PINJARRA

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

URBAN GEOLOGY OF THE PINJARRA SHEET

The aim of this Urban Geology Series is to provide information to all those concerned with aspects of raw material and water supply, rural, urban, industrial or transport development. The intention is to point out geological factors which may affect planning on a broad rather than a specific basis. Detailed site investigations will still be required, but it is hoped that this information will provide a useful framework for such further work.

The area covered by the Pinjarra Sheet is mainly rural; stock grazing and dairy farming are the dominant activities. The only major industrial complex in the area is the Alcoa alumina refinery northeast of Pinjarra. Dairy products are processed at a factory west of Coolup, and there is a small brickworks immediately west of Pinjarra. The main urban zone is Pinjarra and North Pinjarra, situated at the centre of the sheet. Minor settlements are established at North Dandalup, Yunderup, Coolup, and the Fairbridge Farm School. An undeveloped part of the Mandurah townsite extends onto the northwest corner of the sheet. The total land surface of the sheet area is 625 km^2 and inland waters occupy a further 16 km^2. About 85 per cent of the land to the west of the Darling Scarp (see physiographic diagram) is cleared whereas the scarp and the Darling Plateau are largely uncleared.

The geology of the Pinjarra Sheet area west of the Darling Scarp was remapped in 1976 by R.H. Archer and E.R. Biggs of the Geological Survey of Western Australia. Extensive field traverses were carried out on a base-map scale of 1:25 000; 1973 aerial photography was used for minor extrapolation. The geology of the Darling Scarp and Plateau is based, with minor modification, on mapping carried out in 1974-5 by S.A. Wilde and K.–J.B. Hirschberg, also of the Survey. Additional data were supplied by the relevant sections of the Geological Survey.

STRATIGRAPHY AND PHYSIOGRAPHY

Holocene, Pleistocene, and ?Tertiary sediments and sedimentary rocks crop out on the Pinjarra Sheet west of the Darling Scarp and Triassic, Jurassic and Cretaceous sediments have been intersected in deep boreholes within the area. Crystalline rocks of Archaean age, extensively capped by laterite, crop out on and east of the Darling Scarp.

PRECAMBRIAN

Archaean

A variety of granitic, gneissic and migmatitic Archaean rocks, commonly intruded by dolerite dykes and quartz veins, forms the Darling Plateau and its eroded western edge, the Darling Scarp. The plateau is an uplifted, dissected peneplain having an elevation of about 300m.

Six types of granitic rocks have been identified on the Pinjarra Sheet. The **even-grained granitic rocks** are mesocratic, fine to coarse-grained, and range in composition from granodiorite to granite, adamellite being the commonest variety. On a regional basis the rocks are moderately homogeneous. They consist of andesine/oligoclase, microcline, quartz and biotite with locally developed hornblende.

The **porphyritic granite** contains megacrysts of microcline microperthite (average length 20 mm) in a groundmass of microcline, quartz and biotite with local hornblende. The megacrysts are commonly aligned.

Fine to medium-grained granitic rocks containing scattered megacrysts of potash feldspar occur between areas of even-grained and porphyritic granitic rocks, and have features transitional between these two rock types. They are mesocratic, range in composition from adamellite to granite and are texturally similar to the even-grained granites apart from the presence of scattered, ragged megacrysts of microcline with numerous inclusions of plagioclase.

An 11 km-long zone of **porphyritic granite gneiss** extends from near the Pinjarra alumina refinery to east of Coolup. The rock is a coarse-grained quartz-microcline-oligoclase-biotite gneiss with tabular megacrysts of microcline; it is similar in appearance to porphyritic granite but is invariably strongly foliated and contains narrow zones of more deformed gneiss. The granite gneiss resulted from tectonic deformation of porphyritic granite from which it is separated by a mylonitized shear zone.

To the north and south of the porphyritic granite gneiss, patches of **mixed gneissic rocks** crop out. These rocks are predominantly well-banded gneisses of granitic composition, but include other rock types, notably amphibolite.

Migmatite consists of well-banded, or more homogeneous, biotite-streaked gneisses containing diffuse areas of granite. The foliation trend is similar to that in the adjacent gneisses.

Lineations shown on the map indicate predominant foliation trends.

Undifferentiated

Quartz dolerite dykes of Archaean, or possibly Proterozoic age, intrude all Archaean rocks which crop out in the sheet area. The dykes vary in thickness, averaging 10 m. They are melanocratic, consisting, when fresh, of augite, hornblende, plagioclase and minor quartz, although most dykes are extensively altered and/or sheared.

Numerous **quartz veins** crop out on the Pinjarra Sheet, but these have only been shown on the map where they are abundant and have a consistent trend. The veins often mark the junction between rock types and some are mylonitized.

Minor granitic dykes, pegmatite and aplite veins commonly intrude the Achaean rocks.

CAINOZOIC

?Tertiary - Quaternary

The most extensive unit is **laterite** which forms a widespread capping on the granitic and gneissic rocks of the Darling Plateau and on some Quaternary sediments along the foot of the Darling Scarp. The surface is flat to gently undulating and is moderately dissected on the plateau. The laterite is chiefly massive and cemented, and either pisolitic or vesicular. It averages 4 to 5 m in thickness.

Small deposits of unsorted **conglomerate** occur near the foot [illegible]

The associated sands [illegible] limestone, and a[illegible] grains. Some pat[illegible] pinnacles of lim[illegible] frosted, subangu[illegible] white through b[illegible]

Holocene [illegible] Zone and in val[illegible] debris of Archae[illegible] pebbly sand on [illegible] west of the scar[illegible] (which does not [illegible]

Lagoonal [illegible] of Peel Inlet, wh[illegible] phire flats, or sandy beaches. The deposits include several lithologies. Older beaches contain white subangular and grey subrounded quartz sand composed of frosted, medium to coarse grains. Younger beaches comprise grey, brown and black humic sandy clay, silt and clayey sand, often with a saline crust. Close to the present waterline are black and brown foetid mud and clay intercalated with silt and clayey sand. A sub-unit composed entirely of reworked Bassendean Sand pushed up into low parallel ridges has been identified around and south of Yunderup.

Swamp deposits occupy the floors and margins of present or recent shallow lakes and in many cases are still forming. All the sediments contain a moderate to high percentage of peat, imparting a dark grey to black tone to the matrix which is fine-grained sand or silt. Grey, clayey, diatomaceous earth containing appreciable organic matter, occurs in some swamp deposits.

Alluvium occurs along the major rivers and their tributaries. Predominant lithologies are grey and brown silt and clayey sand, with minor black, peaty, sandy clay and shingle composed of laterite and Archaean rock fragments.

STRUCTURE

The Pinjarra Sheet area is divided into two distinct structural regions by the Darling Fault, which separates the Phanerozoic rocks of the Perth Basin from the Precambrian crystalline rocks of the Darling Scarp and Plateau. The fault has an estimated maximum displacement of 15 km and is believed to have followed the line of an Archaean shear zone. The period of greatest movement along the fault was during the Upper Triassic and Lower Cretaceous. The fault is obscured by sediments of the Perth Basin and owing to erosion lies 1 to 2 km west of the present scarp.

To the west of the Darling Fault, the exposed Pleistocene and Holocene sediments form a veneer on 10 km of sedimentary rocks which fill this section of the Perth Basin. The Quaternary sediments are largely unconsolidated or weakly lithified and have been subjected to only minor warping or tilting, probably as a result of compaction. They are horizontal or dip at low angles to the west.

The only structural features of note in the Pleistocene and Holocene sediments are the lineations (predominantly north-northwest trending) which are marked by chains of swamps and depressions in the Bassendean Sand. From seismic and drilling data, faults are known to cut the Precambrian basement, and to affect the overlying Palaeozoic and Mesozoic rocks. It is possible that the lineations are the surface expression of some of these faults, although there is no direct evidence of such a relationship.

To the east of the Darling Fault, the Archaean crystalline rocks are structurally much more complex as a result of extensive regional metamorphism. Foliation trends in the granitic rocks are generally northeasterly to easterly, whereas those in the gneissic rocks are subparallel to the trend of the Darling Fault. The lineations shown in the gneissic rocks on the southeastern part of the sheet are equated with foliation trends. Increased deformation of the gneissic rocks is apparent close to the fault and extensive shear zones and mylonitization are prominent.

ECONOMIC GEOLOGY

BAUXITE

Bauxitic laterite occurs extensively over the granitic rocks of the Darling Plateau and is mined by Alcoa of Australia Pty Ltd at sites to the east of the sheet area. It is possible that some laterite outcrops along the eastern margin of the sheet contain bauxite.

CLAY

Clay for brickmaking has been obtained from the Guildford Formation at the Pinjarra Brickworks. It is likely that this formation contains other lenses of clay, suitable for brickmaking and, possibly, for the manufacture of roofing tiles and vitrified clay pipes. The Guildford Formation outcrops close to the Murray River south-southeast of Pinjarra townsite appear to have the best potential.

Alluvial terraces along the Murray River are prospective for garden loam and possibly, for natural moulding sands.

Pockets of kaolinized granitic rock are likely to occur at the head of drainage lines on the Darling Plateau. A deposit of kaolinized conglomerate north of the Fairbridge Farm School is worked as a source of brick clay.

CRUSHED ROCK AND BUILDING STONE

Abundant resources of granitic rock and dolerite suitable for crushing for use as aggregate, for rock fill, or for building stone, occur along the Darling Scarp. The quartz reefs on the scarp may be suitable sources of crushed quartz for use in exposed aggregate panels, landscaping, and other uses.

The Tamala Limestone which crops out in the northwest of the sheet may be suitable for use as a building stone or in breakwater construction.

DIATOMITE

The lakes and swamps in the western part of the sheet are prospective for diatomite, although no individual deposit has yet been examined in detail and the only diatomaceous material known to occur [illegible]

[illegible] low flows of fresh water in the summer.

Groundwater is drawn from boreholes to supply domestic and pastoral needs; some is obtained at shallow depths from unconfined Quaternary aquifers and the remainder from deeper, confined pressure-aquifers of Mesozoic age.

A more detailed survey of the hydrogeology of specific areas will be required as development progresses.

Unconfined (water table) aquifers

The unconfined aquifers occur in the superficial formations which rest unconformably on the Warnbro Group and directly on the early Jurassic and Precambrian rocks in the east. In the northwest corner of the Pinjarra Sheet the superficial formations rest unconformably on ?Late Tertiary Rockingham Sand, which in turn rests unconformably on the Warnbro Group.

The Quaternary sediments contain groundwater of varying salinity (often not potable) and usually in small supply.

A deep sub-surface channel extends from the north into the extreme northwest of the sheet area and has been filled with moderately sorted, coarse-grained, subangular quartz sand (Rockingham Sand). It extends to a depth of about 65 m below sea level. The unconfined groundwater occurring within this channel is brackish to saline and is not suitable for domestic or household use.

Depth to the water table varies considerably depending on elevation and location. In some low-lying areas the water table is seasonally exposed at the surface, forming lakes and swamps.

Most of the recharge to the superficial aquifers is by direct infiltration of rain but some may be attributed to upward leakage from the deeper, confined aquifers.

In this area the Quaternary superficial aquifers are not considered a significant water source for town supply or industrial use.

Confined (pressure water) aquifers

The most prospective aquifers in the Pinjarra area are of Mesozoic age and can be separated into three major groups: (a) the upper part of the Leederville Formation, (b) the middle and lower parts of the Leederville Formation, and (c) the South Perth Shale (Gage Sandstone Member) and the Cockleshell Gully Formation. Minor aquifers are contained in probable Cockleshell Gully Formation sediments occurring in a fault-bounded block east of Pinjarra

(a) The upper part of the Leederville Formation is a sequence of shales, siltstones and sandstones of marine or near-shore origin, having a maximum thickness of about 80 m. The aquifers are high-yielding, but the salinity of the goundwater is variable, and generally greater then 1 000 mg/l TDS. The potentiometric head is a little above sea level, but it declines westward (see map of groundwater salinities and potentiometric surfaces, below).

Recharge to the aquifers is mostly by downward percolation of rain, but may also be from beneath, especially in areas where the channel containing Rockingham Sand cuts the green clay barrier shown on the accompanying diagrammatic section.

(b) Below the green clay horizon, the middle and lower parts of the Leederville Formation consist of an inter-bedded sequence of sandstone, siltstone and shale, and are often glauconitic. Pebble beds may occur at the top. The succession is predominantly marine, but contains some littoral and non-marine intercalations.

The middle part of the Leederville Formation consists predominantly of thin beds of sand, calcareous sand and silt, the topmost section (about 30 m) of which contains groundwater of 400 to 1 000 mg/l TDS. Salinity increases with depth so that in the lower part of the Leederville Formation, a sequence of thinly bedded silts and sands, contains groundwater of salinity greater than 1 000 mg/l TDS. The salinity also increases to the west.

Recharge to the aquifers takes place east of the green clay subcrop where the beds are slightly turned up and truncated, facilitating recharge. There may be some movement of water upwards from the Cockleshell Gully Formation aquifers where the potentiometric head is higher than in the Leederville Formation.

(c) The South Perth Shale and Cockleshell Gully Formation aquifers both contain pressure water confined by the overlying Leederville Formation and have potentiometric heads which decline to the west.

The intake area is east of Pinjarra, where the potentiometric surface in the Cockleshell Gully aquifers is 27 m above sea level and 8 to 13 m lower than the water table. At the intake area, the salinity of the groundwater is about 200 mg/l TDS, but it increases rapidly with increasing distance from the recharge area, so that just west of Pinjarra it has salinity greater than 3 000 mg/l TDS. Large supplies of domestic-quality water (under 500 mg/l TDS) have been proven in the recharge area.

West of Pinjarra, the groundwater from these aquifers is brackish to saline, containing more than 2 000 mg/l TDS, and it generally increases with depth and towards the west. Large quantities of industrial-quality water can be obtained from the thick coarse-grained sandy beds of these aquifers.

The sediments of the eastern fault block are probably a very shaley part of the Cockleshell Gully Formation in which no aquifers of appreciable extent have been found. The western boundary of the fault block acts as a hydraulic barrier. Water movement within the block is probably very slow and only small supplies are available from the limited aquifers. The salinity of the groundwater is in excess of 2 400 mg/l TDS.

Development

Development of the local shallow groundwater resources to supply domestic requirements cannot be recommended because of the marginal quality and small supply.

The most important aquifer is in the middle part of the Leederville Formation, immediately below the green clay horizon. Yields of between 1 500 m^3/d and 2 000 m^3/d can be expected.

The Cockleshell Gully Formation, immediately west of the eastern fault block, also includes important aquifers. Large quantities of pressure water are available with salinity less than 500 mg/l TDS. However, salinity increases to more than 2 000 mg/l TDS west of Pinjarra.

ENGINEERING GEOLOGY

It is stressed that this section is a generalized summary and that specific site investigation is required. Consequently, no attempt is made to quantify such terms as 'moderate' or 'fair'.

ENGINEERING PROPERTIES

Although there is considerable lithological variation in the **Archaean granitic rocks** of the Darling Scarp and Plateau, their structural properties are broadly similar. When fresh or slightly weathered they are dense and strong, but commonly intersected by fractures and joints. The foundation conditions in the granitic rocks are generally good. They have high bearing capacity and high unconfined strength – generally higher than 200 MPa. (megapascals) – although this decreases with increasing grain size. Close to the Darling Scarp, where the granitic gneisses have been subjected to increased deformation, shear zones are common, and particular care will be required in this area.

When weathered, the granitic rocks are softer and less dense, but provide adequate foundation conditions where only minor stresses are anticipated and when the normal foundation preparation procedures for clayey soils are followed. Weathered granitic rocks tend to be unstable on steep slopes, and seepage is common, particularly in winter. Both these hazards may be increased by excavation into slopes.

Unweathered **dolerite** can be a good foundation with a very high unconfined compressive strength (250 MPa) and low abrasion value. However, it is often strongly fractured and readily decomposes into a greasy plastic clay which has good cohesion and low permeability. The clay shrinks and swells with alternate drying and wetting, more so than the adjacent weathered granitic rocks, and there will be uneven foundation conditions in areas straddling dolerite/granite contacts. Soils developed on dolerite give poor foundation conditions unless the moisture content is kept constant. Mica-bearing, silty doleritic soils, in particular, may contain voids, tend to slake, and are sensitive to remoulding.

[illegible]

Underlying this gravel is a layer of gibbsitic clay, up to 2 m thick, which has a moderate density, void ratio, cohesion and shrinkage, and which tends to harden and crack when dry. To form a good foundation, it needs to be compacted and kept at constant moisture content. Between the gibbsitic clay and bedrock is a white sandy or silty clay of variable thickness. Subsurface drainage is poor, and deep, steep cuts are unstable. Engineering properties vary considerably, depending on the type of parent rock, ranging from moderately good over granitic rocks to poor over dolerite dykes.

The only major outcrop of **conglomerate** in the sheet area (north of Fairbridge Farm School) is deeply weathered, and in view of the mixture of original rock types present, including dolerite, generally unstable foundation conditions may be expected.

The sands of the **Yoganup Formation** have a moderate to high void ratio, a good bulk density, a moderate to high permeability, and are loose to slightly consolidated. Settlement could occur under load. Low, steep faces can stand unsupported for short periods, and iron-oxide case-hardening develops during the summer. The sands require protection against erosion when exposed.

Engineering properties of the **Guildford Formation** vary considerably according to the clay content of the sediments. Natural density is moderate to high, and permeability low except in sand-rich parts of the formation. Cohesion and shrinkage vary. Alternate wetting and drying will cause the clay fraction to swell and shrink, adversely affecting brick-built structures, although this problem can be avoided if the moisture content is kept constant. Low steep cuts are generally stable, although slides may occur in shallow cuts where there is seepage. Storm-water drainage disposal is generally difficult.

Generally moderately to well graded and cohesionless except where it contains minor clay or silt, the **Bassendean Sand** has a moderately high natural density, is very permeable and well drained, and is not subject to shrinkage. It may be moderately well consolidated beneath a loose surface cover which can be remobilized when dry and cleared of vegetation. It is a reasonable foundation material, but is subject to settlement. Drainage disposal is only a problem where the sand is thin and mixed with underlying clays, or in areas of shallow water-table. The thickness and degree of consolidation of the sand, and the depth to water-table, need to be established during site investigation.

The sections of the sheet shown as Bassendean Sand overlying Guildford Formation will generally have the engineering properties of the latter.

Where predominantly composed of calcarenite, the **Tamala Limestone** includes material ranging from soft to very hard, emphasizing the need for individual site examination. The harder material is slightly porous and permeable, of medium natural density, and high to medium compressive strength. Solution cavities occur irregularly and some are filled with unconsolidated sand. Some zones of root casts are observed and these have very high porosity and void ratio, possibly leading to very severe settlement under load. The majority of the limestone has moderate density, moderate permeability and very low shrinkage. Compressive strength increases with drying after excavation. Steep cuts are commonly stable.

The unit composed predominantly of sand is partly consolidated, has a high natural density, high permeability, and no cohesion or shrinkage. Some settlement can be expected beneath foundations. Subsurface pinnacles and thin sheets of dense, hard limestone are common and, where present, will increase excavation costs. Drainage disposal characteristics are good.

As the **colluvium** is a heterogeneous assemblage of different soils and rock fragments, its engineering properties are extremely variable and individual site investigation is essential. Disturbed slopes are likely to be unstable and to require protection against erosion. Seepage and storm-water drainage disposal characteristics depend on clay content.

The **lagoonal and estuarine deposits** are highly variable, low-lying and generally saturated. They are expected to have poor engineering qualities and, because of rapid lateral changes in lithology, will require detailed site investigation. The sub-unit, composed entirely of reworked Bassendean Sand, is expected to have engineering properties comparable to those of that formation, although they may be locally modified by the underlying geology and careful site investigation will again be necessary.

The **swamp deposits** typically have low to moderate natural density and permeability, and moderate to high void ratio and shrinkage. They may include irregular impermeable clay lenses which could be sensitive. The deposits form a very poor foundation material, as irregular settlement is likely. The near-surface water table would impede excavation and drainage and lessen building stability.

Although the varied lithologies present in **alluvium** give rise to a wide range of engineering characteristics, they are generally likely to provide poor foundation conditions. Irregular settlement under load and the near-surface water table would adversely affect building stability and drainage.

EARTHQUAKE HAZARDS

The mapped area is in the 'C' earthquake risk zone. This is a weak seismic zone.

ENVIRONMENTAL GEOLOGY

WASTE DISPOSAL

Dry wastes: Provided sites are distant from areas of groundwater extraction, disposal is probably safe in much of the northwest corner of the sheet area where a thick cover of Tamala Limestone sands will act as a filter on downward percolating water. Elsewhere, suitable sites for large-scale disposal are restricted to those areas where the Bassendean Sand is relatively thick and well drained, and those along the foot slopes of the Darling Scarp where several sandy horizons occur.

Non–toxic liquid or soluble waste: Similar comments to those on dry waste disposal apply. Sites in the Guildford Formation would be unsuitable as it is subject to seasonal inundation and there is a consequent risk of contamination to rivers, lakes and inlets.

Toxic waste: No suitable sites are available for toxic-waste disposal.

SOIL EROSION

As parts of the Coastal Plain are covered by sandy soils, extensive removal of vegetation could lead to wind erosion or rainwater scour.

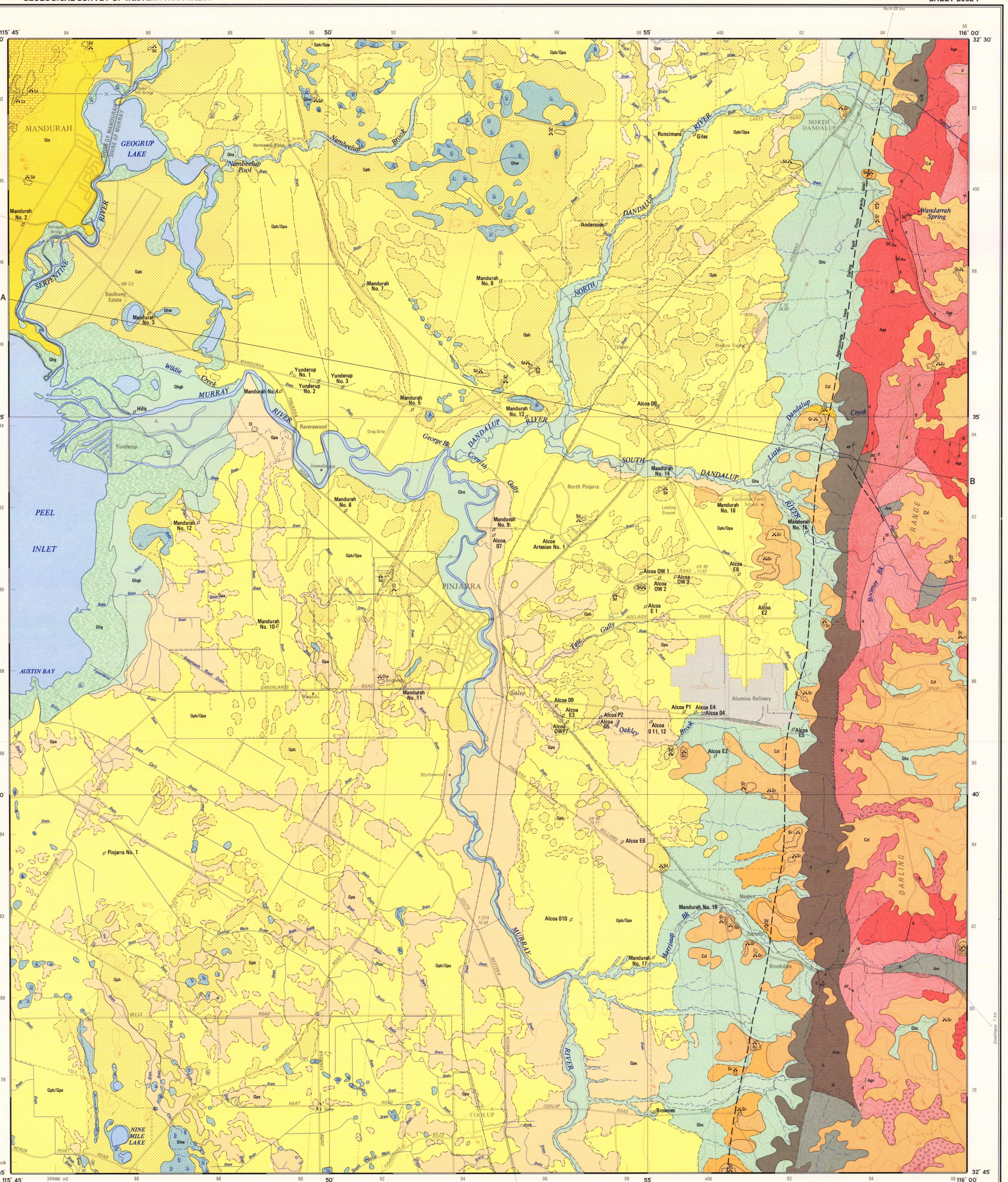
Gullying is a potential hazard on the Darling Scarp, particularly on unvegetated slopes.

MINERAL EXTRACTION

Mineral extraction in the Pinjarra Sheet area is restricted to the mining of construction materials - limestone, sand, clay and gravel - largely for local use. For the most part, pits are too small or naturally well concealed to cause major visual impact, although the extraction of gravel from lateritized colluvium in the Piedmont Zone has required the clearing of relatively large areas of land. Some disused pits are used as rubbish dumps, but the remainder have been abandoned with little or no attempt at rehabilitation. Natural revegetation of abandoned pits (notably gravel pits) is slow, and would be greatly accelerated by the spreading of a thin soil cover. Limestone quarries in the northwest of the sheet area are well concealed and may provide suitable waste disposal sites in the future, provided no groundwater extraction occurs within the dispersion range.

Further extraction of sand, gravel and clay from the area is likely, and new pits should be sited so as to conceal the operations as far as possible and worked in such a way that eventual rehabilitation is possible. Although no quarrying of granitic rocks from the Darling Scarp and Plateau is in progress, future extraction is possible and great care will be required in the location and screening of quarry sites.

Further information may be obtained from the Geological Survey of Western Australia, Mineral House, Perth.



Compiled: R.H. Archer

REFERENCE

Era	Period	Epoch	Symbol	Maximum thickness (m)	Unit
CAINOZOIC	QUATERNARY	HOLOCENE	Qhw	5	Swamp deposits
			Qha	15	Alluvium
			Qhg	10	Estuarine and lagoonal deposits
			Qhgb		reworked Bassendean sand
			Qhc	15	Colluvium
		PLEISTOCENE TO ?HOLOCENE	Qt		TAMALA (COASTAL) LIMESTONE
			Qtl	75	predominantly limestone
			Qts		predominantly sand
		PLEISTOCENE	Qpb	20	BASSENDEAN SAND
			Qpb/Qpa		thin veneer over Guildford Formation
			Qpa	30	GUILDFORD FORMATION
			Qpr	30	YOGANUP FORMATION
	? TERTIARY		Czl	6	Laterite
			Czc	15	Conglomerate
PRECAMBRIAN	UNDIFFERENTIATED		d		Quartz dolerite dykes
			q		Quartz veins
	ARCHAEAN		Age		Even-grained granitic rocks
			Agp		Porphyritic granite
			Agv		Fine to medium-grained granitic rocks
			Anp		Porphyritic granite-gneiss
			An		Mixed gneissic rocks
			Am		Migmatite
					Bedrock largely obscured by residual and alluvial deposits

SYMBOLS

Geological boundary
- Accurate
- Transitional or interdigitated

Fault

Gneissic foliation
- Inclined
- Dip indeterminate

Direction and plunge of lineation

Mylonitized shear zone

Air-photo lineament

Deep borehole (oil or water exploration)

Quarry or pit

Mine (abandoned)

Mineral occurrence
- Clay — Cl
- Sand — Sd
- Limestone — Ls
- Gravel — Gr
- Gold — Au

Contour in metres

Watercourse or drain

Spring

Swamp

Water pipeline

Highway

Major road

Minor road

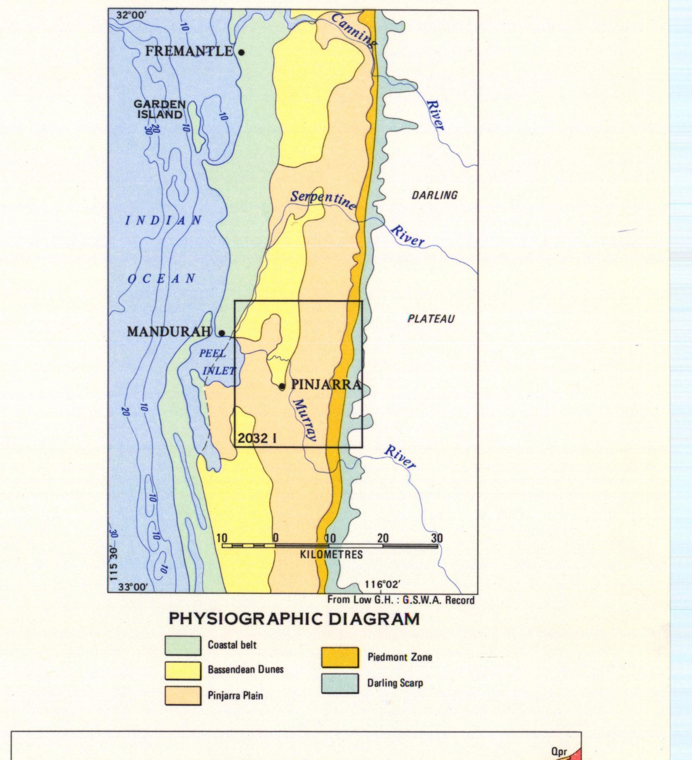
Track

Railway with siding

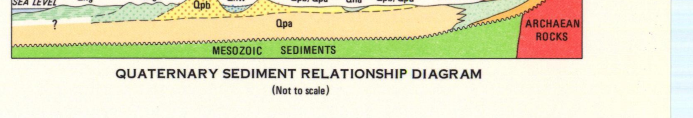
Local Authority boundary

Townsite boundary
- Under Land Act
- Under Local Government Act

[illegible]

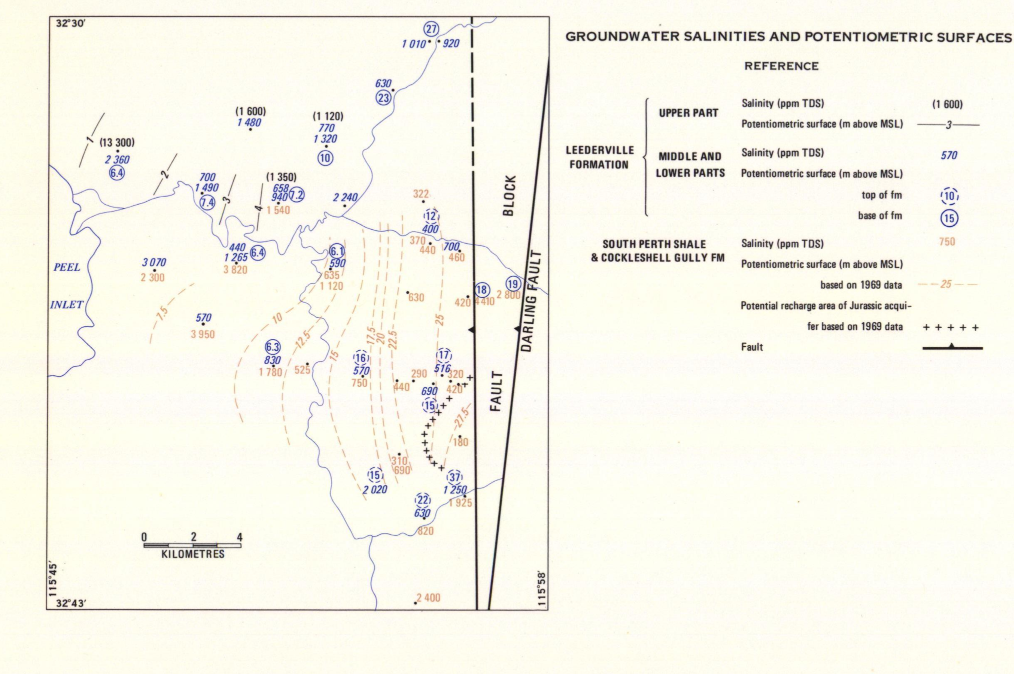


PHYSIOGRAPHIC DIAGRAM



QUATERNARY SEDIMENT RELATIONSHIP DIAGRAM

(Not to scale)

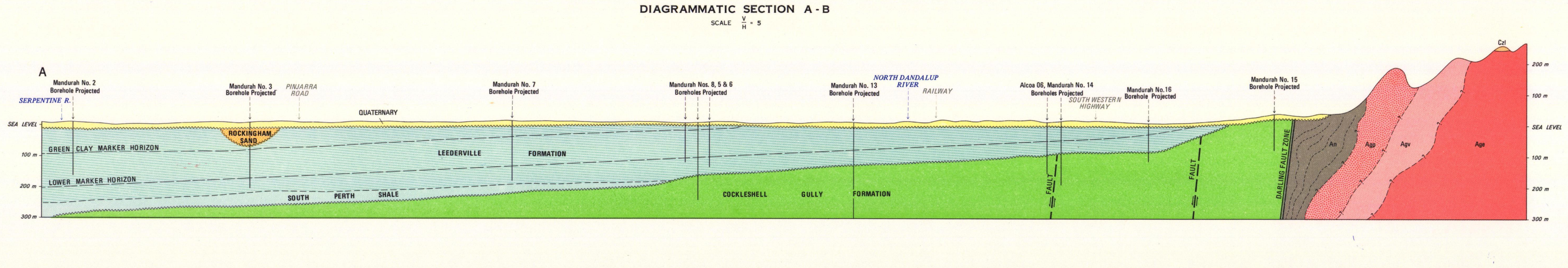


GROUNDWATER SALINITIES AND POTENTIOMETRIC SURFACES

HON. A. MENSAROS, M.L.A. MINISTER FOR MINES

J.H. LORD, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1:50 000



DIAGRAMMATIC SECTION A-B

AGE	FORMATION			MAXIMUM THICKNESS (m)	LITHOLOGY	SALINITY mg/l T.D.S.
QUATERNARY	SUPERFICIAL			15	Gravel, sand, silt and clay	Variable
	UNCONFORMITY					
QUATERNARY	TAMALA LIMESTONE			75	Limestone and sand	Variable mainly brackish to saline
QUATERNARY	BASSENDEAN SAND			20	Sand	
QUATERNARY	GUILDFORD FORMATION			30	Clay, sandy clay, silt and sand	
QUATERNARY	YOGANUP FORMATION			30	Sand	
	UNCONFORMITY					
LATE TERTIARY	ROCKINGHAM SAND			60	Sand	Saline
	UNCONFORMITY					
EARLY CRETACEOUS	WARNBRO GROUP	LEEDERVILLE FORMATION	UPPER PART	80	Thick-bedded sand and shale	1 000 or saline
			MIDDLE PART	150	Thin-bedded sand, silt and calcareous sand	400 - 1 000
			LOWER PART		Thin-bedded silt and sand	> 1 000
		SOUTH PERTH SHALE		50	Shale, sand near base	200 - >3 000
	UNCONFORMITY					
EARLY JURASSIC	COCKLESHELL GULLY FORMATION			2 000+	Thick-bedded sand and shale	200 - >3 000

INDEX TO ADJOINING SHEETS

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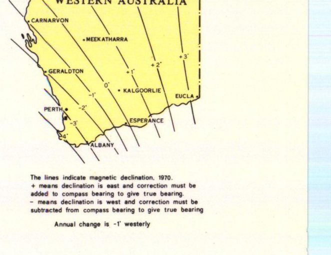
MANDURAH 2032 IV	PINJARRA 2032 I	DWELLINGUP 2132 IV
LAKE CLIFTON 2032 III	HAMEL 2032 II	NANGA 2132 III



DECLINATION DIAGRAM

The lines indicate magnetic declination, 1970.
+ means declination is east and correction must be added to compass bearing to give true bearing.
– means declination is west and correction must be subtracted from compass bearing to give true bearing.
Annual change is -1' westerly

PINJARRA

URBAN GEOLOGY

2032 I

FIRST EDITION 1978