REPORT ON

CONSTRUCTION MATERIALS SURVEY ALONG

MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED

PIPE LINE ROUTE --

PRUDHOE BAY TO 60TH PARALLEL

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INTRODUCTION

This report accompanies summary tables and mapsheets (Appendices 'A' and 'B') describing and showing the location, type, and volume of construction-material sources along the Mackenzie Valley Pipe Line Research Limited pipeline route between Prudhoe Bay, Alaska, and the 60th parallel of latitude, which corresponds to the Northwest Territories/ Alberta border.

TERMS OF REFERENCE

Authorization to conduct this office airphoto and map study was given by Mr. E. D. Wilson, P. Eng., Research Coordinator, Mackenzie Valley Pipe Line Research Limited, Calgary, in a letter dated July 19, 1971.

Excerpts from this letter are as follows:

"You are authorized to conduct an office gravel survey along the MVPLR route. A map showing the route will be mailed to you under a separate cover. The survey will show:

1. Location. The area will be boxed or outlined on a reproducible plan showing the location in respect to the pipeline route.

2. Estimated quantity. This would only be a ballpark figure as was previously discussed, e.g., ½" of map length, 1000 ft. wide and 5 ft. deep contains an estimated 2,000,000 cubic yards.

3. Indication of quality. A grading with respect to quality should be made in contractors' terminology e.g., well graded sand, no fines or poorly graded gravel, clay mixture, etc.

4. Estimate of overburden. Many of the gravel deposits will be covered with silts or organic material. The thickness and type of material which will have to be skimmed off to get to the gravel should be estimated where possible.

5. Method of mining. If the material must be quarried and crushed, harvested and/or crushed, blasted or scooped out of rivers, the method of mining should be proposed and noted on the map. Where river beds are the principal source of gravel, alternate supplies should be located where possible.

Many copies of this information will be required, so the final result should be reproducible."

KINDS OF CONSTRUCTION MATERIALS AVAILABLE

The two principal sources of construction materials along the proposed route between Prudhoe Bay and Fort Simpson are bedrock from quarries and sand, gravel, and cobbles occurring on the active floodplains of larger creeks and rivers. Other small sources of construction material are glaciofluvial (glacial meltwater) deposits, such as kames, kame-terraces, eskers, crevasse fillings, outwash plains, sand deltas, and sand dunes. Farther south -- between Fort Simpson and the 60th parallel -- small glaciofluvial and sandy deltaic and eolian deposits comprise the main sources of construction material. They can be supplemented by ablation till and basal till from borrow pits in topographic highs and well-drained situations.

All volumes are shown as cubic yards per foot of recoverable depth. Volumes are estimated only but are expected to be reliable on the whole, and especially so in the case of active floodplain and quarry rock materials.

Glaciofluvial deposits shown as kames, eskers, crevasse fillings, and high terraces are variable in composition. They contain varying proportions of sand, gravel, cobbles and boulders with lesser silt and till. Because of this, these prospects are shown directly as eskers, kames, etc., on the mapsheets -- rather than as sand and gravel as in the case of recent alluvial deposits on active floodplains.

BEDROCK QUARRIES

Large volumes of bedrock are available at specific locations along the proposed pipeline route between Prudhoe Bay and Fort Simpson.

Prospective bedrock-quarry sites have been mapped. Anticipated available quantities of quarry rock are shown at smaller bedrock quarries only. The larger bedrock deposits, representing many hundred millions of cubic yards of construction material, are shown simply as an "unlimited supply." In these areas, recoverable depths might be several tens of feet, if necessary.

Quarry rock used as fill material probably will not require crushing if it is properly blasted. Blasted materials will tend to segregate as they are dumped in the fill, with the coarser material forming the lower layers of fill and the finer material forming the near-surface layer. Some crushed material or natural sand and gravel will likely be required to "top off" the surface of roads and airstrips. Any loose surficial cobbles, boulders, and other weathered bedrock debris that can be stripped readily at quarry sites may also be used as fill material.

All bedrock quarry sites should yield materials suitable for fill purposes. However, field reconnaissance is required in order to select the best site for a quarry. Bedrock suitable for use as mass concrete aggregate may be obtainable at many of these potential quarries. Where thin concrete walls or reinforced concrete is subject to severe cyclic freeze-thaw action, it may be necessary to haul better quality materials from greater distances (see section on Deleterious materials).

Generally speaking, visual examination in the field will result in the identification of harder, more massive beds or formations in sedimentary and metamorphic rock exposures.

EXPOSED FLOODPLAIN GRANULAR DEPOSITS

Large quantities of sand, gravel, and cobbles are available from the near-surface layer in exposed bars on braided floodplains of major streams along the proposed pipe line route. These granular materials tend to be gap-graded and locally silty.

Depth of granular materials that can be harvested is dependent on the unfrozen zone (active layer) and depth of granular material over till or bedrock, as the case may be. The recoverable depth is expected to range from as little as 1 foot to up to a maximum of around 4 feet in Alaska and the Yukon with an average of around 2 feet and increasing in depth toward the south and southeast in the continuous permafrost region.

In order to keep silting of streams to a minimum during harvesting operations, working areas can be dyked off to divert water flow away from them (see Fig. 1). After the granular material behind the dyke has been excavated and stockpiled and after shallow water behind the dyke has become clear, the dyke can be breached and harvesting operations shifted upstream.

The best time to harvest sand and gravel from streambeds should be late in the summer or early fall when the river is at a low stage and when the maximum seasonal thaw depth has been reached. Material from streambeds will be suitable for fill material. All high-quality concrete will necessitate crushing, washing and sizing of aggregates.

Most major rivers and large creeks between Prudhoe Bay and Sans Sault Rapids on the Mackenzie River -- with the notable exceptions of the Peel River and the Arctic Red River -- appear to harbour significant quantities of sand, gravel, and cobbles -- in general decreasing in average grain size downstream. Small sand and some gravel deposits are also available from exposed point bars on the inside of loops on the larger meandering streams. Also, Mackenzie River bars should not be overlooked, especially in localities just downstream of the mouths of large steep-gradient tributaries.

GLACIOFLUVIAL SAND AND GRAVEL DEPOSITS

Glaciofluvial deposits -- including variable ice-contact deposited kames, eskers and crevasse fillings on the one hand and proglacial valley-train terraces and outwash plains on the other -- are less attractive sources of construction material west of the Arctic Red River. But they become more significant and attractive-appearing southeast of here, where they may be unfrozen to depths of 5 feet or more. Field reconnaissance and some subsurface exploration and testing will be required to discover the more deeply unfrozen areas on south-facing slopes and to locate the best places to develop borrow pits for materials suitable for concrete aggregates on the one hand or fills on the other.

The best sites to develop are well-drained topographic highs, where the water table is low and the granular material is dry and friable or is so-called "dry frozen." The overburden of peat, organic silt or till is expected to be thinner and have a lower moisture content on topographic highs in the case of eskers, kames, and crevasse-filling ridges. Being ice-contact in origin, the individual silt, sand, gravel and bouldery strata are likely to exhibit collapse features -- that is, faults, broken beds, small contortions and large folds. Overburden depths vary from 1 foot to as much as 10 feet in places.

SANDY DELTAIC DEPOSITS

The only glaciolacustrine deposits that are significant in terms of prospective construction materials are clean and slightly silty deltaic fine to coarse sands and also sand and gravel in glacial-lake strandlines (a small and unimportant source). These sandy materials are prospective sources of fill material and may be used as a portion of the fine fraction in concrete aggregates, mainly as blending sand. Field reconnaissance is required to select locations where the water table is lower and the peat and organic overburden is thinner in order to reduce the amount of stripping and ripping that is required. In the Fort Simpson area, where the deltaic sands are expected to be thawed to depths exceeding 10 feet locally, large volumes of fine-granular (sand) borrow will be available.

The largest outwash sand and gravel deposit occurs on the upland between the Mountain and Hume Rivers. Here many hundreds of millions of cubic yards of sand and gravel are variably unfrozen and frozen.

SAND DUNE DEPOSITS

The only eolian (wind-formed) deposits that are significant as sources of construction materials are sand dunes, derived mainly from glacial-lake deltaic fine to medium sands. Material in dunes is expected to be poorly graded fine sand with an average grain size of around 0.5 mm and uniformity coefficient of 2 to 5. Most sand in dunes falls between 0.3 and 0.7 mm.

In the Fort Simpson area, sand dunes are expected to be locally unfrozen to depths exceeding 10 feet and commonly to depths of 5 feet. Higher sand dunes in better-drained areas, with little or no peat cover and with greater unfrozen thicknesses, can be very easily selected in order to obtain maximum recoverable volume of sand per unit area of pit surface.

GLACIAL TILL DEPOSITS

South of Fort Simpson, and also in some locations north to Sans Sault Rapids, low to medium plastic glacial till is considered significant as a potential source of fill material.

Borrow pits should be located at places where the till is relatively dense (a low water/ice content of 8 to 11% or dry frozen) and well drained (lower water table). Examples are drumlinized ground moraine and areas of hummocky moraine. Elevated,well-drained areas are expected to have a thinner cover of peat and slopewash organic silt and sand. Consequently, less stripping will be required and high moisture content will also be less of a problem.

DELETERIOUS MATERIALS

Natural materials proposed for use as concrete aggregate should be checked for deleterious substances, especially where the concrete will be used in walls and foundations subject to cyclic freeze-thaw action and to prolonged vibratory fatigue stresses from mechanical equipment in compressor stations. In most cases it is expected that deleterious rock types can be avoided, or used only as fill material.

Some rock types that are deleterious for high-quality, high strength, durable concrete aggregate are as follows:

Chemically reactive rocks: opaline cherts, opaline shales, chalcedonic cherts, some siliceous limestones, rhyolite and rhyolite tuffs, andesites, phyllites, and schists.

Physically unsound rocks: weak micaceous rocks (schists, phyllite); shales and slates and similar clayey rocks; friable limestones and certain argillaceous dolomites; some weathered micaceous very coarse crystalline rocks (granites, gneisses); some cherts; soft and friable sandstones and siltstones (mainly Cretaceous age and younger). Rock types occurring in the bedrock-quarry prospects are shown on the accompanying descriptive summary sheets for each prospect.

SUMMARY OF OCCURRENCES OF MAIN CONSTRUCTION-MATERIAL SOURCES

A summary of distribution of main construction-material sources along the Mackenzie Valley Pipe Line Research Limited proposed pipe-line route is as follows:

1. Prudhoe Bay to Coleen River. Large volumes of shallow floodplain sand, gravel and cobbles and widespread bedrock quarry sites are available.

2. Coleen River to Old Crow. Large volumes of hard bedrock (mainly granite and metamorphosed sedimentary rocks) available for quarrying.

3. Old Crow to Driftwood River. Widely separated bedrock outcrops and some small-volume shallow alluvial sand and gravel deposits are available.

4. Driftwood River to Peel River. Large volumes of bedrock (sandstone, conglomerate, minor limestone) and fairly large volumes of sand and gravel along Stony Creek, Bell River, and the westward flowing Rat River (and the more-distant eastward-flowing Rat River) are available.

5. Peel River to Arctic Red River. No evident sources of granular material appear in the search-area. Anticipate use of sandstone or shale quarry rock from banks of the Peel and Arctic Red.

6. Arctic Red River to Sans Sault Rapids. Small eskers, large kames, large outwash sand and gravel and high terraces are available. Variable overburden depth and variably frozen and unfrozen. Vary from good to doubtful.

7. Sans Sault Rapids to Great Bear River. Large volumes of bedrock is available for quarrying. Some small sand and gravel deposits occur as streambed alluvium, ice-contact sand and gravel and sand dunes.

8. Great Bear River to Blackwater River. Better-looking granular deposits mainly occur as high terraces. Some small bedrock outcrops also occur along this segment of proposed pipe line route.

9. Blackwater River to Willowlake River. Large volumes of bedrock, small granular deposits, and drumlinized ground moraine are available.

10. Willowlake River to Fort Simpson. Bedrock and scattered granular materials in kames are available below the Ebbutt Hills.

11. Fort Simpson to 60th parallel (Alberta border). Large volumes of construction materials in this area range from fine sand in dunes to sand, gravel, boulders and till in eskers and crevasse fillings as well as till from well-drained topographic highs in ground moraine areas.

OTHER PERTINENT OBSERVATIONS

1. Practically all active floodplain and bedrock sources of construction material can be observed visually. Therefore, they are expected to require very little shallow to no test drilling and test-pit excavation in order to evaluate them in greater detail. This is a tremendous advantage over silt or till-mantled sand and gravel deposits in fossil (inactive) floodplains and some ice-contact deposits, respectively.

2. Glaciofluvial deposits and till borrow areas require more extensive and intensive field exploration and testing in order to determine a) the depth and volume of overburden requiring stripping, b) the soil moisture content ("dry frozen" versus excess ice, as in clay-rich tills on the Peel Plain between Sans Sault Rapids and the Peel River near Fort McPherson), c) the depth of active layer or depth of unfrozen material, and d) the gross structural character of the deposits (stratification, or layering arrangement) and physical properties of the aggregate(strength, soundness, chemical reactivity, etc.).

3. A few potential advantages in developing rock-quarry sites over harvesting loose, unfrozen sand and gravel from riverbeds, especially northwest of Sans Sault Rapids, are the following:

a) expected less costly environmental precautionary measures required in order to prevent disturbance to the natural physical environment and plant and animal ecology factors -- i.e., silting of rivers and creeks and possible effects on waterfowl and fish

b) substantially larger volumes of recoverable construction materials available per unit-area of borrow pit developed

c) the fact that permafrost is unlikely to hinder hardrock quarrying operations to any great extent, whereas permafrost will restrict the depth of sand and gravel below a depth of a few feet in riverbeds, making the latter difficult, slow, and costly

d) generally borrow pits in bedrock quarries can be readily drained so that they will remain dry, whereas the lower portion of sand and gravel strata in riverbeds in continuous permafrost regions will have to be recovered from below river water

e) the working season in bedrock quarries will be limited only by extremely cold weather and by daylight hours whereas unpredictably long waiting periods may be necessary to obtain low-water stages in the river and for the time of maximum seasonal thaw in riverbeds in continuous permafrost regions

f) most of the haul distance from bedrock quarries will be downhill and thus less expensive than uphill haul up and out of river channels

g) the quality of rock material from bedrock quarries is likely to be much more consistent, predictable and easy to control than the customary assortment of rock types found in most alluvial sands and gravels derived from a variety of parent rock types in source areas. This may be a critical factor in obtaining high quality concrete aggregate in a few localities.

4. A large range of particle sizes -- from large angular blocks of bedrock down to sand and silt sizes -- are usually available from quarry operations. This can be controlled largely by proper shooting and blasting

techniques. In any event, the large range in sizes might prove to be desirable in roadbed and airstrip construction. Where rock material is dumped in roadbed construction by the end-haul method, normally it is a fairly simple matter to segregate the larger and smaller materials by pushing the larger rock fragments over the end of the grade with bulldozers. This is probably a desirable type of construction because it would tend to form a coarser more permeable "openwork" subgrade, leaving the finer materials for topping of the roadway. In fact, we feel this could be an important concept in design of the roadway because it provides a capillary break between the underlying tundra and the finer materials above and permits leakage of upslope waters that might be temporarily ponded. Also, the larger the particle size in the roadbed the less chance of complete removal of the road bed from overtopping of the road by such things as sudden heavy runoff from cloudbursts and blocking of culverts with ice.

5. In mapping construction-material sources, some of the smaller, more-doubtful-looking granular deposits have been omitted -- particularly in areas where large, obvious and much better-looking construction material prospects are available. Small and doubtful deposits were only considered significant in areas where large volumes of material are scarce or remote from the proposed pipe line route.

6. In general, in vicinity of Fort McPherson and Arctic Red, the hummocky moraine deposits are highly variable and change in soil and ice content over a matter of a few feet. The ground moraine on undulating terrain is composed of a clay-rich till derived from shale east and west of the Arctic Red River. It is likely to contain a fair amount of segregated ice.

Thus the places to check for usable dry till for subgrade fill construction lie generally south of Norman Wells and, even then, in well-drained, south-facing (sunny) situations.

7. We believe that it can be argued there could be much less damage done to the ecology (fish, waterfowl, wildlife) by carefully designed and controlled removal of gravel from exposed bars in the river than by stripping and stockpiling of peat and organic silt and fine sand overburden on 'fossil' (inactive) flood plains.

8. There is a large amount of shale, soft siltstone and fine-grained sandstone exposed and below the overburden along the proposed pipe line route. This material is easily eroded and can form a large portion of sand and gravel sizes in alluvial flood plain deposits. We have found that these can be easily and economically removed by a "deshaler" here in the Prairie Provinces. It may be necessary to beneficiate the natural sand and gravel deposits locally in order to produce high strength, high durability concrete for special purposes. Thus this method of processing might be advantageously investigated.

9. One of the toughest areas for finding natural sand and gravel is the area from west of Fort McPherson to east of Martin House. In this region the best sources of fill and aggregate are likely to be sandstone quarry rock that is a cap rock (as at Shiltee Rock) and as valley walls (as about 10 miles below Martin House on the right (east) side of the Arctic Red River Valley.

10. Generally the beds of streams in Alaska on the so-called Mountain Route are coarse and cobbly. Where they are wide and braided they contain large quantities of coarse gravel to sand per foot of depth. Streambed gravels in Alaska are thought to contain less silt than the Porcupine River and its tributaries in the Yukon. However, they are still likely to contain sand beds and vary locally from clean to silty.

11. The Porcupine River contains a great deal of silt and is muddy much of the year. Gravel deposits with material up to 3 inches in size contain high quantities of silty and fine sandy sediment below the active flood plain. This fine material would have to be removed by washing if these deposits were to be used in concrete manufacture. A small deposit of gravel occurs where the Old Crow River joins the Porcupine River in vicinity of Old Crow Village.

12. The Old Crow River flood plain is underlain mainly by thick silt and fine sand sediment along its flatter reaches; and it is not until its junction with Thomas Creek, just east of the Canada-Alaska border, that the Old Crow River becomes clean and gravel-bottommed. Bedrock outcrops have been reported to occur along the side of the Old Crow River opposite Mt. Schaeffer.

13. The Driftwood River contains some gravel to fist-size, with much of the gravelly material falling in the pea size to marble size range. At least this is the situation where the proposed pipeline route crosses the Driftwood River. A wide active flood plain composed of sand and coarse gravel occurs in the lower reaches of the Driftwood.

14. In vicinity of Lapierre House, the Bell River is believed to contain silty gravel in the bed and at larger point bars; the gravel here is commonly less than 3 inches in size.

15. The west-flowing Rat River Valley, above its junction with the Bell River, contains large volumes of dirty sand and gravel below a broad, braided active flood plain.

16. On the Peel Plateau west of the Peel River, the middle higher-energy reaches of Stony Creek, of east-flowing Rat River, and of Vittrekwa River all contain large quantities of gravel and sand. Also, on the Peel Plateau, small kame hillocks occur in the hummocky end moraine topography just north of the junction of the Coastal Route and the Mountain Route -- that is, roughly west-northwest of Fort McPherson. But the active layer is thin on these sand and gravel hillocks; moreover, the hillocks themselves are quite small and scattered in occurrence. They are therefore considered relatively poor prospects. They appear on the airphotos as whitish-toned knobs.

17. The Peel and Arctic Red River Valleys contain mainly silt and sand in their lower reaches -- for at least 50 miles above their junction with the Mackenzie Delta and with Mackenzie River, respectively. As a consequence, the best construction-material sites are high sandstone river banks and isolated buttes between the Peel River and the Richardson Mountains; and high, dry sandstone and shale bluffs along the Arctic Red River.

18. Between the Arctic Red and the Mountain River the best prospects are a) sparsely scattered kames and eskers, b) small fluvial terraces and point bars along the steeper sections of the Ramparts and Hume Rivers, and c) the large channel-scarred gravelly outwash in the flat divide between the Hume and Mountain Rivers.

19. Virtually all large braided rivers tributary to the Mackenzie River between Sans Sault Rapids and Fort Simpson contain sand and gravel, with the coarsest gravel occurring in braided streambeds on the west side of the Mackenzie, generally a few miles above the mouths of these high-energy streams. As an example, the Mountain River active flood plain carries very coarse cobbly gravel between its junction with the Gayna River and the first major bend in the Mountain River west of its mouth. Yet between this point and the mouth of the Mountain these coarse gravels play into silt and sand.

20. Apparently the Mackenzie River itself carries relatively little sand and gravel that would be suitable for road-surfacing or concrete-aggregate purposes. Most of the scattered pebbles and stones on exposed bars and beaches overlie silt and fine sand or till in the case of beaches at the edges of the Mackenzie River.

21. Numerous quarry bedrock sites occur along the proposed pipeline route in Alaska. Most of these quarries will yield suitable fill material. Field inspection is required, however, in order to isolate the best places to prospect for good, durable aggregate for use in high-strength concrete. Nevertheless, most large rock-outcrop areas will yield local areas containing suitable rock in the quantities desired for aggregate material. Dominant rock types are quartzitic sandstone, greywacke sandstone, shale, limestone and dolomite, chert, phyllite and slate, and schist. A small area of granitic intrusive rocks straddle the Alaska/Canada border north of the Porcupine River.

22. In the Yukon west of the Old Crow River, the alleged area of granitic intrusive rocks outlined on bedrock-geology maps should be reduced in size by about 60%. In the airphotos the granitic-rock areas can generally be told from older metasediment "roof pendants" because the granitic rocks tend to form spire-shaped, turret-like shapes.

23. Between the Old Crow and the Driftwood Rivers the bedrock along the route is about 70% shale, with the remainder of the exposed rock being somewhat better quality for use in road and airstrip fills and for aggregates used in concrete. Bedrock surrounding Mt. Schaeffer contains relatively high contents of chert and mica in phyllites as well as quartzite, slate, and conglomerate and basic dikes.

24. Between the Driftwood and Peel Rivers the bedrock consists largely of Cretaceous shale and sandstone. Here one should try to select areas of harder sandstone rock as potential quarry sites. These sites often occur as flat-irons, buttes, and as ribs of harder rock outcrop in steep river banks and mountain sides.

25. Potential shale rock quarry sites occur along the lower Peel and Arctic Red Rivers. Here again they should be carefully selected so that any shales and sandstones used will have as low moisture contents as possible. Shale quarries are now being opened in vicinity of Arctic Red Village. This material is being hauled west for use in the construction of a new road linking Fort McPherson and Inuvik.

26. We have shown potential till borrow areas but it is questionable that these can be used because the moisture content of the frozen till can vary

erratically from 8 to 10% moisture (probably suitable for fill borrow) to 25 to 50%. The higher moisture content tills will likely be unsatisfactory as fill borrow unless the ripped frozen chunks of till are placed in the fill and allowed to thaw over one season, then compacted with a dozer and trimmed with a blade grader the following year. Accordingly, we would tend to downgrade the till borrow areas from the standpoint of fill borrow prospects -- especially those till deposits north of Fort Simpson. Yet we believe till at this latitude can be ripped with heavy equipment if the boulder concentration is not too high.

In till areas, one should avoid the peat plateau (bog speckled) phase. This phase is mapped RKM(BS) on the terrain mapping done for MVPLR and NPSG. From our experience elsewhere, these peat-plateau deposits are among the hardest terrain to rip because of poor traction for ripping equipment. On one occasion a "cat" operator was drowned in a collapse scar (whitish bog speckle) in 40 below zero weather -- possibly owing to potentially upward-moving slightly warmer groundwaters that had not frozen because of the heavier snow cover on the sedge meadows.

27. We feel that the coarser and cleaner delta deposits -- for example, deposits mapped DLc-- will yield large quantities of unfrozen sand but that areas mapped as DL would be poor to unsuitable borrow prospects. Exceptions are places where high dunes have formed, as in vicinity of the confluence of the Liard and Mackenzie Rivers.

28. Granular deposits occur in vicinity of the proposed pipeline route along lower Poplar River and Jean-Marie Creek. Granular strata also occur at islands in the lower Liard River but the overburden is thick and they may be uneconomic to develop. Crevasse fillings south of here are narrow and sandy and highly variable in composition.

DIAGRAM SHOWING
ONE METHOD OF HARVESTING SAND AND GRAVEL FROM RIVER BARS IN ORDER TO MINIMIZE ADDING SILT TO RIVER FROM GRAVEL EXTRACTION

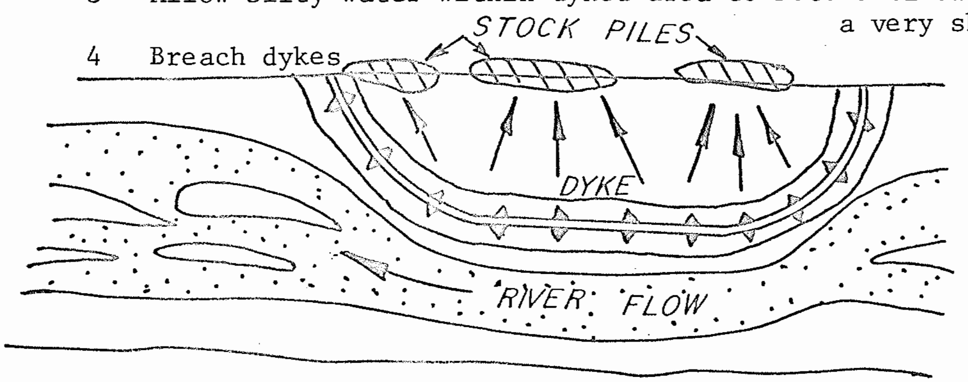
STAGE 1

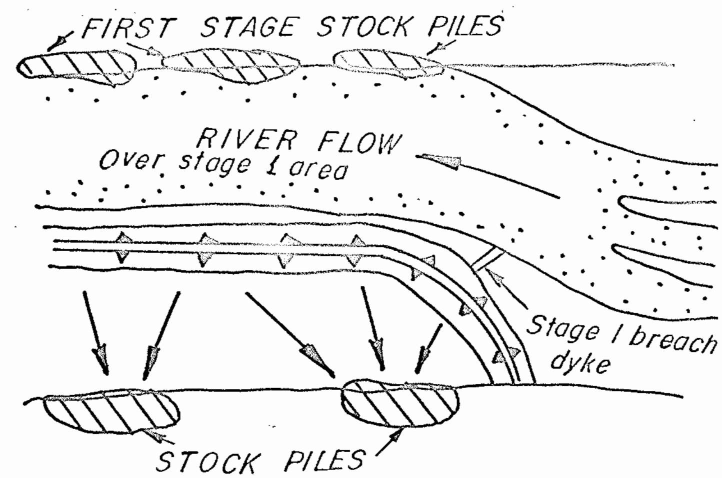
1 Construct a low dyke around the proposed gravel-harvesting area to divert river flow and retain silt and silty water in the recovery area during extraction of sand and gravel

2 Harvest the top few feet of sand and gravel and place in stockpiles or haul directly to construction sites

3 Allow silty water within dyked area to become clear, which should take a very short time

4 Breach dykes





NOTES

1 The harvest area may be one mile or more in length along the exposed riverbed

2 Desirably, the harvesting operations should take place during a period of low river flow and maximum seasonal thaw of permafrost in the riverbed

3 Any waters from the recovery area that filter under or through the pervious dyke should present no serious problem in contamination

STAGE 2

1 Construct a low dyke on the opposite sid of river and divert the river across the area previously excavated to a depth of a few feet during the first stage of operations, thus retaining any silt durin recovery from the opposite side of the river bottom

2 Harvest sand and gravel and stockpile

3 Allow water to become clear within dyked-off borrow pit

4 Breach dykes and move operations upstream

APPENDIX 'A'

Description of individual construction-material sources along Mackenzie Valley Pipe Line Research Limited pipe-line route.

	No. 1				No. 2			
Intended use of material	airport	original pump-station No. 1	roads		roads			
Location where material required -- milepost	0	0	0 - 10		10 - 23			
Volume of material required in cubic yards x 10^5	1.5	2.5	2.0		2.6			
Haul distance in miles	± 3	± 3	± 3		± 6 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	90				45			
Estimated recoverable depth in feet	2 ft average; depends on thawed depth				2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	180				90			
Estimated overburden depth and type of material	nil				nil			
Method of mining	harvest from riverbed and crush* for concrete aggregate				harvest from riverbed and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand and gravel along the active floodplain of the Sagavanirktok River; suitable for fill and concrete aggregate; field check for deleterious material				alluvial sand and gravel along the active floodplain of the Sagavanirktok River (main channel); suitable for granular fill and concrete aggregate; field check for deleterious material			

*See accompanying report for detailed explanation of suggested mining and crushing operations.

	No. 3				No. 4			
Intended use of material	expansion pump station no. 2	roads			original pump station no. 3	roads		
Location where material required -- milepost	37	23 - 40			67	40-78		
Volume of material required in cubic yards x 10^5	2.5	3.4			2.5	7.6		
Haul distance in miles	± 2.5	6 average			± 2	right-of-way follows floodplain		
Estimated volume of material available per foot of depth in cubic yards x 10^5	15				60			
Estimated recoverable depth in feet	2 ft average; depends on thawed depth				2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	30				120			
Estimated overburden depth and type of material	nil				nil			
Method of mining	harvest from river and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand and gravel along the active floodplain of the Shaviovik River; suitable for granular fill and concrete aggregate; check for delterious material				alluvial sand, gravel, and cobble along the active floodplain of the Kavik River; suitable for granular fill and concrete aggregate; check for deleterious material			

	No.5 6 bedrock outcrops				No. 6			
Intended use of material	supplement or alternate to deposit No. 4				roads			
Location where material required -- milepost					78 - 93			
Volume of material required in cubic yards x 10^5					3.0			
Haul distance in miles	1½-2½ to pump-station No. 3	7 average for roads			4 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	6				40			
Estimated recoverable depth in feet	+ 20 ft; depends on economic excavation depth				2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	120				80			
Estimated overburden depth and type of material	may require local stripping of weathered bedrock layer				nil			
Method of mining	develop bedrock quarry and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Cretaceous sandstone, siltstone and shale; includes some pyroclastic rocks; suitable for granular fill, sandstone preferable for concrete aggregate				alluvial sand, gravel and cobbles along the active floodplain of the Canning River; suitable for granular fill and concrete aggregate; check for deleterious material			

	Deposit No. 7				Deposit No. 8			
Intended use of material	airport	original pump-station No. 4	roads		alternate or supplement to deposit No. 7			
Location where material required -- milepost	100	100	93-105					
Volume of material required in cubic yards x 10^5	1.5	2.5	2.4					
Haul distance in miles	$\pm$ 1	$\pm$ 1	3 average		$\pm$ 3 to airport and pumpstation		right-of-way follows floodplain	
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited				40			
Estimated recoverable depth in feet					2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5					80			
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer				nil			
Method of mining	bedrock quarry and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Devonian or older massive schistose quartzites and quartz mica-schists; includes phyllite and slate; may locally include phyllite with interbedded chert, quartzitic sandstone, slaty limestone, and calcareous siltstone; careful field selection needed to avoid deleterious material for concrete aggregate				alluvial sand, gravel and cobble along the active floodplain of the Canning River; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 8A Canning to Chandalar River	No.
Intended use of material		
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles		
Estimated volume of material available per foot of depth in cubic yards x 10^5	5	
Estimated recoverable depth in feet	± 2 ft; depends on thawed depth	
Estimated volume available in cubic yards x 10^5	10	
Estimated overburden depth and type of material	nil on active floodplain	
Method of mining	harvest from river and crush for concrete aggregate	
Notes: type of material, suitability, etc.	alluvial sand, gravel and cobbles along active floodplain of Canning River; suitable for granular fill and concrete aggregate; check for deleterious material	

	No. 9	No. 10
Intended use of material	alternate or supplement to deposit No. 7	road
Location where material required -- milepost		105-120
Volume of material required in cubic yards x 10^5		3.0
Haul distance in miles	1-3 to airport and pumpstation; 4 average for road	4 average depends on quarry location
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited	essentially unlimited
Estimated recoverable depth in feet		
Estimated volume available in cubic yards x 10^5		
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	may require stripping of weathered bedrock layer
Method of mining	bedrock quarry and crush for concrete aggregate	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	similar to material in deposit No. 7; contains deleterious material for concrete aggregate, which might be avoided by careful field examination	predominantly massive schistose quartzite and quartz-mica schist; includes phyllite and slate; variable as a source of borrow; schist, phyllite and slate are poor sources of aggregate if weathered

	Deposit No. 11				Deposit No. 12			
Intended use of material	alternate or supplement to deposit No. 10				original pump station No. 5	road	original pump station No. 6	
Location where material required -- milepost					127	120-195	145	
Volume of material required in cubic yards x 10^5					2.5	15	2.5	
Haul distance in miles	right-of-way follows floodplain				$\pm$ 1	depends on location of quarry sites	$\pm$ 1	
Estimated volume of material available per foot of depth in cubic yards x 10^5	5				essentially unlimited			
Estimated recoverable depth in feet	2 ft average; depends on thawed depth							
Estimated volume available in cubic yards x 10^5	10							
Estimated overburden depth and type of material	nil				may require stripping of weathered bedrock			
Method of mining	harvest from river and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand, gravel, and cobbles along Marsh Fork of Canning River; suitable for granular fill and concrete aggregate; check for deleterious material				Mississippian fine- to coarse-grained limestone and dolomite with nodular to bedded chert; this type of bedrock material is available along the right-of-way from mile 120 to mile 195; chert may or may not be deleterious if used as concrete aggregate (see report)			

	No. 13	No. 14
Intended use of material	supplement or alternate to deposit No. 12	road alternate or supplement to deposit No. 12
Location where material required -- milepost		150-170
Volume of material required in cubic yards x 10^5		4.0
Haul distance in miles	2-3 to pump stations; road follows floodplain from mile 120 to mile 148	5 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	5	2
Estimated recoverable depth in feet	2 ft average; depends on thawed depth	2 ft average; depends on thawed depth
Estimated volume available in cubic yards x 10^5	10	4
Estimated overburden depth and type of material	nil	nil
Method of mining	harvest from river and crush for concrete aggregate	harvest from river and crush for concrete aggregate
Notes: type of material, suitability, etc.	alluvial sand, gravel, and cobbles along the active floodplain of Marsh Fork - Canning River; suitable for concrete aggregate and granular fill; check for deleterious material	alluvial sand, gravel and cobble along active floodplain of tributary to Junjek River; suitable for granular fill and concrete aggregate; check for deleterious material if used as concrete

	No. 13A to Chandalar Rivers				No. 13B to Chandalar Rivers			
Intended use of material								
Location where material required -- milepost								
Volume of material required in cubic yards x 10^5								
Haul distance in miles								
Estimated volume of material available per foot of depth in cubic yards x 10^5	5				5			
Estimated recoverable depth in feet	$\pm$ 2 ft; depends on thawed depth				$\pm$ 2 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	10				10			
Estimated overburden depth and type of material	nil on active floodplain				nil on active floodplain			
Method of mining	harvest from stream and crush for concrete aggregate				harvest from stream and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand, gravel, and cobbles from active floodplain on tributary to Canning River; suitable for granular fill and concrete aggregate; check for delterious material				alluvial sand, gravel and cobble from active floodplain on tributary to Canning River; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 13C to Chandalar Rivers	No. 13D to Chandalar Rivers
Intended use of material		
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles		
Estimated volume of material available per foot of depth in cubic yards x 10^5	1	1.5
Estimated recoverable depth in feet	$\pm$ 2 ft; depends on thawed depth	$\pm$ 2 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5	2	3
Estimated overburden depth and type of material	nil on active floodplain	nil on active floodplain
Method of mining	harvest from creek and crush for concrete aggregate	harvest from creek and crush for concrete aggregate
Notes: type of material, suitability, etc.	alluvial sand, gravel and cobbles from active floodplain of Cane Creek; suitable for granular fill and concrete aggregate; check for deleterious material	alluvial sand, gravel, and cobbles from active floodplain of Cane Creek; suitable for granular fill and concrete aggregate; check for deleterious material

	No. 15				No. 16			
Intended use of material	road	expansion pump-station No. 7			road	expansion pump-station No. 7		
Location where material required -- milepost	170 to limit of economic haul	190			195-205	190		
Volume of material required in cubic yards x 10^5		2.5			2	2.5		
Haul distance in miles		8			depends on quarry locations	$\pm$ 8		
Estimated volume of material available per foot of depth in cubic yards x 10^5	30				essentially unlimited			
Estimated recoverable depth in feet	$\pm$ 2 ft average; depends on thawed depth							
Estimated volume available in cubic yards x 10^5	60							
Estimated overburden depth and type of material	nil				may require stripping of weathered bedrock layer			
Method of mining	harvest from river and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand, gravel, and cobbles along active floodplain of Chandalar River; suitable for granular fill and concrete aggregate; check for deleterious material				Upper Devonian chert- and quartz-pebble conglomerate, quartzitic sandstone and shale; suitable for granular fill; chert and shale are deleterious for concrete aggregate			

	Deposit No. 15				Deposit No. 16			
Intended use of material	road	expansion pump-station No. 7			road	expansion pump-station No. 7		
Location where material required -- milepost	170 to limit of economic haul	190			195-205	190		
Volume of material required in cubic yards x 10^5		2.5			2	2.5		
Haul distance in miles		8			depends on quarry locations	$\pm$ 8		
Estimated volume of material available per foot of depth in cubic yards x 10^5	30				essentially unlimited			
Estimated recoverable depth in feet	$\pm$ 2 ft average; depends on thawed depth							
Estimated volume available in cubic yards x 10^5	60							
Estimated overburden depth and type of material	nil				may require stripping of weathered bedrock layer			
Method of mining	harvest from river and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand, gravel, and cobbles along active floodplain of Chandalar River; suitable for granular fill and concrete aggregate; check for deleterious material				Upper Devonian chert- and quartz-pebble conglomerate, quartzitic sandstone and shale; suitable for granular fill; chert and shale are deleterious for concrete aggregate			

	Deposit No. 17				Deposit No. 18			
Intended use of material	road				road	airport	expansion pump-station No. 8	
Location where material required -- milepost	205-245				245-265	266	266	
Volume of material required in cubic yards x 10^5	8.0				4.0	1.5	2.5	
Haul distance in miles	depends on location of quarry site				7 average	± 18	± 18	
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited				2.0			
Estimated recoverable depth in feet					± 2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5					4			
Estimated overburden depth and type of material	may require some stripping of weathered bedrock layer				nil			
Method of mining	bedrock quarry and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Mississippian shale, Upper Devonian chert and quartz-pebble conglomerate and Devonian chert and slate; suitable for granular fill; chert and shale are deleterious for concrete aggregate				alluvial sand and gravel along active floodplain of Sheenjek River; suitable for granular fil and concrete aggregate; check for deleterious material			

	No. 19 consists of about 5 bedrock highs	No. 20 consists of about 3 or 4 bedrock highs
Intended use of material	supplement or alternate to deposit No. 18	supplement or alternate to deposit No. 18
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles	5 average for road; $\pm$ 13 for airport and pumpstation	7 average for road; $\pm$ 3 miles to airport and pumpstation
Estimated volume of material available per foot of depth in cubic yards x 10^5	10	20
Estimated recoverable depth in feet	+20 ft; depends on economic excavation depth	+ 20 ft; depends on economic excavation depth
Estimated volume available in cubic yards x 10^5	200	400
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	may require stripping of weathered bedrock layer
Method of mining	bedrock quarry and crush for concrete aggregate	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	Permian shale and chert, Mississippian cherty limestone and fine-grained limestone and Jurassic gabbro, basalt and quartz-diorite; field reconnaissance required to select quarry sites in suitable rock types; shale and chert are deleterious in concrete aggregate	Mississippian cherty limestone and fine-grained limestone, quartz-chert pebble conglomerate and Paleozoic sandstone; suitabl for granular fill; chert may be deleterious for concrete aggregate

	No. 21				No. 22
Intended use of material	road	airport	expansion pump-station No. 8	original pump-station No. 9	alternate or supplement to deposit No. 21
Location where material required -- milepost	265 - to limit of economic haul	266	266	303	
Volume of material required in cubic yards x 10^5		1.5	2.5	2.5	
Haul distance in miles		± 16	± 16	± 25	haul to roadway depends on location of quarry sites; ± 2 miles to pumpstation No. 9
Estimated volume of material available per foot of depth in cubic yards x 10^5	2.0				essentially unlimited
Estimated recoverable depth in feet	± 2 ft average; depends on thawed depth				
Estimated volume available in cubic yards x 10^5	4.0				
Estimated overburden depth and type of material	nil				may require stripping of weather bedrock layer
Method of mining	harvest from river and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	alluvial sand and gravel along active floodplain of Coleen River; suitable for granular fill and concrete aggregate; check for deleterious material				Lower Paleozoic semischist and phyllite, and fine-grained quartzose; some laminated phyllite; variable as a source of borrow; schist and phyllite are poorer sources of borrow

	Deposit No. 23	Deposit No. 24 6 bedrock highs
Intended use of material	supplement to deposits No. 21 and No. 22	road
Location where material required -- milepost		± 310-335
Volume of material required in cubic yards x 10^5		5
Haul distance in miles		depends on location of quarry sites
Estimated volume of material available per foot of depth in cubic yards x 10^5		essentially unlimited
Estimated recoverable depth in feet		
Estimated volume available in cubic yards x 10^5		
Estimated overburden depth and type of material	nil on active bars	may require stripping of weathered bedrock
Method of mining	harvest from creek bed	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	small deposits of stratified sand and gravel along active bars of Strangle Woman Creek; suitable for concrete aggregate; check for deleterious material	mainly granodiorite quartz - diorite and granite; good material for granular fill and for concrete aggregate when crushed

	No. 25 5 bedrock highs				No. 26			
Intended use of material	road				airport	expansion pump-station No. 10	supplement to deposit No. 27	
Location where material required -- milepost	±335 to limit of economic haul				366	366		
Volume of material required in cubic yards x 10^5					1.5	2.5		
Haul distance in miles	depends on economics							
Estimated volume of material available per foot of depth in cubic yards x 10^5	10							
Estimated recoverable depth in feet	+20 ft; depends on economic excavation depth							
Estimated volume available in cubic yards x 10^5	200							
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer				nil on active bars			
Method of mining	bedrock quarry and crush for concrete aggregate				harvest from river			
Notes: type of material, suitability, etc.	mainly granodiorite, quartz-diorite, and granite; good source of granular fill and concrete aggregate when crushed				small, mainly sand and gravelly sand deposits along active bars and point bars of the Porcupine River; may average 2000 cubic yards per deposit; source of fine fraction for concrete aggregate; check for deleterious material			

	No. 26A	No.
Intended use of material	supplement to deposit 27	
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles		
Estimated volume of material available per foot of depth in cubic yards x 10^5		
Estimated recoverable depth in feet		
Estimated volume available in cubic yards x 10^5		
Estimated overburden depth and type of material	nil on active bars	
Method of mining	harvest from river	
Notes: type of material, suitability, etc.	alluvial sand and gravel near the junction of Old Crow and Porcupine Rivers; may be 4000 to 5000 cubic yards of mainly sand and some gravel suitable for concrete aggregate and granular fill	

	No. 27	4 bedrock highs			No. 28			
Intended use of material	roads	airport	expansion pump-station No. 10		road			
Location where material required -- milepost	± 335 - 375	366	366		375-385			
Volume of material required in cubic yards x 10^5	8.0	1.5	2.5		2.0			
Haul distance in miles	5 average	2-4	2-4		4 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	10				10			
Estimated recoverable depth in feet	±20 ft; depends on economic excavation depth				+ 20 ft; depends on economic excavation depth			
Estimated volume available in cubic yards x 10^5	200				200			
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer				may require stripping of weathered bedrock layer			
Method of mining	bedrock quarry and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Paleozoic limestone, shale, sandstone, conglomerate and chert; source of granular fill material but chert is deleterious in concrete aggregate				Paleozoic limestone, shale, sandstone, conglomerate and chert; source of granular fill material but chert is deleterious in concrete aggregate			

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	No. 29				No. 30 6 bedrock highs			
Intended use of material	road				road	expansion pump-station No. 11		
Location where material required -- milepost	385-395				395-420	415		
Volume of material required in cubic yards x 10^5	2.0				5.0	2.5		
Haul distance in miles	7 average				4 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	1.0				10			
Estimated recoverable depth in feet	$\pm$ 2 ft average; depends on thawed depth				+20 ft; depends on economic excavation depth			
Estimated volume available in cubic yards x 10^5	2.0				200			
Estimated overburden depth and type of material	nil on active bars				may require stripping of weathered bedrock			
Method of mining	harvest from river and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand and gravel along active floodplain of Driftwood River; suitable for granular fill and concrete aggregate; check for deleterious material				Lower Cretaceous shale and sandstone; suitable for granular fill but shale is deleterious fo concrete aggregate			

	No. 31	right-of-way			No. 32			
Intended use of material	road				road	airport	original pump-station No. 12	
Location where material required -- milepost	420-433				433-470	448	448	
Volume of material required in cubic yards x 10^5	2.6				7.4	1.5	2.5	
Haul distance in miles	4 average				6 average	at site	at site	
Estimated volume of material available per foot of depth in cubic yards x 10^5	20				10			
Estimated recoverable depth in feet	+20 ft; depends on economic excavation depth				$\pm$ 2 ft average; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	400				20			
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer				nil on active bars			
Method of mining	bedrock quarry and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Lower Cretaceous shale and sandstone; suitable for granular fill but shale deleterious for concrete aggregate				alluvial sand, gravel and cobbles along active floodplain of Rat River; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 33	No. 34
Intended use of material	alternate or supplement to deposit No. 32	road
Location where material required -- milepost		470-495
Volume of material required in cubic yards x 10^5		5.0
Haul distance in miles	depends on location of quarry sites	14 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited	2
Estimated recoverable depth in feet		± 2 ft average; depends on thawed depth
Estimated volume available in cubic yards x 10^5		4
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	nil on active bars
Method of mining	bedrock quarry and crush for concrete aggregate	harvest from creek and crush for concrete aggregate
Notes: type of material, suitability, etc.	Lower Cretaceous sandstone and shale; suitable for granular fill but shale deleterious for concrete aggregate	alluvial sand, gravel and cobbles along active floodplain of Stony Creek; suitable for granular fill and concrete aggregate; check for deleterious material

	Deposit No. 34A	Deposit No.
Intended use of material	supplement to deposit 34	
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles	8 from route	
Estimated volume of material available per foot of depth in cubic yards x 10^5	2	
Estimated recoverable depth in feet	2	
Estimated volume available in cubic yards x 10^5	4	
Estimated overburden depth and type of material	nil	
Method of mining	harvest from river	
Notes: type of material, suitability, etc.	alluvial sand and gravel along active floodplain of Vittrekwa River; suitable for granular fill and concrete aggregates	

	Deposit No. 35	Deposit No. 36
Intended use of material	alternate or supplement to deposit No. 34	alternate or supplement to deposit No. 34
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles	± 20 average	± 14 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	1	2
Estimated recoverable depth in feet	+20 ft; depends on economic excavation depth	+ 20 ft; depends on economic excavation depth
Estimated volume available in cubic yards x 10^5	+ 20	+ 40
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	nil on active talus slopes
Method of mining	bedrock quarry and crush for concrete aggregate	bedrock and talus rock quarry and crush for concrete aggregat
Notes: type of material, suitability, etc.	Lower Cretaceous shale and sandstone; suitable for granular fill but shale deleterious in concrete aggregate	massive and broken sandstone and conglomerate at Shiltee Rock; source of granular fill and concrete aggregate; check for deleterious material

	Deposit No. 37				Deposit No. 38			
Intended use of material	road	expansion pump-station No. 13			road	expansion pump-station No. 14		
Location where material required -- milepost	495-525	520			525-585	558		
Volume of material required in cubic yards x 10^5	6.0	2.5			8	2.5		
Haul distance in miles	± 17 average	± 25 average			± 15 average	± 1		
Estimated volume of material available per foot of depth in cubic yards x 10^5	1				2			
Estimated recoverable depth in feet	± 2 ft average; depends on thawed depth				± 20 ft; depends on economic excavation depth			
Estimated volume available in cubic yards x 10^5	2				+ 40			
Estimated overburden depth and type of material	nil on active bars				up to 10 ft of peat and silt			
Method of mining	harvest from river				strip bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial silt and fine sand along active bars on Peel River; Note: This is fine-grained material and may have to be supplemented by coarser material from Shiltee Rock on the west side of Peel River				Upper Devonian and/or Cretaceous sandstone and shale; suitable for granular fill and concrete aggregate but shale deleterious			

	No. 39				No. 40 6 kames and 4 granular ridges			
Intended use of material	road - supplement to deposit No.38				road	expansion pump-station No.15		
Location where material required -- milepost					585 - 645	602		
Volume of material required in cubic yards x 10^5					12	215		
Haul distance in miles					± 20 average	± 4		
Estimated volume of material available per foot of depth in cubic yards x 10^5					2			
Estimated recoverable depth in feet					10 ft			
Estimated volume available in cubic yards x 10^5					20			
Estimated overburden depth and type of material					½ - 3 ft of peat and silt			
Method of mining					strip and quarry from pit; may require blasting and ripping on frozen, north-facing slopes			
Notes: type of material, suitability, etc.	several small eskers near mile 575 are a doubtful source because of small quantity of variably frozen and unfrozen sand, gravel, boulders and till; suitable for granular fill and locally may contain material suitable for concrete aggregate				ridges of granular material, mainl sand with some gravel; kames are expected to be variable in composition and contain sand, gravel, boulders and till; suitable for granular fill and locally may contain material suitable for concrete aggregate			

	No. 41 doubtful deposit				No. 42 doubtful deposit			
Intended use of material	road	airport	original pump-station No. 16		alternate or supplement to deposit No. 41 road	airport	pump-station	No 16
Location where material required -- milepost	645-702	648	648					
Volume of material required in cubic yards x 10^5	11.4	1.5	2.5					
Haul distance in miles	$\pm$ 16 average	$\pm$ 13	$\pm$ 13		$\pm$ 20 average	37	37	
Estimated volume of material available per foot of depth in cubic yards x 10^5	2				3			
Estimated recoverable depth in feet	$\pm$5 ft; depends on thawed depth				$\pm$ 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	$\pm$ 10				$\pm$ 15			
Estimated overburden depth and type of material	½ - 4 ft of peat and 2 - 15 ft of organic silt				½ - 3 ft of peat and 2 - 15 ft of organic silt			
Method of mining	strip, thaw and drain borrow pits				strip, thaw and drain borrow pit			
Notes: type of material, suitability, etc.	high terrace; doubtful deposit because may be largely frozen till and may have thick silt cover up to 15 ft; may be suitable for fill material; if sand and gravel are present, may be source of concrete aggregate				high terrace; doubtful deposit because may be largely frozen ti and have thick silt cover up to 15 ft; suitable for fill materia if sand and gravel are present may be source of concrete aggregate			

	No. 43	Small scattered deposits			No. 44			
Intended use of material	alternate or supplement to deposit No. 42 road	airport	pump-station No. 16		alternate or supplement to deposit No. 41 road	airport	pump-station No. 16	
Location where material required -- milepost								
Volume of material required in cubic yards x 10^5								
Haul distance in miles	± 20 average	37	37		± 25 average	47	47	
Estimated volume of material available per foot of depth in cubic yards x 10^5					1			
Estimated recoverable depth in feet					up to 3 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5					3			
Estimated overburden depth and type of material	nil on active bars				nil on active bars			
Method of mining	harvest from active bars and crush for concrete aggregate				harvest from river and crush for concrete aggregate			
Notes: type of material, suitability, etc.	alluvial sand, gravel and cobbles along active point bars on Hume River; deposits may contain 1,000 to 10,000 cubic yards each; source of concrete aggregate; check for deleterious material				alluvial sand and gravel along active floodplain of Mountain River approximately 10 miles upstream of junction with Mackenzie River; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 45				No. 46 Hills and East Mountain)			
Intended use of material	alternate or supplement to deposit No. 44 road	airport	pump-station No. 16	expansion pump-station No. 17	road			
Location where material required -- milepost				702	703-720			
Volume of material required in cubic yards x 10^5				2.5	3.4			
Haul distance in miles	± 30 average	± 55	± 55	at site	± 7 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	10				50			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				+ 20 ft; depends on economic excavation depth			
Estimated volume available in cubic yards x 10^5	50				1000			
Estimated overburden depth and type of material	½ - 4 ft of peat and 2 - 15 ft of organic silt				may require stripping of weathere bedrock layer			
Method of mining	strip, thaw and drain borrow pits				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	high terrace; doubtful deposit because may be largely frozen till and have a thick cover of silt; contains sand and gravel along bank of Mackenzie River; suitable for granular fill; may contain suitable material for concrete aggregate				Middle Devonian limestone and shale; suitable for granular fill but shale is deleterious for concrete aggregate			

	Deposit No. 47 doubtful deposit	Deposit No. 48
Intended use of material		alternate or supplement to deposit No. 46
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles		± 6 average
Estimated volume of material available per foot of depth in cubic yards x 10^5		5
Estimated recoverable depth in feet		3 to 5 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5		20
Estimated overburden depth and type of material		1 to 5 ft of peat and silt
Method of mining		strip borrow areas and rip frozen material
Notes: type of material, suitability, etc.	large area of outwash sand and gravel approximately 10 miles west of Sans Sault Rapids; doubtful deposit because probably largely frozen and under deep peat cover in topographic lows; field investigation required to locate suitable borrow areas for concrete aggregate material	high terrace and deltaic sand and gravel; doubtful deposit because stripping required and possibility of largely frozen silty overburden material; suitable for granular borrow and concrete aggregate; check for deleterious material

	Deposit No. 49				Deposit No. 50			
Intended use of material	alternate to deposit No. 46 road				road	expansion pump-station No. 18	original pump-station No. 19	
Location where material required -- milepost	720-730				730-810	745	787	
Volume of material required in cubic yards x 10^5	2.0				16	2.5	2.5	
Haul distance in miles	± 3 average				depends on location of quarry sites			
Estimated volume of material available per foot of depth in cubic yards x 10^5	60				essentially unlimited			
Estimated recoverable depth in feet	+20 ft; depends on economic excavation depth							
Estimated volume available in cubic yards x 10^5	1200							
Estimated overburden depth and type of material	may require some stripping of weathered bedrock layer				may require some stripping of weathered bedrock layer			
Method of mining	bedrock quarry and crush for concrete aggregate				bedrock quarry and crush for concrete aggregate			
Notes: type of material, suitability, etc.	Middle Devonian limestone and shale; suitable for granular fill but shale deleterious for conrete aggregate				Middle Devonian limestone and shale and Silurian or Devonian dolomite, gypsum and anhydrite; also note rock glaciers at Mount Thomas and bedrock highs along Norman Range mile 738 to mile 810 suitable for granular fill and concrete aggregate			

	No. 51				No. 52 deposit			
Intended use of material	road	expansion pump-station No. 18			expansion pump-station No. 18	road		
Location where material required -- milepost	supplement to deposit No.			50	supplement to deposit No.			50
Volume of material required in cubic yards x 10^5								
Haul distance in miles		± 4			± 3	along right-of-way		
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.1				0.1			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	0.5				0.5			
Estimated overburden depth and type of material	0 - 3 ft of peat and silt				0 - 3 ft of peat and silt			
Method of mining	strip borrow pits; may require some ripping (dry frozen) and some crushing for concrete aggregate				strip borrow pits; may require some ripping (dry frozen)			
Notes: type of material, suitability, etc.	kames, variable deposit includes silt, sand, gravel, boulders and till, variably frozen and unfrozen; suitable for granular fill and locally may contain suitable material for concrete aggregate; check for deleterious material				sand dunes; mainly poorly graded fine sand, variably frozen and unfrozen; suitable for granular fill and part of fine portion of concrete aggregate			

	Deposit relatively small deposit No. 53	Deposit No. 54 relatively small deposit
Intended use of material	pump-station No. 18	supplement to deposit No. 50 for road
Location where material required -- milepost	supplement to deposit No. 50	
Volume of material required in cubic yards x 10^5		
Haul distance in miles	$\pm$ 5	along right-of-way
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.1	0.1
Estimated recoverable depth in feet	$\pm$ 5 ft; depends on thawed depth	$\pm$ 5 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5	0.5	0.5
Estimated overburden depth and type of material	0 - 3 ft of peat and silt	0 - 3 ft of peat and silt
Method of mining	strip borrow pits; may require ripping (dry frozen) and some crushing for concrete aggregate	strip borrow pits; may require ripping (dry frozen) and some crushing for concrete aggregate
Notes: type of material, suitability, etc.	kames; includes silt, sand, gravel, boulders and till; variably frozen and unfrozen; suitable for granular fill and locally may contain material suitable for concrete aggregate; check for deleterious material	esker-kame complex; includes silt, sand, gravel, boulders and till variably frozen and unfrozen; suitable for granular fill and locally may contain material suitable for concrete aggregate; check for deleterious material

	Deposit No. 55 relatively small deposit	Deposit No. 56 relatively small deposit
Intended use of material	supplement to deposit No. 50 for road	supplement to deposit No. 50 for road
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles	± 3 miles from right-of-way	near right-of-way
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.1	0.1
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth	± 5 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5	0.5	0.5
Estimated overburden depth and type of material	nil along river bank	0 - 3 ft of peat or silt
Method of mining	harvest from river and crush for concrete aggregate	strip borrow pits; may require ripping and some crushing for concrete aggregate
Notes: type of material, suitability, etc.	strip of sand and gravel along river bank approximately 100 ft. wide; also high terrace along river bank; suitable for granular fill and concrete aggregate; check for deleterious material	eskers; variable deposit of silt, sand, gravel, boulders and till; variably frozen and unfrozen; suitable for granular fill; may contain local deposits of material suitable for concrete aggregate

	No. 57	No. 58
Intended use of material	supplement or alternate to deposit No. 50	road
Location where material required -- milepost	780-795	810-835
Volume of material required in cubic yards x 10^5		5
Haul distance in miles		± 7 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.1	0.1
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth	up to 50 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5	0.5 from each of numerous borrow pits along right-of-way	5
Estimated overburden depth and type of material	1 - 4 ft of peat	0 - 3 ft of peat on top of river bank
Method of mining	strip and rip borrow areas; may require some draining	strip and may require some crushing for concrete aggregate
Notes: type of material, suitability, etc.	drumlinized ground moraine along right-of-way; may develop borrow areas on compact till "highs"; suitable for fill material only	60 ft high exposure of sand and gravel along bank of Mackenzie River; suitable for granular fill and concrete aggregate; check for deleterious material

	No. 59				No. 60 approximately 6 deposits			
Intended use of material	road - supplement or alternate to deposit No. 58			expansion pump-station No. 20	road	expansion pumpstation No. 20 -	alternate to deposit No. 59	
Location where material required -- milepost				839	835-850	839		
Volume of material required in cubic yards x 10^5				2.5	3.0	2.5		
Haul distance in miles	± 8 average			10	± 7 average	near deposits		
Estimated volume of material available per foot of depth in cubic yards x 10^5	1				2 per deposit			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	5				10 per deposit			
Estimated overburden depth and type of material	1 - 5 ft of peat and silt				0 - 3 ft of peat			
Method of mining	strip borrow pits and rip; may require some crushing for concrete aggregate				strip inactive dune areas and may require some ripping (dry frozen)			
Notes: type of material, suitability, etc.	high terrace; local deposits of sand and gravel of variable depth; suitable for granular fill and concrete aggregate; check for deleterious material				sand dunes; poorly graded fine sand; suitable for granular fill and fine fraction of concrete aggregate			

	No. 61		ridges		No. 62			
Intended use of material	road				road	original pump-station No. 21		
Location where material required -- milepost	850-868				868-885	878		
Volume of material required in cubic yards x 10^5	3.6				3.4	2.5		
Haul distance in miles	± 5 average				± 4 average depends	on number of pits		
Estimated volume of material available per foot of depth in cubic yards x 10^5	10				10			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	50				50			
Estimated overburden depth and type of material	1 - 4 ft of peat				1 - 5 ft of peat and silt			
Method of mining	strip and drain; may require ripping of compact till				strip borrow areas; may require some ripping; variably frozen			
Notes: type of material, suitability, etc.	drumlinized ground moraine; compact till ridges; suitable for fill material only				high terrace; sand and gravel of variable depth; suitable for granular fill and possibly concrete aggregate; check for deleterious material			

	No. 63	No. 64
Intended use of material	alternate for original pumpstation No. 21	road
Location where material required -- milepost	878	885-893
Volume of material required in cubic yards x 10^5	2.5	1.6
Haul distance in miles	8	$\pm$ 3 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	1	1
Estimated recoverable depth in feet	$\pm$ 5 ft; depends on thawed depth	+ 20 ft; depends on economic excavation depth
Estimated volume available in cubic yards x 10^5	5	20
Estimated overburden depth and type of material	1 - 5 ft of peat and silt	may require stripping of weathere bedrock layer
Method of mining	strip peat; may require some ripping	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	high terrace; better-looking deposit of sand and gravel of variable depth; suitable for granular fill and concrete aggregate; check for deleterious material	Upper Devonian or Cretaceous sandstone and shale; suitable for granular fill but shale deleterious in concrete aggregate

	No. 65	No. 66
Intended use of material	road	supplement or alternate to deposit No. 65
Location where material required -- milepost	893-905	
Volume of material required in cubic yards x 10^5	2.4	
Haul distance in miles	± 4 average	± 6 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	1	1
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth	+ 20 ft; depends on economic excavation depth
Estimated volume available in cubic yards x 10^5	5	20
Estimated overburden depth and type of material	1 - 5 ft of peat and silt	may require some stripping of weathered bedrock layer
Method of mining	strip and may require draining and some ripping and crushing	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	high terrace; better-looking deposit of sand and gravel of variable thickness; suitable for granular fill and concrete aggregate; check for deleterious material	Upper Devonian sandstone and shale; suitable for granular fil but shale deleterious in concret aggregate

	No. 67				No. 68			
Intended use of material	supplement or alternate to deposit No. 65				road			
Location where material required -- milepost					905-920			
Volume of material required in cubic yards x 10^5					3.0			
Haul distance in miles	± 6 average				± 2 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.5				2			
Estimated recoverable depth in feet	± 3 ft; depends on thawed depth and amount of material over bedrock				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	1.5				10			
Estimated overburden depth and type of material	nil on active bars				1 - 5 ft of peat and silt			
Method of mining	harvest from river and crush for concrete aggregate				strip and may require draining; some ripping and crushing			
Notes: type of material, suitability, etc.	alluvial sand and gravel along active bars of Blackwater River; suitable for granular fill and concrete aggregate; check for deleterious material				high terrace; better-looking deposit of sand and gravel; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 69				No. 70			
Intended use of material	road				road	expansion pump-station No. 22		
Location where material required -- milepost	920-930				930-945	932		
Volume of material required in cubic yards x 10^5	2.0				3.0	2.5		
Haul distance in miles	± 8 average				along right-of-way			
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited				3			
Estimated recoverable depth in feet					± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5					15			
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer				1 - 5 ft of peat and silt			
Method of mining	bedrock quarry and crush for concrete aggregate				strip and may require some draining, ripping, and crushing for concrete aggregate			
Notes: type of material, suitability, etc.	Upper Devonian sandstone and shale and/or Middle Devonian limestone and shale; suitable for granular fill but shale deleterious in concrete aggregate				High terrace; sand and gravel of variable thickness and variably frozen and unfrozen; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 71	No. 72
Intended use of material	road	alternate to deposit No. 72
Location where material required -- milepost	945-965	
Volume of material required in cubic yards x 10^5	4.0	
Haul distance in miles	± 4 average	± 10 average
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited	10
Estimated recoverable depth in feet		+ 20 ft; depends on economic excavation depth
Estimated volume available in cubic yards x 10^5		200
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	may require stripping of weathered bedrock layer
Method of mining	bedrock quarry and crush for concrete aggregate	bedrock quarry and crush for concrete aggregate
Notes: type of material, suitability, etc.	Upper Devonian sandstone and shale or Middle Devonian limestone and shale; suitable for granular fill; shale deleterious in concrete aggregate	similar to material in deposit No. 71

	No. 73				No. 74			
Intended use of material	road	airport	original pump-station No. 23		road			
Location where material required -- milepost	965-975	971	971		975-995			
Volume of material required in cubic yards x 10^5	2.0	1.5	2.5		4.0			
Haul distance in miles	± 3 average	± 3	± 3		along right-of-way			
Estimated volume of material available per foot of depth in cubic yards x 10^5	1				0.5			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	5				2.5			
Estimated overburden depth and type of material	1 - 5 ft of peat and silt				1 - 4 ft of peat			
Method of mining	strip and may require some draining, ripping and crushing				strip and may require ripping of compact till			
Notes: type of material, suitability, etc.	high terrace; sand and gravel of variable thickness; variably frozen; may require supplementing from deposit No. 71; suitable for granular fill and concrete aggregate; check for deleterious material				drumlinized ground moraine; compact till ridges along right-of way; suitable for fill material			

	No. 75	No. 76
Intended use of material	supplement or alternate to deposit No. 74	supplement or alternate to deposit No. 74
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles	± 12 average	± 2 to right-of-way
Estimated volume of material available per foot of depth in cubic yards x 10^5	essentially unlimited	0.5
Estimated recoverable depth in feet		± 5 ft; depends on thawed depth
Estimated volume available in cubic yards x 10^5		2.5
Estimated overburden depth and type of material	may require stripping of weathered bedrock layer	1 - 5 ft of peat and silt
Method of mining	bedrock quarry and crush for concrete aggregate	strip and may require draining and some ripping and crushing for concrete aggregate
Notes: type of material, suitability, etc.	Middle Devonian limestone; suitable for granular fill; check suitability for concrete aggregate	high terrace; sand and gravel of variable thickness; variably frozen and unfrozen; suitable for granular fill and concrete aggregate; check for deleterious material

	No. 77				No. 78			
Intended use of material	supplement or alternate to deposit No. 74				road	expansion pump-station No. 24		
Location where material required -- milepost					995-1020	1010		
Volume of material required in cubic yards x 10^5					5.0	2.5		
Haul distance in miles	± 6 average				± 10 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	1				2			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	5				10			
Estimated overburden depth and type of material	0 - 3 ft of peat and silt				1 - 3 ft of peat and silt			
Method of mining	strip and may require some draining, ripping and crushing for concrete aggregate				strip and may require some draining, ripping and crushing for concrete aggregate			
Notes: type of material, suitability, etc.	esker-kame complex; variable deposits of silt, sand, gravel, boulders and till; variably frozen and unfrozen; suitable for granular fill; may locally contain sand and gravel suitable for concrete aggregate				outwash; better-looking deposit of sand and gravel; variably frozen and unfrozen; suitable for granular fill and concrete aggregate; check for deleterious material			

	No. 79				No. 80			
Intended use of material	supplement to deposit No. 78				road			
Location where material required -- milepost					1020 - 1070			
Volume of material required in cubic yards x 10^5					10			
Haul distance in miles	$\pm$ 7 average				$\pm$ 18 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	1				10			
Estimated recoverable depth in feet	$\pm$ 5 ft; depends on thawed depth				+ 20 ft; depends on economic excavation depth			
Estimated volume available in cubic yards x 10^5	5				200			
Estimated overburden depth and type of material	1 - 4 ft of peat				may require stripping of weathered bedrock layer			
Method of mining	strip and may require draining and ripping of compact till				bedrock quarry and crush			
Notes: type of material, suitability, etc.	drumlinized ground moraine; variably frozen till; suitable for fill material				Cretaceous shale; Note: soft rock suitable for fill material only			

	No. 81				No. 82			
Intended use of material	expansion pump-station No. 25	also supplement to deposit No. 80			road	also supplement or alternate to deposit No. 81 for pumpstation No. 25		
Location where material required -- milepost	1069				1070 - 1089			
Volume of material required in cubic yards x 10^5	2.5				4.0			
Haul distance in miles	$\pm$ 35				$\pm$ 10 average		$\pm$ 20	
Estimated volume of material available per foot of depth in cubic yards x 10^5	2				1			
Estimated recoverable depth in feet	$\pm$ 5 ft; depends on thawed depth				$\pm$ 10 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	10				10			
Estimated overburden depth and type of material	0 - 3 ft of peat and silt				1 - 5 ft of peat and silt			
Method of mining	strip and may require draining, ripping and some crush for concrete aggregate				strip and may require draining, ripping and some crush for concrete aggregate			
Notes: type of material, suitability, etc.	kames; variable deposits of silt, sand, gravel, boulders and till; variably frozen and unfrozen; suitable for granular fill; may locally contain material suitable for concrete aggregate				high terrace; sand and gravel of variable depth; variably frozen and unfrozen; suitable for granular fill and locally for concrete aggregate			

	Deposit No. 83				Deposit No. 84			
Intended use of material	road				road			
Location where material required -- milepost	1090 - 1100				1100 - 1112			
Volume of material required in cubic yards x 10^5	2.0				2.4			
Haul distance in miles	along right-of-way				along right-of way			
Estimated volume of material available per foot of depth in cubic yards x 10^5	5				1			
Estimated recoverable depth in feet	± 10 ft; depends on depth of thaw				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	50				5			
Estimated overburden depth and type of material	1 - 5 ft of peat and silt				0 - 3 ft of peat and silt			
Method of mining	strip and may require some draining, rippping and crushing for concrete aggregate				strip and may require some ripping (dry frozen sand)			
Notes: type of material, suitability, etc.	high terrace; sand and gravel of variable thickness; variably frozen and unfrozen; suitable for granular fill and locally for concrete aggregate				sand dunes and deltaic sands; poorly graded fine sand; suitable for granular fill and part of fine fraction of concrete aggregate			

	No. 85				No. 86			
Intended use of material	road	original pump-station No. 26			road			
Location where material required -- milepost	1112 - 1115	1113			1115 - 1135			
Volume of material required in cubic yards x 10^5	0.6	2.5			4.0			
Haul distance in miles	± 1	± 1			along right-of-way			
Estimated volume of material available per foot of depth in cubic yards x 10^5	5				1			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	25				5			
Estimated overburden depth and type of material	0 - 2 ft of peat				1 - 3 ft of peat			
Method of mining	strip and may require some ripping (dry frozen sand)				strip and may require draining and ripping			
Notes: type of material, suitability, etc.	deltaic sand; better-looking deposit of poorly graded sand; suitable for granular fill and part of fine fraction of concrete aggregate				variable; deltaic sand, deltaic sand over ground moraine and drumlinized ground moraine; suitable for fill material			

	No. 87				No. 88			
Intended use of material	supplement or alternate to deposit No. 86				road			
Location where material required -- milepost					1135 - 1150			
Volume of material required in cubic yards x 10^5					3.0			
Haul distance in miles	± 5 average				± 3 average			
Estimated volume of material available per foot of depth in cubic yards x 10^5	2				1			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth				± 5 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	10				5			
Estimated overburden depth and type of material	1 - 5 ft of peat and silt				½ - 5 ft of peat			
Method of mining	strip and may require draining, ripping and some crushing for concrete aggregate				strip and may require some draining and ripping of compact till			
Notes: type of material, suitability, etc.	high terrace; sand and gravel of variable depth; suitable for granular fill and locally for concrete aggregate				drumlinized ground moraine; compact till ridges; suitable for fill material			

	No. 89A	No.
Intended use of material	supplement deposits 89, 90 and 91	
Location where material required -- milepost		
Volume of material required in cubic yards x 10^5		
Haul distance in miles		
Estimated volume of material available per foot of depth in cubic yards x 10^5	4.85	
Estimated recoverable depth in feet	$\pm$ 5 ft in crevasse fillings and 10 to 15 ft in kames	
Estimated volume available in cubic yards x 10^5	$\pm$ 25	
Estimated overburden depth and type of material	½ to 5 ft of peat and organic silt	
Method of mining	strip and rip borrow areas	
Notes: type of material, suitability, etc.	kames and crevasse fillings from Mile 1147 to Mile 1192; variable deposits of silt, sand, gravel, boulders and till; suitable for granular fill and concrete aggregates if deposits are composed of clean sand and gravel	

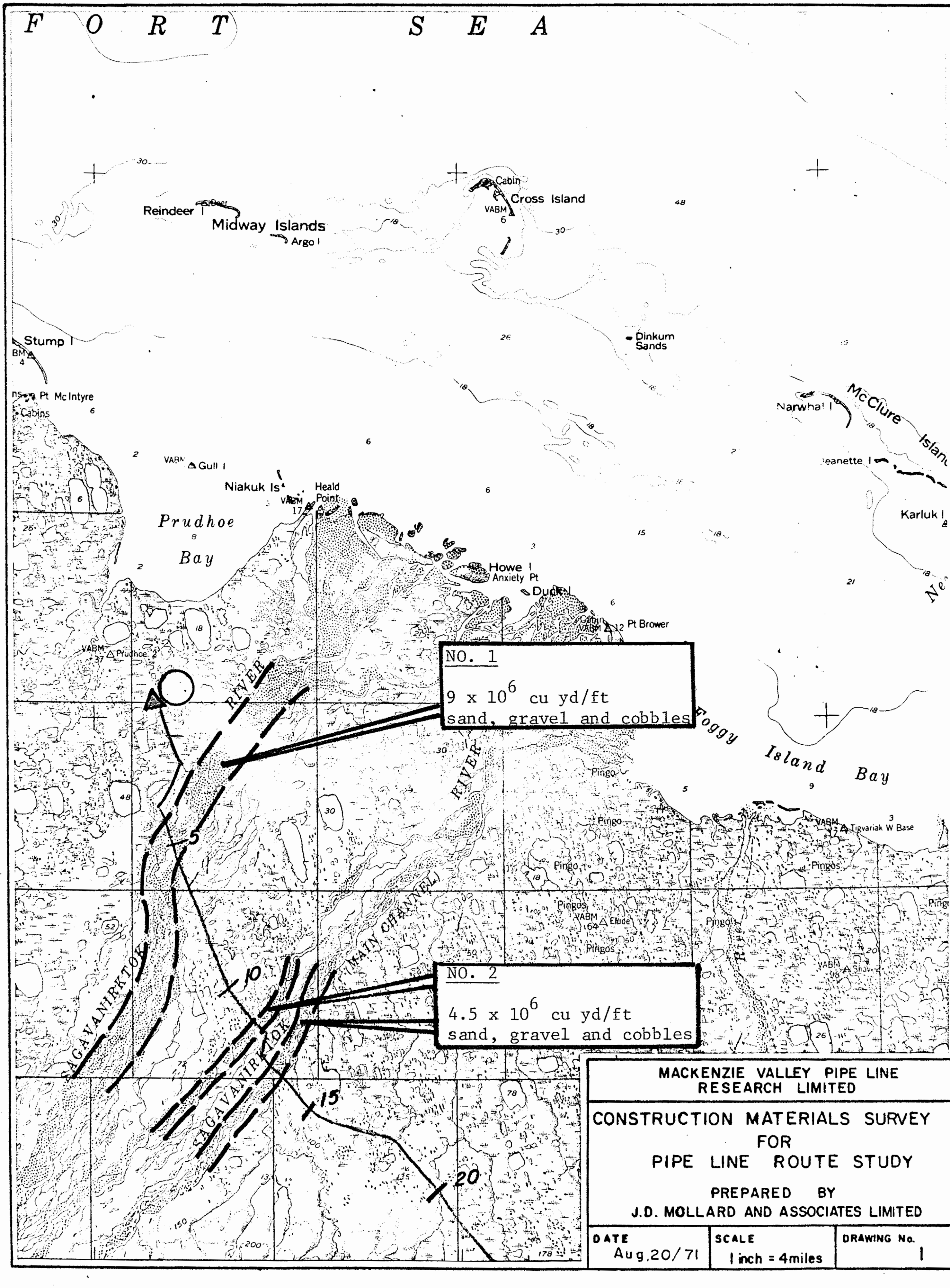
	No. 89				No. 90			
Intended use of material	road				road			
Location where material required -- milepost	1150 - 1160				1160 - 1245			
Volume of material required in cubic yards x 10^5	2.0				17			
Haul distance in miles	± 3				along right-of-way			
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.5				essentially unlimited			
Estimated recoverable depth in feet	± 5 ft; depends on thawed depth							
Estimated volume available in cubic yards x 10^5	2.5							
Estimated overburden depth and type of material	1 - 3 ft of peat				½ - 5 ft of peat			
Method of mining	strip and may require some ripping				strip and may require some ripping			
Notes: type of material, suitability, etc.	crevasse fillings; variable deposits of sand, gravel, boulders and till; suitable for granular fill; may locally contain material acceptable for concrete aggregate				till from topographic highs along right-of-way with few local granular deposits such as crevasse fillings and eskers; suitable for fill material			

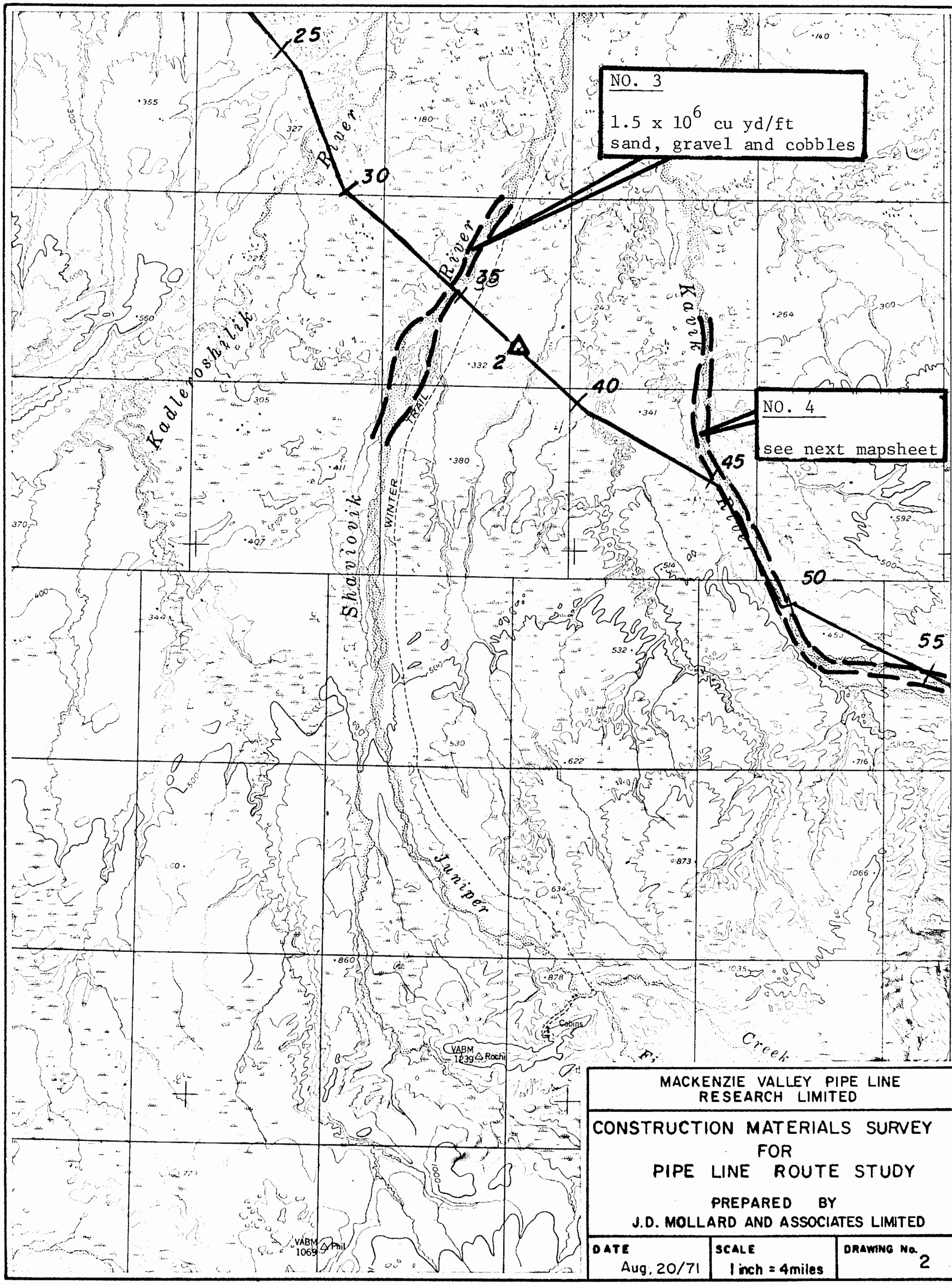
	Deposit No. 91				Deposit No. 92			
Intended use of material	original pump-station No. 28				supplement to deposit No. 91			
Location where material required -- milepost	1184							
Volume of material required in cubic yards x 10^5	2.5							
Haul distance in miles	± 2				± 10			
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.2				0.2			
Estimated recoverable depth in feet	± 10 ft; depends on thawed depth				± 10 ft; depends on thawed depth			
Estimated volume available in cubic yards x 10^5	2				2			
Estimated overburden depth and type of material	1 - 3 ft of peat				1 - 3 ft of peat			
Method of mining	strip and may require some ripping				strip and may require some rippin			
Notes: type of material, suitability, etc.	crevasse fillings; variable deposits of sand, gravel, boulders and till; suitable for granular fill and may locally contain material suitable for concrete aggregate				eskers and crevasse fillings; variable deposits of sand, gravel boulders and till; suitable for granular fill and locally for concrete aggregate			

	No. 93				No.			
Intended use of material	expansion pump-station No.29	supplement to deposit No. 90						
Location where material required -- milepost	1231							
Volume of material required in cubic yards x 10^5	2.5							
Haul distance in miles	± 25							
Estimated volume of material available per foot of depth in cubic yards x 10^5	0.3							
Estimated recoverable depth in feet	± 10 ft; depends on depth of thaw							
Estimated volume available in cubic yards x 10^5	3							
Estimated overburden depth and type of material	1 - 3 ft of peat							
Method of mining	strip and may require some ripping							
Notes: type of material, suitability, etc.	crevasse fillings and eskers; variable deposits of sand, gravel, boulders and till; suitable for granular fill and locally may contain material acceptable for concrete aggregate							

APPENDIX 'B'

Mapsheets showing location, type, and volume of construction-material sources along Mackenzie Valley Pipe Line Research Limited pipe-line route.


F O R T
S E A
Cabin
Cross Island
VABM 6
Reindeer I
Midway Islands
Argo I
Stump I
Pt McIntyre
Cabins
Dinkum Sands
Narwhal I
McClure Islan
Jeanette I
Karluk I
VABM Gull I
Niakuk Is
Heald Point
VABM 17
Prudhoe Bay
Howe I
Anxiety Pt
Duck I
Cabin
VABM 12 Pt Brower
VABM 37 Prudhoe 2
RIVER
NO. 1
9 x 10^6 cu yd/ft
sand, gravel and cobbles
Foggy Island Bay
RIVER
Pingo
VABM Tigvariak W Base
Pingos
(MAIN CHANNEL)
VABM 64 Elude
SAGAVANIRKTOK
NO. 2
4.5 x 10^6 cu yd/ft
sand, gravel and cobbles
SAGAVANIRKTOK
5
10
15
20
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug.20/71
SCALE
1 inch = 4miles
DRAWING No.
1

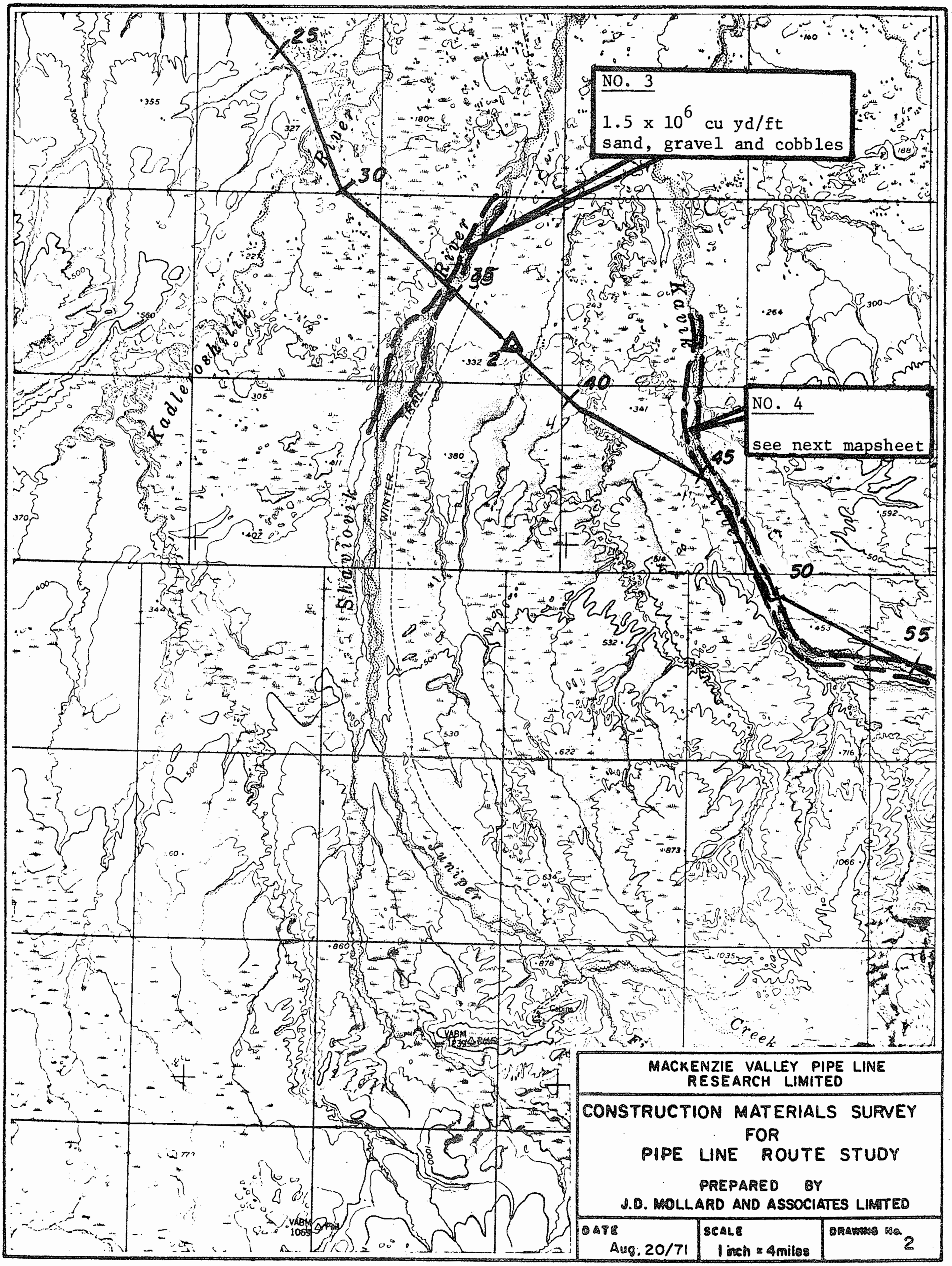


MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED

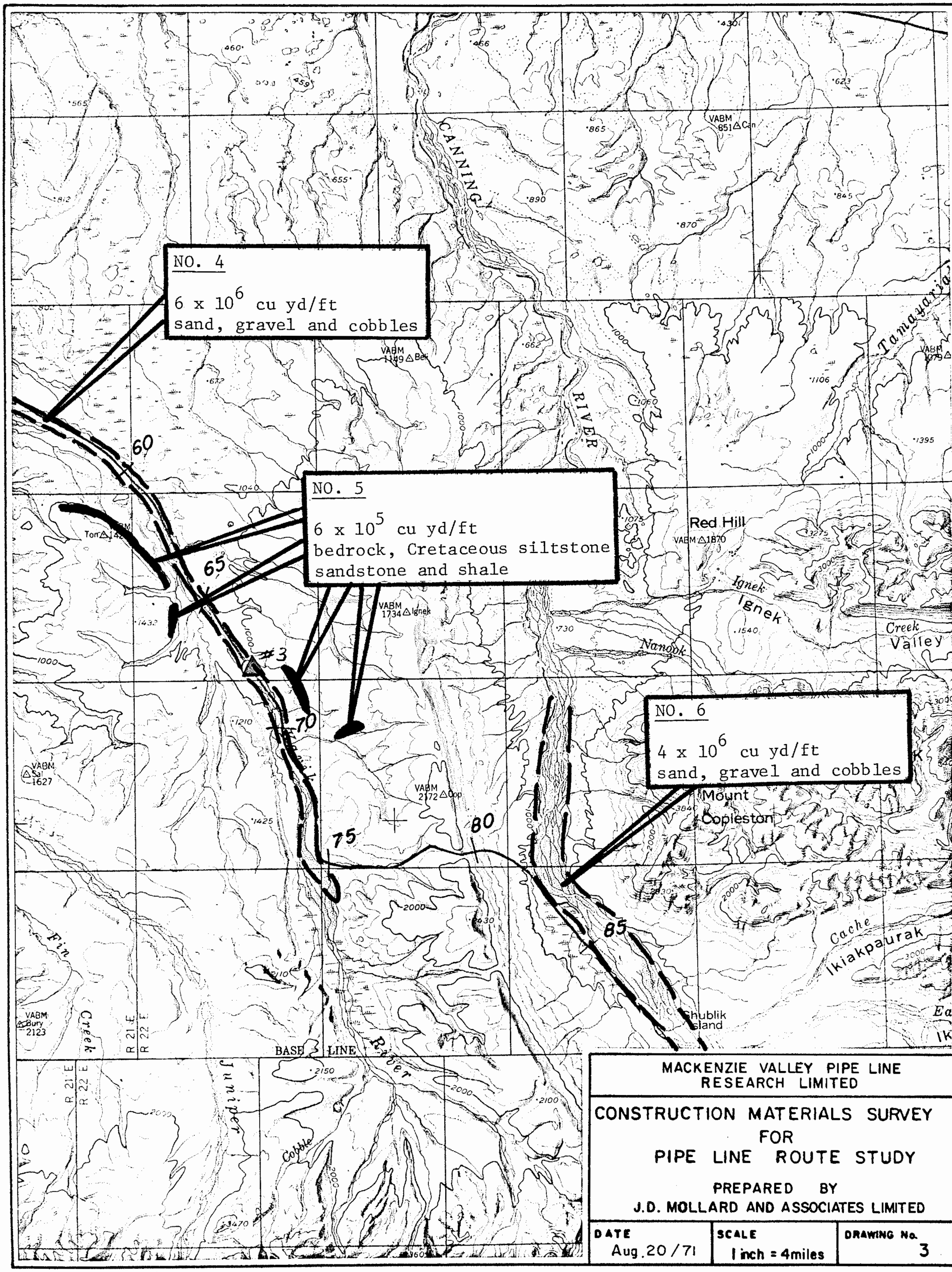
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4miles	2



NO. 3
1.5 x 10^6 cu yd/ft
sand, gravel and cobbles
NO. 4
see next mapsheet
Kadleroshilik
River
Shaviovik
WINTER TRAIL
Juniper
Kavik
Creek
Cabins
25
30
35
40
45
50
55
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug. 20/71
SCALE
1 inch = 4miles
DRAWING No.
2

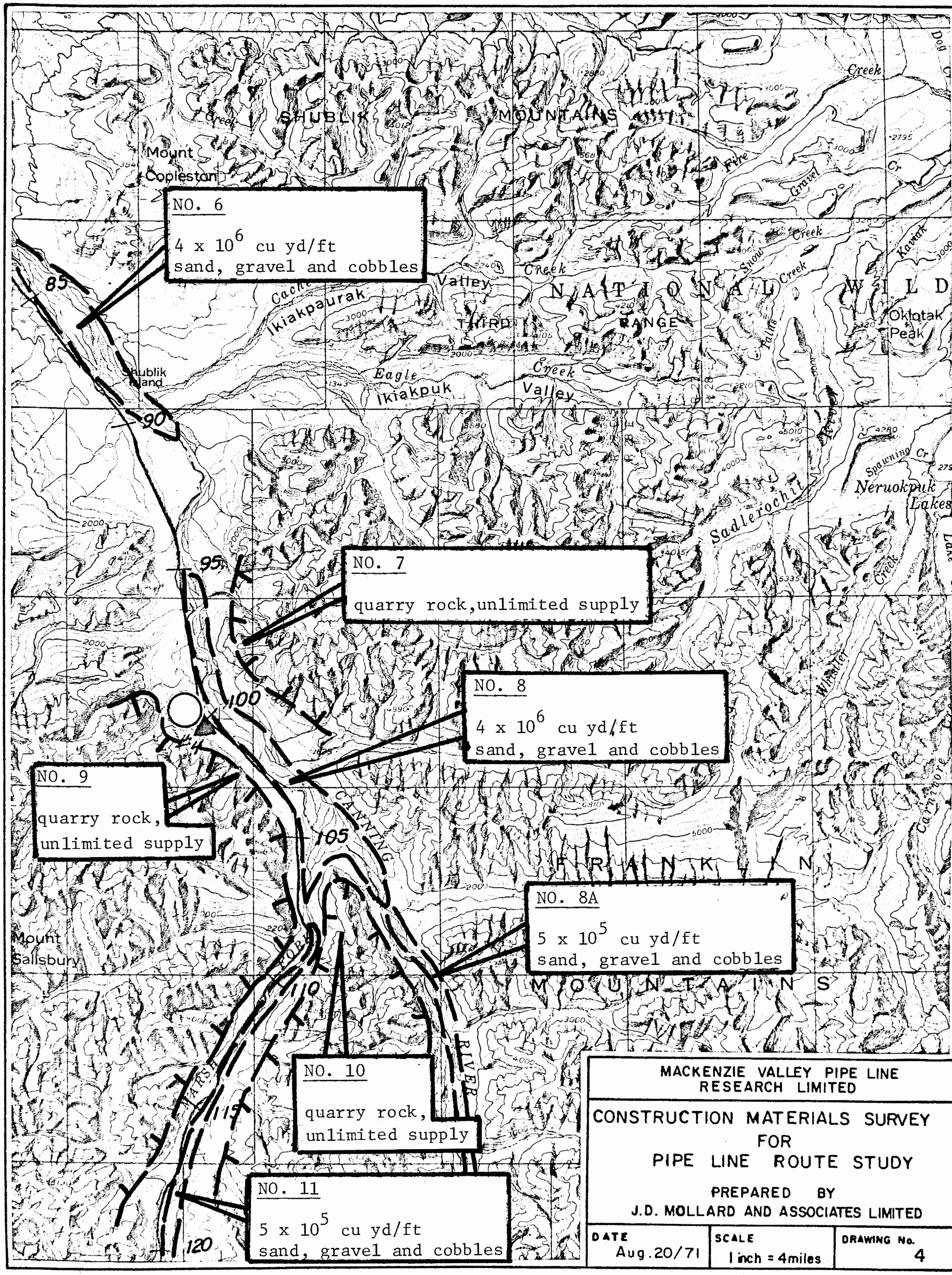


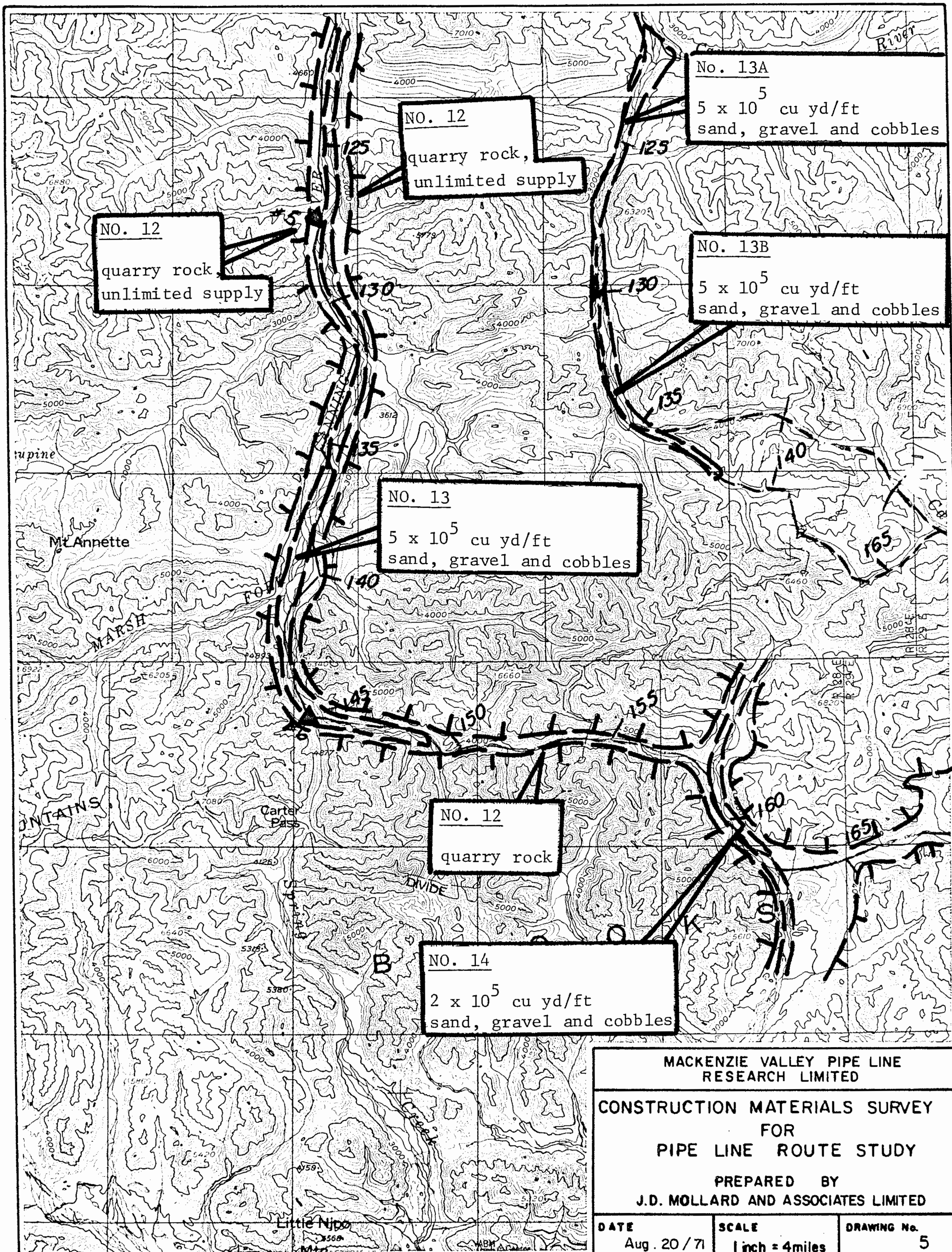
MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED

CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	3


SHUBLIK MOUNTAINS
Mount Copleston
NO. 6
4 x 10^6 cu yd/ft
sand, gravel and cobbles
Ikiakpaurak Valley
THIRD RANGE
NATIONAL WILD
Oklotak Peak
Shublik Island
Eagle Creek
Ikiakpuk Valley
Fire Creek
Gravel Creek
Snow Creek
Kavik
Dog Creek
Sadlerochit
Spawning Cr
Neruokpuk Lakes
NO. 7
quarry rock, unlimited supply
NO. 8
4 x 10^6 cu yd/ft
sand, gravel and cobbles
NO. 9
quarry rock,
unlimited supply
CANNING
FRANKLIN MOUNTAINS
NO. 8A
5 x 10^5 cu yd/ft
sand, gravel and cobbles
Mount Salisbury
MARSH FORK
RIVER
NO. 10
quarry rock,
unlimited supply
NO. 11
5 x 10^5 cu yd/ft
sand, gravel and cobbles
85
90
95
100
105
110
115
120
MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE Aug. 20/71
SCALE 1 inch = 4 miles
DRAWING No. 4



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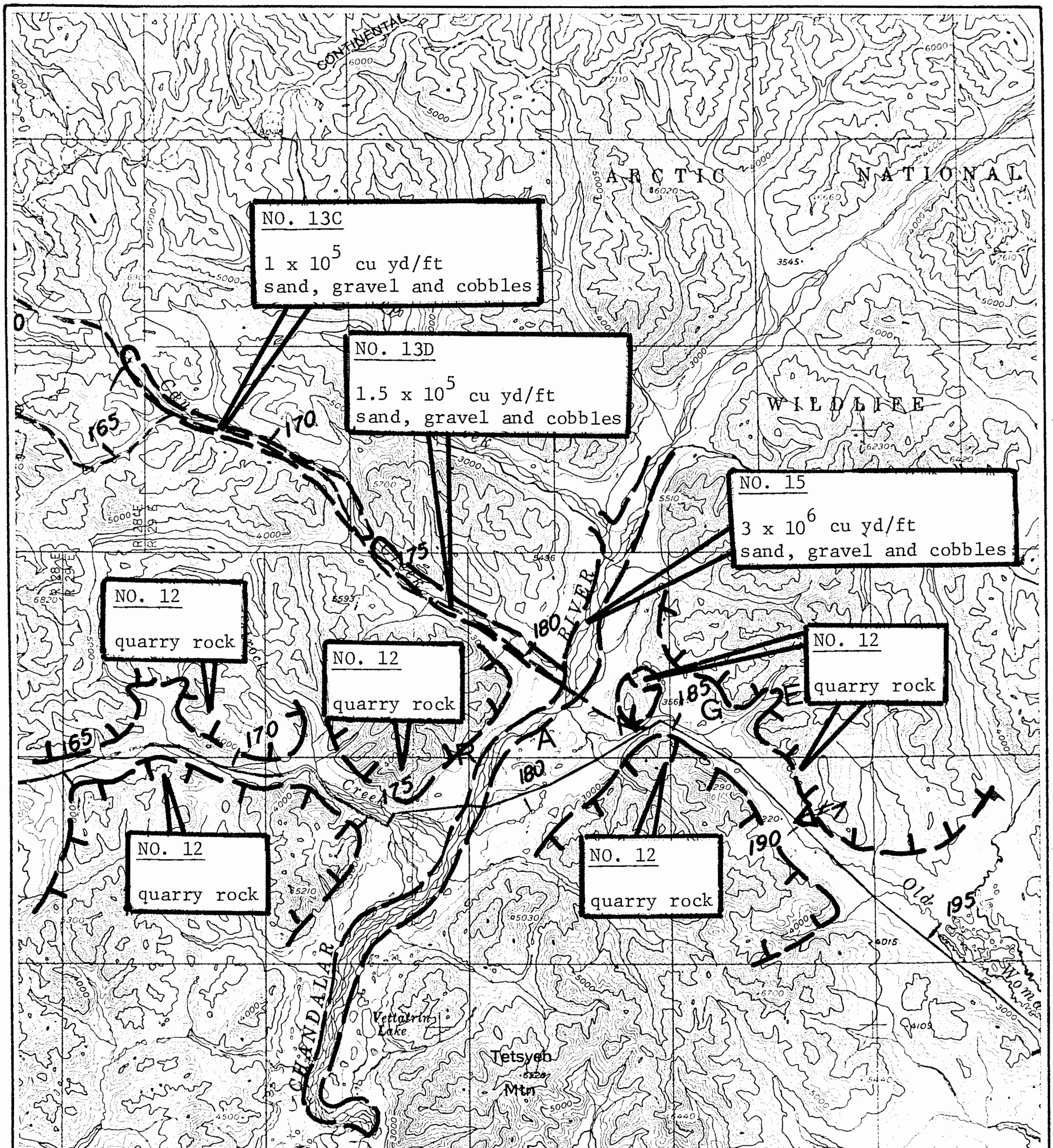
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	5



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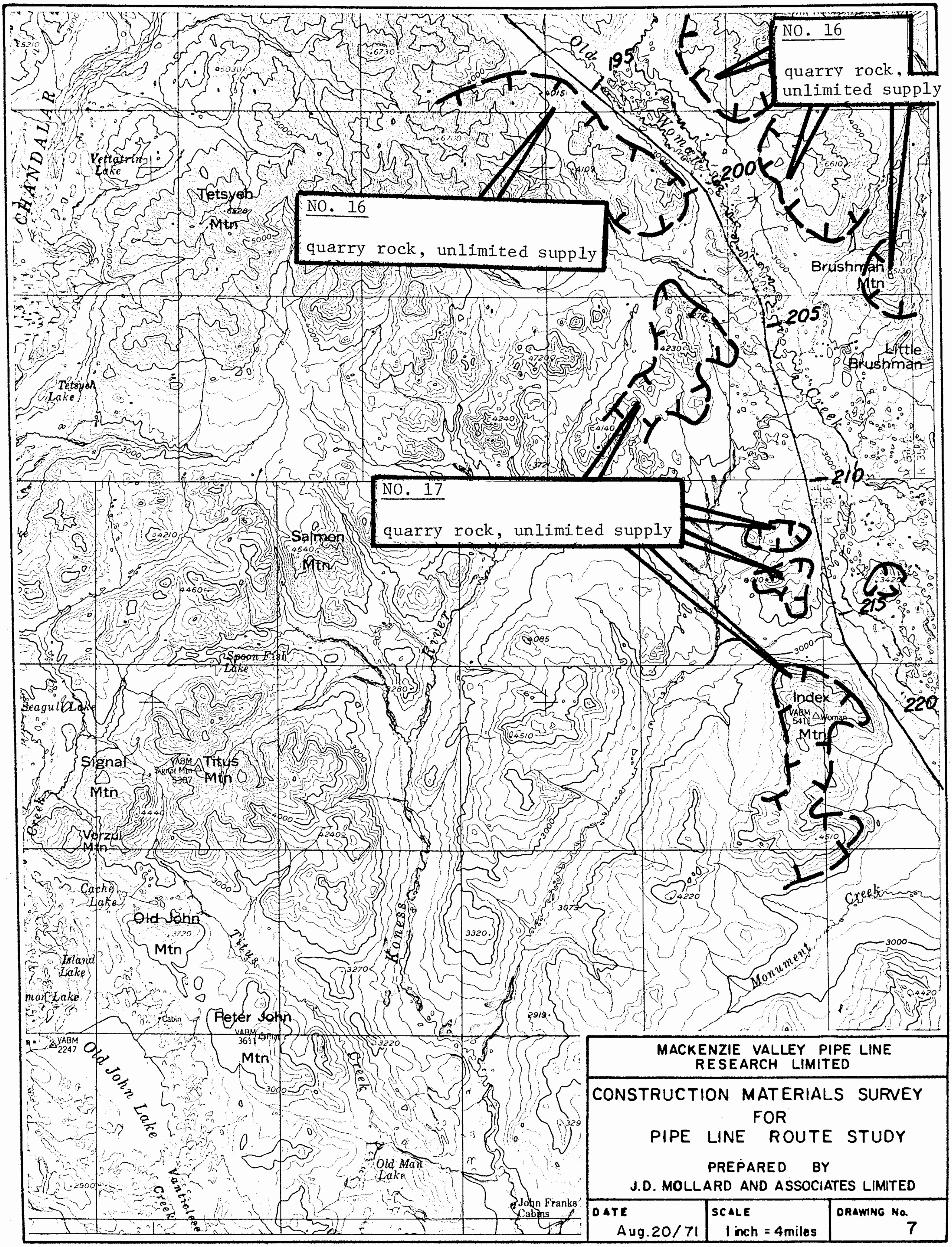
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	6



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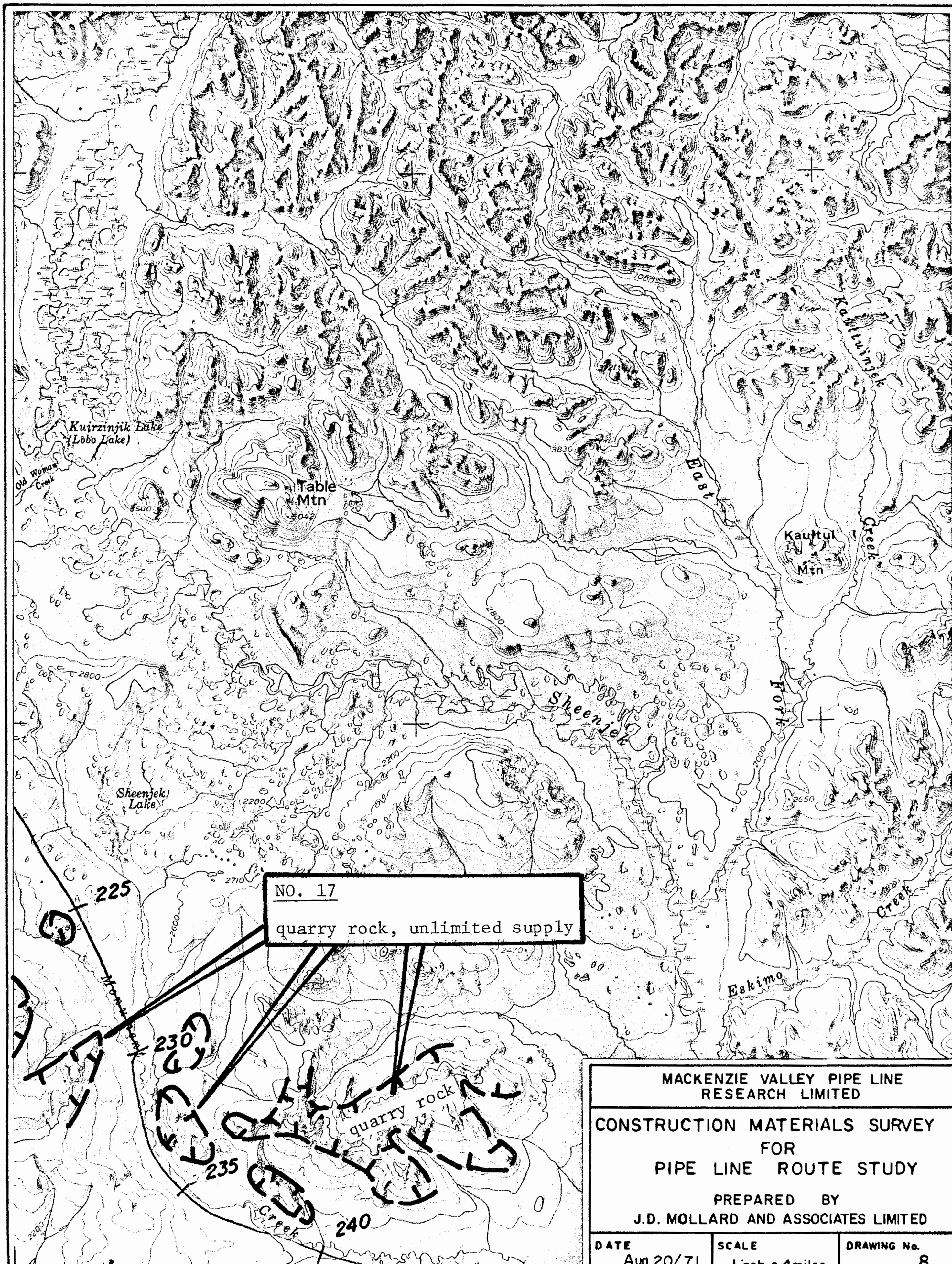
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	7

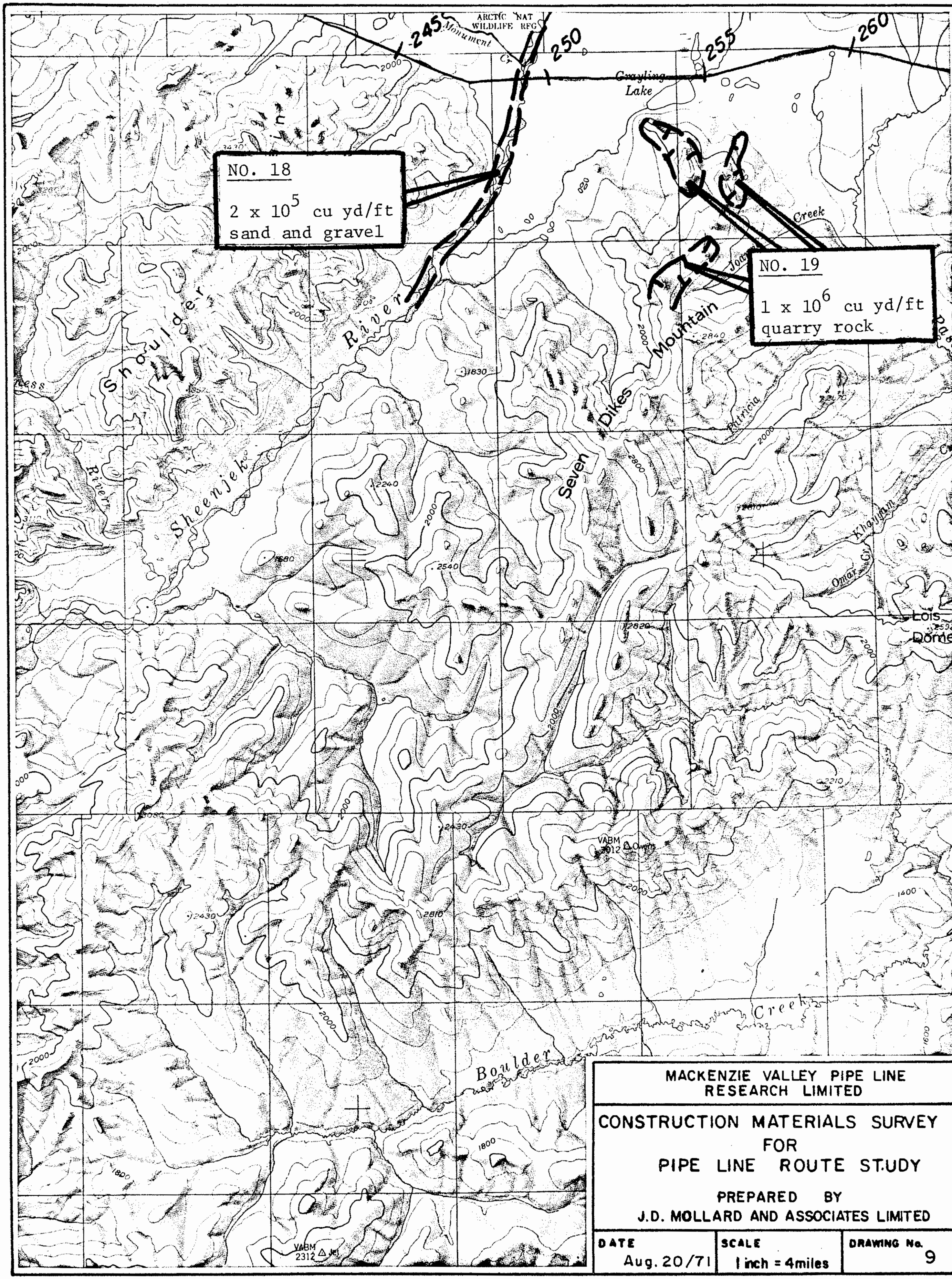


MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED

CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug.20/71	1 inch = 4miles	8

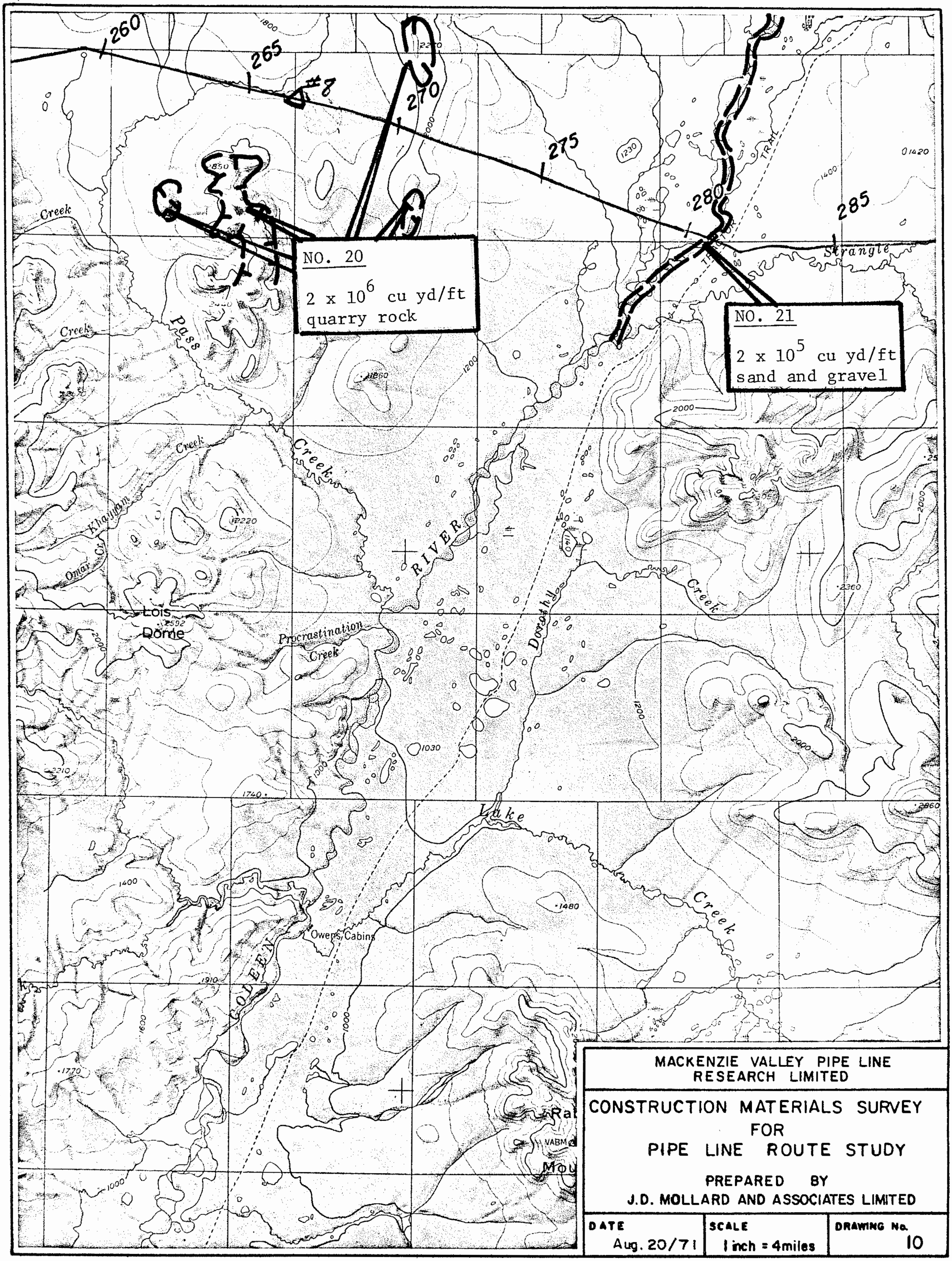


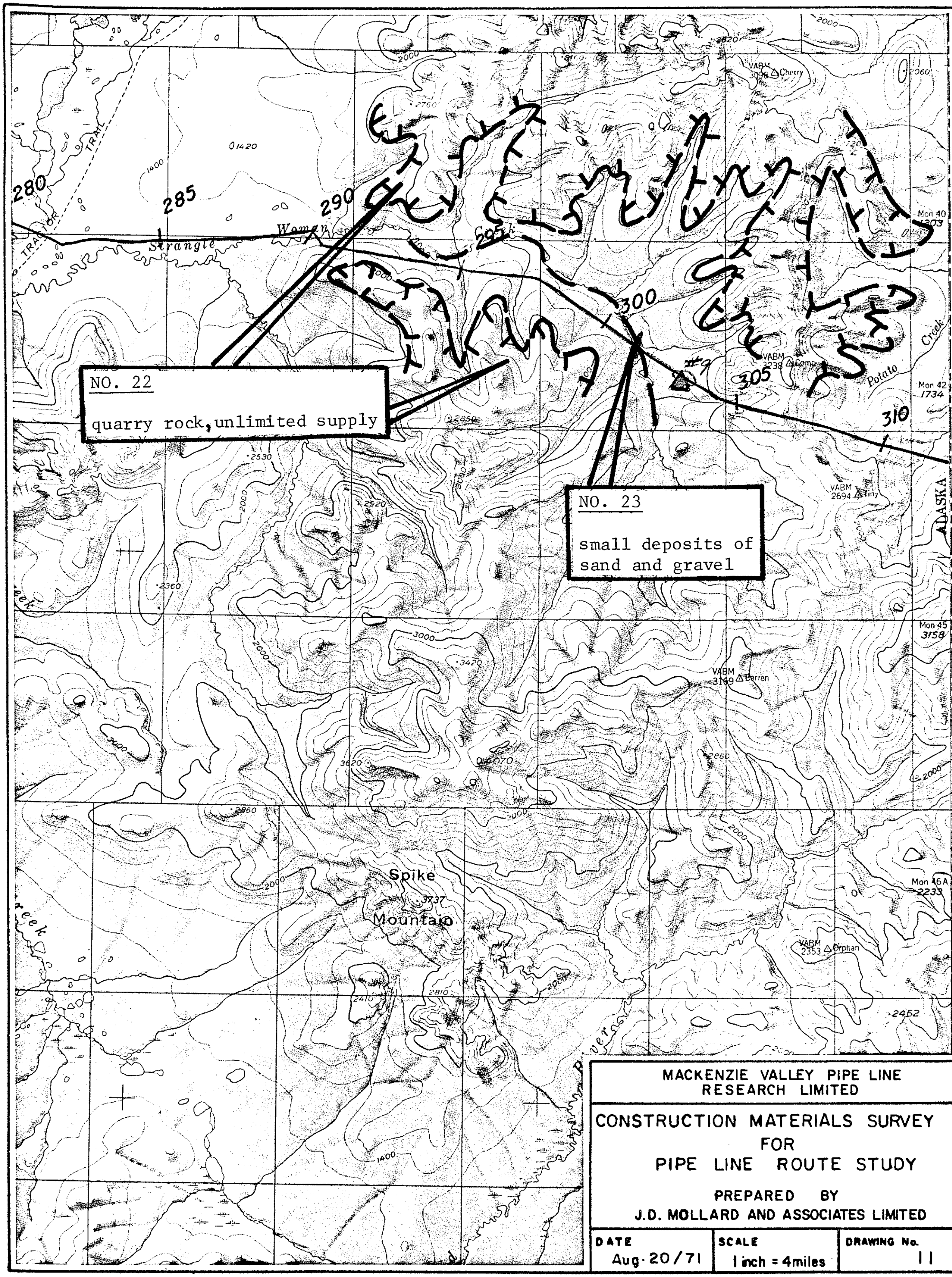
MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED

CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	9


260
265
270
275
280
285
NO. 20
2 x 10^6 cu yd/ft
quarry rock
NO. 21
2 x 10^5 cu yd/ft
sand and gravel
Creek
Pass
Strangle
TRAIL
Creek
Khayyam
Omar Cr.
Lois Dome
2592
Procrastination Creek
RIVER
Dorothy
Creek
Lake
Creek
Owens Cabins
COLEEN
VABM
1200
2000
1420
1230
1860
2220
1030
1740
1480
1400
1910
2210
1770
1000
1600
2360
2860
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug. 20/71
SCALE
1 inch = 4 miles
DRAWING No.
10



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CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY
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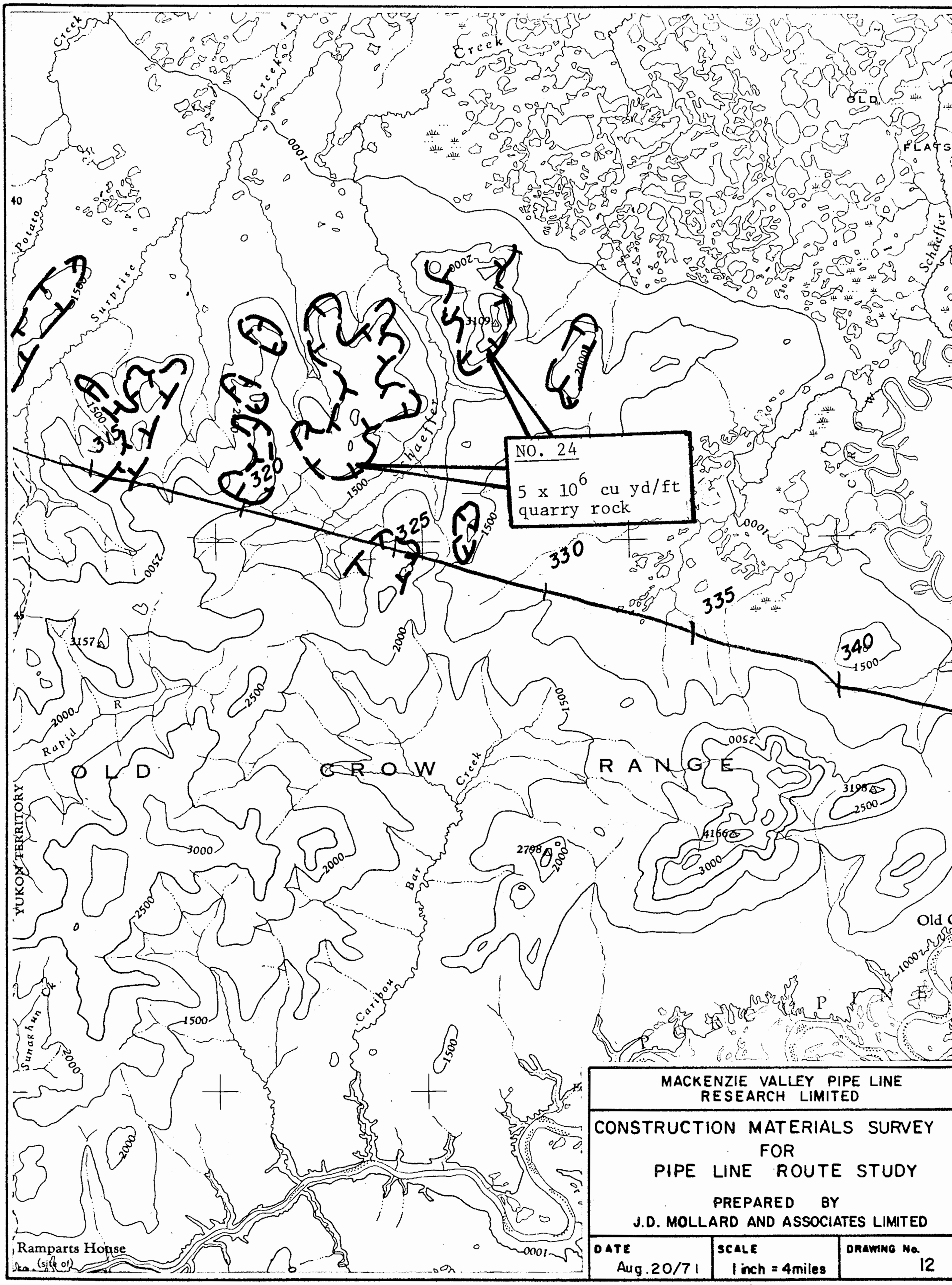
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	11



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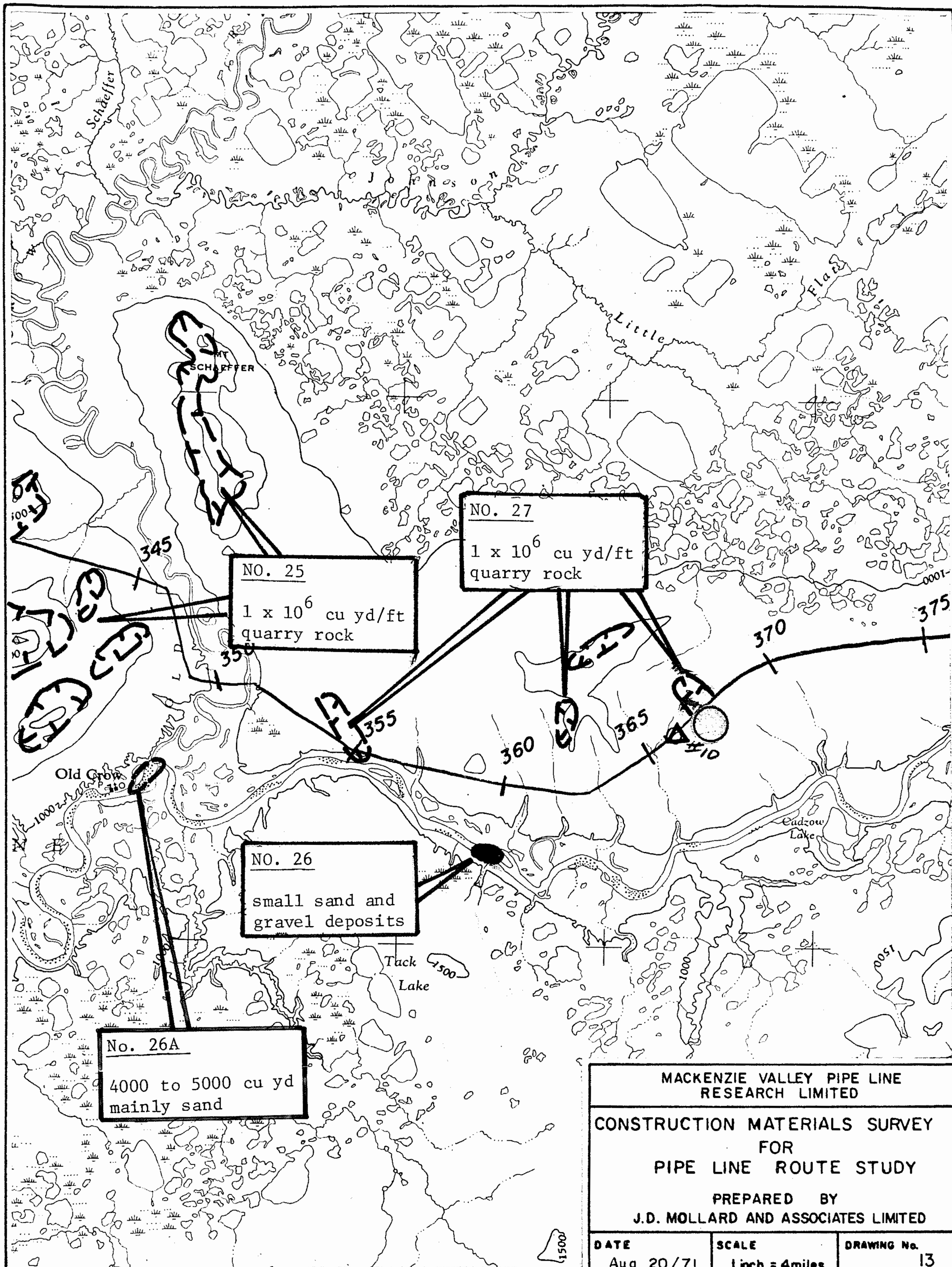
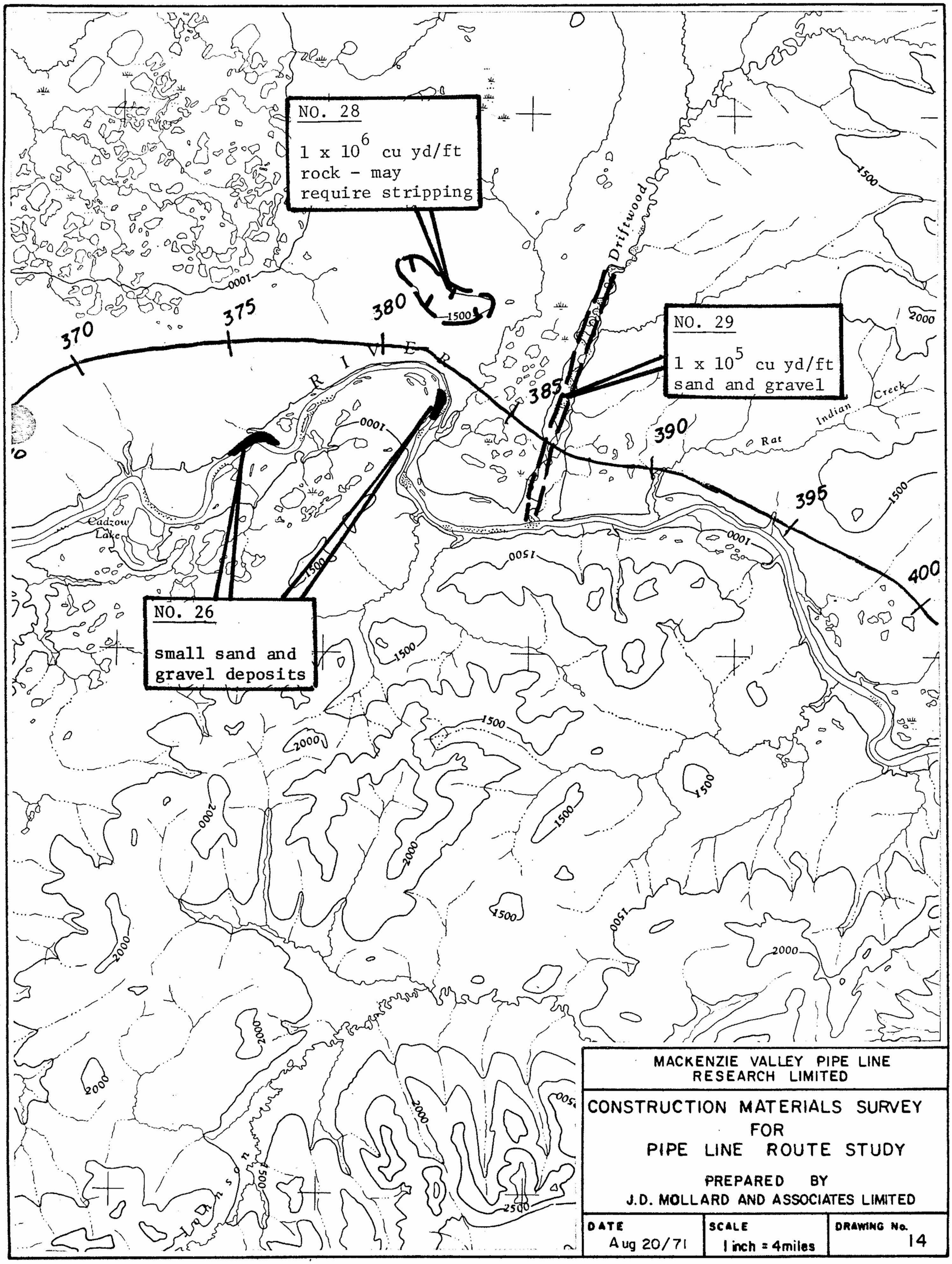
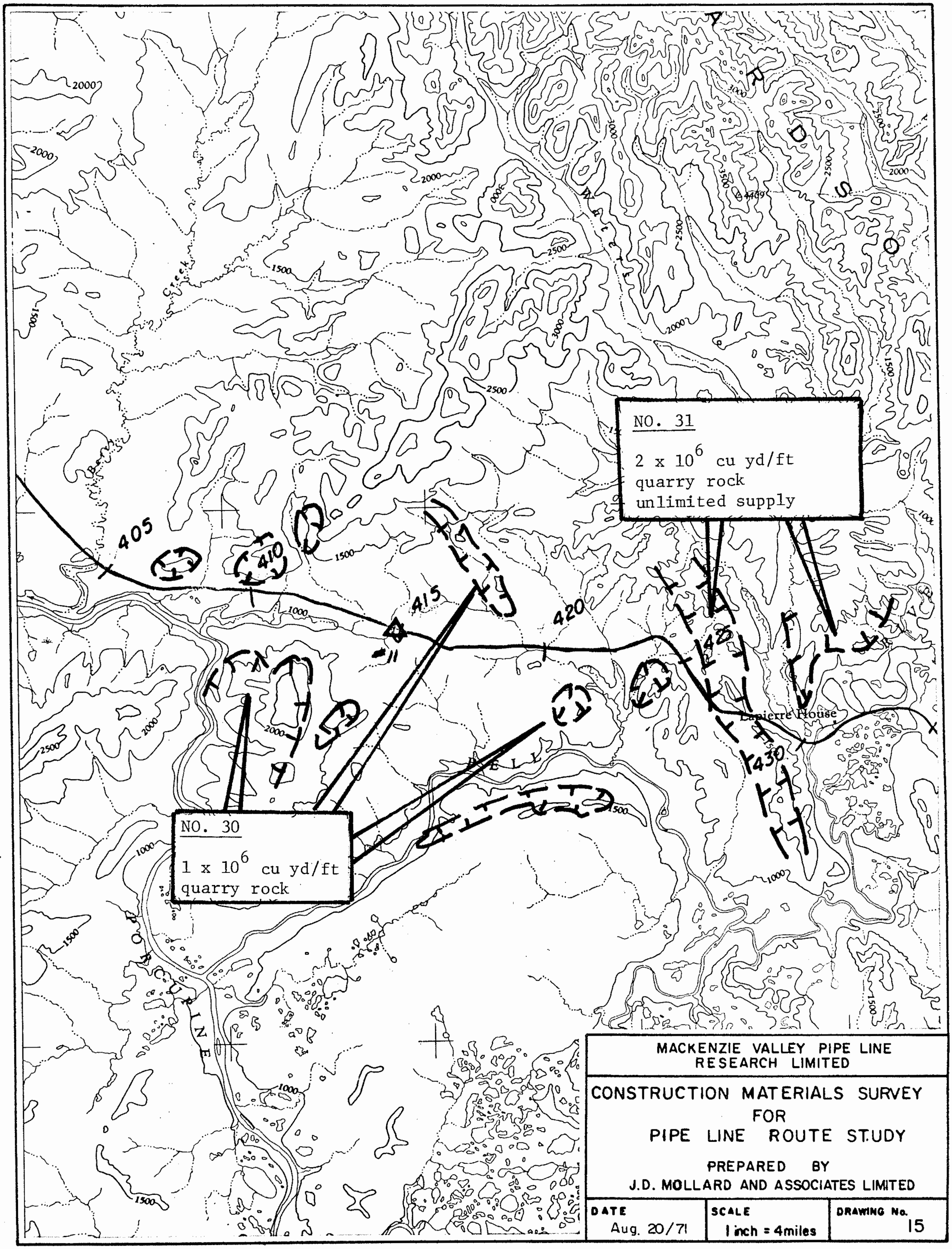
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	12


Schaeffer
Jordan
Little Flat
MT SCHAEFFER
NO. 25
1 x 10^6 cu yd/ft
quarry rock
NO. 27
1 x 10^6 cu yd/ft
quarry rock
NO. 26
small sand and
gravel deposits
No. 26A
4000 to 5000 cu yd
mainly sand
345
350
355
360
365
370
375
#10
Old Crow
Cadzow Lake
Tack Lake
1000
1500
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug 20/71
SCALE
1 inch = 4 miles
DRAWING No.
13


NO. 28
1 x 10^6 cu yd/ft
rock - may
require stripping
NO. 29
1 x 10^5 cu yd/ft
sand and gravel
NO. 26
small sand and
gravel deposits
370
375
380
385
390
395
400
RIVER
Driftwood
Rat
Indian
Creek
Cadzow
Lake
1500
2000
2500
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug 20/71
SCALE
1 inch = 4miles
DRAWING No.
14



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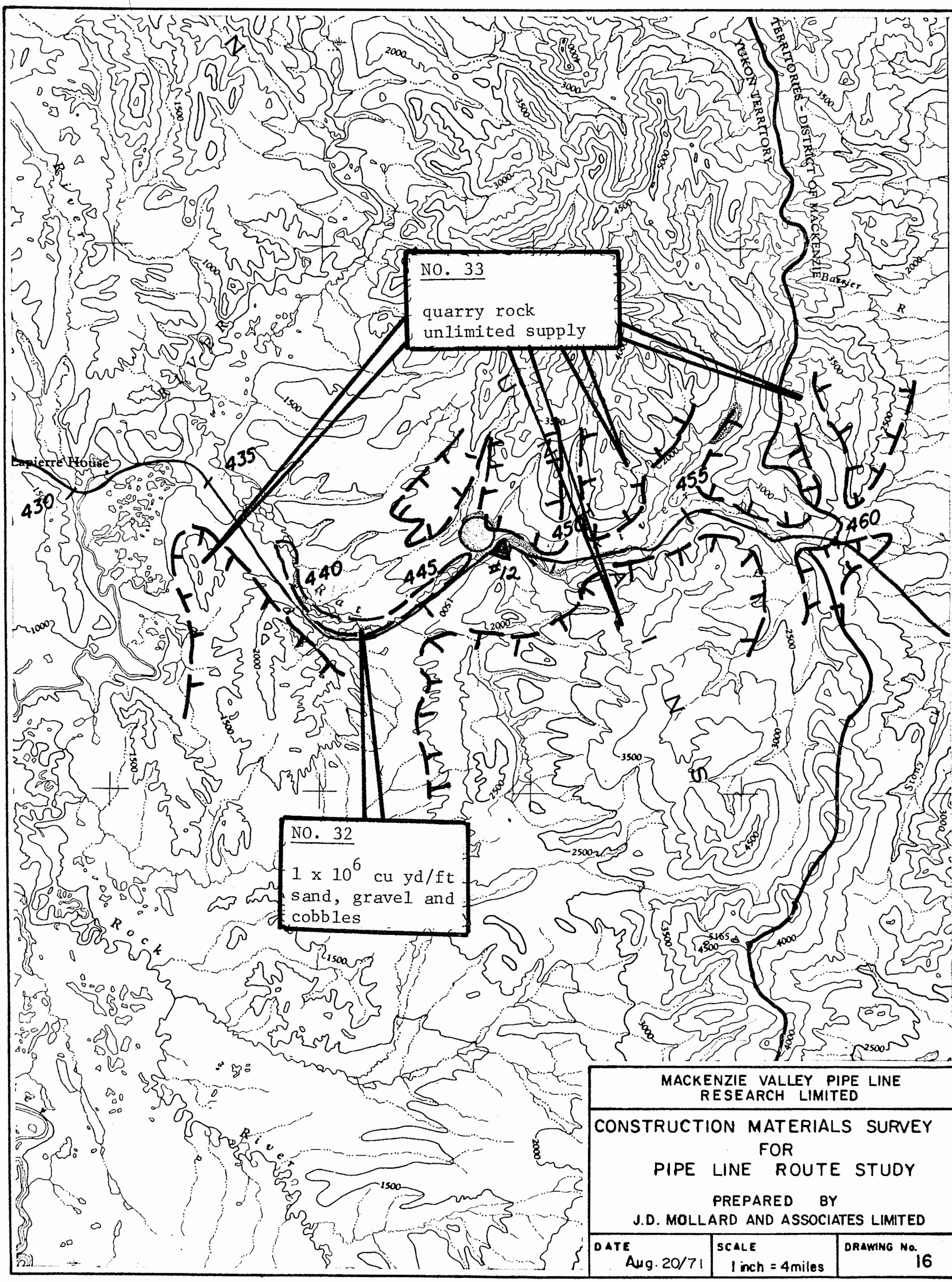
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	15



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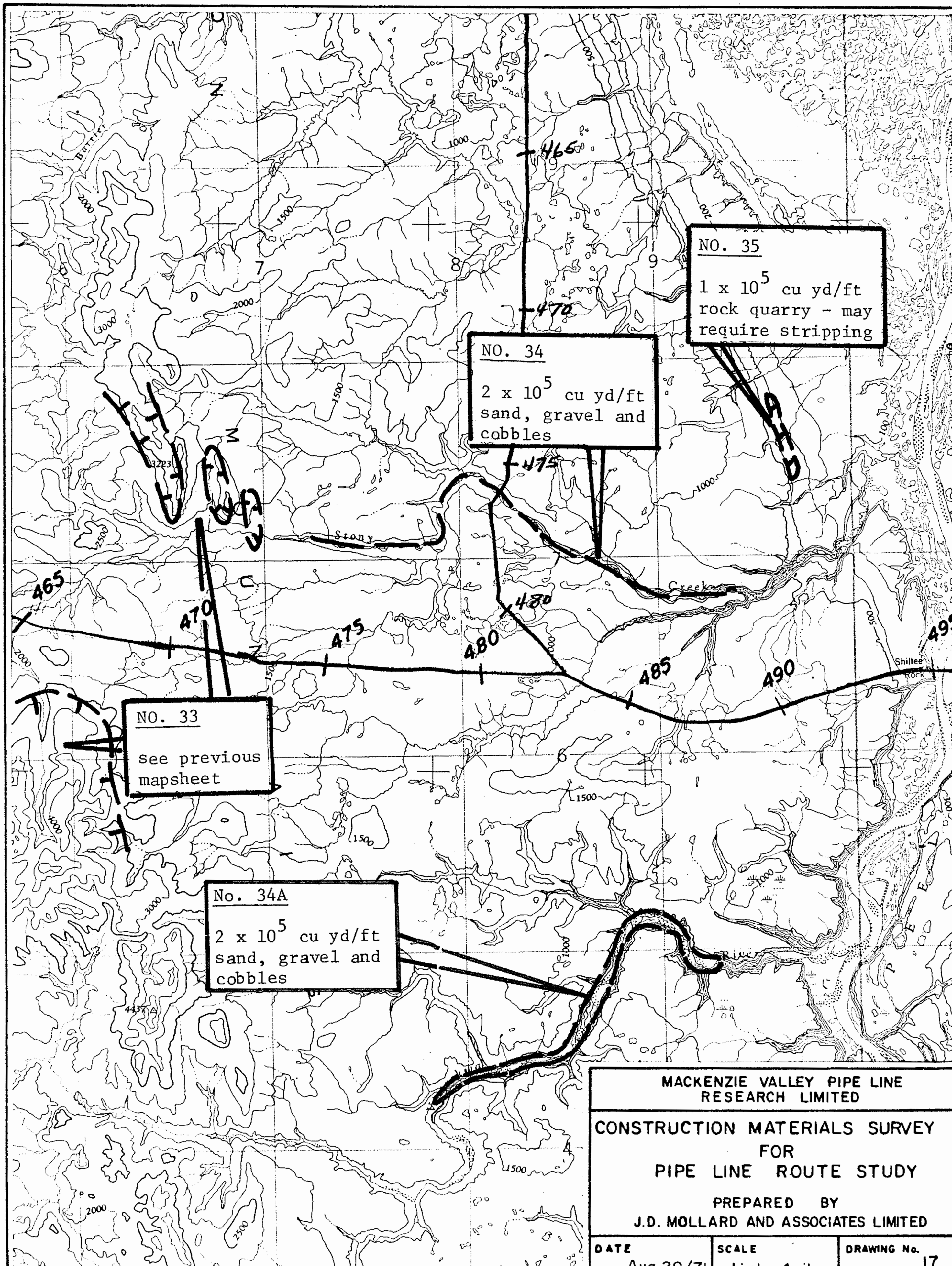
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	16



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CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

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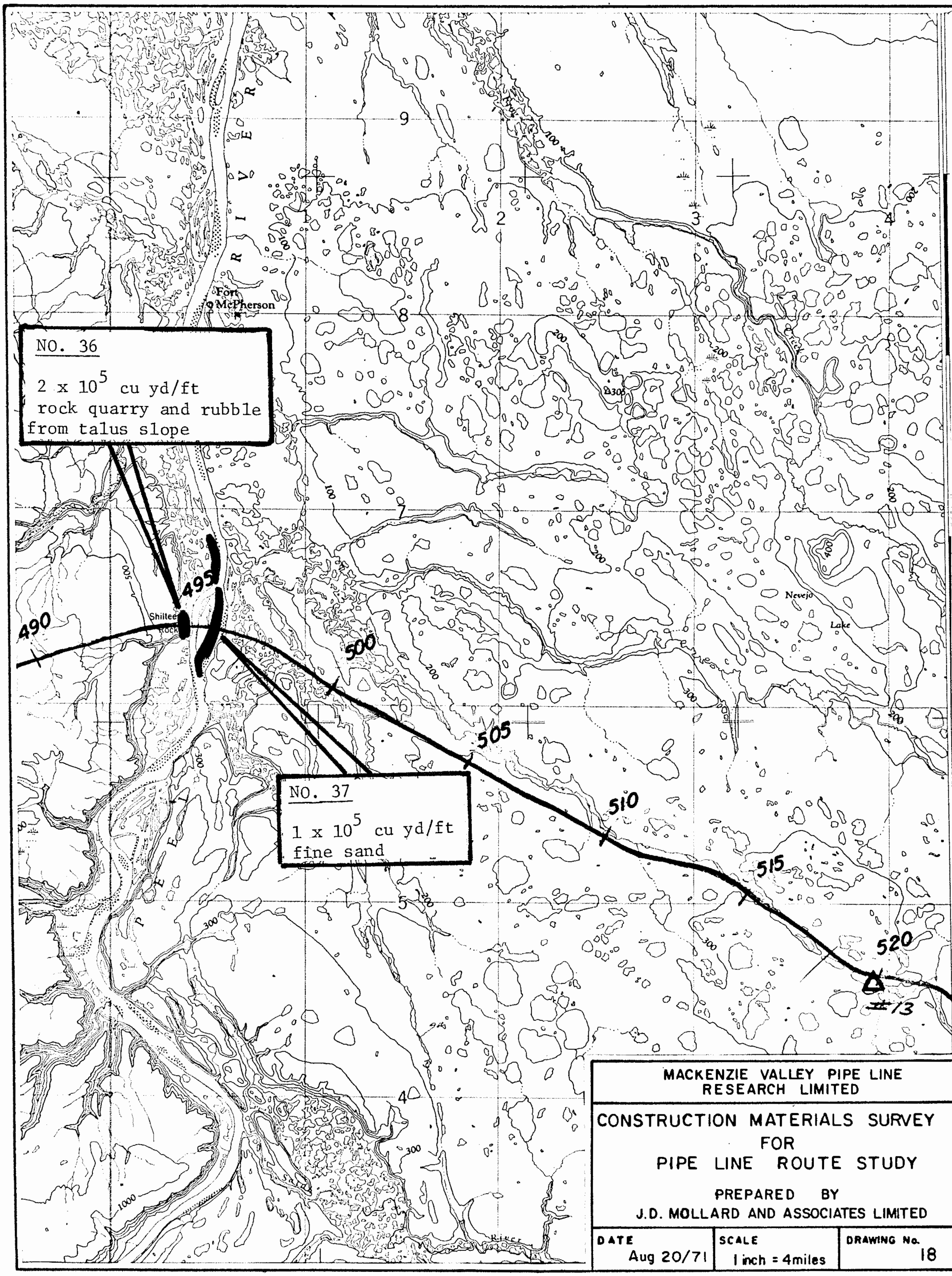
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	17



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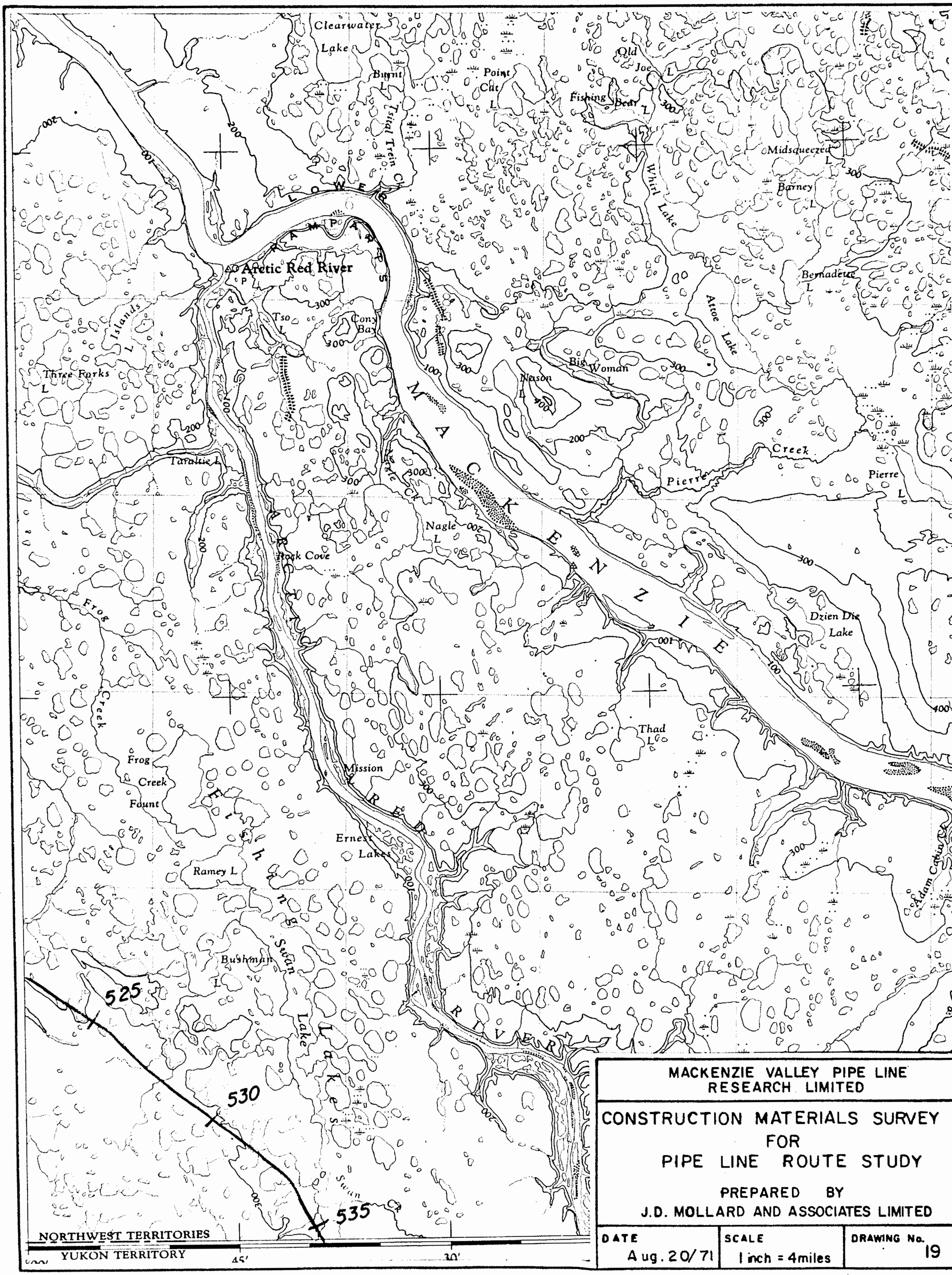
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug 20/71	1 inch = 4 miles	18



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CONSTRUCTION MATERIALS SURVEY
FOR
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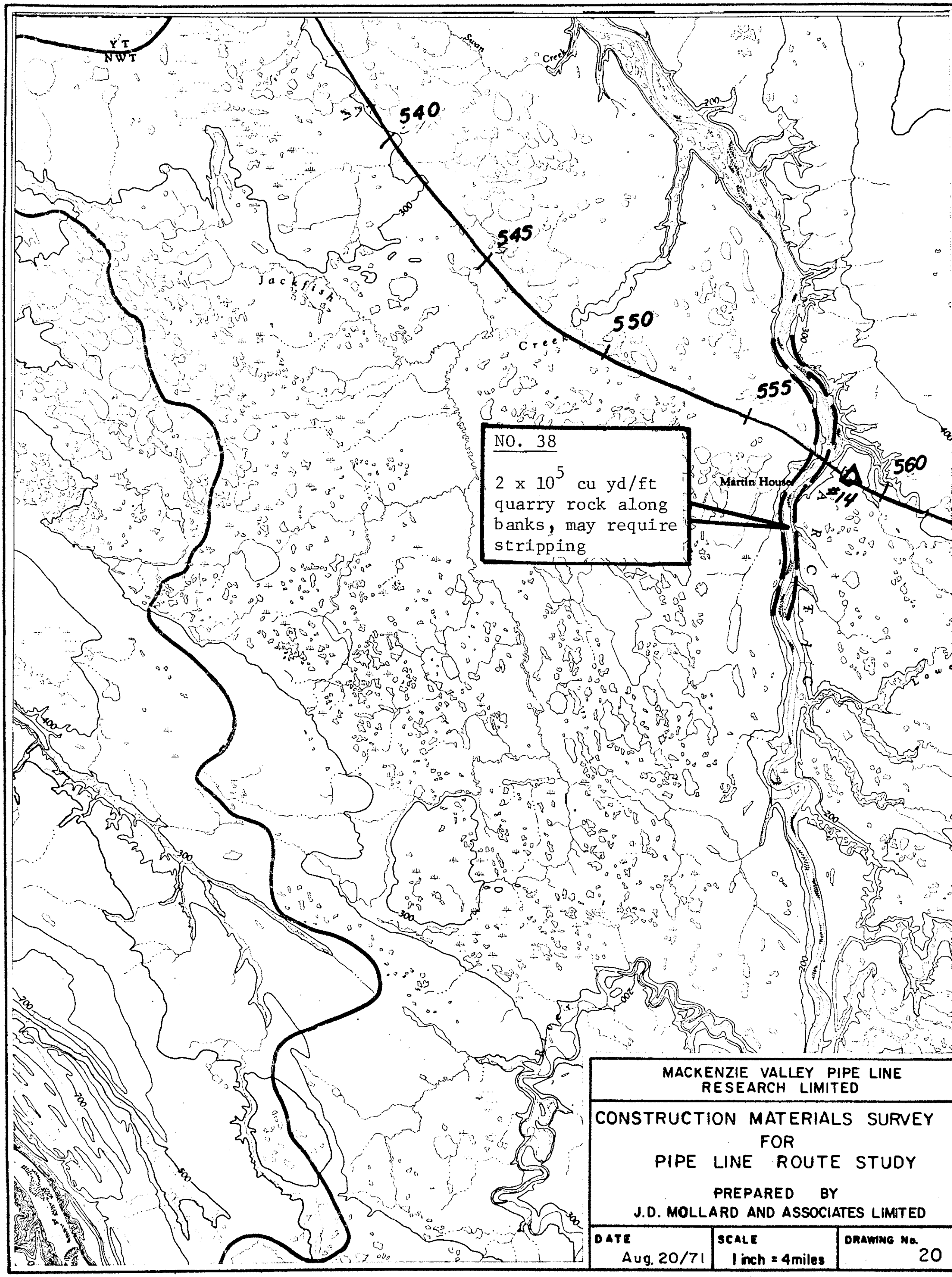
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	19



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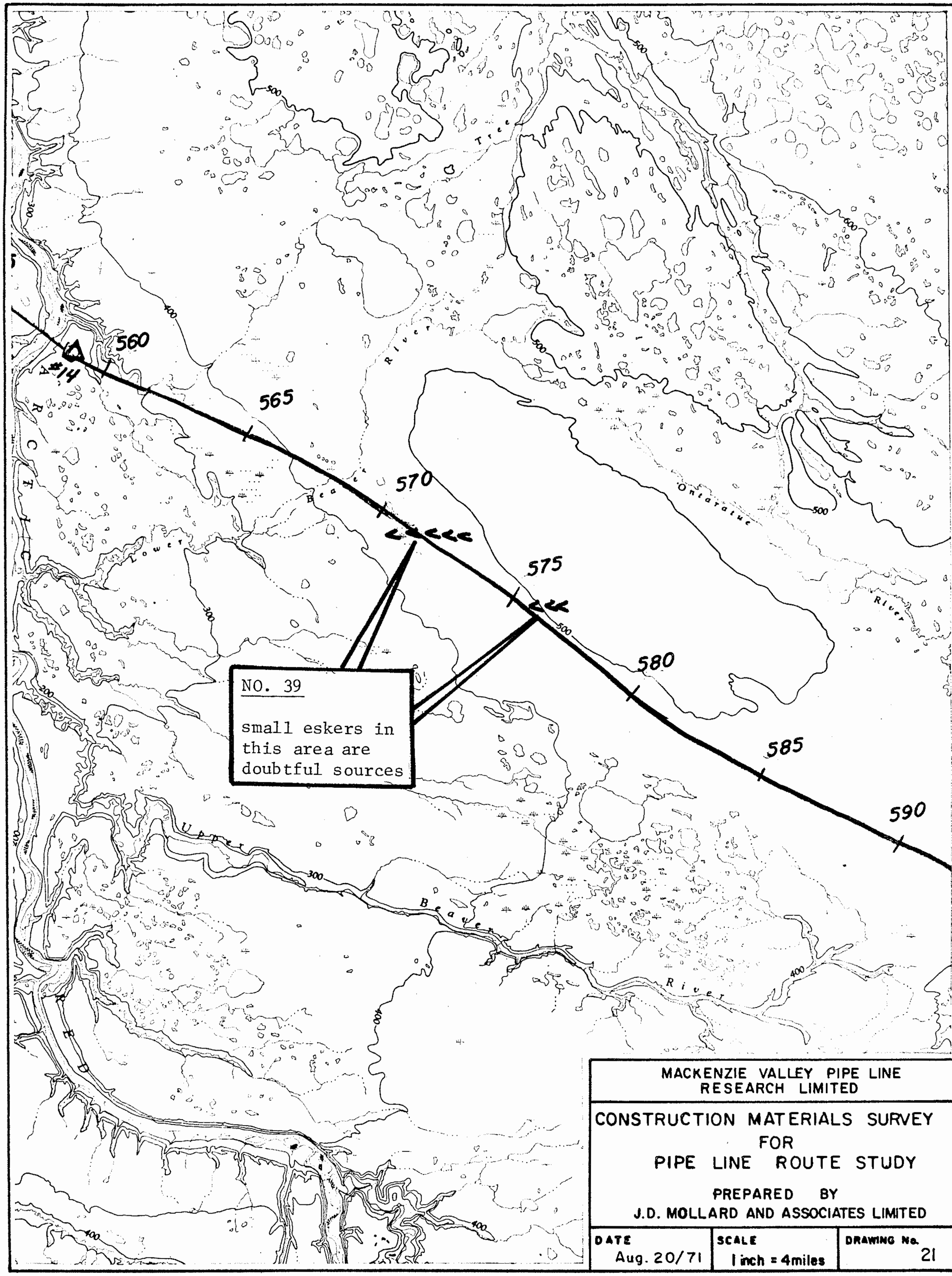
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	20



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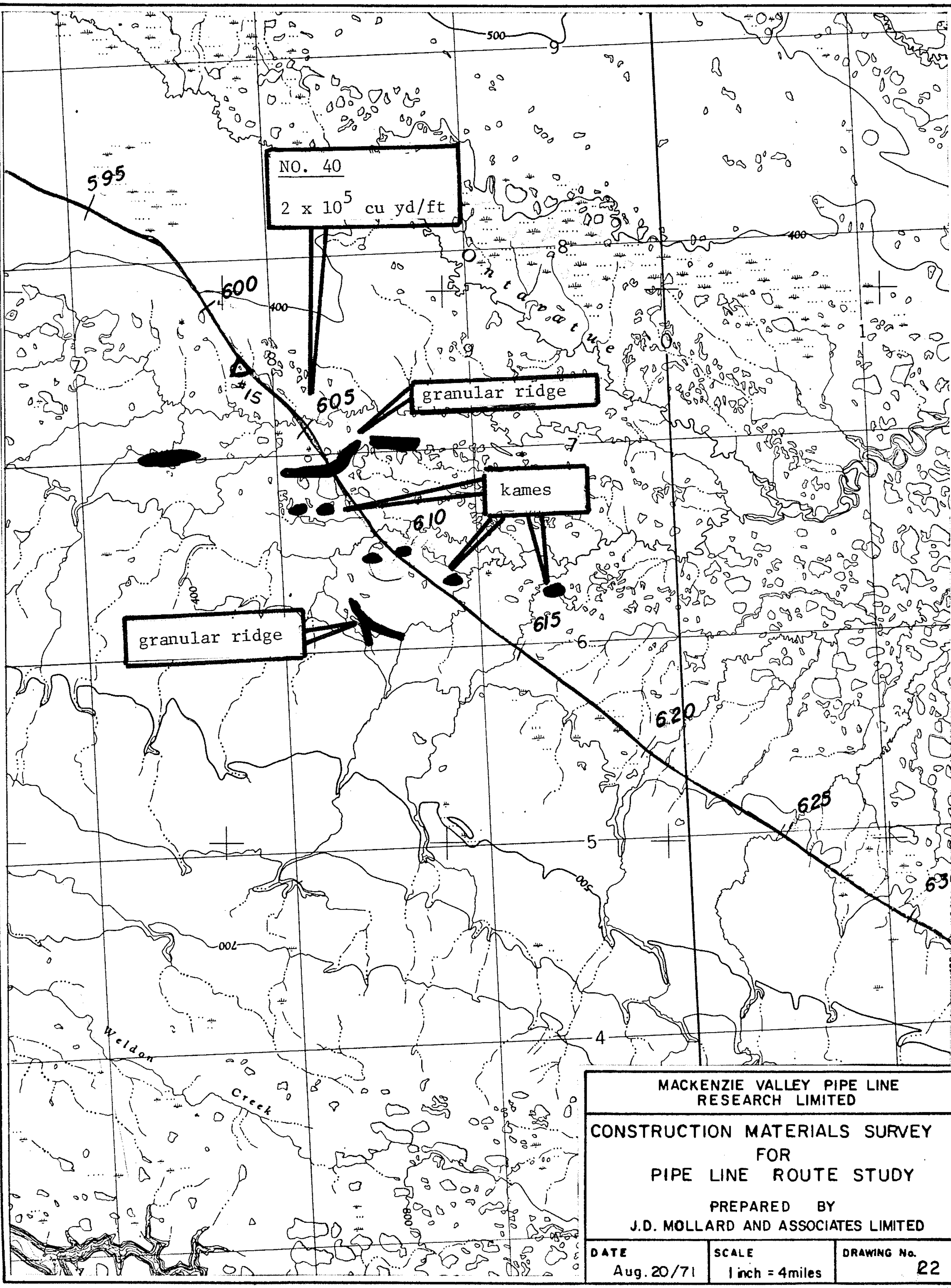
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	21



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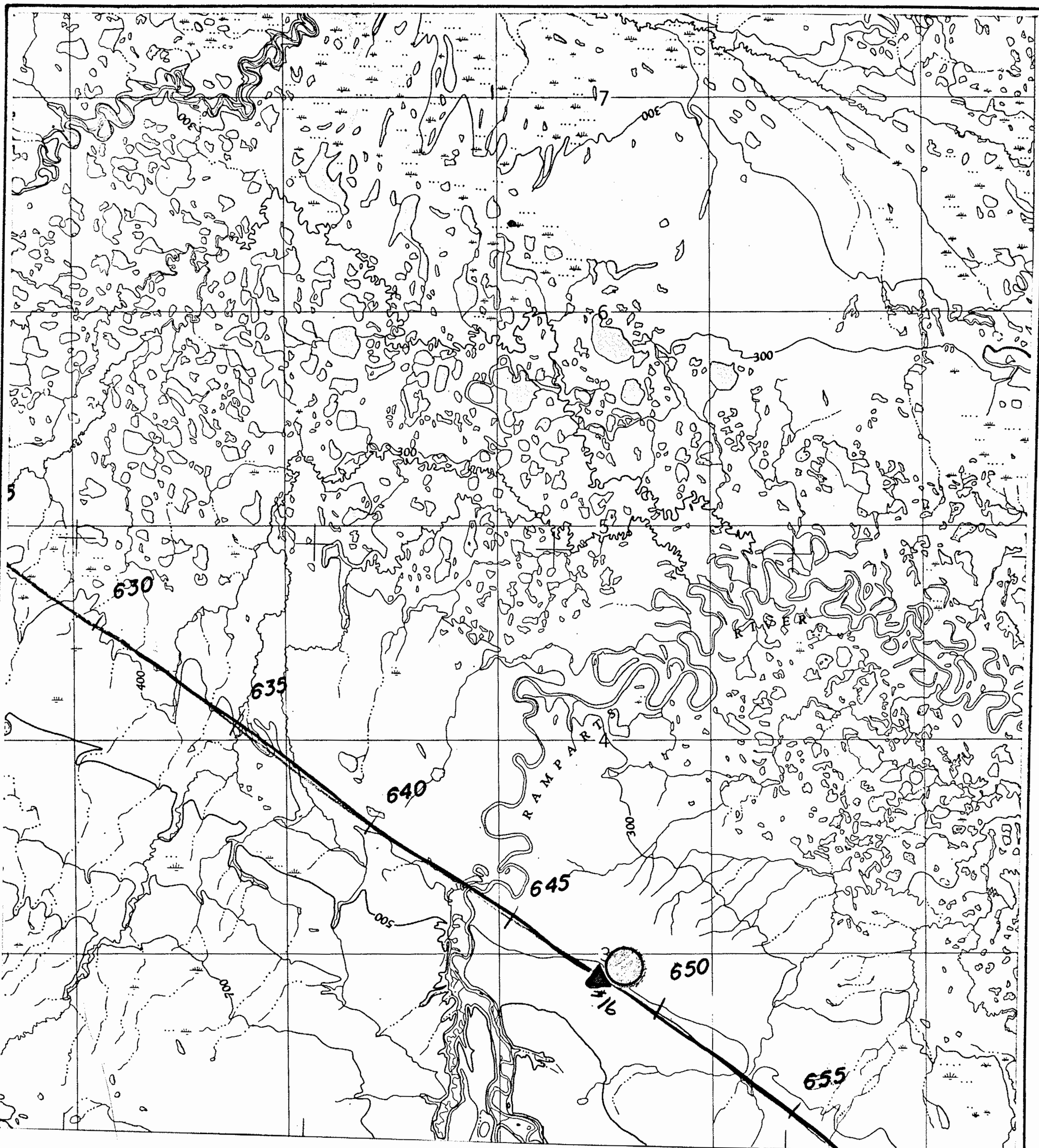
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	22



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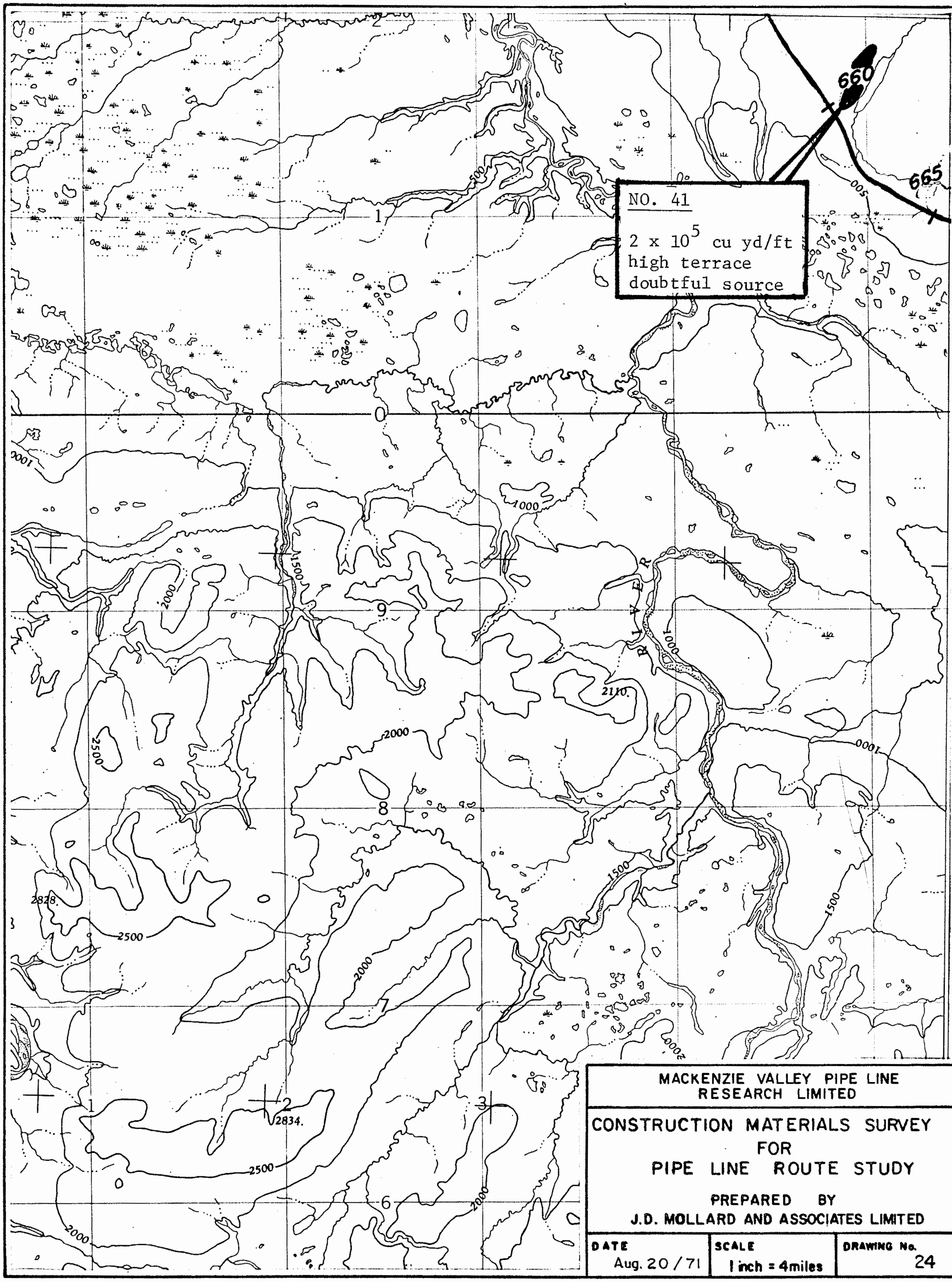
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4miles	23



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CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

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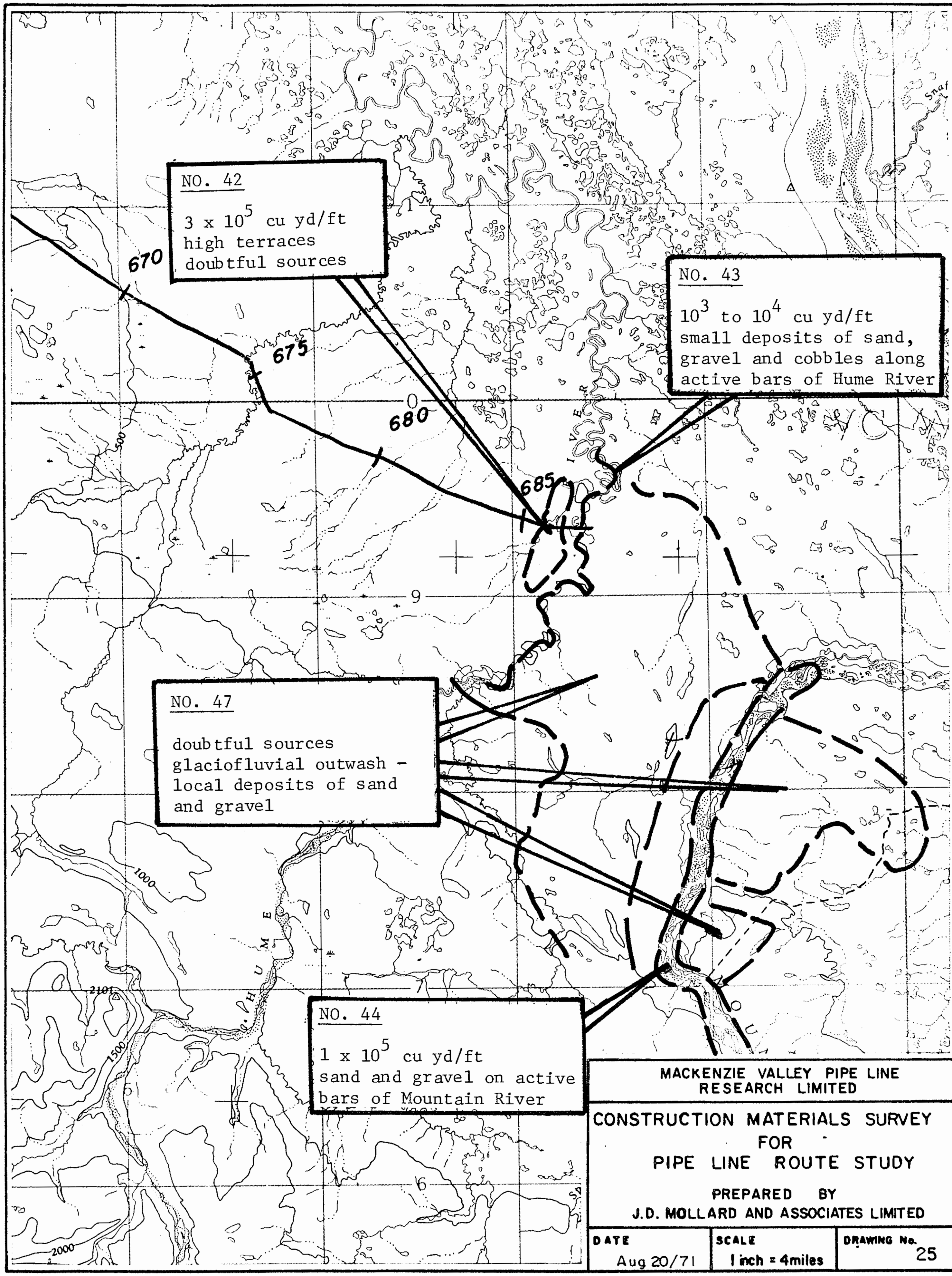
DATE	SCALE	DRAWING No.
Aug. 20 / 71	1 inch = 4 miles	24



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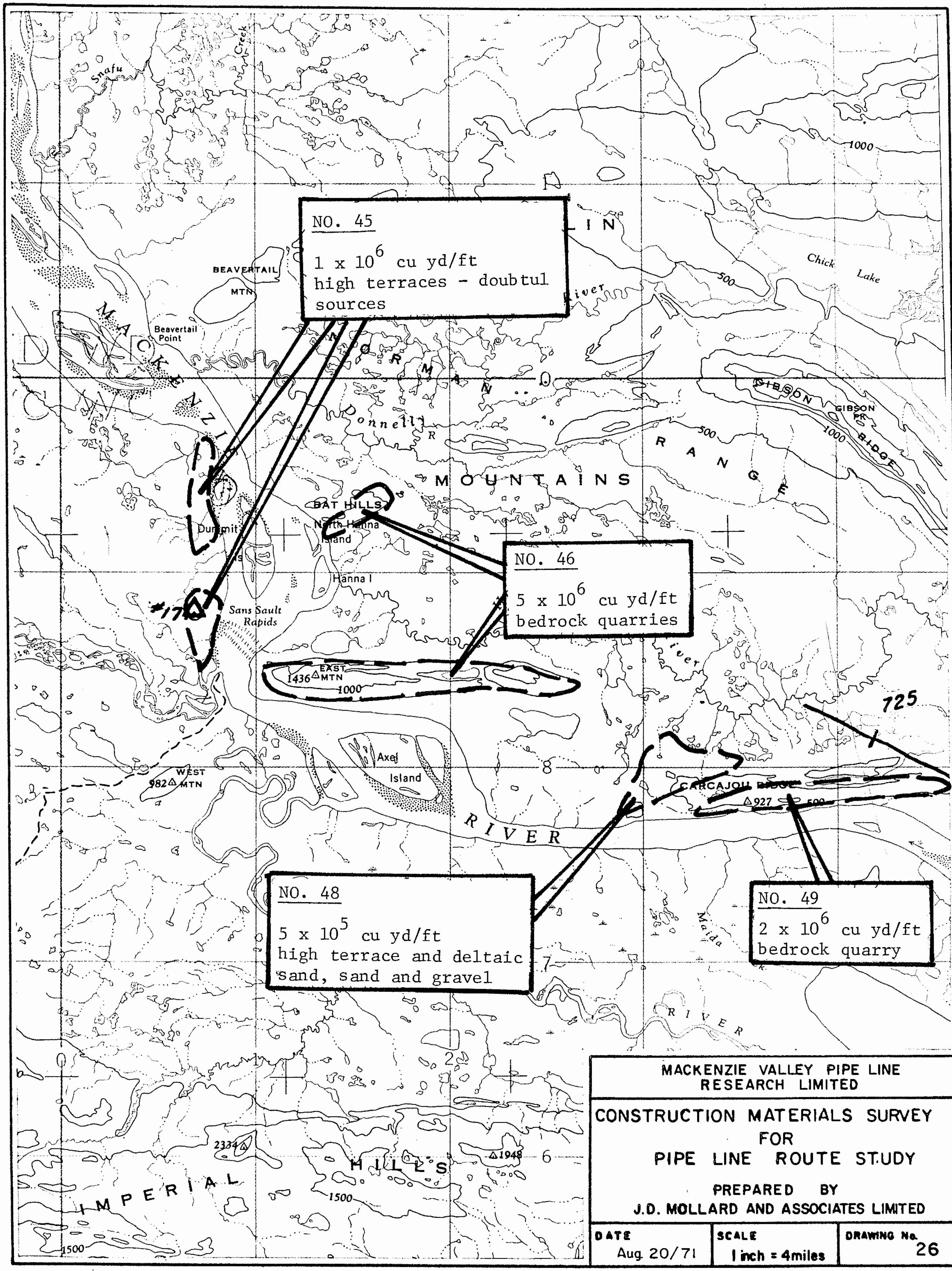
DATE	SCALE	DRAWING No.
Aug 20/71	1 inch = 4 miles	25



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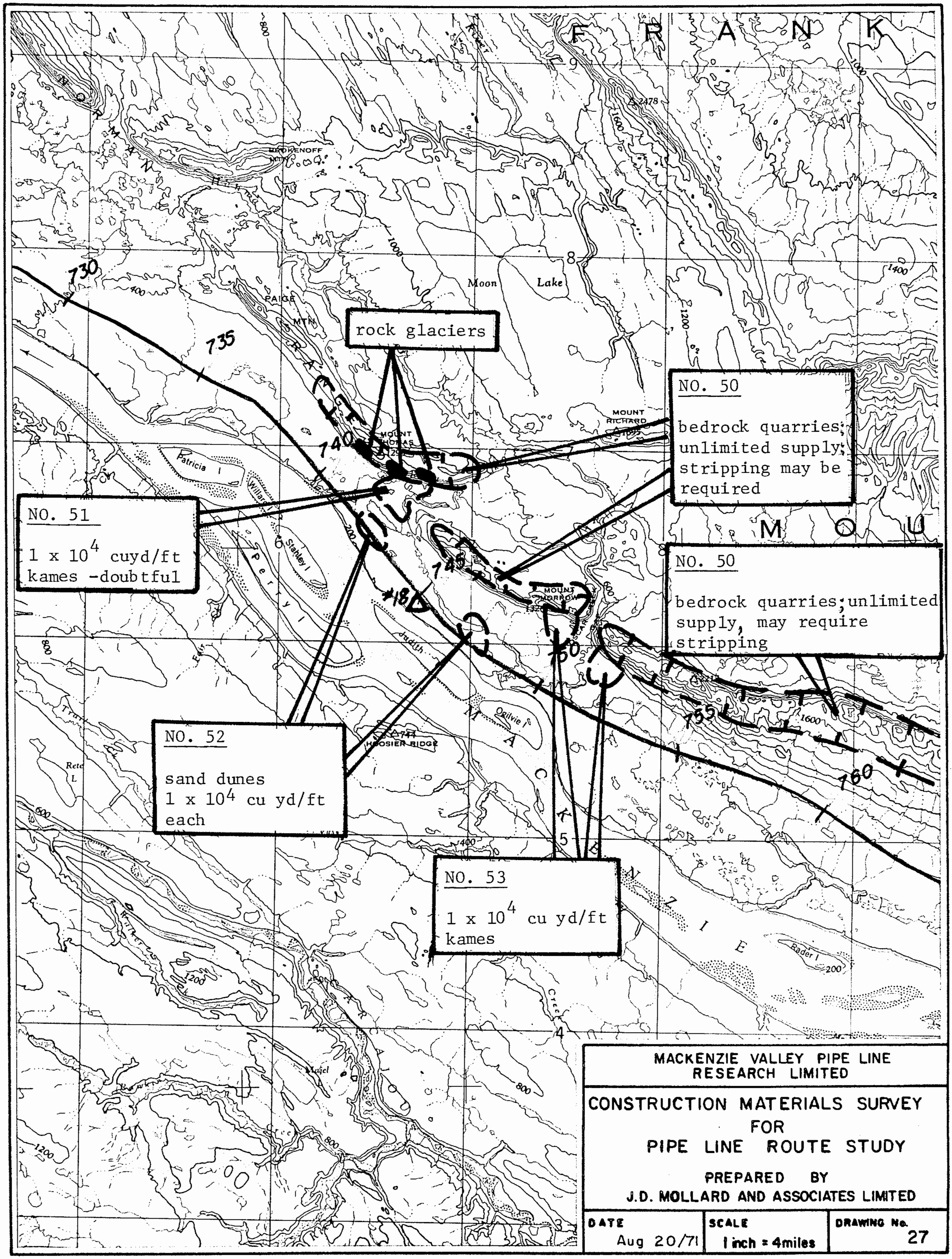
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4miles	26



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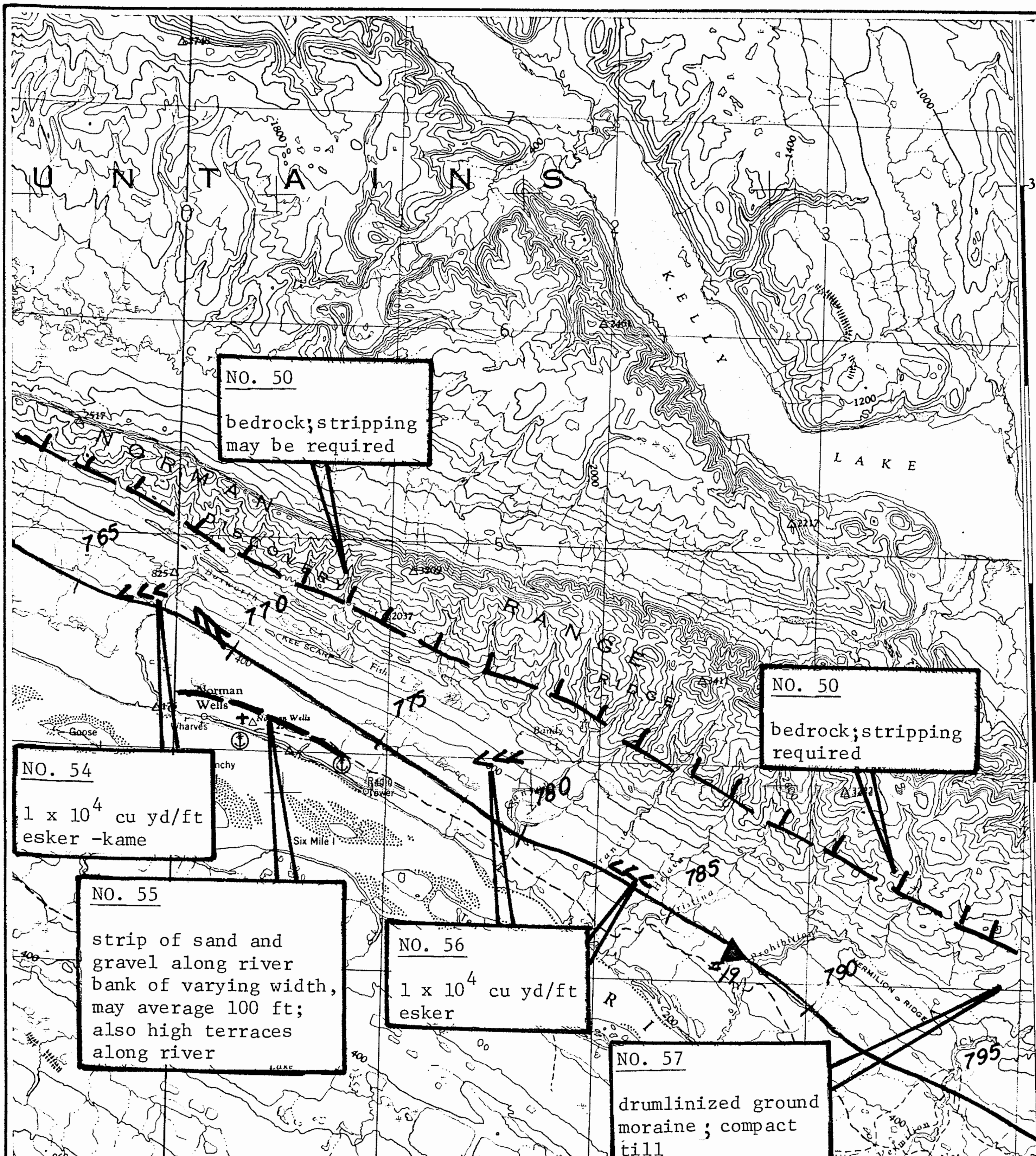
DATE	SCALE	DRAWING No.
Aug 20/71	1 inch = 4 miles	27



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CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

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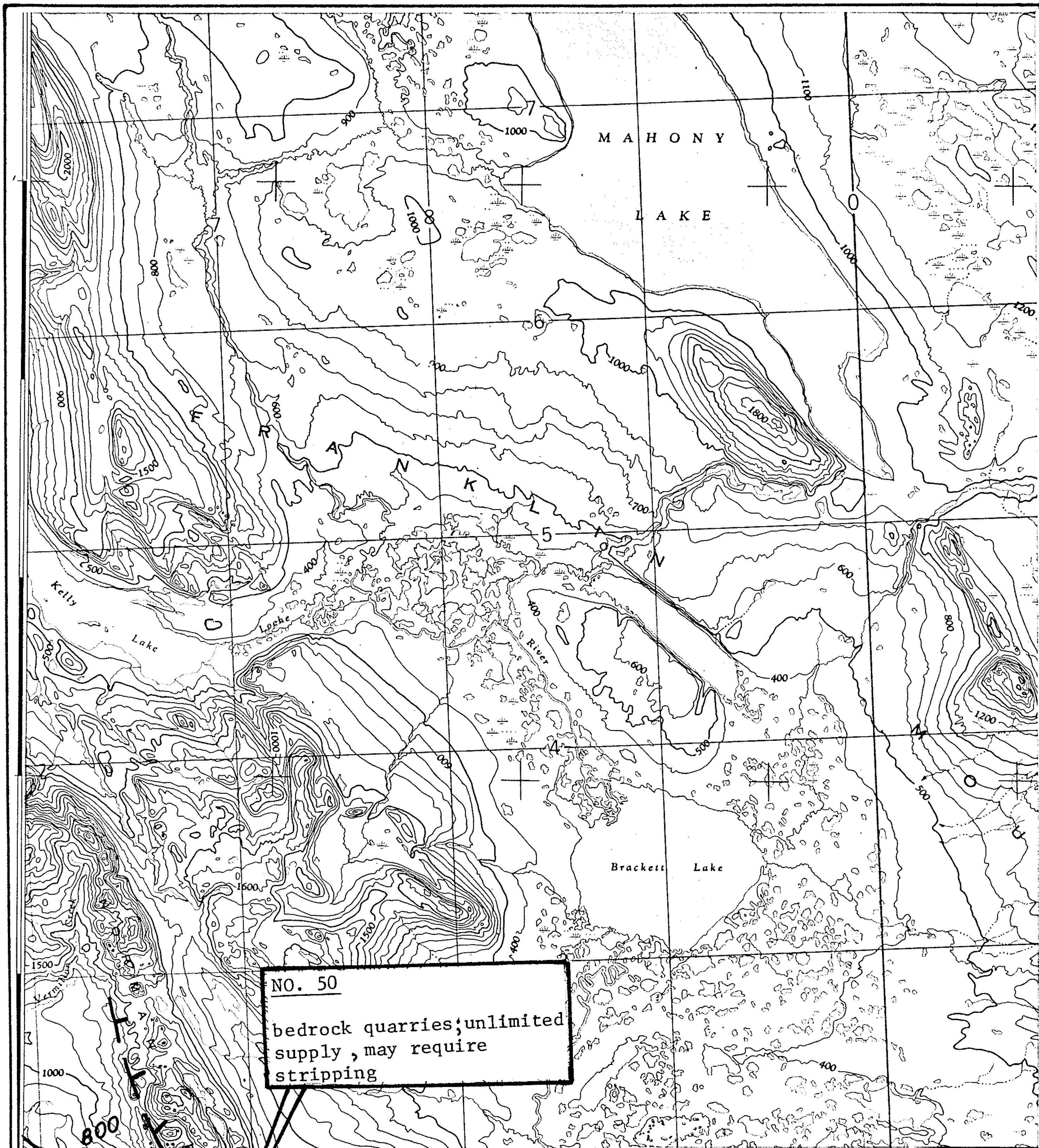
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	28



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CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

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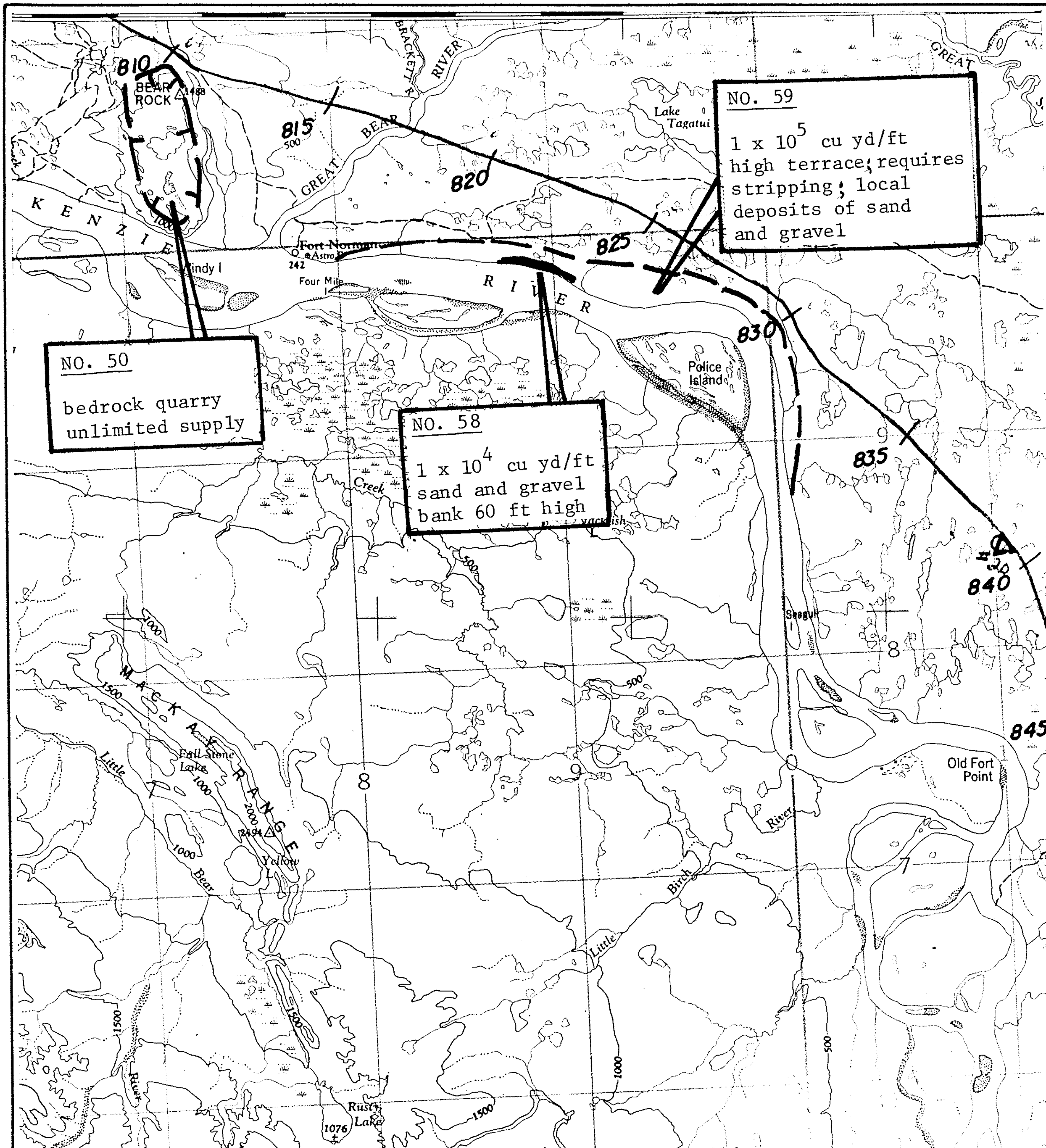
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	29



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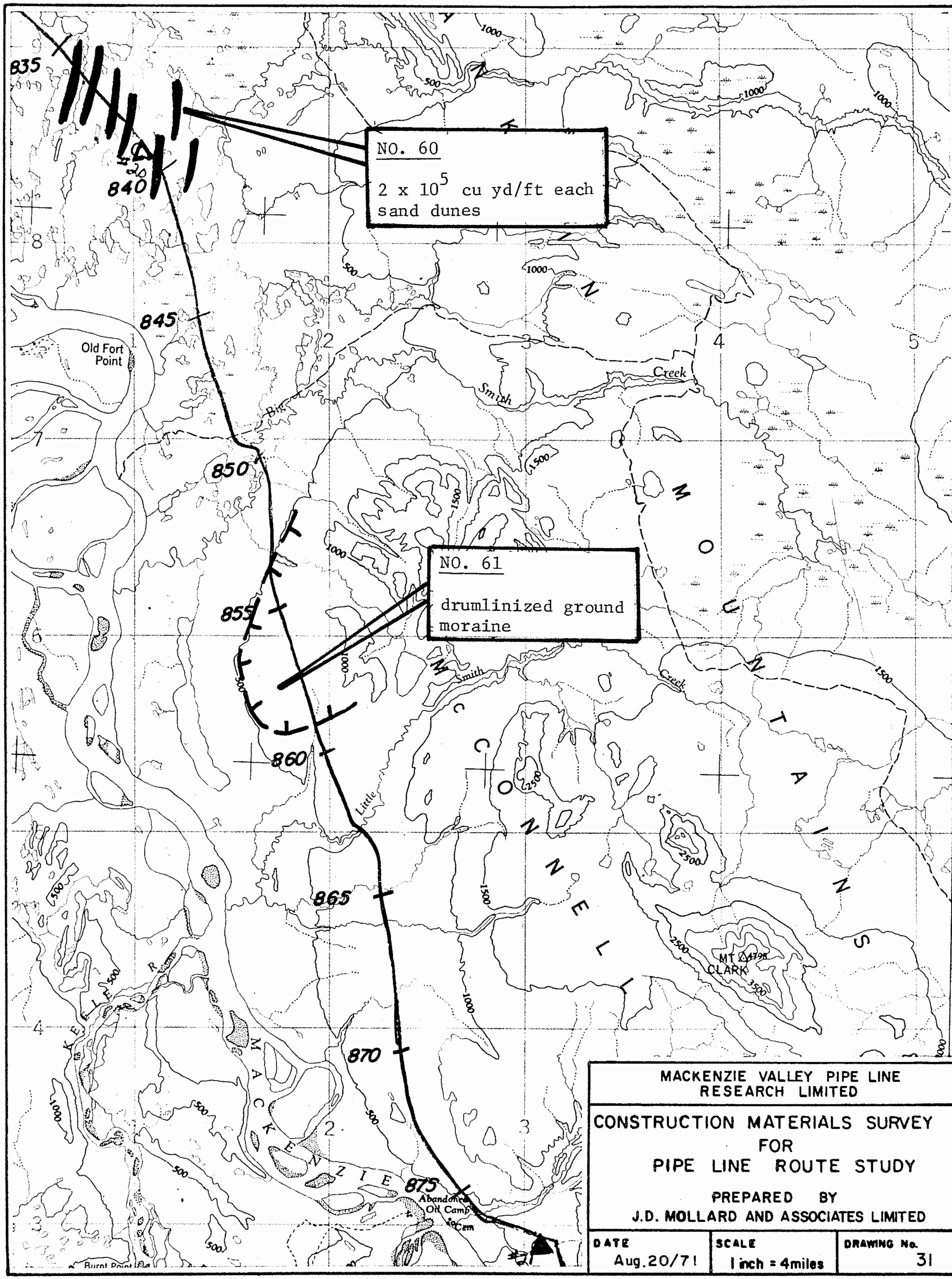
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	30



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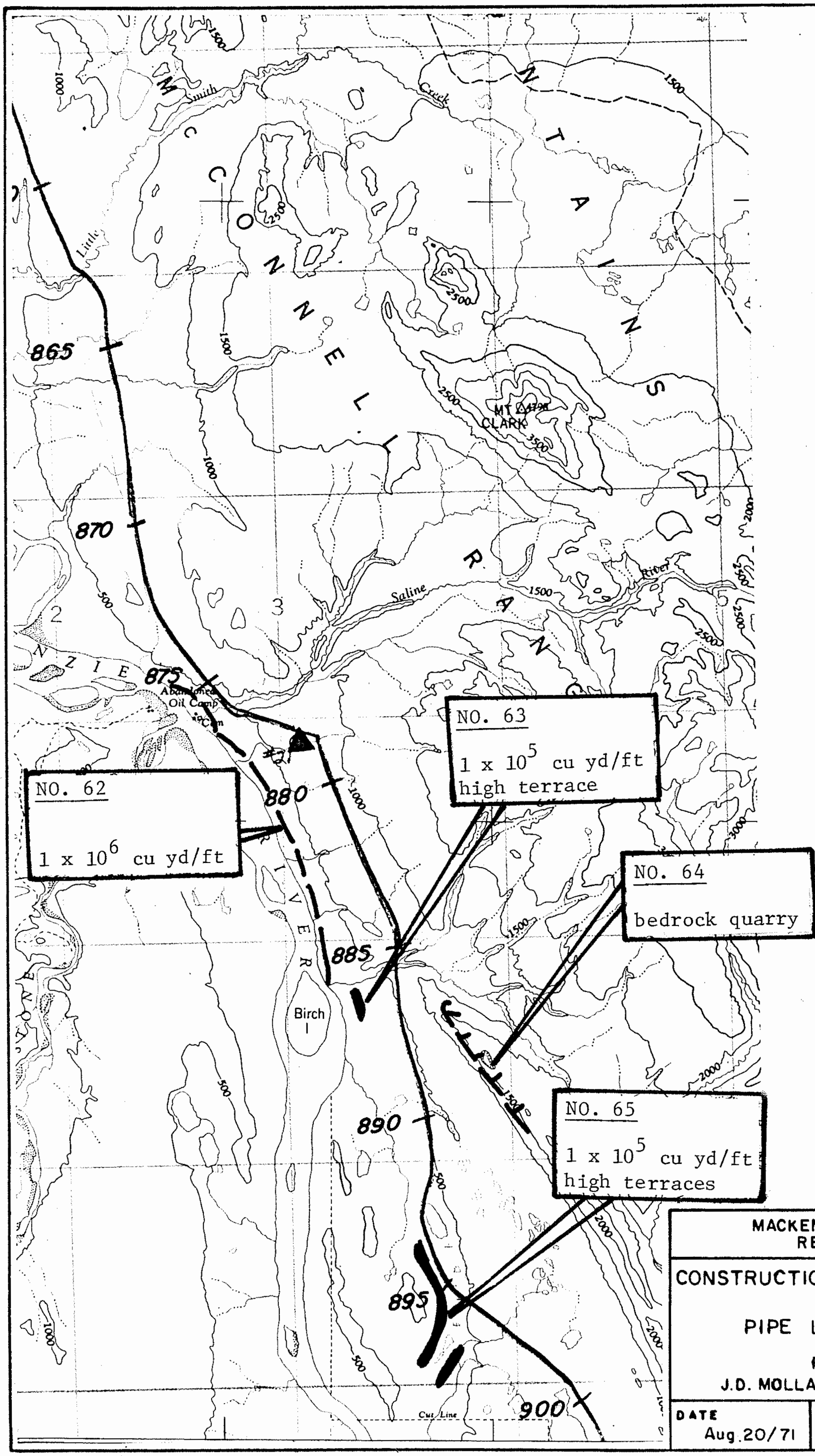
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	31



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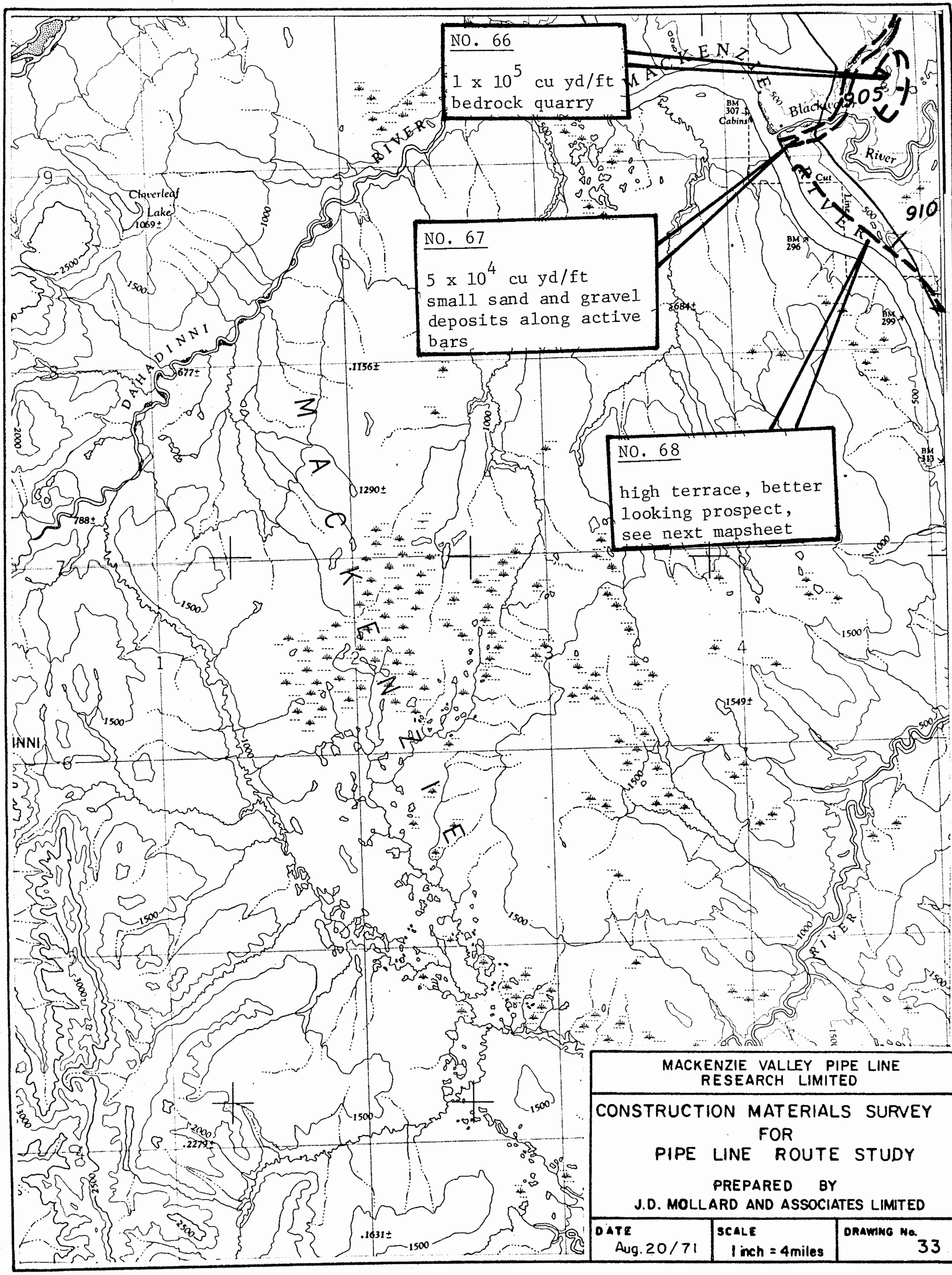
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	32


NO. 66
1 x 10^5 cu yd/ft
bedrock quarry
NO. 67
5 x 10^4 cu yd/ft
small sand and gravel
deposits along active
bars
NO. 68
high terrace, better
looking prospect,
see next mapsheet
MACKENZIE RIVER
MACKENZIE
DAHADINNI
Cloverleaf Lake
Blackwater River
Cabins
905
910
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
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PIPE LINE ROUTE STUDY
PREPARED BY
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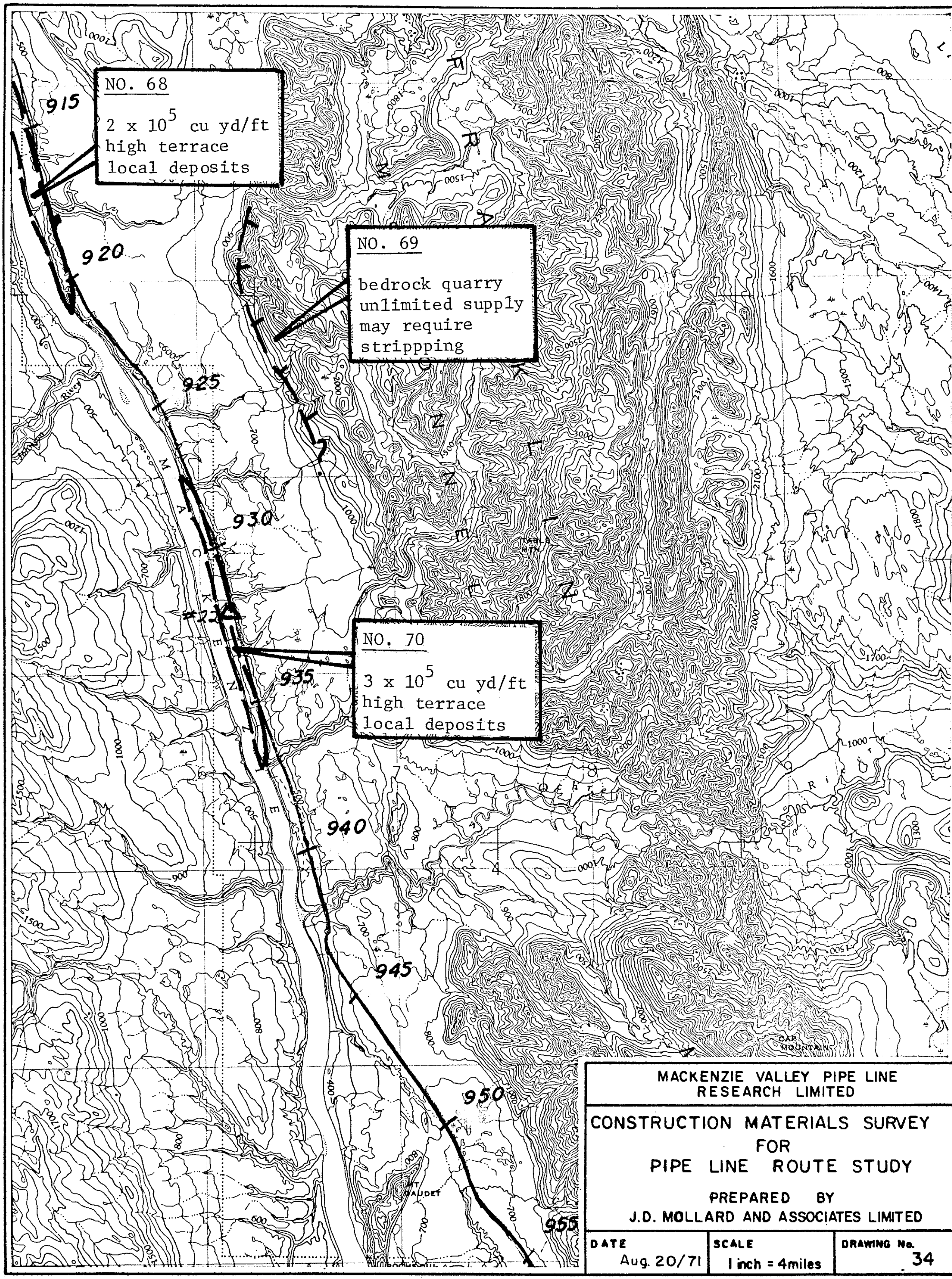
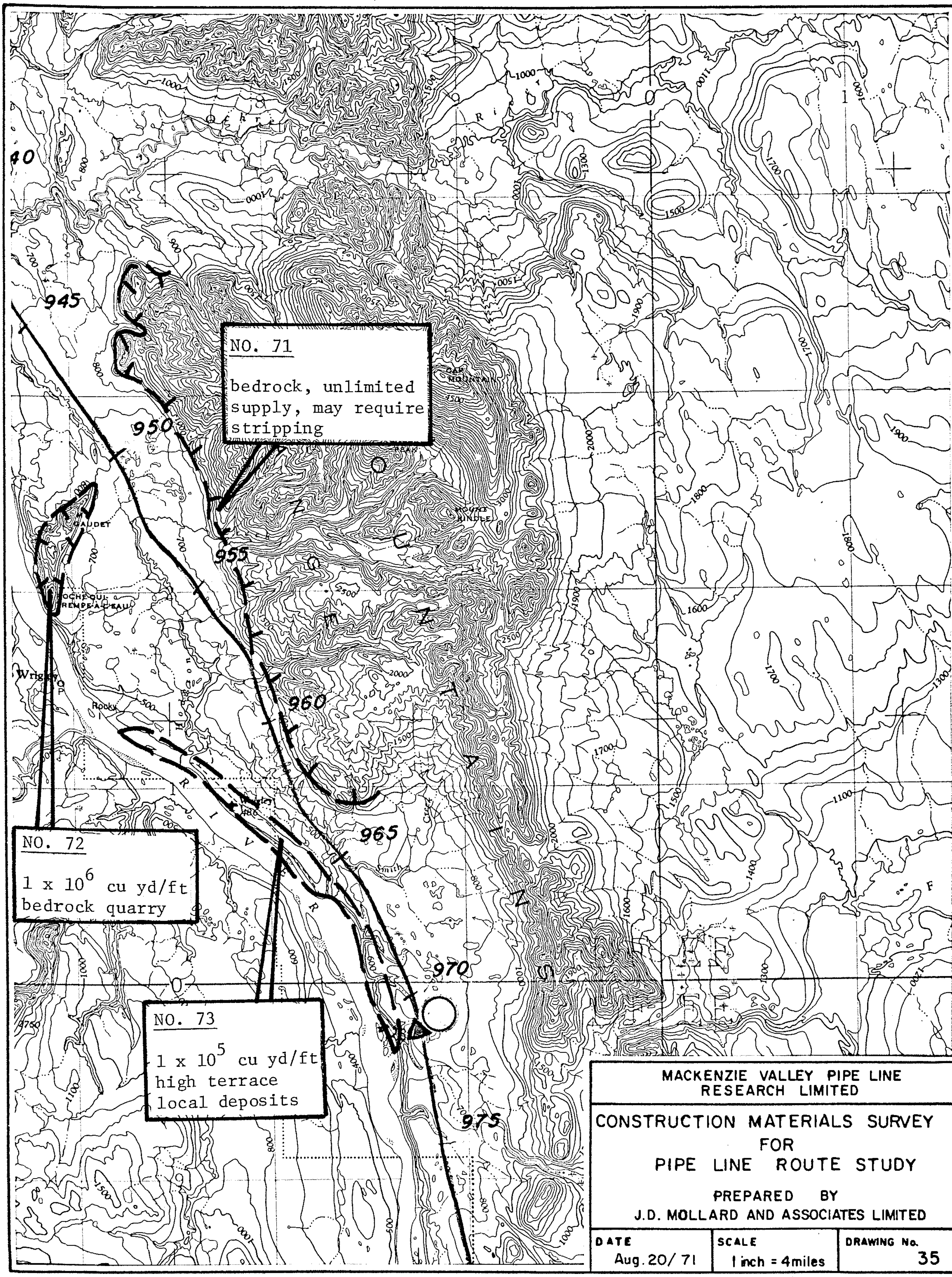
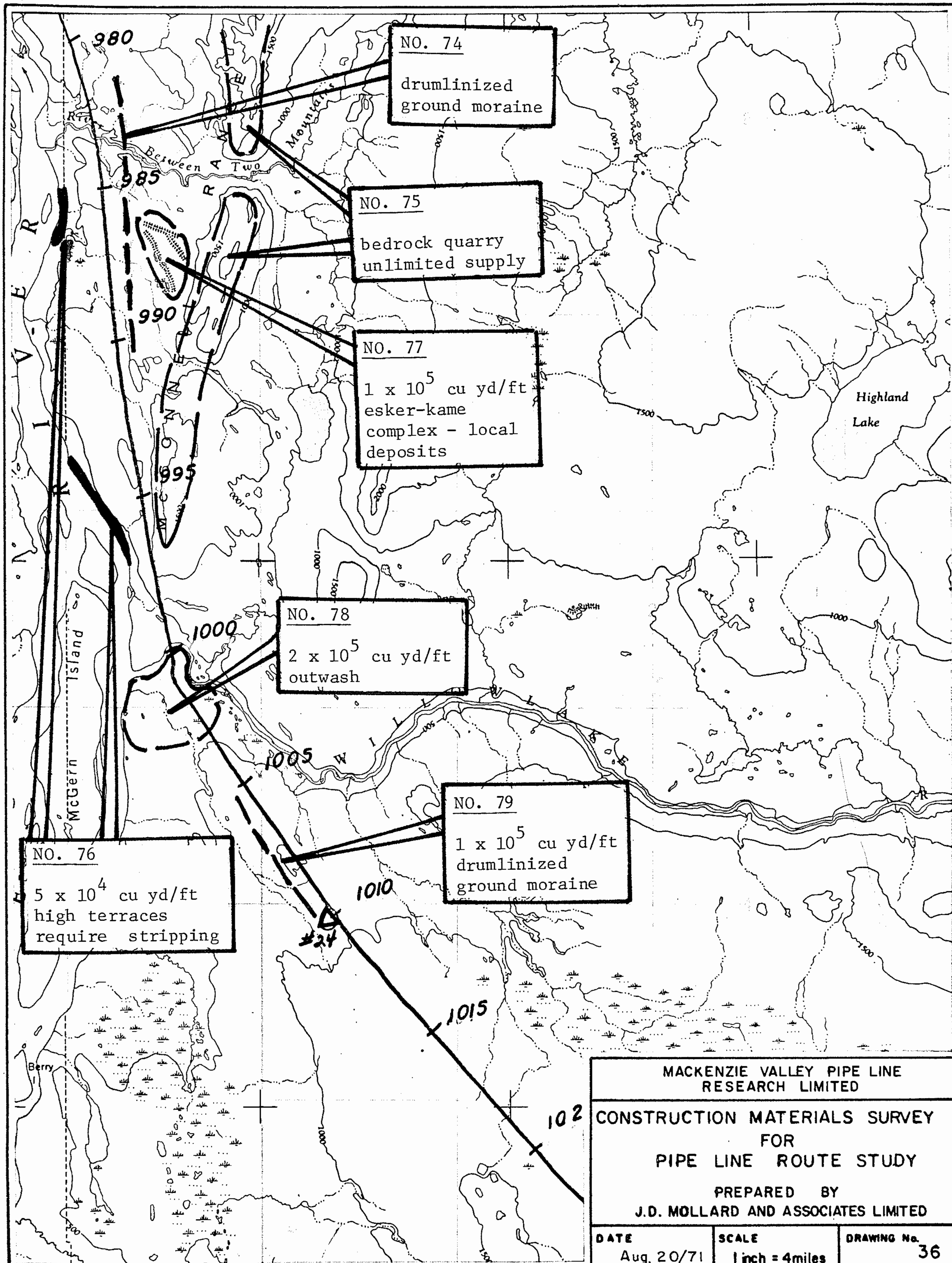
DATE
Aug. 20/71
SCALE
1 inch = 4 miles
DRAWING No.
33


NO. 68
2 x 10^5 cu yd/ft
high terrace
local deposits
NO. 69
bedrock quarry
unlimited supply
may require
strippping
NO. 70
3 x 10^5 cu yd/ft
high terrace
local deposits
915
920
925
930
935
940
945
950
955
#22
MACKENZIE
TABLE MTN.
CAP MOUNTAIN
MT. GAUDET
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug. 20/71
SCALE
I inch = 4 miles
DRAWING No.
34


NO. 71
bedrock, unlimited supply, may require stripping
NO. 72
1 x 10[6] cu yd/ft
bedrock quarry
NO. 73
1 x 10[5] cu yd/ft
high terrace
local deposits
945
950
955
960
965
970
975
Wrigley
Rocky
GAUDET
ROCHE-QUI-TREMPE-A-L'EAU
Smith
Creek
MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug. 20/ 71
SCALE
1 inch = 4 miles
DRAWING No.
35



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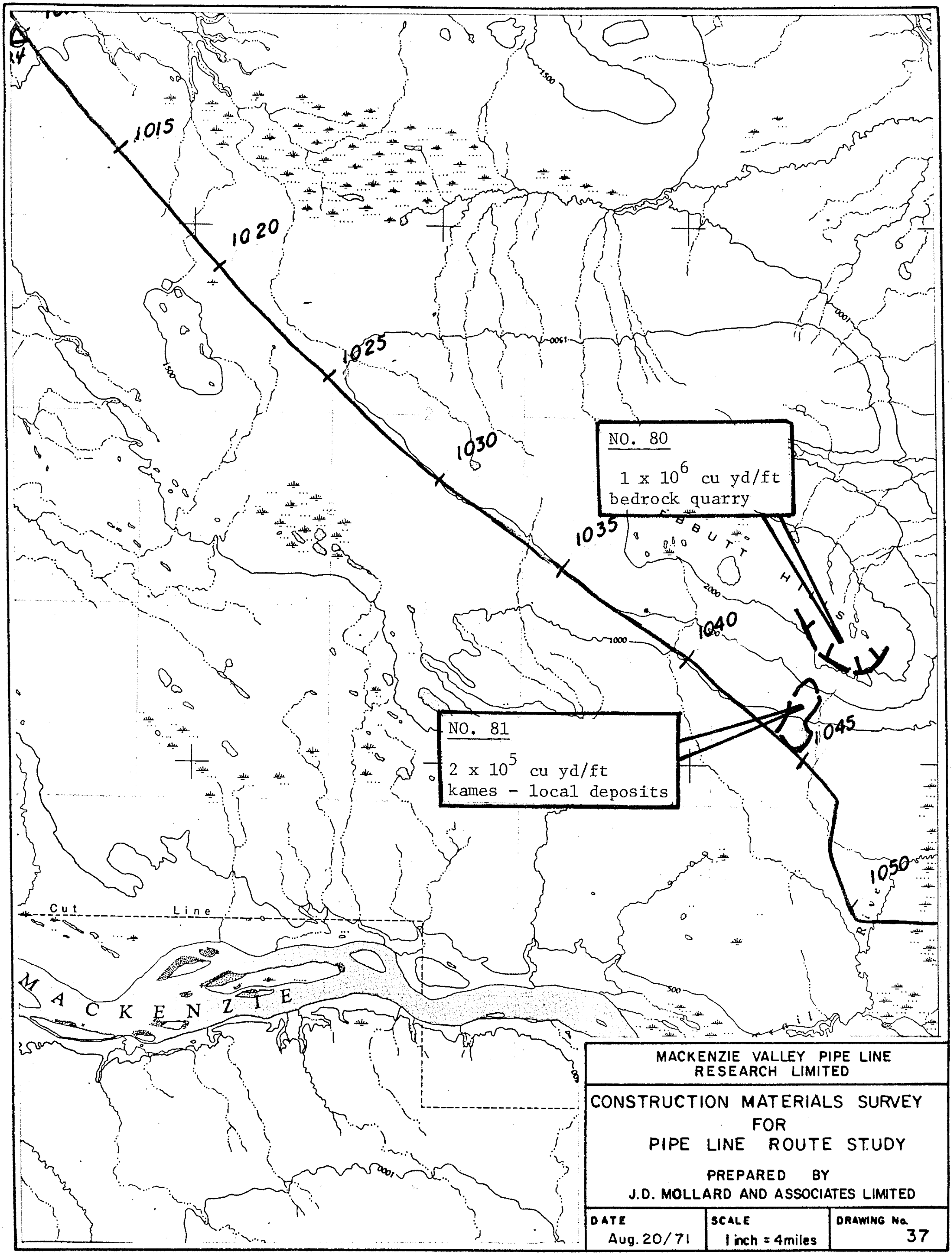
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4miles	36



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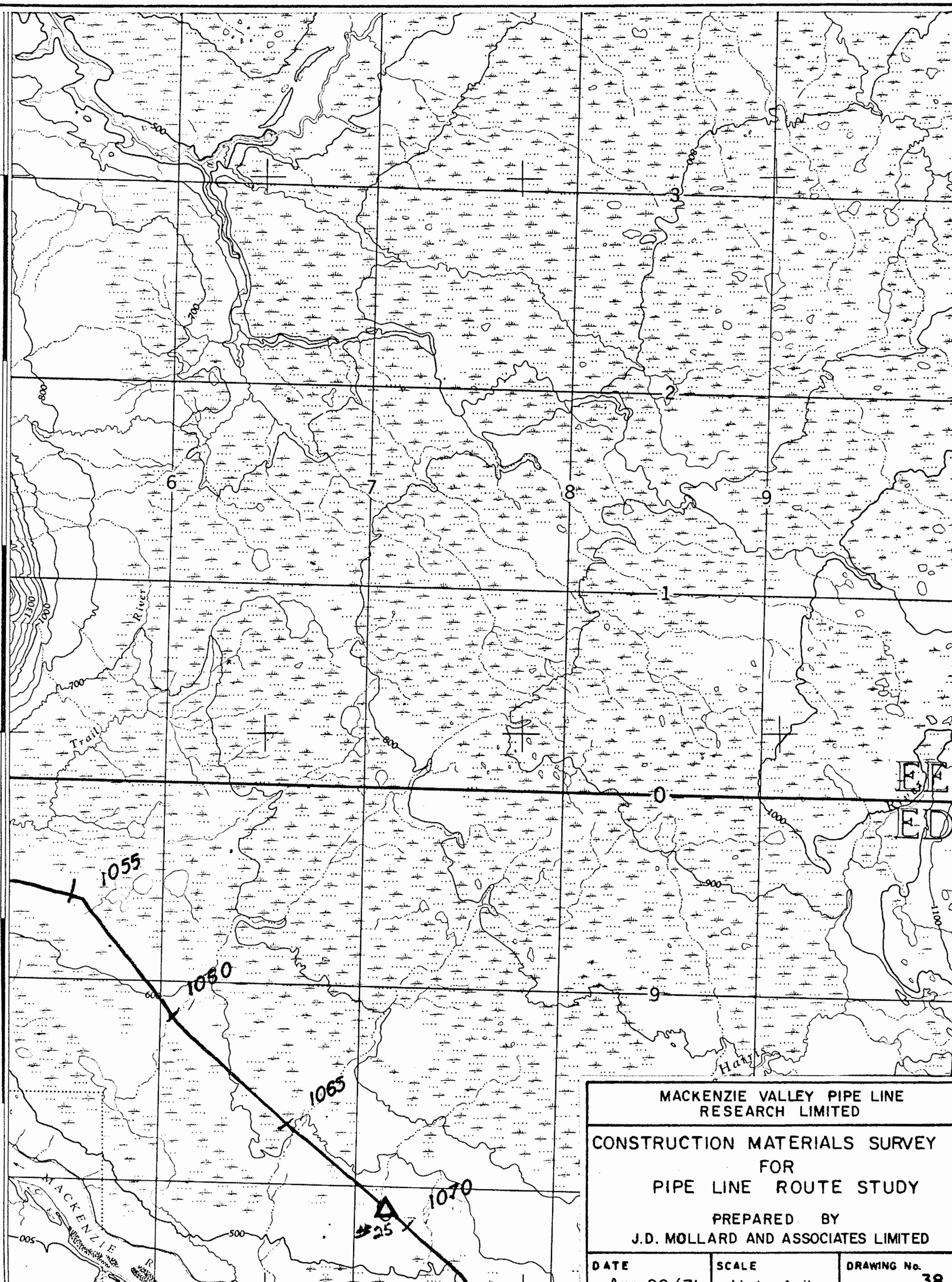
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY

PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4miles	37

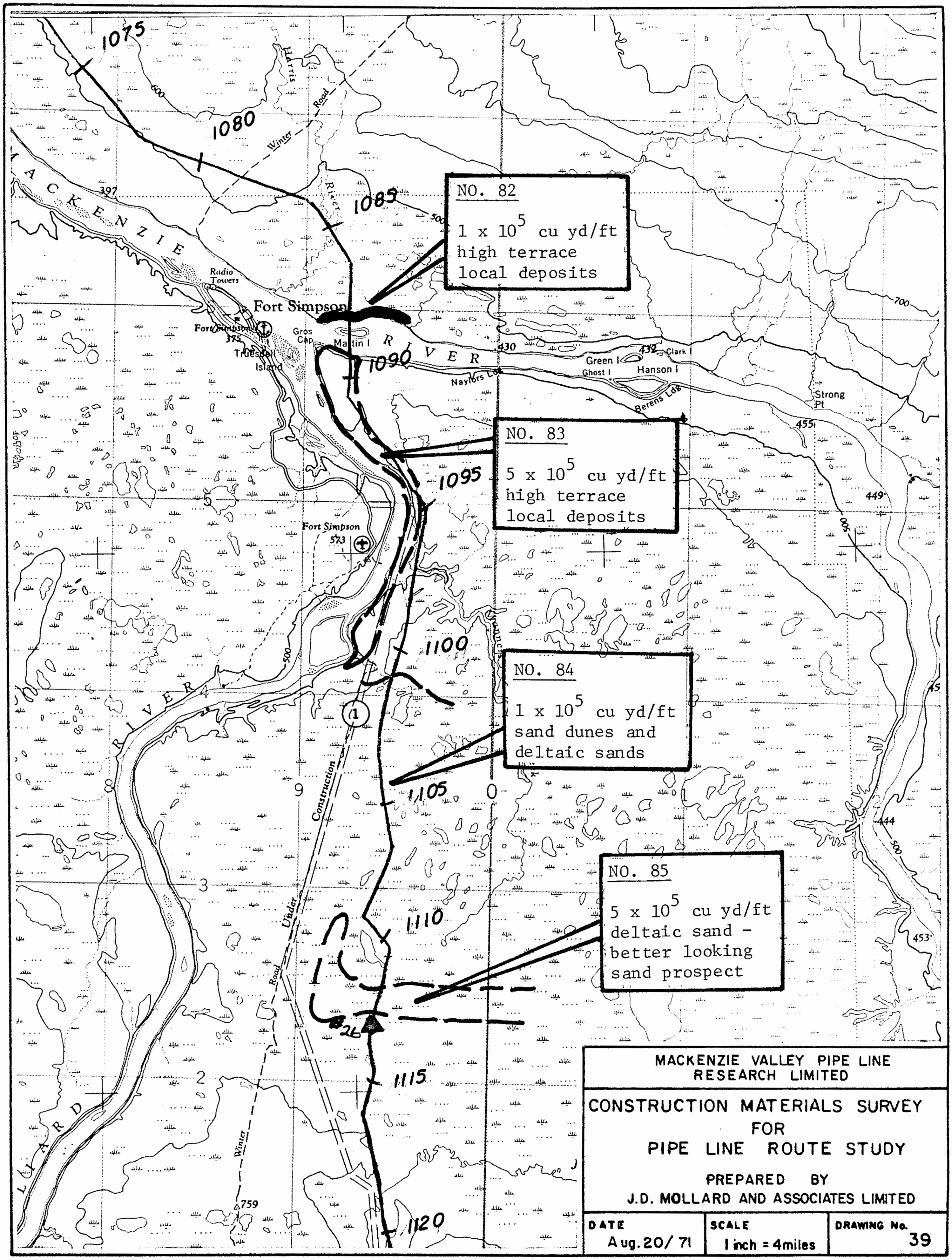


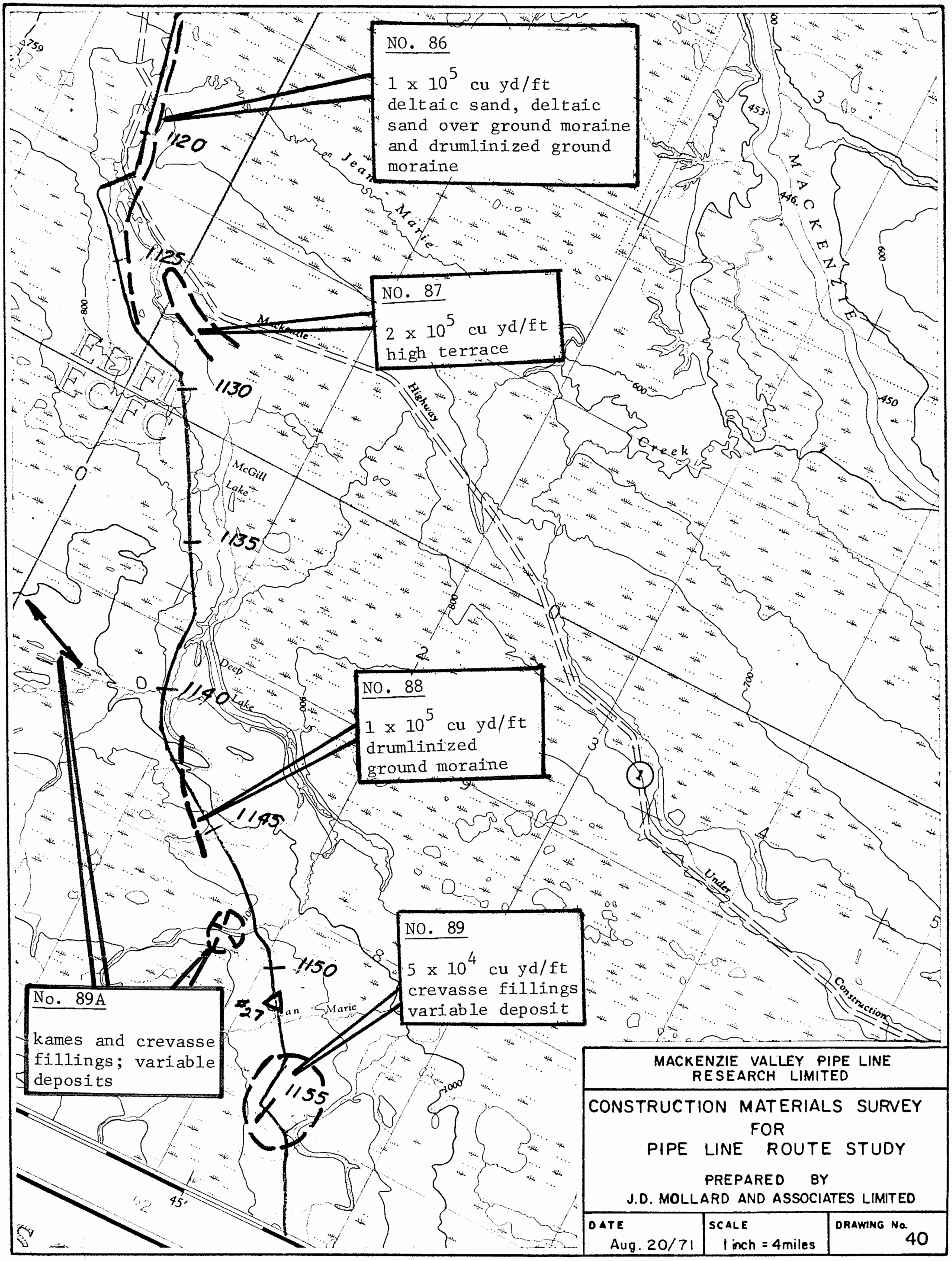
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED

CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY

PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED

DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	38


NO. 82
1 x 10^5 cu yd/ft
high terrace
local deposits
NO. 83
5 x 10^5 cu yd/ft
high terrace
local deposits
NO. 84
1 x 10^5 cu yd/ft
sand dunes and
deltaic sands
NO. 85
5 x 10^5 cu yd/ft
deltaic sand -
better looking
sand prospect
1075
1080
1085
1090
1095
1100
1105
1110
1115
1120
MACKENZIE
RIVER
LIARD
RIVER
Fort Simpson
Radio Towers
Fort Simpson 375
Gros Cap
Martin I
Trueswell Island
Green I
Ghost I
Hanson I
Clark I
Naylors Ldg
Berens Ldg
Strong Pt
Harris
River
Winter Road
Fort Simpson 573
Construction
Under
Road
MACKENZIE VALLEY PIPE LINE
RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY
PREPARED BY
J.D. MOLLARD AND ASSOCIATES LIMITED
DATE
Aug. 20/ 71
SCALE
1 inch = 4 miles
DRAWING No.
39



MACKENZIE VALLEY PIPE LINE
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CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY

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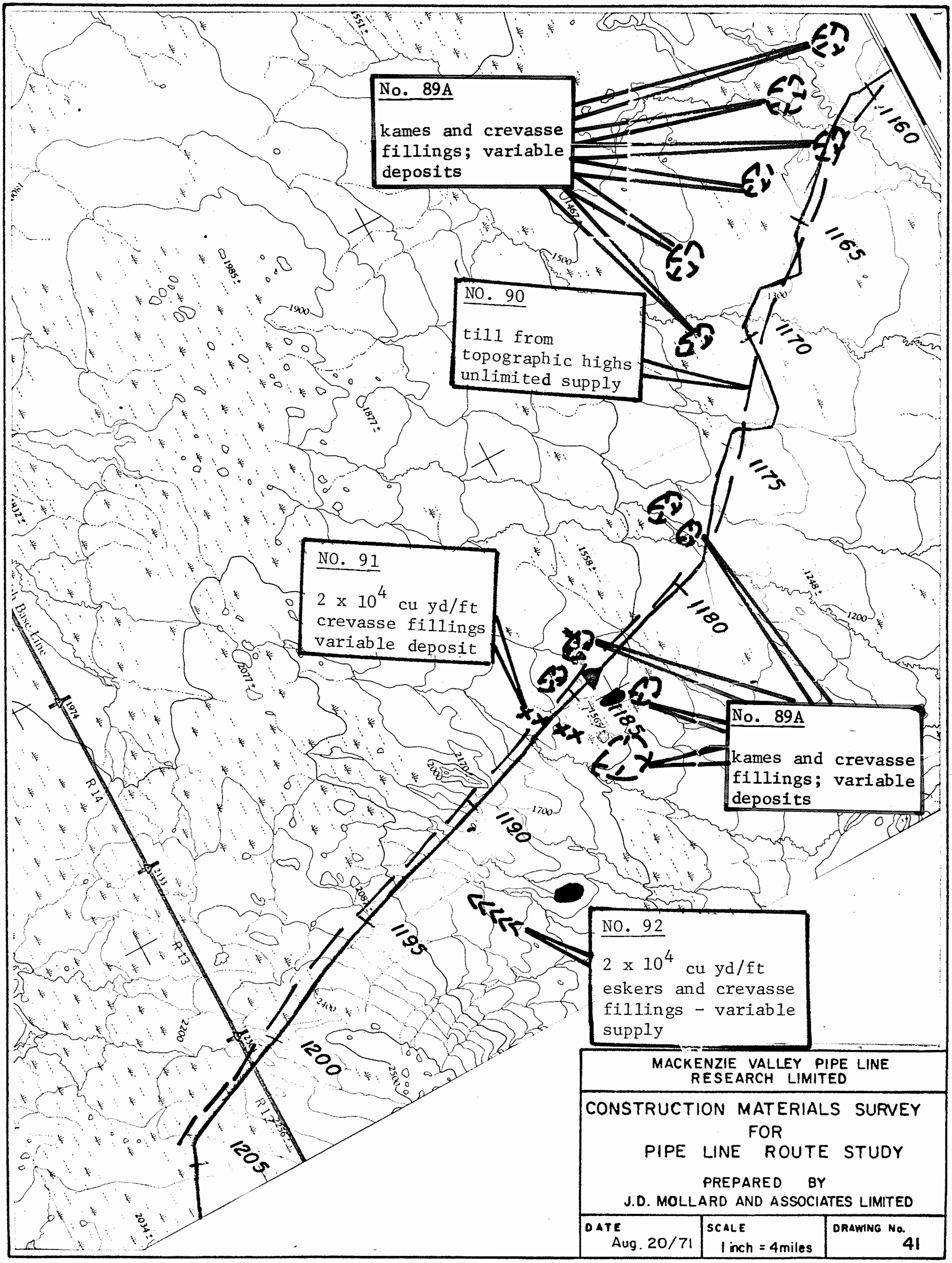
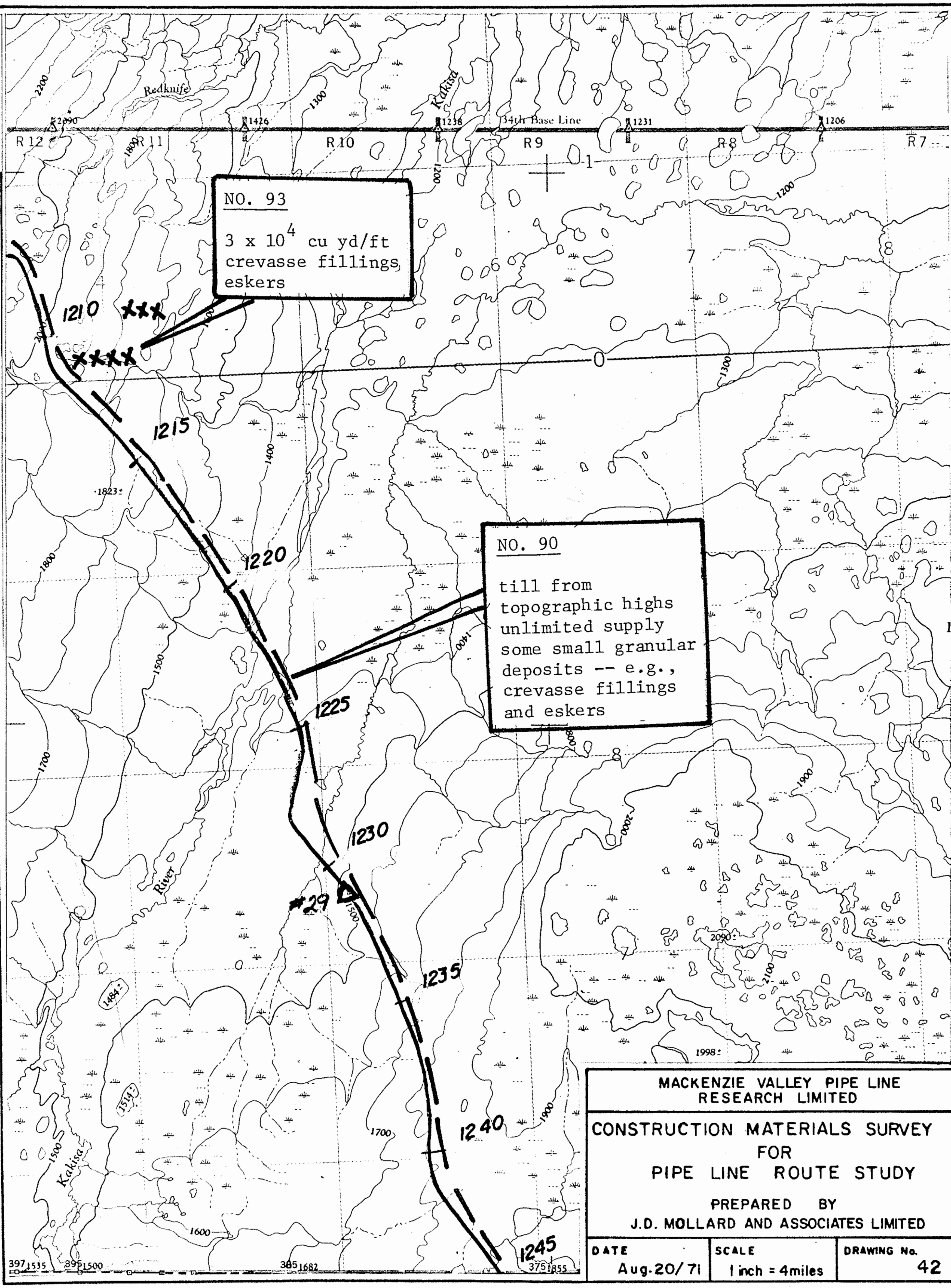
DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	40


No. 89A
kames and crevasse fillings; variable deposits
NO. 90
till from topographic highs unlimited supply
NO. 91
2 x 10⁴ cu yd/ft crevasse fillings variable deposit
No. 89A
kames and crevasse fillings; variable deposits
NO. 92
2 x 10⁴ cu yd/ft eskers and crevasse fillings - variable supply
1160
1165
1170
1175
1180
1185
1190
1195
1200
1205
R14
R13
R17
Base Line
MACKENZIE VALLEY PIPE LINE RESEARCH LIMITED
CONSTRUCTION MATERIALS SURVEY FOR PIPE LINE ROUTE STUDY
PREPARED BY J.D. MOLLARD AND ASSOCIATES LIMITED
DATE Aug. 20/71
SCALE 1 inch = 4 miles
DRAWING No. 41



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CONSTRUCTION MATERIALS SURVEY
FOR
PIPE LINE ROUTE STUDY

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DATE	SCALE	DRAWING No.
Aug. 20/71	1 inch = 4 miles	42

END OF REPORT