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GEOLOGICAL INVESTIGATION OF PROPOSED CANBERRA LAKE, WESTERN AREAS.

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SUMMARY

This report on the western portion of the proposed Canberra Lake, west of Lennox Crossing, deals with the soils and rock outcrops in and about the area that will be inundated; it also includes information on lake edge stability. Geological mapping and surface soil mapping were extended laterally a few hundred feet beyond the 1825-foot contour - the top water level of the proposed lake.

Rocks and stratigraphic units mapped are: quartzose sandstone (Lower Ordovician? Black Mountain Sandstone - Ol?,* a sequence of Middle Ordovician sandstone and shale (Pittman Formation - Omp), siliceous shale (Upper Ordovician Acton Shale - Oua), non-calcareous sandy shale (Lower Silurian State Circle Shale - Sls), and calcareous mudstone (Lower Silurian Turner Shale - Slt) in the horst block between the Acton Fault and Deakin Fault; tuff, tuffaceous sandstone and shale (Upper Silurian Deakin Volcanics - Sud), mudstone (Upper Silurian Yarralumla Formation - Suy), and intrusive massive porphyry (Upper Silurian Mount Painter Porphyry - Sup) west of the Deakin Fault; and calcareous shale (Lower Silurian City Hill Shale - Slh) in the river bed, east of the Acton Fault.

The lake margin will lie along gentleand steep slopes and low-lying areas, with sparse rock outcrops and abundant superficial detritus: alluvium - both recent deposits and older, high-level deposits; lacustrine deposits; aeolian sand and silt; and colluvium.

To achieve the required shore stability, water clarity and firmness underfoot ofthe foreshore special treatment of parts of the lake edge will be necessary. Thiscould include excavation of some unstable material, replacing it with gravel and sand, and extensive filling of low-lying areas after providing for stormwater drainage; particularly in the future Yarralumla Bay (Sheet 14) and west of the Quarry (Sheet 21).

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* Symbols used on map sheets 1 - 24.

INTRODUCTION

At the request of the National Capital Development Commission, surface soil mapping and detailed geological mapping has been carried out in the Western Area of the proposed Canberra Lake basin. The area extends from Lennox Crossing west of Commonwealth Bridge to Canberra Lake Dam. The object was to provide information on the distribution of the various soils and alluvium, of diverse engineering properties; opportunity was also taken to record geological information about the area to be inundated by the lake waters. The lake level will be at R.L.1825feet, Canberra datum; the whole of the area to be submerged was mapped and mapping was extended laterally to a few hundred feet beyond the 1825-foot contour. A plane table and alidade, and a compass and tape were used to do the geological mapping.

The base maps used were the 1-foot contour survey sheets compiled by the Survey Section, Department of the Interior.

Twenty-four geological sheets, each representing an area 2,000 feet square, were drawn, and reproduced on a scale of 1 inch : 200 feet. Their positions are shown on the locality map that accompanies this report (Plate 2).

In an Appendix, brief explanatory notes are given for each sheet.

GEOLOGY

SUPERFICIAL DEPOSITS

The superficial deposits are believed to range in age from Recent to Pleistocene. They consist of Recent alluvium including present-day or contemporary deposits in the river channel, and older, high-level alluvium, lacustrine deposits, wind-blown sand and silt, and colluvium. The superficial deposits are shown on the geological sheets Nos. 1 to 24.

Alluvium

The contemporary or present day alluvium occupies the bed of the Molonglo River; it consists of uncompacted and uncemented sand, gravel, silt, clay and organic matter. The alluvium includes igneous and sedimentary rock fragments, chemically unweathered rock-forming minerals, and organic matter composed partly of recognizable fragments of plant material and partly of material of unknown origin. Recent alluvium occurs adjacent to the contemporary alluvium of the river channel, in deposits that rise above the river bed to the heights attained by flood waters. It consists essentially of the same sedimentary material as the contemporary alluvium, with probably a higher proportion of silt and clay.

The older alluvial deposits, which occur on the valley slopes at higher elevations than the Recent alluvium, consist of gravel, sand, silt and clay. The less resistant pebbles and sand grains are weathered and decomposed, and the deposits are to some extent cemented by clay and iron oxide formed during weathering.

The older alluvium is easily excavated by bulldozer and mechanical shovel. Deep holes need timbering for safety.

Older gravels exposed in excavations at the Canberra Lake dam site range in elevation from about R.L.- 1780 feet to about R.L. 1840 feet. Similar gravels occur at intervals along the southern slope of the river valley between the dam site and Lennox Crossing, and commonly extend up to about R.L. 1830 feet. On the northern side of the river, they have been mapped only at the dam site. Probably they occur elsewhere beneath wind-blown sand and silt, and colluvium.

Lacustrine Deposits.

At the Golf Links, Acton, (Sheets 22, 24) and in the area enclosed by the broad bend of the river at Yarralumla between Sullivan Trigonometrical Station and Corkhill Weir, (Sheets 12 and 13) excavations have exposed beds of sand, gravel and clay at least 30 feet thick. The strata appear more uniform and extensive than the alluvium deposited by the river and are regarded as lacustrine deposits. As in the older alluvium, the least resistant pebbles and sand grains are weathered and decomposed; the products of weathering, together with detrital clay, form a matrix between the harder fragments and feebly cement the deposits.

The lacustrine beds are covered by later deposits, and by soil and are exposed only in excavations.

Wind-blown Sand and Silt.

Fine-grained aeolian sand and silt is widely distributed in the Molonglo valley on slopes that are exposed to westerly winds.

It mainly occurs at the Zoological Park Reserve, at the Royal Canberra golf course and on the northern side of the river opposite Government House; it ranges in elevation from about R.L. 1815 feet up to about R.L. 1845 feet.

Colluvium

In excavations and gullies around Canberra colluvial sand, silt, clay and rock detritus is exposed; in the Canberra Plain it is as much as twenty feet thick; in the Molonglo Valley it occurs east and west of Yarralumla Bay (Sheet 14) where it is up to five feet thick.

BEDROCK

General (Plate 1)

Bedrock exposed in the area includes (?) Lower, Middle and Upper Ordovician sedimentary rocks, Lower Silurian sedimentary rocks, and Upper Silurian sedimentary volcanic and intrusive rocks. They have been described by Öpik (1958) and the names of the formations are those used by Öpik. The only fossil localities found during the mapping have already been described by Öpik.

Two converging faults, the Deakin Fault and the Acton Fault, shown in Plate 1, trend northwest and north across the area and bound the Black Mountain Horst. The two faults divide the area into three parts: west of the Deakin Fault the rocks are of Upper Silurian age: in the horst block, between the Acton Fault and the Deakin Fault, Ordovician and Lower Silurian rocks are found; and east of the Acton Fault Lower Silurian beds crop out (younger strata occur farther east).

Lithology

Rock types mapped are described below in stratigraphic order.

Before Middle Ordovician

Black Mountain Sandstone (Ol?) ✱

The rock is a fine-grained quartz sandstone and has a hard surface which resists weathering: below the surface, however, it is only moderately hard and durable. It consists of rounded quartz grains up to 2 mm. in diameter between which are very fine angular quartz grains and mica. Small outcrops have been mapped in the river channel, east of Black Mountain Peninsula (Sheet 16). The bedding is obscured by jointing. The main joints are lined by quartz; they strike in two directions, 360° * and 270°, and dip vertically to very steeply. A minor vertical joint system strikes about 310°. Excavation of Black Mountain Sandstone would generally require drilling and blasting.

Middle Ordovician

Pittman Formation (Omp)

The Pittman Formation forms a cliff (Sheet 12) in which a sequence of sandstone, micaceous shale, mudstone and black argillaceous shale crops out. The beds dip mainly 35 SSE. Cleavage is poorly developed, and joints are tight and perpendicular to the bedding. The visible thickness is nearly 200 feet. Some of the rock could probably be removed by bulldozer and ripper, if required, but the thick sandstone beds would need drilling and blasting.

Upper Ordovician

Acton Shale (Oua)

The Acton Shale consists of siliceous dark-grey shale. A thickness of over 200 feet is exposed at the Racecourse. Beneath the weathered mantle the rock is fairly hard. The Acton Shale crops out on the slope west of the Australian National University (Sheet 19). The beds are contorted; they strike between 020° and 060° and dip 15° to 70° SE; south-east of the Racecourse (Sheet 20) however, an outcrop dips 40°E. Opik (1958) suggests that the Acton Shale is part of a synclinal core with the trough-line sharply bent. Most joints are tight and dip 60°N.

Lower Silurian

State Circle Shale (Sls)

The State Circle Shale consists of non-calcareous sandy shale and black shale, with beds of fine-grained sandstone The visible thickness is about 150 feet.

A few small outcrops occur on the southern bank of the river at the Zoological Park Reserve (Sheet 11). The rock is well jointed and deeply weathered; beds strike 050° and dip 35°NW. The joints strike in two directions - 350° and 060°, and dips range from vertical to very steeply south-east. The vertical joints are lined by limonite.

✱ Symbols used on map sheets
* Bearings given are magnetic bearings.

Turner Shale (Slt)

The Turner Shale consists of yellow-brown, weathered calcareous mudstone, with thin layers of siltstone and fine-grained sandstone, and numerous ferruginous concretions. Scattered outcrops appear on the southern slopes of the river, near the south-west corner of Royal Canberra golf course between R.L.1845 feet and R.L. 1795 feet (Sheet 21).

The formation is folded and it is possible to see the limbs of a gentle syncline, trending north-north-east, the core of which is covered by cemented gravel of older alluvium. Tight joints dip 60°N.

City Hill Shale (Slh)

The City Hill Shale is a dark-grey calcareous non-tuffaceous shale with limestone bands and lenses.

A small outcrop has been mapped in the river channel south of the Government Offices near Lennox Crossing. (Gardner, 1958)

Upper Silurian

Red Hill Group (Opik, 1958)

The Red Hill Group is composed of the Deakin Volcanics (at the base) and the Yarralumla Formation. The junction of the two formations is a disconformity.

Deakin Volcanics (Sud)

The Deakin Volcanics consist of acid volcanic rock (tuff and rhyolite) interbedded with tuffaceous sandstone and tuffaceous shale. Dark-brown to purple tuff and hard yellow tuffaceous sandstone crop out on the eastern side of Zoological Park Reserve and near Corkhill Weir (Sheets 10 and 13). The tuff is formed of rounded grains of quartz and glassy feldspar. The basal strata of the formation - interbedded laminated sediments - are deeply weathered; they grade up into very fine grained sediments with interbeds of sandstone that show slight superficial weathering. The beds generally dip at 35° to 40°S. Joints are closed and strike in two directions - 040° and 124° - the 040° joints dip 60° - 85° SE and the 124° joints dip 60° - 85°SW.

Yarralumla Formation (Suy)

The Yarralumla Formation contains calcareous shale, sandstone and mudstone. Scattered outcrops of mudstone appear amongst mudstone detritus on high ground inside the Zoological Park Reserve (Sheets 9 and 10). The bedding is obscured by jointing. The joints strike 065° and 150° and dip from 15° to 75° southwards.

Mount Painter Porphyry (Sup)

The Mount Painter Porphyry is a dark, massive porphyry with numerous xenoliths of sedimentary and igneous origin, including fragments of vein quartz. It forms the bedrock through much of the western part of the area mapped; fairly fresh, though superficially weathered, outcrops are exposed along the river channel and, in places along the steeper slopes. Elsewhere the porphyry is covered by a veneer of soil and alluvium.

The Mount Painter Porphyry is an intrusive sill and contains outcropping roof pendants and similar included bodies of Deakin Volcanics and Yarralumla Formation. The Deakin Volcanics and Yarralumla Formation on the eastern side of the Zoological Park Reserve, for example, probably form part of a roof pendant. Öpik (1958) suggests that the contact of the porphyry with the Ordovician and Silurian rocks along the Deakin Fault, is structural only, as it lacks signs of metamorphism.

On the north-western side of the ridge that runs north-north-east through the Zoological Park Reserve the porphyry is more weathered and jointed than in nearby areas; large steep outcrops have been exposed along the river bank.(Sheets 8 and 9).

On the north-western side of the river and in the bed of Black Mountain Creek (Plate 1) a few small scattered outcrops exhibit more widely spaced jointing than the outcropping rocks on the opposite side of the river which have strongly developed fractures whose main trend is parallel to the river.

Near the river, south-west of the ridge through the Zoological Park Reserve, the joints have broken the rock into blocks about twelve to eighteen inches across (Sheet 6). In general, joints are tight, and strike in two main directions - north and east-south-east; dips range from very steep to vertical. Minor vertical joints strike east.

Faults

Deakin Fault

A vertical fault, the Deakin Fault, runs in a north-westerly direction across the Zoological Park Reserve and Black Mountain Peninsula. It forms the boundary between the Upper Silurian Deakin Volcanics and Yarralumla Formation, and the Ordovician, or older, sediments of Black Mountain Sandstone, Pittman Formation and Acton Shale. The trace of the fault within the area mapped is concealed by superficial deposits; however, the fault has produced steep scarps on the slopes of Black Mountain.

The Black Mountain Sandstone and the Middle Ordovician rocks are cut cleanly by the fault. The Silurian rocks, are dragged, with minor fractures trending parallel to the main fault.

The point where the Molonglo River flows across the Deakin Fault onto Mount Painter Porphyry (Sheet 8) is interpreted as the site of a former barrier, now eroded, which dammed the river and created the "prehistoric Molonglo Lake of Canberra" (Öpik, 1958).

Acton Fault

The Acton Fault (Öpik, 1958) trends north-west across the site of the Government Offices at Acton and along the north-eastern spur of the river in the Royal Canberra Golf Links (Sheet 22). In the small area examined, no sign of the Acton Fault has been seen. (Gardner,1958).

On Sheet 17 at 7710N, 28880E, a ferruginous outcrop of Turner Shale (Slt) consists mainly of angular slickensided fragments of rock. Some of the fragments are articulated, which suggests that they were broken in situ to form a fault-breccia.

No other traces of faulting, such as slickensides, or displacement of veins or strata, has been seen in the outcrops below the R.L.1825 foot level.

Persistent joints, trending approximately parallel to the river suggest the possibility of a zone of weakness in the river channel.

LAKE MARGIN

Topography

The Western Area of the Canberra Lake extends from Commonwealth Bridge to the Canberra Lake Dam and is subdivided into West Lake and the Western Reaches (see Plate 1).

West Lake, which will be the widest part of the Canberra Lake, will encompass two islands and extend westwards from Lennox Crossing and Lotus Bay to Black Mountain Peninsula and Yarralumla Bay; it will also include part of Sullivan's Creek to the north.

The Western Reaches will follow the flanks of Black Mountain to the north and the Zoological Park Reserve spur to the south and extend south-east past Government House.

The shore of the lake will consist of both gentle and steep slopes.

Shoreline Stability and Water Turbidity

The Canberra Lake will be exposed to north-westerly and westerly winds and considerable erosion of the Pleistocene and Recent sand, silt and clay deposits (particularly the wind-formed deposits) will probably be caused by wave action. The waves are expected to erode exposed sections of the shore and transport material to the heads of the bays unless protective measures are adopted. Gully erosion may also be produced by local lowering of base level if the unconsolidated sediments are eroded. Unless treatment is undertaken, large quantities of sediments may be removed from the shore of the lake; the coarse material will tend to stay on the beaches and the finer material to be moved to deeper water. Considerable quantities of colloidal matter would be derived from the clay in superficial deposits and weathered outcrops, as a result of abrasion, grinding, and impact of quartz, feldspar and other substances. These colloids would be carried from the shores and would remain in suspension for a long period, resulting in discoloration of the lake water.

Much of the clay, wind-blown sand and silt, and similar material, is weakly cemented and will stand in low vertical cliffs when dry, but when saturated with water may slide on slopes of only a few degrees. The strength of the sediments, as expressed by the angle at which sliding occurs under their own weight is directly related to the degree of saturation; it is greatly reduced by conditions under which pore pressure can develop, as internal friction is then so muc less than in incompletely saturated sediments. Deposits of wind-blown sand and silt and clay that will form part of the lake edge will need to be removed, stabilized by battering, or protected by rip-rap.

Firmness Underfoot

The lake margin will be submitted to more or less complete saturation and where the margin consists of fine-grained wind-blown sand, silt and clay the water will not drain away readily; free percolation will be restricted. As a result of the exclusion of air, root development immediately beneath the surface will be limited and this favours only those types of vegetation adapted to these conditions. In this way, marsh, swamp or bog associations are developed.

The water-table usually follows the shape of the land surface in a less accentuated manner and the depth below the surface at which it is encountered increases at the sides of a valley. In the bottoms of valleys it will approach the lake surface. Complications are produced by impervious strata so that in some cases the water-table may be quite near the surface in elevated situations. Consequently it is difficult to assign a depth above which the water-table does not affect conditions in the surface soil. A water-table lying within about four feet of the surface has a definite effect on the moisture relationships at the surface.

As practically the whole of the foreshore will be accessible to the public all clayey and silty areas will have to be treated to avoid boggy or marshy conditions. Dressing with sand may be adequate in places, but removal and replacement by sand and gravel will be needed elsewhere. Suitable vegetation cover would provide an alternative or supplementary treatment.

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APPENDIX

NOTES ON GEOLOGICAL SHEETS

SHEET 1.

General

Notable features of this Sheet are the contrasting topography and geology on either side of the river. The north-western slope is very steep and rises much higher than the 1845-foot contour shown on the Sheet. Numerous bodies of hard Mount Painter porphyry crop out, and superficial deposits are thin.

The south-eastern slope, on the other hand, rises to a flat or gently undulating surface at about R.L.1835 feet. Outcrops of Mount Painter porphyry appear near the river , below R.L.1800 feet ,but above this thick unconsolidated deposits cover the bedrock.

Superficial Deposits

Contemporary or present-day alluvium forms thin deposits in the bed of the Molonglo River; it consists of coarse loose sand and gravel, silt and clay.

The deposits of older alluvium on the south-eastern valley slope consist of weakly cemented gravel, sand, silt and clay; the upper edge of the exposures range in elevation from about R.L.1790 feet to about R.L.1810 feet; above this line they are covered by blown sand and silt. In the excavation at the dam site the older alluvium rises to about R.L.1820 feet and is covered by about 10 feet of aeolian sand and silt.

Bedrock

Numerous outcrops of porphyritic, dacitic, volcanic rocks are exposed on the steeper slopes of the river valley.

A possible dam site near the eastern edge of this Sheet has been investigated by Gardner (1958), who gives a fuller account of the rocks and sediments of the area.

Lake Margin

The lake margin, on the north-western slope traverses outcrops of bedrock and will be stable. On the south-eastern slope it will be within areas of medium to fine-grained aeolian sand, silty a few inches below the surface. This is likely to be muddy and boggy, and perhaps unstable when saturated, and will require treatment.

SHEET 2.

General

The salient features of Sheet 2 include a steep slope up from the river in the south-west to a rounded crest at about R.L.1830 feet; and a gentle slope on the north-east, that rises to a small flat slightly above R.L. 1845. The south-westerly slope is rocky near its base but the gentle north-easterly slope is formed by fine sand and silt. A broad shallow water-course runs southwards to the river in the western half of the Sheet. In the south-west prominent bodies of porphyry crop out around the river bend, mainly between the 1780-foot and the 1815-foot contours. Above this, the bedrock is covered by high-level older

alluvium, which is capped by aeolian deposits. North-east of the river the surface consists almost entirely of aeolian deposits, except in the shallow water course, where fine sand, silt and clay have been washed out by rain and stream action from adjacent higher ground.

The present-day or contemporary alluvium consists of coarse sand, silt and gravel. The silt was below river level when the mapping was done and is not shown on Sheet 2.

Lake Margin

The lake margin will be almost entirely within areas of medium to fine-grained aeolian sand and will be muddy and boggy. On the south-west, the aeolian sand forms a steep slope and may be unstable when saturated. Where the lake margin crosses the broad depression north-east of the river, excavation and filling with gravel and sand may be desirable, after providing for stormwater drainage.

SHEET 3

General

Cliffs of outcropping porphyry above the river near Government House are capped by aeolian deposits and by high-level older alluvium, including extensive gravel deposits. Porphyry, thinly covered by soil and detritus, occurs in the south-east of the Sheet. Elsewhere south of the river, the surface consists of aeolian deposits which may locally be 10 to 15 feet thick. These probably cover discontinuous areas of older alluvium.

Superficial Deposits

The area north of the river consists of fine and coarse sand, partly of present-day origin and partly older aeolian deposits. A valuable deposit of clean coarse river sand forms the northern bank of the river.

Recently-formed alluvium consists mainly of coarse loose sand, gravel and silt.

Older gravels occur at intervals along the southern slope, up to at least R.L.1830 feet.

Wind-blown sand and silt are widely distributed. Deposits a few hundred feet north of the river are known, by augering, to be up to nine feet thick.

Bedrock

Rock exposures in the area except in the cliffs near Government House, are poor, as the surface is covered by wind-blown material and alluvium.

The rock is porphyry. The scattered outcrops are mainly weathered and soft near the surface; beneath the weathered mantle the porphyry is very hard.

Lake Margin

Where the lake margin, south of the river, will traverse outcrops of bedrock and areas of older alluvium it should be stable. In areas covered by aeolian deposits the margin, unless treated, will probably be unstable on steep slopes and muddy and boggy where the slopes are gentle.

SHEET 4

Superficial Deposits

The superficial deposits consist of wind-blown sand, and range in elevation from R.L. 1810 feet to about R.L. 1845 feet.

The fanglomerate, at the foot of the south-western slope of Black Mountain, consists of detrital fragments of Black Mountain Sandstone which have accumulated to form thick scree; the detritus is partly cemented by iron oxide and clay. The fanglomerate is being used for road aggregate; a pit has exposed a lenticular band of aeolian fine sand and silt, 30 feet long and up to 2 feet thick.

Bedrock

Rock exposures in the area are few and small, and consist of weathered porphyry.

Lake Margin

Slopes are gentle and the lake margin should be stable, but muddy and boggy.

Local slips will possibly occur in the fanglomerate because of the presence of lenticular bands of fine-grained aeolian silt and dust, which may become unstable when saturated.

SHEET 5

Superficial Deposits

The alluvium along the river consists of coarse, loose sand and silt. Silt forms the floors of depressions north and west of the river. It was probably washed down by rainwater from surrounding higher ground.

In the south-east the wind-blown deposits could be fairly thick - possibly up to 15 feet. They will form the margin of the Canberra lake. At the surface these deposits consist mainly of fine sand with very little silt.

Bedrock

Scattered outcrops occur north and west of the river. They consist of weathered tuffaceous sandstone of the Upper Silurian Deakin Volcanics in the north-east and fresh porphyry in the west.

Lake Margin

Slopes are gentle and the lake margin should be stable, but locally muddy and boggy.

SHEET 6

Superficial Deposits

Recent, contemporary, alluvium forms thin deposits in the bed of the Molonglo River; it is composed of coarse sand and gravel, silt and clay. The greater part of the area is covered by wind-blown deposits which extend up the valley sides from the edge of the river alluvium. On the southern side of the river from 6600N to about 7000N the aeolian deposits contain a large proportion of silty material.

Bedrock

Scattered outcrops of partly weathered porphyry occur on both sides of the river, generally below the 1825 foot contour.

Vertical Sections

Vertical sections through the superficial deposits are exposed in erosion gullies and shallow pits.

Locality	Coordinates		Description
A	7762N-22872E	0 - 0'9"	Medium and fine sand & silt
		0' 9"- 3'	Medium and fine sand &silt & clay.
B	7522N-22749E	0 - 4'	Fine to very fine wind-blown sand and silt; clayey from 1'5" to 3".
C	7296N-22718E	0 - 8'	Fine dark river sand and silt; some clay & humus.
D	6422N-23080E	0 - 1'6"	Clayey soil.
		1' 6"-	Weathered porphyry.
E	6474N-22518E	0'- 6'	Very fine wind-blown sand and silt.
		6' - 9'	Decomposed porphyry
		9' -	Weathered porphyry
F	6365N-21713E	0 - 6'	Very fine wind-blown sand and silt.

Lake Margin

The lake margin will be entirely within areas of medium to fine-grained aeolian sand; south of the river from 6600N to 7000N slopes are fairly steep and may be unstable when saturated. Elsewhere slopes are not steep and the lake edge should be stable; it is likely to be muddy and boggy.

SHEET 7

Superficial Deposits

Wind-blown sand and silt covers almost the entire area mapped on the Sheet. In the south and north the wind-blown deposits are possibly fairly thick.

Bedrock

There are few rock exposures; those mapped are small and are of weathered porphyry (Mount Painter porphyry). Near the margin of the lake, from 5400N to 4900N and near the south-west corner of the Sheet, the bedrock is probably less than two feet below the surface.

Lake Margin

Slopes arenot steep, and the lake edge should be stable, except perhaps in the north-west corner of the Sheet. The foreshore is likely to be muddy and boggy.

SHEET 8

Superficial Deposits

Present-day alluvium, composed of coarse, loose sand and gravel, forms thin deposits in the bed of the river.

Older alluvial deposits that occur in the Zoological Park Reserve consist of cemented gravel, sand, silt and clay, and range in elevation from about R.L.1810 feet to about R.L.1830 feet.

Fanglomerate, formed of detrital fragments of Black Mountain Sandstone, is quarried for road aggregate.

Wind-blown sand and silt occurs only in the south-west near Black Mountain Creek and inthe south-east, at the Zoological Park Reserve.

Bedrock

Scattered outcrops of weathered porphyry occur in the bed of Black Mountain Creek and on the west-facing slope of the river valley, at the Zoological Park Reserve, between R.L.1820 feet and R.L.1805 feet. A small outcrop of weathered shale of the Pittman Formation also occurs between R.L.1825 feet and R.L.1815 feet.

Lake Margin

The lake margin will be almost entirely within areas of fanglomerate and of older alluvium, both of which should be stable.

SHEET 9

Superficial Deposits

Recent alluvium forms thin deposits in the bed of the river; it consists of coarse sand, gravel and silt.

Older alluvial deposits, composed of gravel, sand and silt, occur on the southern slope of the river from about R.L.1815 feet to about R.L.1840 feet, and in the south-east from river level up to a little above 1845 feet.

Wind-blown sand and silt extends from north-east to south-west covering the greater part of the south-eastern slope of the river valley; some also occurs on the north-western slope of the river.

Bedrock

Numerous partly weathered porphyry outcrops occur on the south-western slope of the river. Above R.L.1825 feet a few scattered outcrops of fine-grained quartz sandstone of the Black Mountain Sandstone occur. In the south-east, from about R.L.1840 feet to about R.L.1805 feet the outcrops consist mainly of weathered mudstone of Yarralumla Formation and tuffaceous sandstone of Deakin Volcanics.

Lake Margin

The lake margin on the south-eastern slope of the river will be formed by outcrops of bedrock, areas of older alluvium consisting of gravel and sand and areas of medium to coarse-grained sandy aeolian deposits.

They should allprovide a stable margin. In the south-east of the sheet the lake margin will be within an area of medium to coarse-grained, older alluvial sand.

SHEET 10

Superficial Deposits

Very thin superficial deposits of fine sand and silt appear in this area.

Bedrock

Rubble derived from tuffaceous sandstone and outcrops of mudstone and sandstone occur in the north-east of the Sheet area.

Lake Margin

The lake margin in the north-east of the Sheet lies along a steep outcrop of bedrock partly covered by a thin overburden consisting of medium to coarse-grained sand, and should be satisfactory. In the south-western corner of the Sheet the lake margin will be in an area of fine-grained sand and silt, and the gentle slope may be muddy and boggy unless grassed.

SHEET 11.

Superficial Deposits

The alluvium consists of loose sand, gravel and silt and extends east and west from the river. The bank on the west has been excavated from about R.L.1780 feet to about R.L.1805 feet.

Fanglomerate, consisting of detrital fragments of Black Mountain Sandstone partly cemented by iron oxide and clay, forms a steep slope above the river in the north-west.

Bedrock

At the river bank at about R.L. 1785 feet weathered sandy shale of the Lower Silurian State Circle Shale crops out.

On the south the outcrops consist of weathered micaceous sandy shale of the Middle Ordovician Pittman Formation.

Lake Margin

The lake margin west of the river will be within areas of medium to coarse sand, partly wind-blown, and partly older alluvial sand; both will provide stable sandy beaches. In the north the lake margin will be against cliffs and steep slopes of fanglomerate. Local slips will possibly occur in this material, because of the presence of small lenticular bands of fine-grained aeolian silt and dust, which may become unstable when saturated. A vertical cliff 20 feet high eroded into the fanglomerate by the river shows no sign of instability.

On the east the lake margin will cross mainly fine sandy soil, probably colluvial in origin, covering gentle slopes.

A small area of fine grained aeolian sand forms a steep slope for a distance of 100 feet along the 1825-foot contour on the north-east; it may be unstable when saturated.

SHEET 12

General

Nearly all of this sheet is occupied by a low rounded ridge or spur that runs southward from the foot of Black Mountain to Corkhill Weir. It is bounded on the west, south and south-east by the Molonglo River, and on the east by Sullivans Creek and an adjacent low flat. The spur is covered by aeolian sand and silty sand, beneath which are lenticular stratified deposits, possibly lacustrine, of gravel and sand, and minor bands of silt and clay. Sand and gravel have been

won from pits in the south-east for use as construction materials, and much of the remainder of the area has been excavated for burial of garbage. The eastern edge of the spur is formed by a long steep and cliff-like outcrop of sandstone and sandy shale of the Middle Ordovician Pittman Formation.

Superficial Deposits

Recent, contemporary, alluvium occupies the bed of the river; it consists of coarse loose sand and gravel, silt and clay.

The older alluvial deposits which occur on the valley slopes consist of gravel, sand, silt and clay.

Bedrock

On the east is the bold outcrop of weathered beds of the Pittman Formation; on the south, scattered outcrops of tuffaceous sandstone and shale of the Deakin Volcanics, and on the west weathered Mount Painter porphyry.

Lake Margin

The lake margin on the western slope of the spur at about 26600E will lie along an area originally occupied by aeolian, fine sand and silt.

Slopes are gentle and the lake margin would be stable, but muddy and boggy. On the east, the lake margin will lie along the steep outcrop of bedrock.

Near the western margin of the Sheet, west of the Molonglo River, the lake margin from 10200N to 9700N will traverse medium to coarse-grained sand, partly aeolian and partly older alluvial sand. This sand will form firm, stable beaches.

South of 9700N the lake margin will be along a fairly steep slope characterized by thin soil and numerous outcrops of bedrock.

SHEET 13

The northern part of this Sheet, north of the river, covers the southern end of the low spur described under Sheet 12. The geology and the lake-margin conditions described there also apply here.

South of the river, superficial deposits are generally thin and slopes gentle. The lake margin should be stable but between 25500E and 26700E it may be muddy and boggy.

SHEET 14

Superficial Deposits

The superficial deposits consist mainly of fine sand with a very small proportion of coarse sand and clay. Along a low depression a channel feeds water into a swampy area.

Where the lake margin crosses the low-lying swampy and silty area forming the future Yarralumla Bay, special treatment will be desirable. This could include excavation of some unsuitable material at the lake edge, replacing it with gravel and sand, and extensive filling of the low-lying area farther south after providing for stormwater drainage. West and east of the swampy area, the superficial deposits are probably colluvial and should be stable, though somewhat muddy in places.

SHEET 15

Superficial Deposits

The superficial deposits consist of fine to medium sand, silt and clay in which a few drains and ditches have been cut.

The wind-blown sand and silt range in elevation from about R.L.1810 feet to about R.L.1830 feet, and in the west up to 1850 feet.

Clean, medium-grained sand has been excavated from a large pit in the west from 10400N to 11200N. Fanglomerate extends up the slope on the northern side above the boundary of the aeolian deposits.

Bedrock

Weathered sandy shale of the Pittman Formation crops out in the west above R.L.1845 feet.

Lake Margin

The lake margin will consist of aeolian deposits in the west and north-east, and fanglomerate in the north. In the west, from 10400N to 11400N, medium-grained aeolian sand, probably less than 10 feet thick rests on a steeply sloping bedrock-surface; it could be readily excavated and the sloping bedrock would then form the edge of the lake. In the north, from 27800E to 28600E, fanglomerate would form a stable margin to the lake. From 28600E to the eastern edge of the Sheet the fine, aeolian, silty sand would probably form a muddy and boggy margin.

SHEET 16

Recent alluvium forms thin deposits in the bed of the river and consists of coarse loose sand and gravel, silt and clay. The older alluvium consists of gravel, sand, silt and clay. The northern bank is being shallowly excavated for garden loam.

A prominent outcrop of partly weathered Middle Ordovician sandy shale and sandstone of the Pittman Formation occurs on the western side along the river bank. Quartzose fine-grained sandstone, Lower Ordovician ?Black Mountain Sandstone, very hard and resistant to weathering, forms small outcrops in the river bed. With the exception of a small spur in the south, which rises to a little above R.L.1820 feet, the whole Sheet area is well below lake-level.

SHEET 17

The western part of this area will be well below lake-level. The southern and eastern shores will be formed of fine wind-blown sand that contains a small proportion of silt and clay and irregular patches of coarse sand.

Slopes are not steep and the lake margin should be stable. However, because of the potentially boggy nature of this ground, the thickness of aeolian material and its characteristics below the surface could well be tested by pitting or augering.

The low spur that trends north-north-west, through the site of the future South Island and reaches the northern end of the Sheet at 28500E, is covered by similar wind-blown sand and silt. In the east, from 29000E to the eastern edge of the Sheet, the lake margin will be formed of older alluvium that consists of fine to coarse sand and rests on gravel. The gravel, in turn, rests on bedrock, which is exposed in the steep slope above the river flat.

SHEET 18.

In the small area mapped, the surface is covered by fine sand containing a small proportion of coarse sand; an outcrop of bedrock of the Middle Ordovician Pittman Formation occurs a little above lake level. Slopes are gentle and the lake edge should be stable. Probably selective washing out of fine sand will result in a satisfactory beach of coarse sand.

SHEET 19

Superficial Deposits

Recent alluvium forms small deposits of sand, silt and clay on the bed of Sullivans Creek. These are not shown on the Sheet.

Wind-blown sand and silt are widely distributed in deposits up to 5 feet thick.

Bedrock

A bold outcrop of Upper Ordovician siliceous shale of the Acton Shale appears on the slope near the School of Physical Sciences; beneath the weathered mantle the rock is fairly hard. This is near the site of one of Öpik's most prolific fossil localities.

Lake Margin

The lake margin will lie almost entirely in aeolian fine sand and silt. Where slopes are gentle, in the north and in some of the racecourse area, it is likely to be muddy and boggy. Around the outcrop area west of the Australian National University, the margin will be stable and satisfactory.

SHEET 20

Superficial Deposits

The alluvium consists of gravel and sand in the river, and silt and clay on the northern bank where there is a shallow excavation for garden loam.

Nearly all the remainder of the area which includes the site of the future North Island (Plate 2) is covered by aeolian fine sand, containing varying proportions of silt.

Bedrock

A relatively strong outcrop, consisting of partly weathered siliceous shale of the Acton Shale, occurs near the racecourse.

As is the case with Sheet 19, the lake margin lies almost entirely in aeolian deposits, which are likely to be muddy and boggy on gentle slopes.

SHEET 21

Superficial Deposits

Present-day alluvium forms thin deposits in the bed of the river; it consists of loose sand and gravel, silt and clay.

Older alluvial deposits that occur on the south-eastern valley slope, at higher elevations, consist of cemented gravel, sand, silt and clay; where exposed they range in elevation from about R.L.1810 feet to about R.L.1840 feet; above this they are covered by wind-blown sand and silt.

Bedrock

Numerous outcrops appear on the southern slope. They consist of Lower Silurian calcareous mudstone, **(Turner Shale), with ferruginous concretions, siliceous shale of Upper Ordovician, Acton Shale and sandy shale of Middle Ordovician Pittman Formation.**

The Silurian mudstone is infolded into the Ordovician beds. The quarry shown on the Sheet is worked by Commonwealth Brickworks Canberra Limited, for shale for cream-coloured face brick.

Lake Margin

The lake margin in the southern part of the Sheet will cross areas of older alluvium, and others in which the bedrock either appears at the surface as outcrop or is covered by thin soil and scree. The erosion gully near 6600N - 30600E will need special treatment.

SHEET 22

The lake margin will consist mainly of fine to medium-grained aeolian sand, modified in places by road making and excavation for building purposes. Much of this sand will probably provide satisfactory beaches, but where fine-grained it may be muddy and boggy, and unstable on the steeper slopes. This applies more particularly in the south of the Sheet area.

Trenching and tunnelling along a sewer line that crosses the Sheet at about 32600E has shown fluviatile and aeolian deposits ranging in thickness up to 25 feet underlain by older deposits of clay, sand and gravel of fluviatile or lacustrine origin; locally as much as 30 feet thick (Gardner, 1958).

Bedrock

A small outcrop of calcareous shale of the City Hill Shale was mapped on the river bed.

A possible dam site near the eastern edge of this Sheet has been investigated (Gardner, 1958).

SHEET 23

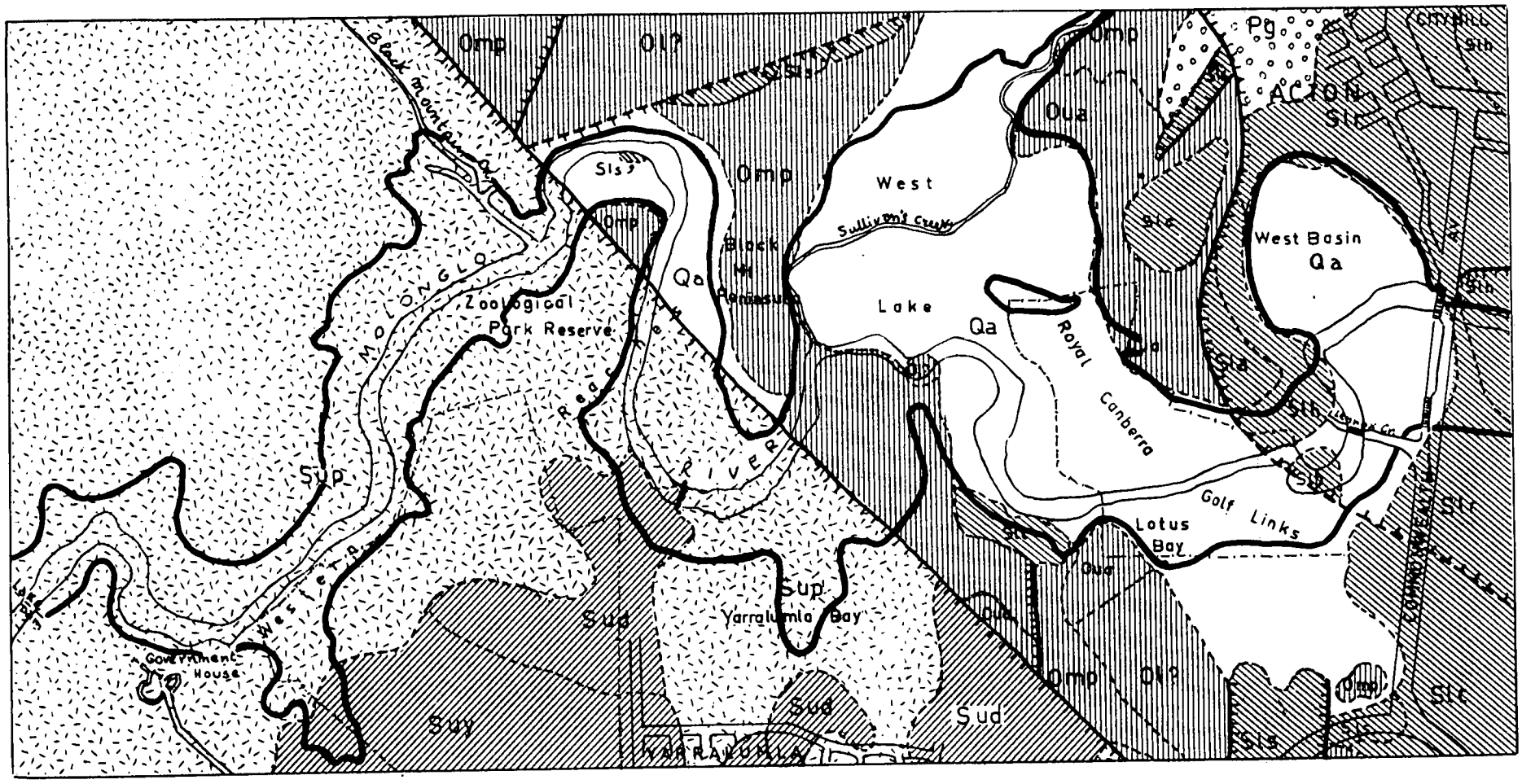
The investigation followed the existing 1825-foot contour. However, the lower part of this area will be filled and the lake edge will be in the position shown on Plate 2. Trenching and tunnellingalong a sewer main that crosses the Sheet in a north-south direction at about grid meridian 33600E has shown that the aeolian deposits are underlain by thick fluviatile, or lacustrine, older deposits of coarse sand and gravel.

SHEET 24

The recent deposits consist of gravel, sand, silt and clay. The wind-blown sand and silt are underlain by older deposits of gravel sand and clay.

No bedrock was mapped.

Where the lake is bounded by fine, wind-blown sand and silt, the lake edge will probably be muddy and boggy. The medium to coarse grained sand will provide satisfactory beaches.



REFERENCE

RECENT TO PLEISTOCENE

Qa Undifferentiated

Pg Fyshwick Gravel

PERMIAN

SILURIAN

Sup Mt Painter Porphyry

Upper

Suy Yarralumla Formation

Sud Deakin Volcanics

Sla Acton Limestone Member

Slh City Hill Shale

Lower

Slr Riverside Formation

Slt Turner Shale

Sls State Circle Shale

Slc Camp Hill Sandstone

ORDOVICIAN

Upper

Middle

Lower?

Oua Acton Shale

Omp Pittman Formation

Olp Black Mt Sandstone

---- Established boundary position approximate

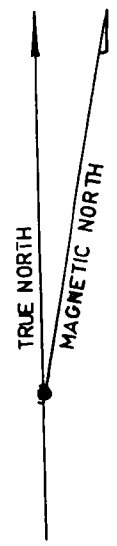
Normal fault (hachures show downthrow)

Normal fault-concealed

1825 ft contour from Canberra Map by Department of the Interior

Fence

Road



GEOLOGICAL MAP OF CANBERRA LAKE WEST OF COMMONWEALTH BRIDGE

Adapted from Geological Map of Canberra, by Opik(1953)

Scale

0 1/4 1/2 1 Mile

Bureau of Mineral Resources, Geology & Geophysics

To accompany Record 1962/166 155/16/50 G.W.D.

GEOLOGICAL INVESTIGATION

EDGE OF PROPOSED CANBERRA LAKE

Based on plane table, compass and tape surveys by R.L.Wildy, J. K.Hill, G.W.D'Addario, J.H.Lilley, J.M.Blackman, R.V. Scott and D.E.Gardner, February 1960 - March 1961
Base map adapted from 1- foot contour survey by Survey Section, Dept. of the Interior.

GENERAL REFERENCE FOR THE GEOLOGICAL SHEETS

Scale 50 0 100 200 300 Feet

SUPERFICIAL DEPOSITS

(Consisting of river alluvium, windblown sand and silt, and detrital fragments derived from bedrock.)

RECENT AND PLEISTOCENE

- Silt
- Medium and fine sand and silt
- Medium and coarse sand and silt
- Gravel and sand
- Aeolian deposit
- Contemporary alluvium

- Swamp

Pb Scattered pebbles

Bs Ferruginous concretions (Buck shot)

Angular rock fragments

Minor constituents of Superficial Deposits

C	Small proportion of coarse sand
(C)	Very small proportion of coarse sand
(m)	Small proportion of medium sand
(f)	Small proportion of fine sand
Cl	Clay
(Cl)	Small proportion of clay

BEDROCK

- Outcrop

SILURIAN

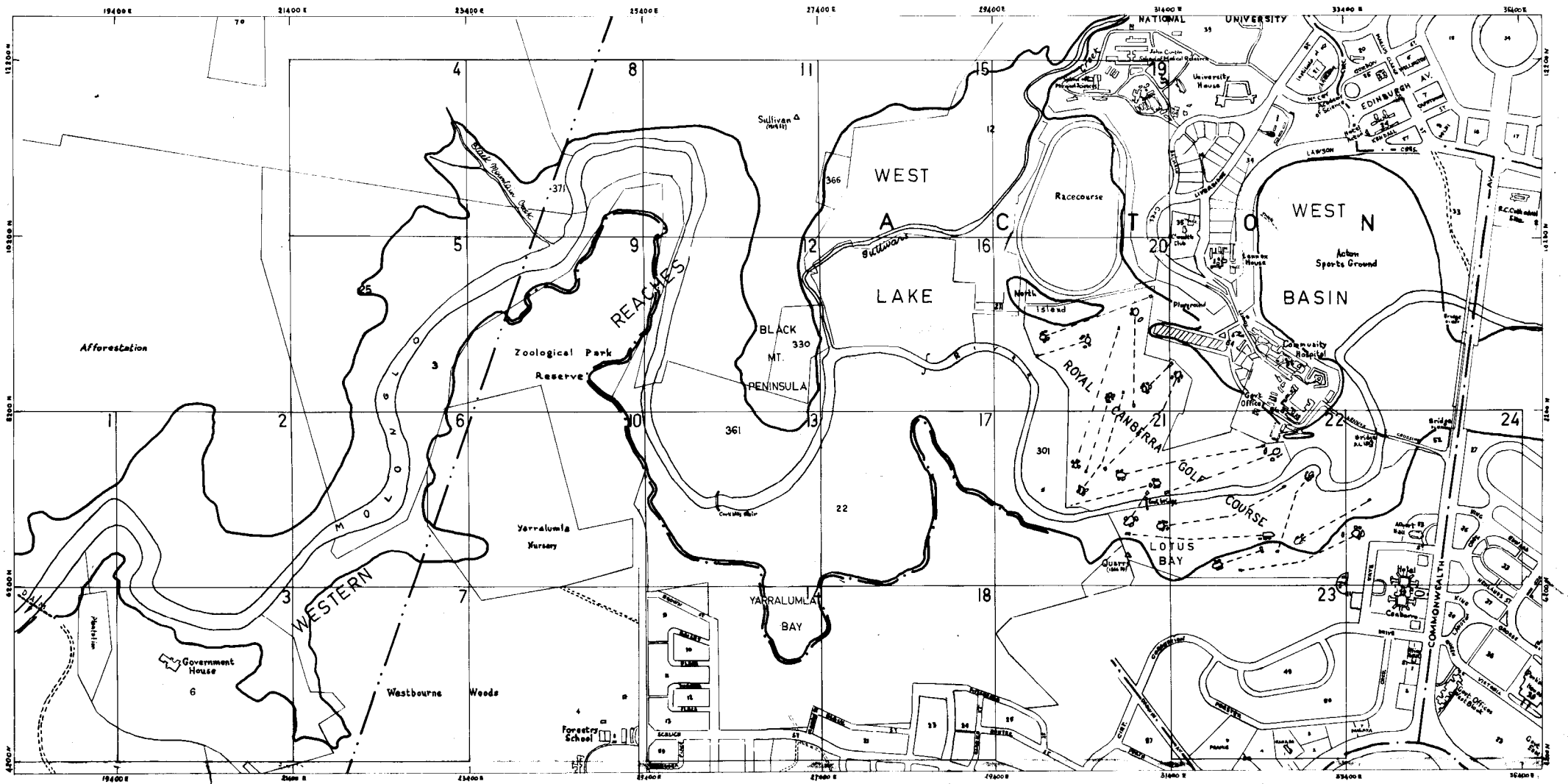
Upper	Sup	Mount Painter Porphyry
	Suy	Yarralumla Formation
	Sud	Deakin Volcanics
Lower	Sla	Acton Limestone Member
	Slh	City Hill Shale
	Slr	Riverside Formation
	Slt	Turner Shale
	Sls	State Circle Shale
	Slc	Camp Hill Sandstone

ORDOVICIAN

Upper	Oua	Acton Shale
Middle	Omp	Pittman Formation
Lower?	Ol	Black Mountain Sandstone

- Strike and dip of bedding
- Strike and dip of jointing
- Geological boundary
- Inferred geological boundary
- Exposed vertical section
- Surface contour based on Canberra datum
- Coordinate based on Stromlo trigonometrical station
- Fence
- Vehicle track
- Power line
- Bench Mark
- Sewer manhole
- Quarry or Sand pit
- Building
- Small scarp
- Hedge
- ▼50 Numbered peg (Rankine & Hill)

LOCALITY MAP SHOWING SHEET BOUNDARIES



ADDITIONAL REFERENCES FOR THE LOCALITY MAP

Scale 0 800 1600 3200 4000 Feet

- Boundary of geological sheet
- 1825 ft. contour from Canberra Map by Department of the Interior
- 3 Land subdivision number
- Land subdivision boundary
- 10 Sheet number
- District boundary
- Division boundary
- Road
- Tee, Fairway and Green

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To accompany Record 1962/166

155/16/51

G.W.D.

SHEET 1

17400 E
17800 E
18200 E
18600 E
19000 E
19400 E

8200 N
7800 N
7400 N
7000 N
6600 N
6200 N

Numerous Outcrops
and
angular rock fragments
Soil

Pipe

Edge

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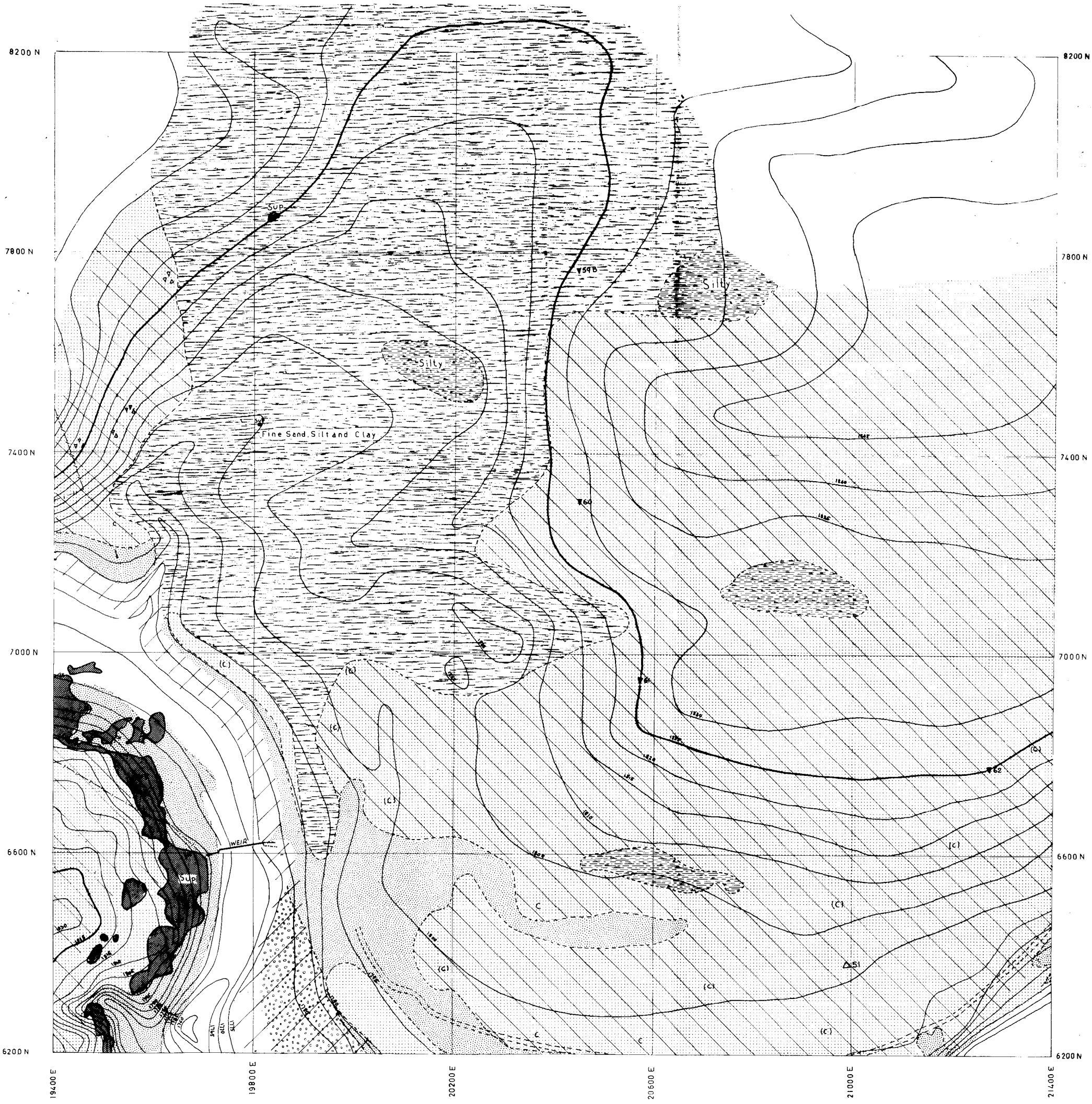
To accompany Record 1962/166

155/16/52



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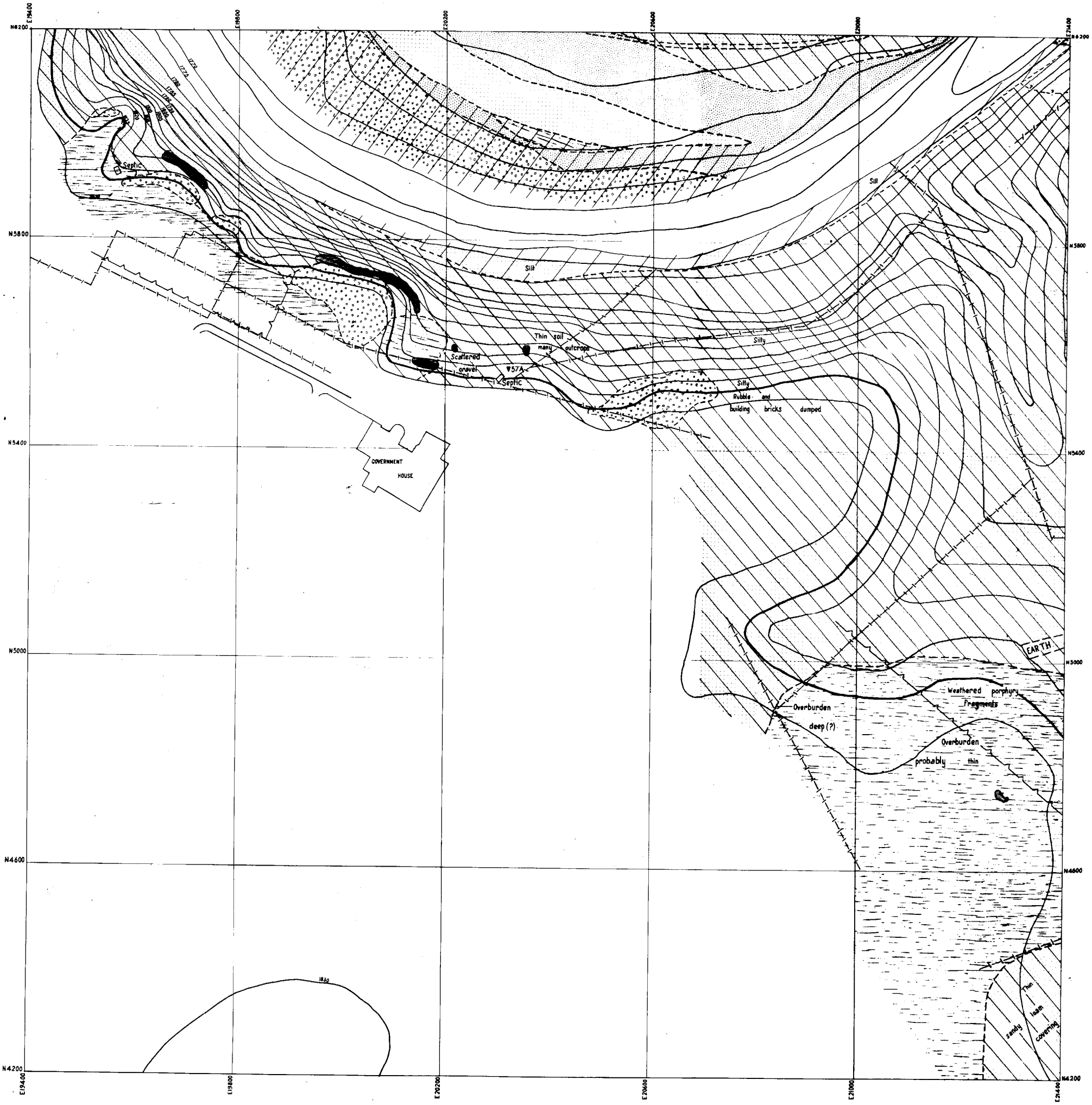

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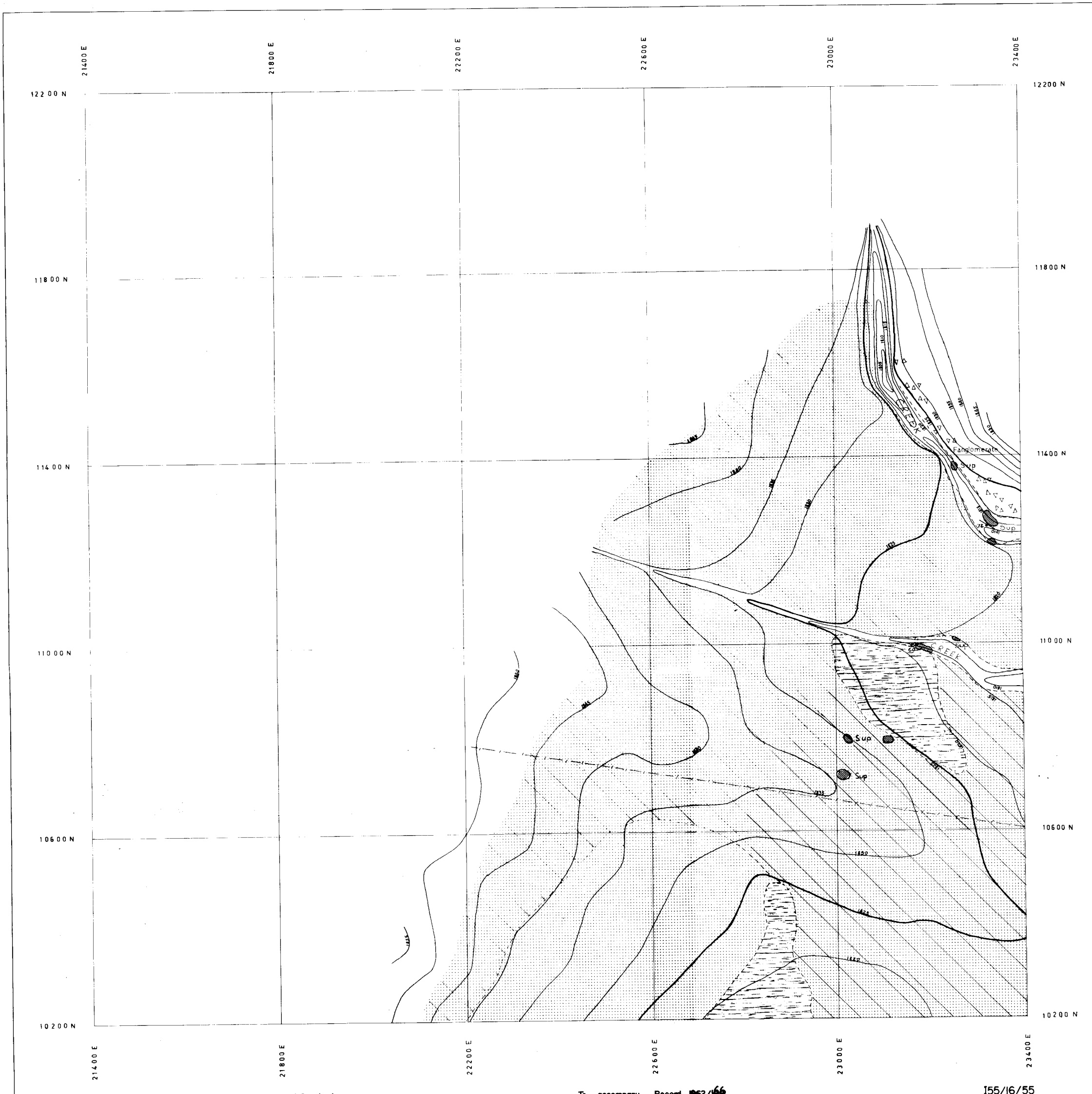
155/16/54

SHEET 4



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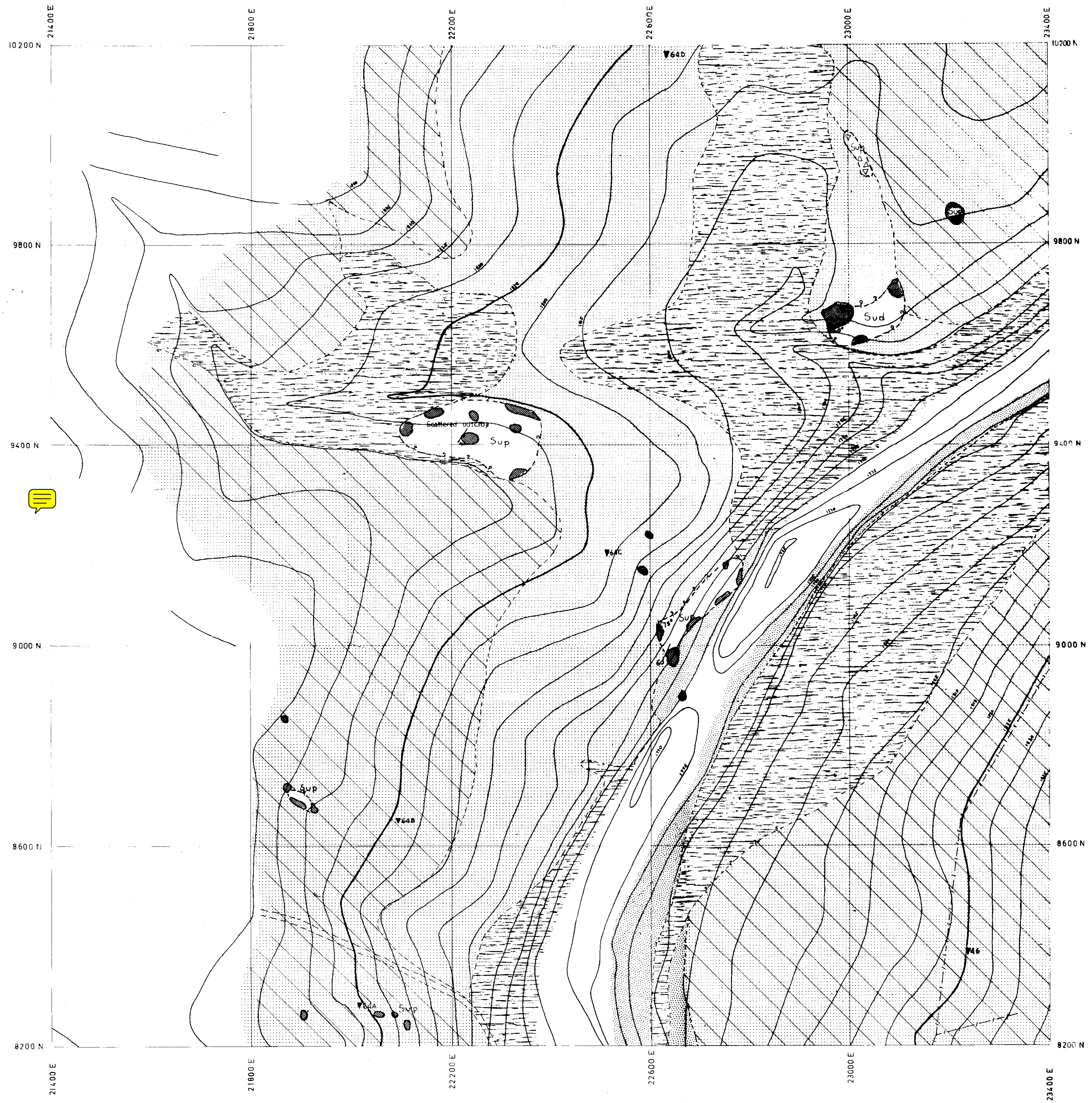
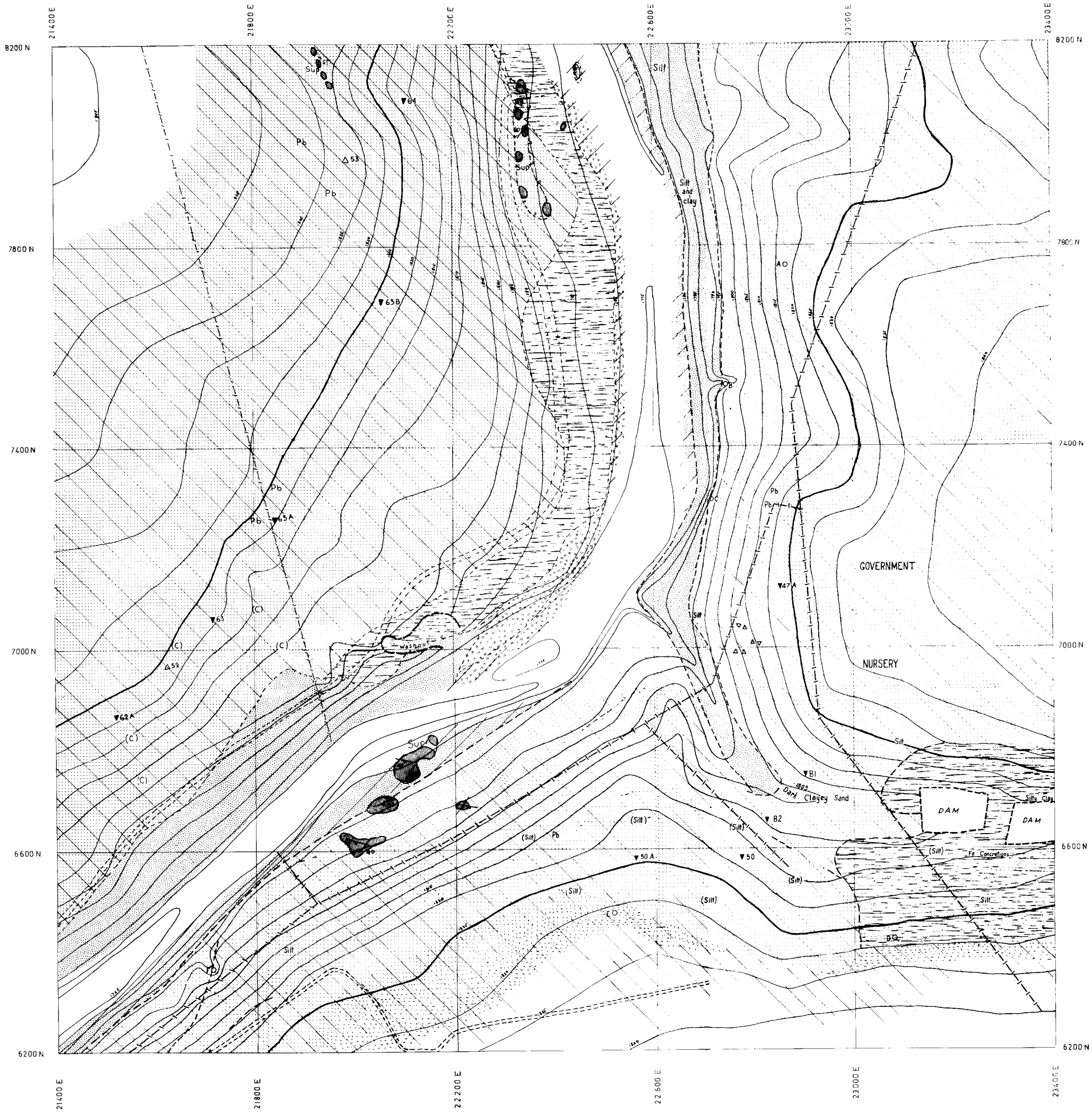
155/16/55


21400 E
21800 E
22200 E
22600 E
23000 E
23400 E
10200 N
9800 N
9400 N
9000 N
8600 N
8200 N
64D
64C
64B
64A
46
Sup
Sud
Scattered outcrop



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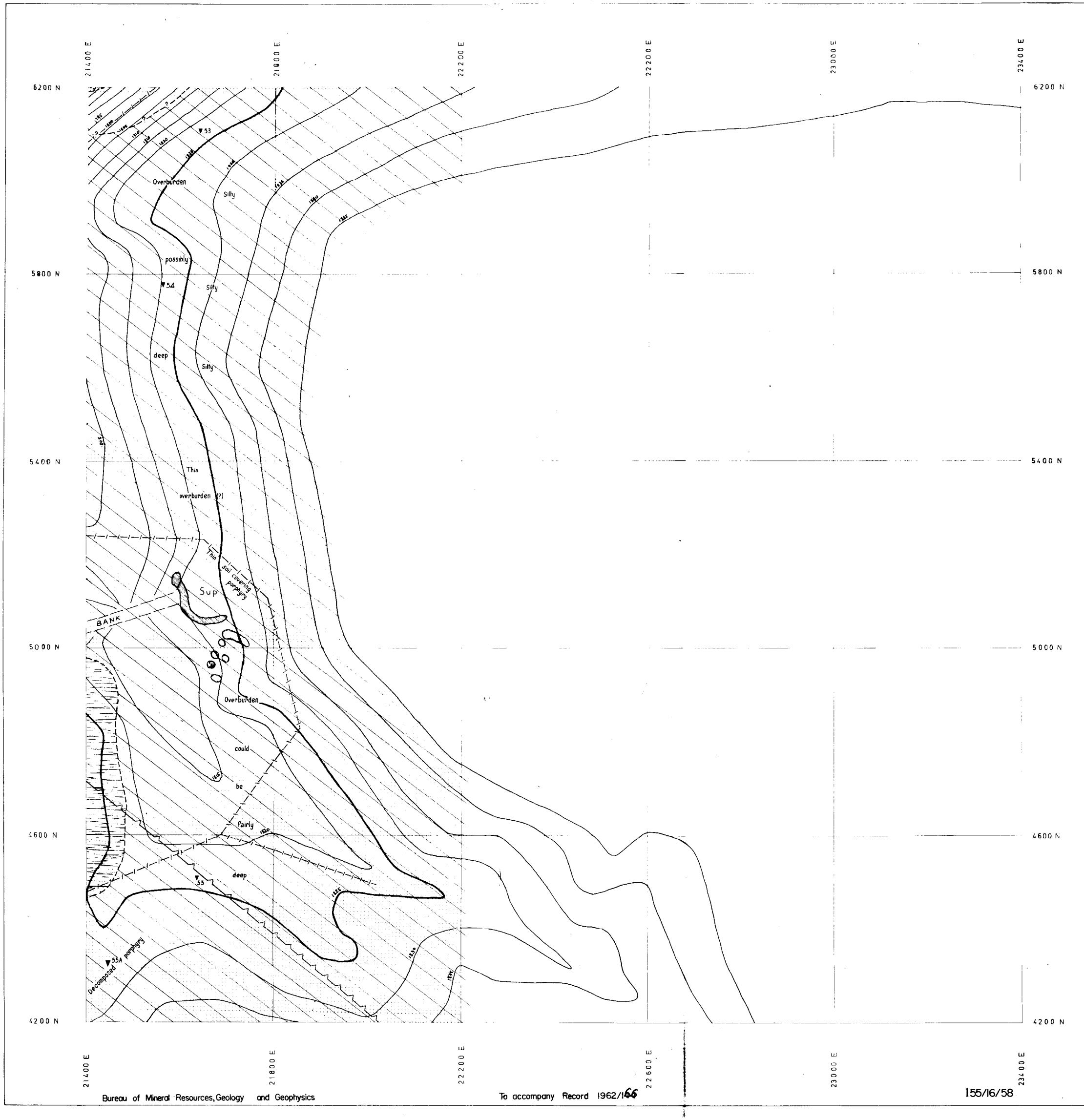
155/16/57



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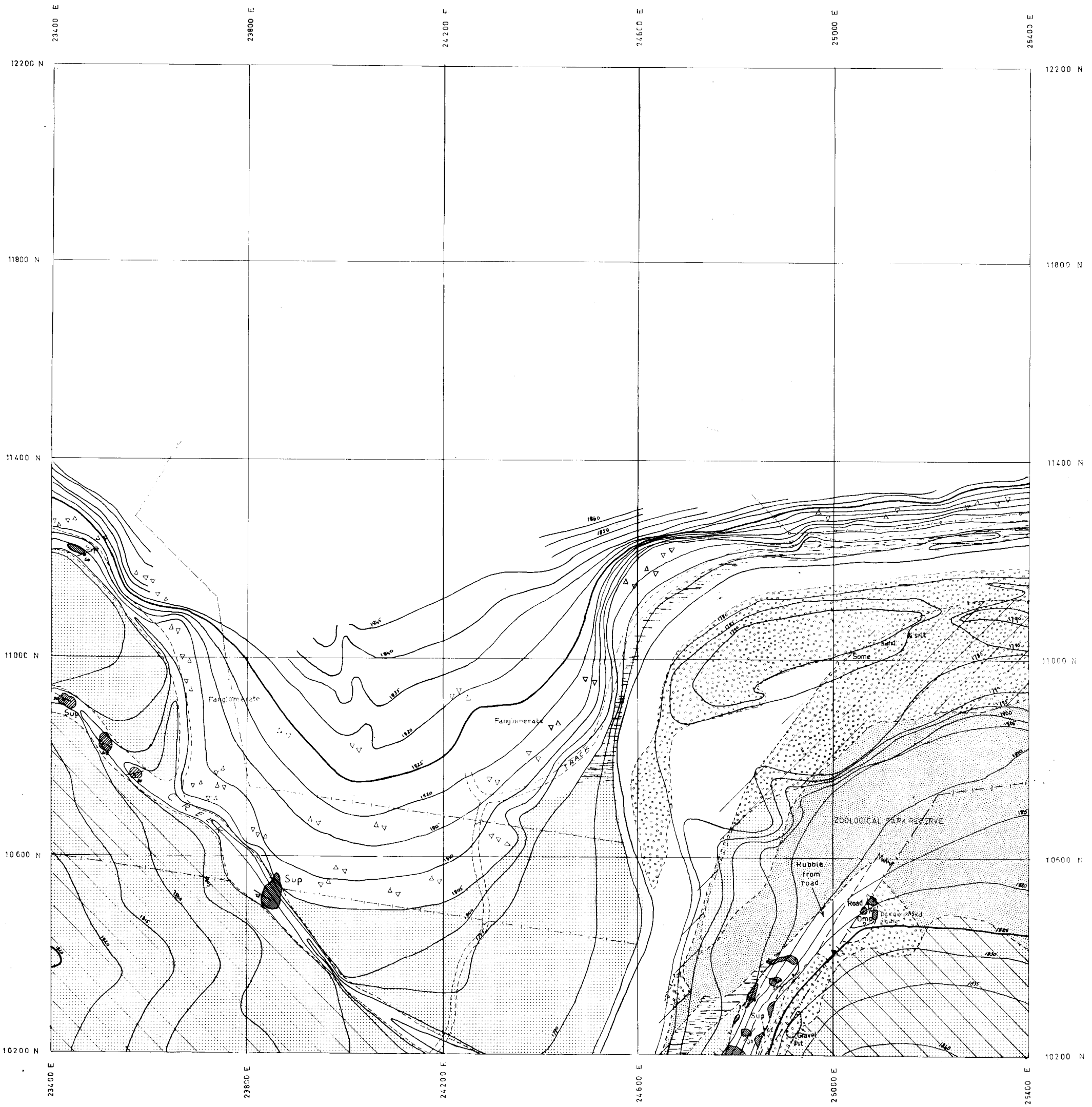
To accompany Record 1962/166

155/16/58



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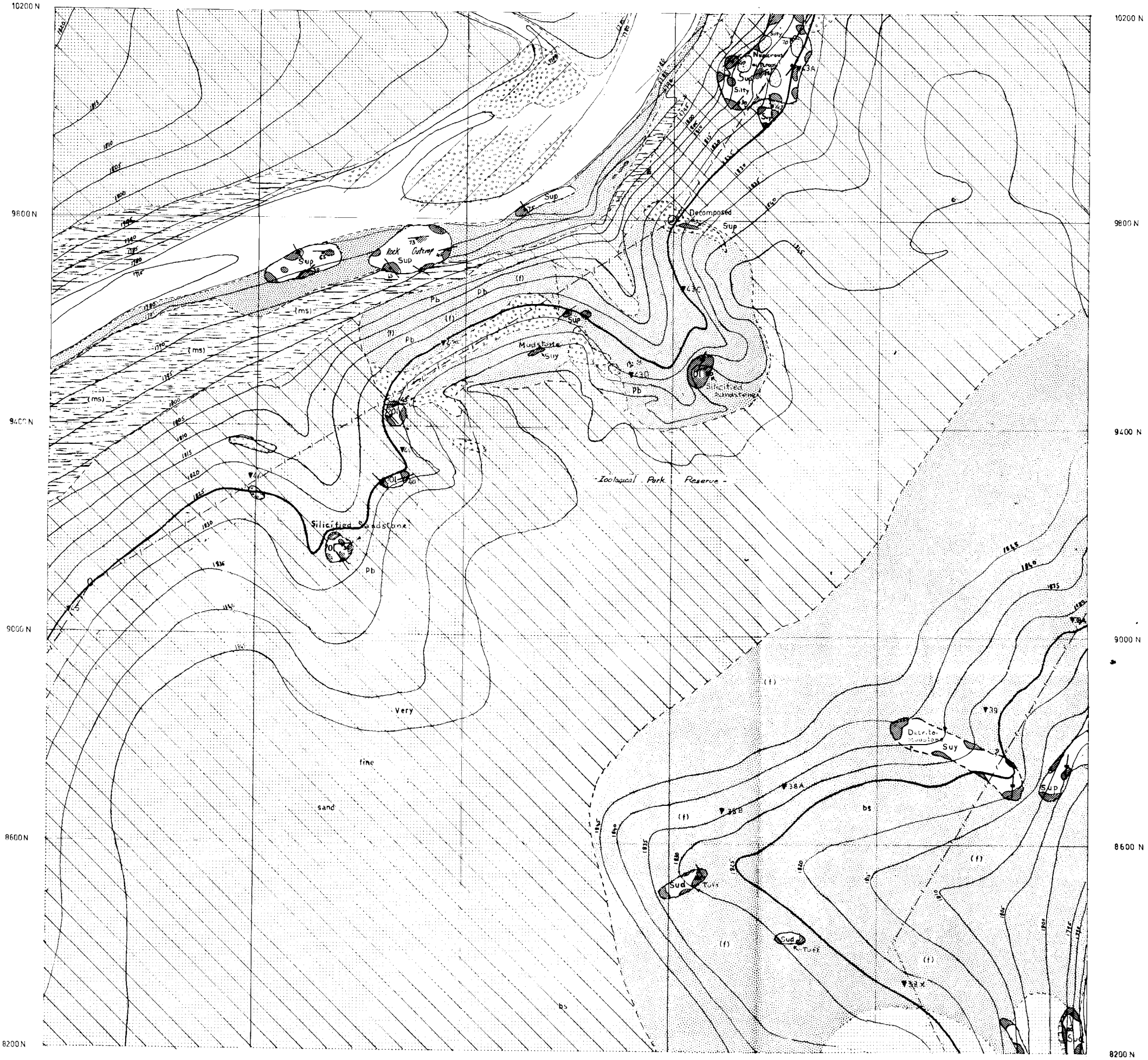
155/16/59



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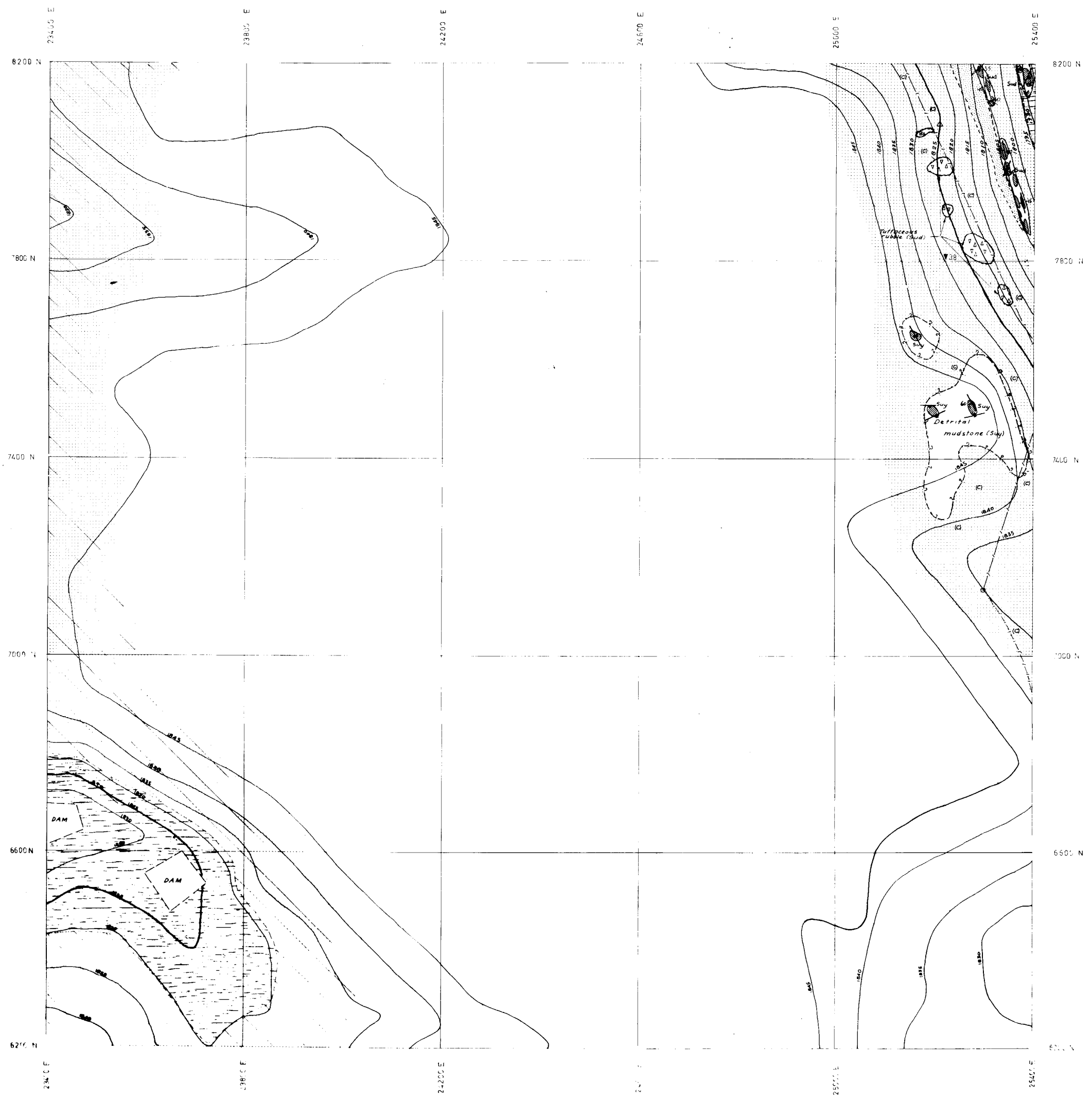
To accompany Record 1962/166

155/16/60



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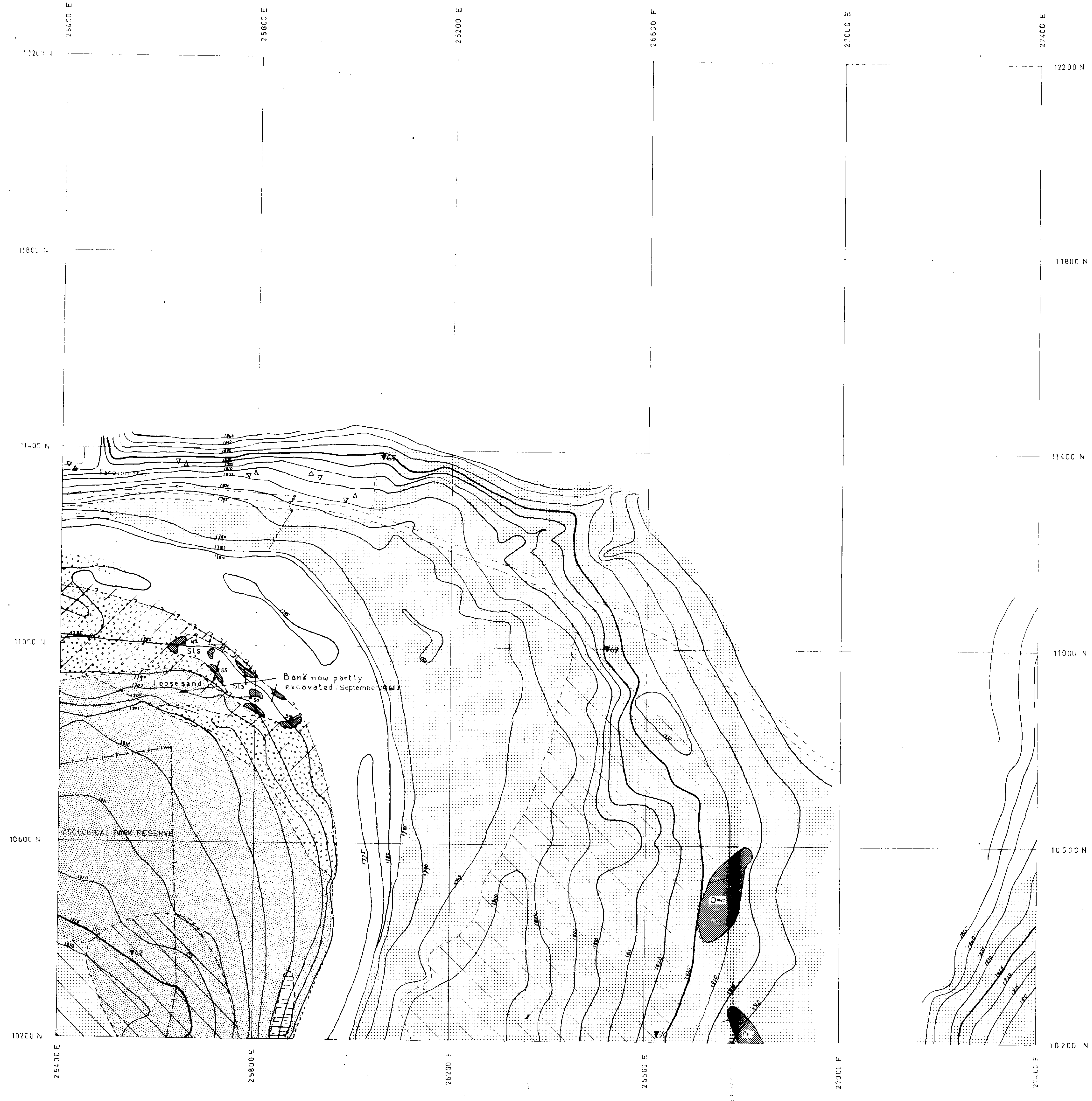
To accompany Record 1962/166

155/16/61

SHEET 11



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To accompany Record 1962/166

155/16/62

SHEET 12

25400 E
25800 E
26200 E
26600 E
27000 E
27400 E

10200 N
9800 N
9400 N
9000 N
8600 N
8200 N

ZOOLOGICAL PARK RESERVE

Sup rubble
Sup
Sup
Sup
Sup
Sup
Sud
Shale
Omp
GRAVEL PIT
C

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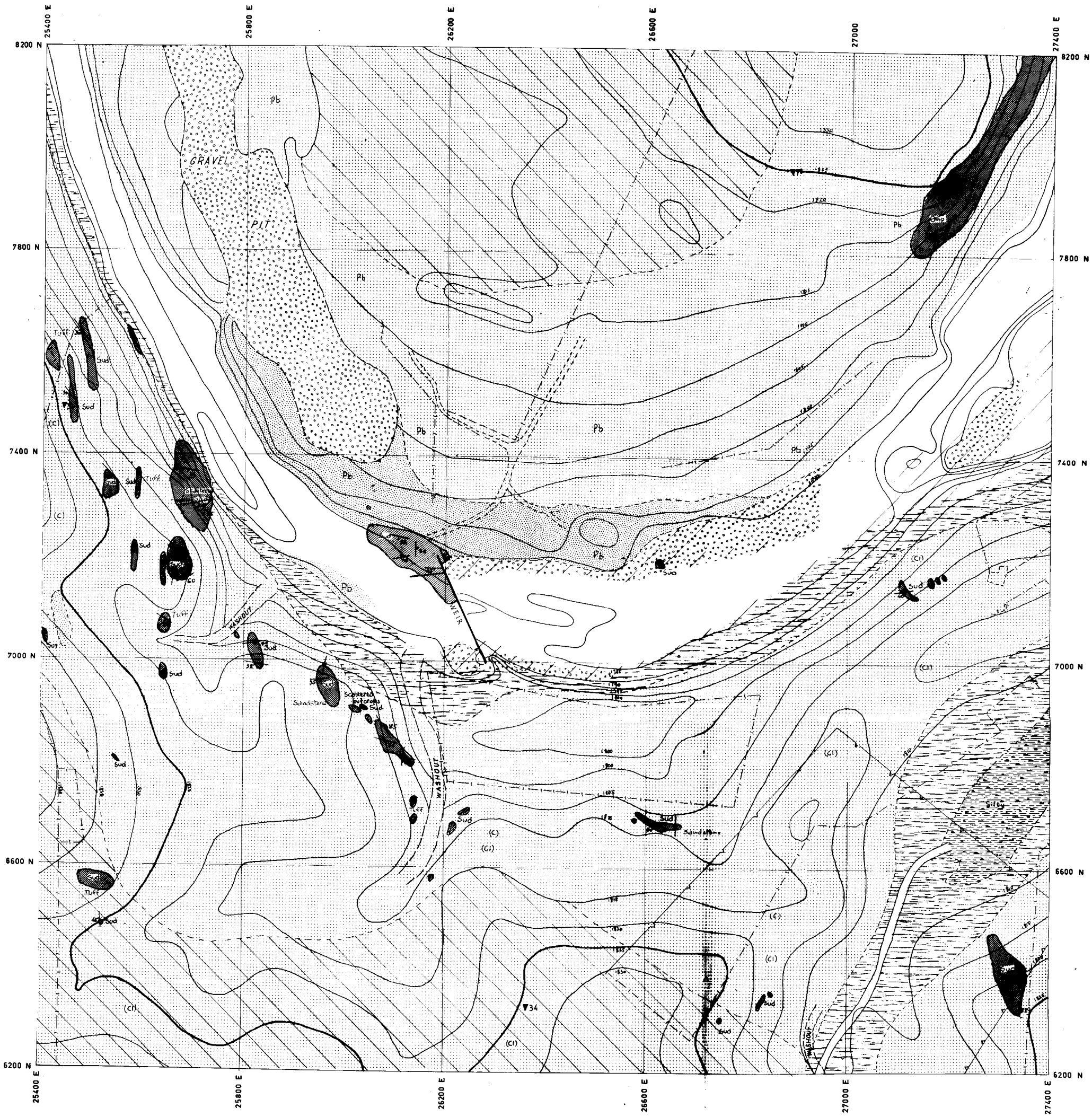
To accompany Record 1962/166

155/16/63



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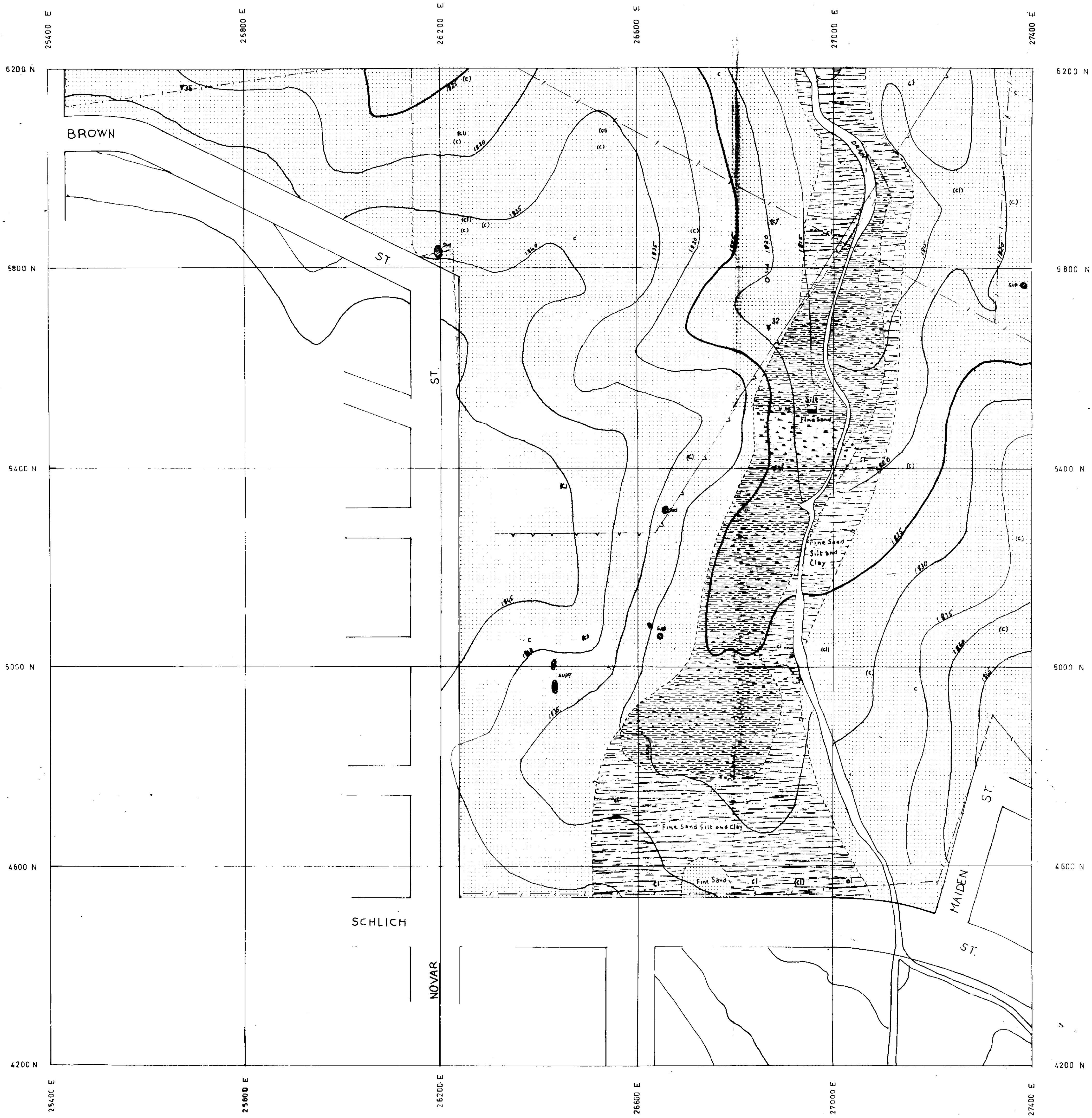
155/16/64



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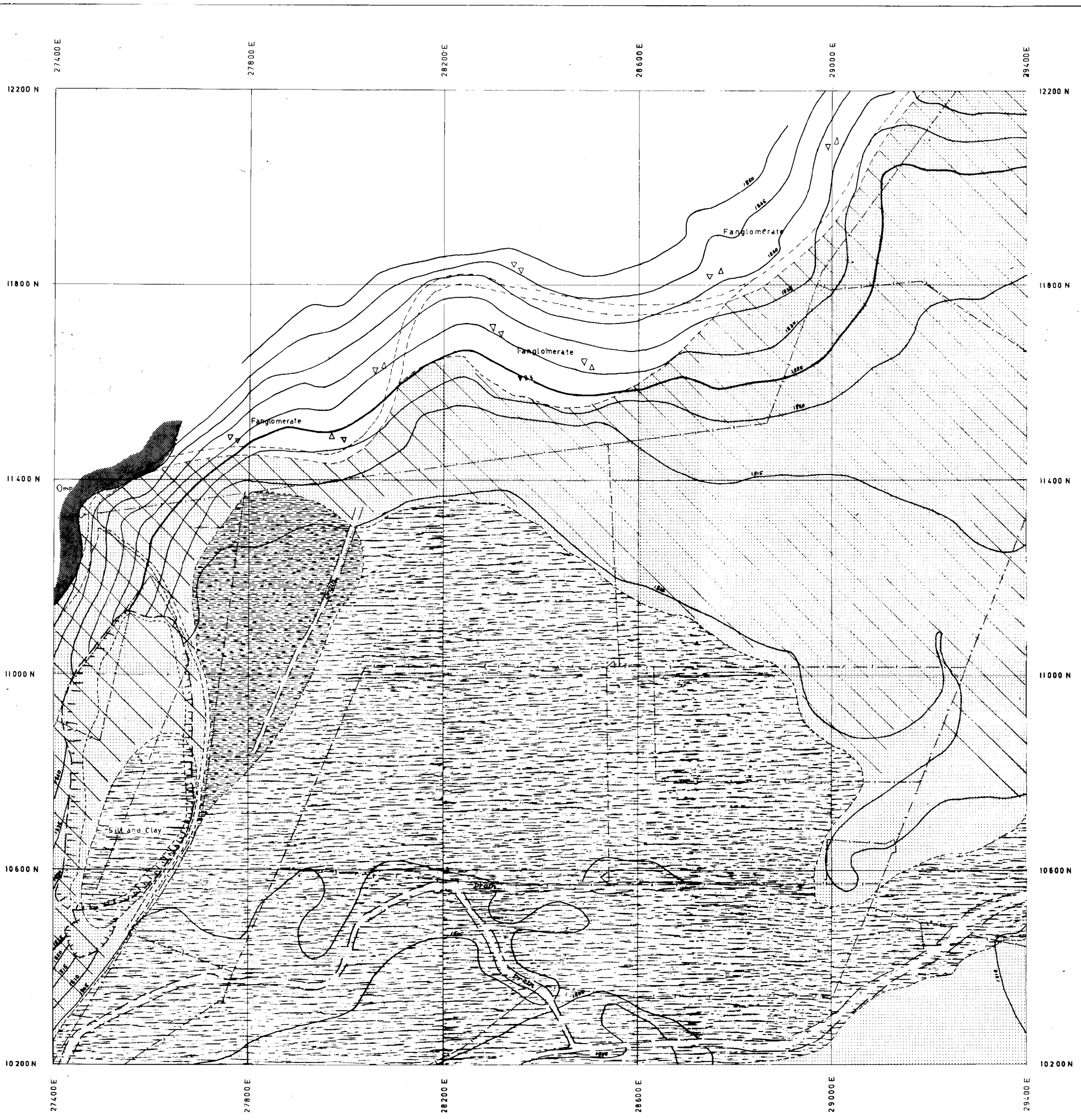
To accompany Record 1962/144

155/16/65



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To accompany Record 1962/166

155/16/66

SHEET 16

27400 E
27800 E
28200 E
28600 E
29000 E
29400 E

10200 N
9800 N
9400 N
9000 N
8600 N
8200 N

Saltwater Creek

Shallow excavation for garden loam

Fine sand silt and clay

Silicified Sandstone

Silicified Sandstone

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To accompany Record 1962/166

155/16/67

(17)

SHEET 17

27400 E 27800 E 28200 E 28600 E 29000 E 29400 E

8200 N 7800 N 7400 N 7000 N 6600 N 6200 N

Bedrock near surface

Scattered outcrops (Omp)

Water

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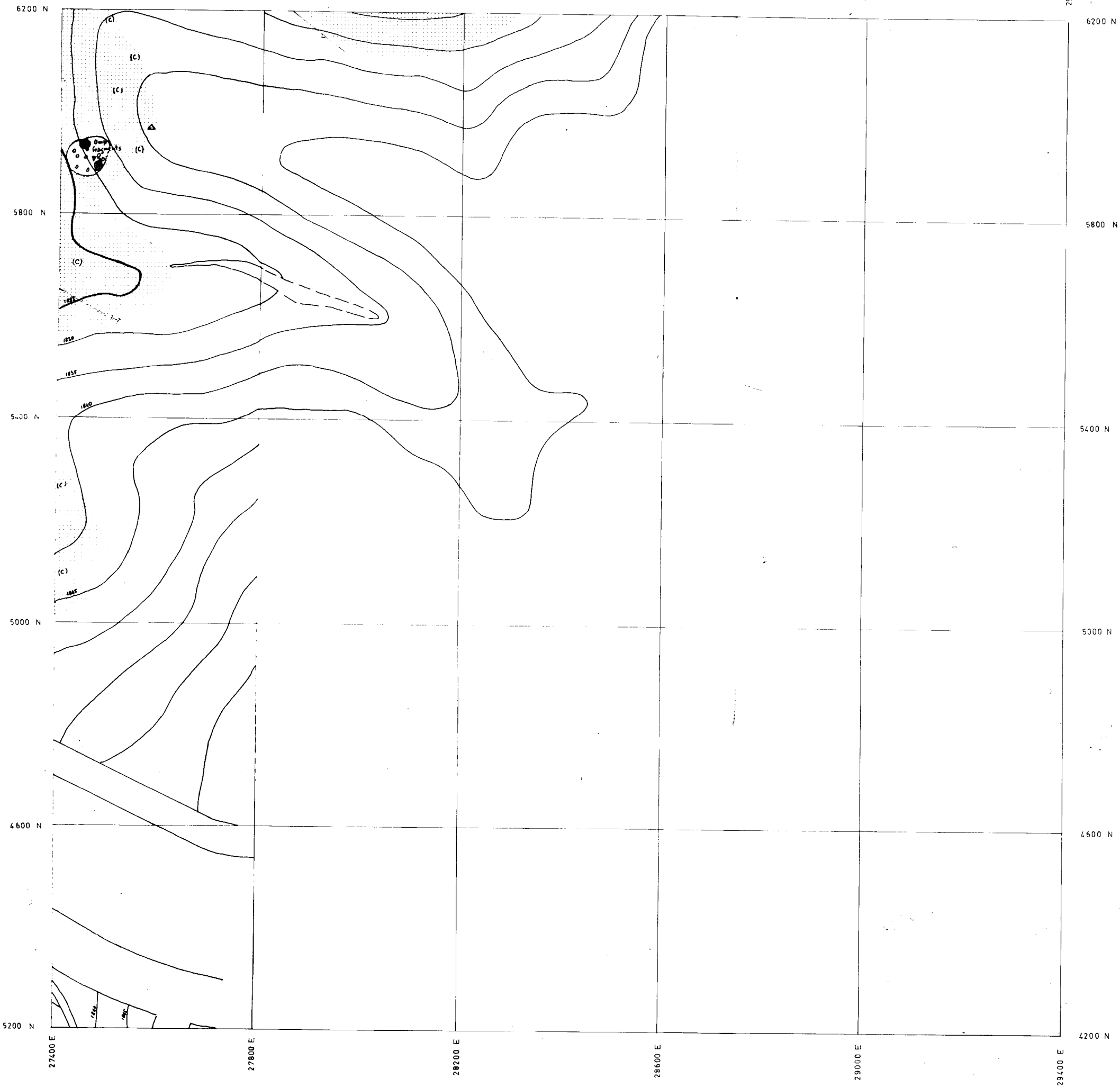
To accompany Record 1962/166

155/16/68

SHEET 18



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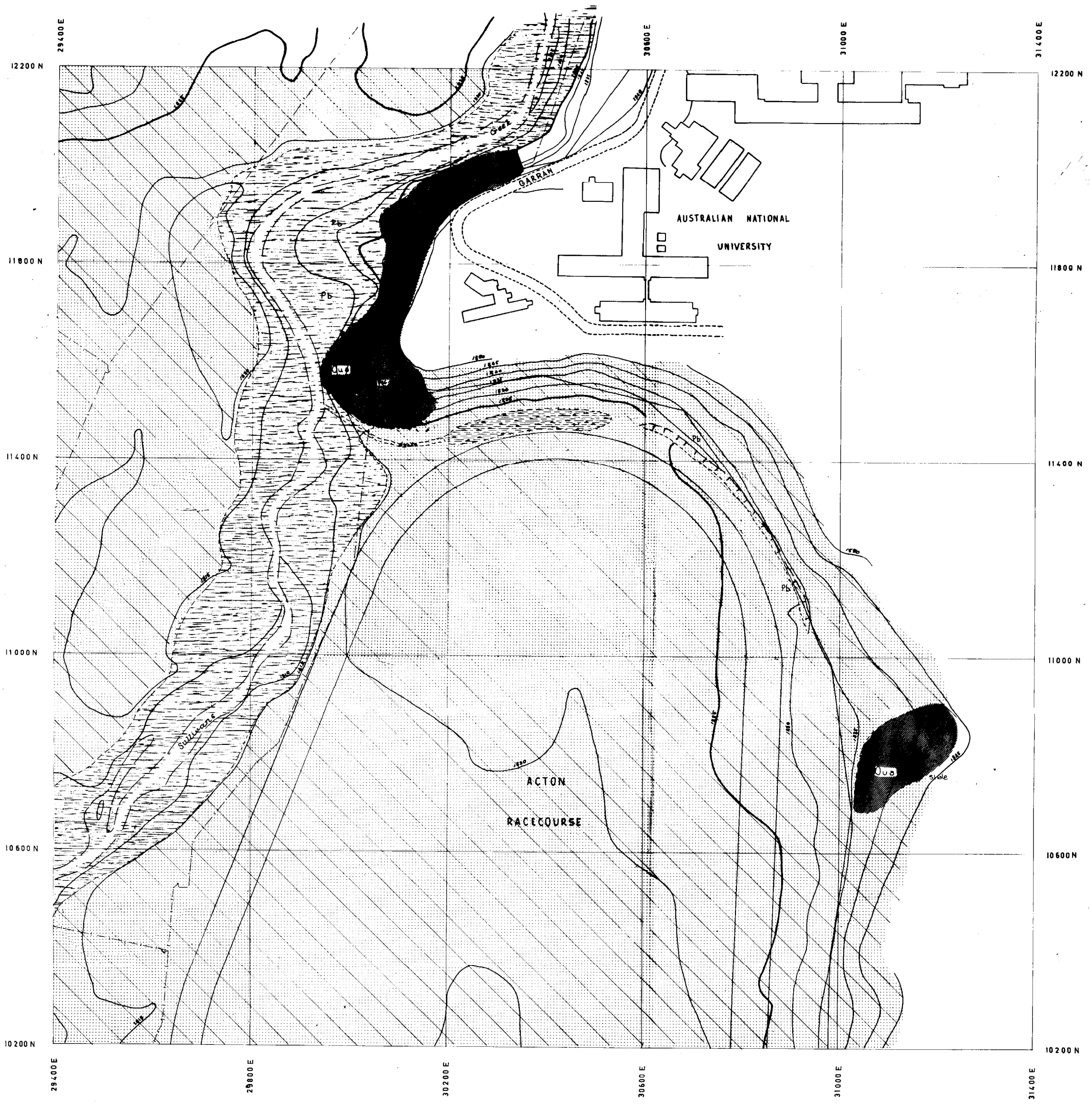
155/16/69



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To accompany Record 1962/166

155/16/70

29400 E
29800 E
30200 E
30600 E
31000 E
31400 E

10200 N
9800 N
9400 N
9000 N
8600 N
8200 N

Shallow excavation for garden loam

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To accompany Record 1962/166

155/16/71

SHEET 21

29400 E
29800 E
30200 E
30600 E
31000 E
31400 E
8200 N
7800 N
7400 N
7000 N
6600 N
6200 N

Scattered Outcrops (Slt)
Slt
Shale
Fe
Omp
Oua
Quarry
Scattered outcrops (Oua)
Silicified Shale
Rock fragments
Cl
(Cl)
C
(C)

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To accompany Record 1962/166

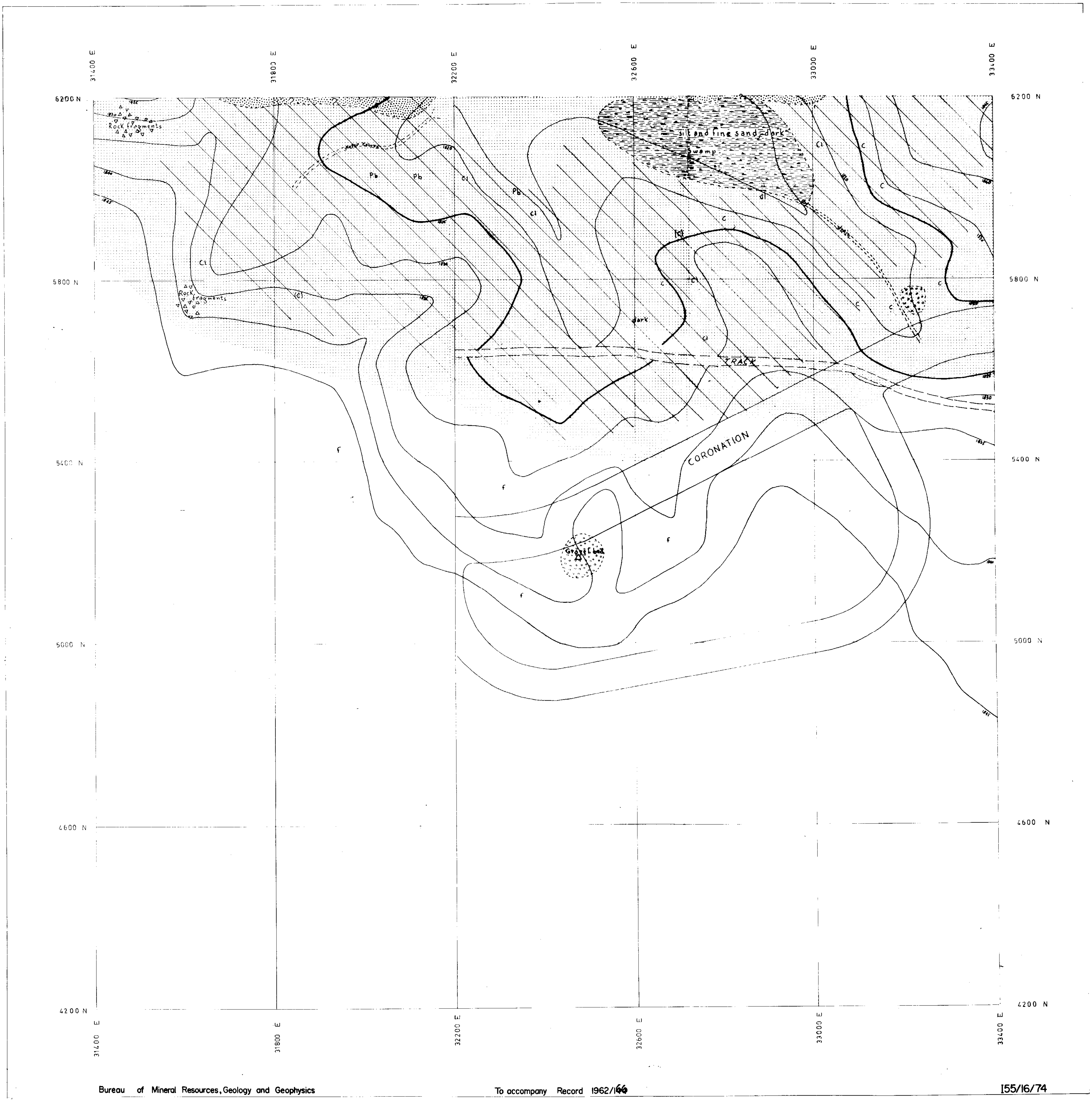
155/16/72

SHEET 22

31400 E
31800 E
32200 E
32600 E
33000 E
33400 E

8200 N
7800 N
7400 N
7000 N
6600 N
6200 N

Govt. Offices
LENNOX
Rubbish dump
Slh
Medium fine River sand and silt
dark
Medium fine sand
Medium fine sand
Pb
Pb
Pb
Cl
Cl
Cl
C
C


31400 E
31800 E
32200 E
32600 E
33000 E
33400 E
6200 N
5800 N
5400 N
5000 N
4600 N
4200 N
Rock fragments
Rock fragments
silt and fine sand-dark
Swamp
TRACK
CORONATION
dark
Pb
Cl
f

33400 E
33800 E
34200 E
34600 E
35000 E
35400 E

8200 N
7800 N
7400 N
7000 N
6600 N
6200 N

CROSSING
COMMONWEALTH
AVENUE
KING
EDWARD
TERRACE
ST.
KAYE
Golf Club House
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