Glennallen to Palmer Spur Line
Bored River Crossing Investigation

Prepared for:

Alaska Natural Gas Development Authority

October 17, 2005
Contract No. 06-0412

Prepared by:

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EXECUTIVE SUMMARY

Michael Baker Jr., Inc. (Baker) conducted a field investigation for the Alaska Natural Gas Development Authority (ANGDA) along the proposed Glennallen to Palmer Natural Gas Spur Line. Baker evaluated twenty-one potential anadromous stream sites that may be crossed by the proposed spur line corridor. Each site was evaluated for constructability of the pipeline by visually inspecting the soil and local geology, hydrologic and hydraulic factors, potential environmental concerns, and miscellaneous factors impacting and/or aiding construction. The proposed spur line route and the potential anadromous streams are identified on the Site Plan, Summary Figure 1. The list of 21 streams Baker was scoped with evaluating is summarized in Summary Table 1.

Prior to the field investigation, Baker determined that the proposed pipeline route does not cross Durham Creek and therefore did not investigate this drainage. The results of the field investigation conducted at each of the 20 sites are presented in Section 3.0. The potential anadromous fish rivers and streams are discussed in consecutive order beginning in Glennallen (pipeline milepost (PLMP) 0.0) and ending in the Palmer area (PLMP 147.2). Design considerations are presented in Section 4.0.

Upon completion of the investigation, Baker recommends that 10 of the 20 sites are crossed using trenching activities. These construction methods may include open cut, dam-and-pump, diversion, or other suitable techniques as appropriate for the particular site. A bored crossing, using horizontal directional drilling techniques, is recommend at the remaining 10 sites. Prior to final design, a thorough subsurface investigation is recommended at each site. The investigation will help identify and delineate subsurface conditions that may pose potential problems during trenching and boring activities.

In addition to delineating potential subsurface conflicts, the investigation should identify the presence or absence of permafrost and assist in quantifying the amount of bedding material required for successful completion of the project. Upon completion of the subsurface investigation, geotechnical engineers will be able to further assist ANGDA in finalizing the type of crossing (trench or bore) and final location of the pipeline route. The investigation completed by Baker under this contract was intended to be preliminary in nature and final design should be based on a more extensive soils investigation conducted during a later engineering and design phase of the project.

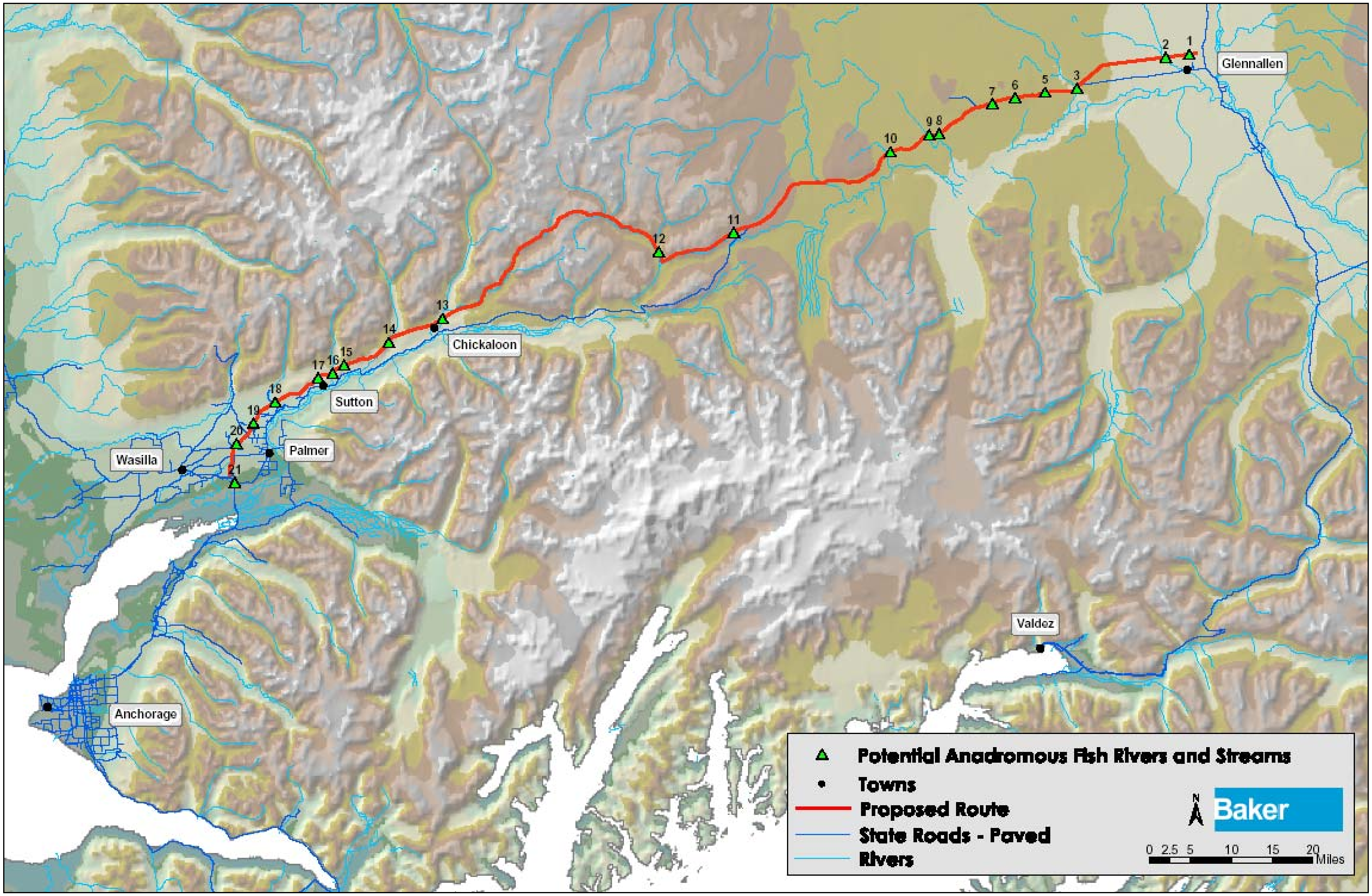
Based on the preliminary investigation Baker recommends that ANDGA consider relocating the proposed pipeline route at Mendeltna Creek, Chickaloon River and Moose Creek. Data from an additional subsurface investigation may suggest the relocation at additional sites as well.

Upon review of the environmental issues and seasonal construction considerations, Baker recommends that pipeline crossing construction occur during the winter at 10 of the 20 sites. Baker believes that construction during the winter months at these 10 sites would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists. Of the remaining 10 sites, year round construction may be considered due to the close proximity to public roads and the limited presence of saturated ground/wetlands in the immediate area. Additional subsurface investigations at year round sites may discover the presence of permafrost in the area suggesting that winter construction compared to summer construction would be preferred.

Consultation with the Department of Natural Resources Office of Habitat Management & Permitting (DNR/OHMP) concluded that 8 of the 21 streams are not considered anadromous fish river or streams. In addition, of the remaining 13 streams, active spawning beds do not exist near the proposed pipeline crossing site in some locations and therefore may be subjected to less stringent permitting requirements. Once the final route has been selected, Baker recommends contacting the DNR/OHMP and the Alaska Department of Fish and Game (ADF&G) to identify relative locations of anadromous spawning beds in relation to the pipeline crossing. In addition to anadromous spawning beds, the DNR/OHMP and ADF&G have stated that active spawning beds of resident fish in the area which may place additional permitting and construction requirements on the project.

Summary Table 1 Potential Anadromous Fish Rivers and Streams

Site Number	Name	PLMP	WGS 84 (Decimal Degrees)	
			Latitude	Longitude
1	East Fork Moose Creek	1.0	62.1352	145.5306
2	Moose Creek	3.9	62.1353	145.6205
3	Tolsona Creek	16.0	62.1007	145.9687
4	Durham Creek	NA	NA	NA
5	Little Woods Creek	20.1	62.1001	146.0899
6	Atlasta Creek	23.9	62.0966	146.2045
7	Tex Smith Lake Drainage	26.8	62.0912	146.2914
8	Woods Creek	34.5	62.0492	146.5052
9	Mendeltna Creek	35.8	62.0493	146.5434
10	Cache Creek	41.2	62.0270	146.6952
11	Startup Creek	64.8	61.9157	147.3133
12	Caribou Creek	75.7	61.8949	147.5997
13	Chickaloon Creek	110.5	61.8115	148.4289
14	Kings River	117.9	61.7780	148.6374
15	Little Granite Creek	124.3	61.7448	148.8100
16	Granite Creek	126.0	61.7318	148.8553
17	Eska River	128.0	61.7259	148.9101
18	Moose Creek	134.3	61.6890	149.0761
19	Carnegie Creek	138.5	61.6554	149.1640
20	Wasilla Creek	141.7	61.6213	149.2323
21	Spring Creek	147.2	61.5531	149.2491
Notes: NA (Not Applicable). Durham Creek is not crossed by the proposed route and therefore was not evaluated by Baker.				



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Section 1.0 Introduction

Michael Baker Jr., Inc. (Baker) conducted a field investigation for the Alaska Natural Gas Development Authority (ANGDA) along the proposed Glennallen to Palmer Natural Gas Spur Line. Baker evaluated twenty-one potential anadromous stream sites that may be crossed by the proposed spur line corridor. Each site was evaluated for constructability of the pipeline by visually inspecting the soil and local geology, hydrologic and hydraulic factors, potential environmental concerns, and miscellaneous factors impacting and/or aiding construction.

The work was divided into the following tasks:

- Field investigation
- Data analysis and report preparation

This report presents the findings and results of the field investigation. The project background, site description, and scope of services are provided in Section 1.0. Section 2.0 details the methods used during the field investigation. Site descriptions and recommendations are provided in Section 3.0. Design considerations are presented in Section 4.0. The proposed spur line route and the potential anadromous streams are identified on the Site Plan, Figure 1.

1.1 Site Location

The project extends from Glennallen to Palmer, Alaska and is located between longitudes 149˚18'W and 145˚30'W, and latitudes 61˚33'N and 62˚9'N. Communities near the proposed spur line right of way corridor include Glennallen, Chickaloon, Sutton, and Palmer.

1.2 Project Background

The ANGDA spur line project began in 2004 as a way of bringing natural gas from the North Slope of Alaska to Alaska's South Central Region. ANGDA has proposed to construct a high-pressure natural gas pipeline (Glennallen to Palmer Spur Line) connecting to the proposed pipeline transporting natural gas from Prudhoe Bay to other destinations. Previous reports completed in 2004 and 2005 include, but are not limited to, a conceptual alignment and an environmental report.

These documents suggest that approximately 81 stream crossings and a few unmarked drainages may be crossed under the proposed project. Preliminary estimates suggest that bored crossings will be required at approximately 10% to 15% of the streams while the remaining streams may be crossed using open trenching construction techniques. It is expected that some of the streams will require open trenching be conducted during winter months to minimize potential environmental impacts.

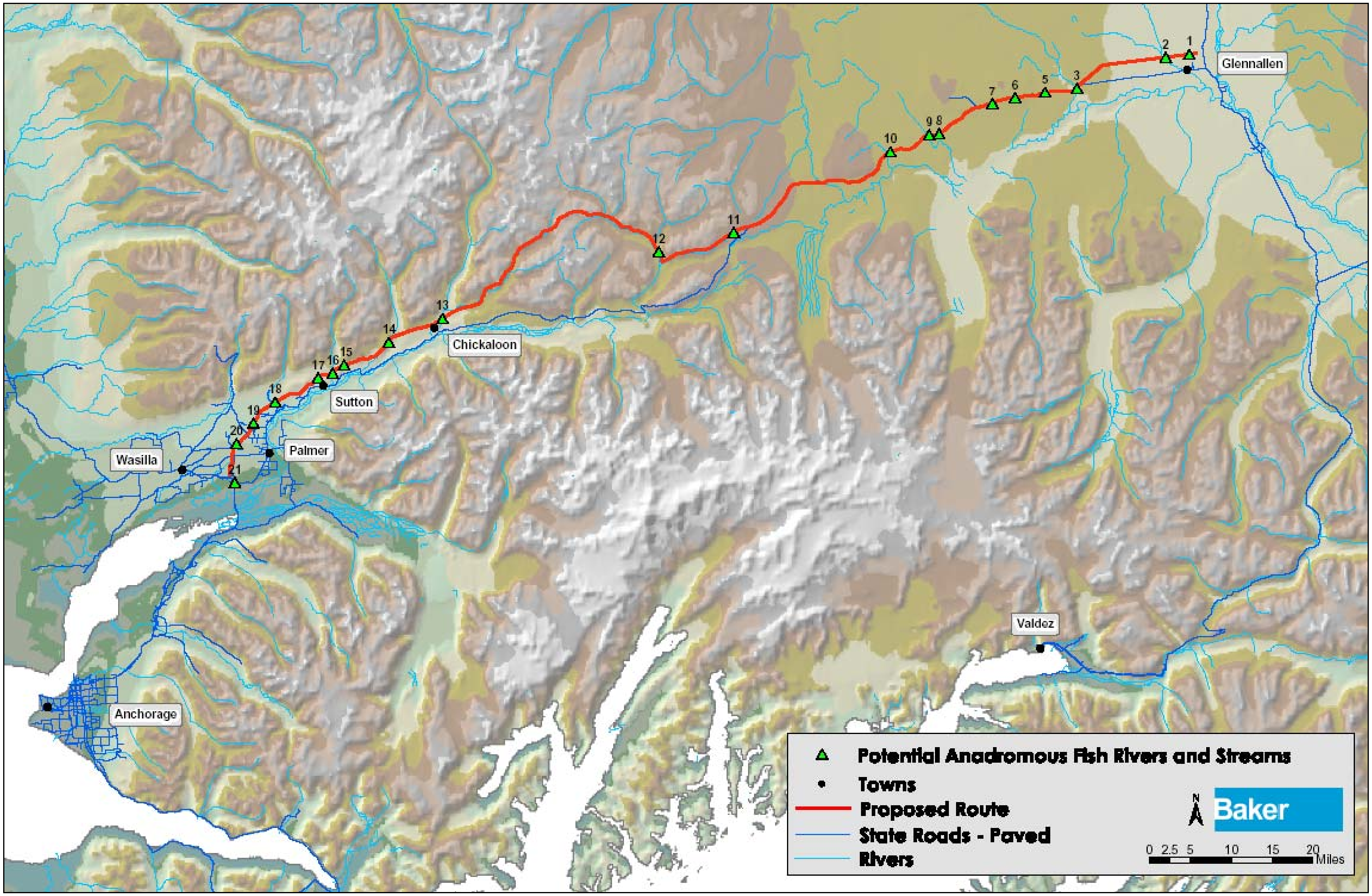

Figure 1 **Site Plan**

Environmental reporting suggests that 21 streams along the proposed route are potentially anadromous fish streams. Anadromous fish are defined as fish that hatch, rear, and migrate as smolt from freshwater to the ocean and return to the freshwater to spawn. Title 16 of Alaska statutes (AS 41.14.870) regulates all activities that may affect anadromous fish streams or that may result in the blockage of fish passage. Baker's involvement under this contract was to investigate and evaluate these 21 identified drainages.

1.3 Scope of Project

Baker's scope of services included conducting a limited field investigation at each of the 21 sites and preparation of a report suggesting preliminary recommendations for pipeline crossing techniques and construction methods. The list of 21 streams Baker was scoped with evaluating is summarized in Table 1 below. The world coordinate and proposed pipeline milepost (PLMP), according to the 2004 conceptual alignment report, is included Table 1. The list of drainages presented in Table 1 was provided to Baker by ANGDA.

Table 1 Potential Anadromous Fish Rivers and Streams

Site Number	Name	PLMP	WGS 84 (Decimal Degrees)	
			Latitude	Longitude
1	East Fork Moose Creek	1.0	62.1352	145.5306
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21	Spring Creek	147.2	61.5531	149.2491
Notes: NA (Not Applicable). Durham Creek is not crossed by the proposed route and therefore was not evaluated by Baker.				

The scope of services Baker provided for this project are summarized below:

- Identify preliminary soil(s) types 100 to 200 feet on either side of the stream bank and along the channel bottom if conditions permit.
- Determine the length of the proposed pipeline crossing and collect GPS coordinates at the high bank and active bank on both sides of the stream if conditions permit.
- Consider difficulties of summer and winter construction and provide preliminary recommendations for the best method of crossing the stream using either open trench, bored or other suitable construction methods and techniques.
- Provide typical drawings for open trench and bored crossing techniques.
- Collect digital photographs at each site looking upstream and downstream of the pipeline crossing.
- Identify through discussions with the Alaska Department of Fish and Game (ADF&G) the limiting environmental dates for fish migration, spawning, and bored and open trench crossings of each stream.
- Prepare a report summarizing the methods, results and recommendations of the field investigation.

Section 2.0 Field Investigation and Methods

Field investigations were conducted with a two-man crew between August 11 and 16, 2005. Between August 11 and August 14, the crew consisted of a licensed professional engineer and an engineering technician. Work began on sites located near Glennallen, Alaska, and preceded south - southwest towards Palmer, Alaska. Access to each site was obtained by walking from the Glenn Highway or nearby public roads across both public and private property. Baker received permission from private property landowners prior to accessing land known to be private.

On August 15 and 16, the Baker crew consisted of two licensed professional engineers. Field investigations were conducted using all terrain vehicles (ATV) at sites S11 (Startup Creek) through S14 (Kings River). Personnel from R&M Engineering Consultants, under contract performing soils studies for ANGDA, joined the Baker crew at sites S11 through S14. Access to each site was via ATV, where applicable, and on foot. ATV travel remained on publicly designated trails only.

The methods used during the field investigation to provide preliminary crossing recommendations are briefly described below. These methods include identifying preliminary soil types and evaluating geologic hazards, estimating the proposed pipeline crossing length/width, estimating stream discharge, and addressing potential environmental and constructability concerns.

2.1 Soil Description

During fieldwork, a Baker geotechnical engineer made visual characterizations of the soil. The soil was not characterized using the Unified Soil Classification System (USCS) based on the American Society of Testing and Materials (ASTM) Method D2487 as laboratory analysis was not conducted on any of the soil samples. Field classification of the soil was in accordance with the *Visual-Manual Procedure* as outlined in ASTM Method D2488.

Soil was visually examined at a minimum of two locations approximately 100 to 200 feet on either side of the stream if conditions permitted. When conditions permitted safe travel into the streambed, the bed material of the channel was also visually classified. Soil was visually inspected and classified to a depth of approximately 12 inches below ground surface. Soil samples were obtained using a small hand shovel. Exposed bedrock outcrops and large boulders present in the vicinity of the crossing were visually inspected.

2.1.1 Scour Potential

When conditions allowed safe travel into the stream, the bed material was examined for the purposes of scour potential. The type of material, diameter size, and shape was documented for potential scour estimations.

2.2 Pipeline Crossing Length/Width

The pipeline crossing widths were determined in the field based on the location represented on the hand held Global Positioning System (GPS). The widths presented in Section 3.0 are considered approximate based on the accuracy of the hand held GPS and the varying conditions of the stream in the general area of the proposed crossing location. Unless the pipeline was known to be crossing the stream at an angle (Caribou Creek), the width of the active channel and high bank were determined assuming the pipeline crossing was perpendicular to the stream.

Widths of both the active bank and high bank were determined in the field at each location. When conditions allowed, a cloth tape was stretched across the channel and widths were recorded in the field. The high bank locations were estimated in the field by a Baker engineer and, in select cases, is not representative of the entire flood plain. When the conditions prohibited safe travel across the stream, the width of the active bank and high bank were determined using a Nikon Laser 440 Prostaff Range Finder. The width was recorded in yards and later converted into feet.

In addition to measured widths, GPS coordinates were collected along the active bank and high bank. GPS units were collected in the WGS 84 datum using a Garmin GPS III Plus hand held unit. When conditions permitted safe travel across the stream, coordinates were collected on both sides of the stream.

2.2.1 Description of Banks

Site sketches, photographs, field notes, and general descriptions in this report refer to right bank and left bank. In accordance with standard hydrologic terminology, the reference of right bank and left bank is based on the observer looking downstream.

This report also refers to the active bank and the high bank. The active bank is the edge of water where as the high bank refers to the ground elevation that water would reach during bank full conditions. Water may, or may not reach the high bank on any given year.

2.3 Estimated Discharge

Baker engineers estimated the discharge of each stream at the proposed crossing location during the field investigation. The discharge measurement does not comply with United States Geological Survey (USGS) methods. Estimates of discharge were made as a basis for estimating the approximate amount of water requiring diversion and or pumping during open trench construction.

Estimated discharge values were determined by multiplying the approximate stream velocity to the cross sectional area. The approximate velocity, measured as surface velocity, was estimated in the field by determining the time required for a piece of debris (e.g., driftwood, etc.) to travel a set distance. The cross sectional area was estimated by multiplying the active channel width by approximate stream depth. The accuracy of the stream depth varied from site to site depending on the ability of Baker engineers to access the stream and collect accurate depths.

2.4 Environmental and Construction Concerns

Baker engineers visually evaluated and documented the local environment and geography in the immediate vicinity of the proposed pipeline crossing. In particular, wetlands, sensitive wildlife habitat, abrupt geographic changes, exposed bedrock outcrops, and large boulders were photographed and identified as potential environmental and construction concerns.

In addition, a brief study was done to determine which streams were considered to be the most sensitive from a habitat standpoint and what types of restrictions would apply during construction. It was found that one of the streams was not crossed by the route, and that eight of the 21 streams are not considered anadromous streams by the Department of Natural Resources Office of Habitat Management & Permitting (DNR/OHMP). In addition, of the remaining thirteen streams, active spawning beds do not exist near the proposed pipeline crossing site in some locations and therefore may be subjected to less stringent permitting requirements. The general seasonal restrictions expected for construction of non-bored type crossings are discussed in Section 4.3.

Section 3.0 Results and Recommendations

The results of the field investigation conducted at each site are presented below. The potential anadromous fish rivers and streams are discussed in consecutive order beginning in Glennallen and ending in the Palmer area. The brief description summarizes the work conducted in accordance with the tasks presented in Section 1.3, Scope of Project, and is based upon the field investigation methods discussed in Section 2.0.

Typical drawings for open trench and bored crossings are presented in Appendix A. Digital photographs from each site are presented in Appendix B. Field notes, including site sketches of plan and profile views, are presented in Appendix C.

3.1 S1 – East Fork Moose Creek (PLMP 1.0)

The proposed pipeline-crossing site at the East Fork of Moose Creek is in an area consisting of stunted black spruce trees, willows, and scattered birch trees. The creek is spread out across low-lying terrain as it flows through saturated tundra/wetlands. Black spruce and willows are present in the low-lying (saturated) areas. Birch trees were observed outside of the floodplain beyond both high banks.

The soil in the immediate vicinity of the proposed crossing site consists of six to eight inches of organics overlying dark brown to gray organic silt and silty sand. Gray silt and clay was observed in one test pit approximately 100 feet from the left high bank. The soil in the midstream of the channel consists of dark brown organic silt. Permafrost is known to exist in the immediate vicinity of site S1. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately 46 feet. The entire flow of the creek is not confined to a single channel. The creek appears to shift/fluctuate across the low-lying area seasonally or during large precipitation events. The average depth of the water across the saturated area was approximately six inches. The width of the high bank was measured at approximately 130 feet. Flow was observed in the creek and the discharge was estimated at less than or equal to five cubic feet per second (cfs).

The recommended crossing type at East Fork Moose Creek is trenching. Due to the limited amount of flow observed in the creek, open cut, dam-and-pump, diversion, or other suitable construction techniques is appropriate for this site. Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

An alternate site, approximately 0.3 to 0.5 miles south of the proposed crossing site was observed during the field investigation. The alternate site consists of a former seismic line or existing utility corridor. The route may minimize potential impacts to the environment and provide an easier access corridor for construction equipment. Private cabins located adjacent to the cleared pathway and the pond or small lake fed by the East Fork of Moose Creek may negate any benefit from moving the route.

3.2 S2 – Moose Creek (PLMP 3.9)

The proposed pipeline crossing site at Moose Creek is in an area consisting of black spruce trees and willows. According to hand held GPS coordinates, the proposed crossing site is located along a straight reach of the creek immediately downstream from a meander in the creek. Both banks are well protected with dense willows and an occasional spruce tree.

The soil in the immediate vicinity of the proposed crossing site consists of a one to two inch organic mat overlying reddish brown organic silt, fine grained sand, and silty sand. Organic silt was observed beyond the right bank and the fine grained sand and silty sand was observed in the test pits beyond the left high bank. Gravel with sand was observed along the left active bank below approximately twelve to eighteen inches of silty sand. The entire channel bed consists of dark gray silty sand mixed with gravel and cobbles ranging from one to eight inches in diameter. Angular boulders up to 30 inches in diameter were observed scattered across the channel bed. Permafrost is known to exist in the immediate vicinity of site S2. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately 36 feet. The depth of water across the creek ranged from 1.1 to 1.6 feet. The width of the high bank was measured at approximately 70 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 70 and 100 cfs.

The recommended crossing type at Moose Creek is trenching. The amount of discharge present in the creek during the winter months is anticipated to be manageable for dam-and-pump methods. As an alternative, the topography and soil observed during the initial investigation appear to be suitable for a bored crossing. Due to the width of the high bank and relatively flat topographic relief at the proposed crossing site, the length of a bored crossing would be minimal.

Construction during the winter months would be more efficient and limit any potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.3 S3 – Tolsona Creek (PLMP 16.0)

The proposed pipeline crossing site at Tolsona Creek is adjacent to the Glenn Highway upstream of the highway bridge. Tolsona Creek is located in a valley bottom approximately 80 to 100 feet below terraces located to the east and west. Vegetation at the crossing site consists of birch trees, spruce trees, willows, and scattered areas of saturated ground/wetland.

Occasional wetlands and a one to two inch organic mat overlying wet dark gray silty sand with approximately 10% gravel was observed in test pits beyond the left bank. Moist olive gray silty sand and scattered areas of gravel with sand were noted beyond the right bank. Gravel and cobbles ranging from one to twelve inches in diameter wee observed across the channel bed. Boulders ranging from 24 to 48 inches in diameter were observed in the channel in the immediate vicinity of the proposed crossing site. Permafrost is known to exist in the immediate vicinity of site S3. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately 50 feet. The depth of water across the creek was estimated between two and 2.5 feet. The width of the high bank was measured at approximately 75 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 250 and 350 cfs.

A bored crossing is recommended at Tolsona Creek. Further subsurface investigations will further define the extent and/or presence of large boulders that may pose potential problems during boring operations. Initial observations suggest that the valley bottom is wide enough to accommodate the required width of a bored crossing. The anticipated depth of scour determined during final design will aid in the determination of burial depth and thus better define the width of a bored crossing.

Due to the close proximity to the Glenn Highway and limited presence of saturated ground/wetland, construction activities can most likely be completed year round providing all conditions in the applicable permits are followed.

3.4 S4 – Durham Creek

Prior to the field investigation Baker worked with the ADF&G and verified that the proposed pipeline route does not cross Durham Creek. Durham Creek is a tributary to the Tazlina River and is located south of the Tazlina River, south of the Glenn Highway. Baker did not conduct a field investigation at Durham Creek.

3.5 S5 – Little Woods Creek (PLMP 20.1)

Little Woods Creek is a small drainage flowing across the Glenn Highway that connects two small bodies of water. The proposed pipeline crossing site is located adjacent to the Glenn Highway in wetlands covered with aquatic grasses, low brush alders, and willows. Dense areas of black spruce exist beyond the left and right high bank. The width of the creek varies in the immediate vicinity of the proposed crossing as it flows through the low-lying area.

The soil on both sides of the creek consists of dark brown organic silt with approximately 10% gravel. The gravel varies from 0.5 to one inch diameter. The soil in the midstream of the channel consists of gravel with sand (gravel ranging from 0.25 to one inch in diameter) and organic silt.

Aquatic grasses cover the streambed and active channel banks. Permafrost is known to exist in the immediate vicinity of site S5. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The approximate width of the active channel near the proposed crossing site ranged from 36 to 66 feet. The approximate width of the high bank ranged from 42 to 72 feet. At the time of the investigation, the majority of the flow in the creek was confined to a single channel. Little Woods Creek passes underneath the highway in a 36-inch diameter culvert. Flow was observed in the creek and the discharge was estimated at less than or equal to 5 cfs.

The recommended crossing type at Little Woods Creek is trenching. Due to the limited amount of flow observed in the creek, open cut, dam-and-pump, diversion, or other suitable construction techniques is appropriate for this site. Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.6 S6 – Atlasta Creek (Possible Tributary to Atlasta Creek) (PLMP 23.9)

Based on available USGS topographic maps and GPS coordinates, Atlasta Creek was not identifiable in the field. According to the most current USGS maps, Baker concluded that Atlasta Creek might have dried up since the most recent USGS map publication. Baker located an unnamed tributary to Atlasta Creek approximately 0.4 miles east of the USGS map location and conducted a field investigation.

The tributary to Atlasta Creek flows across the Glenn Highway through a 24-inch diameter culvert. The proposed pipeline crossing site is located adjacent to the Glenn Highway in an area covered with native grasses and birch trees.

The soil on both sides of the creek consists of dark brown sand with gravel. The gravel ranged from 0.25 to two inches in diameter. Gravel and cobbles ranging from 0.5 to ten inches were present in the streambed. Permafrost is known to exist in the immediate vicinity of site S6. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately six feet. The depth of water across the creek ranged from three to six inches. The width of the high bank was measured at approximately 20 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 5 and 10 cfs.

The recommended crossing type is trenching. Due to the limited amount of flow observed in the creek, open cut, dam-and-pump, diversion, or other suitable construction techniques is appropriate for this site. Due to the close proximity to the Glenn Highway and limited presence of saturated ground/wetland, construction activities can most likely be completed year round providing all conditions in the applicable permits are followed.

3.7 S7 – Tex Smith Lake Drainage (PLMP 26.8)

The Tex Smith Lake Drainage drains Tex Smith Lake and flows south across the Glenn Highway through a 36-inch diameter culvert. The proposed pipeline crossing site is located adjacent to the Glenn Highway in an area covered with native grasses, willows, and birch trees.

The soil on both sides of the creek consists of dry to moist dark brown silty sand underlying a two-inch organic mat. Approximately 10% gravel ranging from one to two inches in diameter was observed in the silty sand in two of the four the test pits. The streambed material consisted of gravel (ranging form 0.25 to 1.5 inches in diameter) and cobbles (up to 12 inches in diameter). Permafrost is known to exist in the immediate vicinity of site S7. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately five feet. The width of the high bank was measured at approximately 19 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 5 and 10 cfs.

The recommended crossing type is trenching. Due to the limited amount of flow observed in the creek, open cut, dam-and-pump, diversion or other suitable construction techniques is appropriate for this site. Due to the close proximity to the Glenn Highway and limited presence of saturated ground/wetland, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed. Utilities, including overhead telephone lines, exist in the immediate area of the proposed crossing.

3.8 S8 – Woods Creek (PLMP 34.5)

The proposed pipeline crossing site at Woods Creek is located adjacent to the Glenn Highway in an area consisting of black spruce trees, willows, alders, and native grasses. Both banks are well protected with dense willows and alders. Woods Creek flows south across the Glenn Highway through a 7-foot diameter culvert.

The soil in the immediate vicinity of the proposed crossing site consists of a two inch organic mat overlying wet dark brown organic silt with approximately 10% gravel (gravel ranging from 0.5 to one inch in diameter). The channel bed consists of cobbles with approximately 20% gravel. The cobbles range from four to eight inches in diameter and the gravel ranges from 0.25 to 0.5 inches in diameter. Aquatic grass is present in approximately 5 to 10% of the streambed. Permafrost is known to exist in the immediate vicinity of site S8. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately nine feet. The depth of water across the creek averaged approximately 1.3 feet. The width of the high bank was measured at approximately 18 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 25 and 50 cfs.

The recommended crossing type at Woods Creek is trenching. The amount of discharge present in the creek during the winter months is anticipated to be manageable for dam-and-pump methods. As an alternative, the topography and soil observed during the initial investigation appear to be suitable for a bored crossing. Due to the width of the high bank and relatively flat topographic relief at the proposed crossing site, the length of a bored crossing would be minimal.

Construction during the winter months would be more efficient and limit any potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.9 S9 – Mendeltna Creek (PLMP 35.8)

The proposed pipeline crossing site at Mendeltna Creek is adjacent to the Glenn Highway upstream of the highway bridge. Mendeltna Creek flows perpendicular towards the Glenn Highway east of the Mendeltna Creek Highway Bridge. Approximately 450 feet from the bridge, the creek meanders west eventually crossing underneath the Glenn Highway.

The proposed pipeline crossing located along the north side of the highway would require a long bore to account for the meandering creek and a public rest area located northwest of the highway bridge. Placement of the pipeline between the creek and the highway embankment does not seem feasible at this time due to the presence of underground utilities and close proximity between the road embankment and meandering creek. Currently the outside (eroding) bend of the creek is approximately 40 feet from the highway embankment toe of slope. A site sketch plan view is presented in Appendix A.

Baker engineers located an alternate crossing site during the field investigation. Due to the presence of private property and a meandering creek on the south side of the Glenn Highway, Baker proposes moving the pipeline crossing north.

3.9.1 S9 – Mendeltna Creek Alternate Site

The S9 alternate site is located approximately 0.2 miles north of the Glenn Highway. The alternate site was located upstream of the meandering channel along a straight reach in the river.

Topography of the site consists of relatively flat tundra covered with native grasses, willows, and black spruce. Subsurface soil investigations determined that the soil beyond the left high bank consists of a six-inch organic mat overlying moist dark brown organic silt. The soil was not investigated along the right bank or in the creek bed, as the creek was unsafe to cross. Observations into the streambed from the left bank noted the presence of cobbles ranging from six to 12 inches and boulders up to 36 inches in diameter. Permafrost is known to exist in the immediate vicinity of site S9. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the alternate crossing site was measured at approximately 62 feet. The width of the high bank was measured at approximately 72 feet. Flow in the creek is confined to a single, well defined channel. Discharge estimates were conducted at the highway bridge. The average depth of water across the creek was estimated at five feet. The discharge in the creek was estimated to be between 250 and 350 cfs.

A bored crossing is recommended at the alternate site of Mendeltna Creek. Further subsurface investigations will further define the extent and/or presence of large boulders that may pose potential problems during boring operations. GPS coordinates collected in the field appear to be immediately upstream of the Fish Lake drainage tributary. Consideration should be given to crossing this tributary in a single bore with Mendeltna Creek.

Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.10 S10 – Cache Creek (PLMP 41.2)

The proposed pipeline crossing site at Cache Creek is located adjacent to the Glenn Highway in an area consisting of black spruce trees, willows, and native grasses. Both banks are protected with native grasses and scattered willows. Cache Creek flows south from Cache Lake across the Glenn Highway through a 15-foot diameter culvert.

The soil in the immediate vicinity of the proposed crossing site consists of a two to four inch organic mat overlying moist dark gray silt with sand and gravel. The gravel ranges from 0.25 to three inches in diameter. The channel bed consists of gravel and cobbles ranging from 0.5 to 12 inches in diameter. Aquatic grass is present in approximately 15% of the streambed. Permafrost is known to exist in the immediate vicinity of site S10. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately 14 feet. The depth of water across the creek averaged approximately 1.5 feet. The width of the high bank was measured at approximately 54 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 40 and 60 cfs.

The recommended crossing type at Woods Creek is trenching. The amount of discharge present in the creek during the winter months is anticipated to be manageable for dam-and-pump methods. As an alternative, the topography and soil observed during the initial investigation appear to be suitable for a bored crossing. Due to the width of the high bank and relatively flat topographic relief at the proposed crossing site, the length of a bored crossing would be minimal.

Construction during the winter months would be more efficient and limit any potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.11 S11 – Startup Creek (PLMP 64.8)

The proposed pipeline crossing site at Startup Creek is in an area consisting of willow brush, alders, and native shrubs. The creek is spread out across low-lying terrain as it flows through depressed tundra.

The soil in the immediate vicinity of the proposed crossing site consists of three-inch organic mat overlying moist dark brown organic silt. The soil in the midstream of the channel consisted of sand and gravel. Gravel ranged from 0.125 to 2.5 inches in diameter. Cobbles up to 12 inches in diameter were observed in the streambed. Permafrost is known to exist in the immediate vicinity of site S1. However, permafrost was not observed during the field investigation in any of the soil samples primarily due to the fact that the soil investigation did not extend beyond/below the active layer.

The width of the active channel near the proposed crossing site was measured at approximately five feet. The entire flow of the creek was confined to a single channel. The width of the high bank was measured at approximately 70 feet. Flow was observed in the creek and the discharge was estimated at less than or equal to 10 cfs.

The recommended crossing type at Startup Creek is trenching. Due to the limited amount of flow observed in the creek, open cut, dam-and-pump, diversion, or other suitable construction techniques is appropriate for this site. Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, permafrost, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.12 S12 – Caribou Creek (PLMP 75.7)

The proposed pipeline crossing site at Caribou Creek is routed along a gravel bar containing sparse willow and alder patches located in the high bank flood plain. Between the high banks and adjacent terraces, an abundance of spruce and birch trees were observed. Due to the amount of discharge observed in the creek, field observations were not conducted on the right bank of the creek.

The soil beyond the left high bank consists of sand underlying a four-inch organic mat. Angular rock up to 48 inches in diameter was observed along the left bank upstream of the proposed crossing site. Visual observation of the right bank suggests that sand and gravel underlay an organic mat, consistent with soils samples investigated on the left bank. Upstream of the crossing along the right bank, weathered/fractured bedrock was noted along the edge of the upper terrace adjacent to the active channel. Observations into the streambed from the left bank were limited due to the clarity of the water. Dark brown sand and cobbles dominate the floodplain between the high banks. Boulders up to 48 inches in diameter were noted in the immediate vicinity of the proposed crossing.

The width of the active channel near the proposed crossing site was measured at approximately 53 feet. The width of the high bank was measured at approximately 432 feet. The proposed alignment for this crossing is not perpendicular to the river and the measured distances along the proposed alignment are larger than those noted perpendicular to the creek. The width of the active channel and high bank along the proposed alignment are 132 feet and 810 feet, respectively. The discharge in the creek was estimated to be between 800 and 1,100 cfs.

A bored crossing is recommended at Caribou Creek. However, due to the presence of large boulders in both the flood plain and active channel, an additional subsurface investigation should be performed to further delineate the extent and/or presence of large boulders that may pose potential problems during boring operations. Initial observations suggest that the valley bottom is wide enough to accommodate the required width of a bored crossing.

Caribou Creek is considered an anadromous stream due to the presence of salmon in the lower portions of the creek. However, documentation of spawning in the upper portions of the creek is limited and the DNR/OHMP indicated that a specified construction window may not be required should trenching activities be desired. A significant amount of flow is anticipated throughout the year in Caribou Creek and dam-and-pump, or other water diversion techniques may prove to be difficult.

3.13 S13 – Chickaloon River (PLMP 110.5)

The proposed pipeline crossing site at the Chickaloon River is in an area consisting predominately of willows, birch, spruce, and cottonwood trees. Due to the amount of discharge observed in the river, field observations were not conducted on the left bank of the river.

The soil beyond the right high bank consists of a four-inch organic mat overlying dark brown sand. Bedrock was observed in the distant hillside and surrounding high banks. The vegetation beyond both banks along the hillsides is densely forested. The left bank consists of bedrock cliff approximately 335 feet high. Discolored water limited visual observation of the channel bottom. Gravel with sand underlying cobbles (up to 18 inches) and boulders (up to 60 inches) were observed along the right bank. Based on the observed velocity, rough turbulent flow, and boulders noted in the active channel, Baker assumes that the streambed is lined with cobbles and large boulders.

The width of the active channel near the proposed crossing site was measured at approximately 111 feet. The width of the high bank was measured at approximately 114 feet. The discharge in the river was estimated to be greater than 1,500 cfs.

Due to the presence of the large bedrock cliff along the left bank, upstream and downstream of the Chickaloon River at the proposed location, a pipeline crossing at the proposed site does not appear feasible. An investigation of the immediate area did not reveal any obvious alternate crossing locations. Because of the heavily forested banks in the area, it was difficult to see if the terrain farther upstream or downstream of the proposed crossing contains gentler topography. The topographic maps for this area indicate similar conditions both upstream and downstream. Due to the dense vegetation, Baker recommends an alternate crossing site be identified using aerial photography, more detailed topographic maps, and a site reconnaissance using aircraft.

A trenched crossing of the Chickaloon River does not appear feasible due to the magnitude of flow observed in the river, the presence of large in-channel boulders, and the known salmon spawning locations in the area. Upon locating an alignment that provides a gentler approach to and from the river, a bored crossing would most likely be recommended. Further subsurface investigations should be performed at the crossing area to properly define the extent and/or presence of large boulders that may pose potential problems during boring operations.

3.14 S14 – Kings River (PLMP 117.9)

The proposed pipeline crossing site at Kings River is in an area covered with dense vegetation. Willows are common along the floodplain in between the high banks. Birch and spruce trees are located beyond the high banks. Due to the amount of discharge observed in the river, field observations were not conducted on the left bank of the river.

The soil beyond the right high bank consists of a thin (0.5 inch) organic mat overlying dark brown sand. Very little under growth is present among the large trees. Boulders up to 24 inches in diameter were observed in the cut bank along the terrace adjacent to the right bank. Boulders up to 60 inches in diameter were noted along the active banks. Bedrock was observed immediately upstream of the proposed crossing location along both banks. The conditions along the left bank appear similar with gravel, cobbles, and occasional boulders up to 24 inches in diameter. The clarity of the water did not allow visual observations of the channel bottom. However, based on the observed velocity, turbulent flow, and occasional large boulders, Baker assumes the channel bottom is consistent with observations along the active bank, which consisted of gravel, cobbles, and boulders.

The width of the active channel near the proposed crossing site was measured at approximately 60 feet. The width of the high bank was measured at approximately 156 feet. Just beyond the right high bank there is an elevated terrace presumed to contain bedrock (approximately 30 feet above the active channel) that may pose potential problems during construction (boring equipment). The discharge in the river was estimated at between 800 and 1,200 cfs.

A bored crossing is recommended at Kings River. Trenching does not seem feasible due to the anticipated flow in the river and known spawning beds of chum and chinook salmon in the immediate area. Further subsurface investigations should be conducted to further define the extent and/or presence of bedrock and large boulders that may pose potential problems during boring operations and is strongly recommended.

Due to the limited presence of saturated ground/wetland, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed.

3.15 S15 – Little Granite Creek (PLMP 124.3)

The proposed pipeline crossing site at Little Granite Creek is located in a remote area heavily vegetated with ferns, low bush cranberries, willows, birch, and cottonwood trees. The creek flows through a V-shaped valley approximately 60 to 80 feet deep.

Soil in the immediate vicinity of the proposed crossing site consists of a two-inch organic mat overlying dark brown sand and silty sand over bedrock. The bedrock is highly weathered and fragments easily with a spade shovel. Cobbles and boulders ranging from six to 42 inches in diameter line the streambed.

The width of the active channel near the proposed crossing site was measured at approximately seven feet. The width of the high bank was measured at approximately 18 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated at less than or equal to 10 cfs.

The recommended crossing type of Little Granite Creek is trenching. However, due to the relatively steep side slopes in the area, trenching activities may be difficult. If the steepness of the slopes dictates that trenching activities are not feasible, the presence of bedrock and boulders may pose problems for a bored crossing. Further subsurface investigations and collection of detailed topography are recommended at the site. Additional investigations will further define the site relief and extent of bedrock and boulders that may pose potential construction problems.

Baker learned that the proposed crossing site is not located near active spawning beds thus possibly eliminating the suggested requirement of a bored crossing. Additional environmental concerns include the proximity of the proposed site to wetlands, beaver habitat, and moose habitat including a natural salt lick observed in the immediate vicinity of the proposed site.

Due to the dense vegetation, locating an alternate site was difficult from the ground. Further investigations should include relocating the proposed crossing site away from the V-shaped valley. A limited site inspection by Baker concluded that relocation of the pipeline out of the valley places the pipeline in or near sensitive wetlands, which may negate any benefit from moving the route.

Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.16 S16 – Granite Creek (PLMP 126.0)

The proposed pipeline crossing site at Granite Creek is in an area thick with willows and birch trees. Due to the amount of discharge observed in the creek, field observations were not conducted on the left bank of the creek.

The soil beyond the right high bank consists of a one to two-inch organic mat overlying gray dry sand. Boulders up to 40 inches in diameter are common along the right bank. Observations into the streambed from the right bank noted the presence of gravel with sand, cobbles (up to eight inches) and boulders up to 60 inches in diameter.

The width of the active channel near the proposed crossing site was measured at approximately 63 feet. The width of the high bank was measured at approximately 99 feet. The width of high bank does not take into account a prior streambed located beyond the right high bank. The width of the older streambed is estimated at approximately 100 feet wide. The streambed was not measured due to the amount of vegetation present in the former channel. Evidence suggests that the former streambed has not seen a significant amount of water recently due to the presence of willows and birch growing in the former streambed. The discharge in the creek was estimated at greater than or equal to 1,000 cfs.

A bored crossing is recommended at Granite Creek. Further subsurface investigations will further define the extent and/or presence of large boulders that may pose potential problems during boring operations. Initial observations suggest that the valley bottom is wide enough to accommodate the required width of a bored crossing.

Spawning salmon (chinook, cohoe, and chum) are known to exist in this area. Due to the limited presence of saturated ground/wetland, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed.

3.17 S17 – Eska Creek (PLMP 128.0)

The proposed pipeline crossing site at Eska Creek is located just west of Jonesville Mine Road in an area heavily vegetated with willow brush and birch, cottonwood, and spruce trees. The creek flows through a moderately wide U-shaped valley approximately 200 to 300 feet deep. Currently the creek flows adjacent to the moderately steep western edge of the valley.

Soil in the immediate vicinity of the proposed crossing site consists of a four to six-inch organic mat overlying brown fine grained sand and cobbles. The active banks and over banks are well protected with willow brush and trees. Evidence of erosion was noted in select spots near the immediate vicinity of the crossing along the left bank. The streambed consists of gravel with sand mixed with cobbles and boulders ranging from six to 24 inches in diameter. The gravel ranges from 0.5 to two inches in diameter. During the field investigation three old streambeds were noted between the active channel and Jonesville Mine Road. The old streambeds suggest that either Eska Creek is migrating towards the west, or the drainage has seen a large amount of water in the past.

The width of the active channel near the proposed crossing site was measured at approximately 28 feet. The width of the high bank was measured at approximately 55 feet. The average depth of water in the creek at the time of the investigation was one foot. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated between 50 and 100 cfs.

Due to the relatively steep side slopes in the area, trenching activities may be difficult at Eska Creek and therefore a bored crossing is recommended. A longer bored crossing may be required to encompass the bluff to the west (approximately 100 feet from the right bank of the creek) and possibly the eastern bluff. Additional subsurface investigations will further define the extent that boulders may pose potential problems during boring operations.

However, assuming that adequate subsurface soils conditions exist, a bore is recommended for this crossing. The presence of spawning salmon (coho and chum) in the area suggests that, if at all possible, this crossing should be bored.

As an alternative crossing site, Eska Creek flows under Jonesville Mine Road approximately 800 feet upstream from the proposed pipeline crossing site. The creek flows through two culverts eight feet high and 13 feet wide. A bored crossing encompassing both the creek and road may be completed at this site. However, the steep bank to the west still requires attention. Avoidance of the steep bluffs may require relocation of the pipeline route to the Glenn Highway right-of-way.

Due to the close proximity to the public roads near Sutton and limited presence of saturated ground/wetland, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed.

3.18 S18 – Moose Creek (PLMP 134.3)

The proposed pipeline crossing site at Moose Creek is located in a remote area heavily vegetated with ferns, willows, devils club, and birch and cottonwood trees. The creek flows through a V-shaped valley approximately 300 to 500 feet deep.

Soil in the immediate vicinity of the proposed crossing site consists of a four-inch organic mat overlying dark brown fine grained sand. Dark brown gravel with sand and cobbles was observed in the exposed hillside beyond the right bank. Due to the amount of discharge observed in the creek, field observations were not conducted on the left bank of the creek. Observations into the streambed from the right bank noted the presence of gravel and cobbles ranging from one to eight inches in diameter and boulders up to 48 inches in diameter.

The width of the active channel near the proposed crossing site was measured at approximately 41 feet. The width of the high bank was measured at approximately 48 feet. The creek banks are well protected with boulders and thick vegetation including willows and trees. Limited bank erosion was noted at the proposed crossing site. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated at between 500 and 1,000 cfs.

Due to the relatively steep side slopes, trenching activities may be difficult at the site. A bored crossing is recommended at the proposed Moose Creek crossing site. Based on the amount of topographic relief between the bluffs (east and west) and the creek bed, a long bored crossing is anticipated. Documented coho spawning downstream of the site, and chinook salmon spawning upstream cause this area to be considered a sensitive area where a bore would be recommended, if at all possible, by DNR/OHMP. However, if a bore is technically challenging, a trenched crossing will have to be considered, but likely only if it is to occur during months when salmon fry have moved out, and prior to spawning (typically mid May to mid July).

Further investigations, including topographic surveys, scour estimation, and subsurface exploration, will better define the approximate boring length. Additional subsurface investigations will also aid in delineating the extent and/or presence of boulders and/or bedrock that may pose potential problems to boring activities.

Avoidance of the steep bluffs may require relocation of the pipeline route to the Glenn Highway right of way. As an alternative crossing site, a shorter bored crossing of Moose Creek may be completed along the highway right of way. A more gradual grade across the Moose Creek valley is present here, thus allowing easier constructability for trenching activities.

Due to the close proximity to the public roads along the western bluff and limited presence of saturated ground/wetland in the area, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed.

3.19 S19 – Carnegie Creek (PLMP 138.5)

Based on available USGS topographic maps and GPS coordinates, Carnegie Creek was not immediately identifiable in the field. Upon further investigation, Baker located Carnegie Creek with the help of a local resident. Baker discovered that the creek does not flow throughout the year at the location of the crossing, and may not flow at all during drier years. Near the proposed pipeline crossing location, the creek was dry in 2002, 2003, and 2004. In 2005, the creek passed water during the spring.

Upon learning that Carnegie Creek does not exist as indicated on USGS maps or at the location identified in the conceptual engineering report, the following information was collected from a location along the creek near the proposed crossing site.

Soil on both sides of the creek consists of an eight-inch organic mat overlying gray silty sand. Willow brush, native grasses, birch trees and spruce trees were abundant adjacent to and beyond both banks. The saturated streambed consists of a four-inch organic mat overlying gravel with sand. Gravel ranged from 0.125 to 0.5 inches in diameter.

The width of the active channel near the proposed crossing site was measured at approximately four feet. The width of the high bank was measured at approximately 27 feet. The creek, as studied during the field investigation, flows across a private driveway through a single two-foot culvert. At the time of the investigation, limited flow was noted in the culvert. The discharge in the creek was estimated to be less than or equal to 1 cfs.

The recommended crossing type is trenching. DNR/OHMP classifies this stream as anadromous in the lower downstream section, but not at the location of the proposed crossing. Open cut, dam-and-pump, diversion, or other suitable construction techniques is appropriate for this site. Evidence suggests that water may not be encountered in the creek during the winter months. Further investigation at the proposed crossing site will determine the presence or absence of saturated ground/wetlands.

3.20 S20 – Wasilla Creek (PLMP 141.7)

The proposed pipeline crossing site at Wasilla Creek is located adjacent to Trunk Road between Palmer and Wasilla. The area is comprised of native grasses, ferns, and willow brush and birch trees. Private farmland is located immediately adjacent to the proposed crossing site. Both banks are well protected with dense willows and alders.

The soil at the proposed crossing site consists of a one-inch organic mat overlying moist dark brown sand. The channel bed consists of gravel with fine grained sand and silty sand. The gravel ranges from 0.25 to two inches in diameter. The banks are well protected with vegetation described above. Limited erosion was observed along the active creek banks near the proposed crossing site.

The width of the active channel near the proposed crossing site was measured at approximately 13 feet. The depth of water across the creek averaged approximately 1.9 feet. The width of the high bank was measured at approximately 24 feet. Flow in the creek is confined to a single, well defined channel. The discharge in the creek was estimated to be between 20 and 40 cfs.

Wasilla Creek contains sensitive coho and chinook salmon spawning grounds as well as very important rainbow trout spawning beds. It is strongly recommended by DNR/OHMP that this stream be crossed using directional boring techniques. Due to the close proximity to public roads and limited presence of saturated ground/wetland in the immediate area, construction activities can most likely be completed year round provided all conditions in the applicable permits are followed.

3.21 S21 – Spring Creek (PLMP 147.2)

The proposed crossing site at Spring Creek is adjacent to and west of the Fireweed Drive frontage road near the Parks and Glenn Highway interchange. Spring Creek flows through wetlands east to west underneath the Glenn Highway and frontage road. The entire flow under the road is confined into two 36-inch diameter culverts.

The proposed crossing site is a large wetland several hundred feet wide. The entire area is covered by saturated ground with native grasses and willows. The average depth of the water in the wetland was approximately 2.5 to 3.0 feet deep. Due to the broad expanse of the wetland width, measurements were not recorded. Baker suggests land surveying or aerial photography to identify and/or determine the extent of the wetland at the crossing site. At the time of the investigation, flow was noted in the culverts; however, discharge estimates of the wetland were not determined.

The recommended crossing type of the Spring Creek wetland is boring. Due to the extent of the wetland and anticipated water depths, a trenched crossing does not appear to be feasible. Also, this precise area is a well documented rearing and spawning area for coho salmon thus making it an extra sensitive habitat where minimizing impact via directional boring is strongly recommended by DNR/OHMP. Construction during the winter months would be more efficient and limit potential environmental impacts. Access to the site and potential impacts to vegetation, wetlands, and fish and wildlife habitat would be reduced once the ground has frozen and sufficient snow coverage exists.

3.22 Summary Tables

A summary of the bank widths, crossing recommendations, and estimated discharge are presented in Table 2. GPS coordinates of the active channel banks and high banks are presented in Table 3.

Table 2 Summary of Bank Widths, Crossing Recommendations and Estimated Discharge

Site	Common Name	Active Channel Width	High Bank Width	Recomm. Crossing	Estimated Discharge (1)	Recomm. Construction Season (2)
S1	East Fork Moose Creek	46 ft.	130 ft.	Trench	< 5 cfs	W
S2	Moose Creek	36 ft.	70 ft.	Trench	70–100 cfs	W
S3	Tolsona Creek	50 ft.	75 ft.	Bore	250–350 cfs	YR
S4	Durham Creek (3)	–	–	–	–	–
S5	Little Woods Creek	36–66 ft.	42–72 ft.	Trench	< 5 cfs	W
S6	Atlasta Creek (4)	6 ft.	20 ft.	Trench	5–10 cfs	YR
S7	Tex Smith Lake Drainage	5 ft.	19 ft.	Trench	5–10 cfs	YR
S8	Woods Creek	9 ft.	18 ft.	Trench	25–50 cfs	W
S9	Mendeltna Creek (5)	62 ft.	72 ft.	Bore	250–300 cfs	W
S10	Cache Creek	14 ft.	54 ft.	Trench	40–60 cfs	W
S11	Startup Creek	5 ft.	70 ft.	Trench	< 10 cfs	W
S12	Caribou Creek (6)	53 ft.	432 ft.	Bore	800–1,100 cfs	YR
	Caribou Creek (7)	132 ft.	810 ft.	Bore	800–1,100 cfs	YR
S13	Chickaloon River	111 ft.	114 ft.	Bore	> 1,500 cfs	YR
S14	Kings River	60 ft.	156 ft.	Bore	800–1,200 cfs	YR
S15	Little Granite Creek	7 ft.	18 ft.	Trench	< 10 cfs	W
S16	Granite Creek	63 ft.	99 ft.	Bore	> 1,000 cfs	YR
S17	Eska Creek	28 ft.	55 ft.	Bore	50–100 cfs	YR
S18	Moose Creek	41 ft.	48 ft.	Bore	500–1,000 cfs	YR
S19	Carnegie Creek	4 ft.	27 ft.	Trench	< 1 cfs	W
S20	Wasilla Creek	13 ft.	24 ft.	Bore	20–40 cfs	YR
S21	Spring Creek	NM	NM	Bore	NM	W

Notes:
(1) Discharge values are estimated and should only be considered as approximate quantities.
(2) Recommended construction season – Summer (S), Winter (W) or Year Round (YR).
(3) The proposed pipeline does not cross Durham Creek and therefore a field investigation was not conducted.
(4) Atlasta Creek was not identified in the field. A tributary to Atlasta Creek was evaluated during the field investigation.
(5) Information from Mendeltna Creek is representative of the alternate site.
(6) Measurements indicative of proposed pipeline crossing perpendicular to the creek.
(7) Measurements indicative of proposed pipeline crossing the creek at an angle as shown in the conceptual alignment report.
cfs – cubic feet per second
NM – Not Measured (Definition of Creek was not definitive due to presence of large wetland)

Table 3 Active Bank and High Bank GPS Coordinates

Site	Common Name	GPS Coordinates - WGS 84 (Decimal Degrees) Left Bank		Right Bank	
		Active Channel	High Bank	Active Channel	High Bank
S1	East Fork Moose Creek	N62.13539 W145.53006	N62.13539 W145.53006	N62.13531 W145.53033	N62.13536 W145.53039
S2	Moose Creek	N62.13533 W145.62056	N62.13536 W145.62047	N62.13528 W145.62069	N62.13525 W145.62075
S3	Tolsona Creek	N62.10056 W145.96853	N62.10058 W145.96850	N62.10047 W145.96861	N62.10039 W145.96867
S4	Durham Creek (1)	–	–	–	–
S5	Little Woods Creek	N62.10011 W146.09014	N62.10014 W146.09008	N62.10017 W146.09036	N62.10019 W146.09042
S6	Atlasta Creek (2)	N62.09686 W146.19317	N62.09683 W146.19314	N62.09683 W146.19314	N62.09686 W146.19319
S7	Tex Smith Lake Drainage	N62.09128 W146.29175	N62.09131 W146.29167	N62.09128 W146.29172	N62.09128 W146.29178
S8	Woods Creek	N62.04928 W146.50550	N62.04925 W146.50544	N62.04928 W146.50550	N62.04925 W146.50556
S9	Mendeltna Creek (3)	N62.05169 W146.54439	N62.05172 W146.54428	NC	NC
S10	Cache Creek	N62.02711 W146.69522	N62.02700 W146.69539	N62.02706 W146.69525	N62.02706 W146.69514
S11	Startup Creek	N61.91575 W147.31347	N61.91583 W147.31331	N61.91575 W147.31350	N61.91575 W147.31367
S12	Caribou Creek	N61.89478 W147.59953	N61.89492 W147.59903	NC	NC
S13	Chickaloon River	NC	NC	N61.81150 W148.42978	N61.81150 W148.42978
S14	Kings River	NC	NC	N61.77811 W148.63761	N61.77814 W148.63794
S15	Little Granite Creek	N61.74494 W148.80953	N61.74472 W148.80947	N61.74497 W148.80953	N61.74483 W148.80953
S16	Granite Creek	NC	NC	N61.73189 W148.85553	N61.73189 W148.85556
S17	Eska Creek	N61.72597 W148.90983	N61.72611 W148.90978	N61.72600 W148.90997	N61.72592 W148.91006
S18	Moose Creek	NC	NC	N61.68861 W149.07539	N61.68864 W149.07550
S19	Carnegie Creek	N61.63789 W149.18589	N61.63783 W149.18586	N61.63781 W149.18581	N61.63778 W149.18586
S20	Wasilla Creek	N61.62131 W149.23281	N61.62133 W149.23278	N61.62133 W149.23292	N61.62133 W149.23292
S21	Spring Creek	NC	NC	NC	NC

Notes:
(1) The proposed pipeline does not cross Durham Creek and therefore a field investigation was not conducted.
(2) Atlasta Creek was not identified in the field. A tributary to Atlasta Creek was evaluated during the field investigation.
(3) Information from Mendeltna Creek is representative of the alternate site. GPS coordinates from the proposed crossing site are presented on the site sketches in Appendix C.
NC – Not Collected. The stream could not be crossed safely and therefore GPS coordinates were only collected on the accessible side of the stream.

Section 4.0 Design Considerations

4.1 Permafrost

Disturbance or removal of the organic surface material will alter the thermal state of the subsurface soil and likely cause thawing of permafrost beyond the channel margins. If the subsurface permafrost is allowed to thaw, substantial settlement of the soil can be expected. Mobilization of equipment into the site should be conducted, if practical, in a manner that minimizes the damage to the existing organic mat. Winter construction should be considered as an option.

4.2 Additional Subsurface Investigations

A thorough subsurface investigation is recommended at each proposed boring site to investigate and delineate any subsurface conditions that may pose potential problems during boring activities. The investigation should be conducted using drilling techniques.

The subsurface soil should be logged and sampled by a qualified geotechnical engineer or geologist. Soil borings should be drilled at select locations on both sides of the creek of the proposed pipeline crossing at a minimum. The number, location, and approximate depth of the soil borings will vary from site to site. At a minimum, the subsurface soil should be investigated to a depth of at least 20 feet below the approximate pipeline depth. The estimated burial/bored depth of the pipeline will depend on site topography, estimated scour in the streambed, and capabilities of the boring equipment (horizontal directional drill). Final subsurface soil information will aid in determination of the burial depth for final design.

4.3 Seasonal Restrictions

Upon investigation, many of the streams that are discussed in this document are not considered to be anadromous streams (at least not at the location of the proposed pipeline crossing) and therefore may be trenched in accordance with less stringent permit requirements. However, for the streams that are considered anadromous, Baker anticipates that, in most cases, ADF&G and DNR/OHMP will require seasonal restrictions for trenched crossings, and only if a bored crossing would be difficult at the site. In select cases where the stream is considered extremely sensitive by ADF&G and DNR/OHMP, a trenched crossing will only be allowed if a bored crossing is determined unfeasible. ANGDA will also need to provide sufficient data that a trenched crossing can be executed responsibly with little or no impact to the habitat.

Generally, if a trenched crossing is preferred and there are known spawning beds in the stream, two seasonal restrictions exist. The first restriction involves avoiding portions of streams where spawning occurs while the eggs are in the ground (typically from July until mid May, but it varies depending on the stream, location, and species). The second restriction is for winter trenching, which is often desired because it is during a time of the year when low flows occur (preferred for dam-and-pump and/or water diversion methods) and access over saturated ground/wetlands are much more manageable. Winter trenching will usually only be allowed in sections of a stream where disturbance of salmon spawning beds can be avoided (i.e., in portions of the river or stream where it is known that no anadromous fish eggs exist).

Section 5.0 References

ANGDA. 2004. 24-Inch Spur Line from Glennallen to Palmer: Conceptual Alignment and Budget Level Cost Estimate. Prepared by Michael Baker Jr., Inc.

ANGDA. 2005. *Spur Gas Pipeline Glennallen to Palmer Environmental Report.* Lynx Enterprises, Inc. (of ASRC Energy Services).

ASTM Method D2488. Visual-Manual Procedure.

Appendix A Typical Drawings for Trench and Bored Crossings

Appendix B Site Photographs

Appendix C Site Sketches