# GEOTECHNICAL EVALUATION

POINTED MOUNTAIN GAS GATHERING SYSTEM
PIPELINE ROUTE FROM WELL A-1 TO LAKE BOTTOM AREA

PRELIMINARY GRADING, STABILIZATION AND RESTORATION PLANS

SUBMITTED TO

AMOCO CANADA PETROLEUM COMPANY LIMITED

BY



ELMER W BROOKER & ASSOCIATES LTD.

REFERENCE IS MADE TO THE ATTACHED "PRELIMINARY GRADING, STABILIZATION AND RESTORATION PLANS" REPORT IN WHICH THE AMOCO POINTED MOUNTAIN P-53 AND K-45 WELLS ARE REFERRED TO UNDER THE AMOCO DESIGNATION OF A-1 AND A-2 RESPECTIVELY.

THE ASSOCIATION OF
PROFESSIONAL ENGINEERS
OF ALBERTA
PERMIT NUMBER
P245
ELMER W. BROOKER
& ASSOCIATES LTD.

# POINTED MOUNTAIN GAS GATHERING SYSTEM

## PRELIMINARY GRADING, STABILIZATION AND RESTORATION PLANS

for

## PIPELINE ROUTE FROM WELL A-1 TO LAKE BOTTOM AREA

Submitted To:

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MAY 1972

E.W. Brooker & Associates Ltd.

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# 1. INTRODUCTION

Amoco Canada Petroleum Company Limited is undertaking construction of processing and gas gathering facilities in the Pointed Mountain area of the Northwest Territories. The gas processing plant is being constructed a short distance to the north of Fisherman Lake and the gas gathering system will extend,to the plant site, from gas wells lying to the north and west of the lake. Present construction on the gas gathering system has been confined to construction of pipelines from Wells A-1 and A-2, to the plant site.

In response to concern that detrimental effects may be imposed on the local environment by construction of the gas gathering system, construction activities by Amoco, to date, have been carried out so as to disturb the local environment to the least degree. In addition, engineering and related studies have been initiated to assess the stability of portions of the gas gathering system. One of the studies was carried out to assess the slope stability conditions along a major portion of the proposed pipeline route from Well A-1 to the plant site. This geotechnical study, undertaken by E. W. Brooker & Associates Ltd., was reported in March 1972, in a report titled, 'Slope Stability Study, Pointed Mountain Gathering System, Pointed Mountain, Northwest Territories.' Another study, undertaken independently by F. F. Slaney & Company Limited, was carried out on the environmental effects of the gas gathering system. This report was presented in January 1972, to the Northern Economic Development Branch, Department of Indian Affairs and Northern Development.

This report has been based on the findings, concerning slope stability and environmental effects, presented in the aforementioned reports. Reported herein are proposed preliminary plans for construction of a pipeline along the proposed right of way from Well A-1 to the old lake bottom area. Included in the plans are preliminary details concerning grading, stabilization, and restoration of conditions on the pipeline right of way during and subsequent to construction of the pipeline. In preparation of the preliminary plans, prime consideration has been given to minimizing disturbance to the local environment.

Contributions to this report, relating to pipelining and construction method, have been made by personnel from Amoco Canada Petroleum Company and Square M Construction Limited. Input regarding biological restoration measures has been provided by Dr. R. Wein, Department of Botany, University of Alberta.

## II. PROPOSED PIPELINE ROUTE LOCATION & TOPOGRAPHY

The proposed section of pipeline, discussed in this report, extends from Well A-1 (Chainage 0 + 00), on Pointed Mountain, to the old lake bottom area (approximately Chainage 146 + 00). Alignment of the pipeline right of way is as shown on Drawings No. A-1A and A-1B, Appendix A. These drawings, which have been reproduced from the previous slope stability report (Brooker 1972), also show the anchor and expansion loop locations, the subsurface soils conditions, and comments pertinent to slope stability along the pipeline route.

The pipeline route is presently cleared to a width of approximately 120 feet along the alignment shown on the drawing; and although rerouting of the upper section (Chainage 0 + 00 to Chainage 32 + 00) is still being considered, the plans presented herein are based on the existing alignment. The topography and vegetation along the pipeline route is characteristically alpine to sub-alpine. Well A-1 exists at an approximate elevation of 3880 feet and the old lake bottom area is at an approximate elevation of 1100 feet. The average slope gradient of the route is approximately 20 percent, with localized gradients along the route ranging from about 10 percent to 70 percent. The majority of the area which the pipeline route traverses is within an alpine drainage basin. Tree growth is sparse along the upper reaches of the line, but becomes heavier as the slope is descended. Discussions of and/or recommendations pertinent to vegetation types, soil conditions and stability conditions along the route have been presented previously (Slaney 1972, Brooker 1972).

## III. CONSTRUCTION AND OPERATIONAL ASPECTS OF THE PIPELINE

The gas gathering line will be constructed predominantly of 10 inch pipe with a wall thickness of 0.344 inches. A 2 inch fuel gas line (wall thickness 0.154 inches) will be placed 24 inches above the gas gathering line. Expansion loops will be incorporated in the gas gathering line at distances ranging from 390 to 820 feet. The loops will extend from 35 to 50 feet perpendicularly from the line, will be located almost entirely on the upslope side of the line (left side of line as the mountain slope is descended), and will be housed in 60 inch culvert half-sections. Conventional concrete anchor blocks will be provided at distances ranging from 438 to 813 feet and will be located between the expansion loops. Location of expansion loops and anchor points has been based on physical and operating characteristics of the pipeline, as well as existing soil and slope conditions. The locations of anchors and expansion loops are shown on Drawings A-1A, A-1B, A-2A and A-2B, Appendix A. Some minor revision of location and orientation of loops and anchors will be required as dictated by existing field conditions.

The gas gathering line, fuel line, expansion loops and anchor blocks will be buried along the entire length of right of way from Well A-1 to the old lake bottom area, where it will be tied into the presently existing above grade line. Burial of the gas gathering line will consist of a minimum of 4 feet of cover (local fill material), which will be obtained from the ditch trenching or other suitable fill material existing on the right of way. The gas gathering line, expansion loops and anchor blocks will be placed in excavations in undisturbed soil; except where local conditions dictate otherwise, wherein quality controlled fills will be provided. Grading of the pipeline will be entirely downgrade with no local sags contemplated through slight upgrade sections. Consequently, deep trenching and/or grading along the route will be carried out to meet this requirement. The majority of construction activity and movement of construction equipment will be confined to the right hand side of the pipeline, as the slope is descended from Well Site A-1. Location of the pipeline within the right of way will not be fixed and will be allowed to vary to take advantage of existing terrain conditions. However, the pipeline will generally be located near the center of the right of way.

Gas temperatures at the wellhead are understood to be about 220 degrees Fahrenheit and will drop to about 170 degrees Fahrenheit by the time the gas reaches the lake bottom area. Insulation and armoring of the gas gathering line will be provided.

More detailed and specific information concerning construction details are presented in the following sections.

## IV. EARTHWORK AND CONSTRUCTION PLANS

During the course of construction of the gas gathering line, a considerable quantity of earthwork will be required in the form of right of way preparation, trenching and backfilling of pipeline excavations, and regrading of right of way. The amount and extent of each of these items that will be required will depend on the slope conditions in any particular section of right of way. Drawings No. A-2A and A-2B, Appendix A, show the existing centerline ground surface profile and proposed pipeline profile along the entire right of way section. Also shown on the drawings are existing cross-slope gradients along the route and areas in which special or extra grading provisions will be required. In those areas requiring additional grading provisions, such as permanent cut and fill sections, details are shown on the drawings. Typical grading plans for other sections have been developed and are discussed in the following sections.

## 4.1 Typical Downslope Sections With Cross-Slopes of Less Than 10 Percent

Substantial sections of the pipeline route consist of areas in which cross-slopes of less than 10 percent are prevalent. These areas are approximately as shown on Drawings A-2A and A-2B, Appendix A. Grade preparation, pipeline installation, and regrading plans are shown on Drawing No. A-3, Appendix A.

Figure (1), Drawing No. A-3, shows a three step approach to preparation of the grade and installation of the pipeline on slopes with cross-gradients of less than 10 percent. The first step consists of grading of the right of way as shown on the drawing to provide a working and travelling surface for construction equipment. This working surface is approximately level in cross-section, 40 feet in width from centerline of the pipeline, and is to remain as the final graded section of the pipeline right of way. The quality of the fill section and the preparation of backslope surfaces will be carefully controlled, because of the fact that the initial grading will be retained as the final cross-section. Some minor downslope grading will likely be carried out over short sections of line to permit easier and safer operation of construction equipment. This grading will, however, be of a temporary nature and will be removed as construction proceeds along the line.

The second step of the operation, illustrated in Figure 1, Drawing No. A-3, consists of trenching for the pipeline, stockpiling of trench material, and fabrication of the pipeline and gas fuel line. Trench dimensions will be approximately as shown in Figure 1. Contemporaneous with this operation is the installation of expansion loops and the construction of anchor blocks as they are required.

Final step in the process is the backfilling of the pipeline trench and covering of the backfilled trench with a protective rip-rap cover as indicated on Figure 1, Drawing No. A-3. Subsequent to backfilling of the trench, provision of drainage measures and biological stabilization measures on the right of way will be carried out. These measures, as discussed in detail in subsequent sections of this report, will be carried out immediately after backfilling, such that construction and restoration are carried to completion as activities proceed downslope.

## 4.2 Typical Downslope Sections With Cross-Slopes Ranging from 10 to 30 Percent

Figure (2), Drawing No. A-3, shows the grading plans for a typical cross-slope section ranging from 10 to 30 percent gradient. A 20 percent gradient has been illustrated and grading plans consist of three steps. The initial step consists of preparation of a temporary working surface through cutting and filling of the cross-slope section as shown. Quality control on filling will not be maintained nor will slope stability on temporary sections be considered critical. However, maximum backslopes of both temporary cut and fill sections will be limited to a maximum of one foot vertical to one foot horizontal to ensure reasonable temporary stability during the short construction period. Although cutting and filling, as illustrated in Figure 2, Drawing No. A-3, has been shown from the centerline of the right of way, location of cut and fill sections will be determined on the basis of existing field conditions and need not necessarily coincide with the centerline of the right of way or the pipeline.

Subsequent to preparation of the temporary working surface trenching, pipe fabrication and backfilling will proceed as described previously and illustrated in Figures 1 and 2, Drawing No. A-3. The final step in the process is restoration of original grades, within practical limits. Quality control will be maintained on backfilling procedures. The highest quality fill consistent with field placement techniques and capabilities, as pertaining to the existing terrain conditions, will be achieved. After regrading has been completed, drainage provisions and biological restoration provisions will be carried out.

The preceding technique will be applicable to the majority of downslope cross-gradient sections along the route. As evident on Drawings No. A-2A and A-2B, the majority of the line is comprised of cross gradients less than 30 percent.

## 4.3 Typical Downslope Sections With Cross-Slopes of 30 to 35 Percent

Apart from localized very steep cross-gradients, the maximum cross-slopes anticipated, for any appreciable length of right of way, are believed to be in the order of 30 to 35 percent. A typical cross-slope of 35 percent is illustrated in Figure 3, Drawing No. A-3. As evident from the figure, the method of grading employed on these steep cross-slope sections is the same as that advocated for sections with cross-slopes ranging from 10 to 30 percent, with the exception that the working surface will be reduced to a minimum of about 35 feet. Because of the steepness of the section, initial grading of the entire right of way will be necessary, and more difficulty will be encountered in regrading and restoration of the right of way subsequent to pipeline installation. In the event that complete re-establishment of initial ground surface profiles cannot be achieved, appropriate stabilization techniques will be employed to ensure the stability of altered slope sections.

## 4.4 Typical Cut Fill Sections Along the Longitudinal Gradient of the Pipeline

Because of localized ridge and gulley features existing in several sections along the route, and the necessity of maintaining a downslope gradient in all sections of the pipeline, some localized cutting and filling will be required in a longitudinal direction along the pipeline. The major cut fill areas have been shown on Drawings No. A-2A and A-2B, at their approximate locations along the profile, and a typical detail of such a section is shown on Detail 'A', Drawing No. A-2B. As evident from the detail, an attempt will be made to maintain the pipeline in original undisturbed ground in order to minimize potential settlement problems. However, if excessive deep trenching is required in order to achieve this, burial of the pipeline in controlled fill will be an alternative scheme. Decisions of this nature will be made by field engineering personnel, and provisions will be instituted to deal with potential problems that may occur by settlement of fills. In areas where installation of the pipeline in fill is not practicable, deep trenching will be required.

## 4.5 Intermittent Drainage Courses

Some of the gulleys referred to in Subsection 4.4 serve as intermittent drainage courses. The flow in these drainage courses, based on field inspection, appears to be quite sporadic and likely of very low volume and velocity, as channels are not well defined. Based on the previous discussion of treatment of gulleys and ridges, some or all of these intermittent drainage courses will be filled in to satisfy pipeline grading requirements. In the event that filling is carried out, the filling will be incorporated into a new drainage course profile within the right of way. Any future drainage that may occur will be routed over the fill which will be adequately rip-rapped and biologically stabilized to minimize channel erosion. A typical detail of the channel modification procedure is illustrated in Drawing A-2B, Appendix A. If deemed feasible in the field, routing of drainage through culverts or other such conduits will be considered.

## 4.6 Areas Requiring Special Construction Consideration

### 4.6.1 Creek Crossing and Steep Side-Hill Area - Approximate Chainages 64 + 00 to 76 + 00

One area requiring special construction consideration is the creek crossing and steep side hill area, extending from approximately chainage 64 + 00 to chainage 76 + 00. This area is shown in Detail 'A' on Drawing No. A-2B, Appendix A.

In order to minimize depth of trenching through this area and maintain proper pipeline gradients, filling in of the creek channels and small gulleys crossing this section of line will be required. Since the gulleys crossing the line terminate in a steep side hill on the left side of the line, maintenance of drainage in the filled gulley sections will not be required. However, drainage in the stream channel, which shows evidence of handling appreciable flows on occasion, will have to be maintained. In this regard, Detail 'A' shows the provision of culverts to handle anticipated stream flows. However, another alternative consists of stream channel modification and routing of stream flow over top of the proposed fill, which would be adequately rip-rapped. Decision on the method of handling future stream flows is presently reserved, and will be based on forthcoming data, concerning existing stream bed profile, projected maximum flows, and potential problems associated with channel erosion and channel icing.

### 4.6.2 Steep Downslope Section From Existing Access Road Crossing to and Including Old Beach Terraces

This area is shown in Detail 'B', Drawing No. A-2B, Appendix A. Because of access road relocation difficulties, regrading across the access road right of way is presently not considered feasible. Alternatively, deep trenching through this area will be carried out, accompanied by conventional pipelining techniques. However, the beach terrace area will be regraded, and cutting and filling will be carried out approximately as shown in Detail 'B'. Maintenance of cut-fill within the right of way limits will be strived for, and adequate stabilization and restoration techniques will be employed after regrading has been carried out.

## V. DRAINAGE AND EROSION MINIMIZATION PROVISIONS

The insitu soils along the pipeline route vary in erosion susceptibility from low to moderate susceptibility, to high erosion susceptibility. The former soil types generally comprise the upper reaches of the route and extend to approximately the creek crossing (approximate chainage 67 + 00). The latter, highly erosion susceptible soils, generally exist below the creek crossing and extend to the lower limits of the line.

The severity of potential erosion depends not only on the soil characteristics, but on such factors as severity of rainfall, infiltration potential, degree and rate of runoff and degree of exposure of the soils to rainfall and runoff. In order to minimize potential erosion it is desirable to control some or all of these factors. Of the foregoing factors, however, only the latter two lend themselves readily to any form of control.

In this regard, drainage provisions, as discussed herein, will be incorporated on the regraded right of way to minimize degree and rate of runoff, and degree of exposure to runoff. Minimization of degree of exposure to rainfall and runoff will also be attempted through biological restoration, which will be discussed in greater detail in the following section.

Drawing No. A-4, Appendix A, illustrates the basic concepts for controlling or facilitating drainage on and/or runoff, along the regraded right of way. The drainage concept consists essentially of providing runoff flow checks along (laterally) and across (transversely) the right of way. In areas where transverse flow across the right of way (moderately steep to steep cross-slopes) is anticipated to be appreciable, lateral flow checks are proposed along the high side of the right of way. These lateral flow checks will serve to stop flow, originating from off right of way areas, from crossing the right of way and contributing to erosion. The runoff water will be collected in the ditch area behind the berm and redirected downslope to a transverse flow check where it will be carried across the right of way. Lateral flow checks, where required, will be discontinuous so as to reduce runoff water velocities and quantities. Flow breakers will be provided in both lateral and transverse flow checks to minimize water velocities.

Lateral flow checks are anticipated to be required only in areas exhibiting steep cross-slope sections, where highly erosion susceptible soils are present. These areas are existent below the creek crossing area. Transverse flow checks, which will collect flow occurring in a longitudinal direction along the right of way are contemplated for all anchor point and expansion loop locations. However, spacing and orientation of transverse flow checks will be dependent on local gradients and the need for checking surface runoff. Intermediate transverse flow check locations will become apparent in the field.

In order to prevent erosion in the pipeline trench itself, rip-rapping over the backfilled trench will be carried out and impervious cut-off plugs or collars will be installed within the pipeline trench at or near expansion loop locations. These plugs, together with the anchor blocks, will check flow of water in the pipeline trench, if ingress of water to the pipeline trench inadvertantly occurs. The ingress of water to the pipeline trench, however, is expected to be minimized by providing some quality control of trench backfill and backfilling procedures.

Typical construction details of lateral and transverse drainage checks, flow breakers, and rip-rap protection of flow surfaces are shown on Drawing No. A-4, Appendix A. As evident from the drawing, use of insitu construction materials is advocated. Ditch and berm construction for flow checks and breakers, using insitu soils, is shown on the drawing. Rip-rapping of flow surfaces will be carried out with local broken rock, or other suitable alternatives such as sand or cement bags. Use of driven sheet piling is considered to be presently required only in very steep slope sections, or where earth retaining capabilities are required. Pipeline ditch plugs or cutoffs will be constructed of well compacted cohesive soil, bagged cement or bentonite. Typical location details of plugs or collars are shown on Drawing A-4, Appendix A.

## VI. RESTORATION & BIOLOGICAL STABILIZATION OF SURFICIAL SOILS ON THE PIPELINE ROUTE

Immediately following implementation or construction of drainage provisions, biological stabilization will be carried out on those soils of moderate to high erosion susceptibility. These soils were noted to exist below the creek crossing (from approximate chainage 67 + 00). However, depending on actual soil conditions encountered, some biological stabilization may be attempted upslope of the creek crossing.

The biological stabilization program presently envisaged will consist of seeding, fertilization and covering of freshly seeded and fertilized surfaces with brush or suitable trash cover (Wein, 1972). As shown on Drawing A-4, all surfaces, exclusive of rip-rapped surfaces or very granular soils, will be treated in this fashion.

Seed type to be used will be determined on the basis of field inspection and evaluation of existing soils by a qualified botanist, who will also determine type and rate of fertilization, and method and rate of seeding. Preliminary information indicates that a seed mix composed of an annual cereal such as oats, and native species if possible, be used. Other species such as brome grass, creeping red fescue, red clover and Russian wild rye grasses may also be employed.

Although summer seeding has been found to meet with only limited success, reseeding immediately after construction next summer is advocated, in the belief that some 'take' will occur and assist in stabilization of surficial soils. After evaluation of the 'take', the right of way can again be reseeded in the late fall or spring using the more successful seed types. Re-fertilization may also be attempted, if deemed necessary. Spring or fall seeding can be carried out annually, as and if required, until native species have re-established themselves on the line; whereupon it can be terminated.

Initial seeding and fertilization will be carried out by hand 'broadcasting' with subsequent reseeding being carried out by aerial means. Brush supplies for protective covering of the seeding and soil surface will be obtained locally, where allowed. Placement of brush cover will be carried out by both manual and mechanical means.

## VII. INSTRUMENTATION OF CRITICAL SLOPE AREAS

As discussed previously (Brooker 1972, Slaney 1972) several critical slope areas, where potentially unstable conditions exist, appear to be present along the pipeline route.

However, also as discussed, the stability of these areas has not been ascertained to be so critical that it is deemed necessary to recommend against construction of the pipeline. Consequently, it has been affirmed that construction of the pipeline can take place without severe risk of failure. However, as a precautionary safeguard, instrumentation has been recommended (Brooker 1972) and will be installed in these critical slope areas.

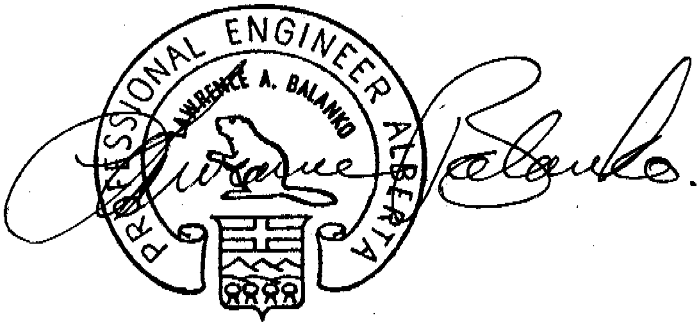
Instrumentation of the slopes will consist of slope movement measurement devices or installations, in the areas outlined on Drawings No. A-2A and A-2B, Appendix A. These installations will consist of precise survey markers installed in conjunction with slope indicator and extensometer devices, if required. The need for field instrumentation, type, and amount of instrumentation will be consistent with field requirements and the relative instability of the areas. Installation of instrumentation will be contemporaneous with construction of the pipeline.

## VIII. CLOSURE

The foregoing preliminary plans have been presented, based on the known requirements for relatively economic construction of a gas gathering system, in conjunction with the known requirements for minimal disturbance to the existing environment. The physical act of constructing the pipeline will in fact have an altering effect on the existing environment at Pointed Mountain, Northwest Territories. This altering effect cannot be eliminated. However, it is believed that the construction plans outlined will keep to a minimum the detrimental environmental effects caused by the construction of a gas gathering pipeline from Well A-1 to the lake bottom area.

Respectfully Submitted,

ELMER W. BROOKER & ASSOCIATES LTD.

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G. R. Gilchrist, P. Eng.

LAB:bjf

# REFERENCES

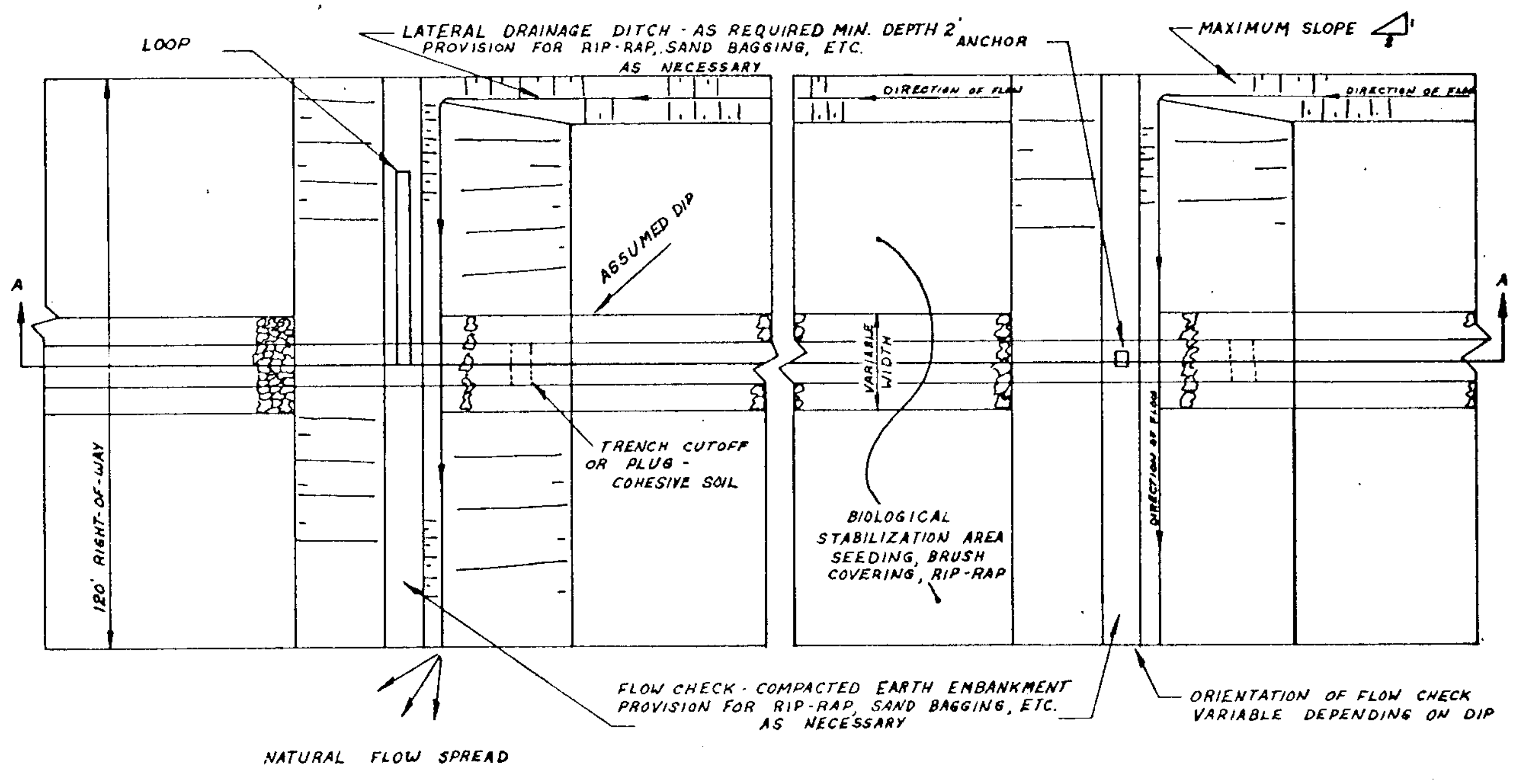
Brooker, E. W. & Associates Ltd., 1972, Slope Stability Study, Pointed Mountain Gas Gathering System, Pointed Mountain, Northwest Territories, Unpublished Report to L. G. Grimble & Associates Ltd.

Slaney, F. F. and Company, 1972, Environmental Effects of Pointed Mountain Natural Gas Gathering Pipelines, Unpublished Report to Northern Economic Development Branch, Department of Indian Affairs and Northern Development

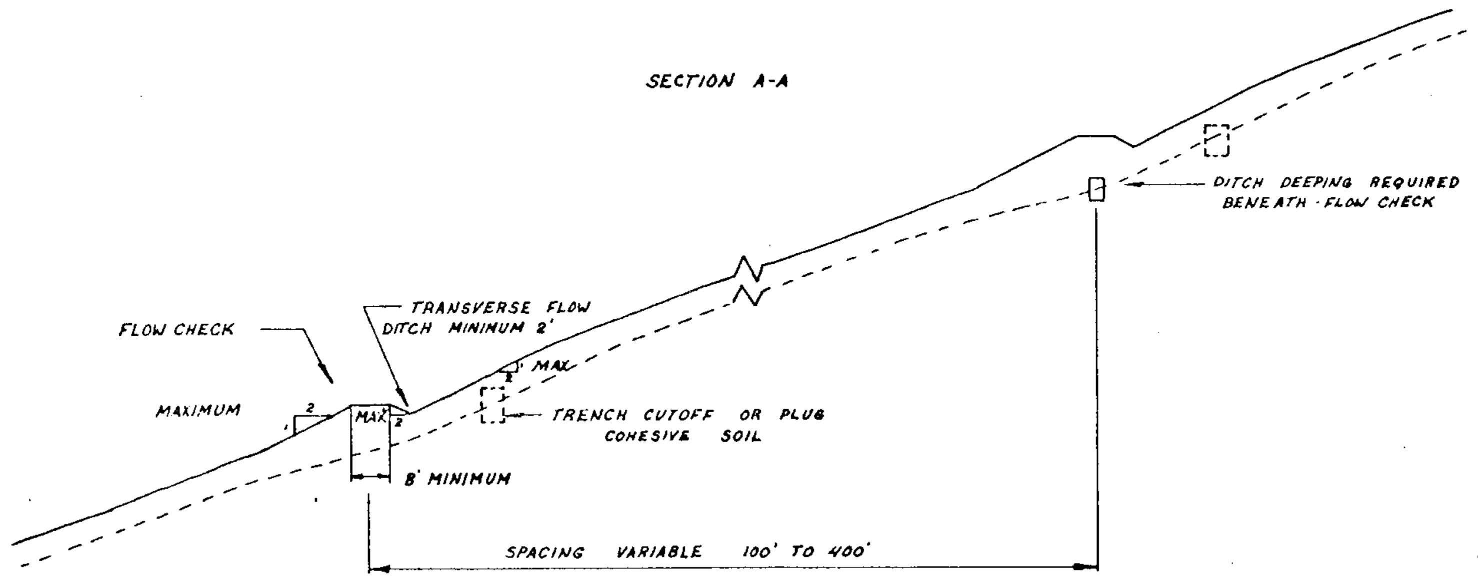
Wein, Dr. R. S., Department of Botany, University of Alberta Personal Communication 1972.

## DRAINAGE AND RESTORATION DETAILS

### PLAN VIEW




### SECTION A-A

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DRAWN BY: A.L.B.
DATE DRAWN: MAY 1, 1972
CHECKED BY: L.A.B.
JOB No.: E 442

SCALE: 1" = 20'
DESIGNED BY: G.R.G.
CHECKED BY: G.R.G.
APPROVED BY: L.A.B.

AMOCO CANADA PETROLEUM COMPANY LTD.
POINTED MOUNTAIN GAS GATHERING SYSTEM
PIPELINE A-1

ELMER W. BROOKER & ASSOCIATES LTD.
CONSULTING CIVIL ENGINEERS

DRAINAGE AND RESTORATION DETAILS

DWG. A—4

SHEET No.

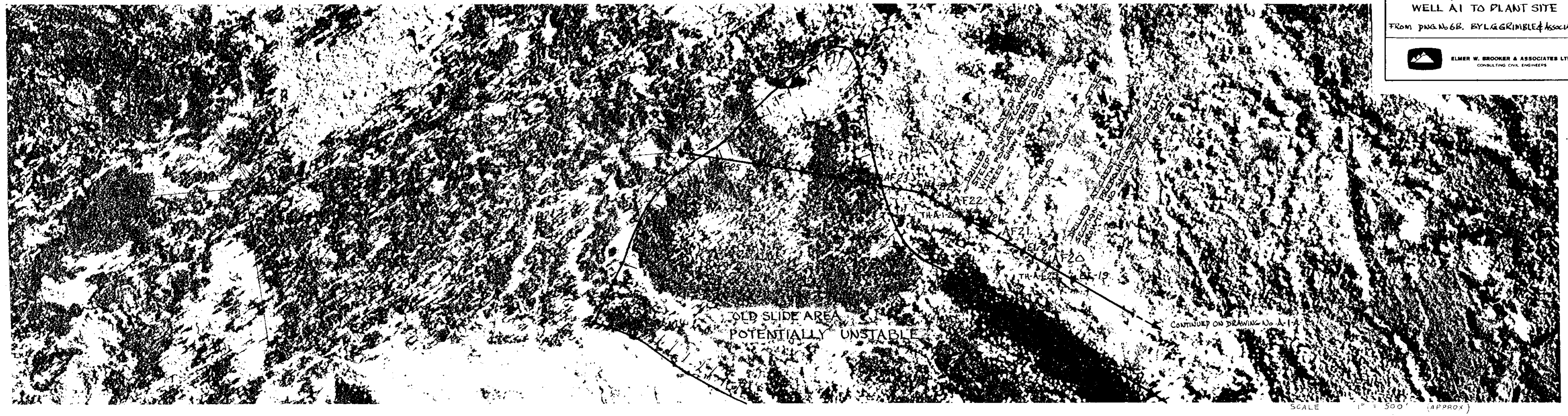
# POINTED MOUNTAIN
## PIPELINE & BOREHOLE LOCATIONS
## WELL A1 TO PLANT SITE

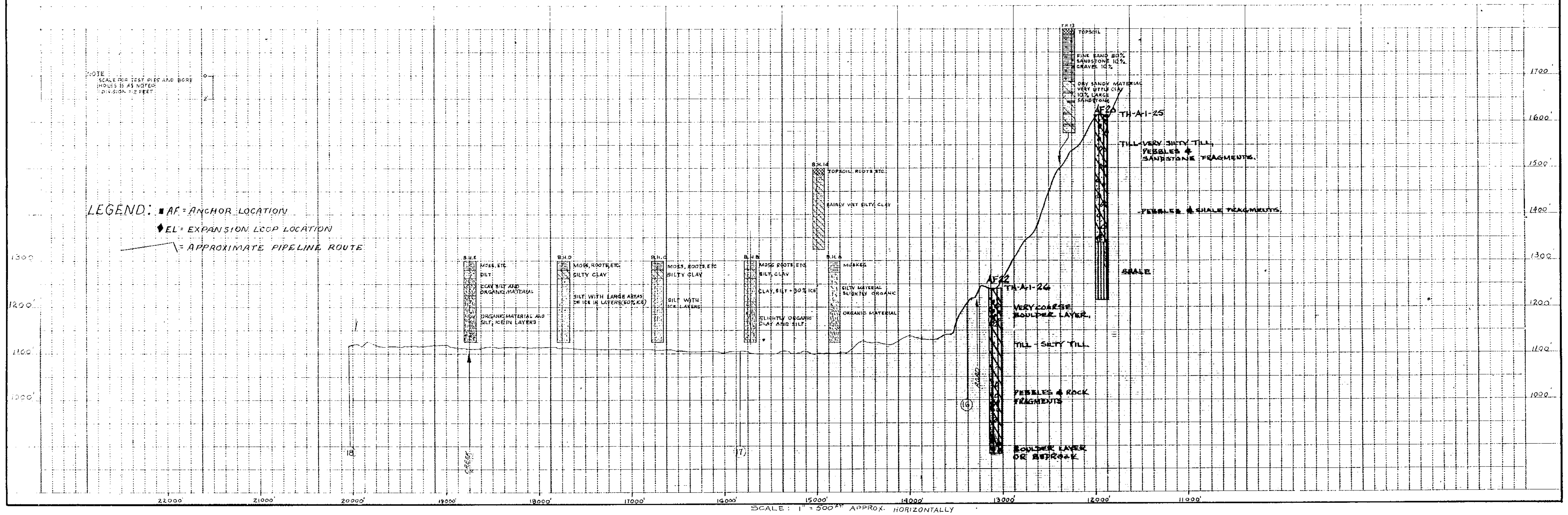
FROM DWG. No. 6B. BY L.G. GRIMBLE & ASSOCIATES

| | |
|---|---|
| DRAWN BY: | B.W. BANKS |
| DATE: | 24.3.72 |
| SCALE: | SHOWN |
| JOB No. | E.442 |

ELMER W. BROOKER & ASSOCIATES LTD.
CONSULTING CIVIL ENGINEERS

A-1-B




AMOCO CANADA PETROLEUM COMPANY LTD.
POINTED MOUNTAIN GAS GATHERING SYSTEM
PIPELINE B—1

**SURFACE PROFILE**
(UPPER SECTION)

DWG. A-2-A E - 442B


NOTE: PROFILE CONTINUED ON DRAWING A-2-A.
NO APPRECIABLE CROSS-SLOPE
CUT
TOPOGRAPHIC LOW NOT A WATER COURSE
FILL
DETAIL A
< 10% CRO'S-SLOPE TO LEFT
DITCH DEEPING AS REQUIRED
NATURAL GROUND SURFACE
RIP RAP AS REQUIRED
ENGINEERED FILL - LOCAL MATERIAL
PIPE LINE
STRIP ORGANICS LAY PIPE LINE AT OR NEAR GROUND SURFACE
DETAIL A
℄ CHAINAGE
GEODETIC ELEVATION (FEET)
LEGEND:
GROUND SURFACE PROFILE
PIPELINE PROFILE
CUT-FILL AREA
NOTE: ELEVATION BASED ON PLAINS DRESSER PLANT BENCH MARK, ELEVATION 1186.40'
AMOCO CANADA PETROLEUM COMPANY LTD.
POINTED MOUNTAIN GAS GATHERING SYSTEM
PIPELINE B-1
SURFACE PROFILE
(LOWER SECTION)
DWG. A-2-B
E-442B


DETAIL B
DETAIL A
REFER TO DETAIL A - THIS DRAWING
REFER TO DETAIL B - THIS DRAWING
GEODETIC ELEVATION (FEET)
℄ CHAINAGE
ACCESS ROAD
DITCH DEEPENING REQUIRED
REGRADING & DITCH DEEPENING REQUIRED
BEACH TERRACES
BEACH TERRACES REGRADING & DITCH DEEPENING REQUIRED
LAKE BOTTOM AREA - FLAT
SLOPE MOVEMENT MEASUREMENT CONTROL AREA
GRADING & DITCH DEEPENING REQUIRED POSSIBLE CHANNEL RESTORATION
MINOR GRADING AND DITCH DEEPENING
10% TO 15% CROSS-SLOPE TO RIGHT
INTERMITTENT STREAM CROSSING POSSIBLE CHANNEL REGRADING
20% TO 30% CROSS-SLOPE TO RIGHT
30% TO 35% CROSS-SLOPE TO RIGHT
GRADING & DITCH DEEPENING REQUIRED
DRAINAGE CHANNEL RESTORATION REQUIRED
ENGINEERED FILL
PIPE SLEEVING
POSSIBLE STREAM DIVERSION-CULVERTS
CUT
FILL
LEGEND:
AF ANCHOR LOCATIONS
EL EXPANSION LOOP LOCATIONS
PIPE LINE PROFILE
℄ GROUND SURFACE PROFILE
REGRADED GROUND SURFACE PROFILE
AMOCO CANADA PETROLEUM COMPANY LTD.
POINTED MOUNTAIN GAS GATHERING SYSTEM
PIPELINE A-1
SURFACE PROFILE
(LOWER SECTION)
DWG. A-2-B
E-442

## TYPICAL GRADING CROSS-SLOPE < 10%

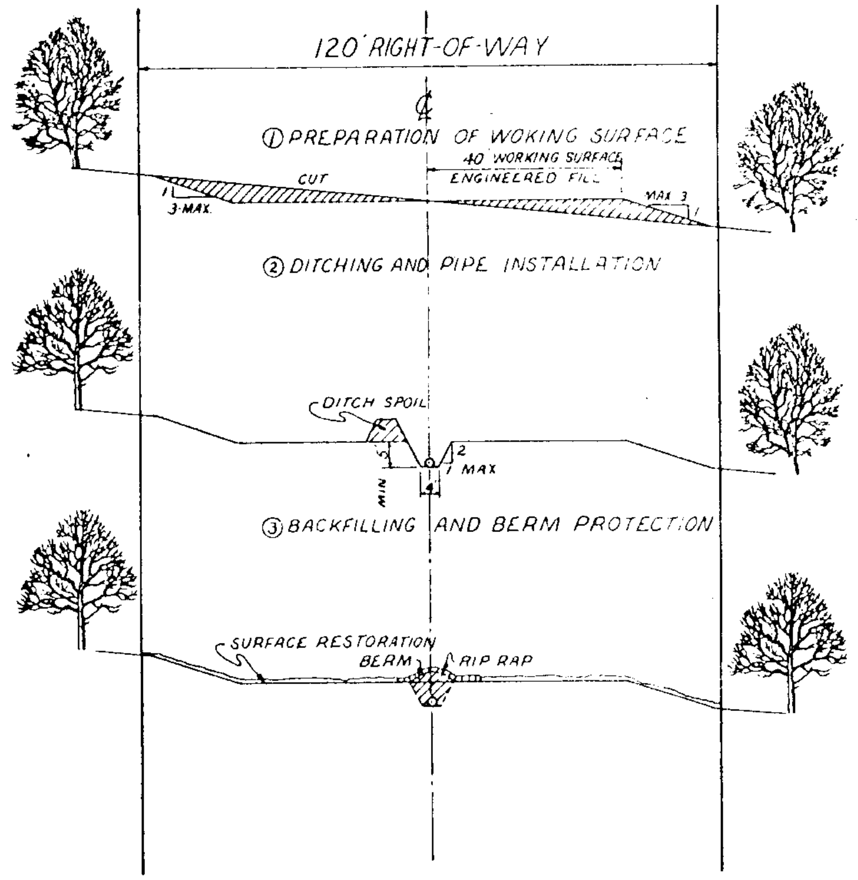



FIGURE Nº 1

## TYPICAL GRADING CROSS-SLOPE 10% TO 30%

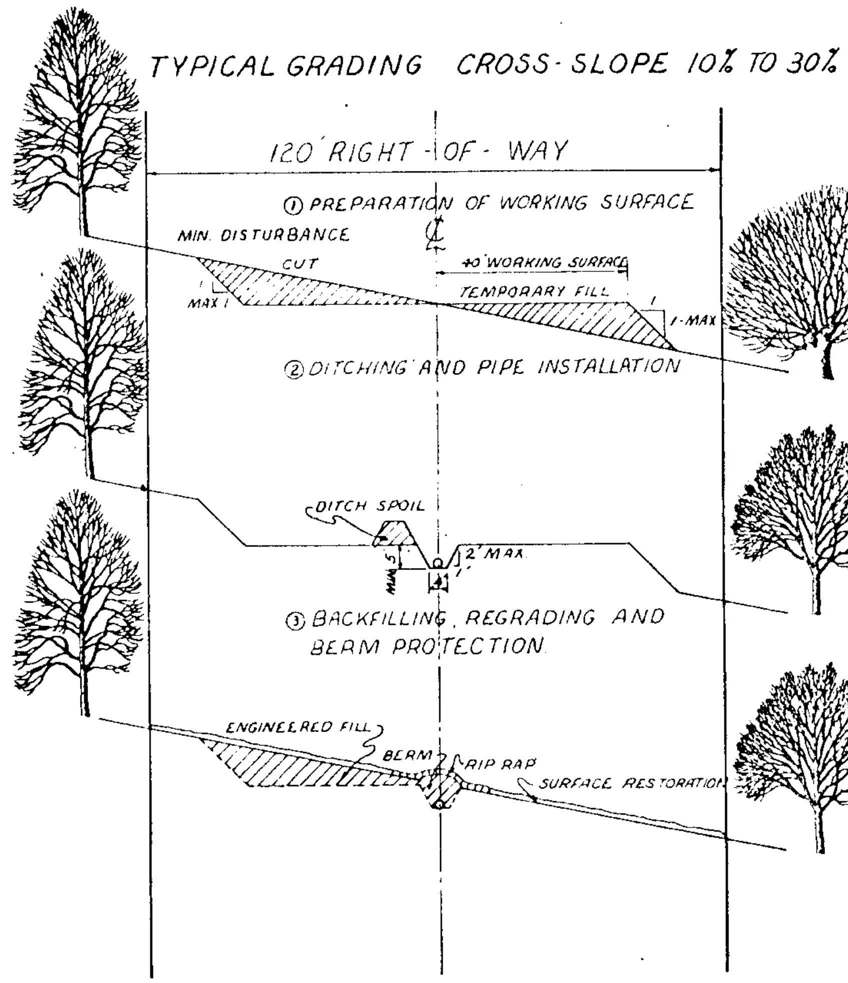



FIGURE Nº 2

## TYPICAL GRADING CROSS-SLOPE 30%-35%

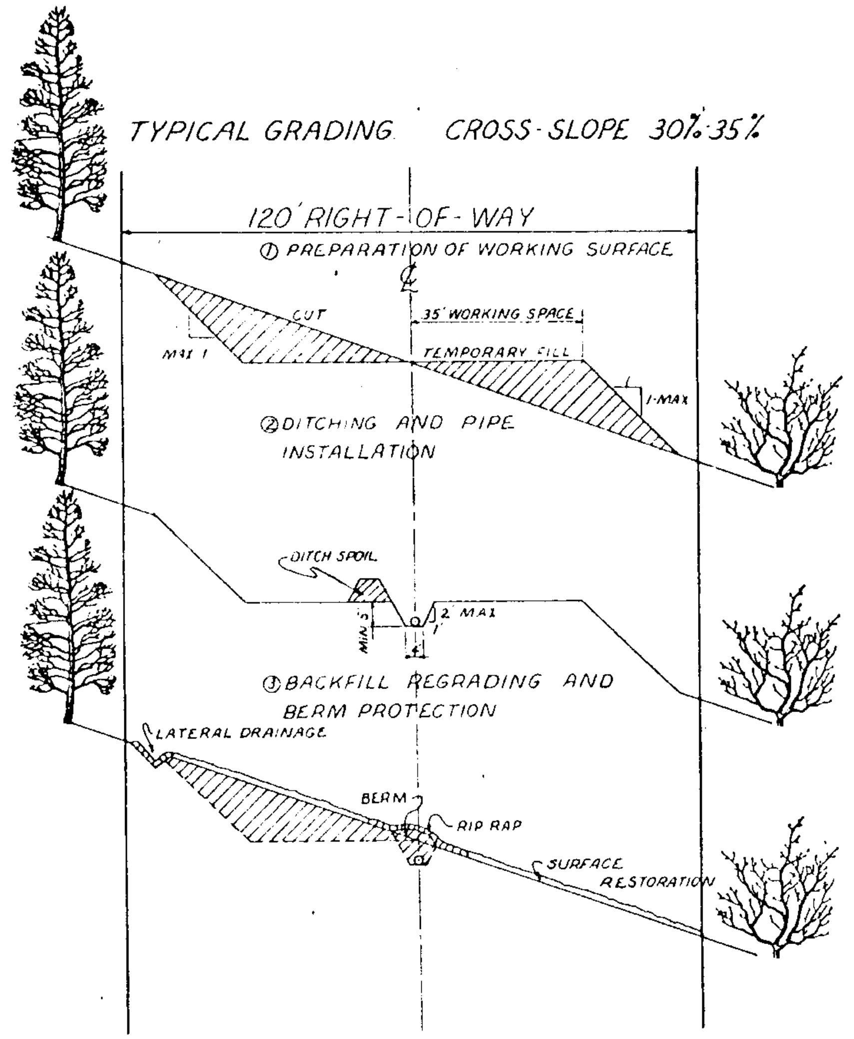



FIGURE Nº 3

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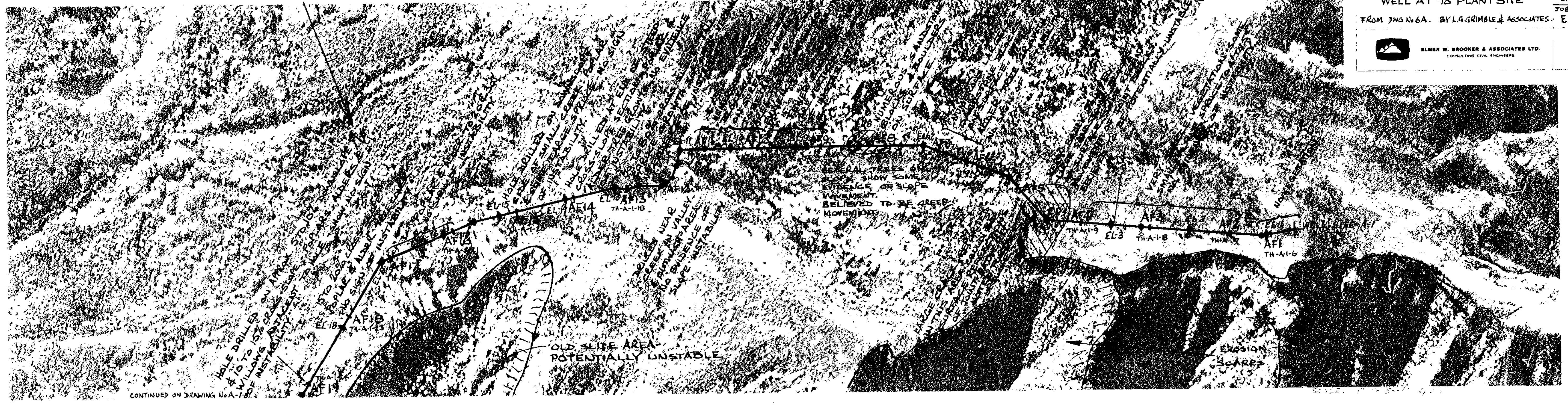
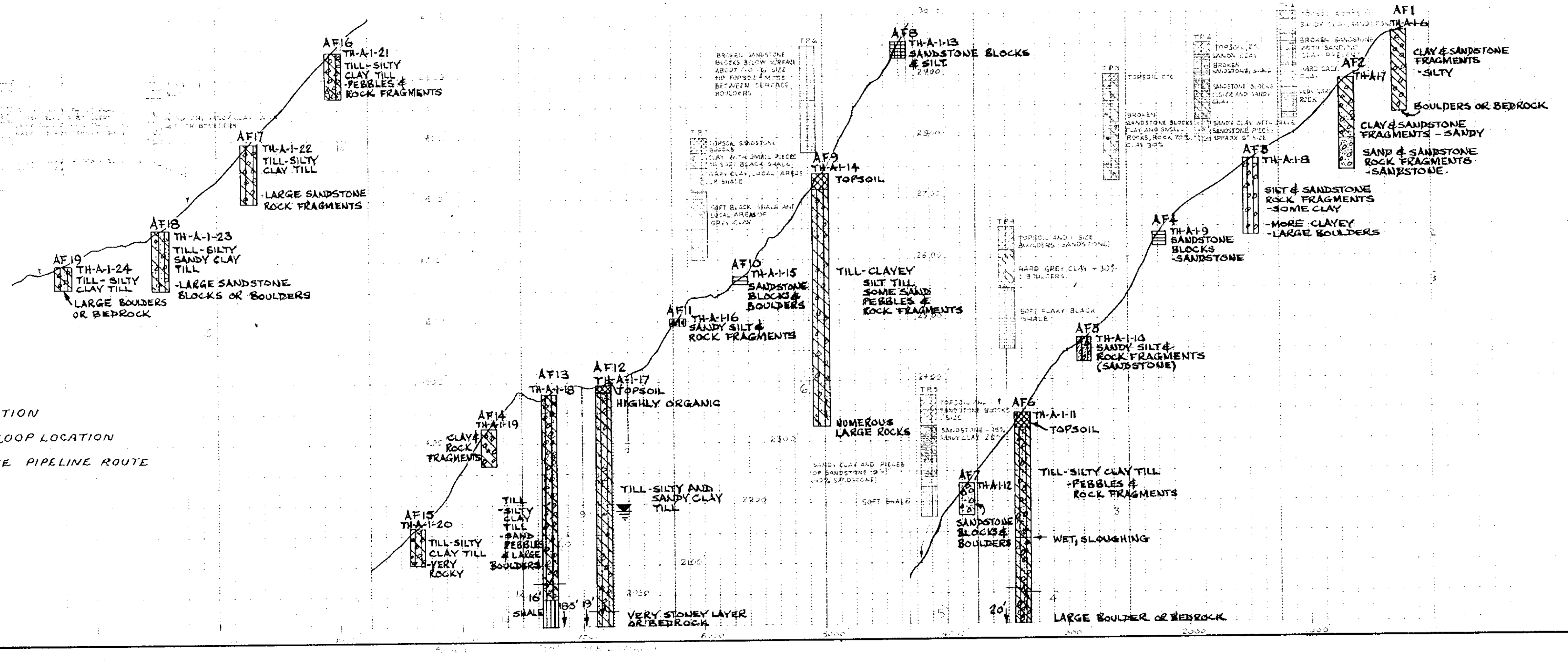
| | | | | | |
|---|---|---|---|---|---|
| DRAWN BY: G.P | SCALE: 1"=20' | AMOCO CANADA PETROLEUM COMPANY LTD. | ELMER W. BROOKER & ASSOCIATES LTD. CONSULTING CIVIL ENGINEERS | TYPICAL CROSS-SECTION GRADING DETAILS | DWG. A-3 |
| DATE DRAWN: 28/4/72 | DESIGNED BY: G.R.G. | POINTED MOUNTAIN GAS GATHERING SYSTEM | | | |
| CHECKED BY: L.A.B. | CHECKED BY: G.R.G. | PIPELINE A-1 | | | SHEET No. |
| JOB No.: E442 | APPROVED BY: L.A.B. | | | | |




LEGEND: ▪ AF = ANCHOR LOCATION
♦ EL = EXPANSION LOOP LOCATION
—— = APPROXIMATE PIPELINE ROUTE

POINTED MOUNTAIN
PIPELINE & BOREHOLE LOCATIONS
WELL A1 TO PLANTSITE

FROM DWG No 6A. BY L.G.GRIMBLE & ASSOCIATES.

| | |
|---|---|
| DRAWN BY: | B.W.BANKS |
| DATE: | 24-3-72 |
| SCALE: | SHOWN |
| JOB No: | E.442 |

ELMER W. BROOKER & ASSOCIATES LTD.
CONSULTING CIVIL ENGINEERS

A-1-A