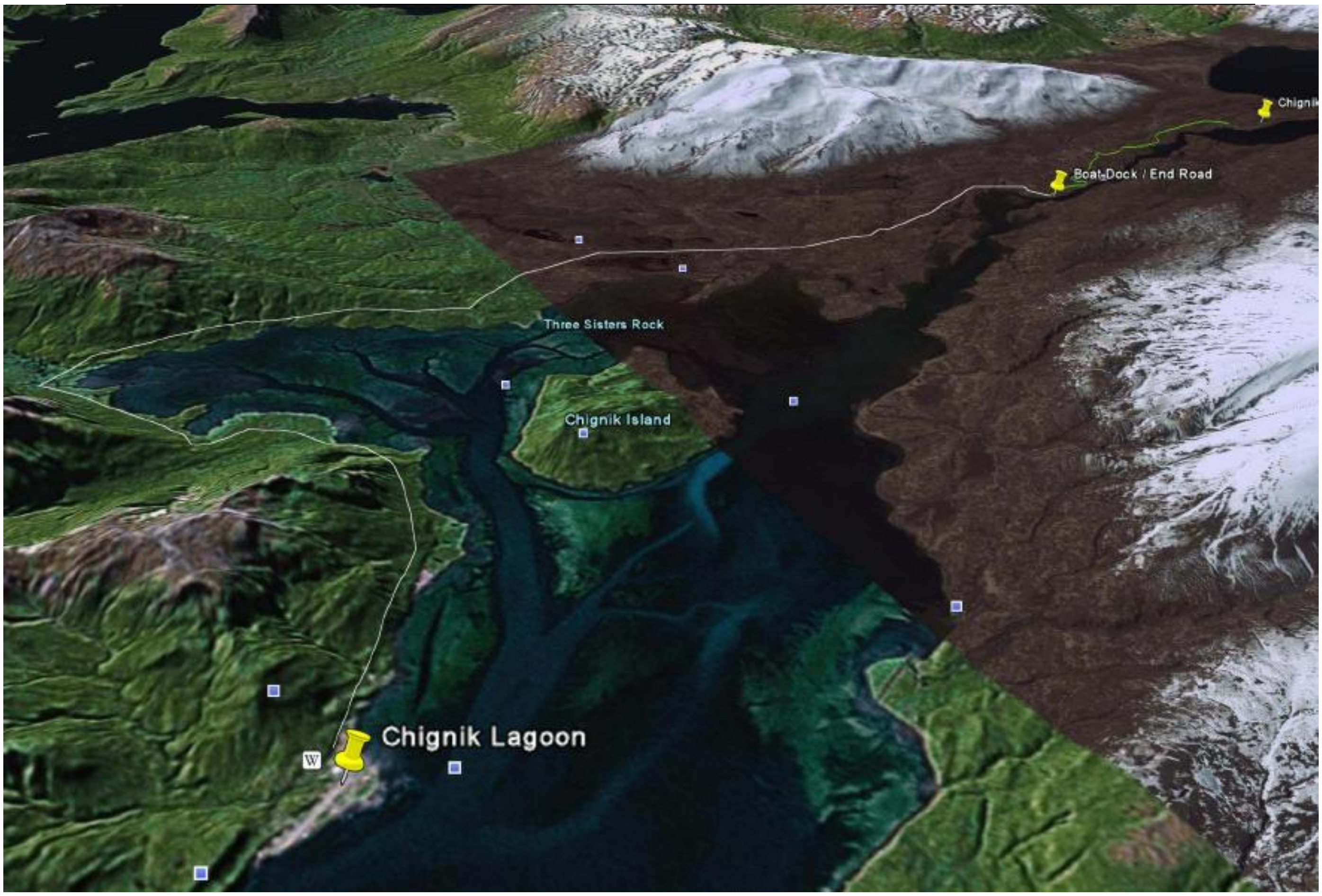
# Feasibility Report

# CHIGNIK LAKE TO LAGOON ROAD




Chignik, Alaska

*Prepared for:*
**The Denali Commission**

*Prepared by:*
**Federal Highway Administration**
Western Federal Lands Highway Division
March **2011**

# Acronyms

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ADT | Average Daily Traffic |
| ADOT&PF | Alaska Department of Transportation and Public Facilities |
| EIS | Environmental Impact Statement |
| FHWA | Federal Highway Administration |
| IRT | Department of Defense, Innovative Readiness Training |
| MPH | Miles per Hour |
| NEPA | National Environmental Policy Act |
| VPD | Vehicles per Day |
| WFLHD | Western Federal Lands Highway Division |

# Executive Summary

## Project Background

The Denali Commission, (DC), requested assistance from the Federal Highway Administration (FHWA), to provide technical assistance to the Department of Defense, Innovative Readiness Training (IRT) program staff in conducting route location and topographic survey of a 14-16-mile road corridor between Chignik Lagoon and Chignik Lake, Alaska. The goal of the technical assistance was to ensure route location and survey data is suitable for subsequent design and construction under FHWA minimum standards due to remote location, low traffic volume and a vehicle fleet comprised of all-terrain vehicles, pickups and fuel/freight transfer trucks.

## Project Location

The Chignik communities are located on the south shore of the Alaska Peninsula, approximately 450 miles southwest of Anchorage. Chignik Lagoon lies 180 air miles south of King Salmon, 8.5 miles west of Chignik and 16 miles east of Chignik Lake. The primary year-round employers are the Chignik Lagoon village council, electric plant and school. Subsistence activities significantly contribute to food sources. Chignik Lake lies 13 miles from Chignik and 265 miles southwest of Kodiak. The people of Chignik Lake depend heavily on subsistence hunting and fishing, and utilize salmon, other fish, caribou, moose and seal.

## Project Purpose

The purpose of the project is to provide a transportation facility that, with limited maintenance, would provide year-round reliable access between Chignik Lake and Chignik Lagoon. The proposed roadway is expected to improve overall transportation reliability and safety, as well as encourage economic efficiency and the consolidation of community services. Construction of a road between the two villages would promote a more economic delivery of fuel for power generation facilities at Chignik Lake.

## Alternatives

Route analysis and terrain investigation required a team of engineering technicians and staff who, through map analysis and ground surveys determined a practical route between the two villages, considering a previously planned airport runway site four miles east of Chignik Lake. FHWA and Denali Commission representatives met with local residents discussing transportation needs, potential routes, seasonal weather conditions and unstable slope locations that might influence the final route. A route was developed starting at the end of the existing road at Chignik Lake and proceeded to Schooner Bay Creek, the Metrofania Valley Airport site, Mallard Duck Bay, Marshinlak Creek, and to the Chignik Lagoon power generation site. FHWA representatives worked with the U.S. Military to establish the route on the ground.

After reviewing survey information, preliminary design was started considering three single lane template alternatives, 1) a 14-foot roadway consisting of a 10-foot lane, 2-foot shoulders, and a

1-foot "V" shaped ditch; 2) a 12-foot roadway consisting of a 10-foot lane, 1-foot shoulders, and a 1-foot "V" shaped ditch; and 3) a 13.5 roadway consisting of a 10-foot lane, 1-foot shoulder, and no ditch. Inter-visible turnouts were considered for each alternative. The 13.5-foot roadway is a result of extending each pavement layer to the excavation backslope which provides an addition1.5 ft of usable width. The last alternative most closely matches the pioneer road concept agreed upon as the appropriate template for this application. It saves 9-feet of excavated width compared to the 14-foot roadway and 9.5-feet of excavated width compared to the standard 12-foot roadway. Additional construction savings can be realized by employing rolling drain dips with the 13.5-foot roadway while still protecting the corridor from erosion by surface water runoff.

Construction alternatives considered include, traditional contracting to a construction contractor and attempting to use the military to construct a pioneer road along the desired corridor as a first phase which would be usable immediately, with follow-up design and construction phases as funding is available.

## Funding

Transportation funding program, SAFETEA-LU, contained funding authorization of $7,000,000 for road construction to connect Chignik Bay, Chignik Lake, and Chignik Lagoon. Authorized funds were originally made available for the State of Alaska Department of Transportation and Public Facilities, (ADOT&PF), to connect all three villages. ADOT&PF's project study determined the costs for a full standard two-lane road to be prohibitive. The Denali Commission authorized spending up to $1,000,000 for reconnaissance engineering for a one-lane pioneer or primitive road standard for connection of Chignik Lake and Chignik Lagoon only, with full support of Chignik Bay and ADOT&PF, to be owned and operated by the Lake and Peninsula Borough.

## Recommendations

The feasibility study recommends a single lane, 12-foot roadway be constructed with a 10-foot lane, 1-foot shoulders, no ditch in the template, inter-visible turnouts at a maximum spacing of 1000-feet, and typical excavation, embankment and foreslopes of 1V:2H. The report further recommends an attempt be made to secure the services of the U.S. Military's Innovative Readiness Training Program for construction of the pioneer road.

## Maintenance

Road maintenance will be performed by the two village communities. Greater diligence will be required to keep the pioneer road open than if funding were available for a higher standard facility. Drainage feature such as the rolling drain dips will have to be maintained. Considering snow accumulation and the annual rainfall, the subgrade will become saturated and the pavement structure will start to fail under loading if drainage structures are not maintained. Snow drifting may cause localized road closure and equipment will need to be available for snow removal to open the road and to protect from subgrade saturation. There are two areas known to experience occasional ice avalanches. One small area appears to be up slope of the Chignik Lagoon land fill and another approximately one mile southwest of Mallard Duck Bay. Reporting minor failures noticed while conduction fuel deliveries and prompt response to those conditions will reduce major maintenance problems and costly repairs. Normal annual maintenance costs are estimated at approximately $75,000,00.

**Major Issues to address**

Support of the Alaska Fish and Wildlife Department will be instrumental in successful installation of major drainage crossings to meet the pioneer road construction concept. Right-of-way and utility impacts within Chignik Lagoon must be mitigated. A long term funding commitment to construction of this road will be required to reach a stable aggregate running surface.

# 1. Introduction

## 1.1 Background

Western Federal Lands Highway Division (WFLHD), Federal Highway Administration (FHWA), through a funding agreement, was contacted to provide technical assistance to the Denali Commission (DC) and the Department of Defense, Innovative Readiness Training (IRT) program staff in conducting route location and topographic survey of a 14-16-mile road corridor between Chignik Lagoon and Chignik Lake, Alaska. The goal of WFLHD technical assistance was to ensure that the route location and survey data will be suitable for subsequent design and construction under FHWA standards, albeit at the minimum standard practical due to remote location, very low volume average daily traffic, (ADT) and a vehicle fleet comprised primarily of all-terrain vehicles, with occasional pickups and fuel/freight transfer trucks.

SAFETEA-LU contained funding authorization of $7,000,000 for road construction to connect Chignik Bay, Chignik Lake, and Chignik Lagoon. The authorized funds were made available for the State of Alaska Department of Transportation and Public Facilities (ADOT&PF). ADOT&PF conducted a study to connect both villages, along with Chignik Bay, and found the costs for a full standard two-lane road to be prohibitive. In consideration of available funding for construction, the Denali Commission authorized spending up to $1,000,000 to perform reconnaissance engineering for a one-lane pioneer or primitive road standard to be owned and operated by the Lake and Peninsula Borough rather than the State of Alaska. WFLHD has extensive experience in low-volume roads and agreed to provide survey oversight and initial studies for a primitive road design.

## 1.2 Location and Setting

This project is located in the area between Chignik Lagoon and Chignik Lake, Alaska. The Chignik communities are located on the south shore of the Alaska Peninsula, approximately 450 miles southwest of Anchorage. No inter-village road system exists, and travel occurs by air and sea. In 1994, the Alaska Department of Transportation and Pubic Facilities, (ADOT&PF), completed a preliminary reconnaissance study, and in 2002, ADOT&PF's "Southwest Alaska Regional Transportation Plan" identified a corridor. According to this plan, the proposed roadway is expected to improve overall transportation reliability and safety, as well as encourage economic efficiency and the consolidation of community services. The estimated population of the two villages is 313 but fluctuates seasonally.

Chignik Lagoon is located on the south shore of the Alaska Peninsula, 450 miles southwest of Anchorage. It lies 180 air miles south of King Salmon, 8.5 miles west of Chignik and 16 miles east of Chignik Lake. The Chignik Lagoon Village Council is a federally-recognized tribe and is located in the community. The 2007 State of Alaska Department of Commerce, Community and Economic Development (DCCED) estimated (not certified) population of Chignik Lagoon is 71. The people of this area have always been sea-dependent, living on otter, sea lion, porpoise, and whale. During the Russian fur boom from 1767 to 1783, the sea otter population was decimated. This, in addition to disease and warfare reduced the Native population to less than half its former size. Fishing is the mainstay of the Chignik Lagoon economy, and the area serves as a regional fishing center. Twenty-nine residents hold commercial fishing permits. The primary year-round employers are the village council, electric plant and school. Subsistence activities significantly contribute to food sources. The Chignik Lagoon Village Council of Chignik Lagoon is the governing body. The Alaska Native Claims Settlement Act (ANCSA) regional corporation for Chignik Lagoon is the Bristol Bay Native Corporation. The native housing authority is Bristol Bay Housing Authority. [1]

Figure 1: Chignik Lagoon

Chignik Lake is located on the south side of the Alaska Peninsula next to the body of water of the same name. It lies 13 miles from Chignik, 265 miles southwest of Kodiak and 474 miles southwest of Anchorage. The Chignik Lake Traditional Council is a federally-recognized tribe and is located in the community. The 2007 State of Alaska Department of Commerce, Community and Economic Development (DCCED) estimated (not certified) population of Chignik Lake is 105. The present population traces its roots from the Alutiiq near Illnik and the old village of Kanatag near Becharof Lake. The community was the winter residence of a single family in 1903. Other families moved from surrounding communities in the early 1950s when a school was built. Fishing is the mainstay of Chignik Lake's economy. Eight residents hold commercial fishing permits. The people depend heavily on subsistence hunting and fishing, and utilize salmon, other fish, caribou, moose and seal. The Chignik Lake Traditional Village Council is the Village

**Figure 2: Chignik Lake**

Council. The Alaska Native Claims Settlement Act (ANCSA) regional corporation for Chignik Lagoon is the Bristol Bay Native Corporation. The native housing authority is Bristol Bay Housing Authority. [1]

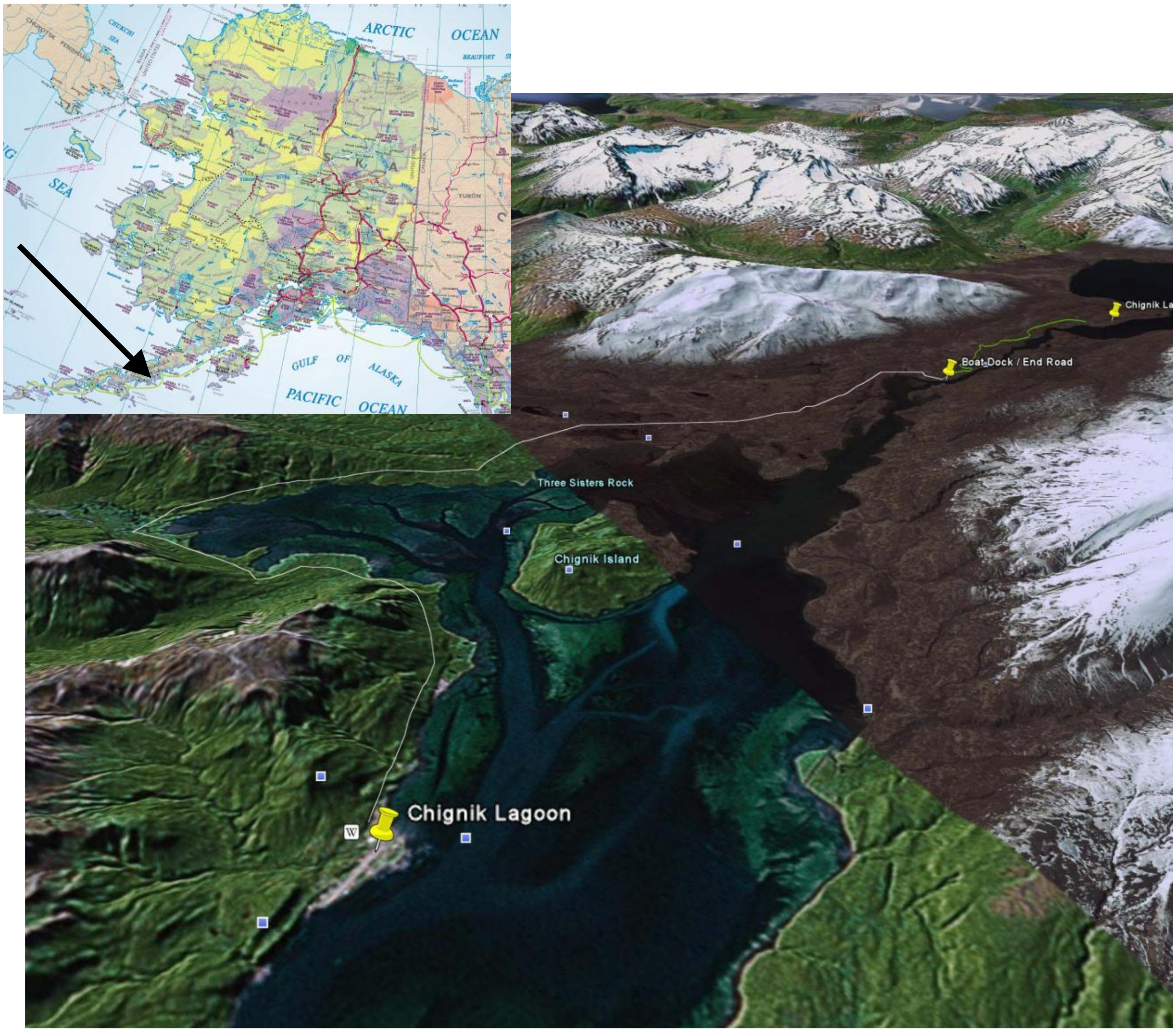



**Figure 3: Project Location**

The local climate is maritime, characterized by cool summers and relatively warm, wet winters. Thick cloud cover and heavy winds are prevalent during winter months. Summer temperatures range from 39 to 60 °F. Winter temperatures range from 21 to 36 °F. Precipitation averages 127 inches annually, with an average annual snowfall of 58 inches.

The land in the project area consists of large mountains bordering tidally-influenced bays and drainages. As the mountains meet the water, there are flatter coastal areas in some places, rolling hills in others, and steeper rocky sections as well. There are several streams along the route, the largest of these draining out through Mallard Duck Bay, a large wetland area that is heavily used by brown bears. The second largest drainage, west of Mallard Duck Bay about midway between the Bay and Chignik Lake, is Metrofania River. This river is tidally influenced and accessible by skiff for some distance as it approaches the lagoon, passing through wetlands and rolling hills. Chignik Lake is not tidally influenced; it is separated from Chignik Lagoon by the Chignik River. The lake is northwest of the route and not in close proximity to any potential alignments.

The area is well vegetated with grasses, brush, and small willows. The vegetation varies from waist deep grass to willows and brush growing to about twenty feet in height, with a few small trees.

## *1.3 Project Purpose*

The purpose of the project being studied in this feasibility report is to provide a transportation facility that, with limited maintenance, would provide year-round reliable access between Chignik Lake and Chignik Lagoon.

There are numerous obvious benefits that reliable ground transportation to access each other's services would provide for the villages and related economical advantages. Additionally, the Chignik Lagoon airport is below standard and the presence of water at either end of the runway, combined with steep terrain, allows few options for expansion. Conversely, boat access to Chignik Lake requires navigating up the Chignik River which is only accessible via small boats. Connecting the villages with ground transportation would alleviate the restriction in access that currently exists for each village. Construction of a road between the two villages would promote a more economic delivery of fuel for the power generation facilities at Chignik Lake. The presence of a reliable road would also allow for better interaction between the two communities and allow for a potential increase in shared services.

## *1.4 Feasibility Analysis Activities*

WFLHD utilized their experience in engineering, environmental compliance, and transportation project development to compile this report to address the feasibility of the proposed project. The following activities were included in the study.

<u>IRT Surveying Project</u>

The Denali Commission's request for assistance was originally an FY 2009 request for assistance from the Innovative Readiness Training (IRT) Program, U.S. Department of Defense. The request was for reconnaissance engineering services for route location along a sixteen-mile corridor to connect Chignik Lagoon and Chignik Lake to improve fuel and freight delivery for Chignik Lake and to provide airport access to Chignik Lagoon. The IRT program accepted and funded the request as a unique opportunity to train personnel on the use of surveying equipment and methods for primitive road design, operational logistics, gear associated with a remote location and cold weather conditions, and route location and field engineering for a primitive road.

Due to the fact that military roads serve a much different purpose than civilian roads, and that there might be needs for technical assistance with surveying efforts, WFLHD was tasked for assistance with the survey. WFLHD provided route location and technical assistance to improve the value of the IRT effort in both advising military personnel and providing useful information for the road location and design.

Initial reconnaissance included representatives from the Denali Commission, FHWA, and the United States Marines. The project was flown in a Black Hawk helicopter, visible in the photo above. The April 2009 trip was made much easier due to the use of military equipment, their expertise in road construction and survey, and the willingness of military personnel to get the job done. FHWA believes there is a real opportunity to deliver an appropriate road facility that will meet the needs of the residents of Chignik Lagoon and Chignik Lake, especially if the United States Marines are involved in the construction of the Chignik Road.

**Figure 4: U.S. Marine Survey**

The IRT survey began in late May and was completed in late August, 2009. The information from this effort was then transferred to WFLHD for possible use in design.

Scoping Efforts

**Figure 5: Scoping Route**

As part of providing route location assistance for the purposes of the IRT survey, WFLHD undertook scoping efforts to gather information on environmental issues, geological and other roadway materials, local knowledge and concerns, fish and wildlife presence, hydrology, potential road usages, and road design and construction issues unique to working in this area of Alaska. The efforts were conducted to evaluate the existing data and context information, identify major needs, issues, and constraints, evaluate the scope and feasibility of proposed improvements, identify goals and objectives, initiate environmental coordination and public outreach, and identify applicable design standards and controls.

This study is the basis from which the more comprehensive, interdisciplinary preliminary engineering activities, surveys, investigations, environmental studies and analyses for the project can be effectively planned, budgeted, and scheduled. As part of this study, recommendations for further study will also be made in order to develop a course of action with suggestions for investigating improvement alternatives and conducting engineering analyses. If the project advances beyond this phase, as part of the project development, compliance with the National Environmental Policy Act (NEPA) and additional compliance activities will be planned and conducted accordingly.

The scoping included coordinating directly with the following Agencies and Organizations:

a. Alaska Department of Fish and Game (attended field review)
b. Alaska Department of Natural Resources State Historic Preservation Office
c. U.S. Army Corps of Engineers Regulatory Branch
d. U.S. Navy Seabees (attended field review and provided engineering assistance)
e. Chignik Bay Tribal Council
f. Chignik Lagoon Native Corporation

Additionally, the following agencies and organizations were utilized for developing information as part of the scoping efforts and/or will be involved in further project development activities:

a. Alaska Peninsula National Wildlife Refuge
b. Alaska Department of Transportation and Public Facilities
c. Alaska Department of Community and Economic Development
d. Alaska Department of Environmental Conservation
e. Alaska Department of Natural Resources
f. National Marine Fisheries Service
g. U.S. Department of the Interior Bureau of Indian Affairs Environmental Services
h. Bureau of Land Management
i. U.S. Environmental Protection Agency
j. U.S. Fish and Wildlife Service, Ecological Service and Archaeology
k. U.S. Forest Service
l. Alaska Department of Public Health
m. Lake and Peninsula Borough
n. Far West Incorporated
o. Chignik River Limited
p. Bristol Bay Native Corporation

Design Efforts

As part of the feasibility analysis and IRT surveying effort, alternative design standards and alignments were considered. Following the survey effort, design concepts were further analyzed in consideration of construction costs, environmental impacts, and for appropriately meeting the purpose and objectives of the proposed project. Concepts that clearly were not reasonable in regards to any of these three considerations were abandoned. The remaining options for design were further analyzed and are presented in this report.

# 2. Design Considerations

## *2.1 Road Design Terminology*

Where the following terms, or pronouns in place of them, are used in this report the intent and meaning are as indicated in the illustration of road structure terms and as explained in the definitions that follow:

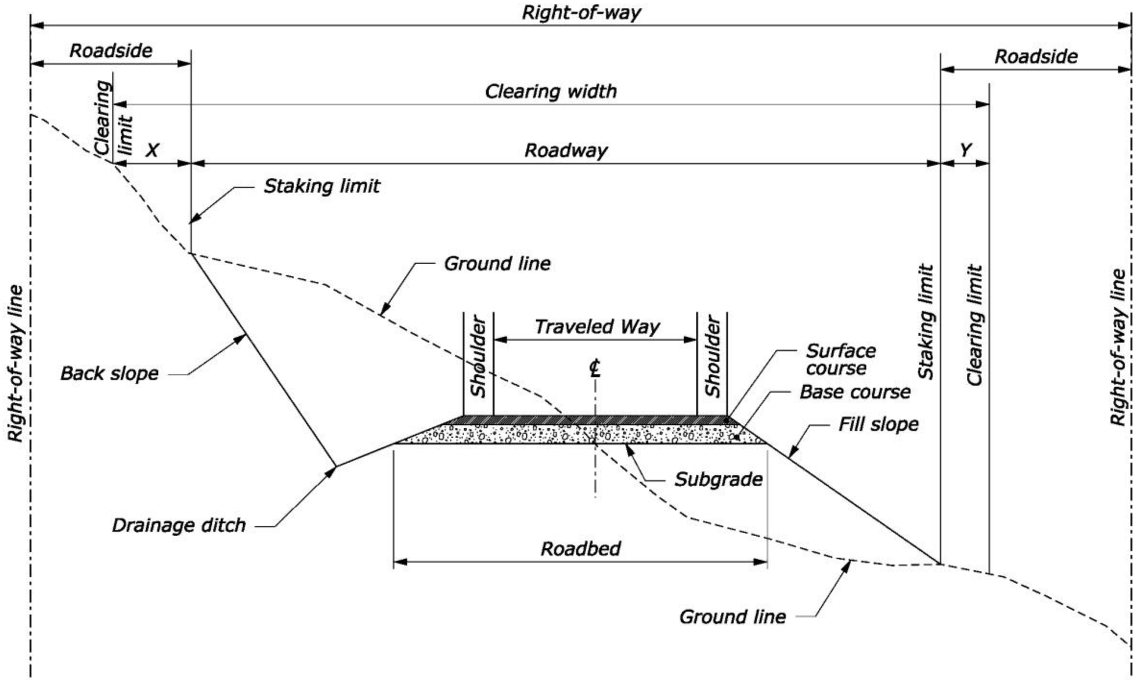



**Figure 6: Illustration of Road Structure Terms**

Backslope – The slope constructed in the native terrain in-slope to the ditch line to accommodate the road bench and achieve both native slope stability and design-speed stopping sight distance. Usually the backslope is steeper than the native slope angle of stability.

Construction Limits – The limits on each side of the project that establish the area disturbed by construction operations and beyond which no disturbance is permitted. Typically the construction limits are the same as the clearing limits, except when additional clearing is required.

Cross Section – A vertical section of the ground or structure at right angles to the centerline or baseline of the roadway or other work.

Ditchline – The drainage ditch width, measured from the edge of the roadway horizontally to the backslope. Nominally not less than 1.5 times the ditch depth. A 6-inch deep ditch constructed with a 2H:1V foreslope from the roadway and a 1H:1V backslope meets the 1.5’ width. (Defined by the Denali National Park Road Design Standard)

Grade – The slope of the road, usually expressed in percent of fall in a given horizontal distance. Example, 10% = a change in elevation of 10 feet vertically in 100 horizontal feet.

Fill Slope – The segment of the road structure that is fill rather than bench supported base or surface material; often refers to the face slope of the fill section.

Foreslope – The transition from road surface to ditch bottom.

Full Bench – The subgrade cut supporting the road structure is fully excavated into the existing topography, with no fill sections underlying the road surface other than constructed base sections.

Inslope Road Template – Cross section of the traveled way constructed to cause surface water to flow towards the cut slope, the inside of the road.

Partial Bench – Called “cut and fill.’ Only a portion of the road surface, usually 50% or more, is supported by a bench cut into the native slope and the rest is supported by a section of constructed aggregate and common soil fill over-lying the native slope.

Pioneer Road – A primitive, temporary road built along the route of a job to provide means for moving equipment and workers along the route. This road is usually un-surfaced and narrow. It is usually constructed at the highest point in the excavation segments and at the lowest elevation in the fill or cut-fill segments.

Profile Grade – The trace of a vertical plane intersecting a particular surface of the proposed road construction located as shown on the plans, usually along the longitudinal centerline of the road bed. Profile grade means either elevation or gradient of the trace according to the context.

Roadbed – The graded portion of a highway or road prepared as a foundation for the pavement structure and shoulders.

Road Structure Footprint – The area the road structure covers, measured horizontally. It extends from the toe of the fill/spill slope to the backslope edge of the ditchline at the road level.

Roadway - (roadway width) – In general, the portion of a highway or road, including shoulders, available for vehicular use. A divided highway has two or more roadways. In construction specifications, the portion of a highway within the construction limits.

Rolling Drain Dip – Rolling drain dips are depressions in the road grade, most frequently used on outsloped roads, to drain and disperse road surface runoff and prevent erosion. They require very little maintenance when installed properly.

Spill Slope – The outer slope created by the overboarding of surface and slide materials during maintenance, repair, traffic and weather activities. Spill slopes are unconsolidated, may be supported by vegetation and are inherently unstable. They can be over-steep, cause structural overloading of the underlying native and fill slopes and create an unsupported false road edge that appears to be part of the structural driving surface.

Subgrade – The top surface of a roadbed upon which the pavement structure and shoulders are constructed. The uppermost material placed in embankments or unmoved from cuts in the normal grading of the roadbed. It is the foundation for the pavement structure.

Traveled Way – That portion of the roadway designated for the movement of vehicles, including curve widening, exclusive of shoulders.

Unsuitable Material – Material not capable of creating stable foundations, embankments, or roadbeds. Unsuitable material includes muck, sod, or soils with high organic content.

Outsloped Road Template – Cross section of the traveled way constructed to cause surface water to flow towards the fill or outside edge of the road.

Crown – The elevation of a road surface at its center above its elevations at its edges to encourage drainage away from centerline.

## *2.2 Road User Needs*

The stated primary use of this proposed road is to allow for transport of fuel, people and goods between Chignik Lagoon and Chignik Lake. The largest design vehicle for the proposed route will be a Single-Unit (SU) Truck as

**Figure 7: Single-Unit Truck**

defined by the American Association of State Highway and Transportation Officials, (AASHTO), Geometric Design of Highways and Streets, 2004 edition, (Green Book). The minimum design turning radius for this vehicle is 42 feet, the centerline turning radius equals 38 feet and the minimum inside radius to be considered for design is 28.3 feet. There is potential use to be considered for a vehicle as large as a Double-Trailer Combination truck, (WB-67D) with a total length of 73.3 feet. This vehicle would have a minimum design turning radius of 45 feet, a centerline turning radius of 41 feet, and a minimum inside radius of 19.3 feet. The alignment corridor surveyed in the field would not prohibit the future enhancement of the route to accommodate a larger fuel delivery vehicle. However, for purposes of this study, a Single-Unit truck will be considered for discussion of alignment and grade.

Discussions with local governing officials included the possibility of using a Conventional School Bus (S-Bus-36) with a total vehicle length of 35.8 feet. The minimum design turning radius for a standard school bus is 38.9 feet, the centerline turning radius is 34.9, feet and the minimum inside radius equals 23.8 feet. A vehicle similar to this would be used in the event of consolidation of community schools. However, a smaller bus or van could be used for this purpose. At present a full sized school bus is not being considered in the design. The alignment corridor surveyed in the field would not prohibit the future upgrade of the route to accommodate a full size school bus.

A portion of the road from Chignik Lagoon to the community disposal site would be used in transport of community garbage. A short approach road would need to be included in the design

**Figure 8: Existing road to Chignik Lagoon Landfill**

of the mainline to accommodate this use. The existing road to the community land fill site is in disrepair. It was originally constructed of concrete slabs anchored to the shoreline and is only usable during periods of low tide. Large portions of the existing route are broken and misaligned.

There is incomplete information relating to the potential use of a portion of the route closer to Chignik Lake by future oil development activities to consider required changes in the template studied. Insufficient information is available at present to address road structure and design criteria to accommodate such traffic and to do so is outside the scope of this study. It is the opinion of WFLHD that the study corridor alignment and grade considered in this report would not prohibit expansion or enhancement of the roadway template to serve such future use.

Passenger cars, light duty vans, pickups, and All-Terrain-Vehicles, (ATV's) would make up the remainder of the traffic along the route. Bicycle and pedestrian use may be limited, especially during the winter, but present as well.

## 2.3 *Alignment Considerations and Features*

The ADOT&PF study included a conceptual design and road alignment, which was used as a starting point in analyzing road options. Following are the key considerations and issues studied with the project setting and road design. The descriptions below reference the stationing generated in the surveying efforts.

<u>Chignik Lagoon</u>

Field investigations included consideration of a route previously constructed along the shore line from the Chignik Lagoon to their landfill site southwest of the community. That route had been constructed of concrete slabs cabled together and placed on shoreline sand. This construction is subject to tidal fluctuations which over time have dislodged the slabs from their original position. Concrete slabs have deteriorated leaving reinforcing steel exposed in some instances. The route can only be used during low tide conditions and a good portion of the road is not functional.

The ADOT&PF design did not include a connection into Chignik Lagoon. The design route ended at the top of a hill at the southwestern end of town. This is a high point reached along an existing gravel surfaced road adjacent to a power lines suspended from poles. The route adjacent to existing power poles was constructed with a grade in excess of 18% and a substandard switchback which would not allow for transport of fuel in the design truck considered. There is insufficient area to construct a proper switchback without the removal of an existing structure. This existing route would not meet the user need of nearly year round delivery of fuel from Chignik Lagoon to Chignik Lake.

Field work during the summer of 2009 located the proposed route beyond the point considered by the ADOT&PF design attempting to deliver the route into Chignik Lagoon proper. Three alignments were considered to traverse existing ground from this high point southwest of town to the same point at the rear of the current power generation site in the center of the Chignik Lagoon community.

<u>Chignik Lagoon to Mallard Duck Bay</u>

The alignment from Chignik Lagoon to Mallard Duck Bay contains some of the steepest slopes and WFLHD concurs with ADOT&PF that this is considered a very difficult section of road alignment.

The proposed route considered by WFLHD crosses a small but deep ravine at the southwestern end of the community and climbs to the small bench beyond. From that point, the alignment uses grades of .5% for approximately 1300 feet, followed by a 3000 foot section where grades of up to 3% can be used. From there, a slight ledge can be utilized with grades of up to 7% required to negotiate existing rock outcrops. Following contours through this section is difficult given the undulating topography. To minimize excavation, the road would have a rolling profile in this section of terrain. The difficult topography for construction continues to about 4.0 miles southwest of Chignik Lagoon (Station 510+00).

From approximately 4.0 miles southwest of Chignik Lagoon to Mallard Duck Bay, the grades are much flatter and the concern for design and construction is more focused on wet and unstable soils. Longer vertical and horizontal curves can be used in this segment which would allow for a straighter road with the actual running speed higher than the expected 15 miles per hour. Within a quarter to a half mile of Mallard Duck Bay, the design crosses flatter ground along the shoulders of the rocky ground forming the upper slopes.

**Figure 9: Terrain Southwest of Mallard Duck Bay**

Mallard Duck Bay Crossing

A number of options were considered for this challenging section of the route. Initially, looking at mapping, it was hoped that the large wetland area could be avoided by taking an alignment that contoured up the valley above the tidal influence area, with a more defined, shorter crossing area. Such a route, if possible, would have added as much as three miles to the length of the project. However, upon field review, the steepness of the valley walls with water present right to the foot of the slopes greatly restricts options that would reduce wetland impacts and remain feasible. The field review concluded that an alignment near the ADOT&PF alignment was the only reasonable approach.

**Figure 10: Mallard Duck Bay- April 2009**

The resulting Mallard Duck Bay crossing (Station 465+00 to 435+00), traverses close to a half-mile of some of the lowest ground along the entire route. The river flowing out of the valley to the south is braided with one main channel and two additional secondary channels. The road template may need to be raised through this segment as much as twelve feet to allow for placement of fish passage structures and to better maintain the traveled way through extreme runoff conditions. See sheets H.1 and H.2 in

Appendix A for an illustration of the potential raised road template and fish passage treatment at this location. A number of ideas were discussed to address the issues with crossing this floodplain and are discussed further in Section 4.1.

If the alignment is routed inland of the first rock knob at the west edge of the valley adjacent to the shore line, it will allow for a more gradual grade transition to higher elevations beyond. This recommended route would provide access to rock deposits to the south of the alignment that might be utilized for base and possibly surface rock for the proposed pioneer road. The proposed route would partially shield excavation and development activities from view in that area. The route leaving Mallard Duck Bay is another of the more difficult design and construction segments to address. The topography is very steep and there exists one steep walled gorge, possibly formed by ice avalanches, shown to the right, that will force the alignment to a lower elevation, closer to the shoreline. The route can then make a gradual transition back away from the shoreline and onto flatter topography as the route approaches Chignik Lake.

**Figure 11: Steep Walled Gorge**

<u>Mallard Duck Bay to Chignik Lake</u>

Leaving Mallard Duck Bay (near station 380+00) grades of up to 9% are required as the route climbs above steep slopes close to the shoreline. The slopes are incised by frequent streams and low vegetation. Full bench and through cut construction will be used for the majority of this segment.

To reduce the excavation to a minimum, design efforts could take a cross-section by cross-section approach. Moving the horizontal alignment up or down slope does not provide relief from the full bench conditions due to the severity of the topography for approximately one mile from Mallard Duck Bay (station 339+00), toward Chignik Lake. This level of design work was not undertaken in this study but would allow for a significant reduction in excavation while not compromising the drivability of the pioneer road. The undulating nature of the topography will not allow for the elimination of through cuts completely as consistent horizontal alignment is pursued. A blending of design criteria for alignment, drivability, and future enhancement of the facility must be done to complete design activities.

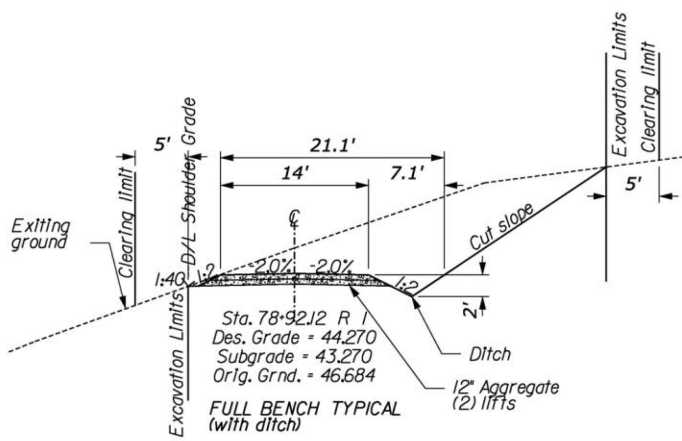



**Figure 12: Full Bench Typical**

The design and construction becomes much easier approximately 8 miles east of Chignik Lake (Station 325+00) as the topography flattens significantly. The crossing at Metrofania Creek would likely require a bridge. Field reconnaissance at this site allowed for adjustment in alignment from a previously considered location to one with higher ground adjacent to the creek and a reduced structure length. There is another large drainage (near Station 289+00) that requires multiple culverts or drainage structures. Another drainage (Station201+00 to 206+00) would require raising grade to accommodate a major drainage structure and to stay out of saturated soils. The gently rolling terrain allows for design grades for long distances midway between Mallard Duck Bay and Chignik Lake (Station 170+00 to 122+00 and 114+00 to 90+00) to be less than 2%.

Nearing the end of the existing road, approximately four miles from Chignik Lake (Station 45+00 to 26+00), the road template should be constructed five feet above the existing ground with rock borrow to keep the road out of saturated soils. From here, the existing road can be reconstructed to connect to Chignik Lake.

## *2.4 Stream Crossings and Drainage*

**Figure 13: ADOT&PF Hydraulic**

ADOT&PF initiated a hydrologic field reconnaissance by HDR, Inc. in 2007 of major drainages along the route from Chignik Lagoon to Chignik Lake. The alignment followed for that reconnaissance was slightly different than the one proposed by FHWA. However, the USGS 1:63,360 topographical maps used to determine drainage basins along the road corridor would be the same used by any subsequent drainage analysis efforts. The route crosses approximately 40 drainages. The ADOT&PF report identifies fifteen of these to require a culvert 4 feet in diameter or greater. Approximately 25 smaller drainages, requiring less than 4 foot diameter culverts, were noted but not documented in the reconnaissance report. The ADOT&PF report tabulated location, name, drainage area, slope, bankfull width, bed material, presence or absence of fish, a judgment of potential fish passage needs, and the proposed conveyance structure. Structure size was not recommended in the report. However, two bridges were suggested, one at Mallard Duck Creek and one at Metrofania Creek. Multiple culverts were recommended at Marshinlak Creek, Mallard Duck North overflow, Dead Boat Creek , Weir Creek East and Weir Creek West. The ADOT&PF reconnaissance report indicated the presence of anadromous fish and the potential need for fish passage measures at eight locations, Marshinlak Creek, Mallard Duck Creek including the north and south overflows, Metrofania Creek, Dead Boat Creek, as well as Weir Creek East and West.

Proposed Drainage along the FHWA proposed route – Major drainages along the route were investigated by a US Navy hydraulic engineer, FHWA road designer, FHWA environmental specialist, and to a limited extent, an Alaska Fish and Wildlife biologist. Although the proposed FHWA alignment is different than that proposed by ADOT&PF, the insights of the State sponsored hydrologic field reconnaissance were very helpful. Final design activities would include calculation of the proper size of each drainage structure. Drainage structure sizes described below are based on visual observations with consideration of ADOT&PF recommendations.

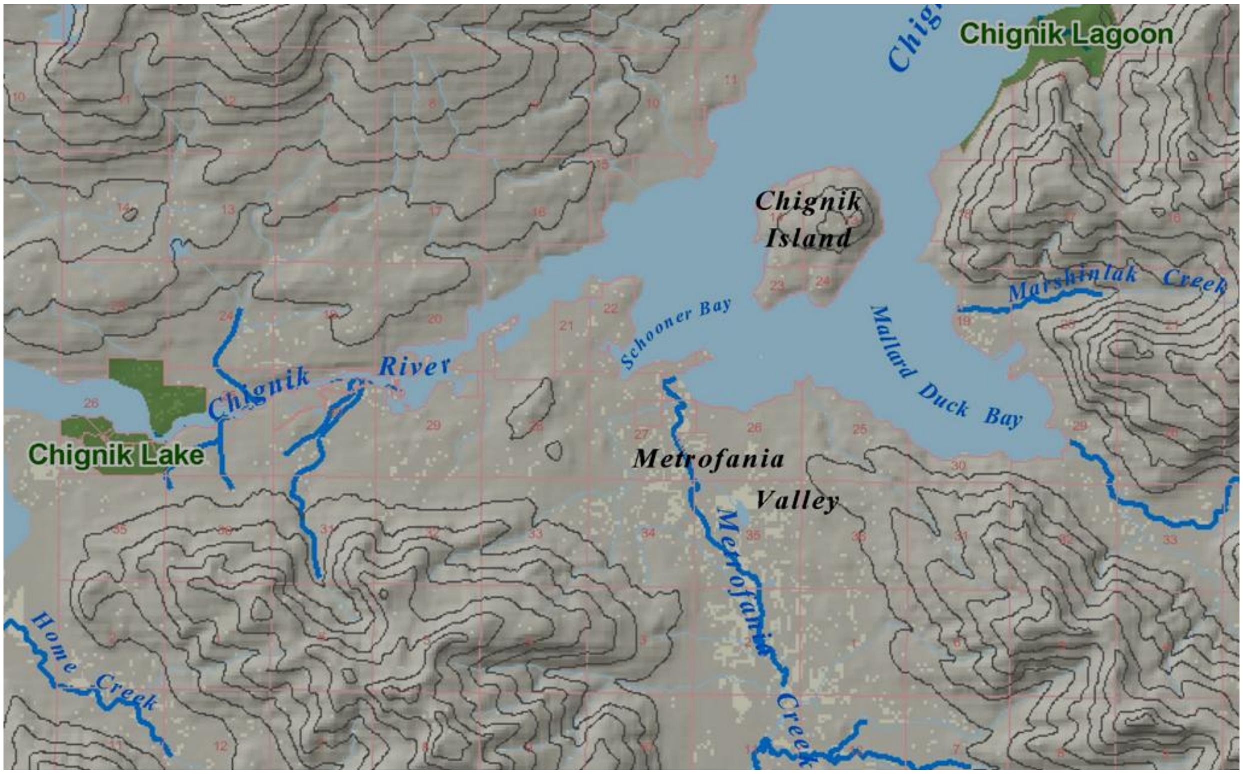



**Figure 14: Anadromous Streams**

Jerrys Point Creek 681+25 - The creek is located in a deep ravine upstream of the residences in the local Chignik Lagoon area. The alignment proposed is up slope of the southern most house but down slope of the rock outcrop sectioned by the creek. The proposed route traverses a series of benches to the south west as the route climbs to an elevation above rock bluffs further to the south west. An estimated 18' diameter culvert will be needed at this crossing.

Landfill Creek 646+25 - This is a deep gully creek. The route proposed places the road approximately 100 feet upslope of the landfill. There are two locations that will require culverts, one at 643+30 and 644+83. Both of these should be a minimum 4 foot diameter culvert.

Green Point 585+25 - The route is located on the alluvial fan and crosses the creek at the approximate elevation of 57 feet. A 4 foot diameter pipe is recommended for this location.

Marshinlak Creek 541+00 - The road crossing is located on a large floodplain. The route was selected that would allow the alignment to be placed behind a rise located closer to the shoreline. This resulted in a better transition to higher elevations and a crossing where the single channel is relatively straight. Given the embankment planned for transition from the steep grades before this station, a 6-foot diameter pipe is believed to be a minimum culvert size.

**Figure 15: Typical Streambed**

This stream is identified as an anadromous stream and the culvert size may increase dependent upon streambed and channel treatment requirements.

Mallard Duck Creek 452+40 – ADOT&PF's hydrologic field reconnaissance describes this location as a large drainage with a high bedload with active migration of overflow channel upstream of the proposed crossing. Considerable time was spent trying to locate the route further up in the drainage looking at contour maps and spending time on site. Although the southeast slopes of the drainage would allow for placement of a road to a more restricted and defined crossing, the northwest slopes are steeper and quick return to the shoreline route would be difficult. The location of the route considered by FHWA is very close to that suggested by ADOT&PF. Consideration by the military Hydraulic Engineer was for placement of multiple pipes rather than a bridge. It appears that three, 10 foot diameter culverts for the pioneer road, would be required at this location and were included in the cost estimate. This is an anadromous stream and fish passage will be an issue. Riprap armoring will be required on the upstream side of the crossing along the road embankment for 250 feet for protection from channel migration. The multiple pipe approach would be less expensive and easier to construct. If the route were upgraded to a higher standard in the future a bridge might be considered as a replacement.

Mallard Duck North Overflow 445+80 - This channel is within the flood plain of Mallard Duck Creek. This channel appears to act as an overflow channel for the main stem of Mallard Duck Creek. It is low in elevation and wide enough to support placement of two 8 foot culverts. This would be prudent for overflow of the main channel during high runoff periods. The roadway would be elevated across much of the Mallard Duck basin to ensure less influence from tidal action and saturated soils on the stability of the road. Fish passage would have to be provided at this crossing as well.

Mallard Duck South Overflow 487+30 - This overflow channel is crossed where the proposed route begins to climb in elevation, exiting the Mallard Duck Bay basin. A fill height of nearly 12 feet at the crossing would accommodate a single 5 foot diameter pipe. Fish passage may be required at this crossing as well which could increase the size slightly.

Fan Creeks 402+80 and 383+00 - Both of these crossings are of un-named creeks which set on alluvial fans. A 4-foot diameter pipe should provide adequate drainage at each of these locations. The route location is tucked up close to the upper slope approaching and departing from each crossing to follow existing contours and lessen centerline grade changes.

Three Sisters Creek 288+50 - This is an unnamed creek that flows into Three Sisters Bay. The proposed crossing is approximately 30 feet upslope of that suggested by ADOT&PF. Consideration should be given to installing a 5 foot diameter culvert at 289+60, in line with the channel at the east end of a segment of the channel that is actually parallel with the proposed alignment. The culvert to be extended or an outflow channel excavated to place the flow back into the channel below the road in a short distance if a 30 degree skew were employed with the installation. Riprap of the headwalls would provide additional protection for road embankment slopes.

Metrofania Creek 222+60 - This is a large drainage which was navigated with a skiff during field investigations. The crossing proposed is located upstream of the original ADOT&PF crossing to a location where there is less erosion evident and where higher banks can be taken advantage of. This would require less stabilization work of the banks of the creek but some armoring would still be advisable. A bridge is recommended by ADOT&PF and FHWA agrees with that method of crossing the creek. This steam will require fish passage consideration and the bridge would meet that requirement and handle expected peak flows better than other drainage structures. The topography on either side of the crossing is flat with the exception of a rise located 400 feet to the west. If investigations reveal a rock deposit here or at the ridge an additional 800 feet west, it would be a good material source for construction of bridge abutments and approaches.

Schooner Bay Creek 174+90 - This unnamed creek flows into Schooner Bay. The fill at this crossing is proposed to be 23 feet to the lowest point in the streambed and is crossed with a 300 foot radius horizontal curve. A 6-foot diameter pipe should be considered for this location to provide clear passage of water. No fish passage issues were identified at this crossing.

Dead Boat Creek 106+40 - This creek was named by ADOT&PF for the abandoned boat located in the bay into which this creek drains. The crossing is located in a very steep sided ravine. The channel opens quickly just below the proposed crossing location on to an extended flat. The height of fill at this crossing would be approximately 46 feet given the current preliminary design profile. ADOT&PF has indicated the need for fish passage mitigation at this site. A 12-foot diameter pipe, equivalent pipe arch culvert, or multiple smaller diameter culverts should be considered for this crossing.

Weir Creek East 27+70 - This stream is unnamed and flows into the Chignik River near the existing fish weir. The crossing is located up on the existing floodplain where the channel is better defined. The proposed grade of the road is elevated approximately 6 feet above the existing ground at the top of the stream channel. A 6-foot diameter pipe should be considered for this crossing. Fish passage must be provided at this crossing. The stream channel meanders just down stream of the crossing and minor realignment of the channel for 50 feet would provide a straight, skewed drainage alignment below the proposed road location.

<u>Weir Creek West 23+50</u> - This unnamed creek also flows into the Chignik River near the existing fish weir. Fish passage must be provided at this crossing. This stream is located in the same floodplain as the East Weir Creek crossing. The channel is wooded and appears to be stable. A 6-foot diameter culvert should be considered for this crossing.
Additional "ditch relief culverts" were included in the preliminary design for the remainder of the route. Culverts are included in the preliminary design run such that surface water is not carried more than 350 to 400 feet before being taken across the road. Culverts should be skewed relative to centerline to facilitate drainage at inlets and armored catch basins should be constructed at each ditch relief pipe. Culverts need to be aligned with existing drainages as much as possible. This approach to drainage is more conservative and is normally associated with a higher average daily traffic level.

An alternative to ditch relief culverts would be to construct the template with a 2.00% inslope to culverts and installation of rolling drain dips in the road template where ever possible. The drain dip is a gentile, rolling drainage structure excavated into the roadbed and then surfaced as the remainder of the roadway prism. Proper angling outwards promotes drainage of the road surface in a controlled manner. The outlet of the drain dip is stabilized with larger stone, riprap. The following spacing is normally employed in the application of drain dips:

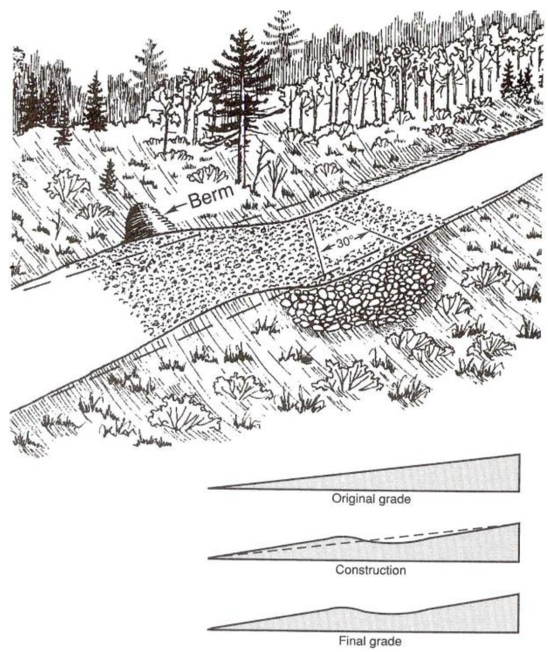



**Figure 16: Rolling Drain Dip**

**Table 1: Rolling Drain Dip Spacing**

| Road Grade (%) | Spacing (ft) | Road Grade (%) | Spacing (ft) |
|---|---|---|---|
| 2 | 300 | 7 | 155 |
| 3 | 235 | 8 | 150 |
| 4 | 200 | 9 | 145 |
| 5 | 180 | 10 | 140 |
| 6 | 165 | 12 | 100 |

Considering the low average daily traffic and the low standard pioneer road application, rolling drain dips could be employed extensively. This would reduce the number of culverts along the route and reduce construction costs while still providing control of surface water runoff.

The drainage recommendations presented here are based on experience and on-site observations. Drainage areas, stream gradient, channel width and construction cost will be considered in more detail when the project moves into the design phase.

## *2.5 Maintenance*

"The first and most important thing to understand in road maintenance is proper shape of the cross section. When proper shape is established and good surface gravel is placed, many gravel road maintenance problems simply go away and road users are provided the best service possible from gravel roads." (Gravel Roads maintenance and Design manual, FHWA, South Dakota Local Transportation Assistance Program.)

Maintenance along this route would be performed through payments to the local communities based on the number of miles to be maintained. Access is limited and expensive and purchase of equipment may prove prohibitive. A template should be considered that is more self maintaining and results in costs commensurate with the pioneer road standard. The surfacing material for the pioneer road should be aggregate rather than an asphalt material. This can be shaped and graded with a standard motor patrol, road grader, with good conservation of material. Reduction of the number of culverts would reduce construction costs but may increase maintenance costs if inslope and outslope templates are not employed properly. Surface water should not be allowed to travel more than 350 to 400 feet without being taken off the roadway by a culvert, outslope template, or rolling drain dip. A grader, end dump truck, and rubber tired backhoe should handle the majority of the maintenance issues along the route. Extensive riprap replacement due to major storm events may require a track mounted excavator. The two communities would need to secure equipment to perform the annual maintenance. Alaska Department of Transportation estimated annual maintenance cost for a two-lane road through this route was approximately $106,500.00. The maintenance of a lower standard road such as the pioneer road being considered may be closer to $75,000.00 annually. Repair due to major, unusual storm events would need to be addressed on a case by case basis.

## *2.6 Material Sources*

There are no commercially developed material sources in the immediate area of this project. A small material source is reported to exist near the northeast end of Chignik Lagoon. It appears that the most economical approach for this project would be development of material sources as part of the roadway excavation and smaller site development adjacent to the proposed route.

The final design profile can be adjusted to generate base material. The first opportunity for this occurs at station 12+00 to 19+00. Lowering the grade through this section might generate material that could be used from 20+00 to 44+00. It is expected that preliminary design excavation from 85+00 to 91+50, 117+00 to 123+00, and 207+00 to 212+00 would generate material suitable for borrow material. Excavation from 344+00 to 365+00 also appears to be deep enough to generated usable rock borrow material.

A designated material site may prove possible near Mallard Duck Bay at the center of the project. Descending on a 3.50% grade, the preliminary alignment is located south of two rock knobs positioned close to the shoreline and north of a third prominent point inland, on the west side of the bay. Excavation of the south side of the material closer to the shoreline would generate rock borrow that could be used to develop the turnpike segment across the lower reaches of Mallard Duck Bay. Creation of a material source might be possible from the elevated knob south of the proposed alignment, shown in the photograph above. This source would be partially concealed from view by the land formations located closer to the shoreline. This would mean a generally centralized material source for construction in both directions and would reduce construction costs across the Mallard Duck Bay flats.

**Figure 17: Potential Material Source – Mallard Duck Bay**

Full bench or through cut construction required in the locations of 516+00 to 526+00, 530+00 to 534+00, 614+00 to 625+00, and 683+00 to 688+00 should generate similar material for base and subbase aggregate.

<u>Design Tradeoffs</u> - A single lane traveled way template was considered for the entire route due to the anticipated use and design vehicle to be accommodated. The typical sections included in Appendix A include 1) a single lane template with two foot shoulders and a ditch; 2) a single lane template with one foot shoulders and a ditch; and 3) a single lane template, in-sloped without a ditch and employing rolling drain dips for surface water drainage. The standard ditch dimensions with a relatively steep 1:2 ditch foreslope, requires 7 feet of horizontal distance to construct a ditch that is "V" shaped and whose bottom is one foot below the subgrade elevation. This is for a total pavement structure depth of 12". The inclusion of a ditch results in subgrade width of 23' to the hinge point to produce a traveled way of 12-feet with 2-foot shoulders. The elimination of the cut side ditch would save 5.5 feet of horizontal excavation for the majority of the project length.

Safety considerations require the inclusion of intervisible turnouts for all template types considered. The design should consider the use of a ditch section for some of the route where grades and side slopes are steeper. However, inslope templates to excavated culvert catch basins is still an effective method of controlling surface water runoff.

The differences between template types will be considered in the Road Design Criteria section below.

## *2.7 Construction and Staging*

Construction Methods and Process

Construction methods normally considered include phased construction. Under this method, a portion of the route can be constructed to a usable terminus providing phased benefit and usability of the route. Phase construction normally results in a segment of the full project scope being constructed to meet all applicable design criteria with complete access from both ends of that segment. In the case of the Chignik road project, there are not intermediate termini that would allow for meaningful phased construction other than a very short segment from Chignik Lagoon to the community landfill and possibly the reconstruction of the existing road segment from Chignik Lake out to the proposed new airport locations. Neither of these segments would result in connection of the two communities.

Road construction could progress from each community toward a meeting point at Mallard Duck Bay. Field investigations attempting access by boat to the Mallard Duck Bay area proved that attempting to mobilize equipment to that location in advance of access from either extreme of the project would prove to be very difficult. However, construction of a temporary pioneer road across the route to potential material sources could be accomplished and multiple crews allowed to work in more than one or two locations simultaneously. The length of expansion along the route would be limited to installation of drainage structures at major crossings.

The preliminary design assumes a pioneer road construction approach to the entire route. A narrow road template would be constructed along the top of proposed cut slopes and at the toe of proposed embankment slopes allowing a distribution of construction effort over a larger area. Drainage installation would progress in a linear manner from one or both of the terminal points. This would ensure better protection of disturbed ground. Roadway excavation could be started in areas of greatest excavation and excess material, especially in areas of more rocky material, hauled to the fill areas.

It is believed that existing rock deposits encountered along the route will provide base rock and borrow material for fill construction in low elevation areas with saturated soils. Surface material may be generated by employing a vibratory grid roller to rock material extracted from cuts until such time that a fully developed material source is created along the route. Potential material sources listed above are based on experience and on site observations. Geotechnical investigations need to be conducted to locate such a source or sources.

Awarding a federal contract with a full administration team would probably better ensure timely completion. However, the US Military could be considered for construction activities as well.

Contracting Options (IRT) - The US Military might be employed to construct the temporary pioneer road through the entire project. Then a contract awarded to complete cuts and fill to appropriate grades and to finish alignment and drainage installation. This would allow for the IRT project to be practiced more in keeping with what the military might do under combat conditions and provide access for a construction contractor to complete the lower standard road with longer lasting drainage structures and template dimensions. The pioneer road constructed by the military at the top of cut slopes and bottom of fill slopes, where appropriate, would result in a facility that could be opened to use by Chignik Lake and Chignik Lagoon more quickly. The military pioneer road could support recreational, visitation, light commercial and even fuel delivery traffic between villages as supply transport under combat conditions would be a consideration in the construction practices normally employed by the military. Centerline staking might be all that is necessary to ensure the desired corridor is followed by military construction. A more detailed ground survey could then be undertaken across the completed pioneer road and a detailed design completed. This construction approach would then allow for a true phased approach to a completed template to the appropriate or desired traffic use level on a segment by segment basis.

# 3. Alternatives

## *3.1 Alignment*

Route analysis and terrain investigation required a team of engineering technicians and staff who, through map analysis and ground surveys sought to determine a practical route between the two villages, taking into consideration connecting the route to a proposed airport runway site four miles east of Chignik Lake.

The Federal Highway Administration and Denali Commission representatives met with local residents and discussed potential transportation needs and routes that should be considered. The local residences provided valuable information concerning weather conditions and apparent stable slope locations that might be considered for the final route. Access to the Chignik Lagoon landfill site was discussed as well as past investigations of routes further up slope from the community. Past construction projects such as the construction of an access road along the shoreline located within the tidal zone were discussed and examined on site. This existing landfill alignment has not proven to be as efficient or stable as originally thought. After listening to valuable local input, the preliminary alignment was started at the Chignik Lake Village near the end of the existing road and preceded toward Chignik Lagoon. Survey was conducted by the US Marine Corps with the assistance of two Navy Seabees. Survey activities progressed from both communities toward the mid-point of the project at Mallard Duck Bay. Survey results were then compared to contours generated from aerial topography gathered under contract by the Alaska Department of Transportation. The beginning elevation of the project is 67 feet. At a couple of locations the current FHWA preliminary alignment drops to within 10' of sea level. This is true of the ADOT&PF preliminary design as well.

**Figure 18: Local Resident**

The Federal Highway Administration assisted the military with advice on route location and what field information would need to be recorded to adequately design the route. Existing benches on the slopes of the Lagoon and the Chignik River were utilized to lesson excavation and construction cost where ever possible. The route was laid out to follow existing contours as much as possible with the constant consideration of distant connection points such as major drainages, the landfill at Chignik Lagoon and the proposed airport runways near Chignik Lake. Regardless of the final template to be employed, there are certain locations on a slope that result in less expensive construction and every effort was made to utilize those and advise the military to look for such sites. The general centerline location was marked on the ground with survey ribbon in advance of survey activities. This allowed for consideration of various alignments without the pressure to finalize the alignment for survey at the same time.

### *3.1.1 Mallard Duck Bay*

The intersection of the three preliminary alignments generated by the Alaska Department of Transportation met at a point in the center of Mallard Duck Bay. Consideration for not only the connection of Chignik Lagoon and Chignik Lake but also future potential connection of Chignik Bay was considered in selection of the alignment through this area. The mud flat is low in elevation and the soils are saturated much of the time if not year round. The initial desire was to locate the road completely off the flat and higher in the drainage to the south and east. Four

**Figure 19: Valley At Mallard Duck Bay**

possible locations for crossing the valley were considered, each at increasingly higher elevations up the drainage. Existing aerial maps gave clues to where stream crossings might be eliminated or where channels were narrower and more stable. The best location for less interaction with the stream was over 9,500 feet to the southeast of the position finally selected. Over 3.6 miles of roadway would have been added to the project if it could have been designed within the limits of the valley. However, that is not the case. The main channel of the stream runs adjacent to the north side of the drainage making road construction very difficult and causing extensive environmental impacts. Steep terrain, including one section of overhanging rock bluffs, make the route adjacent to the north wall of the drainage appear impractical. Locating the road above the bluffs is an option with the exception that traversing the near vertical slope at the mouth of the drainage would be impossible. There are also avalanche zones in deeply incised draws along the north slopes of the drainage that would have to be crossed with the route above the bluffs. It appeared that any advantages derived from avoiding the braded drainage channels in the bottom of the valley were quickly negated by the steep slope construction problems along the north side of the drainage. Snow quickly becomes a problem as the route climbs in elevation and the potential of extended periods where the road might not be usable due to snow would not meet the needs of the communities for this road.

It will not be inexpensive to construct a turn-piked road prism up stream of the Mallard Duck Bay mud flat but it appears to be the best choice of alternatives available. The preliminary route crosses the main channel of the creek once and two overflow channels to the west. There is one additional potential overflow channel to the east which will be addressed with a drainage structure as well. The investigation team spent most of one day and a part of two other days exploring potential routes across this area.

There exists a slight rise up stream of where the main channel leaves the north wall of the drainage and moves out further into the mouth of the valley. This is the highest point, a small ridge, in the lower 1,000 feet of the valley and was selected for location of the route towards the west, near the small lake and beaver pond on the south west wall of the drainage, which can be seen in the photograph above. This crossing point also allows for taking advantage of the broken, undulating ground on the lower slopes as the alignment climbs to higher benches away from the shoreline heading towards Chignik Lake. The photograph immediately above is a view looking from a point behind the first knob towards Chignik Lake. The proposed route would traverse the flatter slopes shown above the water following the shoreline alignment.

**Figure 20: Slopes Southwest of Mallard Duck Bay**

### *3.1.2 Chignik Lagoon*

The community of Chignik Lagoon is situated close to the shoreline and is predominantly located on the 300 to 500 foot wide flat at for the southwest end of the community. The preliminary alignment created by the Alaska DOT terminated at the top of the ridge at the southwest end of that flat on an existing road. The gravel road is located adjacent to power poles and traverses the distance to the shoreline at a grade in excess of 18% with a substandard switch back in the lower third of the slope. No clear decision had been made as to the route into the community from that elevated location. One suggestion was to develop a route along the shoreline and then to simply follow the 18% grade up the hill. There is insufficient area to design a proper switch back due to existing residences at the bottom of the grade. The investigation team looked at using the lower access road to another residence and before the house the route might turn up the hill and connect at the top of the ridge. This route is also too short to allow for acceptable grades.

Knowing that access to the community had to be developed and that hauling fuel would most likely originate from a point near the existing power generation facilities, a route from the high point south west of town to basically the center of the community was flagged for survey. Three alignments were investigated in the development of a preliminary design using FHWA Geopak design software. The first alignment closely followed the proposed 3$^{rd}$ Street alignment as shown on the Chignik Lagoon Community Map, U.S. Survey No. 4898, 1'=100', 2002. This route went through the old Graveyard as did the 3rd street alignment, cut under the house in lot #9 near the 3rd and 4th street proposed intersection, and around the house in lot #6 at the edge of 4th street. From there the route crossed an existing road on the line between lot #11 and 12 and connected to the existing road east of the village generator site and local school. This proved to be a very steep route and became apparent that another route would need to be investigated.

The route finally selected and included in preliminary design calculations is located between the same two points, the high point southwest of town and the small power generation plant. The preferred alignment follows close to the proposed 3rd street alignment, skirts the top of the identified erosion area and aligns with the proposed 2nd street alignment behind the Subsistence Building which was used by the Marine contingent during survey operations. There is a bench on the hillside at that location and it was utilized to develop a flatter grade. The route cuts across the access road to the house currently shown on the lot 4/3 line and swings through lots 2 and a portion of 1 to connect to the existing road east of the village generator site and local school. This additional section of the alignment added 2000 feet to the length of the route. The grade in this last 2000 foot section does not exceed 7.00%.

## 3.2 Design Parameters

*Describe features common to all templates and why selected-design vehicle, speed, curves, etc.*

<u>Denali National Park Road Design Standards Considered:</u>

A number of terms were used by participants in the discussion of road design standards. The following is taken from the Denali National Park Road Design Standards and presented here as a basis for developing project specific design standards:

According to the Denali National Park road design standards, the following guidelines for road design should be followed:

1. Long-term protection of the environment through which the road passes, particularly the physical terrain it rests on and influences.
2. The road winds a sinuous path over dramatic terrain.
3. The road and repairs to the road conform to surrounding topography and not overcome or overpower it.
4. Adjacent terrain dictates variable road width and grade.
5. Engineered structures such as bridges, retaining walls and piles are used only when necessary to protect the resource or preserve road alignment.
6. Native materials are used in construction where possible.
7. The driving surface is gravel.
8. Signs and related items are kept to a minimum.
9. The road is designed with sufficient minimum roadway surface width, intervisible passing pullout location/geometry and sufficient stability in the road structure to allow safe travel, meeting and passing of two design vehicles.

10. The road stability is highly variable during the year because of subgrade moisture and frost, which may limit the season during which safe structural stability is obtainable.

These considerations are embodied in the pioneer road description and were expressed as desirable characteristics of the Chignik road.

Cross Section Geometry - (Denali National Park Road Design Manual)

1. Road surface - Crowned, gently outsloped or insloped (3% to 6%) as required for surface drainage on particular sections.
2. Superelevations in horizontal curves, should not exceed 6%
3. Fill and spill slopes will be no steeper than 1V:1.5H (or angle of repose for the type of structurally sound material being used) and not flatter than 1V:2.5H.
4. The foreslope will be flatter than a 1V:1.5H slope.
5. Backslope angles will be based on the inherent shear angle for the particular soil under normal spring runoff moisture loading (generally angle of repose). In general the newly constructed backslope will extend horizontally from the ditch line up to 2 times the width of the roadway. Where the angle of stability dictates that a wider footprint is necessary, the backslope will be cut to meet the natural slope line at the 2-times-roadway width margin, and if safely possible (road sections with ditches deep and wide enough to allow catchment and detainment of material) slope stability will be allowed to occur through natural gravitational failure over time.

Roadway Width, Minimum - (Denali National Park Road Design Manual)

1. The minimum safely adequate roadway width on any segment will be 16' except for short anomalies where all of the following conditions are met:
   a. Adequate intervisible pullouts exist.
   b. Fill slope depths make achieving minimum segment width impracticable or impossible.
   c. Backslope heights or materials are such that achieving the minimum 16'width is impracticable or would result in unacceptable visual impacts.
   d. Sufficient structural stability exists for a safe travel surface width within 2' from the fill slope edge and 1' from the ditch edge.

   In these areas the absolute minimum road surface width will be 14'.

Design Speed - (Denali National Park Road Design Manual)

The maximum design speed is 35 miles per hour on both paved and graveled sections. Maximum design speed set by the stopping sight distance for particular road sections is shown in Table 2 of the Denali National Park Road Design Manual, which also references Exhibit 3-76 in the 2001 edition of the "Geometric Design of Highways and Streets." (Exhibit 3-75 is the appropriate reference in the 2004 edition.) All maximum design speeds assume a dry and properly maintained road surface providing good friction characteristics. Excessive soil moisture, loss of aggregate or aggregate filler, rain and other factors can make maximum safe speed considerably less than the design speed.

Longitudinal Grades - (Denali National Park Road Design Manual)
Maximum grades shown in Table 3 of the Denali National Park Rod Design Manual equal 16%. This is not considered to be the average or sustained grade for any significant distance.

Clearing - (Denali National Park Road Design Manual)
Standard clearance widths and height assume a maximum 3-year cycle of vegetation control and that revegetation growth rates are slow enough that clearance is not compromised in less than 3 years. Actual clearing widths are not included in the manual but a reasonable minimum has been clearance to the top of cut and toe of fill with a minimum of 4' from the edge of the traveled way.

Drainage - (Denali National Park Road Design Manual)
Drainage is primarily a function of site topography and soils and will be adequate to manage water flow type and volumes affecting the road structure, including within the subgrade section of the road without adversely affecting the road or the adjacent terrain. Drainage system design will accommodate and mimic adjacent natural drainage patterns to the greatest extent feasible without sacrificing road stability. Ditch width will be equal to 2.5 times the drainage depth as measured from the finish surfacing.

Cross culverts will be sized and located to handle maximum water volumes for the particular location. Surface drainage culverts will be extended from the inner edge of the ditch bottom to daylight in the down slope below the road, will be down sloped not less than 4% or more than 8%, and will be placed at the angle to the ditchline axis that allows for water diversion from the ditch without siltation or ponding at the culvert inlet. A culvert downslope grade should not be less than the road surface outslope grade. A minimum of 12 inches of gravel will be placed above the culverts to protect them from the weight of vehicles using the road.

Catch basins at culvert inlets will have a radius of at least 2 times the culvert diameter to allow for effective change in direction of water flow from the ditch to the culvert. Outlet channels may be hardened with emplaced rock, buried gabions, half culverts or geoblocks if necessary to prevent slope scarring or destabilizing erosion from normal culvert flows. Culvert material may be galvanized steel, aluminum, concrete, high density polyethylene or other composite materials.

Bridge and major culvert crossing of streams will be designed to preserve natural flow regimes, physical and biological stream characteristics, and the free passage of native fish. The sizing, configuration and placement of in-stream culverts will ensure the preservation of suitable hydraulic conditions to allow normal fish passage to continue unimpeded.

Intervisible Turnouts - (Denali National Park Road Design Manual)
Turnouts must be clearly visible and easily reachable from one to the next and are generally placed approximately 300' to 700' apart. Construction of new turnouts will take advantage of terrain and minimize disturbance as long as sight distance can be achieved. Passing pullouts, turnouts, will provide a total roadway width of not less than 24 feet and will be a minimum of 75 feet long, including tapers. All turnouts will be designed to meet the same structural criteria as the road. Transition tapers to and from turnouts will not be shorter than a ratio of 1' in width to 10' in length.

Bridges - (Denali National Park Road Design Manual)
Bridges will conform to the minimum load bearing capacities required by the heaviest vehicle allowed on the road, such as 91,000 pound crawler dozers and 150,000 pound GVW (gross vehicle weight) tractor trailers.

Load Bearing Section - (Denali National Park Road Design Manual)
The bearing and shear capacity of weak subgrade soils may be strengthened through use of geotextiles, geogrids or geowebs, or other appropriate bridging membranes, and / or interdiction and diversion of subsurface and surface infiltration water. The thickness of constructed base may be minimized where feasible through the use of geotextiles, geogrids, geowebs, or other appropriate bridging membranes, and or applications of aggregate fillers, palliatives and binders.

### *3.2.1 Proposed Road Design Criteria*

The design criteria proposed by the Federal Highway Administration, Western Federal Lands Highway Division, is based on the "Geometric Design of Highways and Streets," 2004 edition. The "Guidelines for Geometric Design of Very Low-Volume Local Roads" were also considered in the development of these road design standards. The Denali National Park Design Standards were not abandoned but considered and modified as described below.

Previous Design Work by Alaska Department of Transportation - Alaska Department of Transportation, ADOT&PF, published a Chignik Connectors Project Scoping Summary Report in October of 2004. The scoping process was designed to determine the level and scope of environmental analysis, including issues that need to be addressed, the degree of public and agency controversy, and the need to consider other alternatives. The report considered connection of the communities of Chignik, Chignik Lagoon, and Chignik Lake.
The following is a summary of the comments received during the public involvement portion of the scoping process:

a. Safety on the road is a main concern (Currently no road exists between the communities)
b. The road is needed to open up more developable land.
c. Many like the idea of a road connecting the villages to move freight and people.

d. The health of the people of the region is a concern and the road should have an associated trail.
e. The road would be good for the communities, for the schools, and for bringing jobs into the communities.
f. It will be difficult to maintain the road properly year-round
g. Road maintenance will be expensive.
h. The final route chosen for this project will be the most important factor to its long term success.

The Chignik connection project was included in the 2002 Southwest Alaska Transportation Plan, final edition. This plan explained the connection of a road system to the further development of aviation service in the region.

The initial design plan for this road was that it would be a state road built to full two lane standards, maintained and operated by the State of Alaska. However, the expense of connecting the three villages has proven too expensive at standard two-lane highway standards and no actions to move forward with the project have occurred.

A request was made from the communities of Chignik Lake and Chignik Lagoon to connect these two sites with a pioneer single-lane road with intervisible turnouts, a primitive road standard that may prove practical within available funding. All three communities, Chignik Bay, Chignik Lagoon, and Chignik Lake, have approved of the change in design strategy and scope.

Route analysis and terrain investigation requires a team of engineering technicians and staff who would, through map analysis and on the ground surveys, seek to define a practical route between the two villages, taking into consideration connecting the route to a proposed runway site four miles east of Chignik Lake.

ADOT&PF has described a pioneer road as a single-lane, rural, gravel road. The road would be approximately 12 feet wide. The design speed is 30 mph but could be reduced to 20 mph in some segments. This compares to a rural collector road which is a two-lane gravel road, approximately 18' wide with a design speed of 40 miles per hour. The pioneer road would accommodate a pick-up with a trailer or a single-unit truck. To allow for passing traffic, turnouts would be created at ¼ mile intervals where possible.

The Alaska Department of Transportation estimated the difficulty of construction throughout the route. The segment adjacent to Chignik Lagoon and just south of Mallard Duck Bay are defined as "hard to construct." The remainder of the route is classified as moderate to easy construction. After walking the majority of the proposed route FHWA agrees with this assessment.

## *3.3 WFLHD Design Considerations for Chignik Road*

Only simple curves have been applied to the preliminary design given the low design speed, 15 mph, and low ADT. Turnouts were included in the earth work at a maximum spacing of 1000 feet. The width utilized was 10-feet beyond the shoulder with a minimum full width length of 100 feet and transition tapers of 50 feet. Turnouts were positioned as shown on the preliminary plan and profile sheets to accommodate site distance between turnouts. Seventy, (70), turnouts were included in the preliminary design. The Federal Highway Administration Project Development and Design Manual, (PDDM), recommends a preferred 12 foot wide turnout with a 50:1 transition back to normal template width. The PDDM also recommends a minimum 100 foot full width turnout. (Section 9.3.9.10)

Calculation of U, track width for widening on traveled way on curves, proved that a 9' lane would not be sufficient. No curve smaller than 500 foot radius provided for a driver error of 2.0 feet. This eliminated the 9 foot lane without a shoulder option. The 9 foot lane with 1 foot shoulders would provide for U, but would not provide for a driver error of 2.0 feet until the radius was above 500 feet for either the WB-67D, Single-Unit truck, or the WB-40, Truck and trailer, design vehicle.

Design vehicles designated WB-67D and WB-50 in the AASHTO design guide manual, were considered in determination of appropriate minimum horizontal curve radius and curve widening. Practical experience has shown that a loaded log truck with a 40 foot log can negotiate a 50 foot radius curve at the design speed suggested above. The smallest curve on the project is a 100 foot curve.

American Association of State Highway and Transportation Officials, Geometric Design of Highways and Streets, 2004 edition, Design Information:

Minimum radius in AASHTO Green Book for e=2.00%, 15 mph = 506 feet. (Pg 167) Many of the horizontal curves exceed this minimum and the current design is based on a 4.00% e-max at 15 mph.

e=2.00%, 15 mph = min.R = 506
e=2.4%, 15 mph = min R = 271
e=3.2%, 15 mph = min R = 105

The minimum curve radius on the project of 100 feet with a super of 3.6% exceeds AASHTO minimums.

a. Fuel truck – close to a WB-12, 40ft wheel base truck with trailer [WB-40], minimum radius = 40'
b. SU (single unit) truck design – minimum radius = 42'
c. School Bus - (S-Bus-11) [S-Bus-36], minimum radius = 38.9'
d. Alternative fuel truck - WB-20D [WB-67D] truck and trailer, minimum radius = 45'

Minimum radius applied in the preliminary design is 100'.

Minimum roadway width required at the minimum radii and vehicle listed above:

(1) Minimum radius of 40’ = requires 20.7 feet.
(2) Minimum radius of 42’ = requires 13.7 feet
(3) Minimum radius of 38.9’ = requires 15.1 feet
(4) Minimum radius of 45’ = requires 25.7 feet.

The preliminary design alignment exceeds the minimum radii for the potential vehicles that may use the route. Exceeding the minimum radius required is beneficial in reducing excavation and cost.

Curve Widening:

Curve widening - Given Green Book consideration, a 12 foot top width, and the fact that a vehicle can utilize the 2’ shoulders on each side of the 10 foot lane width, and a lateral clearance of 1.5 feet or 2.0 feet, no curve widening will be required over 2.0 feet in width for any of the proposed curves. Additionally, the presence of 10-foot wide turnouts causes the recommendation to not add any curve widening to this 15 mph template.

Centerline Profile:

Maximum grades - Green Book page 233 - For a design speed of 30 mph the range of maximum grades is 7.00% to 12.00%. At present the steepest grade in the design is 7.00%. Basic template shapes for the preliminary design were generated utilizing the FHWA_US_2004_80_20 table at an e-max of 4.00% and a design speed of 15 mph.

Drainage:

The initial hydrologic field reconnaissance was conducted by Mr. Bob Butera, P.E. of HDR Alaska, Inc. on April 25-28, 2007. The report mentions that the proposed route between Chignik Lagoon and Chignik Lagoon crosses approximately 40 drainages, fifteen of which would require structures four foot in diameter or greater. Approximately 25 smaller, less than 4 foot diameter culvert, drainages were noted. No consideration was given in the report for the spacing of ditch relief culverts. Although sizes were not recommended, drainage areas, slope, bed material and an indication of the requirement for fish passage was recorded. Ditch relief culverts would generally be 24” in diameter.

A total of 166 drainage crossings are included in the first run of the preliminary design. “Ditch relief pipes” were established to prevent surface water from traversing finish grade for more than 350 to 450 feet.

Mr. Butera’s report addressed structures in excess of 48” in diameter. It also recommended the installation of two bridges.

Skewed pattern lines for culvert installation as well as pattern lines normal to the proposed centerline were established for ditch transitions and full catch basin excavation limits to result in a more accurate roadway excavation estimate. The extensive input file manipulation for template configurations at ditch relief pipe locations was not performed but would need to be done during normal design activities.

Culvert lengths were estimated considering the preferred skew of each pipe, fill heights, and an extension of two feet beyond the toe of fill. Western Federal Lands Highway Division standard drawing 602-3 was used to determine spacing for installations of multiple pipes, (see appendix B). This approach was discussed on site with Captain Nick Koch, Navy Hydraulics Engineer. It is believe that due to the difficulty in reaching some locations with larger size structures, multiple pipe installations would be less expensive and better facilitate construction of the pioneer road. Multiple pipes and structural plate pipe should be considered for this project.

Approach Roads:

The following approach roads are needed but not yet included in the earthwork:

1. Approach into the existing landfill for the Chignik Lagoon
2. Approach road to the house at the top of the hill near 689+90 and the access road along the existing power poles. This would not amount to much since the finish grade of the proposed route was design to match the existing aggregate road where it is crossed. That would allow for continued access to the house on the hill and residences down closer to the shoreline.
3. Approach road connection near 688+22
4. Depending upon construction timing, an approach to the proposed community air fields may be needed.

Pavement Structure:

General description of a pioneer road is of an un-surfaced facility which is narrow and temporary. The intent is to construct a road that is pioneer in alignment and grade where necessary but protected with an aggregate surface and pavement structure. No asphalt surfacing would be applied for this initial construction effort.

After a preliminary discussion with Mr. John Snyder, Materials Engineer, WFLHD, and consideration of the pavement structure used on project AK DEN 2008(1) Stevens Village Access Study, the templates shown in the preliminary plans were agreed upon as a good starting point until field investigations can be conducted.

Rock was evident in segments with steeper topography and there may be opportunity for development of base material from these deposits by use of a vibratory grid roller during construction. There are also segments that will require extensive borrow material to be placed as ballast beneath the normal pavement structure due to lower elevations and existing saturated soils. The proposed 18" of aggregate base in areas where tundra is present has proven to be a reasonable pavement layer in previous applications. Additional field work is required to accurately identify locations where the tundra may have to be removed and a leveling course or rock borrow layer deposited.

Template Considerations:

A template comprised of a 10' lane and 1' shoulders would provide for a top width of 12' and a C, lateral clearance of 1.73 feet on each side of the design vehicle at a minimum radius. This preliminary design exceeds that minimum.

If an in-slope design is employed with the 10' lane and 1' shoulders, an additional 1.5' would be realized on the inside of the traveled way for all locations outside of culvert and through fill locations due to ensuring a full pavement depth for the entire top width and a reduced pavement wedge beyond the inside limit. This would add to the C, lateral clearance as will as allow for a running course for surface water against the cut slope. The effective lateral clearance would be 2.48' on each side of the design vehicle. This approach would also reduce excavation and total impacts of the construction and is recommended for the initial construction of the Chignik road.

### 3.3.1 14' with ditch

The 14 foot top width is the widest that would have to be considered to meet minimum AASHTO design standards. The single-lane road would have a lane width of 10-feet with 2-foot

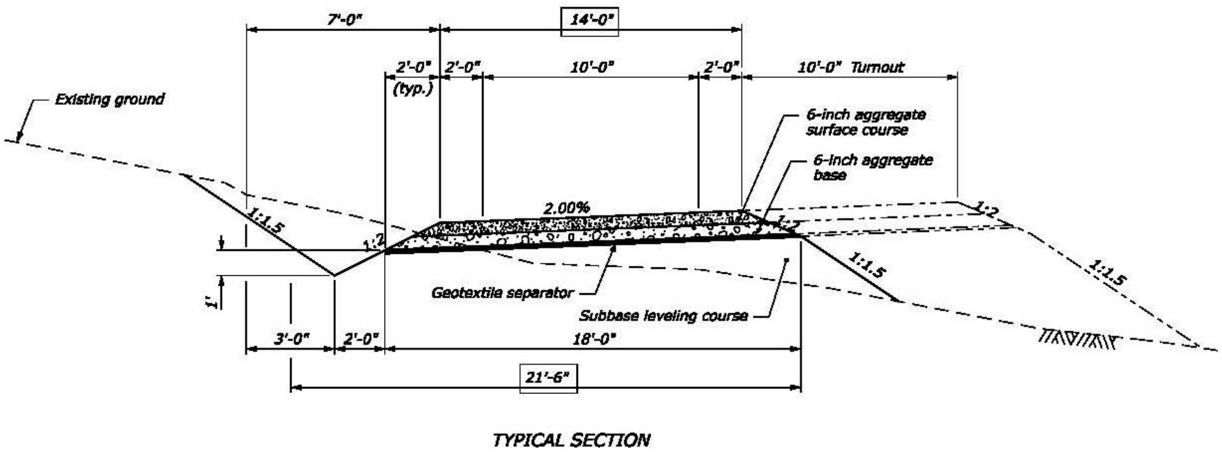



**Figure 21: 14-Foot Roadway Template, With Ditch**

shoulders on each side of the land. A 1 foot deep ditch would be applied below the subgrade elevation which would have a pavement structure comprised of 6 inches of aggregate surface course and 6 inches of aggregate base. The aggregate base would be a courser gradation than the surface material. Foreslopes would be 1V:2H and the back slope, cut slope, would be 1V:1.5H and would be the fill slope. A 10-foot wide turnout would be added at a matching roadway cross slope. Turnouts would be spaced no more than 1000 feet and be intervisible. The minimum full width length would be 100 feet with transition tapers of 50 feet back to basic template width.

This template exceeds the minimum requirement for lateral clearance for the deign vehicle, it allows for control of surface water in a designated ditch and control removal of surface water through culvert catch basins and ditch relief culverts.

The 14-foot top is wider than is necessary to meet minimum safety requirements for the design vehicle. It represents a traditional road template but exceeds the "Pioneer road" concept. It would be more expensive to construct, requiring more excavation and embankment than required to meet the minimum design standards.

### *3.3.2 12' With Ditch*

The 12 foot template with a ditch would consist of a 10-foot single-lane road with a 1-foot shoulder each side of the lane. The surface aggregate would be 6 inches deep placed over 6

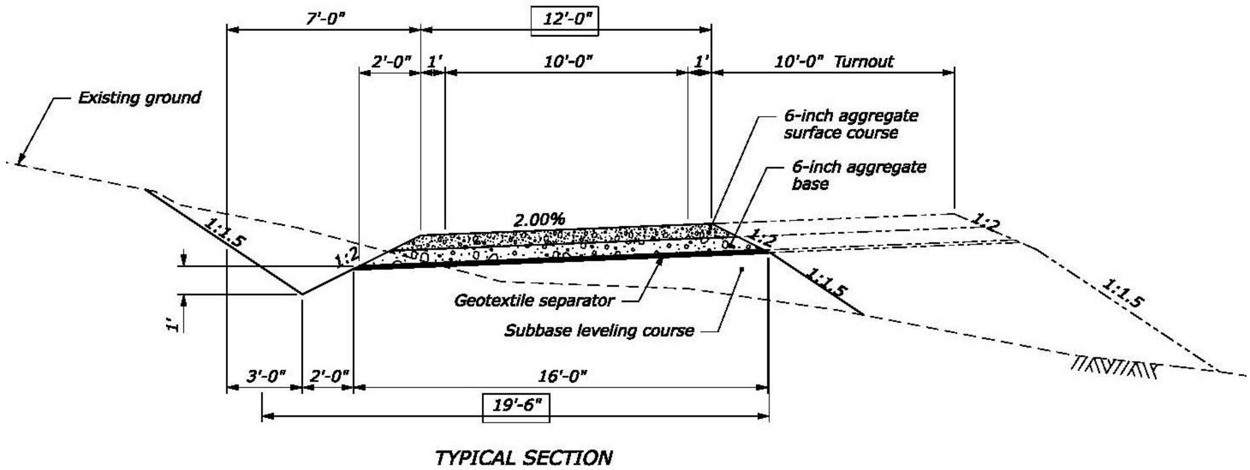



**Figure 22: 12-Foot Roadway Template, With Ditch**

inches of aggregate base material. The ditch would be constructed to a depth of 1-foot below the subgrade with 1V:2H foreslopes. The back slope and embankment slope would be 1V:1.5H. A 10-foot wide turnout would be added at a matching roadway cross slope. Turnouts would be spaced no more than 1000 feet and be intervisible. The minimum full width length would be 100 feet with transition tapers of 50 feet back to basic template width.

This template is obviously narrower than the 14 foot template which would mean less excavation and embankment. Minimum lateral clearance for the design vehicle is not compromised with this template. The total 12-foot top width, traveled way, has been employed in timber harvest in the northwest for a very long time. The 15 mile per hour design speed and low average daily traffic makes this template width very workable as a pioneer road design. A narrower template also means less overall impact. The road would be constructed with a 2.00% crown on tangent sections and a minimum 2.00% superelevation on curves.

There may be an expected disadvantage, the feeling of not having as much room on the road, to this narrower template but functionally there is none.

### *3.3.3 12' No Ditch*

The 12 foot template would consist of a 10-foot single-lane road with 1-foot shoulder each side of the lane. This would constitute the traveled way proper at 12 feet. The surface aggregate would be 6 inches deep placed over 6 inches of aggregate base material. The full pavement

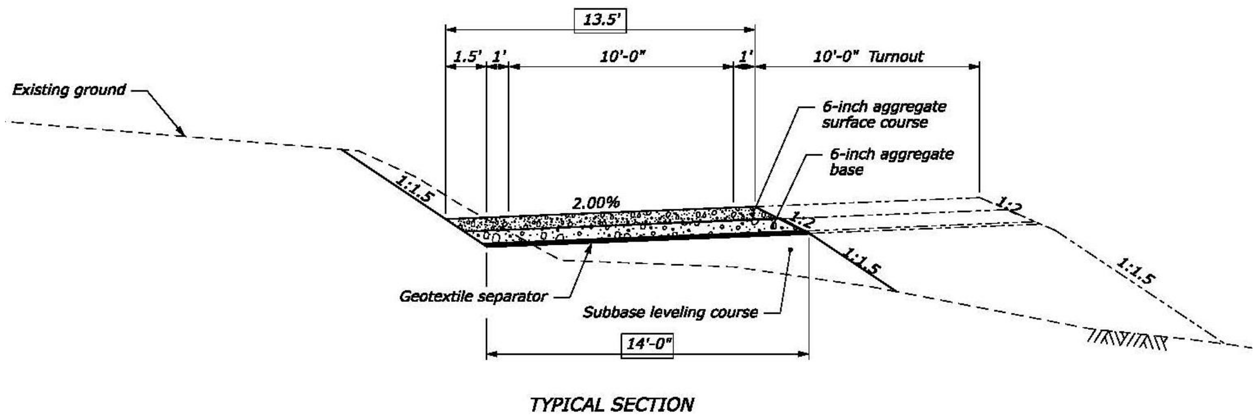



**Figure 23: 13.5-Foot Roadway Template, Without Ditch**

structure depth of 12 inches would be maintained to the point 6 feet from centerline. The back slope would be constructed from the bottom of the pavement structure at the 6 foot horizontal distance from proposed centerline. The 1V:1.5H slope would actually generate 1.5 feet of additional width beyond the outside of the traveled way shoulder on the cut slope side of the road. No ditch would be constructed along the alignment with the exception of any special ditch required for specific reasons and locations. The pavement layers of surface aggregate and base aggregate would be constructed to the connection point between individual layer finish elevations and the backslope. The addition 1.5 at the inside of the traveled way would not have full pavement structure support but would be used to carry surface water at the hinge point at the finish surface. It would also augment the lateral clearance for the design vehicle resulting in a total usable top width of 13.5 feet, 6 inches less than the 14 foot template. The outside shoulder of the road would be the same as described in the previous two templates. Catch basins for culverts installed would be constructed to a depth of 2 times the diameter of the pipe from the finish grade. The slope ratio into the catch basins would be 1V:1.5H and would be constructed from the roadway finish surface hinge point with the back slope, not reducing the standard 12-foot traveled way. This eliminates a narrow section in the top width at the culvert inlets. Catch basin excavation would be tapered over a distance of 50 feet each side of the catch basin back into the standard "no-ditch" cross section. The road way cross slope could be insloped to the culverts to better control surface water runoff. The horizontal radii and 15 mph design speed employed in the preliminary design eliminates the need for superelevation on horizontal curves with the exception of the 100 foot radius curve. That would cause only two horizontal curves to have superelevation applied and they are currently designed for an inslope super so a moderate increase above 2.00% would cover those curves as well. A 10-foot wide turnout would be added at a matching roadway cross slope. Turnouts would be spaced no more than 1000 feet and be intervisible. The minimum full width length would be 100 feet with transition tapers of 50 feet back to basic template width.

The 12 template with no ditch represents a significant reduction in excavation for this route and comes closer to the "pioneer road" concept consideration. The same horizontal and vertical alignment criteria are applied for this template as for the 14 foot template so drivability would not be reduced.

This template would require an additional 1951 CUYD of surface aggregate and base aggregate combined compared to the 12-foot template with a ditch. This is a relatively small amount compared to the excavation savings. This template does not provide for a drainage ditch throughout the length of the project. If the road is to be upgraded in the future that feature can be added. The site distance on outside horizontal curves is not as great without the additional 7 feet of horizontal width required by the ditch. However, inter-visible turnouts ensure safe stopping distances along this route.

Additional opportunities associated with this 12 foot template without a ditch would be to utilized rolling drain dips rather than ditch-relief culverts. Rolling drain dips would take the 2.00% inslope roadway cross section and reverse it to a skewed outslope section, dispersing surface water over the outside shoulder on a hardened apron of riprap. This would control the point at which surface water is sent across the road in the same way that culverts do. The center of the roadway template would be reinforced with additional class 2 riprap beneath the pavement structure to protect from erosion of the roadway template. Engineered properly and placed where longitudinal grades are not excessive, greater than 7.00 %, rolling drain dips do not pose a problem for trucks like the design vehicle for this project, to negotiate. Placement of the riprap across the roadway is less expensive than a culvert would be to install and the catch basin excavation over a 100 foot segment of the road's length is saved. The subgrade is constructed in the normal way and to the same elevation. Then the subgrade is essentially subexcavated for the riprap center of the rolling drain dip. Employing normal pattern lines and cross sections in the design allows for rolling drain dips to be included in the slope stake notes and earthwork for construction.

The 14 foot template is a more traditional width and with the ditch it would provide good protection from and treatment of surface water. The 14 foot template exceeds minimum template width requirements for the design speed and design vehicle to be applied. The 12 foot template with a ditch meets the minimum design template standards for width and operation requirements of the desired design vehicle. The surface water control and treatment are the same as the 14 foot template. The 12 foot template without a ditch, insloped to culverts and rolling drain dips represents the closest configuration to a "pioneer-road" template of the three roadways considered. Surface water is treated and controlled. Lateral clearance for the design vehicle is exceeded; grade and alignment parameters are met as well as in the other two templates.

## *3.4 Other Designs*

Two Lane, Full Service

Alignments generated by FHWA and Alaska DOT are close enough to utilize the preliminary design of the State for the two lane template. They employed large horizontal curve radii and long profile grades. It also appears that the State template included a ditch section, culverts, and superelevation for the full service design generated. The estimated cost of that design alternative has been published at over 26 million dollars.

ATV Road

An ATV trail template, to be utilized by recreational quad vehicles only, would have a maximum top width of 8 feet. The vehicles are slightly less than 4 foot in width, outside to outside of the tires. An ATV trail would not have to follow the alignments described for the single-lane road. Minimum horizontal radii would be much less, grade restrictions would be virtually non existent and the surfacing could be reduced to 4 inches or less. Major drainage crossings and live streams would still have to be addressed but the drainage costs would be greatly reduced. With less aggregate surfacing comes increased erosion control problems even though the vehicle weight is much less than all other vehicles. The construction of an ATV trail does not meet the stated objectives in the scope of work.

## *3.5 Cost Estimate*

Please refer to Appendix A for Preliminary cost estimate information.

1. The Stevens Village Study was used for the limited cost comparisons done to this point.
    a. The total cost for culverts on this project, using those unit prices, would be a little over 1.5 million dollars.
    b. Roadway excavation for the first pass is nearly 345,000 cubic yards. Using the $15.00 per cubic yard estimated price in the Stevens Village Study, that cost would be $5.1 million dollars.
    c. Two bridges were recommended for this project. Again using the Stevens Village costs of $144.00 per square foot, the two bridges would cost in excess of 1.3 million dollars.

    These items alone are nearly 8.0 million dollars. Additional costing work will be done before presenting an estimate to the Denali Commission. Aggregate, clearing, subexcavation, revegetation, survey, mobilization, etc. will have to be added for an accurate cost estimate.
2. The Alaska DOT's preliminary design was a double lane, full service template at an estimated price of 26 million dollars.

3. A preliminary cost estimate representing the 14 foot template with a 1 foot deep ditch is included with the preliminary design plan, profile sheets, and typical sections. The total of bid items equals $19.18 million. Adding a 30% contingency and 10% environmental mitigation, the total estimate increases to 26.850 million dollars.

## *3.6 Recommendations*

Considering the scope of work provided for this project and the stated desire to construct a "pioneer road," FHWA recommends the following:

1. Construct a single lane template with a 12-foot traveled way with 1-foot shoulders and no ditch.
2. Employ a pavement structure of 6-inch aggregate surface course and a 6-inch aggregate base in non tundra locations.
3. Extend each pavement layer to the intersection point with the excavation back slope.
4. Construct a 1V:2H foreslope at the edge of the shoulder at any embankment slope and at any culvert catch basin.
5. Construct cut and fill slopes at 1V:2H in common material and 4V:1H or steeper in competent road excavation.
6. Construct a road prism in tundra areas with a minimum of 18-inches of base aggregate over subbase leveling material recovered from rock excavation segments.
7. Employ rolling drain dips with the islope template and riprap armored fill slopes in place of ditch relief culverts at non live stream locations.
8. Construct inter-visible turnouts spaced a maximum of 1000 feet, 10-feet wide, 100-foot minimum full width length, with transition tapers of no less than 50-feet in length.
9. Install all major stream crossing with multiple drainage structures equivalent to ADOT&PF size recommendations unless new evaluations are made on a more specific alignment location, during the initial pioneer road construction.
10. Attempt to secure an agreement with the military to construct a pioneer road on the centerline alignment as identified by FHWA and then pursue a full design for a conventional construction contract employing a phased construction approach and funding.
11. The alignment identified in the field and represented in the preliminary design follows existing contours where ever possible and provides for an alignment that should be stable both in the pioneer construction phase and any future enhancement reconstruction activities. The alignment does not preclude widening of the pioneer road in the future.

# 4. Issues and Stakeholders

## 4.1 Land Ownership

Although the project is within the boundaries of the Alaska Peninsula National Wildlife Refuge, the land is owned by the village corporation. Subsurface land rights are owned by the regional corporation. The Village of Chignik Lagoon owns lands on the eastern end of the project. There are private lots shown on the community map of Chignik Lagoon, within the town limits. There is an easement for Third Street which could be used for the proposed project alignment. However, there would likely be some right of way adjustments needed to fit the alignment with the topography and platted right of way. Approaching Chignik Lake, the road could tie into an existing road on the eastern end of the community and would likely avoid any private land. See Appendix A for a depiction of the preliminary alignment superimposed over the Chignik Lagoon community properties.

The BLM's SDMS website shows that there are a number of native allotments on the Chignik Lake end of the project, near the shore. These could likely be avoided by the project. Local resources informed of an allotment at Green Point that is not shown on the BLM website. The alignment may cross a portion of this site, though it may be avoidable. The local input on the project from one of the shareholders in the allotment indicated they would appreciate having access to the land

## 4.2 Environmental Compliance

### 4.2.1 Ecosystems

There are a number of ecosystems present in the area, providing habitat for a variety of plant and animals species. The lagoon is a large, shallow water body, with mud flats exposed for several hundred yards in some areas at low tide.

The tidal shoreline is generally soft silts and clays, with deep mud and occasional rock outcrops. There are sandier and rockier beaches as well, more consistently present on the shoreline sections on the western side of the area between Mallard Duck Bay and Chignik River.

Onshore, between Chignik Lagoon and Mallard Duck bay, the route traverses mild to steep hillsides with draws. There is an area near the eastern side of the bay where avalanche chutes can be seen upslope from the proposed route.

Mallard Duck Bay is a large tidal wetland area that is approximately midway through the route. There are tall grasses, ponds, and small streams, as well as the single large stream that meanders through the flats as it approaches the bay.

Leaving Mallard Duck Bay to Chignik Lake the hills steepen alongside the bay. Continuing towards Chignik Lake, the route leaves the coast and crosses rolling hills and wetlands, with low lying tundra vegetation. Metrofania Creek crosses through this area. This terrain continues to the existing road on the eastern approach to Chignik Lake.

**Figure 24: Terrain Near Metrofania Creek**

### *4.2.2 Waters and Wetlands*

According to the Alaska Coastal Management Program (ACMP) website, the project is in the Chignik Inland and Seaward coastal zones. The website indicates that if the project will have reasonably foreseeable effects on the coastal zone, the federal agency must prepare a consistency determination and provide the determination to the state for review (http://alaskacoast.state.ak.us/Projects/FEDGUIDEwd.doc).

Digital mapping for wetlands areas is not available on the USFWS WTI website. There are obvious wetlands present along the route in the entire Mallard Duck Bay area and in some areas near stream crossings, and rolling hills near Metrofania River. Though the majority of the route is upland and on sloped hillsides, there are tundra areas that may be considered wetlands throughout the project. A USACE individual permit would be required since the area of wetlands impacts likely exceed any limits needed for a nationwide permit.

There are no Wild and Scenic Rivers present in the area.

### *4.2.3 Fish and Wildlife*

In Alaska, Essential Fish Habitat for freshwater salmon is defined as areas mapped by the ADFG for salmon presence (http://gis.sf.adfg.state.ak.us/AWC_IMS/viewer.htm). The ADF&G website (http://gis.sf.adfg.state.ak.us/AWC_IMS/viewer.htm) shows four, possibly five streams that would be crossed by the project that contain anadromous fish.

As part of the scoping effort, a representative from ADF&G visited the area and provided input on the project. Fish bearing streams would require fish passage issues to be addressed by any culvert or bridge designs.

**Figure 25: Spectacled Eider**

The USFW Threatened and Endangered Species System Website lists 13 status species for the State of Alaska, 12 animals and one plant. Many of these are marine mammals that may be present in the waters offshore from the project but would not be impacted by the project. The two species of eider listed are not typically found in the area; however there has been one reported sighting of a spectacled eider in the area. Shown in the photo to the left. The habitat in the Chigniks area is different than the habitat where eiders typically inhabit and it is likely the eider was migrating through the area.

Bald eagles are common in the area, with roosting, foraging, and nesting sites present.

Bears, wolves, caribou, foxes, beavers, other small mammals and numerous fish and birds can be found in the area.

### *4.2.4 Cultural Resources*

The project will require Section 106 compliance. The inventory of known sites in the SHPO database was review, and, though there are sites present near the proposed alignment, it is likely these sites could be avoided. Discovery of unrecorded sites will need to be addressed if the project moves forward to construction.

### *4.2.5 Community Impacts/Public Involvement*

Improving transportation between the two rather isolated villages is bound to present some cultural changes and associated issues. Should the project move forward, obtaining local input on and addressing these issues will be a major part of the environmental compliance process.

Since the project was nominated by the tribe and is supported by both villages it is anticipated that the community has been informed of and is in support of the project. Public meetings were held in Chignik Lake and Lagoon in May 2009, ahead of the surveying effort. Other than the Native Allotment access and transportation needs discussed in this report, the discussions were focused on logistics for the IRT effort. No opposition to the project concept was raised, though there are likely some issues with regards to design alternatives and minor alignment revisions that the public would like to express their opinions and ideas on if the project moves forward. The project would benefit from coordination via web, newsletter, and e-mail. Public meetings would further complement outreach efforts if the project moves forward.

### *4.2.6 Other Resources*

The EPA's database (http://iaspub.epa.gov/Cleanups/MapItServlet) and the ADEC Division of Spill Response and Response Contaminated Sites Program website (http://www.dec.state.ak.us/spar/csp/search/results.asp) show no hazardous sites in the project area.

The area is in an attainment area for air quality, there are no impacts to 4(f) resources (the land is owned by the city and local corporation), there are no prime or unique farmlands in Alaska, and there are no sole source aquifers in Alaska.

The following issues were investigated briefly in the scoping effort but do not play a considerable role in the feasibility of the project and analysis of alternatives:

Title VI & Environmental Justice
Air Quality
Climate Change
Noise
Safe Drinking Water Act

## 4.3 Major Issues

Issues of both design and construction must be considered in the planning and delivery of this project.

Preliminary design work has been conducted on aerial survey information supplemented with ground survey conducted by the U.S. Military. If the IRT program is used to construct the pioneer road through the corridor a follow-up decision must be made as to any future design and development. Will an additional survey be conducted for design of an enhanced roadway template at some point in the future? The corridor established to this point would not prohibit further widening of the template to a standard two lane road prism.
Major stream crossings will be difficult to get equipment to in advance of progressive template construction. These crossings will also be expensive and time consuming. Given the relatively short construction season in the region, innovative drainage methods should be considered. Multiple culvert installations rather than single large drainage structures should be considered. They can always be upgraded in the future but if they are insisted on at initial crossing, the road will take years to construct. Support of the Alaska Fish and Wildlife Department will be instrumental in successful installation of major drainage crossings to meet the pioneer road construction concept. The responsiveness of the Alaska Fish and Wildlife Department to this point has been very encouraging.

Right-of-way and utility impacts within Chignik Lagoon must be mitigated. If existing property boundaries are to be avoided then the road will have to be halted at the edge of the Chignik lagoon community at the same location ADOT&PF stopped their preliminary design. The proposed route attempts to provide a useful grade and route to the point where fuel will be delivered to at Chignik Lagoon and from which it will be transported to Chignik Lake. The route currently crosses boundaries laid for streets and potential residential lots.

A long term funding commitment to construction of this road will be required to reach a stable aggregate running surface.

## 4.4 Funding

Although the projected cost of this project is less than previously estimated, it is still a significant amount and much higher than the original 7 million available to the Denali Commission. Funding made available in FY 2011 was approximately $50,000. This would not be enough to start any construction on this project. The project could be cut into segments such as a route to the landfill for the Chignik Lagoon community or the route from Chignik Lake to the Metrofania Valley Airport site(s). However, this would not meet the stated goal of a connection between the two communities.

## 4.5 Project Development Process

Preliminary design has been conducted just to establish if it is feasible to construct a 14 mile low volume road between these two communities. It is feasible and a good route has been determined and surveyed. The following steps need to be completed:

1. If the Military is available to use this route as a training opportunity then additional design is not immediately required. The corridor centerline can be flagged on the ground and the Military can proceed.
2. If a traditional road template must be constructed, then field investigations must commence for cultural, environmental, geotechnical, and water resource inventories. Material source locations must be mapped and quantities estimated.
3. Right-of-way, property ownership impacts must be identified and mitigated. Impacts to private or corporate land can be reduced if steeper grades are employed in the design. They will reduce the safety of the final facility which may not be desirable given the major use will be transport of a combustible fuel.
4. Design criteria must be finalized and formalized for this route. Project partners much agree on the template dimensions, grades, surfacing, and alignment criteria to which the plans and specifications will be developed.
5. A formal detailed cost estimate is needed for the project. This will set the course for a phase approach to design and construction if that is required.
6. Finally, design plans would be developed, and reviewed at 30%, 50%, 70%, and 95% by partner agencies.
7. It is estimated that construction will take three years to complete if the traditional contracting methods are utilized to complete the project.

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This document has been prepared by the WFLHD of the FHWA in cooperation with the Denali Commission and IRT Program. Key personnel from each of these organizations are listed below along with their contact information.


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# Appendices

Appendix A:  Cost Estimates

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| A.1 | Title Sheet |
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Appendix B:  Preliminary Design Sheets

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|---|---|
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