

Water Resources of the Sturt Plateau Region

OVERVIEW REPORT

WESTERN CREEK
NT Por 3047

TARLEE
NT Por 3048

COW CREEK
NT Por 4966

NT Por 5030

NT Por 5031

NT Por 5032

NT Por 5033

WYWORRIE
NT Por 2729

Wyworrie

31382

23859

30509

28191

30873

Middle Waterhole

31399

30872

30335

Lily Waterhole

31397

Emma Bore 31630

No. 2 Bore 7756

32169

Rocky Hole

Blue (Teeyong) 32167

27339

Western Creek

Tarlee

6375

5916

25436

27339

29711

27339

31925

27338

31926

30657

30656

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STURT PLATEAU BEST PRACTICE GROUP INCORPORATED



**LANDS PLANNING
ENVIRONMENT**
Northern Territory Government



Northern Territory Government
Department of Infrastructure, Planning and Environment



WATER RESOURCES

of the

STURT PLATEAU REGION

OVERVIEW

REPORT

REPORT 18/2000D
D. Yin Foo
Darwin
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1. Water Resources Development Options Map

SUMMARY

This report accompanies the *Water Resources Development Options* map. It is designed as a guide for determining the most appropriate type of water supply in an area. Pastoralists could expect to use the map as a basic tool, enabling them to plan the development of their property with consideration to the availability of water supply. Property development would be done in conjunction with appropriate Land Resource mapping.

Groundwater throughout the Sturt Plateau is largely exploited from aquifers developed in the fractures and cavities of a limestone formation. The limestone immediately underlies the surface sediments, which may be up to 60m thick. In some parts, groundwater availability is influenced by the underlying basement rock, usually basalt. Within the region covered by this map, the groundwater potential ranges from excellent, particularly in the north-western parts, to poor along the central section where the basalt emerges to near surface.

Surface water development options within the map region are also generally good. However, experience with surface water structures elsewhere in the Top End has shown that hazards posed by the wet season need to be considered. An effective dam must resist potential flood damage, have viable capacity and harvest adequate sheet flow from the catchment. On the Sturt Plateau, there are difficulties associated with flat topography and low runoff potential and good site selection is often important. However, there is usually sufficient clay in the soil for a viable construction. Evaporation is high and deeper dams with adequate storage to persist through the dry season may not always be an option. In such instances, shallower tanks or dams can still be viable and will permit greater spread of pasture land for at least the early part of the dry season.

1. INTRODUCTION

The Sturt Plateau Best Practice Group (SPBPG) provided the initiative for this project. The intention was to provide station managers with a map tool with up to date information on water resources, and in conjunction with land resource maps, make informed decisions about water and land management issues at property scale. Subsequently, the Northern Territory Government and the National Landcare Program took carriage of, and jointly funded this project. The water resources in the Sturt Plateau region, comprising 23 properties and land trust areas, was studied between May 1997 and June 2000.

The Sturt Plateau region covers approximately 30000 km² and defines an area which extends between Mataranka in the north and Dunmarra in the south. The eastern boundary is featured by an upland area parallelling the Stuart Highway. Its western extremity is featured by 'breakaway' country delineated

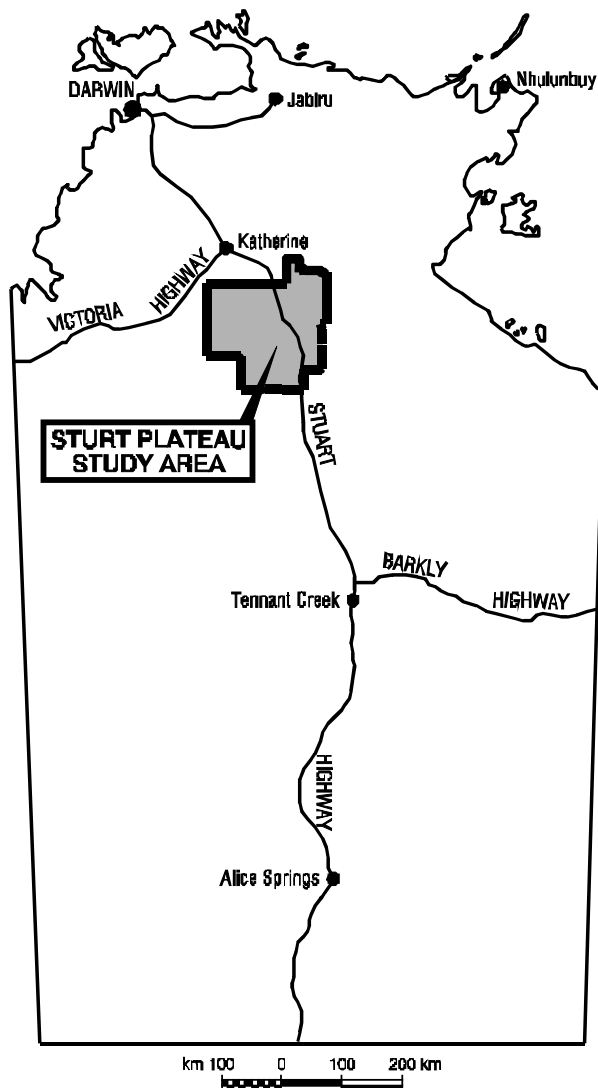


Figure 1 Locality Map

by the Buntine Highway. The regional location is indicated in Figure 1. Road access is good throughout the region. During the wet season, the main roads are generally accessible by light vehicles except during periods of flooding in the local creek systems. However many station tracks may be impassable.

Nearly all of the annual rainfall occurs in the short hot monsoonal wet season between December and March. Rainfall events may occur as intense thunderstorms or as the result of widespread monsoonal activity. Little rainfall is experienced during the remainder of the year. The average rainfalls vary slightly across the region with 792mm at Mataranka in the north, 800mm at Larrimah in the central region and 658mm at Daly Waters in the south. Similarly, pan evaporation is between 5 and 11 millimetres per day (average about 8 mm per day or 2.8 metres per year) in the region. Air temperatures are high throughout the year. The average monthly maxima at Larrimah ranges from about 29 degrees in June to 37 degrees in December.

The corresponding average monthly minima are 13 and 24 degrees. Climatic data for Larrimah are presented in Table 1. The median annual rainfall (10 percentile) and average annual pan evaporation adapted from the Bureau of Meteorology are indicated on Figures 2 and 3 respectively.

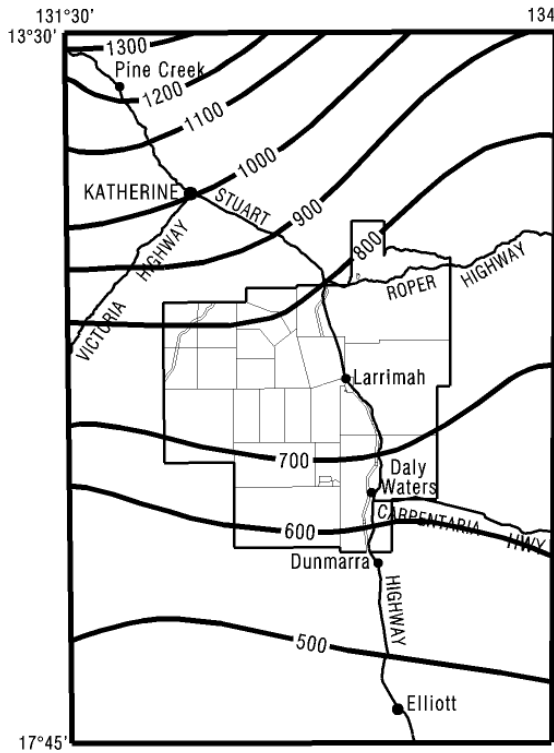


Figure 2 Median Annual Rainfall (mm)

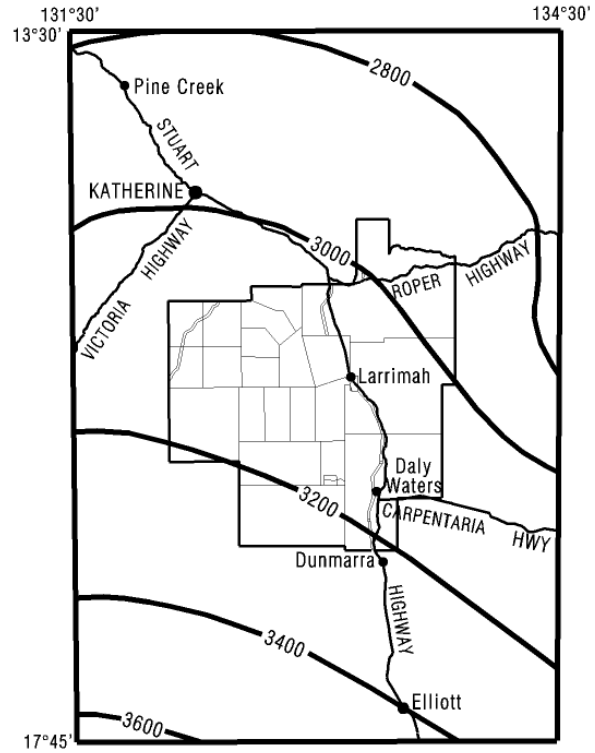


Figure 3 Average Annual Pan Evaporation (mm)

1.1 Landform and Drainage

The Sturt Plateau is most aptly described as being a flat to undulating plain with low rounded crests and isolated ridges. Its surface is largely of deeply weathered and laterised claystone and siltstone sediments of the Cretaceous aged Mullaman Beds. Erosion of the surface has exposed various horizons of the laterised profile. There is a gentle south to north fall of the plateau with elevations reaching 290m (MSL) on the Buchanan Highway to 170m (MSL) along the northern reaches of the study area. A slight 'dish' is apparent in the central part. A contoured physiographic map of the region is depicted on Figure 4.

The northern bounds of the Sturt Plateau is featured by a dissected margin. A largely intact high plateau area in the north-west corner of the study area is represented by an entire Mullaman Bed sequence. The surface of the higher remnant platforms in this area is about 220m above mean sea level (MSL). However, further east, the country tends towards remnant lower plateau which has been eroded down by regional drainage features including the Dry River and the Elsey Creek systems. The land remains relatively flat across this area until it falls from 175m to 100m above MSL where Elsey Creek crosses the Stuart Highway.

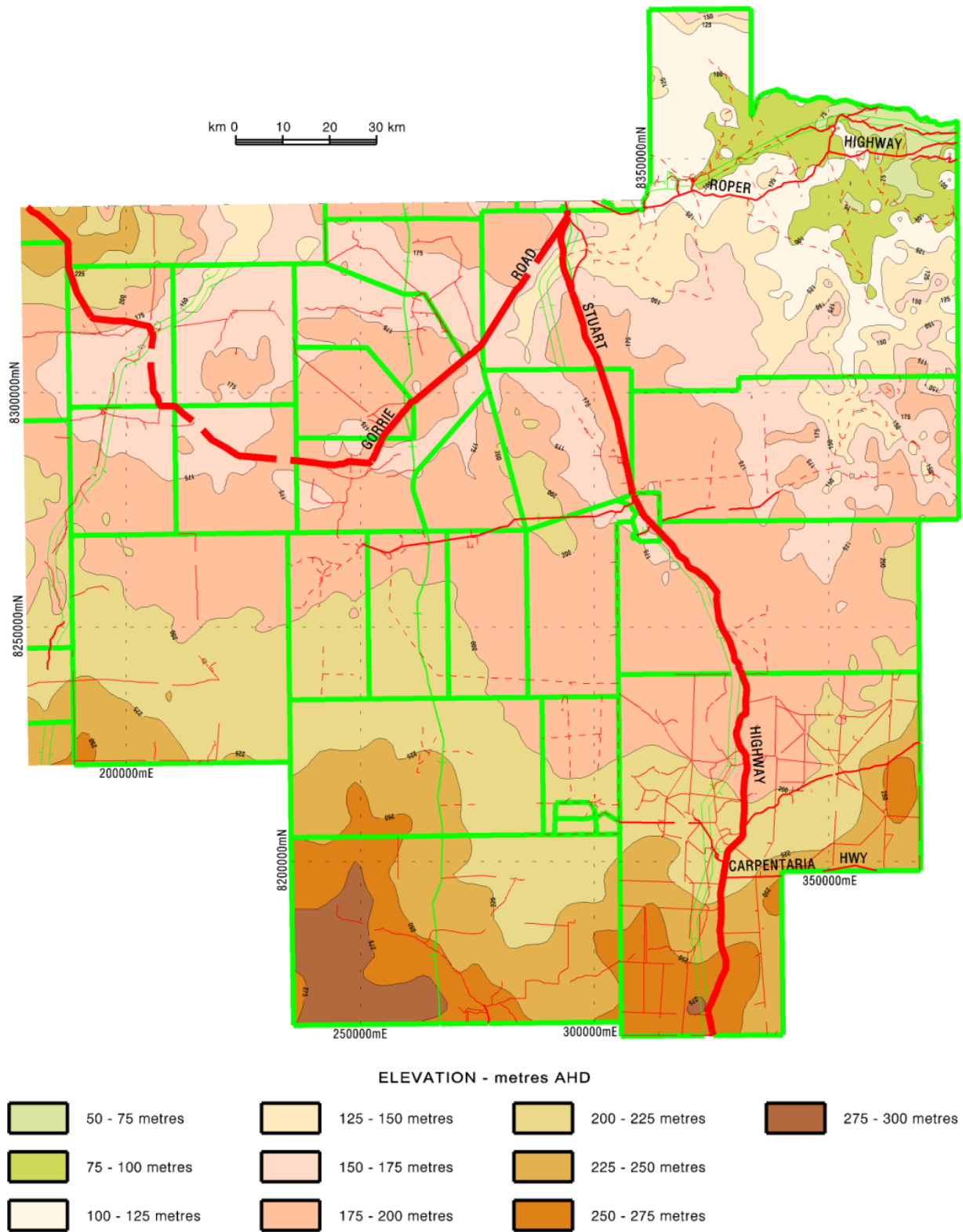


Figure 4 Physiography of the Sturt Plateau

The eastern margin of the study area extends south from Elsey Station where it is adjacent to the Roper River and is bounded to the east by upland scarps and ridges. This area represents the eastern limit of Cambrian aged sedimentary deposition and as such, forms a significant geological and hydrogeological boundary of the Sturt Plateau. Here, the Cambrian sediments abut the argillaceous and arenaceous sediments of the Proterozoic Roper Group of rocks. Physiographic features in this area are largely linear and are controlled by resilient sandstone, and erodable shale and mudstone units.

The western border of the Sturt Plateau is marked by basalt exposures skirting the edge of the Dry River catchment. The country encounters a sharp rise here before meeting the adjacent tableland and scarp country of the Victoria River catchment.

The physiological boundary representing the southern extents of the Sturt Plateau region is rather ill-defined and is best delineated by the Buchanan Highway. The road alignment approximately follows a ridge which runs from east to west, rising to elevations of over 280m in the south-western corner near Top Springs. From the ridge, the surface slopes gradually towards the north. On the southern side of the ridge, the country falls gently into the Lake Woods catchment area.

The Sturt Plateau encompasses two major catchment areas. The Roper drainage system captures all streams east of, and including the Western Creek system, while the Dry River catchment in the west eventually contributes to the Daly River. The drainage systems of the region are considered as weakly developed. Generally, channel incision is poor in the southern and central areas and it is not until the lower reaches of the Dry River and Elsey Creek are approached that some maturity is observed.

The flat terrain of the Sturt Plateau and apparent high storage capacity of waterholes, sinkholes and swamps results in the relatively low contribution (less than 10%) of rainfall to overland flow and eventual streamflow. Wet season streamflows are generally event based.

The upper reaches of the systems at the southern end of the plateau have some definition where greater slope in the land surface has allowed increased channel incision to occur. However, towards the middle reaches of both Daly Waters and Sunday Creeks the drainage paths become less defined and only exceptional rainfall events result in a continuity of flow to Birdum Creek. Less than threshold rainfalls contribute only to floodouts, waterholes and low lying swampy areas within the main drainage path. The Western Creek and Dry River systems are not entirely dissimilar.

Migration of the drainages is evident across the plateau as their relict paths and flood plains are often signified by shallow cracking clays. Of note is the evolution of the Elsey system, which has captured Western Creek, formerly a major tributary of the Dry River.

Along the eastern margin, the Strangways River and Cattle Creek form the main avenues of drainage.

1.2 Geology

Sedimentary rocks of the Cretaceous aged Mullaman Beds and tertiary laterites developed on them, form the majority of outcrops on the Sturt Plateau. They directly overlie rocks of Cambrian age – usually limestone and in some areas, basalt. On the eastern margin of the study area, sandstones, siltstones and interbedded shales of the Proterozoic Roper Group exist. A number of boreholes drilled to depth on the Sturt Plateau, and geophysical data in the form of airborne magnetics and seismic, suggest that this is probably the sub-basement formation underlying the entire region.

The Mullaman beds throughout the region are generally observed in laterised form. The ferricrete capping on the scarp country in the north-west corner and along the southern extents of the Sturt Plateau suggest they probably exist in their entirety at these locations. Elsewhere, the ferricrete horizon has been eroded and only the remainders of the lower horizons exist. Both mottled and pallid zones are usually detected beneath a thin surficial cover of alluvium and detrital material. Highly weathered to weathered claystone and siltstone units underlie the laterised zone to a depth of usually about 40m. The basal sandstone unit beneath this may be up to 10m thick, although this is highly variable. The sandstone ranges from fine to coarse and is friable. This unit does outcrop in the central part of the plateau near Gorrie and Western Creek Stations where it is found as silicified boulders to tors.

In hydrogeological terms, the remnant condition of the Mullaman Bed units have an influence on potential groundwater recharge. Where the sandstone units are thicker and closer to the surface in the southern and eastern parts of the region, there is capacity to provide some recharge to the system. The thicker clayier units in the north do not provide an avenue for recharge. The cross sections on the accompanying map provide an indication of the variability of the clay and sand units across the region.

The intersection of three vast Cambrian aged sedimentary basins occurs beneath the plateau. They are the Daly, Wiso and Georgina basins. There are indications that these basins contain laterally equivalent formations where there are strong correlations of lithology and depositional sequences. The three oldest formations within these basins are seen on the Sturt Plateau. The basal formation is known as the Antrim Plateau Volcanics or its lateral equivalent, the Nutwood Downs Volcanics. They are Cambrian aged basalt flows and were essentially deposited over a Proterozoic landscape. In the context of this report and the hydrogeology of the region, this formation is regarded as basement. Outcrops are only seen at the edges of the Sturt Plateau, however, numerous boreholes drilled within the study area have intersected this formation, indicating that it probably underlies most of the plateau. Generally, it may be expected to be in the order of 140m to 200m

thick in the study area. Near the eastern margins where outliers or anomalies in the former landscape may exist, there is some variability in its thickness. As well, it may be thin where it overlies the ridge separating the regional sedimentary basins. An attempt to map the surface of this formation was made by Randal (Reference 1).

The basalt surface is overlain by limestone. In this study, the limestone, of Cambrian age, is represented by equivalents known as the Tindall Limestone, Montejinni Limestone and Gum Ridge Formations. The entire thickness of the limestone formation is normally in the order of 150m. However, on the Sturt Plateau, erosion has resulted in only the lower units remaining extensive, and over most of the area, this represents less than 50m. Significant thicknesses of the Tindall Limestone (and equivalents) are only found where the basalt basement deepens.

Within the study area, the basement deepens towards the north-western corner underlying Dry River, and along the southern extents of the plateau beneath Hidden Valley and Kalala. In the north-west, the Tindall limestone deepens towards the Daly Basins' regional centre, considered to be north of the King River crossing on the Victoria Highway, where it is in excess of 500m. Similarly, the limestones of the Wiso and Georgina Basins reflect basement trends, deepening towards the south and south-west of the study area respectively.

The northern part of Lakefield is another area where there is a deepening of limestone. Here, the limestone extends to depth as a result of geological faulting of the Cambrian aged formations. This fault is regionally extensive and has been tracked from north of the Nenen/Manbulloo boundary to the south as far as the Buchanan Highway, and approximately aligns with the Birdum Creek system, extending along Daly Waters Creek. The vertical displacement associated with the fault in the vicinity of Larrimah is in the order of 200m.

In terms of groundwater availability, aquifers in the Tindall Limestone and its equivalents represent the most extensive water resource in the Sturt Plateau region. Where it is available, it is considered to be a suitable and reliable water source on which to base pastoral development. However, there are limitations, and in particular, where the formation's submergence is influenced by highs in the basalt basement topography.

The Jinduckin Formation and the Anthony Lagoon Beds, the formations of the Daly and Georgina Basins respectively which overly the limestones, are also present on the Sturt Plateau. The occurrence of the Jinduckin Formation is rare on the Sturt Plateau although is known to be present along the northern margins of the plateau. The Anthony Lagoon Beds have been identified in the south-east of the study area near Kalala. Aquifers in these formations represent a viable source of stock water.

1.3 Current Water Usage

Bores currently supply the vast majority of stock water needs with the remainder coming from waterholes. Where bores are used, steel tanks, and to a lesser extent, turkey nests are the popular forms of temporary storages.

During the wet and the early dry season, most of the surface water that is accessible is used, but as the dry season progresses, these sources become depleted. A few waterholes within the Western Creek and Birdum Creek systems, and those on the relict black soil plains of the Dry River can persist throughout the year. In the upland region on the eastern flanks of Vermelha and Maryfield, smaller but deeper waterholes exist.

On Elsey Station, the Roper River represents a permanent surface water source not found elsewhere on the Sturt Plateau. However, bores are still used on the station to provide for a conjunctive water supply. A few waterholes within the Elsey Creek system (eg. Longreach Waterhole) persist throughout the year.

TABLE 1 CLIMATIC AVERAGES for LARRIMAH

	Mean Rainfall (mm)	Rain Days	Daily Min. Temp (°C)	Daily Max. Temp (°C)	Daily Evap. (mm)
January	201	15	24.0	35.5	10.4
February	191	15	23.6	34.3	7.9
March	154	11	22.5	33.7	7.5
April	33	3	19.6	33.8	8.6
May	14	1	16.2	31.4	6.1
June	5	0	12.8	29.2	5.0
July	4	1	12.0	29.0	6.0
August	0	0	14.7	32.1	7.2
September	5	1	17.9	34.7	6.9
October	27	3	21.6	37.0	8.6
November	65	7	24.1	37.7	11.4
December	113	10	24.3	36.9	8.3
Total	812	67			

2. WATER RESOURCES MAPS

The map accompanying this report was compiled primarily from a four map series of the Sturt Plateau region at a scale of 1:250000. The production of the four maps involved the gathering and assessment of information from survey of literature and work in the area, study of bore records, streamflow records, geophysical data, geological maps and land unit and land systems maps.

The features on the main map and two side maps are described in the following sections.

2.1 Water Supply Development Options Map

The Water Resources Development Options Map is intended for use as a formative-planning tool, indicating suitable options for developing the water resources on the Sturt Plateau. The map classifications are based on a combination of information on groundwater occurrence, soil types and topography. However, the maps are not site specific and local conditions, such as soil types can vary considerably. Therefore detailed site investigations are recommended prior to any construction work. Ultimately, this information should be used in combination with grazing potential and land resources mapping for property development planning.

For an explanation of the colour codes on the main map, refer to the legend entitled "Water Resources Development Options". Four categories of "preferred options" have been mapped:

- OPTION 1* - Where natural waterholes exist, piping presents the most appropriate development option in this area. Man made surface water developments are not suitable and the area is not likely to produce adequate stock supplies from bores.
- OPTION 2* - Within this area, surface water developments are viable and the prospect for stock water supplies from groundwater is low.
- OPTION 3* - Groundwater is a viable option within this area, and surface water development is not suitable.
- OPTION 4* - Water supply development is viable using either groundwater or surface water sources.

2.2 Groundwater Resources Map

Groundwater prospects across the area have been assessed using information on geology, geophysics including ground and airborne surveys and from existing boreholes. The assessment of this data has enabled a more detailed side map entitled the Groundwater Resources Map, to be produced.

Generally, the map indicates that water development potential for stock supplies exists in most areas. While it may be difficult to obtain groundwater supplies in some areas, geophysical or other techniques should be used to enhance the prospect of locating successful sites. Alternatively, surface water supply options may be considered.

Three categories, representing 'average expected or likely bore yields', ranging from less than 0.5L/s to more than 5L/s, are referred on the Groundwater Resources Map. Bores yielding above 0.5L/s are generally regarded as being successful.

The expected yield is based on knowledge of the type of aquifer, and in some cases, the submergence characteristics. For example, consider a limestone aquifer. Where the aquifer submergence is greater than 20m, a bore intersecting a cavity or fractured rock will likely yield in excess of 5L/s. Where the submergence is less than 20m, but more than 5m, a yield of between 0.5 and 5L/s may be expected. In an area where the submergence is less than 5m, the likelihood of intersecting a cavity or fracturing in the formation within this interval, is low. Therefore it is considered as a poor prospect because there is a high risk of failure.

There are five different groundwater environments depicted on the Groundwater Resources map. Three scenarios of aquifer occurrence in limestone are discussed above, while other minor aquifers in the region exist in basalt and sandstone/shale formations.

2.2.1 Yields less than 0.5 L/s

Low yielding bores may be expected in areas primarily where the basalt basement subcrops above or near the water table. In such areas, aquifers will only occur on the weathered (contact) surface or at depth in fractures of the rock. The fractures are difficult to locate as generally, they are masked by a cover of Cretaceous sediments and/or limestone. Bores intersecting the weathered surface of the basalt, in some instances, may yield about 0.3 L/s, and fractured basalt may yield about 1 to 2 L/s.

The use of geophysics currently presents the most cost-effective option in locating a viable aquifer within the basalt. An appropriately designed investigation should aim to locate fractures, which can then be targeted with drilling. Costs will mainly depend on the technique used.

Other low yielding aquifers exist throughout the uplands area along the eastern margin of Elsey Station. They are in basalt, dolerite, siltstone, shale and greywacke rock types. These rock types are featured sometimes as 'mixed' with or within the sandstone beds of the area. While some consistency in locating successful bore sites in weathered shale and siltstone beds is noted, the other rock types are generally not favourable unless associated with faulting. Bores 3545 (no. 5 bore) and

5047 (Mt. Sir James bore) have been successful in locating a supply *beneath* a layer of basalt. This zone is considered to be of moderate to poor prospect for successful bores and some assistance, such as geophysics or aerial photograph interpretation, is recommended to enhance the likelihood of success.

2.2.2 Yields between 0.5 L/s and 5 L/s

This yield category is considered to provide the minimum required for stock watering. There are two groundwater environments in which this category may occur. They are in the limestone underlying the majority of the map area and the sandstones which flank the eastern margin of the map.

Bores in the limestone can range in yield from nil to more than 5 L/s. There is some inconsistency in success and yield from bores in limestone due mainly the natural variations and rather arbitrary occurrence of cavities and fracturing in the rock. Refer Section 3.1.1.

In the central southern part of the plateau, a system of parallel ridges and troughs trending north-west/south-east on the surface of the underlying basalt also has a major affect on groundwater prospect. It may be difficult to locate viable areas where the higher ridges intersect or approach the water table. A map showing these features is shown in Figure 5 and is considered an essential tool in bore site selection within the affected areas. A 1:250000 scale working copy is available from the Natural Resources Division upon request.

Sandstone outcropping as ridges and low hills forms the upland country extending along the eastern flank of Elsey Station and is noted for difficult access to some parts. Localised aquifers occur in weathering features, and fractures associated with faulting. Most station bores drilled in this area obtain adequate stock supplies from this aquifer type. Site selection for stock bores does not appear to be critical as aquifers may be expected to occur consistently across the zone.

2.2.3 Yields more than 5 L/s

Such yields are generally only available where there are significant thicknesses of limestone beneath the water table. For the purposes of this map, this zone are based on aquifer submergence exceeding 20m. This will occur where the basalt deepens. Within this zone, there is only a low failure risk for stock bores.

One of the primary areas of potential high yield is featured in the north-west corner near Dry River Station. This area may be identified as the southern extent of the Daly Basin. From here, the trend of the Tindall Limestone is to descend towards the basin's regional centre.

A similar trend is repeated to the south of Hidden Valley, and south-east from Kalala as the limestone deepens into the Wiso and Georgina Basins respectively.

Regionally extensive geological faulting may be tracked from north of the Nenen/Manbulloo boundary, to the south as far as the Buchanan Highway, aligning approximately with Birdum Creek for some distance. This has resulted in the existence of the Tindall Limestone at depth to the east of the fault. The vertical displacement associated with the fault in the vicinity of Larrimah is in the order of 200m.

2.3 Surface Water Map

Few man made surface water storage constructions exist on the Sturt Plateau. The flat topography, low runoff potential of the area and high evaporation rates may make excavated tank and dam construction unattractive as primary water source options. However, regardless of the difficulties that these factors pose, surface water development options do exist for most areas and formal and purposeful design will provide these options. Even if preferred as secondary options, shallow tanks or dams need to be considered and are encouraged to permit greater spread of pasture land for at least the early part of the dry season.

The region's suitability for surface water development has been assessed by broadly adapting the land systems classifications and supplementing this information with field testing. The Land Systems Classifications (Reference 2), which integrate factors including topography, soil and vegetation types provide an approximation to relative runoff characteristics. Field investigation at a number of localities has allowed assessment of site suitability in terms of depth and clay content and enabled comment on the water retention characteristics of various soils. The results are presented as the Surface Water Resources Map, one of the side maps accompanying the Water Resources Development Map. However, it should be noted that the broad scale of this map is primarily for planning purposes and does not preclude the need for site specific investigations.

Three categories describing the suitability for surface water storages (ie. excavated tanks and dams) have been mapped – *suitable*, *locally suitable* and *unsuitable*.

2.3.1 Suitable for Excavated Tanks and Dams

On the Sturt Plateau, these are largely areas of relict flood plains or the gently undulating country which forms the majority of the plateau. Massive surface cracking clays, up to 2m in depth, are featured on the flood plain areas. On the plains, shallow gravels, moderately deep sand and red and yellow loam soils predominate. It is gravelly where laterite

has developed. The clay content ranges from good to marginal through the profile.

The surface runoff is moderate to low in these areas. Surface water development is usually feasible in most areas as clayey soil is at least 2m thick. Developments are not usually undertaken in gravelly laterite (ferricrete) areas, although shallow water storages may be possible if the ferricrete is “worked”. There may be some variability in conditions and in some cases, the economic viability may be marginal and should be examined.

2.3.2 Locally Suitable for Excavated Tanks and Dams

This category is limited mainly to the relict channels of Elsey Creek and the Dry River. These areas contain variable soils – from cracking clay to sandy and gravelly soils and often the coverage is over shallow rock. The surface water runoff is considered moderate. Surface water developments are feasible where the base rock is rippable and the upper profile is clayey. Site work is recommended to confirm this and also determine the presence of rock.

2.3.3 Unsuitable for Excavated Tanks and Dams

This category is often featured by gravelly laterite (ferricrete) or shallow residual limestone. The intact ferricrete profile generally exists as the capping rock on the Mullaman Bed surface in the north-west and towards the central southern region of the Sturt Plateau. The surface water runoff is moderate. The ferricrete profile is not usually recommended for surface water development due to high permeability.

The eastern margin of the study area is described as hilly country with ridges. Rock outcrop and skeletal soils are mostly based on Lower Proterozoic sandstone or shale. Although the runoff is high, surface water storage development not usually feasible due to the rugged terrain or poor water retention characteristics of the soil. Hillside storages may be possible at the base of escarpments and hills, however, high-quality design is recommended.

3. GROUNDWATER

The main source of water on the Sturt Plateau is groundwater. For stock watering, bores are typically constructed of 150mm steel or PVC casing. The most popular pumping installations are the diesel generator and submersible pump combination or diesel motor with a line shaft helical rotor pump. The delivery rate is usually between 2 and 3 L/s if possible, and the pump is run for two days out of four. The water is pumped to a steel tank or turkey nest with at least two days storage capacity. Troughs are usually float controlled and fed under gravity from storage.

3.1 Aquifer Types

A number of aquifer types are identified within the study area – Cambrian limestone, basalt and Proterozoic sandstones, siltstones and shales.

3.1.1 Cambrian Limestone Aquifers

The vast majority of bores exploit the water resources in the limestone formations of the region. The limestone, known as the Tindall Limestone and its equivalents, the Montejinni Limestone and Gum Ridge Formations host these resources as a single, extensive aquifer system. Within the mapped area, they underlie all but the eastern margin. The discharge from this system is known to sustain the many springs in the reach of the Roper River approximately between Mataranka and Elsey homesteads and the Flora River in the vicinity of the National Park.

The aquifer system is termed karstic - a term which describes a landscape resulting from dissolution and weathering of limestone, and usually noted for cavern development. An aquifer thus formed comprises a myriad of interconnected cavities and fractures within the host rock, and which allows groundwater to move through it (Plate 10). Successful bores intersect submerged cavities, voids and fractures in the rock. The surface expression of underlying limestone is often in the form of sinkholes where a cavity has collapsed. On the Sturt Plateau, these features are innumerable (Plates 4 and 7).

The Tindall Limestone Formation is signified by a distinct sedimentary sequence including crystalline limestone to maroon coloured mudstone, and in its entirety, is approximately 150m thick. Due to post Cambrian erosion, only the bottom 30 to 40m of the formation remains in a large part of the central Sturt Plateau area. Correlation of stratigraphy using geophysical downhole logging indicates that more than four of the bottom units are rarely seen. The two lowest units often vary in thickness, and sometimes are not present. In terms of the aquifer system, the bottom limestone unit is often the only viable target, representing the only unit below the water table. Where it is thin or does not exist, the likelihood of bore success diminishes.

The limestone was deposited over a relatively flat basalt landscape now considered as basement. Within the central portion of the map area, a system of parallel ridges and troughs trending north-west/south-east existed. The use of geophysics (aeromagnetism) has enabled these features to be mapped through the overburden (Reference 3). This map is represented on Figure 5.

The presence of the features has had a profound effect on the deposition of the lower units of the limestone and subsequently, the groundwater regime. The higher ridges affect groundwater flows where they intersect or are near the water table and represent zones, which are non-prospective for groundwater. It is therefore important that bores target the troughs, and the map on Figure 5 will aid in their site selection. A larger scale working map is available from the Natural Resources Division.

Elsewhere, the submergence characteristic of the limestone represents the single most important factor determining bore success, and for the most part, is considered viable.

3.1.2 Proterozoic Sandstone, Siltstone and Shale Aquifers

Data on these aquifers are scant. Most bores intersecting these aquifer types are concentrated in the “traditional” part of Elsey Station. They provide water supplies to paddocks adjacent to the Roper Highway and Roper River.

The sandstone, siltstone and shale of this area represent Roper Group Formations. The rock is highly weathered and aquifers have developed in localised fractures and weathering features.

The sandstones appear to be more favourable, however bores in these aquifers usually produce adequate stock water. Aids such as aerial photograph interpretation or geophysics may be considered to enhance the prospect of success.

3.1.3 Other Aquifers

The Cambrian Jinduckin Formation overlies the Tindall Limestone and consists of sediments of dolomitic nature with limestone, sandstone siltstone and mudstone. It has eroded off over most of the Sturt Plateau and only exists in the northern part of the map area. The formation hosts viable aquifers within the fractured siltstone, sandstone and limestone beds in the vicinity of Lakefield and Elsey west. In the northern part of Dry River Station it is situated above the water table.

A few bores exploit basalt aquifers in the region. However, there is low prospect for groundwater in the basalt as occurrences depend on

fractures in the rock. The fractures are difficult to locate as generally, they are masked by a cover of Cretaceous sediments and Tindall Limestone. Bores intersecting the weathered surface of the basalt, in some instances, may yield about 0.3 L/s, while fractures will usually yield 1 to 2 L/s.

Within this map area, a number of bores have been drilled through the basalt which indicate there to be a variation in thickness of the basalt – from less than 50m to 200m. The thinnest zones overlie outliers and highs on the former Proterozoic land surface.

An aquifer in sandstone is known to exist beneath the basalt, and water quality ranges from good to saline. However, with this limited information, the extent of the resource, its recharge mode, water quality variations and resource sustainability cannot be adequately assessed.

3.2 The Groundwater Systems

For the purposes of this report, the only system to be discussed is the limestone aquifer which is extensive in the region. Other aquifers mentioned in this report are localised or are of limited knowledge.

Groundwater level monitoring information for this aquifer is limited and hence only qualitative assessment is made at this stage. Continuous groundwater level recorders installed in bores 28087 (Tarlee) and 30695 (Dry River) are being used to acquire monitoring data and so far, indicate that the magnitude of seasonal rise and fall is less than 0.5 metres. However, records over the above average wet seasons of 2000/01 and 2001/02 indicate that significant rises in the water levels occurred.

A collation of all available water level information in the region has enabled the mapping of groundwater movements (refer water level contour map in Figure 3, Reference 4). This map indicates that the regional groundwater flows are generally directed towards the north and that the spring discharges in the Flora and Roper Rivers are fed by this groundwater system. Spring fed dry season flows in the Flora River are in the order of 2 – 3 cubic metres per second, while in the Roper River, flows are 1 – 1.5 cubic metres per second.

Recharge to the aquifer is largely from infiltration of rainfall either through the ground surface or via the many sinkholes featured in the region. As reported by locals, many sinkholes do not hold water and any ponded water is only retained for a matter of hours.

Direct infiltration of rainfall is controlled by the nature of the overlying strata. The thick clayey profile of the overlying Cretaceous sediments would preclude this as an avenue of recharge over a large area. Analysis of the water quality variation across the Sturt Plateau contours indicates that most recharge occurs in the southern region.

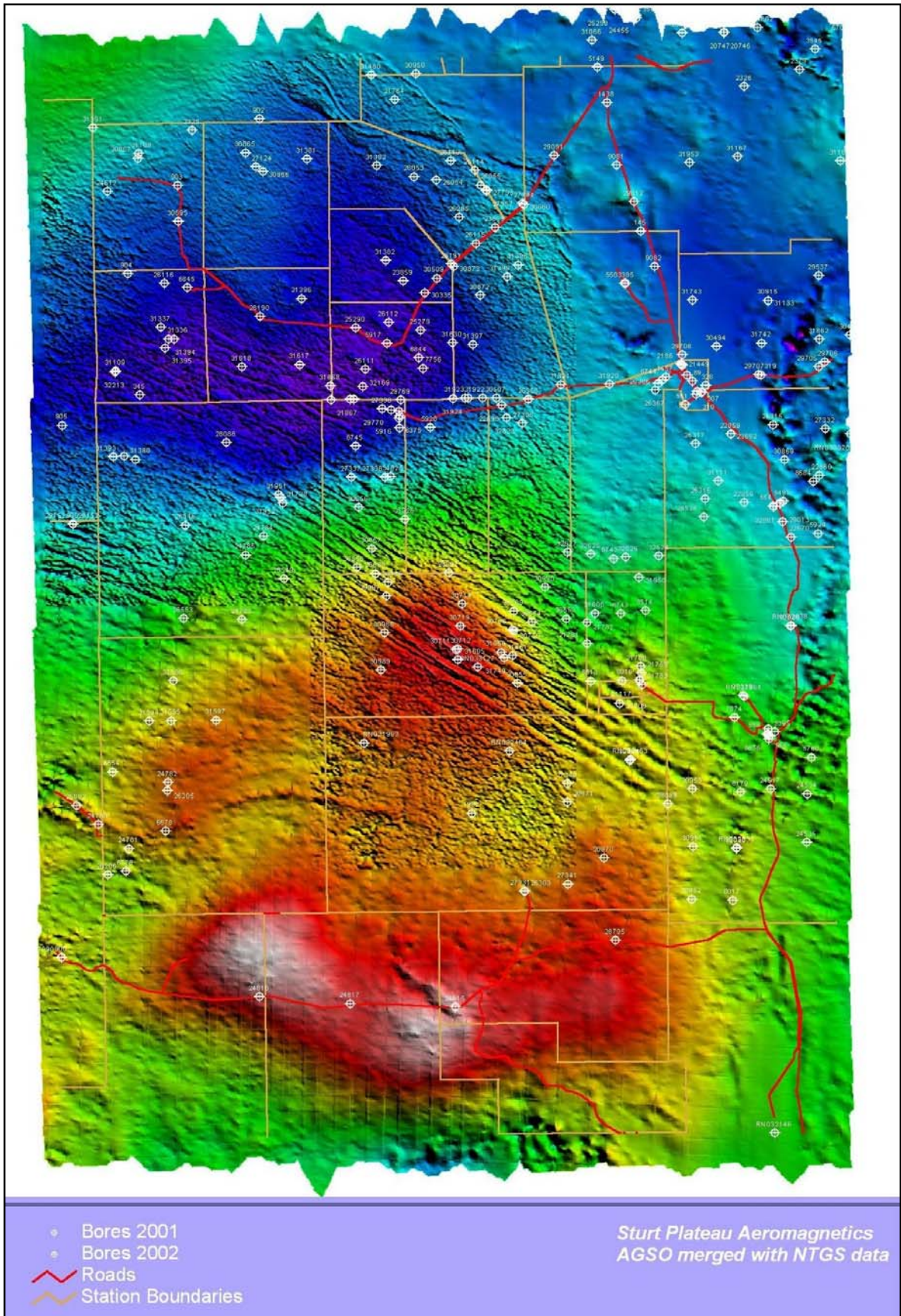


Figure 5 Total Magnetic Intensity Map

4. SURFACE WATER

Two major river systems drain this map area - the Dry River and Western Creek systems. The Western Creek system drains to Elsey Creek in the north-east of the Sturt Plateau. For the most part, the land is described as broad, flat to gently undulating plains and is typical of the Sturt Plateau. Of particular note is the lack of well-defined drainage paths across much of the country.

Flow records exist for both the Dry River and Elsey Creek. These records are indicative of the general runoff characteristics over the Sturt Plateau where only a small percentage of rainfall (less than 10%) eventually contributes to sheet flows over the catchment. Flow only occurs during the wet season after the catchment has been adequately wet or following significant rainfall events. Initial wetting of the catchment may account for up to 40% of the total seasonal rainfall each year. See side graphs for Dry River flow and indicative regional rainfall data.

Typically, the drainage systems on the Sturt Plateau deplete to form isolated pools in the rivers, and waterholes on the relict channel (black soil) areas of the flood plain. The majority of these are dry by about August or September. Longreach waterhole, downstream of Warloch Ponds, is an exception. It is a perennial waterhole and is considered to be maintained by a shallow water table in the groundwater system of the area.

The Roper River in the northern part of this map represents the only permanently flowing surface water supply on the Sturt Plateau. The availability of permanent water made possible the establishment of Elsey Station, its subsequent development along the river and the Roper Stock Route. Many springs in the Mataranka area, and in the reach of the river as far as Elsey Homestead, maintain its flow throughout the year.

The major drainage systems in the eastern map area include the Strangways River, Cattle Creek and Elsey Creek - each draining into the Roper River, however, representing different catchment types. The Strangways River and Cattle Creek drain the ridge and rocky, sometimes sandy, undulating and dissected country of the uplands area on the eastern part of Elsey Station. Although runoff from this area is good, the generally difficult nature of the terrain and presence of shallow rock makes it unsuitable for cost-effective tank excavation and dam construction.

4.1 Waterholes

In the dry season, natural waterholes are found in depressions in streambeds and in the black soil areas of relict floodplains. Most are shallow and become dry a few months after the end of the wet season. The available capacity of such waterholes may be increased by excavation of the base, but only where clay or a rippable and impermeable rock underlies the site. The storage

capacity of a well confined waterhole with high banks could be increased by construction of a bund at its downstream end. The bund would need to be designed and constructed to withstand flood flows.

Examples of waterholes in the study area exist mainly on the present day and ancient Dry River channels and adjacent floodplains. The relict Dry River watercourse runs from Gilnockie through Larrizona and north to Dry River Station. Most of these waterholes do not persist through the dry season.

In contrast, many large, deep waterholes on the Western Creek system have formed within its current path and are perennial. On Gorrie, the waterholes appear to have been influenced by the development of large sinkholes (Plates 1, 9 and 20). Rocky Waterhole (Plate 12) at Vermelha Station is an example of a 'watertable window' fed by drainages from surrounding small aquifers.

4.2 Tanks and Dams

By its nature, monsoonal rainfall in the Top End gives rise to discrete, sometimes significant flow events in local drainage systems. Dam construction types, which are sympathetic to this regime but enable effective and adequate harvest of surface water, are limited. As well, the general lack of defined drainage courses on the Sturt Plateau further limit options.

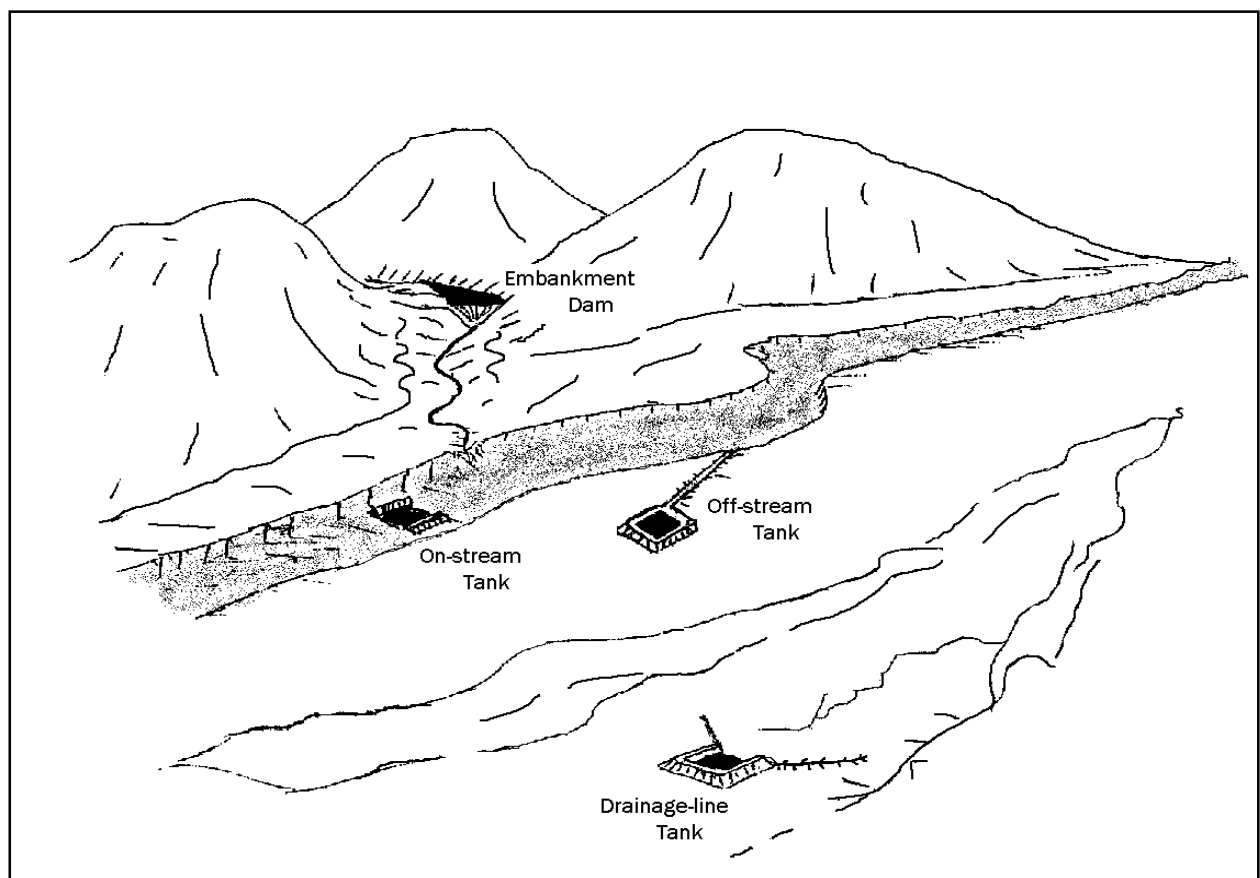


Figure 6 Types of Tanks and Dams

Three types of excavated tanks are suitable for the generally flat to gently sloping plains of this map region. They are on-stream tanks, off-stream tanks, and drainage-line tanks (see Figure 6). An on-stream tank is one which is constructed in a well defined stream channel. Off-stream tanks are constructed away from the main channel but are connected to it by an excavated inlet channel. The third type, the drainage-line tank is the preferred option and is one which is sited along a broad poorly defined watercourse.

The on-stream excavated tank requires a high standard of design and construction and is prone to erosion and silting because of its location in a fast flowing main stream channel. The off-stream design, indicated in Figure 7, reduces these problems by using a man-made channel to divert water from the stream to the tank. This is an improvement on the on-stream design, but has excessive excavation costs because to take advantage of short duration stream flows, the tank level must be below that of the natural stream bed.

The drainage-line tank or hillside storage is constructed in flat to moderately sloping areas where there are no clearly defined incised creeks. This type of construction is considered the most suited to the environment of this area. The tank itself is of the same design as the off-stream one, but without an inlet channel (see Figure 8). Sheet flow on the plains, with its low silt load, may be harvested. Catch drains or wing walls directing flow towards the dam may be used to enhance interception capacity.

Some common problems experienced with excavated tanks include the following:

- inadequate spilltail channels do not direct water away from bunding
- erosion of wing walls
- silting of catch drains

Regular maintenance is required before the wet season to correct these problems.

Another type of dam, the gully or embankment dam, is suited for undulating to hilly country and consists of an embankment built across a drainage line. It should be noted that structural failures are high amongst gully dams, as they require a high standard of design, construction and management. Within the map region, low hilly country is only predominant in the north-western part of Dry River Station. At this location, this type of construction may not be economically feasible due to the nature and permeability of the gravelly lateritic soils.

Construction of gully dams involves potential high costs in dealing with the foundation and mitigation of flood flows with diversion through an adequate by-wash or spill. It is recommended that appropriate planning and design be undertaken, particularly for construction on rock foundations.

The “Earth Movers Training Course” booklets 9 and 10 (Reference 5), and “Design and Construction of Small Earth Dams” (Reference 6) are both

excellent background guides to dam building and design. However, it is important that the information be considered in conjunction with local knowledge as many of the dam types in the booklets are only applicable to the less extreme conditions experienced in southern climates.

4.3 Selection of Sites for Excavated Tanks

The availability of runoff and depth of impermeable soil are usually the determining factors in site selection for excavated tank construction. Conditions appear to be mainly favourable across a major part of the map area as it comprises gently undulating plains to low hills, and the soil has been indicated to be of adequate clays and to sufficient depth. However, site-specific investigations are recommended to confirm that the proposed tank site is suitable (Plate 6).

In areas mapped with cracking clay (black) soils, such as the relict drainage paths of Western Creek and the Dry River, the clay may extend to depths of about two metres in most places and will be suitable for excavated tanks. However it should be noted that this is unlikely to be sufficient depth to be economical, and hence underlying soil conditions should also be investigated to confirm viability.

A drainage-line tank is best suited to this country where there is flat or gently sloping ground. Excavation will be minimised where the tank site has some slope, say about 1%, to allow bunds constructed from excavated material to add to the storage volume of the tank. Drainage-line tanks may also be feasible in areas immediately adjacent to the low hilly country on rippable laterite horizons if there is sufficient depth of clayey soils (Plate 18).

A few areas have been mapped indicating where ferricrete is predominant on the surface. This rock, in its 'in-situ' form is highly permeable and would appear to be non-prospective as a foundation for shallow dam or tank construction. However, Avago and Hidden Valley have conducted informal trials in such areas using small holding dams, and report that success has been achieved over a short period of time, simply by allowing animals to 'work' the soil in the base. After the soil is 'pugged in', a seal is effected. A number of landholders, through personal communication, report a similar result is commonly noted in sinkholes, where once freely draining 'holes' are 'pugged' when animals are allowed access into them.

Areas mapped with variable soils are minor, however may also be suitable for excavated tanks. In these areas, there is a likelihood of encountering dispersive or sandy profiles, or high permeability zones and these should be avoided. Remedial work such as installing a clay or plastic liner brings added expense, however would be necessary.

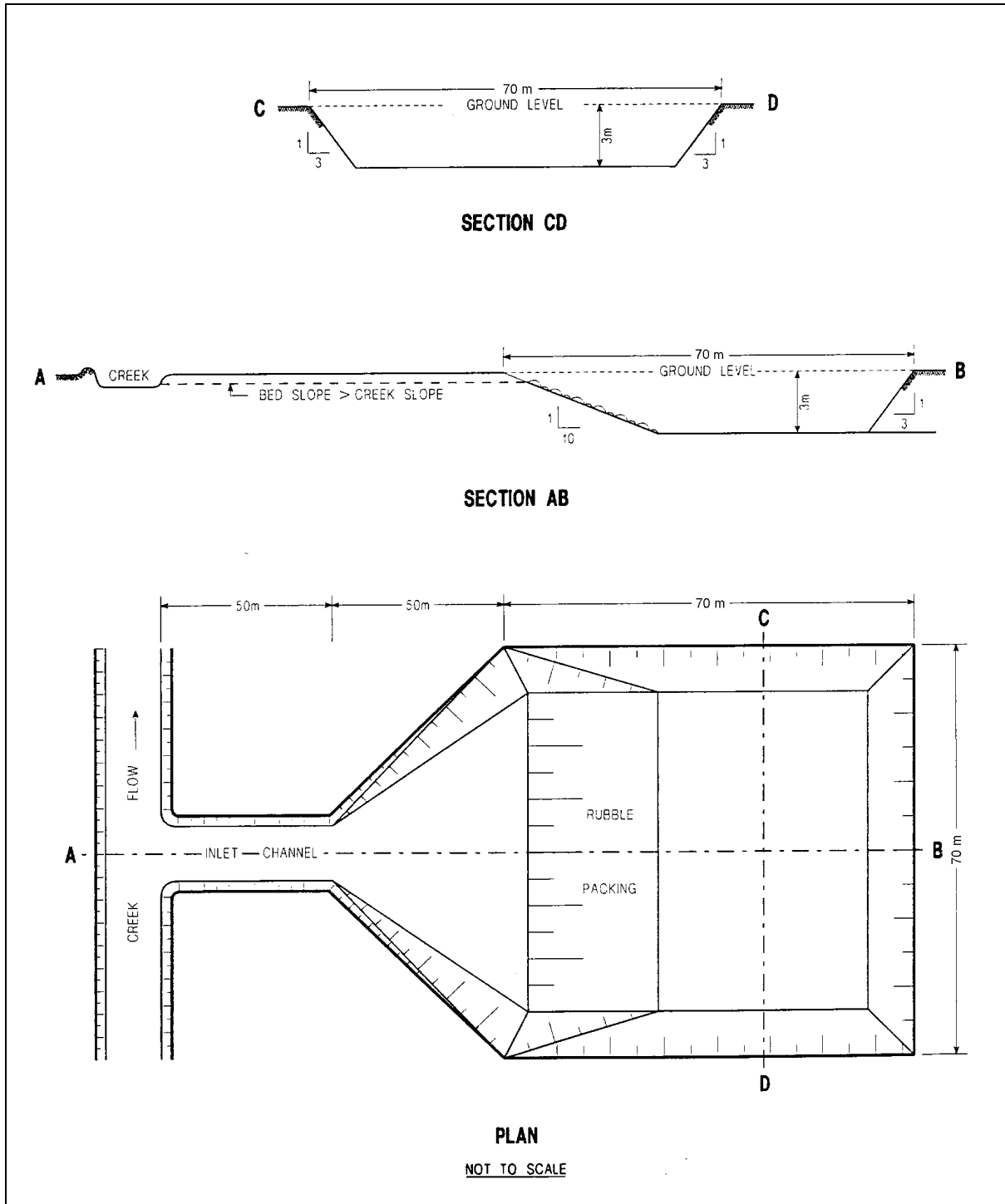


Figure 7 Typical Off-Stream Excavated Tank

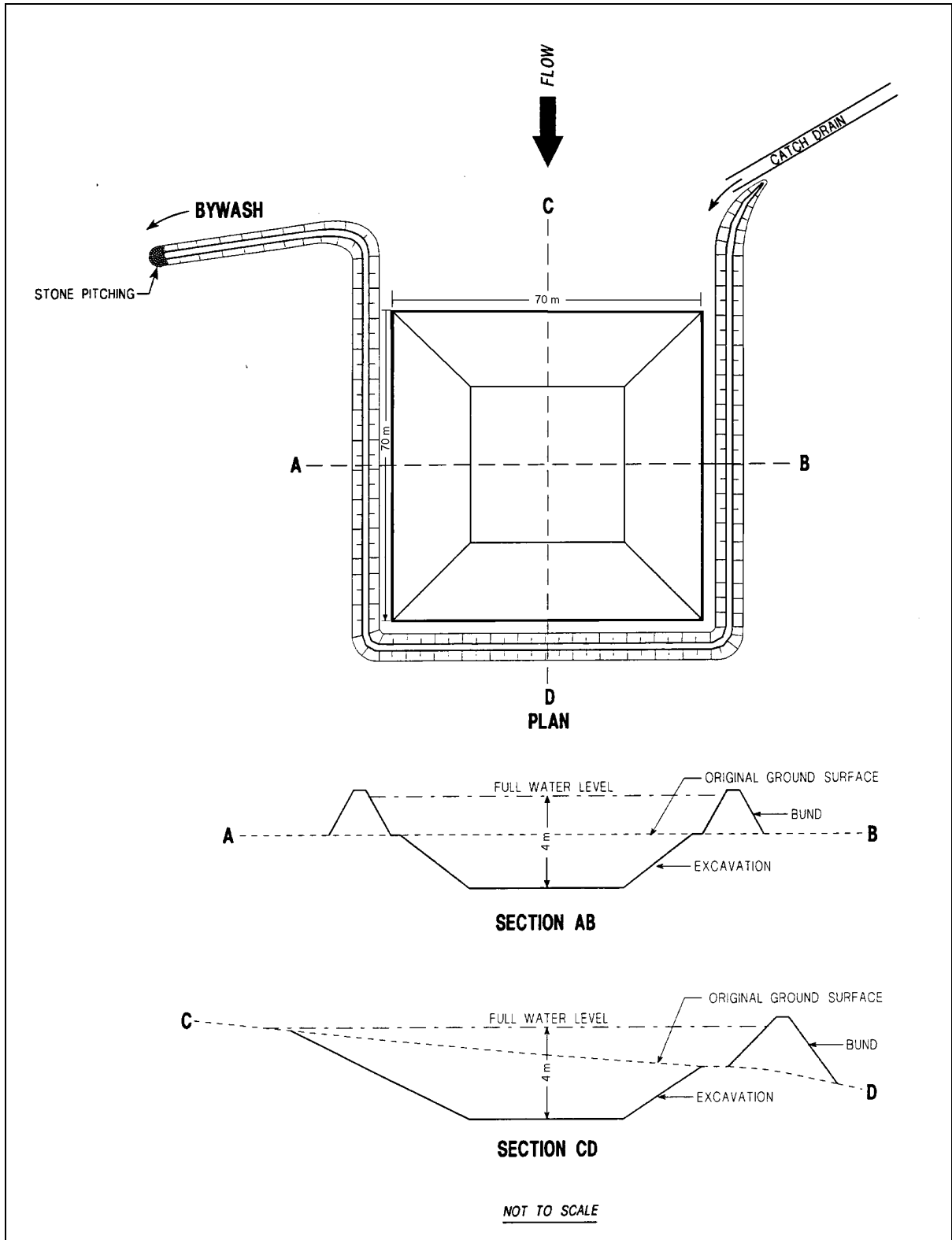


Figure 8 Typical Drainage Line Excavated Tank

4.4 Excavated Tank Site Investigations

Having determined a catchment capable of supplying stock quality water for the required stock numbers, site investigations must be undertaken to confirm that the proposed tank site is suitable. The site investigation guidelines presented here are based on a booklet entitled "Design and Construction of Small Earth Dams" (Reference 6). The key investigation method is to auger a series of investigation holes (Plate 6). In an excavated tank situation this helps to:

- determine the extent of impermeable soils and the presence of any layers which are likely to present leakage problems
- show if there is any impermeable and soft rock present, such as rippable hard clays or laterite
- ascertain whether shallow groundwater is present, and if so, is it suitable for stock
- provide information on the soils to ensure the tank sides will be stable
- If an on-stream tank is proposed, then spillway conditions will also require investigation. If it is too sandy it will erode and wash away or if it is in rock, excavation could be very expensive.

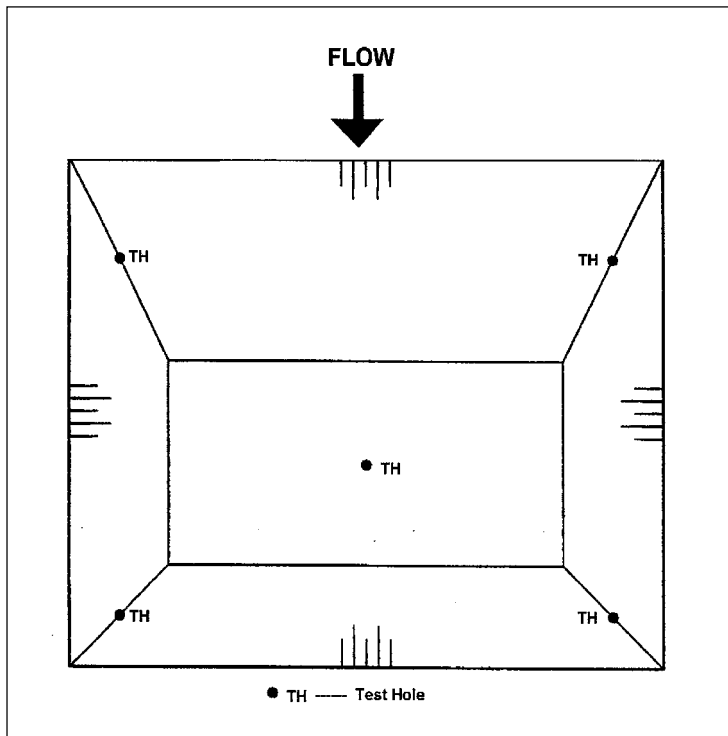
A hand operated 100 mm earth auger capable of drilling to between 5 and 6 metres is the basic tool for the sub-surface investigations. Auger holes are sunk in soil to one metre deeper than the tank design depth, with minimum 500 gram samples taken wherever there is a change in soil. A plan of the soil changes down each hole should be kept to compare variations from hole to hole. Excavated tanks require a minimum five test holes, one in the centre and the other 4 positioned at the mid point of each corner slope of the proposed tank (Figure 9). For the modification of an existing waterhole, auger holes are sunk at 50 metres apart along the centre of the bed, and 100 metres apart along the edges of the bed.

- The site for proposed excavation must fulfil three main conditions :
- the loss by seepage must be relatively low
- the sides must be stable
- silting must not be excessive

4.4.1 Seepage Loss

In most areas, the water table will be deeper than the proposed 3 to 4 metre tank depth. Hence leakage of stored water through the sides and base of the tank is possible. A simple permeability test can give an indication of potential leakage from the tank using the series of auger holes used for soil sampling. The following procedure is proposed but is only indicative:

- Pre-soak each hole for at least 1 hour before starting the test by filling the hole to exactly 0.5 metres below ground level. Maintain the water at this level by topping up as necessary.
- The test is a measurement of the amount of water needed to maintain the water level at 0.5 metres below ground level for one day. Once the test is commenced, the amount of water added is recorded. This should continue for one day.



If the water added exceeds 30 litres per hour, then the site is too permeable for an excavated tank. If it is between 3 and 30 litres per hour then the site is considered doubtful. Some work would be needed to limit the water loss rate or to increase the sealing capacity of the tank floor (eg. use plastic liner or clays). Seepage rates less than 3 litres per hour indicate that leakage will not be a serious problem.

Figure 9 Test Hole Plan for an Excavated Tank

4.4.2 Tests on Soil Samples

Soils commonly consist of particles ranging in size from coarse gravels, through sands and silts, to very fine clays. Gravels and sands can be readily identified by appearance and feel, and unless they are mixed with finer silts and clays, will be prone to leakage. Clays and silts are indistinguishable when dry. While clay is one of the most useful soils in dam building, silt, when wet, is the most troublesome. It tends to be unstable in the presence of water, often collapsing when saturated.

Generally, a favourable site investigation result will confirm the presence of non-dispersive clays that bind together any coarser particles to create a water holding material. Accurate classifications of soil types can be undertaken by sending at least 100 gram of sample to a soil laboratory to provide confirmation of soil suitability. However, simple field tests can give a good indication for the likely behaviour of the soils.

- A simple test to differentiate clay from silt is to moisten the sample and feel it. Clay should be sticky. Pinch a sample between the thumb and forefinger; if it is clay it should be possible to form a flexible ribbon about 1.5 mm thick and at least 40 mm long.
- If the presence of clay is established, then the water holding potential of the soil can be tested using the "bottle test". The bottom of a one litre plastic drink bottle is cut off. The bottle is inverted and one-third filled with the soil to be tested. The bottle is filled with water. If no water seeps through the soil in 24 hours, it has good water-holding properties.
- All clays should be tested for dispersion. Some clays break down in water to form a suspension of clay particles throughout the water. This is dispersion and has been the cause of many dam failures. To test for dispersion, take 5 to 10 grams of air dried soil crumbs and drop them into 100 ml of distilled water in a cup. Allow it to stand for at least one hour without shaking. If the water appears cloudy then dispersion has occurred and special care will be needed if building tanks in these materials. The presence of deep erosion gullies suggests markedly dispersive soils and that these sites should be avoided.

If site investigations show that there is likely to be problems with any of these factors then professional advice should be sought, and remedial measures may be possible. However it may also be necessary to abandon the proposed site.

4.5 Design and Construction of Excavated Tanks

In this section, empirical calculations are used for example purposes only. However, the examples serve to demonstrate typical dimensions which may be encountered on the Sturt Plateau.

The design dimensions for an excavated tank are determined by the number of stock in the paddock to be watered. This is often governed by the carrying capacity of the country and grazing radius. On the Sturt Plateau, this would be typically between 400 and 800 head. Based on a consumption of 50 litres per head per day, the corresponding water requirement is between 6 ML and 12 ML for the 9 month period from April through to December. With a depth of about 4m, which is the minimum preferred for good reliability and 1:3 batters, the larger tank would measure approximately 70m square at the top.

Following from this example, a storage of 12 ML (if neglecting evaporation and leakage losses) as a drainage-line dam would need a minimum catchment area of about 1 km² for the typical environment. This figure assumes an average annual rainfall of 700mm, a runoff threshold of 60% of rainfall and a runoff coefficient of 5%. For tank sizes of larger or smaller storage capacity, the required catchment area would need to be varied correspondingly to capture the required amount of runoff.

The proposed design is indicated in Figure 8 and is relatively simple. Excavated soil can be dumped to waste or used to build a bund on three sides of the tank. Bund and wing walls will increase the storage capacity of a drainage-line tank where there is a moderate slope on the natural ground surface. The excavated volume in this example is large for the proposed design dimensions (approximately 10,000 m³) so construction costs will be high (usually in the order of \$1/m³). The cost will also be influenced by ground conditions.

An off-stream tank shown in Figure 7 is similar and with 12ML capacity. However, its 'filling' capability is controlled by the elevation of the inlet channel in relation to the creek bed and the nature and frequency of flow in the creek. The hydrology of the creek would therefore need to be examined to enable a viable tank to be designed.

4.6 Construction Details of Excavated Tanks, Turkey Nests and Modified Waterholes

Assume preliminary investigations have been conducted and indicate that suitable conditions exist for the proposed construction. The integrity of the structure now hinges on the construction methods utilised.

4.6.1 Drainage-Line Excavated Tanks

The site is first cleared of vegetation and the planned tank laid out on the ground using marker pegs. Excavation is commonly carried out using scrapers or bulldozers. If the tank is in an area with some slope (say greater than 1 in 100), excavated material can be used to construct bunds around three sides of the excavation to increase the storage capacity. The bund should have a minimum berm width of 5 metres (Figure 8). Topsoil with potential for leakage must be removed down to an impervious layer before the bund is built, and compaction may be undertaken using the available machinery. The ideal time to achieve optimum compaction is early in the dry season when soils are still slightly moist.

Three sides of the tank are excavated with a slope of 1 in 3, and flow enters the tank through the side with a mild slope, as low as of 1 in 10. The inflow side may be rubble packed to prevent erosion. Where the excavation is in rock, with little chance of erosion, the inlet batter may be increased to 1 in 4 to decrease the volume of material to be removed. The recommended slopes allow for machinery to enter the tank, excavate, turn and exit with ease.

Catch drains can also be constructed (eg. using a tilted grader blade) to effectively increase the interception capacity of sheet flow towards the tank.

4.6.2 Modifying Waterholes

Modifying a waterhole usually means constructing a narrow excavated tank within the waterhole to increase its storage capacity. Site investigations are critical. If the subsoil is impermeable, non-dispersive, and there is no rock within two metres depth, then excavation should be possible using a scraper. The presence of rock will usually require the use of rippers for excavation. The longitudinal batter could be 1 in 3 or less, while the cross sectional batter should not be more than 1 in 2.

4.6.3. Turkey Nests

The current design and construction techniques for turkey nests are quite sound although special attention should be paid to:

- removal of leaky topsoil from the base before construction
- the selection of a non-dispersive soil as the construction material
- compaction at optimum moisture content. This can be achieved if construction is undertaken early in the dry season while the soil is still moist. Every 100 mm layer of loose soil should be compacted.

The table below gives examples of recommended dimensions, sized for turkey nests of a three day water supply capacity.

Number of Cattle	Inner Diameter At Base (m)	Inner Diameter at Top (m)	Total Height of Turkey Nest (m)	Draught (m)
250	4	13	1.8	0.8
400	6	15	1.8	0.8
600	6	16	2.0	1
1000	6	18.5	2.5	1.5

These figures are based a slope of 1 in 2.5 for the inner sides. The capacity of the tank (in terms of number of cattle) allows for leakage, the overflow standpipe to be 0.5m below the top of the tank and the outlet pipe supported 0.5m above its base. The draught is the depth of available water in the tank and is effectively the tank's storage capacity.

5. WATER QUALITY

The groundwater quality in the area is usually suitable for human consumption in accordance with the National Health and Medical Research Council (NHMRC) guidelines 1996 for potable water and always suitable for stock. A measure of salinity, known as the total dissolved solids (TDS), is considered the primary indicator of water quality. The desirable limit for human consumption is 500mg/L, although up to 1500mg/L is acceptable. Cattle will tolerate TDS up to 7000mg/L. Tables 2 and 3 respectively, summarise the water quality guidelines for potable and stock use. Appendix 3 provides all water quality data for the mapped area.

It may be noted that there is a wide range in water quality. The existence of a number of aquifer types, regional flow regimes and variable recharge conditions have a significant influence on water quality. These conditions are discussed in detail in Reference 4.

Although the limestone aquifer is largely continuous across the plateau, a number of different water quality groups may be identified within it. For example, typical TDS values in the Hidden Valley, Avago, Western Creek and Sunday Creek areas are less than 500mg/L. This water quality improves along the western flank to as far north as Dry River, TDS generally decreasing by about 100 mg/L. The zonation of water quality in the western part of this region is largely influenced by direct infiltration of sinkholes.

However, in the Daly Waters area, TDS are over 1000mg/L. The higher salinity here is the result of a combination of carbonates, and sulphate and sodium chloride salts. Local recharge in the area is identified as the probable cause - elevating chloride levels to over 200 mg/L and sulphate levels to 100mg/L above the surrounding area. Further east of Kalala, the water quality differs and TDS are in the range of 700mg/L to 1100mg/L. Groundwater quality northwards from Kalala to Elsey and discharging at springs along the Roper River, is the resultant combination of these waters.

A marked decrease in water quality is featured in the region of Djilkmिंगgan, where TDS is typically between 1000mg/L to 2000mg/L. This water quality is influenced locally by the catchments of Salt Creek and the lower reaches of Elsey Creek.

Overall, the limestone water is hard to very hard (total hardness over 200mg/L) and scale forming. Measures can be taken to minimise the occurrence of scale development on elements of the reticulation. These include control of thermal variation of the reticulated water and limiting the aeration of the water.

The basalt aquifers that have been encountered underlie the limestone and occur as isolated and independent aquifers. Hence water qualities from different bores vary. However, within the map area, they are usually of satisfactory water quality for stock.

Basalt-derived groundwater differs in general chemistry to that in the overlying limestone aquifers. Of particular note are higher sodium chloride (NaCl) and lower alkalinity levels. The hardness levels tend to be high, and the water ranges from hard to very hard and can be scale forming. Where higher salinities are observed, it is usually due to the presence of sodium chloride. As it is possible that the water quality will deteriorate if pumped excessively, the TDS should be monitored for increases, with testing of the water at six monthly intervals if the bore is in regular operation.

Other aquifer types exist in the Lower Proterozoic rocks on the eastern side of the Sturt Plateau and water quality data from this area is scant. The bores intersecting sandstone in this region typically produce water of TDS less than 500mg/L. Water quality in shale varies significantly and TDS values range to a maximum of 1000mg/L.

Table 2 Water Quality Standards For Domestic Use

SUBSTANCE	GUIDELINE VALUE
pH range	6.5 - 8.5 *
Total dissolved solids	500mg/L #
Chloride	250mg/L #
Sulphate	250mg/L #
Nitrate	50mg/L +
Fluoride	1.5mg/L
Hardness (as Calcium Carbonate)	200mg/L *
Sodium	180mg/L *

Analyses of water intended for human consumption should lie within the guidelines listed below. Discussion relating to the quality of domestic water should be addressed to the Northern Territory Department of Health and Community Services.

(*) Values outside of the guidelines for pH and hardness may result in either build-up of scale in pipes or corrosion of pipes but they do not pose a health problem.

(#) Above these limits the taste may be unacceptable but they do not pose a health problem.

(+) For nitrate, a limit of 50mg/L is recommended for babies less than 3 months old, 100mg/L is the guideline for older children and adults.

Table 3 Water Quality Standards For Stock Use

SUBSTANCE	GUIDELINE VALUE
pH range	6.5 - 8.5
Total dissolved solids	7000mg/L
Sodium chloride	Not more than 75% when total dissolved solids near limit
Sulphate	2000mg/L
Nitrate	400mg/L
Fluoride	2.0mg/L
Magnesium	300mg/L

The composition of mineral supplements to stock feed must be considered when stock waters are near to the guideline limits, especially for fluoride and sulphate. Further information is available from the Chief Veterinary Officer, Northern Territory Department of Primary Industry and Fisheries.

6. SUSTAINABILITY OF WATER SUPPLIES

It is important to note that although the aquifer in this area may produce high yielding bores, there is currently a low level of information available on which to assess the sustainability of the resource. Issues of resource sustainability, environmental impact and allocation need to be addressed in such areas.

6.1 Effects of Droughts on Water Sources

Although drought is not usually defined in absolute terms, it is generally considered a drought situation when significantly lower than average rainfall persists for a prolonged period and when water deficiencies cause disruption to normal stock feeding and watering patterns. A map of Drought Incidence, 1965 – 80 (Reference 7) indicates that the Sturt Plateau region may experience up to a 20% incidence of drought.

6.1.1 Groundwater

The groundwater resources underlying the Sturt Plateau are significant and the amount held in storage is not likely to be depleted by drought under the current land use regime.

Although only limited data exists on seasonal variation of groundwater levels, this data indicates that the decline is usually less than 0.2 metres. In a drought situation when the water levels could decline by up to 2 or 3 metres over a number of years, the most susceptible bores are those in the central plateau area which are marginal in terms of available submergence or those with poor performance characteristics.

In the event of a bore “forking” due to the above situation, two options may be available to maintain a supply. Information on the bore’s construction should first be obtained to determine the submergence characteristics of the pump and of the bore (ie. respective depths between the water level and the (i) pump inlet and (ii) top of the slots).

If there is additional depth between the pump inlet and the top of the slots in the casing, the pump may be lowered. If this is not an option, then reducing the pumping rate will lessen the drawdown and may avoid forking.

Establishing the performance characteristics of the bore by test pumping may also present other options to be considered.

Unfortunately, deepening the bore in such areas is not likely to be a viable option. In most cases, bores will have been drilled to intersect the underlying basalt and are already operating under optimised submergence characteristics. Lastly, the least preferred option, would be to drill a replacement bore. This bore would need to be sited to intersect

the aquifer at greater depth and geophysical methods would be required to locate the most favourable site for the bore.

6.1.2 Surface Water

Surface water supplies are generally more sensitive to drought than groundwater because the latter has a large storage to buffer short term variation in recharge. The effect of drought on dams and waterholes is obviously that they may not be replenished as normal and in extreme cases, will not be replenished at all for several seasons.

Most waterholes on the Sturt Plateau, regardless of drought, are depleted at the end of each dry season. However, they are generally used as additional water sources rather than as the main supply. For those areas relying on natural waterhole, it would be prudent to ensure bore water availability to the paddock.

Many dams constructed can hold a maximum of nine months supply, however, will generally have considerably less usable storage. Low rainfall would therefore render most dams ineffective. The best way to increase the reliability of a dam is to increase its depth. Increasing the area of the dam will only add more longer term storage if the depth is greater than the depth of water which will be lost to evaporation. This is possible, however, usually less economical, on most parts of the Sturt Plateau as the clay in the soil profile usually extends to at least 6 metres in depth.

A way to overcome this depth limitation is to build embankment dams. Although these are generally not recommended due to the potential damage by high flood velocities, they do provide a way to increase the storage beyond that which is possible with a ground level excavated tank. A large embankment dam may also have the potential to provide water for limited irrigation, thus extending the stock feed supply at least in the early part of the drought.

A problem that arises during droughts is that although there may be both adequate water and feed, the two may be located in different areas. As drought progresses, and areas are grazed out, cattle progressively move outwards from the watering points, until a point is reached where the distance that they have to travel between feed and water become too great. This is normally overcome by providing either more bores or dams or by extending the range of the existing sources via pipelines. The latter option would generally be preferred because of costs. Even in normal seasons, multiple watering points originating from a single water source have the potential to reduce the grazing pressure on soil and vegetation. Studies by the CSIRO (Reference 8) have indicated that artificial water sources have had a strong impact on the biodiversity of the flora and fauna. Increasing the number of watering points and at the same time increasing the number of cattle would obviously worsen the situation. On the other hand, spreading the same number of cattle over a larger

area would likely be beneficial in regards to biodiversity, soil conservation and also the condition of the cattle.

6.2 Present Water Usage

The present stock bore usage is rated as low. In comparison to the estimated recharge and quantity of groundwater flowing through the system, the current extraction is about 5 percent.

Few dams or excavated tanks exist on the Sturt Plateau. This form of water supply is viewed as a second generation improvement to an existing development. However, this strategy should be re-considered as conditions in some areas will favour a surface water option rather than a groundwater supply.

7. WATER RESOURCE DATA, LOCATION AND AVAILABILITY

7.1 Borehole Information

The submission of a Final Statement of Bore (detailing its construction, water bearing strata, yield etc.) for each borehole drilled is mandatory in the Northern Territory. This document is submitted by the driller and is held at the Natural Resources Division in Darwin. Copies of the information are in both digital and paper forms and are available on request.

7.2 Water Resource Maps

The map accompanying this report was compiled from water resource maps for four sub-areas in the region. It represents 22 individual properties and land areas on the Sturt Plateau. The mapping has been conducted at 1:250000 scale. The basic information collated and analysed to produce the maps includes geology, topography, land unit and land system mapping, bore data, climate records, aerial photography, satellite imagery and airborne geophysical data. Field surveys were used to check locations of water sources, bores and to sample water and confirm soil and rock types.

A 1:250000 scale Total Magnetic Intensity map is available on request from the Natural Resources Division. This map is recommended to aid in bore site selection in areas where the basalt basement is shallow in relation to the water table. Bores are recommended to be sited within the 'trough' features as shown on the map (see Section 3).

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10. GLOSSARY

AIRLIFT YIELD	The rate at which is extracted from a bore with compressed air as drilling takes place
AMG EASTING	The east-west coordinates of the bore in metres from the grid's origin. It refers to the grid lines on the map.
AMG NORTHING	The north-south coordinates of the bore in metres from the grid's origin. It refers to the grid lines on the map.
AQUIFER	A body of rock that is sufficiently permeable to transmit groundwater and to yield economically significant quantities to bores and springs.
BATTER	Slope expressed as a ratio of horizontal to vertical distance.
BERM	Flat area between excavated area of tank and bund.
BORE	Lined hole constructed with a drilling rig and which is used to extract groundwater.
BORE DIAMETER	The minimum internal bore diameter in millimetres
BORE REGISTERED NUMBER (RN)	A number assigned by the Natural Resources Division to each registered bore.
BUND	Bank constructed of compacted fill used to contain water.
CASING	Tubing used to line boreholes. The length of casing in the hole is expressed in metres and its internal diameter in millimetres.
DEMAND	The volumetric flow rate required for stock watering therefore the rate at which water would be supplied if available.
DEPTH DRILLED	The total depth of the bore in metres below ground level.
FORKING	When the water level in the bore is drawn down to the level of the pump inlet, causing it to take in air.
GROUNDWATER	Water contained in rock below the water table.

KARSTIC	Related to solution features in limestone or dolomite.
OFF-STREAM TANK	Excavated tank built near creeks and connected to the creek by a channel to tap the creek flow.
ON-STREAM TANK	Excavated tank built in the bed of a well defined stream.
PUMPING RATE	The recommended pumping rate in litres per second.
PUMP SETTING	The recommended depth below ground level at which the pump intake should be set.
SLOTS	The apertures located in the casing adjacent to the aquifer. An interval over which they exist is usually expressed between depths in metres below ground level.
SPILLWAY	A structure designed to overflow excess water out of a dam.
SPILL TAIL CHANNEL	A channel built downstream of the spillway to direct excess water back into the creek.
STANDING WATER LEVEL (SWL)	The level below the ground surface to which groundwater will rise in a bore or well.
STORAGE CAPACITY	The volume of water that can be stored in a tank up to its full supply level.
TOTAL DISSOLVED SOLIDS (TDS)	A measure of water salinity based on the quantity of solids left after evaporation of a litre of the sample.
WATER TABLE	The surface resulting when the standing water levels in adjacent bores in the same aquifer are connected.
WATER STRUCK	The depth in metres below ground level at which the main water bearing zone was encountered.
YIELD	The amount of water obtained in litres per second by airlifting usually during drilling of the hole.



Plate 1 Lily Waterhole on Gorrie Station



Plate 2 Dry River Stock Route No. 5 bore



Plate 3 Tufa deposits at Djilkminngan



Plate 4 Sinkhole at Hidden Valley Station



Plate 5 No. 11 bore on the Murrانji Stock Route



Plate 6 Soil sampling at Elsey Station



Plate 7 Sinkhole on Avago Station



Plate 8 New Leaf bore at Sunday Creek Station



Plate 9 Chowyung Waterhole on Gorrie Station



Plate 10 Karstic weathering



Plate 11 Bore 28190 at Larrizona Station



Plate 12 Rocky Waterhole at Vermelha Station



Plate 14 Elsey Creek at the Roper River confluence



Plate 13 No. 7 bore and turkey nest at Vermelha Station



Plate 15 Water sampling at Elsey Creek at the Roper Highway bridge



Plate 16 The Dry River Road crossing



Plate 17 Warloch Ponds in flood, March 1998



Plate 18 Large Drainage Line dam at Hidden Valley homestead



Plate 19 'D' bore and ground tanks at Kalala Station



Plate 20 Malogie Waterhole at Kalala Station