EL PASO ALASKA COMPANY

Docket Nos. CP75-96, *et al.*

Prepared Answering Testimony
and Hearing Exhibits

Dated: May 18, 1976

El Paso ALASKA COMPANY

P. O. BOX 1492
EL PASO, TEXAS 79978
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May 18, 1976

Federal Power Commission
Washington, D. C. 20426

Attention: Mr. Kenneth F. Plumb, Secretary

Re: El Paso Alaska Company;
Docket Nos. CP75-96, *et al.*

Gentlemen:

Enclosed herewith for filing are two (2) copies each of the prepared answering testimony and hearing exhibits on behalf of El Paso Alaska Company in the subject proceedings for the witnesses P. C. Wright, R. S. Murphy and R. H. Winn.

Also enclosed are the originals of affidavits subscribed and sworn to by these witnesses respecting such testimony.

As evidenced by the certificate attached hereto, copies of the prepared answering testimony and hearing exhibits and affidavits are being served upon each person on the restricted service list compiled by the Secretary in this proceeding.

Respectfully submitted,

EL PASO ALASKA COMPANY

By Donald J. MacIver, Jr.
Donald J. Mac Iver, Jr.
One of Counsel

Enclosures

Certificate of Service

I hereby certify that I have this day caused a copy of the foregoing Prepared Answering Testimony and Hearing Exhibits of El Paso Alaska Company to be served upon each person designated on the restricted service list compiled by the Commission Secretary in the consolidated proceedings at Docket Nos. CP75-96, *et al.*, in accordance with the requirements of Section 1.17 of the Rules of Practice and Procedure.

Dated at El Paso, Texas, as of this 19th day of May, 1976.

Donald J. Mac Iver, Jr.

Donald J. Mac Iver, Jr.

Of Counsel for
EL PASO ALASKA COMPANY

P. C. WRIGHT

UNITED STATES OF AMERICA

Before the

FEDERAL POWER COMMISSION

El Paso Alaska Company, *et al.*) Docket Nos. CP75-96, *et al.*

Prepared Answering Testimony

of

Paul C. Wright

Q. Please state your name and the name of your employer.

A. My name is Paul C. Wright. I am employed by Pipe Line Technologists, Inc., Post Office Box 22146, Houston, Texas.

Q. Are you the same Paul C. Wright who previously submitted prepared direct testimony in this proceeding?

A. Yes.

Q. What is the purpose of this prepared answering testimony?

A. The purpose of this prepared answering testimony is to present analyses of proposals contained in the testimony of others in these proceedings so far as they pertain to the possible realignment of El Paso Alaska's Alaskan Gas Pipeline from Prudhoe Bay to the Alaskan LNG Plant which would maximize the utilization of the existing Alyeska oil pipeline work pad and/or the Alyeska-State Haul Road.

Q. Is this realignment intended to supplant the original El Paso Alaska proposed Alaskan Gas Pipeline alignment?

A. No, this realignment is intended to be an alternative to the original Alaskan Gas Pipeline alignment presented in Exhibit EP-62 (PCW-1).

Q. Do you sponsor any new exhibits?

A. Yes, I sponsor nine new exhibits. They are:

Exhibit EP-______ (PCW-22) which consists of 35 alignment sheets (Figures 1 through 35) showing a realignment, to the greatest extent possible, of the proposed Alaskan Gas Pipeline adjacent to either the work pad for the Alyeska oil pipeline or the Alyeska-State Haul Road.

Exhibit EP-______ (PCW-23) which consists of 14 cross sections of the Alaskan Gas Pipeline as it is designed to be realigned adjacent to the Alyeska work pad or Haul Road, or as a separate work pad.

Exhibit EP-______ (PCW-24) which presents five seasonal flow diagrams for the realigned Alaskan Gas Pipeline.

Exhibit EP-______ (PCW-25) which is the annual average day flow diagram for the realigned Alaskan Gas Pipeline.

Exhibit EP-______ (PCW-26) which is the flow diagram for the maximum design capacity of the realigned Alaskan Gas Pipeline.

Exhibit EP-______ (PCW-27) which presents the "Summary of the Impact on the Capital Cost Estimate by Realignment of the Alaskan Gas Pipeline."

Exhibit EP-______ (PCW-28) which presents a list of stream crossings on the realigned Alaskan Gas Pipeline.

Exhibit EP-______ (PCW-29) which presents a list of road crossings on the realigned Alaskan Gas Pipeline.

Exhibit EP-______ (PCW-30) which presents a list of pipeline crossings on the realigned Alaskan Gas Pipeline.

Q. Will you be responsible for each of these exhibits?

A. Yes.

Q. What is the significance of Exhibit EP-______ (PCW-22)?

A. Exhibit EP-______ (PCW-22) is a series of alignment sheets, or maps, showing the location of the realigned Alaskan Gas Pipeline adjacent to the Alyeska oil pipeline and the Alyeska-State Haul Road so as to maximize the use of the work pad along the Alyeska pipeline and the Haul Road. This realignment is a result of a joint study developed between personnel of Pipe Line Technologists, Dames & Moore and El Paso Alaska.

Q. Why was this study conducted?

A. On October 2, 1975, Mr. Bruce D. Sokler, appearing on behalf of the State of Alaska, (at TR 6398) asked me if, under present plans, would any portion of the gas pipeline be laid from the Alyeska-State Haul Road and work pad? My reply was negative since the Alyeska work pad and the Alyeska-State Haul Road were not in existence during the development of El Paso Alaska's pipeline route. However, I also indicated that we were in the process of analyzing the possibility of realignment. On February 10, 1976, Mr. Charles A. Champion, Pipeline Coordinator, State of Alaska (TR 14,977-15,005) stated that he would propose to lay the chilled gas pipeline alongside of the oil pipeline to lessen environmental impact. Many ideas, problems, and possible solutions were developed during this testimony. Also during this period of time, representatives of El Paso Alaska were discussing realignment of the pipeline with Mr. Champion and his staff in Anchorage and with representatives of the Department of the Interior's Alaska Pipeline Office. It was clear that all these people preferred realignment adjacent to the Alyeska oil pipeline and the Haul Road for environmental reasons.

As part of our continuing realignment study, a task force of engineers and environmentalists were sent to the field to inspect the Alyeska facilities which were approximately 50% completed.

My testimony will offer the engineering and cost results of the joint study and will present views on the various concepts developed to implement the proposed pipeline realignment.

Q. What is the significance of Exhibit EP-______ (PCW-23)?

A. Exhibit EP-______ (PCW-23) presents 14 cross sectional schematics showing the different work pad configurations of the Alaskan Gas Pipeline and its relationship to the Alyeska oil pipeline in both its buried and its elevated modes, to the Alyeska work pad, and to the Haul Road. These schematics also demonstrate the situations required when the work pad must be separated from these facilities in order to facilitate pipeline construction.

Please note that these plans call for the use of both an insulated and non-insulated gravel work pad for the construction of the Alaskan Gas Pipeline. This pad is either a widening of the Alyeska work pad or Haul Road, or it is a completely new gravel work pad. The snow work pad concept has been eliminated from these plans, although it might be used as a secondary pad if sufficient snow is found at an appropriate location. Hence, no specific location requiring the use of a snow work pad has been identified.

Q. What is the significance of Exhibit EP-______ (PCW-24)?

A. Exhibit EP-______ (PCW-24) shows the seasonal flow diagrams for the realigned gas pipeline. These were required because the realignment increased the length of the pipeline approximately 13.8 miles, and the flow characteristics changed slightly.

Q. What is the significance of Exhibit EP-______ (PCW-25)?

A. Exhibit EP-______ (PCW-25) presents the annual average day flow diagram which is also slightly different than prior filings because of the increased length.

Q. What is the significance of Exhibit EP-______ (PCW-26)?

A. Exhibit EP-______ (PCW-26) presents the maximum design capacity of the realigned pipeline.

Q. What is the significance of Exhibit EP-_____ (PCW-27)?

Exhibit EP-_____ (PCW-27) is a summary of the incremental increases and decreases in the Estimated Capital Cost of the Alaskan Gas Pipeline as a result of realignment. The result is that the Estimated Capital Cost will increase approximately $37,469,000 which is equivalent to about 1.4% of the capital cost estimate (updated to 1975).

Q. What is the significance of Exhibit EP-_____ (PCW-28)?

A. Exhibit EP-_____ (PCW-28) is a list of stream crossings on the realigned Alaskan Gas Pipeline. The Mile Post locations of all the streams (except the Putuligayuk River) have been changed by the realignment, and the number of significant crossings has decreased by two. The requirements for special excavation at stream crossings is estimated to decrease primarily because of the net decrease in significant crossings and because the major crossing of the Tanana River has been changed from buried to aerial. However, we have chosen to leave the cost estimate for stream crossings unchanged in order to be on the conservative side.

Q. What is the significance of Exhibit EP-_____ (PCW-29)?

A. Exhibit EP-_____ (PCW-29) is a list of road crossings on the realigned Alaskan Gas Pipeline. The Mile Post locations of the crossings have changed and the number of crossings has increased by four over the original alignment. Costs for these added road crossings are in the pipeline construction costs estimates.

Q. What is the significance of Exhibit EP-_____ (PCW-30)?

A. Exhibit EP-_____ (PCW-30) is a list of pipeline crossings on the realigned Alaskan Gas Pipeline. The Mile Post locations of the pipeline crossings have changed and the number of crossings of the Alyeska 48-inch pipeline has increased by eight. Also seven crossings of the Alyeska fuel gas line have been added. The estimated capital costs have been increased for these additional pipeline crossings (Exhibit EP-_____ (PCW-27)).

Q. How do you plan to test the Alaskan Gas Pipeline at these crossings of other pipelines?

A. All of the pipe used in all the crossings of other pipelines will be tested hydrostatically in accordance with Part 192, Title 49, Code of Federal Regulations. The procedure will be similar to that used to test pipe at river crossings. The pipe will be welded up on skids on top of the ground and will be hydrostatically tested on location. After the test is completed, the water will be drained out into tank trucks for easy removal, and the section of pipe will be lowered into the pre-cut ditch and pulled into place beneath and across the other pipeline.

Q. Was it necessary to make any changes in the Estimated Operating Cost?

A. No; however, the realignment locates the pipeline much closer to existing all-weather roads and provides for a gravel work pad. This greatly improves access to the pipeline which makes the operation and maintenance easier, reduces the need for All-Terrain Vehicles, and is less costly.

Q. Was it necessary to make any changes in the design of the pipeline?

A. Only the location of the route and the gravel work pad are changed in the basic design. For environmental reasons some new special construction has been added, such as the Tanana River where an aerial crossing is proposed instead of a submerged crossing. Special crossings of the newly stipulated potential active faults of Clearwater, Donnelly and McGinness were added. Special construction is proposed at the Happy Valley Cut, Squirrel Creek Crossing and Rock Creek Crossing.

Deeper burial of the pipeline is proposed in areas where Alyeska has gone deeper. Additional blasting mats are added to protect the Alyeska elevated pipeline during the blasting of the ditch. These changes are made primarily as a result of experience gained from the construction of the Alyeska pipeline.

Q. What were the major changes in the location of the route?

A. From approximately Mile Post 6 to Mile Post 141 on the proposed realignment across the North Slope, the pipeline is realigned next to the Haul Road or Alyeska work pad. This eliminates the second pipeline across the tundra.

From approximately Mile Post 141 to Mile Post 172 on the proposed realignment, the pipeline is realigned next to the Haul Road or Alyeska work pad on the east side of Galbraith Lake and the Atigun Valley instead of the west side.

From approximately Mile Posts 241 to 263 on the proposed realignment, the pipeline is next to the Haul Road or Alyeska work pad instead of a route through Rosie Creek Pass.

From approximately Mile Posts 530 to 537 on the proposed realignment, the pipeline follows the Alyeska work pad around a hill instead of over it, and uses an aerial crossing of the Tanana River instead of a submerged one, primarily for environmental reasons.

From approximately Mile Posts 580 to 593 on the proposed realignment, the pipeline follows the Alyeska work pad in the low terrain, primarily for environmental reasons.

From approximately Mile Posts 691 to 721 on the proposed realignment, the pipeline follows the Alyeska work pad along the shore of Willow Lake instead of clearing a second right-of-way across country.

In most of the areas between these specifically mentioned, the route is moved over to a location adjacent to the Haul Road or Alyeska work pad as shown in Exhibit EP-_____ (PCW-22). Mile Posts have been changed over the entire realignment.

Q. Was it necessary to make any changes in the design of the compressor stations?

A. No, except that their locations were changed to conform to the realignment of the pipeline and the revised hydraulics calculations. One station location in particular was changed significantly. Compressor Station No. 8 was moved from its original location in the flats of the Salcha River on the original alignment to a location approximately four miles north (Mile Post 493.5 on the realignment) in the north edge of the hills of that area.

Q. Was it necessary to make any changes in the Maintenance Bases?

A. The locations of the Maintenance Bases adjacent to Compressor Stations 2, 5 and 8 were changed along with the relocation of those Stations.

Q. Was it necessary to make any changes or revisions in any of the other facilities?

A. No.

Q. Do your incremental changes in the Estimated Capital Costs reflect these changes and added special construction?

A. Yes.

Q. Are there any other possible changes in the Estimated Capital Costs?

A. Yes, there are several potential savings in capital costs that have not been included here. For example, we are still estimating the necessary construction camps at new cost. There is a possibility that we can negotiate for the Alyeska camps at a reduced cost, but we have no basis for estimating that cost at the present time. The same general comment can be applied to Alyeska communication equipment, storage facilities, bridges, and stock piles of materials used for construction. We prefer to retain our current conservative estimate basis until negotiations with Alyeska can be completed.

In addition, since Spread 6 in the Chugach Mountains is scheduled for summer construction, we could realize some savings in construction equipment by moving it from Spreads 4 and 5, which are primarily winter construction zones. However, the shuttling back and forth of construction equipment is so dependent upon the weather that the construction schedule could be seriously affected. In the realities of actual construction a portion of this equipment undoubtedly will be moved back and forth between spreads. We prefer to continue to use our present estimates in order to be on the conservative side.

Q. What is the effect of this proposed realignment on the project construction schedule?

A. By using a gravel work pad immediately adjacent to the Alyeska work pad and Haul Road, and extending the working width where required, instead of a snow work pad, we extend the length of the winter work season. We can start actual construction earlier because we do not have to wait on snowfall for the snow work pad, and we can continue to work later in the season because we do not have to stop when a snow pad would start to break up. We still plan to utilize winter construction methods so that the freezing weather will help maintain the integrity of the walls of the ditch as it dug and help mitigate degradation of permafrost along the ditch line. The schedule proposed for this alternate plan is to shut down construction of the pipeline in mid December, stay shut down during the entire month of January, and return to work during the first part of February. The number of net working days increases by 9 days in Spreads 1 and 3, by 4 days in Spread 2 and by 10 days in Spread 4. The working efficiency of the personnel will increase, but as of the present time we have not adjusted our capital cost estimates for this factor. We prefer to retain the estimated rate of progress and overall schedule unchanged in order to be on the conservative side.

Q. Where will you obtain the gravel materials to construct the work pad for the Alaskan Gas Pipeline?

A. Primarily from the same sources that Alyeska used for materials to construct their work pad and the haul road. We have obtained from the public records in the offices of the State Pipeline Coordinator and the Federal Authorized Officer the locations of 470 approved sites for the removal of materials along the Alyeska pipeline. We also obtained the inventory of cubic yards of these materials remaining at each site.

Q. Will there be sufficient materials available to construct the work pad that you propose?

A. Yes, our calculations show that we will require approximately 10,566,000 cubic yards of additional materials for our work pad. When this is added to our original estimated requirements, the total becomes approximately 16,400,000 cubic yards of borrow materials. The inventory indicates that there were over 65 million cubic yards remaining at the approved sites in November, 1975.

Mr. Charles A. Champion testified in these proceedings (TR 15,033-038) that Alyeska's estimated additional requirements are 7,381,000 cubic yards. Therefore, there are over 57 million cubic yards remaining in these sites near the Alyeska pipeline. Mr. Champion further stated that there are approximately 220 million cubic yards in designated sites within 20 or 30 miles of the right-of-way. We do not plan to use these more remote sites to which he referred.

Q. What is the estimated distance between the proposed work pad and the existing materials sites?

A. We located all the materials sites currently being used by Alyeska on our maps and located the access roads to these sites as found on the Alyeska maps prepared by the engineering firm of Michael Baker, Jr., Inc. We measured the access road and the length of the haul distance along our proposed work pad. We then determined the quantities of materials that would be required from each site and calculated the average haul distance per cubic yard of material. This average haul distance is 2.65 miles.

Q. And was this the average haul distance that you used to estimate the capital cost of the gravel work pad?

A. Yes.

Q. Mr. Wright, what are your conclusions with respect to this realignment study?

A. It is feasible to utilize either the Alyeska work pad or the Alyeska-State Haul Road in the construction of the proposed Alaskan Gas Pipeline along approximately 79% of the route (not including the last 43 miles where there is no Alyeska pad or road). It will be necessary to widen the work pad or Haul Road to provide work space for the construction equipment and create a buffer zone for the protection of Alyeska. This plan will add approximately $37,469,000 to the Estimated Capital Cost of the project. In return, the plan will lessen the environmental impact of the gas pipeline and it will provide for easy access to the gas pipeline for both construction and operation. There is also the tremendous advantage of being closer to the Alyeska alignment. This means that the geotechnical and other data accumulated by Alyeska is directly applicable to most of the gas pipeline route. It also means that data from approximately 400 miles of open ditch and holes dug for approximately 70,000 Vertical Support Members along another 400 miles of elevated construction is directly applicable. It also means that the experience gained from contractors, engineering consultants, and governmental agencies can be used to great benefit.

Q. Does this conclude your prepared answering testimony, Mr. Wright?

A. Yes, it does.

STATE OF TEXAS)
)
COUNTY OF HARRIS)

PAUL C. WRIGHT, being duly sworn, on oath, says that he is the Paul C. Wright identified in the foregoing prepared answering testimony; that he caused to be prepared such testimony; that the answers appearing therein are trie to the best of his knowledge and belief; and that if asked the questions appearing therein, his answers thereto would, under oath, be the same.

Paul C. Wright

Paul C. Wright

SUBSCRIBED AND SWORN TO before me, the undersigned authority, dated this 28th day of April, 1976.

Frances Denton

Notary Public in and for Harris County, Texas

FRANCES DENTON
Notary Public in and for Harris County, Texas
My Commission Expires June 1, 1977

Exh. EP-1

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____ (PCW-22)
Figures 1 through 35
Witness: P. C. Wright

DESCRIPTION OF FACILITIES
APPENDIX
PROPOSED ALASKAN GAS PIPELINE

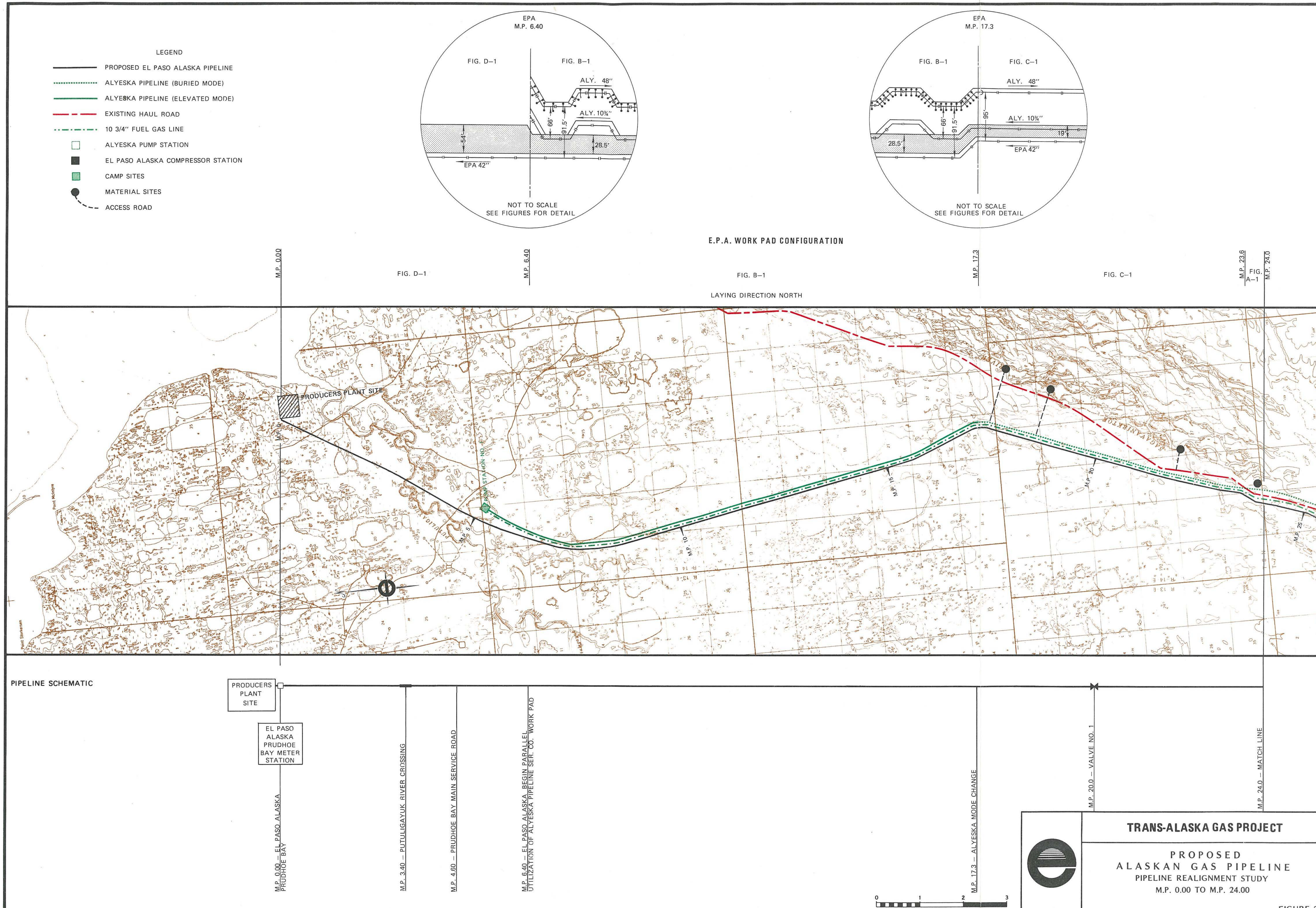
PIPELINE TOPOGRAPHIC REALIGNMENT SHEETS

FIGURE NUMBER	MILEPOST
1	Key Map of Alaska
2	M.P. 0 to M.P. 24
3	M.P. 24 to M.P. 52.60
4	M.P. 52.60 to M.P. 82.80
5	M.P. 82.80 to M.P. 113.4
6	M.P. 113.4 to M.P. 142.2
7	M.P. 142.2 to M.P. 168.4
8	M.P. 168.4 to M.P. 192.8
9	M.P. 192.8 to M.P. 218.3
10	M.P. 218.3 to M.P. 240.3
11	M.P. 240.3 to M.P. 261.0
12	M.P. 261.0 to M.P. 284.0
13	M.P. 284.0 to M.P. 303.6
14	M.P. 303.6 to M.P. 328.3
15	M.P. 328.3 to M.P. 346.9
16	M.P. 346.9 to M.P. 372.4
17	M.P. 372.4 to M.P. 400.9
18	M.P. 400.9 to M.P. 429.2
19	M.P. 429.2 to M.P. 460.6
20	M.P. 460.6 to M.P. 489.9
21	M.P. 489.9 to M.P. 518.7
22	M.P. 518.7 to M.P. 539.5
23	M.P. 539.5 to M.P. 564.9
24	M.P. 564.9 to M.P. 583.6
25	M.P. 583.6 to M.P. 607.7
26	M.P. 607.7 to M.P. 625.7
27	M.P. 625.7 to M.P. 652.9
28	M.P. 652.9 to M.P. 680.7
29	M.P. 680.7 to M.P. 696.1
30	M.P. 696.1 to M.P. 716.2
31	M.P. 716.2 to M.P. 737.0
32	M.P. 737.0 to M.P. 760.4
33	M.P. 760.4 to M.P. 788.2
34	M.P. 788.2 to M.P. 809.7
35	M.P. 809.7 to M.P. 831.1

TRANS-ALASKA GAS PROJECT

KEY MAP OF ALASKA
PIPELINE REALIGNMENT STUDY

FIGURE 1


LEGEND
PROPOSED EL PASO ALASKA PIPELINE
ALYESKA PIPELINE (BURIED MODE)
ALYESKA PIPELINE (ELEVATED MODE)
EXISTING HAUL ROAD
10 3/4" FUEL GAS LINE
ALYESKA PUMP STATION
EL PASO ALASKA COMPRESSOR STATION
CAMP SITES
MATERIAL SITES
ACCESS ROAD
EPA
M.P. 6.40
FIG. D–1
FIG. B–1
ALY. 48"
ALY. 10¾"
66'
91.5'
54'
28.5'
EPA 42"
NOT TO SCALE
SEE FIGURES FOR DETAIL
EPA
M.P. 17.3
FIG. B–1
FIG. C–1
ALY. 48"
ALY. 10¾"
66'
91.5'
95'
19'
28.5'
EPA 42"
NOT TO SCALE
SEE FIGURES FOR DETAIL
E.P.A. WORK PAD CONFIGURATION
M.P. 0.00
FIG. D–1
M.P. 6.40
FIG. B–1
M.P. 17.3
FIG. C–1
M.P. 23.6
FIG. A–1
M.P. 24.0
LAYING DIRECTION NORTH
PRODUCERS PLANT SITE
PUMP STATION NO. 1
RIVER
M.P. 5
M.P. 10
M.P. 15
M.P. 20
M.P. 25
PIPELINE SCHEMATIC
PRODUCERS PLANT SITE
EL PASO ALASKA PRUDHOE BAY METER STATION
M.P. 0.00 – EL PASO ALASKA PRUDHOE BAY
M.P. 3.40 – PUTULIGAYUK RIVER CROSSING
M.P. 4.60 – PRUDHOE BAY MAIN SERVICE ROAD
M.P. 6.40 – EL PASO ALASKA BEGIN PARALLEL UTILIZATION OF ALYESKA PIPELINE SER. CO. WORK PAD
M.P. 17.3 – ALYESKA MODE CHANGE
M.P. 20.0 – VALVE NO. 1
M.P. 24.0 – MATCH LINE
0 1 2 3
SCALE IN MILES
TRANS-ALASKA GAS PROJECT
PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 0.00 TO M.P. 24.00
FIGURE 2

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- 10 3/4" & 8 5/8" FUEL GAS LINE
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

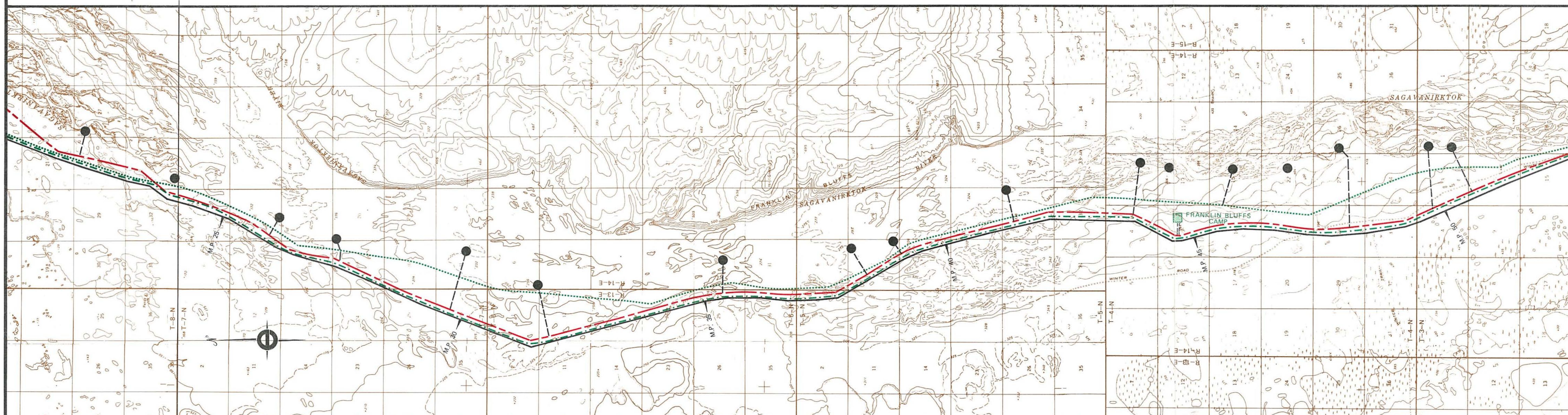
E.P.A. WORK PAD CONFIGURATION

FIG. A–1

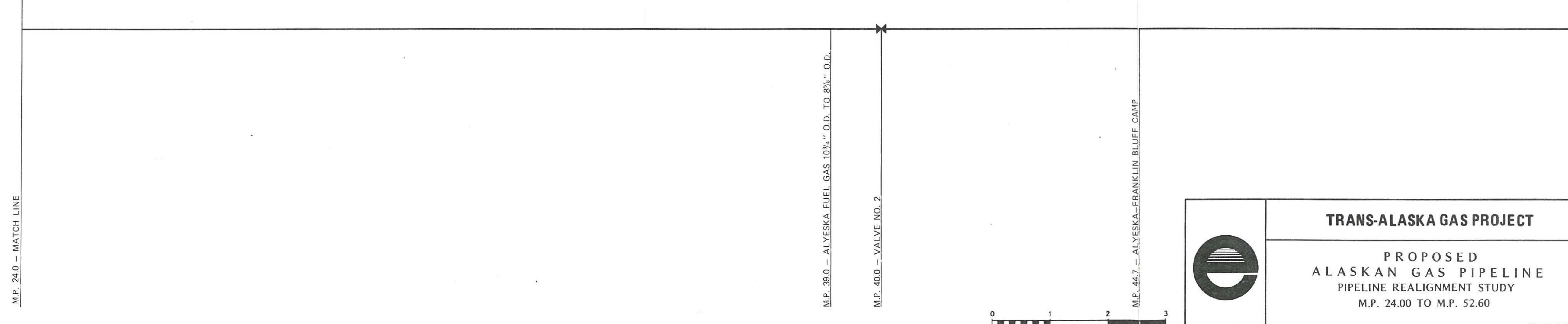
LAYING DIRECTION NORTH

M.P. 24.0

M.P. 52.6



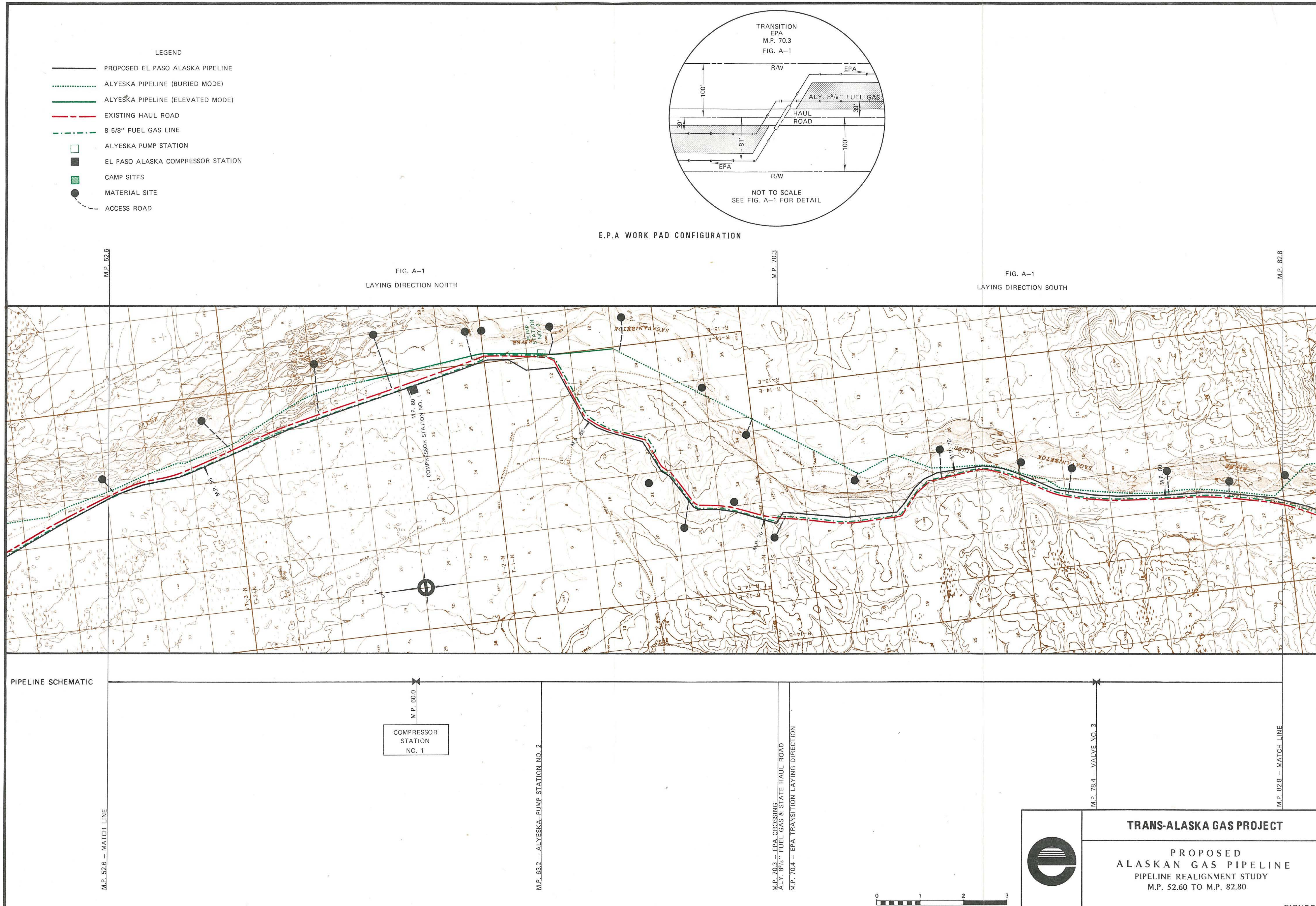
PIPELINE SCHEMATIC



TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 24.00 TO M.P. 52.60

FIGURE 3



PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 52.60 TO M.P. 82.80

FIGURE 4

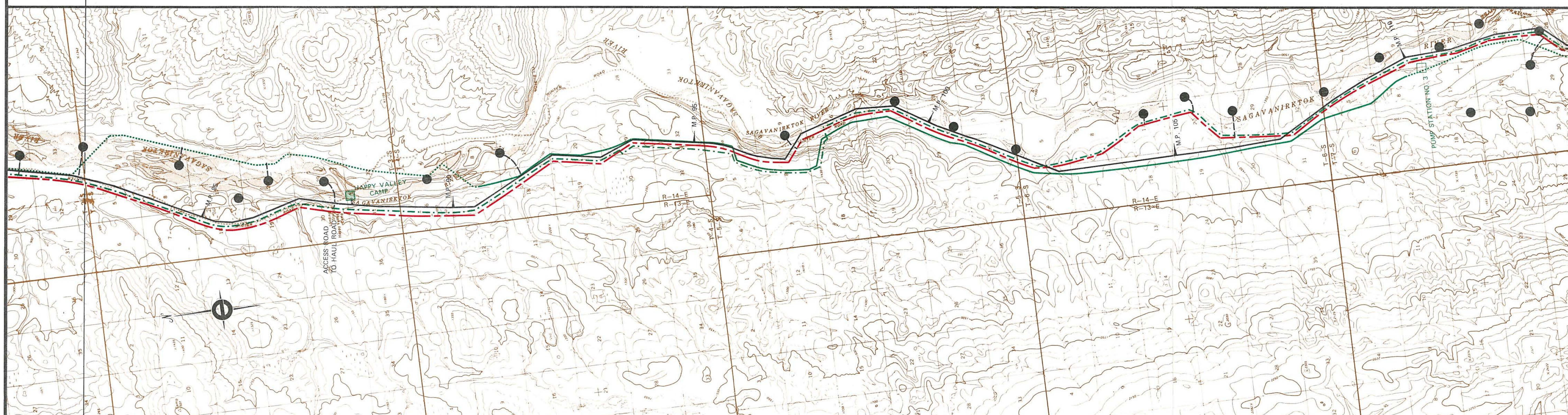
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- 8 5/8" FUEL GAS LINE
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 82.8 — FIG. A–1 — M.P. 102.5 — FIG. B–1 — M.P. 107.2 — FIG. A–1 — M.P. 113.4

LAYING DIRECTION SOUTH



SPECIAL CONSTRUCTION

PIPELINE SCHEMATIC

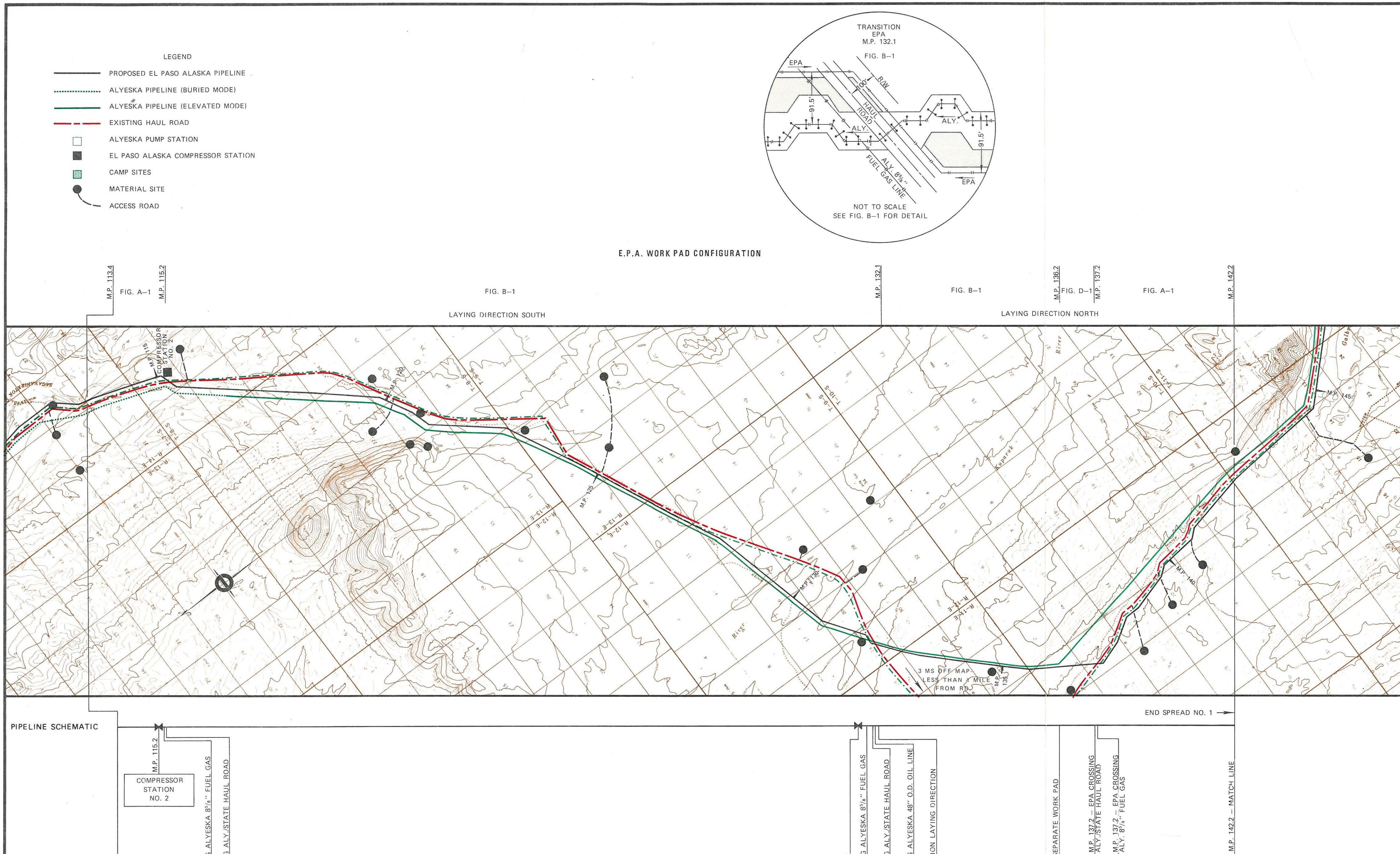
- M.P. 82.8 – MATCH LINE
- M.P. 88.0 – ALYESKA–HAPPY VALLEY CAMP
- M.P. 95.4 – VALVE NO. 4
- M.P. 95.8 – EPA CROSSING ALYESKA 48" O.D. OIL LINE
- M.P. 99.7
- M.P. 102.5 – EPA CROSSING ALYESKA 8⅝" FUEL GAS LINE
- M.P. 102.5 – EPA CROSSING ALY./STATE HAUL ROAD
- M.P. 107.2 – EPA CROSSING ALY./STATE HAUL ROAD
- M.P. 107.2 – EPA CROSSING ALY. 8⅝" FUEL GAS LINE
- M.P. 110.3 ALYESKA PUMP STA. NO. 3
- M.P. 113.4 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 82.80 TO M.P. 113.40

FIGURE 5



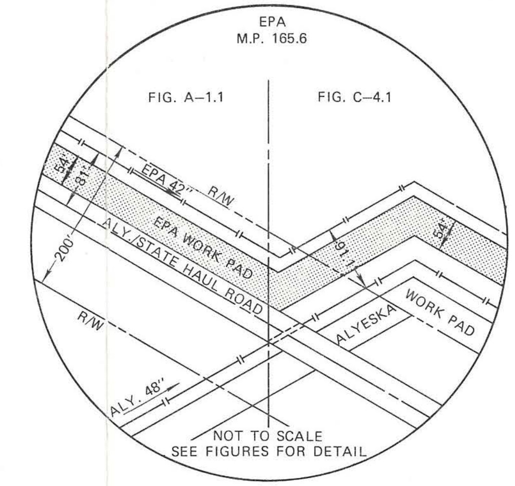
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 113.40 TO M.P. 142.20

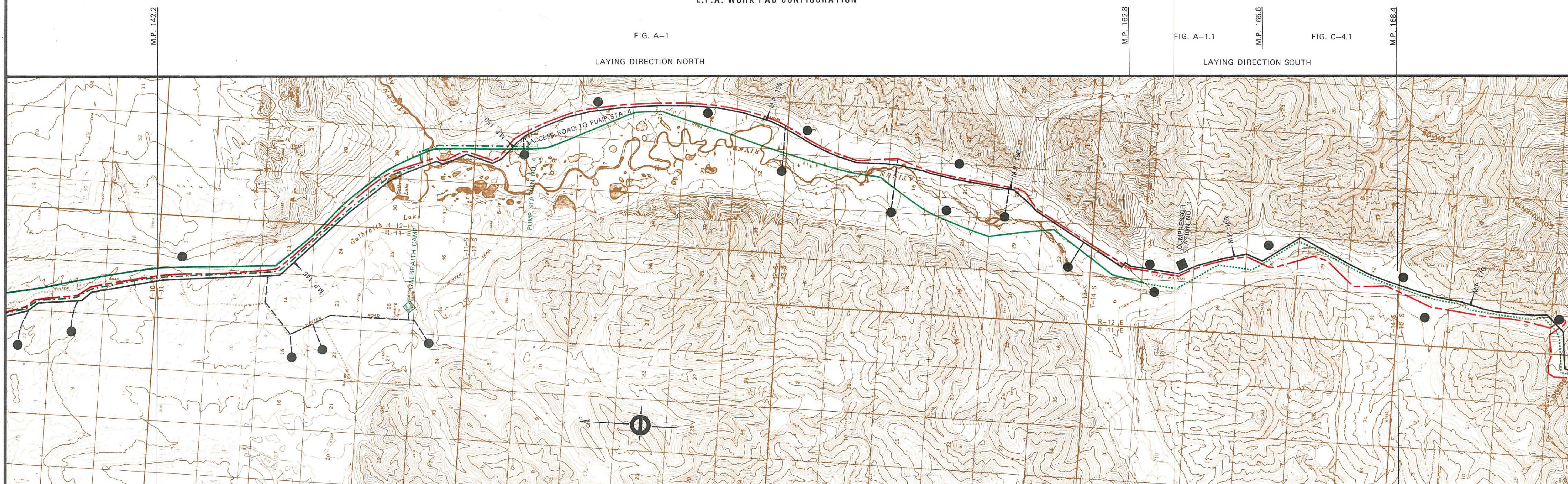
FIGURE 6

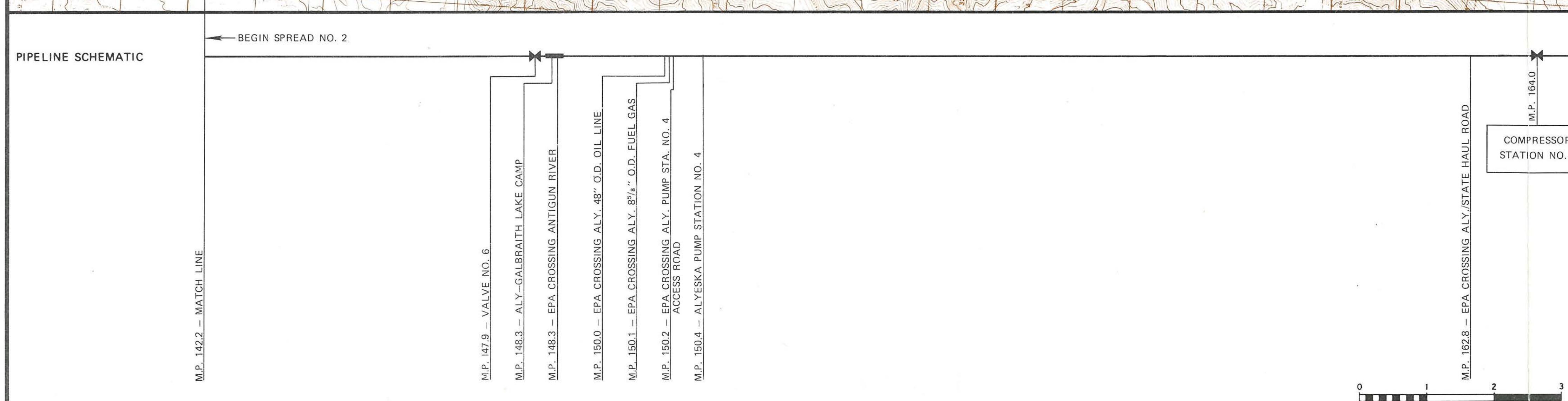
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- 8 5/8" FUEL GAS LINE
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION





TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 142.20 TO M.P. 168.40

FIGURE 7

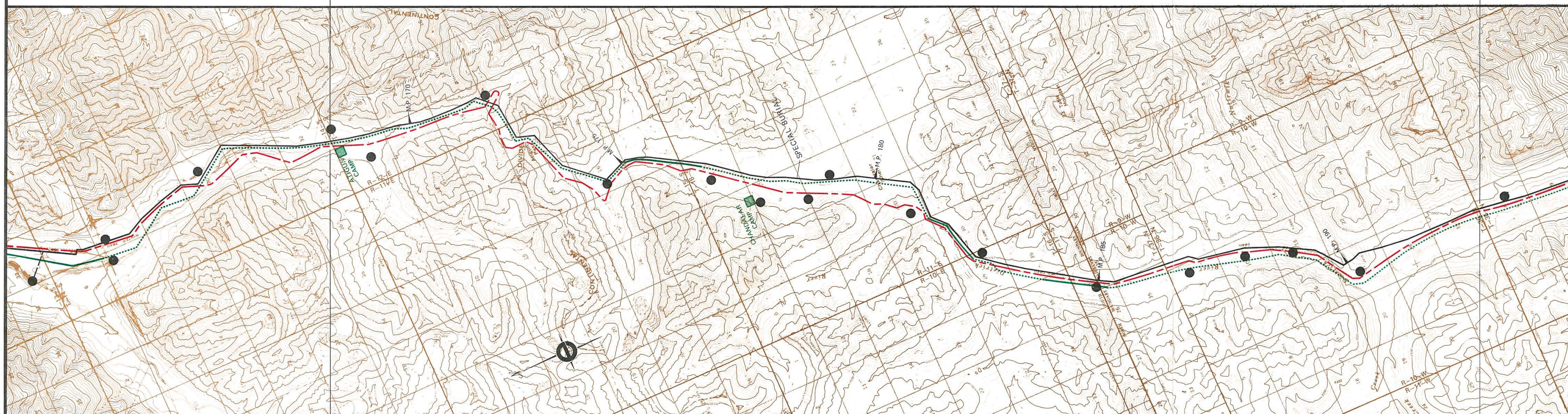
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 168.4 | FIG. C-4.1 | M.P. 175.1 | FIG. B-1.1 | M.P. 176.4 | FIG. C-1.1 | M.P. 181.5 | FIG. D-1.1 | M.P. 183.0 | FIG. A-1.1 | M.P. 188.6 | FIG. D-1.1 | M.P. 191.8 | FIG. A-1.1 | M.P. 192.8

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

SPEICAL CONSTRUCTION

M.P. 168.4 – MATCH LINE
M.P. 168.5 – ALYESKA ATIGUN CAMP
M.P. 171
M.P. 171.7 – EPA CROSSING ALY./STATE HAUL ROAD
M.P. 171.8 – EPA CROSSING ALY./STATE HAUL ROAD
M.P. 172.7 – CONTINENTAL DIVIDE ANTIGUN PASS
M.P. 174
M.P. 177.6 – ALYESKA CHANDALAR CAMP
M.P. 179.4 – E.P.A. CROSSING CHANDALAR RIVER
M.P. 180.7 – CHANDALAR SHELF
M.P. 181.4 – CHANDALAR SHELF
M.P. 183.5 – VALVE NO. 7
M.P. 190.0 – EPA CROSSING NUTIRWIK CREEK
M.P. 192.8 – MATCH LINE

0 1 2 3
SCALE IN MILES

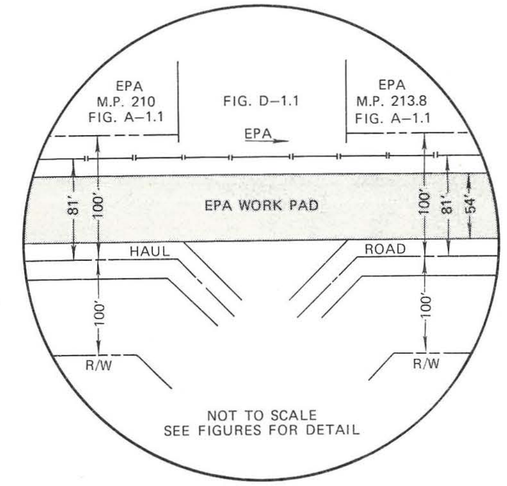
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 168.40 TO M.P. 192.80

FIGURE 8

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION

M.P. 192.8

FIG. A–1.1

LAYING DIRECTION SOUTH

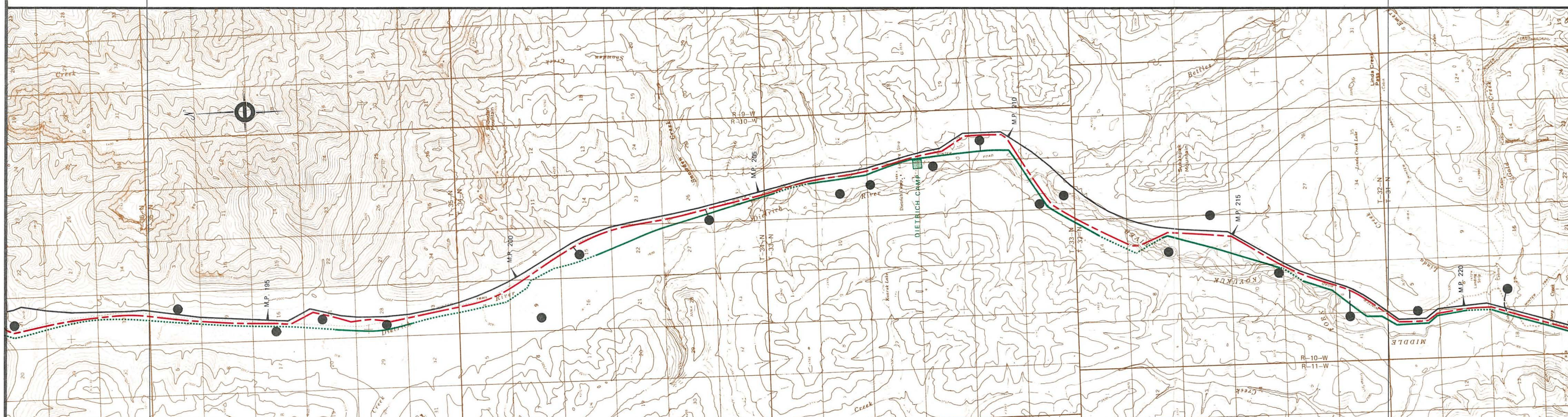
M.P. 210.0

FIG. D–1.1

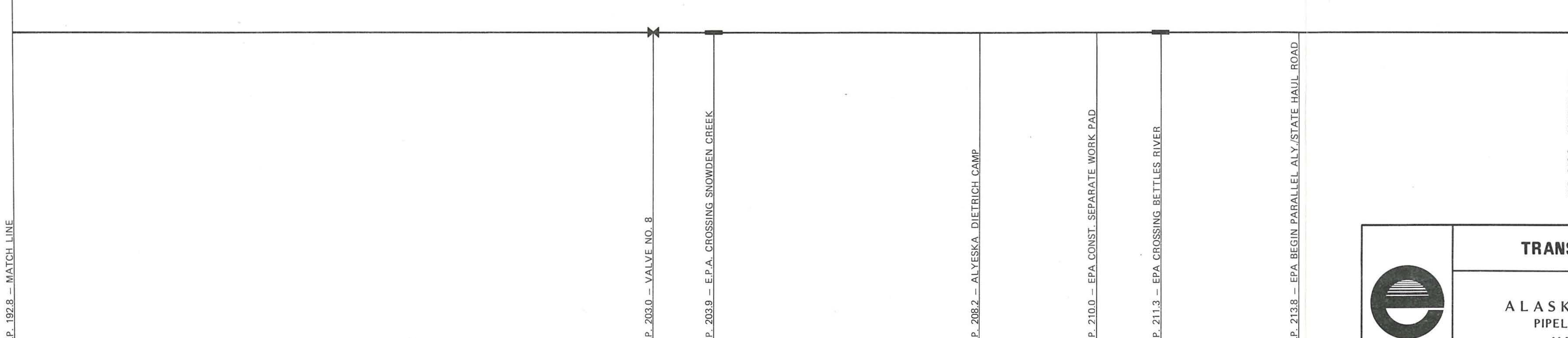
M.P. 213.8

FIG. A–1.1

M.P. 218.3



PIPELINE SCHEMATIC



0 1 2 3
SCALE IN MILES

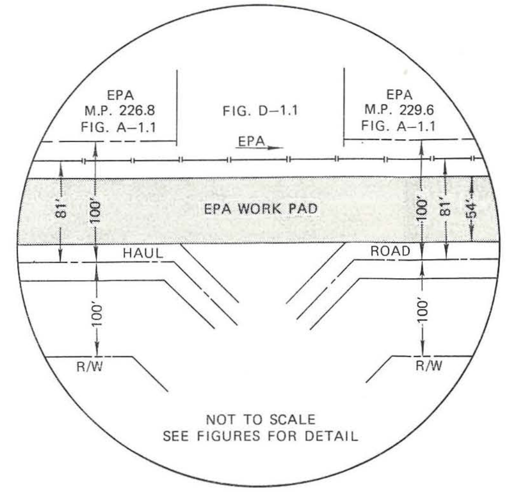
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 192.80 TO M.P. 218.30

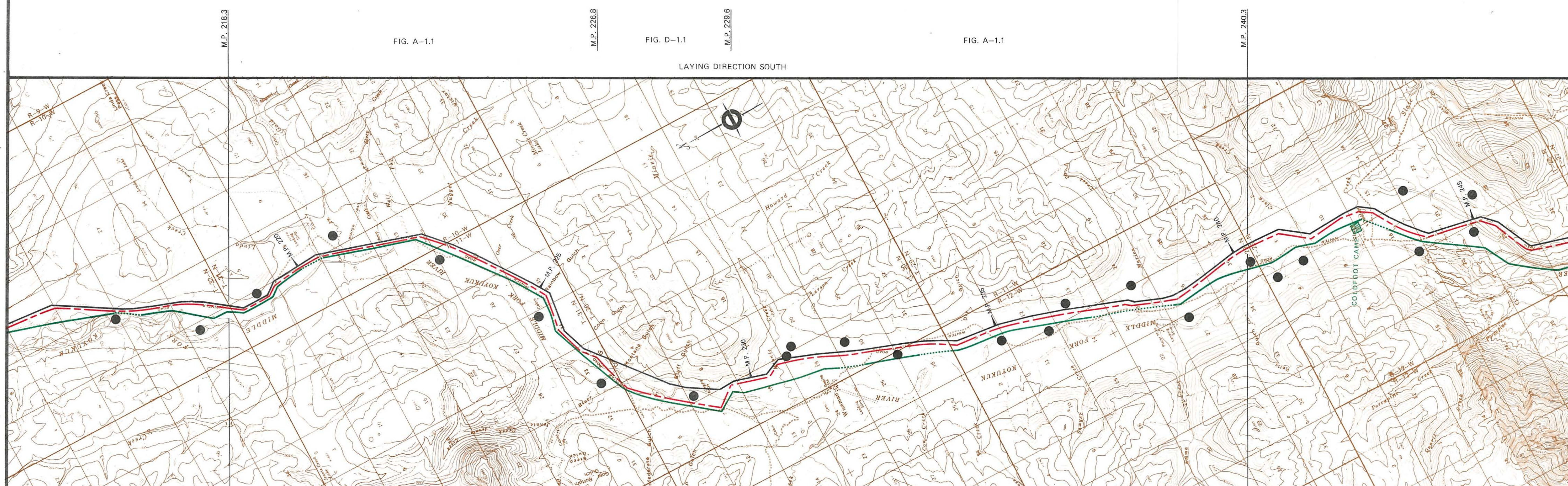
FIGURE 9

LEGEND

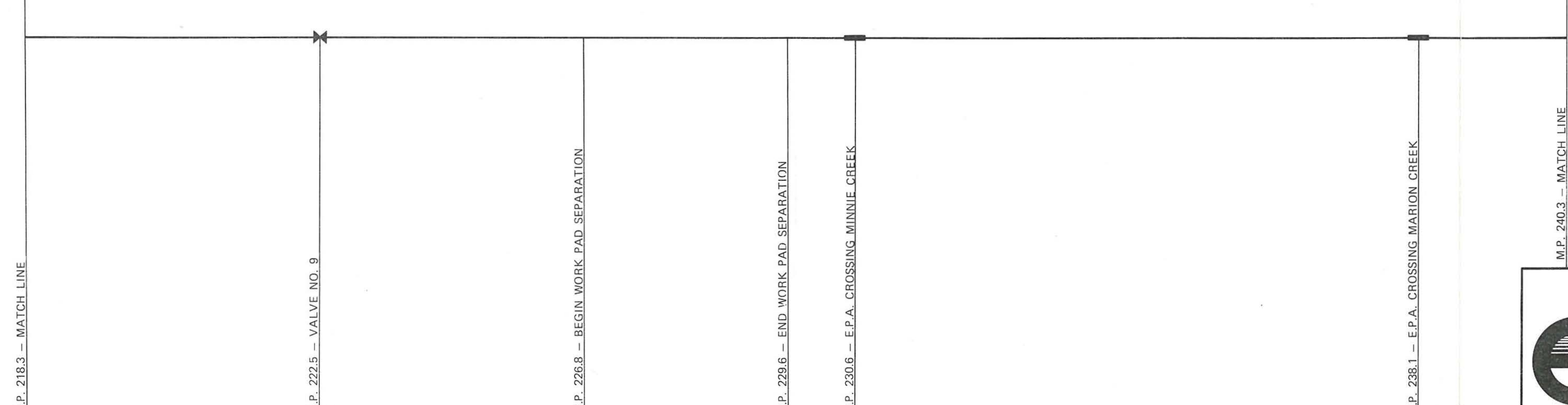
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION



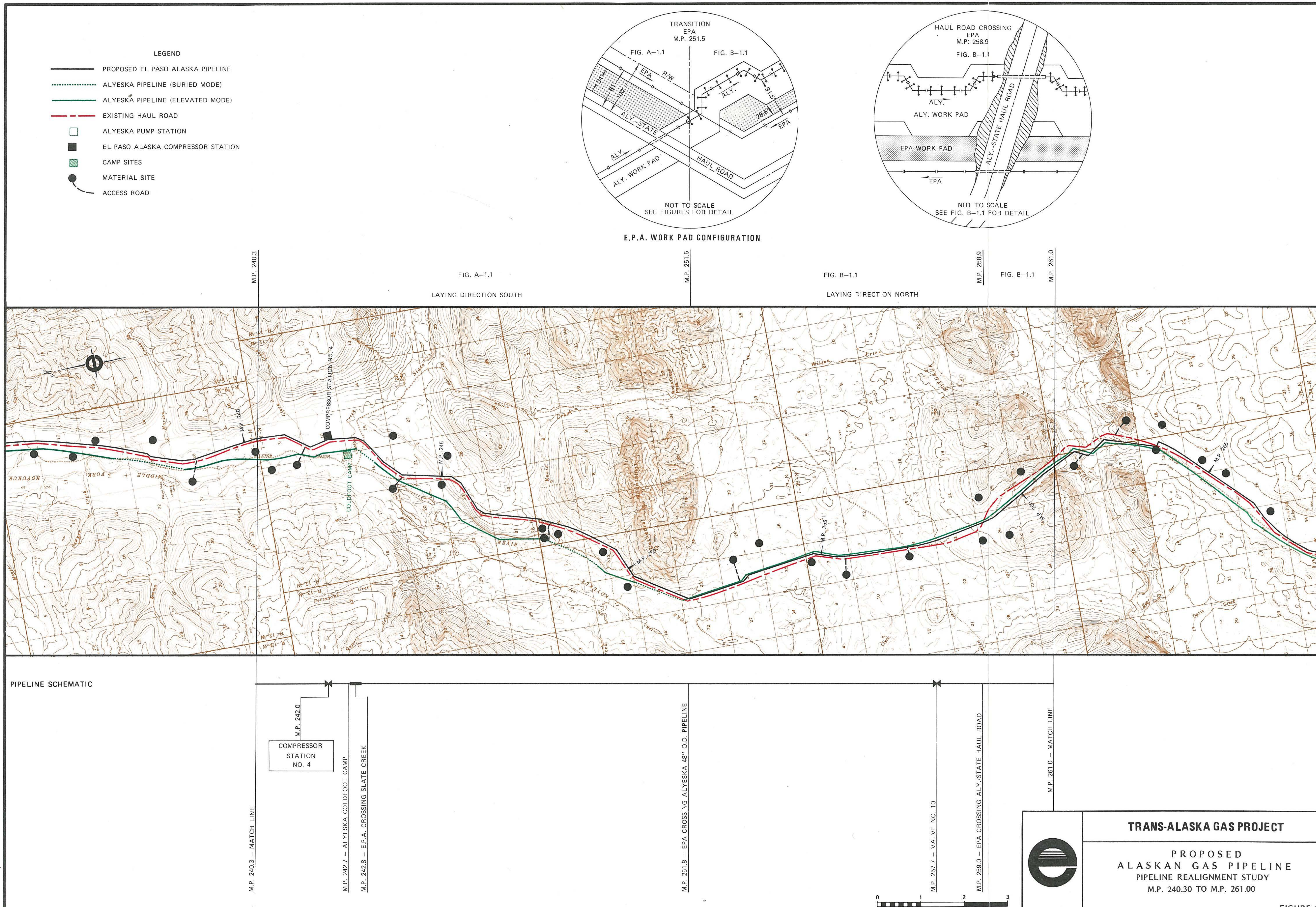
PIPELINE SCHEMATIC

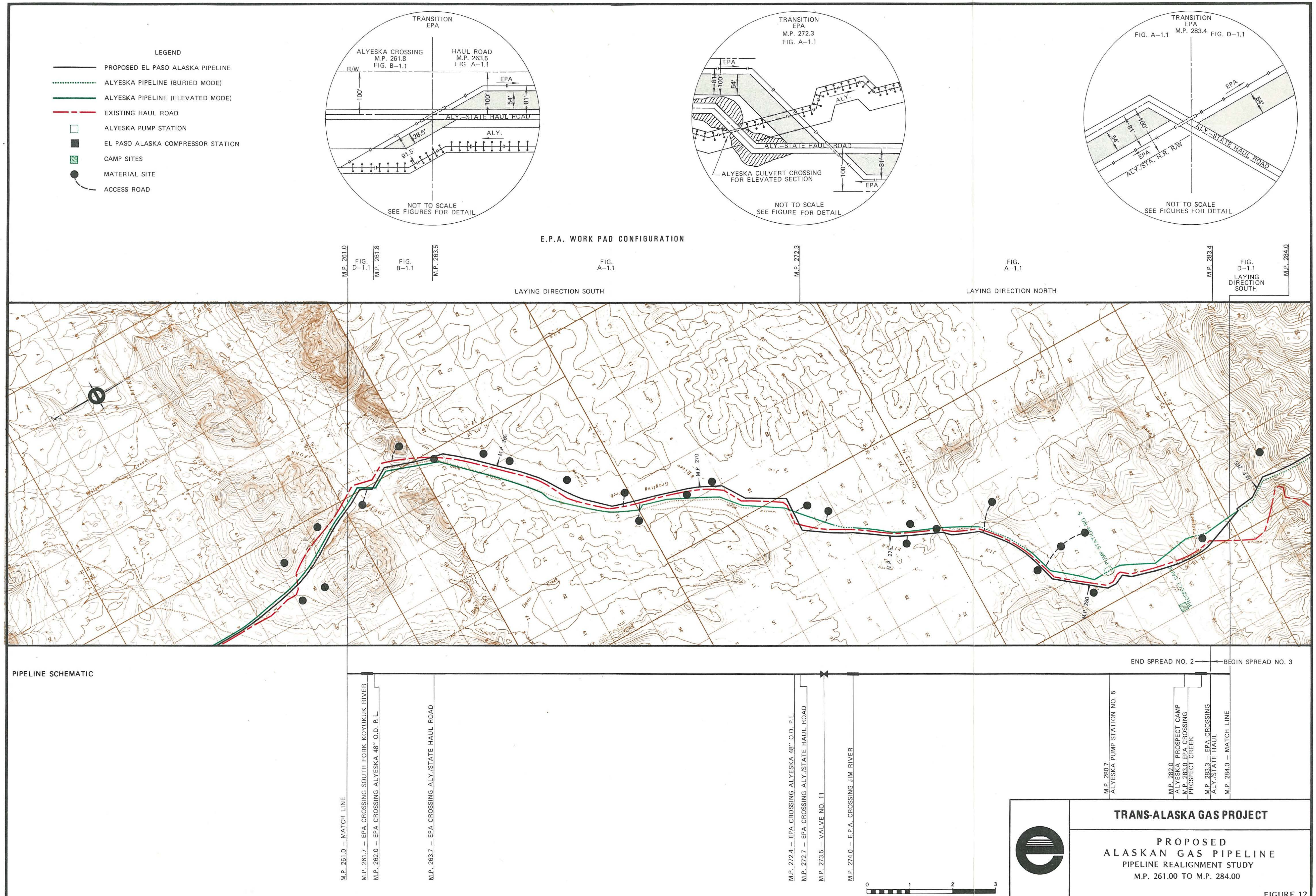


TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 218.30 TO M.P. 240.30

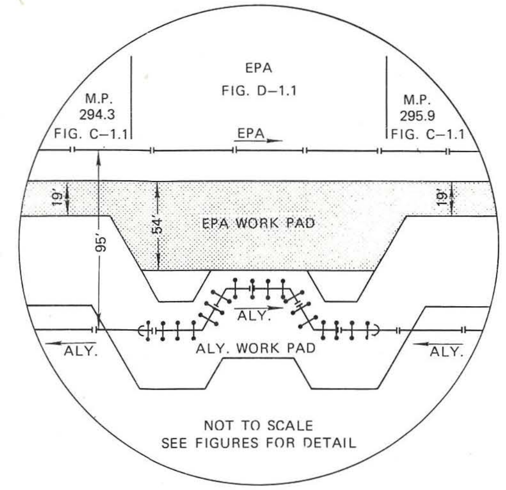
FIGURE 10


LEGEND
PROPOSED EL PASO ALASKA PIPELINE
ALYESKA PIPELINE (BURIED MODE)
ALYESKA PIPELINE (ELEVATED MODE)
EXISTING HAUL ROAD
ALYESKA PUMP STATION
EL PASO ALASKA COMPRESSOR STATION
CAMP SITES
MATERIAL SITE
ACCESS ROAD
TRANSITION
EPA
M.P. 251.5
FIG. A–1.1
FIG. B–1.1
NOT TO SCALE
SEE FIGURES FOR DETAIL
HAUL ROAD CROSSING
EPA
M.P. 258.9
FIG. B–1.1
ALY. WORK PAD
EPA WORK PAD
ALY.–STATE HAUL ROAD
NOT TO SCALE
SEE FIG. B–1.1 FOR DETAIL
E.P.A. WORK PAD CONFIGURATION
M.P. 240.3
FIG. A–1.1
LAYING DIRECTION SOUTH
M.P. 251.5
FIG. B–1.1
LAYING DIRECTION NORTH
M.P. 258.9
FIG. B–1.1
M.P. 261.0
COMPRESSOR STATION NO. 4
COLDFOOT CAMP
M.P. 240
M.P. 245
M.P. 250
M.P. 255
M.P. 260
M.P. 265
MIDDLE FORK KOYUKUK RIVER
PIPELINE SCHEMATIC
M.P. 242.0
COMPRESSOR
STATION
NO. 4
M.P. 240.3 – MATCH LINE
M.P. 242.7 – ALYESKA COLDFOOT CAMP
M.P. 242.8 – E.P.A. CROSSING SLATE CREEK
M.P. 251.8 – EPA CROSSING ALYESKA 48" O.D. PIPELINE
M.P. 257.7 – VALVE NO. 10
M.P. 259.0 – EPA CROSSING ALY./STATE HAUL ROAD
M.P. 261.0 – MATCH LINE
0
1
2
3
SCALE IN MILES
TRANS-ALASKA GAS PROJECT
PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 240.30 TO M.P. 261.00
FIGURE 11


LEGEND
PROPOSED EL PASO ALASKA PIPELINE
ALYESKA PIPELINE (BURIED MODE)
ALYESKA PIPELINE (ELEVATED MODE)
EXISTING HAUL ROAD
ALYESKA PUMP STATION
EL PASO ALASKA COMPRESSOR STATION
CAMP SITES
MATERIAL SITE
ACCESS ROAD
TRANSITION EPA
ALYESKA CROSSING M.P. 261.8 FIG. B–1.1
HAUL ROAD M.P. 263.5 FIG. A–1.1
R/W
EPA
ALY.-STATE HAUL ROAD
ALY.
NOT TO SCALE SEE FIGURES FOR DETAIL
TRANSITION EPA M.P. 272.3 FIG. A–1.1
ALYESKA CULVERT CROSSING FOR ELEVATED SECTION
NOT TO SCALE SEE FIGURE FOR DETAIL
TRANSITION EPA M.P. 283.4
FIG. A–1.1
FIG. D–1.1
ALY.-STATE HAUL ROAD
ALY./STA. H.R. R/W
NOT TO SCALE SEE FIGURES FOR DETAIL
E.P.A. WORK PAD CONFIGURATION
M.P. 261.0
FIG. D–1.1
M.P. 261.8
FIG. B–1.1
M.P. 263.5
FIG. A–1.1
M.P. 272.3
FIG. A–1.1
M.P. 283.4
FIG. D–1.1
LAYING DIRECTION SOUTH
M.P. 284.0
LAYING DIRECTION SOUTH
LAYING DIRECTION NORTH
M.P. 266
M.P. 270
M.P. 276
M.P. 280
M.P. 285
PUMP STATION NO. 5
PIPELINE SCHEMATIC
END SPREAD NO. 2
BEGIN SPREAD NO. 3
M.P. 261.0 – MATCH LINE
M.P. 261.7 – EPA CROSSING SOUTH FORK KOYUKUK RIVER
M.P. 262.0 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 263.7 – EPA CROSSING ALY./STATE HAUL ROAD
M.P. 272.4 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 272.7 – EPA CROSSING ALY./STATE HAUL ROAD
M.P. 273.5 – VALVE NO. 11
M.P. 274.0 – E.P.A. CROSSING JIM RIVER
M.P. 280.7 ALYESKA PUMP STATION NO. 5
M.P. 282.0 ALYESKA PROSPECT CAMP
M.P. 283.0 EPA CROSSING PROSPECT CREEK
M.P. 283.3 – EPA CROSSING ALY./STATE HAUL
M.P. 284.0 – MATCH LINE
0 1 2 3
SCALE IN MILES
TRANS-ALASKA GAS PROJECT
PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 261.00 TO M.P. 284.00
FIGURE 12

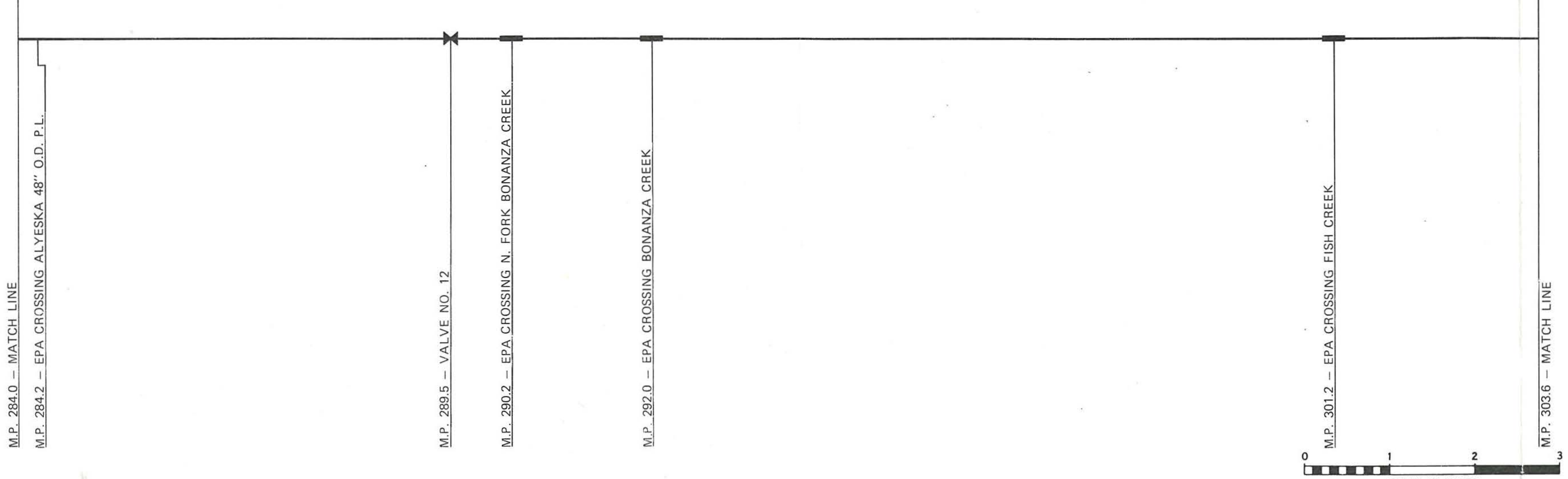
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION

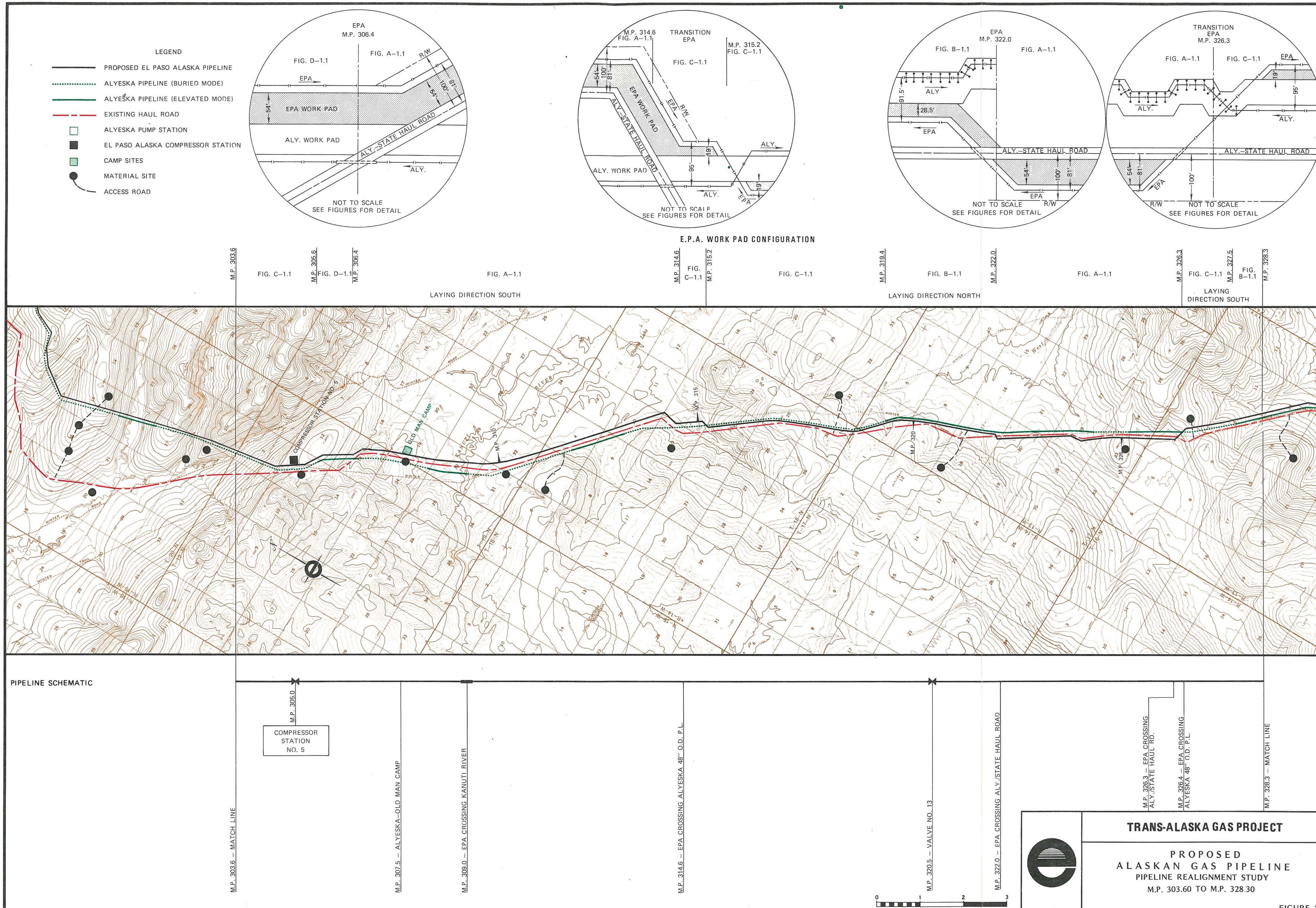
PIPELINE SCHEMATIC



TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 284.00 TO M.P. 303.60

FIGURE 13



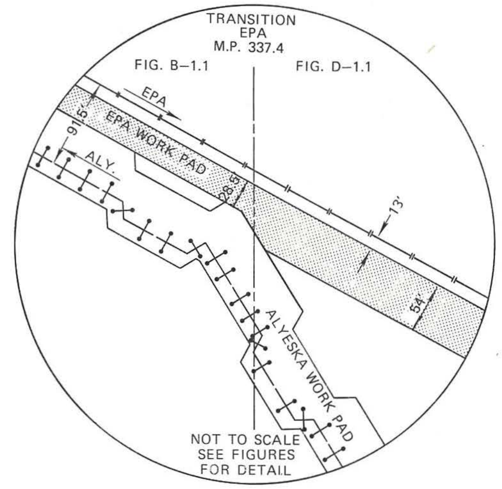
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 303.60 TO M.P. 328.30

FIGURE 14

LEGEND

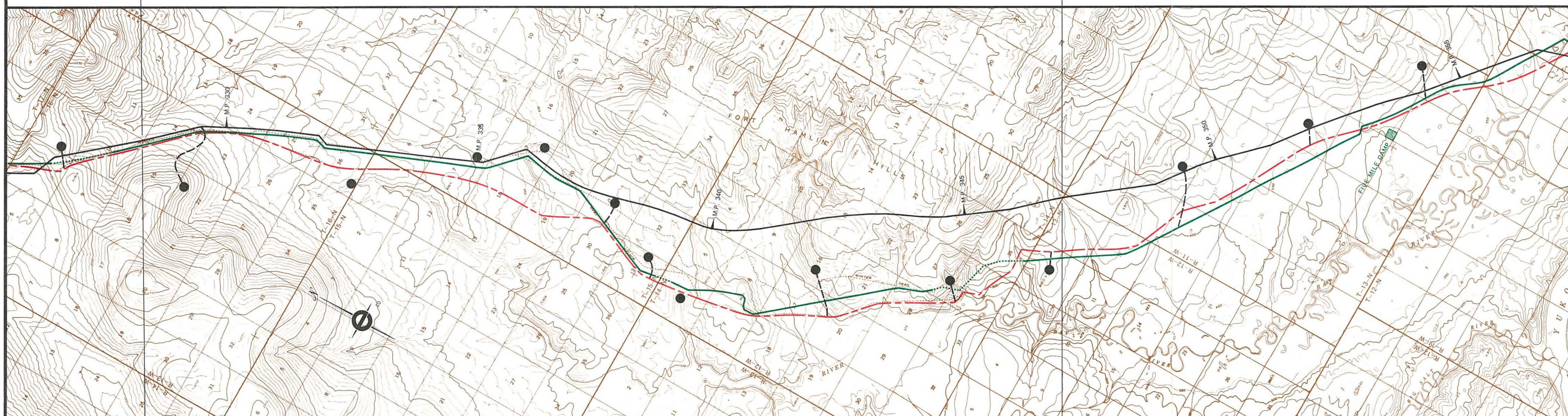
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITES
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION

M.P. 328.3 FIG. B–1.1 M.P. 337.4 FIG. D–1.1 M.P. 346.9

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

M.P. 328.3 – MATCH LINE

M.P. 337.3 – E.P.A. ROUTE DIVERGES FROM ALYESKA

M.P. 337.5 – VALVE NO. 14

M.P. 346.9 – MATCH LINE

0 1 2 3
SCALE IN MILES

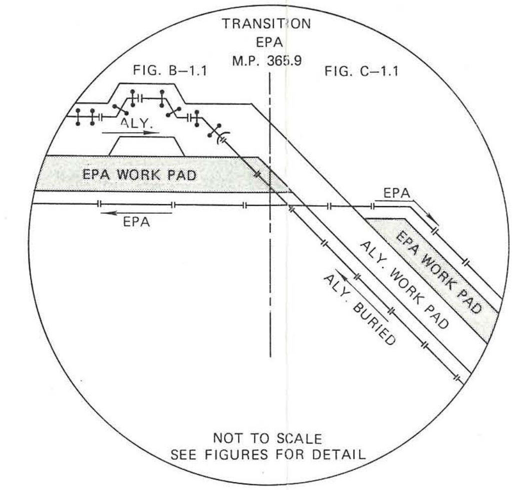
TRANS-ALASKA GAS PROJECT

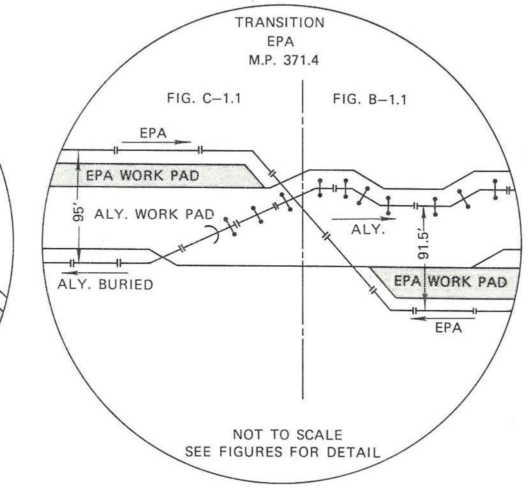
PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 328.30 TO M.P. 346.90

FIGURE 15

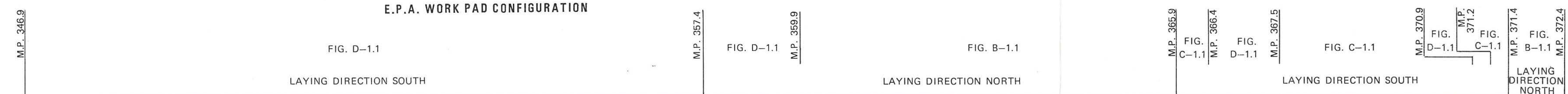
LEGEND

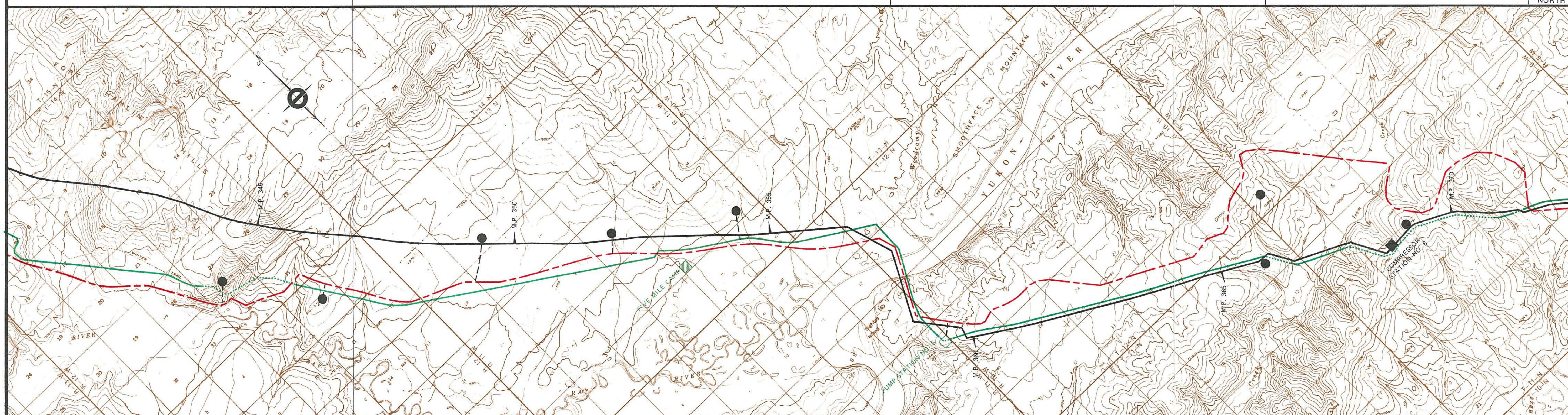
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



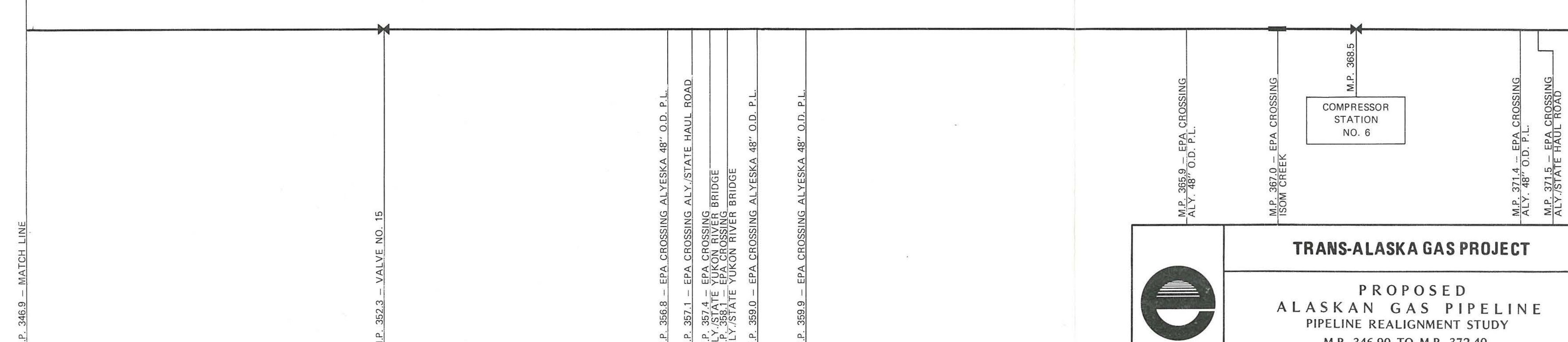


E.P.A. WORK PAD CONFIGURATION





PIPELINE SCHEMATIC



0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 346.90 TO M.P. 372.40

FIGURE 16

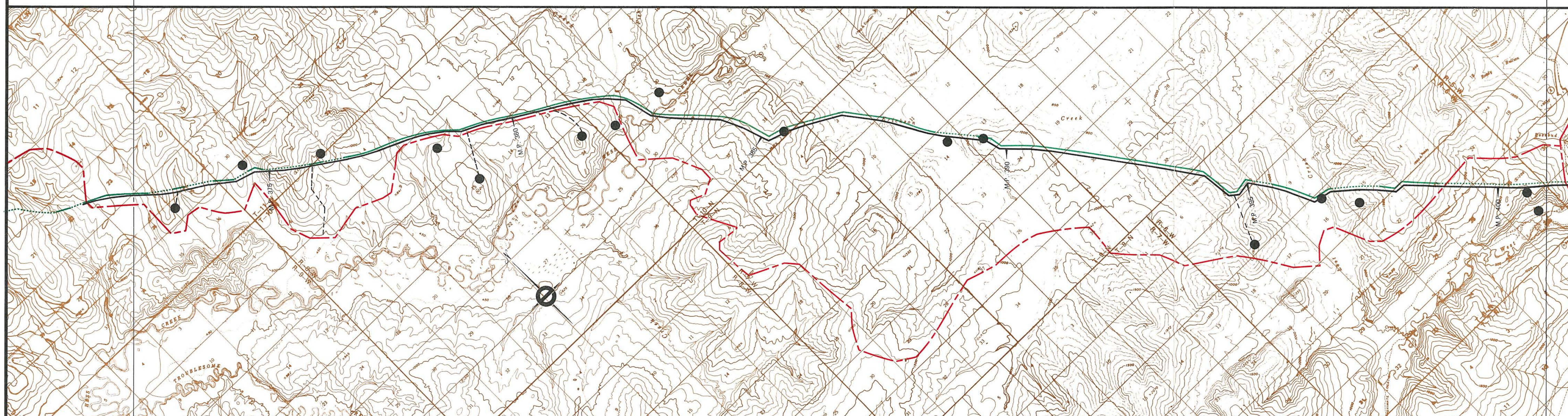
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 372.4 | FIG. B–1.1 | M.P. 372.7 | FIG. C–4.1 | M.P. 373.4 | FIG. B–1.1 | M.P. 373.6 | FIG. C–4.1 | M.P. 374.1 | FIG. B–1.1 | M.P. 374.5 | FIG. C–4.1 | M.P. 374.8 | FIG. B–3.1 | M.P. 375.1 | FIG. C–4.1 | M.P. 376.0 | FIG. B–1.1 | M.P. 376.3 | FIG. C–4.1 | M.P. 376.7 | FIG. B–1.1 | M.P. 380.5 | FIG. B–3.1 | M.P. 386.5 | FIG. B–1.1 | M.P. 388.5 | FIG. C–4.1 | M.P. 389.3 | FIG. B–1.1 | M.P. 395.0 | FIG. C–4.1 | M.P. 395.5 | FIG. B–3.1 | M.P. 396.8 | FIG. C–4.1 | M.P. 397.7 | FIG. B–3.1 | M.P. 399.0 | FIG. C–4.1 | M.P. 399.5 | FIG. C–1.1 | M.P. 400.6 | FIG. C–4.1 | M.P. 400.9

LAYING DIRECTION NORTH



PIPELINE SCHEMATIC

M.P. 372.4 – MATCH LINE

M.P. 383.0 – EPA CROSSING HESS CREEK

M.P. 387.8 – VALVE NO. 16

M.P. 389.0 – EPA CROSSING ERICKSON CREEK

M.P. 396.4
EPA CROSSING COST CREEK

M.P. 399.0 -EPA CROSSING
ALY./STATE HAUL ROAD

M.P. 400.9 – MATCH LINE

0 1 2 3
SCALE IN MILES

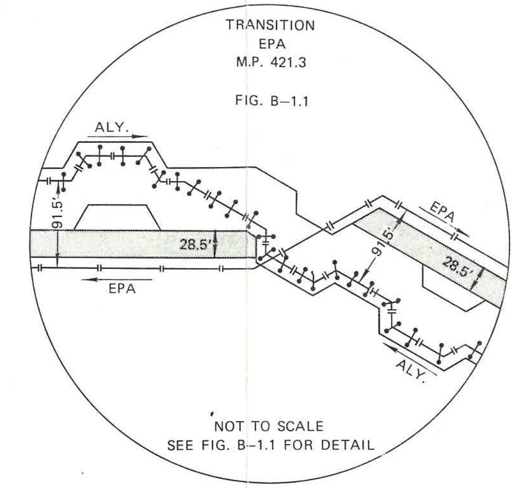
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 372.40 TO M.P. 400.90

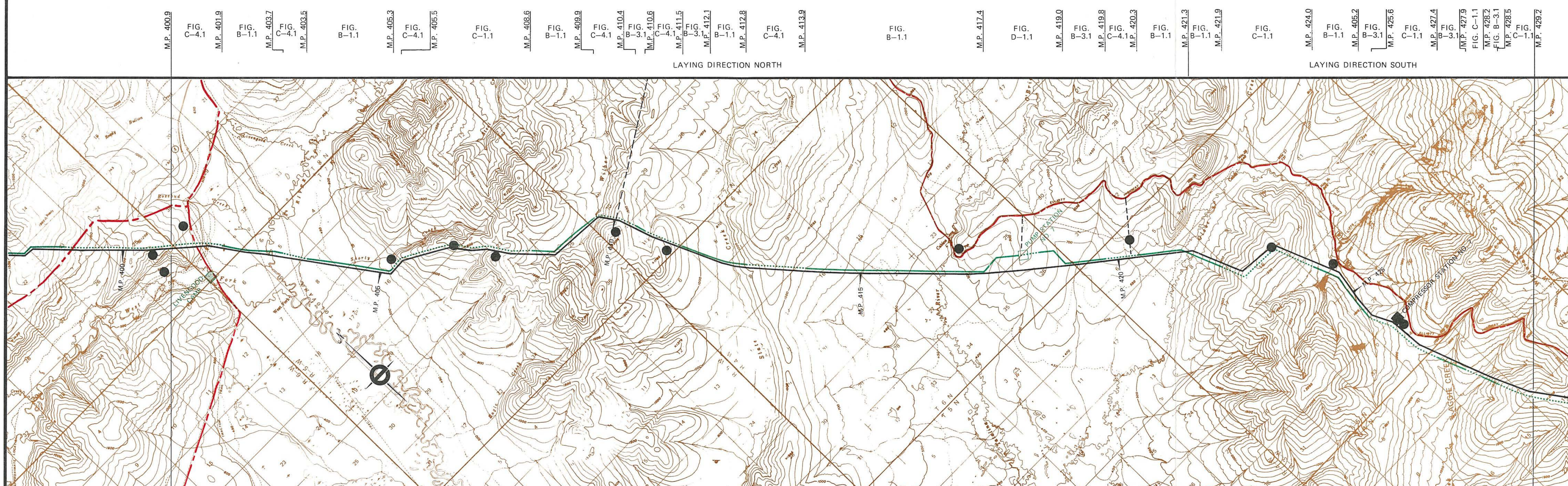
FIGURE 17

LEGEND

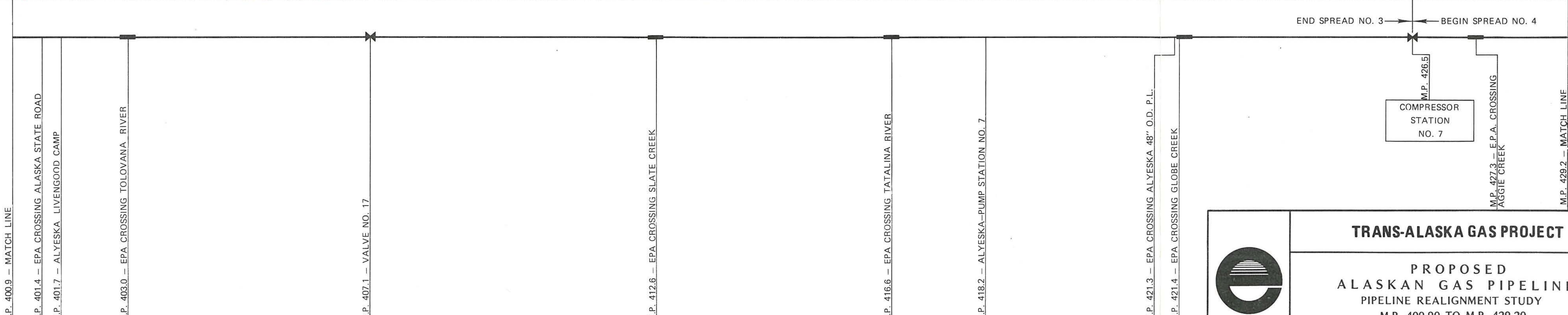
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION



PIPELINE SCHEMATIC



TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 400.90 TO M.P. 429.20

FIGURE 18

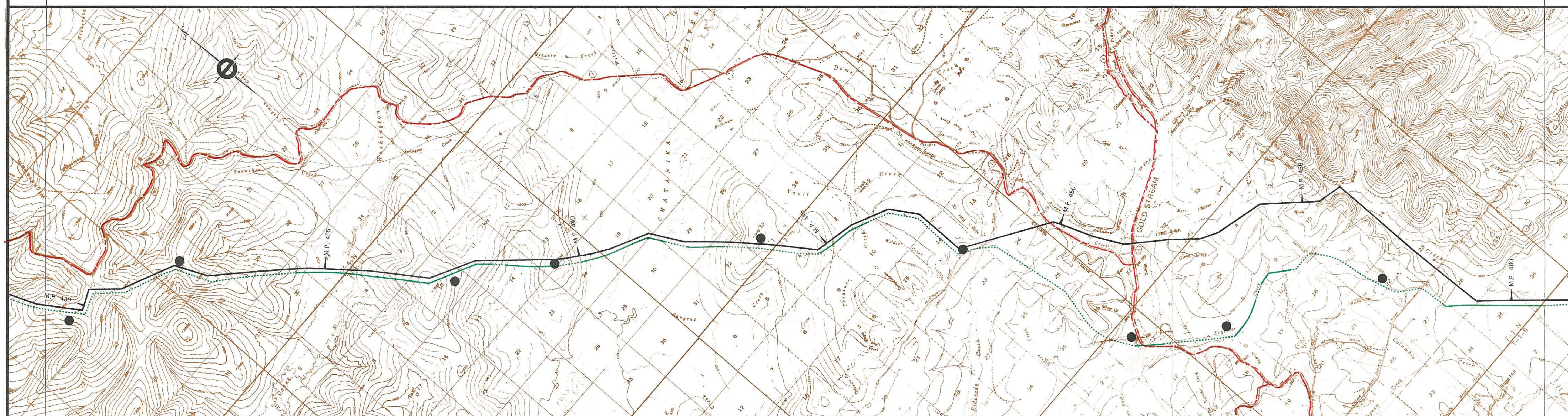
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 429.2 | FIG. C-1.1 | M.P. 434.4 | FIG. B-3.1 | M.P. 438.3 | FIG. C-1.1 | M.P. 438.5 | FIG. B-1.1 | M.P. 439.4 | FIG. C-1.1 | M.P. 440.0 | FIG. B-3.1 | M.P. 441.7 | FIG. C-4.1 | M.P. 442.1 | FIG. B-1.1 | M.P. 442.9 | FIG. C-1.1 | M.P. 444.8 | FIG. B-3.1 | M.P. 446.0 | FIG C-1.1 | M.P. 448.7 | FIG. D-1.1 | M.P. 459.5 | FIG. B-3.1 | M.P. 460.6

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

- M.P. 429.2 – MATCH LINE
- M.P. 435.5 – EPA CROSSING WASHINGTON CREEK
- M.P. 442.0 – EPA CROSSING CHATANIKA RIVER
- M.P. 443.5 – VALVE NO. 18
- M.P. 445.7 – EPA CROSSING TREASURE CREEK
- M.P. 448.7 – EPA CROSSING MURPHY DOME ROAD
- M.P. 449.8 – EPA CROSSING ELLIOTT HIGHWAY
- M.P. 451.5 – EPA CROSSING STEESE HIGHWAY
- M.P. 451.6 – EPA CROSSING GOLDSTREAM CR.
- M.P. 458.3 – EPA CROSSING CHENA HOT SPRINGS RD.
- M.P. 459.8 – VALVE NO.19
- M.P. 460.6 – MATCH LINE

0 1 2 3
SCALE IN MILES

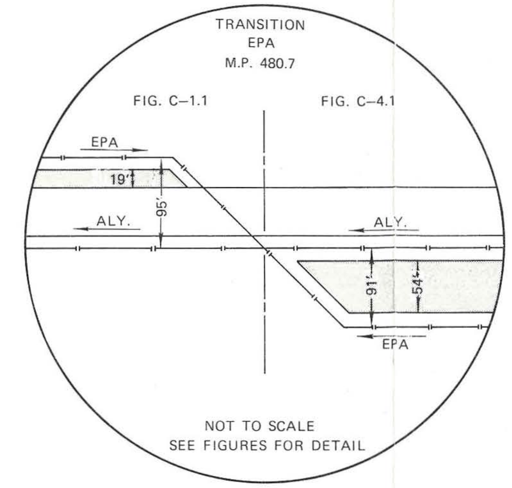
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 429.20 TO M.P. 460.60

FIGURE 19

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

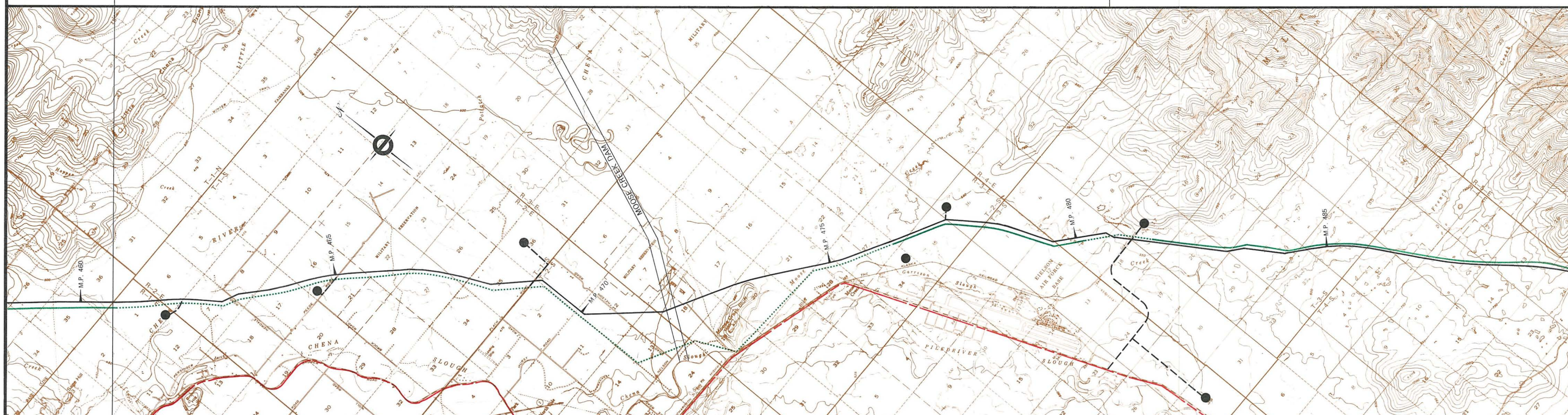


E.P.A. WORK PAD CONFIGURATION

M.P. 460.6 | FIG. C–1.1 | M.P. 461.6 | FIG. C–1.1 | M.P. 470.0 | FIG. D–1.1 | M.P. 474.7 | FIG. C–1.1 | M.P. 476.3 | FIG. B–3.1 | M.P. 477.9 | FIG. C–1.1 | M.P. 479.6 | FIG. B–1.1 | M.P. 480.2 | FIG. C–1.1 | M.P. 480.7 | FIG. C–4.1 | M.P. 481.5 | FIG. B–1.1 | M.P. 489.9

LAYING DIRECTION SOUTH

LAYING DIRECTION NORTH



PIPELINE SCHEMATIC

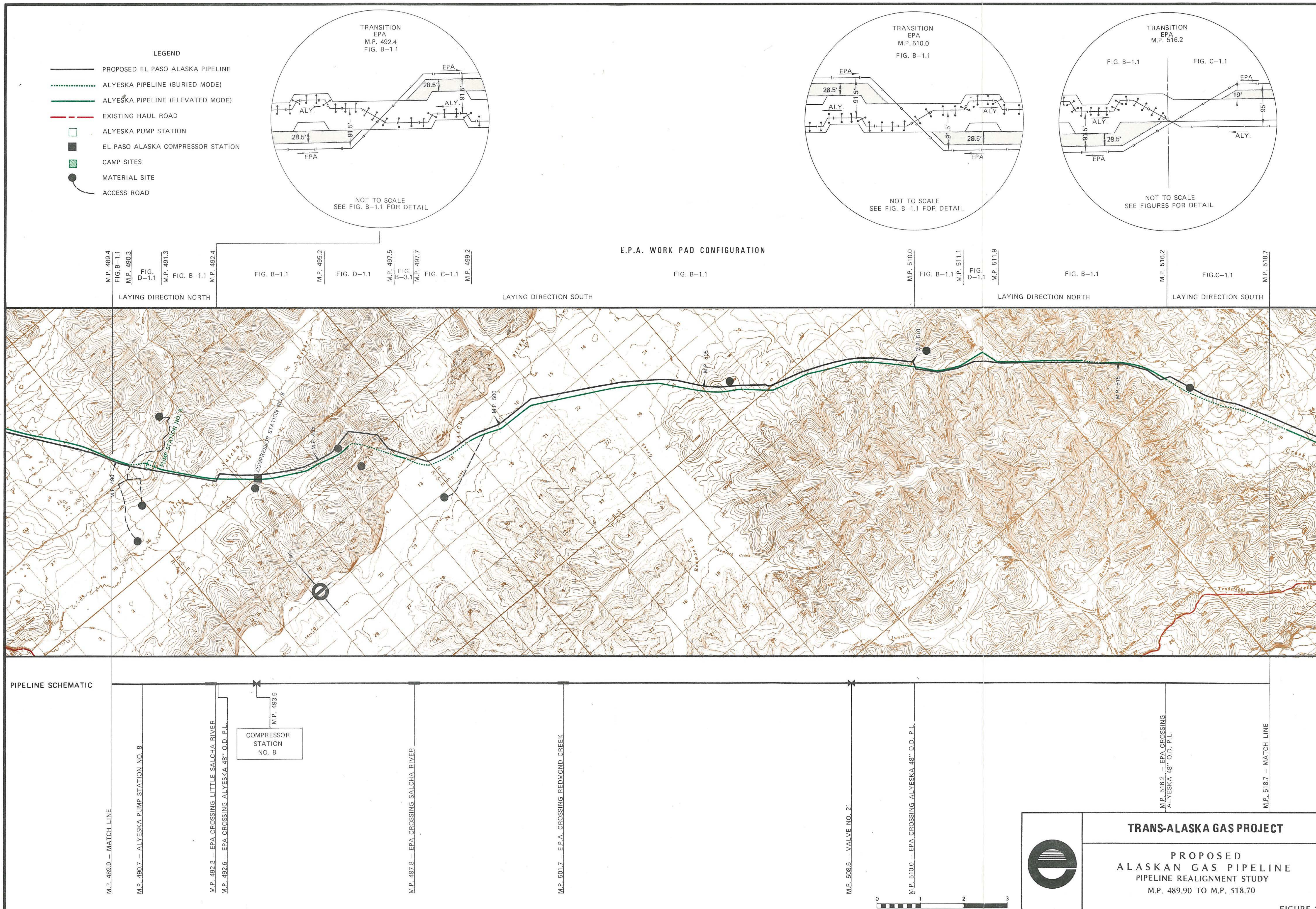
- M.P. 460.6 – MATCH LINE
- M.P. 461.6 – EPA CROSSING CHENA RIVER
- M.P. 463 – E.P.A. CROSSING NORDALE ROAD
- M.P. 465 – E.P.A. CROSSING PEEDE ROAD
- M.P. 468.9 – E.P.A. CROSSING PLACK ROAD
- M.P. 470.7 – E.P.A. CROSSING NELSON ROAD
- M.P. 471.7 – EPA CROSSING MOOSE CREEK DAM
- M.P. 475.1 – E.P.A. CROSSING MINOR STREAM
- M.P. 477.1 – E.P.A. CROSSING MINOR STREAM
- M.P. 478.0 – VALVE NO. 20
- M.P. 478.0 – E.P.A. CROSSING MINOR STREAM
- M.P. 478.6 – E.P.A. CROSSING MINOR STREAM
- M.P. 479.2 – E.P.A. CROSSING MINOR STREAM
- M.P. 479.7 – E.P.A. CROSSING MINOR STREAM
- M.P. 480.7 – EPA CROSSING ALYESKA 48" O.D.P.L.
- M.P. 489.9 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 460.60 TO M.P. 489.90

FIGURE 20



LEGEND
PROPOSED EL PASO ALASKA PIPELINE
ALYESKA PIPELINE (BURIED MODE)
ALYESKA PIPELINE (ELEVATED MODE)
EXISTING HAUL ROAD
ALYESKA PUMP STATION
EL PASO ALASKA COMPRESSOR STATION
CAMP SITES
MATERIAL SITE
ACCESS ROAD
TRANSITION EPA M.P. 492.4 FIG. B–1.1
NOT TO SCALE SEE FIG. B–1.1 FOR DETAIL
TRANSITION EPA M.P. 510.0 FIG. B–1.1
NOT TO SCALE SEE FIG. B–1.1 FOR DETAIL
TRANSITION EPA M.P. 516.2
FIG. B–1.1
FIG. C–1.1
NOT TO SCALE SEE FIGURES FOR DETAIL
E.P.A. WORK PAD CONFIGURATION
LAYING DIRECTION NORTH
LAYING DIRECTION SOUTH
LAYING DIRECTION NORTH
LAYING DIRECTION SOUTH
PIPELINE SCHEMATIC
M.P. 489.9 – MATCH LINE
M.P. 490.7 – ALYESKA PUMP STATION NO. 8
M.P. 492.3 – EPA CROSSING LITTLE SALCHA RIVER
M.P. 492.6 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 493.5
COMPRESSOR STATION NO. 8
M.P. 497.8 – EPA CROSSING SALCHA RIVER
M.P. 501.7 – E.P.A. CROSSING REDMOND CREEK
M.P. 508.6 – VALVE NO. 21
M.P. 510.0 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 516.2 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 518.7 – MATCH LINE
SCALE IN MILES
TRANS-ALASKA GAS PROJECT
PROPOSED ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 489.90 TO M.P. 518.70

FIGURE 21

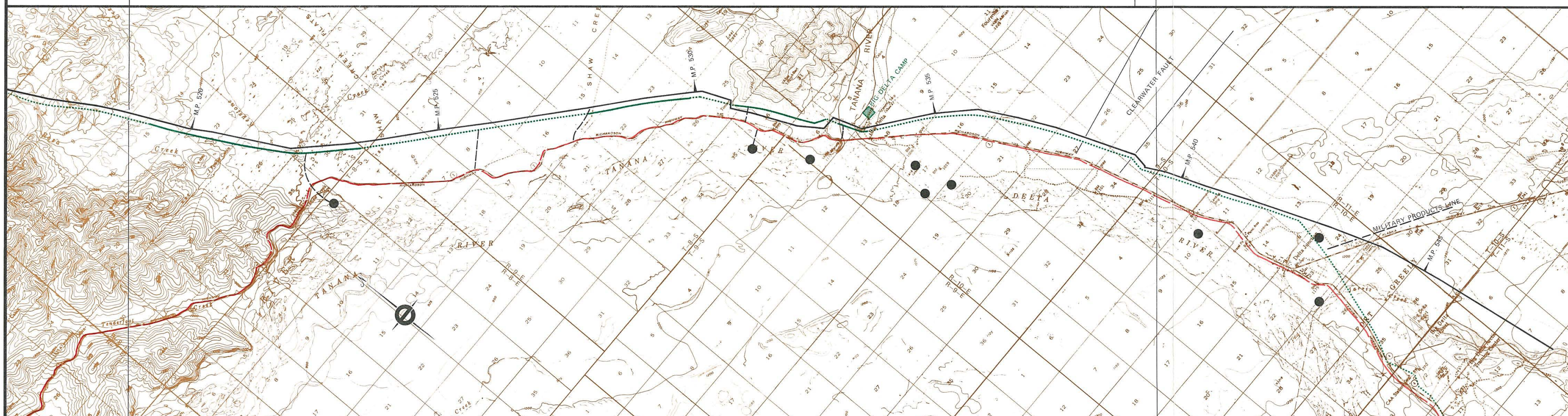
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 518.7 | FIG. C–1.1 | M.P. 519.1 | FIG. B–1.1 | M.P. 523.5 | FIG. C–1.1 | M.P. 527.9 | FIG. B–1.1 | M.P. 529.8 | FIG. C–1.1 | M.P. 530.7 | FIG. D–1.1 | M.P. 533.8 | FIG. C–1.1 | M.P. 538.0 | FIG. C–1.1 | M.P. 539.0 | FIG. C–1.1 | M.P. 539.5

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

SPECIAL CONST.

- M.P. 518.7 – MATCH LINE
- M.P. 522.1 – EPA CROSSING SHAW CREEK
- M.P. 525.7 – VALVE NO. 22
- M.P. 530.8 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 532.9 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 533.3 – EPA CROSSING TANANA RIVER AERIAL SUSPENSION
- M.P. 533.7 – ALYESKA BIG DELTA CAMP
- M.P. 533.8 – EPA BEGIN PARALLEL ALYESKA
- M.P. 537.93 – VALVE NO. 23
- M.P. 538.0 – BEGIN CLEARWATER FAULT
- M.P. 539.0 – END CLEARWATER FAULT
- M.P. 539.07 – VALVE NO. 24
- M.P. 539.5 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 518.70 TO M.P. 539.50

FIGURE 22

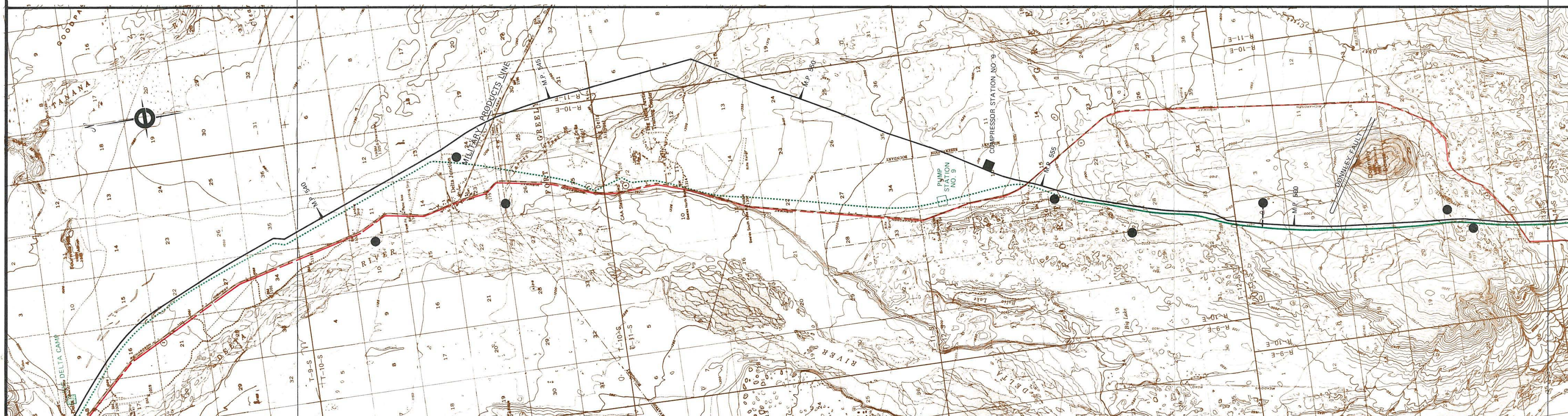
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 539.5 — FIG. C–1.1 — M.P. 542.4 — FIG. D–1.1 — M.P. 554.6 — FIG. C–1.1 — M.P. 555.7 — FIG. B–3.1 — M.P. 557.5 — FIG. B–1.1 — M.P. 564.4 — TRANSITION — M.P. 564.9

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

- M.P. 539.5 – MATCH LINE
- M.P. 543.6 – EPA CROSSING MILITARY PRODUCTS P.L.
- M.P. 543.8 – EPA CROSSING ALASKAN HIGHWAY
- M.P. 547.0 – BIG DELTA ARCTIC TRAINING CENTER
- M.P. 547.9 – EPA CROSSING JARVIS CREEK
- M.P. 553.0 – ALYESKA PUMP STATION NO. 9
- M.P. 553.80 – COMPRESSOR STATION NO. 9
- M.P. 554.3 – EPA CROSSING RICHARDSON HWY.
- M.P. 560.32 – VALVE NO. 25
- M.P. 560.6 – DONNLEY FAULT
- M.P. 560.88 – VALVE NO. 26
- M.P. 564.3 – E.P.A. CROSSING RICHARDSON HIGHWAY
- M.P. 564.4 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 564.9 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 539.50 TO M.P. 564.90

FIGURE 23

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 564.9 | FIG. B–1.1 | M.P. 568.1 FIG. B–3.1 M.P. 568.5 | FIG. C–4.1 | M.P. 570.5 | FIG. B–1.1 | M.P. 573.0 | FIG. C–4.1 | M.P. 576.4 | FIG. C–1.1 | M.P. 581.9 | FIG. C–1.1 | M.P. 583.6

LAYING DIRECTION NORTH

PIPELINE SCHEMATIC

END SPREAD NO. 4 → ← BEGIN SPREAD NO. 5

M.P. 564.9 – MATCH LINE
M.P. 572.4 – E.P.A. CROSSING RUBY CREEK
M.P. 572.9 – EPA CROSSING RICHARDSON HWY.
M.P. 573.8 – E.P.A. CROSSING BEAR CREEK
M.P. 575 – VALVE NO. 27
M.P. 575.8 – E.P.A. CROSSING JARLING CREEK
M.P. 576.0 – EPA CROSSING RICHARDSON HIGHWAY
M.P. 577.8 – E.P.A. CROSSING MINOR CREEK
M.P. 578.8 – E.P.A. CROSSING MINOR CREEK
M.P. 579.0
M.P. 579.3 – E.P.A. CROSSING ONE MILE CREEK
M.P. 580.1 – E.P.A. CROSSING GUNNYSACK CREEK
M.P. 580.5 – E.P.A. CROSSING TRAMP TERRY CREEK
M.P. 581.3 – BLACK RAPIDS TRAINING SITE
M.P. 581.3 – E.P.A. CROSSING FALLS CREEK
M.P. 581.8 – EPA CROSSING RICHARDSON HWY.
M.P. 582.2 – E.P.A. CROSSING SUSY Q CREEK
M.P. 582.8 – E.P.A. CROSSING SUSY Q CREEK
M.P. 583.6 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 564.90 TO M.P. 583.60

FIGURE 24

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

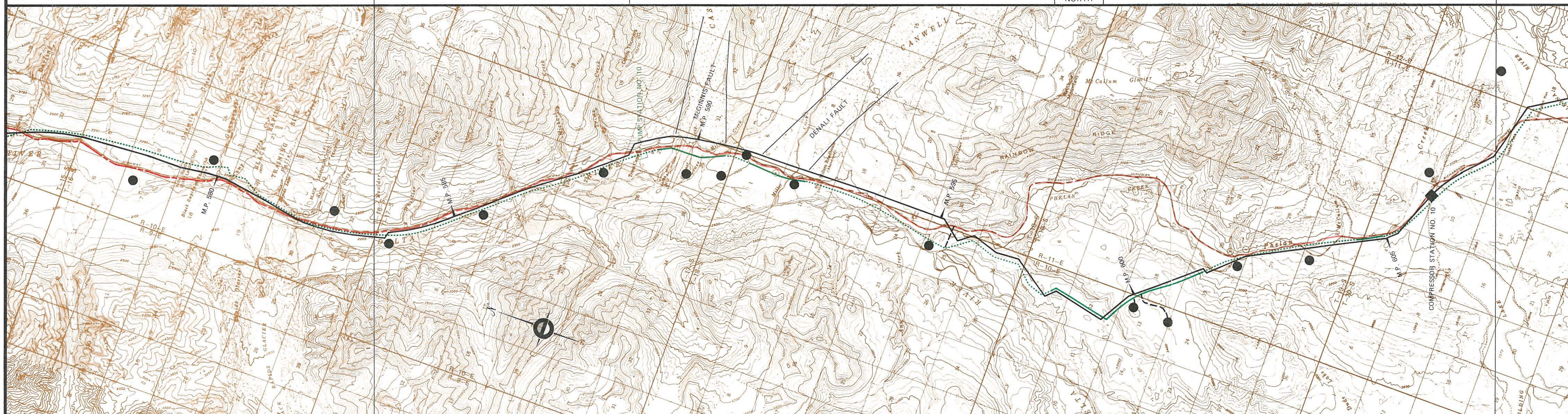
M.P. 583.6	FIG. D–1.1	M.P. 588.6	FIG. D–1.1	M.P. 589.6	FIG. D–1.1	M.P. 590.6	FIG. D–1.1	M.P. 591.3	FIG. D–1.1	M.P. 592.3	FIG. D–1.1	M.P. 598.4	FIG. B–1.1	M.P. 599.3	FIG. B–1.1	M.P. 601.4	FIG. D–1.1	M.P. 604.5	FIG. B–3.1	M.P. 604.9	FIG. C–1.1	M.P. 607.7

LAYING DIRECTION NORTH (M.P. 583.6 – M.P. 588.6)

LAYING DIRECTION SOUTH (M.P. 588.6 – M.P. 598.4)

LAYING DIRECTION NORTH (M.P. 598.4 – M.P. 599.3)

LAYING DIRECTION SOUTH (M.P. 599.3 – M.P. 607.7)



PIPELINE SCHEMATIC

SPECIAL CONSTRUCTION

- M.P. 583.6 – MATCH LINE
- M.P. 583.8 – E.P.A. CROSSING ALYESKA 48" O.D. P.L.
- M.P. 588.6 – EPA CROSSING RICHARDSON HWY.
- M.P. 588.9 – ALYESKA PUMP STATION NO. 10
- M.P. 589.5 – VALVE NO. 28
- M.P. 589.6 – BEGIN McGINNIS FAULT
- M.P. 589.9 – CASTNER CREEK
- M.P. 590.6 – END McGINNIS FAULT
- M.P. 590.9 – VALVE NO. 29
- M.P. 591.3 – BEGIN DENALI FAULT
- M.P. 591.9 – MILLER CREEK
- M.P. 592.3 – END DENALI FAULT
- M.P. 592.4 – VALVE NO. 30
- M.P. 592.75
- M.P. 595.2 – EPA CROSSING RICHARDSON HWY.
- M.P. 596.0 – E.P.A. CROSSING PHELAN CREEK
- M.P. 598.0 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 599.3 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 601.4 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 601.8 – EPA CROSSING PHELAN CREEK
- M.P. 604.9 – E.P.A. CROSSING PHELAN CREEK
- M.P. 605.4 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 606.0 – COMPRESSOR STATION NO. 10
- M.P. 607.7 – MATCH LINE

SCALE IN MILES: 0 1 2 3

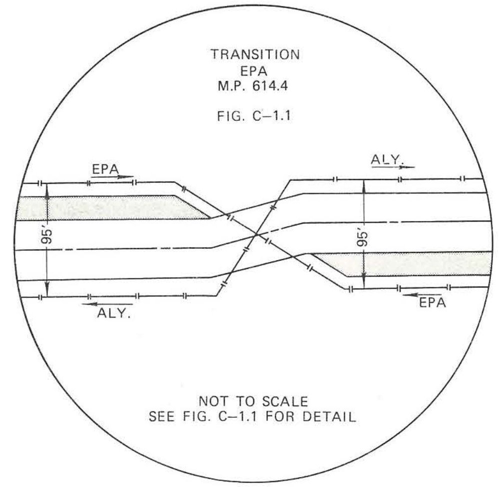
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 583.60 TO M.P. 607.70

FIGURE 25

LEGEND

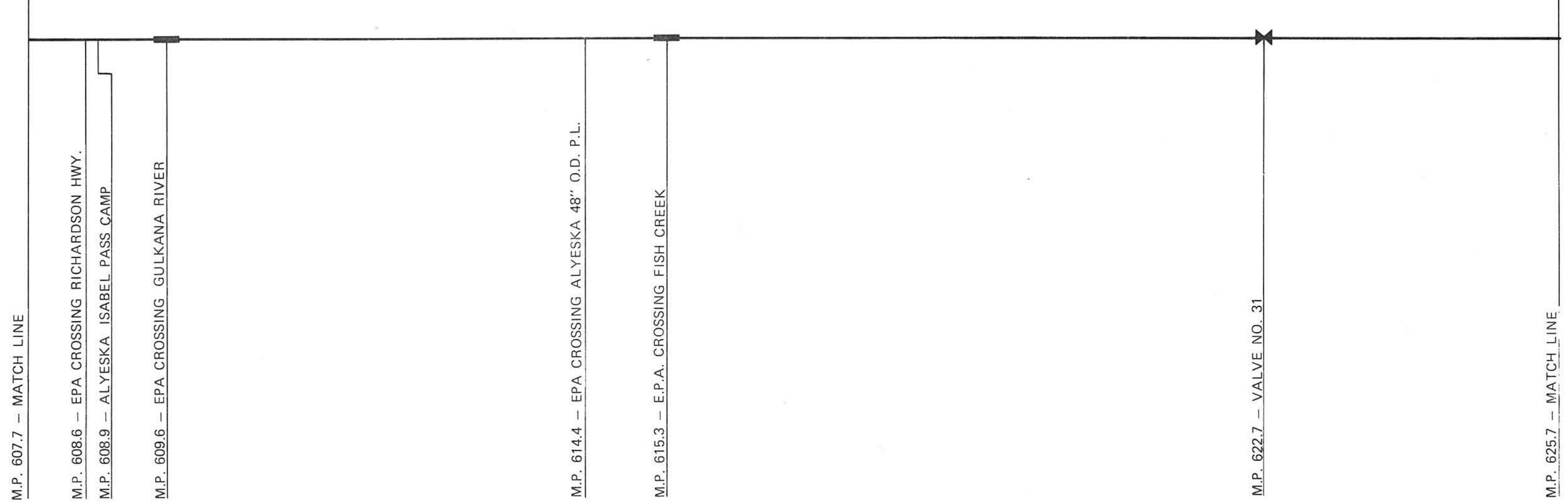
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION

M.P. 607.7		M.P. 614.4		M.P. 625.7
	FIG. C–1.1 LAYING DIRECTION SOUTH		FIG. C–1.1 LAYING DIRECTION NORTH	

PIPELINE SCHEMATIC



0 1 2 3
SCALE IN MILES

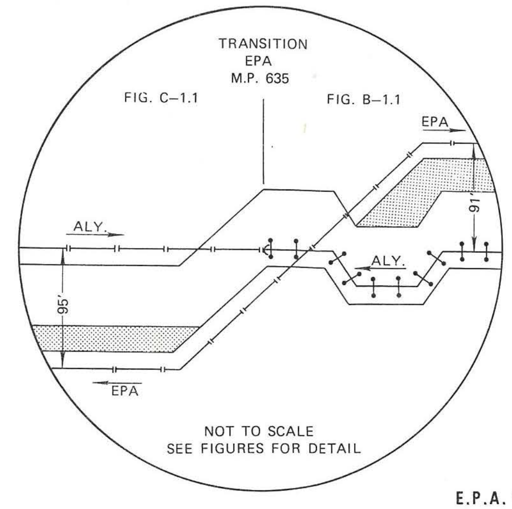
TRANS-ALASKA GAS PROJECT

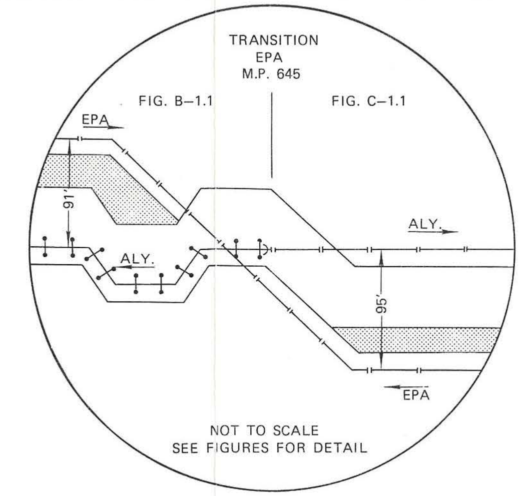
PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 607.70 TO M.P. 625.70

FIGURE 26

LEGEND

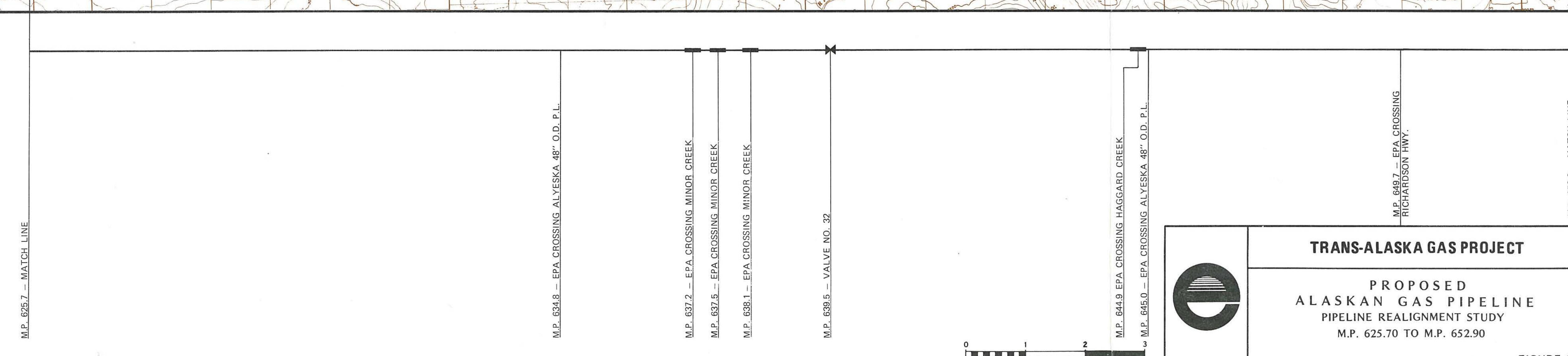
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD





E.P.A. WORK PAD CONFIGURATION

PIPELINE SCHEMATIC



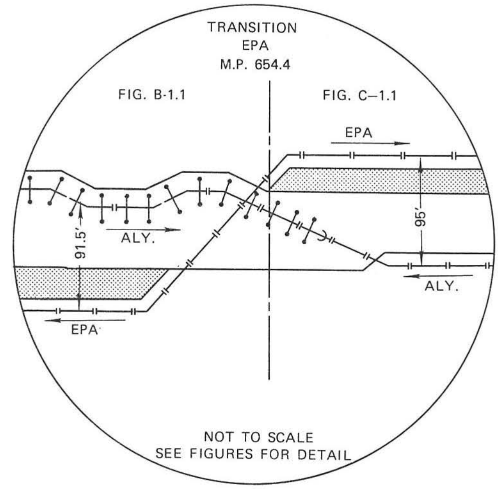
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 625.70 TO M.P. 652.90

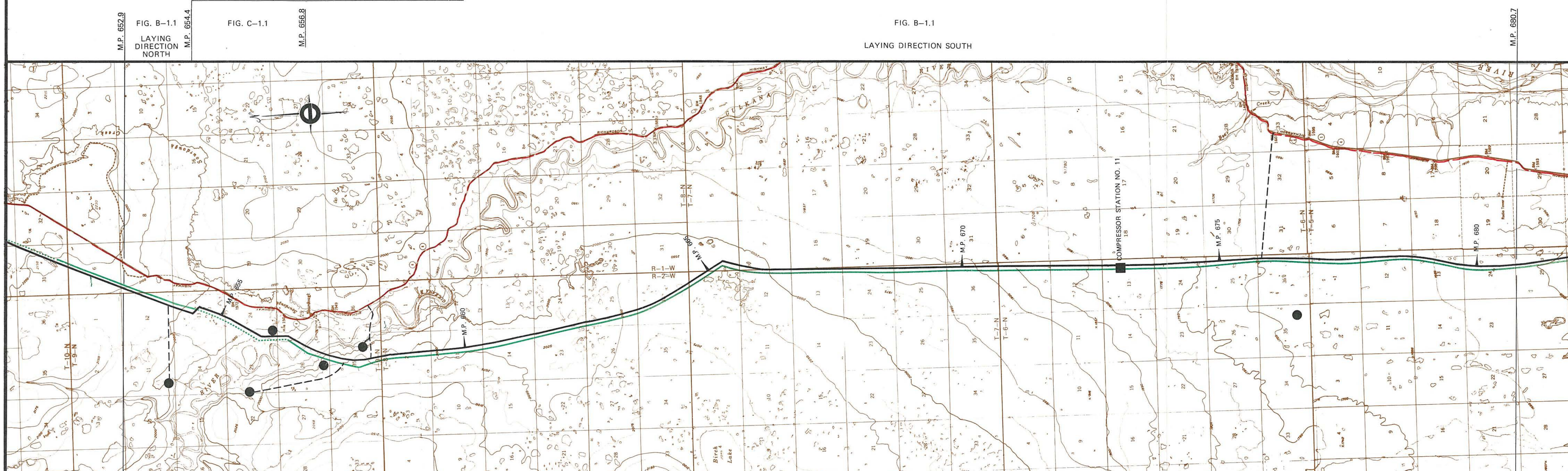
FIGURE 27

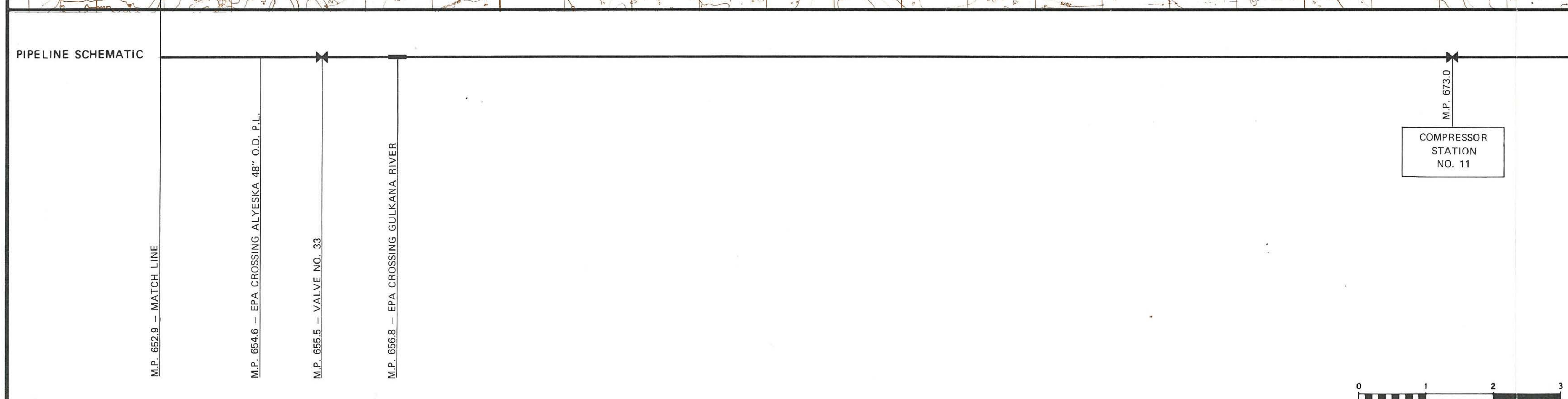
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD



E.P.A. WORK PAD CONFIGURATION





TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 652.90 TO M.P. 680.70

FIGURE 28

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

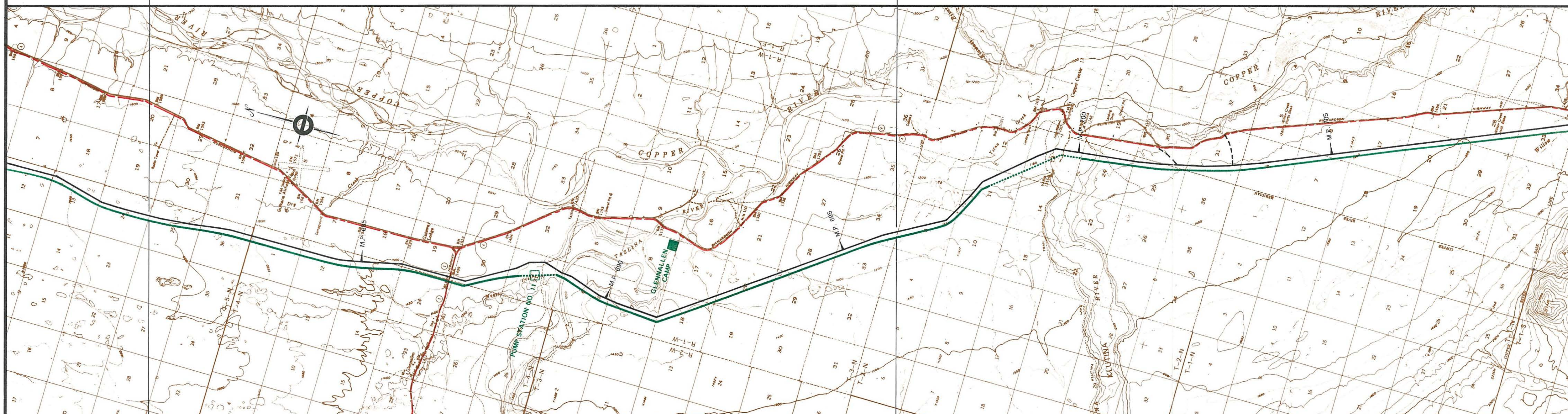
E.P.A. WORK PAD CONFIGURATION

FIG. B–1.1

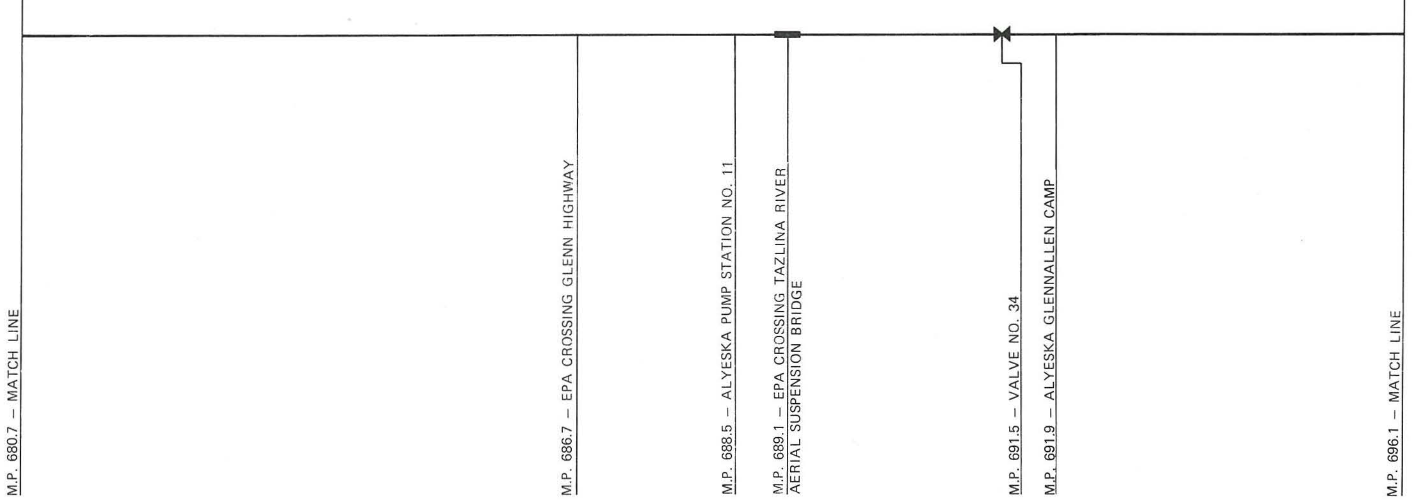
LAYING DIRECTION SOUTH

M.P. 680.7

M.P. 696.1



PIPELINE SCHEMATIC



0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 680.70 TO M.P. 696.10

FIGURE 29

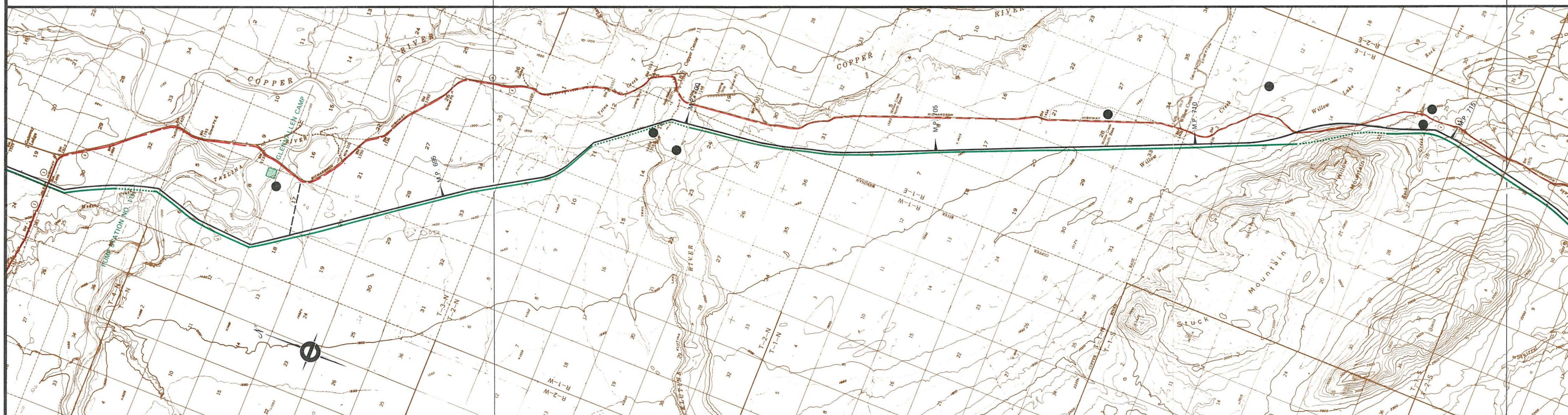
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 696.1 | FIG. B–1.1 | M.P. 710.9 | FIG. D–1.1 | M.P. 714.1 | FIG. B–1.1 | M.P. 716.2

LAYING DIRECTION SOUTH



PIPELINE SCHEMATIC

SPECIAL CONSTRUCTION

SPECIAL CONSTRUCTION

M.P. 696.1 – MATCH LINE

M.P. 700.4 – EPA CROSSING KLUTINA RIVER

M.P. 709 – VALVE NO. 35

M.P. 712.0 – EPA CROSSING RICHARDSON HIGHWAY

M.P. 713.3 – EPA CROSSING RICHARDSON HIGHWAY

M.P. 714.4 ROCK CREEK

M.P. 715.0

M.P. 716.2 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 696.10 TO M.P. 716.20

FIGURE 30

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 716.2 | FIG. B–1.1 | M.P. 719.3 | FIG. B–1.1 | M.P. 721.6 | FIG. C–1.1 | M.P. 723.0 | FIG. B–1.1 | M.P. 724.8 | FIG. C–1.1 | M.P. 727.1 | FIG. D–1.1 | M.P. 737.0

LAYING DIRECTION SOUTH

PIPELINE SCHEMATIC

SPECIAL CONSTRUCTION

M.P. 716.2 – MATCH LINE
M.P. 719.0
M.P. 719.3 – EPA CROSSING SQUIRREL CREEK
M.P. 720.0
M.P. 724.0 – VALVE NO. 36
M.P. 725.8 – EPA CROSSING TONSINA RIVER
M.P. 727.2 – EPA CROSSING ALYESKA 48" O.D. P.L.
M.P. 732.7 – ALYESKA TONSINA CAMP
M.P. 737.0 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 716.20 TO M.P. 737.00

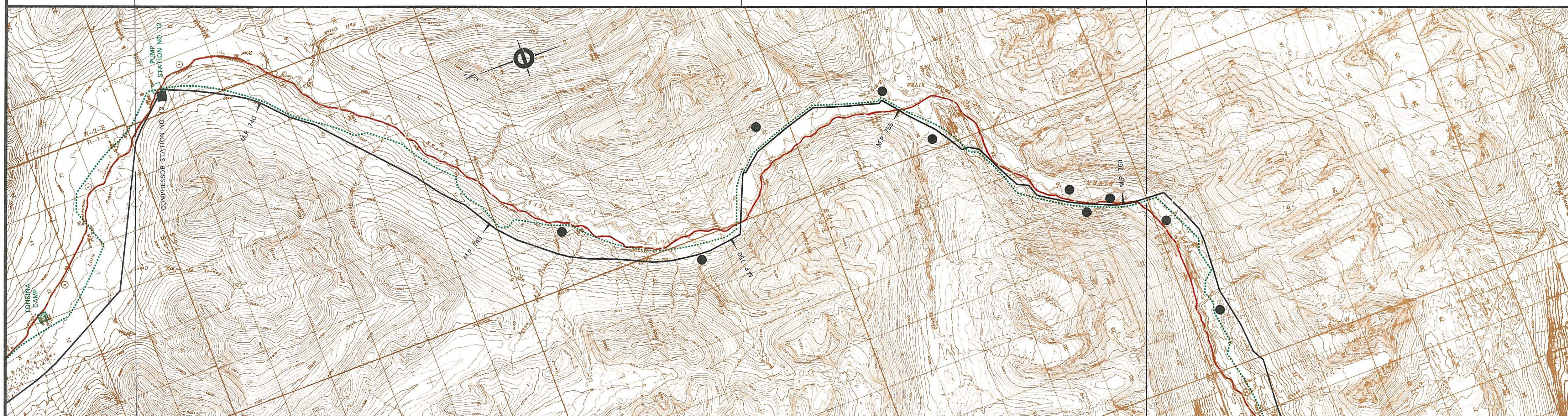
FIGURE 31

LEGEND

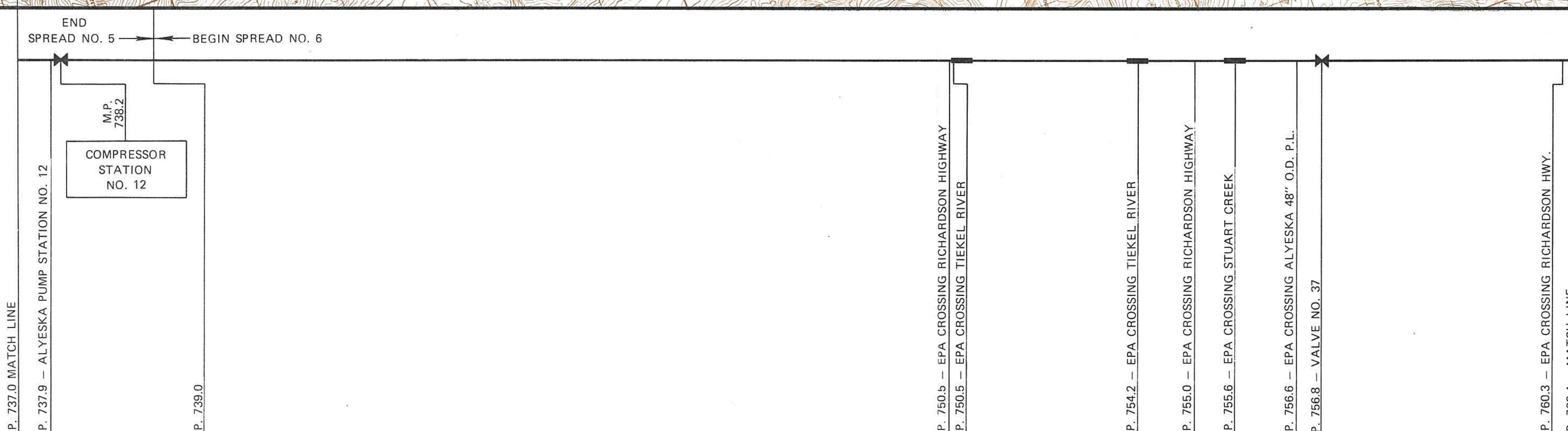
- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 737.0 — FIG. D–1.1 — LAYING DIRECTION NORTH — M.P. 750.4 — FIG. D–1.1 — LAYING DIRECTION SOUTH — M.P. 760.4



PIPELINE SCHEMATIC



0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 737.00 TO M.P. 760.40

FIGURE 32

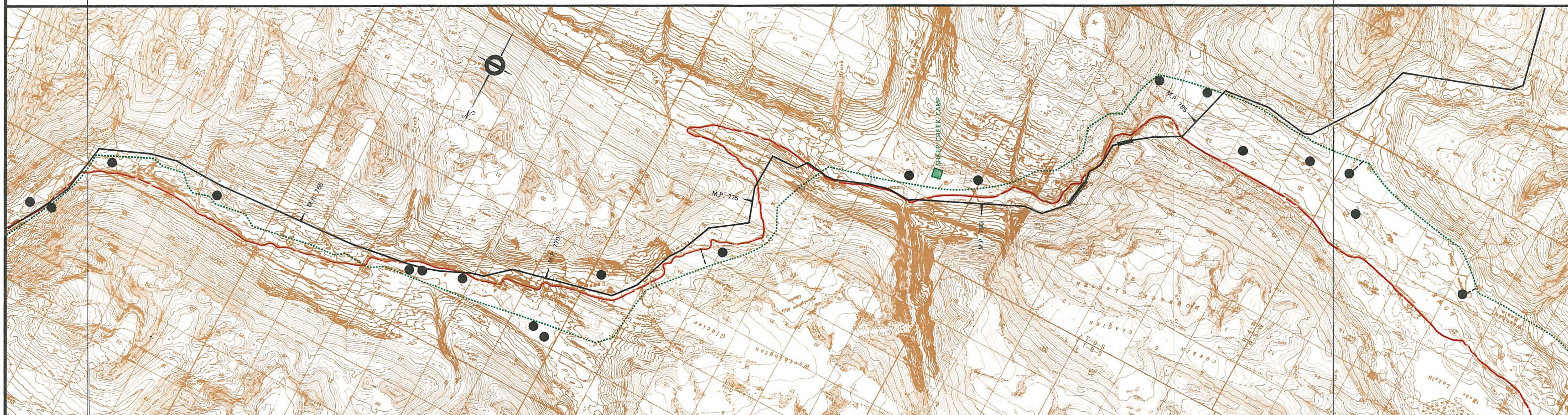
LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- ALYESKA PIPELINE (BURIED MODE)
- ALYESKA PIPELINE (ELEVATED MODE)
- EXISTING HAUL ROAD
- ALYESKA PUMP STATION
- EL PASO ALASKA COMPRESSOR STATION
- CAMP SITES
- MATERIAL SITES
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

M.P. 760.4 — FIG. D–1.1 — M.P. 767.1 — FIG. D–1.1 — M.P. 768.3 — FIG. D–1.1 — M.P. 775.6 — FIG. D–1.1 — M.P. 781.7 — M.P. 782.1 — FIG. D–1.1 — M.P. 783.3 — M.P. 783.6 — FIG. D–1.1 — M.P. 784.6 — FIG. D–1.1 — M.P. 785.6 — FIG. D–1.1 — M.P. 785.8 — FIG. D–1.1 — M.P. 787.5 — FIG. D–1.1 — M.P. 788.2

LAYING DIRECTION SOUTH



SPECIAL CONST.

SPECIAL CONSTRUCTION TUNNELS

PIPELINE SCHEMATIC

- M.P. 760.4 – MATCH LINE
- M.P. 760.6 – EPA CROSSING TSINA RIVER
- M.P. 767.3 – EPA CROSSING RICHARDSON HIGHWAY
- TSINA RIVER FLOODPLAIN
- M.P. 768.5 – EPA CROSSING RICHARDSON HIGHWAY
- M.P. 775.2 – VALVE NO. 38
- M.P. 775.4 – EPA CROSSING RICHARDSON HIGHWAY
- M.P. 776.7 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 778.5 – EPA CROSSING SHEEP CREEK
- M.P. 779.0 – ALYESKA SHEEP CREEK CAMP
- M.P. 780.5 – EPA CROSSING BEAR CREEK
- M.P. 781.7 – TUNNEL ENTRANCE
- M.P. 782.1 – TUNNEL EXIT 2330' LG.
- M.P. 783.3 – TUNNEL ENTRANCE
- M.P. 783.6 – TUNNEL EXIT 1800' LG.
- M.P. 784.6 – EPA CROSSING RICHARDSON HIGHWAY
- M.P. 785.2 – EPA CROSSING LOWE RIVER
- M.P. 785.8 – EPA CROSSING ALYESKA 48" O.D. P.L.
- M.P. 787.5 – EPA DEPARTS ALYESKA ROUTE
- M.P. 788.2 – MATCH LINE

0 1 2 3
SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 760.40 TO M.P. 788.20

FIGURE 33

LEGEND

PROPOSED EL PASO ALASKA PIPELINE

EXISTING HAUL ROAD

EL PASO ALASKA COMPRESSOR STATION

MATERIAL SITE

ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

FIG. D–1.1

LAYING DIRECTION SOUTH

M.P. 788.2

M.P. 809.7

PIPELINE SCHEMATIC

M.P. 788.2 – MATCH LINE

M.P. 790 – VALVE NO. 39

M.P. 797.0 – NO NAME PASS

M.P. 808.0 – VALVE NO. 40

M.P. 809.5 – EPA CROSSING DEAD CREEK

M.P. 809.7 – MATCH LINE

0 1 2 3

SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED

ALASKAN GAS PIPELINE

PIPELINE REALIGNMENT STUDY

M.P. 788.20 TO M.P. 809.70

FIGURE 34

LEGEND

- PROPOSED EL PASO ALASKA PIPELINE
- EL PASO ALASKA COMPRESSOR STATION
- MATERIAL SITE
- ACCESS ROAD

E.P.A. WORK PAD CONFIGURATION

FIG. D–1.1

LAYING DIRECTION SOUTH

M.P. 809.7

M.P. 830.9

PIPELINE SCHEMATIC

M.P. 809.7 – MATCH LINE

M.P. 811.4 – EPA CROSSING GRAVINA RIVER

M.P. 818.2 – E.P.A. SPANS

M.P. 819.5 – VALVE NO. 41

M.P. 825.6 – BEGIN EPA CROSSING COMFORT COVE

M.P. 825.8 – END EPA CROSSING COMFORT COVE

M.P. 830.9 – VALVE NO. 42

M.P. 830.9 – END OF LINE @ L.N.G. METER STATION

0 1 2 3

SCALE IN MILES

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
PIPELINE REALIGNMENT STUDY
M.P. 809.70 TO M.P. 830.90

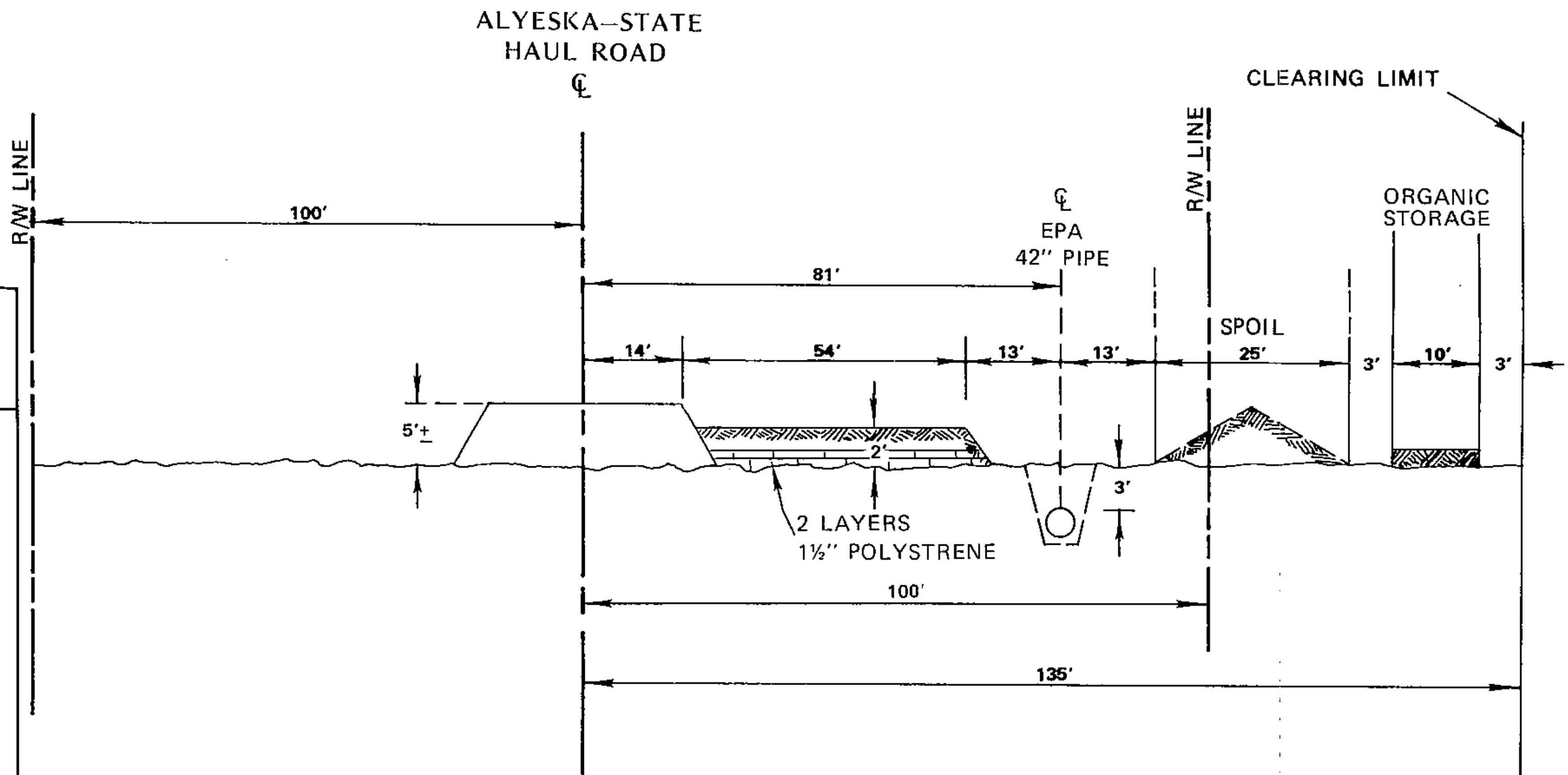
FIGURE 35

Exh. EP- 2

Docket Nos. CP75-96, *et al.*
Exhibit EP-______ (PCW-23)
Figures A-1 through D-1.1
Witness: P. C. Wright

EL PASO ALASKA GAS PIPELINE REALIGNMENT
INDEX TO TYPICAL CROSS SECTIONS

MATERIAL REQUIREMENTS
W/3" INSULATED PAD
18,480 CU. YDS./MI.

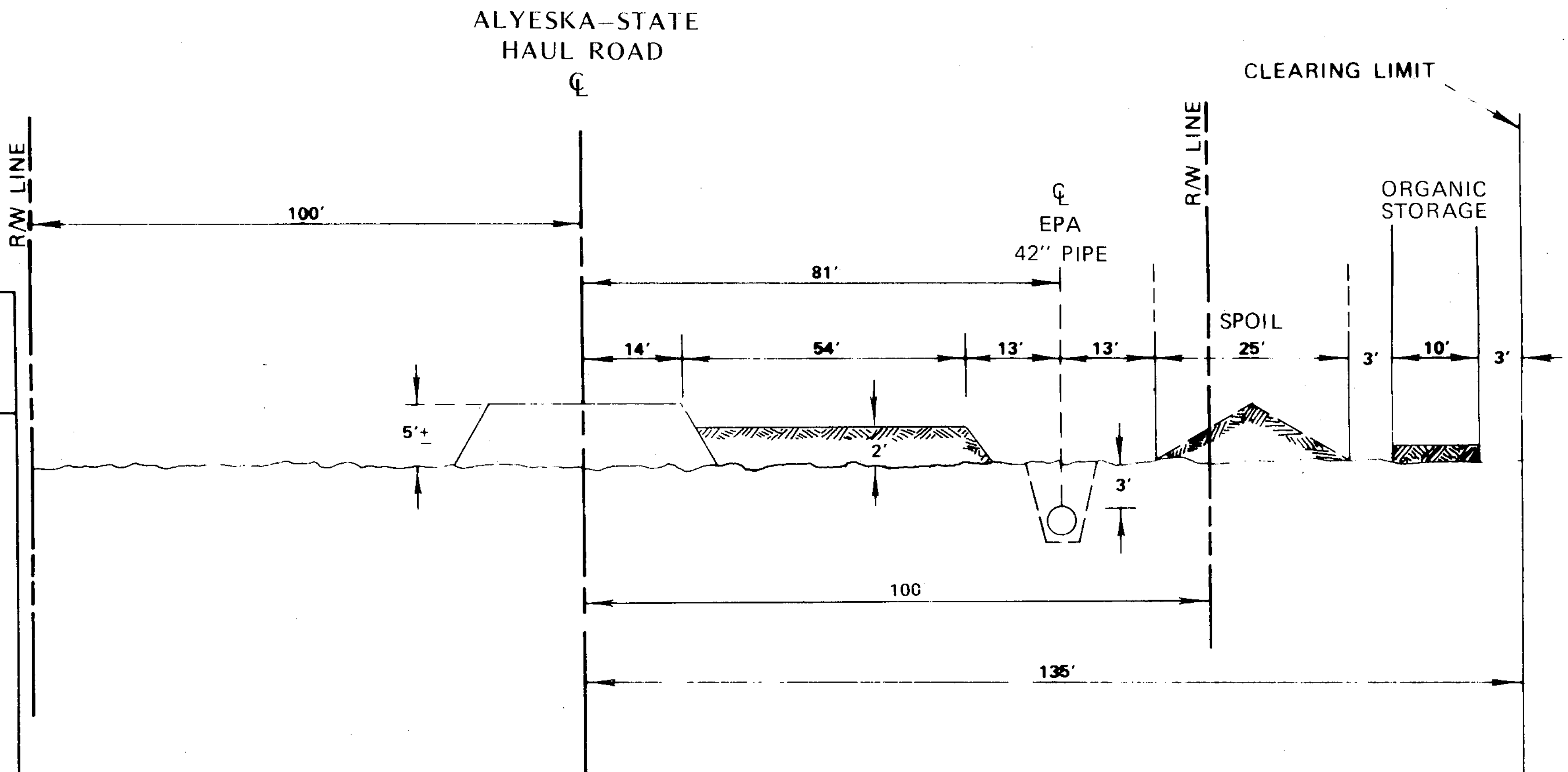


TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA/STATE–HAUL ROAD
REALIGNMENT CONFIGURATION

FIG. A–1

MATERIAL REQUIREMENTS
21,120 CU. YDS./MI.

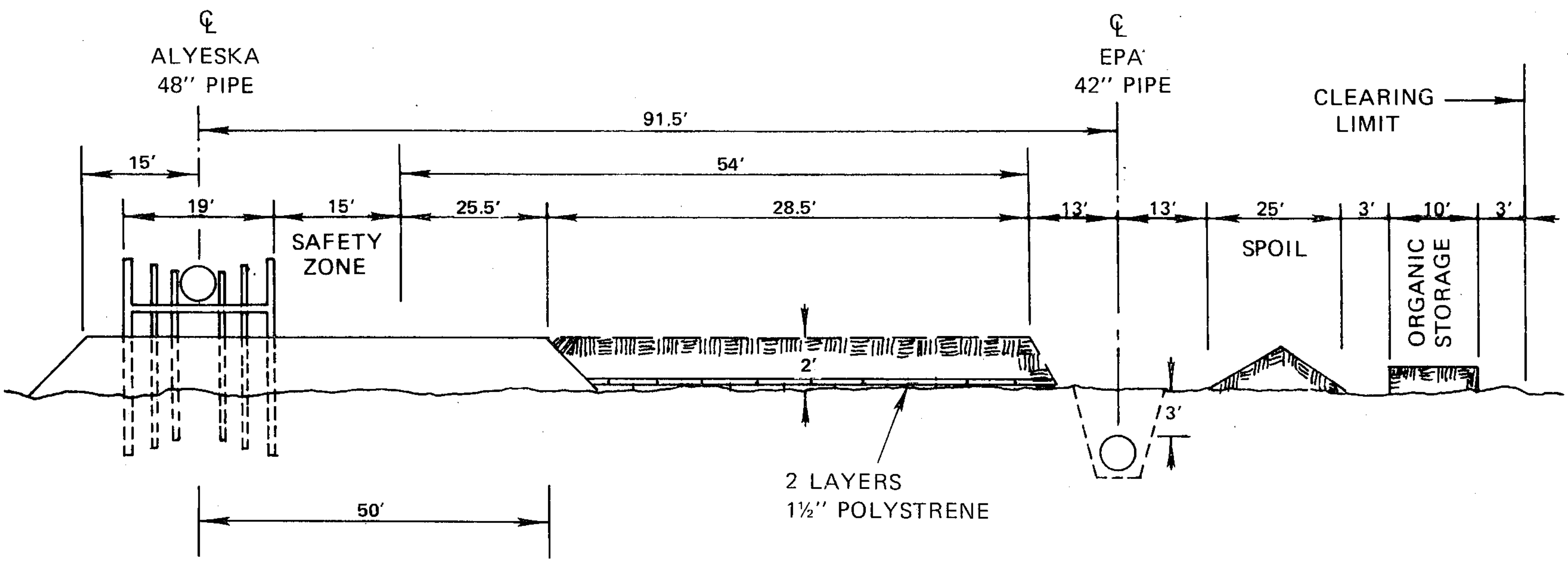


TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA/STATE–HAUL ROAD
REALIGNMENT CONFIGURATION

FIG. A–1.1

WORK PAD EXTENSION
WITH ALYESKA ELEVATED MODE



MATERIAL REQUIREMENTS
W/3" INSULATED PAD
9,753 CU. YDS./MI.

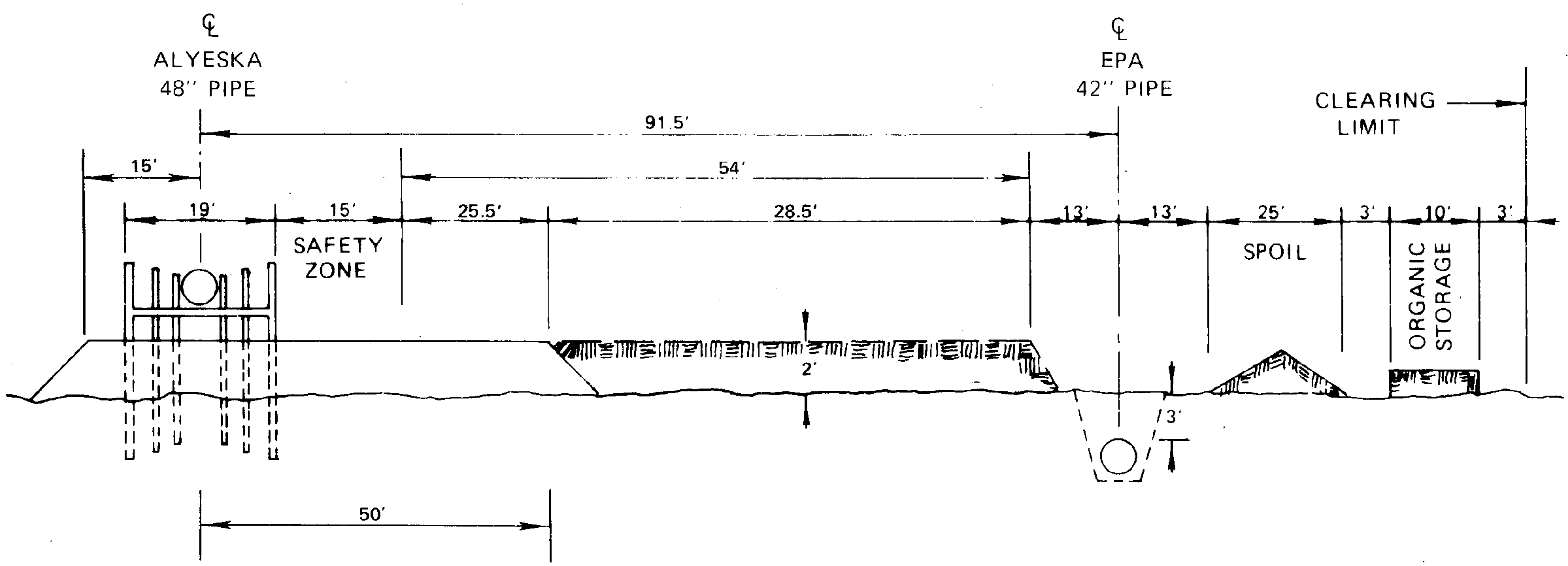
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. ELEVATED PIPELINE
REALIGNMENT CONFIGURATION

FIG. B-1

MATERIAL REQUIREMENTS
11,147 CU. YDS./MI.

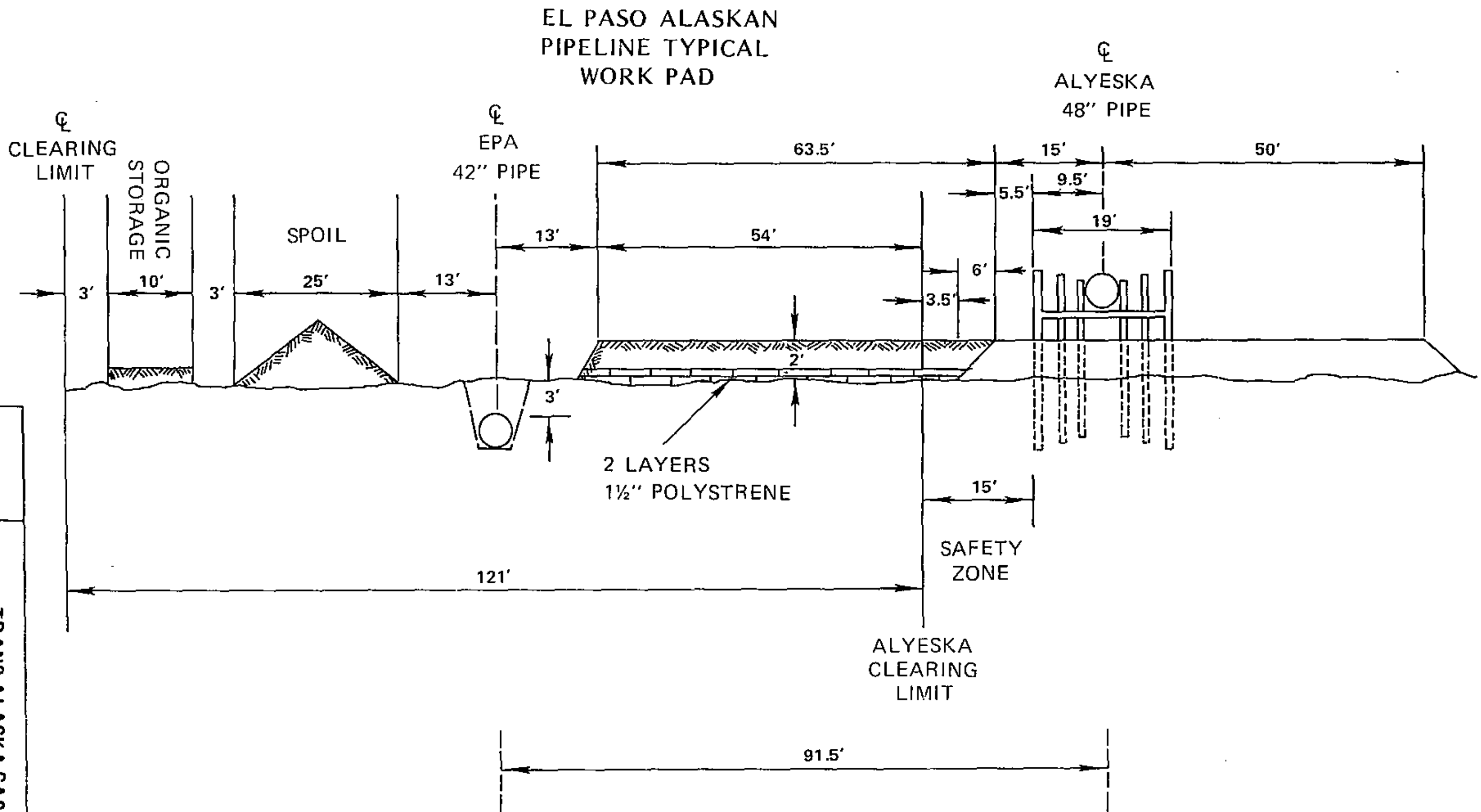
WORK PAD EXTENSION WITH ALYESKA ELEVATED MODE



TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. ELEVATED PIPELINE
REALIGNMENT CONFIGURATION

FIG. B-1.1



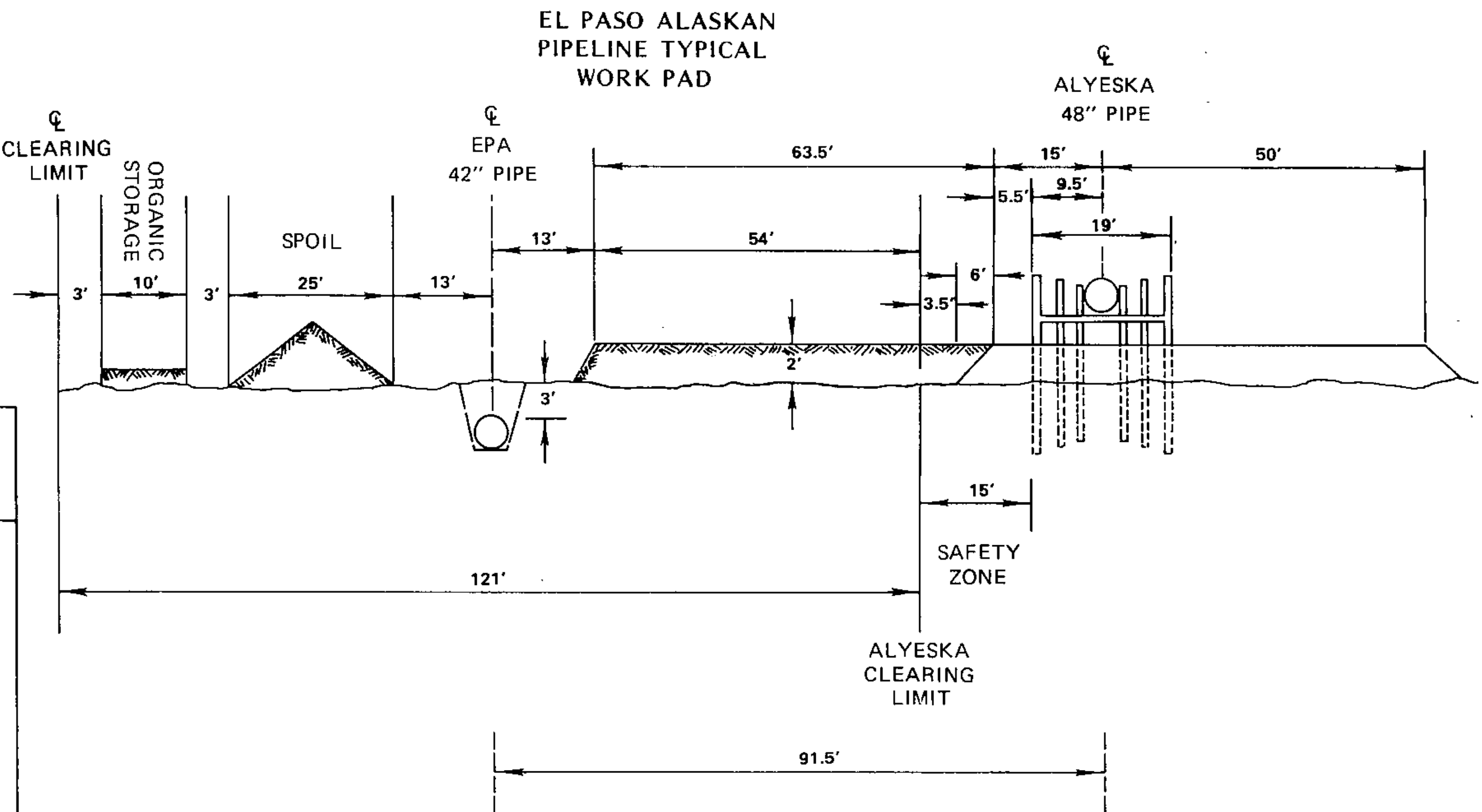
MATERIAL REQUIREMENTS
W/3" INSULATED PAD
21,731 CU. YDS./MI.

TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. ELEVATED PIPELINE
REALIGNMENT CONFIGURATION

FIG. B–3

MATERIAL REQUIREMENTS
24,835 CU. YDS./MI.



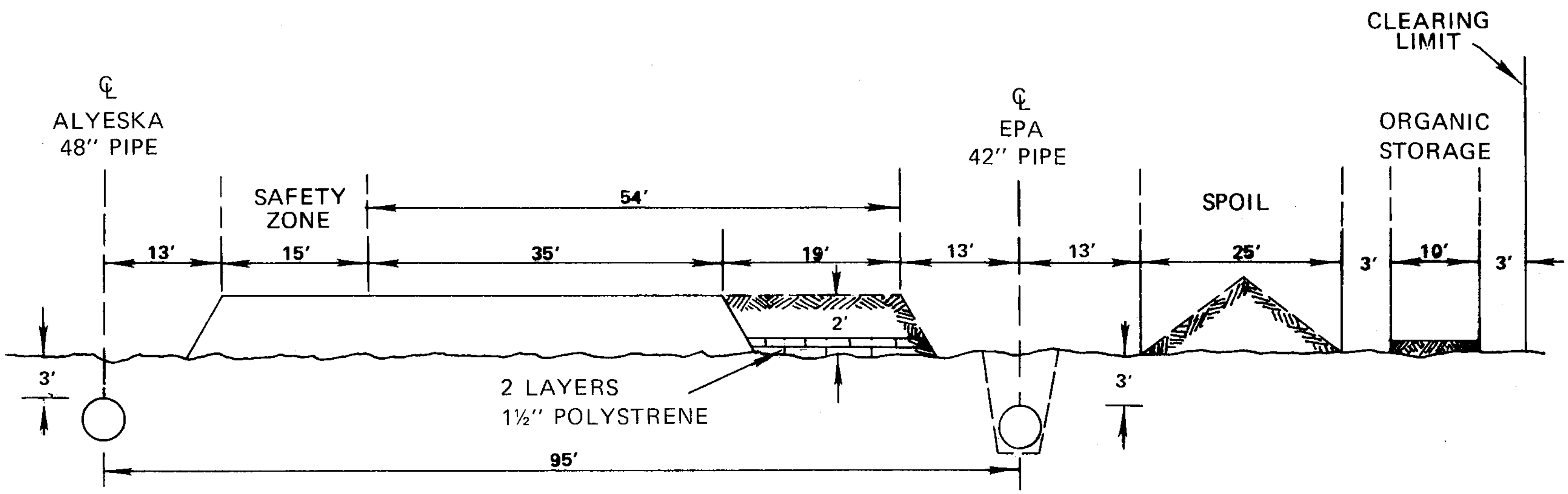
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. ELEVATED PIPELINE
REALIGNMENT CONFIGURATION

FIG. B–3.1

MATERIAL REQUIREMENTS
W/3" INSULATED PAD
6,505 CU. YDS./MI.

ALYESKA BURIED MODE AND EL PASO CONVENTIONAL BURIAL

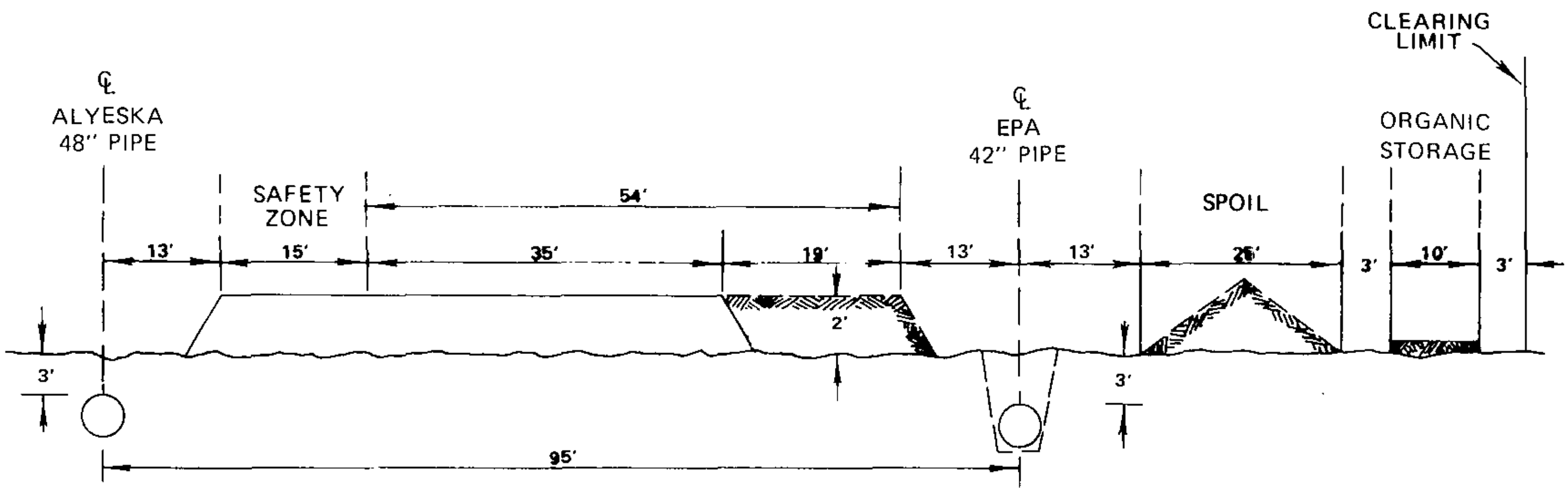


TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION

FIG. C-1

ALYESKA BURIED MODE AND EL PASO CONVENTIONAL BURIAL

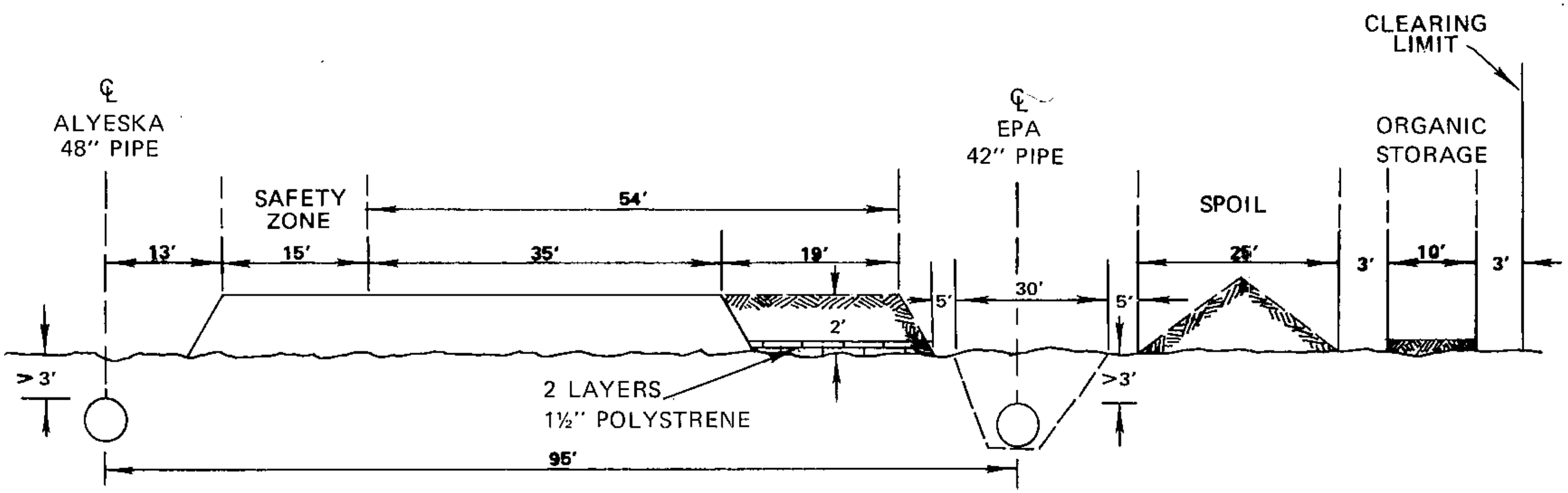


TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION

FIG. C–1.1

ALYESKA BURIED MODE
WITH EL PASO DEEP BURIAL



MATERIAL REQUIREMENTS
W/3" INSULATED PAD
6,505 CU. YDS./MI.

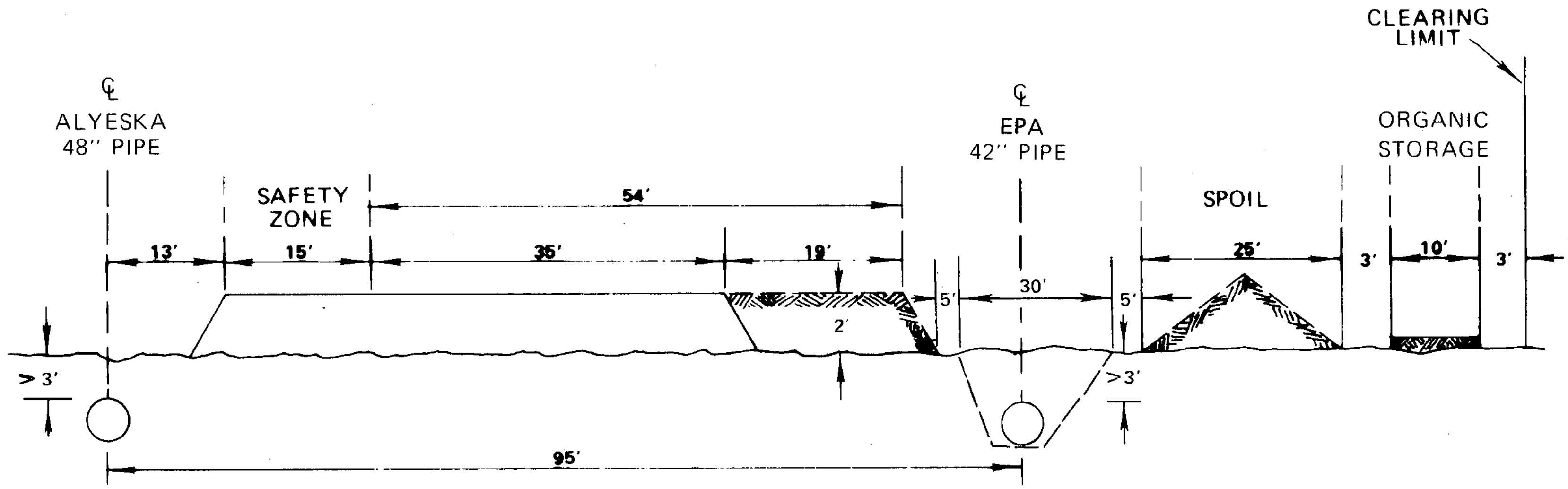
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION

FIG. C–2

MATERIAL REQUIREMENTS
7,431 CU. YDS./MI.

ALYESKA BURIED MODE
WITH EL PASO DEEP BURIAL



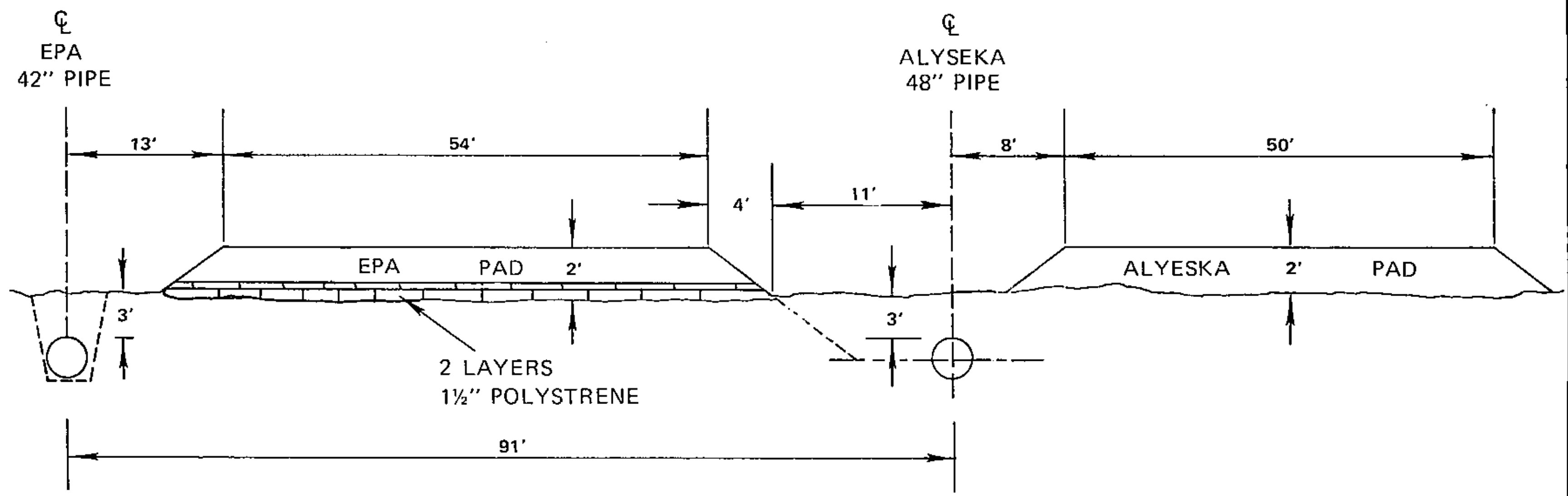
TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION

FIG. C–2.1

EL PASO ALASKAN
PIPELINE TYPICAL
WORK PAD

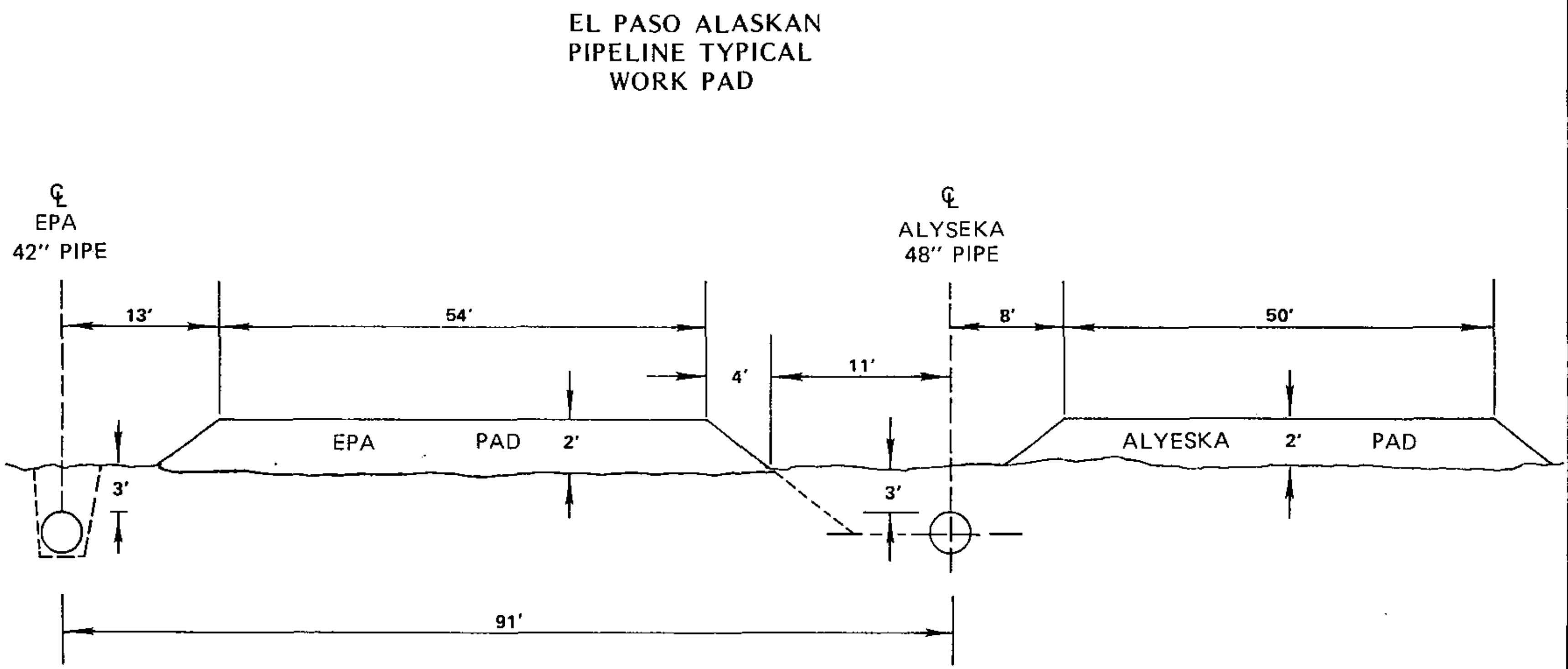
MATERIAL REQUIREMENTS
W/3" INSULATED PAD
19,848.9 CU. YDS./MI.



TRANS-ALASKA GAS PROJECT

PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION

FIG. C-4



MATERIAL REQUIREMENTS
22,685 CU. YDS./MI.

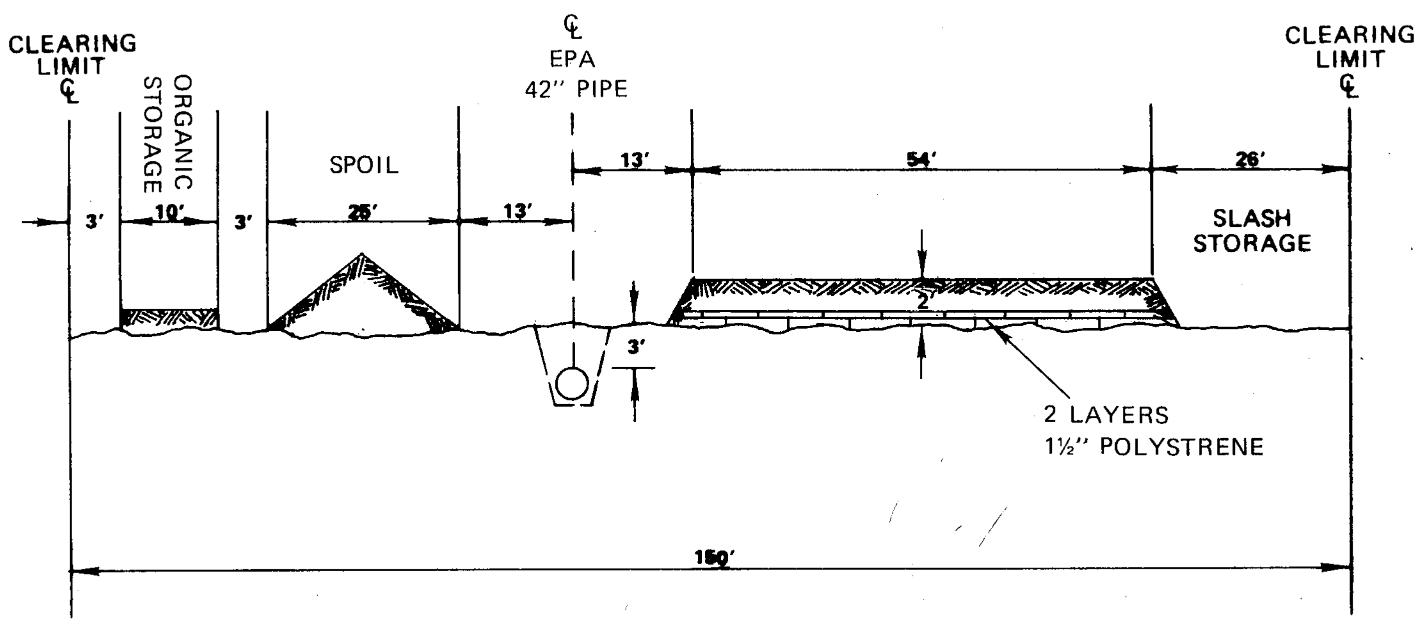
TRANS-ALASKA GAS PROJECT

**PROPOSED
ALASKAN GAS PIPELINE
ALYESKA 48" O.D. BURIED PIPELINE
REALIGNMENT CONFIGURATION**

FIG. C-4.1

MATERIAL REQUIREMENTS
W/3" INSULATED PAD
19,848.9 CU. YDS./MI.

EL PASO ALASKAN PIPELINE TYPICAL WORK PAD

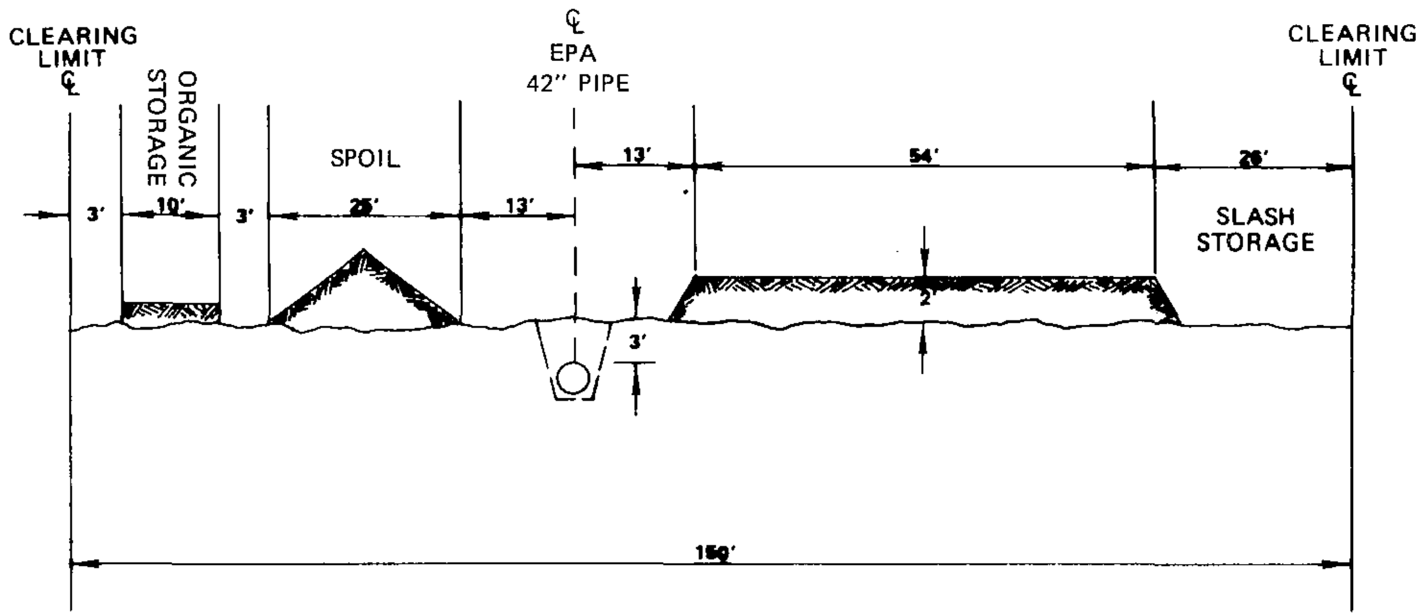


TRANS-ALASKA GAS PROJECT

PROPOSED ALASKAN GAS PIPELINE
CONVENTIONAL BURIAL ON SEPARATED
WORK PAD REALIGNMENT CONFIGURATION

FIG. D–1

EL PASO ALASKAN PIPELINE TYPICAL WORK PAD



MATERIAL REQUIREMENTS
22,685 CU. YDS./MI.

TRANS-ALASKA GAS PROJECT

PROPOSED ALASKAN GAS PIPELINE
CONVENTIONAL BURIAL ON SEPARATED
WORK PAD REALIGNMENT CONFIGURATION

FIG. D-1.1

R. H. WINN

AFFIDAVIT

Robert H. Winn, being first duly sworn, on oath, says that he is the Robert H. Winn identified in the foregoing prepared answering testimony; that he caused to be prepared such testimony; the the answers appearing therein are true to the best of his knowledge and belief; and that if asked the questions appearing therein, his answers thereto would, under oath, be the same.

Robert H Winn

Robert H. Winn

STATE OF ALASKA

THIRD JUDICIAL DISTRICT

THIS IS TO CERTIFY that on this fifth day of May, 1976 before me, the undersigned Notary Public for the State of Alaska, duly commissioned and sworn as such, personally appeared Robert H. Winn know to me and to me known to be the person named in and who executed the foregoing; and acknowledged to me that he signed the same freely and voluntarily for the uses and purposes therin stated.

WITNESS my hand and official seal.

Denise J Ward

Notary Public for Alaska

My commission expires: 6-23-76

UNITED STATES OF AMERICA

Before the

FEDERAL POWER COMMISSION

El Paso Alaska Company, *et al.*) Docket Nos. CP75-96, *et al.*

Prepared Answering Testimony

of

Robert H. Winn

Q. What is your name, business address and occupation?

A. My name is Robert H. Winn; my business address is Dames & Moore, 711 "H" Street, Anchorage, Alaska 99504; and I am a civil engineer.

Q. What is your employment relationship and position with Dames & Moore?

A. I am a partner in Dames & Moore and the Manager of its Anchorage office.

Q. Please outline your educational background and professional experience.

A. I graduated from Missouri School of Mines in 1967 with a B.S. in Civil Engineering.

Immediately after graduation, I was employed by Dames & Moore and assigned to its Houston office. For the next three years, I was responsible for various phases of foundation investigations. During most of this period, I was assigned to Dames & Moore's Honolulu office. In 1970, I transferred to the Toronto office as Chief Engineer. In that capacity, I was responsible for the technical content of foundation studies and other multidiscipline evaluations in eastern Canada.

In 1972, Dames & Moore opened an office in Calgary, and I was assigned as the Manager of that operation. My professional activity during this assignment centered around consultation to Mackenzie Valley Pipeline Research Ltd.'s economic feasibility study for an oil pipeline from Alaska's North Slope and the Mackenzie River Delta, to Edmonton, Alberta, Canada.

In 1974, I assumed responsibility for Dames & Moore's geotechnical consultation to Alyeska Pipeline Service Company and functioned in that capacity until June, 1975, when I became Manager of the Anchorage office.

Q. Are you a registered engineer?

A. Yes, I hold registrations in Hawaii, Ontario, Alberta, Yukon Territory, and Alaska (pending).

Q. What sort of consultation did Dames & Moore provide to Mackenzie Valley Pipeline Research Ltd.?

A. Mackenzie Valley conducted an economic feasibility study for a specific oil pipeline route from Prudhoe Bay to Edmonton, Alberta, Canada with a lateral to the Mackenzie Delta. Dames & Moore provided consultation regarding alignment location and foundation design. I was personally involved with data collection along their alignment between Norman Wells, N.W.T. and Tuktoyaktuk, N.W.T. and the foundation design for aboveground supports. I also evaluated special design problems and assisted with route selection.

Q. Were you technically responsible for this work?

A. I was either directly responsible or delegated that responsibility to a member of my staff.

Q. What were your responsibilities while assigned to the Alyeska project?

A. Dames & Moore has provided consultation to Alyeska since 1969. When Alyeska began working on the Trans-Alaska Pipeline System, they retained several geotechnical consulting firms. Prior to and during my assignment to the project, each consulting firm worked as a unit. I was in charge of Dames & Moore's team. During the course of the project, each consultant became primarily responsible for certain design considerations. Dames & Moore's primary technical responsibilities were slope stability assessment and determination of seismic liquefaction potential. However, all geotechnical consultants working full-time on the Alyeska project were required to deal with the full spectrum of Alyeska's geotechnical design.

When I was assigned to the project, Alyeska had received their right-of-way permit and was beginning to proceed with construction. Thus, my involvement was during a period when design criteria were undergoing detailed review by government agencies and their consultants and when Alyeska was developing field design techniques to address unexpected conditions discovered during construction. I prepared presentations to government agencies and was responsible for preparation of some sections of Alyeska's Field Design Change Manuals. I also analyzed geotechnical data and provided information to Alyeska's mode selection committee, which had final responsibility for assigning construction modes for the entire pipeline route.

After construction started, personnel who worked for me were assigned to construction spreads to help identify conditions encountered and to make appropriate recommendations for field design changes. Since assuming the job of Manager of the Anchorage office, I have maintained a responsibility for Dames & Moore personnel assigned to the Alyeska project. Dames & Moore presently has engineers working in Alyeska's engineering department and at various locations along their pipeline.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of the El Paso Alaska Company.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to summarize Dames & Moore's study of the geotechnical feasibility of utilizing Alyeska's alignment as a combined oil/gas pipeline alignment and to support the geotechnical feasibility of the realignment as presented in Exhibit EP-____(PCW-22).

Q. What documents were prepared for the purpose of this testimony?

A. A report entitled, "Geotechnical Feasibility of Utilizing the Trans-Alaska Pipeline System Alignment as a Combined Alignment for a Hot Oil Pipeline and a Chilled Gas Pipeline." It is Exhibit EP-____(RHW-1).

Q. Would you explain the procedure you used to examine the feasibility of a combined El Paso/Alyeska alignment?

A. The design of the Trans-Alaska Pipeline System's oil pipeline has been based on government stipulations. The manner in which these stipulations have been addressed provides considerable insight into the geotechnical conditions that exist along the alignment. Dames & Moore examined the different standard Alyeska designs to see if they provided enough information to assess the geotechnical feasibility of adding a chilled gas pipeline to the alignment.

Q. Did the different standard Alyeska designs provide enough information?

A. Yes, with one exception. The design of the Alyeska pipeline has not included frost heave considerations.

Q. Did you evaluate how frost heave might affect the feasibility of a combined alignment?

A. Dames & Moore explored what literature is available on the subject, including some of the testimony presented during this proceeding and concluded that frost heave could be adequately addressed in the final design of a chilled gas pipeline utilizing Alyeska's alignment.

Q. What were your conclusions regarding the geotechnical feasibility of utilizing the Alyeska alignment as a combined alignment?

A. Dames & Moore concluded that it is geotechnically feasible.

Q. Can you briefly describe the basis for this conclusion?

A. Alyeska's design and the alignment that they have selected conservatively address geotechnical stability considerations. The manner in which Alyeska has chosen to address these considerations indicates that a chilled gas pipeline can be built along the alignment. Where unusual designs have been developed by Alyeska, another pipeline utilizing this alignment could use similar techniques. Perhaps most important, the geotechnical conditions along Alyeska's alignment have been thoroughly identified and another pipeline utilizing this alignment would be able to take advantage of the geotechnical data developed by Alyeska.

Q. Have you examined the thermal interaction between the oil and gas pipelines?

A. No; but it has been examined by Pipe Line Technologists, Inc. An important point in the thermal interaction analysis is, the Alyeska pipeline is buried only in relatively coarse grain, stable materials. Therefore, thermal interaction is less likely to impact the geotechnical stability than it would in less stable materials.

Q. Have you assessed the geotechnical stability of a combined configuration at any specific locations along the Alyeska alignment?

A. We examined modifications to Alyeska's typical cross sections that would be necessary in order to accommodate a combined configuration and used, as a basis, those geotechnical conditions that would be expected to accompany an Alyeska construction mode.

Q. Can you generally characterize the suitability of the Alyeska alignment for use as a combined oil/gas pipeline alignment from a geotechnical standpoint?

A. Many of the geotechnical considerations addressed in the design of an oil pipeline are important in the design of a gas pipeline. Therefore, in many aspects, the fact that an oil pipeline has been designed following this alignment supports the feasibility of using the alignment for a gas pipeline. This is particularly true of the Alyeska alignment because of the conservative nature of Alyeska design criteria. In a limited sense, the design and construction of an oil pipeline following this alignment can be viewed as a full-scale model for assessing the geotechnical stability of the alignment itself. This is a luxury not often afforded designers or builders.

Q. Did you participate in establishing the El Paso realignment in Exhibit EP-_____(PCW-22)?

A. Yes, members of my staff and I participated in a series of meetings in Anchorage, Cordova, El Paso, and Washington, D. C. to discuss the realignment on a mile-by-mile basis, and we provided advice concerning the suitability of alignment alternatives. After initial meetings in Anchorage, a member of my staff accompanied El Paso personnel and other consultants on a helicopter reconnaissance of the entire route. Specific geotechnical problems areas identified in the meetings were given an on-site review during this reconnaissance.

Q. Did this reconnaissance include those portions of El Paso's alignment that are not coincident with Alyeska's alignment?

A. Yes. The reconnaissance included all of the El Paso realignment as filed in Exhibit EP-_____(PCW-22).

Q. Were any additional data available for those sections of the realignment not coincident with Alyeska's alignment?

A. Yes. Subsurface information along the Haul Road was available. Further, soil maps of the Alyeska alignment and adjacent terrain were reviewed in our analysis. These maps show different terrain types and were developed from aerial photography and verified with ground truth data.

Q. Is there enough information available about the Alyeska-State Haul Road to assess its suitability as a gas pipeline alignment?

A. Yes, although it was not subjected to the same level of investigation that Alyeska's alignment was, a considerable number of soil borings were made prior to construction. Additionally, the performance of the road to date is a good indication of the materials that underly it. Alyeska's pipeline alignment was selected to maximize the amount of pipeline that could be buried. This caused significant portions of the alignment north of Atigun Pass to be located in river flood plains. A chilled gas pipeline would be better aligned if it avoided flood plains and river crossings and traversed areas with a shallow permafrost table. El Paso's use of the Haul Road accomplishes this.

Q. What is your opinion of the geotechnical feasiblity of the El Paso realignment?

A. I believe a chilled gas pipeline can be constructed as proposed in El Paso's realignment study. I've already described my findings concerning the feasiblity of a combined alignment. North of Atigun Pass, permafrost temperatures and use of an insulated workpad will cause a gas pipeline to be encased in a frost bulb that is contiguous with the natural permafrost. This should eliminate the pipeline's vulnerability to geotechnical instabilities.

Although the alignment deviates from Alyeska's alignment in some sections south of Atigun Pass, it stays within the same physiographic provinces. Alyeska's experience and information will permit the successful design and construction of a buried, chilled gas pipeline through those regions.

Q. From a geotechnical standpoint, is El Paso's realignment superior to their original route?

A. The amount of information which is presently available and continues to become available about Alyeska's alignment leads me to believe that geotechnical problems would be minimized through the use of the proposed realignment. Therefore, based upon geotechnical considerations, I believe that El Paso's realignment is superior to their original alignment.

Q. Does this complete your prepared answering testimony?

A. Yes, it does.

Exh. EP-D

Docket Nos. CP75-96, *et al.*
Exhibit EP-______(RHW-1)
Witness: R. H. Winn

GEOTECHNICAL FEASIBILITY OF UTILIZING THE TRANS-ALASKA PIPELINE SYSTEM ALIGNMENT AS A COMBINED ALIGNMENT FOR A HOT OIL PIPELINE AND A CHILLED GAS PIPELINE

Prepared by:

Dames & Moore

May, 1976

Docket Nos. CP75-96, *et al.*
Exhibit EP- (RHW-1)
Witness: R. H. Winn

GEOTECHNICAL FEASIBILITY OF UTILIZING THE TRANS-ALASKA PIPELINE SYSTEM ALIGNMENT AS A COMBINED ALIGNMENT FOR A HOT OIL PIPELINE AND A CHILLED GAS PIPELINE

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Exhibit EP-_____(RHW-1)
Witness: R. H. Winn

GEOTECHNICAL FEASIBILITY OF UTILIZING THE TRANS-ALASKA PIPELINE SYSTEM ALIGNMENT AS A COMBINED ALIGNMENT FOR A HOT OIL PIPELINE AND A CHILLED GAS PIPELINE

1.0 Introduction

The objective of this report is to examine information relating to the design of the Trans-Alaska Pipeline System (Alyeska), and to use this information to assess the geotechnical feasibility of using the Alyeska alignment as a combined oil/gas pipeline alignment.

It is our understanding that Alyeska dealt with geotechnical considerations by assigning construction modes along their alignment (Alyeska [C]). A construction mode is defined as the method used for foundation support of the pipeline. The Alyeska modes were designed to maintain the integrity of the pipeline under the most adverse conditions and loadings. Alyeska mode selections were based on the results of analytical techniques, and the results of these analyses were applied in a conservative manner. For example, slope stability and liquefaction analyses were routinely conducted assuming the groundwater at the ground surface. This assumption was made because in most instances, it was not possible to establish that the groundwater table would not reach the ground surface at some time during the life of the pipeline. Once the appropriate modes were identified within a segment of the alignment, final construction mode selection was based on the most conservative mode identified within that segment. This further increased the stability of the design for those portions of the segment that did not require such a conservative mode. These approaches to the design of Alyeska's pipeline were used to meet government stipulations (U.S. Department of Interior, 1972) that pipe integrity must be maintained in the most catastrophic of circumstances.

Most of the geotechnical information required for design of a chilled gas pipeline has been accumulated during the design of Alyeska's oil pipeline. Examples of this information include cut slope stability and stability of the thaw bulb created by right-of-way clearing. This information, the conservative results of the Alyeska design process, plus the successful design and construction of the Alyeska pipeline provide a full-scale model for a gas pipeline following the same alignment. During the El Paso realignment study, we assisted in the development of modifications to Alyeska's typical cross sections (Alyeska [A]) that would permit the construction of a gas pipeline along the Alyeska alignment. These modified cross-sections are shown on Plates 5.2.1 through 5.3.6.

The thermal interaction between a chilled gas pipeline and a hot oil pipeline has been examined by Pipe Line Technologists, Inc. The results of this examination indicate that the chilled gas pipeline's frost bulb will not intrude beneath the oil pipeline. Alyeska's analyses of the thaw bulb generated by the oil pipeline show it to be stable, and therefore, it will not adversely affect the stability of the gas pipeline. This is so partly because thermal interaction is only a consideration where both pipelines are buried and the types of soils that accommodate burial of the oil pipeline are very stable and not susceptible to significant thaw settlement or slope instability.

Frost heave (jacking) has not been addressed in Alyeska's pipeline design because a hot oil pipeline will thaw, not freeze, adjacent soils, and these soils will remain thawed as long as the pipeline is in operation. However, frost heave may have to be considered in the design of a chilled gas pipeline in some portions of Alyeska's alignment. Therefore, in this feasibility report Dames & Moore has examined the literature available on frost heave (Aitken, 1974; Chalmers and Jackson, 1970; Hoekstra *et al.*, 1965; Jimikis, 1966; Tsytovich, 1973) and has assessed whether this consideration can be successfully addressed in the design of a gas pipeline following Alyeska'a alignment.

2.0 Scope of Work

During this geotechnical feasibility study, Dames & Moore:

- Extracted typical cross-sections from Alyeska design drawings for the Trans-Alaska oil pipeline system;

- Synthesized those portions of public government stipulations and information for the Alyeska pipeline that pertained to and identified the geotechnical conditions that influenced mode selection and geotechnical design of that facility;

- Developed, in consultation with El Paso and Pipe Line Technologists, Inc., modifications to the Alyeska cross-sections that would permit construction of a chilled gas pipeline from a working surface that would be common to, adjacent to, or nearby the working surface used to construct the Alyeska pipeline; and,

- Examined the combined alignment to identify parametrically those elements that are compatible with, and those elements that are in conflict with, Alyeska criteria or accepted principles of geotechnical engineering.

3.0 Alyeska Construction Modes

3.1 General

Geotechnical conditions along the Alyeska alignment have been the major influence on the modes of construction selected for the oil pipeline. The methods and procedures used to select the construction modes are complex and interactive and their detailed description is not within the scope of this report. However, certain basic information concerning the limits of the types of subsurface materials (soil or rock) associated with each construction mode can be perceived by examination of certain criteria and stipulations applied to the geotechnical design of the Alyeska pipeline.

The geotechnical bases for all Alyeska construction mode selections are presented in the Final Environmental Impact Statement (U.S. DOI, 1972) for the Trans-Alaska oil pipeline, dated February 1972, Section 3.3, Stipulations for Proposed Trans-Alaska Pipeline, which states:

> The selection of the Construction Mode (elevated or buried) shall be governed by the following criteria: (3.3.1.1). There shall be an unobstructed air space of at least two feet between the pipe and ground surface; or (3.3.1.2). There shall be no greater heat transfer from the pipe to the ground than results from the use of an unobstructed air space of at least two feet between the pipe and ground surface; or (3.3.1.3). Below the level of the pipe axis the ground shall consist of competent bedrock, soil naturally devoid of permafrost, or if frozen, of thaw-stable sand and gravel. 1/ Above the level of the pipe axis other materials may be present but it must be shown that they will remain stable under all credible conditions; or (3.3.1.4). Results of a detailed field exploration program and analysis indicate that pipe rupture and major terrain disruption will not occur at any place from soil instability. Effects and their interaction, which are to be analyzed on a mile-by-mile basis to justify the proposed Construction Mode, shall include

but not be limited to, thaw plug stability, differential settlement, seismic loading and weakening, and possible movement resulting from slope instability. 2/ ~~As a prerequisite for the use of this criterion, an~~ acceptable comprehensive monitoring system of the Pipeline shall be developed which will include but not be limited to making deformation measurements sufficiently sensitive and prompt to detect the approach to operational tolerance limits (which shall be clearly specified) of the Pipeline; design specifications, operational requirements, and feasibility analysis of such monitoring system shall be submitted in accordance with Stipulation 1.4. Such system shall be operational prior to transmission of oil through the Pipeline.

1/ Thaw-stable sand and gravel is defined as material meeting the following requirements: (a) Material lies within classes GW, GP, SW and SP (Unified Soil Classification), but with up to 6% by weight passing the No. 200 U.S. Standard Sieve; if an inorganic granular soil contains more than 6% finer than the No. 200 sieve its thaw-stability must be justified. (b) There is no excess (segregated or massive) ice. (c) Thawing of the material *in situ* will not result in excess pore pressure.

2/ Because of soil variability and/or unique hydrologic conditions in active floodplains, some of the requirements of Stipulation 3.3.1.3 may not be met in those locations. In such cases proposed designs including special design and/or construction procedures where required by these conditions, must be submitted with justification to the Authorized Officer for approval in accordance with Stipulation 1.4

In response to these stipulations, the following suite of construction modes has been developed by Alyeska (Alyeska, 1973) and are discussed in subsequent sections:

- Conventional Burial

- Deep Burial

- Floodplain Burial
- Special Burial
- Elevated on Vertical Support Members
- Elevated on Thermal Vertical Support Members
- Special Design.

A preliminary design that used gravel pads to elevate the oil pipeline was considered, but not used in final design. Other elevated modes were assigned to these segments.

3.2 Buried Modes

Conventional Burial: The Alyeska pipeline is conventionally buried (3 feet of cover) only where the material below the pipe axis is thawed, the fines (silt and clay) content is less than 6 percent, or where less than 1.0 foot of thaw settlement is reliably predicted, and where thawing and/or design seismic loadings will not result in appreciable strain in the pipe. This mode is specified in Alyeska's design for 35 percent (280 miles) of their alignment. At some locations, the construction mode is specified as conventional burial, but burial is required in or on a certain material, such as bedrock. This implies that very shallow surficial material is suspected to be unstable, but its vertical extent is anticipated to be less than five feet.

Deep Burial: This mode is selected where near surface instability has been identified, but where relatively shallow subsurface materials meet the criteria described above for conventional burial. The Alyeska design specifies a depth of burial for each deep burial segment and in some locations, burial in a specified material is also required. This mode is used for about six percent (45 miles) of the Alyeska alignment.

Floodplain Burial: This mode is used in those sections of the alignment that require designs to accommodate inundation and, in some cases, scour associated with a design flood. Depth of burial is site-specific and is related to other elements of the design, such as river training structures. This mode is used for approximately six percent (45 miles) of the Alyeska alignment.

Special Burial: This mode is sparingly (less than one percent) used along the Alyeska alignment. It requires that the material supporting the pipe be prevented from thawing by insulation and/or refrigeration.

3.3 Elevated Modes

Vertical Support Members (VSM's): This construction mode is used to accommodate conditions of unacceptable thaw settlement. However, it is not used where unstable slopes would threaten to impose significant lateral loads on the VSM's. In areas with a high potential for seismic liquefaction, this mode is only used in flat terrain (less than two percent grade). This mode is excluded from areas that will experience more than six feet of settlement from disruption of the thermal regime. Any potential slope instability must not threaten the pipeline or VSM's. This mode can be used in areas of faulting, but is excluded from areas subject to surficial hazards. The Alyeska design specifies this mode for about 25 percent (200 miles) of their alignment.

Thermal Vertical Support Members: This construction mode is specified by Alyeska for approximately 26 percent (206 miles) of their alignment to avert unacceptably large thaw settlement, slope instability, thaw plug instability, and the loss of strength associated with seismic liquefaction. Normally this mode is used only in areas underlain by near surface permafrost. However, in a few instances, it has been used to stabilize thawed, potentially liquefiable soils. Slope and surface hazard restrictions are similar to those outlined for the non-thermal VSM's. Surface and subsurface drainage must not negate the effectiveness of the thermal action of the VSM's.

3.4 Special Design Areas

Special design areas are where special design considerations are addressed. Examples are major fault crossings and major stream crossings. These areas represent less than three percent (16 miles) of Alyeska's alignment.

4.0 Geotechnical Considerations for a Combined Gas/Oil Pipeline Alignment

4.1 General

This section describes the geotechnical considerations that were evaluated in this assessment of the geotechnical feasibility of utilizing the Alyeska alignment as a combined alignment for a hot oil pipeline and a chilled gas pipeline.

Alyeska has evaluated five types of potential ground movement (Alyeska, 1973) in the design of their pipeline:

- Thaw Settlement
- Slope Stability
- Thaw Plug Stability
- Seismic Liquefaction
- Faulting

Thaw plug stability is a special type of slope stability. The five types of potential ground movement and the relationship between Alyeska's treatment of them and stability considerations for a combined gas/oil pipeline alignment are discussed in subsequent sections. In addition, the phenomenon of frost heave (jacking) must be considered when evaluating the feasbility of a combined gas/oil pipeline alignment and is discussed in Section 4.7.

4.2 Thaw Settlement

Alyeska's design permits a maximum of one foot of buried pipe settlement. This constraint has placed a severe restriction on where the oil pipeline could be buried because of the relatively large thaw bulb that a hot oil pipeline creates. The greater the depth of thaw, the greater the potential for encountering segregated ice and unconsolidated frozen soils that could experience large thaw settlement. Alyeska's design response to excessive thaw settlement has been to either bury beneath the material contributing to settlement or to elevate the pipeline and eliminate the creation of a large thaw bulb.

Thaw settlement will introduce stress in a buried chilled gas pipeline only in the period of time between installation and initial through-put because after this time, growth of the thaw bulb will be arrested. During this period, in those segments of the Alyeska alignment where the hot oil pipeline is buried, thaw settlement affecting a gas pipeline is expected to be very small in comparison to that expected to occur for the hot oil pipeline. The settlement which will occur beneath the hot oil pipeline should be significantly greater because of the operating temperature associated with this pipeline.

Where the Alyeska pipeline is elevated, thaw settlement prior to operation would have to be considered in the design of the gas pipeline because of the potential for thaw-unstable soils beneath the gas pipeline. This should only be a factor where a deep thaw accompanies construction-zone clearing. Thaw settlement should not be a problem north of the Yukon River. Where thaw settlement could induce unacceptable stresses in a gas pipeline these may be reduced to acceptable levels by burying the pipeline deeper, or by retarding the thaw beneath the gas pipeline through the use of insulation in the backfill, or by eliminating the thaw by circulating chilled air in segments of the installed gas pipeline prior to operation.

Because of the above reasons, thaw settlement is not considered to be a severe design constraint for a gas pipeline following the Alyeska alignment and should manifest itself for less than ten percent (80 miles) of the Alyeska alignment.

4.3 Slope Stability

Alyeska has evaluated all significant (greater than ten percent) natural slopes along their alignment using both analytical and empirical methods. The criteria for assessing the stability of a slope were a static factor of safety equal to 1.5 and a dynamic factor of safety equal to 1.0 or at worst, a calculated permanent displacement of five inches or less under contingency earthquake loadings. Where a slope was found to not meet the above criteria and could not be avoided, the slope was either maintained in a frozen condition or graded flatter. Therefore, all natural slopes along the alignment are either thawed and stable or stable if frozen. The installation of a chilled gas pipeline will help frozen slopes remain frozen.

Cut and fill slopes along the Alyeska alignment have been subjected to the same analytical scrutiny as natural slopes and have been required to meet the above criteria if their stability could affect pipeline integrity. If their location is not important to pipeline integrity, they have been designed to exhibit a static factor of safety equal to 1.1. A similar approach could be used in the design of a gas pipeline following the Alyeska alignment, and has been used in the development of typical cross-sections for the combined alignment.

Recent experience gained during construction of Alyeska's pipeline and the Haul Road and other Arctic and sub-Arctic projects has offered valuable insight into the behavior of cuts in ice-rich permafrost. In almost all cases, these cuts "heal" themselves in a short time following exposure of the cut face to thawing conditions (McPhail *et al.*, 1975). During this "healing" process, the soil portion of the permafrost is not carried away by the water generated by thawing, but is deposited on the cut face and forms an insulating blanket on the slope. In a matter of one or two years, the healing is complete and natural revegetation has started to take place.

In some very unique circumstances, the soil particle sizes and the ratio of soil to ice are such that the soil is carried away by the melt water generated by thawing. This does not often occur. However, when it does, it is easy to recognize early in the life of the cut, and an insulating blanket of granular material can be used to eliminate further erosion of the cut.

4.4 Thaw Plug Stability

Thaw plug stability is a special category of slope stability which addresses slopes that lose strength during thawing caused by the construction activity. The criteria used by Alyeska in their evaluation of thaw plug stability have been identical to those described in Section 4.3. Thaw plug stability was not considered a factor in the Alyeska design where the oil pipeline is buried because the oil pipeline is buried only in bedrock, soil natural devoid of permafrost, or thaw-stable sand or gravel. Thaw plug stability was, therefore, a consideration only in elevated segments of Alyeska's alignment. The thawing associated with elevated modes is generated by surface disturbance caused by clearing and work pad construction.

Alyeska's thaw plug stability evaluations assess the stability of the thawed soil parallel to the pipeline and the effect of thaw generated water on the soil strength at the thaw front. If water produced by the thawing process cannot be transmitted away from the thaw front as fast as it is generated, excess pore pressures can develop. These pressures greatly reduce the strength of the soil and create a zone of weakness at the thaw front.

Alyeska has analyzed thaw plug stability south of Atigun Pass assuming a 20-foot thaw depth for soils with a moisture content in excess of 40 percent and a 30-foot depth for soils with a moisture content less than 40 percent. These anticipated thaw depths reflect the 30 year design life of the project. North of Atigun Pass, a thaw bulb is not expected to develop because an insulated work pad is used at potentially unstable locations.

The thaw plug stability analyses conducted during the design of Alyeska's pipeline are applicable to the geotechnical assessment of a combined alignment. The only thermal alterations considered in Alyeska's analysis are due to surface disturbance with the hot oil pipeline radiating little, if any, significant heat to the ground in the elevated mode. Construction of a chilled gas pipeline following Alyeska's alignment would create similar or less critical thermal alternations as the surface disturbance would be mitigated by the heat sink effect of the chilled gas pipeline. In addition, Alyeska has developed designs to further mitigate the effect of surface disturbance which could be used by El Paso to further enhance the stability of a combined alignment.

4.5 Seismic Liquefaction

Seismic liquefaction is the strength loss which some soils experience as a result of relatively long duration (greater than 30 seconds) shaking. This phenomenon can manifest itself during an earthquake when saturated, cohesionless soils lose most of their strength and become a viscous liquid mass that can flow.

Alyeska's design includes a mile-by-mile evaluation of the potential for seismic liquefaction. Where that potential was found to be high, the area was avoided or designs were developed to prevent seismic liquefaction from creating conditions that might threaten pipeline integrity. In areas underlain by thawed soils, the Alyeska pipeline has been designed to be buried beneath materials which could liquefy, and frozen soils that could liquefy if thawed have been maintained in their frozen state by use of thermal VSM's. A chilled gas pipeline following the Alyeska alignment would also maintain frozen potentially liquefiable soils in a frozen state and could be buried beneath thawed potentially liquefiable soils.

4.6 Faulting

Alyeska's alignment and the Trans-Alaska pipeline corridor have been thoroughly investigated to identify active faults and to establish conservative design displacements. In addition, Alyeska has developed special support designs to permit a pipeline to span these tectonic features. Along the Alyeska alignment, the Denali, McGinnis Glacier, Donnely Dome, and Clearwater have been identified as potentially active major faults. Alyeska's information could be used to successfully design and construct a gas pipeline following the Alyeska alignment that would accommodate faulting considerations.

4.7 Frost Heave

Alyeska's alignment has not been evaluated for frost heave potential; however, data and information about the alignment can be used to estimate the effects that frost heave could have on the design of a chilled gas pipeline that follows the Alyeska alignment.

Frost heave results from the formation of ice within soil during freezing. The strains introduced by heaving are related to the volumetric expansion of soil pore water and ice segregation. In-place freezing of soil pore water produces insignificant magnitudes of ~~heave. However, ice segregation that results from moisture migration~~ to the freezing front can be responsible for the creation of large strain. A review of current literature (Aitken, 1974) indicates that frost heave induced strains due to ice segregation can be minimized by increasing the effective overburden pressure.

Frost heave due to seasonal temperature variations has been studied extensively and the phenomenon is well documented (Jimikis, 1966; Tsytovich, 1973). It has been found that the following three conditions must exist for frost heave to occur:

- Freezing temperatures producing a heat loss at the freezing front,
- Water availability, and
- Frost susceptible soil. 1/

Ice segregation is directly related to the availability of water and the rate of heat loss at the freezing front. Fine sand through silt size particle distributions have been found to be the most susceptible to seasonal frost heave. Very fine-grained soils of low permeability (silty clays and clays) are not considered susceptible to seasonal frost heave because of low permeabilities that reduce the rate of water movement in relation to the rate of advance of the freezing front.

1/ Frost susceptible soils are those soils which, because of their grain size distribution and physiochemical properties, promote the migration of pore water towards the freeze front during freezing of the soil, with the result that ice segregation takes place.

In the case of a chilled gas pipeline in thawed soil, the only seasonal thermal effect will be a slight variation in the rate of growth of the freeze bulb. However, the heat loss at the freezing front will be uniform and encourage migration of moisture through less permeable soils. Therefore, the spectrum of soil types that must be considered as frost susceptible is greater for an operating chilled gas pipeline than for natural seasonal thermal variations.

The phenomenon of frost heave has been investigated in both field and laboratory studies. Published data (Aitken, 1974) indicate a reasonable correlation between lab and field data. Vertical stress appeared to inhibit moisture migration and subsequent ice segregation in both field and laboratory tests.

Large vertical forces are required to <u>totally</u> restrain frost heave forces, but vertical forces required to reduce heave induced strain to very <u>small limits</u> are significantly less. Heave induced strains typically decrease with an increase in vertical stress. Available data indicate that heave induced strains for a frost susceptible Alaskan silt are reduced rapidly with increasing vertical stress up to a limit of 10 to 12 psi, beyond which it requires very large stress increases to effect further reduction in heave induced strain.

A chilled gas pipeline following Alyeska's alignment will traverse four generalized thermal classifications:

- Cold Permafrost (less than 30°F)
- Warm Permafrost (greater than 30°F)
- Discontinuous Permafrost
- Thawed Soils.

Along Alyeska's alignment cold permafrost exists north of Atigun Pass (173 miles). Warm permafrost can be expected south of Atigun Pass to the southern limit of the discontinuous permafrost zone. Alyeska's alignment traverses about 517 miles of this type of terrain. This geographic division is conservative and some cold permafrost is found south of Atigun Pass.

Frost heave in cold permafrost areas is not anticipated to be a significant problem due to the typically shallow active layer north of the Brooks Range, the low ground temperatures, and the rapid freezeback of thawed soil below the pipeline.

In warm permafrost (temperature greater than 30°F), the formation of a thaw bulb caused by surface disturbance may result in a significant mass of thawed, frost susceptible soil which will freeze during the early stages of operation. Frost heave may occur under these circumstances.

The thawed portions in areas of discontinuous permafrost provide a medium for potential frost heave. This type of thermal regime is the most complex to evaluate. The most likely area for frost heave is the southern portion of the route, i.e., the Copper River Basin and the north flank of the Chugach Mountains where large areas of thawed soil occur.

The effect of differential heave on pipe stresses is related to the pipe/soil interaction and the location of the ice segregation. Segregation directly adjacent to the pipe will produce higher pipe stresses than ice segregation at the freezing front located several feet below the pipe. It is unlikely that significant lensing will occur in direct contact with the pipe due to the relatively rapid rate at which an initial frozen bulb of soil will be formed. Further mitigation of pipe stresses is provided when the pipe and frozen soil create a relatively stiff system, which increases the overall resistance to differential heave as a result of ice segregation at depth.

For specific locations, the potential for creation of frost heave induced strains can be reduced to acceptable magnitudes by various techniques, including increasing the vertical effective stress, or replacing heave susceptible soils with non-frost susceptible materials. Effective soil stress may be increased by surcharging. Design alternatives include placing a berm over the pipe, replacing low density soils with higher density soils, and burying the pipe deeper. Lowering the water table and/or the occurrence of negative pore pressures associated with the natural desiccation of soils in front of the freezing front during ice segregation will also increase the effective vertical loads.

5.0 Design Cross-Sections

5.1 General

In consultation with El Paso and Pipe Line Technologists, Inc., proposed modifications to the typical Alyeska cross-sections were developed which would permit construction of a buried, chilled gas pipeline from a working surface common to, adjacent to, or nearby the working surface used to construct the Alyeska pipeline (see Plates 5.2.1 through 5.3.6).

This section of the report addresses the geotechnical considerations of the design cross-sections that have been utilized in the El Paso realignment study, on a mile-by-mile basis, along the Alyeska pipeline alignment for a distance of approximately 412 miles. The remaining 419 miles of the proposed 831 mile El Paso realignment, 206 miles of which will parallel the Alyeska/State Haul Road, and 213 miles of which will occupy a separated alignment, are not discussed in this report. The following sections discuss the geotechnical stability of each of the design cross-sections that are applicable to the Alyeska pipeline facilities.

5.2 Oil Pipeline in the Buried Mode (El Paso Mode 'C')

Where the Alyeska pipeline is buried, the soils below the pipe are stable and, typically, no geotechnical stability problems are anticipated with construction of a chilled gas pipeline in these areas.

Of the nearly 412 miles of the Alyeska alignment which the proposed combined alignment will follow, approximately 170 miles will parallel Alyeska's buried modes.

5.2.1 El Paso Mode C-1

El Paso mode 'C' requires an extension of Alyeska's work pad on the opposite site of the pad to the oil pipeline (Mode C-1)(see Plate 5.2.1). In an effort to conserve gravel resources, an insulated work pad design has also been proposed. Together, these cross-sections account for about 144 miles of the C mode designation.

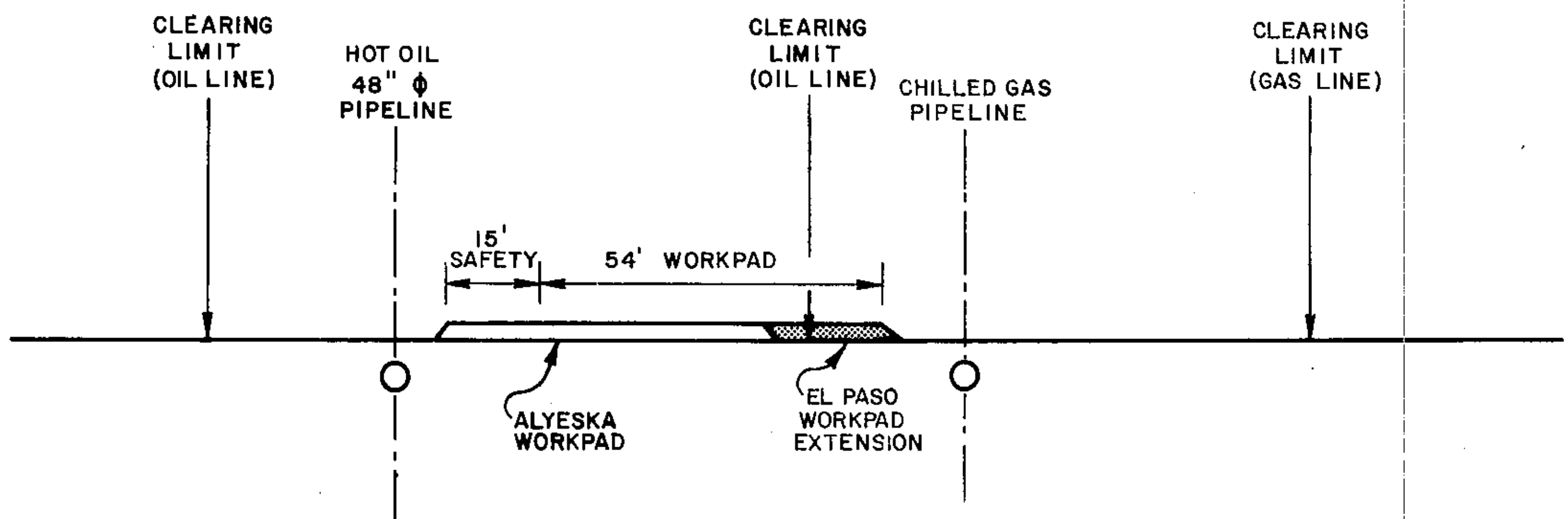
In assessing these designs, it is convenient to consider four cross slope and one through cut configurations.

5.2.1.1 Cross Slope 0-2% (Plate 5.2.1)

In those sections of the alignment where the Alyeska pipeline is buried and the terrain is flat (the grade is less than 2 percent), the operation of a chilled gas pipeline in proximity to the Alyeska pipeline will not subject either pipeline to unstable geotechnical conditions. The Alyeska pipeline is buried only where soils are either thaw-stable or thawed, and this consideration combined with the presence of flat terrain practically eliminates the possibility of instability.

However, because some segments of the alignment in this category are characterized by thawed, relatively fine-grained soils, it may be necessary to adopt gas pipeline designs which will mitigate frost heave effects (see Section 4.7). In addition, some segments of the Alyeska pipeline may be buried in potentially liquefiable materials and a chilled gas pipeline buried in the same material might have to be designed to resist buoyancy forces.

Approximately 63 miles of El Paso's proposed realignment would be constructed from this work pad design.



OIL PIPELINE CONSTRUCTION MODE: BURIED

CROSS SLOPE: 0%-2%

CHILLED GAS PIPELINE CONSTRUCTION MODE: C-I

PLATE 5.2.1

5.2.1.2 Cross Slope 2-15% Work Pad Uphill of Alyeska's Pipeline (Plate 5.2.2)

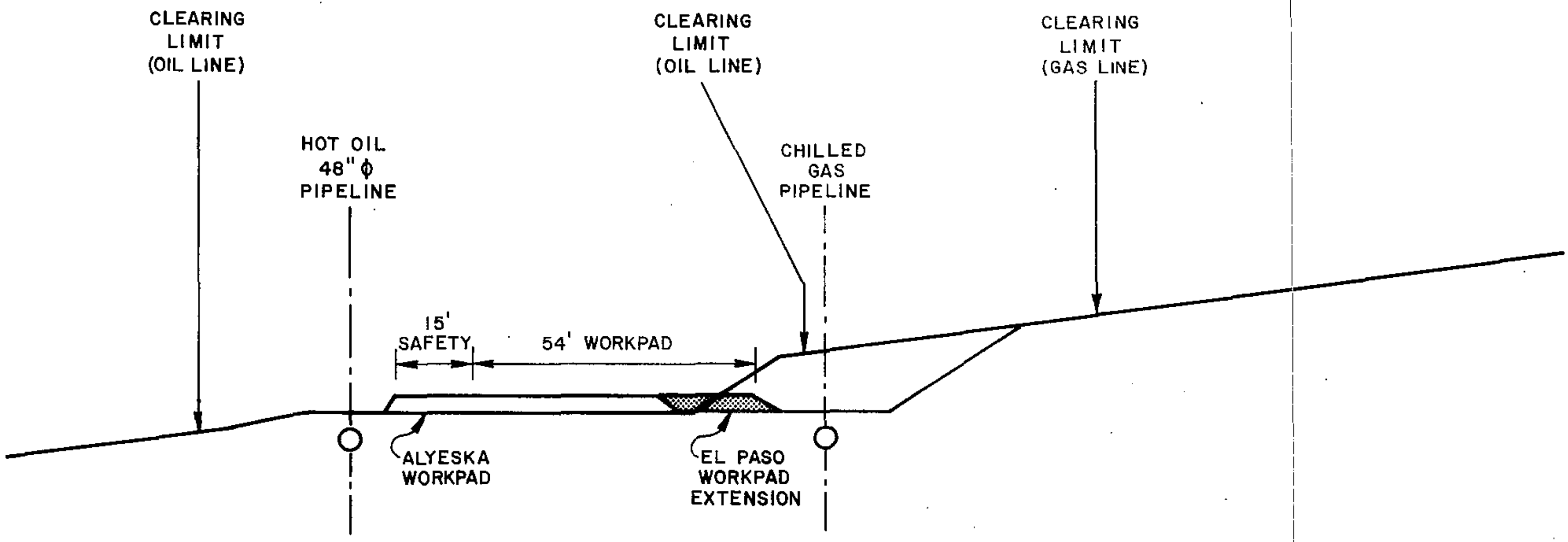
In the Alyeska design, a 15 percent slope is the maximum cross-slope that can accommodate an uphill work pad. This is due to construction considerations, i.e., side boom reach. In some cases, it is unsafe to extend side booms too far while lowering the pipe into the ditch. A slope steeper than 15 percent requires side booms to reach too far if the pipe is placed from an uphill work pad.

Extending the Alyeska sidehill cut uphill and locating a chilled gas pipeline uphill of the Alyeska pipeline should not increase the threat of geotechnical instability to the buried Alyeska pipeline, since the Alyeska stability assessments have included thawing and thawed conditions. The inclusion of a freeze inducing element should in fact enhance the overall stability of the section.

Approximately 37 miles of the proposed El Paso realignment would be construction from this work pad design.

5.2.1.3 Cross Slope 2-15% Work Pad Downhill of Alyeska's Pipeline (Plate 5.2.3)

The downhill location of the Alyeska work pad indicates that the dynamic stability and long-term static stability of the work pad may not have been addressed in the Alyeska design since a failure involving all or a portion of the work pad and materials beneath it would not affect the integrity of the Alyeska pipeline. However, most soils that meet the stringent requirements for burial of the Alyeska pipeline are thaw-stable and non-liquefiable, thus reducing the probability of instability.



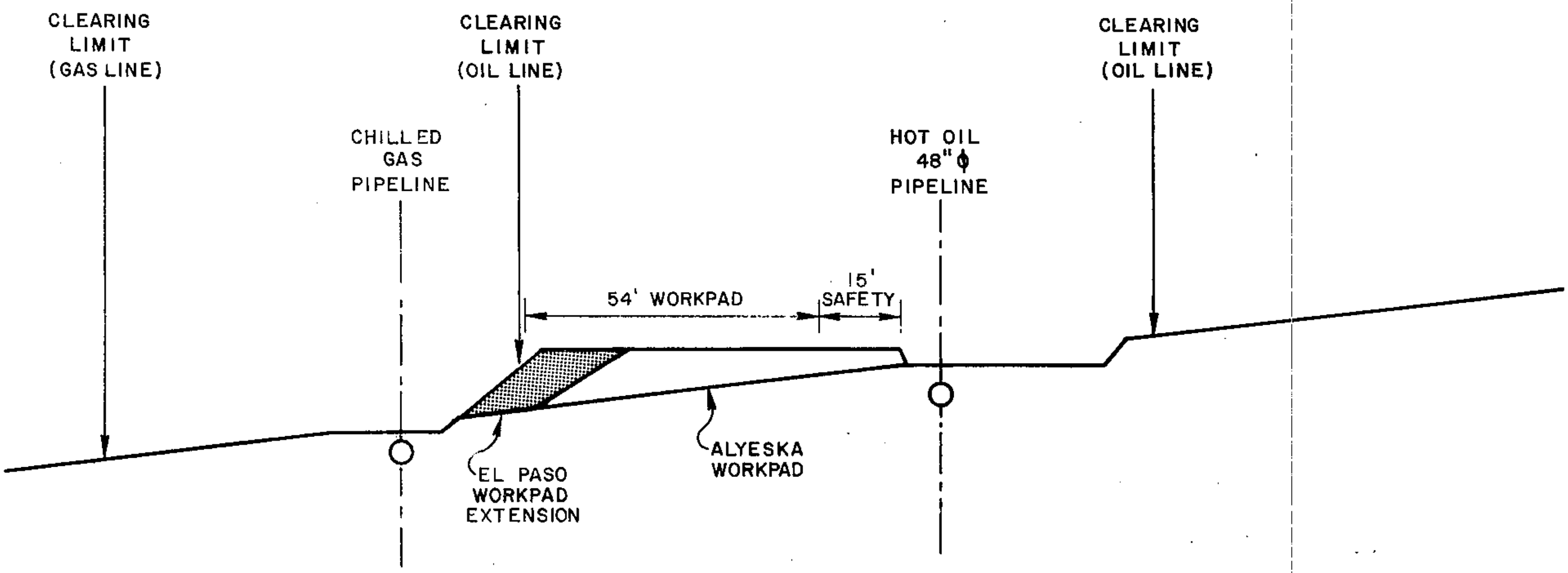
OIL PIPELINE CONSTRUCTION MODE: BURIED

CROSS SLOPE: 2%-15%

WORKPAD UPHILL OF HOT OIL LINE

CHILLED GAS PIPELINE CONSTRUCTION MODE: C-I

PLATE 5.2.2



OIL PIPELINE CONSTRUCTION MODE: BURIED
CROSS SLOPE: 2%-15%
WORKPAD DOWNHILL OF HOT OIL LINE
CHILLED GAS PIPELINE CONSTRUCTION MODE: C-I

PLATE 5.2.3

If geotechnical and thermal conditions are such that the frost bulb surrounding the chilled pipeline is contiguous with underlying permafrost, then it reasonable to expect that the possibility of slope instability affecting the integrity of the gas pipeline will be practically reduced to zero. Where this situation does not exist, designs can be developed to create conditions favorable to the formation of a frost bulb that is contiguous with the permafrost table. In addition, it may be necessary to bury the chilled gas pipeline at a depth similar to the Alyeska depth of burial to avoid problems with shallow instability.

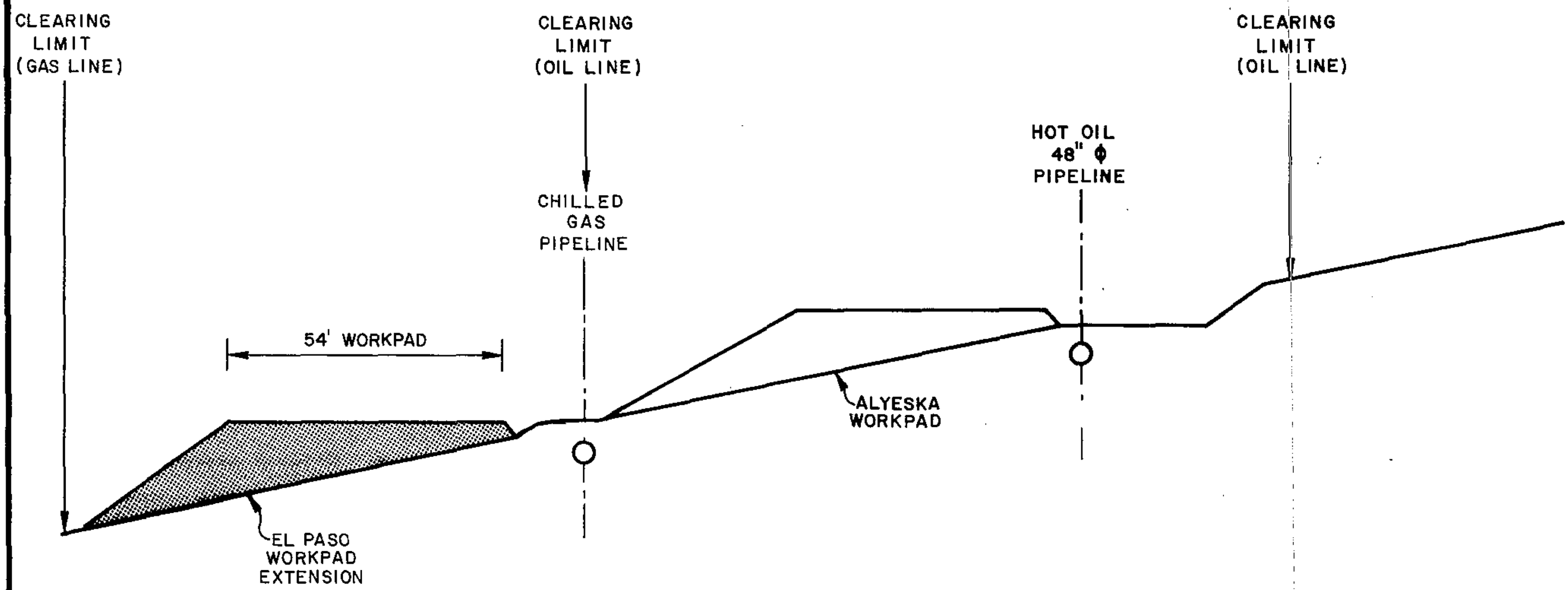
Approximately 30 miles of the proposed El Paso realignment would be constructed from this work pad design.

5.2.1.4 Cross Slope Greater than 15% Work Pad Downhill of Alyeska's Pipeline (Plate 5.2.4)

For this configuration, comments concerning the geotechnical stability are identical with those presented in 5.2.1.3 above. It should be pointed out, again, that the Alyeska design does not include a configuration that locates the work pad uphill of the oil pipeline on side slope greater than 15 percent because of side boom reach limitations. It is assumed that similar limitations would be imposed on the design of a chilled gas pipeline.

Steep cross slopes are not likely to be encountered frequently and should not occupy more than about five miles of the combined alignment.

The similarity between this configuration and mode C-4 (5.2.2, infra.) should be noted. However, there is a fundamental difference in that the El Paso work pad for a C-4 mode is constructed on the opposite side of the oil pipeline to the Alyeska work pad.



OIL PIPELINE CONSTRUCTION MODE: BURIED

CROSS SLOPE: >15%

WORKPAD DOWNHILL OF HOT OIL LINE

CHILLED GAS PIPELINE CONSTRUCTION MODE: C-I

PLATE 5.2.4

5.2.1.5 Through Cuts (Plate 5.2.5)

Considerations of the geotechnical stability of a combined alignment in sections utilizing through cuts are similar to those discussed in 5.2.1.1, above. If the Alyeska through cut is widened and the cut slope height is increased appreciably, or unusual soil conditions are encountered, special slope design considerations may be required. However, these special designs would not preclude utilization of the Alyeska alignment.

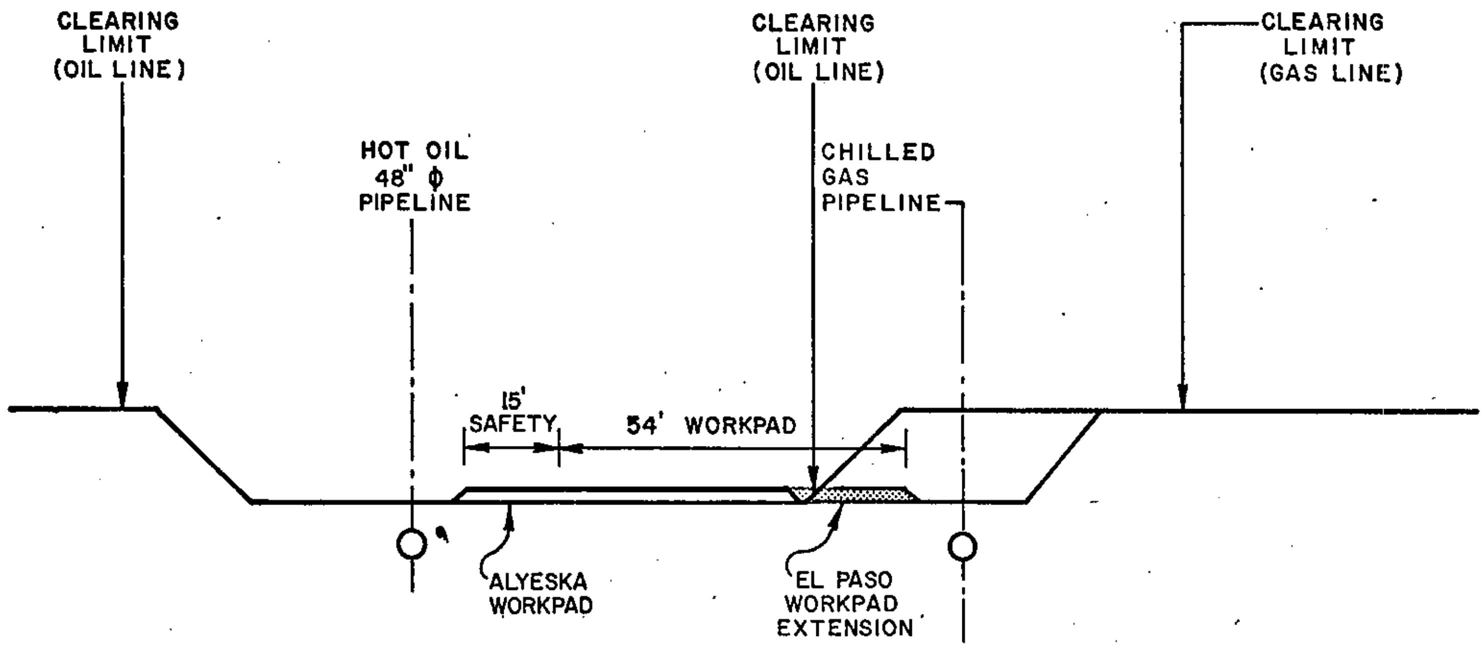
5.2.2 El Paso Mode C-4 (Plate 5.2.6)

Approximately 26 miles of the proposed El Paso pipeline realignment would be constructed from a new work pad in close proximity to the Alyeska working area but on the opposite side of the oil pipeline from the Alyeska work pad (Plate 5.2.6). This construction mode is designated C-4 and will be insulated where applicable. This construction mode is necessary where the existing Alyeska work pad cannot be utilized over short segments due to problems of lay direction, or where some natural barrier to extension of the Alyeska existing pad is present.

From a geotechnical standpoint, stability considerations are similar to those described above (5.2.1).

5.3 Oil Pipeline in the Elevated Mode (El Paso Mode 'B')

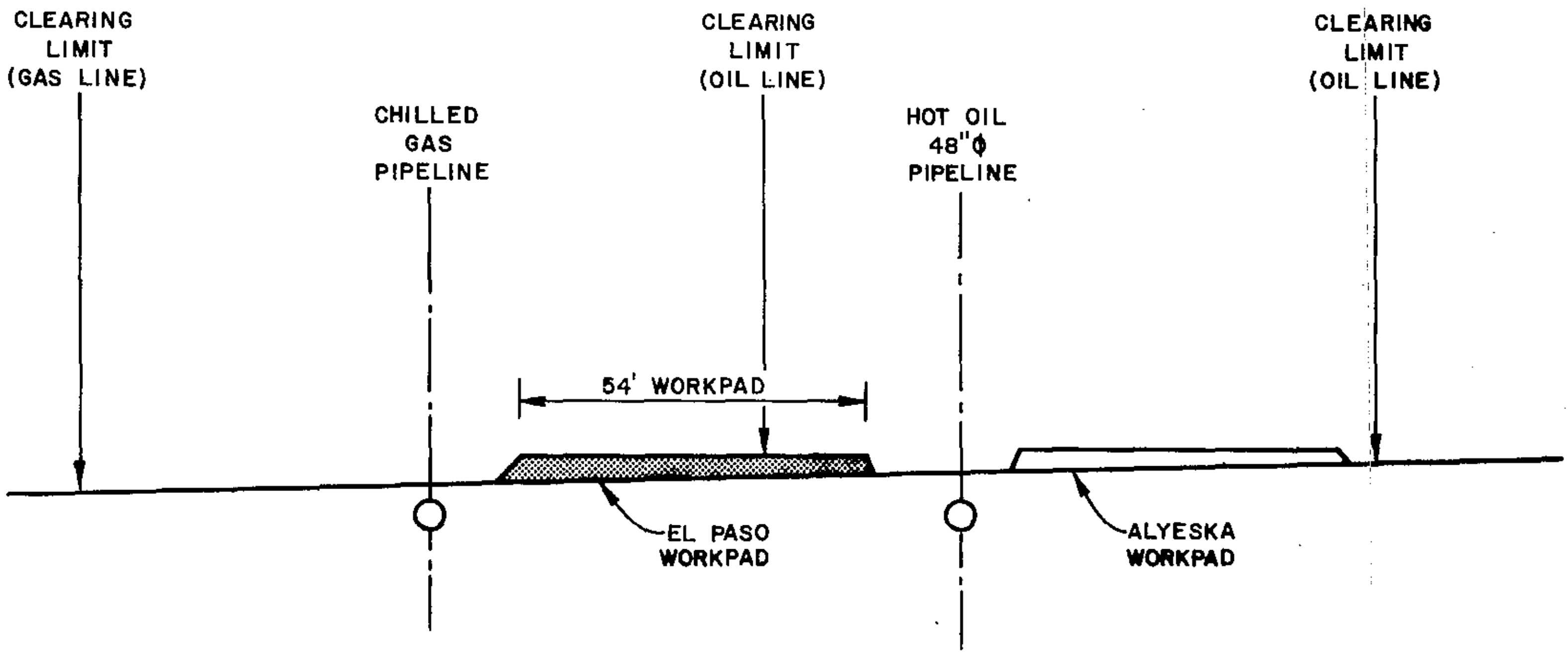
Approximately 242 miles of the proposed 412 miles of the El Paso realignment will utilized the existing Alyeska work pad where the Alyeska pipeline is in the elevated mode. This situation has been designated as mode B by El Paso.



OIL PIPELINE CONSTRUCTION MODE: BURIED THROUGH CUT

CHILLED GAS PIPELINE CONSTRUCTION MODE: C-I

PLATE 5.2.5



OIL PIPELINE CONSTRUCTION MODE: BURIED
CHILLED GAS PIPELINE CONSTRUCTION MODE: C-4
ALL CROSS-SLOPES

PLATE 5.2.6

5.3.1 El Paso Mode B-1

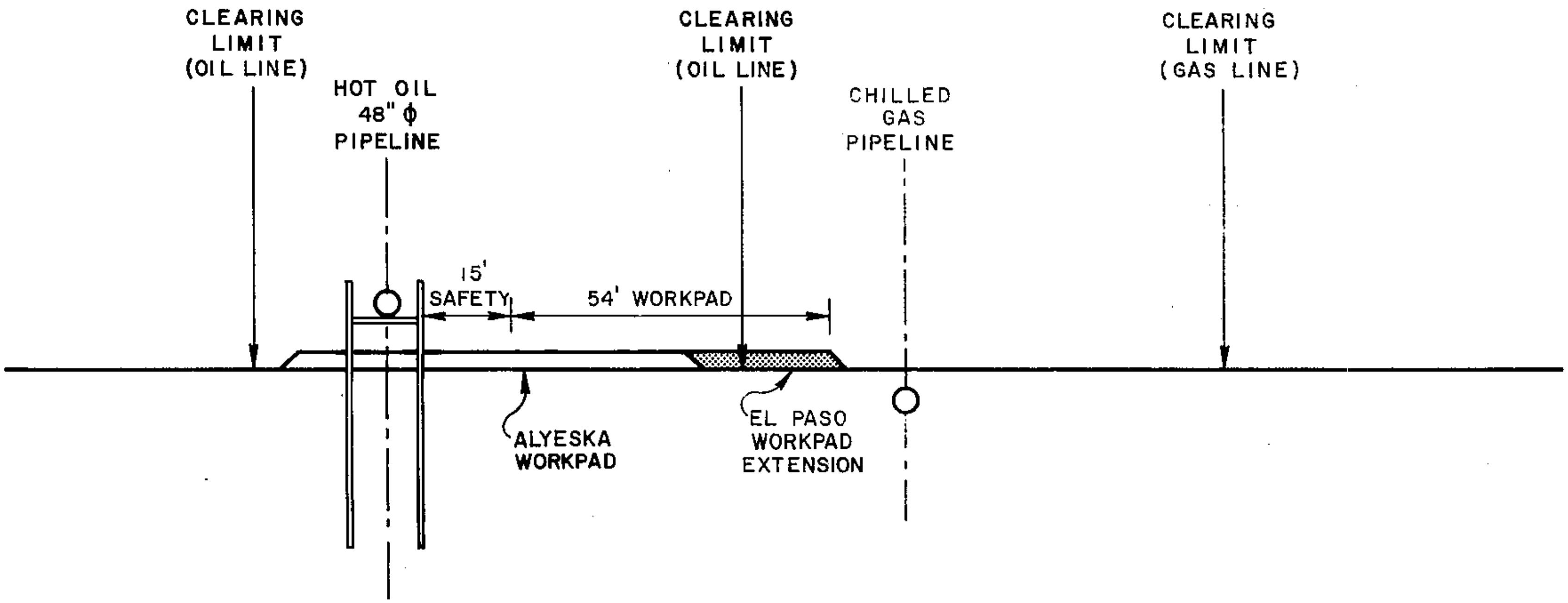
Mode B is subdivided into submodes each having a distinctive construction feature. The most common configuration is a widening of the Alyeska work pad on the side opposite from the oil pipeline with the chilled gas pipeline being laid from this surface (Plate 5.3.1). This mode is designated B-1 and the work pad will be insulated where applicable. Together these submodes account for 218 miles of the 242 mode-B total. The remaining 24 miles will be constructed from a new work pad in close proximity to the Alyeska work area.

5.3.1.1 Cross Slope Less Than 2% (Plate 5.3.1)

In the relatively flat sections of the Alyeska alignment, there is little likelihood that soil displacements will threaten the integrity of either pipeline utilizing the common alignment. If the oil pipeline is elevated to eliminate excessive thaw settlement, a chilled gas pipeline should be free from this concern as it will tend to maintain the underlying soils in a frozen state, rather than permitting them to thaw.

In those sections where the oil pipeline is elevated through regions that are underlain by thawed soils, it may be necessary to consider frost heave in the design of a chilled gas pipeline. However, where the Alyeska pipeline is elevated on thermal VSM's, it is unlikely that the active layer will be thick enough to generate significant frost heave.

Approximately 96 miles of the combined alignment will fall within this category.



OIL PIPELINE CONSTRUCTION MODE: ELEVATED

CROSS SLOPE: < 2%

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-1

PLATE 5.3.1

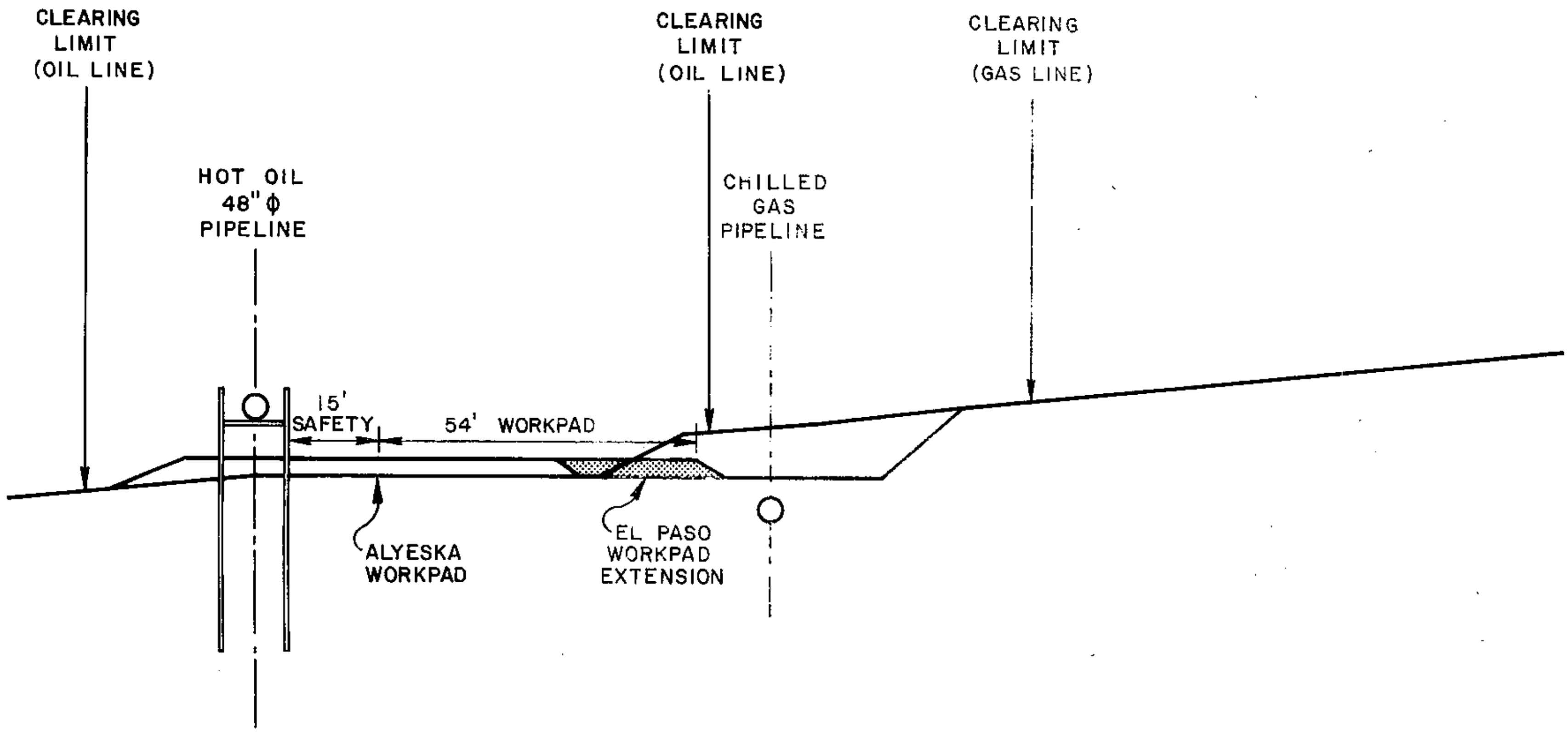
5.3.1.2 Cross Slope 2-15% Work Pad Uphill of Alyeska's Pipeline (Plate 5.3.2)

In this configuration, the Alyeska design has included static and dynamic assessments of work pad stability. The results of these assessments indicate that slope instability does not threaten the integrity of the Alyeska pipeline. Widening the sidehill cut to accommodate a chilled gas pipeline should not affect the conclusions of the Alyeska analyses. Additionally, the operation of a chilled gas pipeline will enhance the overall stability of a combined alignment, particularly if the frost bulb surrounding the chilled gas pipeline is contiguous with underlying permafrost. Thawed soils would require that the gas pipeline be designed to resist any frost heave forces (see Section 4.7).

Approximately 56 miles of the chilled gas pipeline alignment is designed in this way.

5.3.1.3 Cross Slope 2-15% Work Pad Downhill of Alyeska's Pipeline (Plate 5.3.3)

If the oil pipeline is elevated on thermal VSM's, stability will be assured if the frost bulb surrounding the chilled gas pipeline is contiguous with underlying permafrost. If this is not the case, specific analyses and special design measures may be required. Where the Alyeska pipeline is elevated on non-thermal VSM's, frost heave may be a design consideration, but it is unlikely that slope stability considerations will serve as a design constraint. It should be pointed out, however, since it has not been necessary for the Alyeska design to consider instabilities that would not affect the integrity of the oil pipeline, conditions may exist where the work pad may not be dynamically stable and more detailed analyses will be required for specific sites prior to final design.



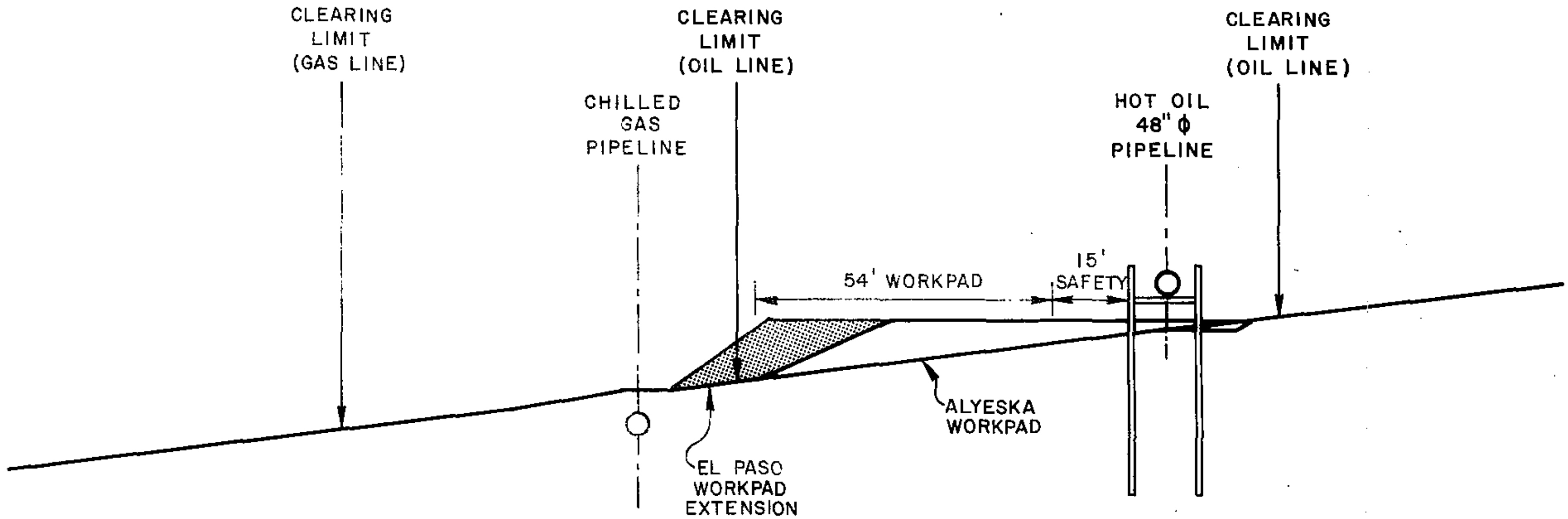
OIL PIPELINE CONSTRUCTION MODE: ELEVATED

CROSS SLOPE: 2%-15%

WORKPAD UPHILL OF HOT OIL LINE

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-I

PLATE 5.3.2



OIL PIPELINE CONSTRUCTION MODE: ELEVATED

CROSS SLOPE: 2-15%

WORKPAD DOWNHILL OF HOT OIL LINE

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-1

PLATE 5.3.3

Approximately 60 miles of the chilled gas pipeline alignment will use this design.

5.3.1.4 Cross Slope Greater than 15% Work Pad Downhill of Alyeska's Pipeline (Plate 5.3.4)

The comments presented in Section 5.3.1.3 apply to this configuration. The probability of unstable conditions being encountered will be increased by the steeper slopes. However, based upon site specific considerations, appropriate designs could be developed to allow construction from this configuration.

This design will be necessary for a total of only six miles.

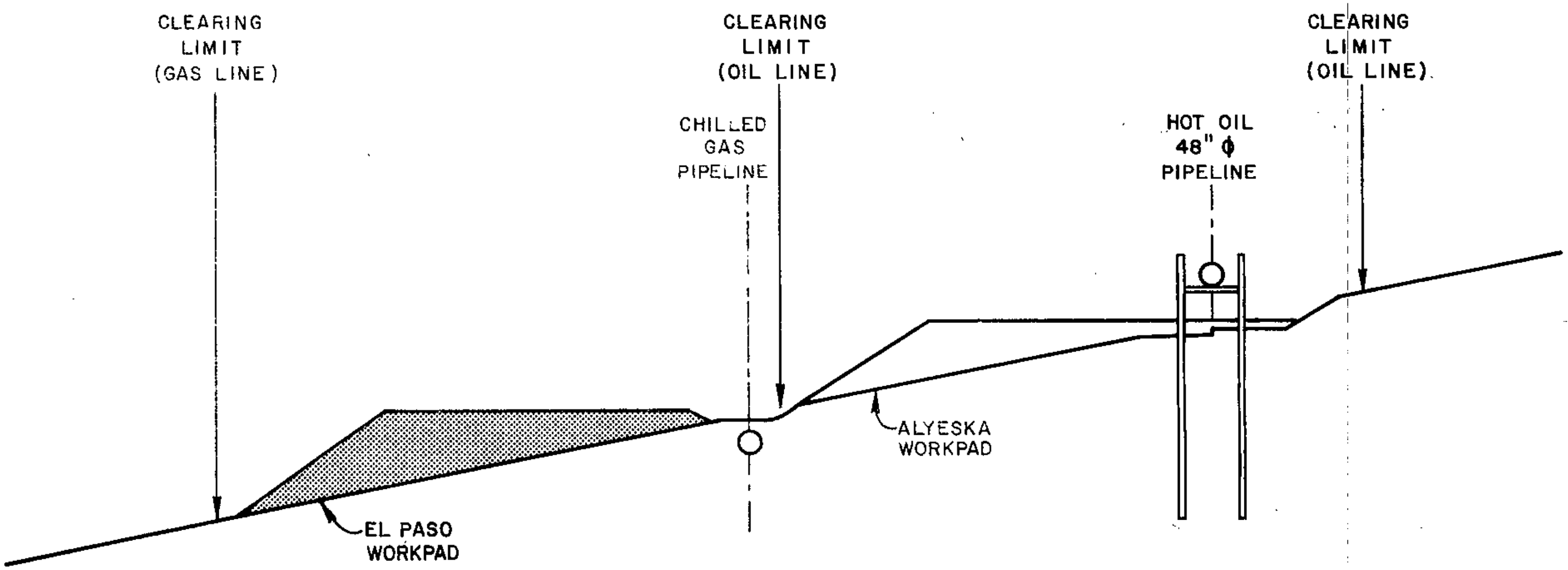
5.3.1.5 Through Cuts (Plate 5.3.5)

Comments presented in Section 5.3.1.1 above apply to this configuration.

5.3.2 El Paso Mode B-3 (Plate 5.3.6)

Approximately 24 miles of the chilled gas pipeline will be constructed from a new work pad in close proximity to the Alyeska work area, but on the opposite side of the oil pipeline from the Alyeska work pad. This mode is designated B-3 (Plate 5.3.6) by El Paso and is necessary where:

- the existing work pad is not utilized for short segments due to the zig-zag oil pipeline configurations;
- a natural barrier to extension of work pad exists; or,
- the lay directions of the oil pipeline and gas pipeline are not compatible.



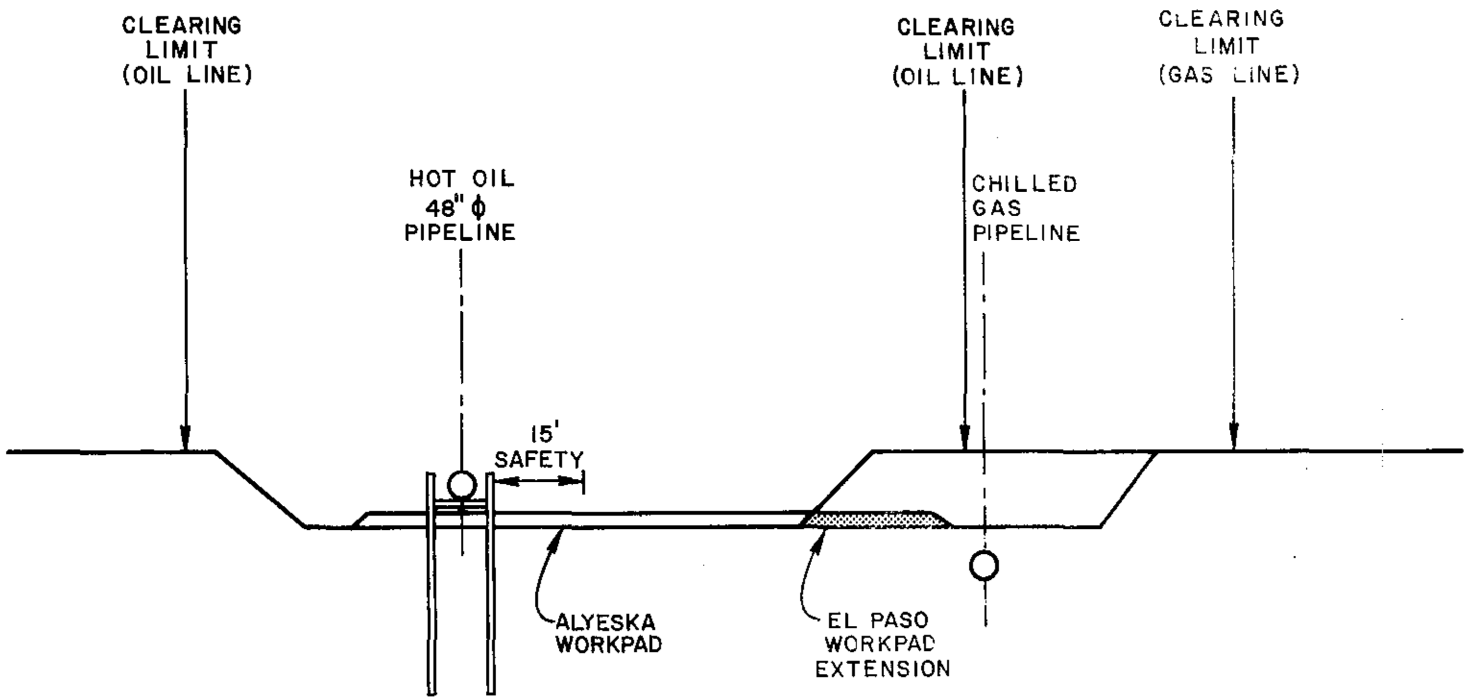
OIL PIPELINE CONSTRUCTION MODE: ELEVATED

CROSS SLOPE: >15%

WORKPAD DOWNHILL OF HOT OIL LINE

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-1

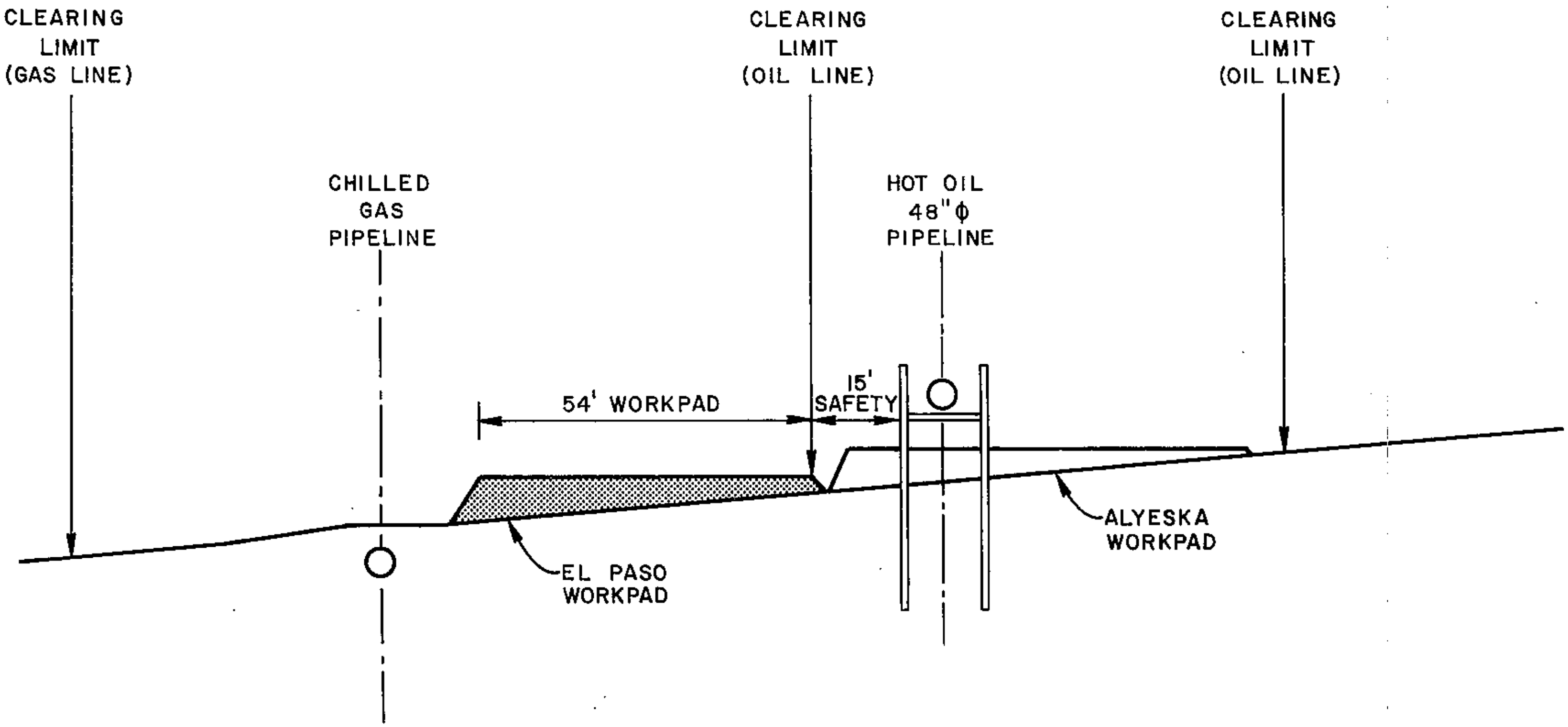
PLATE 5.3.4



OIL PIPELINE CONSTRUCTION MODE: ELEVATED THROUGH CUT

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-I

PLATE 5.3.5



OIL PIPELINE CONSTRUCTION MODE: ELEVATED

CHILLED GAS PIPELINE CONSTRUCTION MODE: B-3

ALL CROSS-SLOPES

PLATE 5.3.6

From a geotechnical standpoint, stability considerations are similar to those described in subsections of 5.3.1.

6.0 Conclusions

The proposed combined chilled gas/hot oil pipeline alignment would traverse terrain presently occupied by a hot oil pipeline constructed in either the buried or elevated mode. Where the Alyeska pipeline is buried, it is generally in relatively coarse grain, stable materials; therefore, there is little likelihood that the installation and operation of an adjacent chilled gas pipeline will create any significant geotechnical instabilities. Where the Alyeska pipeline is designed in its most conservative mode, i.e., elevated on thermal VSM's, the Alyeska design was specifically selected to maintain the subsurface materials in a frozen state; which is precisely the effect that a chilled gas pipeline will create. Since the buried mode and elevated on thermal VSM's mode represent by far the most often used Alyeska modes (71 percent of the Alyeska alignment), it is reasonable to conclude that a chilled gas pipeline could utilize a large portion of the Alyeska alignment without employing unusual geotechnical designs.

Further support for the feasibility of utilizing the Alyeska alignment is offered by the fact that the designers of the Alyeska pipeline have examined the route in great detail and optimized its location to minimize geotechnical design problems. Many of these problems are similar, and some identical, to those that must be considered for design and construction of a chilled gas pipeline. The wealth of information about Alyeska's route that is available and continues to become available, confirms the conclusions about the feasibility of utilizing the chilled gas/hot oil pipeline alignment. The construction modes utilized by Alyeska are geotechnically compatible with a combined oil/gas pipeline utilization of the Alyeska alignment. Some special designs may have to be used in the design of the gas pipeline, but these are within the current capabilities of the engineers and constructors. In addition, the experience acquired during the design and construction of Alyeska's pipeline increases confidence that appropriate design solutions to any unusual problems can be quickly and economically resolved.

Geotechnically, it is far better to deal with a location that has been well explored. The Alyeska alignment may be the most thoroughly explored and analyzed pipeline route in the world. Certainly, it has been examined in sufficient detail to establish its utility as a combined chilled gas/hot oil pipeline alignment.

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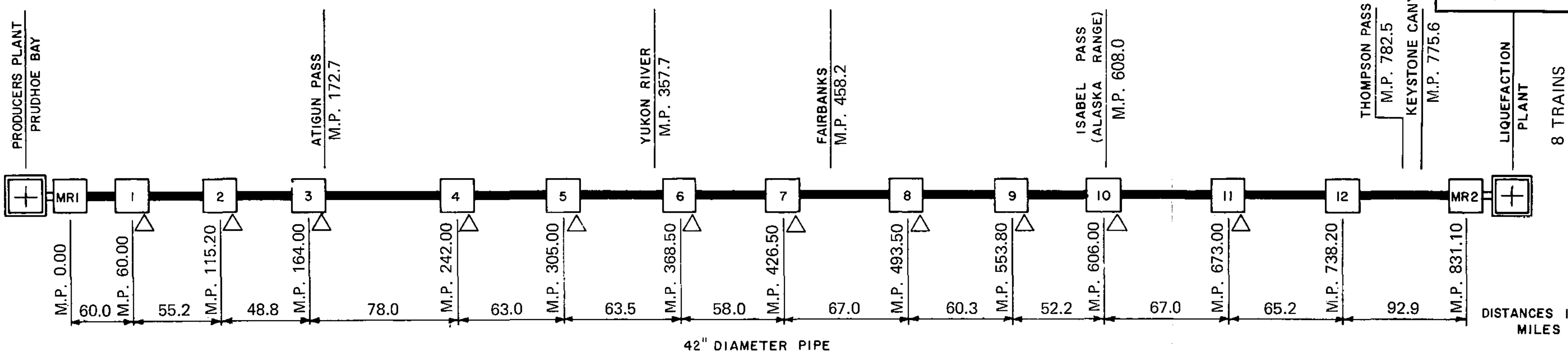
Exh. EP- 4

Docket Nos. CP75-96, *et al.*
Exhibit EP-______ (PCW-24)
5 Pages
Witness: P. C. Wright

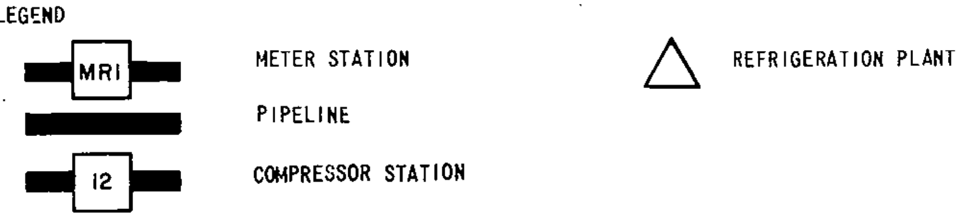
SEASONAL FLOW DIAGRAMS

DOCKET NO. CP75–96, et al
EXHIBIT EP— (PCW–24)
FIGURE 1 OF 5
WITNESS: P. C. WRIGHT



ITEM NO.	ITEM	METER STA. MR 1	COMPR. STA. No. 1	COMPR. STA. No. 2	COMPR. STA. No. 3	COMPR. STA. No. 4	COMPR. STA. No. 5	COMPR. STA. No. 6	COMPR. STA. No. 7	COMPR. STA. No. 8	COMPR. STA. No. 9	COMPR. STA. No. 10	COMPR. STA. No. 11	COMPR. STA. No. 12	METER STA. MR 2
1	STATION INLET FLOW RATE MMCF/SD		3386.23	3377.39	3368.81	3359.71	3352.20	3342.44	3333.16	3323.88	3314.96	3305.81	3296.95	3289.07	
2	STATION OUTLET FLOW RATE MMCF/SD	3386.23	3377.39	3368.81	3359.71	3352.20	3342.44	3333.16	3323.88	3314.96	3305.81	3296.95	3289.07	3282.26	3282.26
3	STATION FUEL MMCF/SD		8.84	8.58	9.10	7.51	9.76	9.28	9.28	8.92	9.15	8.86	7.88	6.81	
4	STATION INLET PRESSURE, P.S.I.A.		1207.9	1212.3	1216.8	1282.5	1177.3	1225.8	1241.0	1261.6	1227.8	1237.5	1294.5	1221.7	
5	STATION INLET TEMPERATURE °F		1.1	0.4	0.2	5.7	1.6	6.1	4.0	5.1	1.1	1.9	8.8	6.0	0.2
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1202.9	1207.3	1211.8	1277.5	1172.3	1220.8	1236.0	1256.6	1222.8	1232.5	1289.5	1216.7	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1685.0	1655.0	1695.0	1695.0	1695.0	1695.0	1695.0	1643.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		43.3	42.0	41.2	40.0	47.0	44.1	42.8	41.7	40.8	40.6	42.6	43.6	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1675.0	1645.0	1685.0	1685.0	1685.0	1685.0	1685.0	1640.0	885.9
10	STATION OUTLET TEMPERATURE °F	30.0	30.0	30.0	25.0	30.0	30.0	25.0	25.0	25.0	25.0	25.0	30.0	43.6	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	31	31	32	32	38	40	42	43	44	44	43	43	44	45
12	COMPRESSOR OPERATING BHP		39847	39041	38338	32382	42573	35678	36201	34099	36675	35705	31374	34656	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.409	1.404	1.399	1.327	1.437	1.356	1.371	1.349	1.386	1.375	1.314	1.350	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		7308	6594	9128	5537	9145	10512	9870	9268	8780	8656	6756	0	
17	REFRIGERATION H.P. REQUIRED COMPR.		3062	3389	6218	3038	5929	8393	8009	7454	7121	6859	4423	0	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0	
19	REFRIGERATION H.P. REQUIRED–COND.		1351	1175	1572	1001	1635	1934	1817	1738	1610	1506	1199	0	

LEGEND



NOTES:

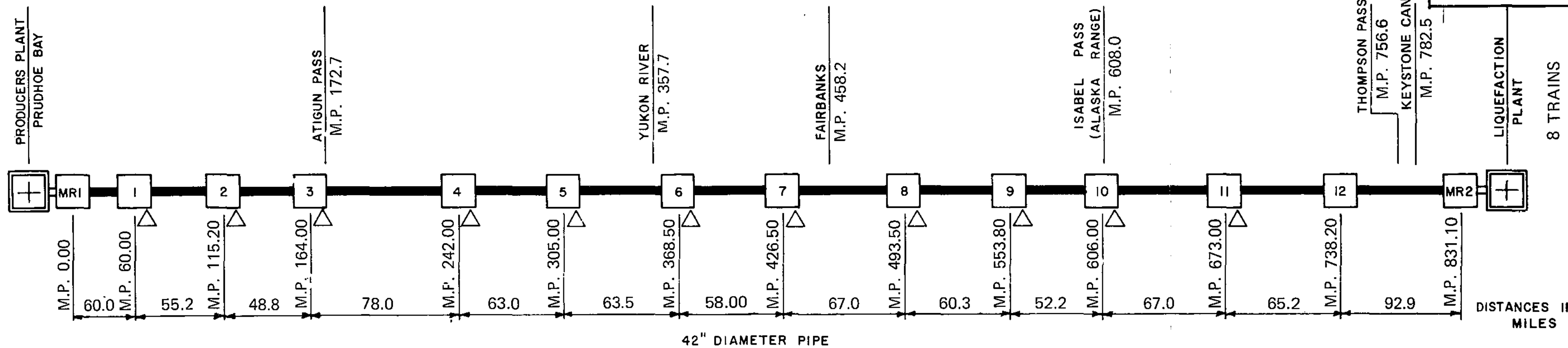
TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	103.97 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM
8 TRAIN OPERATION
SEPTEMBER CONDITIONS
PIPELINE REALIGNMENT STUDY

FPC 1902

DOCKET NO. CP75–96, et al
EXHIBIT EP–__ (PCW–24)
FIGURE 2 OF 5
WITNESS: P. C. WRIGHT



ITEM NO.	ITEM	METER STA. MR 1	COMPR. STA. No. 1	COMPR. STA. No. 2	COMPR. STA. No. 3	COMPR. STA. No. 4	COMPR. STA. No. 5	COMPR. STA. No. 6	COMPR. STA. No. 7	COMPR. STA. No. 8	COMPR. STA. No. 9	COMPR. STA. No. 10	COMPR. STA. No. 11	COMPR. STA. No. 12	METER STA. MR 2
1	STATION INLET FLOW RATE MMCF/SD		3363.64	3356.02	3348.50	3340.96	3334.50	3326.22	3319.57	3312.26	3305.71	3298.30	3291.05	3285.21	
2	STATION OUTLET FLOW RATE MMCF/SD	3363.64	3356.02	3348.50	3340.96	3334.50	3326.22	3319.57	3312.26	3305.71	3298.30	3791.05	3285.21	3278.23	3278.23
3	STATION FUEL MMCF/SD		7.62	7.52	7.54	6.46	8.28	6.65	7.31	6.55	7.41	7.25	5.84	6.98	
4	STATION INLET PRESSURE, P.S.I.A.		1218.7	1219.8	1222.5	1296.0	1182.3	1252.3	1248.6	1282.8	1232.9	1241.8	1323.1	1212.3	
5	STATION INLET TEMPERATURE °F		0.0	0.0	0.1	4.5	0.9	1.7	2.5	0.5	0.0	0.2	4.3	4.2	0.6
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1213.7	1214.8	1217.5	1291.0	1177.3	1247.3	1243.6	1277.8	1227.9	1236.8	1318.1	1207.3	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1685.0	1655.0	1690.0	1695.0	1695.0	1695.0	1685.0	1653.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		40.6	40.5	40.3	37.1	45.5	35.8	39.6	33.8	39.0	38.2	33.3	43.3	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1675.0	1645.0	1680.0	1685.0	1685.0	1685.0	1675.0	1650.0	923.0
10	STATION OUTLET TEMPERATURE °F	30.0	30.0	30.0	25.0	32.0	25.0	25.0	20.0	25.0	25.0	20.0	30.0	43.3	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	–18	–17	–17	–16	–15	–18	–15	–12	–8	–6	–7	–4	6	20
12	COMPRESSOR OPERATING BHP		38008	37815	37457	30561	41510	31549	34460	30748	35881	34879	26722	35913	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.397	1.395	1.392	1.313	1.431	1.327	1.359	1.326	1.380	1.370	1.278	1.369	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		5866	5803	8638	2808	11256	6069	11091	5016	7817	10248	1792	0	
17	REFRIGERATION H.P. REQUIRED COMPR.		0	0	0	0	0	0	0	0	0	0	0	0	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0	
19	REFRIGERATION H.P. REQUIRED–COND.		1091	1037	1444	510	2006	1080	1962	899	1362	1700	309	0	

LEGEND

MRI — METER STATION

PIPELINE

12 — COMPRESSOR STATION

△ REFRIGERATION PLANT

NOTES:

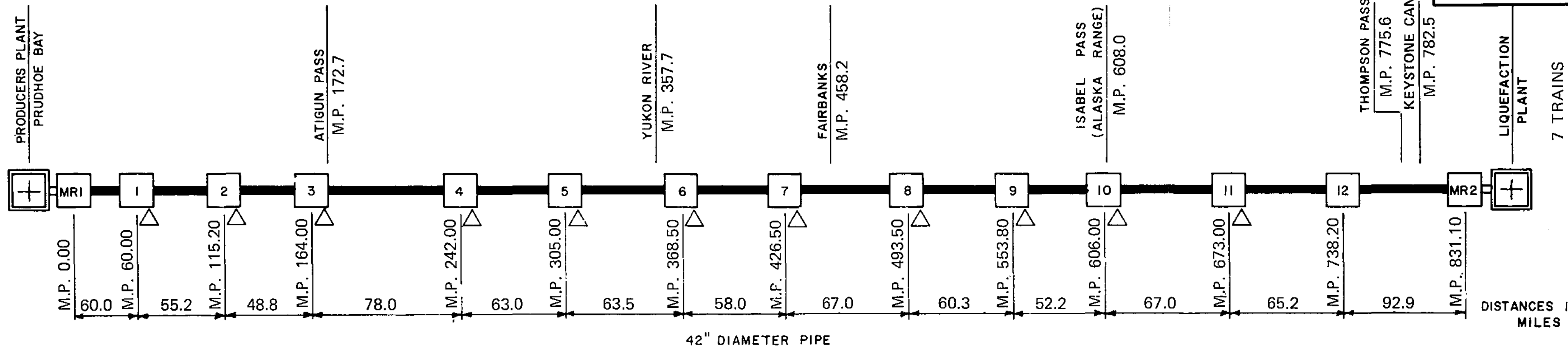
TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	85.41 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM
8 TRAIN OPERATION
WINTER CONDITIONS
PIPELINE REALIGNMENT STUDY

FPC 1903

DOCKET NO. CP75–96, et al
EXHIBIT EP–__ (PCW–24)
FIGURE 3 OF 5
WITNESS: P. C. WRIGHT



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1	STATION INLET FLOW RATE MMCF/SD		2940.67	2934.06	2928.03	2921.21	2916.95	2910.38	2905.61	2898.88	2892.27	2885.61	2878.88	2875.78	
2	STATION OUTLET FLOW RATE MMCF/SD	2940.67	2934.06	2928.03	2921.21	2916.95	2910.38	2905.61	2898.88	2892.27	2885.61	2878.88	2875.78	2872.48	2872.48
3	STATION FUEL MMCF/SD		6.61	6.03	6.82	4.26	6.57	4.77	6.73	6.61	6.66	6.73	3.10	3.30	
4	STATION INLET PRESSURE, P.S.I.A.		1329.8	1328.4	1315.9	1457.3	1322.7	1366.4	1351.5	1378.2	1345.5	1335.1	1433.0	1282.2	
5	STATION INLET TEMPERATURE °F		7.8	3.6	2.5	11.4	2.9	6.8	7.5	8.7	4.5	4.2	13.0	11.9	0.5
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1324.8	1323.4	1310.9	1452.3	1317.7	1361.4	1346.5	1373.2	1340.5	1330.1	1428.0	1277.2	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1680.0	1650.0	1680.0	1695.0	1695.0	1695.0	1650.0	1488.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		37.5	32.6	32.6	29.1	31.2	29.1	33.8	33.7	31.9	32.6	29.8	30.8	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1670.0	1640.0	1670.0	1685.0	1685.0	1685.0	1640.0	1485.0	905.3
10	STATION OUTLET TEMPERATURE °F	30.0	25.0	25.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	29.8	30.8	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	31	31	32	32	38	40	42	43	44	44	43	43	44	45
12	COMPRESSOR OPERATING BHP		24576	23829	24641	14704	23139	18155	21514	20453	22225	22990	13739	15108	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.279	1.281	1.293	1.167	1.275	1.212	1.248	1.234	1.264	1.274	1.155	1.165	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		6208	3831	6424	4701	5705	4620	6945	6893	5990	6307	0	0	
17	REFRIGERATION H.P. REQUIRED COMPR.		3431	2047	4475	3361	4384	3592	5844	5846	5050	5253	0	0	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0	
19	REFRIGERATION H.P. REQUIRED–COND.		1161	685	1109	876	1043	847	1285	1303	1105	1105	0	0	

LEGEND

MRI METER STATION

PIPELINE

12 COMPRESSOR STATION

REFRIGERATION PLANT

NOTES:

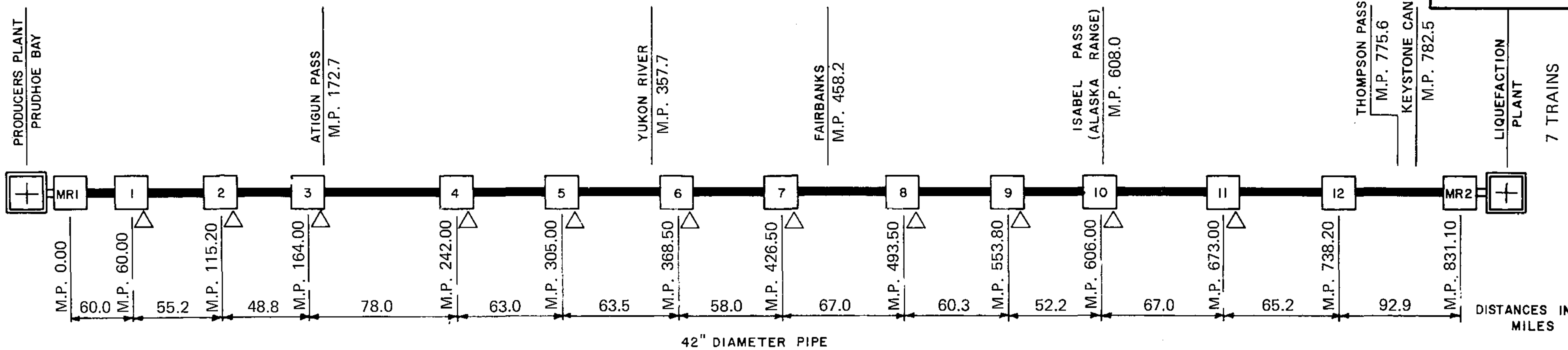
TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	68.19 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM
7 TRAIN OPERATION
SEPTEMBER CONDITIONS
PIPELINE REALIGNMENT STUDY

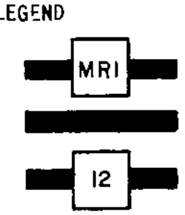
FPC 1904

DOCKET NO. CP75–96, et al
EXHIBIT EP–_ (PCW–24)
FIGURE 4 OF 5
WITNESS: P. C. WRIGHT



ITEM NO.	ITEM	METER STA. MR 1	COMPR. STA. No. 1	COMPR. STA. No. 2	COMPR. STA. No. 3	COMPR. STA. No. 4	COMPR. STA. No. 5	COMPR. STA. No. 6	COMPR. STA. No. 7	COMPR. STA. No. 8	COMPR. STA. No. 9	COMPR. STA. No. 10	COMPR. STA. No. 11	COMPR. STA. No. 12	METER STA. MR 2
1	STATION INLET FLOW RATE MMCF/SD		2924.23	2918.69	2913.32	2907.82	2904.48	2899.23	2895.42	2890.38	2886.23	2881.03	2876.02	2873.11	
2	STATION OUTLET FLOW RATE MMCF/SD	2924.23	2918.69	2913.32	2907.82	2904.48	2899.23	2895.42	2890.38	2886.23	2881.03	2876.02	2873.11	2868.96	2868.96
3	STATION FUEL MMCF/SD		5.54	5.37	5.50	3.34	5.25	3.81	5.04	4.15	5.20	5.01	2.91	4.15	
4	STATION INLET PRESSURE, P.S.I.A.		1336.4	1332.8	1319.2	1465.7	1329.1	1371.9	1356.5	1384.0	1348.8	1337.6	1409.7	1205.8	
5	STATION INLET TEMPERATURE °F		6.4	2.8	2.0	9.5	0.9	4.6	4.9	6.6	3.0	2.2	16.6	9.3	0.6
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1331.4	1327.8	1314.2	1460.7	1324.1	1366.9	1351.5	1379.0	1343.8	1332.6	1404.7	1200.8	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1680.0	1650.0	1680.0	1695.0	1695.0	1695.0	1595.0	1483.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		35.1	31.1	31.7	26.4	28.3	26.1	30.1	30.2	29.7	29.9	31.9	36.0	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1670.0	1640.0	1670.0	1685.0	1685.0	1685.0	1585.0	1480.0	874.2
10	STATION OUTLET TEMPERATURE °	30.0	25.0	25.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	29.9	31.9	36.0	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	–18	–17	–17	–16	–15	–18	–15	–12	–8	–6	–7	–4	6	20
12	COMPRESSOR OPERATING BHP		23607	23148	24131	13894	22192	17356	20541	19249	21638	22369	12409	21320	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.273	1.277	1.290	1.160	1.269	1.207	1.243	1.229	1.261	1.272	1.135	1.235	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		5014	3103	5938	3291	4234	3080	5156	5210	4937	0	0	0	
17	REFRIGERATION H.P. REQUIRED COMPR.		0	0	0	0	0	0	0	0	0	0	0	0	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0	
19	REFRIGERATION H.P. REQUIRED–COND.		932	555	993	598	755	584	912	934	860	0	0	0	

LEGEND



METER STATION
PIPELINE
COMPRESSOR STATION
△ REFRIGERATION PLANT

NOTES:

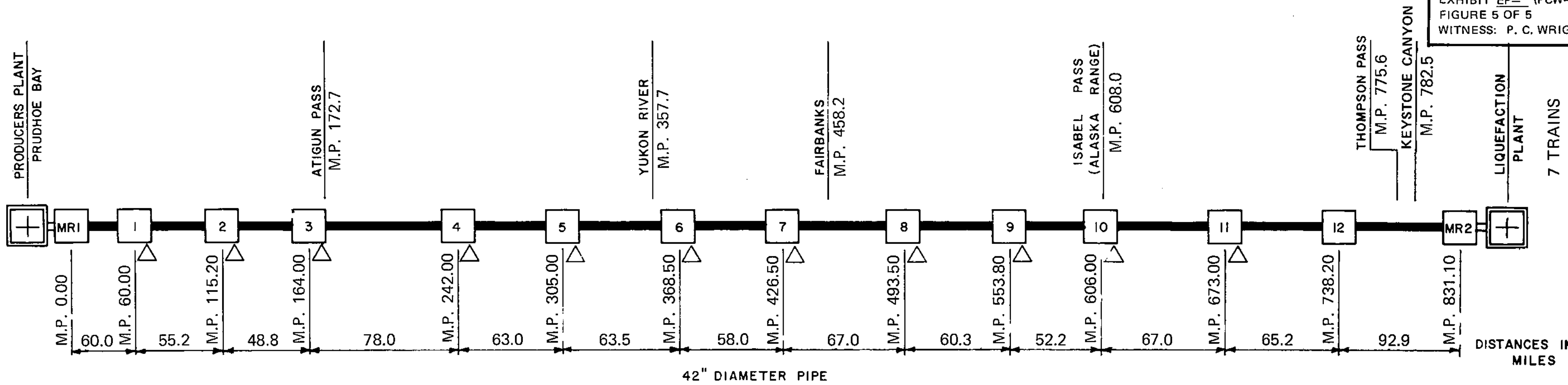
TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	55.27 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM
7 TRAIN OPERATION
WINTER CONDITIONS
PIPELINE REALIGNMENT STUDY

FPC 1905

DOCKET NO. CP75–96, et al
EXHIBIT EP– (PCW–24)
FIGURE 5 OF 5
WITNESS: P. C. WRIGHT



ITEM NO.	ITEM	METER STA. MR 1	COMPR. STA. No. 1	COMPR. STA. No. 2	COMPR. STA. No. 3	COMPR. STA. No. 4	COMPR. STA. No. 5	COMPR. STA. No. 6	COMPR. STA. No. 7	COMPR. STA. No. 8	COMPR. STA. No. 9	COMPR. STA. No. 10	COMPR. STA. No. 11	COMPR. STA. No. 12	METER STA. MR 2
1	STATION INLET FLOW RATE MMCF/SD		2954.32	2947.70	2940.14	2933.31	2927.80	2920.22	2913.72	2906.28	2898.95	2891.65	2884.34	2880.11	
2	STATION OUTLET FLOW RATE MMCF/SD	2954.32	2947.70	2940.14	2933.31	2927.80	2920.22	2913.72	2906.28	2898.95	2891.65	2884.34	2880.11	2877.29	2877.29
3	STATION FUEL MMCF/SD		6.62	7.56	6.83	5.51	7.58	6.50	7.44	7.33	7.30	7.31	4.23	2.82	
4	STATION INLET PRESSURE, P.S.I.A.		1323.2	1314.8	1311.6	1425.6	1306.4	1350.6	1336.7	1359.2	1332.4	1326.2	1412.8	1278.3	
5	STATION INLET TEMPERATURE °F		10.0	9.1	4.6	16.6	8.4	11.5	12.1	13.3	9.2	9.1	17.7	13.3	0.6
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1318.2	1309.8	1306.6	1420.6	1301.4	1345.6	1331.7	1354.2	1327.4	1321.2	1407.8	1273.3	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1680.0	1650.0	1680.0	1695.0	1695.0	1695.0	1650.0	1473.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		40.8	40.6	35.6	37.8	39.6	36.4	40.7	40.8	38.9	39.5	37.0	31.5	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1670.0	1640.0	1670.0	1685.0	1685.0	1685.0	1640.0	1470.0	857.8
10	STATION OUTLET TEMPERATURE °F	30.0	30.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	30.0	31.5	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	40	43	46	49	56	58	59	60	59	58	57	56	56	55
12	COMPRESSOR OPERATING BHP		25735	26220	25544	17755	25712	20523	23614	22712	24311	24761	15838	14577	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.286	1.294	1.297	1.193	1.291	1.226	1.262	1.252	1.277	1.283	1.172	1.157	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		5256	7730	5323	6366	7190	5622	7664	7724	6823	7063	3289	–	
17	REFRIGERATION H.P. REQUIRED COMPR.		3293	6551	4495	5985	7147	5490	7959	7819	6766	6918	2594	–	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	–	
19	REFRIGERATION H.P. REQUIRED–COND.		973	1423	912	1192	1319	1032	1420	1459	1257	1236	583	–	

LEGEND

MRI METER STATION

PIPELINE

12 COMPRESSOR STATION

REFRIGERATION PLANT

NOTES:

TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	77.03 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM
7 TRAIN OPERATION
SUMMER CONDITIONS
PIPELINE REALIGNMENT STUDY

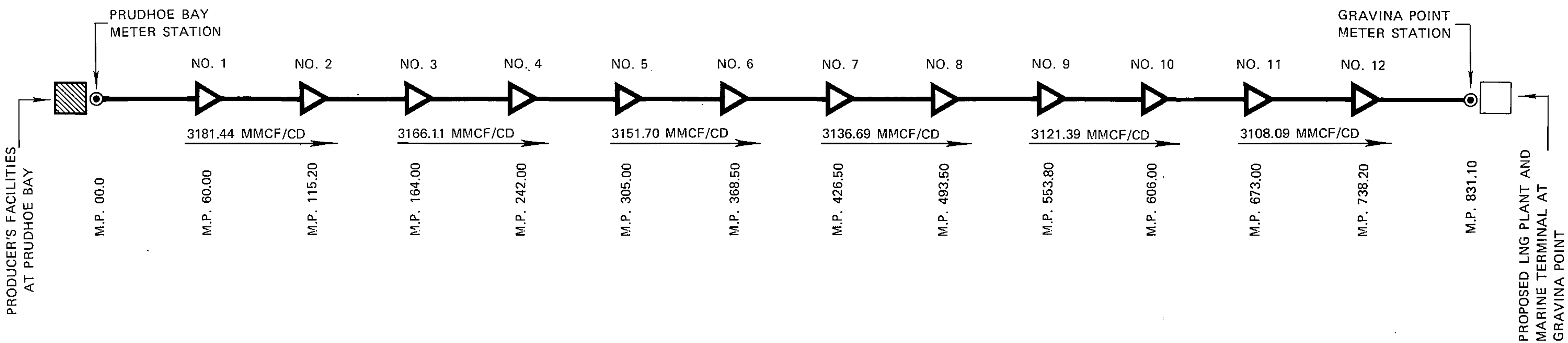
FPC 1906

Exh. EP-5

Docket Nos. CP75-96, *et al.*
Exhibit EP-______ (PCW-25)
Witness: P. C. Wright

AVERAGE DAY FLOW DIAGRAM

DOCKET NO. CP75–96, et al
EXHIBIT EP–____(PCW–25)
FIGURE 1 OF 1
WITNESS: P. C. WRIGHT



SEASONAL DESIGN FLOWS

TIME OF YEAR	FLOW MMCF/D	FUEL MMCF/D
1. 8 TRAIN – SEPTEMBER	3,282.26	103.97
2. 8 TRAIN – WINTER	3,278.23	85.41
3. 7 TRAIN – SEPTEMBER	2,872.48	68.19
4. 7 TRAIN – WINTER	2,868.96	55.27
5. 7 TRAIN – SUMMER	2,877.29	77.03
NO. 1 FOR 128 DAYS	420,129.28	13,308.16
NO. 2 FOR 77 DAYS	252,423.71	6,576.57
NO. 3 FOR 55 DAYS	157,986.40	3,750.45
NO. 4 FOR 13 DAYS	37,296.48	718.51
NO. 5 FOR 92 DAYS	264,710.68	7,086.76
TOTAL PER YEAR MMCF	1,132,546.55	31,440.45
DAILY AVERAGE MMCF/CD	3,102.87	86.14

LEGEND

PROPOSED 42" O.D. PIPELINE
PROPOSED COMPRESSOR STATION
PROPOSED METER STATION
PRODUCER'S FACILITIES
PROPOSED LNG PLANT AND MARINE TERMINAL

NOTES:

TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518

STATION NAME	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9	NO. 10	NO. 11	NO. 12
STATION INLET FLOW RATE MMCF/D	3189.01	3181.44	3173.84	3166.11	3159.96	3151.70	3144.55	3136.69	3129.19	3121.39	3113.72	3108.09
STATION OUTLET FLOW RATE MMCF/D	3181.44	3173.84	3166.11	3159.96	3151.70	3144.55	3136.69	3129.19	3121.39	3113.72	3108.09	3102.87
STATION FUEL MMCF/D	7.57	7.60	7.73	6.15	8.26	7.15	7.86	7.50	7.80	7.67	5.63	5.22
COMPRESSOR INSTALLED H.P. (ISO)	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800
NO. COMPRESSOR UNITS INSTALLED	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400
NO. REFRIGERATION UNITS INSTALLED	1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM SHOWING AVERAGE DAY FLOW BALANCE FOR ALASKAN GAS PIPELINE OPERATION (3189.01 MMCF/D FLOW)

PIPELINE REALIGNMENT STUDY

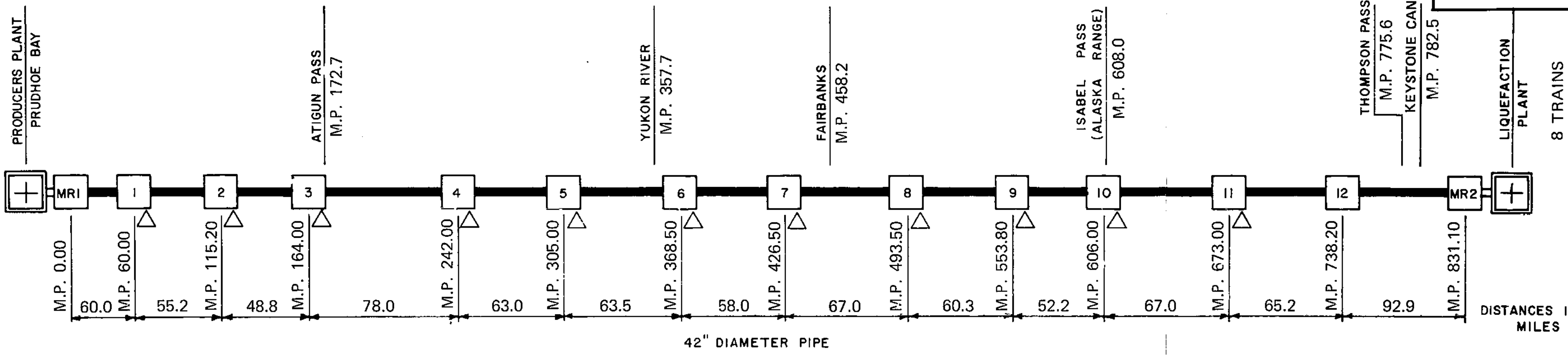
FPC 1907

6

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____ (PCW-26)
Witness: P. C. Wright

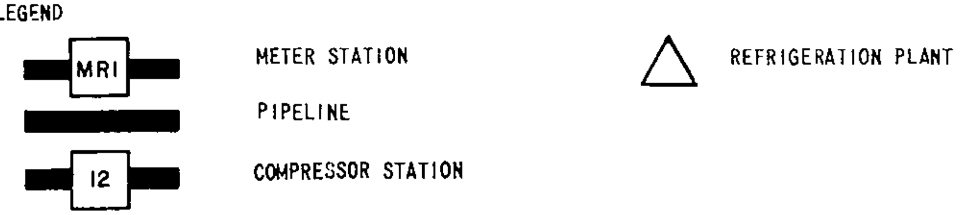
FLOW DIAGRAM FOR MAXIMUM CAPACITY

DOCKET NO. CP75–96, et al
EXHIBIT EP–____ (PCW–26)
FIGURE 1 OF 1
WITNESS: P. C. WRIGHT



ITEM NO.	ITEM	METER STA. MR 1	COMPR. STA. No. 1	COMPR. STA. No. 2	COMPR. STA. No. 3	COMPR. STA. No. 4	COMPR. STA. No. 5	COMPR. STA. No. 6	COMPR. STA. No. 7	COMPR. STA. No. 8	COMPR. STA. No. 9	COMPR. STA. No. 10	COMPR. STA. No. 11	COMPR. STA. No. 12	METER STA. MR 2
1	STATION INLET FLOW RATE MMCF/SD		3480.00	3470.37	3461.03	3450.98	3442.89	3432.06	3422.10	3412.25	3402.53	3392.61	3383.16	3374.49	
2	STATION OUTLET FLOW RATE MMCF/SD	3480.00	3470.37	3461.03	3450.98	3442.89	3432.06	3422.10	3412.25	3402.53	3392.61	3383.16	3374.49	3366.67	3366.67
3	STATION FUEL MMCF/SD		9.63	9.34	10.05	8.09	10.83	9.96	9.85	9.72	9.92	9.45	8.68	7.81	
4	STATION INLET PRESSURE, P.S.I.A.		1172.3	1180.9	1190.7	1245.0	1140.8	1189.4	1216.3	1224.6	1195.8	1211.8	1256.1	1186.0	
5	STATION INLET TEMPERATURE °F		0.0	0.0	0.0	3.6	0.7	3.8	3.9	4.3	0.7	1.6	8.1	5.5	0.3
6	COMPRESSOR INLET PRESSURE, P.S.I.A.		1167.3	1175.9	1185.7	1240.0	1135.8	1184.4	1211.3	1219.6	1190.8	1206.8	1251.1	1181.0	
7	COMPRESSOR OUTLET PRESSURE, P.S.I.A.		1695.0	1695.0	1695.0	1695.0	1680.0	1660.0	1695.0	1695.0	1695.0	1695.0	1695.0	1673.0	
8	COMPRESSOR OUTLET TEMPERATURE °F		46.5	45.4	44.1	41.8	50.2	46.1	45.6	45.0	44.3	43.4	46.1	49.6	
9	STATION OUTLET PRESSURE, P.S.I.A.	1685.0	1685.0	1685.0	1685.0	1685.0	1670.0	1650.0	1685.0	1685.0	1685.0	1685.0	1685.0	1670.0	847.4
10	STATION OUTLET TEMPERATURE °F	32.0	32.0	32.0	25.0	32.0	30.0	27.0	27.0	27.0	27.0	27.0	32.0	49.6	
11	AMBIENT AIR TEMP. °F (MEAN AVG.)	31	31	32	32	38	40	42	43	44	44	43	43	44	45
12	COMPRESSOR OPERATING BHP		45143	43904	42574	36869	47836	40775	40066	39073	41405	39609	36251	42000	
13	COMPRESSOR INSTALLED HP (ISO)		46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	46800	
14	COMPRESSOR RATIO		1.452	1.441	1.430	1.367	1.479	1.402	1.399	1.390	1.423	1.405	1.355	1.417	
15	NO. COMPRESSOR UNITS INSTALLED–BHP		2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	2-23400	
16	REFRIGERATION LOAD (TONS)		8123	7474	10987	5499	11125	10680	10434	10111	9684	9201	7670	0	
17	REFRIGERATION H.P. REQUIRED COMPR.		3861	3738	8063	2826	7659	8166	8193	7908	7666	7044	4882	0	
18	NO. REFRIGERATION COMPR. INSTALLED		1-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	2-4130	0	
19	REFRIGERATION H.P. REQUIRED–COND.		1497	1328	1910	988	2004	1953	1912	1889	1770	1593	1357	0	

LEGEND



NOTES:

TEMPERATURE BASE	60° F
PRESSURE BASE	14.73 psia
GAS SPECIFIC GRAVITY	0.6518
HIGH HEATING VALUE	1130.13 BTU/CF
M.A.O.P.	1685.0 psia
TOTAL FUEL	113.33 MMCF/SD

TRANS-ALASKA GAS PROJECT

FLOW DIAGRAM SHOWING MAXIMUM DESIGN CAPACITY OPERATION FOR ALASKAN GAS PIPELINE (3480.0 MMCF/SD FLOW – SEPTEMBER CONDITIONS)

PIPELINE REALIGNMENT STUDY

FPC 1908

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____ (PCW-27)

Witness: P. C. Wright

Summary of the Impact on the Capital Cost Estimate by Realignment of the Alaskan Gas Pipeline

Incremental Increases	Estimated Cost Impact
Length of Pipeline, 13.8 miles	$23,543,000
Gravel Work Pad 10,566,000 cu. yd.	71,770,000
Additional Blasting Mats	1,752,000
Additional Pipeline Crossings	678,000
Sub-total, Increases	$97,743,000
Incremental Decreases	
Snow Fence Eliminated	$15,270,000
Snow Work Pad Eliminated	12,874,000
Clearing Right-of-Way Reduced	3,647,000
Grading Right-of-Way Reduced	21,824,000
Stringing of Pipe Reduced	2,093,000
Access Roads to Stations Eliminated	4,566,000
Sub-total, Decreases	$60,274,000
Net Incremental Increase in Estimated Capital Cost	$37,469,000

Specifically Identified Contingency Fund Costs
(Not directly associated with the pipeline realignment)

	Estimated Cost Impact
Contingency Fund (1975 Updated Cost Estimate)	$93,986,000
Exhibit EP-148 (PCW-6)	
Identified Costs Charged to Contingency Fund	
Tanana River Suspension Bridge	$ 2,100,000
Additional Active Fault Zone Construction	3,236,000
Willow Lake Special Construction	200,000
Happy Valley Special Construction	1,000,000
Rock Creek Special Construction	500,000
Deep Pipeline Burial at Special Sites	8,858,000
Squirrel Creek Special Construction	1,000,000
Additional Heavy Wall Pipe at Faults and Tanana Bridge	1,101,000
Contingency in Estimated Gravel Pad Cost	470,000
Total	$18,465,000
Remaining Contingency after above charges (Approximately 4% of Total Direct, Indirect and Office Costs)	$75,521,000

Exh. EP- 8

UNITED STATES OF AMERICA

Before the

FEDERAL POWER COMMISSION

El Paso Alaska Company, *et al.*) Docket Nos. CP75-96, *et al.*

Prepared Answering Testimony

of

R. Sage Murphy

Q. Please state your name and your employer.

A. My name is R. Sage Murphy. I am employed by Dames & Moore.

Q. Are you the same R. Sage Murphy who previously submitted prepared direct testimony in this proceeding?

A. Yes. I am.

Q. Have there been any changes in your residence and employment with Dames & Moore since you last testified at these proceedings?

A. Yes. I was admitted to the partnership of Dames & Moore. I have also relocated to the firm's offices at 605 Parfet Street, Denver, Colorado. I am now Director, Pollution Control Services, a position having firmwide responsibilities.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of the El Paso Alaska Company.

Q. What is the purpose of your prepared answering testimony?

A. The purpose of my testimony is to summarize Dames & Moore's analysis of the environmental implications of the proposed El Paso Alaska gas pipeline realignment along Alyeska pipeline facilities and to support from an environmental standpoint, the El Paso realignment as presented in Exhibit EP-_____(PCW-22).

Q. What documents were prepared for the purpose of this testimony?

A. A report entitled "El Paso Alaska Company Pipeline Realignment Study - Supplemental Environmental Considerations." It is Exhibit EP-_____(RSM-3).

Q. How does this report relate to your previously sponsored exhibits?

A. My previously sponsored exhibits addressed the environmental aspects of the El Paso Alaska alignment from Prudhoe Bay, Alaska, to and including the liquefied natural gas (LNG) facilities at Gravina Point, Alaska. This report considers only that portion of the alignment from Prudhoe Bay to the point where the El Paso and Alyeska pipelines diverge in the Lowe River Valley near Valdez.

Further, this report discusses the significant advantages and disadvantages of the proposed El Paso realignment as compared with the original El Paso alignment. It is not intended that the environmental information contained in this report be complete in itself, but is to be supported by the baseline and impact sections of the previously sponsored Exhibits EP-98 and EP-99 (RSM-1 and RSM-2, respectively).

Q. Do you still consider the original El Paso alignment an environmentally sound alignment?

A. Yes, I do. Dames & Moore's basic conclusions rendered on the original alignment have not been altered.

Q. Strictly from the environmental issues, how do you compare the proposed El Paso realignment with the original alignment?

A. The proposed realignment has a net environmental advantage because it maximizes the use of the Alyeska work pad or Alyeska-State Haul Road.

Q. How did you reach this conclusion?

A. This conclusion was reached based upon a series of meetings held to discuss the proposed realignment, a field reconnaissance of the original alignment and the proposed realignment, and review of environmental information available to me developed for the Alyeska project.

Q. From an environmental standpoint, what was Dames & Moore's role in the El Paso realignment study?

A. A series of meetings were held during the weeks of November 10, November 17, and November 24, 1975, in Alaska. The following disciplines were represented at these meetings: pipeline engineering, geotechnical, environmental and construction. Various aspects of locating the gas pipeline adjacent to the existing Alyeska oil pipeline or Haul Road were reviewed during these meetings. My role at these meetings was to represent Dames & Moore's environmental interests in the proposed realignment study.

Q. Were environmental considerations discussed at these meetings?

A. Yes, I made input relative to the environmental aspects of the proposed realignment throughout these meetings.

Q. Was the final realignment determined at this time?

A. No, it was not. In fact, the intention of these meetings was not to decide upon a route, but to brief all parties concerned relative to existing conditions and potential problems in preparation for a planned helicopter reconnaissance of the entire route.

Q. When was this field reconnaissance conducted?

A. The field reconnaissance was conducted from November 18 through November 24. Members of the reconnaissance included representatives of all the disciplines in attendance at the previously mentioned Alaska meetings. The team flew the entire route from Prudhoe Bay to Gravina Point by helicopter.

Q. Would you briefly explain how this trip was conducted?

A. We flew the entire route at low altitude. That is, we inspected the Haul Road, the Alyeska alignment, and the original El Paso Alaska alignment where it diverged from either the Alyeska alignment or the Haul Road. We landed at locations which were identified to be potential problem areas from environmental, engineering, or construction considerations.

Q. You said you proceeded to the Gravina Point plant site. Was this part of the El Paso realignment study?

A. We went to the Gravina Point LNG Plant site, following the original alignment. However, it was not a part of the realignment study per se. The purpose of going down that segment of the route was to reacquaint the reconnaissance team with the portion of the route from the Lowe River Valley to Gravina Point.

Q. Were further meetings held after the reconnaissance was completed?

A. Yes. The first meeting was held in Cordova immediately following the conclusion of the trip. A mile-by-mile discussion was conducted. Environmental considerations were a major concern at this meeting.

Q. Were other meetings held in which environmental considerations were discussed?

A. Yes, both in El Paso and Anchorage. These meetings were extensions of the Cordova meetings. Members of our staff were present at all these meetings.

Q. Were additional environmental data being developed at the same time?

A. Yes, coincident with the reconnaissance, a Dames & Moore staff biologist was working in the Anchorage office of the Joint Federal/State Wildlife Advisory Team (JFWAT) documenting environmental data developed during the Alyeska construction. Much of this information was of very recent origin and was not available in the general literature.

Q. How was this information used in your study?

A. Heretofore unknown sensitive areas were identified and were factored into the realignment decision-making process. For instance, a recently identified chum salmon run near the proposed Tanana River crossing along with an archaeological site on the south bank of this crossing, dictated that an aerial crossing immediately adjacent to the Alyeska aerial crossing be included as part of the realignment study. Without such new information a sound decision could not have been made.

Q. Does the realignment as presented in Mr. P. C. Wright's testimony reflect the environmental recommendations presented by you and your staff?

A. Yes, the realignment as presented includes all the environmental recommendations made by Dames & Moore.

Q. Do any significant divergencies from the Alyeska work pad or the Haul Road exist in the proposed El Paso realignment?

A. Yes, the originally proposed divergence in the Hamlin Hills north of the Yukon River was retained. We feel this divergence offers advantages over the Alyeska route because the latter traverses rugged territory overgrown with a spruce forest. The higher elevation divergence of the El Paso route will require less earthwork, and thus, reduce potential for erosion and require little clearing of trees.

Q. You stated that the realigned route would have environmental advantages over the original route. What are these advantages?

A. The primary advantages relate to the greater use of existing facilities such as the Alyeska work pad and the Haul Road, and the availability of site specific environmental data. Both these factors are a direct result of the Alyeska project.

Q. Please explain the importance of the greater use of existing Alyeska facilities such as the work pad and the Haul Road.

A. Use of the Alyeska work pad and the Haul Road, both of which may need to be extended in width, will eliminate the need for snow work pads and snow roads as well as the potential need for water to construct these facilities. Not only will the existing gravel work pad and the Haul Road help El Paso in maintaining its construction schedule, but will also reduce the potential environmental impacts which could occur during operation and maintenance activities.

Q. Will other benefits accrue through the use of the existing Alyeska work pad and Haul Road?

A. Yes. It is Dames and Moore's opinion that the incremental environmental impact will be less using these existing facilities since two separate and distinct cuts across the landscape will not be required; site specific environmental information is known throughout the route; accessibility will be excellent; and less total land use will be committed to the El Paso project.

Q. What do you consider the major disadvantage of the proposed realignment?

A. The need for additional gravel is the major disadvantage of the proposed realignment. Approximately 10.6 million cubic yards of additional gravel or other select material will be required. Although this material is plentiful, its extraction could cause potential problems to the water resources due to erosion and stream siltation.

Q. Can these problems be mitigated or prevented?

A. Yes, particularly now that such a complete assembly of knowledge has been developed on the area by Alyeska and the governmental agencies. Proper construction techniques and seasonal timing of construction would eliminate most of these potential problems.

Q. Do you consider this gravel use to be a significant environmental impact?

A. No, not when compared to the identified potential availability of 220 million cubic yards within the utility corridor. In addition, a large amount of El Paso's gravel requirements can be satisfied from non-depleted Alyeska sites.

Q. Are there environmental disadvantages of the proposed El Paso realignment?

A. No. The net result of the above mentioned advantages and disadvantages has led me to conclude that the proposed El Paso realignment will have less impact than the original alignment.

Q. Does this conclude your prepared answering testimony?

A. Yes, it does.

STATE OF COLORADO)
) SS.
COUNTY OF JEFFERSON)

R. SAGE MURPHY, being first duly sworn, on oath, says that he is the R. SAGE MURPHY identified in the foregoing prepared answering testimony; that he caused to be prepared such testimony; that the answers appearing therein are true to the best of his knowledge and belief; and that if asked the questions appearing therein, his answers thereto would, under oath, be the same.

R. Sage Murphy

SUSCRIBED AND SWORN TO before me, the undersigned authority, on this 5th day of May, 1976.

Notary Public
Of the State of Colorado
My Commission expires August 27, 1979

Exh. EP- 9

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____ (PCW-30)
Witness: P. C. Wright

ALASKAN GAS PIPELINE

LIST OF PIPELINE CROSSINGS

Mile Post	Description
0.9	Field Fuel Gas Pipeline
70.3	Alyeska Fuel Gas Pipeline (8-5/8")
95.8	Alyeska Oil Pipeline (48" O.D.)
102.5	Alyeska Fuel Gas Pipeline (8-5/8")
107.2	Alyeska Fuel Gas Pipeline (8-5/8")
115.2	Alyeska Fuel Gas Pipeline (8-5/8")
132.0	Alyeska Fuel Gas Pipeline (8-5/8")
132.0	Alyeska Oil Pipeline (48" O.D.)
137.2	Alyeska Fuel Gas Pipeline (8-5/8")
150.0	Alyeska Oil Pipeline (48" O.D.)
150.0	Alyeska Fuel Gas Pipeline (8-5/8")
251.8	Alyeska Oil Pipeline (48" O.D.)
262.0	Alyeska Oil Pipeline (48" O.D.)
272.4	Alyeska Oil Pipeline (48" O.D.)
284.2	Alyeska Oil Pipeline (48" O.D.)
314.6	Alyeska Oil Pipeline (48" O.D.)
326.4	Alyeska Oil Pipeline (48" O.D.)
356.8	Alyeska Oil Pipeline (48" O.D.)
359.0	Alyeska Oil Pipeline (48" O.D.)
359.9	Alyeska Oil Pipeline (48" O.D.)
365.9	Alyeska Oil Pipeline (48" O.D.)
371.4	Alyeska Oil Pipeline (48" O.D.)
421.3	Alyeska Oil Pipeline (48" O.D.)
480.7	Alyeska Oil Pipeline (48" O.D.)
492.6	Alyeska Oil Pipeline (48" O.D.)
510.0	Alyeska Oil Pipeline (48" O.D.)
516.2	Alyeska Oil Pipeline (48" O.D.)
530.8	Alyeska Oil Pipeline (48" O.D.)
532.9	Alyeska Oil Pipeline (48" O.D.)
543.6	Military Products Pipeline (8" O.D.)
564.4	Alyeska Oil Pipeline (48" O.D.)
583.8	Alyeska Oil Pipeline (48" O.D.)
598.0	Alyeska Oil Pipeline (48" O.D.)
599.3	Alyeska Oil Pipeline (48" O.D.)
601.4	Alyeska Oil Pipeline (48" O.D.)
605.4	Alyeska Oil Pipeline (48" O.D.)
614.4	Alyeska Oil Pipeline (48" O.D.)
634.8	Alyeska Oil Pipeline (48" O.D.)
645.	Alyeska Oil Pipeline (48" O.D.)
654.6	Alyeska Oil Pipeline (48" O.D.)
727.2	Alyeska Oil Pipeline (48" O.D.)
756.6	Alyeska Oil Pipeline (48" O.D.)
776.7	Alyeska Oil Pipeline (48" O.D.)
785.8	Alyeska Oil Pipeline (48" O.D.)

R. S. MURPHY

Docket Nos. CP75-96, *et al.*
Exhibit EP-______ (PCW-29)
Witness: P. C. Wright

ALASKAN GAS PIPELINE

LIST OF ROAD CROSSINGS

Mile Post	Description
4.6	Service Road-Prudhoe Bay
70.3	Alyeska/State Haul Road
102.5	Alyeska/State Haul Road
107.2	Alyeska/State Haul Road
115.2	Alyeska/State Haul Road
132.0	Alyeska/State Haul Road
137.2	Alyeska/State Haul Road
162.8	Alyeska/State Haul Road
171.7	Alyeska/State Haul Road
171.8	Alyeska/State Haul Road
259.0	Alyeska/State Haul Road
263.7	Alyeska/State Haul Road
272.7	Alyeska/State Haul Road
283.3	Alyeska/State Haul Road
322.0	Alyeska/State Haul Road
326.3	Alyeska/State Haul Road
357.1	Alyeska/State Haul Road
371.5	Alyeska/State Haul Road
399.0	Alyeska/State Haul Road
401.4	State Road
448.7	Murphy Dome Road
449.9	Elliot Highway
451.5	Steese Highway
458.3	Chena-Hot Springs Road
463.0	Nordale Road
465.0	Peede Road
468.9	Plack Road
470.7	Nelson Road
543.8	Alcan Highway
554.3	Richardson Highway
564.3	Richardson Highway
572.9	Richardson Highway
576.0	Richardson Highway
581.8	Richardson Highway
588.6	Richardson Highway
595.2	Richardson Highway
608.6	Richardson Highway
649.7	Richardson Highway
686.7	Glenn Highway
712.0	Richardson Highway
712.3	Richardson Highway
750.5	Richardson Highway
755.0	Richardson Highway
760.3	Richardson Highway
767.3	Richardson Highway
768.5	Richardson Highway
775.4	Richardson Highway
784.6	Richardson Highway

Exh. EP- 10

Docket Nos. CP75-96, *et al.*
Exhibit EP-______ (PCW-28)

Witness: P. C. Wright

ALASKA GAS PIPELINE

LIST OF STREAM CROSSINGS

		Mile Post	Minimum Depth of Cover	Lateral Concrete Coating	Crossing Length
* 1.	Putuligayuk River	3.4	8'	520'	600'
2.	Antigun River	148.3	8'	500'	540'
3.	Chandalar River	179.4	8'	500'	540'
4.	Nutirwik Creek	190.0	5'	800'	880'
5.	Snowden Creek	203.9	5'	600'	680'
* 6.	Bettles River	211.3	8'	1,000'	1,080'
7.	Minnie Creek	230.6	5'	520'	600'
8.	Marion Creek	238.1	5'	520'	600'
9.	Slate Creek	242.8	5'	1,000'	1,080'
*10.	South Fork Koyukuk	261.7	8'	1,120'	1,200'
11.	Jim River	274.0	5'	520'	600'
12.	Prospect Creek	283.0	5'	520'	600'
13.	North Fork Bonanza Creek	290.2	5'	320'	400'
14.	Bonanza Creek	292.0	5'	320'	400'
15.	Fish Creek	301.2	5'	200'	280'
*16.	Kanuti River	309.0	5'	200'	280'
*17.	Yukon River	357.7	Elevated on Hwy Bridge		2,295'
18.	Isom Creek	367.0	5'	200'	280'
19.	Hess Creek	383.0	5'	200'	280'
20.	Erickson Creek	389.0	5'	120'	200'
21.	Lost Creek	399.0	5'	120'	200'
22.	Tolovana River	403.0	5'	320'	400'
23.	Slate Creek	412.6	5'	200'	280'
24.	Tatalina River	416.6	5'	800'	880'
25.	Globe Creek	421.4	5'	520'	600'
26.	Aggie Creek	427.3	5'	120'	200'
27.	Washington Creek	435.5	5'	320'	400'
28.	Chatanika River	442.0	5'	1,000'	1,080'
29.	Treasure Creek	445.7	5'	320'	400'
30.	Goldstream Creek	451.5	5'	200'	280'
*31.	Chena River	461.6	9'	600'	680'
32.	Moose Creek Reservoir	475.1-479.7	5'	5,300'	5,380'
33.	French Creek (6 Crossings)	479.7	5'	520'	600'
34.	Little Salcha River	492.3	5'	1,000'	1,080'
*35.	Salcha River	497.8	10'	720'	800'
36.	Redmond Creek	501.7	5'	320'	400'
37.	Shaw Creek	522.1	5'	320'	400'
*38.	Tanana River	533.5	Aerial Crossing		1,080'
39.	Jarvis Creek	547.9	5'	1,200	1,280
40.	Ruby Creek	572.4	5'	320'	400'
41.	Bear Creek	573.8	5'	1,520'	1,600'
42.	Darling Creek	575.8	5'	800'	880'

LIST OF STREAM CROSSING (CONTD)

	Stream	Mile Post	Minimum Depth of Cover	Lateral Concrete Coating	Crossing Length
43.	One Mile Creek	579.3	5'	320'	400'
44.	Gunnysack Creek	580.1	5'	520'	600'
45.	Camp Terry Creek	580.5	5'	320'	400'
46.	Falls Creek	581.3	5'	200'	280
47.	Suzy Q Creek	582.2	5'	280'	360'
48.	Lower Suzy Q Creek	582.8	5'	320'	400'
49.	Castner Creek	589.9	5'	4,000'	4,080'
50.	Miller Creek	591.9	5'	1,000'	1,080'
*51.	Phelan Creek No. 1	595.2	5'	1,520'	1,600'
*52.	Phelan Creek No. 2	601.8	5'	2,320'	2,400'
53.	Phelan Creek No. 3	604.9	5'	920'	1,000'
54.	Gulkana River	609.6	5'	720'	800'
55.	Fish Creek	615.3	5'	200'	280'
*56.	Gulkana River	656.8	10'	600'	680'
*57.	Tazalina River	689.1	Aerial Crossing		800'
*58.	Klutina River	700.4	5'	1,000	1,080'
59.	Rock Creek	714.3	5'	200'	280'
60.	Squirrel Creek	719.3	5'	400'	480'
*61.	Tonsina River	725.8	5'	760'	840'
62.	Tiekel River No. 1	750.5	5'	320'	400'
63.	Tiekel River No. 2	754.2	5'	4,000	4,080'
*64.	Tsina River	760.6	5'	320'	400'
65.	Tsina River	767.4-768.4	5'	5,280'	5,280'
*66.	Sheep Creek	778.5	7'	400'	480'
67.	Bear Creek	780.5	5'	400'	480'
*68.	Lowe River	785.2	7'	4,000	4,080'
69.	Dead Creek	809.5	5'	320'	400'
70.	Gravina River	811.4	5'	320'	400'

*Major River Crossings

Exh. EP-11

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____(RSM-3)
Witness: R. S. Murphy

EL PASO ALASKA COMPANY
PIPELINE REALIGNMENT STUDY
SUPPLEMENTAL ENVIRONMENTAL CONSIDERATIONS

Prepared by:

Dames & Moore

May, 1976

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____(RSM-3)
Witness: R. S. Murphy

EL PASO ALASKA COMPANY
PIPELINE REALIGNMENT STUDY
SUPPLEMENTAL ENVIRONMENTAL CONSIDERATIONS

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EL PASO ALASKA COMPANY
PIPELINE REALIGNMENT STUDY
SUPPLEMENTAL ENVIRONMENTAL CONSIDERATIONS

I. Introduction

This report is a reassessment of environmental considerations along the proposed El Paso Alaska gas pipeline route from Prudhoe Bay to the point on the Lowe River where it diverges from the Alyeska oil pipeline. The reassessment is a result of a pipeline realignment study to determine the feasibility of El Paso Alaska maximizing the use of Alyeska Pipeline Service Company's existing work pad and/or the Alyeska-State Haul Road. The Haul Road is, of course, restricted to the areas north of the Yukon River. The proposed El Paso realignment will have some different environmental consequences than the original alignment proposed in El Paso Alaska's initial filing before the Federal Power Commission at FPC Docket Nos. CP75-96, *et al.*

This report takes into account the proposed El Paso pipeline realignment and includes information not available at the time of the preparation of the original El Paso application. However, it is not intended that the environmental information contained herein be complete in itself, but is to be supported by the baseline and impact sections of Exhibits EP-98 and EP-99. Only those major divergences from the Alyeska facilities are discussed in this report. Those divergences which were identified in Exhibits EP-98 and EP-99 are not discussed in detail in this report.

The subject matter which follows contains a discussion of the realignment divergences from the Alyeska facilities, advantages of the realignment, disadvantages of the realignment, and conclusions. Two appendices are included which identify environmentally sensitive areas (one for streams and stream crossings, one for mammals and birds). Much of the information contained in these appendices is new data, having been acquired by field investigations during the course of Alyeska construction subsequent to the preparation of Exhibits EP-98 and EP-99.

II. Discussion of Major Divergences

The proposed El Paso realignment is intended to locate the gas pipeline adjacent to the existing Alyeska work pad and/or the Haul Road wherever feasible based on engineering, economic, and environmental constraints. This report addresses only environmental constraints which are intended to be factored into the other considerations.

The most logical manner to present this information is through a discussion of each major divergence of El Paso Alaska's realignment from either the Haul Road or the Alyeska oil pipeline. Mileposts used in the following discussion apply to El Paso Alaska's proposed realignment. Those sections of El Paso's original alignment which are essentially adjacent to the Alyeska work pad or the Haul Road and have not changed during the realignment study will not be discussed in detail in this report. Exhibits EP-98 and EP-99 contain a discussion of these divergences.

The discussion which follows on these divergences is based upon acquisition and analysis of information available from the Joint State/Federal Fish and Wildlife Advisory Team as of December 1, 1975. A mile-by-mile helicopter reconnaissance was made at approximately the same time for the purpose of evaluating this data, to review specific locations which were identified to be potential environmental problem areas, and to update the original information contained in El Paso Exhibits EP-98 and EP-99.

(1) Compressor Station - Pump Stations: It is physically impossible to construct an adjacent alignment when the pipeline approaches either an El Paso compressor station

or an Alyeska pump station. It is estimated that approximately one mile of new work pad will be required by El Paso at several pump and compressor stations for this reason. Thus, because of physical constraints, a maximum of ten new work pads be required to construct the gas pipeline (six pump stations and four compressor stations). These facilities should not have a significant environmental impact.

(2) Major Stream Crossing: At all aerial crossings, with the exception of the Yukon River Bridge, and at buried crossings of most major streams, particularly south of the Tanana River, engineering and construction considerations dictate that such crossings be separated by an average of one-quarter mile due to the amount of earthwork on the banks. These divergences are minor in nature and will require less than 15 miles of new work pad throughout the extent of the project. None of the proposed divergences is considered environmentally significant except the Tanana River Crossing which is treated in item (11) below.

(3) MP 0 to MP 6.4: The physical constraints of the Prudhoe Bay field, existing facilities and authorized but not yet constructed facilities dictate that the first 6.4 miles of gas pipeline should be constructed from a gravel work pad independent of the existing Alyeska work pad or the Haul Road. (The Haul Road is too far to the east and traverses lower ground until MP 24 where it is reasonable to effect adjacent alignment). A new gravel work pad will be constructed between MP 0 and MP 6.4 which follows the approximate original El Paso alignment. Because of the activity in the area, this new work pad should not have a significant environmental impact.

(4) Bettles River Area (MP 210 to MP 213.8): El Paso's original alignment in the Bettles River area - MP 210 to MP 213.8 is recommended rather than a realignment along the Alyeska work pad or the Haul Road. Alyeska's facilities cross the Dietrich/Koyukuk River twice, and the Alyeska pipeline follows the river bottoms in the active flood plain for approximately one-half mile. El Paso does not cross these rivers but crosses the Bettles River at MP 211.3. Construction within the flood plain of the Middle Fork Koyukuk River is considered environmentally acceptable. However, the area is environmentally sensitive regardless of where constructed. Gyrfalcons and eagles are common in the area and a lambing area is located nearby. Caribou migrate through the area from August through November and mid-March through mid-June. From an environmental standpoint, the number of river crossings should be minimized, which is accomplished in El Paso's original alignment.

(5) MP 226.8 to MP 229.6: This is a very similar situation to item (4) above. It is environmentally preferable to retain El Paso's original alignment, but less satisfactory from an aesthetic standpoint.

(6) Rosie Creek Area (MP 241 to MP 263): Alyeska was urged to follow a Rosie Creek route in order to minimize crossing of many small tributary streams of the North Fork Koyukuk river. As is the case throughout much of this area, the main rivers are utilized as migration routes for fishes while the tributaries are utilized as spawning areas. However, Alyeska ultimately selected a route to the west of Cathedral Mountains.

The Rosie Creek area, particularly the southern half, is a waterfowl nesting area and provides winter moose habitat. There is little available gravel in the area, and any construction utilizing existing gravel sources would require long hauls. Mammals displaced by Alyeska construction may well have entered the Rosie Creek area.

Further, construction in the Rosie Creek area would withdraw more habitat from use than a combined alignment since much of the area between the two pipelines could easily be lost to use by mammals. For all of the above reasons, El Paso has not realigned in the Rosie Creek area.

The Alyeska oil pipeline and Haul Road construction has already created an impact, and another pipeline following the Alyeska facilities would cause an incremental impact. Although a gas pipeline along the Alyeska work pad and/or the Haul Road would be longer and could create some difficult construction in the congested area at the base of Cathedral Mountain, El Paso's realignment will follow the Alyeska work pad or the Haul Road in this area.

(7) Fort Hamlin Hills (MP 337.4 to MP 356.6): This 19-mile section of the route is in very hilly country, with the Alyeska work pad and Haul Road crossing the hilly terrain, ridges, and ravines at approximately right angles. El Paso's original alignment is to the east of Alyeska's construction on higher and more uniform sloping terrain. The construction difficulty, the potential of erosion due to excessive earthwork, and the loss of additional timber resources if constructed adjacent to Alyeska, argue for continued use of El Paso's original route. From biotic

considerations, El Paso's original route is less sensitive as only a few caribou use the area regularly. Further, there are very few trees at the higher elevation; and thus, there will not be a significant aesthetic impact resulting from construction at higher elevation. For these reasons, El Paso will continue to follow its original alignment.

(8) Fairbanks Area (MP 448.7 to MP 459.5): The divergence in question is essentially identical to that described in Exhibits EP-98 and EP-99. Because the area in question is on the fringe of the settled Fairbanks area, the various environmental factors considered for remote area divergences do not apply here. For instance, throughout the area there are a number of cleared rights-of-way cut through the trees for various other utilities such as power lines, telephone lines, access roads, and survey lines. The divergence is dictated by sound engineering judgment in lieu of environmental factors in this particular area since the whole area is highly influenced by the Fairbanks population center of which it is a part. We feel that no advantages from the environmental point of view would accrue if the El Paso realignment were placed immediately adjacent to the Alyeska alignment in this area.

(9) Moose Creek Dam Area (MP 470 to MP 474.7): This divergence precludes El Paso Alaska from having to construct in the very tight area between Moose Creek Bluff, the Alyeska pipeline, the Richardson Highway, and Piledriver Slough. Any environmental impacts are slight in this short divergence because the area is heavily used and is in the midst of the Moose Creek Dam which is presently

under construction by the U. S. Corps of Engineers. The area of the dam construction, which accounts for a good part of this divergence, is being heavily impinged by man and machinery at this time; and therefore, sensitive wildlife areas, if present, would have already been disturbed prior to El Paso Alaska's entrance into the area.

(10) Compressor Station No. 8 (MP 493.5): Compressor Station No. 8 has been relocated to provide minimum access requirements as compared to the initial location. The present compressor station location is the most compatible with the environment of any possible location within 15 miles. This is true from the standpoint of construction and operation related environmental impacts.

(11) Tanana Crossing (MP 533.3): The original El Paso alignment crosses the Tanana River in a buried mode about 1.5 miles east of the Alyeska pipeline aerial crossing. Although El Paso's original alignment avoids the congestion near the Alyeska crossing (Richardson Highway, power transmission line, and oil products line) and would be more economical to construct, it is considered necessary to realign the gas pipeline as close to Alyeska as possible. Supporting evidence for this recommendation is as follows:

(a) There is an archaeological site on the south side of the river near the original El Paso crossing.

(b) A late chum salmon spawning area was recently discovered immediately downstream of the original El Paso buried crossing.

Therefore, El Paso will realign its river crossing and move it immediately upstream of the Alyeska aerial crossing. Furthermore, because of the significance of the Tanana River for grayling migration and overwintering, in addition to the above mentioned chum salmon spawning, the realigned El Paso crossing will be aerial instead of buried.

(12) Big Delta Area (MP 542.4 to MP 554.6): This divergence around the community of Big Delta is basically identical to the original El Paso Alaska alignment. El Paso's proposed realignment, approximately two miles from the Alyeska line and/or the Richardson Highway, circling the Big Delta Arctic Training Center, Big Delta Airport, and the community of Big Delta itself, will not cause a significant impact because the areas between the two pipelines are rather extensively used by man; and, those mammals present in the area are quite accustomed to this activity. Those species which would not be accustomed to such activity have moved from the area long prior to the pipeline construction, either Alyeska's or El Paso's. There is a herd of buffalo in this area which are not particularly impinged upon by the construction in that they have lived there for a number of years. The streams which are crossed are nonproductive streams in that they are glacier fed. Therefore, the same comments made on the original alignment would apply to El Paso's proposed realignment.

(13) Black Rapids Area (MP 580 to MP 593): The Alyeska route lies predominantly in the Delta River flood plain downslope of the Richardson Highway. The original El Paso alignment is above the highway throughout this section and above timber line in most areas. Aesthetics are a

major consideration in this area which is one of the more traveled and accessible areas along the route. Any additional cleared right-of-way would be very noticeable and detract from the aesthetics of this area.

The extent of timber habitat between the river and the mountain bases is small. Disturbance of any of the timbered areas would be much more significant than in other more gently sloping areas. The high summer flows of the Delta River and steep mountains prevent many animals from leaving this long narrow habitat. Further, important lambing areas are present in the mountains immediately to the east. Avoidance of these areas is environmentally important. Therefore, El Paso's pipeline will be realigned between the highway and the oil pipeline or downslope of the oil pipeline or between the highway and the mountain base in this area.

(14) Willow Lake-Stuck Mountain Area (MP 710.9 to MP 714.1): The original El Paso alignment diverged around Stuck Mountain and Willow Mountain for a very significant length. This major divergence has been eliminated, and the El Paso pipeline has been realigned to parallel the Alyeska work pad with the exception of the above mileposts. This section is between Willow Mountain and Willow Lake in a rather highly congested area which includes the Richardson Highway, the Alyeska oil pipeline, and some power lines. Locating the line approximately 1,000 feet east of the Richardson Highway, which requires two highway crossings, has been accomplished for engineering purposes. The proximity of Willow Lake to the proposed El Paso realignment is not considered to be important environmentally because this section of the

pipeline will be relatively easy to construct and the construction can be performed without damage to the lake. This divergence is very small compared to the very long divergence (approximately 36 miles) of the original alignment. Therefore, there is a net environmental and aesthetic benefit resulting from El Paso's proposed realignment in the Willow Lake-Stuck Mountain area.

(15) Thompson Pass Area (MP 775 to MP 779): The proposed El Paso realignment, as it comes off the bench near the Worthington Glacier and reenters Thompson Pass, will utilize the recently abandoned roadbed of the Richardson Highway rather than be adjacent to the Alyeska oil pipeline. This roadbed, which is quite stable and is presently being replaced by a new alignment, is an ideal location for El Paso's pipeline. No additional earthwork, clearing, or other environmentally disturbing factors will be required through this stretch of the alignment. It is considered the most environmentally sound location within this stretch of the alignment.

(16) Keystone Canyon (MP 780 to MP 786): El Paso's original alignment is on the west side of the canyon. Alyeska is constructing on the east side. Physical constraints preclude the use of the Alyeska work pad in this area. If El Paso were to realign to the east side of the canyon, a separate work pad would be necessary. Hence, the original El Paso alignment will be utilized since there would be no environmental advantages accruing from relocating to the east side of the canyon.

III. Advantages of Realignment versus the Original Alignment

(1) Aesthetic: The proposed realignment will replace the possibility of two separate cleared rights-of-way across undeveloped countryside, with a single but slightly wider right-of-way. Aesthetically, this is more important in traverses of timbered areas than across treeless areas where the gas pipeline will be buried and the oil pipeline elevated.

(2) Water Uses: Since all construction along the proposed El Paso realignment will take place from gravel work pads, the need for snow work pads has been eliminated. Although original El Paso plans were based upon collection of snow to construct snow work pads, contingency plans for making snow from available water sources were developed and probably would have been implemented during construction. Recently enacted State of Alaska regulations have severely restricted water withdrawals from a number of North Slope rivers. Therefore, El Paso's proposed realignment has eliminated potential water resource impacts to these critical rivers and further has reduced potential construction delays resulting from the unavailability of water.

(3) Stream Crossings: With but a few minor exceptions, El Paso's proposed realignment will cross the same streams as the original alignment, but in different locations. Since the start of construction of the Alyeska oil pipeline project, the Joint State/Federal Fish and Wildlife Advisory Team (JFWAT) has identified approximately 100 streams of previously unknown importance for fish (see Appendix A). Now that these streams have been identified

and their sensitive periods of the year are known, precautions can be taken during the construction planning period to avoid construction impacts to these streams. Thus, the potential for construction delay is reduced. Further, since El Paso's proposed realignment is adjacent to the Alyeska oil pipeline or the Haul Road, Alyeska's site specific information can be more fully utilized in the engineering design and construction.

(4) Biologically Sensitive Areas: Biologically sensitive areas such as raptor nesting sites, bear dens and caribou migration paths have been identified and studied by JFWAT in an analogous manner as fish streams (see Appendix B). Thus, there are but slight probabilities that any irreversible impact will be made upon these species. Furthermore, the Alyeska construction activity and attendant traffic in the immediate vicinity has displaced many animal species while others have become accustomed to these activities by man. Thus, the continued activity in an already disturbed area caused by El Paso's proposed realignment only causes an incremental impact in these areas.

(5) Construction and Maintenance Considerations: Alyeska's work pad and the Haul Road will have continuing activity in the future due to operation and maintenance resupply and inspection activities. If El Paso's pipeline is located adjacent to these existing facilities only an incremental impact will be created; whereas, if the gas line is several thousands of feet to a few miles distant, a separate and possibly independent impact from operation and maintenance activities is possible.

A single slightly wider area of activity containing two pipelines will have less impact than two pipelines separated by undeveloped land, even though the latter case has been shown to be environmentally acceptable. In some instances on El Paso's original alignment the area between the two pipelines could be of such dimensions that associated activity, both during construction and operation, could essentially impinge upon natural biological processes. Although such an impact is considered quite small, it would be eliminated along most of El Paso's proposed realignment.

(6) Accessibility During Operation: El Paso's proposed realignment will allow routine maintenance and emergency repairs to be performed from the existing all-weather gravel Haul Road and gravel access roads. Since El Paso's original alignment and construction plan required snow work pads, access to the gas pipeline for maintenance purposes would have posed the possibility for environmental damage during the period from break-up to freeze-up. El Paso's proposed realignment will allow maintenance to be performed at any time from the gravel work pad or the Haul Road.

(7) Damage to Tundra: El Paso's proposed realignment will lessen potential damage to the tundra. Although the surface directly beneath the new work pad will be altered, the area of this surface will be small when compared to that beneath a snow work pad. If the gravel work pad is properly constructed and maintained, no irreversible damage to the tundra is expected to occur. However, accidents, unknowledgeable equipment operators, and natural climatic conditions can all contribute to varying

degrees of tundra degradation. Slight as these may be, they will be minimized with El Paso's proposed realignment.

IV. Disadvantages of Realignment versus Original Alignment

(1) Gravel Requirements: Construction of a gravel work pad, whether it be an extension of the existing Alyeska work pad or Haul Road or a completely separate entity, will require more gravel than El Paso's original proposal which used snow work pads. It is presently anticipated that El Paso's proposed realignment will increase the gravel requirement from 6.5 million cubic yards to 16.4 million cubic yards. The environmental impact of extraction and transporting gravel can be severe and is well recognized by El Paso and regulatory agencies. Associated problems caused by securing this material include: aesthetic impacts, siltation of adjacent streams, erosion, and exhaustion of a nonrenewable resource.

The area north of the Yukon River will require approximately one-half of El Paso's total gravel requirement. Many sites used for gravel and other select material by Alyeska will be available for further use by El Paso. Current information available from the Department of the Interior and Alyeska indicates that over three times the required 16.4 million cubic yards of gravel required for the proposed El Paso realignment will remain in currently operating gravel pits upon completion of the Alyeska project.

New material sites available within an economic haul distance from the construction zone have been identified during the El Paso realignment study. With proper planning and construction techniques, the environmental impact from extraction at these sites is not considered to be significant.

(2) Drainage and Fish Passage: Extension of the Alyeska work pad or the Haul Road may require an addition to many of the existing drainage structures. Some environmental problems are anticipated at those structures designed at maximum grade (thus maximum permissible water velocities) at crossings of streams supporting migrating or resident fish populations. When an additional 50-60 feet is added onto such a culvert to accommodate the El Paso work pad, the total length fish would have to travel against maximum water velocities could be greater than certain age groups can routinely handle. Although this situation is considered a potential disadvantage, proper design and construction techniques can be utilized to minimize environmental impact.

Many culverts will have to be extended; however, nearly all of these are drainage culverts which carry water only during spring break-up and summer rain storms. Thus, extension of these culverts will have little or no importance to fish populations.

V. Conclusions

Based upon El Paso's original alignment, the construction and operation of a gas pipeline within the Trans-Alaska Utility Corridor would add incremental impacts onto existing Alyeska impacts. The proposed El Paso realignment discussed herein supports this same conclusion, but it will be incrementally less, and therefore, a more desirable alternative from strictly environmental considerations.

With but a few exceptions, the environmentally sensitive areas within the Utility Corridor from Prudhoe Bay to the Lowe River have been very well documented by Alyeska. Important natural conditions are known at the exact locations where the gas pipeline will be realigned, thus obviating the need for extrapolations of Alyeska data or time-consuming original alignment studies.

Once the gas pipeline is installed adjacent to the existing Alyeska work pad or the Haul Road, its presence will be hardly notice-above. This situation will make the incremental impact extremely small. The overall environmental impact of the compressor stations will be significantly reduced with respect to El Paso's original alignment. The reduction in impact can be attributed to the fewer miles of access roads required by the proposed El Paso realignment when compared with the original alignment.

The net environmental impacts of the proposed El Paso realignment will be less than those of the original alignment. Namely, a lessening of the aesthetic impacts, lesser demand upon water resources, well documented stream crossings, identification of biologically sensitive areas, lessening of potential tundra damage, elimination of two parallel but separate construction zones, and an increased accessibility during operation are all considered advantages of the proposed realignment over the original alignment. The only disadvantages created by the realignment will be the use of an additional 10.6 million cubic yards of gravel and the possibility of potential hydraulic problems associated with fish passage through culverts.

Docket Nos. CP75-96, *et al.*
Exhibit EP-_____(RSM-3)
Witness: R. S. Murphy

APPENDIX A

FISH STREAMS AND CRITICAL PERIODS

The following table lists all streams along the Alyeska pipeline from Valdez to Prudhoe Bay known to contain fish species having recreational or commercial fishery value. The stream names, Alyeska alignment sheet numbers, engineering survey stations, and critical periods were taken from a Joint State/Federal Fish and Wildlife Advisory Team document. The species indicated are those known to inhabit the streams. Observations for many streams are limited, and it is likely that the species lists are somewhat incomplete. The critical periods reflect activities of important species observed in the stream, primarily migration, spawning, and egg incubation. In general, the information is felt to be reasonably accurate. The more important streams have received the greatest amount of investigation. Critical areas, especially overwintering sites, are continuously being identified, however; and the critical periods indicated will require continuous updating.

The limits of the sensitive periods shown in the accompanying tables are fairly broad to account for variability introduced by climatic and other factors. Two periods are shown within each stream - critical and less critical. In general, it is desirable to avoid stream disturbance during either period. If need for construction can be justified, it may be possible to construct with the imposition of certain protective restrictions. Where warranted, on-site monitoring by a regulatory agency to determine status of fish activity may shorten critical periods.

A separate column in the table provides an indication of degree of sensitivity of the identified stream. A mark in this column reflects a judgment that the stream may contain a particularly large, important, or sensitive fish population, and that constraints upon construction activities during critical periods may be more restrictive than in other cases. However, use of special construction procedures and continued monitoring would allow construction on a site specific basis.

Docket Nos. CP75-96, *et al.*
Exhibit EP-______(RSM-3)
Witness: R. S. Murphy

KEY TO SPECIES ABBREVIATIONS

Abbreviation	Common Name	Scientific Name
AC	Arctic Char	*Salvelinus alpinus*
AL	Arctic Lamprey	*Lampetra japonica*
BB	Burbot	*Lota lota*
BL	American Brook Lamprey	*Lampetra lamottei*
BW	Broad Whitefish	*Coregonus nasus*
CA	Arctic Cisco	*Coregonus autumnalis*
CD	Sculpins	Family Cottidae
CN	Slimy Sculpins	*Cottus cognatus*
CS	Least Cisco	*Coregonus sardinella*
DS	Chum (Dog) Salmon	*Oncorhynchus keta*
DV	Dolly Varden	*Salvelinus malma*
GR	Arctic Grayling	*Thymallus arcticus*
HO	Pond Smelt	*Hypomesus olidus*
HW	Humpback Whitefish	*Coregonus pidschian*
KS	Chinook (King)	*Oncorphynchus*
LC	Lake Chub	*Couesius plumbeus*
LS	Longnose Sucker	*Catostomus catostomus*
LT	Lake Trout	*Salvelinus namaycush*
NP	Northern Pike	*Esox lucius*
S9	Ninespine Stickleback	*Pungitius pungitius*
OM	Rainbow Smelt	*Osmerus mordax*
PS	Pink Salmon	*Oncorhynchus gorbusha*
RS	Sockeye (Red) Salmon	*Oncorhynchus nerka*
RW	Round Whitefish	*Prosopium cylindraceum*
IN	Inconnu (Sheefish)	*Stenodus leucichthys*
SB	Sticklebacks	Family Gasterosteidae
SH	Steelhead Trout	*Salmo gairdneri*
SK	Suckers	Family Catostomidae
SS	Coho (Silver) Salmon	*Oncorhynchus kisutch*
WF	Whitefishes	Family Salmonidae

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	1	252+70	Abercrombie Gulch	PS, DS, DV, SS	▲	- -	- -	- -				—	—	—	—	—	- -
	2	275+10	Abercrombie Slough	SS, DS	▲	- -	- -	- -				—	—	—	—	—	- -
		285+57			▲	- -	- -	- -				—	—	—	—	—	- -
		289+28			▲	- -	- -	- -				—	—	—	—	—	- -
		308+18			▲	- -	- -	- -				—	—	—	—	—	- -
		414+17			▲	- -	- -	- -				—	—	—	—	—	- -
		487+32				- -	- -	- -				—	—	- -	- -	- -	- -
		491+33				- -	- -	- -				—	—	- -	- -	- -	- -
		506+06	Canyon Slough Complex	DV, SS	▲	- -	- -	- -				—	—	—	—	—	- -
		527+01		DV, SS	▲	- -	- -	- -				—	—	—	—	—	- -
		537+83	Salmonberry Creek	DV, SS	▲	- -	- -	- -				—	—	—	—	—	- -
		545+15		DV, SS	▲	- -	- -	- -				—	—	—	—	—	- -
	3	577+91 to 603+58	Canyon Slough Complex	PS, SS, RS, DV	▲	- -	- -	- -				—	—	—	—	—	- -
		797+94 to 800+62				- -	- -	- -				—	—	—	—	—	- -

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	3-4	804+20	Clear Stream Area		▲	- -	- -	- -				—	—	—	—	—	- -
		816+66 to 831+00		PS, SS, DV	▲	- -	- -	- -				—	—	—	—	—	- -
	5	1109+00 to 1110+40	Lowe River	PS, SS, DS, DV, RS	▲								—	—	—	—	- -
		1140+66		SS	▲									—	—	—	- -
	7	334+58 to 355+80	(Upper Middle) Tsina River	DV									—	—	—	—	- -
751.0		502+95 to 505+00	(Lower Middle) Tsina River	DV									—	—	—	—	- -
760.6	8	842+38	(Lower) Tsina River	DV									—	—	—	—	- -
	9	863+65 to 868+87	Gravel Pit Pond	DV		- -	- -	- -					—	—	—	—	- -
		875+53	Pond Outlet	DV		- -	- -	- -					—	—	—	—	- -
755.6		1097+77	Stuart Creek	DV										—	—	—	- -
754.2	10	1167+45 to 1168+18	(Lower) Tiekel River	DV, RS SS	▲	- -	- -	- -	- -				—	—	—	—	- -
		1216+00				- -	- -	- -	- -				—	—	—	—	- -

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period – – – Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
750.5		1368+49 to 1369+02	(Lower) Tiekel River	DV		– –	– –	– –	– –				———	———	———	———	– –
	13	86+56	(Upper) Little Tonsina River	KS, GR, DV, SS	▲	– –	– –	– –	– –	– –	———	———	———	———	———	– –	– –
		184+74	(Middle) Little Tonsina River	KS, GR, DV, SS	▲	– –	– –	– –	– –	– –	———	———	———	———	———	– –	
		231+95	Fourth of July Cr.	SS	▲				– –	– –	———	———	———	———	———		
		266+73		KS	▲				– –	– –	———	———	———	———	———		
725.8	15	598+00 to 599+15	Tonsina River	GR, LT, SH, BB, DV, RS, KS, SS	▲				– –	– –	———	———	———	———	———	– –	
		603+70 to 605+20	(Branch) Tonsina River						– –	– –	———	———	———	———	———	– –	
719.3	16	951+38	Squirrel Creek	KS, GR	▲					– –	———	———	———	———	———	– –	
714.4	17	1216+47	Rock Creek	GR						———	———	– –					
709.5		1483+55	Willow Creek	GR						———	———	– –					
700.4	19	501+34 to 502+96	Klutina River	GR, WF, BB, LT, SH, RS, KS, SS, DV	▲				– –	———	———	———	———	———	———	———	

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	J	F	M	A	M	J	J	A	S	O	N	D
689.1	21	1051+99 to 1055+53	Tazlina River	RS, WF, KS, BB, DV, GR, LS, LT	▲				- -	—	—	—	—	—	—	—	- -
		1058+40 to 1100+00	Moose Creek	GR, CD	▲			—	—	—	—	—	—	—			
656.8	26	2794+17 to 2796+75	(Lower) Gulkana River	RS, KS, GR	▲	- -	- -	- -	- -	—	—	—	—	—	—	—	- -
644.9	28	3394+49	Haggard Creek	GR						—	—	- -					
636.6	29	3763+18	Gillespie Creek	GR						—	—	- -					
	30	3790+18	Meier's Creek	GR, KS	▲					—	—	—	—	- -	- -		
		3796+0		GR, KS	▲					—	—	—	—	- -	- -		
		3830+92		GR, KS	▲					—	—	- -					
615.3	33	4943+20 to 4943+45	Fish Creek	RS, GR, CD	▲				- -	—	—	—	—	—	- -		
		4952+46		GR						—	—	- -					
609.6	34	5204+22	Gunn Creek	RS, GR	▲					—	—	—	—	—	- -		
		5244+71	(Upper) Gulkana River	RS, GR, CD	▲	- -	- -	- -	- -	—	—	—	—	—	- -	- -	- -

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		5261+34								—	—	- -					
		5280+37								—	—	- -					
		5281+50								—	—	- -					
	35-36	5550+00 to 5650+36	Phelan Spring		▲					- -	- -	- -	—	—	—	—	
601.8		5551 to 5659+36	Phelan Creek		▲	—	—	—						—	—	—	—
	36A-37	5677+11 to 6002+29	(Upper) Delta River	BB, GR, WF						—	—	- -					
	36A	5916+93 to 5977+11								—	—	- -	—	—	—	—	—
	36A-37	6010+72 to 6016+72	Middle Delta River	WF, GR, BB, NP, SK	▲												
		6029+60 to 6057+51	Middle Delta River	WF, GR, BB, NP, SK	▲												
	38	6351+31 to 6538+78															
		6534+74 to 6472+00								- -	- -	- -	—	—	—		

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	39	6682+00	Rapid Lake	RB													
	40	7066+00								——	——	- -					
533.3	47	9209+98 to 9218+72	Tanana River	GR, WF, BB, KS, SS, DS, IN, NP	▲	- -	- -	- -	- -	——	——	——	——	——	——	——	——
522.1	49	9788+89 to 9789+42	Shaw Creek	GR, WF, BB, SB	▲	- -	- -	- -	- -	——	——	- -		——	——	- -	- -
		9800+35	Rosa Creek							——	——	- -		——	——		
		9854								——	——	- -					
		9861+00 to 9867+50								——	——	- -		——	——		
511.7	51	10210+10	Minton Creek	GR		- -	- -	- -	- -	——	——	——	——	——	——	- -	- -
		10221+20		GR		- -	- -	- -	- -	——	——	——	——	——	——	- -	- -
		10245+00				- -	- -	- -	- -	——	——	——	——	——	——	- -	- -
		10254+90				- -	- -	- -	- -	——	——	——	——	——	——	- -	- -
		10285+00				- -	- -	- -	- -	——	——	——	——	——	——	- -	- -
		10300+21				- -	- -	- -	- -	——	——	——	——	——	——	- -	- -

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		10347+40				- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
		10362+59				- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
		10378+50 to 10393+35															
		10388+15				- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
		10487+25	Gold Run Creek			- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
501.7	53	10855+33	Redmond Creek	KS, DS, GR, WF, CD	▲	- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
497.8	53A	19+00 to 20+65	Salcha River	WF, BB, NP, SB, KS, DS, SS, GR	▲	- -	- -	- -	- -	—	—	—	—	—	—	—	- -
	54	219+0		GR						—	—	- -					
492.3		281+71 to 281+94	Little Salcha River	GR, WF, KS, DS	▲	- -	- -	- -	- -	—	—	—	—	—	—	—	- -
		342+95	(Trib.) Little Salcha River	GR						—	—	- -					
	55	545+10				- -	- -	- -	- -	—	—	- -		—	—	- -	- -
		558+65				- -	- -	- -	- -	—	—	- -		—	—	- -	- -

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▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
		568+75				- -	- -	- -	- -	———	———	-		———	———	- -	- -
		591+55	Million Dollar Cr.			- -	- -	- -	- -	———	———	-		———	———	- -	- -
		592+22															
485.4		643+55	French Creek	GR, WF, BB		- -	- -	- -	- -	———	———	-		———	———	- -	- -
	56	809+56				- -	- -	- -	- -	———	———	-		———	———	- -	- -
		942+85	French Creek			- -	- -	- -	- -	———	———	-		———	———	- -	- -
		993+69				- -	- -	- -	- -	———	———	-		———	———	- -	- -
		1018+95				- -	- -	- -	- -	———	———	-		———	———	- -	- -
		1035+43				- -	- -	- -	- -	———	———	-		———	———	- -	- -
	57	1125+18	French Creek			- -	- -	- -	- -	———	———	-		———	———	- -	- -
475.1		1188+02	Moose Creek	GR, WF, NP		- -	- -	- -	- -	———	———	-		———	———	- -	- -
		1250+46 to 1250+95				- -	- -	- -	- -	———	———	-		———	———	- -	- -
		1320+26 to 1321+62				- -	- -	- -	- -	———	———	-		———	———	- -	- -

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▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	58	1579+61 to 1581+14				- -	- -	- -	- -	——	——	—		——	——	- -	- -
		1588+24 to 1589+46				- -	- -	- -	- -	——	——	—		——	——	- -	- -
		1592+43 to 1593+57				- -	- -	- -	- -	——	——	—		——	——	- -	- -
	59	1720+18		GR						——	——	—					
		1730+50 to 1732+89								——	——	—					
		1845+55								——	——	—					
461.6		1849+50 to 1853+06	Chena River	RW, LS, CN, GR, BW, BL, NS, HW, CS, KS, DS, NP, BB, SS, IN	▲	- -	- -	- -	- -	——	——	——	——	——	——	——	- -
451.6	61	336+01	Gold Stream Creek	CS, HW, BB, NP, AB, GR, IN	▲					——	——	—					

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▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
445.7	62	659+43	Treasure Creek	GR						—	—	—					
442.0	63	873+63 to 874+80	Chatanika River	LS, CS, CD, GR, BB, CA, HW, RW, KS, SS, DS, IN, NP	▲	- -	- -	- -	- -	—	—	—	—	—	—	- -	- -
		914+00	Shocker Creek							—	—	—					
435.5	64	1209+62	Washington Creek	GR, WF, NP						—	—	—					
	65	1595+22		GR						—	—	—					
427.3		1635+99	Aggie Creek	GR						—	—	—					
	66	1759+94 to 1768+66								—	—	—					
421.4		1966+77	Globe Creek	GR						—	—	—					
	67	2166+87		GR						—	—	—					
		2196+28								—	—	—					
416.6		2241+22 to 2242+57	Tatalina River	IN, CI, GR, NP, WF, BB	▲	- -	- -	- -	- -	—	—	—			- -	- -	- -

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▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	68	2456+31		GR						———	———	- -					
412.6		2459+42	Slate Creek	GR						———	———	- -					
409.7		2609+50	Wilber Creek	GR						———	———	- -					
403.0	70	2957+57 to 2958+13	Tolovana River	NP, BB, CI, CS, LW, AB, KS, DS, IN, GR, WF	▲	- -	- -	- -	- -	———	———	———	———	———	———	- -	- -
396.4	71	104+33	Lost Creek	GR, WF		- -	- -	- -		———	———	- -		———	———	- -	- -
389.0	72	336+15	Erickson Creek							———	———	- -					
		513+62	Erickson Creek	GR, LS						———	———	- -					
	73	611+95	Erickson Creek	GR, LS						———	———	- -					
383.0		819+31 to 820+49	Hess Creek	CD, RW, BW, HW, CS, BC, IN, NP, GR, LS	▲				———	———	———	- -					
		829+56	Fish Creek	GR						———	———	- -					
	75	1242+46	Hot Cat Creek	GR						———	———	- -					

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▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
367.0	76	1642+39 to 1651+65	Isom Creek	GR						—	—	- -					
357.4	78	60+00 to 78+97	Yukon River	PS, RS, HO, OM, AL, BL, LS, CN, CA, HW, RN, BB, NP, TP, LC, BW, CS, IN, WF, GR, KS, DS, SS	▲	- -	- -	- -	- -	—	—	—	—	—	—	—	- -
		158+21								—	—	- -					
		215+81		GR					—	—	—	- -					
	79	508+20							—	—	—	- -					
	80	899+00		GR					—	—	—	- -					
	81	971+29 to 971+39	Hamlin Hill Creek	GR					—	—	—	- -					
	82	58+00	North Fork Ray River	LS, CD, LC, IN, NP, RW, GR, BB	▲				—	—	—	- -					

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▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J F M A M J J A S O N D
		270+10				
324.1	84	673+00	S. Fork of W. Fork Dall River	BW, CS, BC, IN, GR, NP, HW	△	
321.6		798+00	M. Fork of W. Fork Dall River	IN, GR, WF	△	
		961+80				
315.0	85	1149+39	Olsen Lake Creek	GR		
	86	56+03	Caribou Mountain Creek	GR		
309.0		230+76 to 231+50	Kanuti River	NP, CD, BB, DS, GR, RW	△	
	87	232+50	Netsch's Creek	GR		
		349+10				
		370+50				
		520+60	South Fork Fish Cr.	GR, CD		
		578+00				

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▲ Denotes Highly Sensitive —— Denotes Critical Period ---- Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
301.2	88	653+13	Fish Creek	GR, RW, SK, CD					——	——	——	—					
		742+18	Alder Mountain Cr.	GR					——	——	——	—					
	89	932+10	Pung's Crossing Cr.						——	——	——	—					
292.0		1123+60	S. Fork Bonanza Creek	GR, RW, NP, LS, CN	▲	——	——	——	——	——	——	—		——	——	——	——
		1151+75							——	——	——	—					
290.2		1208+32	N. Fork Bonanza Creek	GR, RW, CD, LS	▲				——	——	——	—		——	——	----	----
	90	1327+40	S. Fk. Gobbler's Knob Creek	GR					——	——	——	—					
		1340+00	Gobbler's Knob Cr.						——	——	——	—					
		1345+40	N. Fk. Gobbler's Knob Creek	GR					——	——	——	—					
283.0	91	1590+00	Prospect Creek	RW, CN, GR, KS	▲	----	----	----	——	——	——	——	——	——	——	----	----
		210+85							——	——	——	—					
277.1		254+56	Jim River	DS, KS, GR, RW, DS, CD	▲	——	——	——	——	——	——	——	——	——	——	——	——

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
276.8	92	270+51	Jim River	DS, KS, GR, RW, DS, CD	▲	—	—	—	—	—	—	—	—	—	—	—	—
		272+49							—	—	—	- -					
		333+75	Douglas Creek	GR, CD					—	—	—	- -					
		406+86		GR, CD					—	—	—	- -					
274.0		453+30 to 453+88	Jim River	DS, KS, GR, RW, DS, CD	▲	—	—	—	—	—	—	—	—	—	—	—	—
	93	833+40		GR, CD					—	—	—	- -					
	94	963+13		GR, CD					—	—	—	- -					
261.7	95	1069+68 to 1075+15	S. Fork Koyukuk River	SK, CD, GR, KS, DS, HW	▲	- -	- -	- -	—	—	—	—	—	—	—	- -	- -
	96	295+17	S. Rosie Pass Cr.	NP, CD					—	—	—	- -					
253.3		418+00	N. Fork Windy Arm	GR					—	—	—	- -					
		458+88							—	—	—	- -					
		518+39							—	—	—	- -					
		525+30															

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	97	554+00 to 561+00	Jackson Slough						—	—	—	-					
		570+78							—	—	—	-					
		622+32 to 632+50	Middle Fork Koyukuk River	LS, RW, KS, DS, CD, GR, DV, NP					—	—	—	-					
247.9		684+00	Rosie Creek	GR, CD					—	—	—	-					
		760+00	Coldfoot Slough						—	—	—	-					
		805+20							—	—	—	-					
		810+00							—	—	—	-					
		827+37							—	—	—	-					
		835+52							—	—	—	-					
		818+20							—	—	—	-					
		842+00							—	—	—	-					
	98	864+72							—	—	—	-					
		888+00							—	—	—	-					
		966+40							—	—	—	-					

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▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	J	F	M	A	M	J	J	A	S	O	N	D
						PERIODS OF SENSITIVITY (see code)											
242.8		976+83	Slate Creek	GR, DV	▲	- -	- -	- -	—	—	—	—	—	—	—	- -	- -
		1004+86		GR, CD					—	—	—	—					
		1015+62							—	—	—	—					
		1020+54		GR					—	—	—	—					
241.4		1033+06	Clara Creek						—	—	—	—					
		1051+75							—	—	—	—					
		1057+00							—	—	—	—					
		1079+50							—	—	—	—					
		8+47							—	—	—	—					
		1087+00 to 1089+00							—	—	—	—					
	99	45+43							—	—	—	—					
238.1		59+85 to 61+85	Marion Creek	GR, DV, CN	▲	- -	- -	- -	—	—	—	—		—	—	- -	- -
		85+66		GR					—	—	—	—					
	100	392+00							—	—	—	—					
		398+00							—	—	—	—					

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
230.6		456+95	Minnie Creek	GR, CD, BB	△	- -	- -	- -	—	—	—	- -					
		516+95 to 520+34	M. Fk. Koyukuk	LS, RW, KS, DS, CD, GR, DV, NP	△	- -	- -	- -	—	—	—	—	—	—	—	- -	- -
		523+33							—	—	—	- -					
	101	635+50	Hammond River	GR, WF	△				—	—	—	—	—	—	—	- -	- -
		651+50	(Upper) M. Fork Koyukuk River	DV, CS, CD, GR, RW, LS	△				—	—	—	- -	—	—	—	- -	- -
		664+00	One-O-One Creek						—	—	—	- -					
		777+00							—	—	—	- -					
		780+87							—	—	—	- -					
		796+36	Rainbow Creek	GR					—	—	—	- -					
224.0		802+62 to 803+62	Over Creek						—	—	—	- -					
		886+52	Nugget Creek						—	—	—	- -					
	102	906+78	Wolf Pup Creek						—	—	—	- -					

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
221.8		933+01	Sheep Creek						—	—	—	-					
		948+66		GR					—	—	—	-					
221.0		976+00	Gold Creek	GR, CD					—	—	—	-					
220.4		1001+18	Linda Creek	CD					—	—	—	-					
		1133+00							—	—	—	-					
	103	1207+63 to 1237+55	Upper M. Fork Koyukuk River	LS, RW, KS, DS, CD, GR, DV, NP	▲				—	—	—	-					
215.3		1276+77	Sukakpak Creek	GR					—	—	—	-					
		1250+00							—	—	—	-					
		1258+35							—	—	—	-					
		1268+96							—	—	—	-					
		1305+12 to 1305+90	Pamplin Pot Holes	GR					—	—	—	-					
		1351+50							—	—	—	-					
		1361+45 to 1384+47	M. Fork Koyukuk River		▲				—	—	—	-	—	—	—	- -	- -

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		1412+00							—	—	—	–					
		1420+00							—	—	—	–					
		1450+60							—	—	—	–					
	104	1526+55 to 1533+95	Lower Dietrich River	GR, RW, DV, LS, CN	△					—	—	–	–	—	—	–	–
		1579+18 to 1581+65	Wiehl Mountain Creek	GR						—	—	–					
		1602+80		GR						—	—	–	–	—	—	–	–
		1608+00								—	—	–					
		1637+81		GR						—	—	–					
		1756+00 to 1792+00															
203.9	105	1869+54	Snowden Creek	GR, CD						—	—	–					
		1906+65	Snowden Pond	GR						—	—	–					
		1940+81	Number Lakes Creek	GR, CD						—	—	–					
		1947+76		GR, CD						—	—	–					

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						J	F	M	A	M	J	J	A	S	O	N	D
		1952+70		LS, RW, GR						—	—	--	--	—	—	--	--
		2011+00								—	—	--	--	—	—	--	--
		2011+33 to 2108+00															
	106	72+43								—	—	--	--	—	—	--	--
		2164+67 to 2167+22	Dietrich River	GR, RW, DV, BB, CD, LS, CN	▲	—	—	—	—	—	—	--	--	—	—	—	—
		2182+00 to 2195+05	Dietrich River	GR, RW, DV, BB, CD, LS, CN	▲	—	—	—	—	—	—	--	--	—	—	—	—
	107	236+38 to 295+10	M. Dietrich River	GR, RW, DV, BB, CD, LS, CN	▲					—	—	--	--	—	—	--	--
190.0		375+54	Nutirwik Creek	GR						—	—	--					
		379+39 to 457+37	M. Dietrich River	GR, DV, BB, CD, RW	▲					—	—	--	--	—	—	--	--

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	108	500+36 to 513+95	Dietrich River	GR, DV, CD, BB, RW	▲					——	——	- -	- -	——	——	- -	- -
		525+75 to 556+00								——	——	- -	- -	——	——	- -	- -
		574+16 to 602+46								——	——	- -	- -	——	——	- -	- -
		609+06 to 617+00	Dietrich River		▲												
		621+69 to 626+00								——	——	- -	- -	——	——	- -	- -
		663+02								——	——	- -					
		714+42 to 753+00			▲					——	——	- -	- -	——	——	- -	- -
		753+00 to 761+14								——	——	- -	- -	——	——	- -	- -
		767+68 to 771+50								——	——	- -	- -	——	——	- -	- -

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		797+80															
	109	832+56		GR						——	——	- -					
181.6		840+52 to 841+65		GR, DV						——	——	- -	- -	——	——	- -	- -
179.4		945+23 to 957+00	W. Fork N. Fork Chandalar River	GR, CD, NP, CI, HW	▲					——	——	- -		——	——		
178.3		1003+18 to 1005+98	W. Fork N. Fork Chandalar River	GR, CD, NP, CI, HW	▲					——	——	- -	- -	——	——		
177.8		1030+40 to 1096+55	W. Fork N. Fork Chandalar River	GR, CD, NP, CI, HW	▲					——	——	- -	- -	——	——		
		1046+14		GR, CD, NP, CI, HW						——	——	- -	- -	——	——		
175.0	110	58+00 to 79+00	W. Fork N. Fork Chandalar River	GR, CD, NP, CI, HW	▲					——	——	- -	- -	——	——		

PERIODS OF SENSITIVITY (see code)

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EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		270+00 to 340+00	Atigun River		▲					——	——	——	——	——	-		
	111	347+50 to 350+00	Atigun River	AC, CD, LT, GR, BB, RW	▲					——	——	——	——	——	-		
		368+00 to 383+30								——	——	——	——	——	-		
		383+30 to 409+25								——	——	——	——	——	-		
		409+25 to 428+42								——	——	——	——	——	-		
		428+42 to 666+00	Atigun River														
		666+00 to 703+60	Atigun River														
		768+30								——	——	-	——	——	-		
	112	860+00								——	——	-	——	——	-		
		879+00								——	——	-	——	——	-		
		882+00								——	——	-	——	——	-		

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	J	F	M	A	M	J	J	A	S	O	N	D
	113	1168+75	Roche Mountonnee Creek	GR, WF LT	▲					—	—	- -	—	—	- -		
		1227+00								—	—	- -	—	—	- -		
	114	29+85		GR						—	—	- -	—	—	- -		
		36+77								—	—	- -	—	—	- -		
		38+72								—	—	- -	—	—	- -		
		48+78								—	—	- -	—	—	- -		
150.4		130+60	Tea Lake Inlet							—	—	—	—	—	—	- -	- -
		153+43								—	—	- -	—	—	—		
		155+29		LT, GR, RW						—	—	- -	—	—	—		
148.3		20+94	Atigun River	AC, CD, LT, GR, BB, RW	▲					—	—	—	—	—	- -	- -	- -
	115	393+10								—	—	- -	—	—	- -		
		394+50								—	—	- -	—	—	- -		
		420+65								—	—	- -	—	—	- -		

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		438+29								—	—	-	—	—	-		
		462+30								—	—	-	—	—	-		
		494+0								—	—	-	—	—	-		
	116	720+60								—	—	-	—	—	-		
		799+82								—	—	-	—	—	-		
		804+36								—	—	-	—	—	-		
132.3	117	842+00	Kuparuk River	GR	▲					—	—	—	—	—	—		
		921+30								—	—	—	—	—	—		
		968+30	Toolik River	GR, AC	▲					—	—	—	—	—	—		
		973+00								—	—	-					
		1037+10								—	—	-					
	118	1323+71	Oksrukuyik River	AC, GR, CD	▲					—	—	—	—	—	—		
	119	1513+06								—	—	-					
	120	895+76	Lower Oksrukuyik River	AC, GR, CD	▲					—	—	—	—	—			
		947+99								—	—	-					

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	121	1029+20								—	—	- -					
		1033+60								—	—	- -					
		1060+34								—	—	- -					
		1076+38								—	—	- -					
		1125+03	Polygon Creek							—	—	- -	—	—	- -		
	122	1280+00								—	—	—	—	—	- -		
		1296+93								—	—	—	—	—	- -		
		1424+79								—	—	- -					
		1445+85								—	—	- -					
	123	1722+00								—	—	- -					
		20+12								—	—	—	—	—	- -		
		58+15 to 82+26	Sag River	CS, BB, BW, HW, S9, AC, GR, RW, CD, PS, DS, CA	▲	- -	- -	- -	- -	—	—	- -	—	—	—	- -	- -
	124	236+18 to 383+00	Sag River		▲												
		240+00								—	—	- -					

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code)											
						J	F	M	A	M	J	J	A	S	O	N	D
	125	446+59 to 479+77	Sag River		▲	-	-	-	-	—	—	-	—	—	—	-	- -
		470+00 to 488+00								—	—	-					
		493+45								—	—	-					
		666+0								—	—	-					
		696+0								—	—	-					
	126	733+00 to 734+50								—	—	-					
		746+50 to 748+00								—	—	-					
		788+00 to 792+00								—	—	-					
		897+87 to 933+28	Sag River		▲	-	-	-	-	—	—	-	—	—	—	-	- -
	127	1143+83 to 1197+12	Sag River		▲	-	-	-	-	—	—	-	—	—	—	-	- -

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	129	266+00								—	—	-					
		322+25								—	—	-					
		396+00								—	—	-					
		414+20								—	—	-					
		430+00								—	—	-					
		491+50								—	—	-					
		500+25								—	—	-					
		525+10 to 557+50	Sag River		▲												
		531+00								—	—	-					
	130	826+50								—	—	-					
		831+00								—	—	-					
		872+00								—	—	-					
		893+50								—	—	-					
		905+50								—	—	-					
		937+70								—	—	-					

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
		957+00								———	———	—					
		1045+00								———	———	—					
		1077+00								———	———	—					
	131	1076+10 to 1106+70	Sag River														
	132	4800+00								———	———	—					
		4822+31 to 4827+89	Sag River														
		4829+00								———	———	—					
		4951+44 to 4972+20	Sag River														
	133	4932+20 to 5103+20	Sag River														
		5210+93 to 5251+61	Sag River														
	134	5295+23	Sag River														
		5396+10 to 5479+00	Sag River														

STREAM SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period - - - - Denotes Less Critical Period

EP Alaska Milepost	Alyeska Alignment Sheet No.	Station No.	Stream Name	Identified Species	Highly Sensitive	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	137	1478+52								———	———	—					
		1541+70 to 1550+00	Sag River							———	———	—					

APPENDIX B

SENSITIVE WILDLIFE AREAS

The following table lists, by El Paso milepost, sensitive wildlife areas along the Alyeska pipeline route. Species factors and periods of sensitivity are indicated. The information sources are working documents compiled by the Joint State/Federal Fish and Wildlife Advisory Team, illustrating wildlife status along the pipeline, and critical seasons for each species.

A separate column in the table provides an indication of degree of sensitivity of the identified factor at the given location. A mark in this column reflects a judgment that the factor may be highly sensitive, and that restrictions upon construction during the critical period could be imposed by regulatory agencies. Constraints will depend upon status of the factor at the time of construction, for example, whether or not a falcon nest is occupied in that year. In the remaining cases, constraints could be less restrictive.

Specific restrictions for construction activities related to each sensitive species have been developed in connection with the Alyeska pipeline project by regulatory agencies. These restrictions are included among the stipulations attached to construction permits issued to Alyeska. General types of restrictions are listed below:

Raptors (bald and golden eagles, peregrine falcons, gyrfalcons, goshawks, and rough-legged hawks)

Ground and low level aerial activities may be subject to restriction during the nesting period (early April to mid-August) and during the salmon spawning seasons. A buffer zone of undisturbed vegetation may be required around each nest tree. For bald eagles, if a nest tree must be removed to accommodate planned development, a special permit must first be obtained. Peregrine falcons are especially sensitive and are the only animal currently considered an endangered species in Alaska.

Waterfowl

Discretionary ground and aerial activities are indicated from as soon as margins of water bodies are free of ice through late July.

Black and Grizzly Bears

Bears are readily attracted when improper garbage disposal practices are used. Once attracted, they may become a hazard to men and equipment. This problem is effectively relieved by eliminating all refuse containers, garbage pits, or other human food sources that are accessible to bears. If a bear must be killed in defense of life or property, proper reporting of the incident must be made to the Alaska Department of Fish and Game.

Moose

Moose may be actively moving at any season of the year, location restrictions may include limiting the amount of open ditch ahead and behind pipelaying activities, and other measures to allow free movement of animals.

Caribou

Caribou undergo regular and essential seasonal migrations. Ground and low-level aerial activities should be kept to a minimum during migration periods. Free movement and passage of caribou must be assured.

Bison

Spring and fall migrations associated with calving take place from mid-March to mid-October. Bison are susceptible to falling in open trenches, and amounts of open ditch ahead of and behind pipelaying activities may be limited. Bison may be aggressive to men or moving equipment. Appropriate warning should be issued to workers in area while bison are present. During the calving period (15 April to 15 June) ground and aerial activities shall be conducted so as to assure no harm or harassment.

Dall Sheep

Lambing areas are highly sensitive to disturbance. Lambing generally occurs above 2,500-foot elevation from early May to mid-June. Lambs are vulnerable to injury when sheep are panicked in rough terrain by low-flying aircraft, particularly helicopters. Ground and aerial activities during this period may be subject to restrictions so as to assure no harm or harassment.

WILDLIFE SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period

EP Alaska Milepost	Alyeska Milepost	Species Factor	Degree of Sensitivity	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
	780-792	Bald Eagle Concentration	▲			—	—	—	—	—	—				
	792	Eagle Nest Site	▲				—	—	—	—	—				
766-768	765-767	Eagle Nest Site	▲				—	—	—	—	—				
762-764	761-763	Eagle Nest Site	▲				—	—	—	—	—				
694-734	693-733	High Moose Density													
727-731	726-730	Eagle Nest Site	▲				—	—	—	—	—				
724-728	723-727	Waterfowl Nesting Area	▲					—	—	—					
714-718	713-717	Sheep Lambing	▲					—	—						
715-717	714-716	Raptor Nest Site					—	—	—	—	—				
711-714	710-713	Waterfowl Nesting Area	▲					—	—	—					
704-708	703-707	Waterfowl Nesting Area	▲					—	—	—					
632-679	631-678	Waterfowl Nesting Area	▲					—	—	—					
602-678	600-676	Caribou Migration Zone		—		—	—	—					—	—	—
602-678	600-676	Moose Movement Zone					—	—	—	—		—	—		
627-654	626-653	Caribou Migration Zone	▲	—		—	—	—					—	—	—
614-619	613-618	Waterfowl Nesting Area	▲					—	—	—					

WILDLIFE SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period

EP Alaska Milepost	Alyeska Milepost	Species Factor	Degree of Sensitivity	PERIODS OF SENSITIVITY (see code)											
				J	F	M	A	M	J	J	A	S	O	N	D
609-618	608-617	Grizzly Concentration	▲												
609-610	608-609	Waterfowl Nesting Area	▲					—	—	—					
590-592	587-589	Eagle Nest Site	▲				—	—	—	—	—				
571-588	568-585	Sheep Lambing	▲					—	—						
579-581	576-578	Eagle Nest Site	▲				—	—	—	—	—				
548-578	545-575	Bison Calving	▲				—	—	—						
543-565	540-562	Bison Migration Zone				—	—			—	—	—	—		
530-532	526-528	Raptor Nest Site	▲				—	—	—	—	—				
515-532	511-528	High Moose Density					—	—	—	—		—	—		
518-530	514-526	Waterfowl Nesting Area	▲					—	—	—					
487-518	483-514	Caribou Habitat						—	—	—					
485-488	490-493	Raptor Nest Site	▲				—	—	—	—	—				
458-476	453-471	Moose Movement Zone		—	—	—	—	—	—	—	—	—	—	—	—
460-465	455-460	Waterfowl Nesting Area						—	—	—					
440-442	433-436	Waterfowl Nesting Area	▲					—	—	—					
419-423	413-415	Eagle Nest Site	▲				—	—	—	—	—				

WILDLIFE SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period

EP Alaska Milepost	Alyeska Milepost	Species Factor	Degree of Sensitivity	PERIODS OF SENSITIVITY (see code)											
				J	F	M	A	M	J	J	A	S	O	N	D
414-419	407-413	Waterfowl Nesting Area						—	—	—					
414-419	407-413	High Moose Density					—	—	—	—		—	—		
403-405	396-398	Waterfowl Nesting Area						—	—	—					
401-403	394-396	High Moose Density					—	—	—	—		—	—		
380-382	374-376	Waterfowl Nesting Area	▲					—	—	—					
313-374	305-367	Eagle Nest Site					—	—	—	—	—				
359-361	352-354	Raptor Nest Site	▲				—	—	—	—	—				
342-357	333-349	Waterfowl Nesting Area						—	—	—					
339-342	330-333	Waterfowl Nesting Area	▲					—	—	—					
308-313	300-305	Waterfowl Nesting Area						—	—	—					
307-308	299-300	Waterfowl Nesting Area	▲					—	—	—					
263-268	258-273	Waterfowl Nesting Area	▲					—	—	—					
258-260	251-253	Raptor Nest Sites													
250-258	243-251	Raptor Nest Sites	▲					—	—	—					
147-247	140-240	Caribou Migration Zone	▲			—	—				—	—	—	—	
234-236	227-229	Eagle Nest Sites	▲				—	—	—	—	—				

WILDLIFE SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive —— Denotes Critical Period

EP Alaska Milepost	Alyeska Milepost	Species Factor	Degree of Sensitivity	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
221-223	214-216	Eagle Nest Sites	▲				—	—	—	—	—				
215-217	208-210	Eagle Nest Sites	▲				—	—	—	—	—				
212-214	205-207	Eagle Nest Sites	▲				—	—	—	—	—				
206-213	199-206	Sheep Lambing	▲					—	—						
207-211	200-204	Eagle Nest Sites					—	—	—	—	—				
175-210	168-203	Sheep Movement Zone		—	—	—	—	—	—	—	—	—	—	—	—
192-204	185-197	Sheep Lambing	▲					—	—						
193-203	187-196	Eagle Nest Sites	▲				—	—	—	—	—				
186-190	179-183	Sheep Lambing	▲					—	—						
180-188	173-181	Eagle Nesting	▲				—	—	—	—	—				
176-183	169-176	Sheep Lambing	▲					—	—						
170-172	163-165	Sheep Movement Zone		—	—	—	—	—	—	—	—	—	—	—	—
154-163	147-156	Eagle Nest Sites					—	—	—	—	—				
144-149	137-142	Raptor Nest Sites					—	—	—	—	—				
146	140	Wolf Den													
142-145	135-138	Sheep Lambing Area	▲				—	—							

WILDLIFE SENSITIVITY INDEX - TRANS ALASKA PIPELINE ROUTE

▲ Denotes Highly Sensitive ——— Denotes Critical Period

EP Alaska Milepost	Alyeska Milepost	Species Factor	Degree of Sensitivity	PERIODS OF SENSITIVITY (see code) J	F	M	A	M	J	J	A	S	O	N	D
119-122	112-115	Raptor Nest Sites					—	—	—	—	—				
118-120	111-113	Sheep Lambing Area	▲				—	—							
82-116	77-112	Winter Moose Concentration													
94-98	89-93	Raptor Nest Sites	▲				—	—	—	—	—				
88-90	83-85	Raptor Nest Sites	▲				—	—	—	—	—				
84-85	79-80	Raptor Nest Sites	▲				—	—	—	—	—				
78-80	73-75	Raptor Nest Sites	▲				—	—	—	—	—				
66-72	61-67	Raptor Nest Sites	▲				—	—	—	—	—				
64-66	59-61	Raptor Nest Sites	▲				—	—	—	—	—				
61-63	56-58	Raptor Nest Sites	▲				—	—	—	—	—				
5-64	0-59	Waterfowl Nesting Area	▲					—	—	—					
23-40	18-35	Raptor Nest Sites	▲				—	—	—	—	—				