Kok.1

A SOILS AND LAND MANAGEMENT STUDY

OF

MT KOKEBY

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Introduction

Land degradation has become the focus of attention in the WA Wheatbelt. Several forms of degradation are recognized including: salinity, waterlogging, wind and water erosion, acidification, structural decline, sub-soil compaction, water repellance, vegetation decline and water eutrophication. Most of these forms of degradation involve water - too much water, in the wrong place at the wrong time. Moreover, most of them can only sensibly be ameliorated or corrected by a coordinated, catchment-wide approach.

Land Conservation District Committees are a tangible response by rural communities to the need for integrated catchment management plans (Robertson 1989). Such plans must be based on an initial assessment of the land resources of the catchment, and the main forms of degradation.

The present study was undertaken on an area of approximately 400 ha adjacent to the Mt. Kokeby siding (32°13'S; 116°58'E), close to the Avon River, about 12 km south of Beverley (Fig.1). The study area includes two blocks of remnant vegetation but the land use is predominately agricultural. The study objective was to determine the distribution of soils at Mt. Kokeby, the main factors limiting capability for use and the current forms of degradation evident. Preliminary proposals were also outlined for the management of the remnant vegetation blocks in the context of an integrated catchment management plan.

Materials and methods

The survey area was approximately 2 km x 2 km being bounded on the southern side by the Dale-Kokeby Rd and on the eastern side by the Great Southern Highway. On its eastern boundary, the survey area was within 50 - 500 m of the Avon River. It included the old Mr. Kokeby townsite, the adjacent Water Reserve and the adjacent private land to the west and north.

Landform elements and vegetation types were mapped by aerial photograph interpretation. Both 1;50,000 photographs (WA 2268 Pinjarra Run 4 Scale 1:50,000 4.1.85 photo nos 5220, 5219) and a 5 x magnification of these photographs of the study area were used.

Field surveying was conducted in early May 1991, using a physiographic technique (McDonald et al. 1990) along five transects. Each of the transects was surveyed by four groups. The results reported were extracted from the most reliable results: in the valley floor especially more detailed surveying is required.

Soil mapping units and their soil profile characteristics were described using a simplified version of the sheets recommended by McDonald *et al.* (1990) (Appendix 1). Elevations were estimated by extrapolation from a 1:25,000 Topographical map of the area.

Soil samples from each soil horizon were collected at 20 locations in the survey area (Appendix 2). These were tested for pH (1:5 H_2O and 0.01 MCa $C1_2$) electrical conductivity (1:5) and soil colour (Table 1).

Maps at 1:10,000 (approximately) were drawn for land use/vegetation and soil types (Figs. 2, 4).

RESULTS

Soil types

Fourteen soil mapping units were recognized (Fig. 2): These were grouped into 7 units that can broadly be equated with soil types.

1. Gravelly coarse grey sands on granite - deep and shallow phases

2. Sand on ferruginous gravel - the sand may be yellow or grey and the gravel loose pisolites or indurated.

3. Deep grey sand - moderate and gentle slope phases.

4. Yellow Duplex.

5. Hardsetting dark grey-brown clay-phases with or without a shallow sandy loam A horizon.

6. Reddish-brown loam or clay loam- phases with or without coarse gravel or cobbles.

7. Brown alluvial loam.

Descriptions of Soil Mapping Units.

1. <u>Coarse grey sands</u>

1a Shallow coarse grey sand (<50 cm solum)
Limited distribution on crest of ridge (Fig. 3).
Soil surface covered by fine angular quartz gravel (2-20 mm). Entire SMU cleared for pasture except for infrequent white gum remnants (Fig. 4).

Typical profile

0-18 cm A1:	Light grey (10 YR 7.5/2) coarse sand with 10-20% fine quartz gravel
8-18 cm A2:	Brownish gray (10YR 6.5/2) coarse sand with about 50% quartz gravel.
18-36 cm C:	Greyish yellow brown (10YR 5/2) weathered granite with coarse sand and 50-90% quartz gravel.

Moderate acidity and non-saline (Table 1). Surface concentration of quartz gravel suggests wind erosion has been active. Shallow rooting depth and good drainage would limit water availability. May be an important recharge area for groundwater.

1b Coarse grey sand (> 50cm solum)

Dominates the upper slope (0.5-5°) of the ridge (Fig. 3): Mapping Unit (SMU) is adjacent on the upper slope to SMU1a and downslope to 2a or 2b. The prevalence of quartz gravel on the surface is less than SMU1a, and the solum depth is greater. There is a distinct A2 horizon and a reddish mottled B horizon which has a higher clay % than the A horizon.

Typical profile

0-9 cm	A1:	Brownish grey (10YR 7/2) sand Small amount of quartz gravel (<10%)
9-18 cm	A2:	Dull yellow orange (7.5 YR 5/1) sandy loam. Mottled red. small amount (2-10%) of quartz gravel.
18-33 cm	B1:	Dull brown (7.5 YR5/4) Sandy loam. Mottled red - Firm.
33+	B2:	Light brown (7.5 YR5/6) sandy loam.

Slightly to strongly acid [pH($CaCl_2$)6.4-4.0] in surface layers (Table 1). Non saline although B horizon of profiles with sandy loam texture may have significant salts. At the transition to SMU 2a, 2b, the B horizon has higher clay %. Wind and water erosion are probable risks to exposed surfaces of this SMU. Surface acidity may be too high for some species.

2. Sand on Ferruginous Gravel.

Four phases were recognized, including two on the western ridge and two on the eastern hill (Fig. 2). On the ridge the ferruginous gravel flanked the hill at about 230 m in a midslope position (Fig. 3). On the eastern hill its elevation was lower (210-220 m asl). In both cases the ferruginous gravel layer had an incline towards the drainage lines suggesting it was formed in the drainage line at a former period when the base level for erosion was higher, but it has subsequently been substantially dissected.

2a Shallow grey sand on indurated ferruginous gravel.

Distribution limited and confined to the white gum remnant in the north west of 'Easthope" and along the lower ridge to the south west of 'Easthope" and the white gum remnant north of the gravel pit (Figs 2, 4). The induration of the laterite was incomplete but was difficult to penetrate with a spade or auger. The laterite was quartz-rich. Slopes are gentle (0-4°). White gum is the dominant vegetation.

Typical profile

0-5 cm Grey-brown loamy sand
5-25cm Light grey brown loamy sand with 10-20% ferruginous pisolites.
25 + cm Strong cemented ferruginous pisolites in a yellowish sandy loam matrix.

The depth of sand over the duricrust varies from 0-50 cm: the prevalence of pisolites in the sandy matrix also varies. pH is moderately acid (5.5 - 6.2) and the soil is non-saline (Table 1). The laterite duricrust prevents cultivation, and limits rooting depth of annual species. These areas may be important recharge zones for groundwater.

2b Grey sand on ferruginous gravel.

This SMU is quite extensive on the midslopes of the western hill, flanking it at about 230 m asl on its northern, eastern and southern sides (the west was not investigated): it is broken by a spillway to the south of the white gum remnant on "Easthope" which occupies SMU2a (Figs 2, 3). A further area which conforms to the description for this SMU occurs on the lower western slopes of the eastern hill. This unit was vegetated by white gum woodland; some of which has been cleared on "Easthope" for pasture, and some of which in the eastern hill has been extensively disturbed by removal of the ferruginous gravel layer for road building: rubbish is being dumped in some of the gravel pits (Fig 4).

Typical profile

0-10 cm	(10YR5/1) loamy sand
20-20 cm	(7.5 YR 7/1) loamy sand
20-100+ cm	(10YR 7/2) gravelly (>50%) loamy sand

Moderately-strongly acid (4.7-5.5) and non-saline (EC ≤ 0.06 mS/cm) (Table 1).
Gentle slope (1-4°)

2c Yellow sand over ferruginous gravel.

Exists in three restricted areas: two defined areas downslope of the lateritic plateau on the south and north of the ridge (Fig. 2). Here the yellow sand was deep (up to 5 m in places where a bore was sunk) with ferruginous pisolites at depth. The third area was on the western part of the hill where the sand was shallower and the ferruginous gravel layer better defined.

Typical profile: none described in detail. Approximate description for eastern hill

0-30 cm	Yellow-brown sand or loamy sand
30-100 cm	Pisolites in yellow sand matrix
100+ cm	Mottled zone clay.

No chemical analysis but expected to react strongly with P; moderate-strongly acid and non-saline. Slopes negligible to gentle (0-4°).

3. Deep grey sand

Two phases were recognized. They occupy the mid-lower slopes of the western ridge (Figs 2, 3). The vegetation is heath or banksia woodland (Fig. 4). The material underlying the sand is not clear but probably mottled zone clay.

3a Deep grey-yellow sand.

Heath is the distinctive vegetation of this SMU. It occupies the mid-lower slopes of the ridge and is downslope of SMU2 and upslope of SMU 3b.
Typical profile

0-10 cm	Dull yellowish brown (10YR 5/3) sand
10-40 cm	Dull yellow orange (10 YR 7/4) sand
40-70 cm	Light yellow orange (10YR 8/4) sand
70-90+ cm	Yellow orange (10YR 8/6) sand.

Moderately-acid-neutral, non-saline. Gentle slopes (2-5°). Active wind erosion under pasture. Nutrient and water holding capacity limited.

3b. Deep light grey

Occupies the toe of the slope. Probably colluvial, leached sands.

Typical profile

0-3 cm A1:	Light grey (2.5 YR 7.5/1) sand
3-30 cm A2:	Light grey (2.5 YR 6/1) sand
30-70 cm B1:	Light grey (10 YR 7/1) loamy sand
70-120 cm +B2	Light grey (10 YR 8/1) loamy sand

Neutral pH at the surface (pH in H_2O: 5.7 - 6.1) but becoming alkaline (7.3 - 7.8) and saline (EC 1:5 0.2 - 0.54 mS/cm) with depth (>30 cm). The soil profile was wetter than upslope. This together with its topographic position its distinctive vegetation and higher EC suggests a significant groundwater influence on this soil. Gentle slope (0-1^{o}). Phosphorus holding capacity of this soil likely to be low and given its proximity to the drainage line there is a high risk of eutrophication of groundwater and surface water from fertilizer use on this soil.

4. Duplex valley soils

Duplex soils occupy the western drainage lines of the valley and also an extensive area to the northeast of "Easthope" (Figs 2, 3). The depth of sand over clay varies. On the shallower phases, sedges grasses and samphire are the dominant vegetation the latter indicating saline surface soils. (Figs 2, 4). On the deeper phases, sand plain cypress or mallee are the dominant species in the overstorey. When cleared, pasture growth appears to be more vigorous with the deeper sandy A horizon: moreover in the remnant, samphire is absent on the deeper sands.. There is evidence of tree death in the drainage line.

4a Yellow duplex soils

Waterlogged duplex soils of the valley floor (Figs. 2, 3). Possibly equivalent to the Mortlock surface described by Mulcahy and Hingston (1962).

Typical profile (Site 4A)

0-5 cm	A1:	Greyish-yellow (2.5 Y6/2) sand
5-40 cm	A2:	Light grey (10YR7/1) sand
40 +	B:	Dark greyish yellow (2-5 Y5.5/2) heavy clay. Ferruginous nodules at the interface of the A2 and B horizon.

Neutral to strongly acid in the A horizon, becoming neutral to alkaline in the B horizon (Table 1). Saline to strongly saline, especially in the B horizon. Soils prone to water logging : eg. water in deep drains at 1.5 m depth in autumn.

5. Hardsetting Grey-brown clay.

Like the duplex soils, SMU5 occupies the valley floor but on the eastern side (Figs. 2, 3). It is characterized by the dense Melaleuca heath vegetation (Fig. 4) and either absence of a sandy A horizon or a very thin layer of sand on the soil surface.

5a Greyish brown loamy sand on sandy clay loam.

Occurs at a slightly higher elevation between SMU7 on the east and SMU5b on the west (Fig. 3).

Typical profile (Site 3E)

0-3 cm Dark brown (?) loamy
3-10 cm Grey brown (?) sandy clay loam

Moderately acid (5.4-6.2) and saline (Table 1). High soil strength and possible waterlogging.

5b Grey brown clay.

Typical profile

0-2 cm Dark greyish yellow (2.5Y 4/2) light clay
2-10 cm Yellowish brown (2.5 Y 5/3) light clay
10 + cm Olive yellow (5Y 6/3) light clay.

Moderately acid to moderately alkaline pH and strongly saline (Table 1). Waterlogging is probably a severe constraint. Soil is hard setting when dry.

6. Reddish brown loam

6a Stoney Reddish Brown Loam
Comparable to the York surface of Mulcahy and Hingston (1962) with partly weathered coarse gravel/cobbles or "floaters" in the profile or on the soil surface. SMU occupies the spur north of the morrel remnant (Figs 2, 4). In the lower part of the SMU, dolerite boulders were outcropping on the surface, and $CaCO_3$ nodules were found.

Typical profile

0-30 cm Reddish-brown (?) sandy loam with 10-20% rock fragments (6-20 mm diam)
30 + cm Brown (?) sandy loam with rock fragments.

Chemical properties not determined.
Gentle slope (0-2°).

6b Reddish brown loam.

Occupies most of the eastern part of the hill and vegetated by tall stands of red morrell with some salmon gum on the lower slopes (Figs 2, 3, 4). There is a distinct soil colour and vegetation change along its western boundary suggesting that SMU6b coincides with a dolerite dyke (Figs 2, 3, 4).

Typical profile

0-5 cm Dark Reddish brown (5 YR 3/5) sandy clay loam containing 10-20% ferruginous pisolites (2-6mm)

5-15 cm Dark Reddish brown (5YR 4/6) sandy clay loam containing ferruginous pisolites.

15-30 cm Dark Reddish brown (2-5YR 4/7) sandy clay loam with $CaCO_3$ nodules.

30-70+ cm Bright brown (2-5 YR 5/7) sandy clay loam with $CaCO_3$ nodules.

Neutral pH at surface increasing to strongly alkaline at depth (Table 1). Gentle slopes (0-1°). Partly disturbed for rubbish dumping. Electrical conductivity increases with depth.

7. Brown alluvial loam.

Recent alluvial parent material from the Avon River. Probably equivalent to the Avon surface of Mulcahy and Hingston (1962).

Typical profile (Site 1E)

0-5 cm Dark brown sandy loam with well developed sub-angular blocky structure.

5 - 60+ cm Brown? with $CaCO_3$ nodules at about 30 cm.

Strongly acid A horizon decreasing with depth (Table 1). $CaCO_3$ nodules at 30-50 cm. Slightly to strongly saline.

Soil Stratigraphy

The intensity of sampling was not sufficient for a thorough analysis of the soil stratigraphy or to make firm statements about the formation of soils mapped. The following is a tentative interpretation of the stratigraphy of the soils (Fig. 3). Section A - B is a transect from the highest point on the western ridge to the Avon River passing through the eastern hilltop. The ridge is a granite outcrop although some of the exposed rock also resembles quartizite. At the top of the ridge partly weathered granite is very close to the surface and soils are very shallow coarse sands. Immediately downslope the soils increase in depth and develop a distinctive B horizon with a higher clay content. Flanking the ridge at about 230 m asl is a narrow lateritized plateau. In places the ferruginous pisolites are strongly cemented as a duricrust but generally they are uncemented. The pisolites appear to be quartz rich. The extent to which the pisolites are underlain by mottled zone clays was not adequately determined.

Downslope of the laterite remnants, deep pale yellow-grey sands mantled the mid-low slopes. Again, the extent to which these sands were underlain by mottled zone clays was not determined. In the drainage lines at the lowest elevation of the transect, limited augering suggests that the country rock may be close to the surface (70 - 120cm depth). Here duplex soils predominate although they vary in the depth of sand on clay. Further east in the valley floor, the sandy A horizon appears to either disappear or exist only as a shallow layer.

The eastern hill is believed to be the dissected remnant of a lateritized profile. But its soils are complicated by a distinct colour change which probably correspond with a N-S running dolerite dyke. Dolerite rocks were observed on the soil surface to the north of the transect. Moreover, on the lower northern slopes of the hill, the reddish loam soils contained partly weathered rock fragments suggesting that the pallid zone clay remnants had been completely stripped away so that soils were forming directly on the exposed country rock.

On the eastern hill the soils of the slopes were mantled by sands or sandy loams overlying ferruginous gravel which in turn overlies clay. The dolerite influence resulted in higher clay content, strong reddish colours, less ferruginous gravel, and

$CaCO_3$ nodules at depth. Red morrel was the dominant vegetation on these soils but not found elsewhere in the survey area (Fig. 3). By contrast, the granitic influence on the western side of the hill was associated with the yellow or grey sands on gravel and white gum dominant vegetation.

On the eastern end of the transect the soils were recent alluvial brown loams.

TABLE 1. Selected soil properties of each soil mapping unit (SMU) in the Mt Kokeby survey.

SMU[A]	Transect Position[B] [Depth]	pH H_2O	EC mS/cm $CaCl_2$		Description
1a	3C	5.77	4.92	0.06	Coarse grey stoney sand on
	[0-36cm]	5.46	4.86	0.05	granite
		5.28	5.36	0.03	
1b	1A	6.52	6.39	0.2	Grey sand over
		6.24	6.23	0.2	yellow-orange
	[0-105cm]	6.21	6.04	0.14	loamy sand
		6.00	6.22	0.17	
	4B	4.45	4.00	0.14	Brownish grey sand over
		5.04	4.01	0.15	brownish sandy loam
	[0-33cm+]	5.36	4.77	0.18	
		6.05	5.45	0.69	
2a	2A	5.32	4.72	0.04	Greyish sand over
		5.45	5.54	0.06	Ferruginous sand
2b	1B	5.71	5.52	-	Light grey brown loamy
	[0-25cm]	6.08	5.87	0.19	sand over
		6.66	6.16	0.28	laterite duricrust
3a	3D	6.25}	5.67}	0.33}	Grey sand on light yellow
	[0-25+ cm]	6.34} 6.30	5.68} 5.67	0.06} 0.09	
		5.77	5.86	0.08	
		6.01	6.14	0.02	
3a	1C	6.96	6.96	0.04	Light yellow sand
		6.84	(7.28)	0.07	
	[0-90 cm]	6.83	(7.40)	0.05	
		7.02	(7.34)	0.05	
3b	3A	6.13	(7.52)	0.02	Deep light grey sand
		5.73	(7.46)	0.31	
	[0-120cm+]	7.82	(8.7)	0.24	
		7.30	*8.48)	0.54	
4	2E	6.65	(7.19)	0.71	Light grey sand on
	[0-40cm+]	6.88	(6.97)	2.06	brownish clay
	2B	7.04	?7.46	(?0.10) -	Grey yellow brown sand
		8.18	?8.35	(?0.05) 5.3	
		7.60	?7.65	?(0.13) 4.2	
		9.07	?8.43	(?0.25) 1.4	

SMU	Transect Position Depth	pH		EC mS/cm	
		H_2O	$CaCl_2$		Description
	3B	5.75}	5.17}	9.68}	
	[0-40+ cm]	5.25}5.50	4.16}	0.62}1.77	
		5.16	4.67	0.52	
		5.30	5.23	2.06	
4A	[0-40+cm]	5.51	5.44	0.03	Greyish yellow sand over yellowish clay
		4.69	4.70	0.44	
		6.71	6.14	1.16	
5	4D	6.07	5.78	1.26	Dark greyish yellow light clay
	0-10+ cm]	8.07	7.61	3.2	
		8.13	7.86	11.8	
	3E	5.90	5.37	1.07	Dark greyish brown loamy sand on sandy clay loam
	[0-3+cm]	6.53	6.22	1.94	
6b	2C	7.16	7.14	0.47	Yellow brown loamy sandy over dull orange-reddish sandy loam
	[0-60 cm]	7.02	7.12	0.47	
		7.19	7.12	0.29	
	4C	7.05	6.61	0.13	Red-brown sandy clay loam with pisolites at 30 cm
	[0-70 cm]	7.84	7.30	0.19	
		8.47	7.84	0.70	
		8.47	8.10	0.53	
7	4E	5.6	4.99	0.93	Yellow orange loamy sand
	[0-15+cm]	5.22	5.44	0.40	
	1E	5.47	4.97	5.9	
	[0-50cm]	6.33	5.7	4.0	
		6.21	5.73	3.8	

A. KEY TO SOIL TYPES

1. Stoney Course sands on granite
   a. Shallow phase on ridge crest (20-30 cm solum depth).

   b. Deeper phase with B horizon (80- cm solum depth).

2. Sand on gravel
   a. Shallow sand on moderately indurated gravel.
   b. Shallow sands on ferruginous gravel.
   c. Deep yellow sand on gravel.

3. Deep grey sand
   a. Deep grey sand (1-2m) and light yellow sand.
   b. Deep grey sand at toe of slope.

4. Yellow Duplex
    a. Grey sand on clay.

5. Hardsetting Dark grey-brown clay.
    a. Shallow sandy loam A horizon
    b. Dark grey brown clay.

6. Reddish brown loam
    a. Rock floaters in profile: soil on lower slopes.
    b. No rocks in upper solum but pisoliths at base of A horizon.

7. Brown alluvial loam.

B. SEE APPENDIX FOR LOCATION OF SOIL SAMPLING SITES

Discussion

District, catchment and soils context
The Mt Kokeby remnant (MKR) is in the lower part of a small catchment draining north into the Avon River. The ridge to the west and hill to the east appear to form a hydraulic barrier to surface and groundwater flow: the condition of the remnant vegetation in the drainage line and the farmland to the north of it is therefore susceptible to those land management practices to the south in the catchment which increase water runoff or groundwater recharge. As much of the catchment has been cleared and since many of the soils of the Sheahan and Kokeby associations are sandy or gravelly (Lantzke and Foster, 1990) high recharge rates are possible. Moreover the broad extent of wide valley floors with minimal gradient restricts the removal of excess water by drainage.

Generally in the Avon, the valley floor soils are dominated by the recent alluvial surfaces (Avon surface), the floors of tributary valleys by the older alluvium of the Mortlock surface and the valley slopes by the reddish brown loams (York surface) forming on freshly weathered country rock. Some of these features are represented at Kokeby. The valley floor between the hill and ridge is occupied by soils resembling the Mortlock surface; to the west and southwest of the hill, soils resemble the Avon surface: and the spur to the north of the hill is covered by soils resembling the York surfaces.

Lateritic profiles are infrequent in the Avon valley especially at low elevations (<270m asl) (Mulcahy and Hingston 1961). Kokeby appears to be an exception in this respect. Most of the soils on the ridge between the valley floor and about 230m asl are mantled by laterite profiles or their breakdown products: similarly at about 210-220m asl on the west of the hill, lateritic podzolic soils occur. A further distinctive characteristic of the hill is the significant remnant of Red Morrell which dominate the reddish brown loams which appear to have formed on the dissected pallid zone influenced by the doleritic parent rock. Mulcahy *et al.* (1972) have suggested a possible explanation for the unusual soil properties at Kokeby. They have suggested that a paleo-drainage line stretches from the Avon River at Kokeby to the upper reaches of the Darkin River valley in the Darling Range. At either end of the paleo-drainage line are remnants of the lateritized land surface which was probably characterized by deep grey sands over ferruginous gravel merging into a mottled clay layer which in turn lay over a pallid zone, a layer of saprolite and finally unweathered rock. At Kokeby, the remnants are relatively dissected but there is still extensive areas of grey sands over ferruginous gravel or as collvium over mottled zone and/or pallid zone clays.

Impacts on MKR

Several impacts on the MKR are evident. Without intervention, the MKR is likely to degrade further. The hill is degraded by removal of the ferruginous gravel and is being used in part as a rubbish dump.

The valley floors are salt-affected. Trees deaths are evident along the drainage line. These are possibly Flooded gums since they are prevalent along the drainage lines further up the catchment. Samphire appears to spreading up the drainage lines in the remnant as might be anticipated from the relatively high EC values measured.

In the valley to the north of the MKR, deep drains (1.5m) have been installed to alleviate waterlogging in the pastures. The impact of this on the MKR is not clear. It may simply remove the excess water running off the catchment. If however it significantly lowers the watertable in the valley there may be impacts on the vegetation.

Grass weeds were prevalent along the drainage line and under the Melaleuca thickets on the southern side on the MKR. These have possibly originated from the runoff water from the farms further up the catchment. Their presence may also be influenced by increased nutrient levels from farm runoff.

The MKR has a relatively high perimeter to area ratio which is exacerbated by the clearing of small farms on the old townsite. There are two implications. Firstly the long perimeter means that a high proportion of the MKR suffers edge effects which impact on both the flora and fauna (Main 1987). Secondly, for a small reserve it has a large number of neighbours: seven.

Future management

The MKR can be treated as a case study in the retention, protection and management of remnants. In the long term its status depends on the cooperative involvement of the local community and particularly that of the landusers in the catchment.

Is there any community interest in protection of the MKR among its neighbours (there are 7 including Westrail), from the current land owner (Water Authority), local landcare groups (there is one for the Beverley Shire), the local government (Beverley Shire Council) or government agencies (WADA, CALM, Main Roads)? Approaches to WADA and CALM could establish many of the these points.

The approach of a landcare group might be as follows:
Assess the land degradation problems of the catchment.
Identify the relevant landusers.
Establish a working group to consult with the Beverley Land Conservation District to form a Kokeby Catchment group.
Conduct of land resource survey of the catchment concentrating on the assessment of degraded land.
Prepare catchment management plans
Prepare specific management plans for the MKR. Important elements of the plan would include:

- an assessment of the conservation value of the MKR;
- vesting the land with a land management agency, either the LCDC, CALM or Beverley Shire Council
- the possibility of linking the MKR with other remnants on private land, especially that north of "Easthope", the old townsite properties and on public land along the railway reserve, road reserves and the Avon River;
- fencing and restricting access to the MKR
- establishing some form of facility in the reserve so that it can be used for passive recreation or educational purposes.

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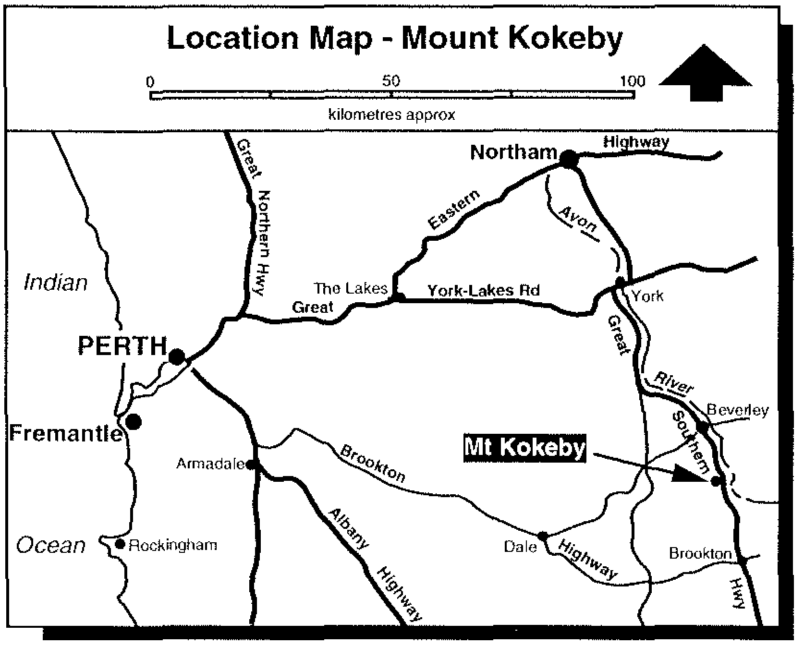
<u>Figure Captions</u>

Figure 1. Location of survey area.

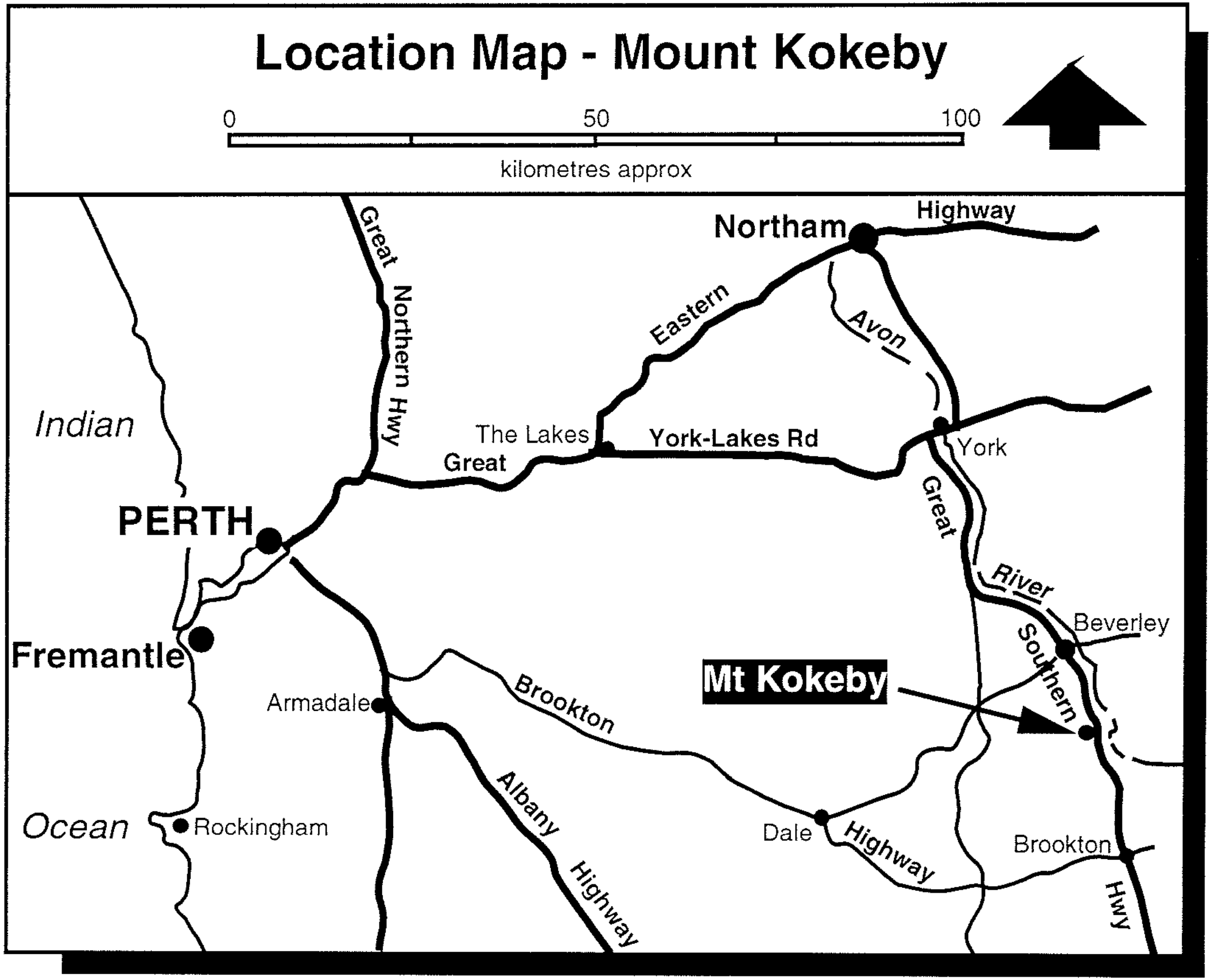
Figure 2 Distribution of soil types in the Mt. Kokeby survey area. From a preliminary survey by Land Management students, 1991. See text for description of soil mapping units.

Figure 3 Soil stratigraphy along a W-E transect across the survey area.

Figure 4 Land Use and vegetation of the Mt. Kokeby survey area in May 1991.



Location Map - Mount Kokeby
0
50
100
kilometres approx
Northam
Highway
Great Northern Hwy
Eastern
Avon
Indian
The Lakes
York-Lakes Rd
Great
York
PERTH
Great
River
Beverley
Fremantle
Southern
Mt Kokeby
Armadale
Brookton
Albany
Highway
Ocean
Rockingham
Dale
Highway
Brookton
Hwy


Location Map - Mount Kokeby
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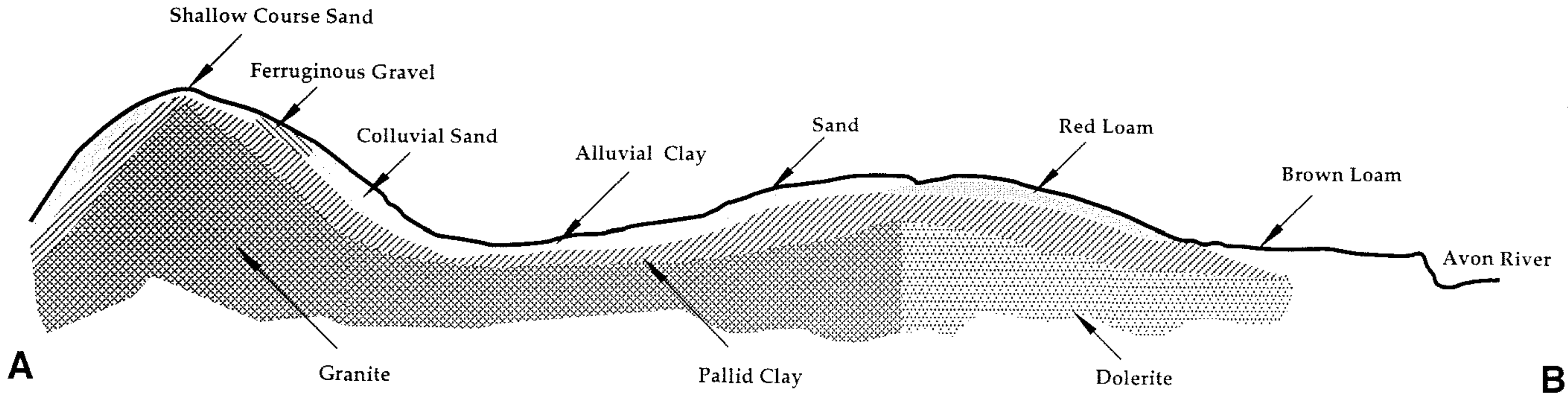
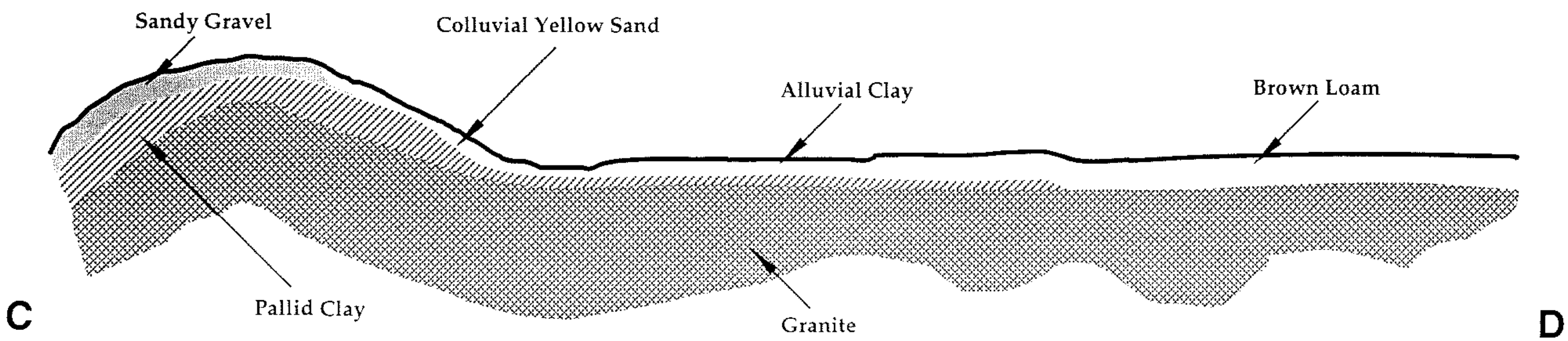
Brookton
Albany
Highway
Ocean
Rockingham
Dale
Highway
Brookton
Hwy



Section A - B



Section C - D

SOIL TYPES

1. Stoney Course sands on granite
   a. Shallow phase on ridge crest (20-30cm solum depth)
   b. Deeper phase with B horizon (80- cm solum depth).

2. Sand on gravel
   a. Shallow sand on moderately indurated gravel.
   b. Shallow sands on ferruginous gravel.
   c. Deep yellow sand on gravel.

3. Deep grey sand
   a. Deep grey sand (1-2m) onlight yellow sand.
   b. Deep grey sand at toe of slope.

4. Yellow Duplex
   a. Grey sand on clay.
   b. Deeper grey sand on clay.

5. Hardsetting Dark grey-brown clay.
   a. Shallow sandy loam A horizon.
   b. Dark grey brown clay.

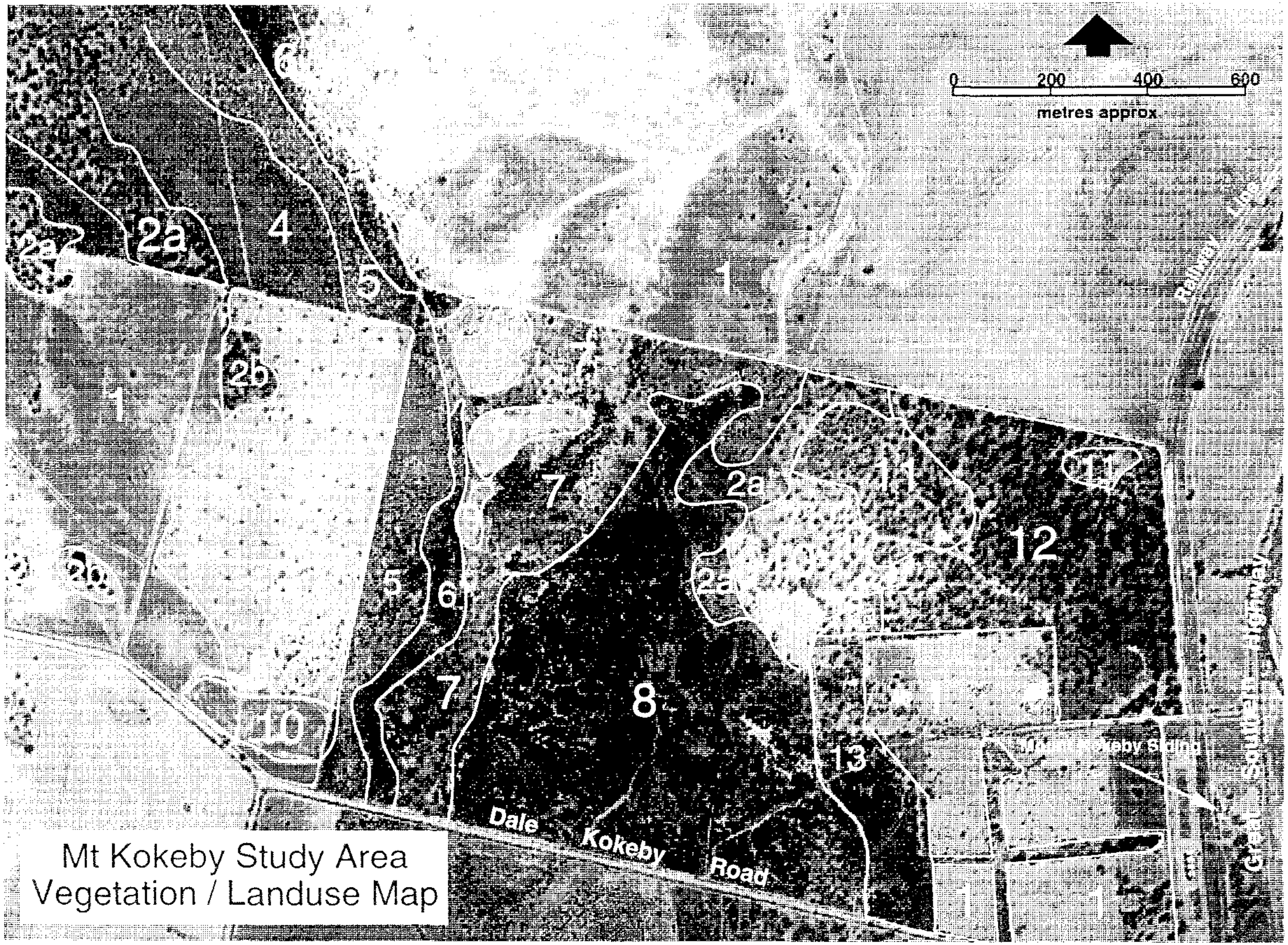
6. Reddish brown loam
   a. Rock floaters in profile: soil on lower slopes.
   b. No rocks in upper solum but pisoliths at base of A horizon.

7. Brown alluvial loam.

Mount Kokeby Study Area
Soil Map

KEY

1. Pasture
2a. Wandoo woodland
 b. Wandoo remnant
3. Recently cleared Woodland
4. Heath
5. Banksia woodland
6. Actinostrobus
7. Sedges
8. Melaleuca heath
9. Salt pan
10. Gravel quarry
11. Rubbish tip
12. Morell woodland
13. Salmon gum and heath



Mt Kokeby Study Area
Vegetation / Landuse Map