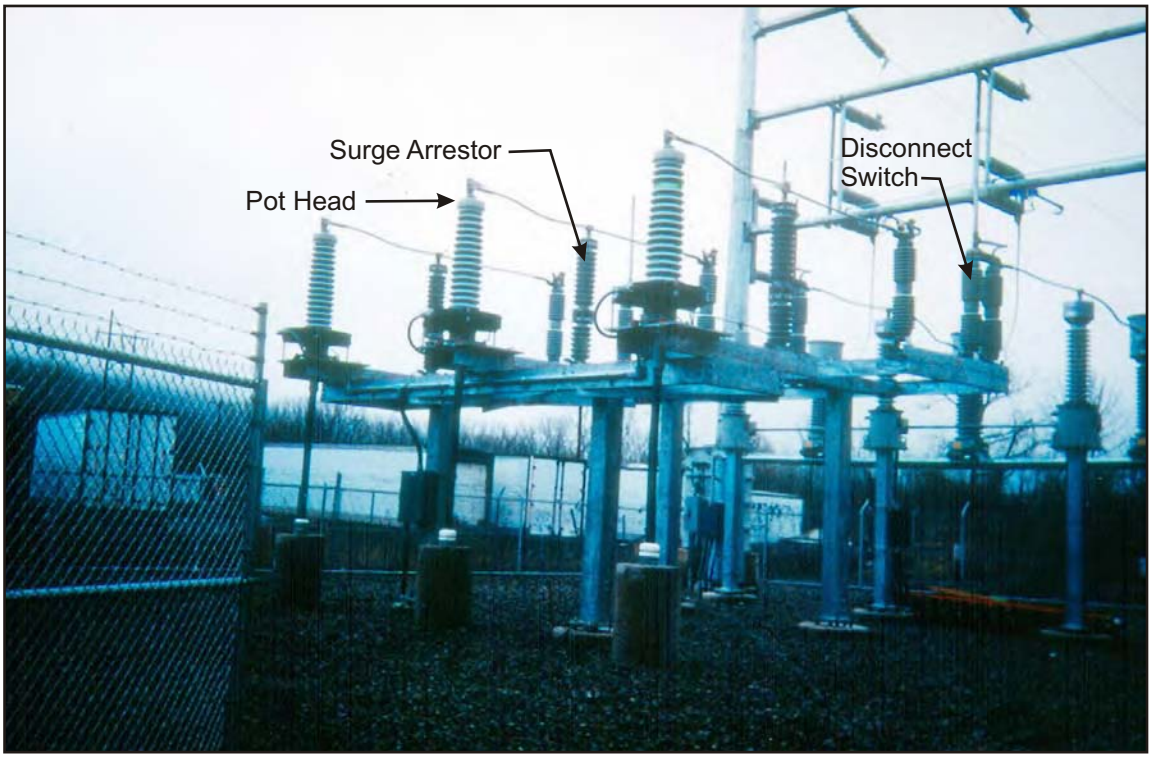


ELEVATION VIEW

FIGURE 5

CONCEPTUAL 345 kV TRANSITION STATION
Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004



Comparison to 6 foot fence in background shows the large size of 345 kV equipment. The top of the potheads and surge arrestors are about 32 feet above grade.

FIGURE 6

EXAMPLE OF 345 kV TRANSITION STATION
Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004

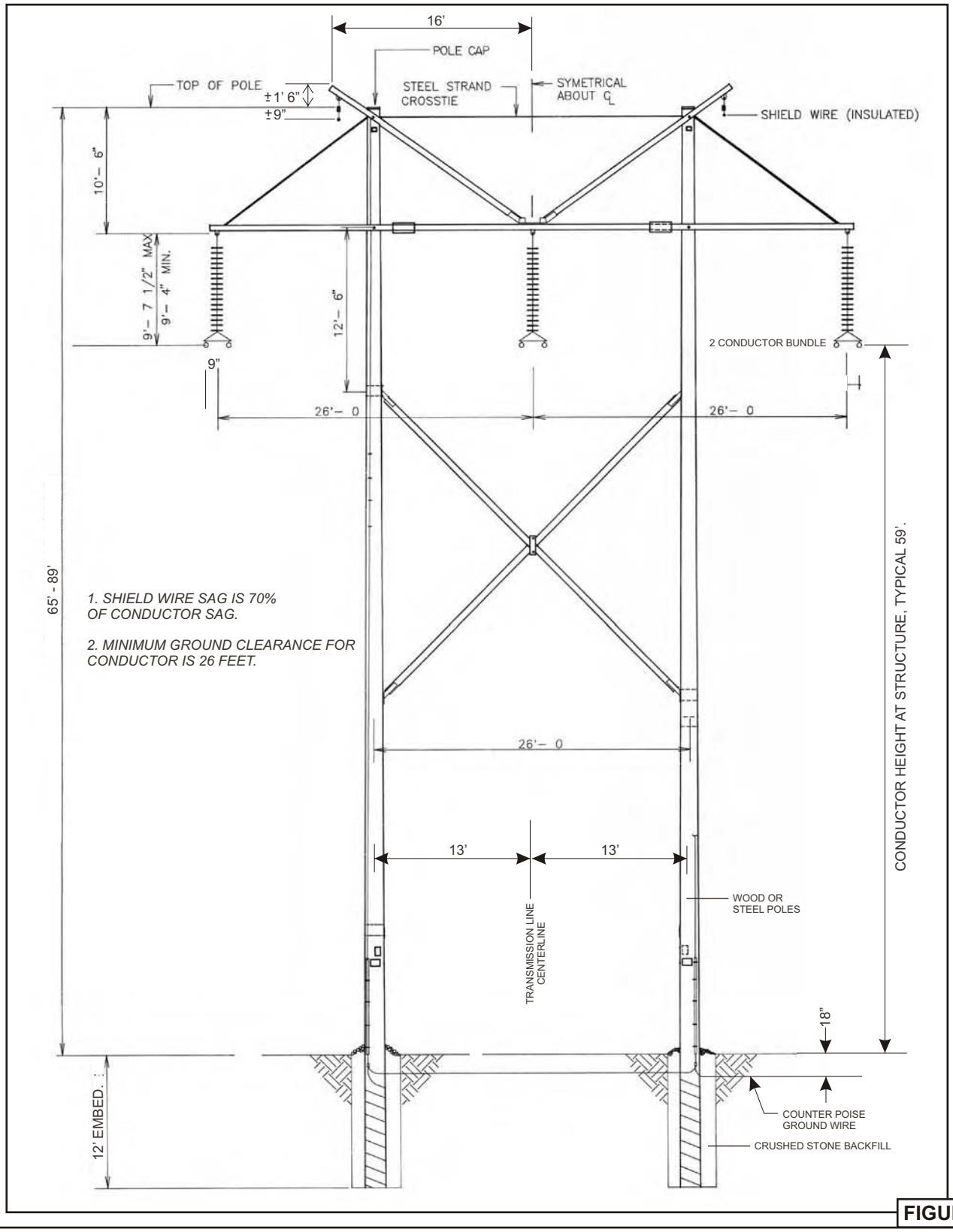


FIGURE 7

TYPICAL 345 kV OVERHEAD TANGENT STRUCTURE

Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

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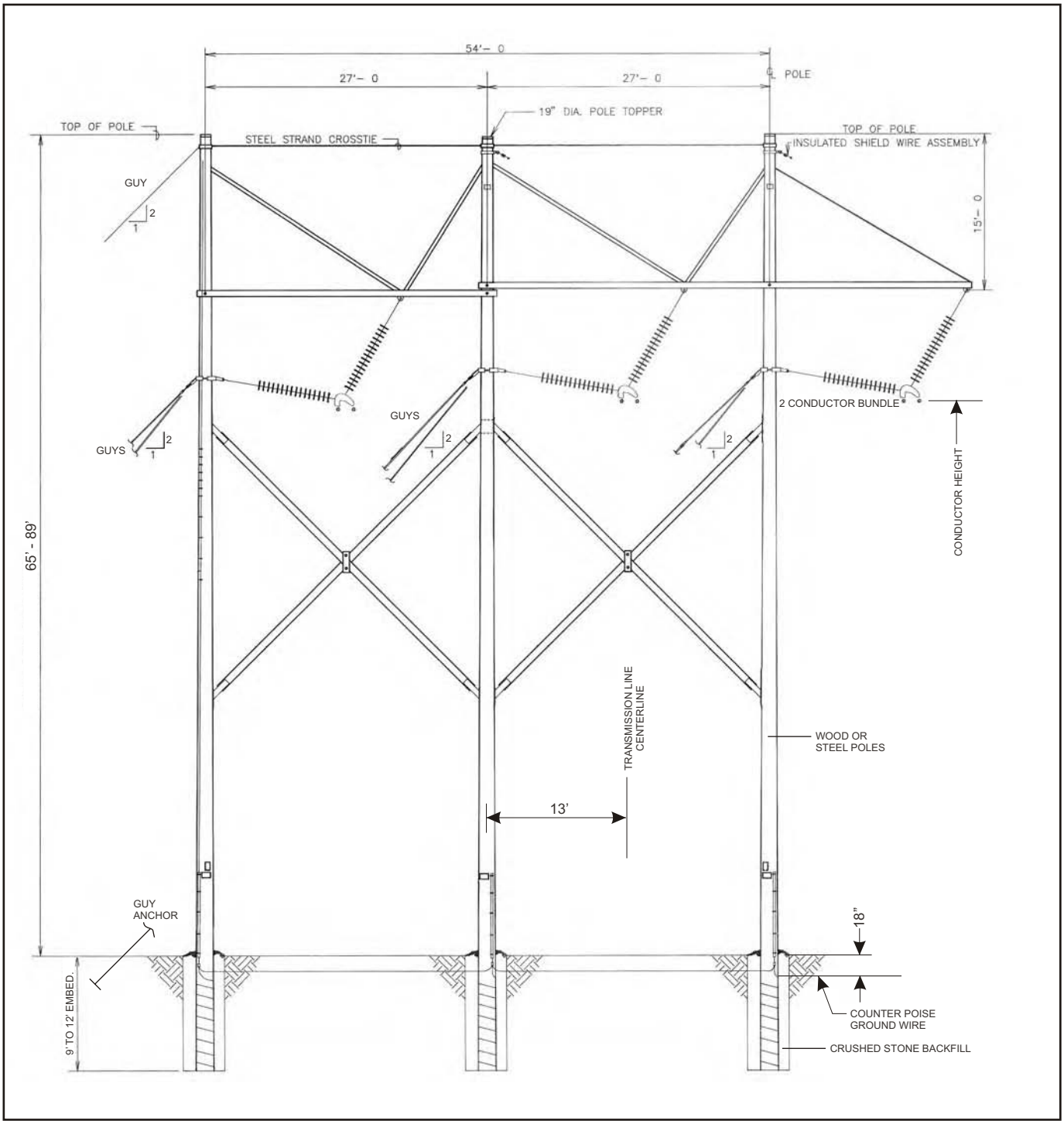

FIGURE 8

TYPICAL 345 kV OVERHEAD 5° - 20° LIGHT MEDIUM ANGLE STRUCTURE

Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004

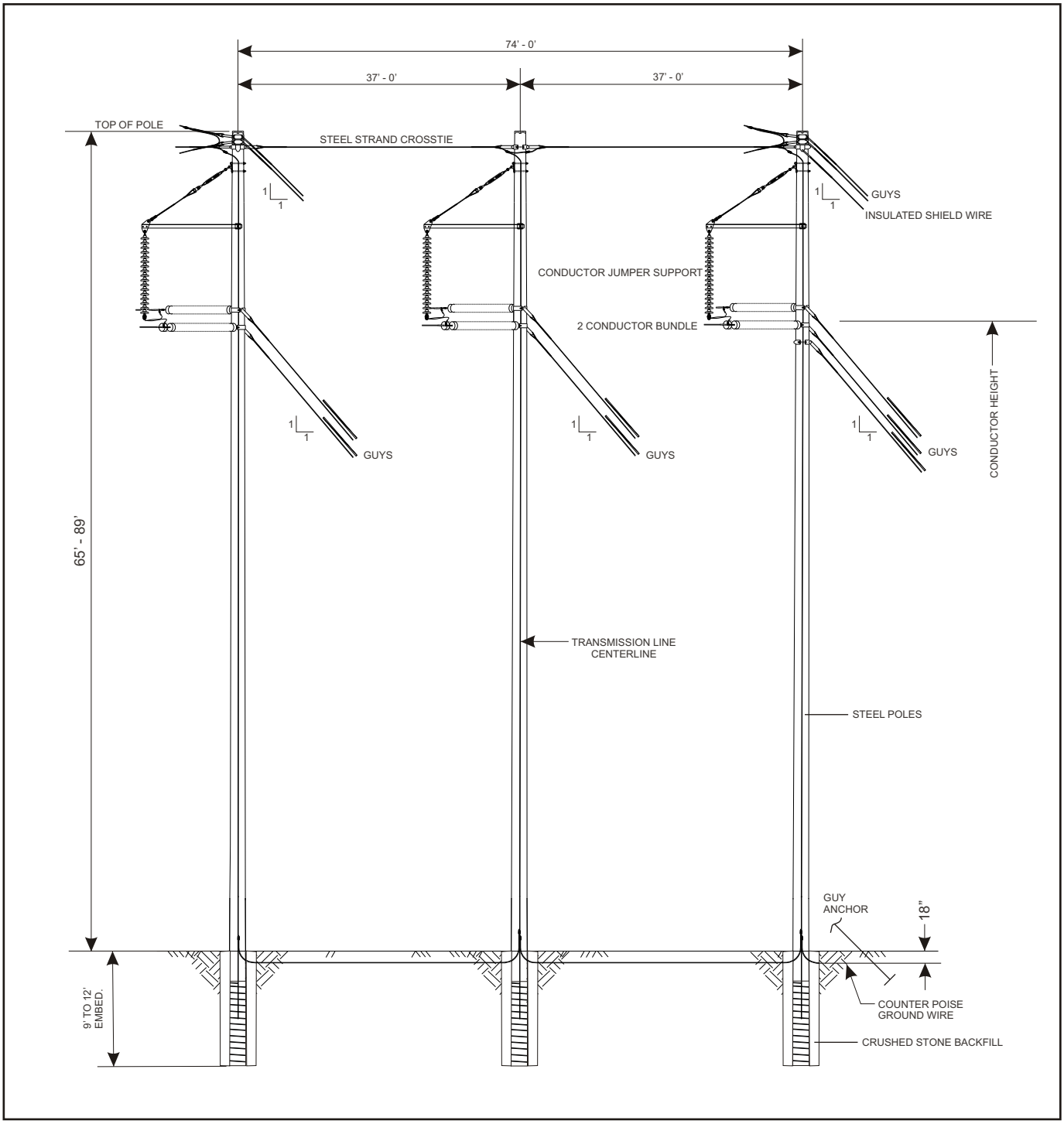

FIGURE 9

TYPICAL 345 kV DEADEND PULLOFF 30° - 90° ANGLE STRUCTURE

Northeast Reliability Interconnect

345 kV Transmission Line

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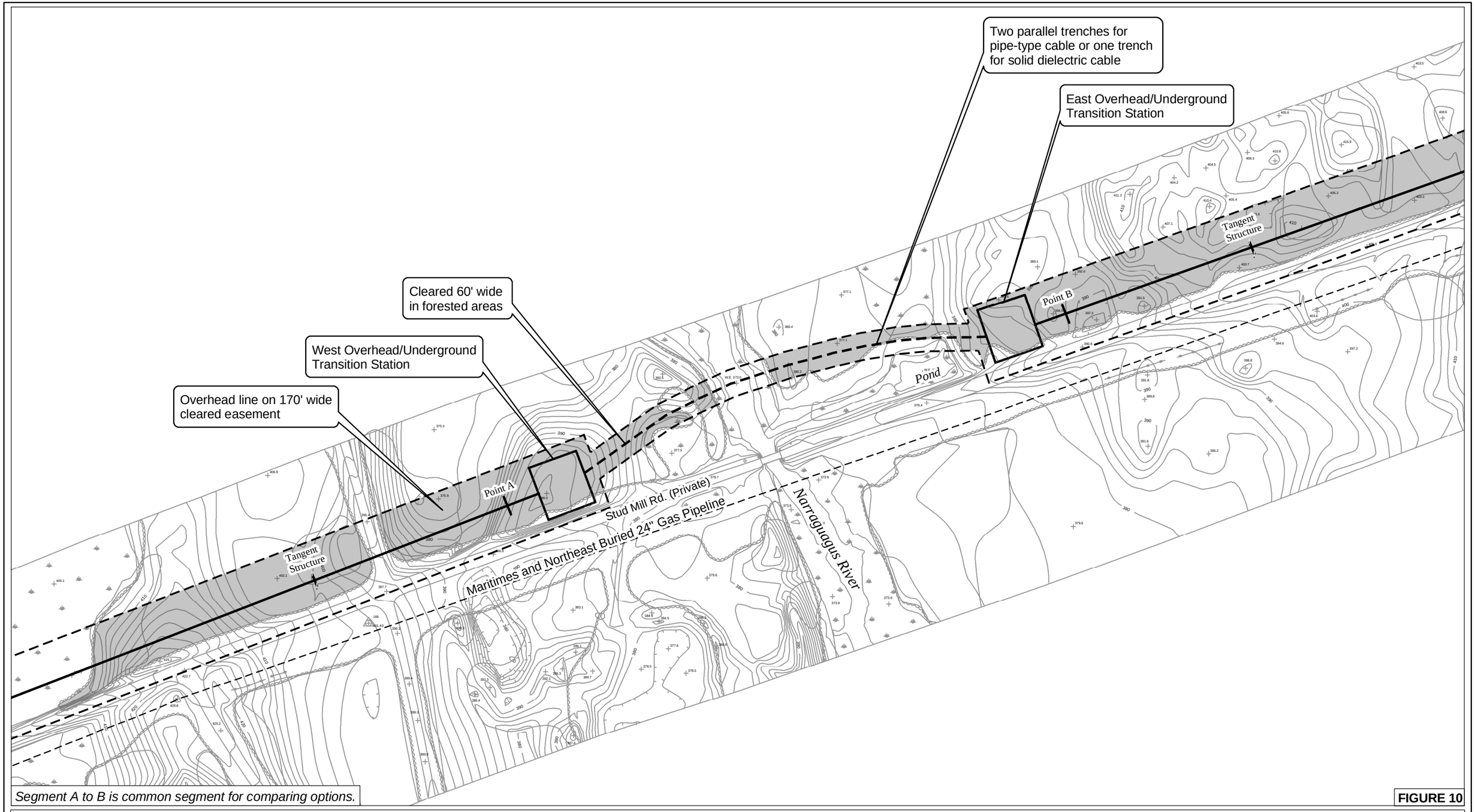


Segment A to B is common segment for comparing options.

FIGURE 10

- Proposed Overhead Transmission Line A
- Proposed Underground Transmission Line A
- Easement Boundary
- Area Where Clearing Is Required
- Existing Pipeline
- Overhead Structure (typical location)

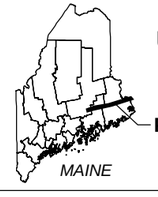
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



OPTION 1

UNDERGROUND TRENCH CROSSING OF NARRAGUAGUS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

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Two parallel trenches for pipe-type cable or one trench for solid dielectric cable

East Overhead/Underground Transition Station

Cleared 60' wide in forested areas

Two parallel bores for pipe-type cable or one bore for solid dielectric cable

West Overhead/Underground Transition Station

Overhead line on 170' wide cleared easement

Directional Drill

Trenched

Pond

Point B

Tangent Structure

Point A

Trenched

Stud Mill Rd. (Private)

Maritimes and Northeast Buried 24" Gas Pipeline

Narraguagus River

Tangent Structure

Segment A to B is common segment for comparing options.

FIGURE 11

- Proposed Overhead Transmission Line A
- Proposed Underground Transmission Line A
- Easement Boundary
- Area Where Clearing Is Required
- Existing Pipeline
- Overhead Structure (typical location)

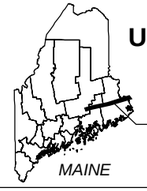
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



OPTION 2

UNDERGROUND TRENCH AND DRILL CROSSING OF NARRAGUAGUS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

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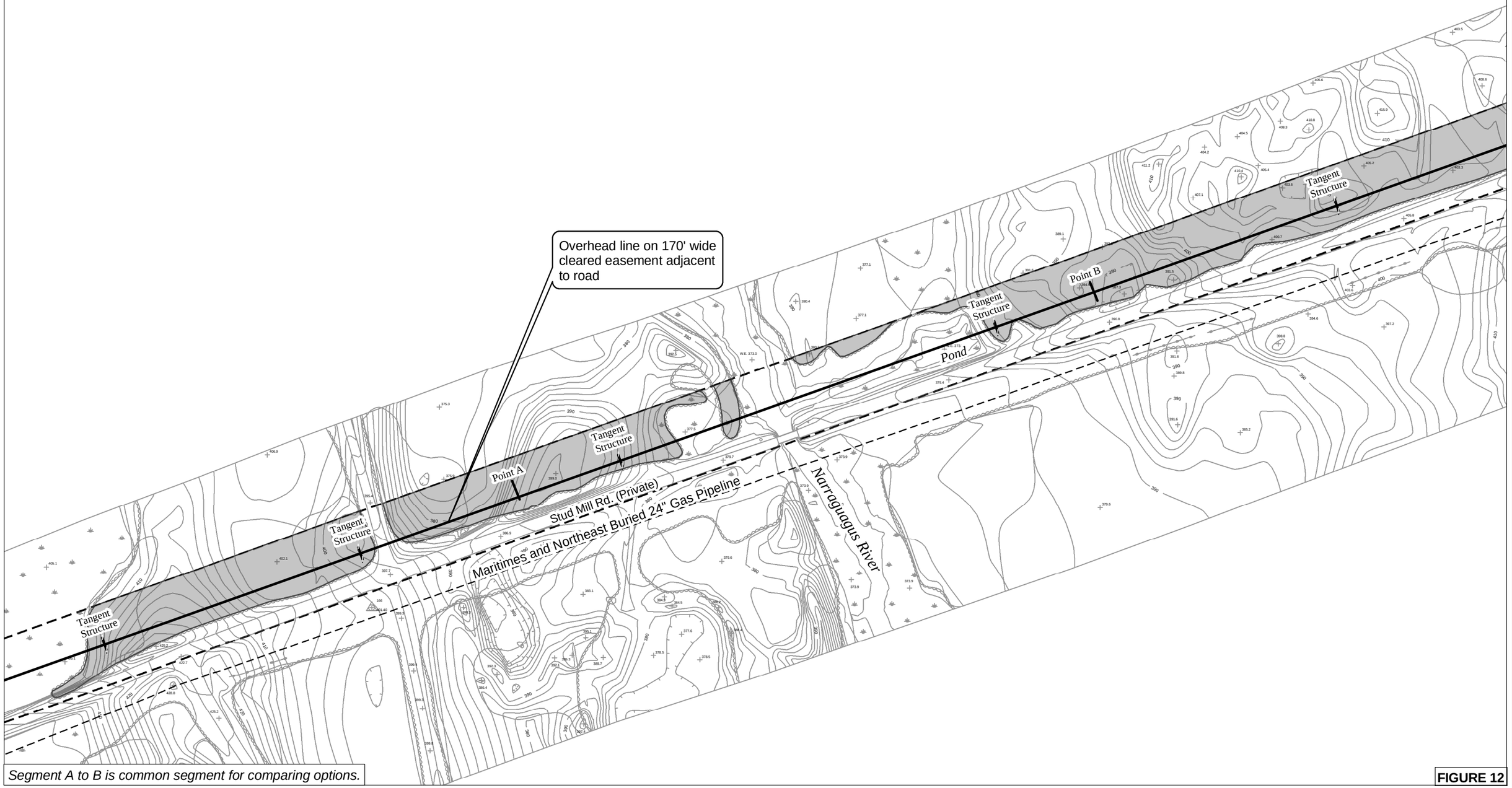


Segment A to B is common segment for comparing options.

FIGURE 12

- Proposed Overhead Transmission Line A
- Proposed Underground Transmission Line A
- Easement Boundary
- Area Where Clearing Is Required
- Existing Pipeline
- Overhead Structure (typical location)

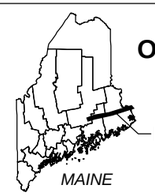
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



Project Area

OPTION 3
OVERHEAD BASIC ALIGNMENT CROSSING OF NARRAGUAGUS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

November 9, 2004

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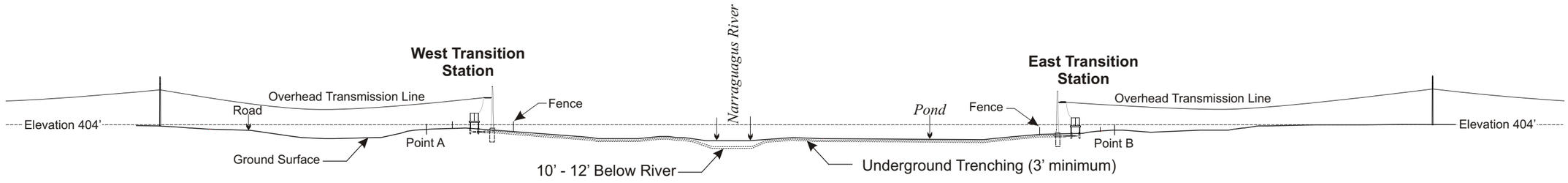
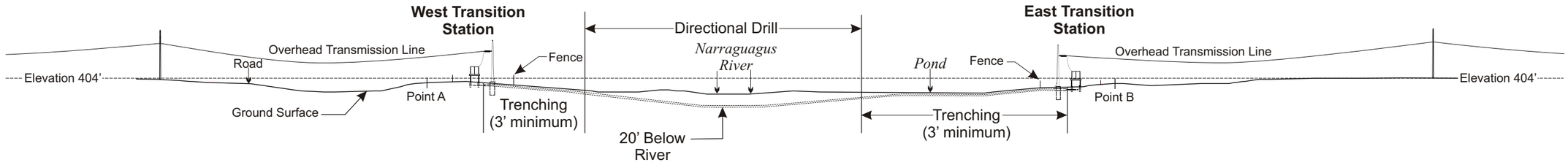
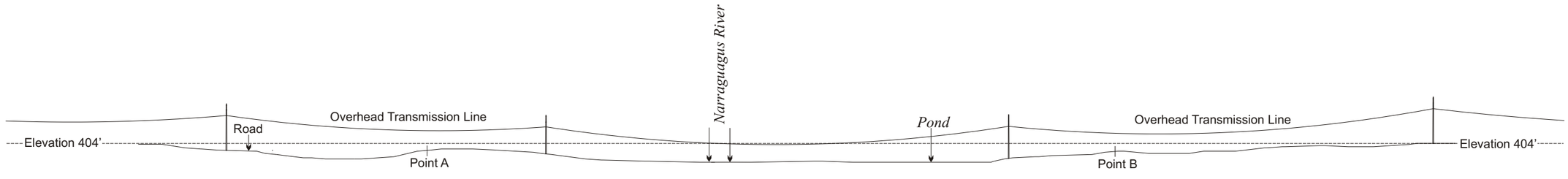


Option 1: Underground Trench Crossing



Option 2: Underground Trench and Drill Crossing



Option 3: Overhead Basic Alignment Crossing

FIGURE 13

Vertical Scale: 1" = 200'
Horizontal Scale: 1" = 200'

Note: Segment A to B is common segment for comparing options.
Conceptual representation - for general review only.

PROFILE VIEW
OPTIONS 1, 2, AND 3 CROSSINGS OF NARRAGUAGUS RIVER
Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004

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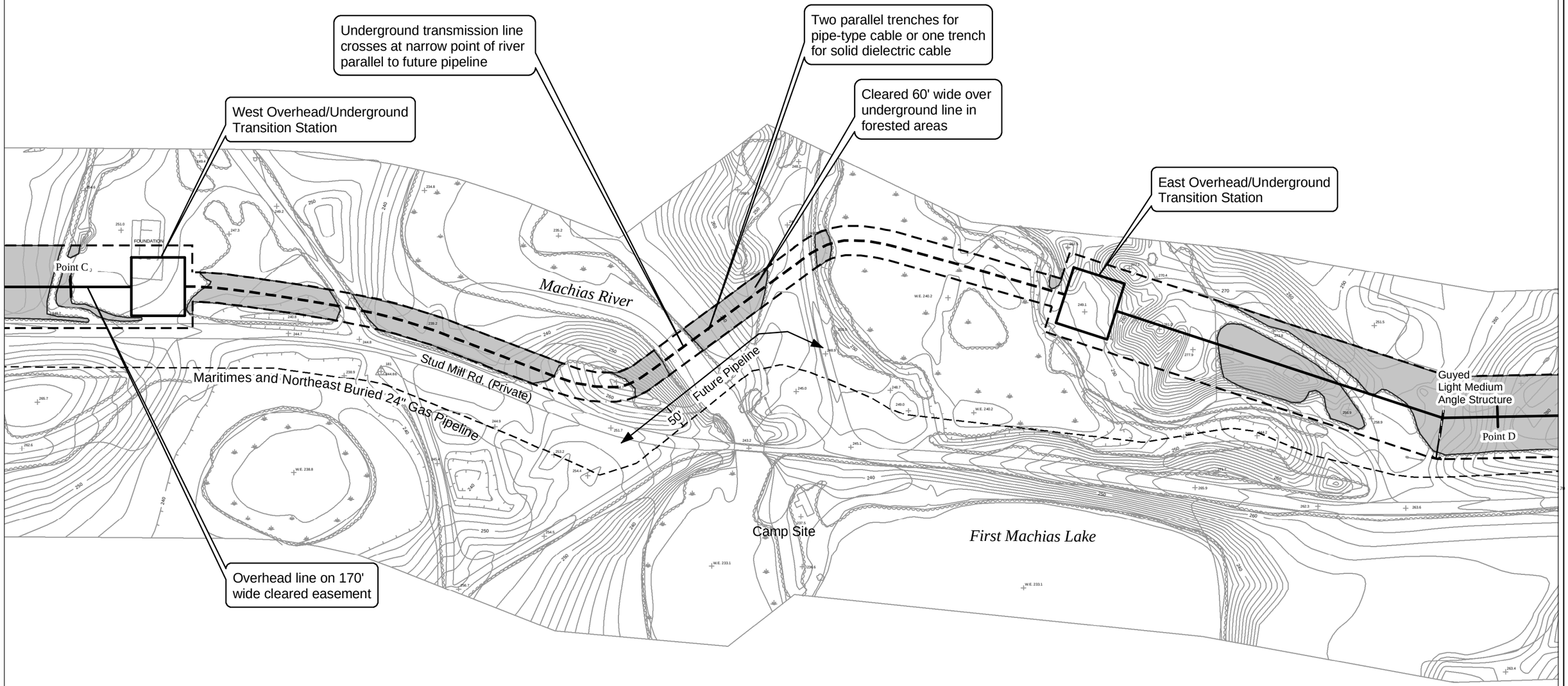
Note: All area shown on map is within the conservation easement north of Studmill Road.



Segment C to D is common segment for comparing options.

FIGURE 14

Proposed Overhead Transmission Line A
Proposed Underground Transmission Line A
Easement Boundary
Area Where Clearing Is Required
Existing Pipeline
Overhead Structure (typical location) ⟵ Guy Wire

Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.

Project Area

OPTION 1
UNDERGROUND TRENCH CROSSING OF MACHIAS RIVER
Northeast Reliability Interconnect - 345 kV Transmission Line
Bangor Hydro Electric Company
November 9, 2004

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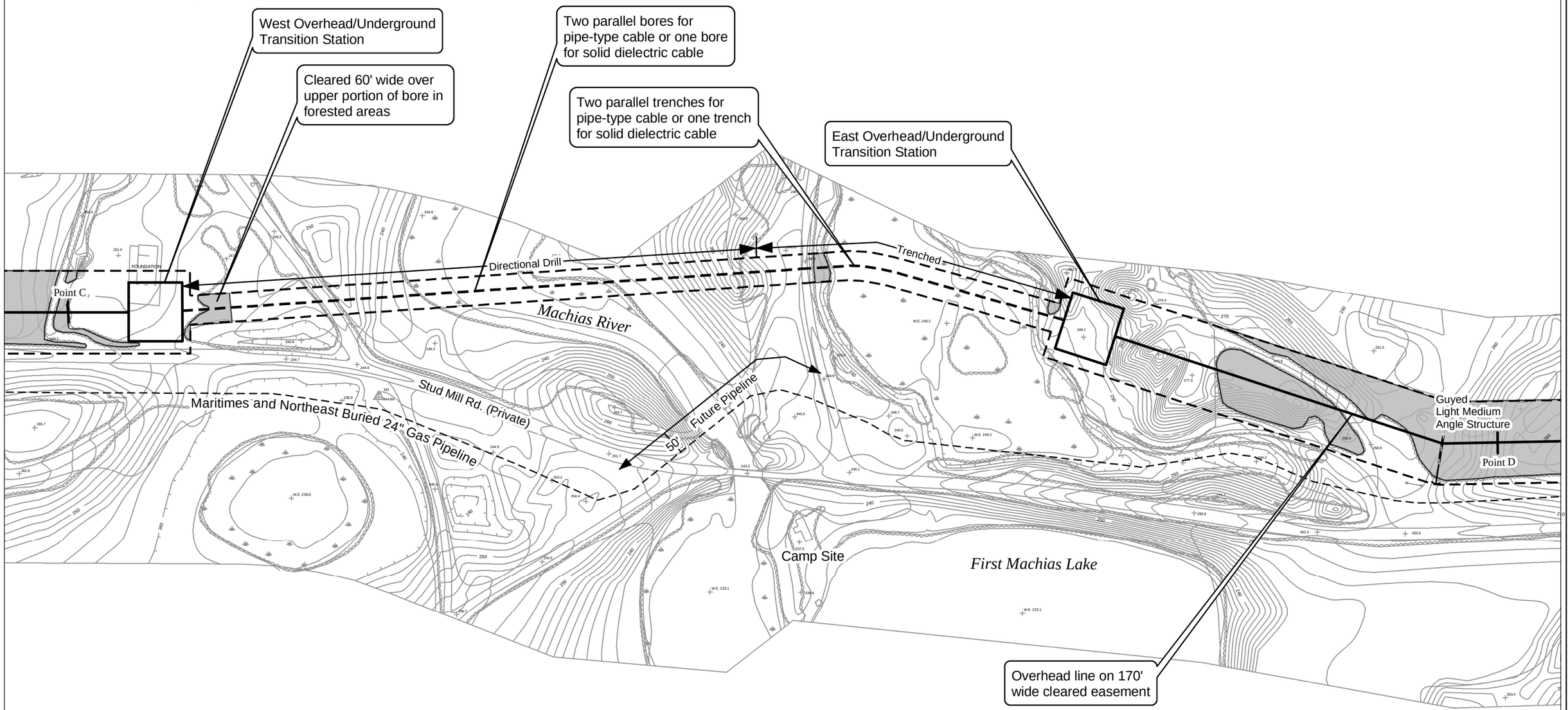
Note: All area shown on map is within the conservation easement north of Studmill Road.



Segment C to D is common segment for comparing options.

FIGURE 15

- Proposed Overhead Transmission Line A
- Proposed Underground Transmission Line A
- Easement Boundary
- Area Where Clearing Is Required
- Existing Pipeline
- Overhead Structure (typical location) ⟵ Guy Wire

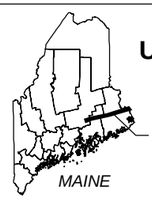
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



OPTION 2

UNDERGROUND TRENCH AND DRILL CROSSING OF MACHIAS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

November 9, 2004

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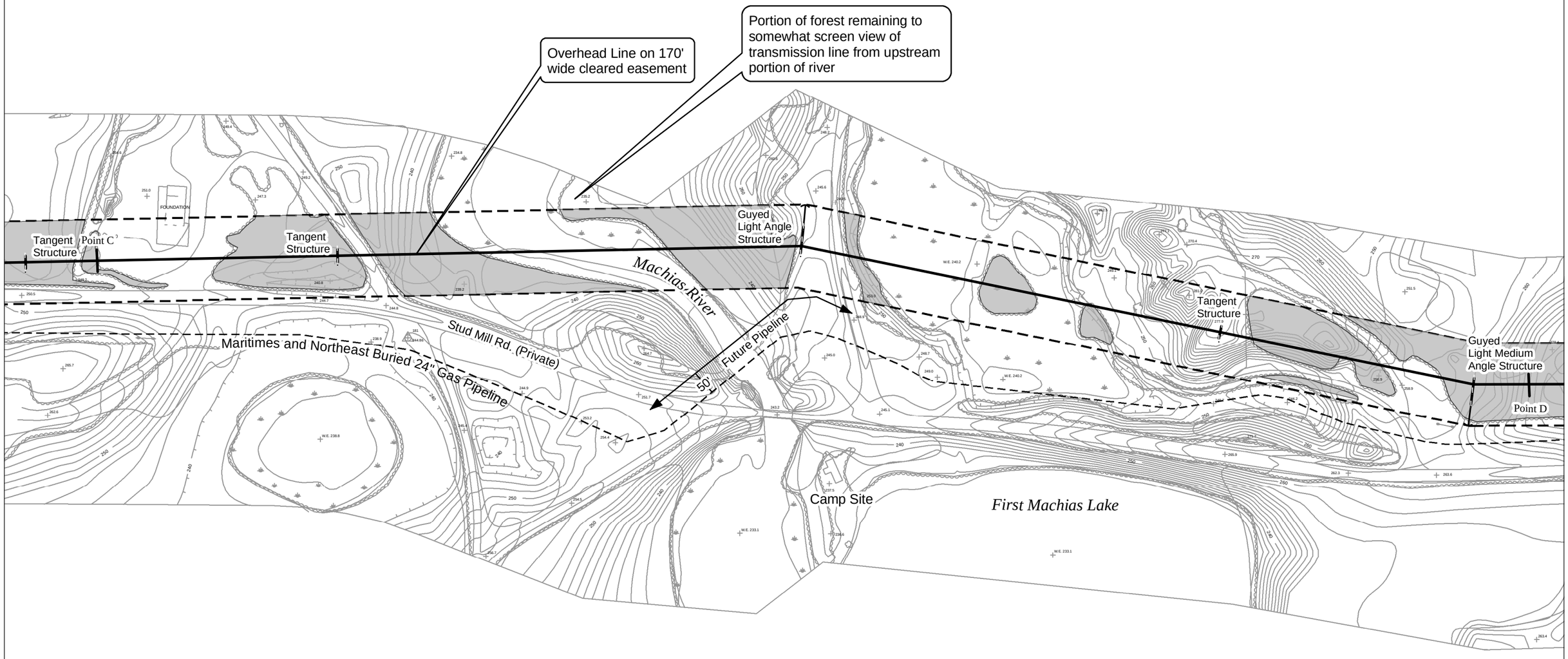
Note: All area shown on map is within the conservation easement north of Studmill Road.



Segment C to D is common segment for comparing options.

FIGURE 16

Proposed Overhead Transmission Line A
Proposed Underground Transmission Line A
Easement Boundary
Area Where Clearing Is Required
Existing Pipeline
Overhead Structure (typical location) ⟵ Guy Wire

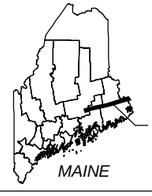
Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data.

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.



Project Area

OPTION 3

OVERHEAD BASIC ALIGNMENT CROSSING OF MACHIAS RIVER

Northeast Reliability Interconnect - 345 kV Transmission Line

Bangor Hydro Electric Company

November 9, 2004

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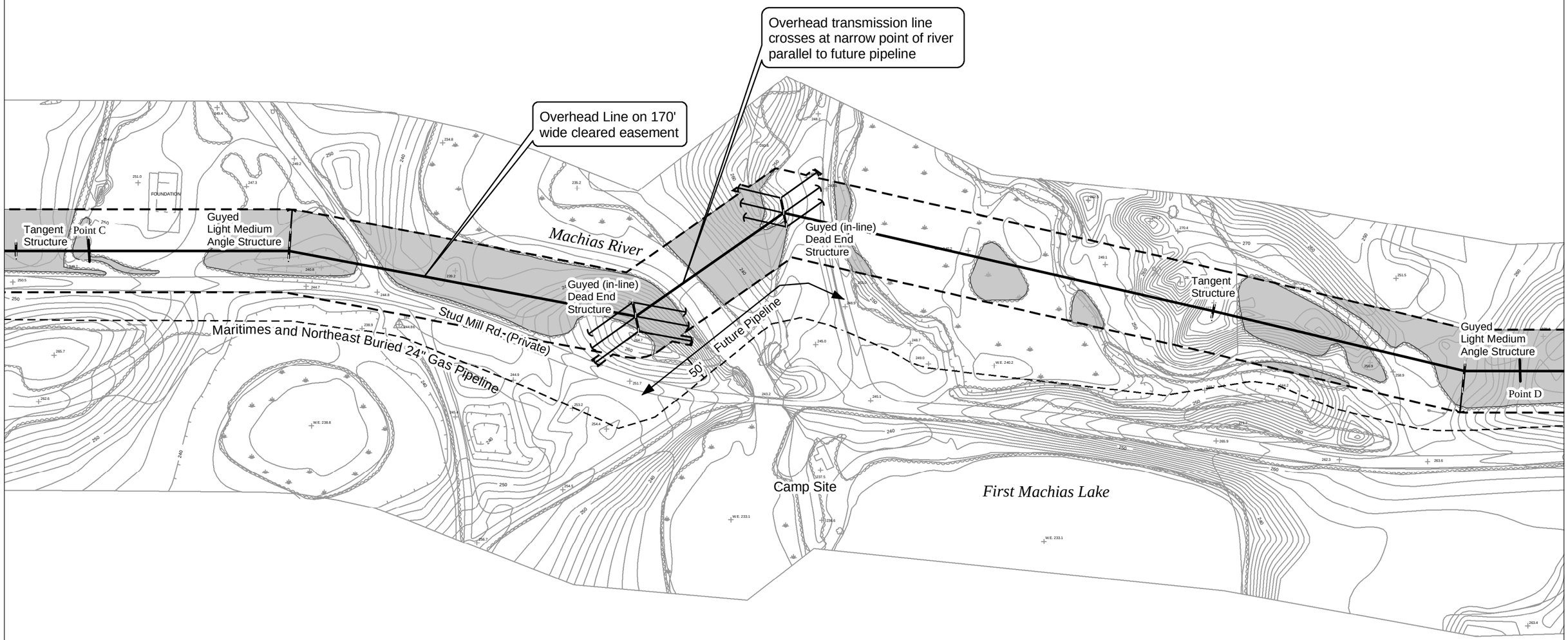
Note: All area shown on map is within the conservation easement north of Studmill Road.



Segment C to D is common segment for comparing options.

FIGURE 17

Proposed Overhead Transmission Line A
Proposed Underground Transmission Line A
Easement Boundary
Area Where Clearing Is Required
Existing Pipeline
Overhead Structure (typical location) ⟵ Guy Wire

Basemap Source: Aerial Survey & Photo, Inc. - aerial photography & PLS-CADD data

Scale: 1" = 200' (1:2,400)

0 100 200 300 400

Feet

Geographic Coordinate System: Maine State Plane East FIPS 1801.
Datum: North American Datum 1983 (NAD83).
Projection: Transverse Mercator.
Linear Unit: US Feet.
Ellipsoid: Geodetic Reference System 1980.

OPTION 4
OVERHEAD PARALLEL TO PIPELINE CROSSING OF MACHIAS RIVER
Northeast Reliability Interconnect - 345 kV Transmission Line
Bangor Hydro Electric Company
November 9, 2004

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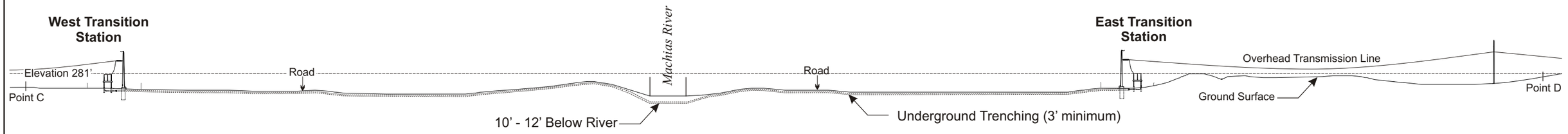
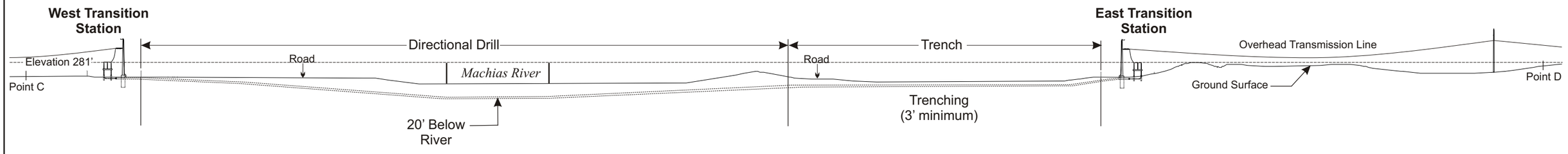


Option 1: Underground Trench Crossing



Option 2: Underground Trench and Drill Crossing

FIGURE 18

Vertical Scale: 1" = 200'
Horizontal Scale: 1" = 200'

Note: Segment A to B is common segment for comparing options.
Conceptual representation - for general review only.

PROFILE VIEW
OPTIONS 1 AND 2 CROSSINGS OF MACHIAS RIVER
Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004

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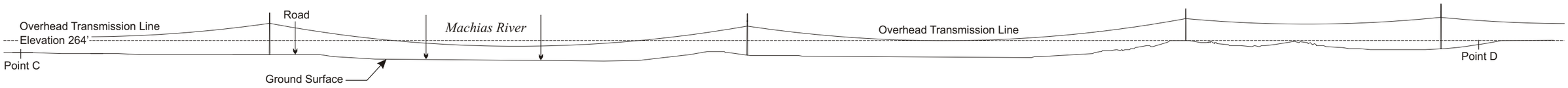
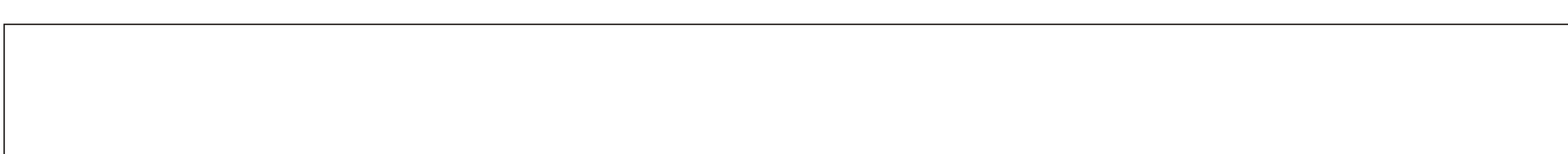


Option 3: Overhead Basic Alignment Crossing



Option 4: Overhead Parallel To Pipeline Crossing

FIGURE 19

Vertical Scale: 1" = 200'
Horizontal Scale: 1" = 200'

Note: Segment A to B is common segment for comparing options.
Conceptual representation - for general review only.

PROFILE VIEW
OPTIONS 3 AND 4 CROSSINGS OF MACHIAS RIVER
Northeast Reliability Interconnect
345 kV Transmission Line
Bangor Hydro-Electric Company

November 1, 2004

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APPENDIX A
DETAILED COST ESTIMATE TABLES A1 – A11

(CAI COPIES ONLY)

TABLE A-1
OPTION 1A - TRENCHED PIPE-TYPE CABLE CROSSING OF NARRAGUAGUS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION			TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS											
Site Work											
Land			1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'			3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'			350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations			26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier			12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations			920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal						31,995			99,240	131,235	
Steel Structures											
Dead end structure			2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)			2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)			4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal						143,077			72,281	215,359	
Grounding/Cable Work											
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors			26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)			0	EA	25,000	0	13.000	0	0	0	
Spare cable terminator for solid dielectric cable (2 terminators)			0	EA	25,000	0		0	0	0	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)			12	EA	35,000	432,600	16.000	192	20,172	452,772	
Spare cable terminator (pipe-type cable, 2 terminators)			2	EA	35,000	72,100		0	0	72,100	
Cable Trifurcator (pipe-type cable, 2 per crossing)			2	EA	40,000	82,400	24.000	48	5,043	87,443	
Grounding/Cable Work Subtotal						599,336			66,818	666,155	
Station Equipment (3)											
Arrester, Surge, 345 kV Sys., 256 kV Station			6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)			2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)			2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)			200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)			1	EA	385,000	396,550	0.000	0	0	396,550	
345KV Overhead Terminal Structures			2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)			1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal						624,180			88,040	712,220	
SUBTOTAL - TWO TRANSITION STATIONS						$1,398,589			$326,379	$1,724,968	
UNDERGROUND 345 KV TRANSMISSION LINE											
Right-of-Way Easement Acquisition	60 ft wide	950 ft long	1.31	AC	2,983	4,020	24.000	31	3,299	7,320	
Easement Subtotal						4,020			3,299	7,320	
Excavation and Backfill (4)											
River crossing, pipe-type, cofferdam, pipe, etc (trench only)		70 ft long	70	FT	707	50,975	4.680	328	34,418	85,392	85,392
River crossing, s.dielectric, cofferdam, pipe,etc (trench only)		0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type)		2 Trench(es)	1,900	FT	4	7,828	0.168	319	33,535	41,363	742,214
Trench dewatering/shoring	80% of length	2 Trench(es)	1,520	FT	8	12,525	2.500	3,800	399,228	411,753	
Trench blasting	25% of length	2 Trench(es)	475	FT	33	16,145	0.730	347	36,430	52,575	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele)		2 Trench(es)	1,900	FT	77	150,689	0.430	817	85,834	236,523	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die)		0 Trench(es)	0	FT	58	0	1.230	0	0	0	
Directional drilling, mob/demob			0	EA	430,000	0	0.000	0	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent		0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent		0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal						238,162			589,444	827,606	
Pipe											
30 In HDPE casing, s-dielectric cable, drilling, 1 pipe		0 Pipes	0	FT	75	0	0.200	0	0	0	1,386,206
30 In HDPE river casing (1 per crossing, dielectric, trenching only)		0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only)		2 Pipes	1,900	FT	30	58,710	0.200	380	39,923	98,633	
Pipe Subtotal						58,710			39,923	98,633	
Cable (5)											
Pipe-type cable (6 per crossing)		6 Cables	6,384	FT	55	361,654	1.100	7,022	737,773	1,099,427	
Spare pipe-type cable (3 cables)		3 Cables	3,192	FT	55	180,827	0.000	0	0	180,827	
Solid dielectric cable (6 per crossing)		0 Cables	0	FT	90	0	1.100	0	0	0	
Spare solid dielectric cable (1 cable)		0 Cables	0	FT	90	0	0.000	0	0	0	
Cable Subtotal						542,480			737,773	1,280,254	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE						$843,373			$1,370,440	$2,213,813	2,213,813
OVERHEAD TRANSMISSION LINE											
Tangent structure, wood H-frame			0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)			0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)			0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire			250	FT	12	3,000	0.11	28	2,889	5,889	
Right-of-way	170 ft wide	250 ft long	0.98	AC	2,983	2,910	0.00	0	0	2,910	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile			250	FT	0	0	0.07	18	1,839	1,839	
SUBTOTAL - OVERHEAD TRANSMISSION LINE						5,910			4,728	10,638	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE						$2,247,872			$1,701,547	$3,949,419	
OTHER COSTS											
Geotech, surveying			1	LOT					80,000	80,000	
Design engineering			5%	of total						197,471	
Owner's overhead cost and project management			20%	of total						789,884	
AFDUC			1%	of total						39,494	
Overall project contingency			15%	of total						592,413	
Credit for overhead line not built			-$160	FT						-152,000	
Other Costs Subtotal										$1,547,262	
RIVER CROSSING TOTAL										**$5,496,680**	

ASSUMPTIONS:

Length of trenching	950 Feet		
Length of directional drilling	0 Feet		
Length of each pipe-type cable	950 feet plus	12% for connect=	1,064 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	250 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-2
OPTION 1B - TRENCHED SOLID DIELECTRIC CABLE CROSSING OF NARRAGUAGUS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	12	EA	25,000	309,000	13.000	156	16,389	325,389	
Spare cable terminator for solid dielectric cable (2 terminators)	2	EA	25,000	51,500		0	0	51,500	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	0	EA	35,000	0	16.000	0	0	0	
Spare cable terminator (pipe-type cable, 2 terminators)	0	EA	35,000	0		0	0	0	
Cable Trifurcator (pipe-type cable, 2 per crossing)	0	EA	40,000	0	24.000	0	0	0	
Grounding/Cable Work Subtotal				372,736			57,993	430,730	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	0	EA	385,000	0	0.000	0	0	0	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				227,630			88,040	315,670	
SUBTOTAL - TWO TRANSITION STATIONS				$775,439			$317,554	$1,092,993	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 950 ft long	1.31	AC	2,983	4,020	24.000	31	3,299	7,320	
Easement Subtotal				4,020			3,299	7,320	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	65,276
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 70 ft long	70	FT	428	30,859	4.680	328	34,418	65,276	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 1 Trench(es)	950	FT	4	3,914	0.168	160	16,768	20,682	371,107
Trench dewatering/shoring 80% of length 1 Trench(es)	760	FT	8	6,262	2.500	1,900	199,614	205,876	
Trench blasting 25% of length 1 Trench(es)	238	FT	33	8,073	0.730	173	18,215	26,287	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 1 Trench(es)	950	FT	77	75,345	0.430	409	42,917	118,262	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 1 Trench(es)	950	FT	58	56,753	1.230	1,169	122,763	179,516	
Directional drilling, mob/demob	0	EA	430,000	0	0.000	0	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal				181,205			434,694	615,899	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0	1,626,966
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 1 Pipes	100	FT	75	7,725	0.400	40	4,202	11,927	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 0 Pipes	0	FT	30	0	0.200	0	0	0	
Pipe Subtotal				7,725			4,202	11,927	
Cable (5)									
Pipe-type cable (6 per crossing) 0 Cables	0	FT	55	0	1.100	0	0	0	
Spare pipe-type cable (3 cables) 0 Cables	0	FT	55	0	0.000	0	0	0	
Solid dielectric cable (6 per crossing) 6 Cables	6,384	FT	90	591,797	1.100	7,022	737,773	1,329,570	
Spare solid dielectric cable (1 cable) 1 Cables	1,064	FT	90	98,633	0.000	0	0	98,633	
Cable Subtotal				690,430			737,773	1,428,203	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$883,380			$1,179,969	$2,063,349	2,063,349
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	250	FT	12	3,000	0.11	28	2,889	5,889	
Right-of-way 170 ft wide 250 ft long	0.98	AC	2,983	2,910	0.00	0	0	2,910	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	250	FT	0	0	0.07	18	1,839	1,839	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				5,910			4,728	10,638	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$1,664,729			$1,502,251	$3,166,980	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							158,349	
Owner's overhead cost and project management	20% of total							633,396	
AFDUC	1% of total							31,670	
Overall project contingency	15% of total							475,047	
Credit for overhead line not built	-$160	FT						-152,000	
Other Costs Subtotal								$1,226,462	
RIVER CROSSING TOTAL								**$4,393,442**	

ASSUMPTIONS:

Length of trenching	950 Feet		
Length of directional drilling	0 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	950 feet plus	12% for connect=	1,064 feet
Length of overhead line	250 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-3
OPTION 2A - TRENCHED AND BORED PIPE-TYPE CABLE CROSSING OF NARRAGUAGUS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	0	EA	25,000	0	13.000	0	0	0	
Spare cable terminator for solid dielectric cable (2 terminators)	0	EA	25,000	0		0	0	0	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	12	EA	35,000	432,600	16.000	192	20,172	452,772	
Spare cable terminator (pipe-type cable, 2 terminators)	2	EA	35,000	72,100		0	0	72,100	
Cable Trifurcator (pipe-type cable, 2 per crossing)	2	EA	40,000	82,400	24.000	48	5,043	87,443	
Grounding/Cable Work Subtotal				599,336			66,818	666,155	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	1	EA	385,000	396,550	0.000	0	0	396,550	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				624,180			88,040	712,220	
SUBTOTAL - TWO TRANSITION STATIONS				$1,398,589			$326,379	$1,724,968	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 950 ft long	1.31	AC	2,983	4,020	24.000	31	3,299	7,320	
Easement Subtotal				4,020			3,299	7,320	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 2 Trench(es)	900	FT	4	3,708	0.168	151	15,885	19,593	351,575
Trench dewatering/shoring 80% of length 2 Trench(es)	720	FT	8	5,933	2.500	1,800	189,108	195,041	
Trench blasting 25% of length 2 Trench(es)	225	FT	33	7,648	0.730	164	17,256	24,904	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 2 Trench(es)	900	FT	77	71,379	0.430	387	40,658	112,037	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 0 Trench(es)	0	FT	58	0	1.230	0	0	0	
Directional drilling, mob/demob	1	EA	430,000	442,900	0.000	0	0	442,900	1,016,610
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 2 Bores	1,000	FT	557	573,710	0.000	0	0	573,710	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal				1,105,278			262,907	1,368,185	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0	1,334,294
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 2 Pipes	900	FT	30	27,810	0.200	180	18,911	46,721	
Pipe Subtotal				27,810			18,911	46,721	
Cable (5)									
Pipe-type cable (6 per crossing) 6 Cables	6,384	FT	55	361,654	1.100	7,022	737,773	1,099,427	
Spare pipe-type cable (3 cables) 3 Cables	3,192	FT	55	180,827	0.000	0	0	180,827	
Solid dielectric cable (6 per crossing) 0 Cables	0	FT	90	0	1.100	0	0	0	
Spare solid dielectric cable (1 cable) 0 Cables	0	FT	90	0	0.000	0	0	0	
Cable Subtotal				542,480			737,773	1,280,254	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$1,679,588			$1,022,891	$2,702,479	2,702,479
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	250	FT	12	3,000	0.11	28	2,889	5,889	
Right-of-way 170 ft wide 250 ft long	0.98	AC	2,983	2,910	0.00	0	0	2,910	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	250	FT	0	0	0.07	18	1,839	1,839	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				5,910			4,728	10,638	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$3,084,087			$1,353,998	$4,438,085	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							221,904	
Owner's overhead cost and project management	20% of total							887,617	
AFDUC	1% of total							44,381	
Overall project contingency	15% of total							665,713	
Credit for overhead line not built	-$160	FT						-152,000	
Other Costs Subtotal								$1,747,615	
RIVER CROSSING TOTAL								**$6,185,701**	

ASSUMPTIONS:

Length of trenching	450 Feet		
Length of directional drilling	500 Feet		
Length of each pipe-type cable	950 feet plus	12% for connect=	1,064 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	250 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-4
OPTION 2B - TRENCHED AND BORED SOLID DIELECTRIC CABLE CROSSING OF NARRAGUAGUS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	12	EA	25,000	309,000	13.000	156	16,389	325,389	
Spare cable terminator for solid dielectric cable (2 terminators)	2	EA	25,000	51,500		0	0	51,500	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	0	EA	35,000	0	16.000	0	0	0	
Spare cable terminator (pipe-type cable, 2 terminators)	0	EA	35,000	0		0	0	0	
Cable Trifurcator (pipe-type cable, 2 per crossing)	0	EA	40,000	0	24.000	0	0	0	
Grounding/Cable Work Subtotal				372,736			57,993	430,730	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	0	EA	385,000	0	0.000	0	0	0	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				227,630			88,040	315,670	
SUBTOTAL - TWO TRANSITION STATIONS				$775,439			$317,554	$1,092,993	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 950 ft long	1.31	AC	2,983	4,020	24.000	31	3,299	7,320	
Easement Subtotal				4,020			3,299	7,320	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 1 Trench(es)	450	FT	4	1,854	0.168	76	7,943	9,797	175,787
Trench dewatering/shoring 80% of length 1 Trench(es)	360	FT	8	2,966	2.500	900	94,554	97,520	
Trench blasting 25% of length 1 Trench(es)	113	FT	33	3,824	0.730	82	8,628	12,452	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 1 Trench(es)	450	FT	77	35,690	0.430	194	20,329	56,019	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 1 Trench(es)	450	FT	58	26,883	1.230	554	58,151	85,034	
Directional drilling, mob/demob	1	EA	430,000	442,900	0.000	0	0	442,900	956,355
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 1 Bores	500	FT	997	513,455	0.000	0	0	513,455	
Excavation and Backfill Subtotal				1,027,572			189,604	1,217,176	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 1 Pipes	500	FT	75	38,625	0.200	100	10,506	49,131	1,569,688
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 0 Pipes	0	FT	30	0	0.200	0	0	0	
Pipe Subtotal				38,625			10,506	49,131	
Cable (5)									
Pipe-type cable (6 per crossing) 0 Cables	0	FT	55	0	1.100	0	0	0	
Spare pipe-type cable (3 cables) 0 Cables	0	FT	55	0	0.000	0	0	0	
Solid dielectric cable (6 per crossing) 6 Cables	6,384	FT	90	591,797	1.100	7,022	737,773	1,329,570	
Spare solid dielectric cable (1 cable) 1 Cables	1,064	FT	90	98,633	0.000	0	0	98,633	
Cable Subtotal				690,430			737,773	1,428,203	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$1,760,647			$941,183	$2,701,830	2,701,830
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	250	FT	12	3,000	0.11	28	2,889	5,889	
Right-of-way 170 ft wide 250 ft long	0.98	AC	2,983	2,910	0.00	0	0	2,910	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	250	FT	0	0	0.07	18	1,839	1,839	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				5,910			4,728	10,638	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$2,541,996			$1,263,465	$3,805,461	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							190,273	
Owner's overhead cost and project management	20% of total							761,092	
AFDUC	1% of total							38,055	
Overall project contingency	15% of total							570,819	
Credit for overhead line not built	-$160	FT						-152,000	
Other Costs Subtotal								$1,488,239	
RIVER CROSSING TOTAL								**$5,293,700**	

ASSUMPTIONS:

Length of trenching	450 Feet		
Length of directional drilling	500 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	950 feet plus	12% for connect=	1,064 feet
Length of overhead line	250 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-5
OPTION 3 - OVERHEAD CROSSING ON BASIC ALIGNMENT OF NARRAGUAGUS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST
TWO 345 KV TRANSITION STATIONS								
Site Work								
Land	0	AC	2,983	0	24.000	0	0	0
Site Grading, cut & fill-2 stations 110'x100'	0	CY	0.00	0	0.150	0	0	0
Site Grading, trenching on site-2 stations 110'x100'	0	CY	0.00	0	0.200	0	0	0
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	0	SF	0.46	0	0.002	0	0	0
Foundation Concrete, 345 kV, Various Structure., 1 Pier	0	CY	845	0	24.000	0	0	0
Fence, Chain link, 8' High, With Gates-2 stations	0	FT	6	0	0.065	0	0	0
Site Work Subtotal				0			0	0
Steel Structures								
Dead end structure	0	EA	37,900	0	240.000	0	0	0
345 kV, SA Support, 3 PH (1656 LB)	0	EA	1,555	0	32.000	0	0	0
345kV Terminator Structure (3PH)	0	EA	15,000	0	36.000	0	0	0
Steel Structure Subtotal				0			0	0
Grounding/Cable Work								
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	0	SF	0.45	0	0.015	0	0	0
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	0	EA	25,000	0	13.000	0	0	0
Spare cable terminator for solid dielectric cable (2 terminators)	0	EA	25,000	0		0	0	0
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	0	EA	35,000	0	16.000	0	0	0
Spare cable terminator (pipe-type cable, 2 terminators)	0	EA	35,000	0		0	0	0
Cable Trifurcator (pipe-type cable, 2 per crossing)	0	EA	40,000	0	24.000	0	0	0
Grounding/Cable Work Subtotal				0			0	0
Station Equipment (3)								
Arrester, Surge, 345 kV Sys., 256 kV Station	0	EA	10,000	0	15.000	0	0	0
Station low-voltage AC power source (propane generator)	0	EA	12,000	0	8.000	0	0	0
Station DC system power source (batteries & charger)	0	EA	6,000	0	66.000	0	0	0
Station Control House (100 sq ft ea)	0	SF	46	0	0.600	0	0	0
Pressurizing System (pipe-type cable, 1 per crossing)	0	EA	385,000	0	0.000	0	0	0
345KV Overhead Terminal Structures	0	EA	37,900	0	240.000	0	0	0
Monitoring and Communications (1 per crossing)(3)	0	EA	40,000	0	0.000	0	0	0
Station Equipment Subtotal				0			0	0
SUBTOTAL - TWO TRANSITION STATIONS				$0			$0	$0
UNDERGROUND 345 KV TRANSMISSION LINE								
Right-of-Way Easement Acquisition 0 ft wide 0 ft long	0.00	AC	2,983	0	24.000	0	0	0
Easement Subtotal				0			0	0
Excavation and Backfill (4)								
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0
Trench excavation (1 trench solid dielectric, 2 pipe-type) 0 Trench(es)	0	FT	4	0	0.168	0	0	0
Trench dewatering/shoring 80% of length 0 Trench(es)	0	FT	8	0	2.500	0	0	0
Trench blasting 25% of length 0 Trench(es)	0	FT	33	0	0.730	0	0	0
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 0 Trench(es)	0	FT	77	0	0.430	0	0	0
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 0 Trench(es)	0	FT	58	0	1.230	0	0	0
Directional drilling, mob/demob	0	EA	430,000	0	0.000	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0
Excavation and Backfill Subtotal				0			0	0
Pipe								
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0
10 Inch steel pipe (2 per crossing, pipe-type cable only) 0 Pipes	0	FT	30	0	0.200	0	0	0
Pipe Subtotal				0			0	0
Cable (5)								
Pipe-type cable (6 per crossing) 0 Cables	0	FT	55	0	1.100	0	0	0
Spare pipe-type cable (3 cables) 0 Cables	0	FT	55	0	0.000	0	0	0
Solid dielectric cable (6 per crossing) 0 Cables	0	FT	90	0	1.100	0	0	0
Spare solid dielectric cable (1 cable) 0 Cables	0	FT	90	0	0.000	0	0	0
Cable Subtotal				0			0	0
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$0			$0	$0
OVERHEAD TRANSMISSION LINE								
Tangent structure, wood H-frame	2	EA	14,000	28,000	54	108	11,346	39,346
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0
Conductor and Shield Wire	1,300	FT	12	15,600	0.11	143	15,024	30,624
Right-of-way 170 ft wide 1300 ft long	5.07	AC	2,983	15,134	0.00	0	0	15,134
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	1,300	FT	0	0	0.07	91	9,560	9,560
SUBTOTAL - OVERHEAD TRANSMISSION LINE				58,734			35,931	94,665
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$58,734			$35,931	$94,665
OTHER COSTS								
Geotech, surveying	1	LOT					80,000	80,000
Design engineering	5% of total							4,733
Owner's overhead cost and project management	20% of total							18,933
AFDUC	1% of total							947
Overall project contingency	15% of total							14,200
Credit for overhead line not built	-$160	FT						0
Other Costs Subtotal								$118,813
RIVER CROSSING TOTAL								**$213,477**

ASSUMPTIONS:

Length of trenching	0 Feet		
Length of directional drilling	0 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	1,300 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-6
OPTION 1A - TRENCHED PIPE-TYPE CABLE CROSSING OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	0	EA	25,000	0	13.000	0	0	0	
Spare cable terminator for solid dielectric cable (2 terminators)	0	EA	25,000	0		0	0	0	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	12	EA	35,000	432,600	16.000	192	20,172	452,772	
Spare cable terminator (pipe-type cable, 2 terminators)	2	EA	35,000	72,100		0	0	72,100	
Cable Trifurcator (pipe-type cable, 2 per crossing)	2	EA	40,000	82,400	24.000	48	5,043	87,443	
Grounding/Cable Work Subtotal				599,336			66,818	666,155	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	1	EA	385,000	396,550	0.000	0	0	396,550	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				624,180			88,040	712,220	
SUBTOTAL - TWO TRANSITION STATIONS				$1,398,589			$326,379	$1,724,968	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 1950 ft long	2.69	AC	2,983	8,253	24.000	64	6,772	15,025	
Easement Subtotal				8,253			6,772	15,025	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 70 ft long	70	FT	707	50,975	4.680	328	34,418	85,392	85,392
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 2 Trench(es)	3,900	FT	4	16,068	0.168	655	68,835	84,903	1,523,491
Trench dewatering/shoring 80% of length 2 Trench(es)	3,120	FT	8	25,709	2.500	7,800	819,468	845,177	
Trench blasting 25% of length 2 Trench(es)	975	FT	33	33,140	0.730	712	74,776	107,917	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 2 Trench(es)	3,900	FT	77	309,309	0.430	1,677	176,186	485,495	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 0 Trench(es)	0	FT	58	0	1.230	0	0	0	
Directional drilling, mob/demob	0	EA	430,000	0	0.000	0	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal				435,201			1,173,683	1,608,884	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0	2,845,371
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 2 Pipes	3,900	FT	30	120,510	0.200	780	81,947	202,457	
Pipe Subtotal				120,510			81,947	202,457	
Cable (5)									
Pipe-type cable (6 per crossing) 6 Cables	13,104	FT	55	742,342	1.100	14,414	1,514,377	2,256,718	
Spare pipe-type cable (3 cables) 3 Cables	6,552	FT	55	371,171	0.000	0	0	371,171	
Solid dielectric cable (6 per crossing) 0 Cables	0	FT	90	0	1.100	0	0	0	
Spare solid dielectric cable (1 cable) 0 Cables	0	FT	90	0	0.000	0	0	0	
Cable Subtotal				1,113,512			1,514,377	2,627,889	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$1,677,476			$2,776,779	$4,454,255	4,454,255
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	1	EA	23,000	23,000	109	109	11,452	34,452	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	1,060	FT	12	12,720	0.11	117	12,250	24,970	
Right-of-way 170 ft wide 1060 ft long	4.14	AC	2,983	12,340	0.00	0	0	12,340	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	1,060	FT	0	0	0.07	74	7,795	7,795	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				48,060			31,497	79,557	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$3,124,124			$3,134,656	$6,258,780	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5%	of total						312,939	
Owner's overhead cost and project management	20%	of total						1,251,756	
AFDUC	1%	of total						62,588	
Overall project contingency	15%	of total						938,817	
Credit for overhead line not built	-$160	FT						-312,000	
Other Costs Subtotal								$2,334,100	
RIVER CROSSING TOTAL								**$8,592,880**	

ASSUMPTIONS:

Length of trenching	1950	Feet	
Length of directional drilling	0	Feet	
Length of each pipe-type cable	1,950	feet plus 12% for connect=	2,184 feet
Length of each solid-dielectric cable	0	feet plus 12% for connect=	0 feet
Length of overhead line	1,060	Feet	
Cost inflation	1.03	Multiplier factor	
Construction labor	102	$/hour	

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-7
OPTION 1B - TRENCHED SOLID DIELECTRIC CABLE CROSSING OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	12	EA	25,000	309,000	13.000	156	16,389	325,389	
Spare cable terminator for solid dielectric cable (2 terminators)	2	EA	25,000	51,500		0	0	51,500	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	0	EA	35,000	0	16.000	0	0	0	
Spare cable terminator (pipe-type cable, 2 terminators)	0	EA	35,000	0		0	0	0	
Cable Trifurcator (pipe-type cable, 2 per crossing)	0	EA	40,000	0	24.000	0	0	0	
Grounding/Cable Work Subtotal				372,736			57,993	430,730	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	0	EA	385,000	0	0.000	0	0	0	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				227,630			88,040	315,670	
SUBTOTAL - TWO TRANSITION STATIONS				$775,439			$317,554	$1,092,993	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 1950 ft long	2.69	AC	2,983	8,253	24.000	64	6,772	15,025	
Easement Subtotal				8,253			6,772	15,025	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	65,276
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 70 ft long	70	FT	428	30,859	4.680	328	34,418	65,276	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 1 Trench(es)	1,950	FT	4	8,034	0.168	328	34,418	42,452	761,746
Trench dewatering/shoring 80% of length 1 Trench(es)	1,560	FT	8	12,854	2.500	3,900	409,734	422,588	
Trench blasting 25% of length 1 Trench(es)	488	FT	33	16,570	0.730	356	37,388	53,958	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 1 Trench(es)	1,950	FT	77	154,655	0.430	839	88,093	242,747	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 1 Trench(es)	1,950	FT	58	116,493	1.230	2,399	251,986	368,479	
Directional drilling, mob/demob	0	EA	430,000	0	0.000	0	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal				339,465			856,037	1,195,502	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0	3,327,006
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 1 Pipes	100	FT	75	7,725	0.400	40	4,202	11,927	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 0 Pipes	0	FT	30	0	0.200	0	0	0	
Pipe Subtotal				7,725			4,202	11,927	
Cable (5)									
Pipe-type cable (6 per crossing) 0 Cables	0	FT	55	0	1.100	0	0	0	
Spare pipe-type cable (3 cables) 0 Cables	0	FT	55	0	0.000	0	0	0	
Solid dielectric cable (6 per crossing) 6 Cables	13,104	FT	90	1,214,741	1.100	14,414	1,514,377	2,729,118	
Spare solid dielectric cable (1 cable) 1 Cables	2,184	FT	90	202,457	0.000	0	0	202,457	
Cable Subtotal				1,417,198			1,514,377	2,931,574	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$1,772,640			$2,381,388	$4,154,028	4,154,028
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	1	EA	23,000	23,000	109	109	11,452	34,452	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	1,060	FT	12	12,720	0.11	117	12,250	24,970	
Right-of-way 170 ft wide 1060 ft long	4.14	AC	2,983	12,340	0.00	0	0	12,340	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	1,060	FT	0	0	0.07	74	7,795	7,795	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				48,060			31,497	79,557	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$2,596,139			$2,730,440	$5,326,579	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							266,329	
Owner's overhead cost and project management	20% of total							1,065,316	
AFDUC	1% of total							53,266	
Overall project contingency	15% of total							798,987	
Credit for overhead line not built	-$160	FT						-312,000	
Other Costs Subtotal								$1,951,897	
RIVER CROSSING TOTAL								**$7,278,476**	

ASSUMPTIONS:

Length of trenching	1950	Feet	
Length of directional drilling	0	Feet	
Length of each pipe-type cable	0	feet plus 12% for connect=	0 feet
Length of each solid-dielectric cable	1,950	feet plus 12% for connect=	2,184 feet
Length of overhead line	1,060	Feet	
Cost inflation	1.03	Multiplier factor	
Construction labor	102	$/hour	

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-8
OPTION 2A - TRENCHED AND BORED PIPE-TYPE CABLE CROSSING OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	0	EA	25,000	0	13.000	0	0	0	
Spare cable terminator for solid dielectric cable (2 terminators)	0	EA	25,000	0		0	0	0	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	12	EA	35,000	432,600	16.000	192	20,172	452,772	
Spare cable terminator (pipe-type cable, 2 terminators)	2	EA	35,000	72,100		0	0	72,100	
Cable Trifurcator (pipe-type cable, 2 per crossing)	2	EA	40,000	82,400	24.000	48	5,043	87,443	
Grounding/Cable Work Subtotal				599,336			66,818	666,155	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	1	EA	385,000	396,550	0.000	0	0	396,550	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				624,180			88,040	712,220	
SUBTOTAL - TWO TRANSITION STATIONS				$1,398,589			$326,379	$1,724,968	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 1830 ft long	2.52	AC	2,983	7,745	24.000	60	6,356	14,100	
Easement Subtotal				7,745			6,356	14,100	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 2 Trench(es)	1,280	FT	4	5,274	0.168	215	22,592	27,866	500,018
Trench dewatering/shoring 80% of length 2 Trench(es)	1,024	FT	8	8,438	2.500	2,560	268,954	277,391	
Trench blasting 25% of length 2 Trench(es)	320	FT	33	10,877	0.730	234	24,542	35,419	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 2 Trench(es)	1,280	FT	77	101,517	0.430	550	57,825	159,342	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 0 Trench(es)	0	FT	58	0	1.230	0	0	0	
Directional drilling, mob/demob	1	EA	430,000	442,900	0.000	0	0	442,900	1,808,330
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 2 Bores	2,380	FT	557	1,365,430	0.000	0	0	1,365,430	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 0 Bores	0	FT	997	0	0.000	0	0	0	
Excavation and Backfill Subtotal				1,934,435			373,913	2,308,348	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 0 Pipes	0	FT	75	0	0.200	0	0	0	2,546,721
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 2 Pipes	1,280	FT	30	39,552	0.200	256	26,895	66,447	
Pipe Subtotal				39,552			26,895	66,447	
Cable (5)									
Pipe-type cable (6 per crossing) 6 Cables	12,298	FT	55	696,659	1.100	13,527	1,421,184	2,117,843	
Spare pipe-type cable (3 cables) 3 Cables	6,149	FT	55	348,330	0.000	0	0	348,330	
Solid dielectric cable (6 per crossing) 0 Cables	0	FT	90	0	1.100	0	0	0	
Spare solid dielectric cable (1 cable) 0 Cables	0	FT	90	0	0.000	0	0	0	
Cable Subtotal				1,044,989			1,421,184	2,466,173	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$3,026,720			$1,828,348	$4,855,068	4,855,068
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	1,060	FT	12	12,720	0.11	117	12,250	24,970	
Right-of-way 170 ft wide 1060 ft long	4.14	AC	2,983	12,340	0.00	0	0	12,340	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	1,060	FT	0	0	0.07	74	7,795	7,795	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				25,060			20,045	45,106	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$4,450,369			$2,174,773	$6,625,142	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							331,257	
Owner's overhead cost and project management	20% of total							1,325,028	
AFDUC	1% of total							66,251	
Overall project contingency	15% of total							993,771	
Credit for overhead line not built	-$160	FT						-292,800	
Other Costs Subtotal								$2,503,508	
RIVER CROSSING TOTAL								**$9,128,650**	

ASSUMPTIONS:

Length of trenching	640 Feet		
Length of directional drilling	1,190 Feet		
Length of each pipe-type cable	1,830 feet plus	12% for connect=	2,050 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	1,060 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-9
OPTION 2B - TRENCHED AND BORED SOLID DIELECTRIC CABLE CROSSING OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION	TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST	
TWO 345 KV TRANSITION STATIONS									
Site Work									
Land	1	AC	2,983	3,072	24.000	24	2,521	5,594	
Site Grading, cut & fill-2 stations 110'x100'	3,000	CY	0.00	0	0.150	450	47,277	47,277	
Site Grading, trenching on site-2 stations 110'x100'	350	CY	0.00	0	0.200	70	7,354	7,354	
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations	26,400	SF	0.46	12,508	0.002	53	5,547	18,055	
Foundation Concrete, 345 kV, Various Structure., 1 Pier	12	CY	845	10,444	24.000	288	30,257	40,701	
Fence, Chain link, 8' High, With Gates-2 stations	920	FT	6	5,970	0.065	60	6,283	12,252	
Site Work Subtotal				31,995			99,240	131,235	
Steel Structures									
Dead end structure	2	EA	37,900	78,074	240.000	480	50,429	128,503	
345 kV, SA Support, 3 PH (1656 LB)	2	EA	1,555	3,203	32.000	64	6,724	9,927	
345kV Terminator Structure (3PH)	4	EA	15,000	61,800	36.000	144	15,129	76,929	
Steel Structure Subtotal				143,077			72,281	215,359	
Grounding/Cable Work									
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors	26,400	SF	0.45	12,236	0.015	396	41,604	53,840	
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)	12	EA	25,000	309,000	13.000	156	16,389	325,389	
Spare cable terminator for solid dielectric cable (2 terminators)	2	EA	25,000	51,500		0	0	51,500	
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)	0	EA	35,000	0	16.000	0	0	0	
Spare cable terminator (pipe-type cable, 2 terminators)	0	EA	35,000	0		0	0	0	
Cable Trifurcator (pipe-type cable, 2 per crossing)	0	EA	40,000	0	24.000	0	0	0	
Grounding/Cable Work Subtotal				372,736			57,993	430,730	
Station Equipment (3)									
Arrester, Surge, 345 kV Sys., 256 kV Station	6	EA	10,000	61,800	15.000	90	9,455	71,255	
Station low-voltage AC power source (propane generator)	2	EA	12,000	24,720	8.000	16	1,681	26,401	
Station DC system power source (batteries & charger)	2	EA	6,000	12,360	66.000	132	13,868	26,228	
Station Control House (100 sq ft ea)	200	SF	46	9,476	0.600	120	12,607	22,083	
Pressurizing System (pipe-type cable, 1 per crossing)	0	EA	385,000	0	0.000	0	0	0	
345KV Overhead Terminal Structures	2	EA	37,900	78,074	240.000	480	50,429	128,503	
Monitoring and Communications (1 per crossing)(3)	1	EA	40,000	41,200	0.000	0	0	41,200	
Station Equipment Subtotal				227,630			88,040	315,670	
SUBTOTAL - TWO TRANSITION STATIONS				$775,439			$317,554	$1,092,993	
UNDERGROUND 345 KV TRANSMISSION LINE									
Right-of-Way Easement Acquisition 60 ft wide 1830 ft long	2.52	AC	2,983	7,745	24.000	60	6,356	14,100	
Easement Subtotal				7,745			6,356	14,100	
Excavation and Backfill (4)									
River crossing, pipe-type, cofferdam, pipe, etc (trench only) 0 ft long	0	FT	707	0	4.680	0	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only) 0 ft long	0	FT	428	0	4.680	0	0	0	
Trench excavation (1 trench solid dielectric, 2 pipe-type) 1 Trench(es)	640	FT	4	2,637	0.168	108	11,296	13,933	250,009
Trench dewatering/shoring 80% of length 1 Trench(es)	512	FT	8	4,219	2.500	1,280	134,477	138,696	
Trench blasting 25% of length 1 Trench(es)	160	FT	33	5,438	0.730	117	12,271	17,709	
Trench thermal backfill, (2 for pipe-type, 1 for solid diele) 1 Trench(es)	640	FT	77	50,758	0.430	275	28,913	79,671	
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die) 1 Trench(es)	640	FT	58	38,234	1.230	787	82,703	120,937	
Directional drilling, mob/demob	1	EA	430,000	442,900	0.000	0	0	442,900	1,664,923
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent 0 Bores	0	FT	557	0	0.000	0	0	0	
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent 1 Bores	1,190	FT	997	1,222,023	0.000	0	0	1,222,023	
Excavation and Backfill Subtotal				1,766,209			269,660	2,035,869	
Pipe									
30 In HDPE casing (1 per crossing, dielectric, drilling only) 1 Pipes	1,190	FT	75	91,928	0.200	238	25,004	116,932	3,003,139
30 In HDPE river casing (1 per crossing, dielectric, trenching only) 0 Pipes	0	FT	75	0	0.400	0	0	0	
10 Inch steel pipe (2 per crossing, pipe-type cable only) 0 Pipes	0	FT	30	0	0.200	0	0	0	
Pipe Subtotal				91,928			25,004	116,932	
Cable (5)									
Pipe-type cable (6 per crossing) 0 Cables	0	FT	55	0	1.100	0	0	0	
Spare pipe-type cable (3 cables) 0 Cables	0	FT	55	0	0.000	0	0	0	
Solid dielectric cable (6 per crossing) 6 Cables	12,298	FT	90	1,139,988	1.100	13,527	1,421,184	2,561,172	
Spare solid dielectric cable (1 cable) 1 Cables	2,050	FT	90	189,998	0.000	0	0	189,998	
Cable Subtotal				1,329,985			1,421,184	2,751,170	
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE				$3,195,867			$1,722,204	$4,918,071	4,918,071
OVERHEAD TRANSMISSION LINE									
Tangent structure, wood H-frame	0	EA	14,000	0	54	0	0	0	
Guyed angle (1 to 30 deg)	0	EA	23,000	0	109	0	0	0	
Guyed dead end (30 to 90 deg.)	0	EA	29,100	0	230	0	0	0	
Conductor and Shield Wire	1,060	FT	12	12,720	0.11	117	12,250	24,970	
Right-of-way 170 ft wide 1060 ft long	4.14	AC	2,983	12,340	0.00	0	0	12,340	
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile	1,060	FT	0	0	0.07	74	7,795	7,795	
SUBTOTAL - OVERHEAD TRANSMISSION LINE				25,060			20,045	45,106	
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE				$3,996,365			$2,059,804	$6,056,169	
OTHER COSTS									
Geotech, surveying	1	LOT					80,000	80,000	
Design engineering	5% of total							302,808	
Owner's overhead cost and project management	20% of total							1,211,234	
AFDUC	1% of total							60,562	
Overall project contingency	15% of total							908,425	
Credit for overhead line not built	-$160	FT						-292,800	
Other Costs Subtotal								$2,270,229	
RIVER CROSSING TOTAL								**$8,326,399**	

ASSUMPTIONS:

Length of trenching	640 Feet		
Length of directional drilling	1190 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	1,830 feet plus	12% for connect=	2,050 feet
Length of overhead line	1,060 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-10
OPTION 3 - OVERHEAD CROSSING ON BASIC ALIGNMENT OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION			TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST
TWO 345 KV TRANSITION STATIONS										
Site Work										
Land			0	AC	2,983	0	24.000	0	0	0
Site Grading, cut & fill-2 stations 110'x100'			0	CY	0.00	0	0.150	0	0	0
Site Grading, trenching on site-2 stations 110'x100'			0	CY	0.00	0	0.200	0	0	0
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations			0	SF	0.46	0	0.002	0	0	0
Foundation Concrete, 345 kV, Various Structure., 1 Pier			0	CY	845	0	24.000	0	0	0
Fence, Chain link, 8' High, With Gates-2 stations			0	FT	6	0	0.065	0	0	0
Site Work Subtotal						0			0	0
Steel Structures										
Dead end structure			0	EA	37,900	0	240.000	0	0	0
345 kV, SA Support, 3 PH (1656 LB)			0	EA	1,555	0	32.000	0	0	0
345kV Terminator Structure (3PH)			0	EA	15,000	0	36.000	0	0	0
Steel Structure Subtotal						0			0	0
Grounding/Cable Work										
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors			0	SF	0.45	0	0.015	0	0	0
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)			0	EA	25,000	0	13.000	0	0	0
Spare cable terminator for solid dielectric cable (2 terminators)			0	EA	25,000	0		0	0	0
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)			0	EA	35,000	0	16.000	0	0	0
Spare cable terminator (pipe-type cable, 2 terminators)			0	EA	35,000	0		0	0	0
Cable Trifurcator (pipe-type cable, 2 per crossing)			0	EA	40,000	0	24.000	0	0	0
Grounding/Cable Work Subtotal						0			0	0
Station Equipment (3)										
Arrester, Surge, 345 kV Sys., 256 kV Station			0	EA	10,000	0	15.000	0	0	0
Station low-voltage AC power source (propane generator)			0	EA	12,000	0	8.000	0	0	0
Station DC system power source (batteries & charger)			0	EA	6,000	0	66.000	0	0	0
Station Control House (100 sq ft ea)			0	SF	46	0	0.600	0	0	0
Pressurizing System (pipe-type cable, 1 per crossing)			0	EA	385,000	0	0.000	0	0	0
345KV Overhead Terminal Structures			0	EA	37,900	0	240.000	0	0	0
Monitoring and Communications (1 per crossing)(3)			0	EA	40,000	0	0.000	0	0	0
Station Equipment Subtotal						0			0	0
SUBTOTAL - TWO TRANSITION STATIONS						$0			$0	$0
UNDERGROUND 345 KV TRANSMISSION LINE										
Right-of-Way Easement Acquisition	0 ft wide	0 ft long	0.00	AC	2,983	0	24.000	0	0	0
Easement Subtotal						0			0	0
Excavation and Backfill (4)										
River crossing, pipe-type, cofferdam, pipe, etc (trench only)		0 ft long	0	FT	707	0	4.680	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only)		0 ft long	0	FT	428	0	4.680	0	0	0
Trench excavation (1 trench solid dielectric, 2 pipe-type)		0 Trench(es)	0	FT	4	0	0.168	0	0	0
Trench dewatering/shoring	80% of length	0 Trench(es)	0	FT	8	0	2.500	0	0	0
Trench blasting	25% of length	0 Trench(es)	0	FT	33	0	0.730	0	0	0
Trench thermal backfill, (2 for pipe-type, 1 for solid diele)		0 Trench(es)	0	FT	77	0	0.430	0	0	0
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die)		0 Trench(es)	0	FT	58	0	1.230	0	0	0
Directional drilling, mob/demob			0	EA	430,000	0	0.000	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent		0 Bores	0	FT	557	0	0.000	0	0	0
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent		0 Bores	0	FT	997	0	0.000	0	0	0
Excavation and Backfill Subtotal						0			0	0
Pipe										
30 In HDPE casing (1 per crossing, dielectric, drilling only)		0 Pipes	0	FT	75	0	0.200	0	0	0
30 In HDPE river casing (1 per crossing, dielectric, trenching only)		0 Pipes	0	FT	75	0	0.400	0	0	0
10 Inch steel pipe (2 per crossing, pipe-type cable only)		0 Pipes	0	FT	30	0	0.200	0	0	0
Pipe Subtotal						0			0	0
Cable (5)										
Pipe-type cable (6 per crossing)		0 Cables	0	FT	55	0	1.100	0	0	0
Spare pipe-type cable (3 cables)		0 Cables	0	FT	55	0	0.000	0	0	0
Solid dielectric cable (6 per crossing)		6 Cables	0	FT	90	0	1.100	0	0	0
Spare solid dielectric cable (1 cable)		1 Cables	0	FT	90	0	0.000	0	0	0
Cable Subtotal						0			0	0
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE						$0			$0	$0
OVERHEAD TRANSMISSION LINE										
Tangent structure, wood H-frame			2	EA	14,000	28,000	54	108	11,346	39,346
Guyed angle (1 to 30 deg)			2	EA	23,000	46,000	109	218	22,903	68,903
Guyed dead end (30 to 90 deg.)			0	EA	29,100	0	230	0	0	0
Conductor and Shield Wire			2,970	FT	12	35,640	0.11	327	34,323	69,963
Right-of-way	170 ft wide	2970 ft long	11.59	AC	2,983	34,576	0.00	0	0	34,576
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile			2,970	FT	0	0	0.07	208	21,842	21,842
SUBTOTAL - OVERHEAD TRANSMISSION LINE						144,216			90,415	234,630
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE						$144,216			$90,415	$234,630
OTHER COSTS										
Geotech, surveying			1	LOT					80,000	80,000
Design engineering			5% of total							11,732
Owner's overhead cost and project management			20% of total							46,926
AFDUC			1% of total							2,346
Overall project contingency			15% of total							35,195
Credit for overhead line not built			-$160	FT						0
Other Costs Subtotal										$176,198
RIVER CROSSING TOTAL										**$410,829**

ASSUMPTIONS:

Length of trenching	0 Feet		
Length of directional drilling	0 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	2,970 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

TABLE A-11
OPTION 4 - OVERHEAD PARALLEL TO PIPELINE CROSSING OF MACHIAS RIVER
CONCEPTUAL COST ESTIMATE (1)
Northeast Reliability Interconnect 345 kV Transmission Line
06-Dec-04

DESCRIPTION			TOTAL QTY	UNIT	MATERIAL UNIT COST	MATERIAL COST (2)	LABOR WHRS PER UNIT	TOTAL WHRS	LABOR COST (2)	TOTAL COST
TWO 345 KV TRANSITION STATIONS										
Site Work										
Land			0	AC	2,983	0	24.000	0	0	0
Site Grading, cut & fill-2 stations 110'x100'			0	CY	0.00	0	0.150	0	0	0
Site Grading, trenching on site-2 stations 110'x100'			0	CY	0.00	0	0.200	0	0	0
Surfacing, crushed stone, 6 " deep, 2-110 ft by 100 ft stations			0	SF	0.46	0	0.002	0	0	0
Foundation Concrete, 345 kV, Various Structure., 1 Pier			0	CY	845	0	24.000	0	0	0
Fence, Chain link, 8' High, With Gates-2 stations			0	FT	6	0	0.065	0	0	0
Site Work Subtotal						0			0	0
Steel Structures										
Dead end structure			0	EA	37,900	0	240.000	0	0	0
345 kV, SA Support, 3 PH (1656 LB)			0	EA	1,555	0	32.000	0	0	0
345kV Terminator Structure (3PH)			0	EA	15,000	0	36.000	0	0	0
Steel Structure Subtotal						0			0	0
Grounding/Cable Work										
Grounding Sys.,20'x20" Grid,4/0 wire,rods,connectors			0	SF	0.45	0	0.015	0	0	0
Cable Terminator, 345kV, Outdoor, (solid dielectric cable, 12 per crossing)			0	EA	25,000	0	13.000	0	0	0
Spare cable terminator for solid dielectric cable (2 terminators)			0	EA	25,000	0		0	0	0
Cable Terminator, 345kV, Outdoor, Porcelain (pipe-type cable, 12 per cross)			0	EA	35,000	0	16.000	0	0	0
Spare cable terminator (pipe-type cable, 2 terminators)			0	EA	35,000	0		0	0	0
Cable Trifurcator (pipe-type cable, 2 per crossing)			0	EA	40,000	0	24.000	0	0	0
Grounding/Cable Work Subtotal						0			0	0
Station Equipment (3)										
Arrester, Surge, 345 kV Sys., 256 kV Station			0	EA	10,000	0	15.000	0	0	0
Station low-voltage AC power source (propane generator)			0	EA	12,000	0	8.000	0	0	0
Station DC system power source (batteries & charger)			0	EA	6,000	0	66.000	0	0	0
Station Control House (100 sq ft ea)			0	SF	46	0	0.600	0	0	0
Pressurizing System (pipe-type cable, 1 per crossing)			0	EA	385,000	0	0.000	0	0	0
345KV Overhead Terminal Structures			0	EA	37,900	0	240.000	0	0	0
Monitoring and Communications (1 per crossing)(3)			0	EA	40,000	0	0.000	0	0	0
Station Equipment Subtotal						0			0	0
SUBTOTAL - TWO TRANSITION STATIONS						$0			$0	$0
UNDERGROUND 345 KV TRANSMISSION LINE										
Right-of-Way Easement Acquisition	0 ft wide	0 ft long	0.00	AC	2,983	0	24.000	0	0	0
Easement Subtotal						0			0	0
Excavation and Backfill (4)										
River crossing, pipe-type, cofferdam, pipe, etc (trench only)		0 ft long	0	FT	707	0	4.680	0	0	0
River crossing, s.dielectric, cofferdam, pipe,etc (trench only)		0 ft long	0	FT	428	0	4.680	0	0	0
Trench excavation (1 trench solid dielectric, 2 pipe-type)		0 Trench(es)	0	FT	4	0	0.168	0	0	0
Trench dewatering/shoring	80% of length	0 Trench(es)	0	FT	8	0	2.500	0	0	0
Trench blasting	25% of length	0 Trench(es)	0	FT	33	0	0.730	0	0	0
Trench thermal backfill, (2 for pipe-type, 1 for solid diele)		0 Trench(es)	0	FT	77	0	0.430	0	0	0
Trench duct bank, 3'x3',w/9 PVC pipes (0 pipe-type,1 sol die)		0 Trench(es)	0	FT	58	0	1.230	0	0	0
Directional drilling, mob/demob			0	EA	430,000	0	0.000	0	0	0
Dir drill 10 in dia pipe-type cable, 2 bores, incl equip rent		0 Bores	0	FT	557	0	0.000	0	0	0
Dir drill 30 in dia pipe, s-dielectric cable,1 bore, incl equip rent		0 Bores	0	FT	997	0	0.000	0	0	0
Excavation and Backfill Subtotal						0			0	0
Pipe										
30 In HDPE casing (1 per crossing, dielectric, drilling only)		0 Pipes	0	FT	75	0	0.200	0	0	0
30 In HDPE river casing (1 per crossing, dielectric, trenching only)		0 Pipes	0	FT	75	0	0.400	0	0	0
10 Inch steel pipe (2 per crossing, pipe-type cable only)		0 Pipes	0	FT	30	0	0.200	0	0	0
Pipe Subtotal						0			0	0
Cable (5)										
Pipe-type cable (6 per crossing)		0 Cables	0	FT	55	0	1.100	0	0	0
Spare pipe-type cable (3 cables)		0 Cables	0	FT	55	0	0.000	0	0	0
Solid dielectric cable (6 per crossing)		0 Cables	0	FT	90	0	1.100	0	0	0
Spare solid dielectric cable (1 cable)		0 Cables	0	FT	90	0	0.000	0	0	0
Cable Subtotal						0			0	0
SUBTOTAL - UNDERGROUND 345 KV TRANSMISSION LINE						$0			$0	$0
OVERHEAD TRANSMISSION LINE										
Tangent structure, wood H-frame			1	EA	14,000	14,000	54	54	5,673	19,673
Guyed angle (1 to 30 deg)			2	EA	23,000	46,000	109	218	22,903	68,903
Guyed dead end (30 to 90 deg.)			2	EA	29,100	58,200	230	460	48,328	106,528
Conductor and Shield Wire			3,080	FT	12	36,960	0.11	339	35,594	72,554
Right-of-way	170 ft wide	3080 ft long	12.02	AC	2,983	35,856	0.00	0	0	35,856
Right-of-way Clearing 155 ft wide, with 7 finger roads per mile			3,080	FT	0	0	0.07	216	22,651	22,651
SUBTOTAL - OVERHEAD TRANSMISSION LINE						191,016			135,149	326,165
SUBTOTAL - TWO TRANSITION STATIONS, UNDERGROUND LINE, AND OVERHEAD LINE						$191,016			$135,149	$326,165
OTHER COSTS										
Geotech, surveying			1	LOT					80,000	80,000
Design engineering			5% of total							16,308
Owner's overhead cost and project management			20% of total							65,233
AFDUC			1% of total							3,262
Overall project contingency			15% of total							48,925
Credit for overhead line not built			-$160	FT						0
Other Costs Subtotal										$213,728
RIVER CROSSING TOTAL										**$539,893**

ASSUMPTIONS:

Length of trenching	0 Feet		
Length of directional drilling	0 Feet		
Length of each pipe-type cable	0 feet plus	12% for connect=	0 feet
Length of each solid-dielectric cable	0 feet plus	12% for connect=	0 feet
Length of overhead line	3,080 Feet		
Cost inflation	1.03 Multiplier factor		
Construction labor	102 $/hour		

NOTES:

(1) CONCEPTUAL COST ESTIMATE ONLY.
NOT INTENDED FOR CONSTRUCTION PURPOSES.
(2) Includes cost inflation escalation at rate shown on left.
(3) Assumes use of transmission line communications system for monitoring underground sections.
(4) Trenches are 3 feet by 6 feet.
(5) Assumes solid dielectric cable is 2 sets of 3-345 kV, 1C, 1600mm (3157KCMIL), cu, XLPE; or 2 sets of 3 pipe-type paper insulated cable. Based on 1000 MW (~940A/c derated). Geothermal analysis is required to properly design and size cable system.

CAI Commonwealth Associates, Inc.
engineers • consultants • construction managers

HEADQUARTERS:
P.O. Box 1124
Jackson, Michigan 49204-1124

Telephone: (517) 788-3000
Fax: (517) 788-3003

REGIONAL OFFICE:
P.O. Box 247
LaConner, WA 98257-0247

Telephone: (360) 466-2214
Fax: (360) 466-1744