Hydrologic and Hydraulic Features of the Alaska/Canada Railroad Link
(Alaska Segment)

by
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Project Background

The United States government and the government of Canada are in need of a Railroad connection between Fairbanks and the existing railroad system of the northwest Canada. This proposed project will make possible to commute/freight throughout the major North American cities via railroad (see figure 1 for the general location of the project). All the supplies of the materials and the transport of thousands of tons of minerals have been done by other modes of transportation than railroad which is very costly especially in the context of the soaring sky-high gasoline prices. The proposed railroad will not only enhance the economic activities in the northwest Canada and Interior Alaska, it will be a backbone for the required infrastructure for the construction of the long-awaited Gas Pipeline project. A feasibility study has been already completed for the railroad extension from Fairbanks and Delta Junction and the detailed Environmental Impact Assessment Study (EIS) has been being carried out at present. In 2005, the US government and the government of Canada commissioned a feasibility study for the link of the Alaskan and Canadian Railroad system. Since the proposed railroad link has to cross a number of small to large rivers and has to follow them for some distance, the hydrology and the hydraulics of those rivers dictates the design of the bridges and the railroad track itself with the necessary river training works. The selection of appropriate bridge site has a considerable impact on the finalization of the alignment and ultimately on the overall project cost. The importance of the hydrologic and hydraulic studies for the feasibility of a railroad project can hardly be exaggerated. This chapter presents the hydrology and hydraulic engineering features that are important to the overall study of the project. However, the detailed studies of every river crossings are beyond the scope of this study. The detailed studies will be carried out during the EIS.

Objective and Scope

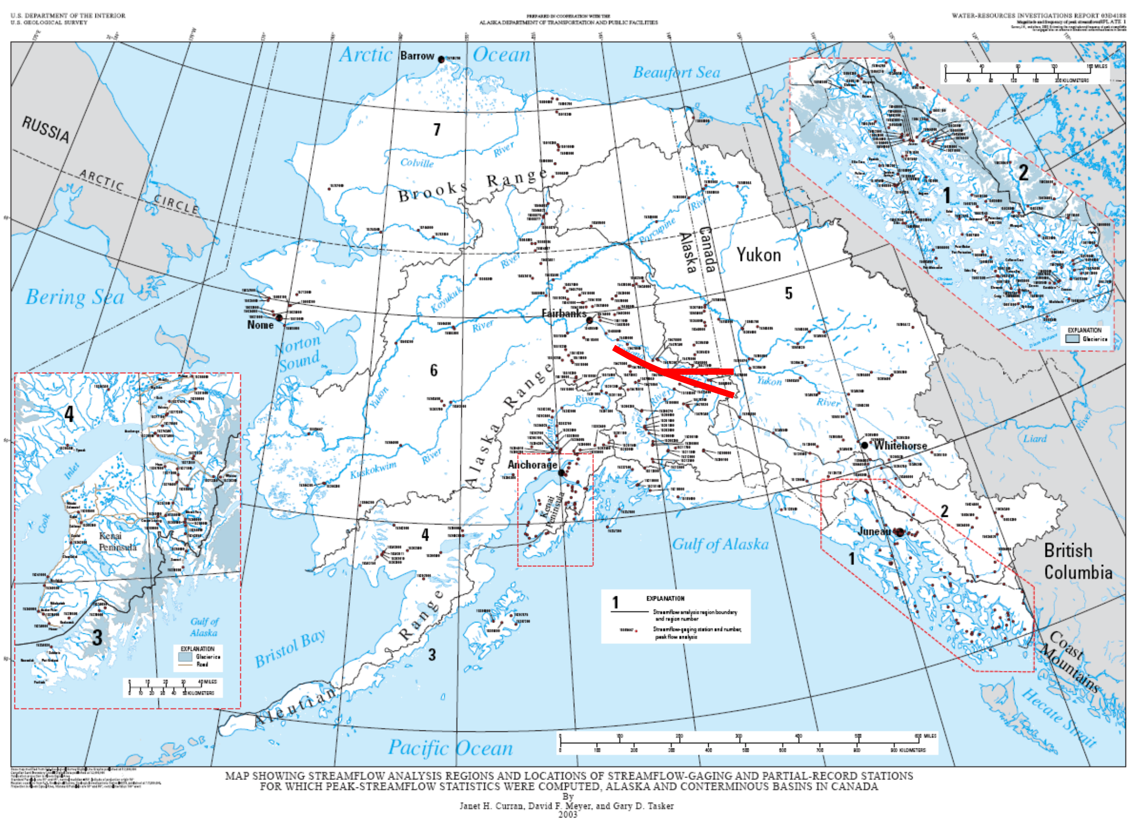
The main objective of the hydrologic and hydraulic engineering work is to provide water related engineering information needed for the stream crossing structures. Some features that are strongly influenced by the hydrology and hydraulic features include the bridge structure and foundations, the abutments, the approaches, adjacent sloughs that are a part of the braided channel system and the riparian flood plain system upstream and downstream of the location.

Once the hydrologic regime is known, the hydraulic engineering study determines the influence of the bridge structure on the stream channel and riparian features both upstream and downstream. Emphasis is given to the protection of the bridge structure, piers, abutments, and nearby riparian areas (Carlson et al. 2005).

The scope of this study is to locate the crossing points along the proposed route and provide surface water hydrologic and hydraulic information as much as possible for the cost estimation of the river crossing structures and other kinds of cross drainage structures for the feasibility study purpose. It will provide a basis for the detailed hydrologic and hydraulic analysis to be carried out during the EIS studies. Since there is very limited groundwater hydrology information available in the study area, there is no significant assessment of groundwater hydrology incorporated in this report. However, groundwater hydrology plays a very important role in the design of the railroad track, the slope stability, the aufeis accumulation, winter stream flow regime, survival of the aquatic creatures, spring and fall ice flows and jams, winter ice jams, debris flow and impact, and fish passage. The topomap, DEM data, Drainage network data, DOT bridge data along the Alaska Highway, Aerial photographs, Landsat images have been used to determine the with of each stream crossing.

Description of the Study Area

The study area starts from Delta Junction to the Alaska Canada Border following the Tanana River valley i.e. the Alaska Highway and the Ladue River as an alternate route diverging from the Tanacross. The area lies in the Interior Alaska between the Alaska Range in the south and the Brooks Range in the north. The proposed railroad routes and the drainage network in the study area has been show in Figure 2.



Source: http://pubs.usgs.gov/wri/wri034188/pdf/wri034188.plate_v1.10.pdf

Figure 1. Map showing the general location of the study area and the stream flow analysis regions for the use of the USGS regression equations.

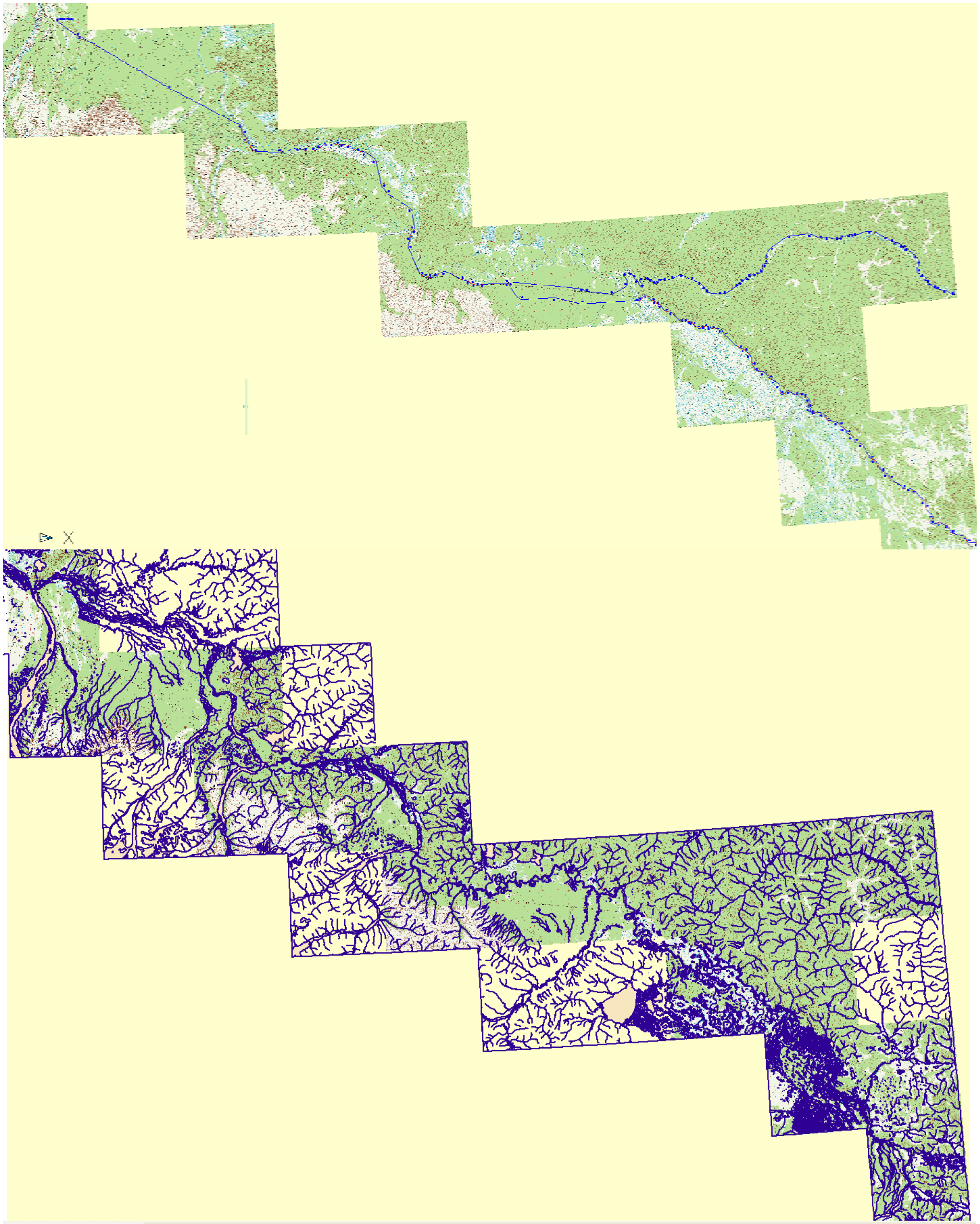


Figure 2 a. The proposed alternate railroad routes
b. the drainage network in the study area.

Alaska Highway Route

Major Bridges are those over 500 feet in length, and with the exception of Grestle River, have piers over 20 feet high: They are located over the following named rivers:

River	Length (ft)
Grestle River	1690
Johnson River	900
Robertson River	1840
Tanana River	950

Bridges less than 500 feet in length and piers less than 20 feet are located at the following river and stream crossings:

Stream	Length (ft)
Sawmill Creek	140
Little Grestle River	200
Dry Creek	300
Johnson Slough	200
Johnson Slough	200
Chief Creek	40
Bear Creek	80
Cathedral Rapid 2	70
Cathedral Rapid 1	70
Yerrick Creek	190
Tok River	240
Beaver Creek	80
Gardiner Creek	110

Bridges less than 500 feet in length and piers more than 20 feet are located at the following river and stream crossings:

Stream	Length (ft)
Unnamed Slough	150
Unnamed Slough	200
Sheep Creek	100
Cathedral Rapid 3	150
Bitters Creek	100
Silver Creek	100
10 Mile River	100
Sweet Water Creek	100
Scotty Creek	100

In addition to the above bridges, there are 68 identified small drainage courses that will require large diameter culverts with headwalls.

Ladue Route

Major Bridges are those over 500 feet in length, and with the exception of Grestle River, have piers over 20 feet high: They are located over the following named rivers:

River	Length (ft)
Grestle River	1690
Johnson River	900
Robertson River	1840
Tanana River	950

Bridges less than 500 feet in length and piers less than 20 feet are located at the following river and stream crossings:

Stream	Length (ft)
Sawmill Creek	140
Little Grestle River	200
Dry Creek	300
Johnson Slough	200
Johnson Slough	200
Chief Creek	40
Bear Creek	80
Cathedral Rapid 2	70
Cathedral Rapid 1	70
Yerrick Creek	190
Tok River	240

Bridges less than 500 feet in length and piers more than 20 feet are located at the following river and stream crossings:

Stream	Length (ft)
Unnamed Slough	150
Unnamed Slough	200
Sheep Creek	100
Cathedral Rapid 3	150
Unnamed Creek	100
Unnamed Creek	100
Unnamed Creek	100
Ladue River	150
Ladue River	150
Unnamed Creek	100
Unnamed Creek	100
Chicken Creek	100
Unnamed Creek	100
Ladue River	200
Ladue River	200
Ladue River	250
McArthur Creek	100

In addition to the above bridges, there are 60 identified small drainage courses that will require large diameter culverts with headwalls.

The U.S. Geological Survey (USGS) does not have streamflow-gaging stations exist near the proposed crossing sites on the three rivers being analyzed that provide data for peak streamflow magnitude and frequency estimations. Therefore, to estimate peak streamflow magnitudes for the 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year recurrence-interval flows, regression analysis equations developed and published by the USGS (Curran, et al, 2003) were used.

The USGS study has divided Alaska into seven streamflow analysis regions. Having similar hydrologic characteristics, all the stream crossings in this study area are located in the same USGS streamflow analysis Region 6.

$$Q2 = 52.87\ A^{0.8929}\ (ST+1)^{-0.2676}\ (F+1)^{-0.3076}$$

$$Q5 = 88.08\ A^{0.8479}\ (ST+1)^{-0.2596}\ (F+1)^{-0.2648}$$

$$Q10 = 115.7\ A^{0.8253}\ (ST+1)^{-0.2579}\ (F+1)^{-0.2443}$$

$$Q25 = 154.8\ A^{0.8026}\ (ST+1)^{-0.2585}\ (F+1)^{-0.2243}$$

$$Q50 = 186.7\ A^{0.7885}\ (ST+1)^{-0.2599}\ (F+1)^{-0.2124}$$

$$Q100 = 220.6\ A^{0.7764}\ (ST+1)^{-0.2616}\ (F+1)^{-0.2023}$$

$$Q200 = 256.6\ A^{0.7656}\ (ST+1)^{-0.2636}\ (F+1)^{-0.1935}$$

$$Q500 = 307.7\ A^{0.7530}\ (ST+1)^{-0.2662}\ (F+1)^{-0.1833}$$

Where, the independent variables:

A = drainage basin area (square miles)
ST = % of area of storage (lakes and ponds) in the drainage basin
F = % area of forests in the drainage basin

The approximate area of the catchments, forest area, and the area of storage within that catchments of each crossing was estimated using ArcGIS with DEM, drainage network data, and topomap.

Hydraulic Engineering

AREMA 2003 describes hydraulics as the study of water conveyance either through a conduit (conduit can be a small culvert or a multi-span bridge structure) under pressure or a conduit exposed to atmospheric pressure. It suggests that the main objective the engineer should try to achieve a safe and economical system that poses no danger to the railway operations or the adjacent property owners during a significant storm event.

Since the detailed hydraulic analysis of each river crossing wasn't feasible at the time when the data should have been provided for the estimation of the river crossings costs, the detailed analysis using ArcHydro, ArcGIS, HEC-GeoHMS, HEC-GeoRAS (www.hec.usace.army.mil) in an integrated approach is being carried out but has not been presented in this report. A number of other hydraulic factors will need to be addressed for the final design of the crossing site. These include additional scour and fill calculations, ice load and jamming potential, timber debris loading and related scour, fish passage and habitat impact. Careful attention will need to be given to sufficient bank protection for upstream and downstream banks, construction and protection of guide banks at the structures and protection of the abutments at each bridge end.

Conclusions

The United States government and the government of Canada are in need of a Railroad connection between Fairbanks and the existing railroad system of the northwest Canada for the economic and timely fashioned freight of their abundant mineral resources in the northern region and the basic infrastructure for the proposed North Slope Gas Pipeline Project. Since the proposed railroad has to cross hundreds of small and large rivers and some rivers are very much braided in nature and the spring breakup and aufeising of the rivers play a crucial role in the feasibility study. The present study identified the possible drainage crossings and their width for the estimation of the crossing structures like culverts and bridges. The topomap, DEM data, Drainage network data, DOT bridge data along the Alaska Highway, Aerial photographs, Landsat images have been extensively used to determine the width of each stream crossing. From the geotechnical and economical point of view the more stable and viable routes have been proposed along the Alaska Highway and along the Ladue River. There is no much significant difference in the number of crossings in both the alternates. The hydrologic and hydraulic features of the drainages along both routes play a very important role in the selection of the best alternative. The response of the hydraulic features of the project will determine their effects on the structure and of the structure on the nearby channel and riparian environment. Even though the results of the detailed hydrologic and hydraulic studies couldn't be presented in this report due to its timeframe and the scope of the level of the study, the present study will provide a very convenient platform for the detailed studies and final design of the river crossing structures.

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