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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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PRELIMINARY NOTES ON THE GEOLOGY OF THE TUGGERANONG URBAN DEVELOPMENT AREA, A.C.T.

by

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SUMMARY

The proposed Tuggeranong Urban Development Area consists of undulating country and incipiently eroded plain-land, partly surrounded by steeply rising hilly country. The bedrock - Silurian and Devonian volcanic rocks - is covered by colluvial and alluvial soil up to about 10 feet deep.

Soil and bedrock will present no unusual or particularly difficult problems in civil engineering. Much of the trenching that will be needed in the area can probably be done by mechanical excavators, with explosives needed only in small areas. Adequate foundations for building will generally be found at shallow depths. Greater depths will be needed in some areas covered by deep soil. No limestone, and hence no cavernous bedrock is known to occur in the area.

Drainage will not present particular difficulties except that the gradient of the drainage channels is rather gentle for the fairly large volumes of stormwater that will need to be removed, and the natural outlet for the northern part of the area is somewhat restricted. Local problems may be encountered in colluvium.

Stone suitable for cruching as aggregate for concrete and roads is available at several prospective quarry sites around the margins of the area. Natural sand and gravel, mainly in the Murrumbidgee River, appears to be in short supply. No economic mineralization occurs in the area.

INTRODUCTION

In response to a request from the National Capital Development Commission, preliminary notes are given here on the geology of the proposed Tuggeranong Urban Development Area. They are based on the results of reconnaissance mapping by J.R. Mendum and by D.E. Gardner, on mapping of the Weston Creek and Woden areas, and on the regional geology shown on the Canberra 1:250,000 Sheet. The geological notes are accompanied by a locality map (Plate 1), a soil map (Plate 2) and a bedrock map (Plate 3).

TOPOGRAPHY

The Tuggeranong development area includes a northern area, drained by Village Creek and Tuggeranong Creek, and a southern area, drained by two creeks that flow into the Murrumbidgee River. Both areas are of subdued relief and are in part flat-lying. The northern area forms a topographic basin, open in the south-west towards the Murrumbidgee River. Two low ridges enter it from the north and the east, and form the divides between southward flowing and westward flowing creeks. The northern part of the northern area is gently undulating; the southern part, which has the name Isabella Plains, consists of a level plain that has been shallowly dissected by the streams that cross it.

The southern area is narrower than the northern; it has the appearance of a northerly trending valley, with gently sloping sides, that drains to the north and to the south.

GENERAL GEOLOGY

BEDROCK

Lithology

The bedrock consists of Silurian and Devonian volcanic rocks, mainly welded ash-flow tuff. Outcrops are rare except in the creek channels and on the hills in and around the area. A preliminary bedrock map is given in Plate 3. The Silurian rocks are a southward extension of those that have been mapped in the Woden and Weston Creek areas. They form nearly all the northern area and the north-eastern part of the southern area. The Devonian volcanics closely resemble the Silurian in composition and in their engineering properties; they occur in a triagular area in the central-western part of the northern area, and form all but the north-eastern part of the southern area. A typical specimen of the volcanic rock consists of scattered large grains or phenocrysts of quartz about 4 mm across, commonly accompanied by feldspar grains and sparse mica grains enclosed in a matrix of smaller grains of the same minerals together with devitrified volcanic glass. In some specimens the glass is obviously fragmental, and consists of shards pressed together and partly welded. In other specimens, welding and devitrification has destroyed the outlines of the shards, and the rock resembles quartz porphyry, both in hand specimen and thin section.

Tors

Under certain conditions of topography, rock jointing, groundwater level and drainage the bedrock weathers, over a long period of time, downwards along joints to depths of many feet, leaving cores of fresh, hard rock. Such hard cores are exposed, as tors, if the decomposed rock is removed by rain and wind. Typical tors are seen in Canberra on the northern side of Limestone Avenue oposite the Ainslie-Rex Hotel. They probably occur in hilly parts of the Tuggeranong area, exposed at the surface, or covered by soil.

Faults

Known faults are shown on Plate 3; others are probably hidden by the soil that covers most of the area. They are believed to be very old faults which have not been active since the Tertiary period, at the latest. The rock on the fault zones is sheared, and closely jointed, but does not seem to have undergone much chemical alteration or decomposition. Where exposed in Tuggeranong Creek about half a mile south-west of Tuggeranong Trigonometrical Station, the bedrock is mildly sheared over a width of about 50 feet. Except in some local lenticular patches three or four feet wide, where the rock is softened by weathering, the shearing does not seem to have noticeably reduced the hardness of the rock. Similarly, where the known faults cross Tuggeranong Creek about 1000 feet north of Pine Island Road, and Village Creek about half a mile south of Kambah Road, serious deterioration of the bedrock is not apparent.

SOIL

Principal Soil Types

In both the northern and the southern areas the bedrock is nearly everywhere covered by soil. A preliminary soil map appears in Plate 2. In this report, the term soil means the unconsolidated aggregate of mineral and rock fragments that rests on the bedrock. On the basis of origin or method of emplacement of the particles three types of soil occur in the area. One type has formed in situ through decomposition of the bedrock: it grades downwards into weathered and fresh bedrock. A second type consists of the particles of decomposed bedrock commonly mingled with hard rock fragments, which have drifted down-slope to form colluvial deposits. The downslope drifting of the soil particles is most effective under the conditions of diurnal freezing and thawing which prevailed during the Pleistocene. The third soil-type consists of clay, silt, sand and pebbles, initially the products of decomposition of the bedrock, which have been carried by streams and deposited as alluvium. The greatest soil thickness is found around the margins of the area near the bottoms of the steep slopes, and in particular at the ends of gullies or valleys that lead down from the higher country. In such places layered colluvial deposits and outwash fans which range back in age into the Pleistocene, are as much as 20 feet thick. They extend, with decreasing thickness, for a considerable distance across the flat country. Alluvium occurs beneath the top soil in the plains that are traversed by the principal streams, mainly in their middle reaches. The most extensive deposits are in Isabelle Plains. Like the colluvial deposits and outwash fans, the alluvium was deposited in former geological times, probably in the Pleistocene. In the time that has elapsed since then, the constituent pebbles and grains have been subjected to weathering. Unstable rocks and minerals have decomposed, partly or completely, giving rise to clayey end products. Other products of weathering and decomposition, principally hydrated oxides of iron, and locally calcium carbonate and silica, have been deposited on and around the grains and pebbles, and have weakly cemented the alluvium and colluvium.

Organic soil

In localities that remain damp for a large part of the year, the decay products of swamp-type vegetation accumulate, together with any sedimentary material that may be deposited, to form a black soil that is rich in organic matter. Typical localities are flat valley floors traversed by streams, which receive seepage water from surrounding higher regions, and layered colluvial deposits, in which water is able to seep from a permeable bed that acts as an aquifer. Springs occur locally near the bottoms of slopes where water seeps away from the joint system in the bedrock; such seepage water may enter and emerge from colluvium, and small areas of organic soil are associated with them.

Soil profile

To the pedologist, the term soil has a more restricted meaning than it has to the engineer. It denotes the top four or five feet of alluvium, colluvium or weathered bedrock that is subject to the effects of weathering and organisms. The typical soil consists of three distinct layers or soil horizons which, together, make up the soil profile. The top layer, or A-horizon has lost some of its finer constituents, mainly clay, which have been leached out by ground-water and deposited in the middle layer, or B-horizon. The bottom layer or C-horizon consists of little-altered parent material.

Where the soil in the area has remained for a long time undisturbed by the deposition of fresh material or erosion of the existing material, and where the level of the ground water has been several feet below the surface, a mature profile has developed showing a sandy A-horizon and a B-horizon that contains a large proportion of plastic clay. Such localities occur on broad divides and plains that are not subject to deposition.

The colluvial deposits commonly show two or more buried soil profiles beneath the present-day profile. Their B-horizons, which occur at depths of the order of 5 to 10 feet below the surface, consist largely of jointed, very plastic clay.

APPLIED GEOLOGY

BEDROCK - DEFINITION AND DESCRIPTION OF TERMS

Quantitative data are not available on the properties, of the Silurian and Devonian volcanic rocks, that are of importance in engineering applications. Comments given here are based on rough qualitative tests and observations on the field. They refer to fresh rock and to rock at four progressive stages of weathering, viz., slightly, moderately, highly, and completely weathered rock. A specimen of fresh rock a few inches thick can be broken with a geological hammer only by repeated heavy blows. It is hard and tough and must have high compressive strength and rigidity.

Slightly weathered rock can be broken only by a heavy blow. It is harder and more rigid than sandstone, and, though inferior to the fresh volcanic rock, would be strong enough to support a very heavy loading. Moderately weathered rock is easily broken with a hammer and does not give the ringing sound of fresh and slightly weathered rock; however, it has, typically, the properties of a rock rather than those of a soil. It has appreciable unconfined compressive strength. It loses strength when wet, but does not swell when moistened from the dry state. It would support a moderate lodading. This is typically the foundation material in the Commonwealth Offices buildings on Block 17, Section 8, Phillip.

The highly weathered rock consists typically of tightly packed and interlocking sand-sized grains formed through physical seaparation of mineral grains that have undergone fairly advanced weathering but not complete decomposition. It is easily shattered with a hammer. When moistened the highly weathered rock loses much of its strength, through weakening of the cohesive bond between the grains. The properties are those of a soft rock or a weakly indurated slightly clayey sand. This highly weathered bedrock would be suitable as a lightly loaded foundation. Another type of the volcanic rock, which is not widely distributed, contains little granular quartz, but a higher proportion of feldspar. When highly weathered this forms a uniformly soft clayey material. Completely weathered bedrock consists, typically, of grains of quartz scattered sparingly through a matrix of silt and clay. It can be regarded as a silty, sandy clay, which swells when moistened from the dry state and has low strength when wet.

The descriptions given above refer to rock specimens. Within a rock mass serving as foundation for a structure several degrees of weathering may be present.

EXCAVATIONS

Fresh or slightly weathered bedrock can be excavated only by heavy drilling and blasting. Moderately weathered bedrock ranges in hardness and toughness from rock that needs some drilling and blasting to rock that can readily be excavated by jack hammer and by a bulldozer and ripper. Highly weathered bedrock can readily be excavated by a trenching machine.

Special dificulties may arise in trenching highly weathered bedrock where tor-like weathering has taken place. The material that is being trenched may change abruptly from a soil that is easily excavated to a residual mass of fresh bedrock that persists for several feet along the trench line.

FOUNDATIONS

The properties of fresh and of weathered bedrock as foundation material are mentioned above under Bedrock. Fresh and slightly weathered bedrock would provide exceedingly strong foundations; shaping of the foundation or footing by excavating would be costly. Moderately weathered bedrock would provide foundations that are satisfactory for large buildings; it can be excavated by bulldozer and ripper and by jack hammer, with local drilling and blasting.

Highly weathered bedrock would provide suitable foundations for small buildings. The soil that represents completely weathered bedrock is essentially a sandy and silty clay, subject to changes of volume with changing moisture content, and to some settlement under moderate loading.

Transported soil tends to occur as alternating layers with various proportions of clay, silt, sand, and gravel, which may change abruptly both laterally and vertically. If a structure is to be founded on alluvium, drilling and sampling should be done to determine its composition to some depth below the level of the footings. This is to ensure that the load is not ultimately taken by a deeper layer that would be subject to unacceptable settlement.

As noted under "Geology", the colluvium and alluvium in the Tuggeranong area are now more clayey than they were when they were deposited, because of in situ weathering and decomposition of unstable rock and mineral fragments.

In localities where a soil profile has developed, as discussed under General Geology, a clay-depleted A-horizon overlies a clay-enriched B-horizon, with problems of low shear strength and of changes of volume with changing moisture content.

Where tor-like weathering is prevalent, special methods need to be employed to ensure that an apparently solid mass of hard rock is not a core of fresh rock completely surrounded by decomposed rock.

ROADWAYS

Throughout the greater part of the area, the roads will be constructed on unconsolidated colluvium and alluvium. The roadbed will be formed of subsoil, from which, probably, the topsoil, has been stripped. In small areas, mainly in the north, the roadbed will consist of weathered bedrock, and perhaps very short lengths of fresh bedrock. Moderately weathered bedrock, and, given satisfactory drainage, even highly weathered bedrock will support heavy to moderate loadings. Well-drained alluvium and colluvium, provided that they are not exceptionally clayey, will support light to moderate loadings. The poorest sub-grade material will occur where the roadbed consists of clayey soil and of highly organic soil. Clayey soil occurs in completely weathered bedrock, in clayey layers or lenticular layers in alluvium and colluvium, and in the B-horizon where a soil profile has developed. Areas on which organic soil has formed will probably be indicated by signs of dampness, such as swamp-type of vegetation.

Where a clayey sub-grade occurs it will probably be necessary to provide a sub-base; locally it might be economical to excavate to highly weathered bedrock.

Organic soil has a ready market as top dressing for lawns and gardens.

STABILITY OF SLOPES

The volcanic rock in the area is massive; bedding planes, which might be potential planes of weakness do not occur. Joints and faults, some of which are clay-lined, form possible slip surfaces, and in steep slopes, particularly in weathered bedrock, their orientations should be examined.

Wet completely weathered bedrock is unstable on a steep or vertical face, such as the wall of a trench. The alluvial and colluvial deposits are weakly cemented, and vertical faces in erosion gullies and along creeks appear to be stable. It is not known whether the weak cementation of the alluvium and colluvium is present throughout the area.

GROUNDWATER AND DRAINAGE

The northern part of the northern area and all of the southern area are probably amenable to effective drainage by ordinary methods. Local drainage problems, with pressure water in places, will probably be encountered in colluvium, at the base of the hills, as development proceeds. The magnitude of the problems should generally not be greater than in the Canberra and Woden Districts. Isabella Plains, in the southern part of the northern area, is very flat-lying, and liable to be boggy in wet weather under conditions of natural drainage. Since the area is enclosed by higher ground on all sides except the west, it probably receives seepage water throughout the greater part of the year. As a result the groundwater level is probably as a fairly shallow depth.

Drainage of the Isabella Plains region might be facilitated by the provision of a new outlet to the Murrumbidgee River from the vicinity of the sharp bend in Tuggeranong Creek, south of Tuggeranong Trigonometrical Station. A tunnel or a deep open drain could be excavated below or through the low divide that carries Pine Island Road. If this supplementary drainage were provided, it would reduce the volume of flood water in the lower reaches of Tuggeranong Creek.

MATERIALS

No search has been made for materials in the proposed Tuggeranong urban development area. The following notes, based on the known geology, indicate what resources in materials of construction and economic mineral deposits can reasonably be expected.

ROADMAKING MATERIALS

Base Course. The most acidic of the Silurian and Devonian volcanic rocks where moderately weathered, yield a material that is fairly hard, but chips and breaks when rolled to make a reasonably graded fairly satisfactorily bonded base course. Excessive weathering yields too high a proportion of clayey matter and results in unacceptable plasticity. Where the moderately weathered rock is closely jointed, it can be excavated by bulldozer and ripper, assisted by local drilling and blasting. This type of material was won at several localities between Kambah Road and the road to Tuggeranong Siding when the Monaro Highway was being reconstructed some years ago. Probably other localities could be found in the hilly country that surrounds the Tuggeranong urban development area.

An alternative material that might occur in sufficient quantities to be worth while exploiting is gravel in the Murrumbidgee River. The quantities that might be won are not known. Southwards from Tharwa ancient gravel beds occur at a considerable height above the river. Probably they are too weathered and clayey to be of use in roadmaking.

An aditional prospective source of base course material that might become available in limited quantities would be the weathered rock that would be removed as overburden from any crushed rock quarry that is opened in or near the area.

Surface Course. For the surface course of roadways, crushed stone would be available from crushing platns at quarries in the south of Canberra, or from quarries that might be established on the Tuggeranong area. The common type of volcanic rocks, acidic ash flow welded tuff, is hard and tough and substantially free from sulphide minerals; it should provide an excellent aggregate for concrete and for the surface course of roads. Quarry sites should be found without much difficulty on the hills around the area.

CONCRETE AGGREGATE

The main source of concrete aggregate would be crushed rock. The rock that is available and the location of quarry sites are mentioned above under Surface Course (for roads). Any prospective quarry site should be tested by submitting diamond drill core from the site to the standard tests for aggregate. Since the volcanic rock contains devitrified volcanic glass, a test for expansive reaction with cement is regarded as of great importance.

A supplementary source of aggregate might be found in gravel deposits in the Murrumbidgee River. The high level gravels mentioned as a possible source of aggregate for the base course for roads would not be suitable for concrete.

SAND AND GRAVEL

Prospective Sources

Fresh, hard sand and gravel occurs in Recent deposits along the rivers and streams. The aparently extensive deposits of older alluvium that surround the middle reaches of Tuggeranong Creek, and which occur in remnants of Murrumbidgee River terraces south of Tharwa have weathered in situ and are probably too clayey, for most construction purposes.

Sand. Sand would be needed in large quantities as fine aggregate for concrete. It has been won for several years from the Murrumbidgee River a short distance downstream from Tharwa, and from a deposit near Point Hut Crossing.

Recently work was suspended on the deposits near Tharwa, while waiting for replenishment that might come with the river in high flow.

The deposit near Point Hut is small and depends on annual replenishment. Resources of nearby sections of the river are not known. Fairly large deposits are thought to occur a short distance upstream from Tharwa, and probable large resources occur in a river flat at Jews Bend, 2½ miles west of the northern end of the northern area.

Small deposits probably occur in Tuggeranong and Village Creeks. The available sand will probably be in demand for bedding sand for pipes in trenches. It might be preferable if decomposed granite were used for this purpose. Borrow pits could be established at various localities in granite terrain a short distance west of the Murrumbidgee River, and probably in the similar country at the eastern edge of the southern part of the southern area.

Gravel. The sources of gravel in the river are substantially the same as those of sand. Quantities available are not known. The largest resources are thought to occur a short distance upstream from Tharwa, and in a river flat 2½ miles west of the northern end of the northern area.

GARDEN LOAM

The possible occurrence of organic soil suitable for use as garden loam is mentioned under General Geology. Organic soil will probably be found on some of the narrow flats along water courses, in colluvial deposits near the bottoms of steep slopes, and in poorly drained areas of flat country, such as Isabella Plains.

ECONOMIC MINERALIZATION

No occurrences of metallic minerals, economic or otherwise, have been recorded from the area. No gossanous outcrops or mineralized quartz veins are known. It seems very unlikely that any economic mineral deposit will be found within the area.

REFERENCES

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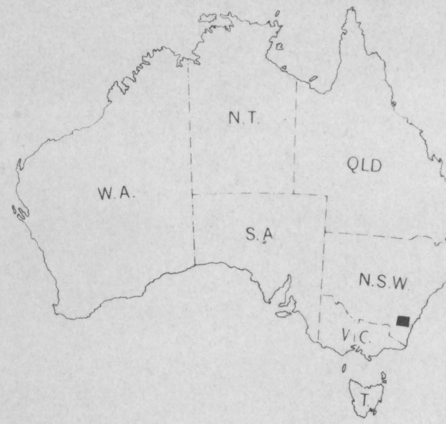
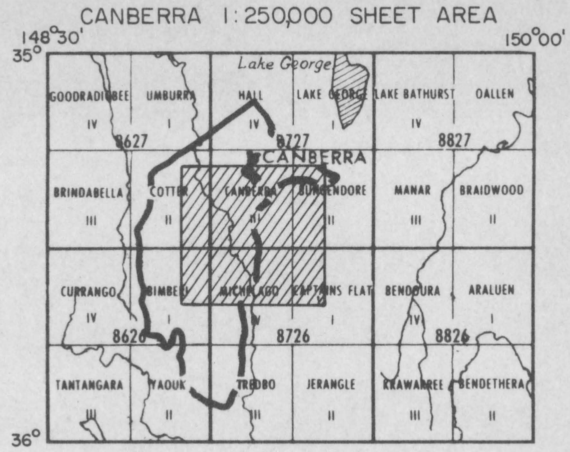
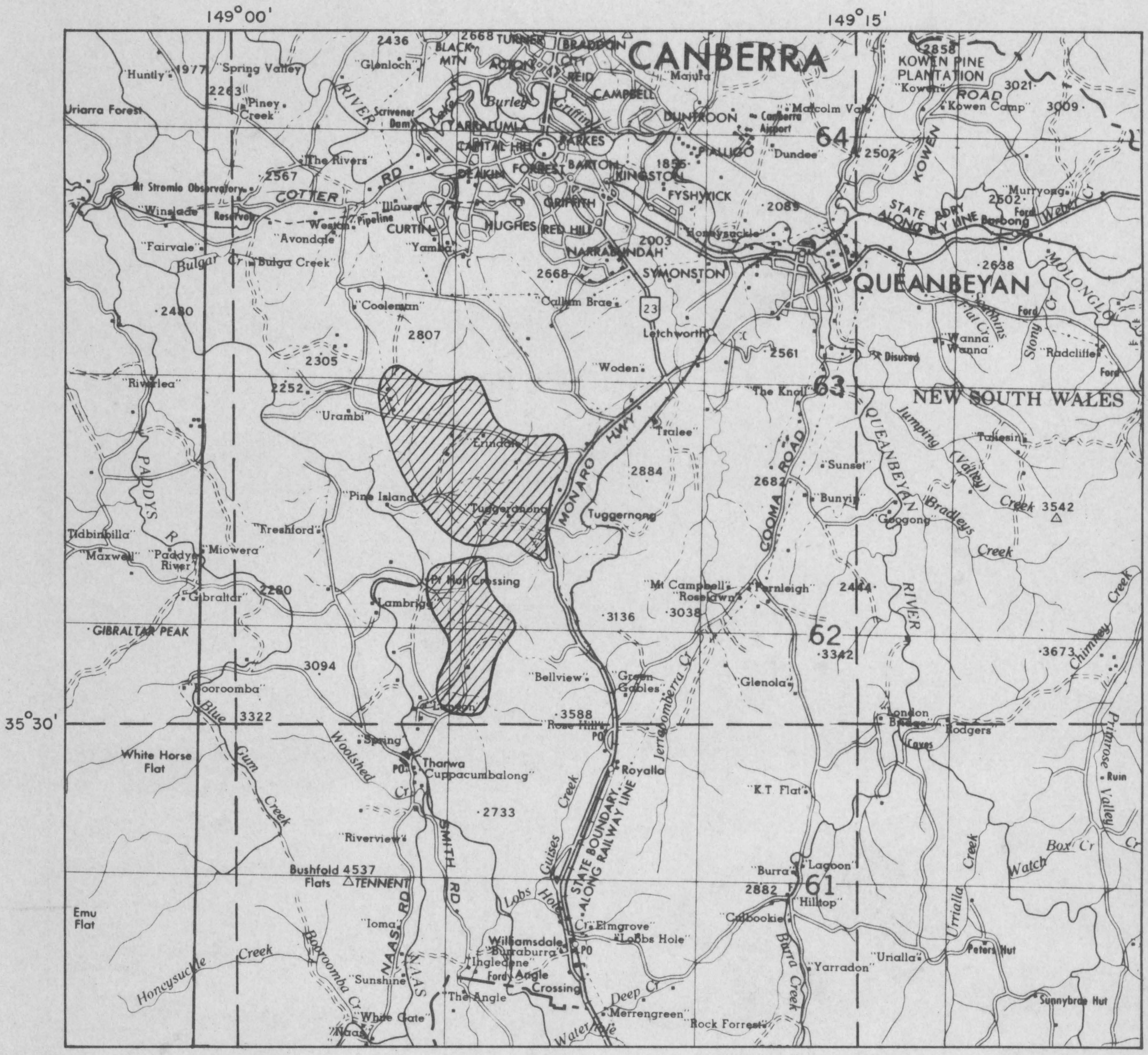
WILSON, C., and NEWSTEAD, P., 1967 - Geology of the Weston Creek area, Australian Capital Territory. Bur. Miner. Resour. Aust. Rep. 1967/102 (unpubl.)

LOCALITY MAP



CANBERRA 1:250,000 SHEET AREA





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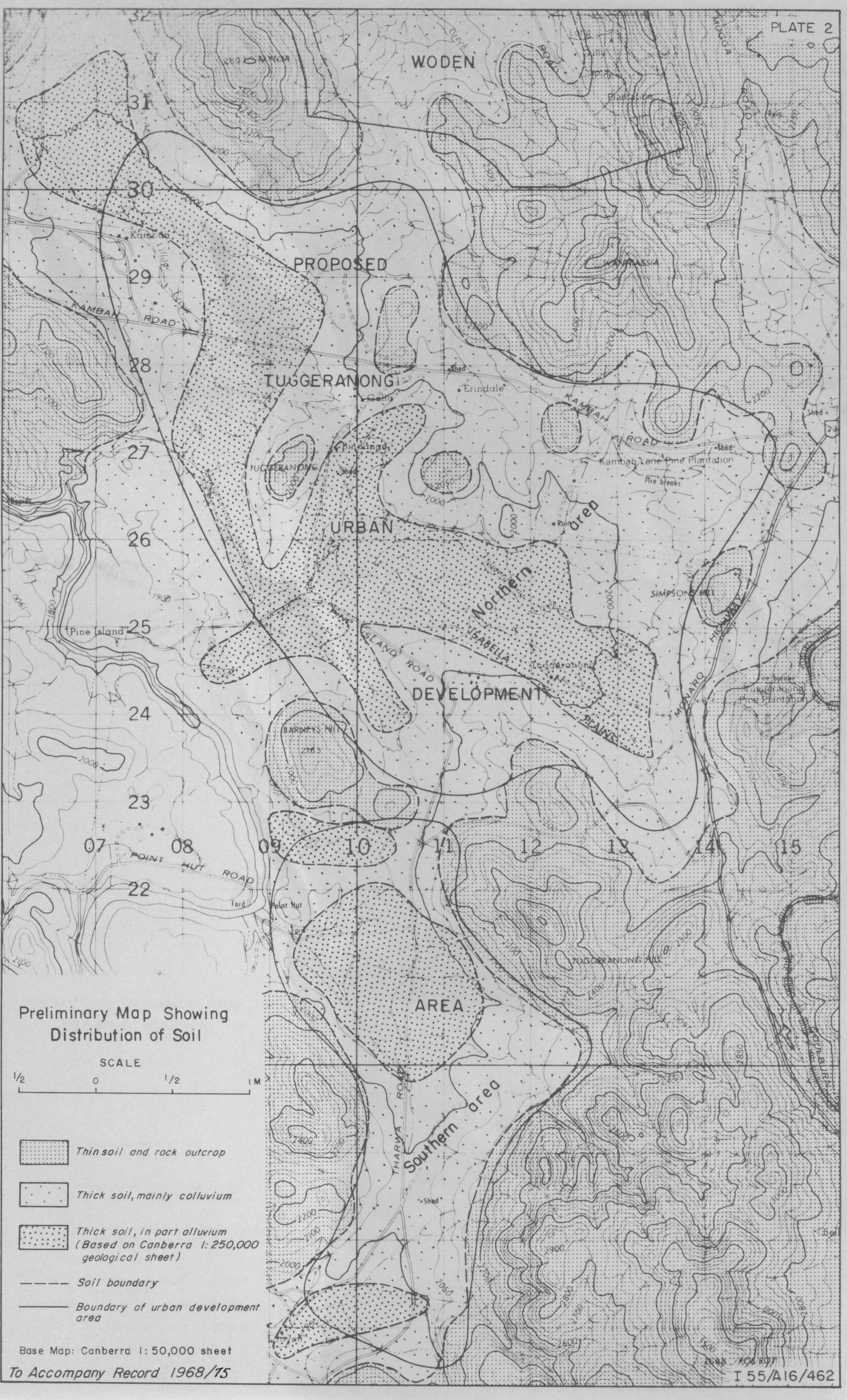
Proposed Tuggeranong urban development area

PLATE 2



Preliminary Map Showing Distribution of Soil

To Accompany Record 1968/75

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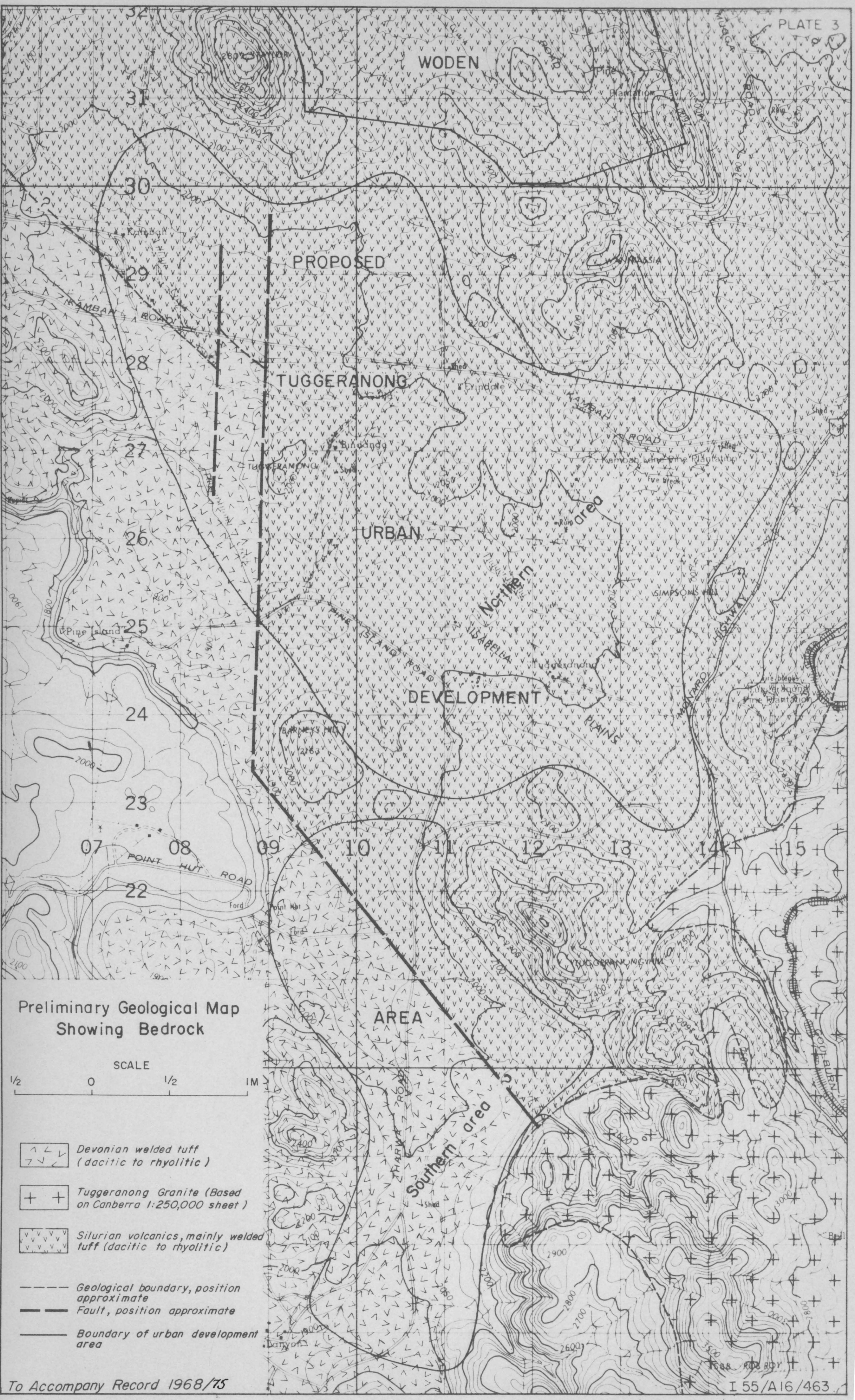
PLATE 3
WODEN
PROPOSED
TUGGERANONG
URBAN
DEVELOPMENT
AREA
Northern area
Southern area
KAMBAH ROAD
PINE ISLAND ROAD
POINT HUT ROAD
ISABELLA PLAINS
MONARO HIGHWAY
MUGGA ROAD
SIMPSONS HILL
TUGGERANONG HILL
BARNEYS HILL
Pine Island
Point Hut
Ford
Shed
Tuggeranong
Preliminary Geological Map
Showing Bedrock
SCALE
1/2 0 1/2 1M
Devonian welded tuff (dacitic to rhyolitic)
Tuggeranong Granite (Based on Canberra 1:250,000 sheet)
Silurian volcanics, mainly welded tuff (dacitic to rhyolitic)
Geological boundary, position approximate
Fault, position approximate
Boundary of urban development area
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