GLENNALLEN TO PALMER SPUR LINE
SOILS STUDIES

1.0 INTRODUCTION

1.1 Background

The Alaska Natural Gas Development Authority (ANGDA) is currently proposing a natural gas spur pipeline between Glennallen and Palmer, Alaska. R&M Consultants, Inc. (R&M) was tasked by ANGDA to provide professional geotechnical services (soils studies) for the project. This screening-level geotechnical information will be used to further evaluate and analyze the proposed spur pipeline routing.

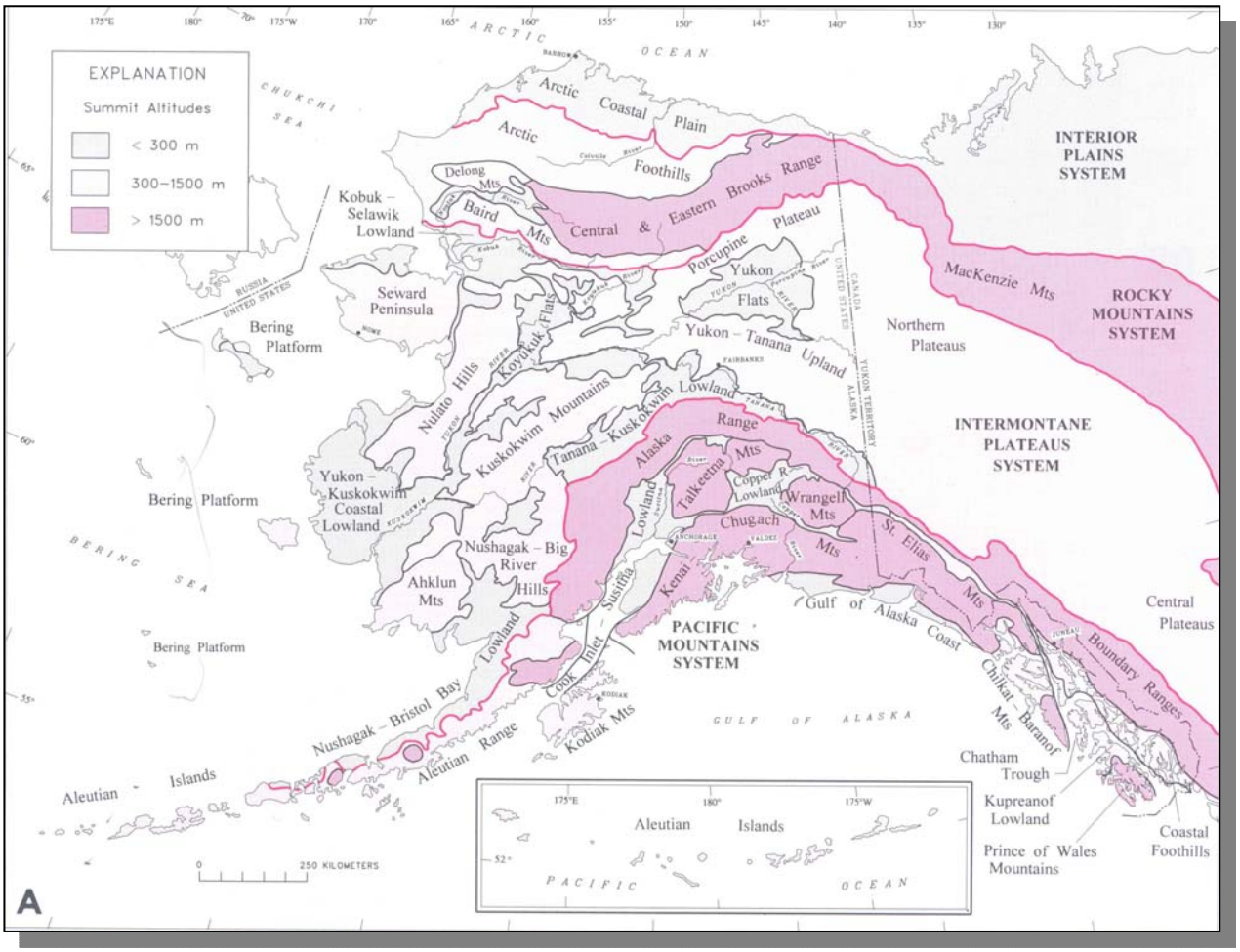
As part of these soil studies, aerial photo interpretation and terrain analysis, coupled with limited route reconnaissance, was used to delineate areas with various attributes such as soil types, vegetation, slope instability and thermal state. Aerial photo interpretation and terrain analysis are time-proven methods that have been used in the United States and Canada for more than fifty years. These methods have been especially useful for other Alaska pipeline routing studies.

The concept of the "physiographic province" has been found to provide a useful and convenient means for categorizing and understanding the physical environment of Alaska. The term applies to any relatively large geographic area with a unique and characteristic suite of properties including a common geologic genesis and history, common sets of currently active geologic processes, similar topography and similar rock and soil types. It is not surprising that areas that share the attributes listed above also are found to have similar flora, fauna, and climate. The unifying principles behind the physiographic province concept have also been found to have application on engineering projects in Alaska. To investigate the geotechnical feasibility of a large project, it is most effective to consider physiographic provinces in terms of the general conditions and constraints they impose as well as the resultant impacts on pipeline routing and design. Six physiographic provinces and subprovinces are crossed by the route under consideration for the Natural Gas Spur Pipeline between Glennallen and Palmer. A generalized physiographic province map is shown on Figure 1.

From the standpoint of technical feasibility, a considerable range of environmental considerations and constraints must be accommodated in pipeline routing. The variation in soil conditions can be approached systematically by dividing the proposed alignment into segments based on physiographic provinces and dealing with each segment separately. An effective basis for subdividing physiographic provinces into units with dimensions appropriate for pipeline design is the terrain unit concept. Terrain units, as used by R&M, are three-dimensional representations of soil and bedrock types, expected to occur from the ground surface to a depth of about 20 to 25 feet.

FIGURE 1

GENERALIZED PHYSIOGRAPHIC PROVINCES OF ALASKA



After Plafker and Berg, 1994, and Wahrhaftig, 1965.

Terrain units are classified by letter symbols that represent their basic genesis such as floodplain, colluvium, and bedrock. One of the reasons that the terrain unit concept is useful is that the genesis of most terrain units is related to the physiographic province in which they occur. Statistical correlations have been developed by R&M on other projects in Alaska between terrain units and such important soil properties as grain size distribution, moisture content, density and thermal state. With these relationships, geotechnical personnel can better relate borehole and other site-specific information to the overall environment; a particularly important consideration for tasks at the feasibility stage such as pipeline routing.

Terrain units have been classified along the route and are presented along with other geotechnical parameters on the "Route Soil Conditions" sheets. An explanation of the terrain unit classification system immediately precedes the Route Soil Conditions sheets.

The route description and geotechnical conclusions presented herein are based on our current understanding of the project and location as outlined within and illustrated on the attached drawings. Any deviation from the proposed location would necessitate further evaluation of route soil conditions.

1.2 Contract Authorization

This work was completed under the terms of Contract No. 06-0410 between the State of Alaska, Department of Revenue, Alaska Natural Gas Development Authority and R&M Consultants, Inc.

Measurements and weights presented in this report are generally shown as traditional U.S. Imperial units. However, some geologic data are presented in International System (SI) units following the cited investigator. Any unit conversions should be made with the appropriate numbers carried to three or more significant figures. Geologic definitions generally follow those of the American Geological Institute (Jackson, 1997).

1.3 Purpose and Scope-of-Work

The intent of this investigation has been to gather data on the geologic and geotechnical conditions which could affect design and construction of the proposed spur pipeline. This report presents a summary of our findings from the aerial photo analysis and route reconnaissance, and contains our conclusions and recommendations with regard to pipeline routing and preliminary design.

The scope-of-work for R&M's soil study efforts includes the following:

- Identifying general characteristics of route soils, the associated lengths and relevant construction issues;
- Locating potential exceptions, i.e., bedrock, alluvial, marsh, faults, etc.;
- Working with other contractors to gather stream bank and stream crossing soils data;
- Locating existing and potential new material (gravel, sand and bedrock) sites and spoil disposal sites;

- Locating and incorporating other sources of soil information from sources such as the Matanuska-Susitna Borough, Alaska Department of Transportation & Public Facilities (DOT&PF) and private sectors for project use; and
- Suggesting methods to gather additional soils data.

It is understood that final design will be based on geotechnical sampling and analysis during future engineering and design phases.

This report is comprised of two volumes. Volume 1 summarizes the results of the field and office programs along with the methods and procedures used to complete the work. Volume 1 also presents our conclusions and recommendations regarding alignment conditions and proposed construction. Volume 2, Appendices, contains the Route Soil Conditions sheets and Field Site Description sheets.

1.4 Concept Plan

The proposed spur pipeline is considered a gas transmission line and must, at a minimum, meet the requirements of 49 CFR 192 under the jurisdiction of the U.S. Department of Transportation, Office of Pipeline Safety. It is understood that the wall thickness for the 24-inch spur line is expected to vary from 0.562-inch to 1.031-inch, based on preliminary operating pressure calculations. Valves and corrosion control systems will be provided as mandated by regulation.

We understand that existing roads will provide the main access for construction, as well as future maintenance activities, thus the need for project specific access roads will be minimal. Figure 2 provides a typical trench section detail. The minimum depth of cover (DOC) is designated as 30 inches, except where consolidated rock is encountered. At those locations, a DOC of 18 inches will be allowable. Stream or road crossings may require additional DOC. Horizontal directional drilling may be required to place the spur line at environmentally sensitive areas or major road crossings.

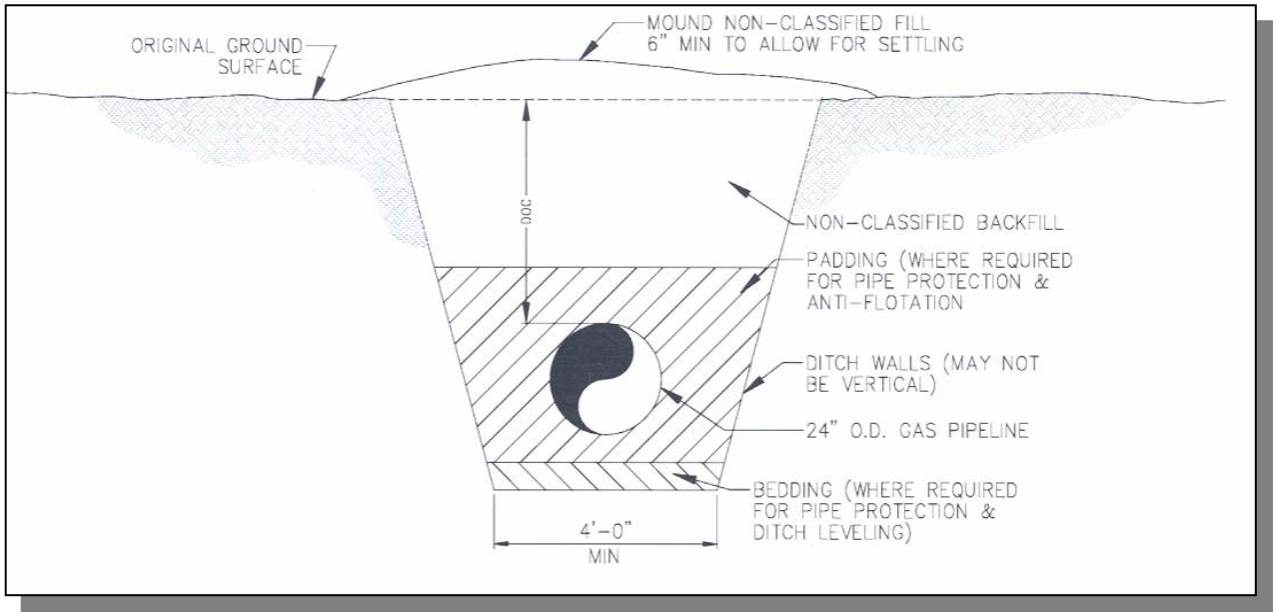
Winter construction utilizing snow/ice workpads will be performed along portions of the alignment that traverse wet or permafrost-rich soils. For summer construction areas, the right-of-way (ROW) will be cleared and grubbed of vegetation and graded to provide a relatively level surface. In some areas a temporary workpad may be required. Temporary workpads will be removed to the extent possible and the right-of-way restored following all construction activities. It is anticipated that construction zone activities, potential impacts and restoration efforts will be addressed in detail during the project design phase.

1.5 Existing Information

No prior geotechnical investigations have been performed for the proposed spur pipeline. Therefore, a number of U.S. Geological Survey, Alaska Division of Geological and Geophysical Surveys and Alaska Department of Transportation and Public Facilities documents as well as other technical reports were reviewed in regards to regional conditions and site-specific

FIGURE 2

TYPICAL TRENCH DETAIL



After Michael Baker, Jr., Inc., 2005.

information. These various reports are cited herein and listed in the References section of this report.

Geologic reconnaissance of the Glennallen area and Copper River Basin dates back to the late 1800s and early 1900s (Mendenhall, 1902). The presence of coal deposits in the lower Matanuska Valley has led to geologic mapping of areas within the project corridor as early as 1910 (Martin and Katz, 1912). In 1927, Capps continued with earlier mapping and added coverage of the area between Chickaloon River and Hicks Creek. Coal deposits were also discovered on the south side of the Matanuska River, northeast of Wolverine Creek by Landes (1927). Large scale detailed maps of coal deposits covering the areas of the Wishbone Hill district were published by Barnes and Payne (1956), and subsequent work by Barnes in 1956 and 1958 extended the mapping to the Knob Creek area.

The detailed mapping was extended further east to the Chickaloon River by Barnes and Sokol in 1959. In 1962, Barnes published a geologic map of all the lower Matanuska Valley, which is the most detailed geology available for the last 30 miles of the project corridor. Detterman and others (1976) published a map showing the surface trace characteristics of the Castle Mountain and Caribou segments of the Castle Mountain fault system. Fault traces, large individual landslides and areas of potential landslides are delineated on this map. Detterman's map covers the project corridor between Caribou Creek and Palmer.

Some of the more detailed geology of the project corridor was published by Grantz in 1961, covering the area of Caribou Creek and Sheep Mountain at a scale of 1:48,000. East of this area and extending to about Slide Mountain, Grantz (1960) published a generalized geologic map showing igneous rocks and larger faults. In addition, Grantz and Fay published a geologic road log from Sutton to Caribou Creek in 1964. Beikman (1974) compiled existing regional data as part of the state mapping project. Regional geologic mapping for the Anchorage quadrangle was published at a scale of 1:250,000 by the U.S. Geological Survey (Winkler, 1992).

Published geologic maps used in conjunction with other data gathered for this report are listed below in Table 1. The segment of project corridor covered by each publication used and the scale at which they were published is also listed.

TABLE 1

PRIMARY GEOLOGIC REFERENCES

Author (Date)	Location	Scale
Nichols and Yehle (1969)	Glennallen to Tolsona Creek	1:125,000
Grantz (1960)	Little Nelchina River to Caribou Creek	1:96,000
Grantz (1961)	Caribou Creek to Sheep Mountain	1:48,000
Capps, et al. (1927)	Hicks Creek to Kings River	1:62,500
Detterman, et al. (1976)	Caribou Creek to Palmer	1:63,360
Barnes (1962)	Chickaloon River to Palmer	1:63,360

Various terrain studies of the greater Glennallen area have also been performed by the Department of the Army (1955, 1959 and 1960). Ferrians (1971) has also published preliminary engineering geology maps of the Trans-Alaska Pipeline (TAPS) route within the Gulkana quadrangle.

Subsequent to the publication of the above-listed U.S. Geological Survey documents, several additional documents have been prepared for the area. In 1981, R&M Consultants, Inc. conducted geological and geotechnical investigations for a Glenn Highway realignment study between Palmer and about Milepost 135 (Little Nelchina River). The study was prepared for the Alaska Department of Transportation and Public Facilities (DOT&PF) and included terrain unit mapping, bedrock studies, and seismicity and fault delineation (R&M, 1981). Terrain unit maps and bedrock geology maps were prepared on USGS 1:63,360 scale maps enlarged to 1 inch = 1,000 feet. Field studies included test borings, detailed bedrock mapping in selected areas and a geologic hazards investigation. The R&M Glenn Highway study is an important source document for this report.

Additionally, in 1978 R&M Consultants conducted a study near Glennallen which provided subsurface analysis for sanitary sewer systems at proposed homesites for the State of Alaska Division of Lands (R&M, 1978). Airphoto analysis and terrain unit mapping were performed for eight large parcels located in the vicinity of Glennallen.

In 1985, Arctic GeoResource Associates and Arctic Geo-Terrain Consulting prepared land-use maps for the Alaska Department of Natural Resources as part of the Alaska Land and Resource System (ALARS). Maps were registered to the 1:63,360 USGS map series. Engineering geology maps from the Gulkana (A-3), (A-4), (A-5), (A-6), and Valdez (D-8) quadrangles were utilized for the current spur line soils study.

More than 30 soils reports for the Glenn Highway were obtained from DOT&PF. These reports were then reviewed for applicability to this project. They are listed separately within the References section of this report. Various aerial photographs used for terrain unit analysis are also listed within the References section.

Geologic map information from the primary references listed above has been compiled onto the Route Soils Conditions sheets presented in Appendix A of this report. Efforts have been made to standardize the information from the different sources where this could be done without changing the original author's intent. Geologic information from this study was used to supplement the existing literature, providing added detail in the project corridor.