

B2H Exhibit BB Errata Sheet

Dear Reader:

Exhibit BB provides information regarding greenhouse gas emissions, compliance with the Oregon Forest Practices Act, issues raised by the Confederated Tribes of the Umatilla Indian Reservation, and undergrounding the transmission line. Further, this Exhibit includes a comprehensive list of each of Idaho Power Company's (IPC) proposed site certificate conditions.

The Applicant submitted its final Application for Site Certification on October 3, 2018. Subsequently, the Oregon Department of Energy requested certain additional information about the Project pursuant to Oregon Administrative Rule (OAR) 345-015-0190(9). This errata sheet provides the requested information—which may include corrections to the exhibit text, tables, figures, and/or proposed conditions—as it relates to Exhibit BB.

As you read this exhibit, please keep in mind that any additional information identified in this errata sheet shall prevail over the contents of the exhibit document itself.

Summary of Additional Information Provided for Exhibit BB and Its Attachments

Page #	Section #	Description of Change(s) Made
Page BB vi	TOC	Added Attachment BB-3A Undergrounding Cost Report to list of attachments
Attachment BB-3A	Attachment BB-3A	Comparison of Cost and Ground Disturbance Between Underground and Overhead Installation Within the Viewshed of the National Historic Oregon Trail Interpretive Center (NHOTIC)
Attachment BB-4	Attachment BB-4	Revised IPC Proposed Site Certificate Condition that were modified in other exhibits

Specific Additional Information Provided for Exhibit BB

Page BB-iv

Description of Additional Information: Added undergrounding cost report to list of attachments.

Text Edits Shown in Red:

Attachment BB-3A. Comparison of Cost and Ground Disturbance Between Underground and Overhead Installation Within the Viewshed of the National Historic Oregon Trail Interpretive Center (NHOTIC)

Page BB-6, Section 3.4.1

Description of Additional Information: Added cost estimate for undergrounding the transmission line for the portion of the route located in front of the National Historic Oregon Trail Interpretive Center.

Text Edits Shown in Red:

IPC reports that while recent research is developing new techniques for manufacturing, design, construction, and maintenance of underground transmission lines, there are several important issues that make the technology for extra high voltage transmission lines impractical for long length installations as described below:

- Cost—One major reason that utilities do not normally install extra high voltage transmission lines underground is that the construction costs are increased by 12 to 17 times over an overhead counterpart, or more (National Grid 2009). In response to comments from the public about undergrounding the transmission line in front of the National Historic Oregon Trail Interpretive Center, IPC obtained a cost estimate for the relevant 2.5-mile segment and found that it would cost approximately 30 to 33 times more to install the project underground in front of the Center in comparison to the projected overhead installation cost (see Attachment BB-3A). These additional costs must be approved by the public utilities commission and are passed on to all the ratepayers, not just those near the area of underground installation.

Specific Additional Information Provided for Attachment BB-4, List of IPC's Proposed Site Certificate Conditions

Description of Additional Information: Added provisions to the following Conditions.

Text Edits Shown in Red:

Fish and Wildlife Condition 2: *Prior to construction, the certificate holder shall conduct, as applicable, the following biological surveys on all portions of the site boundary, regardless of whether those portions have been surveyed at the time of issuance of the site certificate:*

- a. *Washington ground squirrels;*
- b. *Raptor nest;*
- c. *Pigmy rabbits; and*
- d. *Greater sage-grouse, as necessary for the State of Oregon to calculate the amount of sage-grouse habitat compensatory mitigation required for the facility using Oregon's Sage-Grouse Habitat Quantification Tool.*

Fish and Wildlife Condition 8: *Prior to construction, the certificate holder shall finalize, and submit to the department for its approval, a final Sage-Grouse Habitat Mitigation Plan.*

- a. *The certificate holder shall provide to the department the information necessary for the State of Oregon to calculate the amount of sage-grouse habitat compensatory mitigation required for the facility using Oregon's Sage-Grouse Habitat Quantification Tool.*
- b. *The final Sage-Grouse Habitat Mitigation Plan shall address the potential sage-grouse habitat impacts through mitigation banking, an in-lieu fee program, development of mitigation projects by the certificate holder, or a combination of the same.*
 - i. *To the extent the certificate holder shall develop its own mitigation projects, the final Sage-Grouse Habitat Mitigation Plan shall:*
 1. *Identify the location of each mitigation site, including a map of the same;*
 2. *Identify the number of credit-acres that each mitigation site will provide for the certificate holder;*
 3. *Include a site-specific mitigation management plan for each mitigation site that provides for:*
 - A. *A baseline ecological assessment;*
 - B. *Conservation actions to be implemented at the site;*
 - C. *An implementation schedule for the baseline ecological assessment and conservation actions;*
 - D. *Performance measures;*
 - E. *A reporting plan; and*
 - F. *A monitoring plan.*
 - ii. *To the extent the site certificate shall utilize a mitigation bank or in-lieu fee program, the final Sage-Grouse Habitat Mitigation Plan shall:*
 1. *Describe the nature, extent, and history of the mitigation bank or in-lieu fee program; and*
 2. *Identify the number of credit-acres that each mitigation site will provide for the certificate holder.*

iii. The final Sage-Grouse Habitat Mitigation Plan shall include compensatory mitigation sufficient to address impacts from, at a minimum, all facility components except indirect impacts from access roads. As referenced in Fish and Wildlife Condition 25, the certificate holder shall demonstrate during or about the third year of operation that sage-grouse habitat mitigation shall be commensurate with the final compensatory mitigation calculations, which will be based on the as-constructed facility and will include indirect impacts from access roads, either by showing the already-implemented mitigation is sufficient to cover all facility component impacts, or by proposing additional mitigation to address any uncovered impacts.

c. Oregon's Sage-Grouse Habitat Quantification Tool shall be used to calculate the amount of sage-grouse habitat compensatory mitigation required for the facility and the number of credit-acres that each mitigation site will provide for the certificate holder.

d. The Sage-Grouse Habitat Mitigation Plan may be amended from time to time by agreement of the certificate holder and the department. Such amendments may be made without amendment to the site certificate. The Council authorizes the department to agree to amendments of the plan and to mitigation actions that may be required under the plan; however, the Council retains the authority to approve, reject, or modify any amendment of the plan agreed to by the department.

Fish and Wildlife Condition 14: During construction, if active pygmy rabbit colonies or the roost of a State Sensitive bat species is observed during the biological surveys set forth in Fish and Wildlife Conditions 1, 2, or 3, the certificate holder shall submit to the department for its approval a notification addressing the following:

- a. Identification of the State Sensitive bat species observed;
- b. Location of the pygmy rabbit colony or bat roost; and
- c. Any actions the certificate holder will take to avoid, minimize, or mitigate impacts to the pygmy rabbit colony or bat roost.

Public Services Condition 3: Prior to construction, the certificate holder shall finalize, and submit to the department for its approval, a final Fire Prevention and Suppression Plan. The final Fire Prevention and Suppression Plan shall include the following, unless otherwise approved by the department:

- a. The protective measures as described in the draft Fire Prevention and Suppression Plan in ASC Exhibit U, Attachment U-3, shall be included and implemented as part of the final Fire Prevention and Suppression Plan; and
- b. A description of the fire districts and rural fire protection districts that will provide emergency response services during construction and copies of any agreements between the certificate holder and the districts related to that coverage.

Public Services Condition 4: Prior to construction, the certificate holder shall submit to the department for its approval an Environmental and Safety Training Plan, which shall address:

- a. Measures for securing multi-use areas and work sites when not in use; ~~and~~
- b. Drug/alcohol/firearm policies with clear consequences for violations-; ~~and~~
- c. An emergency and medical response plan.

Siting Standard Condition 1: During construction, the certificate holder shall take the following steps to reduce or manage human exposure to electromagnetic fields:

- a. Constructing all aboveground transmission lines at least 200 feet from any residence or other occupied structure, measured from the centerline of the transmission line;
- b. Constructing all aboveground 500 kV transmission lines with a minimum clearance of 34.5 feet from the ground ~~at normal-under all~~ operating conditions;
- c. Constructing all aboveground 230 kV transmission lines with a minimum clearance of 20 feet from the ground ~~at normal-under all~~ operating conditions;
- d. Constructing all aboveground 138 kV transmission lines with a minimum clearance of 20 feet from the ground ~~at normal-under all~~ operating conditions;
- e. In areas where aboveground transmission line will cross an existing transmission line, constructing the transmission line at a height and separation ensuring that alternating current electric fields do not exceed 9-kV per meter at one meter above the ground surface; and
- f. Constructing all aboveground transmission lines, the Longhorn Station, and the communication stations in accordance with the requirements of the 2017 edition of the National Electrical Safety Code.

Scenic Resources Condition 4: During construction, to address potentially significant adverse impacts to the scenic resources at the Ladd Marsh portion of the Grande Tour Route, if the Proposed Route is constructed the certificate holder shall construct the facility using tower structures meeting the following criteria between approximately Milepost 108 and Milepost 113:

- a. Lattice-frames; and
- b. Frames will be stained with Natina finish.

March 20, 2019

IDAHO POWER COMPANY

Boardman to Hemingway 500 kV Transmission Line Project

*Comparison of Cost and Ground Disturbance
Between Underground and Overhead
Installation Within the Viewshed of the
National Historic Oregon Trail
Interpretive Center (NHOTIC)*

PROJECT NUMBER:

156536

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Boardman to Hemingway 500 kV Transmission Line Project

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REVISION HISTORY		
DATE	REVISED BY	REVISION
03/01/2019	Jerry Johnson	0 – Issued for Use
03/20/2019	Jerry Johnson	1 – Issued for Use

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1. EXECUTIVE SUMMARY

Idaho Power is proposing to construct the Boardman to Hemingway Transmission Line Project—a 500kV transmission line extending approximately 300 miles from the proposed Longhorn Station in Boardman, Oregon to the existing Hemingway Substation in southwestern Idaho. The proposed route for the B2H Project runs below, and in front of, the National Historic Oregon Trail Interpretative Center (NHOTIC) near Baker City, Oregon. This report was developed in response to questions regarding the costs of possibly constructing the line section underground near the NHOTIC.

Current underground transmission technology and estimated costs for similar installations were studied and results are provided within. To POWER's knowledge there is only one 500 kV underground installation in the United States, located in Chino Hills, CA which involved the installation of a 500 kV XLPE underground segment that is approximately 3.5 miles in length. The cost for that project was approximately \$224 million. Underground cable system costs are largely dependent on material costs, which fluctuate with the economic market and availability. The estimated cost for constructing a 1.5-mile-long 500kV AC XLPE underground cable system for the B2H Project ranges from approximately \$102 million to \$111 million. The range of costs for the underground cable system is indicative of the variability of costs provided by differing manufacturers and the range of design options. These estimated underground costs are an extreme increase when compared to the overhead with is estimated at \$3.4 million. The underground system would costs \$98.6 to \$107.6 million more than overhead.

Ground disturbance from an UG installation would be substantially greater than that for an OH installation. The underground option requires overhead-to-underground transition stations and splicing vaults. Transition stations are similar in size to a switching substation station and have ground disturbances that are not required for the overhead option. Assuming a corridor of 100-ft wide for the entire length of underground segment, this would have a direct surface impact of over 30 acres along the 1.5-mile length. Since much of the right-of-way is on side hills, the biggest impact is the amount cut and fill material that would need to be removed from the Project location and disposed off-site, as compared to the overhead option (approximately 250,000yd³ more for the underground option).

The maximum reel length for shipping the XLPE cable is contingent upon the conductor size, insulation thickness, and sheath design along with the manufacturer's shipping capabilities. For this report, that is assumed to be about 1700 feet. Splices will be required to connect the multiple sections of cable. Splices will be made in splicing vaults that will be placed approximately every 1500 feet.

2. PROJECT DESCRIPTION.

Idaho Power is proposing to construct the Boardman to Hemingway Transmission Line Project—a 500kV transmission line extending approximately 300 miles from the proposed Longhorn Station in Boardman, Oregon to the existing Hemingway Substation in southwestern Idaho. The proposed route for the B2H Project runs below, and in front of, the National Historic Oregon Trail Interpretative Center (NHOTIC) near Baker City, Oregon. In response to questions regarding the costs of possibly constructing a 1.5 mile section line section underground near the NHOTIC, this comparison report between overhead and underground was developed. Figure 1 show the routing of transmission line and the section of line used for the overhead/underground comparison.



Figure 1 Underground Route Segment near the NHOTIC

3. UNDERGROUND TRANSMISSION LINE DISCUSSION

The following sections describe a 500 kV underground transmission line generally as reference when considering this option as an alternative to crossing the NOHTIC with an overhead transmission line.

3.1 500 kV Underground Experience

Options for underground cable systems include High-Pressure Fluid-Filled (HPFF), Gas-Insulated Line (GIL), Self-Contained Fluid-Filled (SCFF) and High Voltage Extruded Dielectric (HVED). Currently there are no 500 kV HPFF pipe-type systems in the United States; while this system provides high reliability, it requires additional equipment resulting in the additional opportunity for component failure resulting in lower reliability. GIL systems have very little 500 kV experience which is limited to substation installations less than 1,000 feet in length. Today, primarily two types of underground cable systems are being installed at the 500 kV AC voltage level worldwide. They are:

- High Voltage Extruded Dielectric (HVED) cable system
- Self-Contained Fluid-Filled (SCFF) cable system.

While a majority of the previous extra high voltage (EHV) underground cable installations worldwide are SCFF, a significant amount of HVED cable has recently been installed. As the cable manufacturing process has evolved and utilizing cross-linked polyethylene (XLPE) as the primary insulation material, HVED cable systems have largely become the preferred underground cable system for underground cable installations in the US. With the emergence of the XLPE cable technology at higher voltages, installations of SCFF cable systems have begun to decrease. The advantage of the XLPE cable system is the elimination of the need for continuous monitoring of fluid systems and reduced environmental risks. XLPE cable systems are proving to be the technology of choice for this voltage level, over SCFF systems for applications like is being considered here. One disadvantage of EHV XLPE cable systems is that the application of this technology for this voltage level is relatively new and therefore life expectancy and reliability of such an installation is unknown.

Underground transmission lines are not commonly considered for 500 kV transmission lines due to the minimal experience worldwide, technical considerations and the substantial cost of such an installation. There are a very limited number of underground XLPE cable systems installed in the world at 500 kV. There has only been three installations of 500 kV XLPE cable outside the US and these were all installed in tunnels.

There has been one project completed in the US at 500kV in Chino Hills, CA which involved the installation of a 500 kV underground segment that is approximately 3.5 miles in length. This project cost was approximately \$224 million. This underground segment was installed with XLPE in duct bank and splicing vaults.

3.2 Cable System

There are many factors to consider when designing the optimal and most economical underground cable systems. One of the main factors is the thermal performance of the underground cable system. The main considerations for thermal performance to avoid overheating include:

- Cable Size – Larger cables allow for increased load transfer, however XLPE cables are typically limited to 5000 kcmil, due to manufacturing and transportation limitations.
- Soil Thermal Resistivity – The ability of the heat to dissipate away from the cable is based on the thermal properties of the soil/backfill installed around the cable.

- Cable Depth – The deeper the cable is from the surface the harder it is for the surrounding soil to dissipate the heat, thus resulting in a lower ampacity.
- Cable Separation – Other cables in close proximity also generate heat, thus resulting in mutual heating. Mutual heating can be reduced by increasing the separation of the cables.

Based on these considerations, the expected cable system for this three-phase line would require four cables per phase to achieve the necessary ampacity rating of 2000 amperes.

The most common method of installation of EHV XLPE cable systems in the world is by direct burying the cable, with a few being installed in tunnels or ducts. While direct burial is the most economical method for XLPE cable systems, the most common method used in the US is to install the cable in concrete encased ducts, commonly called a duct bank system. This type of system provides mechanical protection, eliminates any re-excavation in the event of a cable failure, and allows accessing the cable much easier for repairs. For this Project, four separate duct banks are necessary to achieve the desired rating. Each duct bank is expected to include a total of four ducts; one for each of the three cables, and one spare of the four cables per phase system. The duct banks would be separated by approximately 10 to 15 feet to reduce mutual heating. The concrete duct bank is covered with thermally approved backfill. Figure 2 is an example duct bank layout for a similar installation.

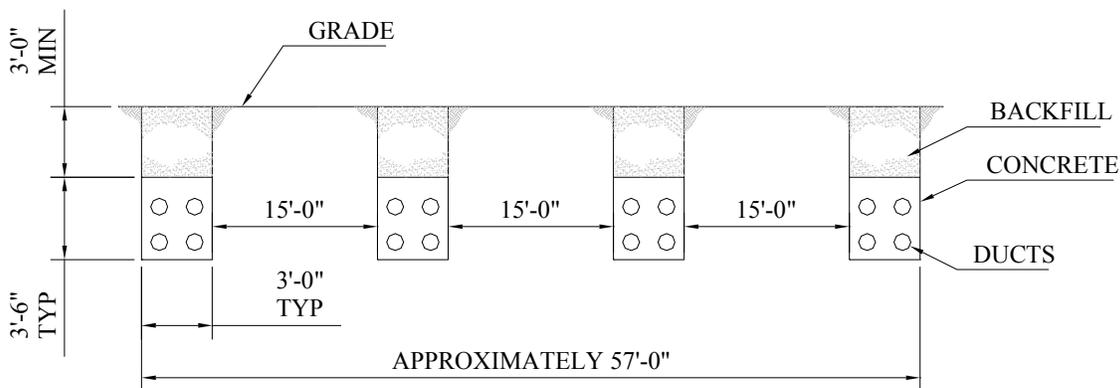


Figure 2: Possible 500 kV Duct Bank Layout

500 kV XLPE cable lengths are limited to approximately 1,500 feet in length. When the underground segment exceeds this length, splicing vaults are required. The outside dimensions for a splicing vault is approximately 10 feet wide by 50 feet long. Splicing vaults allow for racking of the cables and provide a location for splicing of the cables to create continuity of the cable system. Separate splicing vaults are required for each set of cables. Figure 3 shows typical splicing vault installation



Figure 3: Typical Splicing Vault Installation (lower voltage example)

3.3 Construction Methods

In general, the most economical construction method for constructing an underground duct bank is by open cut trenching. Trenchless methods such as horizontal directional drilling (HDD) and jack and bore (J&B) are also common when open trenching is not allowed or feasible. These construction methods are described in more detail in the following sections.

Following the installation of the duct bank and splicing vaults, the cable would be installed. Cable installation procedures and equipment would be based on environmental conditions, equipment and material placement and pulling requirements. The typical cable pulling setup would be to set the reel of cable at the transition site and place the winch truck at the opposite end.



Figure 4: Typical Cable Pulling Setup

3.3.1 Open Trench

This consists of using excavation equipment to remove any concrete, asphalt road surface, topsoil and sub-grade material to the desired depth. The material removed is taken to an appropriate off-site location for disposal or used for fill as appropriate. Once a portion of the trench is dug, polyvinyl chloride (PVC) conduit is assembled and lowered into the trench. The area around the conduit is filled with a high strength thermally corrective concrete (3000 psi). After the concrete is installed the trench is backfilled and the site restored.



Figure 5: Typical Trench Excavation (Single Trench Only)

It should be noted that Figure 5 represents one duct bank, whereas an underground segment as part of the B2H Project would require a total of four.

The majority of underground transmission installed via open cut excavation in the U.S. follows existing road right-of-way (ROW) with relatively flat terrain and slopes that do not exceed 10%. However, the underground segment of the B2H Project would follow the existing overhead ROW. This would require a considerable amount of cut and fill along the ROW (see Figure 6) to accommodate the installation of the ductbank. In addition, splicing vaults should be installed on flat/level subsurface, which may require additional excavation and contouring where slopes exist, making open cutting problematic.

In areas where there are significant elevation changes along the route, the cables that are installed would tend to creep downhill. This is caused by a combination of gravitational forces and expansion/contraction that occurs when the cables heat and cool during daily load cycles. If means are not provided to mitigate this then the cables would eventually move downhill resulting in excessive bending of the cable or cable joints in the downhill splicing vault as well as higher than expected tensions in the cable at the upper ends. In order to minimize this and eliminate the potential for failure, additional supporting splicing vaults may be needed to restrain the cable in areas where there are significant elevation differences between splicing vaults.

It is expected that subsurface rock would be found along much, if not all of the route. This would require significantly more drilling and blasting than would be required for the overhead installation. Costs for these special construction techniques can be significant.

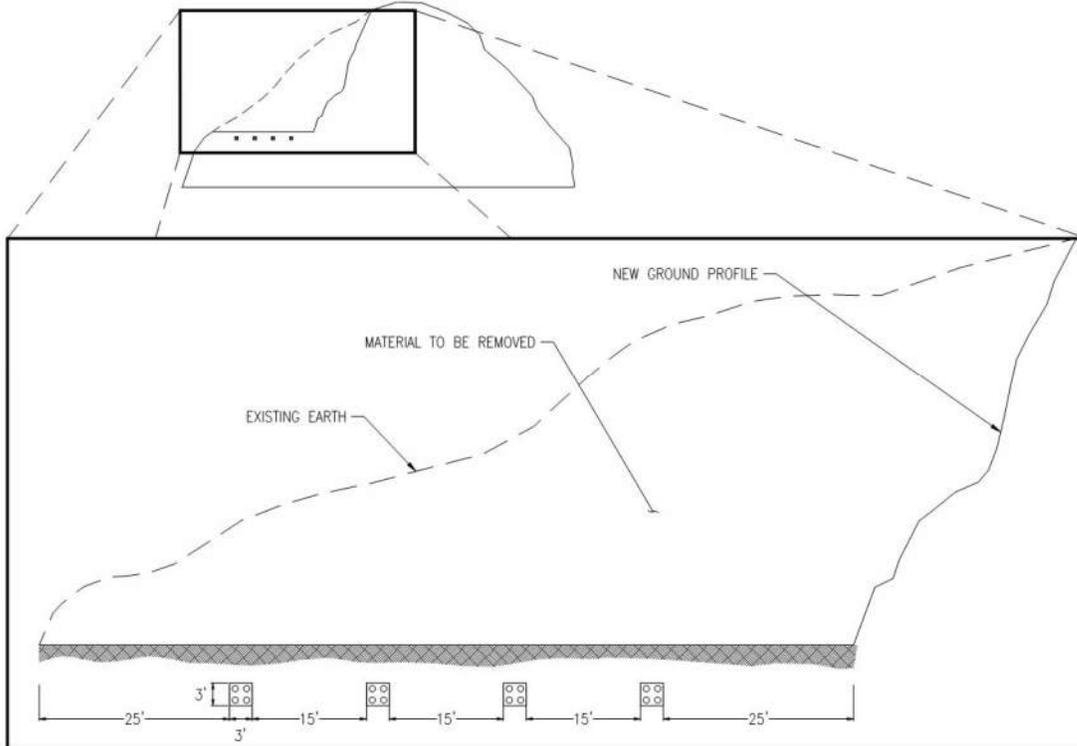


Figure 6: Cut and Fill Detail

3.3.2 Jack and Bore (J&B)

The jack and boring method is commonly used for short crossings, under 400 feet, and where no bends are required. But J&B has been used for longer lengths depending on the soil conditions. A J&B installation consists of installing a casing under the obstruction and then installing the conduit inside the casing. A bore pit having a minimum size of 40 feet long by 10 feet wide would be excavated to install a single casing. This bore pit is required by the boring equipment and for placing and welding 20-foot sections of casing pipe. Also, prior to starting the boring process, a receiving pit approximately 10 feet in length is excavated for each casing on the opposite side of the crossing.



Figure 6: Typical Jack and Bore Setup (Lower Voltage Example)

3.3.3 Horizontal Directional Drilling (HDD)

The HDD method is commonly used for longer crossing and where bends may be needed. An HDD installation for a HVED cable system consists of installing a casing with conduits inside or just installing the conduits in a bundle by themselves. The HDD method consists of a process, where a small diameter pilot hole is drilled from entry to exit, followed by a reamer that is pulled back to enlarge the pilot hole. Finally, the product pipe is pulled into the enlarged hole. HDD operations have become quite popular with utilities since it eliminates the need to excavate large bore pits and the work can be performed from the surface. While this method does not require any significant pit excavation, it does require a significant area at the entry point and exit points of the drill. A typical entry point site requires an area of about 100 feet by 150 feet and an exit area of 100 feet by 100 feet.



Figure 7: Typical HDD Setup (Lower Voltage Example)

3.3.4 Frac-Out Event

HDD operations have the potential to release drilling fluids to the ground surface through frac-out events. A frac-out event occurs when excessive drilling pressure is applied and drilling fluid (mud) propagates vertically toward the surface through fractured bedrock or overlying soils. This event has the potential to cause damage to environmental resources at the site of the frac-out and beyond. The damage can vary depending on the severity and location. Impacts would result from drilling fluids and subsurface soils being spread over the land surface. A large frac-out event (temporary or long term) may be considered to have high impacts in areas where there are rare, threatened and endangered species; in or near rivers, streams, wetlands or other water resources; on or near steep slopes or erosive soils; if there are cultural resources in the area; or if near a visually sensitive area. Frac-out events at the ground surface are typically easier to locate and remediate than those occurring under rivers, streams, and wetlands. Drilling fluids and sediment entering a surface water feature as a result of a frac-out may cause a temporary increase in turbidity or siltation that can negatively impact aquatic life, by covering spawning/feeding areas and clogging fish gills.

3.3.5 Trenchless Methods on B2H

Trenchless methods are not preferred by operators because they are less cost-effective than open cut methods and they pose engineering limitations as discussed above. Trenchless methods are used only when open cut methods are impractical, impossible, or imposed by regulators. For the section of the B2H Project evaluated at NHOTIC, there are no apparent geological, topographic, or environmental limitations in the area that would require the use of trenchless methods, and therefore, an open cut method is preferred for the B2H Project from a cost and engineering perspective. Specifically, XPLE cable installation would provide the most economical, reliable, and maintainable solution for consideration for this Project.

3.4 Overhead to Underground Transition Stations

The design of a 500 kV transition station is similar to a small switching station. The layout and size of a transition site would be determined by the amount of equipment needed, such as disconnect switches, shunt reactors, breakers, control house, etc. For this application, the transition station would consist of an overhead take-off tower, typically an A-frame structure located at one end of the yard. Disconnect switches and circuit breakers are generally installed between the overhead line and underground cables. Switches would be installed for each set of cables to allow for further isolation allowing the system to operate at reduced capacity. Figure 8 shows an example layout for a minimum size transition station with four cables per phase and a shunt reactor. Similar to a substation, the land area used for transition stations is preferably flat. This will require cut and fill operations to adjust the existing grade and the correlated environmental impacts. The approximate land use area is two (2) acres per transition station.

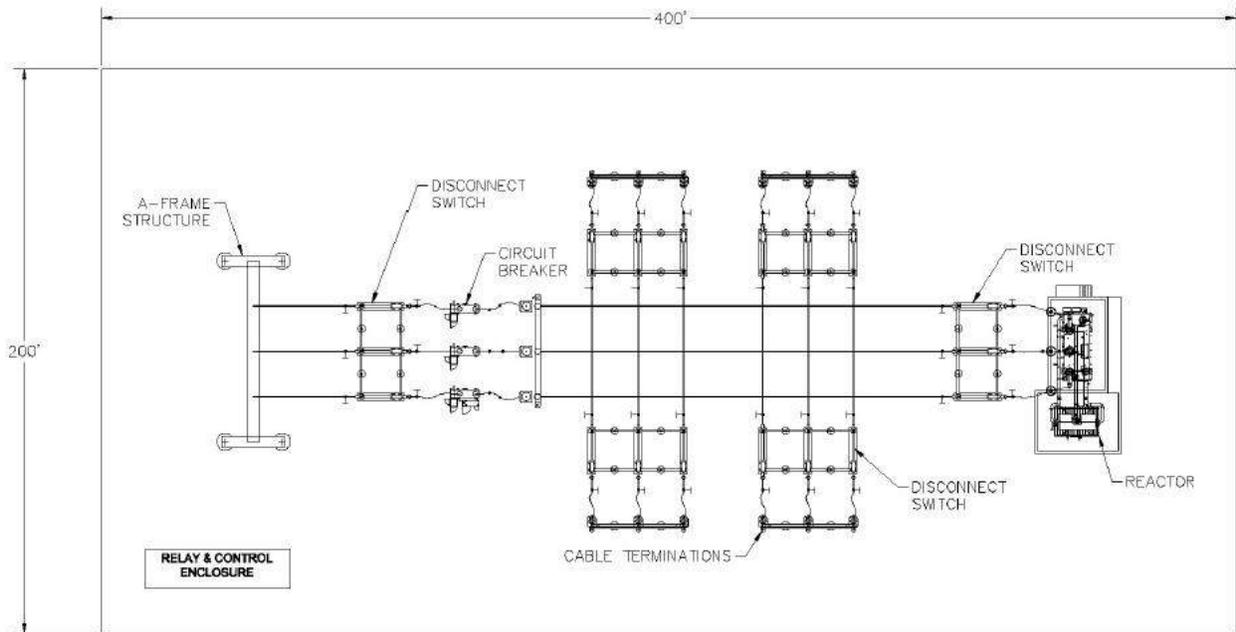


Figure 8: Possible 500 kV Transition Station Layout

Figure 9 provides a sample photo of a transition station for a 500 kV underground line with two cable terminations per phase (which is half the number that would be needed for the B2H Project. B2H requires four cables per phase). The layout for the B2H transition stations would be slightly larger in size depending on the equipment needed in the station.



Figure 9: Example 500 kV Transition Station

3.5 Electrical Considerations

The characteristics of 500 kV underground cables are significantly different from those of 500 kV overhead lines, and these differences must be taken into account when considering integrating underground cables into a transmission system composed primarily of overhead lines. The following is a list of some of the important design considerations.

- Cable reactive-compensation requirements
- Effects on power flows
- Effects on switching devices
- Effects on surge-protective devices
- Steady-state voltage effects
- Impact on system parallel harmonic resonance frequency
- Short-term overload characteristics
- Increased losses
- More complex protection scheme

An in-depth analysis of these topics requires sophisticated load-flow, transient-stability, short-circuit, and overvoltage calculation computer programs.

3.5.1 Operation and Repairs

Frequency and duration of outages affect the reliability of a transmission line. Outages on overhead transmission lines are most often caused by weather-related events (e.g., lightning or strong storms) or accidental collisions with conductors or structures. Overhead transmission line outages can be restored in a relative short time after some field reconnaissance to determine the probable cause of the outage. Repair times for are typically less than 24 hours in duration as damaged areas are relatively easy to locate on overhead lines.

Outages on underground transmission lines are most often the result of ground excavation in the vicinity of the buried cables, or a failure of accessories such as terminations and splices. The typical time needed to repair failure of accessories such as terminations and splices is often lengthy because these repairs require additional effort to identify, access, expose, and repair the damaged cables, and could take several days or weeks to fully restore service. For 500kV, the worst-case scenario could take months to repair if new cable needed to be manufactured.

The combined effect of outage and repair time must be taken into consideration to determine overall reliability or availability of a transmission line. Although outages are more likely on overhead transmission lines due to the variability of storms, repair times for overhead transmission line outages are considerably shorter in duration, which typically results in greater reliability of overhead transmission lines.

4. GROUND DISTURBANCE COMPARISON

While typically only a 30-foot width is required for most lower voltage underground projects, this Project, at 500kV, would require a significantly larger corridor width. In an attempt to minimize conductor size, each duct bank will need 10-15 foot center-to-center separation resulting in a total corridor width of approximately 60 feet after access and constructability is considered (Refer to Figure 2). All trees and vegetation in the permanent and temporary easements would need to be cleared for construction. The right of way would be required to remain permanently free of trees and other large vegetation to avoid root interference with the duct systems.

As mentioned earlier, the installation of the ductbank and splicing vault system would require significant amount of cut and fill. It is estimated that approximately 80% of the underground route would be installed on side hills. The elevation change for a 60-ft to 100-ft corridor ranges between 5-ft and 25-ft along the route. The Figure 10 shows typical installation using cut and fill.

The transition stations would require a considerably larger area cut and filled to accommodate equipment and ensuring that the proper ground clearances are maintained.

When compared to underground, the overhead option has a much smaller ground disturbance impact along the route. The amount of cut and fill, for the overhead option is limited to the areas at the transmission tower locations (250-ft x 250-ft). Most, if not all of this material can be spread within the Project ROW. For the underground option more than 250,000yd³ may have to be removed from the Project site.

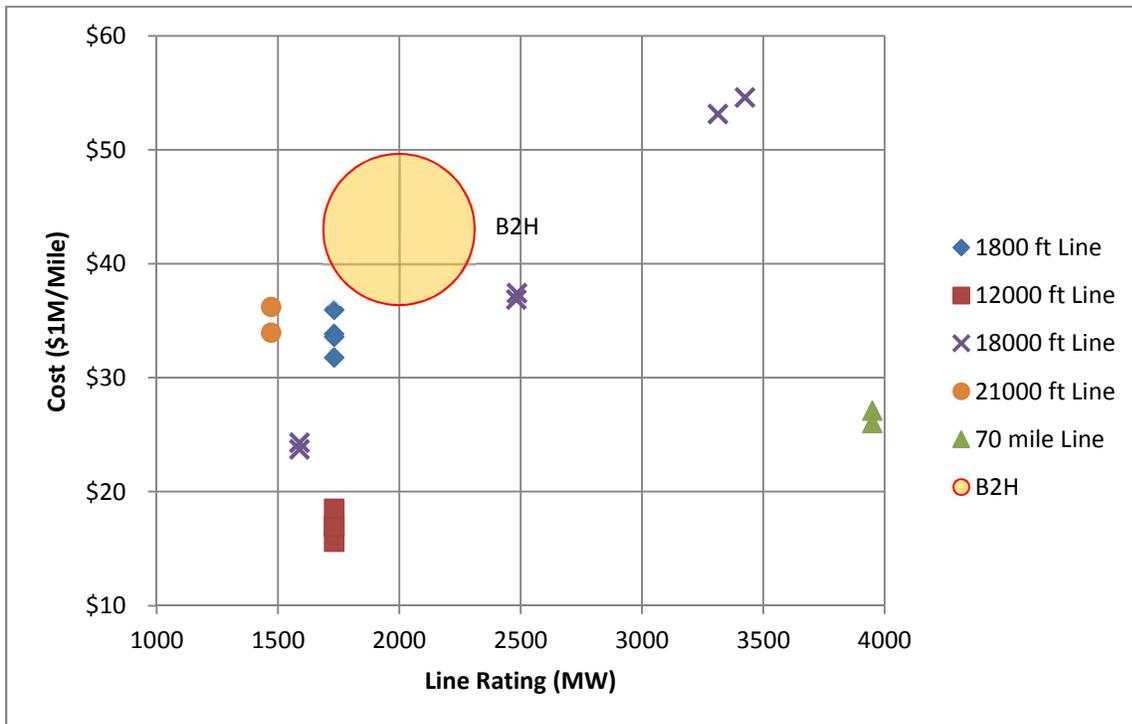


Figure 10: Example 500kV Underground Construction Corridor in Chino Hills, CA

5. COST COMPARISON

POWER gathered a number of cost estimates for the construction of 500 kV underground transmission lines. Some of these estimates are taken from recent POWER developments and others are taken from publicly available data on the subject. The results of this cost survey are provided in the following table. This table includes underground segment length, line rating, total cost and cost per mile. The cost survey indicates significant variety in per mile cost of underground sections. Variances in the cost survey are due to installation method (i.e. open trench vs. horizontal directional drill), location specific constraints, the date correlated to material costs and the requirement of a spare cable(s). Short line costs are significantly impacted by mobilization and demobilizations costs which are relatively less significant on long lines. Therefore, long lines will cost less per mile. The cost survey indicates that a 500 kV underground transmission line capable of the load requirements of B2H for the estimated length of this underground section would cost approximately \$41 to \$62 million dollars per mile for materials and construction.

The estimated costs for the 1.5-mile length of underground transmission at the National Historic Oregon Trail Interpretive Center (NHOTIC) are in the range of \$62 to \$93 million. Transition stations are roughly estimated to cost \$3 to \$6 million each, depending on the need and extent of circuit breakers and reactive compensation required at the station. In addition, the lack in experience of underground lines at this voltage level warrants consideration for significant contingency when planning such a development, therefore a contingency of 50% has been selected for the overall cost estimate of this underground transmission line. The roughly estimated total cost of the underground section including transition stations and contingency is approximately \$68(\$102) to \$74(\$111) million, based on this simple cost survey analysis. This was developed under the guidelines of a Class 5 Estimate as classified in AACE International Cost Estimate Classifications www.aacei.org. Expected accuracy range is Low: -20% to -50% and High: +30 % to +100%.



Underground 500 kV Line Segment Cost Survey				
UG Line Segment Designation	Length (miles)	Line Rating (MW)	Total Cost (\$1M)	Cost per Mile (\$1M/mile)
1	0.3	2,000	10.8	36
2	0.3	2,000	11.5	38
3	0.3	2,000	11.5	38
4	0.3	2,000	12.3	41
5	2.3	2,000	35.5	15
6	2.3	2,000	38.5	17
7	2.3	2,000	38.6	17
8	2.3	2,000	42.1	18
9	3.5	3,955	191	55
10	3.5	2,870	131	37
11	3.5	1,835	83	24
12	3.5	3,825	186	53
13	3.5	2,867	129	37
14	3.5	1,835	85	24
15	68.5	4,560	1,783.9	26
16	76	4,560	2,060.6	27
17	4	1,700	96	34
18	4	1,700	144	36

Figure 11: Cost Survey Results

6. OVERHEAD TO UNDERGROUND COMPARISON

The following table compares the overhead crossing option to the underground option.

Topic	Subtopic	Overhead*	Underground
Costs (1.5 miles of construction)	Material and Construction Costs	Approximately \$3.4 million.	\$102-\$111 million
Above Ground/Visual Components	Transmission Towers and Wires	15 overhead transmission towers, span of conductors and shield wires.	Two overhead deadends, spans of conductors and shield wires entering transition station
	Other	None	Transition station bay structures
		None	Structures supporting switches, breakers, lightning arresters, terminations, fencing, grading, gravel, grounding and station access road.
Construction Disturbance Areas	Transmission Towers	15 structures (Approx. 250 ft. x 250 ft.) 21.5 acres Total	Two deadend structures (Approx. 250 ft. x 250 ft.) 2.9 acres Total
	Stringing/Pulling Sites	1 site estimated (Approx. 250 ft. x 400 ft.) 2.3 acres Total	Sites required adjacent to both deadend structures (Approx. 250 ft. x 600 ft.) 6.9 acres Total
	Transition Station	None	Transition Site Construction Area (Approx. 250 ft. x 450 ft.) 4.6 acres Total
	Underground Line	None	Disturbance area approximately 100 ft. x 1.5 miles 18.2 acres Total
Soil/Material Remove from Site (Cubic Yards)	Transmission Towers	Minimal, any excess soil can be spread within the construction footprint	Minimal, any excess soil can be spread within the construction footprint
	Splicing vaults	None	13,000yd³ of material to be removed
	Ductbank	None	21,000yd³ of material to be removed
	Cut/Fill	Minimal, any excess soil can be spread within the construction footprint	Range: 60,000 yd³ to 290,000yd³ of material removed
Permanent Disturbance Areas	Transmission Towers	15 structures (Approx. 40 ft. x 40 ft. and 130 ft. tall, max.)	Two deadend structures (Approx. 50 ft. x 50 ft. and 170 ft. tall)
	Transition Station	None	Approx. 200 ft. x 400 ft., with structures approximately 70 ft. tall.
	Splicing vaults	None	20 splicing vaults (5/ duct bank) approx. 10 ft. x 50 ft.
	Access Roads	Access roads to the tower sites (14-ft wide)	Access roads to the tower sites and along the entire underground cable length

*Overhead Information Provided by Idaho Power Company

Since the majority of the unground route would traverse side hills and follow hill contours, the underground option has a substantial larger amount of material that would need to be removed from the Project location (over 250,000 yd³) and disposed of off-site than the overhead option.

When compared to the overhead option, the underground alternative includes significantly increased costs. As shown in the table above, it would cost approximately 30 to 33 times more to install the B2H Project underground in front of the NHOTIC in comparison to the projected overhead installation cost.