AMBLER MINING DISTRICT INDUSTRIAL ACCESS PROJECT

SF299 APPLICATION

COMMUNICATIONS AMENDMENT

APRIL 2019

Prepared on behalf of:

Alaska Industrial Development and Export Authority
813 West Northern Lights Boulevard
Anchorage, Alaska 99503

Prepared by:

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AIDEA is submitting this amendment to the SF299 application for the Ambler Mining District Industrial Access Project (AMDIAP). AIDEA noted in its June 2016 application submittal that there would likely be interest in installing fiber optic communications facilities in the future and is now providing this additional information for inclusion of the fiber optic/communication facilities in the environmental review.

This amendment provides information on the addition of fiber optic and communications systems within the right-of-way (ROW) previously requested. Information provided in Sections 1 through 6 of the June 2016 application form has not changed. Information provided in the follow sections focuses on the proposed fiber optic/communications facilities and how that might change information previously submitted.

As part of this amendment, AIDEA is also requesting an additional maintenance site location on BLM land near the Dalton Highway. A general proposed area is included in Attachment 1.

7. Project Description *(describe in detail)*:

a. **Type of system or facility,** *(e.g., canal, pipeline, road)*;

b. **related structures and facilities;**

c. **physical specifications** *(length, width, grading, etc.)*;

d. **term of years needed;**

e. **time of year of use or operation;**

f. **Volume or amount of product to be transported;**

g. **duration and timing of construction; and**

h. **temporary work areas needed for construction.**

a Proposed Facility.

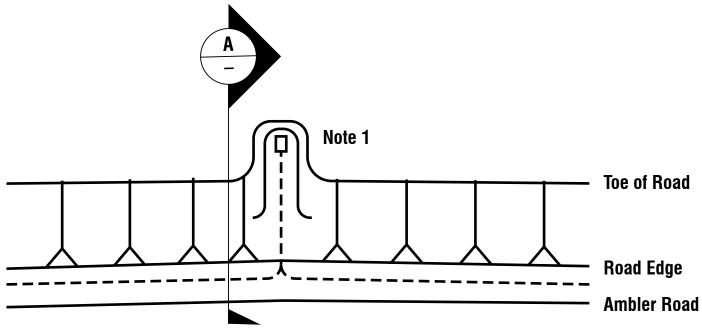
The proposed AMDIAP is a 211-mile limited-access gravel road to provide access from the Ambler Mining District to the Dalton Highway and is described in the June 2016 SF299 AMIDAP application. This supplement addresses communications facilities for the proposed AMDIAP. Communications facilities, including fiber optic and radio communications systems, are considered essential to safe and efficient road construction and operations.

AIDEA's proposed communication facilities are designed to provide communications for road construction and operations only. It is likely, however, that once the fiber optic line and communications facilities are in place other entities (mine operators, local communities, emergency response/public safety, government agencies) may be interested in the ability to use excess capability in the fiber optic line or communications facilities. Any such change or expansion of use would require additional review and permitting by relevant agencies.

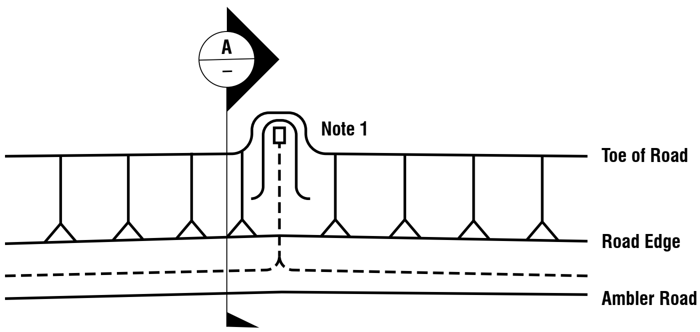
b Related Structures and Facilities along the entire road corridor, including water crossings.

Components of the AMDIAP road and associated structures were discussed in the June 2016 AMDIAP SF299 application. This discussion focuses on the proposed fiber optic and communications system. Additional information on these systems is included in Attachments 2 and 3.

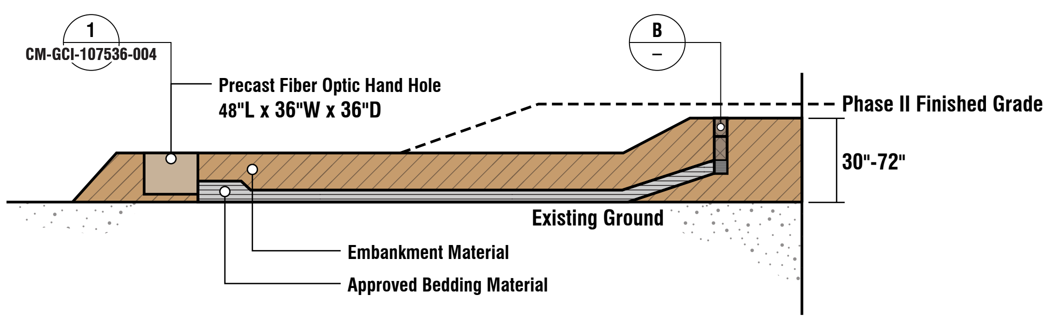
The fiber optic communications component of the project would consist primarily of a fiber optic line installed in a high-density polyethylene (HDPE) 2-inch diameter conduit in the proposed road embankment (Figure 1). The fiber optic line would be put in as part of the Phase II road construction process. The fiber optic line and hand holes, as well as all of the other components of the communications sytems, would be located within the footprint of the ROW requested under the SF299 application in June 2016.



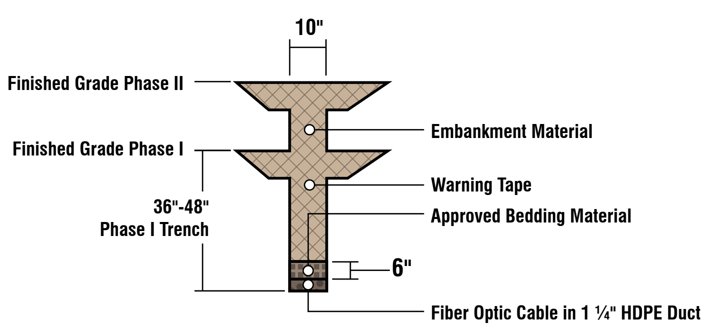
1 – **Phase II 1-Lane Road**
NTS



2 – **Phase III 2-Lane Road**
NTS



A – **Phased Road Section**
NTS



B – **Road Trench Detail** (Typical)
As Shown

Notes:

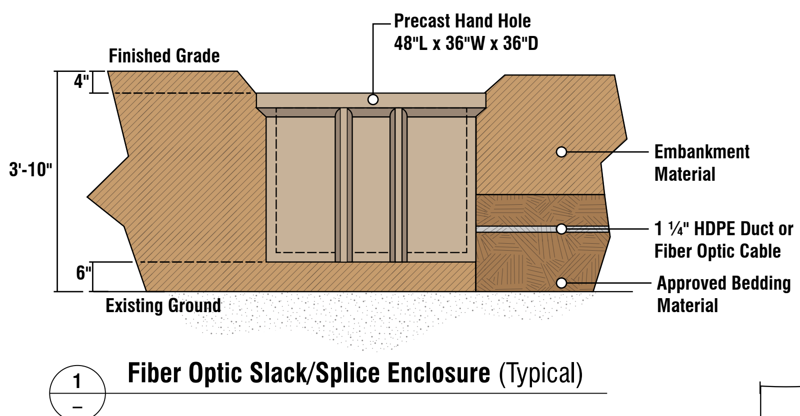
1. For fiber-in-duct installation, splice/slack boxes must be placed every 3000-5000 feet.

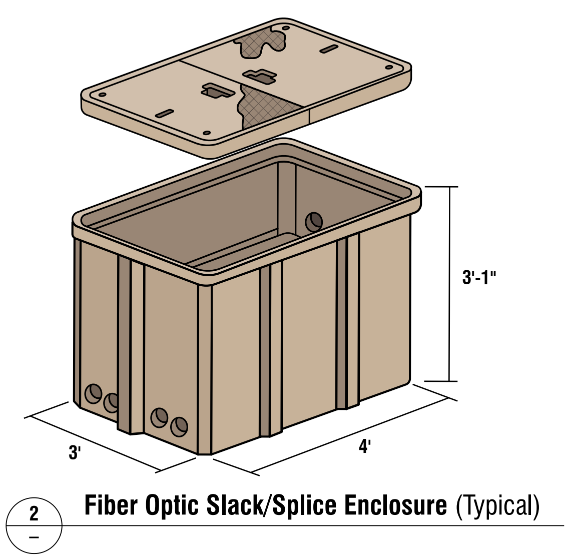
Figure 1. Fiber Optic Installation Typicals
Source: GCI 2019 (See Attachments for Additional Details)

The fiber optic line would include hand hole access points every mile or so to use during construction to splice the fiber optic line and for access in the event of any repair or maintenance needs. Although most hand holes would be installed in the embankment as shown below, some hand holes may need to be installed above ground on bollard mounts (Figures 2 and 3).

In addition to the hand holes, the system would include regeneration stations incorporated into the road maintenance stations. The regeneration equipment as well as a fiber optic slack/splice supplies would be located inside an 11-foot by 11-foot equipment module. These units are typically pre-fabricated metal units in tan or grey. The equipment would be powered from the maintenance station generator and fueling system.

Figure 2. Typical Hand Hole Access





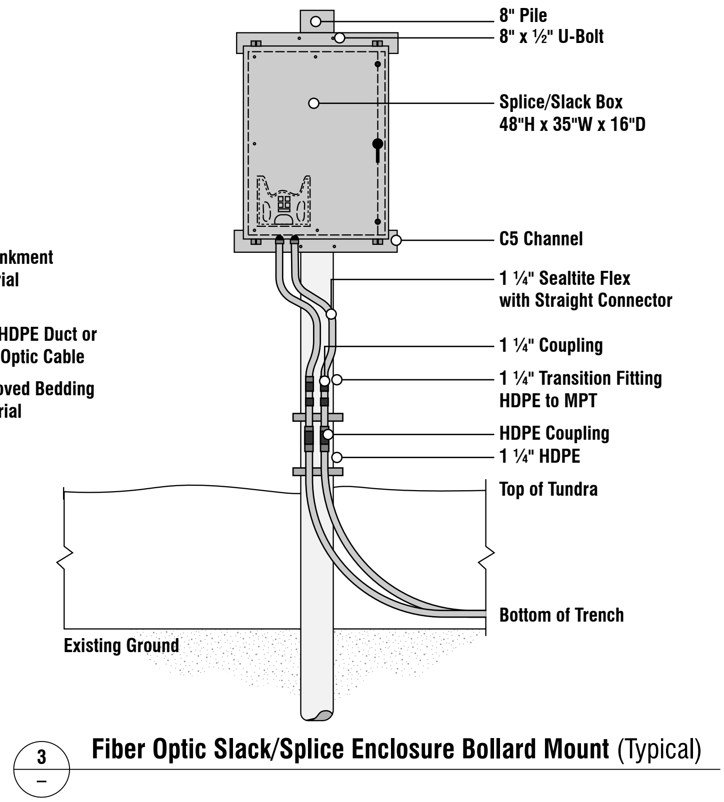


Figure 3. Hand Hole Installation Typical
Source: GCI 2019 (see Attachments for Additional Details)

Figure 4 is an example of a typical floor plan of a regeneration/communications equipment facility at a maintenance station.

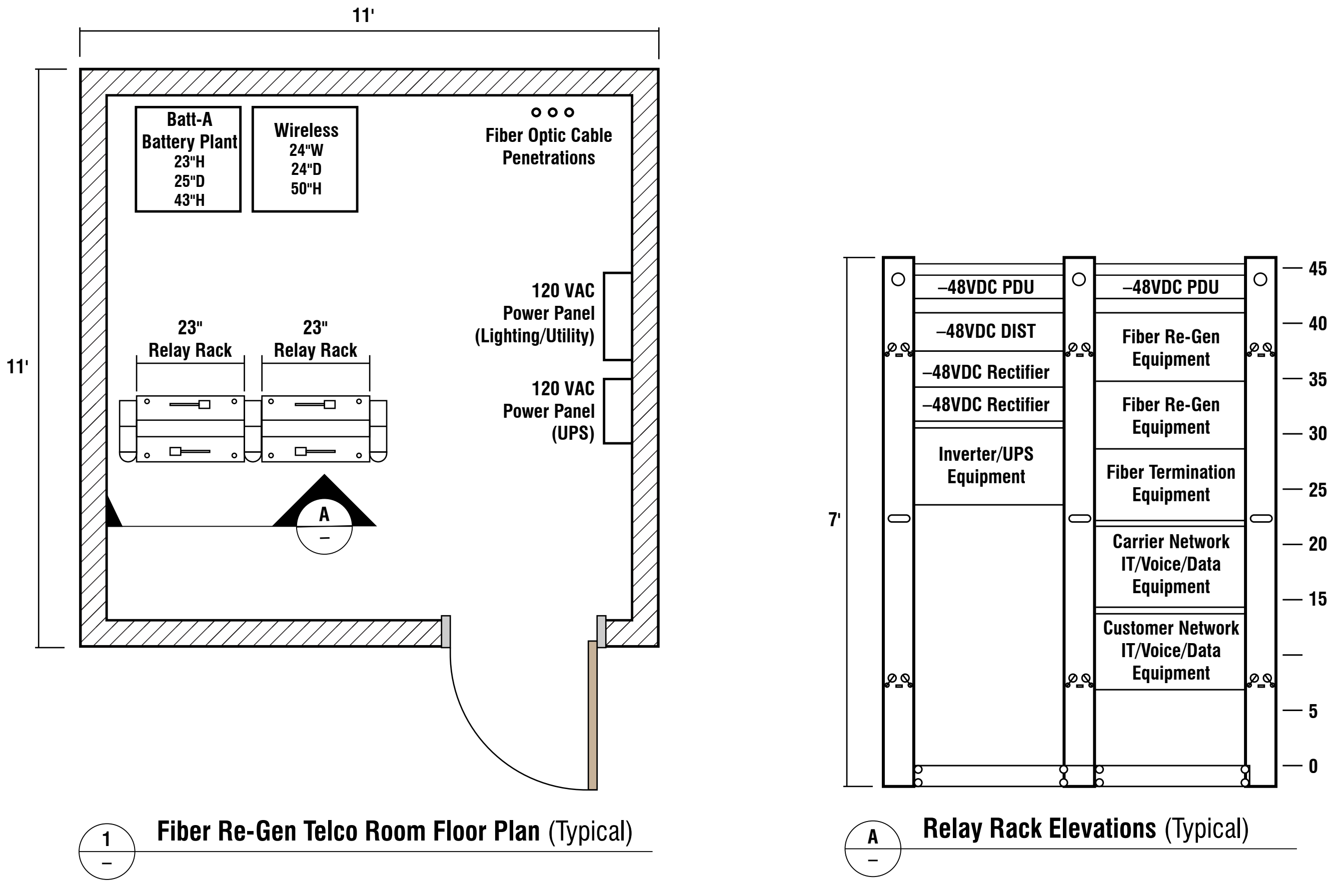


Figure 4. Regeneration/Communications Center Floor Plan
Source: GCI 2019 (see Attachments for Additional Details)

The fiber optic cable is proposed to be bored under major river crossings (those with bridges), while the fiber optic line would be installed in the road embankment over culverts (see Figures 5 and 6). There may be situations where boring the fiber optic line beneath culverts is more practical and effective, particularly on the larger culverts. If lines are bored beneath the ground surface, typical directional boring equipment would be used.

Notes:

1. Bridge plan and section details from DOWL drawing “Small Bridge (<50ft)”

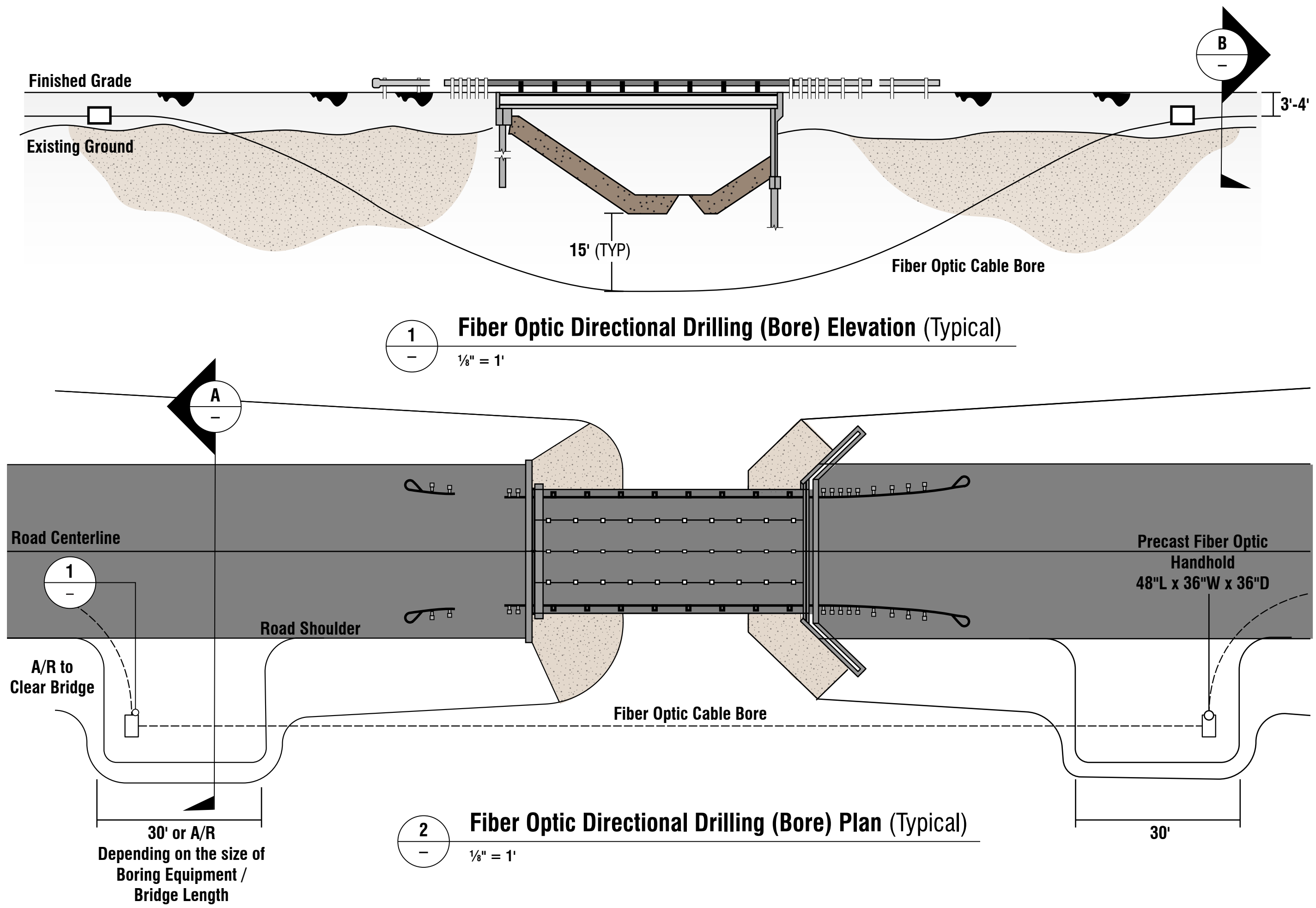


Figure 5. Directional Drilling Under Bridge Typical
Source: GCI 2019 (See Attachments for Additional Details)

Notes:

1. Fiber optic cables and or conduits may be installed over culverts that are less than 38" below the roadway surface.

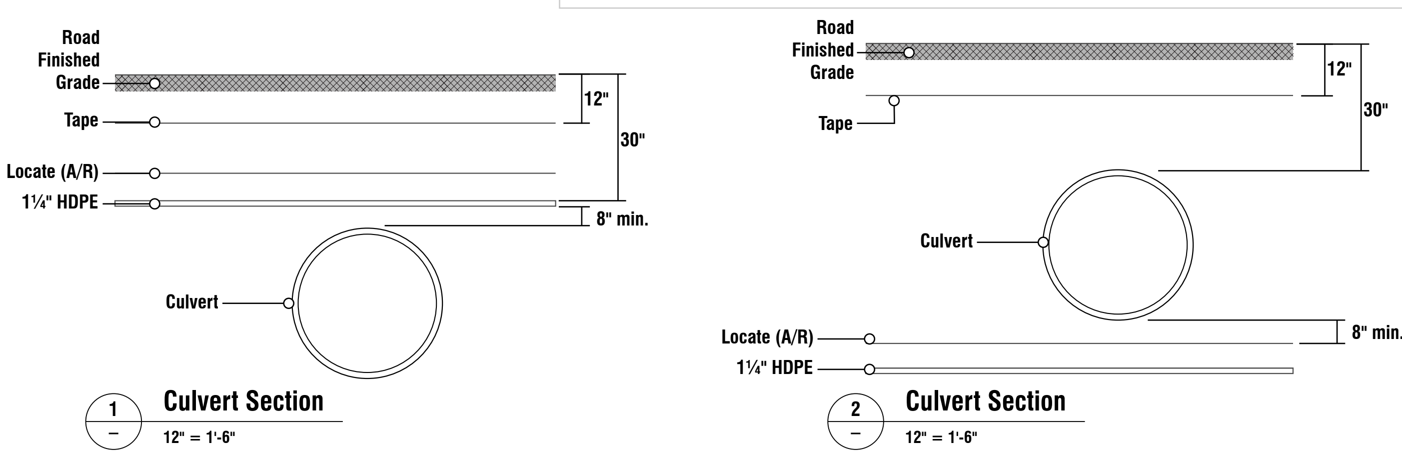


Figure 6. Culvert Detail
Source: GCI 2019 (See Attachments for Additional Details)

The radio and satellite communication facilities would be constructed with the maintenance stations in Phase I. Radio communication towers would be located within proposed maintenance sites to support two-way radio communications. In addition to the tower, radio equipment would be included within the 11-foot by 11-foot communications center unit within the overall maintenance station (Figure 7). Equipment located within the communications center would include a telecom module, relay racks, and power panels. Figure 8 shows that the radio communications towers would be 100 to 150 feet tall and self-supporting (no guy wires) and typically grey in color.

A backup satellite communications system would be used to support two-way radio coverage along the road and to provide backup communications for road construction, operations, and maintenance in the event of a failure of the fiber optic system. Equipment for this system would include a satellite dish and a Very Small Aperture Terminal (VSAT), co-located with the fiber optic and radio equipment in the communications center at road maintenance facilities. The satellite dish would be approximately 10 feet tall as shown in Figure 9. The communications system would be connected to the maintenance station's generator and fuel storage system.

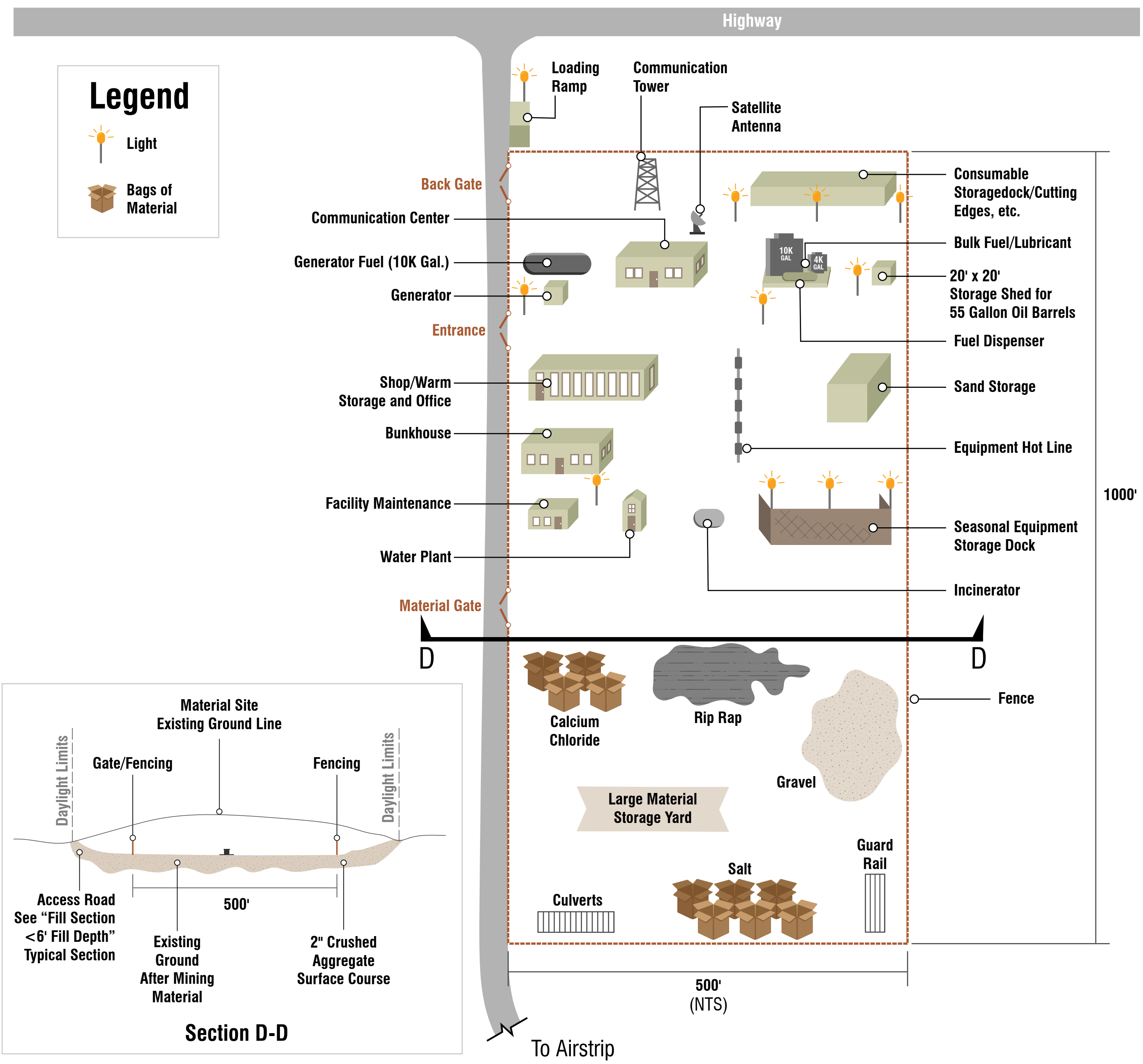


Figure 7. Maintenance Station Typical

As noted in the maintenance station typical figure in the original SF299, it is anticipated that there would be fuel storage at the maintenance station. One or two 10,000-gallon above-ground storage tanks are proposed for fueling vehicles and equipment and a 4,000-gallon tank for lubricants. This fuel storage would support generator operations at the maintenance station, including power for the communications systems.

To ensure radio communication along the corridor during road construction and operation, there would need to be a total of 7 (for 95% coverage) to 12 (for 100% coverage) towers along the corridor. Towers would be installed at each maintenance station and at several material site locations along the corridor. The proposed location of towers is illustrated in Attachment 3. Each tower would require a generator shed, equipment rack shed, and 4,000-gallon fuel tank as shown in Figure 8.

Table 1 summarizes the fiber optic and communications features that would be incorporated into the AMDIAP.

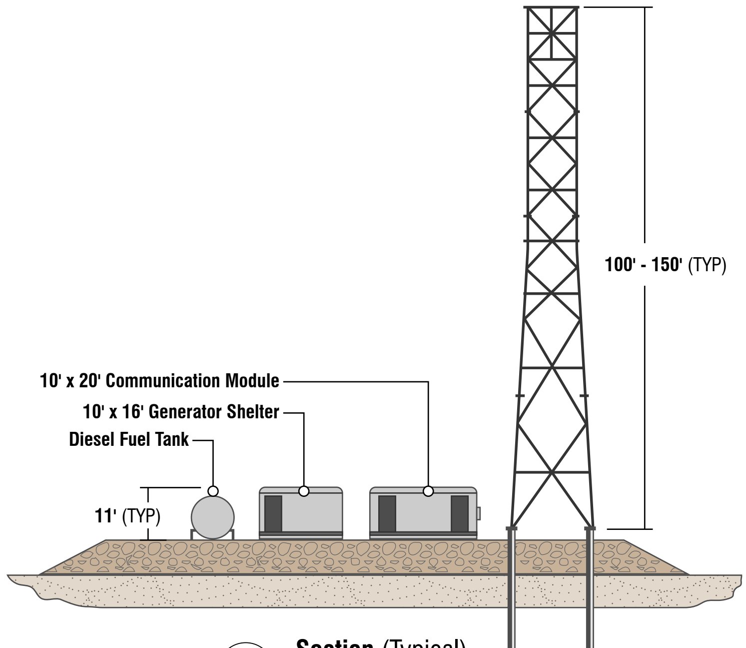
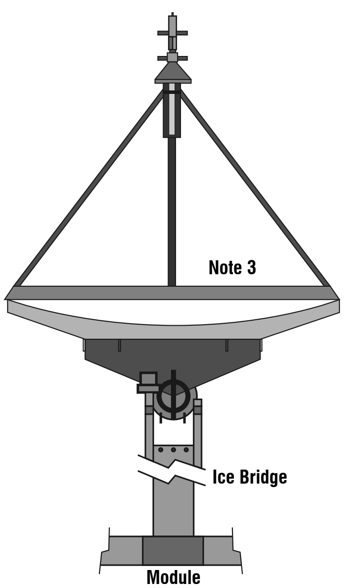
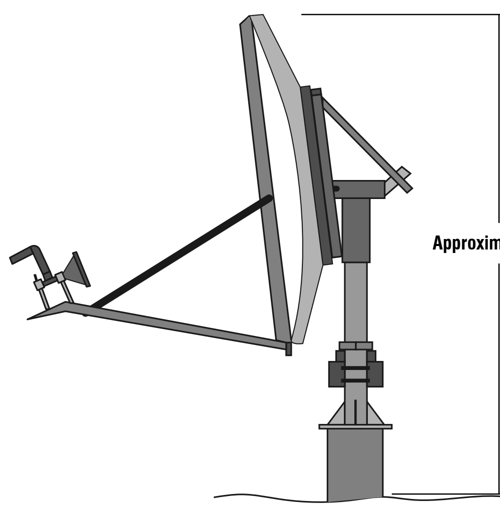


Figure 8. Typical Radio Communications Tower and Photograph
Source: GCI 2019

A
–
Section (Typical)
1" = 10'



2
–
V-Sat Plan View (Typical)
¼" = 1'



B
–
V-Sat Side View (Typical)
¼" = 1'

Figure 9. Satellite Dish Typical | Source: GCI 2019

Data Type	Quantity	
	Preferred Corridor	Alternative Corridor
Main FIber Optic Cable (Miles)	211	224
Hand Hole Vaults (Number)	294	332
Regeneration Systems (Number)	5	5
Number of River Bores (Number)	28	25
Communication Towers	7-12	7-12
Generators at Material Site Towers	2-7	2-7
Satellite Facilities	5	5

**These are approximate numbers; final numbers would be determined once road corridor design and communication system design is complete.*
Hand holes estimated at one per mile, two at each river crossing, plus 10% contingency.
River bore would occur at bridge crossings, i.e. water crossings greater than 20 feet wide.

c Physical Specifications.

Attachments 1 and 2 provide plan views and typical sections for the fiber optic system facilities and the radio communication system. It is assumed that all systems will be within the fill footprint in road and maintenance station areas included in the June 2016 AMDIAP application. The fiber optic line and hand holes will be within the road footprint. The regeneration system components, the communications towers, and the satellite facilities would primarily be located within the maintenance station footprints. Some communications towers and support facilities (generator shed, generator, fuel storage tank) would be located within the disturbance footprint of two to seven material sites.

d Time of year of use or operation.

Fiber optic and communications facilities would be used throughout the year for the entire term of the project.

e Volume or amount of product to be transported.

The fiber optic and communications facilities would not change the volume of product being transported.

f Volume or amount of product to be transported.

The fiber optic and communications facilities would not change the volume of product being transported.

g Duration and timing of construction.

The following is basic and preliminary constructing timing sequence that would be typical for construction of AMDIAP. This sequence is independent of the specific construction contractor and is typical for this type of road construction.

- Survey alignment
- Clear Phase III roadway footprint
- Construct winter/ice road along road alignment
- Prepare for pioneer road construction by staging material and equipment along the corridor in the winter
- Material source/pit preparation
- Material source excavation
- Construct pioneer road for length of corridor
    a. Road construction progresses working from each construction camp in both directions.
    b. Construction includes hauling and placing material, compaction, grading, installing culverts, and constructing bridges.

c. Construct maintenance stations and radio communication facilities.

- Construction from Phase I to Phase II would likely occur within a few years. Fiber optic facilities would be constructed in Phase II. Construction of Phase III would occur when demand requires.

Communication towers would be installed at identified locations as the pioneer road reaches those locations during Phase I. From the beginning of construction until fiber optic connectivity is installed during Phase II, communications along the corridor would be via two-way radio communications.

Construction of the fiber optic/communications system would occur during Phase II, when the full-depth embankment is constructed. Once embankment material reaches the appropriate elevation during Phase II construction, the empty HDPE duct would be placed within the material and buried as construction of the road embankment continues up to the final grade. Once an appropriate length of duct is installed in the embankment, the fiber optic cable would be jetted through through the empty duct. The fiber optic line would follow access roads to maintenance sites.

h Temporary work areas needed for construction.

Fiber optic and communications system construction would use the same temporary work areas and construction camps as previously described for AMDIAP.

i Communications Systems Maintenance.

The communications systems would be monitored continuously. Generators are serviced every two weeks, with each service consisting of an oil and filter change and general inspection. Radio towers and satellite dishes would be inspected annually; annual inspection would include a check for cracked or loose elements, misaligned bracing or supports, rust or corrosion, loose grounding attachment points, and foundation integrity. Racked equipment in the communications centers and at radio towers would not require frequent repairs or maintenance, but equipment air filters will need to be changed per manufacturer recommendations or if needed based on annual inspection. Interruptions of service may require communications specialists to visit a specific site to diagnose and correct equipment problems, but these occurrences would be expected to occur less than once per year.

8. Attach a map covering the area and show location of project proposal.

The project area remains the same with the addition of one maintenance station (Attachment 1). Additional information on the fiber optic and communications facilities are provided in Attachments 2 and 3.

13a. Describe other reasonable alternative routes and modes considered.

AMDIAP corridor alternatives considered were addressed in the AMDIAP application. Given AMDIAP's location in northwest Alaska, there are no existing communications facilities and all feasible options are being incorporated into the communications system plan (radio, satellite and fiber optic).

13b. Why were these alternatives not selected?

The reasons for alternatives not being selected were addressed in the AMDIAP application and Attachment 1 to this supplement.

13c. Give an explanation as to why it is necessary to cross Federal Lands.

The explanation of the need to cross federal lands was provided in the AMDIAP application.

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency.

A list of local, state, and federal applications is included in the AMDIAP application. Inclusion of the fiber optic/communications facilities would require a Federal Communications Commission (FCC) license for the entity operating the communications system. The FCC license would be acquired after a corridor is selected. The communications facilities are not expected to otherwise change the list of required permits and consultations from local, state, and federal agencies.

15. Provide statement of need for project, including the economic feasibility of items such as (a) cost of proposal (construction, operation, and maintenance); (b) estimated cost of next best alternative; and (c) expected public benefits.

The purpose and need for the AMDIAP was addressed in the June 2016 AMDIAP application. The inclusion of fiber optic facilities and communications system as part of the project supports the construction, operation and maintenance of the road, allowing for more safe and efficient operations.

Although the communications systems developed as part of this project would be for road use. Once the fiber optic cables are in, there is a potential for mine operators and communities in the vicinity of the project to want to connect to the fiber optic system. Any additional users would need to apply to the appropriate federal agencies for review and approval.

a The cost of the proposed construction, operation, and maintenance.

The estimated cost for construction of the fiber optic line is estimated at $28.5M; regeneration facility equipment for the proposed maintenance areas would be less than $1M. The two-way radio system, including 7 to 12 sites, would cost approximately $13.2M.

Operations and maintenance costs are expected to be approximately $200,000 per year for the fiber optic system and up to $500,000 for the radio communications system.

The backup satellite system could be constructed for approximately $250,000 and would have annual operating costs of approximately $200,000.

b The estimated cost of the next best alternative.

The next best alternative would be satellite communications alone. Comparable band width on a satellite system would be orders of magnitude more expensive than fiber optic. However, a reasonable lower-bandwidth satellite system could be constructed for approximately $250,000 and would have annual operating costs of approximately $200,000.

c The expected public benefits of the proposed project.

The public benefits from AMDIAP were addressed in the AMDIAP application. Incorporation of fiber optic and communication facilities into the AMDIAP would provide additional public benefits including:

- The ability to monitor and manage road users to enforce access restrictions, increase safety of road users, and monitor wildlife interactions.

Expansion of fiber optic into the Upper Kobuk area may provide an opportunity for local governments to increase communications capabilities for their communities, increasing opportunities for remote access to telemedicine, online education resources, and even telework and online business opportunities. Although this is not part of the proposed project, it is a reasonably forseeable future indirect benefit.

16. Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.

Although the fiber optic facilities proposed as part of AMDIAP would not directly access and serve individual communities, it could provide communities an opportunity to reasonable expand their communications infrastructure as described above. This would not be expected to result in substantial changes in local populations, although increased work opportunities in the communities could result in more working age residents staying in the community as opposed to leaving to find wage employment.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability.

a Air Quality

Air quality effects from construction and operation of the fiber optic and communications system would be a minimal contributor to the overall air emissions related to the project. Construction emissions directly associated with the fiber optic and communications system installation would include use of equipment to construct the trench in the embankment, install the hand holes along the road, install the regeneration systems at the maintenance stations, and construct communications towers. Construction emissions would be minimized through use of standard best management practices (BMPs) related to dust suppression, equipment maintenance, and other factors. Operation of the fiber optic and communications system will require power generated by generators at maintenance stations, but power would be required at these sites even without the fiber optic system. Operational impacts from the fiber optic system would be minimal.

b Visual Impact

The fiber optic facilities would be installed within the road embankment and would be a minor component of the visual effect of the road. Regeneration facilities and other communications infrastructure would be incorporated into the maintenance stations. Inclusion of fiber optic and communications system infrastructure would increase the change from current conditions, but only marginally considering the overall effect from road and maintenance area facilities.

Communication towers would be the most distinct visual feature of the communications system. Towers may be 100 to 150 feet tall. Towers would be located at each maintenance station and there would be 3 additional towers located in material sites. The towers in the maintenance stations would be the tallest component of the facility but would not be incompatible with the maintenance station use and appearance. The 3 other towers would be located at areas used as material sites, and so would not be inconsistent with the industrial nature of these sites. The towers may be visible to people using the road and to subsistence users that may occasionally pass through the area.

c Surface and ground water quality and quantity

The fiber optic system would be constructed as part of Phase II of AMDIAP construction, when the full width of the embankment is constructed. The fiber optic system construction would contribute minimally to the overall construction effects. The fiber optic system and communications system would have no additional effects on surface or ground water quantities.

d The control or structural change on any stream or other body of water

The fiber optic system and communications system would not result in structural changes on streams or other water bodies. Fiber optic will be bored underneath river beds or in conduits suspended from the bridges.

e Existing noise levels

Construction of the fiber optic and communications system would not substantially change overall construction noise levels. Operational noise from fiber optic and communications systems is minimal and primarily around the maintenance stations and material sites.

f The surface of the land, including vegetation, permafrost, soil, and soil stability

Effects on the land, vegetation, permafrost and soils are discussed in the AMDIAP SF299 application. Construction of the fiber optic system within the road embankment footprint and the regeneration and communications systems within the proposed maintenance stations would have minimal contribution to project effects. Communications towers not located at maintenance stations would be located at material sites or landing strips.

18. Describe the probable effects that the proposed project will have on (a) populations of fish, plant life, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.

a Populations of fish, plant life, wildlife, and marine life, including threatened and endangered species

Effects on the habitat and populations of fish, wildlife, birds, and marine life from the AMDIAP project are discussed in the SF299 application. Construction of the fiber optic system within the road embankment footprint and the regeneration and communications systems within the proposed maintenance stations and material sites would have minimal contribution to project effects.

No federally listed threatened or endangered species are known to occur along the proposed corridor.

Operation of the fiber optic and communications systems would not contribute to additional impacts on fish and wildlife along the proposed corridor but could reduce these impacts by allowing AIDEA and the road operator to monitor road use, complywith road access limitations, and monitor of wildlife movements in the area. As with the Delong Mountain Transportation System (DMTS), wildlife impacts may be minimized by communicating with road users and stopping road operations when key species are sighted on or adjacent to the road.

b Marine mammals, including hunting, capturing, collecting, or killing these animals

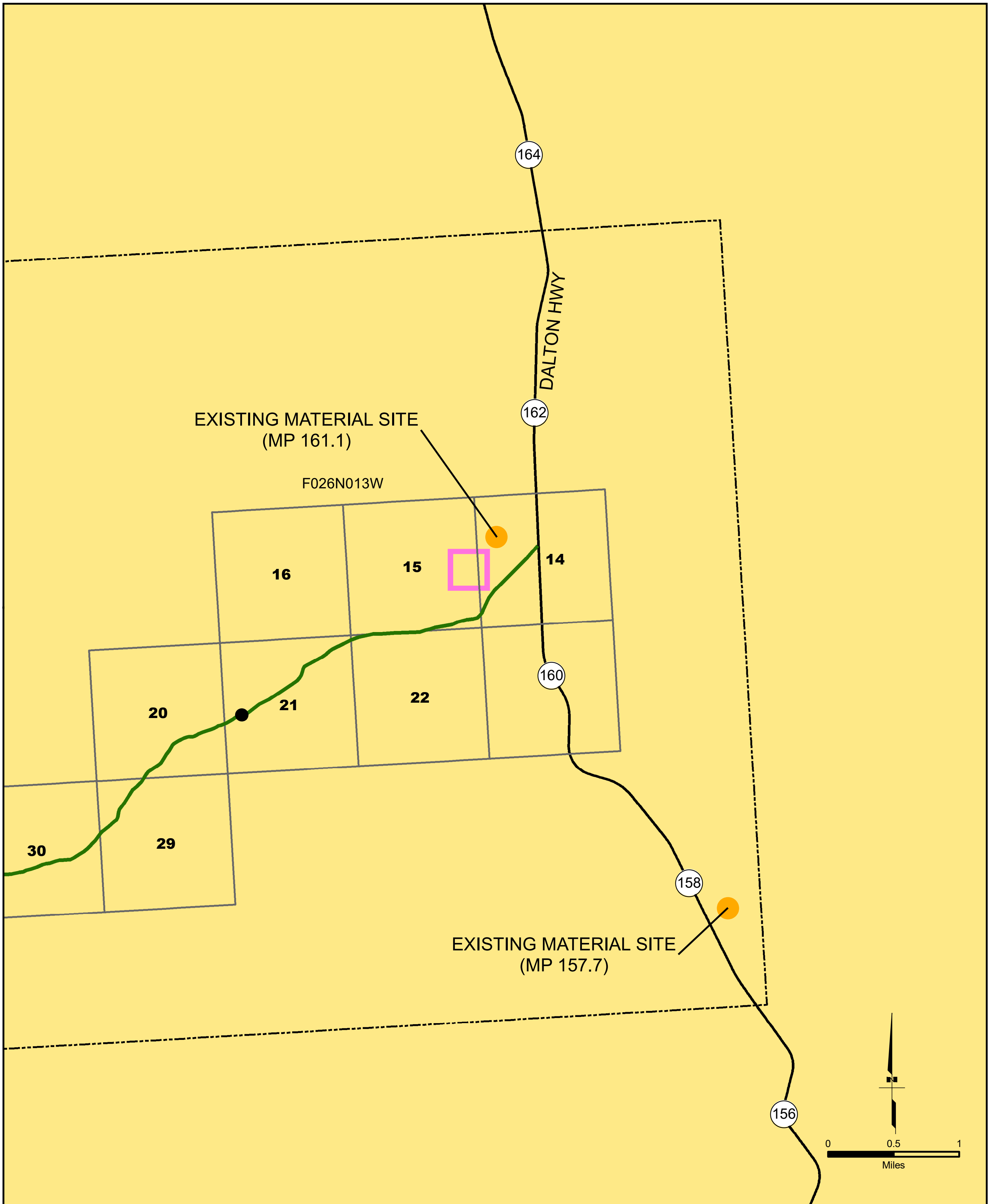
Neither the AMDIAP nor the fiber optic and communications systems would impact marine mammals.

19. State whether any hazardous material, as defined in this paragraph, will be used, produced, transported or stored on or within the right-of-way or any of the right-of-way facilities, or used I the construction, operation, maintenance or termination of the right-of-way or any of its facilities. "Hazardous material" means any substance, pollutant or contaminant that is listed as hazardous under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. 9601 et seq., and its regulations. The definition of hazardous substances under CERCLA includes any "hazardous waste" as defined in the Resource Conservation and Recovery Act of 1976 (RCRA), as amended, 42 U.S.C. 9601 et seq., and its regulations. The term hazardous materials also includes any nuclear or byproduct material as defined by the Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq. The term does not include petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated as a hazardous substance under CERCLA Section 101(14), 42 U.S.C. 9601 (14), nor does the term include natural gas.

Inclusion of the fiber optic and communications systems would not require any hazardous materials in addition to the those discussed in the AMDIAP SF299 application.

ATTACHMENT 1

PROPOSED DALTON HIGHWAY
MAINTENANCE STATION SITE



Preferred (Northern) Alignment
Turnout
Mile Post
Material Sites
BLM
Township
Section

AMBLER MINING DISTRICT INDUSTRIAL ACCESS ROAD

DOWL

AIDEA Alaska Industrial Development and Export Authority

Proposed Material Site/ Maintenance Station

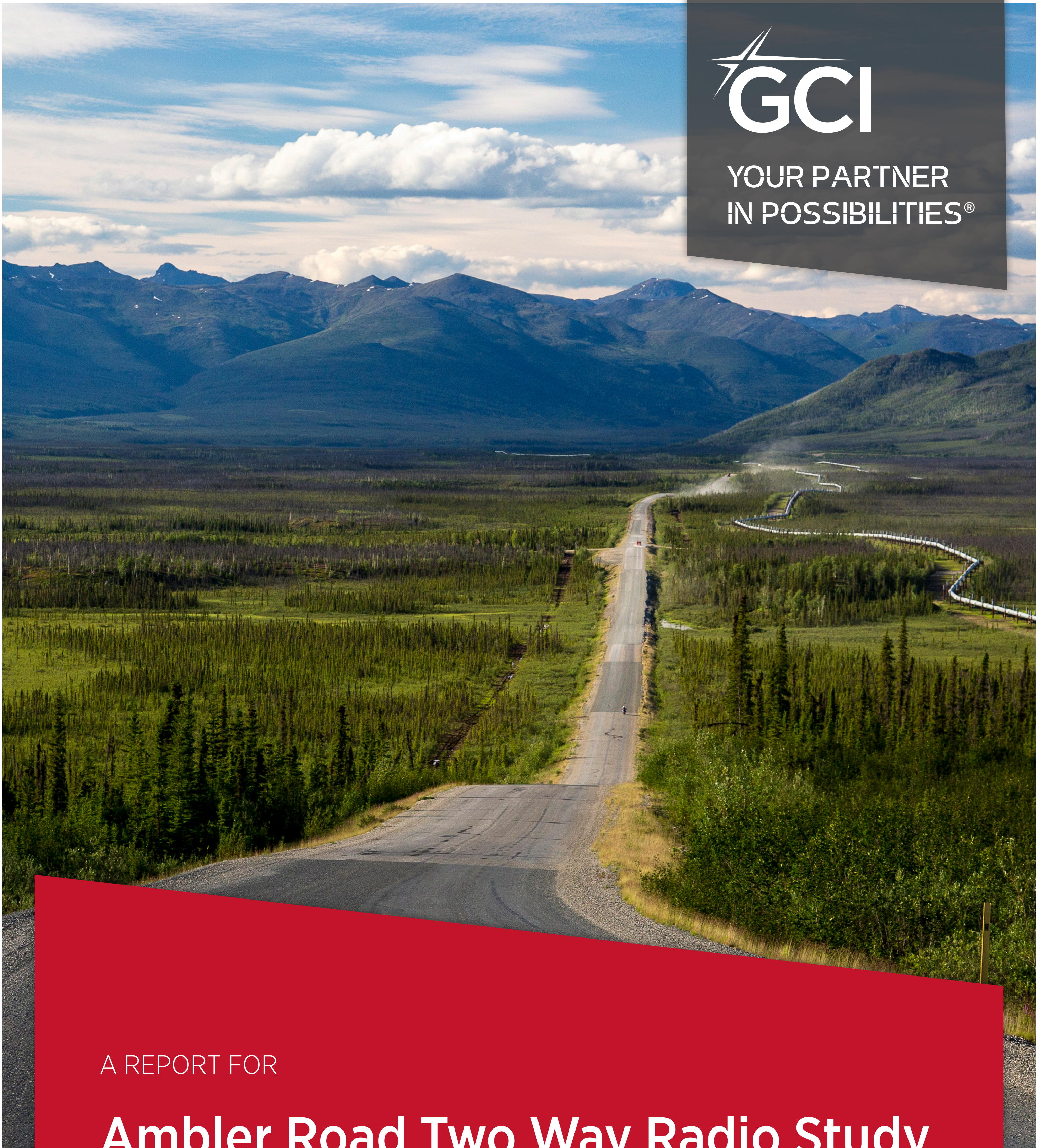
Ambler Mining District Industrial Access Road

April 11, 2019

Q:\33\60693-10\60GIS\Northern Bypass\BLM WDL BLM land Updated.mxd

ATTACHMENT 2

AMBLER ROAD TWO-WAY RADIO STUDY



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A REPORT FOR

Ambler Road Two Way Radio Study

Submitted March 8, 2019

Table of Contents

Glossary

- **AFG:** Above Finished Grade.
- **AIDEA:** Alaska Industrial Development and Export Authority.
- **AMDIAP:** Alaska Mining District Industrial Access Project.
- **DBm:** Signal level in decibels (dB) with reference to one milliwatt (mW).
- **DBd:** Measure of the gain relative to a dipole antenna.
- **Mobile Radio:** Radio mounted in a vehicle or other moving object.
- **Multicoupler:** Device that enables multiple radio channels to be received through a common antenna system.
- **NAD83:** North American Datum of 1983.
- **Omnidirectional (antenna):** Class of antenna which radiates equal power in all directions .
- **Pathloss 5.1:** Software package used to perform this coverage study.
- **QoS:** Quality of Service.
- **Receiver Threshold:** The value, in DBm, at which a radio signal is degraded to the point that a radio system can no longer receive it.
- **Repeater Site:** A location that is equipped with all necessary equipment for the transmission and reception of radio signals. Equipment at a Repeater Site includes an antenna, tower, radio, and all necessary equipment to provide power.
- **RF:** Radio Frequency.
- **RoW:** Right of Way.
- **Transmit Combiner:** Device used with a transmitting radio (at a repeater site) to transmit multiple signals from a common antenna system.
- **UHF:** Ultra High Frequency, a designation for the range of radio frequency electromagnetic waves from 300 to 3,000 MHz.
- **VHF:** Very High Frequency, a designation for the range of radio frequency electromagnetic waves from 30 to 300 MHz.

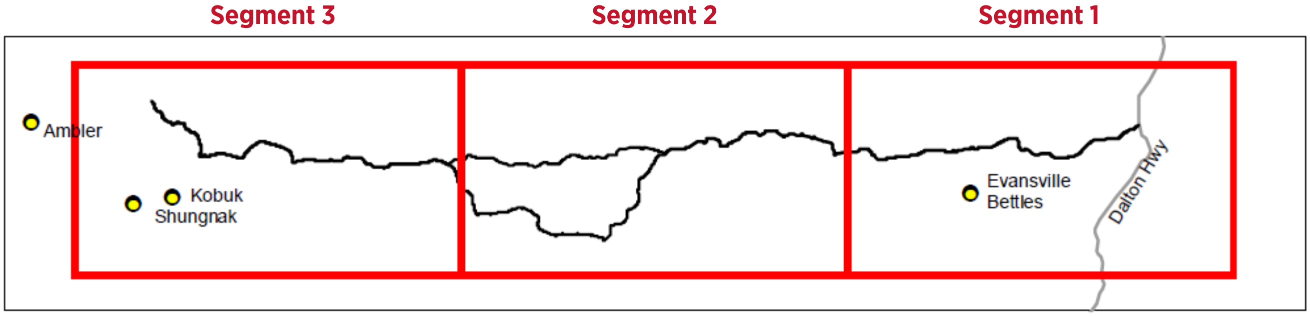
Introduction

This preliminary study details the recommended tower locations, physical requirements, and assumptions for a very high frequency (VHF) two-way radio system along the Alaska Industrial Development and Export Authority (AIDEA) Ambler Mining District Industrial Access Project (AMDIAP) road. This study also provides high-level estimated costs for the proposed installations, as well as basic maintenance costs for the two-way radio equipment. Detailed exact costs, specifications, and equipment manufacturers are not provided in this study.

Summary

This radio study presents two system design scenarios. The first design provides coverage for more than 95% of the roadway, and is intended to provide a cost-effective option for basic two-way coverage. The second design scenario provides coverage for 100% of the road, with no segments of the road experiencing service blackouts. The results of this study show that 95% radio coverage can be achieved for the length of the proposed Ambler Road route using a total of seven (7) repeater sites, while 100% coverage can be achieved for the length of the road using twelve (12) repeater sites. All repeater site locations for both scenarios are provided in this document. The quality of radio coverage is shown within the color bands overlaid on the system map.

- Green = good coverage
- Yellow-Orange = marginal coverage
- Black = little or no coverage

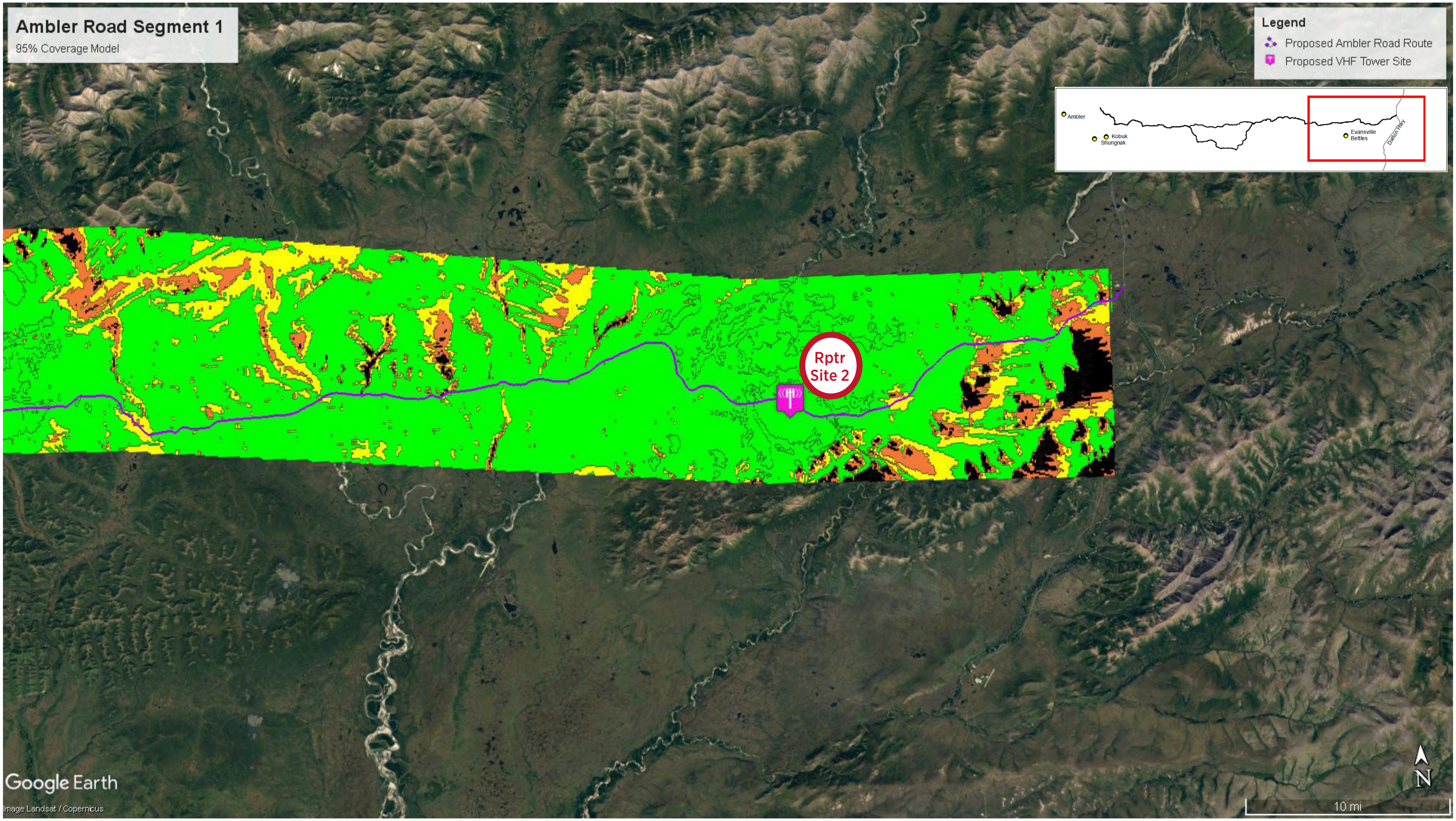


For this study, a computer based radio coverage analysis was utilized to produce the system coverage maps. Terrain dataset resolution was 1 second where available and 2 seconds for the remainder of the study area. Locational and situational confidence levels for both scenarios analyzed in this study are 95%.

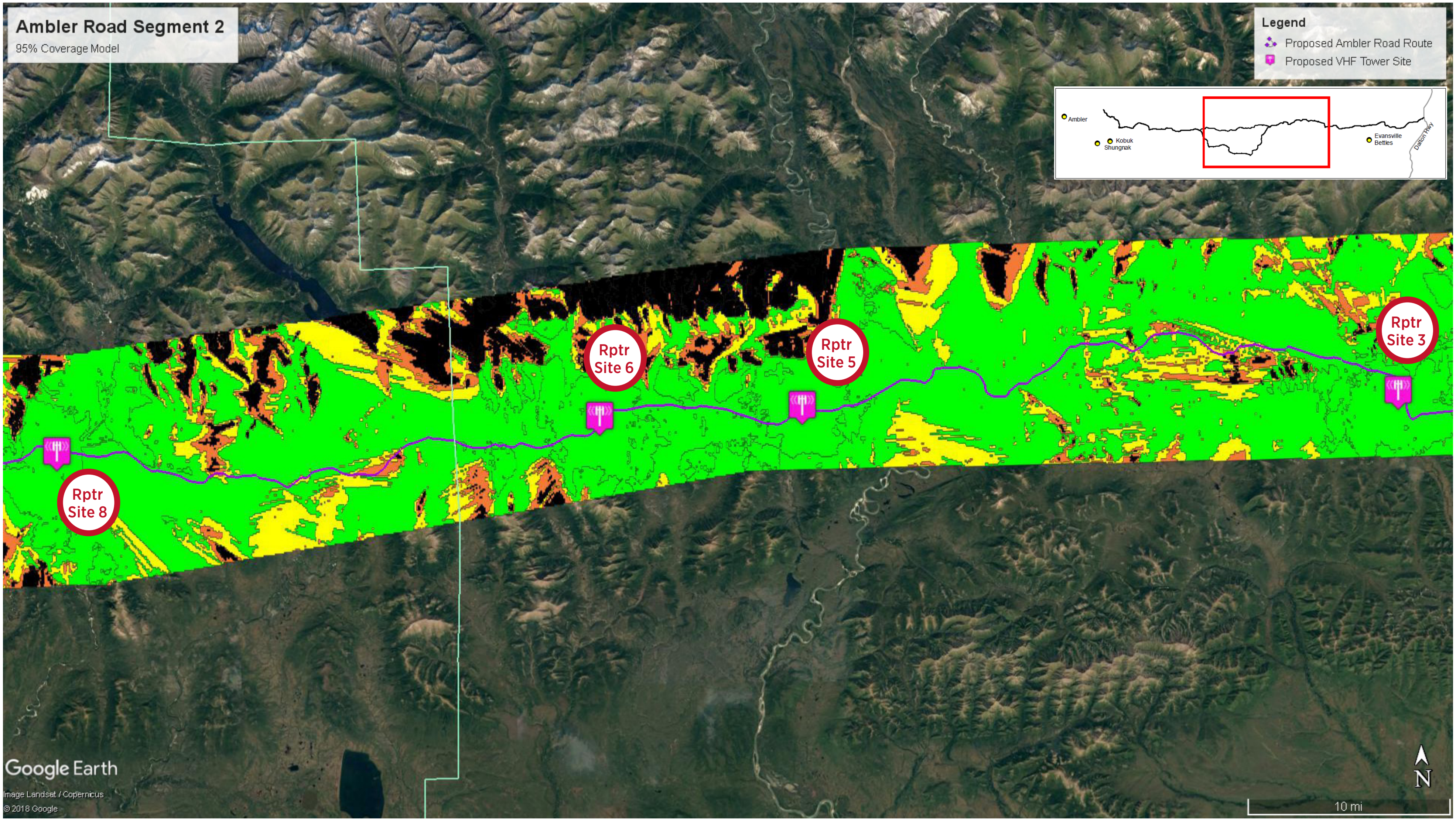
The radio repeater sites were selected based upon topography, the alignment of the road right of way (RoW), and access to the road RoW for construction, operations, and maintenance. Each repeater site assumes that the antenna is mounted at 100 feet above ground level (AGL) on a self-supported tower structure.

The VHF radio frequency band was selected to maximize the coverage area to road traffic using a minimum number of radio repeater stations and towers. For a given number of towers, multi-site radio systems in the VHF frequency band are more resilient to geographical obstructions and tree losses/foliage than radio systems that utilize higher frequency bands such as ultra high frequency (UHF), 700/800MHz, and cellular.

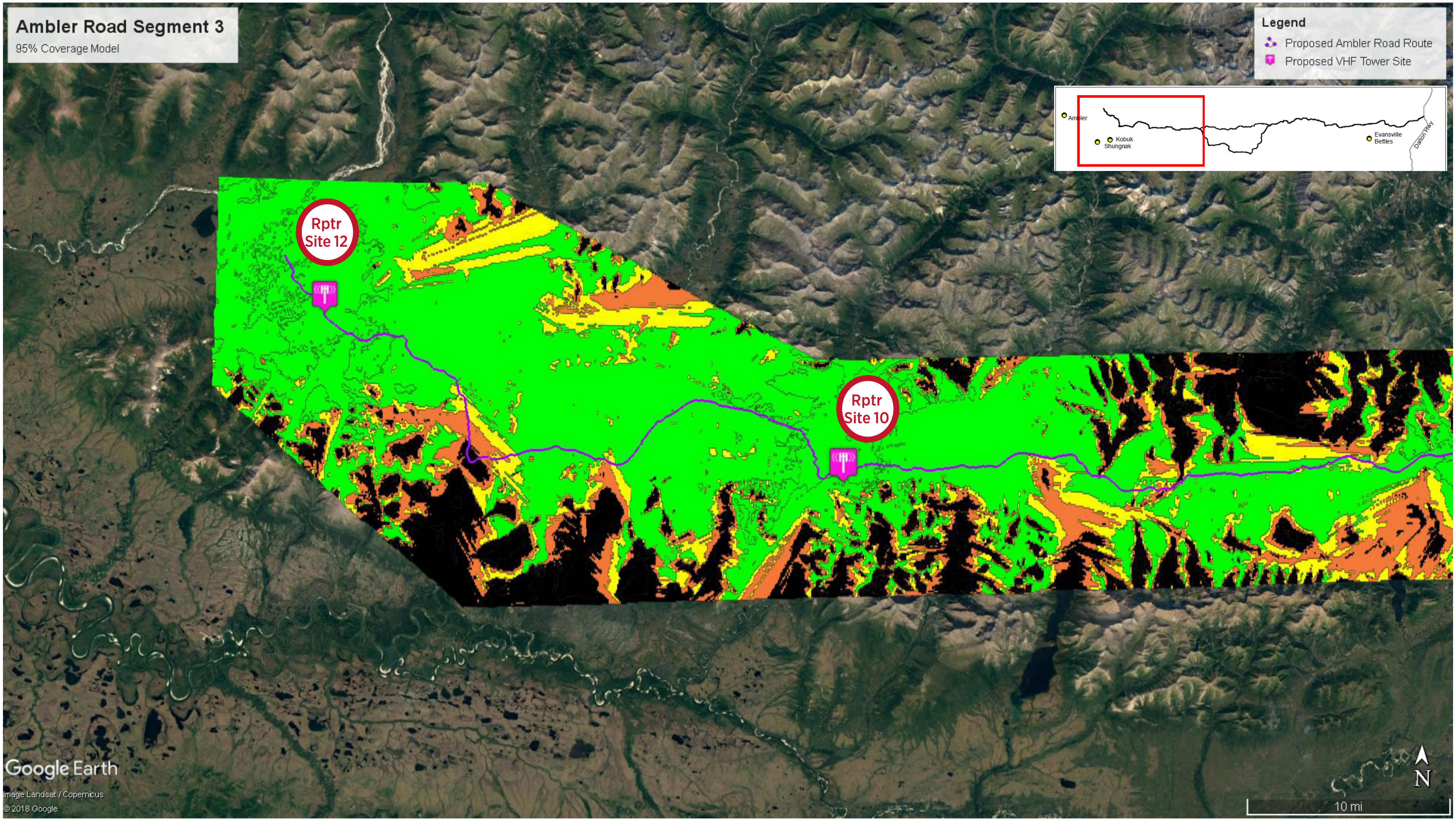
95% Coverage: Ambler Road Segment 1



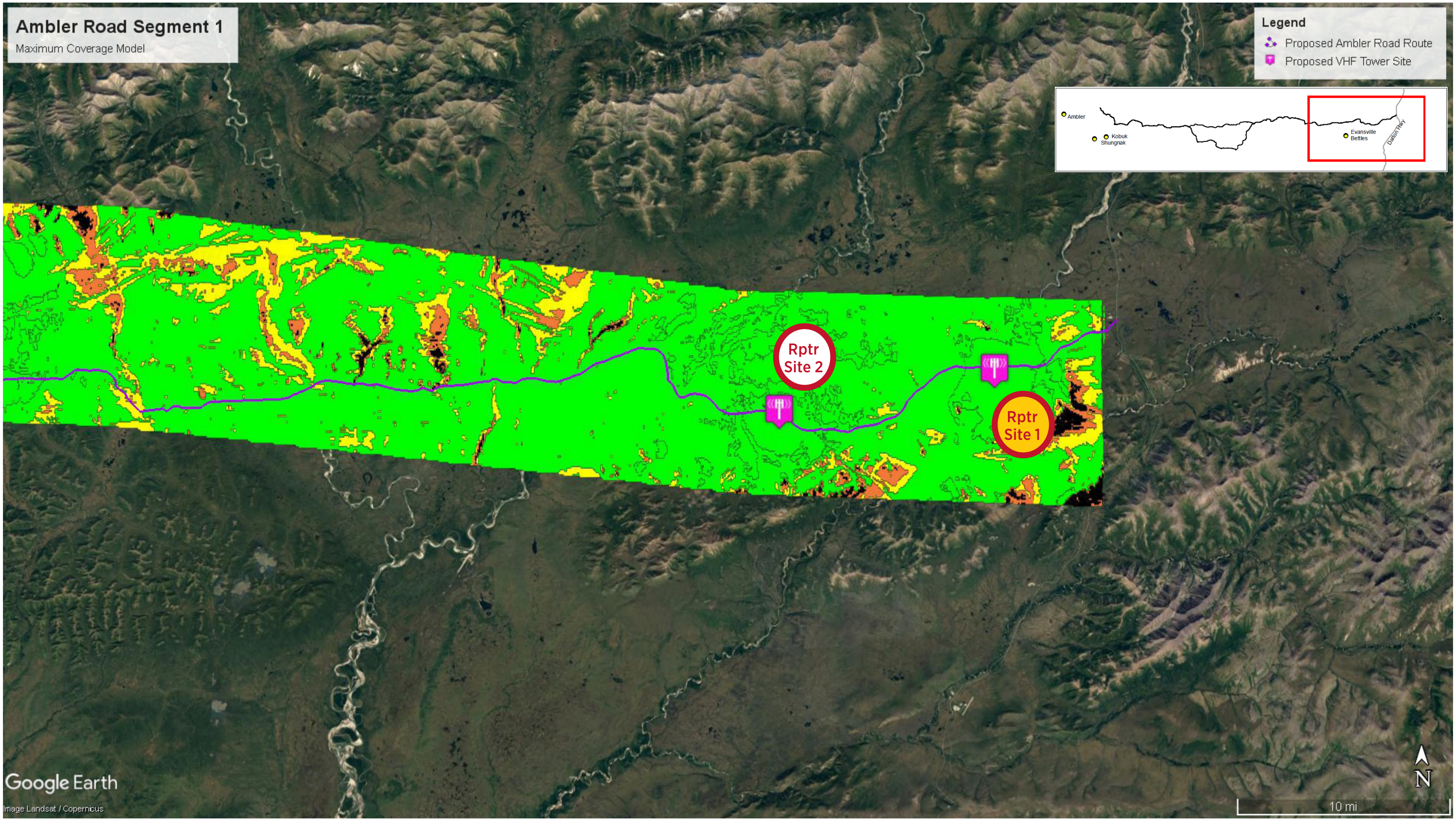
95% Coverage: Ambler Road Segment 2



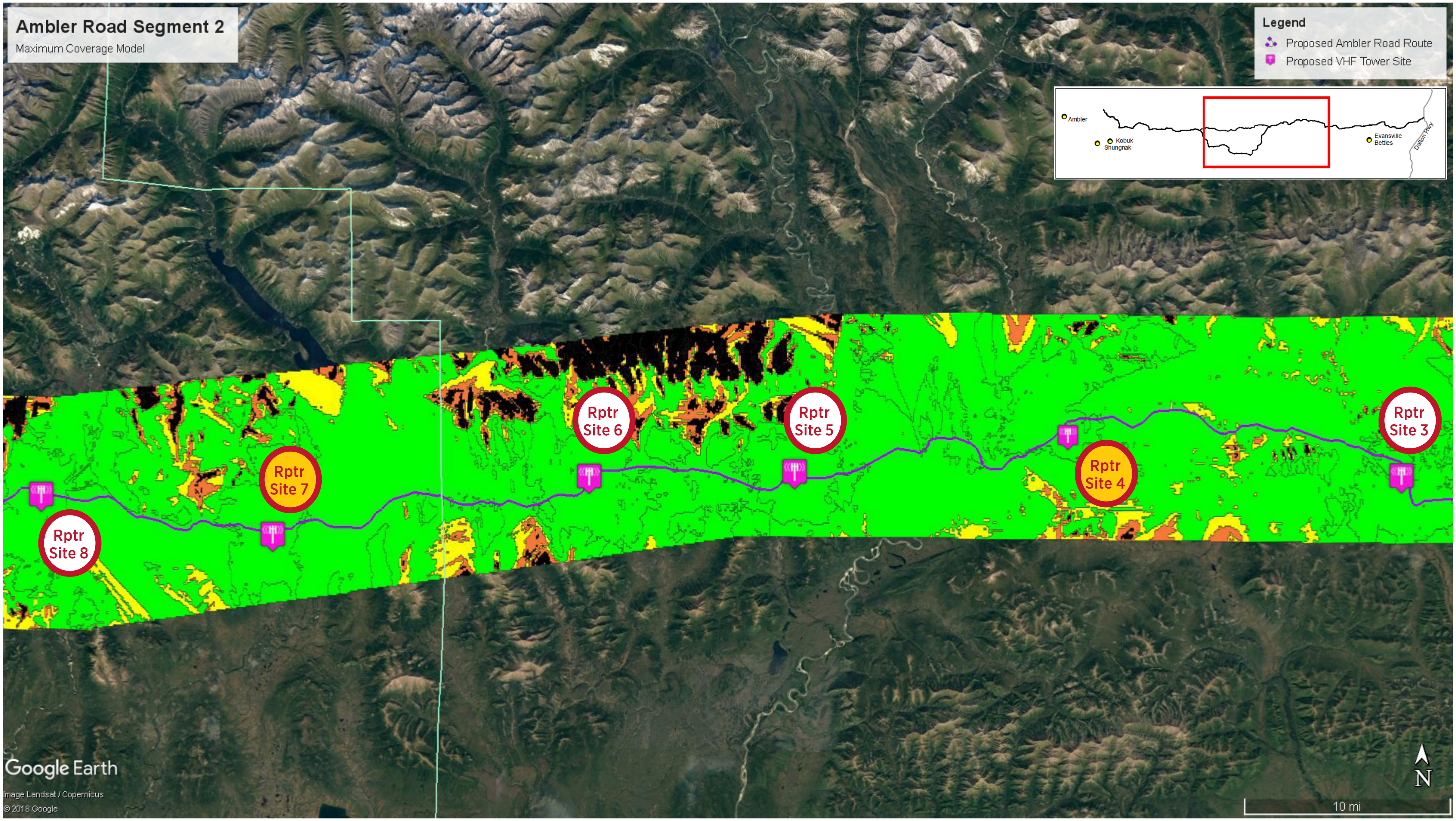
95% Coverage: Ambler Road Segment 3



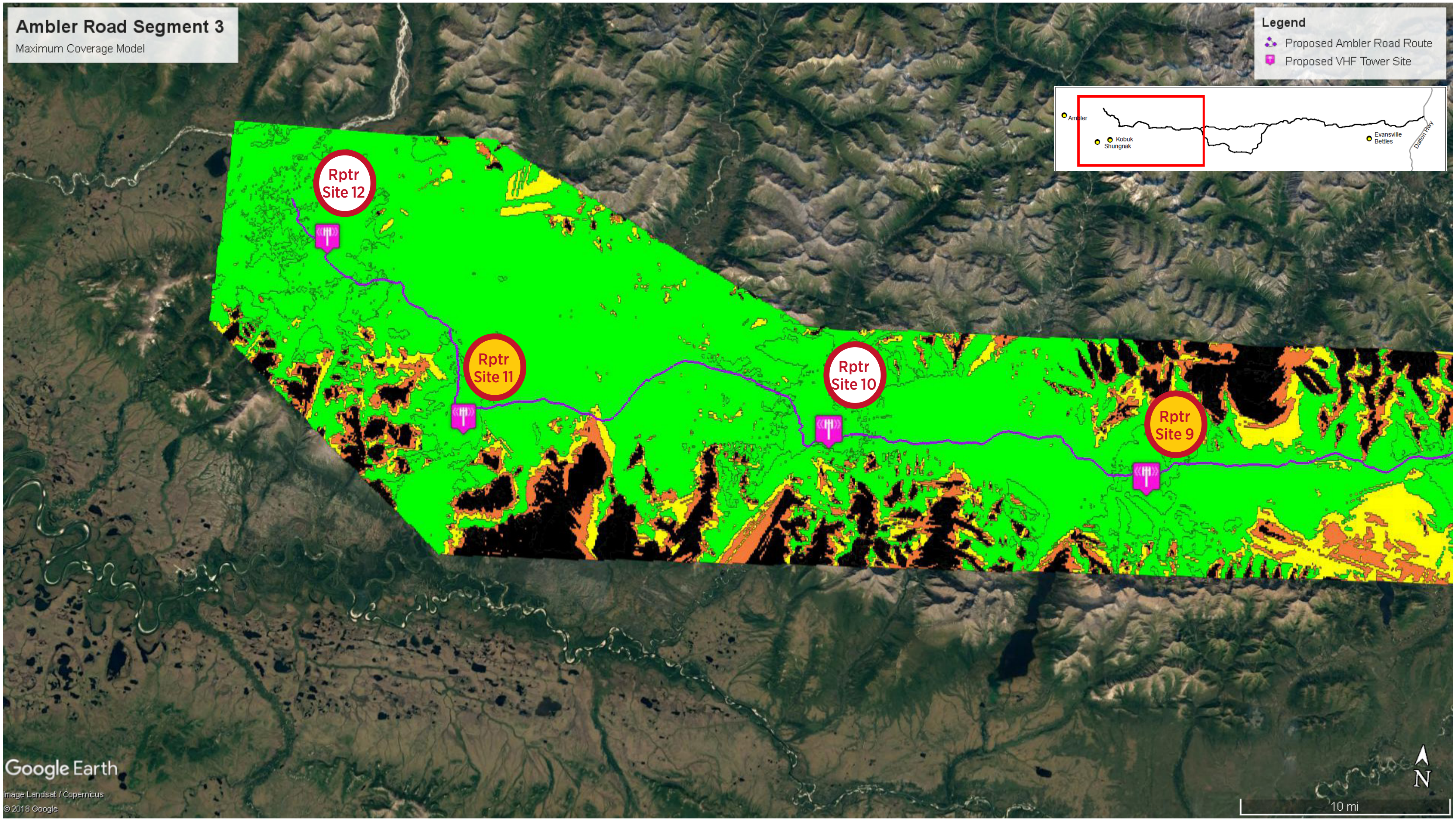
100% Coverage: Ambler Road Segment 1



100% Coverage: Ambler Road Segment 2



100% Coverage: Ambler Road Segment 3



Assumptions and Equipment Parameters

- **Technical Equipment Details:** The following list identifies the assumptions and technical equipment specifications used for the study. The specifications used are generally based on industry-typical values. They are not intended to provide recommendations nor are they based on particular pieces of equipment specific to one manufacturer.
  - Radios are VHF, operating at a frequency of 150 MHz.
  - Radio repeater system uses one radio duplex channel.
  - Each base station radio modeled in the study uses 100 Watts, consistent with a higher-powered industry typical base station radio system.
  - Each mobile radio modeled in the study uses 50 Watts, consistent with a higher-powered industry typical mobile radio system.
  - The base station antenna modeled in the study is a 21' omnidirectional type with a gain of 6dBd.
  - The remote antenna modeled in the study is a 6' omnidirectional type with a gain of 3dBd.
  - Each base station repeater is modeled with a multicoupler and transmit combiner. These result in a 2db net receive and 3dB net transmit loss, respectively.
  - Per common VHF radio parameters, receiver threshold is assumed to occur at -120dBm.
  - Receiver threshold levels shown in the coverage study are referenced to the base stations mobile "talk-back" coverage.
- **Physical:** The following list identifies the landscape and tower parameters used for the study.
  - Ground elevations used for analysis are based on pathloss terrain database, North American Datum of 1983(NAD83)
  - All repeater antennas are modeled at a mounting height of 100' AGL. This assumes all towers are no less than 100' tall.
  - The total transmission line length (between radio and antenna) is modeled at 140'.
  - The mobile antenna is mounted on the roof of a pick-up truck at a height of 6' above finished grade (AFG).
  - The finished grade of the road is 8' above the original terrain, for a total receiving antenna height of 14' including vehicle height.
  - Radio coverage area for each tower is isolated to that specific coverage area for that radio repeater. Vehicles in the coverage area of one tower will generally be able to communicate with vehicles within the coverage area of that same tower. Wide area systems utilizing multiple interconnected radio repeaters are possible but are dependent on the sites being interconnected through a high-availability, low latency IP communications backbone network between all sites.
  - Adjacent towers are not designed for line-of-site (LOS) microwave communications between tower sites
  - No analysis was performed to determine in-building coverage for handheld radios.

Study Methodology

To establish a coverage map for this study, radio repeater base stations were chosen based on the coordinate data provided by DOWL. Construction camps and airstrips were selected as radio repeater locations in the initial model build, per input from DOWL.

Radio and antenna parameters were chosen based on common VHF radio guidelines and specifications, and industry-typical equipment files were loaded into the area coverage model. Though actual radio and antennas specified for the project build may differ from those used in this coverage study, no meaningful variance in signal gain/loss is anticipated.

After analyzing the initial coverage provided by the towers modeled at construction camps and airstrips, tower and antenna heights were adjusted to a maximum elevation of 200' AFG to fill coverage gaps. No meaningful benefit was observed as a result of the tower height adjustments, so additional tower sites were required in the model to provide coverage in areas with little or no signal.

Three criteria were used to determine the suitability of an additional tower site:

- Site must be a proposed material site per location and coordinate data provided by DOWL
- Site must be accessible from the proposed Ambler Road RoW to allow for easy access and maintenance of the equipment
- Site must be located in an optimized location to overcome geographical obstacles that impede signal levels.

The study determined that, for the first scenario with the objective of 95% coverage, two additional repeater sites in addition to the five sites located at construction camps and airstrips are required. This results in a total of seven (7) repeater sites, all of which are located at air strips (3), construction camps (2), or material sites (2). The analysis predicts radio coverage for approximately 97.5% of the RoW in this scenario.

For the second scenario, where 100% RoW coverage is required, twelve (12) tower sites are required. All twelve of the proposed repeater sites are located at air strips (3), construction camps (2), or material sites (7). The sites selected per this study, listed from East to West, are listed in the table below:

Site Description	Req. for 100% coverage	Lat	Long
Repeater Site #1: Material Site #0, Easternmost	X	67.04423187	150.5761664
Repeater Site #2: Construction Camp, Easternmost		67.01708333	150.9658333
Repeater Site #3: Landing Strip #2, Easternmost landing strip		67.05459292	152.4359574
Repeater Site #4: Material Site #5, Alatna Hills Schist	X	67.08556435	153.0296691
Repeater Site #5: Construction Camp, N. Helpmejack Piedmon Gravels		67.05949246	153.5145904
Repeater Site #6: Material Site #9, Alatna Portage Piedmont Gravels		67.05491827	153.8787847
Repeater Site #7: Material Site #10, GANPP Outwash	X	67.00853695	154.4433393
Repeater Site #8: Landing Strip #3, Middle landing strip		67.03434657	154.853654

Site Description	Req. for 100% coverage	Lat	Long
Repeater Site #9: Material Site #14, NE Narvak Lake Piedmont Gravels	X	66.99855555	155.4582519
Repeater Site #10: Material Site #17, Mauneluk River Alluvial Terrace		67.01863977	156.0306469
Repeater Site #11: Material Site #20, Kogoluktuk River Drift	X	67.00799571	156.6881981
Repeater Site #12: Landing Strip #1, Westernmost landing strip		67.12839886	156.9713087

Refer to drawing CM-GCI-107536-002-001 (page 19) for typical communications tower and communications shelter section views.

Cost Analysis

The approximate cost to prepare the pads, purchase equipment, and install equipment at each tower site is provided in the table below. Please note that the costs in this section assume vehicle access to the sites via the proposed Ambler Road RoW. The first section of the table provides estimates for the preparation of each pad, along with the purchase and installation costs for the generator and communications shelters. These will be required to provide power to the stationary radio equipment and to house any indoor-only electronics.

The second section of the table provides an estimate for the installation of the towers and radio equipment. This estimate assumes that the pad preparation work, defined in the first section of the table, has been completed.

Pad with Communication Shelter, Tower, and Radio Equipment - Parts and Labor Cost Estimate

Description and Scope of Work	COST ESTIMATE - PER SITE		
	Minimum Cost	Maximum Cost	Average Cost
• Engineer and fabricate communications module, generator module, and generator fueling system • Prep pad, install communications module • Prep pad, install diesel generator and module	$750,000	$850,000	$800,000
• Perform RF coverage studies and system design, channel planning • Install communications towers • Order repeaters, network equipment, antennas, TX lines, mobiles • Program equipment and radios • FCC licensing • Deploy system, install mobiles, train users	$260,000	$360,000	$310,000
	TOTAL COST ESTIMATE		
	Minimum Cost	Maximum Cost	Average Cost
7 Sites (95% coverage)	$7,070,000	$8,470,000	$7,770,000
12 Sites (100% coverage)	$12,120,000	$14,520,000	$13,320,000

Maintenance Recommendations

This section provides cost projections based on estimated maintenance intervals for the two-way radio equipment, as well as the generators and towers located at each of the proposed repeater sites. Tables are provided for the 100% coverage scenario with 12 tower sites, as well as the 95% coverage scenario with 7 tower sites. This estimate assumes the following:

- Generators installed at each site are running continuously to allow the radio system to operate full-time.
- Generators are serviced every 2 weeks, with one service consisting of an oil and filter change, and labor for refueling.
- One generator support ticket, as defined in the tables below, includes the servicing of all generators.
- Labor cost for generator fueling is included in this estimate. Fuel cost is not included due to variability in pricing and volume.
- Towers are inspected annually.
- Service technicians require 24 hours of total travel time to/from the site per ticket.

System	Tech Hours per Ticket	Tickets per Year	Total Hours per Year	Technician Bill Rate	Total Labor Cost per Year	Materials and Equipment
Tower Inspections	72	7	504	$150	$75,600	$3,000
Radio Troubleshooting	36	4	144	$150	$21,600	$3,000
Remote Monitoring, Administration, Field Correspondence	-	-	150	$150	$22,500	-
Generator Basic Maintenance	36	26	936	$150	$140,400	$100,000
Annual Estimated Costs of Operations and Maintenance					$260,100	$106,000
Annual Total Estimated Costs of Operations and Maintenance (**7 tower sites**)					**$366,100**	

System	Tech Hours per Ticket	Tickets per Year	Total Hours per Year	Technician Bill Rate	Total Labor Cost per Year	Materials and Equipment
Tower Inspections	72	12	864	$150	$129,600	$5,000
Radio Troubleshooting	36	6	216	$150	$32,400	$5,000
Remote Monitoring, Administration, Field Correspondence	-	-	240	$150	$36,000	-
Generator Basic Maintenance	48	26	1248	$150	$187,200	$100,000
Annual Estimated Costs of Operations and Maintenance					$385,200	$110,000
Annual Total Estimated Costs of Operations and Maintenance (**12 tower sites**)					**$495,200**	

Conclusion

The results of this study indicate that a VHF two-way radio system is viable on the proposed Ambler Road route, with seven tower sites required to achieve 95% coverage and twelve tower sites required for 100% coverage. All sites are located within the proposed material sites, airport sites, and construction camps. We are confident that this system could provide reliable two-way communications to truck traffic travelling along the proposed route.

If wide area coverage from multiple repeater sites is required, then a backbone IP transport network linking all sites will be required. This functionality could be incorporated into the two-way radio system following the installation of the proposed fiber optic network.

AMDIAP Material Sites and Landing Strips

Number	Name	Lat	Long
4	John River Glacial Drift	67.04442261940	-153.13224577200
5	Heart Mountain Glacial Drift	67.06306623900	-153.13224577200
6	M.F. of Alatna Alluvial	67.07649754050	-153.13224577200
6	M.F. of Alatna Glacial Outwash	67.07219345350	-153.13224577200
7	Alatna River Alluvium and Terrace Gravels	67.07059486480	-153.32243530000
8	N. Helpmejack Piedmon Gravels	67.05986263760	-153.68531696100
9	Alatna Portage Piedmont Gravels	67.05491827380	-153.87878473200
10	GANPP Outwash	67.00853695300	-154.44333934700
12	Beaver Creek Drift	67.02521204280	-155.18686109000
11	Reed River Bluffs - Drift	67.03947486440	-154.82175748300
14	NE Narvak Lake Piedmont G	66.99855555280	-155.45825190700
15	E Avaraart Lake Drift	67.02508834490	-155.61894910400
16	S Avaraart Lake Drift	67.01884849180	-155.77700361400
17	Mauneluk River Alluvial Terrace	67.01863976520	-156.03064691600
18	E Ambler Lowlands PG A	67.05917650670	-156.26783190300
18	E Ambler Lowlands PG B	67.06036930990	-156.30280544700
19	E Ambler Lowlands G Drift	67.03703460820	-156.38642844900
20	Kogoluktuk River Drift/Alluvium	67.00799571260	-156.68819810800
21	Central Ambler Lowlands Glacial Drift	67.08112355920	-156.75509110100
22	Shungnak River Drift and Terrace Gravels	67.12619551280	-156.97935418900
23	Ambler River Alluvium	67.15887892750	-157.05422969200
24	Helpmejack Hills Outwash	67.05949246250	-153.51459039900
12	Beaver Creek Outwash	67.02154612340	-155.16392194300
13	W Beaver Creek Piedmont	67.01092856500	-155.31314520200
31	E Ambler Lowlands Alluvial Fan	67.01092166280	-156.41433956400
20	Kogoluktuk River Alluvium	67.02936743520	-156.67088051100
4	Alatna Hills Quartzite	67.07179190950	-152.87646489800
5	Alatna Hills Schist	67.08556434840	-153.02966907600
6	Avaraat Lake Andesite	67.04969113100	-155.69470914500

Number	Name	Lat	Long
7	Mauneluk River Basalt	67.01531856350	-155.98013026200
8	Ambler Lowlands Marble	67.07131246900	-156.73940860800
0	East End Material Site	67.01416668730	-151.82494319700
0	East End Material Site	67.04946524830	-151.60175734700
0	East End Material Site	67.03947820040	-151.59476453200
0	East End Material Site	67.05782606540	-151.17926625500
0	East End Material Site	67.03291729590	-151.15775506000
0	East End Material Site	67.01708870370	-150.96593776000
0	East End Material Site	67.04635993790	-150.62811036900
0	East End Material Site	67.04423187210	-150.57616635300

Material Site	Lat	Long
MP 157.7	67.03315264410	-150.29527033200
MP 161.1	67.08212000000	-150.36288700000

Proposed Landing Strip	Lat	Long
1	67.12839886130	-156.97130874300
2	67.05459292370	-152.43595735500
3	67.03434657120	-154.85365400500

Figure 2-3: Project Elements (1)

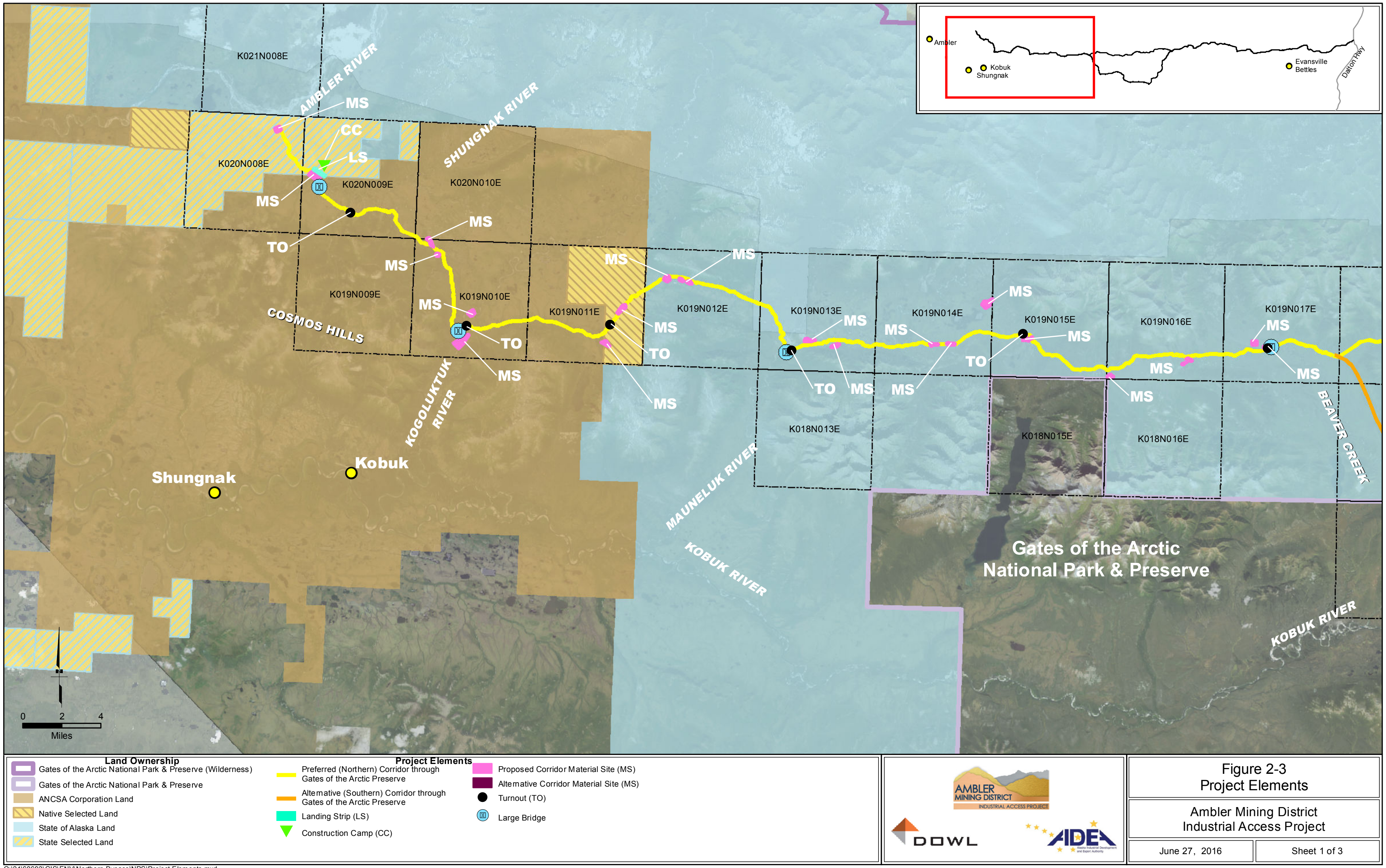


Figure 2-3: Project Elements (2)

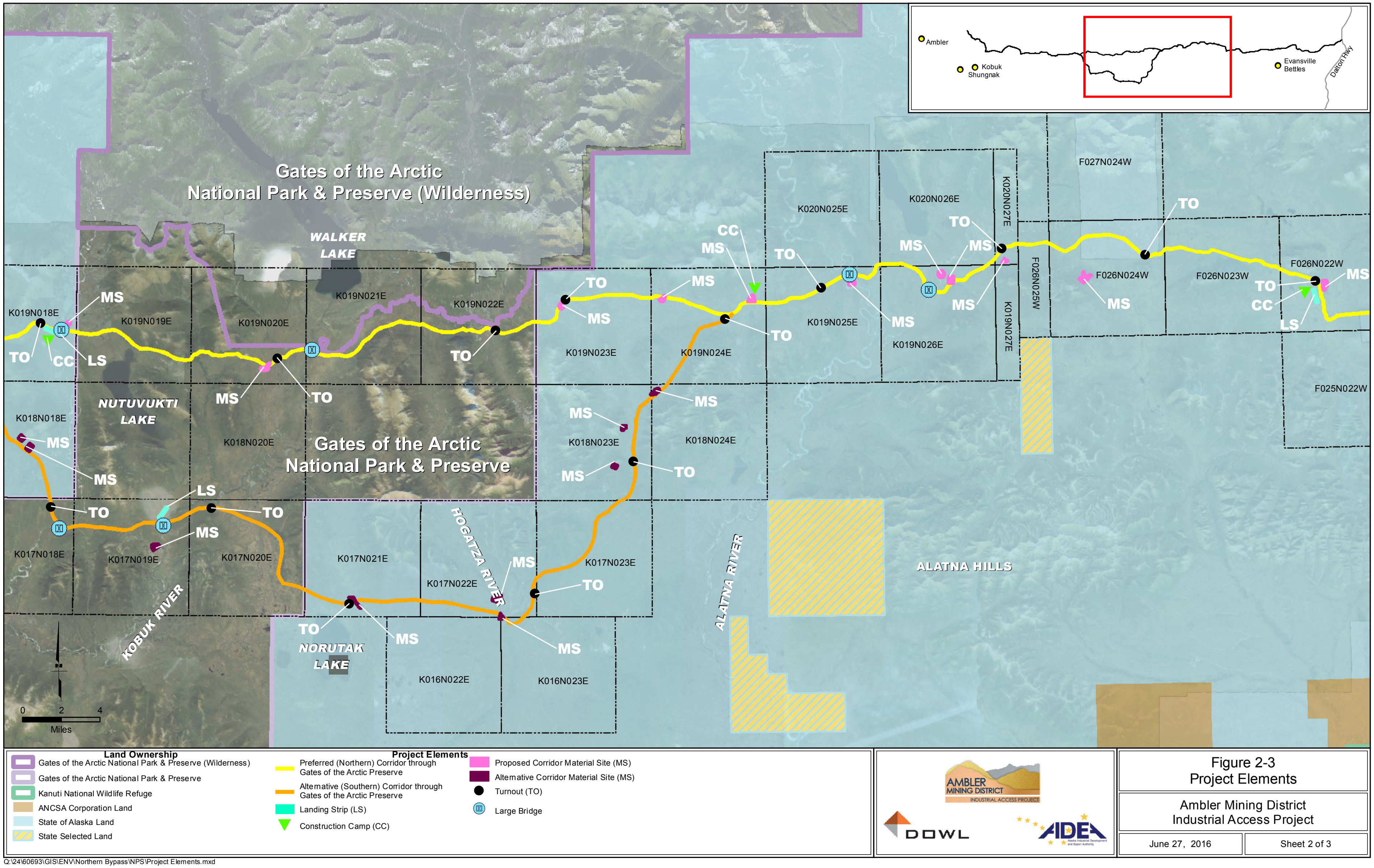
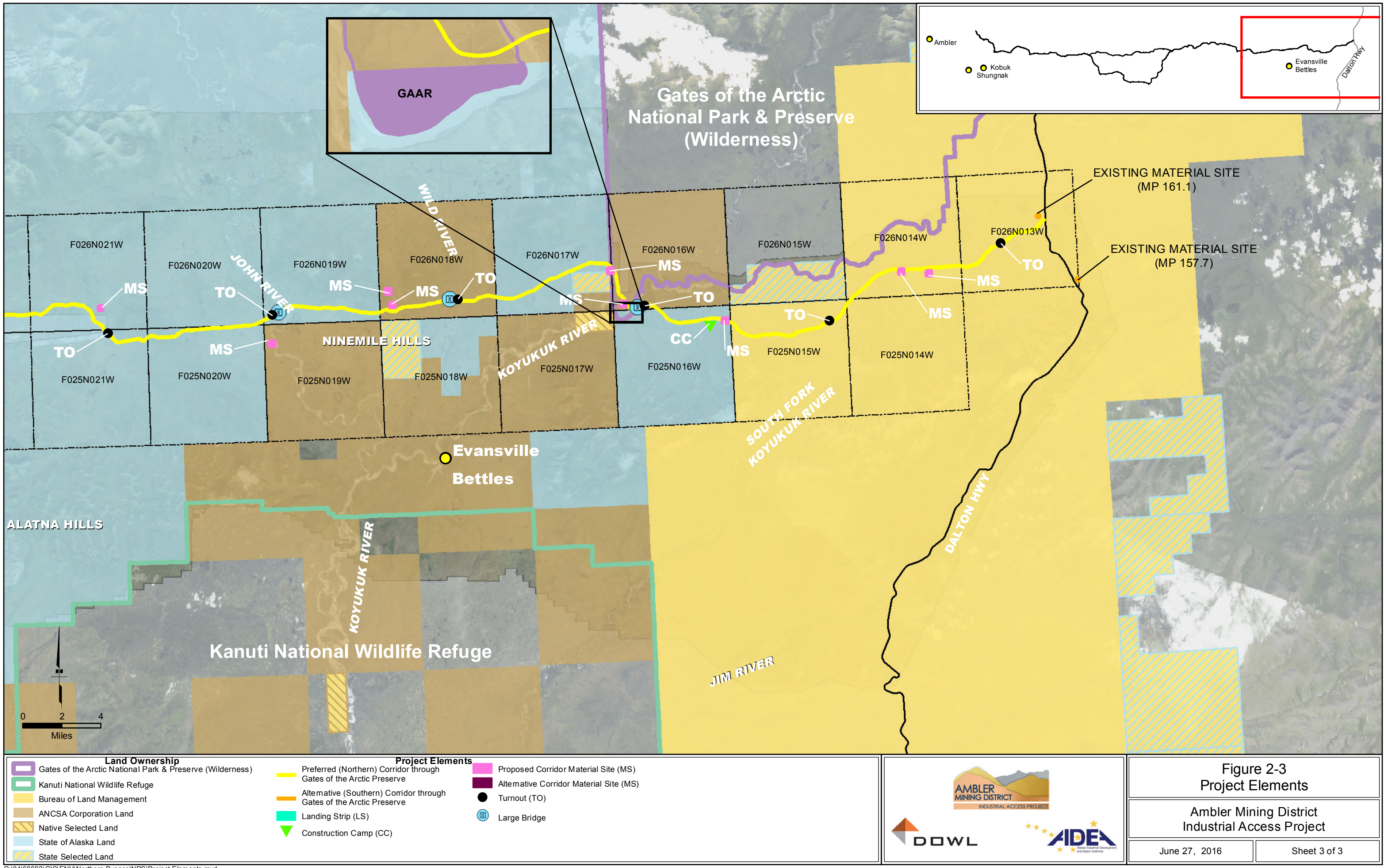
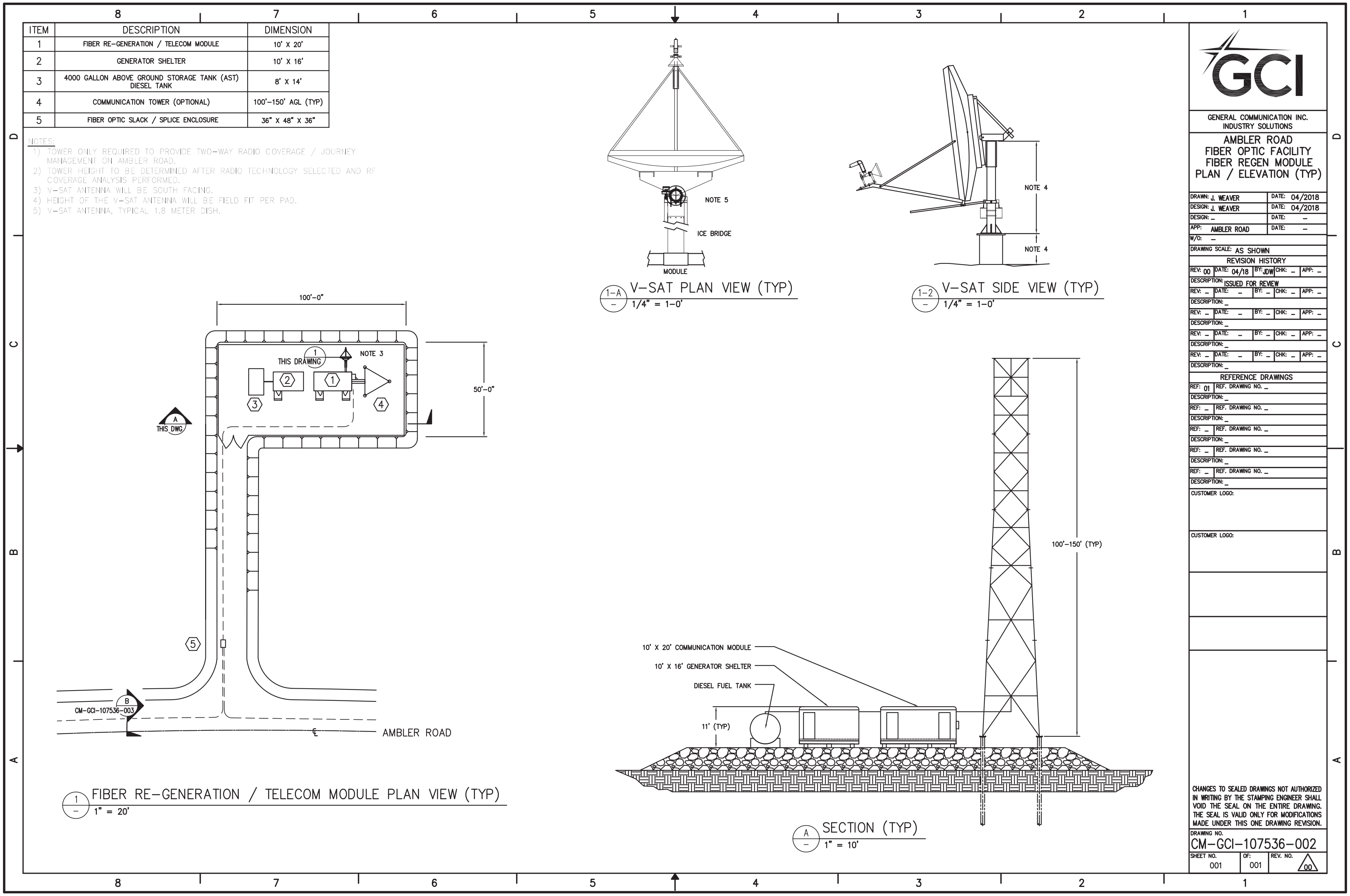


Figure 2-3: Project Elements (3)



Reference Drawing: CM-1-GCI-107536-002-001-Plan-Fiber



ATTACHMENT 3

AMBLER ROAD FIBER OPTIC FACILITY

Ambler Road
Fiber Optic Facility

Table of Contents

Executive Summary

Installation of a fiber optic (FO) cable along the proposed Alaska Industrial Development and Export Authority (AIDEA) Ambler Mining District Industrial Access Project (AMDIAP) road would provide many benefits to the operations of the road. A fiber optic facility provides critical communications infrastructure which allows for the safe and secure operations of this 211-mile-long road in remote Alaska. Simultaneously installing FO cable during the construction of the Ambler Road would be the most economically viable strategy to bring in this communication facility.

Glossary

- **AIDEA:** Alaska Industrial Development and Export Authority
- **AMDIAP:** Alaska Mining District Industrial Access Project
- **Bandwidth:** Maximum rate of data transfer across a given circuit or path, usually expressed in Gigabits per second (Gbps) or Megabits per second (Mbps)
- **CCTV:** Closed Circuit TV
- **DMR:** Digital Mobile Radio
- **Downlink:** satellite communications from "internet" or satellite service provider to the subscriber (satellite DOWN to subscriber)
- **FO:** Fiber Optic
- **Gbps:** Gigabits per second
- **HDD:** Horizontal Directional Drilling
- **HDPE:** High Density PolyEthylene
- **HH:** Handhole
- **LTE:** A 4G mobile communication standard "Long Term Evolution"
- **Mbps:** Megabits per second
- **MTTR:** Mean Time To Repair
- **Multi-Mode:** a type of fiber optic cable typically used for shorter distances
- **NOC:** Network Operations Center
- **PSTN:** Public Switched Telephone Network
- **QoS:** Quality of Service
- **Single-Mode:** a type of fiber optic cable typically used for long distances
- **SOFC:** Solid Oxide Fuel Cell (remote power generators powered from propane)
- **Uplink:** satellite communications from subscriber to the satellite service provider or "internet" (subscriber UP to the satellite)
- **VSAT:** Very Small Aperature Terminal

Benefits of the Fiber Optic Facility

A fiber optic cable installed along the Ambler road would enable technology that increases the safety, security, and efficiency of road operations.

Safety

TWO-WAY RADIO OPTIONS

The end-to-end communications provided by a fiber optic facility could enable wide-area two-way radio communications. Digital Mobile Radio (DMR) systems today can track vehicle data such as location and speed and can keep track of remote and lone workers. These radios can also provide access to the Public Switched Telephone Network (PSTN). These features are enabled by providing a communication channel between radio sites along the road.

Modern two-way radios have GPS receivers that can report their position back to a monitoring station. Each fiber optic regeneration pad will already be equipped with space (permits allowing) and power that could supply two-way radio repeaters and optional communication towers.

Using the assumption that the fiber optic signal regeneration pads will be approximately 50 -70 miles apart, the RF signal would need to propogate at least 25 miles out from each pad to provide sufficient coverage. For instance, utilizing a 150FT tower at each repeater location (signal regeneration pads), and assuming that each mobile radio will be mounted in a standard sized pickup on an elevated roadway (say a total height of 10FT), it is theoretically possible for a VHF signal to propagate the required distances.

The radio coverage would depend largely on the position and height of the radio towers relative to the road. Future radio coverage studies would be required in order to determine coverage areas and any possible gaps along the length of the Ambler Road. Due to the topology of the road, it is likely that additional communication sites and towers would need to be installed to ensure seamless coverage along the length of the road.

WIRELESS – MOBILE COMMUNICATIONS

The connectivity that the FO Facility provides also enables the build out of wireless – mobile communication sites along the Ambler Road. Wireless connectivity provides an added layer of protection and redundancy to the communication network along the Ambler road. Wireless (cellular) communications are typical available up to 7 miles from a tower site. By building out the wireless radio system at all of the maintenance stations you would establish "hot-spots" along the road but seamless coverage would not be achieved. Depending on the long term viability of the business case, a commercial carrier may require an "aid-to-construction" which is a one-time, non-reoccurring fee to build this network. This cost is estimated in the tables below.

Security

FIBER INTRUSION DETECTION

Fiber optic intrusion detection systems could be deployed to monitor travel at select points on the Ambler road. Typically, this type of system would be installed along the fence line of a secure location. Minute variations in the fiber optic signal on these buried fiber optic cables would trigger a notification to a remote service center which would initiate response procedures. A potential application for this project would be to monitor traffic on the Ambler road.

VIDEO SURVEILLANCE OPTIONS

Closed Circuit TV cameras (CCTV) provide remote visual monitoring of areas deemed important for security and/or safety reasons. Examples include guard shack checkpoints, the fiber regeneration pads, or any other sensitive Ambler road facilities of interest. The video images taken from the camera would be transmitted down the fiber optic cable to remote monitoring locations.

Figure 1: Example of a combination solar / wind powered CCTV camera.

Deployed CCTV cameras along the Ambler road away from generator power is possible but becomes especially difficult in the winter months. In the summer months, solar power can create enough energy to charge a battery and power cameras which operate on the order of 20-100 watts. Solar power generation is more feasible during the summer months due to the increase in insolation. Although CCTV cameras can be powered from combinations of solar, wind, fuel-cell or conventional generators, the more complicated the system gets the more unreliable and maintenance intensive it becomes.

Modern fuel cells that run off of propane are commercially available as well. These units could operate during the winter months to provide power to the camera systems. A 150 gallon tank would provide enough energy to last a 500 watt fuel cell from September to April for a typical two camera system. In the summer the system could be switched back to solar power. These fuel cell systems require annual maintenance (filter servicing and “bundle” replacements) but can be remotely monitored to ensure system reliability. 500 watt propane Solid Oxide Fuel Cells (SOFC) cost approximately $35k.

Environmental

ENVIRONMENTAL MONITORING OPTIONS

The FO Facility along the Ambler road could also be leveraged to provide data connectivity to hydrological monitoring stations or any other data collection devices installed along its length. As with CCTV stations, active devices require electrical energy during months of operation.

EFFICIENCY

End to end communications allow for journey management which (in addition to improving safety) can maximize the use of a single-lane road or a road that at times will have single-direction traffic. Scheduling traffic on the road is simplified if there is an awareness of all of the vehicles locations, speed, and direction.

Major Elements of Fiber Optic Construction

Summary

Fiber Optic cable is typically installed aerially on power poles or in a utility corridor underground. When installed underground the cable can be directly buried or installed in a high-density polyethylene (HDPE) raceway/duct (fiber-in-duct). Aerial fiber is not being considered for the Ambler road as there is no existing pole line to leverage. In general, fiber-in-duct is more costly to install than direct buried fiber but offers operational benefits. Both methods use periodically spaced “hand-holes” which serve as locations to splice and to store slack fiber.

At river crossings or bridges, the fiber could be installed using directional boring equipment which would bore a path under the river that the fiber could be installed in or the fiber could be installed in conduit along the bridge span.

Fiber optic signals must be regenerated periodically to overcome signal attenuation and spreading (dispersion). This distance ranges and depends on a number of factors but is typically around 62 miles or 100km. The 211 mile Ambler road would need three signal regen locations along its span as well as an initial tie-in to the Dalton highway FO network and a location at the Ambler Mine area. This signal “regen” equipment can be installed in a stand-alone communication module or in a telecom room located within one of the planned maintenance buildings on the road.

The following section will outline the major elements of FO installations.

Fiber Optic Cable Installation

FIBER-IN-DUCT INSTALLATION METHODOLOGY

In brief installing an underground fiber optic cable in duct involves making a trench, laying in HDPE conduit/duct, backfilling the trench and then using air compressors and fiber jetting/blowing machines to install fiber in the installed duct. The air compressors supply a pulling force along the length of the fiber optic cable while a tractor mechanism pushes the fiber into the duct. This air-assisted installation method is limited to approximately 3000 to 5000 feet depending on multiple factors such as linearity of duct, air temperature, type of fiber cable and HDPE specifications.

Fiber-in-duct installation costs are approximately $120k/mile in rural Alaskan regions.

The primary benefits of installing FO cable in duct are:

- Superior crush resistance to freeze/thaw cycles in the soil, and damage from contact with trench backfill material.
- Easier and more frequently spaced access to the FO cable. Slack boxes or hand holes are installed every 3000’ – 5000’.

- Faster Mean-Time-To-Repair. When FO cable is installed in duct, there is an opportunity to store cable slack coils every 3000' to 5000'. In the event of a fiber cut, this cable slack can be uncoiled and used to replace the damaged section of fiber.

DIRECT-BURY INSTALLATION METHODOLOGY

Similarly to installing fiber-in-duct, installing a direct bury underground fiber optic cable involves making a trench, laying in the armored fiber optic cable, and backfilling the trench. The distance limitation between slack/splice enclosures or "hand holes" is only limited by the length of the fiber that is on the cable real. This length is typically 15,000' to 20,000' feet.

Direct bury FO installation costs are approximately $90k/mile in rural Alaskan regions.

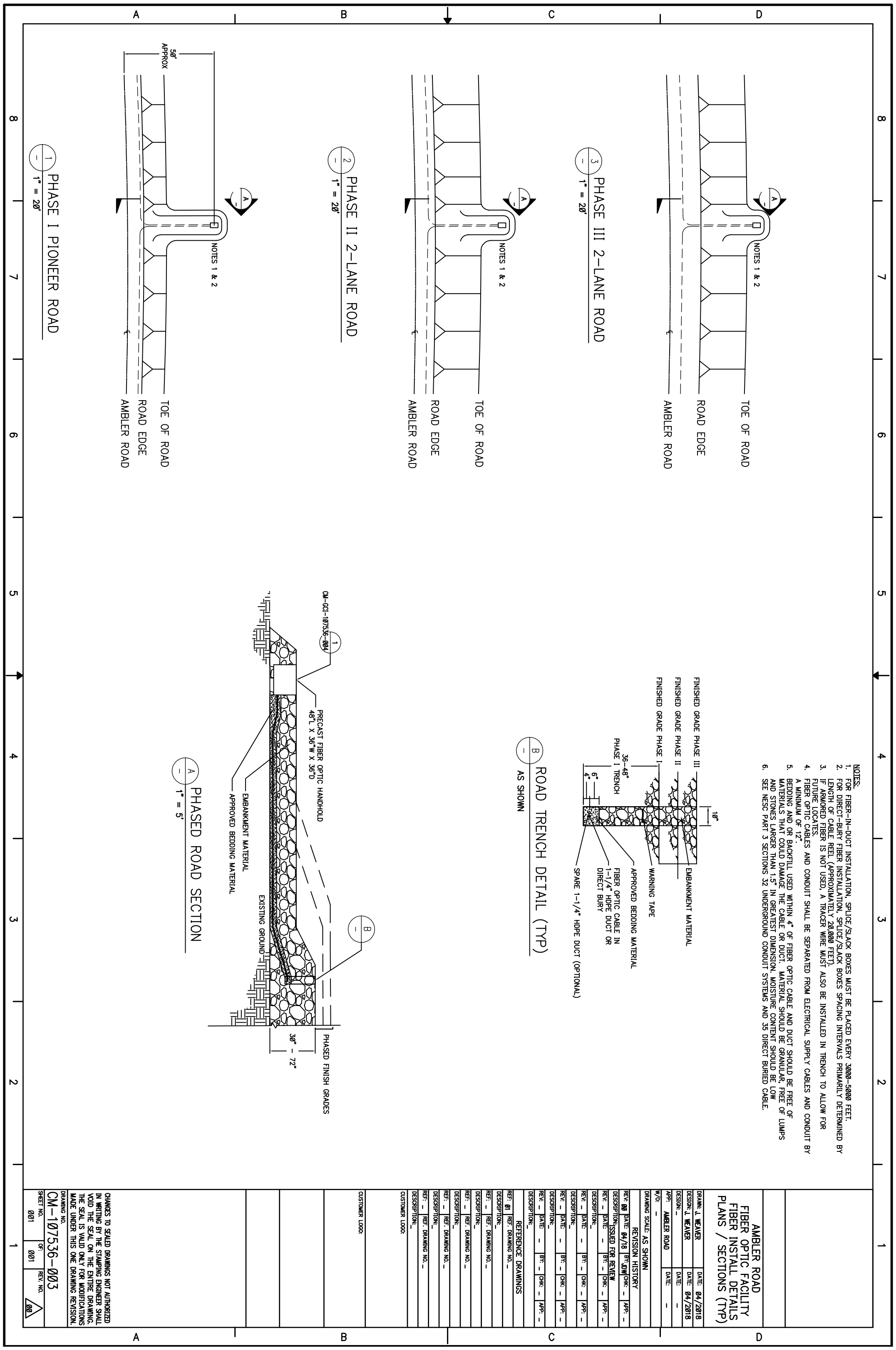
Figure 2: Typical fiber optic trench

The primary benefit of installing direct bury FO cable is cost savings, but it comes at the expense of future maintenance and flexibility.

Comparison Matrix - Summary of Capabilities	Direct	HDPE
Cable Protection - FOC Single Armored (needs to be designed for Duct installation)	X	X
Cable Protection - Requires padding underneath cable/duct prior to install in trench	X	X
Cable Protection - Requires padding above cable/duct after installation in trench	X	X
Cable Protection - Install protects from pull stress (fiber is jetted) and from native backfill rocks (damage during trench backfill process)		X
Cable Protection - From temperature induced ground expansion and contraction		X
Cable Protection - From ground burrowing animals (diameter larger than jaw size)		X
Cable Protection - Added protection during future excavations (road work, trenching for utilities, maintenance repairs, etc.)		X
Hand-Hole Vaults - Will require less vaults when installing large continuous sections	X	
Hand-Hole Vaults - Can be used to store cable slack for future emergency repairs		X
Hand-Hole Vaults - Emergency repairs may require placement of future vaults for splice canisters	X	
Cable Splices – Initial installation method minimizes splices and therefore signal loss across the fiber	X	
Cable Splices - Crossings/Tie-ins may require cutting fiber and installing extra splices	X	X
Cable Splices - Changes of cable path after placement will require cutting fiber, splicing, and additional hand-hole vaults	X	X
Cable Splices - Adding future connections may only require a single splice point by pulling back existing slack to an available hand-hole		X
Adjustability - Fiber can be easily replaced due to maintenance or future expansion of branch circuits		X
Adjustability - Install can easily accommodate tie-ins such as road/river crossings		X

The table below summarizes the benefits of each method in more detail:

Reference Drawing: CM-107536-003-001 – ROAD PLAN AND SECTIONS



Fiber Optic Hand Holes

Polymer concrete precast "Handhole" (HH) vaults are necessary for coiling and storing spare fiber optic cable for future emergency repairs, branch circuits and future growth expansion. They also act as pulling/jetting assist points during initial installation. Lastly, these slack boxes can be used as needed to store splice enclosures for the fiber optic cable splices (approximately every 15000-20000 FT).

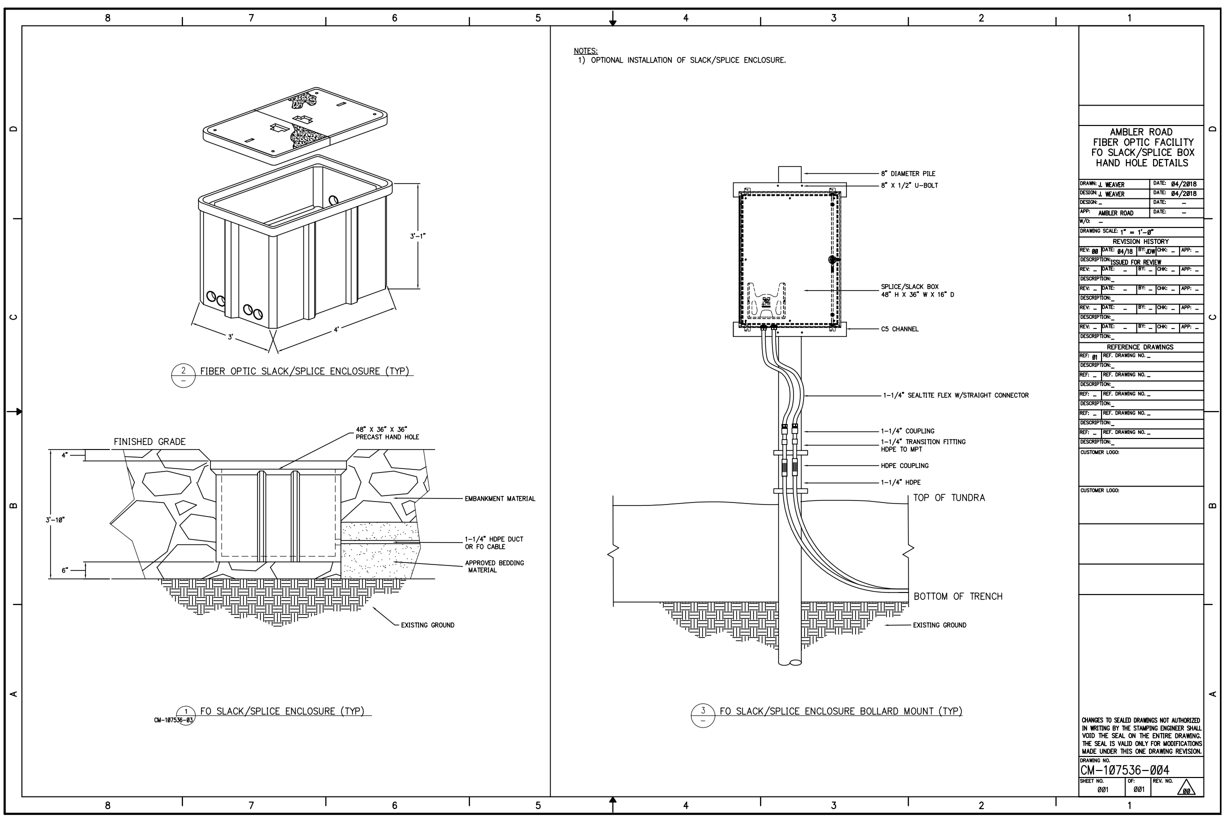
Figure 3: Typical handhole vault

The spacing of these vaults is dependent on the method of construction. If a fiber optic cable is direct buried, the spacing between HH vaults is dependent on the length of the cable. If the fiber optic cable is installed in duct, you must place one every 3000-5000 FT which is the typical maximum blowing/jetting distance. HH vaults are also usually installed at every road crossing, river crossing, and/or regeneration pad.

Each HH vault will have a Marker Post (MP) installed on two sides of the vault for easy identification from the road or ground level. This is especially important if the vaults are buried or otherwise out of sight so that they can be easily excavated. Each vault used as a splice point for the fiber optic cable will use a special Test Post (TP). This TP will be connected to a locate wire and be useful in the event of a break to help isolate an incident along the fiber route.

Lastly, each HH will require a bottom pad layer and apron to assist with water drainage and prevent post-installation shifting. The exact design will be determined with further engineering.

Reference Drawing: CM-107536-004-001 – PLAN – BRIDGE AND SLACK BOX DETAILS

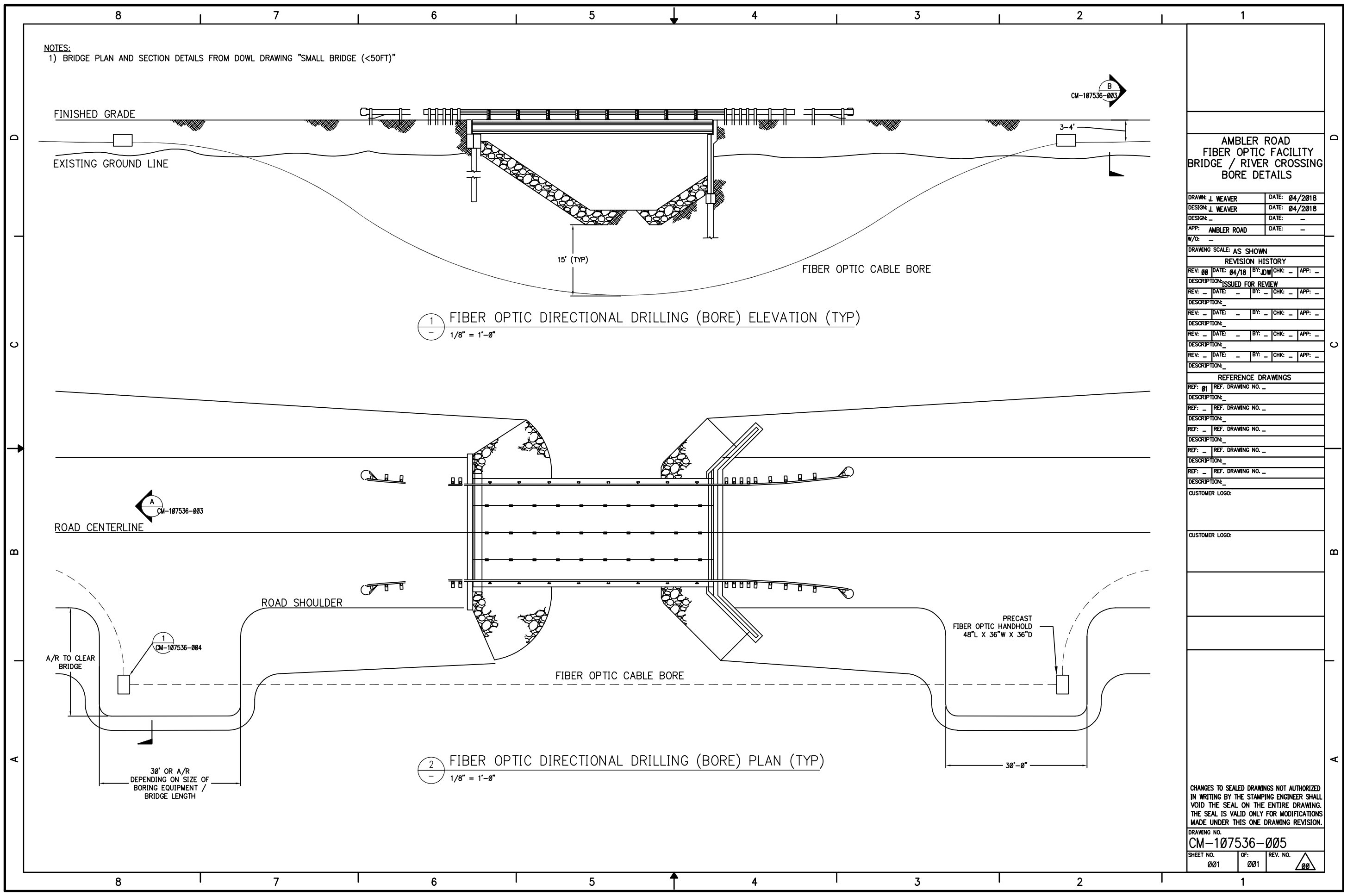


Fiber Optic River Crossings

At river crossings or bridges fiber optic cable could be installed in a bore beneath the waterway or in conduit attached to the underside of the bridge. Boring operations (Horizontal Directional Drilling or HDD) require a bore drill to create a path from one side to the other. Once the bore has reached the far-end the fiber optic duct would be pulled back through the newly created bore. After the duct has successfully been installed within the bore, it can be secured on both ends and the fiber optic cable itself can be pulled or jetted through. HDD rigs are capable of drilling up to 1000 feet.

If a bore is not possible or determined to be not cost effective, the fiber optic cable will utilize an existing bridge structure that have been erected for the road to traverse the waterway. Securing the fiber optic cable and duct to the bridge will depend on its configuration and available support structures. The fiber optic cable and duct could be routed through schedule 40 Rigid Metal Conduit or clampted or tensioned securely in place. If the fiber and duct is not installed in a metallic conduit, the fiber optic cable would be exposed to view and also to potential damage from wildlife and road maintenance activities. HDPE duct is typically manufactured using carbon black to prevent damage from UV light.

Reference Drawing: CM-107536-005-001 – PLAN AND ELEVATION – BRIDGE BORE

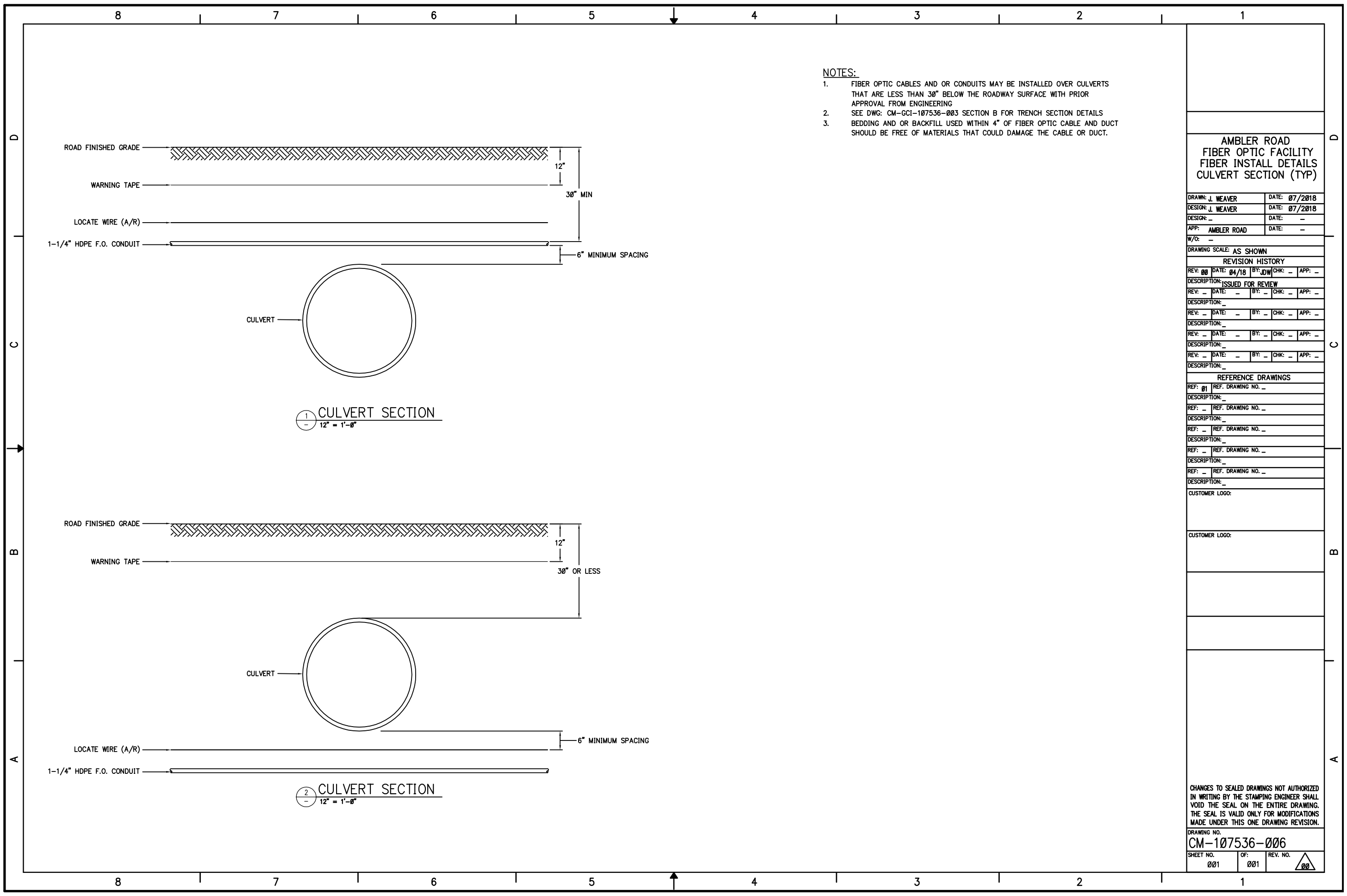


Fiber Optic Culvert Crossings

Figure 4: Typical Bore Operation

The Ambler road has approximately 3000 culverts along its 211-mile length. Culvert resizing or replacement can expose the fiber optic cable to damage if the fiber is installed on top of the culvert. The culverts for this project are expected to have a 30 year usable life. For this project, it would be cost prohibitive to bore the fiber cable under each of these culverts. Due to the cost of boring and expected long life span of the culverts, it recommended to install the fiber optic cable in the road above the buried culverts. If there are planned culvert maintenance activities, that section of fiber can be temporarily bypassed in order to prevent any extended communication service outage.

Reference Drawing: CM-107536-006-001 – DETAILS – CULVERT CROSSING



Fiber Optic Signal Regeneration

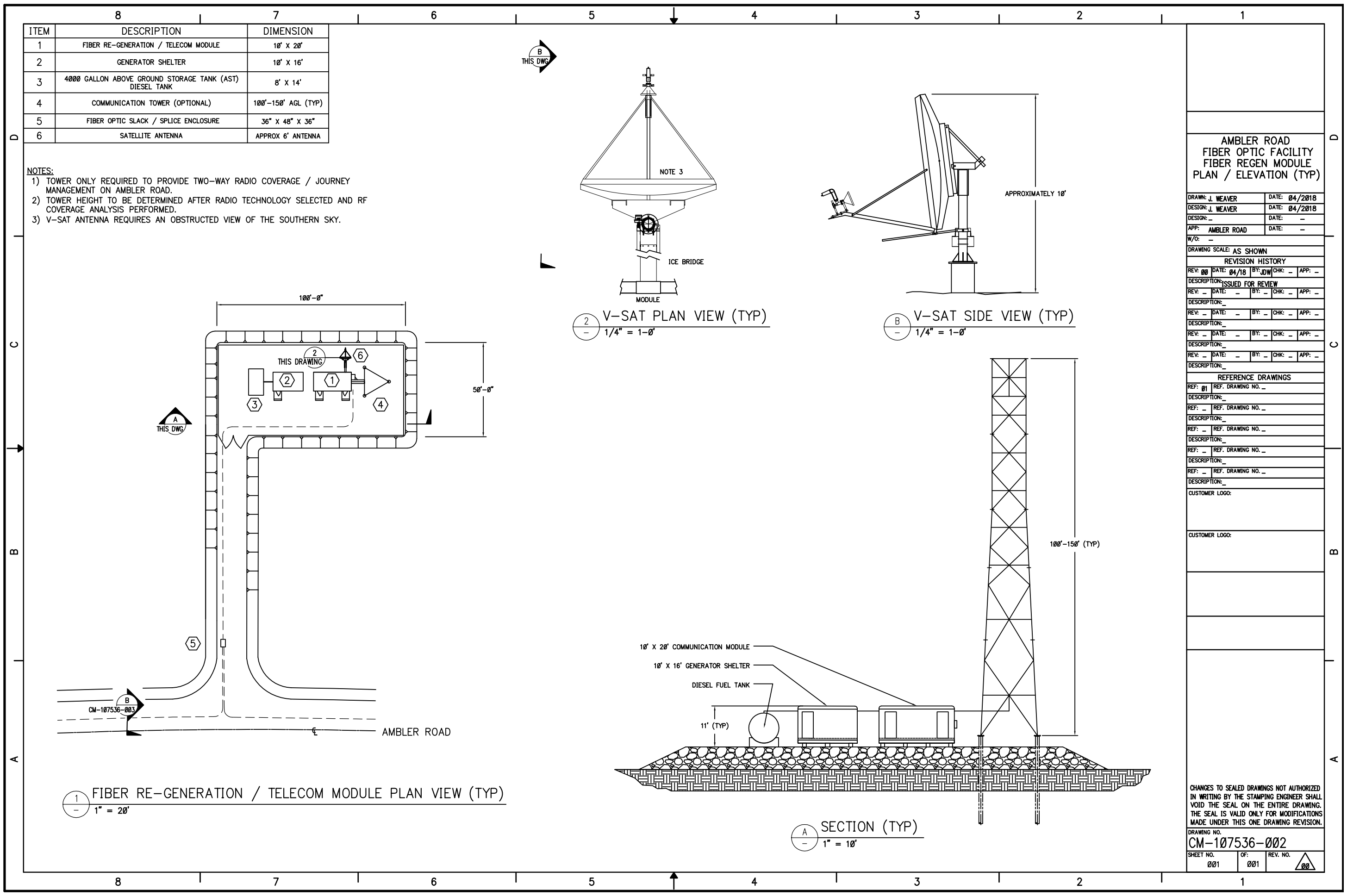
STAND-ALONE FO SIGNAL REGEN MODULE

A fiber optic signal regeneration and network access module typically consists of a 10' x 20' equipment module which contains the fiber optic splice and patch panels, back-up power systems, and the signal regeneration equipment. Power is provided by generators and fuel storage tanks. These tanks require annual refueling. Several annual maintenance trips are required to ensure safe reliable and permitted operation. Annual fire marshal inspections are also often required. These locations could also be leveraged as CCTV monitoring as well as tower communication sites to enable two-way radio communications along the Ambler road.

Costs are approximately $850k to $1M to deploy. Annual maintenance costs include any required Fire Marshal inspections, refueling and generator/site maintenance.

If a two-way radio system is planned to provide radio coverage along the road, the location of any stand-alone FO signal regeneration modules and associated radio towers should be carefully considered.

Reference Drawing: CM-107536-002-001 – PLAN – FIBER RE-GEN MODULE



DIESEL VS PROPANE GENERATORS

Diesel powered generators are typically used in northern Alaska due to maintenance requirements and complications around using propane in the cold. Propane tank vapor pressure decreases with the ambient temperature. This can be mitigated with more complicated fueling systems, but that can decrease reliability. With the proper diesel fuel additives, diesel generators can operate in sub-arctic conditions.

Diesel generators typically operate at a lower rpm and have a longer running life. The higher RPMs typically associated with propane generators can require more maintenance such as filter and oil changes.

Fuel charges for propane are higher than diesel. Propane is cleaner burning but poses a greater safety risk in the event of a leak or explosion.

Natural Gas generators were also considered as an alternative but are not recommended for this application due to the following drawbacks:

- LNG is stored in a compressed state, thus transportation and containment are more expensive.
- LNG has a lower power-density as compared to diesel, so larger storage tanks or more frequent fueling intervals are required.
- LNG must be kept at a very low temperature / high pressure, so the containment vessel requires specific pressure and refrigeration requirements that must be maintained year-round.

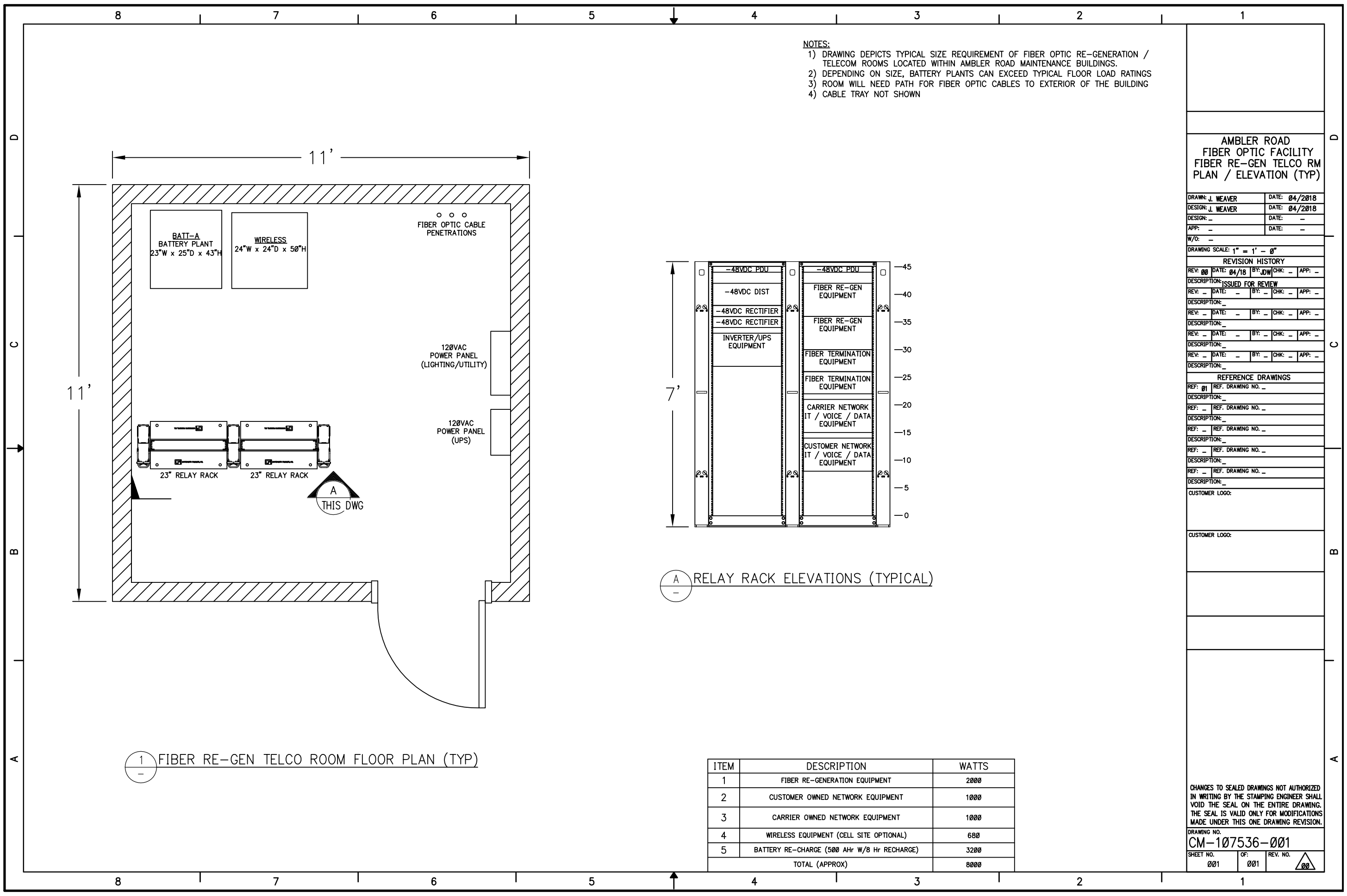
Category	Diesel	Propane
Engine Life (hours)	**Longer life engines due to lower RPM**	**Shorter life engines due to higher RPM**
Cost of Fuel / Year	**Diesel will use less fuel than Propane: 15kW @ full load = 1.1 gallons/hr**	**Propane: 15kW @ full load = 3.3 gallons/hr**
Environmental Concerns	**More environmental concerns**	**Cleaner to operate, less spill hazard**
Maintenance Costs	**Less Maintenance due to lower RPM**	**More Maintenance due to higher RPM**
Safety	**Least flammable fuel source**	**Flammable fuel source**
Other	**Can suffers from "Wet-Stacking" if loaded below 40%. Can be mitigated with Controls**	**Propane fueling systems suffer in the extreme cold. Can be mitigated.**

MAINTENANCE BUILDING FO SIGNAL REGEN TELECOM ROOM

Should space and power in the Ambler road maintenance buildings be negotiated with the FO Facility owner/operator, the signal regen equipment could be installed in a telecom room. This method would eliminate much of the cost of the fiber optic signal regeneration. This room would need to be a minimum of 11' x 11' and would also contain the regeneration equipment, back-up power systems as well as network and phone equipment to support the maintenance building operations. The room would need to be larger if the site contains wireless / cellular site equipment, and two-way radio equipment.

Costs are approximately $125k to engineer, procure all equipment and materials, and construct the 11'x11' enclosure.

Reference Drawing CM-107536-001-001 – PLAN – FIBER RE-GEN TELCO ROOM



ITEM	DESCRIPTION	WATTS
1	FIBER RE-GENERATION EQUIPMENT	2000
2	CUSTOMER OWNED NETWORK EQUIPMENT	1000
3	CARRIER OWNED NETWORK EQUIPMENT	1000
4	WIRELESS EQUIPMENT (CELL SITE OPTIONAL)	680
5	BATTERY RE-CHARGE (500 AHr W/8 Hr RECHARGE)	3200
	TOTAL (APPROX)	8000

Maintenance Issues and Operation

Fiber optic communications systems require specialized equipment and trained personnel to maintain and repair. The shelters and fiber optic regeneration equipment will require periodic inspection and maintenance. The electrical generators will also require re-fueling and maintenance.

The Ambler road FO system would typically be backed up by a satellite system to ensure that mission critical communication circuits would remain active in the event of a fiber break or equipment failure. Very Small Aperture Terminal (VSAT) systems could be co-located with the fiber regeneration and tower sites to ensure uninterrupted communications.

The FO network and facilities will require remote monitoring and a response team would need to be in place to respond to any network issues or fiber optic failures.

Emergency Maintenance Repairs

In the event of a fiber break or network outage it is essential to have a well understood response plan in order to quickly restore the system to an operational state. The table below itemizes a series of steps required in any incident response along with the anticipated time necessary for each task. Combined these form a total estimated Mean Time To Repair (MTTR).

The example scenario to the right assumes the response of personnel based in Fairbanks to a fiber break.

Mean Time to Response (MTTR) - Incident	Minimum Hours	Maximum Hours
Step 1 - Incident is reported to the Service Center by the customer. Repair Ticket is generated. Preliminary troubleshooting commences.	0	1
Step 2 - Preliminary troubleshooting does not resolve the issue. Repair ticket is escalated to Technical Support for in-depth remote troubleshooting.	1	4
Step 3 - Remote troubleshooting does not resolve the issue. Response Team mobilizes for on-site deployment.	1	2
Step 4 - Response Team travels (approximately 200-250 miles) from Fairbanks to the start of the Ambler Road.	6	6
Step 5 - Response Team travels (approximately 0-200 miles) along the Ambler Road to the incident location.	0	6
Step 6 - Attempt to identify that exact location of the cause for the incident.	0	1
Step 7 - Depending on the location identified, perform snow removal and/or excavation work to expose the damaged fiber cable.	0	4
Step 8 - Perform repairs on the damaged fiber to include prep, splice, and testing. This MTTR uses a 48-strand fiber optic cable as a baseline. Repairing priority strands first to restore critical services is represented by the minimum hours.	4	12
Note - On-site cleanup, return travel to Fairbanks, and other close-out tasks have not been included as they are post-repair activities.	0	0
Total Hours	12	36

Network and FO Facility Monitoring

The reporting and monitoring of network or FO cable faults is essential for reliable operations. The owner and or operator of the road FO facility will likely elect to have 24/7/365 monitoring. This monitoring is typically performed at a Network Operations Center (NOC). The NOC would install systems that continually monitor the fiber optic facility and provide fiber fault locations. It is possible that the owner / operators of the Ambler Road FO Facility would already have a NOC in service.

Satellite Backup Communications

In the event of FO Facility failure, it is possible and common to be equipped with backup communications via Satellite. The backup/service restoral satellite communication link would likely operate at a fraction of the speed of the normal FO service but would ensure that critical communications be kept online in the event of a FO outage.

It would be possible to provide emergency restoral with a single VSAT satellite system at the Ambler end of the FO Facility. If there was a fiber break along the road, the voice and data communication traffic to the East of the break would route normally down the fiber to the Dalton highway tie-in. The voice and data communication traffic to the West of the break would route to the Ambler VSAT.

Typically, commercial VSAT service providers offer emergency restoral VSAT services are offered at a reduced MRC as they are not used 99.99% of the time. An approximate cost would be $500/month/Mbps. It is also typical to only backup a percentage of your normal bandwidth with prioritization policies put in place for particular categories of data traffic. For example all voice services would have priority over traffic identified as CCTV traffic.

Example Scenario: In the event of a fiber break, usable bandwidth could drop from 1Gbps (fiber based communications) to 3Mbps (satellite backup service). The 3Mbps would need to be carefully allocated to ensure that the phones and emergency services still work. This is done by classification and marking traffic using Quality of Service (QoS) and then establishing different forwarding / queueing rules for higher priority traffic in the site network routers.

Alternative Solutions

Summary

The two primary transport mediums for voice and data communications around the world are fiber optic cable and microwave radio. Due to the remote nature of our state, Alaska is also heavily dependent on Satellite communications. FO cable is desirable due to its low latency, high reliability, and high available bandwidth compared to Satellite and Microwave Radio.

Fiber Optic

The Ambler road's tie in to the Dalton Highway allows for convenient connectivity to existing Telco operated fiber optic cable networks. Fiber optic cable is also recommended for this project due to its high bandwidth, high reliability, and lower bandwidth cost than satellite or microwave radio based communications in this state.

Satellite

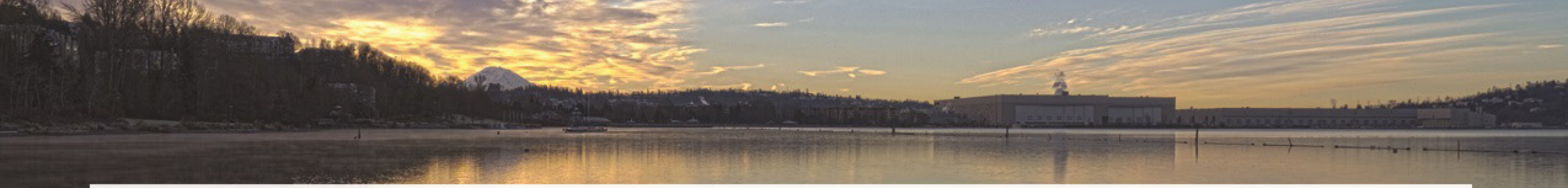
Satellite communications are currently used in Ambler and across the state to provide internet access and to allow for even Cellular / wireless service to work in rural areas. The biggest drawbacks to satellite are the inherent cost and latency (round trip time) for a data packet to be sent to the satellite and for the signal to be repeated back to an earth base station and the cost for bandwidth. The cost for satellite bandwidth is orders of magnitude more than terrestrial service. The inherent latency is approximately 470ms which is noticeable to the human ear during a voice conversation and can interrupt some data service streams. Satellite system communications would greatly complicate the operation of a "trunked" field-wide two-way radio system.

Microwave

A licensed microwave radio systems could be built out to support the Ambler Road but this solution has several drawbacks. Microwave radio systems require much more maintenance than fiber optic systems and when mountaintop repeater sites are required, the initial cost can be similar.

While bandwidth is unlimited on fiber optic cable, capacity on microwave radio is limited but can be in the Gigabit per second (Gbps) range. Microwave radio system radio paths are typically engineered to be available 99.999% of the time. Available is usually defined related to 10-6 Bit Error Rate (BER) or better. FO systems are typically up 100% of the time related to a 10-12 BER. Microwave radio systems are influenced by atmospheric conditions which do not affect FO communications.

A preliminary path analysis indicates that any microwave system supporting the Ambler road would be multi-hop with additional mountain top repeater sites required. A typical mountaintop repeater site needs about 3 site visits per year for fueling and maintenance activities and costs between 3 and 5 million to build.



Other User Groups and Applications

Summary

In addition to benefiting the safety, security and efficiency of operations of the road itself, the FO facility would also benefit other user groups. The Ambler Mine operator and the rural communities in the area also stand to benefit. Mine operations will require voice and data services which could leverage the Ambler road FO facility. Microwave radio links or spur FO segments could also be installed to support the local villages and communities in the area.

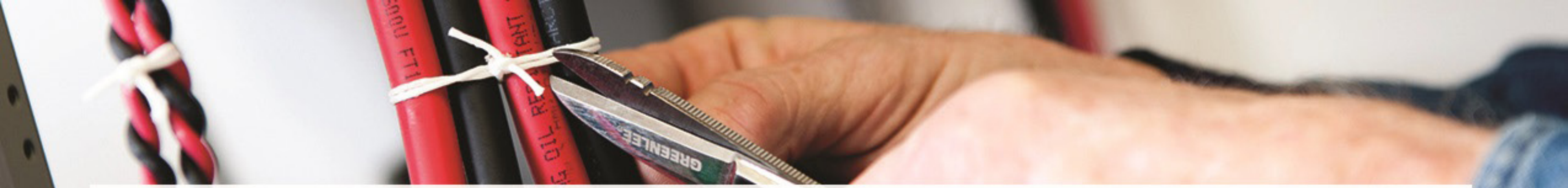
Mine Operators

Below are some general examples of services that a fiber optic system would enable for the Ambler mine operators.

- **Business Network –** Email & Messaging, Timecards, Company Server Access, Video Conferencing
- **Process Network –** Secure Closed Network for Automation and Instrumentation, SCADA
- **Morale Network –** Internet, social media, and personal email access for off-shift workers
- **Utility Network –** Connectivity for non-critical or low security risk equipment
- **Fire & Gas Network –** Dedicated secure closed network for Fire & Gas Equipment
- **Security Network –** Network supporting security and emergency services and CCTV cameras
- **Monitoring & Alarm Network –** Network to relay remote monitoring information
- **Radio Network –** Two-way radio network to support ROIP and remote programming
- **Voice Network –** Network to support call managers and VOIP telephones

Rural Communities

- **Rural Broadband –** Improved network / internet access for rural communities in this area allows for improved economic / commercial possibilities, education, and “telehealth” systems.



Ownership

There are several scenarios for who could own and maintain the proposed fiber optic system. Some examples of currently or potentially involved parties might be:

- AIDEA (Alaska Industrial Development and Export Authority)
- Ambler Mining District (End-Users)
- Telecommunication Carriers (Telcos)
- Government Entity (Local, State, Federal, other)
- Public-Private Partnership
- Investor Owner/Operator

ROM Cost Estimate of Fiber Optic Facility

There are numerous variables for any Fiber Optic System that have been considered to produce this cost estimate. This system will cost anywhere between a minimum of $18.3M up to a maximum of $36.3M. This gives the project an average cost estimate of $27.3M with a rough order of magnitude (ROM) of +/-33%.

GRAND TOTAL COST ESTIMATE FO FACILITY SUMMARY				
	COST ESTIMATE - PER FIBER METHOD			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
FIBER IN DUCT MINIMUM COST = FIBER DUCT AND USING MAINTENANCE BUILDINGS FOR REGEN EQUIPMENT MAXIMUM COST = FIBER DUCT AND STANDALONE REGEN PAD	$26.157,000.00	$36,305,000.00	$31,231,000.00	16.25%
DIRECT BURIAL FIBER MINIMUM COST = DIRECT FIBER AND USING MAINTENANCE BUILDINGS FOR REGEN EQUIPMENT MAXIMUM COST = DIRECT FIBER AND STANDALONE REGEN PAD	$18,324,000.00	$25,149,000.00	$21,736,000.00	15.70%
	ROM TOTAL COST ESTIMATE			
+/-25% ROUGH ORDER OF MAGNITUDE COST ESTIMATE FOR CONCEPTUAL FIBER OPTIC SYSTEM	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
	$18,324,000.00	$36,305,000.00	$27,315,000.00	32.92%

Install Methods Considered:

The first major consideration is whether to install fiber optic cable in duct or as direct burial. Estimated ROM costs:

- Fiber-in-Duct: Approx $28.5M
- Direct Burial Fiber: Approx $19M

Detailed Cost Estimate summary tables have been included below for more information:

Fiber Install - Method 1 - Fiber-in-Duct				
	COST ESTIMATE - PER MILE			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
Scope of Work: • Excavate Trench • Backfill Bottom Pad Layer • Install 1-1/4" or 1-1/2" duct (including River Crossings and other Tie-ins) • Install Locate Trace Wire • Backfill Middle Pad Layer • Install Fiber Optic Warning Tape • Backfill Top Pad Layer (Remaining Trench with native rocks and fill) • Install Hand-Hole Vaults (including Vault Drainage Bed and Apron) • Install Marker and Test Posts • Terminate Locate Trace Wire at Hand-Hole Vaults and Test Posts • Test and Proof the Duct prior to Cable Install • Jet or Blow Armored Fiber Optic Cable into Duct • Terminate Splices and Install Splice Enclosures within Hand-Hole Vaults • Test and Commission Fiber Optic Cable	$121,500.00	$148,500.00	$135,000.00	10.00%
FIBER OPTIC CABLE IN HDPE DUCT FOR 211 MILE AMBLER ACCESS ROAD	**TOTAL COST ESTIMATE - 211 MILES**			
	Minimum Cost	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
	$25,637,000.00	$31,334,000.00	$28,485,000.00	10.00%

Regeneration Sites - Method 2 - New Standalone Pads				
	COST ESTIMATE - PER SITE			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
Scope of Work: • Engineer and fabricate Communication Module and associated Generator Module and fueling system • Install Communications Module • Install Diesel Generator and Module • Pull Fiber Optic Cable and/or Duct into Existing Building • Install Slack Box at Building Entry • Install Fiber Optic Regeneration Equipment • Install Networking Equipment • Terminate and Splice Fiber Optic Cable to Equipment and Fiber Patch Panels • NOTE: Optional Systems NOT included (Tower, Two-Way, CCTV, etc.)	$855,600.00	$994,400.00	$925,000.00	7.50%
FIBER OPTIC REGENERATION EQUIPMENT LOCATED AT STANDALONE PADS FOR 211 MILE AMBLER ACCESS ROAD	**TOTAL COST ESTIMATE - 5 SITES**			
	Minimum Cost	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
	$4,278,000.00	$4,971,900.00	$4,625,000.00	7.50%

Both methods listed will accrue approximately $470K in horizontal directional drilling (HDD) costs if the fiber is to be bored underground at all of the bridge locations. The project would require approximately 7200' of boring to go under all of the 29 planned bridges. This assumes a 20/80 radio of bedrock to mixed rock/cobbles soil type. This cost could be largely eliminated if the fiber and duct was routed underneath the bridges in rigid conduit. The estimates below do not include the equipment mobilization and demobilization fees of approximately $5k/bore locations.

The second major consideration is whether existing maintenance buildings will be leveraged to contain the signal regeneration and communication equipment or if new standalone pads are required (up to 5 sites):

- Regeneration Sites using Existing Maintenance Buildings and Pads: Approx $625k
- Regeneration Sites using New Standalone Pads Approx $4.625M
- Note: a hybrid of the two options is possible

ROM Cost Estimate of Additional Systems

Two-Way Radio System and Associated Communication Towers

A wide area two-way radio system would require the installation of communication towers. This would likely be the primary cost depending on the complexity and sophistication of the radio system. The table below estimates the costs of a 5 to 8 site radio system and includes the costs of the communication towers.

Digital Mobile Radio System - Wide Area				
	COST ESTIMATE			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
Scope of Work: • Perform RF Coverage Studies and System Design, Channel Planning • Install Communication Towers (Min: 5, Max: 8) • Order Repeaters, Network Equipment, Antennas, TX Lines, Portables, Mobiles • Program equipment and radios • FCC Licensing • Deploy System, Install Portables, Distribute Mobiles, Train Users	$ 1,403,750.00	$ 3,017,950.00	$ 2,210,850.00	36.51%

Wireless Communication Sites / Cellular Sites (Telecommunication Carrier Owned)

If wireless / cellular communication is desired, it may be possible to negotiate an "aid-to-construction" non-reoccurring fee to a wireless service provider to build out cellular infrastructure at the Ambler road tower sites. The cost would be negotiable and would depend on what RF bands / carriers would be supported. RF coverage areas around wireless sites can extend up to about 7 miles away depending on numerous factors. A typical cost for a wireless site build out is estimated below:

Wireless Network "Cellular Service" BY SITE				
	COST ESTIMATE			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
Carrier Scope of Work: (assumes existing tower structures) • Perform RF Coverage Studies and System Design, Channel Planning • Order Repeaters, Network Equipment, Antennas, TX Lines, Portables, Mobiles • Program equipment and radios • FCC Licensing • Deploy/Install System	$ 287,000.00	$ 426,200.00	$ 356,600.00	19.52%

Satellite Backup Communication System

As described above, a backup satellite communication system could be deployed to protect against un-anticipated and lengthy communication outages should the fiber optic cable system be damaged. After the system is built out, there would be a monthly re-occurring charge to the satellite service provider to reserve your satellite bandwidth.

Satellite Backup Service "Emergency Service Restoral" BY SITE				
	COST ESTIMATE			
Description	**Minimum Cost**	**Maximum Cost**	**Average Cost**	**+/-% ROM Tolerance**
Scope of Work: • Perform RF Coverage Studies and System Design, Develop Option file for Satellite Modem • Order Dish, Modem, and auxiliary equipment • Program routers for route redundancy / fail-over • Design and build satellite dish foundation (typically a single pile) • Deploy/Install System	$ 19,500.00	$ 41,000.00	$ 30,250.00	35.54%

Temporary Construction Communications

Summary

Voice and data communications are necessary for the efficient, safe and successful construction of any large project. Construction offices and camps should be equipped with computers, printers, phones and the associated voice and data circuits. It is imperative that field crews and heavy equipment operators be equipped with two-way radio communications to conduct their operations safely and efficiently. The typical temporary communication network for construction efforts include VSAT satellite voice and data communications, two-way radio repeaters with portable and hand held radios, and unlicensed microwave radio links for distribution of satellite bandwidth to areas near VSAT terminal.

ELEMENTS

Some elements that should be considered for the construction effort of the Ambler road are:

- **Construction Radio Communications**
  - Portable Radios for Heavy Equipment and trucks
  - Mobile / hand held Radios for field crews
  - Base-station radios at field construction offices
  - Temporary communication towers
  - FCC Licensing
- **Satellite Phone Communications**
- **Satellite Voice and Data communications for Construction offices and Camps**
  - Commercial Carrier (Telco) circuit orders
  - Morale Network
  - Business Network
- **On-Site Field Technician**

Timeline

This infrastructure should be planned 6 months in advance of construction activities. Satellite circuits and voice and data backhaul infrastructure takes time to plan and order from commercial carriers. Radio Frequency (RF) coverage studies and FCC license applications need to be completed and processed for microwave and two-way radio systems. Long lead equipment needs to be ordered, pre-programmed and tested and then staged for deployment. Permitting needs to be put in place for guyed, temporary construction communication towers.

Estimated Cost

The cost for construction communications is dependent on the number of personnel supported, lengths of deployment, camp sizes and locations, bandwidth requirements, and systems deployed.

Typical costs:

- 100 man camp supported with satellite communications (10Mb downlink/5Mb uplink) has an average initial commissioning non-reoccurring cost (NRC) of $30K with a monthly reoccurring cost (MRC) of $15K
- 20-30 man camp supported with satellite communications (3Mb downlink/3Mb uplink) has an average initial NRC of $20K with a MRC of $8K
- Telecom technician field crews can cost the project $35k/month

Summary

This FO communication facility provides the backbone for many other systems that rely on the reliable flow of data. Systems like two-way radio, wireless / cellular, CCTV, and security monitoring would leverage the fiber optic cable for their operation.

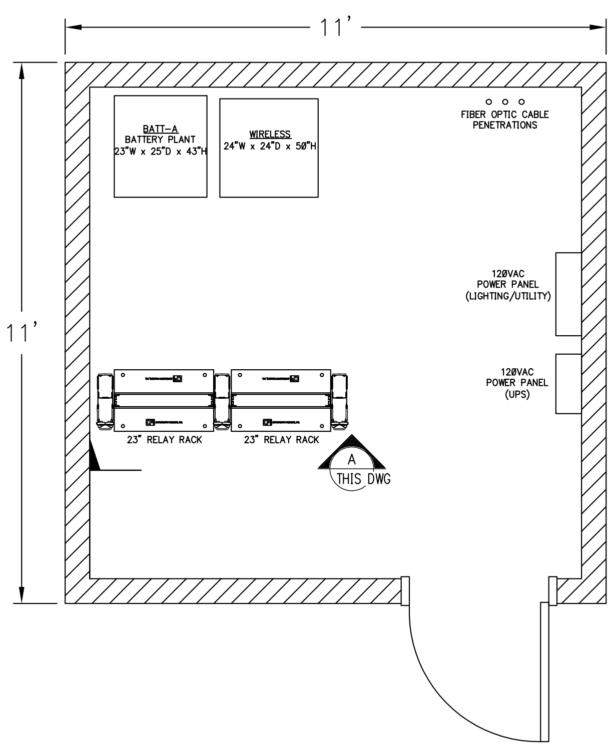
The installation cost of the FO facility depends in part on the construction method of the fiber install (direct buried vs fiber-in-duct) and also the location of the fiber optic regeneration sites.

Permitting and installing a fiber optic facility during the initial construction phase of the Ambler road is an opportunity to provide the communications infrastructure necessary for the safe, secure and efficient operation of the road.

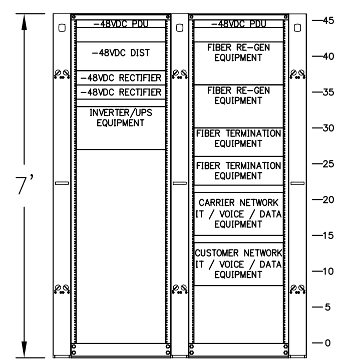
Reference Drawings

1. CM-107536-002-001 – PLAN – FIBER RE-GEN MODULE
2. CM-107536-001-001 – PLAN – FIBER RE-GEN TELCO ROOM
3. CM-107536-003-001 – ROAD PLAN AND SECTIONS
4. CM-107536-004-001 – PLAN – BRIDGE AND SLACK BOX DETAILS
5. CM-107536-005-001 – PLAN AND ELEVATION – BRIDGE BORE
6. CM-107536-006-001 - DETAILS - CULVERT CROSSING

NOTES:
1) DRAWING DEPICTS TYPICAL SIZE REQUIREMENT OF FIBER OPTIC RE-GENERATION / TELECOM ROOMS LOCATED WITHIN AMBLER ROAD MAINTENANCE BUILDINGS.
2) DEPENDING ON SIZE, BATTERY PLANTS CAN EXCEED TYPICAL FLOOR LOAD RATINGS
3) ROOM WILL NEED PATH FOR FIBER OPTIC CABLES TO EXTERIOR OF THE BUILDING
4) CABLE TRAY NOT SHOWN



1 FIBER RE-GEN TELCO ROOM FLOOR PLAN (TYP)



A RELAY RACK ELEVATIONS (TYPICAL)

ITEM	DESCRIPTION	WATTS
1	FIBER RE-GENERATION EQUIPMENT	2000
2	CUSTOMER OWNED NETWORK EQUIPMENT	1000
3	CARRIER OWNED NETWORK EQUIPMENT	1000
4	WIRELESS EQUIPMENT (CELL SITE OPTIONAL)	600
5	BATTERY RE-CHARGE (500 AHr W/8 Hr RECHARGE)	3200
	TOTAL (APPROX)	8000

AMBLER ROAD
FIBER OPTIC FACILITY
FIBER RE-GEN TELCO RM
PLAN / ELEVATION (TYP)

DRAWN: J. WEAVER — DATE: 04/2018
DESIGN: J. WEAVER — DATE: 04/2018
DESIGN: _ — DATE: –
APP: – — DATE: –
W/O: –
DRAWING SCALE: 1" = 1' - 0"

REVISION HISTORY
REV: 00 DATE: 04/18 BY: JDW CHK: – APP: –
DESCRIPTION: ISSUED FOR REVIEW
REV: – DATE: – BY: – CHK: – APP: –
DESCRIPTION: _
REV: – DATE: – BY: – CHK: – APP: –
DESCRIPTION: _
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CUSTOMER LOGO:

CUSTOMER LOGO:

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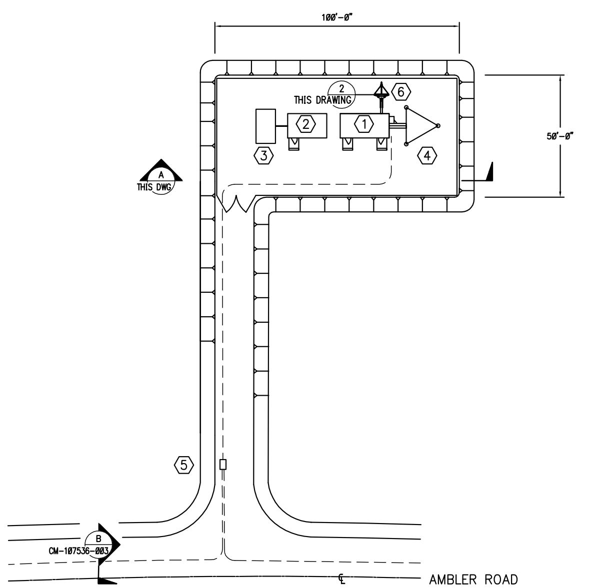
DRAWING NO.
CM-107536-001
SHEET NO. 001 OF: 001 REV. NO. 00

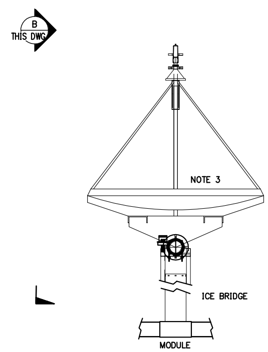
ITEM	DESCRIPTION	DIMENSION
1	FIBER RE-GENERATION / TELECOM MODULE	10' X 20'
2	GENERATOR SHELTER	10' X 16'
3	4000 GALLON ABOVE GROUND STORAGE TANK (AST) DIESEL TANK	8' X 14'
4	COMMUNICATION TOWER (OPTIONAL)	100'-150' AGL (TYP)
5	FIBER OPTIC SLACK / SPLICE ENCLOSURE	36" X 48" X 36"
6	SATELLITE ANTENNA	APPROX 6' ANTENNA

NOTES:

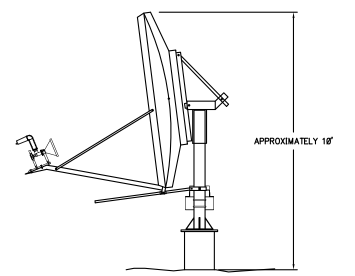
1) TOWER ONLY REQUIRED TO PROVIDE TWO-WAY RADIO COVERAGE / JOURNEY MANAGEMENT ON AMBLER ROAD.
2) TOWER HEIGHT TO BE DETERMINED AFTER RADIO TECHNOLOGY SELECTED AND RF COVERAGE ANALYSIS PERFORMED.
3) V-SAT ANTENNA REQUIRES AN OBSTRUCTED VIEW OF THE SOUTHERN SKY.



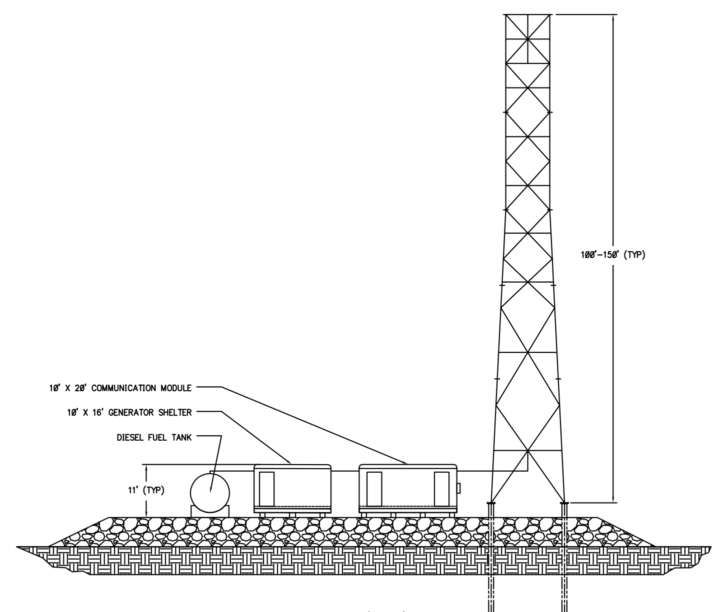
FIBER RE-GENERATION / TELECOM MODULE PLAN VIEW (TYP)
1" = 20'



V-SAT PLAN VIEW (TYP)
1/4" = 1-0'



V-SAT SIDE VIEW (TYP)
1/4" = 1-0'



SECTION (TYP)
1" = 10'

AMBLER ROAD
FIBER OPTIC FACILITY
FIBER REGEN MODULE
PLAN / ELEVATION (TYP)

DRAWN: J. WEAVER DATE: 04/2018
DESIGN: J. WEAVER DATE: 04/2018
DESIGN: _ DATE: –
APP: AMBLER ROAD DATE: –
W/O: –
DRAWING SCALE: AS SHOWN

REVISION HISTORY
REV: 00 DATE: 04/18 BY: JDW CHK: _ APP: _
DESCRIPTION: ISSUED FOR REVIEW

REFERENCE DRAWINGS
REF: 01 REF. DRAWING NO. _

CUSTOMER LOGO:

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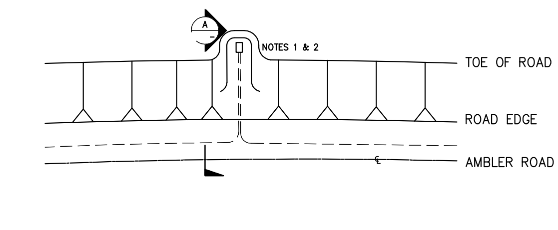
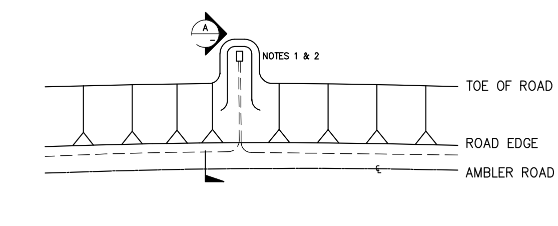
DRAWING NO. CM-107536-002
SHEET NO. 001 OF: 001 REV. NO. 00

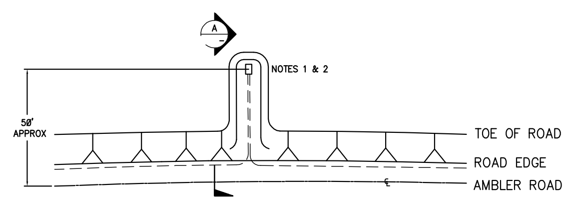
NOTES:
1. FOR FIBER-IN-DUCT INSTALLATION, SPLICE/SLACK BOXES MUST BE PLACED EVERY 3000-5000 FEET.
2. FOR DIRECT-BURY FIBER INSTALLATION, SPLICE/SLACK BOXES SPACING INTERVALS PRIMARILY DETERMINED BY LENGTH OF CABLE REEL (APPROXIMATELY 20,000 FEET).
3. IF ARMORED FIBER IS NOT USED, A TRACER WIRE MUST ALSO BE INSTALLED IN TRENCH TO ALLOW FOR FUTURE LOCATES.
4. FIBER OPTIC CABLES AND CONDUIT SHALL BE SEPARATED FROM ELECTRICAL SUPPLY CABLES AND CONDUIT BY A MINIMUM OF 12".
5. BEDDING AND OR BACKFILL USED WITHIN 4" OF FIBER OPTIC CABLE AND DUCT SHOULD BE FREE OF MATERIALS THAT COULD DAMAGE THE CABLE OR DUCT. MATERIAL SHOULD BE GRANULAR, FREE OF LUMPS AND STONES LARGER THAN 1.5" IN GREATEST DIMENSION. MOISTURE CONTENT SHOULD BE LOW
6. SEE NESC PART 3 SECTIONS 32 UNDERGROUND CONDUIT SYSTEMS AND 35 DIRECT BURIED CABLE.



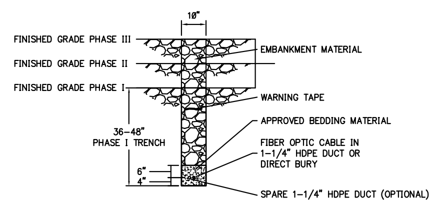
3 PHASE III 2-LANE ROAD
1" = 20'



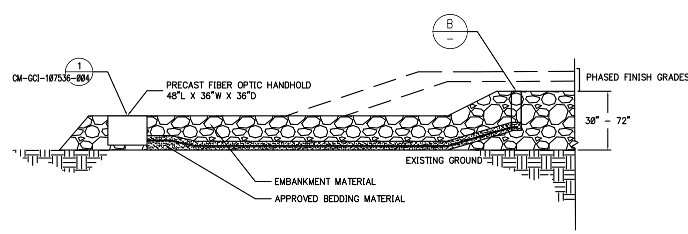
2 PHASE II 2-LANE ROAD
1" = 20'



1 PHASE I PIONEER ROAD
1" = 20'



B ROAD TRENCH DETAIL (TYP)
AS SHOWN



A PHASED ROAD SECTION
1" = 5'

AMBLER ROAD
FIBER OPTIC FACILITY
FIBER INSTALL DETAILS
PLANS / SECTIONS (TYP)

DRAWN: J. WEAVER	DATE: 04/2018
DESIGN: J. WEAVER	DATE: 04/2018
DESIGN: _	DATE: –
APP: AMBLER ROAD	DATE: –
W/O: –	
DRAWING SCALE: AS SHOWN	

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DRAWING NO. CM-107536-003

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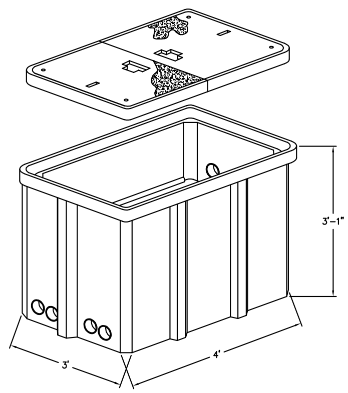
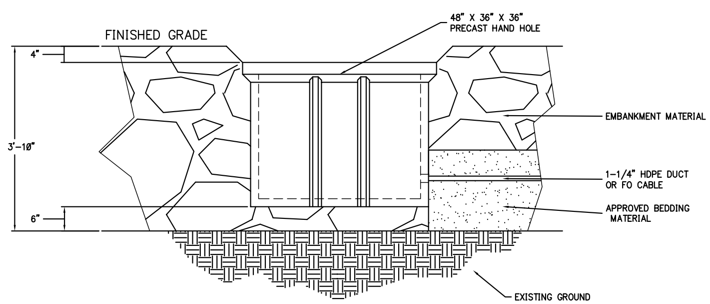
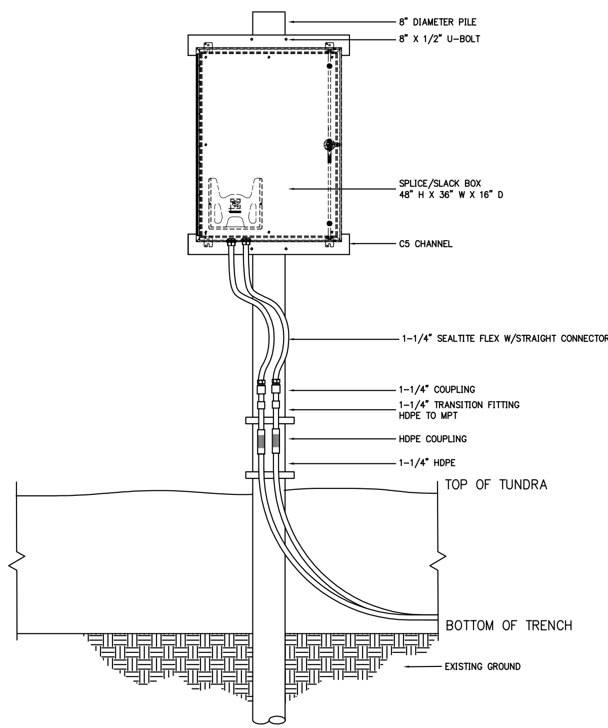
NOTES:
1) OPTIONAL INSTALLATION OF SLACK/SPLICE ENCLOSURE.



2 FIBER OPTIC SLACK/SPLICE ENCLOSURE (TYP)



1 FO SLACK/SPLICE ENCLOSURE (TYP)
CM-107536-03



3 FO SLACK/SPLICE ENCLOSURE BOLLARD MOUNT (TYP)

AMBLER ROAD
FIBER OPTIC FACILITY
FO SLACK/SPLICE BOX
HAND HOLE DETAILS

DRAWN: J. WEAVER — DATE: 04/2018
DESIGN: J. WEAVER — DATE: 04/2018
DESIGN: – — DATE: –
APP: AMBLER ROAD — DATE: –
W/O: –
DRAWING SCALE: 1" = 1'-0"

REVISION HISTORY

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DRAWING NO. CM-107536-004
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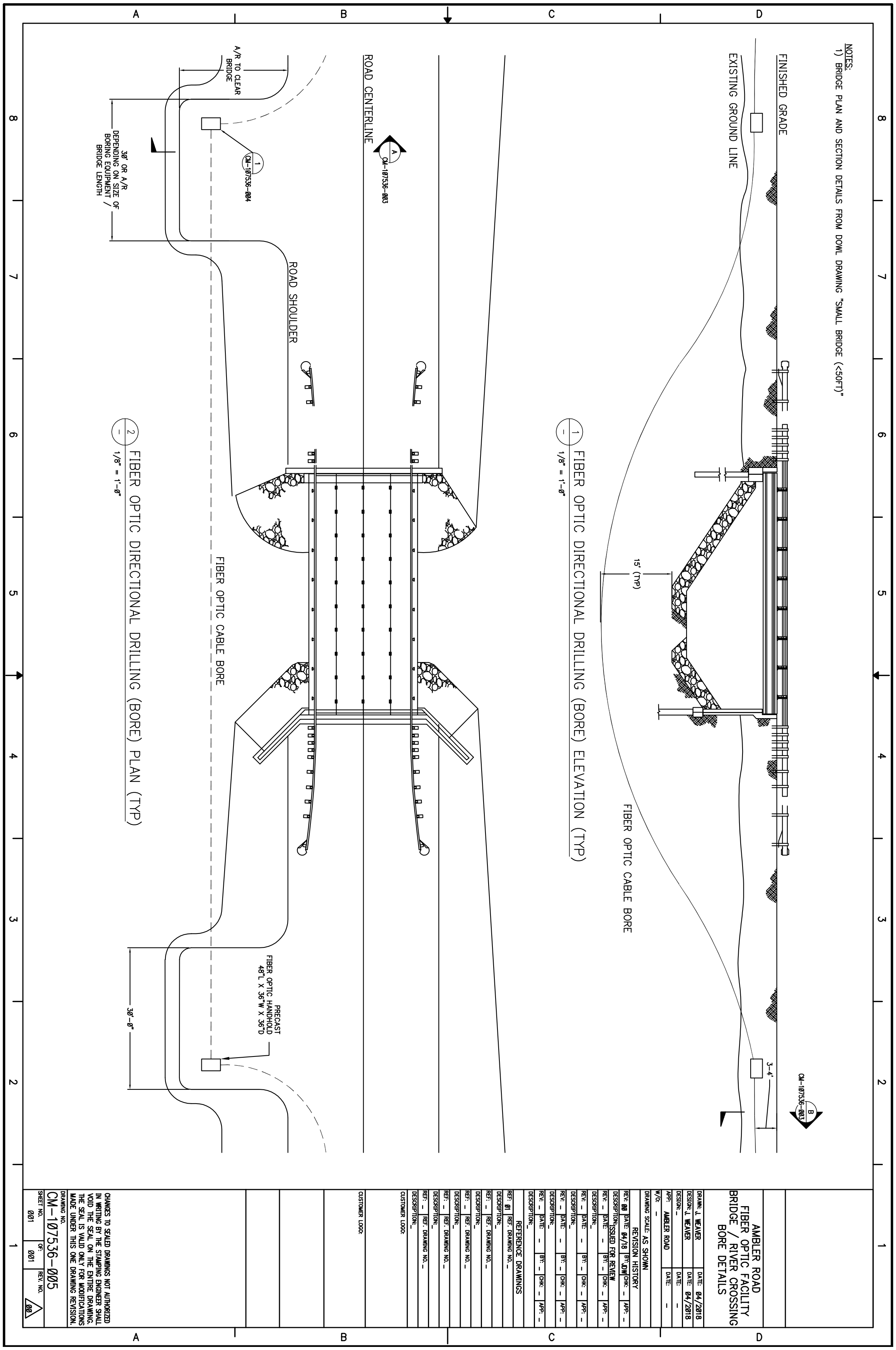
NOTES:
1) BRIDGE PLAN AND SECTION DETAILS FROM DOWL DRAWING "SMALL BRIDGE (<50FT)"
FINISHED GRADE
EXISTING GROUND LINE
CM-107536-003
3-4'
15' (TYP)
FIBER OPTIC CABLE BORE
1 FIBER OPTIC DIRECTIONAL DRILLING (BORE) ELEVATION (TYP)
1/8" = 1'-0"
CM-107536-003
ROAD CENTERLINE
ROAD SHOULDER
A/R TO CLEAR BRIDGE
CM-107536-004
PRECAST FIBER OPTIC HANDHOLD 48"L X 36"W X 36"D
FIBER OPTIC CABLE BORE
30' OR A/R DEPENDING ON SIZE OF BORING EQUIPMENT / BRIDGE LENGTH
30'-0"
2 FIBER OPTIC DIRECTIONAL DRILLING (BORE) PLAN (TYP)
1/8" = 1'-0"
AMBLER ROAD
FIBER OPTIC FACILITY
BRIDGE / RIVER CROSSING
BORE DETAILS
DRAWN: J. WEAVER DATE: 04/2018
DESIGN: J. WEAVER DATE: 04/2018
DESIGN: – DATE: –
APP: AMBLER ROAD DATE: –
W/O: –
DRAWING SCALE: AS SHOWN
REVISION HISTORY
REV: 00 DATE: 04/18 BY: JDW CHK: – APP: –
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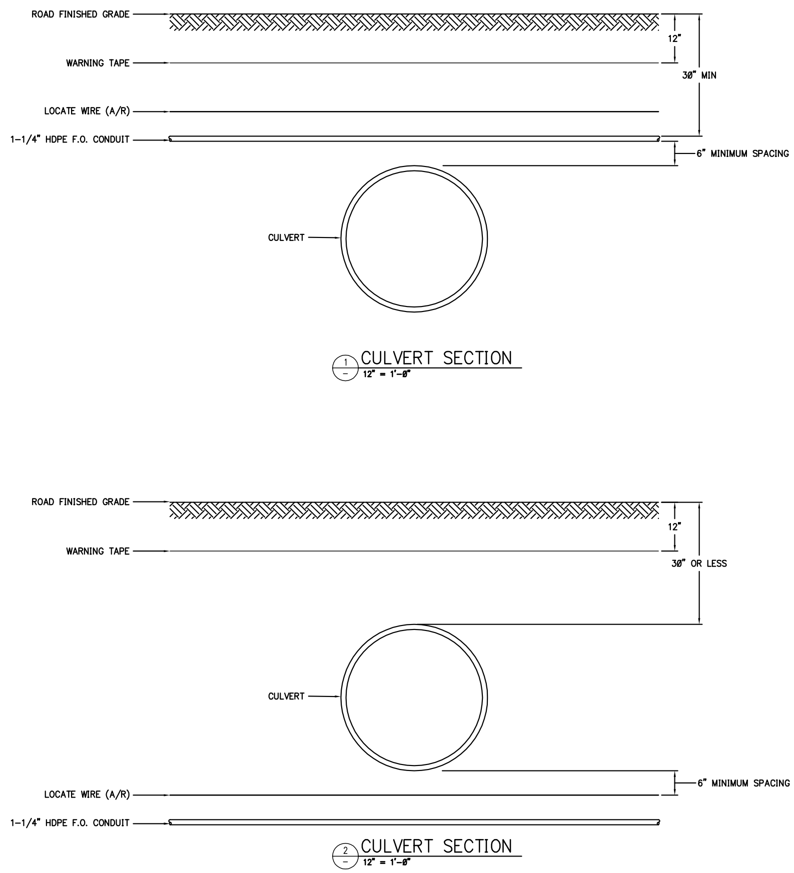
DRAWING NO.
CM-107536-005
SHEET NO. 001
OF: 001
REV. NO. 00



NOTES:

1. FIBER OPTIC CABLES AND OR CONDUITS MAY BE INSTALLED OVER CULVERTS THAT ARE LESS THAN 30" BELOW THE ROADWAY SURFACE WITH PRIOR APPROVAL FROM ENGINEERING
2. SEE DWG: CM-GCI-107536-003 SECTION B FOR TRENCH SECTION DETAILS
3. BEDDING AND OR BACKFILL USED WITHIN 4" OF FIBER OPTIC CABLE AND DUCT SHOULD BE FREE OF MATERIALS THAT COULD DAMAGE THE CABLE OR DUCT.

AMBLER ROAD
FIBER OPTIC FACILITY
FIBER INSTALL DETAILS
CULVERT SECTION (TYP)

DRAWN: J. WEAVER	DATE: 07/2018
DESIGN: J. WEAVER	DATE: 07/2018
DESIGN: _	DATE: –
APP: AMBLER ROAD	DATE: –
W/O: –	
DRAWING SCALE: AS SHOWN	

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DRAWING NO. CM-107536-006

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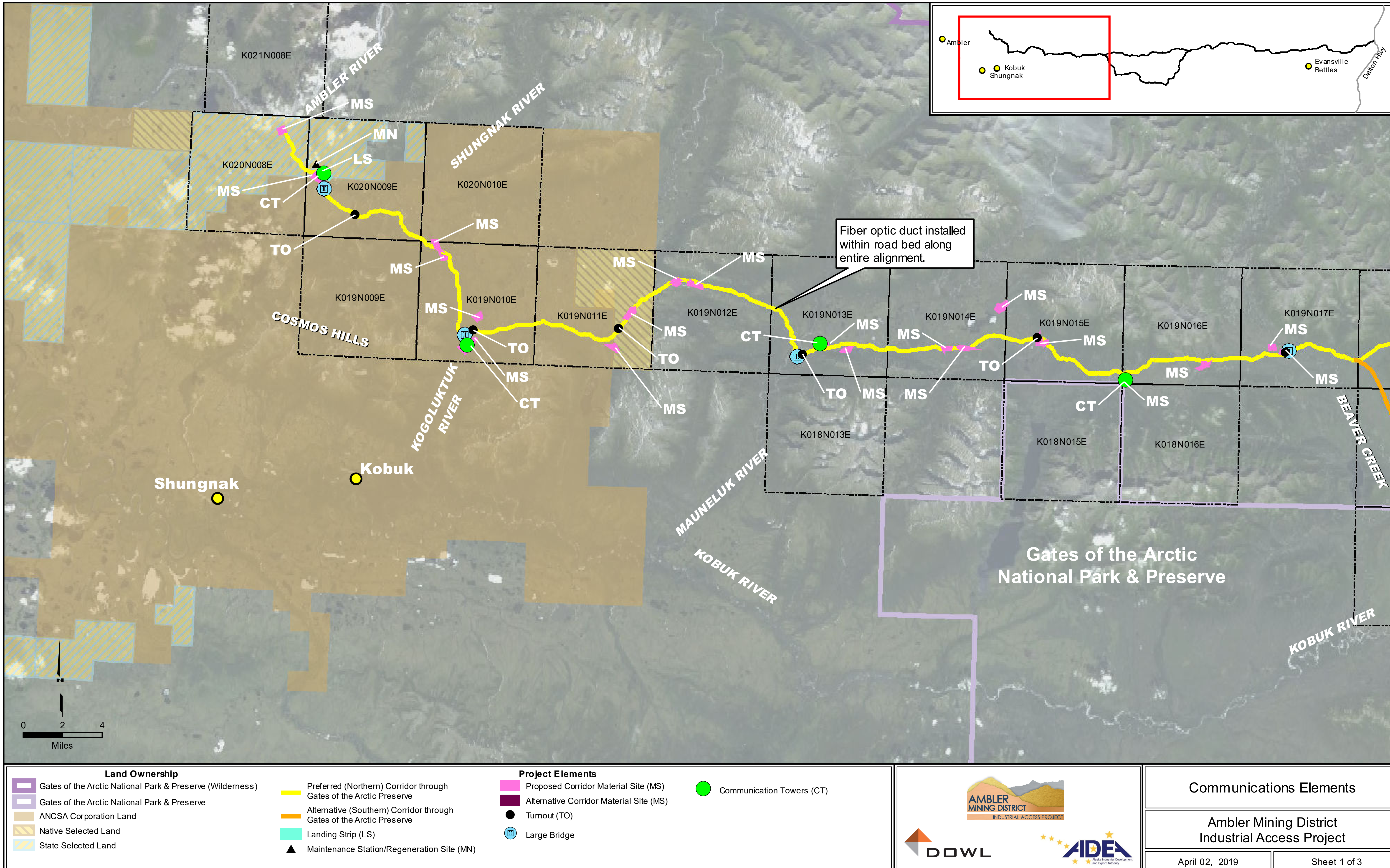
ATTACHMENT 4

AMDIAP COMMUNICATIONS ELEMENTS



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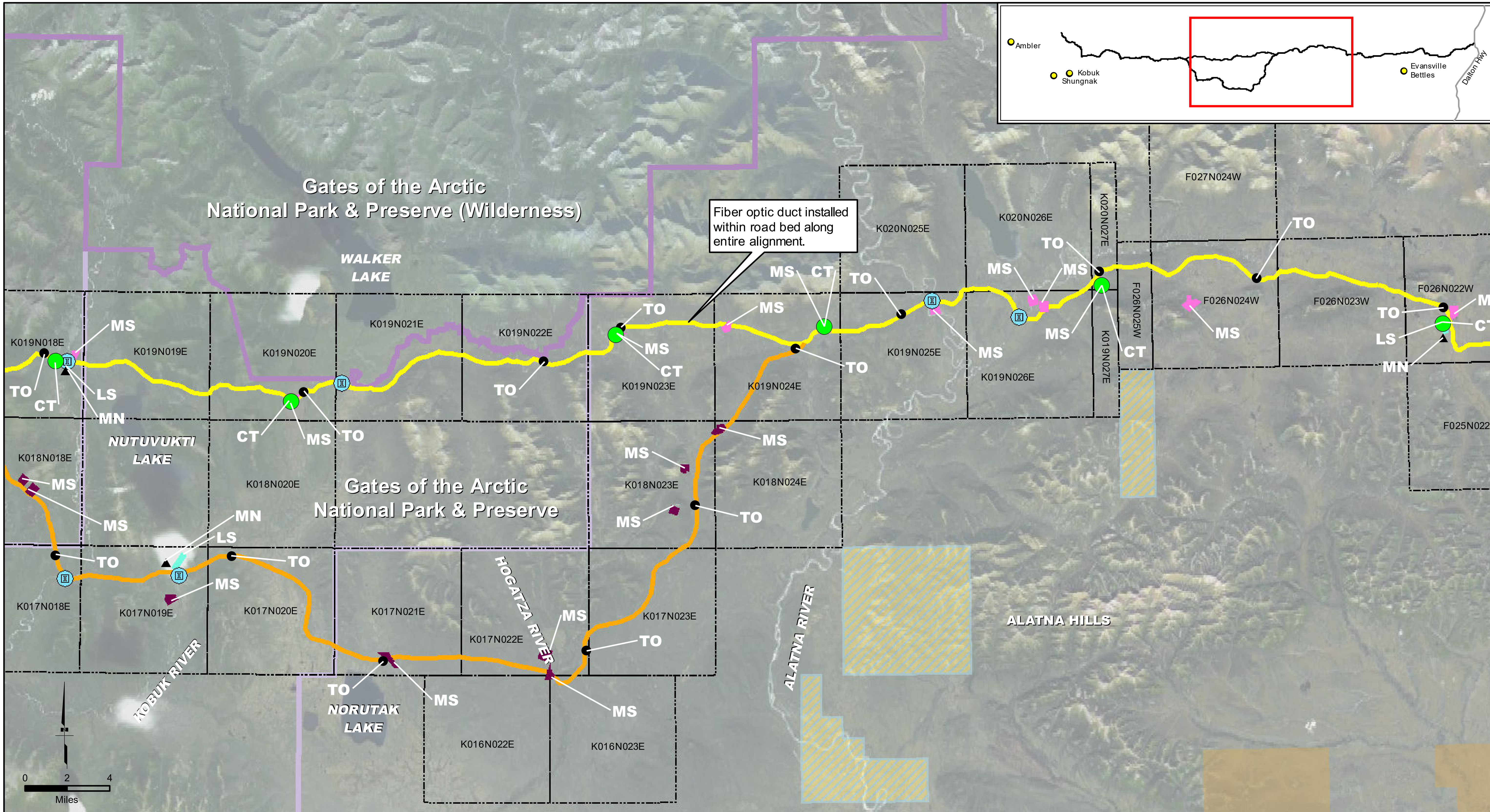

Land Ownership

- Gates of the Arctic National Park & Preserve (Wilderness)
- Gates of the Arctic National Park & Preserve
- Kanuti National Wildlife Refuge
- ANCSA Corporation Land
- State Selected Land
- Preferred (Northern) Corridor through Gates of the Arctic Preserve
- Alternative (Southern) Corridor through Gates of the Arctic Preserve
- Landing Strip (LS)
- Maintenance Station/Regeneration Site (MN)

Project Elements

- Proposed Corridor Material Site (MS)
- Alternative Corridor Material Site (MS)
- Turnout (TO)
- Large Bridge
- Communication Towers (CT)

AMBLER MINING DISTRICT
INDUSTRIAL ACCESS PROJECT

DOWL

AIDEA

Communications Elements

Ambler Mining District
Industrial Access Project

April 02, 2019	Sheet 2 of 3

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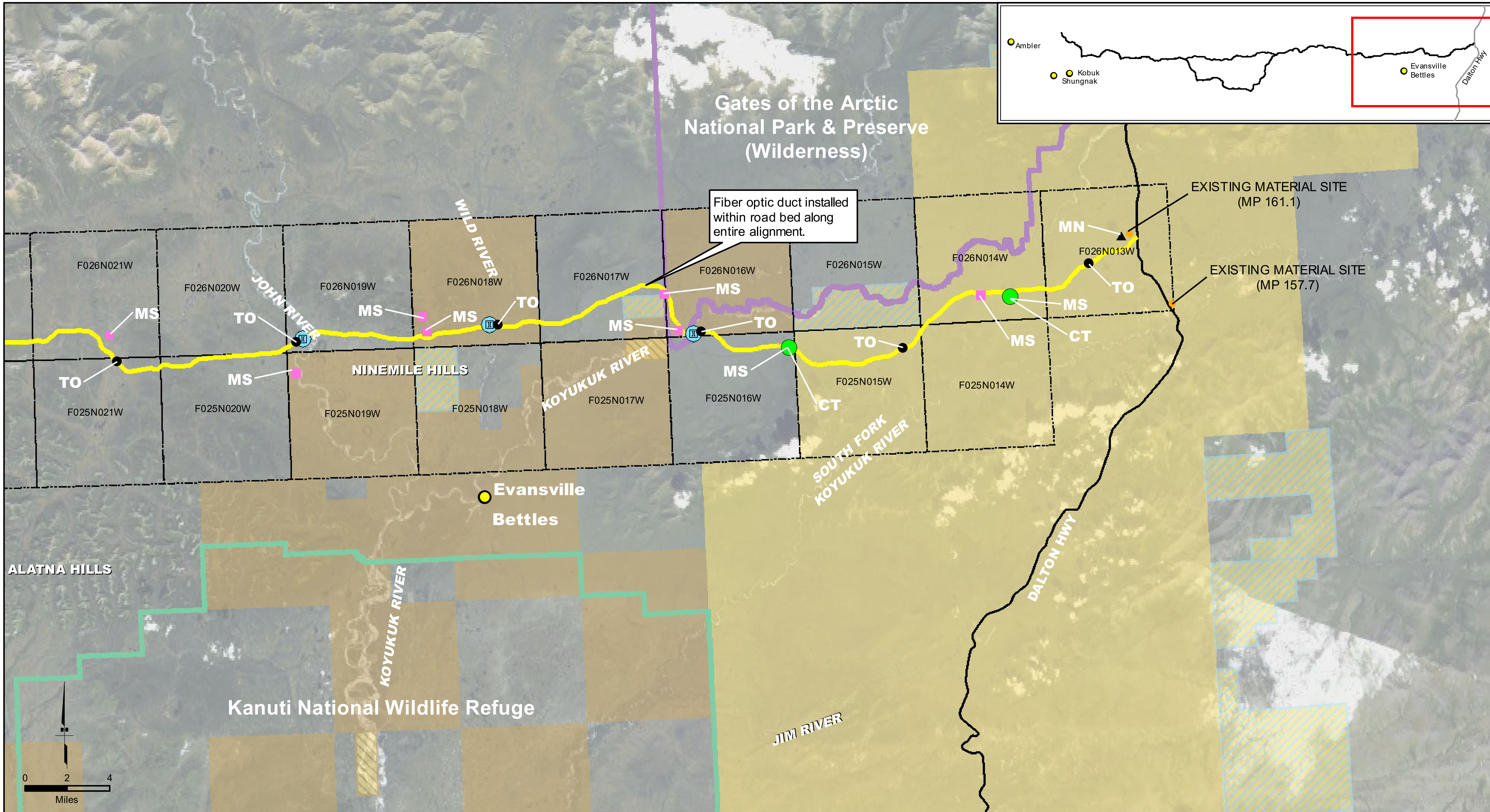

Land Ownership

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- Kanuti National Wildlife Refuge
- Bureau of Land Management
- ANCSA Corporation Land
- Native Selected Land
- State Selected Land

- Preferred (Northern) Corridor through Gates of the Arctic Preserve
- Alternative (Southern) Corridor through Gates of the Arctic Preserve
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- Maintenance Station/Regeneration Site (MN)

Project Elements

- Proposed Corridor Material Site (MS)
- Alternative Corridor Material Site (MS)
- Turnout (TO)
- Large Bridge
- Communication Towers (CT)

AMBLER MINING DISTRICT INDUSTRIAL ACCESS PROJECT

DOWL

AIDEA Alaska Industrial Development and Export Authority

Communications Elements

Ambler Mining District
Industrial Access Project

April 02, 2019

Sheet 3 of 3

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