2. SITE INVENTORY AND ASSESSMENT

2.1 PHYSICAL ENVIRONMENT

2.1.1 CREEK HYDROLOGY

This study looks at the entire catchment area of the Rapid Creek. The Creek, measured from Marrara Swamp to the mouth at Casuarina Coastal Reserve is approximately 9.8 km in length, draining a catchment of over 28 km^2 as shown in Figure 2.1

Catchment Drainage System

The entire catchment of Rapid Creek has been investigated and a literature review undertaken as part of this study. On this basis, the creek hydrology may be assessed and evaluated. The sources of water in the creek may be broadly classified as urban run-off and natural recharge. The urban run-off has two distinctive flows that relate to the wet and dry seasons. During the wet, urban run-off is typically high flow stormwater with levels and volumes closely linked to rain events. During the dry season, low flow stormwater results from garden irrigation and car washing.

Natural recharge is also related to the two predominant seasons. During the wet season, the swamps fill and begin to discharge into the creek. This, along with overland flow, maintains a significant water volume in the creek during the wet season. Storm events are accompanied by increased waterflows and levels. During the dry season, the effect of storm events is rarely important.

A number of studies indicate that Marrara Swamp and the secondary swamps within the RAAF grounds slowly discharge water and are a major factor in the persistence of streamflows into the dry season. The swamps contain water for much of the dry season and are one probable source of groundwater recharge in the catchment. The swamp also acts as a large detention storage during flood events. (Willing & Partners, 1976; Dwyer, 1980).

The Marrara Swamp overflows into two natural drainage arms - to the north and the south - which are in the most part ill-defined. The southern arm flows into a secondary swamp close to the eastern end of the airport runway, and rejoins the northern arm in another large swampy area, upstream of the existing flood mitigation weir. (Refer Figure 2.1). Below the weir the creek becomes a well defined channel with a moderate gradient and a number of deep pools. In the area downstream of Kimmorley Bridge, the creek comes under tidal influence.

The creek serves an important function as the main element of the catchment drainage system, conveying runoff from the developed areas. A number of open drains and road culverts drain the flat, upper regions of the catchment. Major open drains within the RAAF Base and FAC land empty into the creek, as does an unlined drain behind the caravan park at Karama. Feeding into Marrara Swamp are a number of drains, with culverts under Amy Johnson Avenue.

Downstream of Kimmorley Bridge, the contributing catchment to the creek are highly developed residential suburbs with piped drainage systems, and there are several stormwater outfalls to the creek.

Rapid Creek follows a well defined channel through the riverine monsoon forest, where low flows persist well into the dry season.

The paperbark swamp area on the southern arm of Rapid Creek is an important component in the overall flood mitigation role of the upper catchment.

HYDROLOGY

Figure 2.1

1 IN 100 YEAR FLOOD LEVELS
SOURCES: WILLINGS AND PARTNERS, 1976
CAMERON McNAMARA, 1982
DWYER, 1980

OPEN STORMWATER DRAINS

PIPED OUTLETS

PRIMARY ZONE STORM SURGE

SECONDARY ZONE STORM SURGE

CATCHMENT BOUNDARY

RAPID CREEK
MANAGEMENT STUDY

0 500 1000 M

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Waterflow Characteristics and Flooding

The creek essentially retains its natural form and bank profile for its entire length, although there has been some channelization works east of Amy Johnson Avenue and along the northern arm. Some straightening works were carried out upstream of Trower Road prior to 1980. There is evidence that the creek bed between the flood mitigation weir and Kimmorley Bridge has experienced bottom scouring and bank erosion. It is possible that this is a natural occurrence associated with peak flows along this steeply graded section of creek. However, when comparing the creek profiles of Rapid Creek with other creeks with undeveloped catchments (eg Kings Creek) it becomes clear that the steep banks, overhanging in some places, is atypical. This is supported by photographic evidence (see over) that indicates a slow flowing creek with water lillies established. The literature review was unable to source any data that specifically identified this problem. Given the major drainage channels entering the creek, increased run-off and heightened peak flows, it would appear that the development of the catchment is the most likely cause of the scouring.

As with other watercourses in the Top End, water flows vary greatly as a result of variations in rainfall and evaporation. During the wet season, December - March, creek flow is large and the creek regularly overtops the defined channels. In the area of the swamps and Pandanus communities, the groundwater rises above ground level and extends to cover large areas. Marrara Swamp is often inundated across an area greater than 15 ha.

The swamps, in conjunction with the well-vegetated, ill-defined channels of the north and south arms serve a major role in flood control and mitigation (Cameron McNamara, 1982). The road crossings at McMillans and Trower Roads were designed to a minimum standard that they should not be flooded more frequently than once in 20 years on average. However, with changes in the catchment upstream of Kimmorley Bridge, it is likely that McMillans Road would flood more frequently than this (Cameron McNamara, 1982) and there is anecdotal evidence of this. The same report goes on to note that the upper catchment of Rapid Creek is the major control on reducing peak flows and maximum flood levels. This role is dependent on maintaining the 'unimproved' nature of the creek.

Low flows in the lower reaches of the creek are maintained well into the dry because of the slow drainage of the swamps and the unconfirmed belief that ground water maintains a minor spring in the area of the flood mitigation weir. The upper reaches of the creek including Marrara Swamp, do dry up completely during the dry season. Surface water is retained in the swamp upstream of the flood mitigation weir and the defined channel and deep pools below the weir hold substantial water through to the following wet season .

Low flows from developed areas occur, and are usually the result of excessive water from irrigation or washing down. In some cases, this water enters the constructed stormwater system, but will not reach the creek itself. Such instances have been recorded by the team in the major open unlined drains draining from the Karama residential area, RAC grounds and from the Marrara Sports Complex. However, the large stormwater outlet in the area of Ellengowan Drive and other smaller outlets in the Rapid Creek, Alawa and Milner areas are typical exceptions. These systems drain urban areas and the piped outlets empty directly into a channelized tributary. Figure 2.1 indicates the areas subject to flooding and the major drainage lines and piped outlets in the catchment.

2.1.2 WATER QUALITY

Water Quality Testing and Monitoring

A number of water quality monitoring programmes have been undertaken within the Rapid Creek Catchment since 1980. Several of these have been implemented as a direct response to proposals to expand the Darwin Airport and other developments within the catchment. Prior to 1980, there is very little water quality data available for Rapid Creek, and there is no

comprehensive work on water quality below Kimmorley Bridge. A report prepared by Cameron McNamara (1982) for Transport and Works, identified existing problems and potential threats to water quality associated with proposed developments in the catchment. At that time, there were indications that bacteriological contamination of the waters exceeded accepted criteria for primary contact (swimming). Qualitative assessments were made of pollution sources and likely impacts of existing and proposed developments, recommendations were suggested to ameliorate these impacts.

The recommendations applied to the following pollutants - sediments, oils and grease, BOD and nutrients, bacterial, litter - and were assessed under the 1982 existing situation, and the forecast future situation. The future situation incorporated the various proposed developments within the catchment, including expanding residential areas of Karama and Northlakes, Northlakes Golf Course, Airport extensions and Marrara Sports Complex.

Various recommendations relating to provision of silt traps and control of erosion may have been incorporated during construction, but there is evidence of continuing erosion and siltation occurring. Several potentially incompatible land uses have not proceeded. Removal of buffalo from RAAF grounds has proved sussessful, but their is some evidence of pig activity upstream of the flood mitigation weir.

The large open unlined drains draining the FAC land, Marrara Sports Complex and running parallel to McMillans Road east of Lee Point Road are presently eroding. The flows and velocities in these drains have significantly altered the characteristics of the catchment in these localities. The result has been erosion, both in the drains themselves, and also along the creek.

The Northlakes Golf Course and Marrara Sports Complex makes use of recycled waste water. Recommendations were adopted, but there continues to be problems of nutrients entering the creek during the wet season, when the storage dam overflows. At this time significant volumes of waste water, containing fertilizer, weedicides and fungicides enter the creek.

Grease and oil traps were recommended for the airport site and these have been incorporated in the development, in the form of hay bale arrestors.

Water sampling undertaken by Dames & Moore (1986) over a period of $2^1/2$ years, together with the Department of Transport & Works Water Division records from July 1981 to May 1983, provides an adequate, although limited, range of results from which baseline variability of water quality in the catchment can be assessed.

Seasonal variations in factors such as electrical conductivity (EC), pH, water temperature, dissolved oxygen levels, nitrate variability, ammonia variability and phosphorous levels and sediment loads are typical of a nutrient deficient monsoon environment. (Dames & Moore, 1986). Of particular interest is the low EC values which reflects a very low buffering capacity in the stream to counteract acidic and alkaline effluents of human origin or other natural processes leading to changes in pH (Dames & Moore, 1986). Nitrate levels in the northern arm were high and it was thought this was the result of the greater vegetation clearance and increased urbanisation in this area of the catchment and the use of treated effluent for irrigation at Northlakes Golf Course. Phosphorous levels are highly variable, with definite dry season maximum values consistent with the effects of organic decomposition.

Water quality in Rapid Creek below the flood mitigation weir remains high. This is a result of the thickly vegetated swamp environments acting as a biological filter to remove chemical constituents and particulate matter (Dames & Moore, 1986). Bacteria levels unacceptable for recreational swimming have been recorded following major first flush events, but other health risks from nutrients and toxic chemicals are considered minimal (Dames & Moore, 1986). A report by PAWA (1990) confirmed that concentrations of

E. coli (faecal pollution indicator bacteria) were below the guideline figures used by the N.H and MRC (1988) for primary contact recreation.

The effects of sediments on water quality is significant. Disturbed and cleared sites will contribute to the pollution load since the massive red and yellow earths that are the dominant catchment soil type are classified as moderately high erodibility. (Fogarty *et al*, 1979).

Site disturbance and clearing of vegetation will seriously impact on water quality with increased suspended sediment loads and turbidity (Dames & Moore, 1986).

Sources of Contamination

The upper reaches of the catchment remain in a relatively undeveloped state. Potential sources of pollution are restricted to urban stormwater from Karama subdivision and stormwater from the agricultural areas east of Amy Johnson Avenue. The primary pollutants are likely to be nutrients and chemicals, including low concentration of oils, grease and hydrocarbons off paved areas. The use of treated effluent water at Northlakes Golf Course does release nutrients into the Rapid Creek catchment, and monitoring in the area has indicated raised nitrate levels (Dames & Moore, 1986).

Phosphorous levels are commonly high in urban stormwater. Although the levels in the creek are highly variable, it appears that the dry season values are consistent with the effects of biological decomposition (Dames & Moore, 1986). The swamp environments in the upper catchment are important biological filters and storage areas which collect and attenuate sediment and chemical constituents entering Rapid Creek.

Between the flood mitigation weir and McMillans Road the major source of pollutants is oils, grease and hydrocarbons from the RAAF and FAC grounds, and nutrients from Marrara Sports Complex. Accidental fuel leaks from the airport pose a real threat to the water quality (Kinhill, 1991). Provision has been made to deal with leaks, but this is restricted to hay bale arresters. They are yet to be tested in a real situation, and require regular maintenance. Maintenance programmes at the sports complex can be expected to release chemical nutrients (fertilizers, pesticides, weedicides) and organic material into Rapid Creek.

This area of the catchment is also a significant source of sediments due to the expansive areas of cleared land within the RAAF and FAC lands and the steep gradients of the open unlined drains. Surface flows collect significant sediment loads leading to turbidity within Rapid Creek.

Downstream of McMillans Road, the main sources of pollutants are expected to be urban stormwater and nutrient/animal wastes from the rural living blocks. The potential hazards of urban stormwater have been discussed above. Manure and other animal wastes from the rural living blocks could lead to eutrophication and bacterial contamination of the creek. (Cameron McNamara, 1982).

This lower section of the creek is tidal to approximately 400 metres below McMillans Road and this factor contributes to the regular flushing of the creek, whereby the pollutants may be removed from the system.

2.1.3 LANDFORM AND SOILS

Figure 2.2 illustrates the different land units described by Fogarty *et al* (1979). The report forms the basis for the following description.

Landform

The Rapid Creek catchment has been divided into 4 broad landform divisions essentially on the basis of the continuing process of geological erosion and deposition (Fogarty *et al*, 1979). The landform is the basis for classification of the terrain into units because it has a controlling influence over soils, drainage and vegetation.

These include:

Plateau surface - a flat to gently undulating surface which forms the watershed of the catchment.

Plateau drainage areas - This division covers the slowly draining perennial/annual wetlands and linking spillways in the area of the swamp and north and south arms in the RAAF Base grounds.

Plateau sideslopes and foothills - These areas are usually at gentle to moderate gradients and coincide with the area of Rapid Creek below the flood mitigation weir.

Coastal plains and estuarine flats - the alluvial and marine clays of the mangrove areas and coastal sands of Casuarina Coastal Reserve are typical of this landform. Typically low relief and negligible slope.

Soils

Soils through the catchment vary substantially and often over short distances. The characteristics of the soils are very important for two reasons, firstly they play a critical role in determining the type and location of the vegetation communities, and secondly, they place limitations on development due to drainage, soil depth and susceptibility to degradation (Fogarty et al, 1979)

The catchment, particularly on the plateau surface and sideslopes is characterized by red and yellow massive earths. The depth of these soils vary but are often shallow and they are all easily eroded if cleared of vegetation. Other soils in the catchment include earthy and siliceous sands (found on the lower slopes) and grey cracking clays and marine muds. While the sands are excessively well drained, the clays and muds, due to their location and structure are poorly drained.

2.1.4 VEGETATION

A detailed vegetation survey of the different plant communities using photographic interpretation and field checks was prepared by Clark and Brocklehurst (undated). Additional field survey work has been undertaken by the consultant team as part of this study. This survey work was directed at extending the species list for various communities, field checking the original work where required and identifying management issues. The survey does not attempt to delineate accurately the different communities and their extent. Nor does it aim to be comprehensive in identifying all species present. The details of the sites and transects surveyed appears in Appendix 1. By combining the information obtained in the two surveys, it is possible to summarise the broad vegetation communities as follows (Refer Figure 2.3).

Mangroves

Mangroves extend from the mouth of Rapid Creek to the area adjacent to the Darwin Water Gardens. The community is dominated by *Avicennia marina, Ceriops tagal var. australis* and *Bruguiera exaristata*. At its upstream limit the main mangrove community was *Lumnitzera racemosa*. This community is healthy, comparatively robust and has recovered well both from cyclone damage, clearing and filling during the mid-seventies. Typically of mangroves in the tropics, the community displays a healthy diversity, however, because of the short steep slopes of the estuary, the community is less diverse and not clearly banded as other areas of the Top End. The occurrence of *Acanthus ilicifolius* makes the area almost unique since it is rare in those mangroves that have been classified in the Northern Territory (Dwyer, 1980).

Riverine Monsoon Forest

This community consists of a narrow band of rainforests species that extends from approximately 500 metres downstream of Kimmorley Bridge to just below the flood mitigation weir. In parts the community is little more than a single row of trees on either side of the creek, and in other places it extends to 50 metres wide. Dominant species are *Acacia auriculiformis, Syzygium angophoroides, Carallia brachiata* and *Lophostemon lactiflius.* Other important species include *Pandanus spiralis, Barringtonia acutangula, Alstonia actinophylla, Maranthes corymbosa* and *Euodia elleryana*.

Perhaps the most interesting species in this community is *Syzygium angophoroides* which is indicative of permanent fresh water. It is unusual to find this species so close to the coast and is typical in deep, moist gullies on the escarpment edges of Litchfield and Kakadu.

Pandanus/Transitional

These communities occur in areas where a combination of soil types, slopes and drainage systems results in higher moisture than in the surrounding woodlands. *Pandanus spiralis* is dominant, occasionally in pure stands, but also in association with *Lophostemon lactifluus, Eucalyptus alba* (occasionally) and *Eucalyptus polycarpa*.

Eucalyptus Woodland

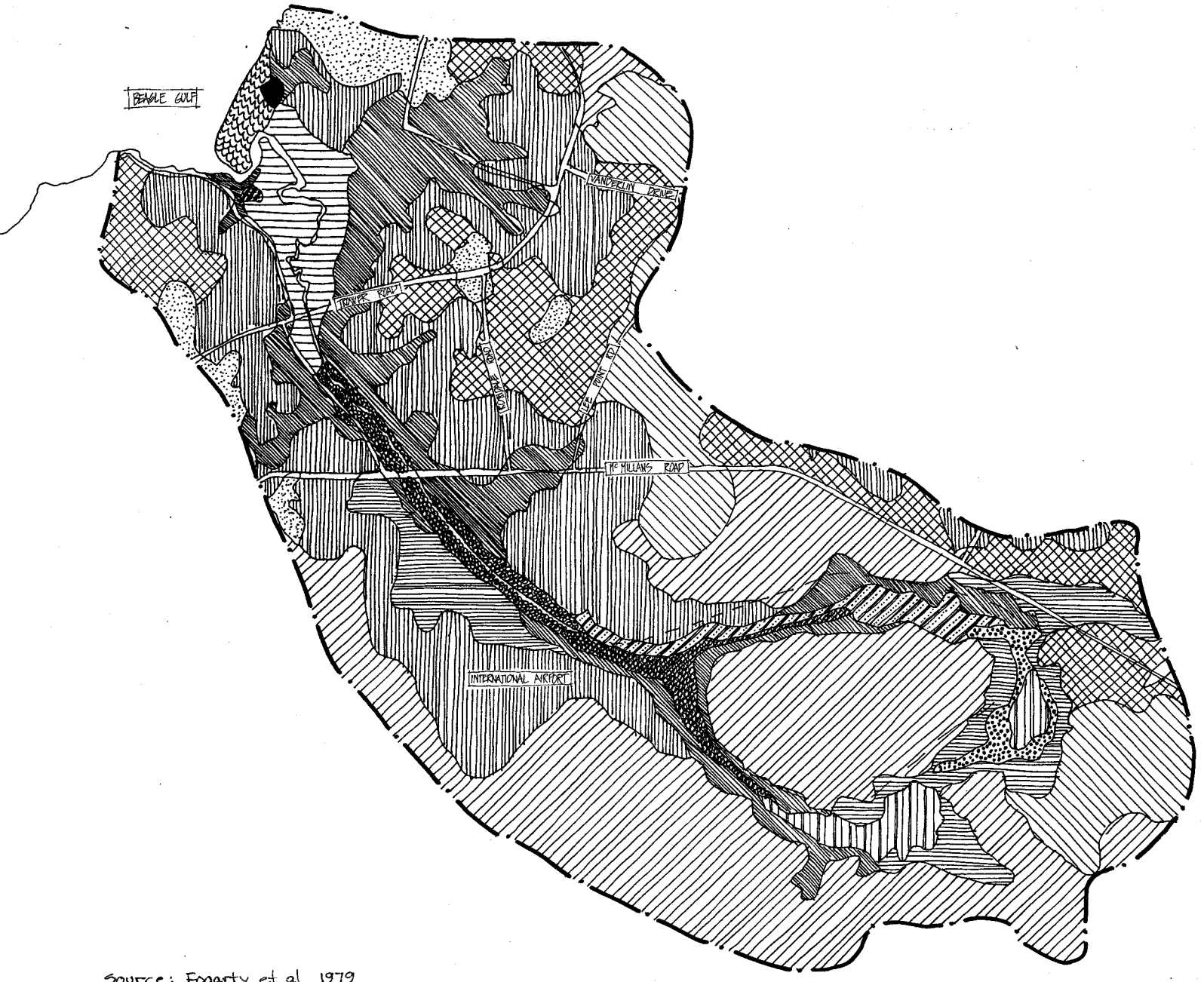
This community is restricted to the upper slopes and plateau surface of the RAAF Base. This community while common in the Top End is not well represented in the Darwin area. The community is dominated by *Eucalyptus miniata* and *Eucalyptus tetradonta*. The area within the two arms of the creek has a sparse midstory and ground layer, apart from *Sorghum intrans.* The area north of the creek, behind Marrara Sports Complex and Northlakes Golf Course is relatively healthy, showing moderate regeneration and seedling recruitment. *Terminalia ferdinandiana, Livistona humilis, Acacia aulacocarpa, Cycas armstrongii* and *Erythrophleum chlorostachys* appear as scattered individuals.

Paperbark Swamps

This community is quite restricted within the study area. It is dominated by *Melaleuca viridflora*, often in association with *Pandanus spiralis* and *Grevillea pteridifolia*.

Weeds

Weeds are widespread throughout the catchment and are particularly prevalent through the low lying grassland communities (*Pennisetum polystachion, Andropogan gayanus*) and in cleared/disturbed areas of the mangrove and monsoon forest communities (*Leucaena leucocaphala* and isolated *Mimosa pigra*). Drainage lines from and fringes to residential areas are often infested with garden escapes.



Source: Fogarty et al, 1979

LAND UNITS

Figure 2.2

UPLAND DEPRESSIONS AND DRAINAGE WAYS

- 2a1 EARTHY + SILICEOUS SANDS; GRASSLAND, MINOR WOODLAND
- 2a2 HUMIC GLEYS DOMINANT; MELALEUCA CLOSED FOREST

SIDE SLOPES AND LOW HILLS

- 3a RED AND GRAVELLY RED MASSIVE EARTHS; WOODLAND WITH MINOR CLOSED FOREST.

LOWER FOOTSLOPES

- 5a YELLOW MASSIVE EARTHS MINOR RED MASSIVE EARTHS; OPEN GRAVELLY; OPEN FOREST.
- 5b LAYERED ORGANIC SOILS WITH CLOSED FOREST DOMINANT, OFTEN RAINFOREST.

DRAINAGE FLOORS

- 6b EARTHY SANDS, MINOR HUMIC GLEYS; WOODLAND WITH MINOR CLOSED FOREST.

LITTORAL AREAS

- 8a1 SALINE GREY CRACKING CLAYS; GRASSLAND
- 8a2 RECENT MARINE MUDS FREQUENT ROCK OUTCROP. MANGROVE CLOSED FOREST
- 8b1 CALCAREOUS DUNE SANDS; GRASSLAND/TREES.
- 8b2 STABILISED BEACH RIDGE SYSTEM CLOSED FOREST

LOW PLATEAU SURFACE

- 1a RED MASSIVE EARTHS; OPEN FOREST
- 1b1 RED + YELLOW MASSIVE EARTHS; O.F.
- 1b2 GRAVELLY RED + YELLOW MASSIVE EARTHS; OF.
- 1c LITHOSOLS; WOODLAND TO O.F.
- 1d YELLOW MASSIVE EARTHS + MINOR RED MASSIVE EARTHS; OPEN FOREST

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MANAGEMENT STUDY

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VEGETATION COMMUNITIES

Figure 2.3

- MANGROVE COMMUNITIES
- MONSOON FORESTS
- TRANSITION
- PANDANUS COMMUNITIES
- EUCALYPTUS COMMUNITIES
- CLEARED LAND
- GRASSLAND COMMUNITIES
- PAPERBARK COMMUNITIES

SOURCE: 1. CLARK AND BROCKLEHURST VEGETATION MAP
2. J. BROCK, FIELD SURVEY, 1993

RAPID CREEK MANAGEMENT STUDY

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Coffee bush infestation on disturbed land adjoining Northern Territory University and mangrove community.

Healthy pandanus community on northern area of Rapid Creek.

2.1.5 FAUNA

The study team undertook an intensive literature search and limited field survey work to investigate the diversity of fauna in Rapid Creek. This survey does not constitute an intensive fauna survey of the region, but merely attempts to highlight species likely to occur in the region. The details of species lists appear in Appendix 2.1 Terrestrial Fauna, 2.2 Freshwater Fauna and 2.3 Mangrove/Estuarine Fauna.

The literature search did identify a significant absence of any freshwater studies within the Darwin Region. The current knowledge on freshwater environments in the Top End is restricted to the Alligator Rivers region. Current studies on freshwater ecology of the Magela Creek and floodplains will soon be complete and this will provide a good basis from which similar habitats/ecosystems in the Darwin region can be assessed. Due to the size of the Rapid Creek system, it is likely that the diversity of fauna would be reduced. A reconnaissance of the freshwater environment upstream of McMillans Road confirmed that the creek maintains a diverse stream community, with large numbers of crustaceans and fish.

The species lists included in Appendix 2 is compiled from a number of earlier surveys and published reports. In the absence of a detailed field survey, or any specific study of freshwater streams in the Top End, this survey provides a list of species or families which have been encountered in the Top End. A diverse range of organisms utilize freshwater habitats and the fauna in the Northern Territory is not likely to be very different from any other Australian region. While different species will occur, the basic structure of the communities are essentially composed of the same specialized group of animals, including Annelid worms, insects, crustaceans and fish.

Mosquitoes

Mosquitoes are a natural component of most aquatic environments. In the Rapid Creek catchment, the occurrence of mosquito species is of particular concern due to the proximity of the airport. The World Health Organisation has a requirement that mosquito breeding sites are eliminated for a distance of 400 metres from the perimeter of an international transit area. The Northern Territory and Commonwealth Health Departments have extended this zone to 1600 metres, in view of the normal flight range of some of the malaria vector species present.

Control of mosquito breeding is therefore required for health reasons. The residential and recreational areas of Marrara, Northlakes, Malak and Karama could also be expected to benefit from mosquito control as a result of reduced annoyance factors.

The catchment at present does not pose a significant mosquito threat, however, the three swamp areas within the RAAF grounds are potentially major mosquito breeding areas, should the present system be altered. Peter Whelan (pers comm, 1993) has noted that the factors necessary to maintain the above areas relatively free of mosquito breeding include ensuring low nutrient levels in the water, forest canopy cover over creek lines and swamps, the maintenance of good freshwater fish populations in all areas of the swamp, and the maintenance of the relatively small or reduced areas of freshwater semi-aquatic reed species. Peter Whelan (pers comm, 1993) has identified the native rainbow fish populations as effectively controlling mosquito breeding in much of the swamp system. The greatest threat to their continued role in mosquito control would be pollution and loss of their dry season refuges in the lower reaches of the creek and the swamp area at the confluence of the two arms.

In the lower reaches of the creek, the main potential for mosquito breeding is the low flows associated with stormwater drains entering the creek from the airport, Marrara Sports

Complex and residential areas. Further details of the mosquito breeding and control are contained in Appendix 3.

2.1.6 FIRE

Fire has been an inherent factor in the Top End landscape for thousands of years. Fires often start naturally as the result of lightning strikes during the dry season when there is a large fuel supply from grasses, in particular *Sorghum intrans.*

Aboriginals have long used fire as a management tool to clear vegetation and promote new growth. Their intimate knowledge of the natural systems resulted in a patchwork burning matrix in the early dry season.

As Darwin has developed, these two, well established patterns have been eliminated and there have been significant changes to the natural fire regime. Fire is still an important factor in the catchment. While some fires are controlled burns to reduce fuel loads in the early dry season, many of the fires are uncontrolled. These sporadic fires frequently result from itinerant camping, but it is believed motor bike riders and children playing are also responsible.

While no specific study of fire impact has been carried out in the area, observations of long term residents, supported by historical photographs, indicate that there has been significant changes in the vegetation structure and diversity in some communities. While fire is an important aspect of the woodland communities, the paperbark and swamp communities and the monsoon forest community are susceptible to fire damage. (Brock, 1988; Russell-Smith, 1984).

2.2 CULTURAL ENVIRONMENT

The cultural environment of Rapid Creek has drawn on the richness of the natural systems to produce a multi-layered 'fabric' that is a valuable resource to the greater Darwin area. This section describes the different layers, and relates them to the physical environment.

2.2.1 LANDSCAPE INVENTORY AND SCENIC ASSESSMENT

Landscape Inventory

This landscape inventory is concerned with those areas within the catchment which retain their natural habitats and vegetation cover, and those other areas adjacent to the creek corridor that are modified landscapes but retain open space characteristics (i.e. well vegetated, limited built structures).

In restricting the inventory to these areas, the landscape may be classified into five main character types : mangrove and estuarine landscape, closed forest landscape, wooded landscape, swamp and drainage area landscape, cultivated landscape.

Within each character type a number of landscape settings have been identified based on water characteristics, vegetation communities, and topographic profile of the creek. These are described and illustrated below. Their location in the catchment is shown in Figure 2.4.

Mangrove and Estuarine Landscape - This character type is quite uniform and corresponds to the lower, tidal waters and flats towards the mouth of the creek. The vegetation is dominated by the closed vegetation of a variety of mangrove species.

Closed Forest Landscape - This character type is quite uniform and corresponds to the narrow corridor of riverine monsoon forest between Trower Road and the flood mitigation weir. The width of the vegetation varies from between 2 and 50 metres on either bank and is closely linked to the contained, relatively fast flowing creek. This type may be divided into two settings degraded Closed Forest (below McMillans Road) and *Acacia auriculiformis/Syzygium angophoroides* dominated Closed Forest (above McMillans Road).

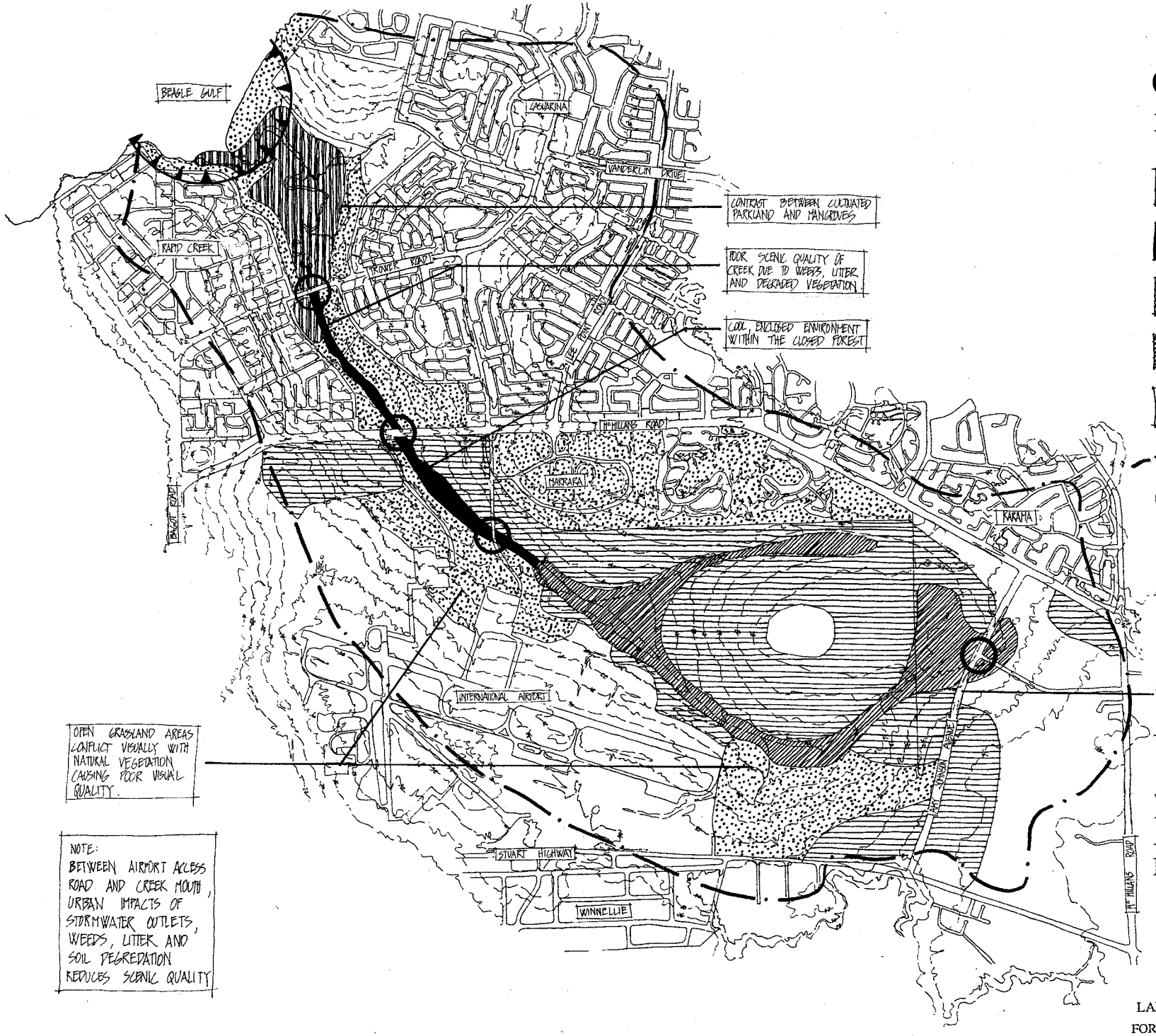
Woodland Landscape - This character type is spread throughout the catchment and is generally found on the higher slopes and plateaus away from the creek itself. There are two settings within this type.

Eucalyptus dominated woodlands occur within the RAAF grounds and also extend east of Amy Johnson Avenue. This setting, while well represented in the Top End, is restricted within the Darwin urban area. It is typically an open, timbered landscape with extensive grass understory. Transition Woodlands occur on the slopes, in closer proximity to the creek. They often exhibit a greater species diversity in the canopy layer and would include *Eucalyptus sp, Pandanus spiralis, Syzygium suborbiculare* and *Lophostemon lactifluus.*

Swamp and Drainage Area Landscape - This character type is located along the drainage lines upstream of the flood mitigation weir. There are a number of settings, that are determined by vegetation. All these settings exhibit major seasonal variations with changes in water levels. Pandanus dominated swamps consist of virtually pure stands of *Pandanus spiralis* which create a distinct form and texture to the area. They are quite dense and sheltered areas.

LANDSCAPE CHARACTER TYPES

Figure 2.4



MANGROVE AND ESTUARINE

CLOSED FOREST

WOODLAND

SWAMP AND DRAINAGE

CULTIVATED LAND

CATCHMENT BOUNDARY

MAJOR ROAD CROSSINGS:
IMPORTANT VIEWING POINTS, BUT RAPID CREEK IS OBSCURED FROM ROAD TRAFFIC.

VIEWS:
HIGH SCENIC QUALITY AT CREEK MOUTH – VIEWS ALONG COAST AND INTO MANGROVE COMMUNITY.

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Melaleuca dominated swamps consist of varied densities of *Melaleuca viridflora*. These swamps are more open than the *Pandanus* swamps, although the plant density is often greater.

Grass dominated swamps are very open, with only scattered or no trees. The grasses create a fine texture and accentuate the flat nature of the landscape. The annual life cycle of the grasses results in a visually dynamic landscape.

Cultivated Landscape - This broad character type includes all modified landscapes and recreation areas which are not dominated by natural communities. They are readily recognized as man-modified and their use and appeal is very much a reflection of the level of maintenance. A number of settings are identified. There is a marked contrast to the remnant natural communities described above. Developed active recreation areas include Marrara Sports Complex, Northlakes and the sports ovals fronting Lakeside Drive. The areas are well maintained with lush green grass throughout the year and a dominance of canopy shade trees (mostly exotic). They are easily recognizable as active recreation areas and are generally well used.

Developed passive recreation areas include those parkland areas adjacent to the natural areas (reserves adjacent to Casuarina Drive and Rapid Creek Road, Darwin Water Gardens). These areas are quite variable in level of maintenance. They are scenic in themselves, but rely for their appeal on their proximity to the creek, coast, and natural vegetation communities.

Other open space areas include those essentially undeveloped areas that tend to be quite open with limited structures. Large areas of the RAAF and FAC grounds fall into this setting, as does Casuarina Coastal Reserve. These areas are very open, undeveloped and have very low levels of maintenance.

Scenic Quality

The diversity of remnant vegetation communities along with the various modified landscapes, has resulted in a rich scenic environment with aesthetic qualities that are generally high. The presence of and views to the water are always important in the Top End. This may be shallow, standing water below the paperbarks alongside Amy Johnson Avenue; the swiftly flowing current through the riverine monsoon forest; or the tidal ebb and flow along the coast and through the estuarine areas.

The seasonal change and ephemeral qualities of the different settings as they reflect the changing water regime and plants flower and fruit contribute to a readily visible natural cycle.

The presence of fish and crustaceans within the creek and banks; noisy bird populations of black cockatoos and crimson lorikeets; quiet patience of the water birds; darting flight of bee eaters and swallows; and bat colonies all add to the rich visual experience of the creek corridor

The visual quality is largely dependent on the natural systems and the maintenance of them is critical. At the same time negative impacts on these systems will reduce the scenic quality. Impacts that detract from the visual quality include:

- Rubbish dumping, in particular littering of cans, bottles and papers.
- Indiscriminate car parking and access tracks, with corresponding loss of ground cover and erosion (sheet, gully, rill).
- Degradation of vegetation, loss of canopy and significant weed invasion.
- Low flows from urban stormwater systems.
- Inappropriate development that is often poorly sited and designed, with inadequate attention given to the necessary rehabilitation of disturbed areas.

Littering, rubbish dumping, poor water quality and weed encroachment all have a negative impact on the scenic quality.

Visual Access

The creek corridor, where the highest quality areas occur has a limited visual access. This is primarily due to the adjoining landuses. The rural blocks near McMillans Road and the restricted access to the RAAF grounds means that large areas are visible only from limited positions and perimeters.

The creek and vegetation communities have a high visibility in the estuarine reaches between McMillans Road and the airport access road, and adjacent to Amy Johnson Avenue. Vehicle and pedestrian access is important in determining the visual significance of the creek.

The linear nature of the creek, from headwaters to the sea, is not clearly interpreted in the present urban setting, since visual access is disjointed. The visual links are not clear.

2.2.2 RECREATION ASSESSMENT

Rapid Creek is an important recreation resource within the Darwin urban area. Its value relates primarily to passive recreational activities that rely to a large extent on the peaceful, scenic qualities of the creek and its vegetation. Active organised sports are also pursued in areas adjacent to the creek. The great majority of users would be residents of Darwin's northern suburbs, however, it would be expected that other Darwin residents, and visitors (NT, Australia & overseas) are also present. No comprehensive recreational studies have been undertaken of the Rapid Creek region. This assessment therefore draws on relevant recreational studies that have been undertaken in the Northern Territory, communications with residents of the area, and team knowledge of the area (surveyed and experience).

Passive Recreation

Passive recreation encompasses a wide range of recreational activities ranging from the more active pursuits of swimming, running and cycling to sunset watching and picnicing. A further recreational value is enjoyed by a part of the population in the knowledge that the natural resource exists and is protected. Other activities include walking, fishing, unstructured play, nature watching and general relaxing.

These activities would not generally conflict so long as the space is available, they can happen in parallel. Facility requirements are minimal, restricted in most cases to park furniture and infrastructure such as paths, seating, bins, barbecues, shelters, play equipment, water, lighting and parking. In the areas where such facilities are provided they are well used. Some of the activities listed above require only the natural setting of the creek.

All activities however do depend on access, and this is well supported by the fact that accessible sites, with appropriate facilities, are generally well used. The major areas of passive recreation are the riverine monsoon forest and in the areas of public access downstream of McMillans Road, including the Darwin Water Gardens and parks fronting Casuarina Drive.

Active Recreation

Active recreational pursuits do not depend on the presence of the creek and generally derive no benefit from it. Active recreation is confined to the Marrara Sports Complex and the Alawa ovals. As an important part of the entire recreational spectrum, it is important that active pursuits are catered for, and as part of the broad open space resource, they will

continue to perform an ancillary role for passive recreation and maintenance of scenic quality.

Conflicting Recreational Uses

A number of recreational pursuits do introduce conflicts. These include motorbike (and BMX) riding, off-road driving and indiscriminate camping. These activities, while generally restricted to areas that have limited access, do conflict with other passive uses, and weaken the amenity of them.

2.2.3 CULTURAL HERITAGE

Rapid Creek has played an important role in the lives and history of both Aborigines and Europeans. A discussion of this cultural heritage follows.

Aboriginal Heritage

Rapid Creek forms part of the traditional lands of the Larrakia people who continue to maintain links with the area. The estuarine area has always been a good camping site with plentiful food, natural spring water and tall shady trees. The area is still a popular area for itinerant campers.

The Larrakia name for the creek - *Gurambai* - means 'elbow' and refers to the shape of the creek at the mouth (Heffernan, 1992). The Aboriginal Areas Protection Authority has two recorded sites within the catchment. The first site is a Banyan (*Ficus virens*) behind the sand dunes in Casuarina Coastal Reserve. This tree has suffered damage in recent years from fire and mistreatment. It is the site of an aboriginal battlefield and also a burial ground (Heffernan, 1992; CCNT, 1991). A second recorded site is a large Banyan on the southern bank of Rapid Creek adjacent to the footbridge. A major sacred site in the area is *Dariba Nunggalinya* (Old Man Rock) which lies to the north west of the creek mouth. Dariba means 'old man' - a term of respect - and Nunggalinya, is the name of the first Larrakia man. *Dariba Nunggalinya* protects Darwin and the Larrakia people and the Aboriginals believe that if he is disturbed a natural calamity will occur. (Heffernan, 1992).

Today, Aboriginals still use the areas around the mouth of the creek and adjacent to the monsoon forest for camp sites. Some traditional food gathering is still carried out. Also the *Pandanus spiralis* fronds are collected for basket weaving and the roots of *Diospyros maritima* is still occasionally utilised to provide yellow dyes.

European Heritage

Rapid Creek has been a popular recreational area for almost 100 years. Picnics, camping, fishing and swimming have always been regular activities on the creek and this use continues today. At the turn of the century and up until the 1920's a trip to Rapid Creek from Darwin for a picnic, swim or to camp was considered a 'big day out'.

Between 1882 and 1891, the Jesuits ran a Catholic Mission in the area (Heffernan, 1992). The main building was located near the corner of Ryland Road and Pinder Street, Millner. The grounds (including agricultural areas) extended down to the creek in the area of the Darwin Water Gardens and out to the coast.

From the 1940's till the 1960's the local Chinese community would celebrate 10/10 day each year with a large picnic near the mouth of the creek. The day included a large feast, playing of traditional Chinese games, fishing and swimming.

During the same period, there was a large Chinese vegetable garden in the area that is now occupied by the Beachfront Hotel. The garden was apparently a viable commercial operation, and Aboriginal people who camped nearby (usually Tiwi Islanders) would sometimes work there.

Another commercial operation in the area was crocodile trapping and skinning, carried out in the area of the mouth and along the Nightcliff coastline during the forties and as recently as the sixties.

The war years saw a large influx of people to Darwin and the creek became an even more important recreational area. It was now also easily accessible. American servicemen used the freshwater section of the creek for swimming and relaxing. The swimming holes through the monsoon forest upstream of Henry Wrigley Drive, are locally known as Yankee Pools, because of this association.

The various cultural features are shown on Figure 2.5

2.2.4 LAND TENURE/LAND ZONING

The present condition of the Rapid Creek catchment and the future management of the resources is closely related to land tenure and land zoning.

Land Tenure

The great majority of land within the catchment is under freehold title. A number of key areas are presently vacant Crown Land and there are opportunities to make positive use of this situation in the management plan. There are also small areas of land that are either Reserve or Land Set Aside.

Land Zoning

The present land zoning, while it retains an undeveloped creek corridor, does not adequately reflect the environmental constraints of vegetation and flooding. The creek corridor is zoned open space, from the mouth through to Henry Wrigley Drive. Marrara Swamp is also zoned open space.

The remainder of the creek corridor falls within RAAF and FAC grounds and is zoned Special Use. The present zonings have been reasonably successful in protecting the creek resource. With increased development and population growth, the present zonings will come under threat in a number of key areas. These include the areas west of Amy Johnson Avenue (Refer Lands and Housing Land Use Policy - Appendix 4), the rural living blocks both sides of the creek downstream of McMillans Road, and the open space area bounded by the creek, McMillans Road and Henry Wrigley Drive.

The land zoning across the catchment are shown on Figure 2.6.

CULTURAL HERITAGE

Figure 2.5

▲ SACRED ABORIGINAL SITE (SOURCE AAPA)

■ RECORDED ABORIGINAL SITE (SOURCE AAPA)

✱ TRADITIONAL/PRESENT DAY CAMP SITE

CATCHMENT BOUNDARY

RAPID CREEK MANAGEMENT STUDY

0 500 1000 M

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LAND ZONING

Figure 2.6

- OPEN SPACE 1
- OPEN SPACE 2
- OPEN SPACE 3
- RESIDENTIAL
- BUSINESS
- COMMUNITY PURPOSE
- FUTURE USE
- CATCHMENT BOUNDARY

SOURCE: NT PLANNING AUTHORITY
DARWIN TOWN PLAN, 1990

RAPID CREEK MANAGEMENT STUDY

0 500 1000 M

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