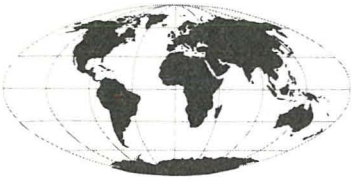
STUDIES FOR GAS PIPELINE SYSTEMS

DAMES & MOORE

Consultants in the Environmental and Applied Earth Sciences

STUDIES FOR GAS PIPELINE SYSTEMS



DAMES & MOORE

Consultants in the Environmental and Applied Earth Sciences

ITEMS REQUIRED TO CONDUCT PIPELINE ROUTE STUDIES:

1. EVALUATE ALTERNATIVE PIPELINE CORRIDORS.
2. SELECT OPTIMUM PIPELINE ROUTES BASED UPON TECHNICAL, ENVIRONMENTAL AND SOCIO-ECONOMIC PARAMETERS.
3. SELECT MOST VIABLE CORRIDOR CONSIDERING OTHER PARAMETERS OF THE CLIENT.
4. MAKE ENVIRONMENTAL ASSESSMENT AND PREPARE AN ENVIRONMENTAL IMPACT REPORT FOR THE PROPOSED PIPELINE SYSTEM.
5. CONDUCT DETAILED TERRAIN AND GEOTECHNICAL STUDIES TO PROVIDE CRITERIA FOR ENGINEERING DESIGN.
6. PROVIDE PRELIMINARY AND FINAL ENGINEERING DESIGN.
7. PROVIDE FIELD INSPECTION SERVICES DURING CONSTRUCTION.

ITEMS THAT MUST BE EVALUATED TO DETERMINE TECHNICAL, ENVIRONMENTAL, AND SOCIO-ECONOMIC PARAMETERS:

1. GEOLOGY
2. GEOMORPHOLOGY
3. SOILS
4. HYDROLOGY
5. BIOLOGY
6. CLIMATOLOGY
7. SEISMOLOGY
8. EXISTING AND PROPOSED LAND USE
9. POPULATION PROJECTIONS
10. HISTORY
11. ARCHAEOLOGY
12. ECONOMIC AND SOCIAL CONSIDERATIONS

STEP-BY-STEP PROCEDURE TO OBTAIN DATA FOR THE VARIOUS SCIENTIFIC AND ENGINEERING ITEMS NECESSARY FOR EVALUATION.

1. MAKE A THOROUGH REVIEW OF AVAILABLE DATA

2. STUDY AERIAL PHOTOGRAPHS COVERING THE AREA OF INVESTIGATION

3. UNDERGO AN EXAMINATION OF VARIOUS ALTERNATE PIPELINE CORRIDORS WITH A FIELD INVESTIGATION PARTY OF EXPERIENCED SCIENTISTS AND ENGINEERS, COLLECTING NECESSARY DATA TO PROPERLY EVALUATE PERTINENT CONDITIONS

4. MAP ALL DATA, SUPERIMPOSING OVERLAYS ON A BASE MAP SO THAT THE INTER-RELATIONSHIPS OF THE VARIOUS CONSTRAINTS CAN BE EVALUATED AND ANALYZED WHEN SELECTING THE OPTIMUM CORRIDOR

SPECIAL PROCEDURES NECESSARY FOR OBTAINING DATA REQUIRED IN EVALUATING OFFSHORE AREAS OF INVESTIGATION.

1. OBTAINING AND REVIEWING AVAILABLE DATA PERTINENT TO DESIGN AND CONSTRUCTION OF PIPELINES IN THE AREA OF INVESTIGATION

2. GEOPHYSICAL SURVEYING INCLUDING:
   - --HIGH RESOLUTION SEISMIC REFLECTION PROFILING
   - --SIDE SCANNING SONAR
   - --PRECISION DEPTH SOUNDING SURVEYS

3. OCEANOGRAPHIC SURVEYING INCLUDING:
   - --MEASUREMENTS OF CURRENT SPEED AND DIRECTION
   - --SEDIMENT SAMPLING


POTENTIAL DEEP WATER SITES
EVIRONMENTALLY STUDIED BY
DAMES & MOORE
DAMES & MOORE
Consultants in the Environmental
and Applied Earth Sciences
DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

EXAMPLES OF

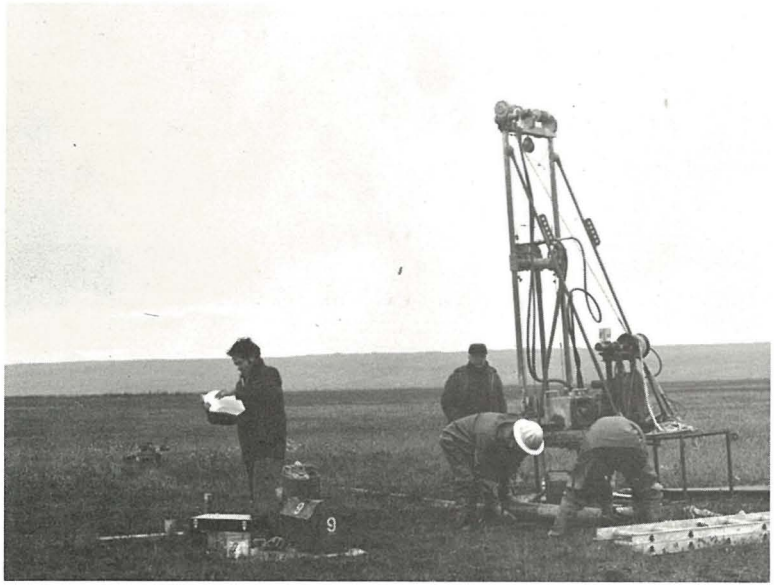
DAMES & MOORE

FIELD OPERATIONS

PORTABLE DRILL RIG UTILIZED BY DAMES & MOORE
FOR SUBSURFACE FIELD INVESTIGATION WORK

ONSHORE SOIL SAMPLING

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES



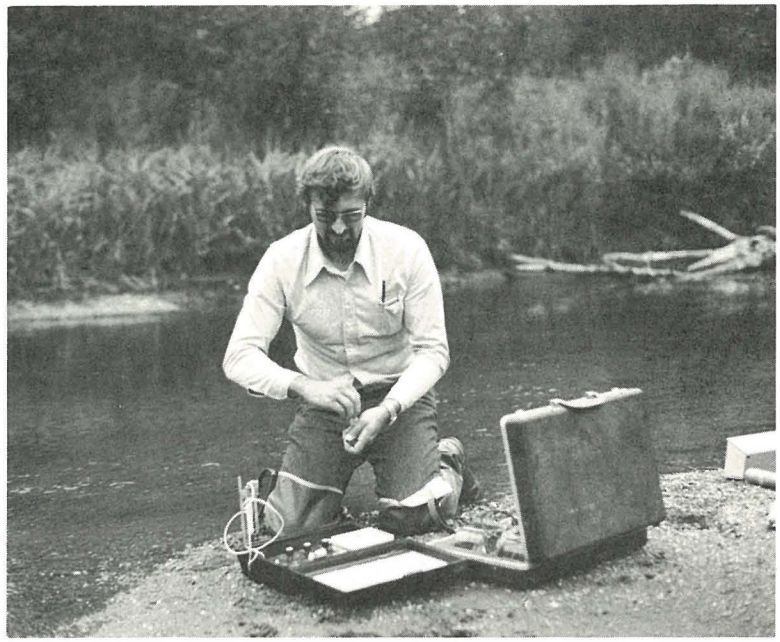
SETTING - UP AND DRILLING OPERATIONS AT
TRADING BAY, COOK INLET, ALASKA UTILIZING
A PORTABLE ROTARY - WASH TYPE DRILLING RIG

ONSHORE SOIL SAMPLING

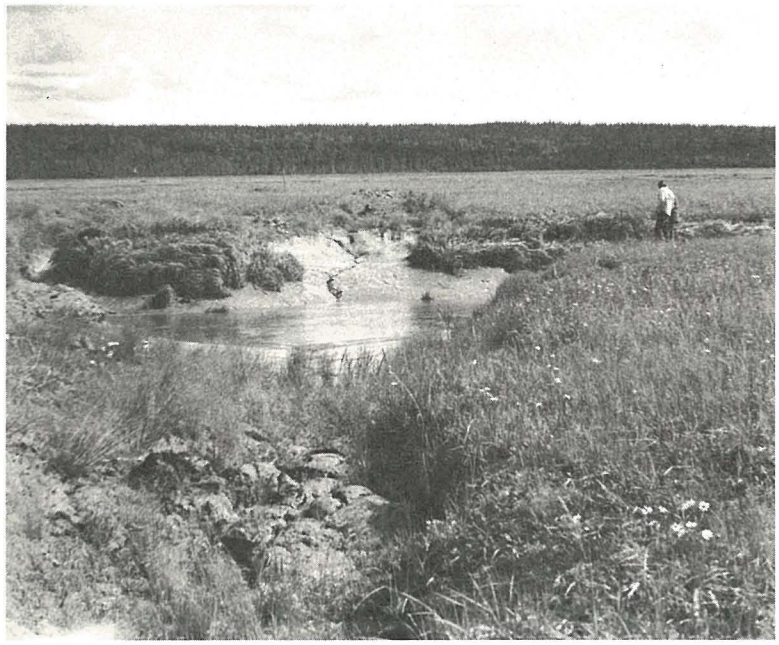
DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

PORTABLE DRILL RIG BEING TRANSPORTED TO
NEW BORING LOCATION BY SIBORSKY S-55T
HELICOPTER, TRADING BAY, COOK INLET, ALASKA

ONSHORE SOIL SAMPLING



DAMES & MOORE HYDROLOGIST TAKING CURRENT MEASUREMENTS AT LEWIS RIVER, COOK INLET, ALASKA



EXISTING PIPELINE CROSSING THE NICOLAI CREEK, COOK INLET, ALASKA

ONSHORE FIELD INVESTIGATION

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

BOTTOM CORE SAMPLING DEVICE CAPABLE OF TAKING FIVE FEET OF OVERBURDEN SAMPLE

DAMES & MOORE MARINE GEOLOGIST DURING OFF-SHORE FIELD RECONNAISSANCE

OFFSHORE FIELD INVESTIGATION

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

CLAM-SHELL GRAB SAMPLING EQUIPMENT SPECIFICALLY DESIGNED TO OPERATE IN COOK INLET

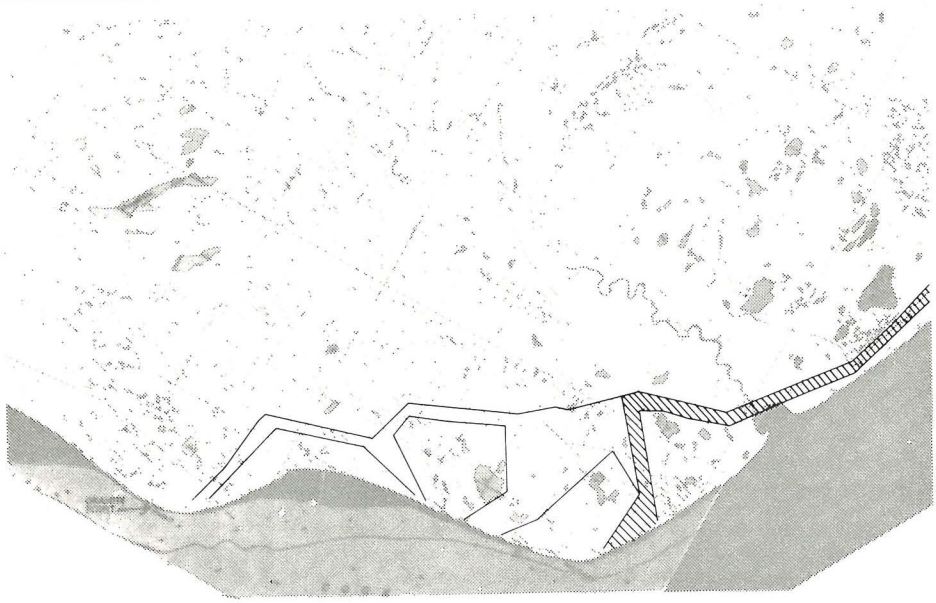
EXAMPLE OF THE DISTRUBED BOTTOM SEDIMENT SAMPLE OBTAINED BY THE ABOVE CLAM-SHELL EQUIPMENT

UNIT CONSISTING OF CURRENT SPEED SENSOR, CURRENT DIRECTION MEASURING SYSTEM, AND DEPTH SOUNDER

OFFSHORE SEDIMENT SAMPLING

DAMES & MOORE
CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

THE FOLLOWING PLATES ARE EXAMPLES OF ILLUSTRATIONS SHOWING VARIOUS TECHNICAL, ENVIRONMENTAL AND SOCIO-ECONOMIC PARAMETERS USED TO EVALUATE THE OPTIMUM ROUTE SELECTION FOR PORTIONS OF PROPOSED PIPELINE SYSTEMS AT COOK INLET, ALASKA



PREFERRED AND ALTERNATE PIPELINE CORRIDORS MAP 1

LEGEND

SECONDARY ROAD

UNIMPROVED DIRT ROAD

EXISTING PIPELINE

EXISTING TRANSMISSION LINE

PROPOSED PIPELINE CORRIDOR

PREFERRED PIPELINE CORRIDOR

ARCHAEOLOGICAL SITES MAP 1

LEGEND

SECONDARY ROAD

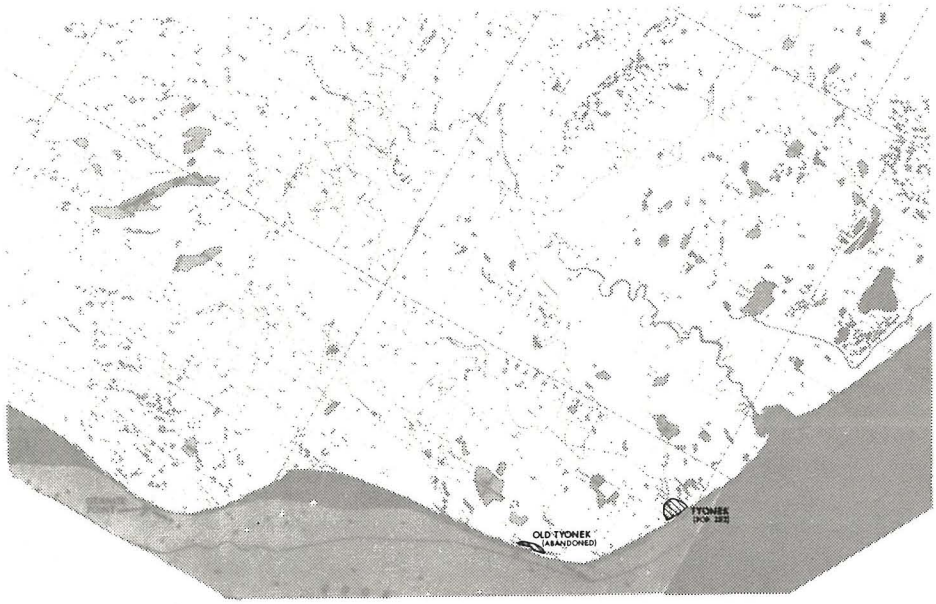
UNIMPROVED DIRT ROAD

EXISTING PIPELINE

EXISTING TRANSMISSION LINE

ARCHAEOLOGICAL SITE AND NUMBER - SEE NOTE 3

3 FOR DESCRIPTION AND REFERENCES SEE SECTION 2.4.1.1.8



POPULATION CENTERS MAP 1

LEGEND

SECONDARY ROAD

UNIMPROVED DIRT ROAD

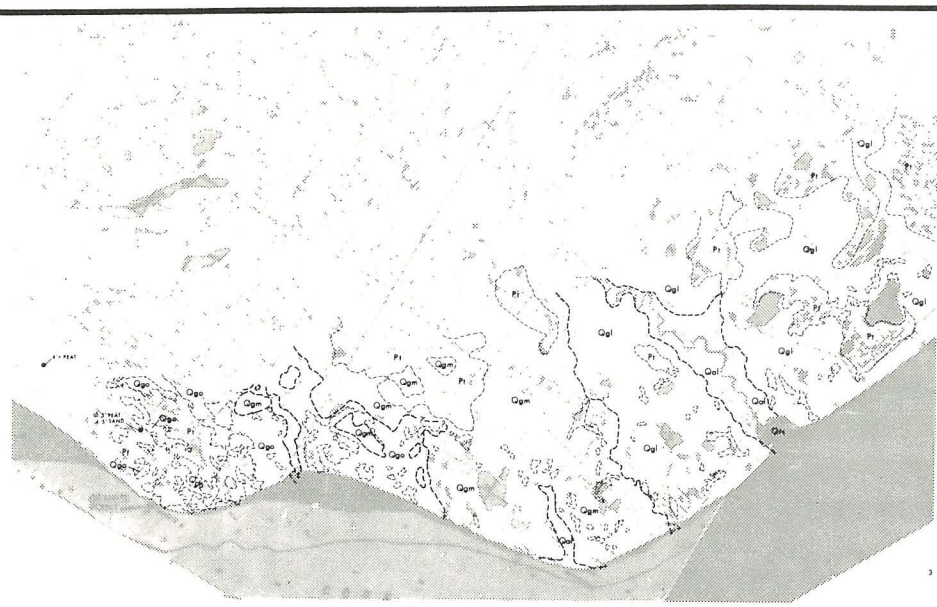
EXISTING PIPELINE

EXISTING TRANSMISSION LINE

COHOE (POP. = 100)

POPULATION CENTER AND POPULATION

EXAMPLES OF OVERLAYS SHOWING PERTINENT ENVIRONMENTAL AND ENGINEERING PARAMETERS OVER A PIPELINE STUDE ROUTE

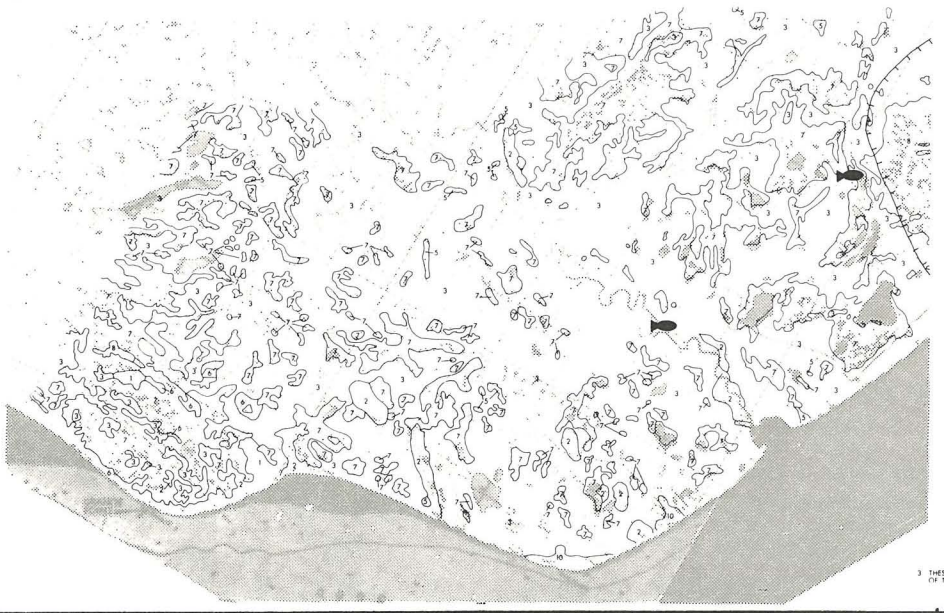


SURFICIAL GEOLOGY
MAP 1

LEGEND

- SECONDARY ROAD
- UNIMPROVED DIRT ROAD
- EXISTING PIPELINE
- EXISTING TRANSMISSION LINE
- BOUNDARY BETWEEN UNITS - ORGANIC
- BOUNDARY BETWEEN UNITS - INORGANIC
- BORING LOCATION (DAMES & MOORE)
- BORING LOCATION (U.S.G.S.)
- ALASKA STATE HIGHWAY DEPT., MATERIALS SITE
- Pt PEAT
- Qts TIDAL SILT
- Qal ALLUVIUM
- Qgl GLACIAL LAKE DEPOSITS
- Qgo GLACIAL OUTWASH
- Qgm MORAINE

3 DATA FROM AERIAL PHOTOGRAPH INTERPRETATION AND AVAILABLE LITERATURE



TERRESTRIAL AND
AQUATIC BIOLOGY
MAP 1

LEGEND

- SECONDARY ROAD
- UNIMPROVED DIRT ROAD
- EXISTING PIPELINE
- EXISTING TRANSMISSION LINE

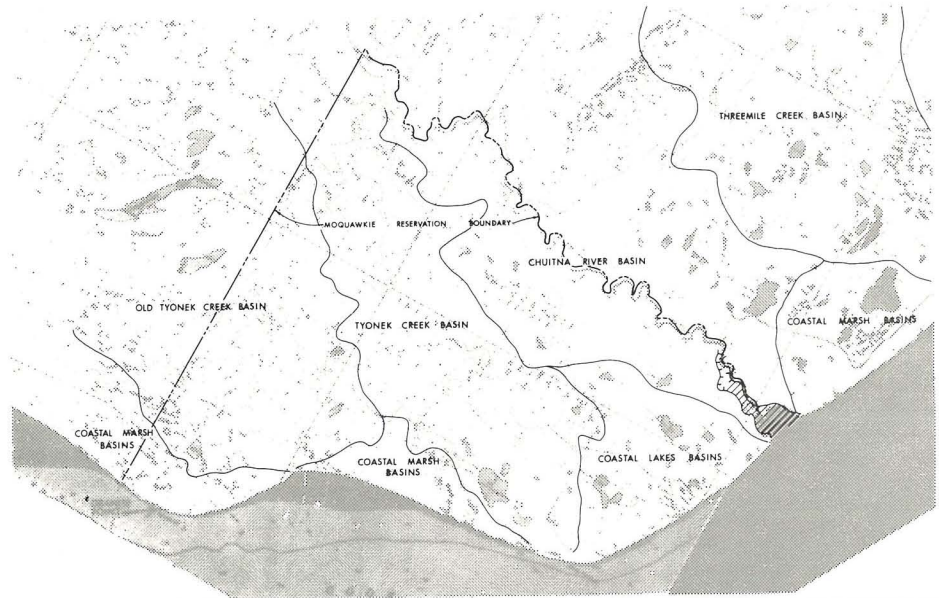
VEGETATION

1. EVERGREEN FOREST
2. DECIDUOUS FOREST
3. MIXED EVERGREEN - DECIDUOUS FOREST
4. EVERGREEN SCRUB
5. WILLOW - BIRCH SCRUB
6. ALDER SCRUB
7. MUSKEG
8. SPRUCE MUSKEG
9. WILLOW - BIRCH MUSKEG
10. NON - NATURAL VEGETATION
11. VEGETATION OF RECENTLY BURNED AREAS

WILDLIFE CONCENTRATION AREAS (SEE NOTE 3)

- SALMON SPAWNING AND/OR SPORTS FISH STREAM
- MOOSE: Spring - Summer concentration area. Northeast portion of study area is also a winter concentration area

3 THESE AREAS DENOTE HIGH CONCENTRATIONS DURING ALL OR PART OF THE YEAR



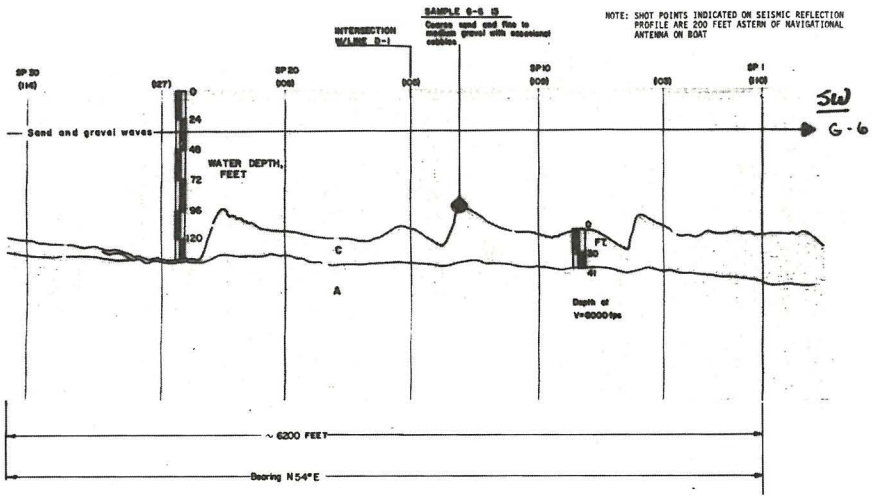
HYDROLOGY AND
DRAINAGE BASINS
MAP 1

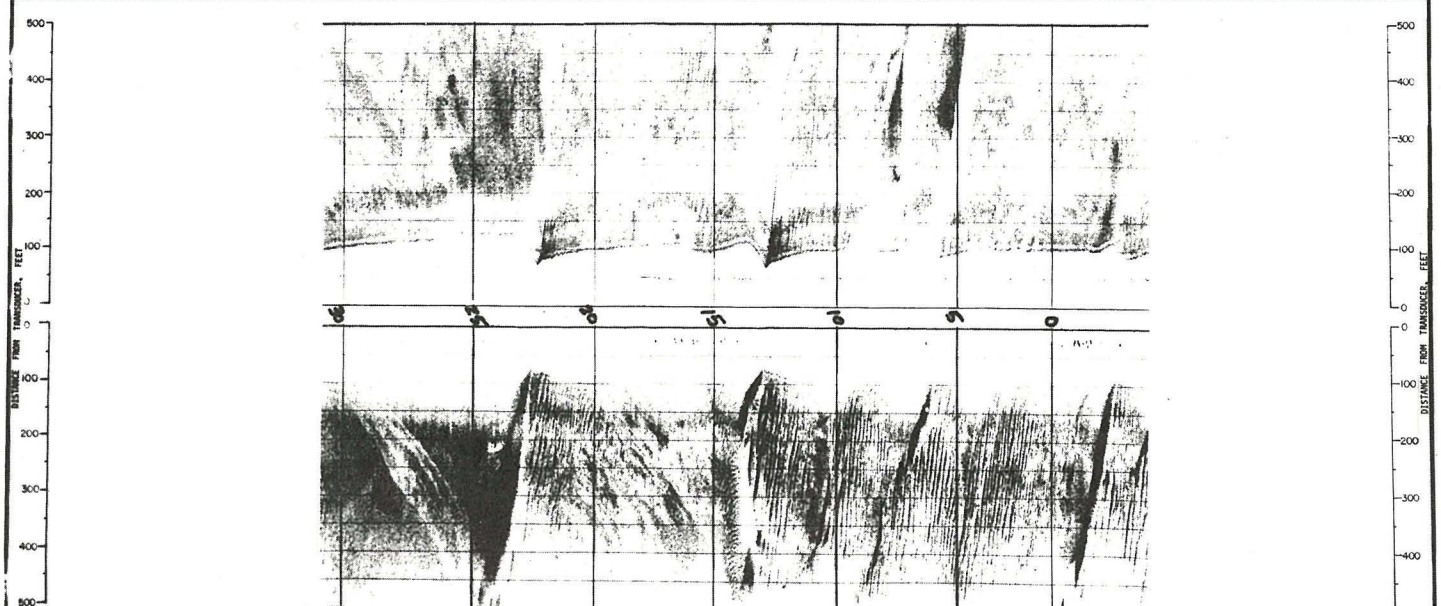
LEGEND

- SECONDARY ROAD
- UNIMPROVED DIRT ROAD
- EXISTING PIPELINE
- EXISTING TRANSMISSION LINE
- BOUNDARY OF MAJOR DRAINAGE BASIN
- RIVER FLOOD PLAIN
- AREAS SUSCEPTIBLE TO FLOODING BY EXTREME TIDES

EXAMPLES OF OVERLAYS SHOWING PERTINENT ENVIRONMENTAL AND ENGINEERING PARAMETERS OVER A PIPELINE STUDE ROUTE

DAMES & MOORE





SEISMIC REFLECTION PROFILE

ABBREVIATIONS & SYMBOLS

SP 130 - INDICATED NAUTICAL STATION (SHOT POINT)

(72) - INDICATED MLLW DATUM WATER DEPTH, FEET

◆ - LOCATION OF SAMPLE

——— GEOLOGIC CONTACT

NOTE: ASSUMED COMPRESSIONAL ACOUSTICAL WAVE VELOCITIES TO DETERMINE VERTICAL STRATUM THICKNESSES:

WATER	4800 fps
LAYER A (KENAI FORMATION)	12000 fps
LAYER B (GLACIAL TILL)	6000 fps
LAYER C (UNCONSOLIDATED POST-GLACIAL DEPOSITS)	6000 fps

NOTE HORIZONTAL DISTANCE BETWEEN EACH SHOT POINT IS APPROXIMATELY 200 FEET.

SIDE SCAN SONAR RECORD

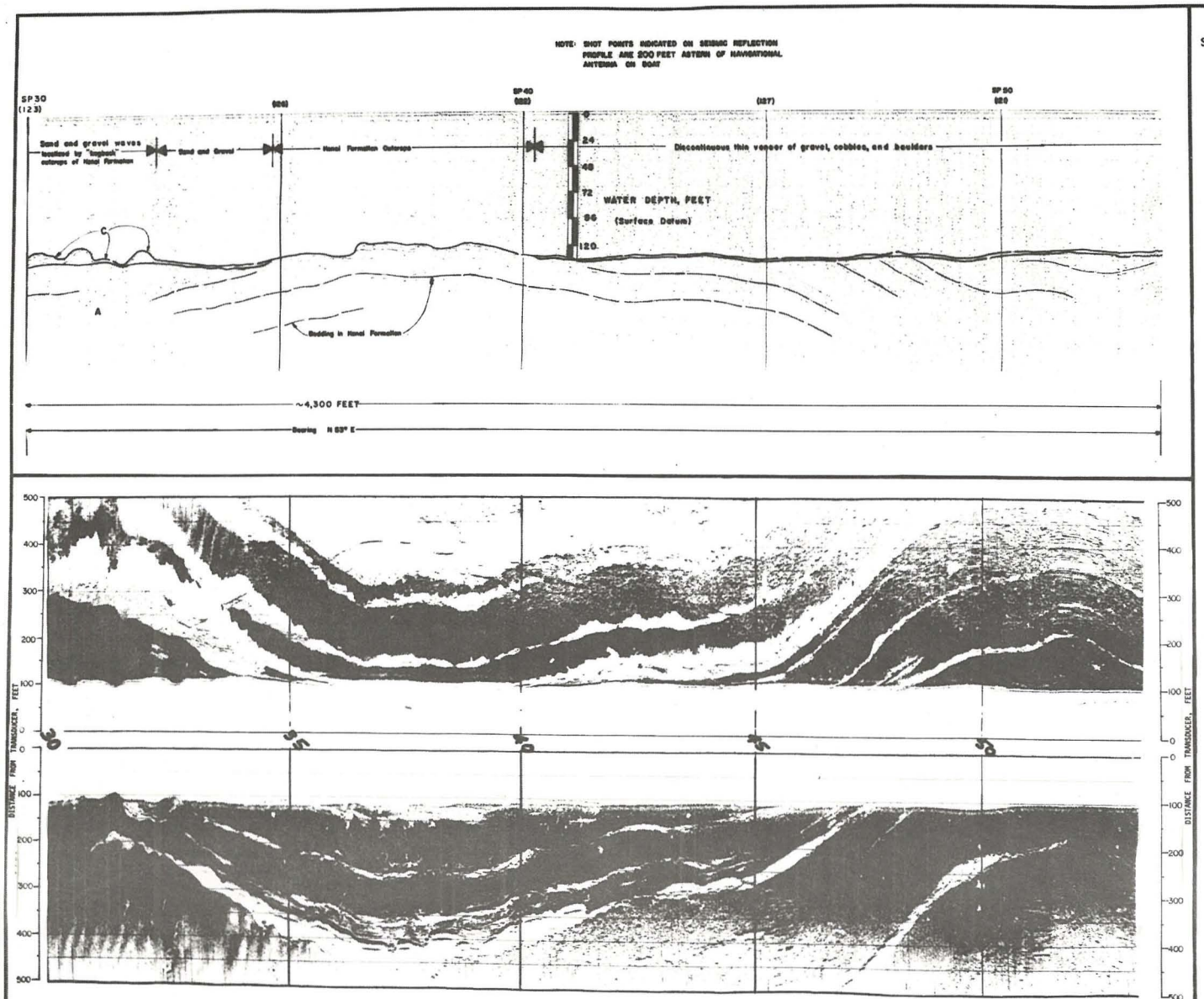
SEISMIC REFLECTION PROFILE & SIDE SCAN SONAR RECORD ALONG LINE G-6

FROM SHOT POINT 31 TO SHOT POINT 0

DAMES & MOORE

DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES



SEISMIC REFLECTION PROFILE

ABBREVIATIONS & SYMBOLS

SP 130 - INDICATED NAUTICAL STATION (SHOT POINT)

(72) - INDICATED MLLW DATUM WATER DEPTH, FEET

◆ - LOCATION OF SAMPLE

——— GEOLOGIC CONTACT

NOTE: ASSUMED COMPRESSIONAL ACOUSTICAL WAVE VELOCITIES TO DETERMINE VERTICAL STRATUM THICKNESSES:

WATER	4800 fps
LAYER A (KENAI FORMATION)	12 000 fps
LAYER B (GLACIAL TILL)	6000 fps
LAYER C (UNCONSOLIDATED POST-GLACIAL DEPOSITS)	6000 fps

NOTE: HORIZONTAL DISTANCE BETWEEN EACH SHOT POINT IS APPROXIMATELY 200 FEET.

SIDE SCAN SONAR RECORD

SEISMIC REFLECTION PROFILE & SIDE SCAN SONAR RECORD ALONG LINE G-4

FROM SHOT POINT 30 TO SHOT POINT 52

DAMES & MOORE

DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

MAP OF SUSITNA RIVER CHANNEL CHANGES FROM 1952 TO 1974

LEGEND:

RIVER CHANNEL 1952

RIVER CHANNEL 1974

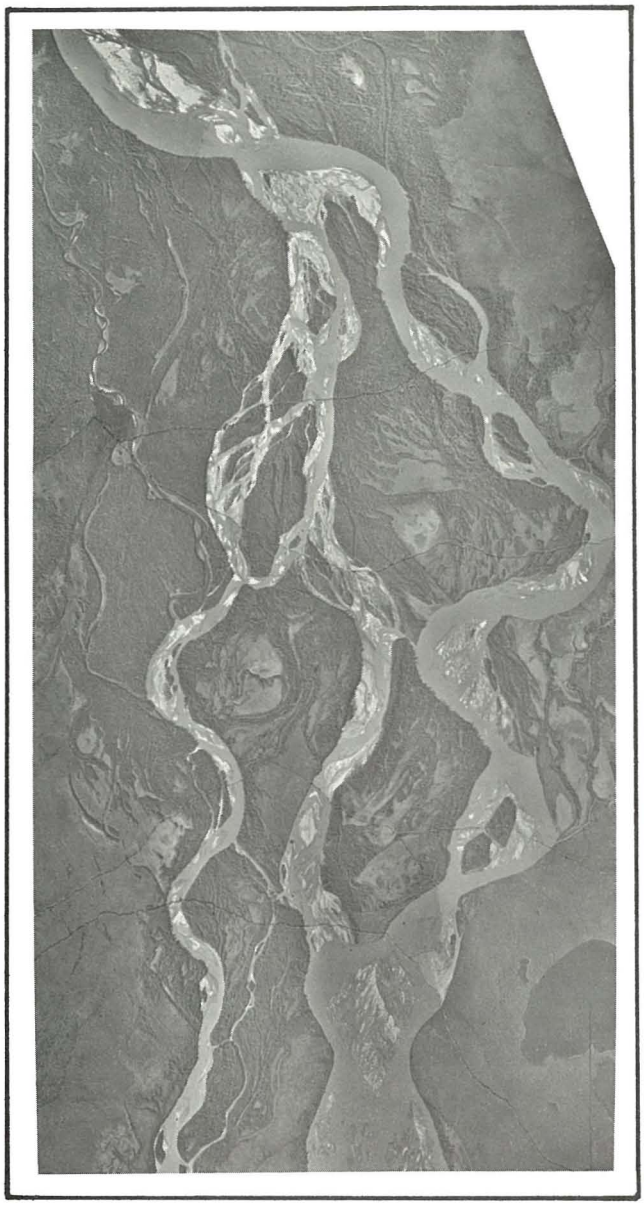
SCALE IN MILES

0 1 2 3

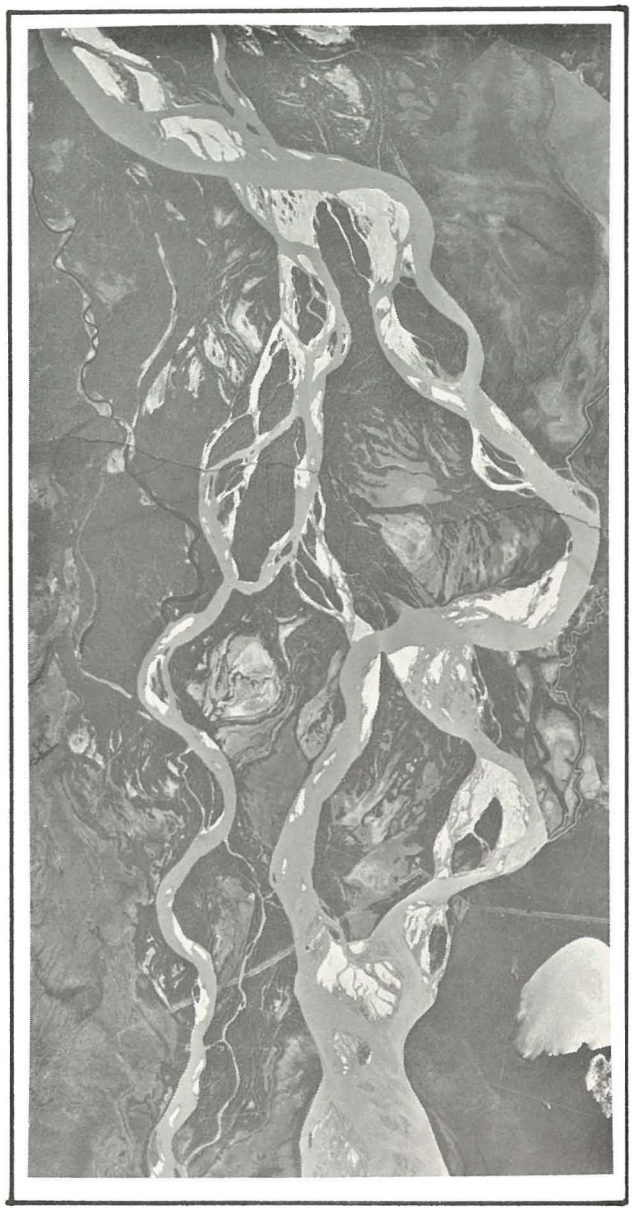
DAMES & MOORE

CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

PLATE



1950



1974

AERIAL PHOTOS OF SUSITNA RIVER, COOK INLET, ALASKA

SHOWING CHANGES IN RIVER CHANNELS FROM 1950 - 1974