POWER AND WATER AUTHORITY
WATER RESOURCES DIVISION

WATER RESOURCES SURVEY OF THE
WESTERN VICTORIA RIVER DISTRICT

NEWRY STATION

REPORT 33/1995D
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WATER RESOURCES SURVEY OF NEWRY STATION
NORTHERN TERRITORY

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LIST OF ABBREVIATIONS

km	-	kilometre
L/s	-	litres per second
m	-	metre
m^3	-	cubic metre
mg/L	-	milligrams per litre
ML	-	megalitre (one million litres)
mm	-	millimetre
μS/cm	-	microsiemens per centimetre
pH	-	acidity and alkalinity index
TDS	-	total dissolved solids

LIST OF CONVERSIONS

1 mm (millimetre)	=	.04 inches (4 points)
1 m (metre)	=	3.3 feet
1 km (kilometre)	=	0.6 miles
1 L (litre)	=	0.22 gallons
1 ML (megalitre)	=	220,000 gallons
1 L/s (litre per second)	=	800 gallons per hour

SUMMARY

The accompanying Water Resources Development Map can be used as a guide to determine the type of water supply most appropriate to specific areas of the station. Over most of the inland plains the best options for future water supply developments are considered to be excavated tanks, sited to capture wet season sheet floods. The reliability of existing tanks can be improved in many cases by deepening where appropriate. All existing and planned surface water storages including excavated tanks, waterholes and springs should be fenced and stock watering infrastructure provided. Groundwater is generally not available beneath the plains. In the basalt country south of the highway groundwater is the best options for future water supply developments but careful site selection is necessary in order to obtain adequate yields.

Newry has a good distribution of watering points in most areas but from the point of view of spreading grazing pressure more evenly, some sections of the station could benefit from additional watering points.

1. INTRODUCTION

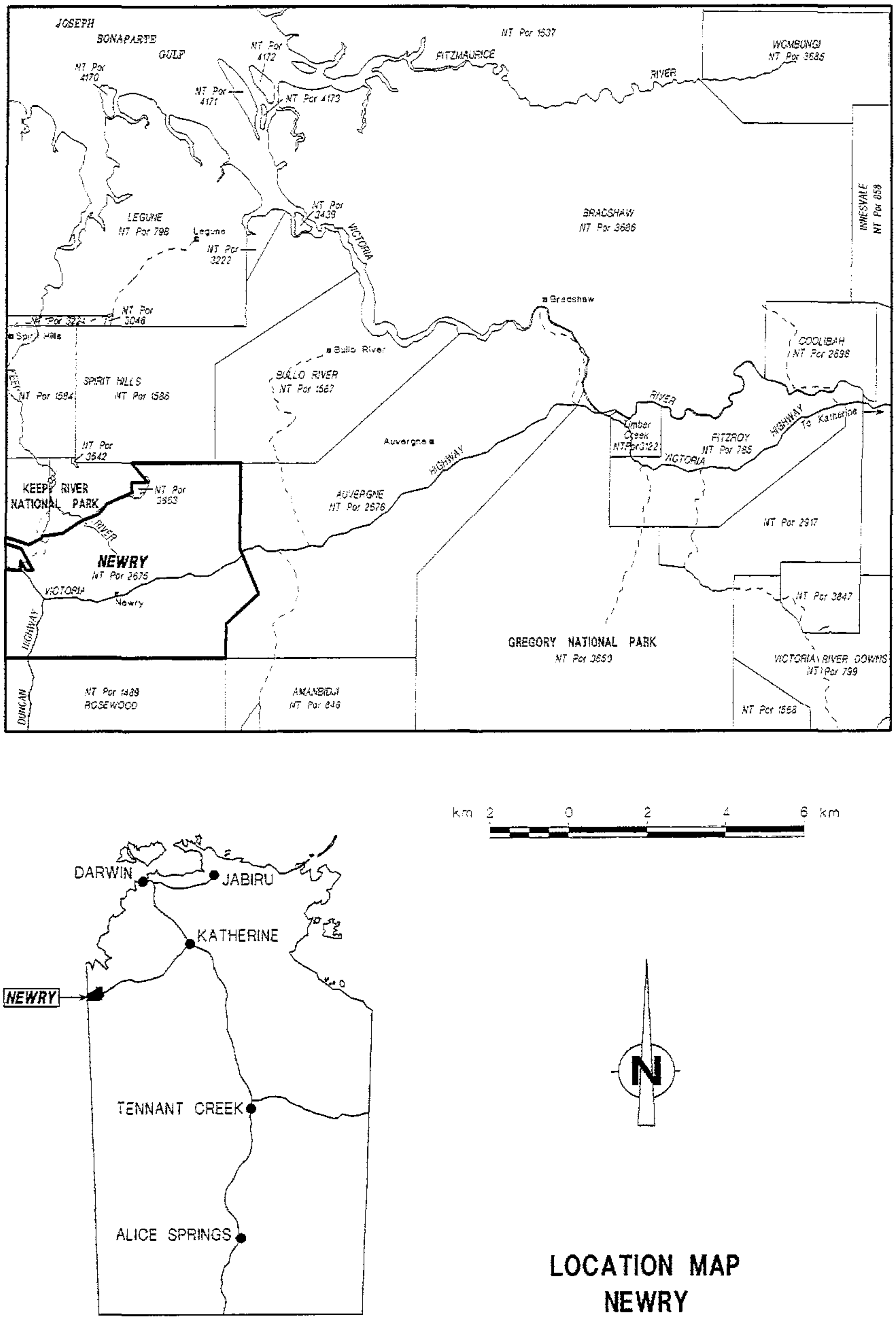
This project was initiated by the Victoria River District Conservation Association (VRDCA) and it's aim is to provide station managers with up to date information on water resources , so that they can make more informed decisions about water and land management. It is funded by the Northern Territory Government and the National Landcare Program with a contribution by the VRDCA. A total of 20 properties will be studied between July 1993 and June 1998.

Newry station covers an area of 2348km^2 and is located on the Western Australian border straddling the Victoria Highway. It is bordered to the north by Keep River National Park, Spirit Hill station, to the east by Auvergne station and to the south by Rosewood station (Figure 1).

The availability of stock water is the major influence on stock management since virtually all of the annual rainfall, which averages 753 mm, occurs in the short hot monsoonal wet season between December and March (Table 1). For the remainder of the year temperatures are warm and very little rainfall is experienced. During the Wet, when the streams flow, much of the low lying country is inundated by water. Recharge to groundwater aquifers occurs at this time. During the Dry evaporation rates of between 5 mm and 9 mm (average about 7 mm per day or 2.3 metres per year) ensure that water levels in creeks, dams and tanks, and shallow bores decline rapidly. The average monthly maxima range from about 30.1 degrees in July to 38.7 degrees in November. The corresponding average monthly minima are 14.4 and 24.7 degrees.

The station can be classed into three broad landform types; rugged hills and ranges, inland plains and the dissected basalt plateau (Figure 2).

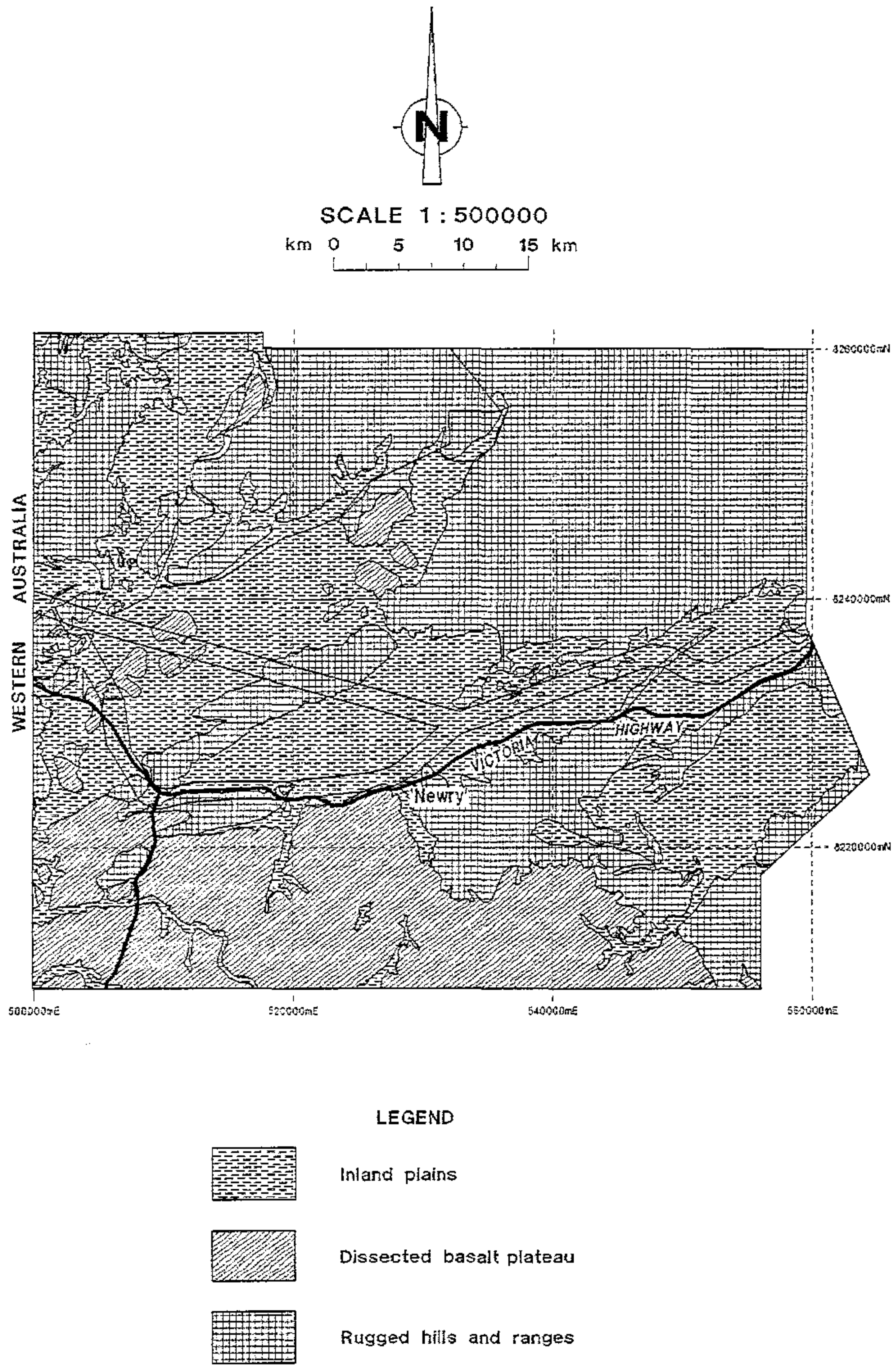
The ranges cover much of the northern part of the station where they rise abruptly out of the plains to a maximum elevation of approximately 300 metres above sea level at the southwestern end of the Pinkerton Range. Formed in hard sandstone their locations and shape are controlled by geological structures such as dipping strata and faults. They are steep and rocky, supporting low woodland and low open woodland. Numerous short streams dissect the ranges, with many deep valleys, gorges and



LOCATION MAP
NEWRY

Fig. 1

Plate 1: Saddle Creek Dam, showing damage to the inlet pipe and erosion of the bund at the inlet



LANDFORM MAP OF NEWRY STATION

Figure 2

waterholes. Soils are thin and stony. No pastoral development is carried out in the ranges due to the rugged terrain.

The inland plains are elongated in a northeast-southwest direction and have formed as a result of preferential erosion of soft siltstone and shale beds. Their topography is generally flat especially near the main streams but in other areas it is undulating with occasional low hills. Along the flanks of the ranges moderately steep colluvial fans are sometimes present. Elevations range from about 50 metres above sea level in the north near Ernie Lagoon to about 90 metres near the homestead. Soils include black cracking clays along the rivers and in areas where shales occur at shallow depths with leached loamy soils elsewhere. They are covered in woodland with patches of grasslands on the black clay soils.

The dissected basalt plateau includes most of the area south of the Victoria Highway. It is formed on a sequence of extensive, flat lying basalt flows and has been deeply dissected by streams in the headwaters of the Keep, West Bains and Ord River systems. At least two distinct plateau levels are present on Newry with elevation of approximately 190 and 290 metres above sea level. These have formed on the tops of more resistant basalt flows and are now only preserved as remnants on hill tops and mesas.

The station falls mainly within the catchment of the Keep River with areas in the northeast draining to the Bullo River, in the southwest to the Ord River and areas in the southeast to the West Bains River. The Keep River flows to the northeast , at right angles to much of the geological structure of the area. As a consequence it has cut straight through several ranges , forming narrow gaps and gorges.

TABLE 1

CLIMATIC AVERAGES - NEWRY STATION

	RAINFALL (mm)	RAIN DAYS	DAILY MINIMUM TEMPERATURE (°C)	DAILY MAXIMUM TEMPERATURE (°C)
JANUARY	187	10	24.8	36.1
FEBRUARY	184	10	24.6	34.8
MARCH	125	6	23.7	34.9
APRIL	21	2	20.7	35.1
MAY	7	1	18.5	32.8
JUNE	3	0	15.6	30.4
JULY	3	0	14.4	30.1
AUGUST	1	0	16.5	33.3
SEPTEMBER	3	0	19.9	36.1
OCTOBER	22	2	23	38.2
NOVEMBER	71	5	24.7	38.7
DECEMBER	127	7	25	37.8
TOTAL	753	43		

2. WATER SUPPLY DEVELOPMENT

An attempt has been made to classify the station according to the type of water resource developments considered most appropriate for particular areas. The results are shown on the accompanying **Water Resources Development Map** of Newry station. The map was made by combining information on existing developments (dams, bores etc.) with information on groundwater occurrence, topography and soil types. Local conditions, such as soil types can vary considerably, so the map should not be taken as a definitive guide to cover every situation. Rather it is a broad scale map which is intended to give an overall picture of possible development options. Detailed on-ground investigations are recommended when considering specific developments.

For an explanation of the colours on the map refer to the legend entitled "**Water Resources Development Options**". The various "preferred options" listed there fall into four types:

- -areas which are unsuitable for artificial water supplies such as surface water storages or bores (options 1 and 2).
- -areas in which surface water storages is the best option (options 3).
- -areas in which groundwater is the best option (options 4 and 5).
- -areas in which surfacewater and groundwater may both be viable options (options 6 and 7).

Some of the main features of the map are:

- -the areas used most for grazing, the inland plains, are generally only suitable for the development of surfacewater supplies. Groundwater is generally unavailable as the area is mostly underlain by shale.
- -large areas of the station in the north and northeast are unsuitable for water supply developments due to the rugged terrain.
- -the basalt plateau south of the highway is best suited to the development of groundwater supplies, however careful selection of bore sites is necessary in order to locate usable supplies.

3. GROUNDWATER

Groundwater conditions across the station have been assessed using geological information, satellite images, aerial photos and information from existing boreholes. The results are presented as the "Groundwater Resources Map", one of the two small side maps on the accompanying map of Newry station.

Technical information on water bores is shown in Appendix 1. More detailed information on individual bores is held on the Water Resources Division's files and is available on request. Chemical analyses of groundwaters and recommended limits for common uses are listed in Appendix 2 and 3, while the results of the pump testing program are presented in Appendix 4 .

Stock water is presently obtained from seventeen bores on Newry. Numerous bores drilled on the station have been unsuccessful due to insufficient supply.

Rock type is the main factor which determines groundwater availability and the two yield zones shown on the map (0 to 0.5 and 0.5 to 5 Litres per second) reflect different rock formations.

Groundwater is stored in and moves through minute spaces in rocks caused by fractures (cracks), the spaces between sand grains or spaces where minerals have been dissolved away. If economically viable quantities of water can be extracted, the water bearing horizon is termed an aquifer. The zones of groundwater yield are meant to give an indication of the most likely yield which could be expected. Natural variations in the properties of rocks means that variation also occurs in groundwater yields. For example in a zone mapped as 0.5 to 5.0 L/s a certain percentage of bores may obtain higher yields and some may obtain lower yields. At a specific site, yield is often highly dependent on the number of water bearing fractures intersected. There are generally too few existing bores to determine the likely yields with statistical certainty. Rather they are based on a combination of geological knowledge and known yields.
Prospects for successful bores can be improved by siting bores along major fractures identified on aerial photographs or satellite images. Valleys cutting into the hills may also indicate the presence of water bearing fracture zones.

Both of the yield zones on the groundwater map are now described:

3.1 Areas with yields 0 to 0.5 L/sec.

This zone includes those areas of the inland plains underlain by a siltstone and shale formation known as the Angalarri Siltstone. Many unsuccessful attempts have been made to find groundwater in this rock, both on Newry and adjoining stations. The few successes, have obtained small supplies from weathered rock at depths of between 10 and 15 metres (eg. Fish Creek bore , RN2822, 0.1 L/s and Aerodrome Bore, RN2824, 0.6 L/s). On Auvergne station thin water bearing sandstone and dolomite beds have been encountered within the siltstone although none have been located on Newry. A major aquifer the, Jasper Gorge Sandstone is known to underlie the Angalarri Siltstone on Auvergne. The deepest bore drilled to date in Angalarri Siltstone is RN29731 located at Hungry billabong. This did not strike any water to its total depth of 120 metres and did not pass out of the siltstone. The Jasper Gorge Sandstone is probably located at depths in excess of 150 metres on Newry and so would be uneconomic to drill for stock supplies. Three Mile Bore, RN897 obtains 1.5 L/s possibly from river gravels associated with the Keep River. Bores located adjacent to major creeks, targeting either weathered shale or river gravels offer the best chance of success in this zone.

Another area in which yields are likely to be less than 0.5 L/s is in the northwestern part of the station around Ernie Lagoon. A belt of rocks including schist, slate, granite and volcanic rocks runs from there to the southwest into the Keep River National Park. Although untested on Newry, several bores in the park have only obtained yields of less than 0.1 L/s.

3.2 Areas with yields 0.5 to 5.0 L/s.

Two main areas on the station contain rocks likely to yield moderate supplies of groundwater. These include the sandstone ranges in the north and the basalt country south of the highway. Few bores have been drilled into the sandstone due mainly to poor access. New Hungry bore (RN29223) ,Blackfellows Creek bore (RN6031)and the road bore (RN26163) were drilled in more accessible sandstone areas and obtain good supplies. These bores together with bores drilled into similar formations on Bullo River station to the northeast indicate that a relatively high success rate can be expected in the sandstones. Adequate supplies are normally encountered shallower than 45 metres.

Basalt forms an important aquifer in the southern part of the station. Of the fourteen bores drilled into basalt only five produced enough water to warrant their construction. Groundwater occurrence therefore is highly localised and drilling in basalt can be risky. Prospects can be improved however by siting bores along prominent fractures, which are visible on aerial photographs. Several of these are shown on the groundwater map but aerial photographs are necessary for actual location on the ground. Depths at which water was struck vary between 6 and 80 metres. The bore RN6030, at 213 metres deep is the deepest drilled into basalt on the station. It only encountered a flow of less than 0.1 L/s. Apart from fractures in the basalt, thin sandstone beds located between and beneath the basalt flows are also known to form aquifers. A prospective target on Newry is a sandstone at the very base of the basalt, known as the Kinevans Sandstone. This bed outcrops on the northeastern margin of the basalt plateau and progressively deepens towards the southwest and west. A bore would have to be located within 5 kilometres of the margin in order to strike the sandstone at a depth shallower than 150 metres. Keep bore (RN4637) drilled alongside the sandstone outcrop obtains 1L /s from this aquifer .

4. SURFACE WATER

Surface water flow in the creeks, rivers, and the floodplains is largely confined to the wet season. However replenishment of some waterholes and some creek flows during the Dry are due to spring flows. An effective annual evaporation rate of about 2.6 metres is responsible for the subsequent rapid loss of stored water from tanks and waterholes. During the average Wet, flow of the Keep River, and minor streams are often accompanied by sheet flow over much of the low lying inland plains country. After the Wet, all drainages deplete to form unconnected waterholes, the majority of which are dry by about October. Surface water studies have been directed at designing structures to conserve enough of the wet season flow to provide reliable stock supplies for the duration of the Dry. In a paddock holding 500 head the requirement is to hold nine megalitres (million litres) of water for stock supply (50 litres/day/head) after allowance is made for evaporation losses.

For it's stock water supply from surface water, Newry Station is largely dependent on springs, waterholes and temporary billabongs. Less than 10% of the stock water demand on the station is supplied from natural and artificial surface water storages.

The region has been divided into eight zones showing suitability for surface water development for stock watering. They are based on soil type , topography and runoff characteristics. The results are presented as the **Surface Water Resources Map**, one of the two small side maps accompanying the Water Resources Development Map of Newry.

4.1 Surface Water Storage Types

Three types of excavated tanks are suitable for the gently undulating, and sloping alluvial plains, onstream tanks, offstream tanks, and drainage-line tanks, the latter being the preferred option. On Newry the depth of excavated tanks should be 3 to 3.5 metres, depending on subsoil types. As the depth of the tank increases beyond three metres, it's reliability increases. Details of the station's key surface water storages and an assessment of their capabilities are given in Appendix 5.

The natural surface water storages which are not supplied by springs are shallow and have insufficient storages to last till the end of Dry. Evaporation(leakage to a lesser extent) is a major limiting factor on the usefulness of surface water storages. Saddle Creek dam which was originally built as a stock route dam has been hardly used in recent times. It is an offstream type excavated tank surrounded by bunds on all four sides. Though the depth of the tank from the top of the bund is more than 3m, the excavated depth is about 2.3m. The design and construction of this type of tank has resulted in the following problems. Similar type tanks built in Auvergne station experience the same problems.

(1) damage to inlet pipes and scour of bund walls around it (Plate 1).

(2) rill erosion of the bund and silting of the tanks .

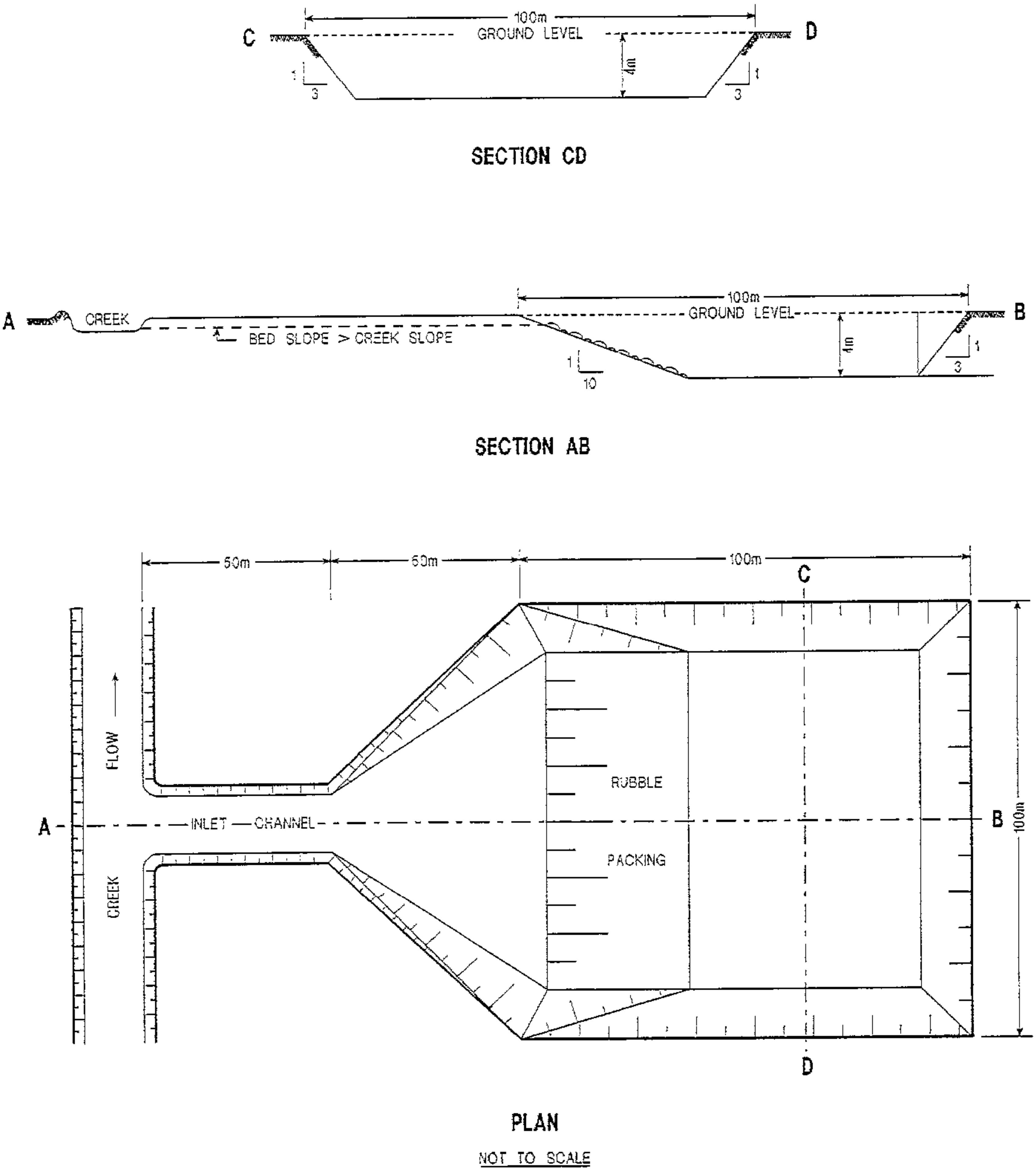
(3) tanks fail to capture most of the inflow due to poor sealing flap gates.

Regular maintenance is required before the next Wet to correct damage due to these problems.

The onstream excavated tank requires a high standard of design and construction and is prone to erosion or silting because of its location in a fast flowing main stream channel. The offstream design (Figure 3) reduces these problems by using a man-made channel to divert water from a natural stream to the tank. This is an improvement on the onstream design, but has excessive excavation costs since to take advantage of short lived stream flows, the tank level must be below that of the natural stream bed.

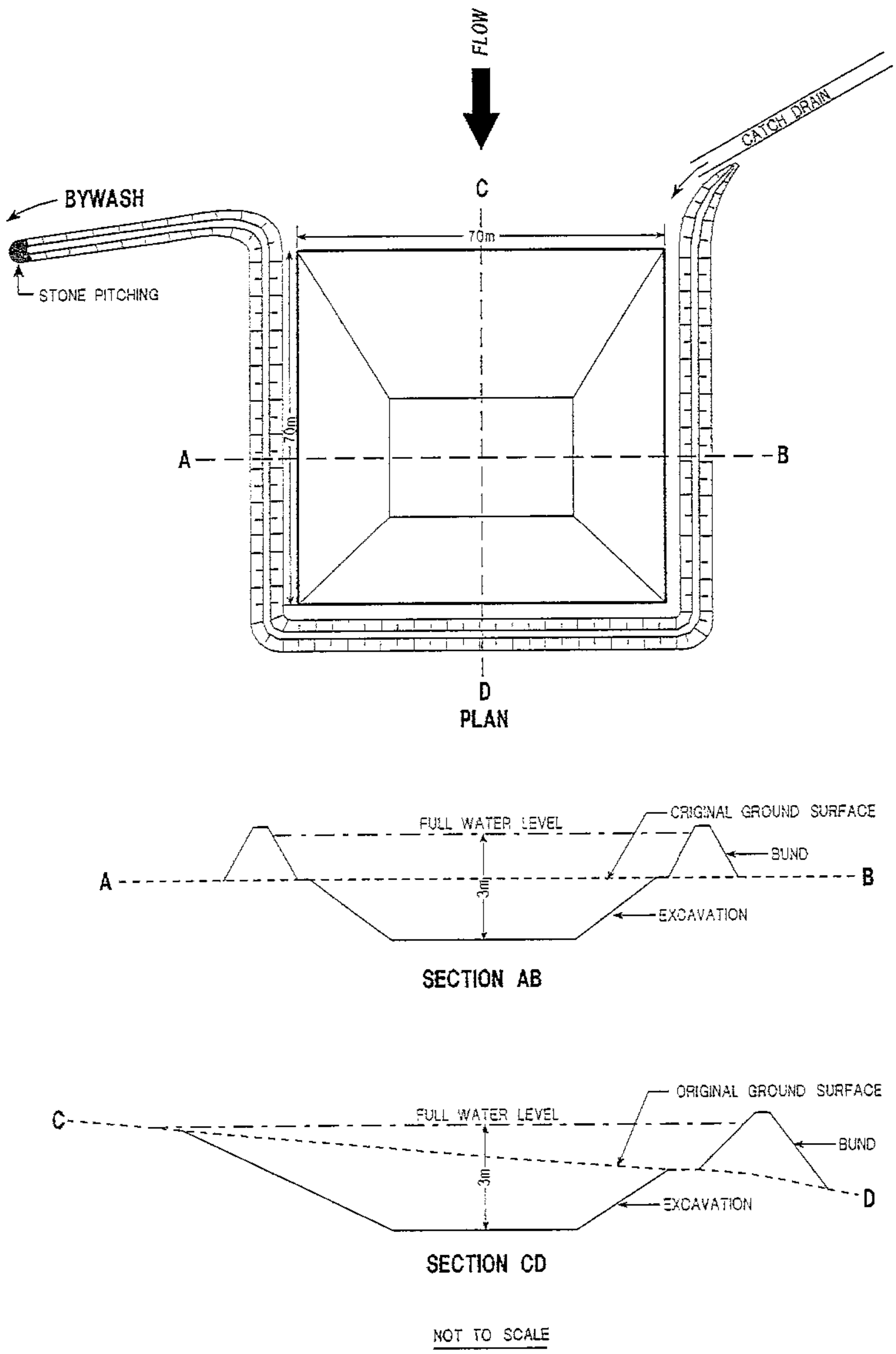
The drainage-line tank (Figure 4) is an excavated tank constructed in flat to moderately sloping areas where there are no clearly defined creek systems. The tank itself is of the same design as the offstream one, but without an inlet channel. It is excavated in a drainage area which does not have a defined creek system and water may be directed towards it using catch drains or wing walls. Sheet flow on the plains, with its low silt load, may be harvested in this manner. This design is suitable for Newry and has been used successfully on Auvergne and Bradshaw Stations in the same situation.

Another type of dam, the gully dam is suited to gently undulating 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. Construction of these dams in the hilly country on Newry may not be possible due to the thin permeable soils, permeable sandstone, and basalt which is very hard to rip. Areas where soils are clayey may be locally suitable for gully dams. The minimum average depth of the dam should be 4 metres in order to compensate for the high evaporation. All excess runoff has to be taken through a by-wash or spill. Constructing a gully dam at an appropriate location in the region would involve high costs in coping with the foundation condition and flood flows. It is recommended to consult a Civil Engineer before planning to construct these dams on rock foundation. Embankments more than 3 metres high need licensing from the Water Resources Division.



TYPICAL OFFSTREAM EXCAVATED TANK

Fig. 3



TYPICAL DRAINAGE-LINE EXCAVATED TANK

Fig 4

4.2 Selection of Sites for Excavated Tanks

The selection of a site for an excavated tank is determined by the availability of runoff and the water tightness of the ground. A drainage-line tank is best located on 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. On areas mapped as flat alluvial plains on the **Surface Water Resources Map** cracking clays may extend to a depth of up to 2 metres in many areas and are suitable for excavated tanks where it is underlain by shale. Areas mapped as gently sloping alluvial plains may also be suitable, however places with sandier soils should be avoided. Drainage-line tanks may be feasible in areas immediately adjacent to the hilly country if clayey soils underlain by shale are present. Areas suitable for consideration are also summarised on the **Water Resources Development Map**. Following selection of a general area, more detailed investigation is required (Appendix 6) and may require the input of an geotechnical consultant. For drainage-line storages a minimum catchment area of 0.5 km^2 is required. Other types of excavated tanks require a minimum catchment area of 1.5 km^2.

Cracking clay soils are suitable for holding water. Also shale, as it is water tight and easily rippable. Remedial work such as installing a clay liner, or reselection of the site will be necessary where dispersive or sandy soils, or high permeability zones are encountered.

4.3 Design and Construction of Excavated Tanks

Design dimensions for the excavated tank are determined by the stock numbers to be watered for a whole year (stock numbers will be higher if the tank is utilised for only part of the year). This in turn is dependent on the carrying capacity of the paddock, usually varying between 200 and 700 head (ie. a requirement of between 3.6 and 12.8 megalitres per year when based on 50 litres per head per day).

The larger the catchment, the more runoff that can be expected to be captured by a tank. As for drainage-line tanks, catchment sizes between 0.5 km^2 and 1.5 km^2 should supply between 225 and 550 head respectively, with 90% reliability (ie. for 9 years out of 10), using the proposed drainage-line storage design. An offstream tank design with a catchment size range of between 1.5 and 4 km^2 should supply between 300 and 750 head of cattle, with 90% reliability.

The basic design for a typical drainage-line tank is shown in Figure 4 and dimensions of 80 x 80 x 3 metres are recommended for stock numbers up to 450. Dimensions of 100 x 100 x 4 metres are required for stock numbers up to 900, depending on the area of the catchment. A minimum tank depth of 3 to 4 metres is required to allow for an annual 2.6 metres water loss due to evaporation. The basic design for a typical offstream tank is shown in Figure 3 and dimensions of 100 x 80 x 3.5 metres are required for stock numbers up to approximately 750. The design of excavated tanks are covered in more detail in the internal Water Resources Division Report No 19/1995D, entitled " Surface Water Storage Potential - Newry Station".

Construction is covered in more detail in Appendix 7. The proposed design is relatively simple. Excavated spoil can be dumped to waste or used to build a bund on three sides of the tank.

A bund and wing walls will increase the storage capacity of an drainage-line tank where there is a moderate slope on the natural ground surface. Excavated volumes are large for the proposed design dimensions (approximately 10,000 m^3 for the smaller tank, and 16,000 m^3 for the large) so construction costs will be high. Cost will also be influenced by ground conditions.

4.4 Waterholes and Springs

Natural waterholes are present during the Dry, in depressions in stream and riverbeds. Some of the waterholes , such as Old Newry Spring, and Dingo Spring waterholes never dry as they are fed by springs. The available capacity of the waterholes could be increased by excavation of the base (Appendix 7), but only where site investigation proves that this will not result in leakage. A shale base could be excavated without fear of leakage, however the regions underlain by sandstone and basalt may be difficult to excavate and may not be water tight. Waterholes in the hilly country may be deepened, provided the excavation is confined to cracking clay soils. The storage capacity of a well confined waterhole with high banks could be increased by construction of a bund at its downstream end.

Springs usually occur on hill slopes and in river valleys. Piping water from springs to areas where groundwater or surface water are not available may be an option in some situations. Mud spring in Newry is being exploited for stock watering. If a spring is found to have more than 2 litres per second flow at the end of dry, it should be more than sufficient to supply a turkey nest designed to store three days supply of stock water for 500 head of cattle.

4.5 Piping of Surface Water

Piping water may be an alternative low cost water supply option where possible. Pumping direct to turkey nests is the preferred option because of the smaller volumes of water lost to evaporation. Fifty millimetre polythene pipe, buried where possible, can be used to pipe water up to four kilometres in flat country. The distance can be increased by using larger diameter pipes and higher capacity pumps. It is desirable to bury polythene pipes to protect them from physical damage (eg. grass fires or accidental ploughing) and because their strength is reduced if subjected to elevated daytime temperatures. Burial, to protect from fire, stock trampling, etc., is easy where surficial materials allow excavation using a tilted grader blade, but is not possible in areas of exposed rock.

4.6 Supply of Stock Water from Tanks

Turkey nests are required as a balancing reservoir between the tank and stock watering troughs. Dimensions for turkey nests providing three days water for various stocking rates are given in Appendix 7.

The basic equipment to transfer water from an excavated storage tank to a turkey nest is a pump, with a choice of three energy sources, diesel, wind or solar. The initial cost of a windmill or solar powered pump is high but running costs are low. The low cost and availability of a relatively cheap diesel motor and centrifugal pump makes diesel the preferred option even though running costs are high. The advantages are mobility and ease of maintenance.

5. RECOMMENDATIONS

1. The water resources development map should be used to determine the type of water supply most appropriate to a specific area on the Station. In areas where alternative options are available economics will normally determine the final development type selected.
2. Excavated tanks away from clearly defined drainages, and sited to harvest sheet flow are considered the best option for new sources of stock water for most of the plains area. Piping of water from reliable supplies (bores, waterholes and springs) in adjacent areas is also an option.
3. The provision of reliable water supplies with a maximum grazing radius of six kilometres throughout the good pasture of the plains should be a priority, in order to reduce over-grazing and soil erosion.
4. Advice should be sought from geotechnical engineering consultants when considering the construction of larger excavated tanks, or from groundwater consultants or the Water Resources Division for detailed bore siting information.

Specific recommendations are considered under three headings: distribution, groundwater, and surface water.

5.1 Water Supply Distribution

In many parts of the V.R.D. over-grazing has resulted in a reduction of ground cover and in places, in soil erosion. Another unwanted result is degradation of pasture quality by allowing unbeneficial species and weeds to become dominant. Apart from the number of cattle present, the distribution of watering points is a major factor affecting grazing pressure. A rule of thumb commonly adopted for planning the location of watering points is that they should be located so that cattle can graze the whole paddock without having to walk more than six kilometres for water. Where possible, tanks or bores should be located to give a maximum spacing of twelve kilometres between watering points. Otherwise the water can be piped to turkey nests or directly to troughs in appropriate locations. The piping of water away from supplies sited in the corners of paddocks may decrease the grazing pressure by keeping the cattle spread over a greater area. (Figure 5).

Newry has a reasonably good distribution of watering points, however it could still benefit from additional ones, either in the form of new excavated tanks and bores or as piped supplies from existing sources.

5.2 Groundwater

The best prospects for reliable groundwater supplies are in the areas south of the highway underlain by basalt and in other areas underlain by sandstone. Aquifers in these rocks are often localised and so chances of success can be increased by careful site selection. Yields of up to five litres per second are available from many parts of these areas. Water quality across the station is good and is not a limiting factor for groundwater use. Much of the inland plains is underlain by siltstone with little water bearing potential. Drilling for groundwater is not recommended in such areas.

5.3 Surface Water

Drainage-line and offstream type excavated tanks are recommended for areas with black clay soils. Drainage-line type tanks are also recommended in areas of cracking clay soils or where thin top soils are underlain by rippable shale. Selection of sites depends on the presence of suitable sub-soils. Gully dams may be locally suitable in undulating country but site investigations and proper design and construction methods are essential. Site investigations are an essential prerequisite for any construction work. All existing and planned surface water storages (excavated tanks, waterholes, springs etc.) should be fenced and stock watering infrastructure such as troughs, windmills, turkey nests or on-ground fabricated tanks should be provided.

6. ACKNOWLEDGMENTS

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APPENDIX 1

STATION BORES

The following table is a list of bores drilled on the station together with selected details about their location, construction and groundwater intersections. More detailed information on many bores is available on request from the Water Resources Division in Darwin. Some of the headings on the table are explained below:

-BORE RN A registered number assigned to each bore by the Water Resources Division.

-EASTING The east-west coordinates of the bore in metres. It refers to the grid lines on the map.

-NORTHING The north-south coordinates of the bore in metres. It refers to the grid lines on the map.

-DEPTH The total depth of the bore in metres below ground level.

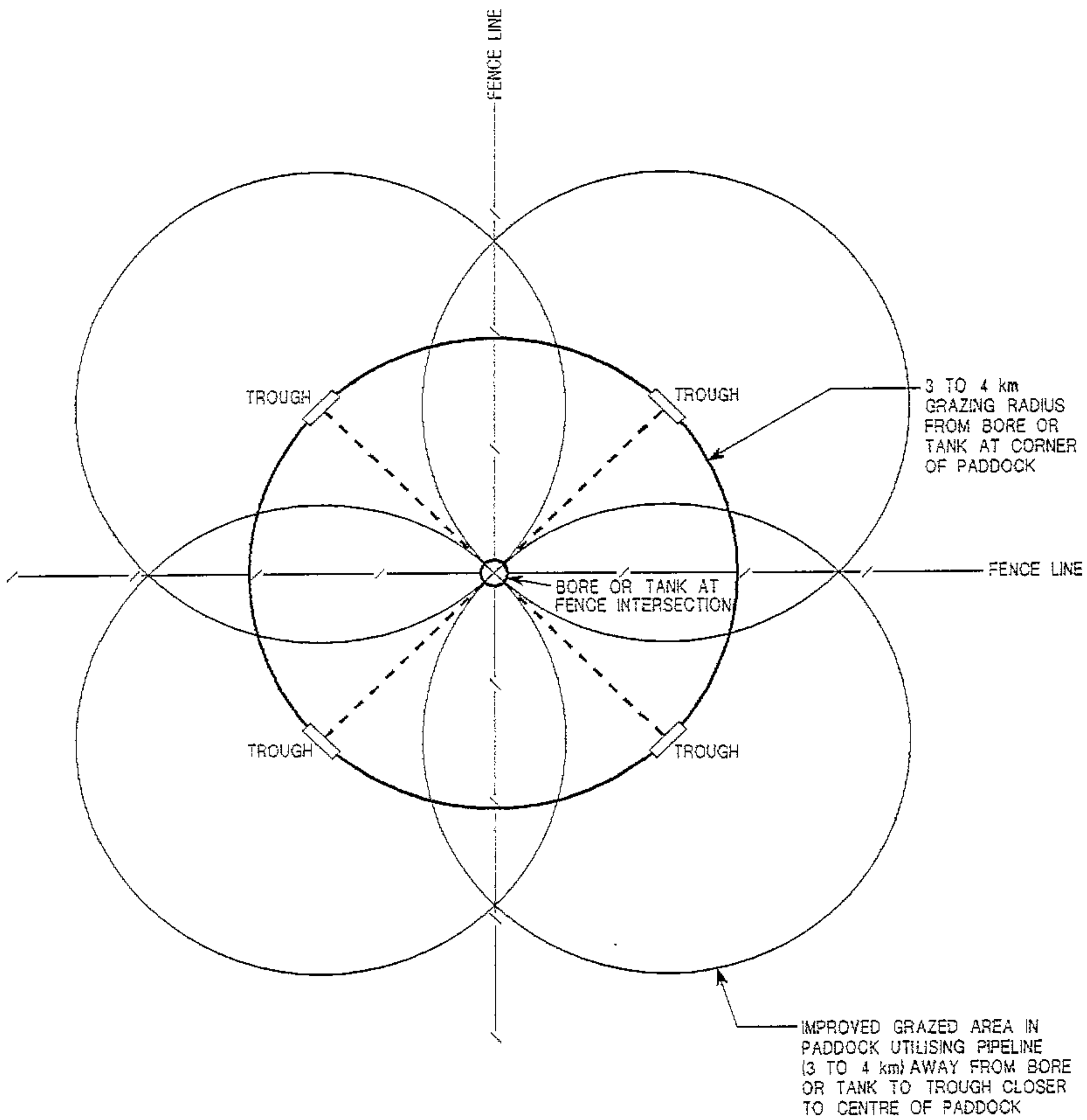
-CASING The length of casing in the hole in metres and it's internal diametre in millimetres .

-DEPTH STRUCK The depth in metres below ground level at which the main water bearing zone was encountered.

-AIRLIFT YIELD The amount of water obtained in litres per second by airlifting, usually during drilling of the hole.

-SWL Standing water level, the depth below ground level that water rises to in the bore.

-SLOTS The depths in metres below ground level between which the bore casing is slotted.



SKETCH SHOWING IMPROVED SIZE OF GRAZING AREA DUE TO PIPING AWAY FROM RELIABLE BORE OR TANK

Fig. 5

APPENDIX 1 STATION BORES NEWRY

BORE NO.	STATUS	EASTING	NORTHING	LOCAL NAME	COMPLETION DATE	Depth drilled(m)	Casing depth(m) x ID(mm)	Depth struck(m)	Airlift yield(L/S)	SWL(m)	Slots(m)
RN165	Abandoned	543500	8237250		4/11/56	45.7					
RN166	Abandoned	544750	8236750		20/11/55	61					
RN897	Equipped	528616	8230335	THREE MILE BORE	4/16/05				1.5		
RN898	Abandoned	528999	8225212			91.4		42	0.9		
RN899	Equipped	519570	8222100	MORIARTY'S BORE	1952	50.6	x 152	36.8	2	36.9	
RN1701	Abandoned	549000	8235200			152.4					
RN1702	Abandoned	551200	8232200						0.65		
RN2031	Equipped	502300	8215154	OLD NEWRY BORE	1929	18.3	x 152				
RN2032	Equipped	510517	8218735	GLENARRA BORE	1938		x 152				
RN2033	Abandoned	528600	8230300	HOMESTEAD WELL		18.3					
RN2034	Equipped	503539	8226075	DONKEY GAP BORE	1959	18.2	x 152		2.5		
RN2822	Equipped	550193	8226386	FISH CREEK BORE	11/4/61	30.5		13.1	0.13	13.1	
RN2823	Abandoned	520800	8226200		29/6/61	29.9		9.8	0.2	9.8	
RN2824	Equipped	522208	8229142	AERODROME BORE	30/7/61	18.9	18.9 x 152	13.7	0.6	8.8	
RN4352	Equipped	511984	8211868	MATILDA CREEK BORE	1960		x 152				
RN4368	Abandoned	518950	8217100	DRY SPRINGS BORE	1959						
RN4450	Equipped	525418	8214099	BOUNDARY BORE	1960		x 203				
RN4637	Equipped	530334	8219880	KEEP BORE	1956		x 152		1		
RN4638	Capped	526623	8240077	HUNGRY BORE	1956	40					
RN4639	Equipped	510050	8236359	CAVE BORE	1956				1		
RN4985	Abandoned	538350	8229150		21/8/66	91.4		16.7	0.1	13.7	
RN5572	Abandoned	528300	8225550	HOMESTEAD BORE 4A	11/8/66	61		6.1		5.2	
RN5660	Abandoned	528999	8225212	HOMESTEAD BORE 4B	22/9/66	45.7		16.8		5.5	
RN5663	Abandoned	528000	8212100		13/11/66	61		6.1		5.2	
RN6029	Equipped	535864	8220282	EMU SPRINGS BORE	29/10/67	55.8	55.8 x 152	48.8	3	5.5	48.8-55.8
RN6030	Abandoned	518800	8216150		9/10/67	213.4		6.1		6.1	
RN6031	Equipped	553314	8219236	BLACKFELLOW CREEK BORE	31/10/67	25.3	25.3 x 140	12.2	1	7.3	
RN6032	Capped	533913	8212130	LLOYDS BORE	26/10/67	63.4	x203	39.6	10	4	
RN6838	Equipped	538425	8230111	QUART POT BORE	10/9/69	47.5	nil	15.2	0.6	10.8	
RN7249	Equipped	527144	8224690	HOMESTEAD BORE	28/8/70	77.7	77.7 x 152	70.1	1.6		71.7-77.7
RN7296	Equipped	528234	8247885	CAMPBELL'S BORE	5/10/70	76.2	76.2 x 152	27	0.75	19.8	70.1-76.2
RN7297	Capped	501234	8220163	CHRISTMAS BORE	1/10/70	121.9	3 x 203	80	0.55	9.4	
RN7298	Abandoned	513300	8257600	WATTS FOLLY	3/10/70	106.7					
RN8159	Abandoned	533600	8211450		28/11/66	9.1					
RN8227	Abandoned	533913	8212150		25/9/73	110		46	0.25	6	
RN8228	Abandoned	511850	8230700		6/10/73	66	24 x 152	58	1.2		12-18
RN8229	Abandoned	524253	8218660	MUD SPRING BORE	28/9/73	110					
RN8230	Equipped	533136	8223178	BALINGERS BORE	30/9/73	80	80 x 152	30	2.5	9	30-34
RN8231	Capped	527800	8244900		3/9/73	59	59 x 152	52	2.8	9	25-43
RN8232	Abandoned	520000	8236900		1973			26			
RN8233	Abandoned	514600	8221100		10/10/73	110			0.29	21	
RN23861	Abandoned	509519	8224272	RN 23861	13/8/85	100					
RN23862	Capped	509325	8223423		14/8/85	36	36 x 152	11	2.2	4.9	30-36

APPENDIX 1 STATION BORES NEWRY

BORE NO.	STATUS	EASTING	NORTHING	LOCAL NAME	COMPLETION DATE	Depth drilled(m)	Casing depth(m) x ID(mm)	Depth struck(m)	Airlift yield(L/S)	SWL(m)	Slots(m)
RN26163	Capped	541682	8229904	SCOTTS BORE	27/8/90	58.3	58 x 168	24	5	17.6	19.3-25.8
RN26798	Capped	533528	8252109		19/7/90	85	38.8 x 168	20.5	0.7	flowing	20-26
RN27171	Abandoned	554000	8232000		20/8/90						
RN27172	Abandoned	556000	8233500		20/8/90						
RN27173	Abandoned	554100	8232400		20/8/90			16			
RN27174	Abandoned	501400	8232100		21/8/90			27			
RN27175	Abandoned	501000	8232200		21/8/90						
RN27176	Abandoned	500800	8231700		22/8/90						
RN27177	Abandoned	500250	8232200		24/8/90			26			
RN27705	Abandoned	528800	8234300		2/6/92	84		6			
RN27706	Capped	517400	8212850	FAREWELL BORE	3/6/92	90	26 x 158	18	0.5	5.3	13-19.5
RN29223	Equipped	526623	8240077	NEW HUNGRY BORE	3/ 7/93	45	45 x 152	23	2	17	33-45
RN29731	Abandoned	522048	8244355		23/11/94	120.4					
RN29732	Abandoned	548525	8230515		26/11/94	120.4	5.5 x 207	18	0.4		

APPENDIX 2

CHEMICAL ANALYSES OF GROUNDWATERS

The following table lists chemical analyses performed on groundwaters on Newry. See Appendix 3 for an explanation of the main factors which limit water use for stock and domestic consumption.

APPENDIX 2 CHEMICAL ANALYSES OF GROUNDWATERS NEWRY STATION

BORE RN	BORE NAME	DATE	CONDUCTIVITY	T.D.S.	pH	SODIUM	POTASSIUM	CALCIUM	MAGNESIUM	CHLORIDE	SULPHATE	BICARBONATE	NITRATE	FLUORIDE	IRON	SILICA	ALKALINITY	HARDNESS
			uS/Cm	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
897	THREE MILE BORE	7/11/55		534		58	1	20	35	20	22	373		0.7				189
897	THREE MILE BORE	2/6/69	590	420	7.7	65	1	42	29	24	12	361		0.2	0.1		296	226
897	THREE MILE BORE	17/10/90	620	365	7.8	65	2	36	27	20	23	360		0.3	0.1		295	200
897	THREE MILE BORE	21/9/94	580	344	7.7	55	1	46	24	13	21	353	4	0.3	<.1	34	290	214
898		7/11/55		723		48	7	80	57	165	201	332						434
898		27/9/65	609	370	8.0	30	2	38	34	16	14	168			<.1		315	238
898		31/5/69	520	340	7.9	30	2	48	27	16	8	325		0.1	0.4		266	228
899	MORIARTY'S BORE	15/6/67	386	263	9.5	120	0.2	1	36	16		107					176	18
899	MORIARTY'S BORE	30/5/69	590	410	7.8	105	<1	24	19	24	12	337		0.2	<.1		276	152
899	MORIARTY'S BORE	18/10/90	405	290	9.1	94	1	1	<1	13	19	149		0.2	0.3		178	3
899	MORIARTY'S BORE	23/9/94	399	272	9.5	98	<1	1	<1	12	20	114	<1	0.2	0.1	61	180	2
2031	OLD NEWRY BORE	7/11/55		534		58	1	20	35	20	22	373		0.7			117	189
2031	OLD NEWRY BORE	15/6/67	747	526	9.3	215	0.7	3	68	66	97	115			0.9		188	290
2031	OLD NEWRY BORE	31/5/69	700	520	8.9	195	<1	6	<1	62	105	173		0.4	2.6		190	10
2032	GLENARRA BORE	15/6/67	519	323	7.6	47	0.3	3	47	16		167			0.0		274	204
2032	GLENARRA BORE	20/5/69	450	310	7.5	80	<1	20	16	18	3	281		0.2	<.1		230	118
2032	GLENARRA BORE	18/10/90	490	355	7.9	115	1	5	2	20	14	277		0.3	9.4		227	21
2032	GLENARRA BORE	23/9/94	419	295	9.3	102	<1	2	1	16	13	169	1	0.2	0.2	57	202	9
2034	DONKEY GAP BORE	15/6/67	585	338	8.0	35	2	6	64	14	20	176			0.1		288	282
2034	DONKEY GAP BORE	31/5/69	650	400	7.9	32	1	64	35	12	37	407		0.2	<.1		334	306
2034	DONKEY GAP BORE	18/10/90	680	405	7.3	33	2	57	41	11	28	422		0.3	<.1		346	311
2034	DONKEY GAP BORE	22/9/94	643	407	7.6	32	1	68	34	8	23	421	1	0.3	<.1	47	345	310
2822	FISH CREEK BORE	13/6/67	692	400	8.1	90	2	5	62	24	63	181			0.0		296	272
2822	FISH CREEK BORE	29/5/69	620	380	7.8	49	1	22	47	20	63	327		0.2	<.1		268	248
2022	FISH CREEK BORE	17/10/90	640	365	7.6	17	2	59	43	18	1	396		0.2	<.1		324	324
2022	FISH CREEK BORE	27/9/94	640	370	7.3	20	1	73	35	11	19	416	<1	0.2	0.1	28	341	326
2823		14/6/67	1163	742	7.8	165	2	47	54	44	178	251					412	342
2824	AERODROME BORE	31/5/69	1400	950	7.8	175	2	108	65	66	297	527		0.5	<.1		432	484
2824	AERODROME BORE	17/10/90	1005	610	7.8	132	3	45	41	25	109	520		0.4	<.1		427	281
2824	AERODROME BORE	21/9/94	1020	638	7.8	121	2	71	35	23	111	541	3	0.3	<.1	35	444	321
4352	MATILDA CREEK BORE	15/6/67	808	503	8.0	46	0.4	6	116	32	11	259			0.0		424	394
4352	MATILDA CREEK BORE	30/5/69	750	480	7.5	38	<1	78	58	28	4	498		0.2	0.1		408	384
4352	MATILDA CREEK BORE	14/11/81	760	470	7.4	34	1	53	57	22	14	493		0.4	<.1		404	357
4352	MATILDA CREEK BORE	18/10/90	820	490	7.5	34	1	59	62	13	15	551		0.3	<.1		452	402
4450	BOUNDARY BORE	2/6/69	650	470	7.5	37	<1	64	40	16	11	471		0.2	0.1		386	338
4450	BOUNDARY BORE	23/9/94	594	398	7.6	55	<1	48	27	11	19	383	<1	0.3	<.1	67	314	231
4450	BOUNDARY BORE	16/11/94	433	308	6.7	80	<1	14	8	15	28	248	<1	0.3	0.1	58	203	68
4637	KEEP BORE	13/6/67	637	372	7.8	35	0.6	6	69	20		205			0.0		336	302
4637	KEEP BORE	30/5/69	620	370	7.5	36	<1	42	40	20	<2	403		0.1	<.1		331	274
4637	KEEP BORE	18/10/90	770	470	7.5	41	3	71	43	12	17	510		0.2	0.3		418	354
4637	KEEP BORE	26/9/94	640	413	8.1	35	1	68	34	7	13	440	<1	0.2	0.5	63	361	310
4638	HUNGRY BORE	13/6/67	1060	744	7.7	85	3	46	86	46	207	203			0.0		332	472
4638	HUNGRY, BORE	2/6/69	820	660	7.1	85	3	46	38	44	305	98		0.4	0.1		80	286
4639	CAVE BORE	16/6/67	700	406	7.9	85	0.8	27		36		200		0.1	0.0		328	
4639	CAVE BORE	22/4/94	658	399	7.9	10	<1	65	31	11	12	436	1	0.3	<.1	42	358	290
6029	EMU SPRINGS BORE	30/5/69	670	450	7.5	34	1	72	40	12	24	461		0.2	0.1		378	346
6029	EMU SPRINGS BORE	26/9/94	680	426	7.9	29	1	72	38	7	24	449	1	0.2	0.2	57	368	336
6029	EMU SPRINGS BORE	14/11/94	789	505	6.9	42	2	92	37	11	98	439	1	0.2	0.8	49	360	382
6031	BLACKFELLOW CREEK BORE	29/5/69	520	280	7.6	13	1	42	40	12	6	354		<.1	0.1		290	282
6031	BLACKFELLOW CREEK BORE	17/10/90	665	390	8.0	47	2	26	50	19	55	362		0.2	0.1		297	271
6031	BLACKFELLOW CREEK BORE	27/9/94	769	468	7.8	46	2	76	43	16	54	453	2	0.2	<.1	44	372	367
6031	BLACKFELLOW CREEK BORE	19/11/94	752	423	7.2	46	2	73	42	17	54	456	2	0.2	0.1	43	374	355
7249	HOMESTEAD BORE	17/10/90	1190	840	7.4	94	4	116	30	54	297	333		0.3	1.6		273	447
7249	HOMESTEAD BORE	17/10/90	1115	815	7.6	116	4	57	44	65	350	166		0.2	0.2		136	323

APPENDIX 2 CHEMICAL ANALYSES OF GROUNDWATERS NEWRY STATION

BORE RN	BORE NAME	DATE	CONDUCTIVITY	T.D.S.	pH	SODIUM	POTASSIUM	CALCIUM	MAGNESIUM	CHLORIDE	SULPHATE	BICARBONATE	NITRATE	FLUORIDE	IRON	SILICA	ALKALINITY	HARDNESS
			uS/Cm	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
7249	HOMESTEAD BORE	21/9/94	3100	2520	7.3	390	13	345	48	203	1350	238	<1	0.4	2.4	27	195	1060
7296	CAMPBELL'S BORE	1/10/70	530		8.0					8		234					192	128
7297	CHRISTMAS BORE	1/10/70	380		9.0					29		90					106	20
7297	CHRISTMAS BORE	28/4/72	320	250	9.5	65	<1	3	<1	18	44	16		0.5	0.2		84	9
7297	CHRISTMAS BORE	28/4/72	320	240	9.5	65	<1	3	<1	19	41	16		0.5	0.2		84	10
7297	CHRISTMAS BORE	17/11/94	488	302	7.2	55	1	42	16	16	11	305	1	0.6	1.9	37	250	171
8159		2/5/72	1830	1330	7.3	200	9	174	37	102	608	305		1.0	1.3		250	586
8159		2/5/72	1830	1330	7.3	200	9	172	34	93	603	305		1.0	0.8		250	569
8227		25/9/73	540	370	8.2	94	9	15	9	19	24	299		0.3	20.0		245	75
8229	MUD SPRING BORE	8/10/73	360	250	7.3	73	5	7	2	25	12	175		0.2			144	23
8229	MUD SPRING BORE	23/9/94	383	290	8.1	96	1	3	<1	11	22	220	<1	0.2	1.3	58	180	7
8230	BALINGERS BORE	13/10/77	690		6.9					16		339					278	300
8230	BALINGERS BORE	18/10/90	955	665	7.5	61	2	110	30	25	229	342		0.2	0.4		280	399
8230	BALINGERS BORE	21/9/94	613	380	7.3	24	1	72	29	6	24	382	3	0.1	0.8	51	313	299
8231		3/9/73	9160	8750	7.6	1400	15	529	414	795	4500	358		2.3			294	3015
8233		4/10/73	1540	1120	8.0	159	9	54	85	95	545	176		0.7	0.6		144	484
26163	SCOTTS BORE	3/9/90	1600	1000	6.9	68	5	117	116	144	157	680		0.4	<.1		557	765
26798		17/7/90	2620	2550	7.5	41	26	501	115	20	1659	146		0.7			120	1725
26798		31/8/90		2545							1775							
26798		31/8/90	2950	2845	6.9	30	22	561	120	13	1852	179		0.7			147	1695
27706	FAREWELL BORE	1/6/92	533	347	8.0	51	6	34	23	20	18	311		0.3			255	180
29223	NEW HUNGRY BORE	22/9/94	875	599	7.3	44	3	84	43						0.1			387
29223	NEW HUNGRY BORE	10/11/94	943	619	7.1	52	3	98	53	28	148	437	7	0.3	0.1	60	358	463
29732		26/11/94	1100	625	7.6	192	32	27	27	32	62	632	<1	1.0		8	518	179

APPENDIX 3

WATER QUALITY REQUIREMENTS FOR STOCK AND DOMESTIC WATER

1. WATER QUALITY STANDARDS FOR STOCK USE

SUBSTANCE	GUIDELINE VALUE
pH range	5.5 - 9.0
Total dissolved solids	8000 mg/L
Sodium chloride	Not more than 75% when total dissolved solids near limit.
Sulphate	2000 mg/L
Nitrate	400 mg/L
Fluoride	5.0 mg/L
Magnesium	300 mg/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.

2. WATER QUALITY STANDARDS FOR DOMESTIC USE (NATIONAL HEALTH AND MEDICAL RESEARCH COUNCIL, AND AUSTRALIAN WATER RESOURCES COUNCIL CRITERIA)

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.

SUBSTANCE	GUIDELINE VALUE
pH range	6.5 - 8.5
Total dissolved solids	1000 mg/L
Chloride	400 mg/L
Sulphate	400 mg/L
Nitrate	45 mg/L
Fluoride	0.5 - 1.7 mg/L
Hardness (as Calcium Carbonate)	500 mg/L
Sodium	300 mg/L

APPENDIX 4

PUMPING TEST RESULTS

The results of pumping tests carried out on bores on Newry are summarised in the following table. More detailed information is available from the Water Resources Division in Darwin.

RN	BORE NAME	PUMP RATE (L/s)	PUMP SETTING (m)	BORE DIAMETER (mm)	SWL (m)
4450	Boundary	5	30	190	25.4
6029	Emu Springs	2	20	147	8.0
6031	Blackfellow Creek	2	14	142	7.9
7297	Christmas	0.1	55	190	9.2
29223	New Hungry	2	25	142	8.9
26163	Scotts	14	27	152	16.8

PUMP RATE -The recommended pump rate in litres per second

PUMP SETTING -The recommended depth below ground level at which the pump intake should be set

BORE DIAMETER -The minimum internal bore diameter in millimetres

SWL -The standing water level in the bore, in metres below ground level, measured immediatly prior to the test

APPENDIX 5

DAMS AND WATERHOLES ON NEWRY

1. HUNGRY BILLABONG:

This billabong is on one of the tributaries of the Keep River. It comprises three small separate pools. It fills every year but normally dries by June. The depth of water at the deepest point is about 0.8m. It is said that the billabong leaks and this is likely because it is located on alluvial plains which may have some sand pockets. In an average wet year it can supply 50 head of cattle from April to July. It cannot be deepen because of sand pockets. Insufficient depth and storage as well as leakage are the main factors that causes this billabong to be undependable.

2. SHOEBURN LAGOON:

This lagoon is part of a tributary to the Keep River. It dries by August but supplies 200 head of cattle during the dry till September. It has sufficient depth to supply water for 100 head of cattle from April to December with about 90% reliability.

3. MUDSPRINGS:

Water seeps out of the ground and collects in a shallow pool about 25 metres long and 6 metres wide. It then disappears into the ground a short distance downstream. The depth of water is about 0.2 to 0.3 metres. It is a perennial spring with a flow of 0.2 to 0.3 L/sec. The pool and the spring are not fenced and the cattle walk into the pool to drink. There is a ground tank with a capacity of 20000 litres. This can provide water for 100 head of cattle over four days. The number can be increased to 150 head over two to three days. This tank is not presently in use. It is recommended that the spring and the pool be fenced and water be pumped into the existing tank.

4. NEWRY BORE SPRINGS:

This is a waterhole in Matilda Creek which is spring fed. It is a shallow with a very small storage capacity. It never goes dry. It provides water to 100 head of cattle every day. This demand indicates a flow of 0.1 L/sec. Deepening is not recommended until subsoil conditions are investigated.

5. DINGO SPRINGS:
This is a waterhole which is spring fed. Creekflow lasts for about two months after the wet but after that it is only spring fed. It supports 200 to 300 head of cattle on average over a year. The waterhole can supply 300 head of cattle initially for the first two months soon after an average wet, and thereafter 150 to 200 head during the dry. This indicates a constant spring flow of 0.1L/sec. Deepening the waterhole is not recommended due to the possibility of leakage.

6. SADDLE CREEK DAM:

This is a stock route dam constructed by the government but has not been used for some years. It is an offstream type excavated tank. The inlet is breached, however there is sufficient depth below ground level to supply stock water. In an average wet year, it could supply 500 head of cattle, and in a dry year, 400 head of cattle with 90% reliability.

7. BUBBLE BUBBLE SPRING:

This spring is fenced and serves the local aboriginal community. It overflows down the Chinaman Creek where cattle freely walk in and drink. It is said to supply 200 head of cattle over a year. This spring serves the community and therefore cannot be categorised as a stock water supply source.

APPENDIX 6

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 very useful booklet entitled "Design and Construction of Small Earth Dams" (Nelson, 1985, Inkarta Press, Melbourne). The key investigation method is to auger a series of investigation holes. In an excavated tank situation this helps to:

- determine the extent of impermeable soils and the presence of any layers which are likely to have leakage problems
- show if there is any impermeable and soft rock present, such as rippable shale
- 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 onstream 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.

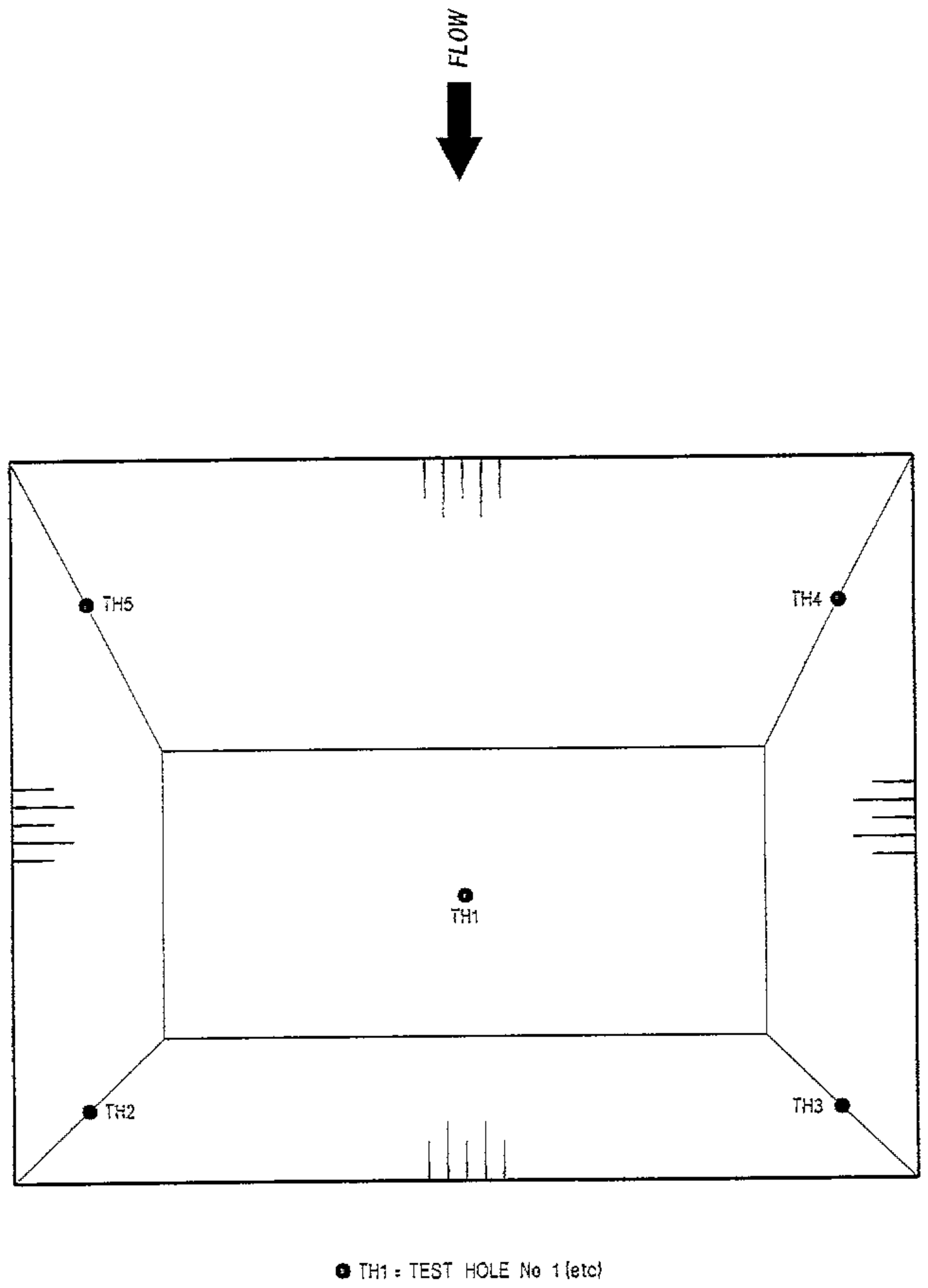
A hand operated 100 mm earth auger capable of drilling to between 5 and 6 metres is the basic tool for the subsurface investigations. Auger holes are sunk in soil to one metre deeper than the tank design depth, with minimum 500 gram samples taken wherever there is a change in soil. A plan of the soil 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 6). 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

1. Seepage Loss

In most areas of the plains country the watertable will be deeper than the proposed 4 to 4.5 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:

1. 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 and maintaining it at this level by addition of water.
2. The test involves maintaining this water level (0.5 metres below ground level). The amount of water added to keep the water level is recorded. Continue the test for one day.



TEST HOLE PLAN FOR
AN EXCAVATED TANK

Fig 6

/usr/long/wvrdrp.dgn

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 area should be considered as doubtful and should only be accepted with professional advice. Rates less than 3 litres per hour indicate that leakage will not be a serious problem.

2. Tests on Soil Samples

Soils commonly consist of particles which may range 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 the Conservation Commission of the Northern Territory and these provide a very good indication of soil suitability. However simple field tests can give a good feel for the likely behaviour of the soils.

1. 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.

2. 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 1.25 ml 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.

3. 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 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 be necessary to abandon the proposed site

APPENDIX 7

CONSTRUCTION DETAILS OF EXCAVATED TANKS, TURKEY NESTS AND MODIFIED WATERHOLES

Assuming preliminary investigations (Appendix 6) have shown the suitability of a site for a specific structure then construction can be begin. No matter how good the design, poor construction methods can lead to a less than perfect structure.

1. 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 it's storage capacity. The bund should have a minimum berm width of 5 metres (Figure 4). Topsoil with potential for leakage must be removed down to an impervious layer before the bund is built, and compaction should be undertaken using the available machinery. The ideal time to achieve optimum compaction is early in the Dry 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.

For offstream excavated tanks catch drains can be constructed, eg. using a tilted grader blade, to direct an increased volume of sheet flow towards the tank.

2. Turkey Nests
The current design and construction techniques for turkey nests are adequate although special attention should be paid to:

- removal of leaky topsoil from the base before construction;

- the selection of a non - dispersive soil construction material (Appendix 6);

- compaction at optimum moisture content. This can be achieved if construction is undertaken early in the Dry while soil is still moist. Every 100 mm layer of loose soil should be compacted.

For three days water supply from a turkey nest the following dimensions are recommended:

NUMBER OF CATTLE	INNER DIAMETER AT BASE (metres)	INNER DIAMETER AT TOP (metres)	HEIGHT (metres)
200	6	13	1.1
500	8	16	1.5

These figures are based on sides with a 1 in 2.5 slope.

3. 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.

APPENDIX 8

GLOSSARY

AQUIFER A body of rock that is sufficiently permeable to conduct 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 Small diameter hole constructed with a drilling rig, and down which a pump is lowered to extract groundwater.

BUND Bank, constructed of compacted fill, used to contain water.

DEMAND The volumetric flow rate required for stock watering, therefore the rate at which water would be supplied if available.

DRAINAGE -LINE TANK Excavated tank built in an area which does not have a defined creek.

GROUNDWATER Water contained in rock below the water table.

OFFSTREAM TANK Excavated tanks built near creeks, and connected to the creek by a channel to tap the creek flow.

ONSTREAM TANK Excavated tanks built across a well defined stream.

RELIABILITY The frequency at which a tank would be able to supply the annual stock water demand, eg. 90% reliability means that the tank should be able to supply annual stock demand for on average every nine years out of ten.

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.

WATERTABLE The surface resulting when the standing water levels in adjacent bores in the same aquifer are connected.