ALASKA TRANSPORTATION CORRIDOR STUDY

Memorandum Reports — March 1972
Volume No. V

BASIC CONCEPTS

ROUTE ANALYSIS AND SELECTION

PRELIMINARY DESIGN

RECOMMENDATIONS FOR FINAL DESIGN

prepared for the

FEDERAL HIGHWAY ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION

prepared by

TUDOR—KELLY—SHANNON

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Dear Mr. Conyers:

With this letter we submit Memorandum Reports, Volume V, on the Alaska Transportation Corridor Study. This volume comprises four memorandum reports:

1. Basic Concepts, describing methods and procedures employed in the course of the Study for air photo interpretation, field reconnaissance, photogrammetric mapping and subsurface investigations;

2. Route Analysis and Selection, describing the methods and procedures used to evaluate the merits of alternative routes within the approved corridors and to develop specific horizontal and vertical alinements;

3. Preliminary Design, describing the major work elements comprising preliminary design; and

4. Recommendations for Final Design, describing the need for and the outline of a recommended program in the areas of mapping, subsurface investigation, test sections, hydrology and climatology.

Respectfully submitted,

TUDOR ENGINEERING COMPANY

Bela Vadasz

Bela Vadasz
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BASIC CONCEPTS

AIR PHOTO INTERPRETATION

Air photo interpretation was performed by examining and interpreting vertical air photos that overlap sufficiently to provide stereo images. Experienced air photo interpreters can quite accurately identify land forms, soil conditions and rock types, and surface drainage conditions; and they can predict engineering factors related to probable subsurface conditions, stability of streams, potential borrow sources, and surface drainage. When used in conjunction with reconnaissance in the field and subsurface investigations, air photo interpretation becomes an invaluable aid in locating the best potential routes and in identifying areas that should be avoided.

Air photo interpretation was used in three phases of the Study: during preliminary stages prior to reconnaissance; during reconnaissance studies and subsurface investigations; and during route selection and final preparation of soil maps. Early in the Study, all available air photos covering potential study areas were obtained. Using these along with United States Geological Survey (USGS) topographic maps, potential routes were selected in the office. These preliminary analyses permitted elimination of many miles of route unsatisfactory for one reason or another and greatly reduced the amount of field work by identifying in advance the routes that should receive reconnaissance in the field. During reconnaissance studies and subsurface investigations air photos provided substantial help in relating observed soil conditions to previous interpretations and in identifying boundaries of land forms and specific subsurface conditions. They also assisted the geologist in laying out subsurface investigations, and they were used to record boring locations. During preparation of large-scale soil maps on the 1 inch = 800 foot manuscripts, the air photos again served to identify land forms and soil boundaries and they were used extensively in detailed route selection.

At the beginning of the project air photos were obtained covering the following areas:

1. 1952 to 1955 – USGS black-and-white photos to a scale of 1:40,000 from Nenana to Tanana by way of Minto and the Rampart rapids, and from Tanana to Todatonten Lake.

2. 1955 – USGS black-and-white photos to a scale of 1:40,000 covering a portion of the North Slope.

3. 1955 – USGS rectified oblique black-and-white photos between Alatna and Kobuk and covering a portion of the Brooks Range.

4. 1968 – Alaska Railroad black-and-white photos to a scale of 1:12,000 from Dunbar to Nuklauket Pass by way of the Rampart rapids.

5. 1969 – Alaska Railroad color photos to a scale of 1:4,000 from Nuklauket Pass to Bettles, from Bettles up the John River to Anaktuvuk Pass, and from Bettles up the North Fork of the Koyukuk to the North Fork headwall.

6. 1969 - TAPS (Alyeska) black-and-white photos to a scale of 1:60,000 from Coldfoot to Sagwon.

7. 1969 – TAPS (Alyeska) black-and-white photos to a scale of 1:18,000 covering a few selected areas between Coldfoot and Sagwon.

The above photos were utilized both prior to and during reconnaissance and subsurface investigations performed during the summer and fall of 1970 and proved very helpful in interpreting subsurface conditions over the routes studied. The oblique photos, because of the angle and small scale, could not be used to full advantage. Interpretation of conditions through the Brooks Range from TAPS (Alyeska) photos was limited because they were taken late in the season when the higher ground was covered with snow.

During the summer of 1970 the USGS obtained additional photo coverage to a scale of 1:80,000 of the Bettles quadrangle and of a large part of the study area from the Brooks Range to the Arctic Ocean. Prints covering routes being studied were made available by the USGS early in the fall of 1970. These were very helpful for field and office work performed subsequent to their receipt.

As discussed elsewhere, black-and-white air photos were obtained as a part of this project to a scale of 1:48,000 for preparing topographic manuscripts and for analyzing and selecting routes. These photos provided added coverage and were utilized in identifying land-form types and boundaries for soil map preparation and in delineating specific alinements.

FIELD RECONNAISSANCE

Field reconnaissance accomplished three purposes: (1) it provided on-site verification of photo interpretation, (2) it eliminated less desirable routes from further study, and (3) it permitted selection of transportation corridors within relatively narrow limits. This phase of the work commenced in May, 1970, immediately following completion of office map and photo interpretation studies, and was completed in late September the same year. Review reconnaissance to acquire additional details in specific areas identified during office work took place during the spring and summer of 1971. Altogether the field reconnaissance covered approximately 3,000 miles of potential routes, and resulted in corridor selection for approximately 700 miles of railroad and 200 miles of highway.

The reconnaissance made use of fixed-wing aircraft for rapid generalized studies, and of helicopters for closer detailed study which included landings to observe exposures.

Most of the reconnaissance, except where two teams participated in the reconnaissance through the Brooks Range, was performed by one team of engineers and geologists. The primary reconnaissance team was made up of one soils engineer, one photo interpreter and one location engineer, under the direct supervision of assigned Project Managers. This team studied all potential routes including approaches to the Brooks Range, but not the passes. Because of the complexity of potential routes through the passes, these areas were studied by another team consisting of two engineering geologists and one location engineer.

As segments of the work were completed, each was reviewed by the Joint Venture and the best corridors were recommended to the Client for approval. Boundaries were then established for supplemental photography and mapping.

PHOTOGRAMMETRIC MAPPING

Topographic maps, based on aerial photogrammetry, covering the selected corridors were prepared for route analysis and selection and preliminary design. The required aerial photogrammetry was performed by the subcontractors of the Joint Venture for the majority of the area involved. Photogrammetric maps prepared for the Alyeska Pipeline Service Company (ALPS) were utilized for some 160 miles where the railroad extension and the pipeline share a common corridor: the canyons of the Middle Fork of the Koyukuk River, the Dietrich River and the Atigun River, and the floodplain of the Sagavanirktok River. Supplementary photogrammetric mapping by the subcontractors of the Joint Venture was required to cover some adjacent areas not included in the ALPS mapping.

After selection of the corridors, the areas requiring aerial photography were delineated on 1:63,360 or 1:250,000 USGS maps, as available. The 1:48,000 aerial photographs, with an 80-percent overlap, were taken at an altitude of 24,000 feet, using Zeiss and Wild cameras. The Nenana to Alatna corridor was flown in the summer of 1970. Aerial photography for the Prospect Creek to Kobuk corridor, via Bettles and Alatna, had originally been scheduled for the summer of 1971 but was accelerated and flown in 1970 to provide early maps for office work in the spring of 1971. The remainder, including alternatives not developed earlier, was flown in the summer of 1971. Some of the areas mapped for ALPS were reflown to obtain aerial photos of improved quality.

A third-order (closure of 1:5000) survey-control system was established for the Study. Horizontal control for the survey is based on USGS triangulation stations, United States Coast and Geodetic Survey (USC&GS) triangulation stations and United States Bureau of Land Management (BLM) electronic traverse stations. Vertical control is based on USGS and USC&GS vertical-angle bench marks. Coordinates for the new control points are based on the Alaska State Plane Coordinate System, Zones 4 and 5, as applicable.

The two major phases involved in the field survey work were the setting of suitably placed photo targets and the tying in of these targets to USGS control stations to provide horizontal and vertical control.

In most instances the photo targets were set in the field prior to flights. Where this was not possible because of schedule or weather restrictions, air-photo identification of ground features was used to spot points for photo control. The targets were located where possible two at each end of a six-model bridge, with an additional photo-control pass-point in every third stereo model. Elevations of all targets were established with an accuracy of plus or minus two feet by vertical-angle traverse.

A geodetic traverse, using electronic measuring devices and one second theodolites, was surveyed to establish the basic horizontal and vertical control. Additional control points were stubbed in from the USGS control stations or from the traverse.

To provide topography for alternative studies for an 18-mile section along the West Fork of the Atigun River, USGS control and 1:80,000 photography were used in conjunction with the 1:48,000 photography prepared for the Study. Points from the 1:80,000 photography were identified and transferred onto the 1:48,000 photography so the USGS control could be used without additional field surveys.

The topographic manuscripts were prepared on mylar-treated polyester film (mylar) at a scale of 1 inch = 800 feet covering approximately a five-mile width of topography. ALPS supplied 1 inch = 400 foot manuscripts for the corridor common with the proposed pipeline. The 1 inch = 800 foot manuscripts in these areas were compiled by photographic reduction of the ALPS manuscripts. The remainder of the 750 miles of coverage was compiled from aerial photography taken for the Study. Upon completion of the aerial photography and ground control surveys, pass points were selected on the photographs to fit the analytical aero-triangulation and photogrammetric mapping. The field survey points were processed by an electronic comparator to provide the horizontal and vertical control for the mapping. K&E and Kelch stereo plotters were used to prepare the topographic manuscripts.

The manuscripts show contours at 20-foot vertical intervals, except for the manuscripts obtained from ALPS, which have 10-foot intervals. Survey control points, spot elevations, and the State coordinate grid are shown as well as significant planimetric features discernible on the photography.

SUBSURFACE INVESTIGATIONS

Subsurface investigations were required to verify the results of air photo analyses and field reconnaissance studies, and to develop more detailed information on foundation conditions. The object of subsurface investigations which consisted of soil borings and geophysical studies was primarily to develop general information pertaining to land forms along the corridors rather than to develop soil profiles. Four borings at the Yukon River were drilled specifically to establish feasibility of a crossing at that location and to develop preliminary information for the bridge foundation.

The soils borings were performed by a subcontractor, commencing in August 1970 and continuing through September between Nenana and Alatna. Test holes for the bridge foundation at the Yukon River crossing were drilled between February and April 1971 while the river was covered with ice. Soil borings over the remainder of the project north of Alatna were performed from June to August 1971 and a few supplemental borings were added between Nenana and Alatna during the same time period.

Except for the Yukon River borings which were drilled by a large rotary drill, soil borings were drilled by small light-weight rotary drills transported by helicopter. Unfrozen materials were drilled using an auger bit, frozen materials were usually drilled with a core barrel. Representative samples were selected for laboratory testing for gradation, natural moisture, and Atterberg limits. The Yukon River borings were sampled at frequent intervals using standard penetration sampler and procedures, and selected representative samples were tested in the laboratory for gradation.

Following is a tabulation of soil borings performed within the Study area:

1. **Nenana to Alatna**

Total Number	105	
Average Depth	15.8	ft.
Total Depth	1,657	ft.

2. **Prospect Creek to Kobuk**

Total Number	116	
Average Depth	13.5	ft.
Total Depth	1,564	ft.

3. **Alatna to Prudhoe Bay**

Total Number	114	
Average Depth	11.6	ft.
Total Depth	1,319	ft.

4. Yukon River Crossing

Total Number

Land holes	2	
River holes	2	
Minimum Depth	137	ft.
Maximum Depth	204	ft.
Total Depth	709	ft.

TAPS (ALPS) borings totaling 129, were utilized between Coldfoot and Galbraith Lake for correlating subsurface data with air photo interpretation and observations made during field reconnaissance.

Locations and logs of soil borings together with pertinent TAPS (ALPS) borings are included with the plan and profile drawings.

Geophysical studies were performed by the Joint Venture for special purposes such as delineating frozen conditions; determining the location and extent of borrow materials; the character of certain landforms, such as talus slopes, morainal deposits, and alluvial fans; and the depth to bedrock in certain areas. Geophysical studies utilized both seismic and electrosensitivity methods.

Geophysical studies for the Yukon River crossing, performed in June 1970, utilized seismic methods to aid in evaluating foundation conditions, and fathometer soundings to develop river cross-sections at several points. Seismic work was performed at Round Point, the selected crossing site, and at another possible crossing upstream near Tanana village. Seventeen cross-sections were developed for hydrological purposes by sounding over a reach of the river approximately 30 miles long.

The locations of the sites where geophysical electroresistivity or seismic observations were made are shown on the plan and profile drawings.

ROUTE ANALYSIS AND SELECTION

The object of route analysis and selection was to determine the most feasible location for the highway and for the railroad within the corridors selected and approved prior to this stage of the Study. The bases of this activity were the 1 inch = 800 foot topographic manuscripts; the Criteria for Preliminary Design; operating and maintenance requirements; subsurface investigation; refinement of air photo interpretation; hydrology of major streams; and field reviews of topography, foundation conditions, snow and ice conditions, drainage, borrow sites, and structure sites.

The location of practically every mile of the highway and of the extensions of The Alaska Railroad is primarily governed by foundation conditions and only secondarily by grades and geometry. The method adopted for route analysis and selection therefore was first to map the broad outlines of soils, geologic, snow, and icing information on prints of the topographic manuscripts; then to lay out on the manuscripts routes and river crossings feasible from the standpoints of both foundation conditions and geometry. The hydrology of major streams and drainage courses, based on field observations and photo interpretation, was also considered in developing the alinements.

Alternatives were developed for numerous sections of the routes. Earthwork, borrow, structures, and drainage along with maintenance and operation costs were analyzed and comparative estimates prepared to arrive at recommendations offering the best balance between capital and recurrent expenditures. Statistics of The Alaska Railroad were reviewed in the early stages of the study on a basis of the few major accounting items: Maintenance of Way and Structures, Maintenance of Equipment, Transportation, and General and Administrative Expenses. Maintenance-of-way expenses were analyzed in greater detail, as described in Interim Report 1. These major groups of expenses were then broken down, based on national averages and Interstate Commerce Commission statistics, into variable costs and fixed costs. The variable costs are a function of traffic, length of line, rise and fall, curvature, and foundation and climatological conditions; the fixed costs are independent of the above factors. The approximate unit operating and maintenance costs for each segment were estimated by adjusting the variable costs to reflect the prevailing various traffic, geometric, and foundation conditions. Traffic assignments used for this purpose are described in detail in Interim Report 2.

This method is not accurate enough to develop a reliable operating budget for a future railroad, especially with an increase of such magnitude in traffic and length. It is, however, adequate to serve as a basis for preliminary design criteria and for economic comparisons among alternatives, complementing construction cost comparisons.

Because of the greater uncertainties and special non-quantifiable hardships involved with maintenance in these frozen regions, alternatives offering less maintenance or more favorable foundation and operation conditions were sometimes preferred even where economics might have suggested otherwise. The railroad alinements in the valleys of the Kobuk, the Koyukuk, and the upper Tozitna Rivers exemplify these principles: in all three instances more expensive floodplain alternatives were preferred to less costly sidehill alinements. A longer tunnel through the Brooks Range, offering a better profile, superior geological and topographical conditions, and a more direct route, was preferred to a longer, less expensive alternative utilizing a shorter tunnel.

Efforts were made to develop horizontal and vertical alinements offering balanced earthwork in areas where this was practicable. It should be noted that, because of the foundation conditions peculiar to the regions traversed, only a few attempts in this direction were successful. In most areas frozen or unstable materials prohibit cuts and materials excavated from cuts are not suitable for the construction of stable embankments. In addition, embankments are required to provide insulation in permafrost areas, flood-clearance in floodplains, and protection against snowdrifting in other areas.

The recommended railroad and highway routes and alternatives were presented for approval to the representatives of the Department of Transportation, The Alaska Railroad, and the Alaska Department of Highways in sections varying in length from 40 to 150 miles. This procedure of incremental approvals facilitated the utilization of manpower and provided a more even distribution of work load.

A number of physical conflicts of the railroad with the proposed Alyeska Pipeline Service Company (ALPS) pipeline and service road were encountered in the valleys of the Middle Fork of the Koyukuk River, and the Dietrich, Chandalar, Atigun, and Sagavanirktok Rivers. Current drawings of the pipeline and service road facilities were procured in late 1971. All physical conflicts between the railroad and the ALPS facilities were identified and individually analyzed. Where practicable, the railroad alinement was modified to avoid the conflict. Where this was not engineeringly or economically feasible, an alternative pipeline or service-road alinement was developed and recommended to ALPS. As no comments had been received from ALPS, it was assumed for estimating purposes that the pipeline and the service road would be built prior to the beginning of railroad construction and would incorporate the recommended modifications.

Trestles or special structures are contemplated for pipeline crossings. As the vertical alinement of the pipeline has not been determined yet for most crossing locations, the railroad profile was established to provide adequate vertical clearance to accommodate an elevated pipe. Grade crossings are contemplated for most of the service-road crossings. The costs of minor horizontal and vertical revisions of the road at the sites of future railroad crossings were included in the cost estimate.

In a few instances the highway or railroad alinement is in physical conflict with existing winter trails. Costs for crossing or relocating the trails were included in the estimate.

PRELIMINARY DESIGN

The object of preliminary design was to refine and update the approved routes with additional soils, structural, hydrologic, and geometric data. Major structures located in route analysis were more fully investigated to locate abutments and piers. Lengths and other details of major structures were established. The locations and lengths of trestles were determined. The tentative profiles were refined to reflect additional soils and hydrologic information, and the final plans and profiles were projected onto the plan and profile drawings. Index drawings and condensed profiles were compiled, along with other special drawings. Quantity estimates, described elsewhere, were also included in the preliminary design phase.

EARTHWORK

Foundation conditions largely control alinement throughout the project. River floodplains in the Study's confines usually furnish adequate quantities of construction materials and generally consist of clean, coarse, granular materials which make the best foundations for embankments and are subject to little or no settlement after construction. A substantial portion of the recommended alinement follows floodplains.

Young floodplains south and north of the Brooks Range usually have a thin silty cover over gravel, but little or no organic cover while old floodplains usually have a thicker silty cover and several feet of peat or other organic material. All floodplain materials north of the Brooks Range are almost always permanently frozen except for a thin active zone; old floodplain overburden materials are icy and contain segregated ice. South of the Brooks Range young floodplains are seldom permanently frozen while old floodplains are permanently frozen but tend to be somewhat less icy than north of the range.

Bedrock furnishes excellent roadbed foundation and can be crossed by either cuts or fills. Unfortunately bedrock comprises only a small part of the alinement. Cuts were kept to a minimum and daylighted for ease of snow removal.

Except for floodplain gravels and bedrock, all other materials, to some extent, have undesirable characteristics for roadbed foundations. Many of these materials are fine grained and many are frozen with segregated ice. Frozen, icy materials are subject to instability and settlement when crossed by roadways that provide insufficient insulation and cuts are subject to continued degradation of the roadbed and cut slopes.

South of the Yukon River, fine-grained materials comprise many miles of roadbed foundations. In this reach, the materials are subject for the most part to seasonal frost; permafrost, where present, contains a minimum amount of segregated ice and probably extends to limited depth. Over this reach the alinement usually follows higher ground where drainage and moisture conditions are most favorable. Foundation problems on lower ground are related principally to freezing and thawing. In this area where permafrost is sporadic there is little likelihood of preserving permafrost. Therefore, where on lower ground, fills of adequate height are provided to insulate the foundation against deep seasonal freezing to minimize heaving.

Between the Yukon River and the Brooks Range there are a number of places where the alinement must cross frozen moraines, silty colluvial slopes and deep, icy alluvial materials. The alinement was established to avoid cuts in these materials. Properly designed and constructed embankments are required to preserve frozen foundation conditions. The selected alinement follows the best drained areas and those likely to contain the least segregated ice, insofar as possible. The preliminary design provides fills in excess of minimum theoretical heights to keep the foundation from thawing. Preliminary design of the slopes considers that they would be insulated by the addition of peat and fines from foundation and borrow stripping to preserve foundations beyond the roadway shoulders. Winter construction will be required in some areas to preserve the permafrost.

North of the Brooks Range the alinement follows substantial reaches of floodplains and alluvial fans where foundations are granular and not subject to excess settlement. The alinement also crosses a long reach of morainal materials, and for the last thirty miles it follows nearly flat coastal plains with several feet of icy silt and segregated ice overlying gravel. Although frozen and probably containing some ice, these morainal materials are coarse and stony, and not likely to be subject to large settlements and instability. Moreover, ground temperatures and average air temperatures are low. The preliminary design provides for continuous fills to preserve the frozen foundation and this can be achieved by lesser fill heights than south of the Brooks Range. These fills are of about the same height as those proven successful in the Prudhoe Bay area.

Surface drainage is the single most important earthwork design feature. Surface water seeping through or beneath fills brings in heat and thaws foundation material. When foundations contain segregated ice or are frozen with high moisture content material, detrimental settlement can be expected if thawing occurs. The preliminary design provides continuous drainage throughout all frozen areas where improper control could result in damage to fill foundations. The precise layout of drainage ditches and control structures will become a most important feature of final design.

SOILS DATA

Soils data shown on manuscripts and plan and profile drawings include classifications and land-form boundaries, locations and depths of soil borings, generalized logs of foundation conditions, and typical roadbed sections. Land-form descriptions are in accordance with standard terminology and are based upon air photo interpretation and analyses of other data collected during field reconnaissance, subsurface explorations, and laboratory testing.

Soils descriptions are very general because land-form composition, such as type, occurrence, moisture and ice content can have a wide variation. Therefore, soil descriptions are intended to indicate the predominant type and character of material, but do not attempt to describe all types and variations that occur.

Locations and depths of soil borings, and composite logs are shown on plan and profile drawings. Individual boring logs and laboratory test data are shown on special drawings. The composite logs indicate the variation in conditions expected throughout a land form. A typical composite log shows the expected variation in depth of peat on the surface, expected variations in thickness and type of fine soils and approximate depths to gravel. It also shows where materials are likely to be frozen and the probable occurrence of segregated ice.

HYDROLOGY

Field hydrologic observations were used in delineating the initial routes. These were later supplemented by the calculation of stream flows and high-water elevations.

The 50-year and 100-year flood discharges for major streams at specific locations were provided by the U. S. Army Corps of Engineers from a regional frequency analysis. These discharges are approximate but adequate for preliminary design. Peak discharges for other locations along major streams were derived by modifying the Corps' discharges by interpolation, proration, or addition or subtraction of tributary drainage areas. Approximate high-water surface elevations were calculated for major structures and embankments in floodplains, based on the peak discharge, topographic data, and assumed channel cross-section and roughness coefficient. The channel section of the Yukon River was defined by geophysical soundings.

Minor drainage courses were located and drainage areas delineated on the 1 inch = 800 foot scale manuscripts, 1:63,360 or 1:250,000 USGS maps, or on aerial photographs. Peak discharges were calculated using the "Rational Method," BLM standards, or a constant per-mile discharge, as set forth in the Criteria for Preliminary Design. Culverts were sized in accordance with nomographs pubished by the Bureau of Public Roads for corrugated metal pipes. Relief culverts of the same capacity were placed at a higher level in deep embankments to facilitate drainage during icy periods. Equalizing trestles and culverts were provided where embankments are located in active floodplains, cross active sloughs or cut off loops of major streams.

At some streams, trestles were provided where heavy debris-runoff was expected, even though culverts would have been hydraulically adequate. Where the railroad line crosses alluvial fans with unstable drainage courses debris traps were provided to protect the trestles and the roadway.

STRUCTURES

Bridge structures for the Study include major highway bridges, major railroad bridges and railroad trestles. The major railroad and highway structures are listed in Figures 1 and 2. Other structures are drainage culverts, terminal and mad maintenance buildings and a railroad tunnel.

Preliminary bridge design entailed the study of each significant stream crossing in sufficient detail to establish the location of the site, the span configuration and the foundation type and depth. Design was performed in sufficient detail to serve as a basis for quantity and cost estimates. In the interest of economy, simple, standardized details in modular systems were developed for both superstructures and substructures.

Initial site selection was based upon stereoscopic study of aerial photographs. Alternative structure locations were selected and then evaluated based on alinement, grade and soil considerations. Channel stability, hydrologic conditions, structure durability, and economy were considered in selecting these crossings. Final structure locations are shown on the plan and profile sheets.

Structure lengths and span configurations were established after the alinement was approved. The length and grade are predominantly dependent on hydrology, topography and navigational clearance requirements. After selecting a reasonable structure length to accommodate the predicted 100-year flood discharge, the design high-water elevations were calculated. Clearances above the high-water elevations were provided for the passage of ice, stream-borne debris and navigational requirements.

Using the hydrologic information, substructure design, and riverbed geology, scour depths were estimated. The pier footings were founded below the estimated natural scour depth.

Protection at abutments from the effects of scour is provided bythe use of heavy stone riprap. Where scour is expected to be a serious problem, stone spur dikes or training walls were provided. Typical spur-dike layouts are shown on Figures 3 and 4.

All piers and abutments are supported on H-piles which are suitable for driving in dense sands and gravels. The penetrations required to support the design loads were estimated from preliminary soil and geological investigations. Some piles were battered to develop additional resistance to lateral and longitudinal forces.

Pier footings were sized to accommodate the required number of piles and to resist overturning moments. To withstand and deflect floating debris and ice, the upstream nose of the pier shaft is armored and wedged. This wedge shape also serves to promote laminar flow which reduces hydraulic forces and local scour. At abutments a sub-backwall is provided to allow expansion and contraction of approach fills due to seasonal frost. Typical substructure details for railroad and highway bridges are shown on Figures 6 and 7.

All railroad bridges were designed for single track with non-ballasted open deck. The highway bridges have a 40-foot clearance between railings to accommodate future widening of the roadway.

Steel meeting the requirements of American Society for Testing and Materials (ASTM) A588 was used for preliminary superstructure design. Its corrosion-resistant properties will greatly reduce maintenance costs and its high strength characteristics will reduce steel quantities. Another important feature of low-alloy steel is the retention of ductile characteristics at the low temperatures experienced in the arctic environment. In order to provide optimum structural integrity, it was assumed that all welding would be performed and inspected in the controlled atmosphere of the fabrication plant. All field connections would be bolted to eliminate field welds and to speed erection.

The two fundamental types of superstructures used for this Study are girders and trusses. Modular truss and girder designs were used for all major bridges except the Yukon River bridge. The basic truss, used only for railroad bridges, is a through-type Warren system with a curved upper chord. Portal height is adjusted to assure adequate clearance and mid-span depth is based on current practice for economy. The width of the bridge is at least one twentieth of the span length, and the bay or floor-beam spacing is based on economy of the floor system and vertical truss bracing. Since truss-type structures are very effective in terms of weight optimization for intermediate to long-span structures, this system was used where spans over 270 feet were required. A typical truss structure is shown on Figure 3 and typical details are included in Figure 6.

The nature of the Yukon River, with its substantial flow, comparatively high velocity, attendant scour, and massive ice flows at breakup, dictates a structure with a minimum number of water piers. In order to achieve these long spans and provide navigational clearances, a through-type cantilevered truss system with five continuous spans was designed. An alternative is included for adding a two-lane highway to this structure which increases the required structural steel quantity by approximately 20 percent. A conceptual drawing of this structure is shown on Figure 8 and general details unique to this structure are shown on Figure 9.

Girder-type superstructures were used for preliminary design of all highway bridges and for railroad bridges with spans up to 270 feet in length. With girders, overhead obstruction is eliminated and the appearance of the simple structural system is aesthetically attractive. For long-span highway girders, economy is realized by haunching the section at supports. The maximum depth considered was 15 feet to permit shipment on the existing Alaska Railroad. Typical girder design are shown on figures 4 and 5, and typical details are included in Figures 6 and 7.

Basic prestressed concrete railroad trestles with ballasted decks are recommended to minimize maintenace. The standard prestressed box girders and precast pier caps follow the design established in the Manual of Recommended Practice of the American Railway Engineering Association (AREA). Steel H-piles will be driven to penetrations sufficient to develop the required bearing capacity and to resist ice-jacking forces. Pile sections will be extended from the ground to the pier caps with adequate cross bracing.

Tunneling is assumed to be through rock having a wide range of quality from poor to good. It is also assumed there will be faults, squeezing ground, and ground water. For this preliminary design, the tunnel section is fully lined with reinforced concrete. General details for the lining, drainage, and miscellaneous features follow design provisions described in the AREA manual. The profile grade slopes in each direction to facilitate drainage and construction. Portals are designed to contain local sloughing and to distribute seepage and drainage accumulation without developing erosion or icing problems. Automatic doors are provided to improve ventilation.

PLAN AND PROFILE DRAWINGS

Upon route approval, 24-inch by 36-inch mylar plan and profile drawings were prepared for preliminary design. The plan section was prepared from the aerial photography and the topographic manuscripts. A 1.5 mile wide strip of aerial photography, 20 inches wide in the 1 inch = 800 foot scale, was the basis for the plan section. Appropriate individual air photos were enlarged for this purpose. Contours, control points, spot elevations, grid ticks, and grid coordinates were scribed from the topographic manuscripts.

The plan section shows the centerline of the track with 1,000-foot station markers and mileposts, the degree of curve, bridge and trestle abutments with length of structure, and locations of culverts with diameters of 72 inches or greater. In addition, boring locations, channel relocations, and borrow areas were plotted along with existing topographic features and significant geological and soil conditions.

The profile section, on a screened grid with a horizontal scale of 1 inch = 800 feet and a vertical scale of 1 inch = 80 feet, shows the ground line at the track centerline and the top of rail grade line. Gradients, vertical curves, bridges, trestles, and culverts with diameters of 72 inches or greater are indicated.

The plan and profile drawings also show composite boring logs and types of cross-sections used. A 1-1/2 inch wide blank strip for typical sections and other information was also provided on the standard plan and profile drawings.

Figures 10 through 14 show representative samples of completed plan and profile drawings.

Special drawings indicating other details such as survey control, typical sections, condensed profile, and soils data were prepared to complement the plan and profile drawings.

Route	No.	Stream	Station Begin Bridge	Bridge Length	Type of Superstructure	Spans - C/L Bearings	Est. H.W.	Design Flood Q100 in cfs	Abutments	Piers (Av. Ht.)	Pile Loading, Tons Abuts.	Pile Loading, Tons Piers	Structure Concrete Cu. Yd.	Structural Steel Lbs.	Reinf. Steel Lbs.	Piling L.F.	Rock Protection Cu. Yd.	Structural Excavation
		LOCATION AND DESIGN DATA											ESTIMATED QUANTITIES					
Nenana To Alatna	1	Nenana River	52+95	815'	Truss	400'-400'	360	86,500	2@ Type II	1@ 70'	40	80	1400	2,680,000	210,000	9700	28,000	1400 C.Y.
	2	E. Middle River	186+65	160'	Girder	45'-60'-45'	360	—	2@ Type I	2@ 40'	20	30	630	90,000	120,000	7100	2,000	1000 C.Y.
	3	W. Middle River	221+70	160'	Girder	45'-60'-45'	360	—	2@ Type I	2@ 40'	20	30	630	90,000	120,000	7100	2,000	1000 C.Y.
	4	Kantishna River	1595+25	1015'	Truss	500'-500'	298	120,000	2@ Type II	1@ 76'	60	80	1470	4,230,000	220,000	14,200	28,000	1940 C.Y.
	5	Zitziana River	2655+15	355'	Girder	105'-135'-105'	298	26,900	2@ Type I	2@ 35'	20	40	680	480,000	110,000	7,400	2,000	1250 C.Y.
	6	Cosna River	4207+65	355'	Girder	105'-135'-105'	239	22,200	"	2@ 42'	20	40	760	480,000	120,000	8,100	2,500	1000 C.Y.
	7	Chitanana River	4638+35	460'	Girder	90'-120'-135'-105'	264	24,500	"	2@ 42'	20	40	1030	630,000	170,000	11,400	2,700	1880 C.Y.
	8	Yukon River	6289+55	3590'	See Dwg.	—	220	1,335,000	2@ Type I	2@100', 4@112'	30	110	25,560	22,965,000	3,614,000	60,500	35,000	49,750 C.Y.
	9	Tozitna River #1	6806+20	510'	Truss	500'	272	41,500	2@ Type II	—	60	—	200	2,120,000	37,000	4340	28,000	—
	10	Tozitna River #2	7311+70	505'	Girder	150'-195'-150'	354	38,000	2@ Type I	2@ 43'	30	50	880	980,000	130,000	6,050	2,400	1400 C.Y.
	11	Tozitna River #3	7440+70	505'	Girder	150'-195'-150'	378	37,000	"	2@ 43'	30	50	880	980,000	130,000	6,050	2,200	1400 C.Y.
	12	Tozitna River #4	7815+30	445'	Girder	135'-165'-135'	461	34,000	"	2@ 35'	30	50	780	720,000	130,000	6,050	2,000	1500 C.Y.
	13	Tozitna River #5	7970+00	445'	Girder	135'-165'-135'	490	21,600	"	2@ 38'	30	50	720	720,000	110,000	8800	1,500	1250 C.Y.
	14	Dagislahkna Creek #1	8047+00	310'	Girder	90'-120'-90'	503	18,000	"	2@ 38'	20	40	720	390,000	110,000	6700	2,000	1100 C.Y.
	15	Dagislahkna Creek #2	8165+30	310'	Girder	90'-120'-90'	524	14,500	"	2@ 32'	20	30	640	390,000	100,000	4850	1,400	1000 C.Y.
	16	Dagislahkna Creek #3	8398+00	205'	Girder	60'-75'-60'	570	9,100	"	2@ 31'	20	30	630	130,000	100,000	6550	1,400	750 C.Y.
	17	Dagislahkna Creek #4	8527+20	265'	Girder	75'-105'-75'	600	8,600	"	2@ 34'	20	30	660	300,000	100,000	6700	1,500	750 C.Y.
	18	Mentanontli River #1	11850+40	355'	Girder	105'-135'-105'	490	17,000	"	2@ 42'	20	40	760	480,000	130,000	5700	15,000	1250 C.Y.
	19	Mentanontli River #2	12166+70	310'	Girder	90'-120'-90'	425	17,000	"	2@ 38'	20	40	710	390,000	110,000	5200	2,200	1100 C.Y.
	20	Kanuti River	12345+50	565'	Girder	165'-225'-165	415	63,000	"	2@ 50'	40	80	1430	1,350,000	220,000	9100	24,000	1900 C.Y.
	21	Koyukuk River #1	13403+90	985'	Girder 120'-Truss 500'-Girders 105'-135'-105'		420	180,000	"	2@72', 2@66'	30	M-70, 6-50	3410	2,820,000	550,000	15800	28,000	3560 C.Y.
Alatna To Prudhoe Bay	22	Henshaw Creek	14013+50	310'	Girder	90'-120'-90'	487	30,000	"	2@ 36'	20	40	740	390,000	120,000	6600	1,500	1000 C.Y.
	23	Peavey Creek	14574+20	160'	Girder	45'-60'-45'	494	3,000	"	2@ 36'	20	30	740	90,000	120,000	5050	1,500	800 C.Y.
	24	Koyukuk River #2	14697+45	1460'	Gir. 120'-Tr. 450'-Gir. 135'-180'-240'-180'-135'		506	145,000	"	2@55', 4@57'	30	60	4450	4,000,000	670,000	24,480	24,000	5860 C.Y.
	25	Freak Creek	15108+20	160'	Girder	45'-60'-45'	534	1,500	"	2@ 35'	20	30	730	90,000	120,000	5,350	1,800	750 C.Y.
	26	Koyukuk River #3	16354+10	820'	Girder	120'-210'-270'-210'	659	89,100	"	1@36', 2@42'	50	(1)50, (2)70	1970	2,420,000	320,000	11,850	20,000	2300 C.Y.
	27	Channel	16447+20	220'	Girder	60'-90'-60'	684	—	"	2@ 34'	20	30	720	160,000	120,000	5700	1,500	850 C.Y.
	28	Koyukuk River #4	16779+50	730'	Girder	180'-240'-180'-120'	727	54,000	"	2@ 50', 1@45'	40	(2)60, (1)50	1820	1,810,000	290,000	5490	20,000	2450 C.Y.
	29	Middle Fork #1	16900+70	610'	Girder	180'-240'-180'	731	55,000	"	2@ 55'	40	60	2770	1,580,000	250,000	4440	24,000	2380 C.Y.
	30	12 Mile Creek	18081+60	160'	Girder	45'-60'-45'	968	4,000	"	2@ 35'	20	30	710	90,000	110,000	4850	800	750 C.Y.
	31	Middle Fork #2	18270+70	925'	Girder	150'-195'-225'-195'-150'	995	44,300	"	4@ 35'	30	50	1910	2,290,000	270,000	13,560	11,000	3540 C.Y.
	32	Slate Creek	18450+30	205'	Girder	60'-75'-60	1040	5,590	"	2@ 36'	20	30	740	130,000	120,000	5550	1,500	580 C.Y.
	33	Marion Creek	18681+80	205'	Girder	60'-75'-60'	1095	3,980	"	2@ 38'	20	30	710	130,000	120,000	5550	12,000	580 C.Y.
	34	Middle Fork #3	18966+20	505'	Girder	150'-195'-150'	1160	38,700	"	2@ 42'	30	50	860	980,000	120,000	6700	20,000	1250 C.Y.
	35	Wiseman Creek	19045+90	160'	Girder	45'-60'-45'	1180	3,600	"	2@ 30'	20	20	620	90,000	100,000	4850	900	750 C.Y.
	36	Hammond River	19277+60	250'	Girder	75'-90'-75'	1223	9,800	"	2@ 35'	20	30	680	190,000	110,000	5700	1,200	1000 C.Y.
	37	Middle Fork #4	19291+00	400'	Girder	120'-150'-120'	1222	28,300	"	2@ 35'	30	40	780	600,000	110,000	6200	1,500	1000 C.Y.
	38	Middle Fork #5	20010+60	400'	Girder	120'-150'-120'	1382	26,000	"	2@ 40'	30	40	840	600,000	120,000	6200	2,000	1250 C.Y.
	39	Middle Fork #6	20034+00	310'	Girder	90'-120'-90'	1383		"	2@ 37'	20	40	800	390,000	110,000	5700	1,500	1150 C.Y.
	40	Dietrich River	20153+45	400'	Girder	120'-150'-120'	1415	12,100	"	2@ 79'	30	60	1220	600,000	210,000	6900	42,000	800 C.Y.
	41	Gordo Creek	20220+80	400'	Girder	120'-150'-120'	1453	1,500	"	2@ 32'	30	40	540	600,000	100,000	5850	1,500	800 C.Y.
	42	Atigun River #1	23480+20	310'	Girder	90'-120'-90'	3138	3,490	"	2@ 75'	20	50	1070	390,000	200,000	1800	3,500	750 C.Y.
	43	No Name Creek #1	24117+60	160'	Girder	45'-60'-45'	2654	1,470	"	2@ 25'	20	30	450	90,000	90,000	1800	800	600 C.Y.
	44	Atigun River #2	24422+70	400'	Girder	120'-150'-120'	2623	10,800	"	2@ 99'	30	70	1300	600,000	240,000	1800	5,500	1000 C.Y.
	45	Kuparuk River	25719+50	160'	Girder	45'-60'-45'	1960	4190	"	2@ 56'	20	40	940	90,000	160,000	1800	2,500	750 C.Y.
	46	Toolik River #1	26168+20	250'	Girder	75'-90'-75'	1328	6,960	"	2@ 35'	20	40	580	190,000	110,000	1650	1,800	750 C.Y.
	47	Toolik River #2	27108+50	310'	Girder	90'-120'-90'	1081	9,000	"	2@ 35'	20	40	580	390,000	110,000	1650	1,500	750 C.Y.
	48	Toolik River #3	27376+50	265'	Girder	75'-105'-75'	972	13,000	"	2@ 37'	20	40	600	300,000	110,000	1650	1,500	750 C.Y.
	49	No Name Creek #2	28319+60	160'	Girder	45'-60'-45'	580	4,040	"	2@ 38'	15	30	610	90,000	120,000	1650	1,500	750 C.Y.
	50	Toolik River #4	28340+90	355'	Girder	105'-135'-105'	578	18,000	"	2@ 35'	20	40	560	480,000	110,000	1650	2,000	1000 C.Y.
	51	Toolik River #5	28496+00	355'	Girder	105'-135'-105'	543	18,000	"	2@ 35'	20	40	680	480,000	110,000	1650	2,000	750 C.Y.
	52	Toolik River #6	29003+90	400'	Girder	120'-150'-120'	410	33,000	"	2@ 30'	30	40	620	600,000	100,000	1650	2,000	750 C.Y.
	53	Toolik River #7	29151+30	400'	Girder	120'-150'-120'	378	58,000	"	2@ 45'	30	50	780	600,000	130,000	1650	2,500	750 C.Y.
Alatna To Kobuk	54	Alatna River	1444+40	1240'	Girder	165'-(4)@225'-165'	478	90,000	"	5@ 45'	40	50	2760	3,050,000	440,000	18750	20,000	4760 C.Y.
	55	Siruk Creek	1992+00	400'	Girder	120'-150'-120'	560	18,000	"	2@ 80'	20	60	1140	600,000	210,000	3050	7,000	1000 C.Y.
	56	E. Fork Hogatza River	3161+80	205'	Girder	60'-75'-60'	715	7,800	"	2@ 38'	20	30	710	130,000	110,000	5350	1,800	1000 C.Y.
	57	N. Fork Hogatza River	3213+60	205'	Girder	60'-75'-60'	715	6,210	"	2@ 57'	20	30	700	130,000	110,000	5350	1,500	1000 C.Y.
	58	Kobuk River #1	4875+50	550'	Girder	165'-210'-165'	360	38,100	"	2@ 58'	40	50	1130	1,220,000	160,000	8520	15,000	1700 C.Y.
	59	Akpelik Creek	5254+90	160'	Girder	45'-60'-45'	335	5,110	"	2@ 27'	20	20	580	90,000	90,000	5200	600	850 C.Y.
	60	Kobuk River #2	5479+70	610'	Girder	180'-240'-180'	308	42,700	"	2@ 38'	40	50	1190	1,580,000	170,000	7200	20,000	1840 C.Y.
	61	Kobuk River #3	5728+20	610'	Girder	180'-240'-180'	277	43,200	"	2@ 42'	40	50	1270	1,580,000	190,000	9150	15,000	2040 C.Y.
	62	Selby River	5887+80	250'	Girder	75'-90'-75'	262	6,000	"	2@ 30'	20	30	620	190,000	100,000	5700	1,400	1000 C.Y.
	63	Kobuk River #4	5936+90	700'	Girder	210'-270'-210'	244	47,000	"	2@ 38'	50	60	1190	2,170,000	170,000	9150	1,500	2040 C.Y.
	64	Pah River	6268+50	550'	Girder	165'-210'-165'	225	21,900	"	2@ 43'	40	50	1160	1,220,000	190,000	7520	4,000	1700 C.Y.
	65	Kobuk River #5	6361+50	700'	Girder	210'-270'-210'	218	61,500	"	2@ 43'	50	60	1290	2,170,000	190,000	9680	20,000	1900 C.Y.
	66	Killik River	6513+30	160'	Girder	45'-60'-45'	209	3,580	"	2@ 40'	20	30	740	90,000	120,000	5550	1,200	750 C.Y.
	67	Kobuk River #6	6555+40	700'	Girder	210'-270'-210'	205	62,500	"	2@ 53'	50	70	1490	2,170,000	230,000	10,000	20,000	2500 C.Y.
	68	Angutikada Creek	6994+70	160'	Girder	45'-60'-45'	170	5,000	"	2@ 35'	20	30	570	90,000	110,000	5200	1,000	1100 C.Y.
	69	Kobuk River #7	7496+50	700'	Girder	210'-270'-210'	125	84,500	"	2@ 55'	50	70	1530	2,170,000	230,000	10,110	24,000	2000 C.Y.
	70	Kobuk River #8	7592+70	505'	Girder	150'-195'-150'	124		2@ Type I	2@ 50	30	50	960	980,000	140,000	7050	20,000	1500 C.Y.

DESIGNED BY C.P.S.
DRAWN BY K.B.
CHECKED BY A.H.W.

TUDOR – KELLY – SHANNON
ALASKA TRANSPORTATION CORRIDOR CONSULTANTS
SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA

APPROVED: [signature]

FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION
ALASKA TRANSPORTATION CORRIDOR STUDY

MAJOR RAILROAD STRUCTURES

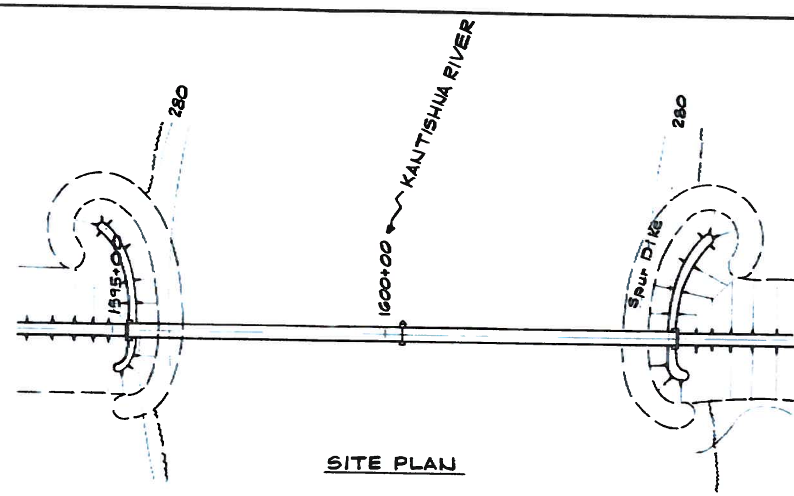
SCALE: NONE
DATE: APR 30 72
DRAWING NUMBER
SHEET 158 OF 235

Figure 1

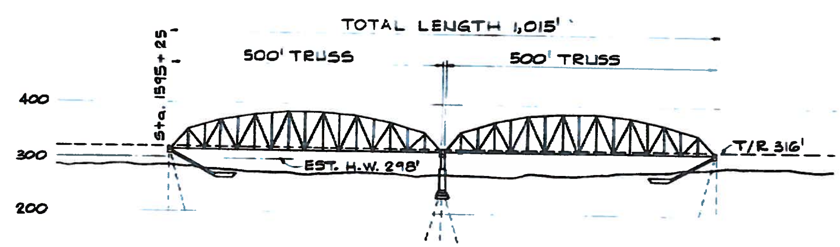
Stream	Station Begin Bridge	Bridge Length	Type of Superstructure	Spans - ℄ Bearings	Est. H.W.	Design Flood Q_{100} in cfs	Abutments	Piers (Av. Ht.)	Pile Loading, Tons: Abuts.	Pile Loading, Tons: Piers	Structure Concrete Cu. Yd.	Structural Steel Lbs.	Reinf. Steel Lbs.	Piling L.F.	Rock Protection Cu. Yd.	Structural Excavation Cu. Yd.	Superstructure Deck Sq. Ft.	Bridge Railing L.F.
HIGHWAY BRIDGES																		
1 Jim River	70+80	310'	Girder	90'-120'-90'	876	19,000	2 @ Type IV	30'	20	40	930	320,000	130,000	7260	1,400	1360	12,400	620
2 South Fork Koyukuk River	659+70	415'	Girder	120'-165'-120'	715	27,000	2 @ Type IV	43	20	50	1000	560,000	160,000	7900	11,000	1700	16,600	830
3 Koyukuk River #2	1692+50	755'	Girder	135'-180'-240'-180'	576	145,000	2 @ Type IV	70'	20	60	1970	1,440,000	300,000	13,050	2400	3060	30,200	1510
4 Jane Creek	1749+60	160'	Girder	45-60'-45	578	4 [illegible]00	2 @ Type III	30'	20	50	170	80,000	30,000	1850	1,500	20	6,400	320
5 E. Fork Henshaw Creek	2800+90	205'	Girder	60'-75'-60'	748	11,950	2 @ Type III	25'	30	50	170	130,000	30,000	1920	1000	20	8,200	410
6 W. Fork Henshaw Creek	2919+40	250'	Girder	75'-90'-75'	725	13,200	2 @ Type III	25'	30	50	200	150,000	36,000	2460	1800	20	10,000	500
7 Alatna River	37[illegible]+35	700'	Girder	210-270-210	465	91,000	2 @ Type IV	50'	20	50	1180	1,660,000	180,000	9300	12,000	1020	28,000	1400
8 Siruk Creek	4457+40	250'	Girder	75-90'-75	560	18,000	2 @ Type III	45	30	30	700	200,000	130,000	2600	3,000	340	10,000	500
9 Hogatza River	5504+10	265'	Girder	75'-95'-75'	710	13,960	2 @ Type IV	30'	30	30	800	250,000	130,000	6720	1,500	510	10,600	530
10 Bear Creek	7314+10	160'	Girder	45-60'-45'	350	2,000	2 @ Type III	25'	20	50	160	80,000	30,000	1930	1200	20	6,400	320
11 Judy Creek	7645+80	115'	Girder	30'-45'-30'	354	1,100	2 @ Type III	25'	20	50	160	50,000	30,000	1680	1,000	20	4,600	180
12 Pah River	8465+30	550'	Girder	165-210'-165	225	21,900	2 @ Type IV	40'	20	50	1150	1,010,000	160,000	1700	12,000	1700	22,000	1100
13 Angutikada Creek	9124+90	160'	Girder	45'-60'-45'	170	5,400	2 @ Type III	25'	20	50	170	80,000	30,000	1920	800	20	6400	320
14 Kobuk "A"	9624+50	700	Girder	210'-270'-210'	125	84,500	2 @ Type IV	42'	20	50	1250	1,660,000	160,000	8800	20,000	1700	28,000	1400
15 Kobuk "B"	9720+00	505'	Girder	150'-195'-150'	124		2 @ Type IV	55'	20	50	1410	860,000	190,000	7700	20,000	1840	20,200	1010

DESIGNED BY C.P.S. · DRAWN BY K.B. · CHECKED BY A.H.N.	**TUDOR – KELLY – SHANNON** ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED:	**FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION** ALASKA TRANSPORTATION CORRIDOR STUDY **MAJOR HIGHWAY STRUCTURES** SCALE: NONE · DATE: 4-15-72 · DRAWING NUMBER · SHEET OF

Figure 2



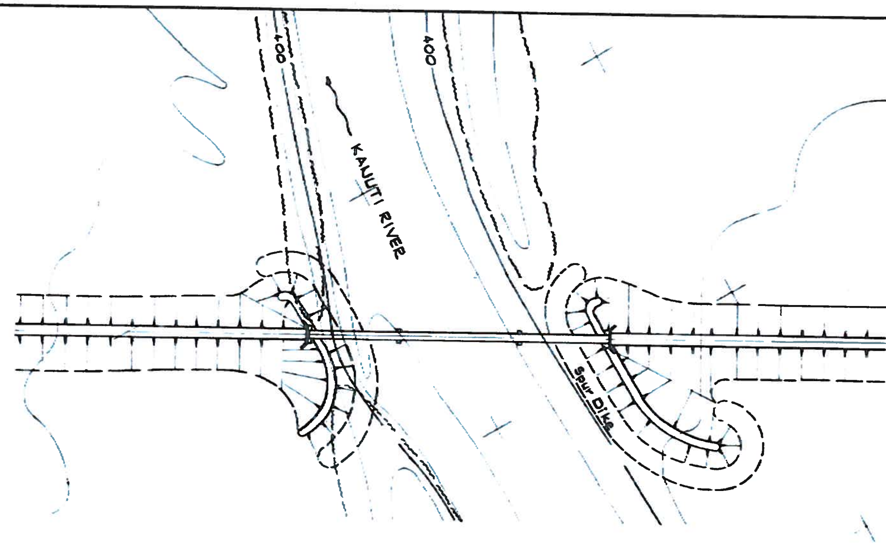
SITE PLAN



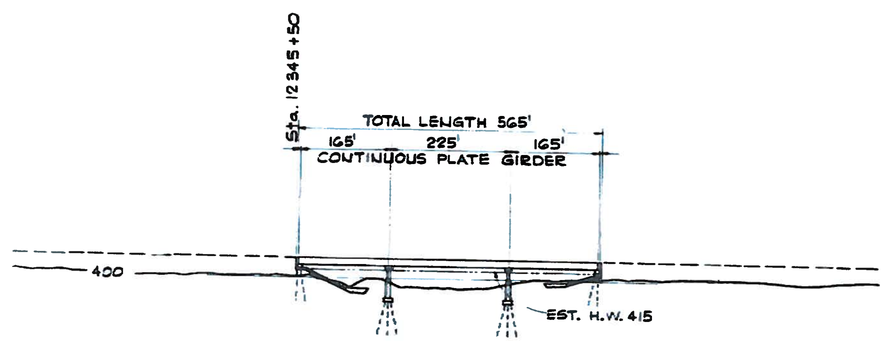
PROFILE ON ℄

DESIGNED BY C.P.S. DRAWN BY K.B. CHECKED BY A.H.W.	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY TYPICAL RAILROAD TRUSS BRIDGE	SCALE NONE DATE 4-15-72 DRAWING NUMBER SHEET OF

Figure 3



SITE PLAN

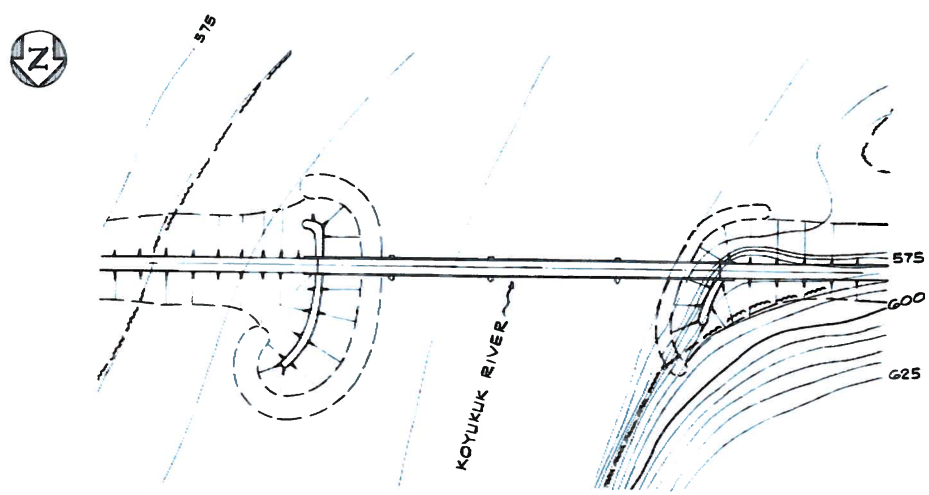


ELEVATION

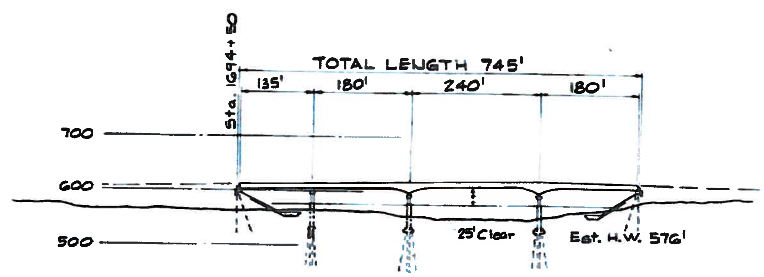
KANUTI RIVER

DESIGNED BY C.P.S. DRAWN BY K.B. CHECKED BY A.H.W.	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY TYPICAL RAILROAD GIRDER BRIDGE	SCALE NONE DATE 4-15-72 DRAWING NUMBER SHEET OF

Figure 4



SITE PLAN

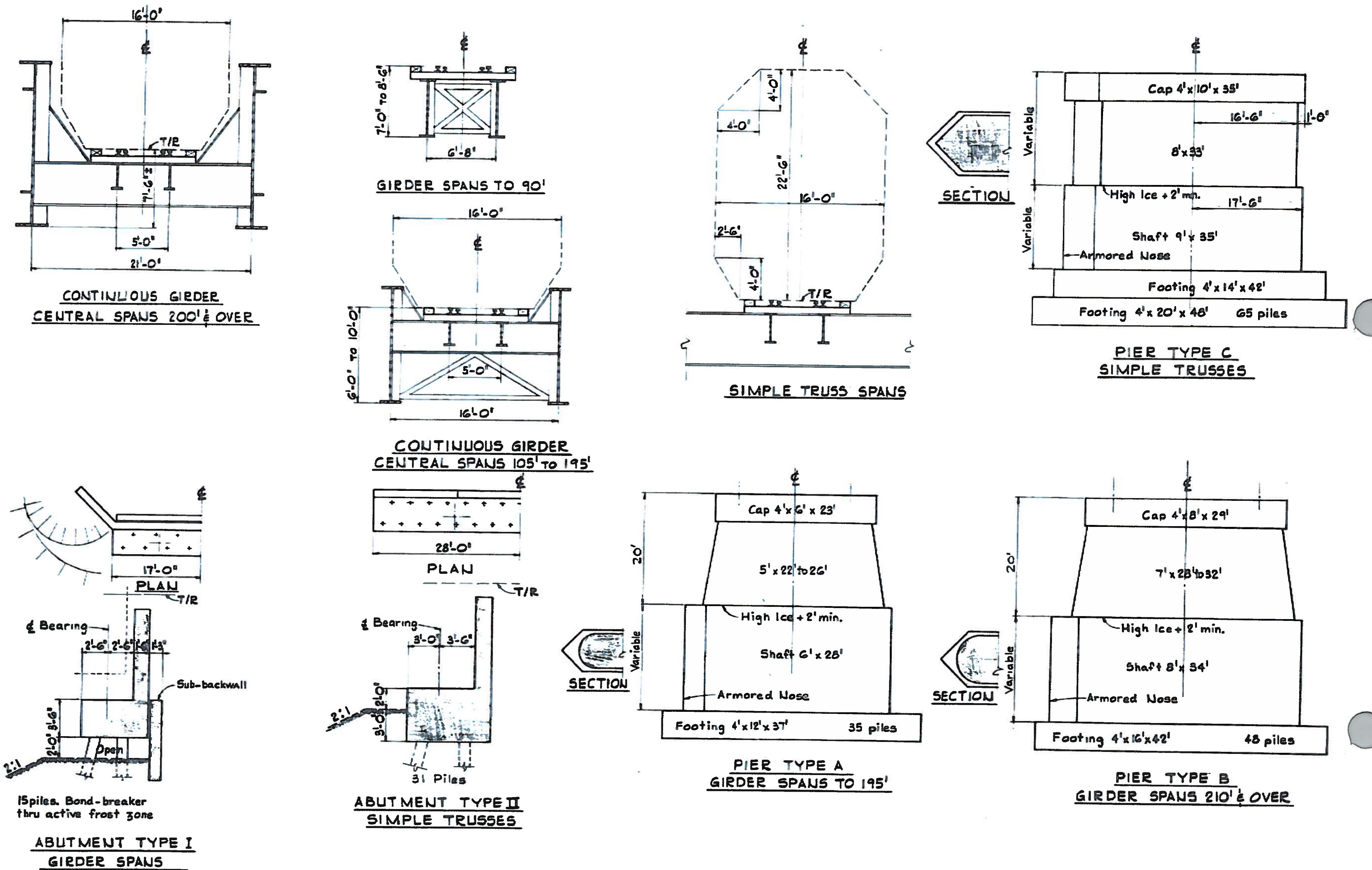


ELEVATION

KOYUKUK RIVER

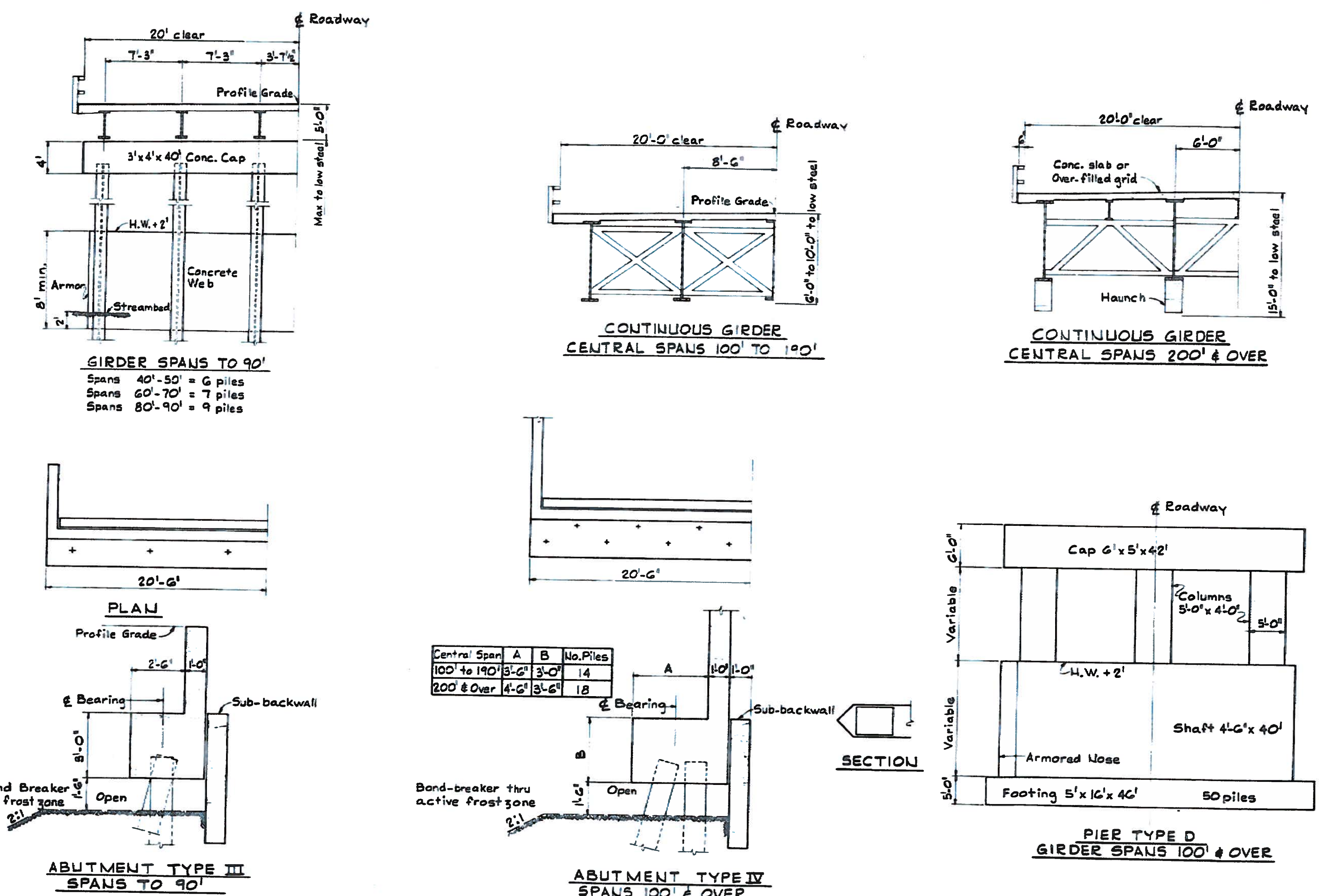
DESIGNED BY C.PS DRAWN BY K.B. CHECKED BY A.H.W.	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY TYPICAL HIGHWAY BRIDGE	SCALE NONE DATE 4-15-72 DRAWING NUMBER SHEET OF

Figure 5



DESIGNED BY C.P.S. DRAWN BY K.B. CHECKED BY A.H.W.	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY TYPICAL DETAILS FOR RAILROAD BRIDGES	SCALE NONE DATE 4-15-72 DRAWING NUMBER SHEET OF

Figure 6



Central Span	A	B	No. Piles
100' to 190'	3'-6"	3'-0"	14
200' & Over	4'-6"	3'-6"	18

DESIGNED BY C.P.S.
DRAWN BY K.B.
CHECKED BY A.H.W.

TUDOR – KELLY – SHANNON
ALASKA TRANSPORTATION CORRIDOR CONSULTANTS
SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA

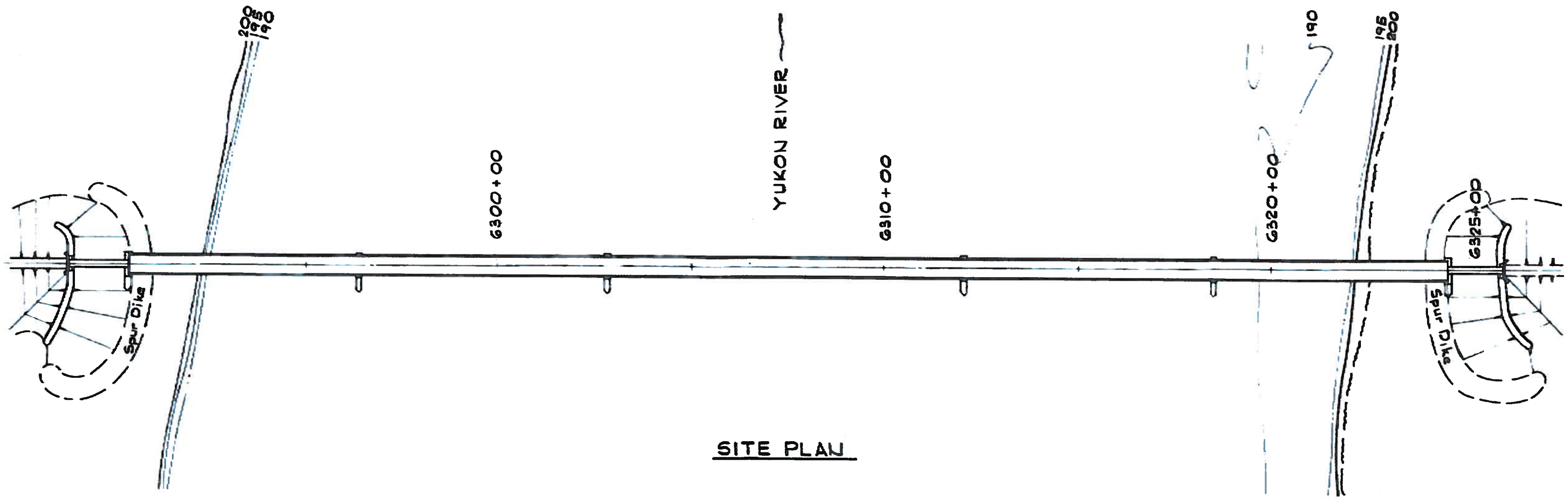
APPROVED

FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION
ALASKA TRANSPORTATION CORRIDOR STUDY

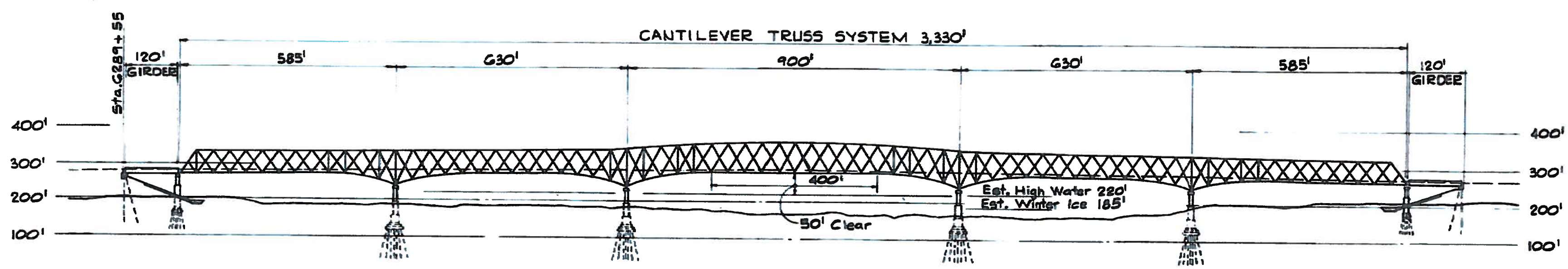
TYPICAL DETAILS FOR HIGHWAY BRIDGES

SCALE NONE
DATE 4-15-72
DRAWING NUMBER
SHEET OF

Figure 7



SITE PLAN



ELEVATION

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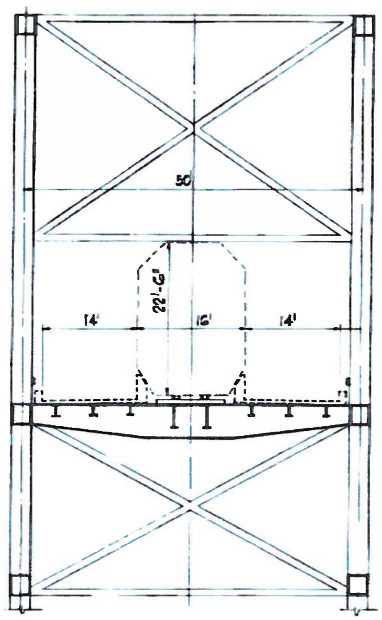
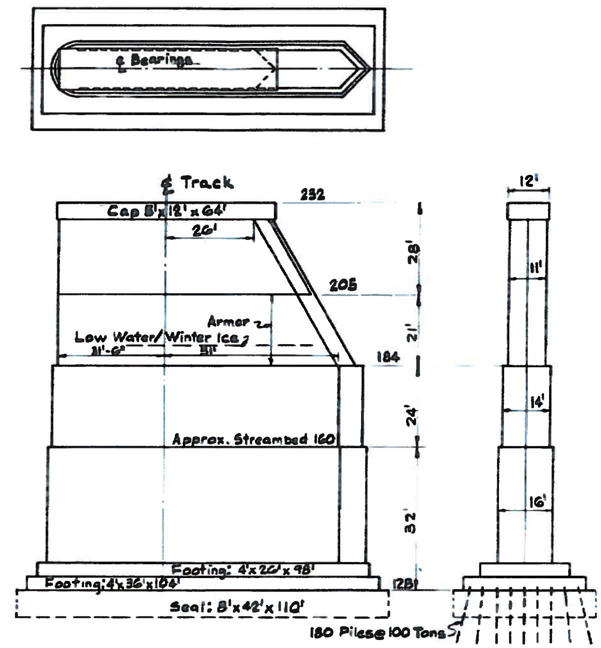
Figure 8

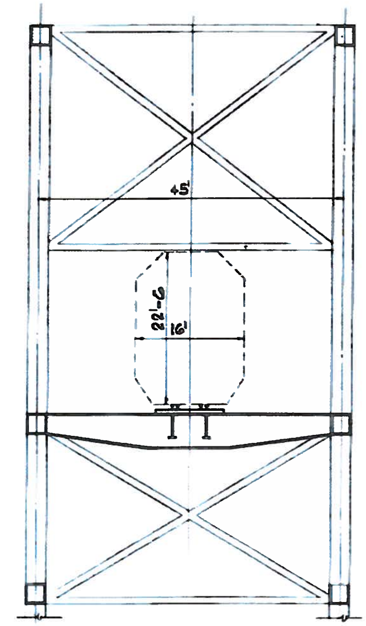


TYPICAL SECTION NEAR MAIN PIER

Alternative for possible dual railroad and highway service.



TYPICAL MAIN PIER



TYPICAL SECTION NEAR MAIN PIER

Railroad Loading Only

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Figure 9

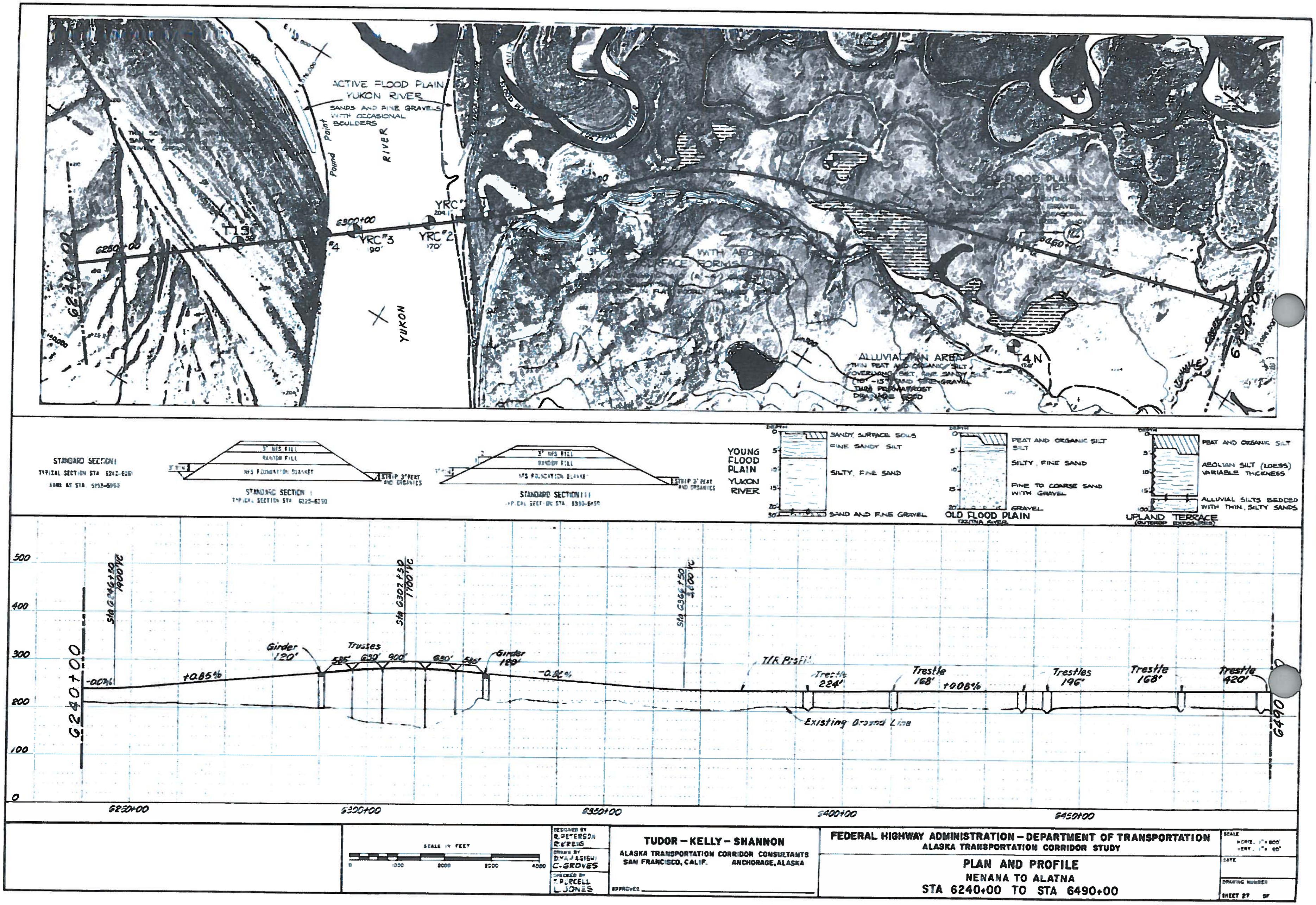
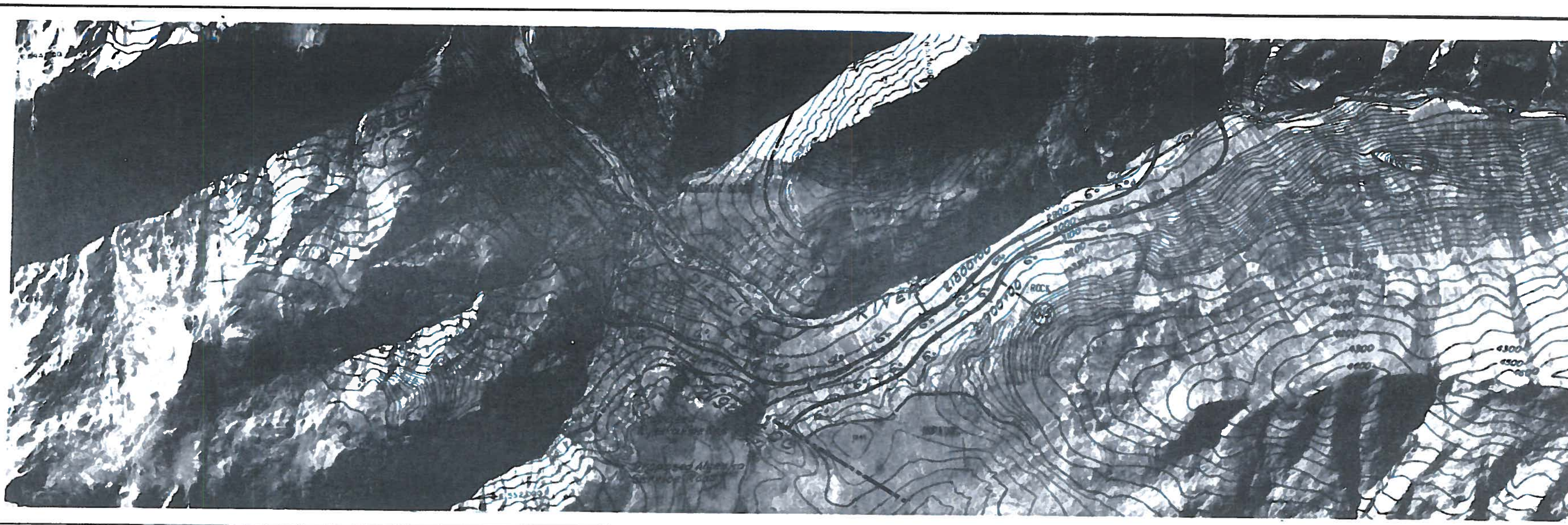

ACTIVE FLOOD PLAIN
YUKON RIVER
SANDS AND FINE GRAVELS WITH OCCASIONAL BOULDERS
Pound Point
RIVER
YUKON
YRC
YRC #2
170'
YRC #3
190'
6300+00
6250+00
6240+00
ALLUVIAL FAN AREA
T4N
STANDARD SECTION I
TYPICAL SECTION STA 6240-6281
SAME AS STA 5953-6063
STANDARD SECTION II
TYPICAL SECTION STA 6325-6290
STANDARD SECTION III
TYPICAL SECTION STA 6330-6490
3" NFS FILL
RANDOM FILL
NFS FOUNDATION BLANKET
STRIP 3" PEAT AND ORGANICS
YOUNG FLOOD PLAIN YUKON RIVER
SANDY SURFACE SOILS
FINE SANDY SILT
SILTY, FINE SAND
SAND AND FINE GRAVEL
OLD FLOOD PLAIN
PEAT AND ORGANIC SILT
SILTY, FINE SAND
FINE TO COARSE SAND WITH GRAVEL
GRAVEL
UPLAND TERRACE
PEAT AND ORGANIC SILT
AEOLIAN SILT (LOESS) VARIABLE THICKNESS
ALLUVIAL SILTS BEDDED WITH THIN, SILTY SANDS
Sta 6246+50 1900' VC
Sta 6302+50 1700' VC
Sta 6366+50 2100' VC
Girder 120'
Trusses
585' 630' 900' 630' 585'
Girder 189'
-0.0%
+0.85%
-0.82%
T/R Profile
Trestle 224'
Trestle 168'
+0.08%
Trestles 196'
Trestle 168'
Trestle 420'
Existing Ground Line
500
400
300
200
100
0
6250+00
6300+00
6350+00
6400+00
6450+00
6490
SCALE IN FEET
0 1000 2000 3000 4000
DESIGNED BY R. PETERSON R. KREIG
DRAWN BY D. YAMASHI C. GROVES
CHECKED BY T. PURCELL L. JONES
TUDOR – KELLY – SHANNON
ALASKA TRANSPORTATION CORRIDOR CONSULTANTS
SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA
APPROVED
FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION
ALASKA TRANSPORTATION CORRIDOR STUDY
PLAN AND PROFILE
NENANA TO ALATNA
STA 6240+00 TO STA 6490+00
SCALE HORIZ. 1" = 800' VERT. 1" = 80'
DATE
DRAWING NUMBER
SHEET 27 OF

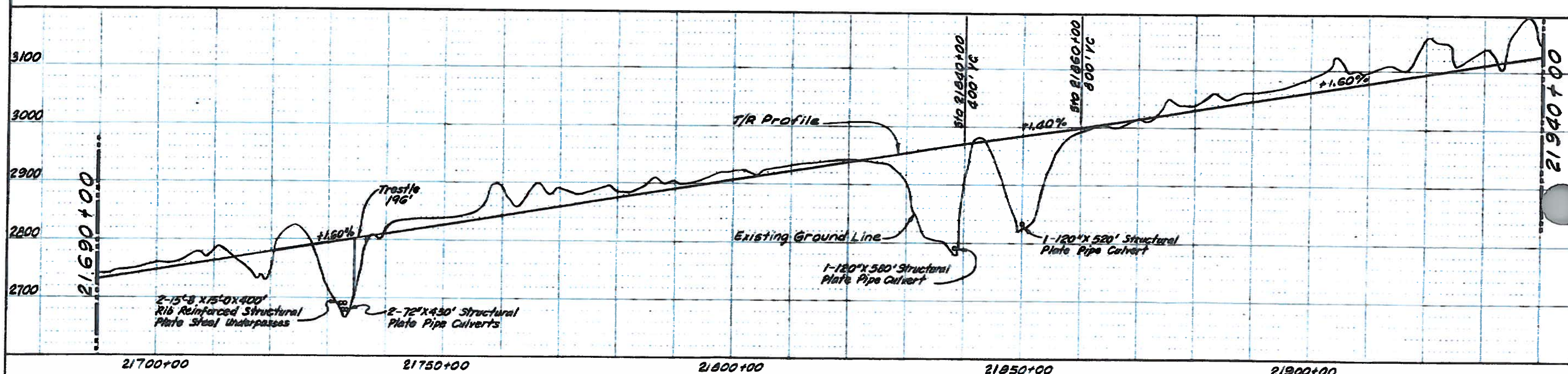
Figure 10



STANDARD SECTION I (FILLS)
TYPICAL SECTION STA [illegible]
SAME AS STA 21480-21530

STANDARD SECTION VI (CUTS)
TYPICAL SECTION STA 21690-21940
SAME AS STA 21284-21460

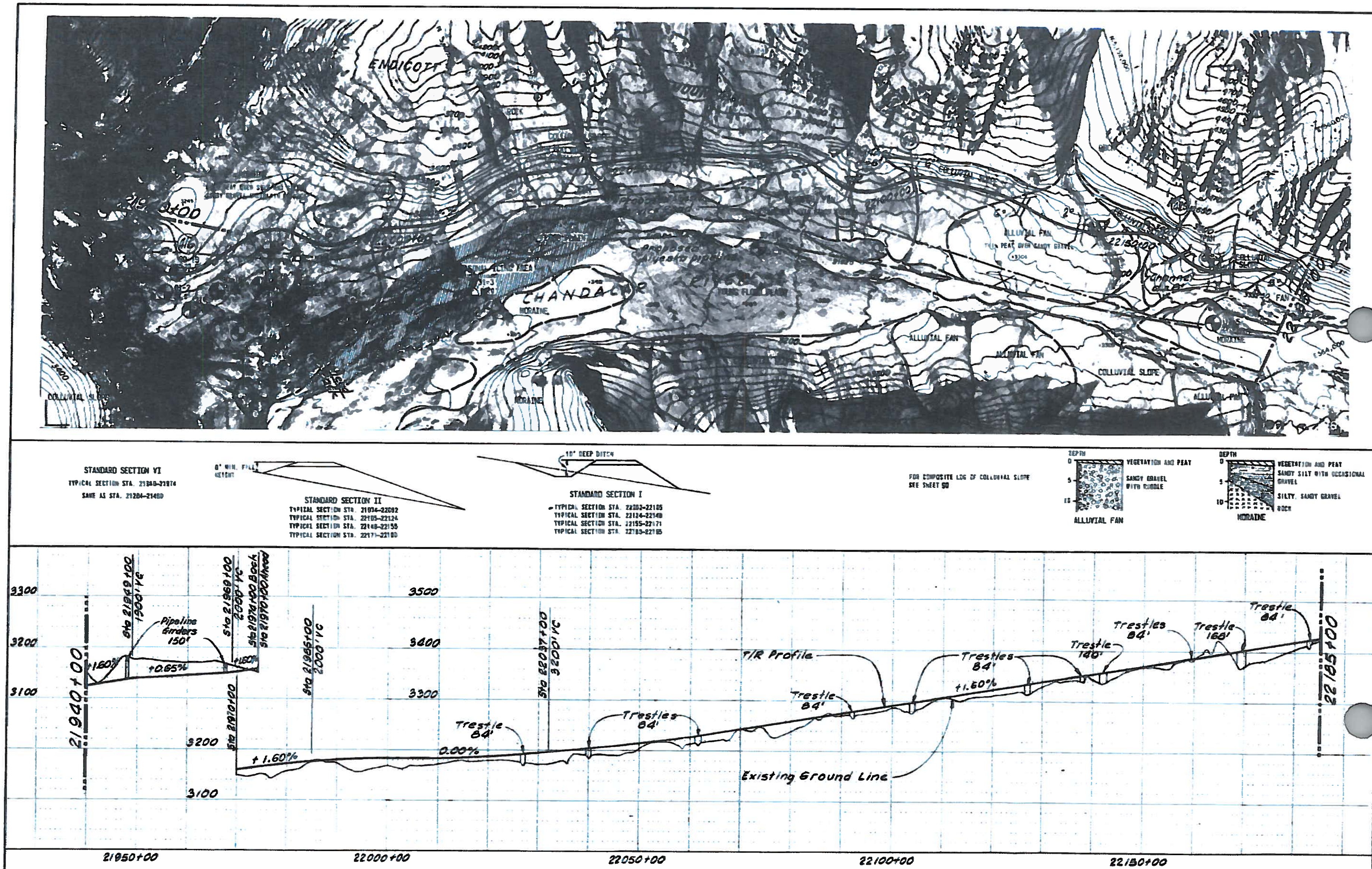
FOR COMPOSITE LOG OF COLLUVIAL SLOPE
SEE SHEET 00



SCALE IN FEET 0 1000 2000 3000 4000	DESIGNED BY T. PURCELL J. NOVAK DRAWN BY L. BRAVO C. GROVES CHECKED BY K. HEILIG L. JONES	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY PLAN AND PROFILE ALATNA TO DEADHORSE STA 21690+00 TO STA 21940+00

SCALE HORIZ. 1" = 600' VERT. 1" = 60'
DATE
DRAWING NUMBER
SHEET 90 OF

Figure 11



SCALE IN FEET

0 1000 2000 3000 4000

DESIGNED BY T. PURCELL, J. NOVAK
DRAWN BY L. BRAVO, C. GROVES
CHECKED BY K. HEILIG, L. JONES

TUDOR – KELLY – SHANNON
ALASKA TRANSPORTATION CORRIDOR CONSULTANTS
SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA

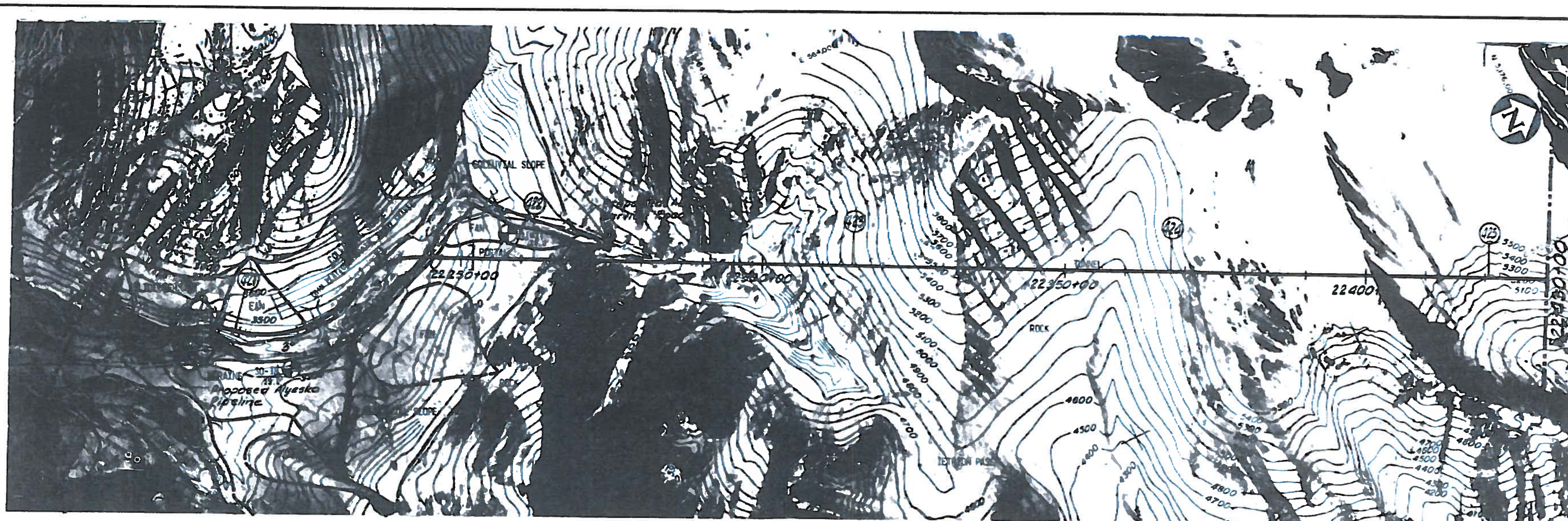
APPROVED ____________

FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION
ALASKA TRANSPORTATION CORRIDOR STUDY

PLAN AND PROFILE
ALATNA TO DEADHORSE
STA 21940+00 TO STA 22185+00

SCALE HORIZ. 1" = 600' VERT. 1" = 60'
DATE
DRAWING NUMBER
SHEET 91 OF

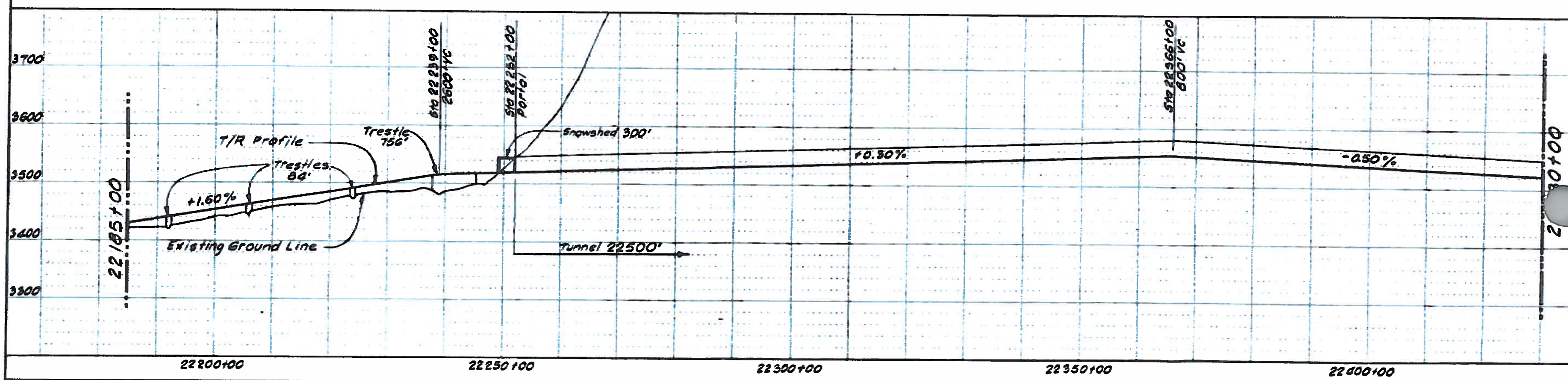
Figure 12



STANDARD SECTION I
TYPICAL SECTION STA. 22185–22192
SAME AS STA. 22092–22125

STANDARD SECTION II
TYPICAL SECTION STA. 22192–22248
SAME AS STA. 21974–22082

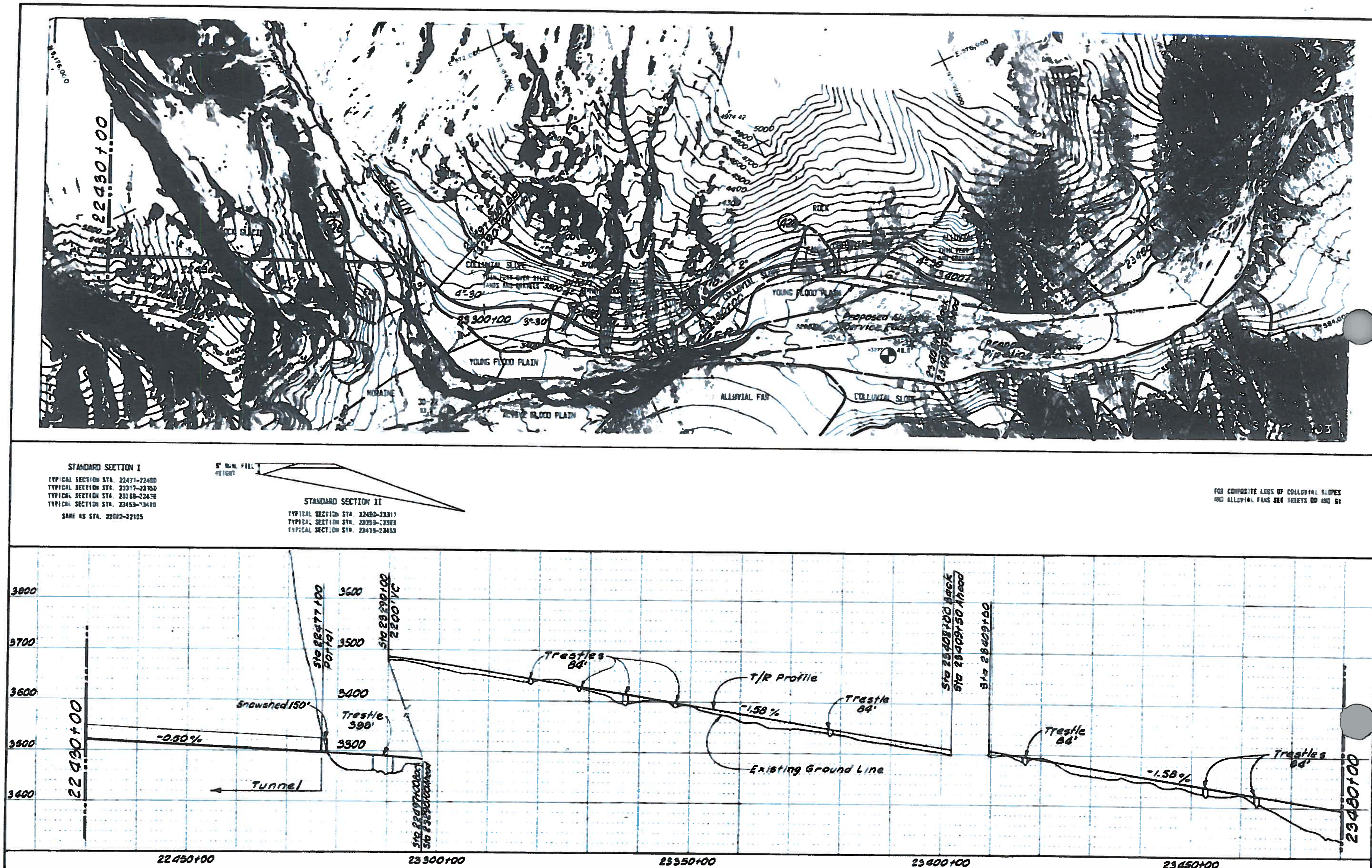
FOR COMPOSITE LOGS OF COLLUVIAL SLOPES AND ALLUVIAL FANS SEE SHEETS 80 AND 81



SCALE IN FEET
0 1000 2000 3000 4000

DESIGNED BY T. PURCELL J. NOVAK DRAWN BY L. BRAVO C. GROVES CHECKED BY G. HEILIG L. JONES	TUDOR – KELLY – SHANNON ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED	FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION ALASKA TRANSPORTATION CORRIDOR STUDY PLAN AND PROFILE ALATNA TO DEADHORSE STA 22185+00 TO STA 22430+00	SCALE HORIZ. 1" = 800' VERT. 1" = 80' DATE DRAWING NUMBER SHEET 92 OF

Figure13



SCALE IN FEET 0 1000 2000 3000 4000	DESIGNED BY T. PURCELL, J. NOVAK DRAWN BY L. BRAVO, C. GROVES CHECKED BY K. HEILIG, L. JONES	**TUDOR – KELLY – SHANNON** ALASKA TRANSPORTATION CORRIDOR CONSULTANTS SAN FRANCISCO, CALIF. ANCHORAGE, ALASKA APPROVED ______	**FEDERAL HIGHWAY ADMINISTRATION – DEPARTMENT OF TRANSPORTATION** ALASKA TRANSPORTATION CORRIDOR STUDY **PLAN AND PROFILE** ALATNA TO DEADHORSE STA 22430+00 TO STA 23480+00

SCALE: HORIZ. 1" = 600'; VERT. 1" = 60'
DATE
DRAWING NUMBER
SHEET 95 OF

Figure 14

RECOMMENDATIONS FOR FINAL DESIGN

The routes selected and developed during the Study represent alinements that are the most suitable within the framework of available information. It is not implied, however, that all details of this preliminary design will remain unchanged at the time of final design. Details of geometry, cross-sections, major and minor structures, drainage facilities, and possibly, other elements will undoubtedly undergo further studies and refinements in final design when the extent of information will exceed that now available.

The recommendations made herein outline the extent and nature of the major elements of information needed for final design. Some elements are recommended to be developed at the time of final design, such as mapping and subsurface exploration. Others, such as programs for test sections and for hydrological and climatological data collection should desirably be initiated well in advance of final design.

PHOTOGRAMMETRIC MAPPING

Aerial photographs, surveys, and topographic manuscripts of greater detail than those used for this Study will be required for detail design.

The approved routes should be reflown at lower altitude and aerial photographs taken at a scale of 1:6000. The recommended width of coverage is 4500 feet. An 80-percent end-lap is recommended.

Horizontal control should be of second-order closure. Vertical surveying should be performed with third-order accuracy. Horizontal and vertical control points should be established on each side approximately 1500 feet from the flight centerline at approximately two-mile intervals. An additional control point should be established on the flight centerline, in the middle of the two-mile intervals. Bench marks for basic vertical control should be established along the flight centerline at approximately one-half mile intervals. The control points should be established by traverses, triangulation and trilateration. As many of the new points as possible should be tied into the USGS and USC&GS control points used for this Study. All new control points should be targeted. Every other bench mark should be of a construction capable of withstanding ice-jacking forces.

Topographic manuscripts should be of 1 inch = 100 foot scale with 5 foot contour intervals and should cover a strip 2600 feet to 3000 feet wide. Grid spot-elevations or supplemental 2-foot contours should be added in flat areas and at major structure sites. For quantity estimating and earthwork design purposes, photogrammetric cross-sections should be compiled.

SUBSURFACE INVESTIGATION

Much more detailed subsurface investigation than that performed for this Study will be needed for final route selection and detailed roadbed design. Borings, geophysical studies, test pits, and laboratory testing with subsequent analysis of results must be undertaken.

Subsurface investigations for final design cannot be located at this time at any definite interval, such as a boring every 1000 feet. From the preliminary work performed for this Study it is apparent that many problem areas will require one or more borings within a hundred-foot interval, but in other areas two or three borings per mile may be sufficient. It is expected that an average of approximately 12 borings per mile will be needed for the entire project. Additional borings should be located at bridge and borrow sites.

Considerable benefit is expected to result from geophysical studies at certain locations. They are useful in obtaining general information regarding depth to bedrock, type of overburden material, and presence of permafrost and massive ground ice. Their primary use will be in connection with preliminary analysis of the many potential borrow sites where surface exposures are not adequate for analysis. Geophysical explorations on ridges with potential rock cores will indicate if the rock strata are too thin or too deeply buried for quarry development and if the quality is likely to be suitable. Negative results will eliminate expensive borings. They will be useful also for predicting depth of gravel deposits and at bridge sites for indicating depth to bedrock and density of streambed materials.

Test pits are needed principally for determining the character of potential gravel or soil borrow areas. In some cases test pits will be needed to develop supplementary information during or after test drilling. This is especially true where materials are coarse, where samples from borings are not representative, and where drilling and sampling procedures do not give a clear picture of changes in materials.

TEST SECTIONS

Observations of existing projects have been helpful in formulating many of the design concepts used throughout this Study and continued observations will provide valuable additional information. However, almost all existing projects are located either in marginal permafrost areas, such as near Fairbanks, or in deeply frozen areas, such as on the North Slope. These do not provide sufficient information in areas where climatic conditions are intermediate and where design based upon inadequate information could lead to serious maintenance problems.

Test sections should be installed to obtain the required information and to verify a number of design concepts used in this Study such as fill heights, methods of insulating fills and cut slopes, and surface drainage control.

HYDROLOGICAL AND CLIMATOLOGICAL PROGRAM

In many parts of the Study area basic hydrological and climatological data are lacking. A field investigation and data collection program is recommended and outlined below to obtain adequate information for final design.

The collection of hydrological and climatological data should be coordinated with the agency responsible for the specific data to be collected and the various programs integrated with existing networks, particularly rainfall and stream-flow networks. The networks of hydrological and climatological stations should be closely related to those physical factors which affect hydrology most significantly, such as topography, morphology, geology, and soil types. The minimum program should be planned in such a manner that the network can become an integral part of an optimum network. The principal stations, that is, those stations which will be operated continuously and indefinitely, should be designated as soon as possible and the construction of the station should reflect the desired permanency. The secondary stations to be observed for only a limited period of time should also be designated and their construction should reflect their temporary nature. Even one or two years of observation would provide meaningful data although limited in reliability. Observations through a five to ten year period would provide more reliable data.

To supplement existing stream gaging data, a program for the installation of additional gaging stations, with automatic water-level records, should be initiated in cooperation with the United States Geological Survey. The stations should be located so that the area of drainage basins to be measured would represent a balanced distribution, ranging from five square miles up to 50,000 square miles. Continuing records should be kept on the existing gaging stations south of the Brooks Range. Iceflow and spring-breakup data are required throughout the Study area. This information should be obtained by actual field observations and the installation of the required gaging stations. Together with the stream gaging station program, crest gages should be installed at major river crossings. Surveys at crossing locations should include river profiles and cross-sections upstream and downstream from crossing locations.

ALPS has initiated a program for the collection of climatological data along the proposed pipeline. This information will be adequate for that portion of the recommended route which follows approximately the same alinement. With the exception of a very few stations, mostly located in the lower half of the Study area, there are insufficient data available. It is therefore recommended that a program for the collection of basic climatological data such as precipitation, temperature, and wind direction and velocity be initiated at the existing and proposed stations.