Appendix 5 – Inland Waters

5.1 Description and Values

'Water keeps our landscapes alive and maintaining the health of our rivers, wetlands and groundwater resources is a critical foundation for all environmental planning (draft NT Parks and Conservation Master Plan 2004).'

For the purposes of this Plan, Inland Waters means wetlands (excluding coastal wetlands), waterways (rivers, creeks, streams), and groundwaters (subterranean water resources). There is a rich variety of inland waters in the Territory, from the mighty rivers and extensive floodplains of the Top End to the short-lived rivers and periodic wetlands of the Arid Centre. River systems are largely unmodified and their natural flows little reduced. Some wetland ecosystems are coming under increasing pressures, but still support abundant endemic and migratory wildlife and retain their high cultural and social values for all Territorians. All public water supplies and almost all irrigation in the Territory are dependent on groundwater sources. In addition, there is increasing understanding of the vital part that groundwater plays in sustaining rivers and wetlands throughout the Territory.

5.1.1 Wetlands

The Northern Territory is widely recognised as possessing a highly prized asset in its mostly intact wetlands. This section covers all those wetlands lying inland from the high tide mark (those that are seaward of the high tide mark are discussed in the Coastal and Marine Section).

The Territory's wetlands are an important and valuable resource for conservation, primary production, fishing, recreation and tourism. They also carry very high Indigenous cultural values. Thirty-three wetlands are currently listed as nationally significant and three are internationally recognised under the Ramsar Convention. Current wetland assessments, yet to be published, may lead to additional wetland listings.

The range of Territory wetlands includes:

- the few permanent lakes and swamps, generally occurring along the northern coast, generally densely vegetated and important dry season aggregation sites for wildlife;
- extensively occurring seasonal lakes and swamps in the Top End and Savannah Rangelands, within the limits of the monsoonal rains (Storrs and Finlayson 1997);
- seasonal and intermittently flooded plains across the Top End, generally alongside rivers affected by monsoon rains and seasonal inundation;
- freshwater ponds associated with the rocky ranges, such as the West MacDonnells and the George Gill Ranges in the Arid Centre, as well as the escarpments of the Top End; and
- extensive areas (approx. 2800 square kilometres) of Arid Centre salt lakes and playas, such as the salt lakes of the Amadeus Basin and the playas of Lake Mackay, Lake White and Lake MacDonald.

The exact total area, number of types and overall condition of wetlands across the Northern Territory are not currently known. While there has been a great amount of research into floodplain ecology in the Top End, there has been little attention given elsewhere. This is particularly so for the Arid Centre. The importance of particular wetlands throughout the Territory for endemic and migratory waterbirds is a clearly recognised knowledge gap. There is also growing awareness that some waterbirds require continued access to regional networks of wetlands for their survival.

While they have not as yet been systematically monitored or studied across the Territory, weeds, feral animals and seawater intrusion are known as current threats that cause decline in the health of some wetlands and floodplain areas. The importance of wetlands to indigenous cultural values is an emerging area of research.

5.1.2 Waterways

There are 39 major river basins in the NT, 30 flowing from the Top End into the Timor Sea and Gulf of Carpentaria and nine draining into the inland Western Plateau and Lake Eyre regions of the Arid Centre (see Map 27). Total mean annual flow from all Top End rivers is estimated to be some 59,500,000 ML/year. For the Arid Centre, it is estimated to be some 4,400,000 ML/year.

Approximately 90% of the annual flow in Top End rivers occurs in the wet season between December and March. In the dry season, most rivers and streams carry little or no flow, with many smaller streams contracting to a series of pools or billabongs. A few rivers, however, of which the Daly River and Roper River are the major examples, receive significant groundwater discharges that maintain strong river flows throughout the dry season.

Surface waters in the Arid Centre are confined to a number of short-lived river systems as well as saline lake systems and flood-outs. These rivers are usually dry, only flowing and flooding in years of heavy rainfall.

The following information, drawn from the Australian Water Resources Assessment 2000 (NLWRA, 2000), summarises annual flows, sustainable yield and level of use made of Territory rivers. Mean flows are derived from the approach taken in the Assessment, whereby sustainable yields were set at 20% and 5% of flows, respectively, in Top End rivers and Arid Centre rivers. This approach is in keeping with the broad water allocation framework applying in the Northern Territory.

This summary clearly shows the marked differences between the Top End and Arid Centre. Mean total flow in the northern flowing river basins is approximately 14 times greater than for the inland flowing river basins. The summary also shows the generally very low levels of water use compared to river flows throughout the Territory.

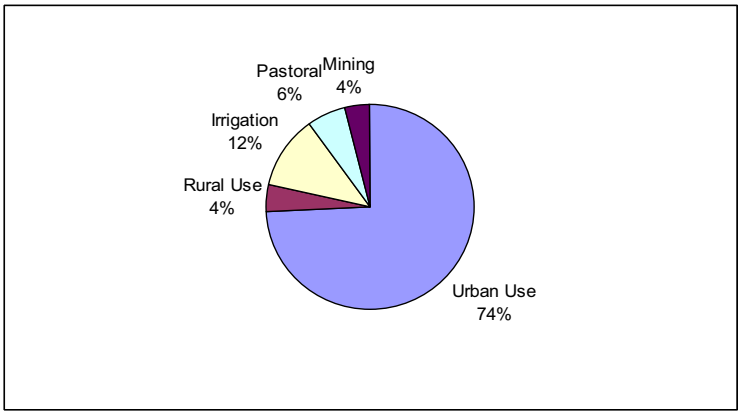
Table 5.1: Mean flow, sustainable yield and water use in Northern Territory rivers

RIVER BASINS	MEAN FLOW ML/year	SUSTAINABLE YIELD ML/year	LEVEL OF USE ML/year	USE as % of SUSTAINABLE YIELD
DRAINING TO THE TIMOR SEA				
Bathurst & Melville Islands	2,940,000	588,000	210	0.04**%**
Adelaide River		No data given	No data given	
Blyth River	1,100,000	220,000	0	0.00%
Buckingham River	2,200,000	440,000	0	0.00%
Daly River	5,550,000	1,110,000	9,500	0.86%
Darwin/Blackmore Rivers	350,000	70,000	38,200	54.57%
E. Alligator River	4,50,000	900,000	0	0.00%
Finniss/Elizabeth/Howard Rivers	2,400,000	480,000	160	0.03%
Fitzmaurice River	1,400,000	280,000	10	0.00%
Goomadeer River	2,450,000	490,000	0	0.00%
Goyder River	1,514,000	302,800	0	0.00%
Keep River	390,000	78,000	45	0.06%
Liverpool River	2,850,000	570,000	0	0.00%
Mary River	2,000,000	400,000	103	0.03%
Moyle River	550,000	110,000	0	0.00%
Ord River	830,000	166,000	85	0.05%

S. Alligator River		0	0	0.00%
Victoria River	2,800,000	560,000	1,010	0.18%
Wildman River	300,000	60,000	0	0.00%
SUBTOTALS	**33,064,000**	**6,236,800**	**49,113**	**0.79%**
DRAINING TO THE GULF OF CARPENTARIA				
Groote Eylandt	650,000	130,000	3,000	2.31%
Calvert River	900,000	180,000	18	0.01%
Koolatong River	1,550,000	310,000	0	0.00%
Limmen Bight River	1,500,000	300,000	25	0.01%
McArthur River	3,150,000	630,000	495	0.08%
Nicholson River	670,000	134,000	18	0.01%
Robinson River	900,000	180,000	12	0.01%
Roper River	4,750,000	950,000	526	0.06%
Rosie River	450,000	90,000	5	0.01%
Settlement Creek	800,000	160,000	12	0.01%
Towns River	500,000	100,000	0	0.00%
Walker River	3,300,000	660,000	0	0.00%
SUBTOTALS	**18,470,000**	**3,694,000**	**1,111**	**0.03%**
TOP END TOTALS	**55,124,000**	**10,648,800**	**53,434**	**0.50%**
DRAINING INLAND TO LAKE EYRE				
Finke River	160,000	8,000	75	0.94%
Georgina River	2,500,000	125,000	150	0.12%
Hay River	140,000	7,000	50	0.71%
Todd River	80,000	4,000	100	2.50%
SUBTOTALS	**2,880,000**	**144,000**	**375**	**0.26%**
DRAINING INLAND TO THE WESTERN PLATEAU REGION				
Barkly	600,000	30,000	575	1.92 %
Burt	76,000	3,800	85	2.24%
Mackay	22,000	1,100	145	13.18%
Warburton	0	0	0	
Wiso	800,000	40,000	320	0.80%
SUBTOTALS	**1,498,00**	**74,900**	**1,125**	**1.50%**
ARID CENTRE TOTALS	**4,378,000**	**218,900**	**1,500**	**0.69%**

Urban and rural residential water supplies account for approximately 80% of all the surface water used in the Territory. Darwin's public water supply, drawing from Darwin River Dam, accounts for most of this use (see information for Darwin/Blackmore Rivers above). Katherine's public water supply accounts for most of the remainder, drawing from Donkey Camp Pool on the Katherine River (see Daly River above). Irrigation by surface water is concentrated mainly on the Katherine River.

Figure 5.1: Percentage use of all surface water by sector



The health and water quality condition of rivers and wetlands has not been systematically monitored or extensively studied in the Territory. Most general water quality work has focussed on the Darwin region, while elsewhere it is largely restricted to monitoring of potable water supplies.

Twelve rivers in the Northern Territory were included in the 2001 Australian Assessment of River Condition (Norris et al. 2001), comprising 11% of the total length of Territory rivers. The sites selected were those for which there was sufficient information, with assessment based on an aquatic biota index and involving water quality determinations. Darwin and Katherine urban areas, agricultural regions and areas downstream of currently operating or abandoned mines were deliberately selected. The assessment did not cover sites in National Parks or areas subject to low intensity grazing and may have consequently over-estimated river impairment.

Of the sites investigated on the 12 Territory rivers, the study found that 2% had severely impaired biological communities and 10% were significantly impaired. No sites were found to be substantially or severely modified, although 34% of those assessed were considered moderately modified. Disturbance to the catchment and changes to the habitat due to land use contributed most to the damage. There was very little change to hydrological regimes of the assessed rivers.

5.1.3 Groundwater

There are 7 major groundwater provinces lying generally within the Top End, and 9 within the Arid Centre (Map 28). Wet season rains across the Top End are a relatively reliable source of aquifer recharge at average annual rates of between 20mm and 500mm. Only very occasional high rainfalls occur in the Arid Centre, so that aquifer recharge averages out to between 2mm and 250mm per year. These variable rates of recharge are equivalent to average replenishment of some 11,500,000 ML/year in total across Top End aquifers and some 1,265,000 ML/year across the Arid Centre.

In some regions ground water flows into rivers during dry periods. It also rises to the surface through springs or can be pumped to the surface. In the Arid Centre, groundwater discharges to the surface by evaporation through the beds of salt lakes. In the Northern Territory, the yield of water from bores is typically less than 2l/s but higher yields occur in the Daly, Wiso, Georgina and Amadeus Basins (Chin et al, 2000).

Salinity can restrict the use of groundwater. On average groundwaters in the Arid Centre contain more salts than those from the wetter areas further north (DIPE 2004) (see Map 29). Excessive concentrations of some minerals can limit the uses of the groundwater, for example making it suitable for livestock or industry but not human consumption. Irrigating crops with saline water can also result in the build up of salts in the soil, reducing soil productivity.

The following information, drawn from the Australian Water Resources Assessment 2000 (NLWRA, 2000), summarises annual recharge rates, sustainable yield and level of use in the Territory's groundwater provinces. Recharge rates are derived from the approach taken in the Assessment, whereby sustainable yields were set at 50% of recharge for all aquifers.

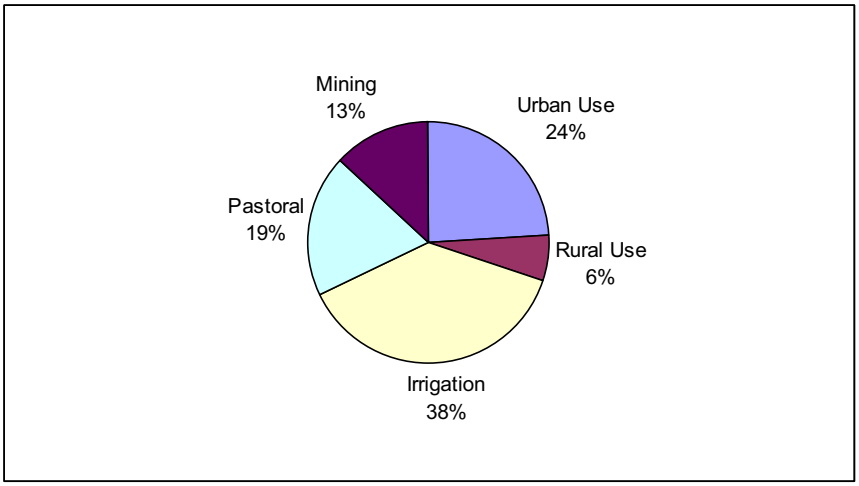
This summary clearly shows the marked differences between the Top End and Arid Centre. Mean annual recharge of groundwater in the Top End is almost ten times greater than for the Arid Centre. The summary also shows the generally very low levels of groundwater used compared to average aquifer recharge rates throughout the Territory.

Table 5.2: Groundwater recharge, sustainable yield, and use in the Northern Territory

RIVER BASINS	MEAN RECHARGE ML/year	SUSTAINABLE YIELD ML/year	LEVEL OF USE ML/year	USE as % of SUSTAINABLE YIELD
TOP END GROUNDWATER RESOURCES				
Melville Groundwater Province	490,908	245,454	1,222	0.50%
Halls Creek Groundwater Province	886	443	0	0.00%
Bonaparte Groundwater Province	2,282,072	1,141,036	5	0.00%
Ord-Victoria Groundwater Province	1,121,126	560,563	6,972	1.24%
Daly River Groundwater Province	1,298,312	649,156	19,397	2.99%
Pine Creek Groundwater Province	1,845,498	922,749	41,854	4.54%
Arafura Groundwater Province	241,608	120,804	1,451	1.20%
McArthur Groundwater Province	4,720,530	2,360,265	22,547	0.96%
SUBTOTALS	**11,510,032**	**5,755,016**	**92,226**	**1.60%**
ARID CENTRE GROUNDWATER RESOURCES				
Wiso Groundwater Province	231,470	115,735	4,343	3.75%
Tennant Creek Groundwater Province	57,618	28,809	647	2.25%
Georgina Groundwater Province	342,174	171,087	8,794	5.14%
Great Artesian Basin	1,640	820	950	116%
Musgrave Groundwater Province	48,230	24,115	303	1.26%
Amadeus Groundwater Province	199,670	99,835	16,176	16.2%
Aranta Groundwater Province	296,384	148,192	7,469	5.04%
Ngalia Groundwater Province	21,826	10,913	163	1.49%
Tanami Groundwater Province	66,860	33,430	394	1.18%
SUBTOTALS	**1,265,872**	**632,936**	**39,239**	**6.20%**

Groundwater is the major source of water supply throughout the Territory. Irrigation is the largest user, followed closely by urban and rural uses. While surface water is the major source of water for Darwin and Katherine, groundwater contributes about 10% and 30%, respectively, to each of these major water supply systems. Most community public water supplies depend entirely on groundwater.

Figure 5.2: Percentage use of all groundwater by sector



5.2 Issues and Threats

5.2.1 Unsustainable Extraction of Water

Extraction of ground water alters water table levels most markedly in the vicinity of each bore and, cumulatively, across regions (Department of Water Resources 2000). These alterations in water table levels may have impacts on ground water-dependent ecosystems and can lead to changes in vegetation communities (DIPE 2003). Reduced water in other water dependent ecosystems, such as wetlands, can result in the retraction of vegetation communities and a reduced ability of these areas to support aggregations of fauna.

A review of the level of extraction of ground waters in the Northern Territory (Chin et al 2000) showed that Alice Springs water supply was taking water from the Mereenie Sandstone aquifer at more than the rate of local recharge into the aquifer. Groundwater levels in the vicinity of the aquifer have declined by about 1 metre per year over the past decade. Because the aquifer is over a thousand metres thick, it can sustain such a rate of extraction for many decades to come. Also, because the natural water table is some 100 metres deep, there are unlikely to be any ecosystems that depend on this part of the aquifer. Continued extraction will, however, reduce the regional flow of groundwater through this aquifer towards near the surface discharge zone further to the west. Avoiding ecological impacts at this distant groundwater discharge zone is being considered in the planning for future water supply to Alice Springs.

The review (Chin et al 2000) also showed that water extraction from the Alice Springs Town Basin aquifer was higher than the estimated recharge rate. Water levels in this aquifer have been unnaturally high for the past several decades as the result of higher than average recharge flows in the Todd River. Consequently, the aquifer has risen into the overlying, naturally saline soil strata and rising water salinity is threatening the riverine red gum community. Extraction above the natural rate of recharge into the aquifer is being managed in order to lower water tables and reduce salinity to more natural historical levels.

The level of abstraction of surface waters in the NT was reviewed under the National Land and Water Resources Audit. The review found that 39 of the Northern Territory's 40 Surface Water Management Areas fell into the lowest level of resource development (0-30% of sustainable yield extracted). The Darwin/Blackmore River Management Area was considered medium level developed (30-70%) and no areas were considered highly developed (70-100%) or overdeveloped (>100%) (Chin et al. 2000).

At present, rural residential and pastoral water use – some 21% of the total - in the Territory does not require licensing. The remaining 79% is regulated through licensing. The Territory needs to ensure that water extraction is regulated through informed management plans, especially in regions where ground water recharge is limited by infrequent rainfall. Landholders and communities must be made aware of the potential effects of over extraction and encouraged to conserve water. We also need to consider all potential water efficiency measures, such as re-using grey water and stormwater, particularly in Water Control Districts, which include Alice Springs, Darwin Rural, Gove, Katherine, Tennant Creek and Ti Tree.

5.2.2 Changes to Water Flow Regimes

The construction of barrages and dams and changes to drainage systems have the potential to impact on the ecosystems of waterways. The connectivity of waterways is extremely important to river and wetland systems, as are seasonal and inter-decadal patterns of river flow. River biota are adapted to the natural regime of channel-floodplain interactions, and highly seasonal flow regimes. Indeed, the character of individual wetlands is determined by the patterns of flooding and drying that they experience (Parks and Wildlife 2000). Any changes to flow regimes and connectivity of rivers and wetlands have the potential to impact on wetland and river health. Changes to connectivity can also affect the exchange and transport of nutrients and carbon in the system, as well as the movement of migratory species such as fish and turtles. Downstream effects of changes to freshwater flows have the potential to impact upon mangrove, seagrass and other coastal ecosystems.

Physical changes to the movement and flow regimes in Territory waterways are relatively limited. There are only four major dams; on Darwin River, Manton River (water supply), Otto Creek (recreation) in the Top End and Mary Anne Creek (recreation) in the Arid Centre. A 1.5 meters high weir on the Katherine River provides storage for Katherine's water supply. Additional major water supply dams are planned for Darwin and Katherine but will not be required for several decades. A program of barrage construction has been in place for the past decade to control sea-water intrusion and restore the natural freshwater degraded wetlands on the Mary River coastal floodplain.

5.2.3 Land Clearing

Inappropriate land clearing and development can cause impacts on wetland and other aquatic ecosystems through several mechanisms including increased sediment load, changed carbon and nutrient availability, changed thermal environment, changed channel form and bank stability, and altered hydrology as well as allow for the establishment of weeds. Land clearing is of particular concern in riparian zones. Clearing can cause erosion, leading to increased turbidity and potential siltation of wetlands or changed water flow. These in turn affects habitat and the distribution and abundance of aquatic organisms.

More information on land clearing can be found in. Appendix 3 - Terrestrial Biodiversity.

5.2.4 Fire

In riparian zones, few species are fire tolerant. Fire has the potential to change ecosystems by reducing populations of certain species, causing ecosystem imbalances and providing opportunity for erosion, pollution (nutrients and sediments) and weed infestation.

More information on fire can be found in Appendix 3 - Terrestrial Biodiversity.

5.2.5 Introduced Pest Species

Introduced pest species of plants and animals represent one of the largest threats to the ecosystems of the Northern Territory. Weeds (invasive plant species listed under National and/or NT legislation and policy) in particular pose specific problems for maintaining habitat diversity in wetlands, especially in the tropics (Parks and Wildlife Commission 2000). Fourteen of the 18 worst environmental weeds in

Australia invade wetlands and twelve of them are found in the Northern Territory (Storrs and Finlayson 1997). Humphries et al. (1991) state the following about weeds in tropical wetlands and riparian zones: '…riparian systems are most heavily invaded within any given environment and are therefore at greatest risk, the importance of these systems, particularly at times of drought, increases the ecological seriousness of this situation. Tropical wetlands are in critical danger'.

These species are of particular concern for the NT's water resources (Storrs and Finlayson, 1997):

- *Acacia nilotica* (prickly acacia) – isolated plants occur along the Barkly Highway and on the black soil plains in the Barkly region.
- *Brachiaria mutica* (paragrass); *Echinochola polystachya* (aleman grass) and *Hymenachne amplexicaulis* (olive hymenachne) – paragrass is highly invasive and has spread across wetlands in Northern Australia, as a result of both deliberate planting and through spreading from pastoral areas. Paragrass is used for bank stabilisation and for "improved" pasture. Aleman grass and olive hymenachne are more recent and localised introductions. These species are thought to cause a monoculture, reducing biodiversity and modifying ecosystems.
- *Cenchrus ciliaris* (buffel grass) – widespread across the southern region of the Northern Territory, forming dense stands along southern river riparian zones. A related species, Mossman River grass is becoming more widespread in some areas of the Hugh and Finke Rivers.
- *Eichhornia crassipes* (water hyacinth) - a floating weed species that has long been recognised as a major weed and has been largely controlled. Local infestations still exist, for example at Fogg Dam.
- *Mimosa pigra* – an aggressive prickly shrub forms dense monospecific stands on the floodplains of the Top End. Estimates suggest it currently covers some 120,000 hectares of wetland. Control programs are currently being implemented, including biological control, mechanical removal, herbicides and burning. This weed is a serious threat.
- *Parkinsonia aculeata* (Parkinsonia) – found around bores, dams and along creeks and riverbanks across the Northern Territory, with prominent outbreaks on the Barkly Tablelands and the Victoria River District. This species can dominate the vegetation of watercourses and ephemeral lakes.
- *Prosopsis limensis* (mesquite) – a small tree found on the Barkly Tablelands and in isolated patches near Katherine and between Tennant Creek and Alice Springs.
- *Salvinia molesta* (salvinia) – free floating aquatic fern which has infested areas at Nhulunbuy and on the Finniss, Howard, Daly, Adelaide, South Alligator and East Alligator Rivers. Management of this species generally uses biological control and has been successful in several regions. Salvinia competes with native plant species and may alter water quality of billabongs and waterways.
- *Tamarix aphylla* (athel pine) – commonly planted around bores in arid regions and infesting sections of the Ross River, Palmer River and the Finke River.
- *Cabomba caroliniana* (Cabomba) – can invade permanent waters and seasonally flooded wetlands. It has been detected in the Darwin River and is now subject to an active eradication program. The plant can drastically reduce plant diversity and can reduce water quality for drinking and aquatic life.

Introduced pest species of animals also cause impacts to rivers and wetlands, denuding large areas of vegetation, increasing erosion and changing water flow patterns. In the Mary River, buffalos may also have contributed to saltwater intrusion into freshwater wetlands.
Species of particular concern include (Storrs and Finlayson 1997):

- *Bubalus bubalis* (Asian water buffalo) – responsible for widescale destruction on the coastal floodplains of the Territory prior to the 1980s, through grazing, trampling and wallowing. In the 1980s, feral buffalo were largely eradicated, although large populations still exist in Arnhem Land. Floodplains and billabongs previously grazed by buffalo have now become choked by native and introduced species, including sedges and grasses, which are not normally found in these habitats.

- *Camelus dromedarius* (camels) – concentrated around salt lakes and clay pans in the arid regions and regularly visiting watering holes, including dams, soaks, bores and native wells, to which they cause significant damage and utilise water relied upon by other species.
- *Equus caballus* (horse) and *Equus asinus* (donkey) – prevalent in the southern and central regions and dependant on waterholes for drinking. They can cause serious degradation to individual pools.
- *Oryctolagus cuniculus* (rabbit) – impacts are mainly in the southern region of the Northern Territory, where their activity is focussed in calcareous areas including the fringes of salt lakes and ephemeral wetlands. Excessive grazing of these important habitats can devastate margins of these pools and lakes.
- *Sus scrofa* (pig) – causes widespread damage around the edges of wetlands across the Northern Territory, causing erosion and allowing establishment of weeds species.
- *Bufo marinus* (cane toad) – movement of the toad across the Northern Territory has occurred in recent years, with the northern front currently just outside of Darwin. Cane Toads are thought to impact primarily upon its predators (northern quolls, lizards, snakes, and goannas) and may compete at the tadpole stage with native frog species.
- Exotic fish – localised incursions of freshwater aquarium species have occurred, but impacts are largely unknown.

More information on weeds, invasive plants and feral animals can be found in Appendix 3 - Terrestrial Biodiversity.

5.2.6 Overgrazing (See Appendix 4 – Land)

5.2.7 Pollution (Chemical, Thermal, Nutrient)

Mining, aquaculture, tourism, urban development and agriculture all have significant potential to cause pollution if not properly managed. Pesticides, herbicides and fertilisers used for agriculture and horticulture may contribute nutrients and contaminants to waterways and have the potential to be damaging to native species and communities (Parks and Wildlife Commission, 2000). There can also be chemical pollution of permanent waterholes from recreation: swimmers using sunscreen, soaps and insect repellents have been known to cause problems (Storrs and Finlayson, 1997). Poisoning of waterfowl from ingested lead shot has also posed a problem in hunting reserves in the Top End (Parks and Wildlife Commission 2000).

Stormwater, industrial discharges and sewage outfalls are additional sources of pollution in urban areas. Sewage outfalls may be directed into local creeks and, depending on where they are, may be untreated (Working Group to the Darwin Harbour Advisory Committee 2003). Sewage effluent can increase nutrient concentrations, release faecal coliforms and act as a source of sediments and toxicants, all of which may affect water quality. Stormwater drains become a concentrated source of discharge of nutrients and contaminants into urban rivers and creeks, while land use changes also affecti rates of infiltration and water flow across the region. Industrial wastewaters, containing sediments, contaminants, nutrients and hydrocarbons that may affect water quality, may also be released directly into the stormwater system (Working Group to the Darwin Harbour Advisory Committee 2003).

The major waterways in the Darwin area are the Blackmore, Elizabeth and Howard Rivers and Berry Creek. The loads and concentrations of contaminants (nutrients, metals and suspended material) are similar in rural streams and streams in undisturbed areas, which suggests little impact on water quality in the rural Darwin region. Concentrations of nutrients, metals and suspended material in runoff from urban and light industrial areas, however, is higher than in undisturbed catchments, suggesting impacts from stormwater and sewage on urban streams.

Over the past 20 years, ten studies have been carried out investigating pesticide contamination of surface and ground water in the Darwin region (Waugh and Padovan 2003). These studies indicate a

low level of pesticide contamination in surface waters that drain urban and industrial areas of Darwin. Organochlorines were the most common pesticides detected possibly because they are the chemicals which used to be used in termite control, but which have now been banned because they persist in the environment.

Studies of water quality in the Mary River at 42 sites in 2002 showed that the current state of water quality in the upper catchment is generally within the appropriate guidelines for slightly disturbed ecosystems. It also suggests current land uses are not adversely affecting water quality during seasonal recessional flow (Schultz et al. 2002). Notable exceptions to this included elevated total concentrations of toxic metals (specifically cadmium, copper, nickel and zinc) from active and inactive mine sites and elevated nutrients (nitrogen), electrical conductivities and hardness downstream of active mines

5.2.8 Mining

Mining is a large, highly regulated industry within the NT, but there is concern about the potential for pollution of downstream aquatic ecosystems and the use of tailings dams by birds and migratory species (Telfer 1998, Tropical Savannas CRC 2000). Modern monitoring and management practice has, however, reduced the potential for impact from mining.

One potential high impact form of mining pollution is acid mine drainage, which happens when sulphide minerals oxidise and subsequently leach by rainfall into drainage waters. The problem can be exacerbated when acid drainage incorporates other minerals, such as heavy metals, including radioactive elements. Acid mine drainage affects the pH of the aquatic ecosystems and may kill fish and other aquatic organisms. There is a high risk of acid mine drainage whenever new sulphide-rich minerals and coal deposits are mined. Some of the highest impacts in the past have come from abandoned mines (eg. Rum Jungle). Many have not been monitored and there is some concern about the impacts these historical mines could be having (Roper River Landcare Group Inc 2004).

Extractive mining for products such as coarse and fine sand, gravel and crushed rock may also cause impacts to rivers and wetlands. Mining involves land clearing, extraction and subsequent revegetation. The extent of extractive mining is poorly documented.

5.2.9 Irrigation Salinity

See Appendix 4: *4.2.1 Unsustainable Land Use Practices*

5.2.10 Hunting/Harvesting

Recreational and Indigenous hunting across the Northern Territory may adversely affect certain species and ecosystems. These may be direct impacts through loss of species, or indirect when, for example, there is an increase in lead accumulation in wetlands from lead shot used for hunting Magpie Geese. Hunting and harvesting are adequately managed at present and do not form a significant threat. However should these hunting and harvesting rates increase, appropriate thresholds should be determined through monitoring

5.2.11 Tourism and Recreation

The highly valued lifestyle of Territorians and tourism, a key component of the Northern Territory economy, is dependent on the maintenance of our relatively undisturbed and unique environment. Waterways and wetlands are important areas for tourism and recreation across the Northern Territory. Tourists and locals generally congregate at the more popular sites and could therefore have a significant localised impact on the environment by causing erosion, pollution, spreading weeds, wildlife disturbance and pressure on fish stocks. At this stage, impacts appear to be limited, which reflects the fact that many areas of the Northern Territory are inaccessible (Storrs and Finlayson 1997) and many accessible areas are appropriately managed as reserves. There is, however, a need to plan for increased numbers of visitors to remote regions to ensure maintenance of the economic viability of the ‘outback’ experience and biodiversity

5.2.12 Saltwater Intrusion

Large areas of the floodplains of the Top End coast lie at or below current high tide level, but maintain freshwater due to separation from the sea by natural barriers. In some places, these barriers have been breached, resulting in saltwater intrusion into previously freshwater habitats. There is some debate as to whether the process is natural, but certainly human activities and feral animals have exacerbated the process. In the future, rising sea levels will contribute to the process. Between 1940 and 1988, some 17,000 hectares of Mary River wetlands were lost to saltwater intrusion (Applegate 1994). This sparked active management of the issue by the Northern Territory Government, which included installation of a major barrage at Shady Camp on the Mary River, as well as a series of barrages around a Flora and Fauna Reserve to Woolner Station. These works reclaimed some 2,000 hectares of salt-affected land. Progressive reclamation is also occurring on the Adelaide River.

5.2.13 Climate Change

Their is still a large degree of uncertainty about the effects of increasing concentrations of greenhouse gases in the earth's atmosphere although there is now a considerable consensus among scientists that the earths temperature and sea levels will rise (Hennessy, 2004). See Chapter 4 – Land; Chapter 5 – Inland Waters; Chapter 6 – Coastal and Marine; Appendix 3 – Terrestrial Biodiversity; and Appendix 6 – Coastal and Marine.

5.2.14 Insufficient Baseline Knowledge

There are several known gaps in the knowledge of inland aquatic ecosystems, among them:

- maps of inland water ecosystems to determine distribution and extent;
- condition of inland aquatic ecosystems across the NT to determine broad condition and ecological integrity;
- time series data to detect changes in water quality and ecological integrity;
- a baseline understanding of loads of nutrients, sediments and contaminants entering waterways, particularly from urban catchments;
- knowledge of environmental flow requirements for inland aquatic ecosystems;
- the extent, impacts and risks of particular threats on inland aquatic ecosystems, for example fire, feral animals, weeds, mining and climate change; and
- a means for coordinating research and monitoring efforts and for integrating and coordinating monitoring data and information.

5.3 Current Management Responses

5.3.1 National Water Initiative Agreement

In 2004 the Australian Government and all State and Territory Governments signed an agreement for the National Water Initiative, which extended the 1994 Council of Australian Governments Water Reform Framework.

The objective of National Water Initiative is to provide greater certainty for investment and the environment, and underpin the capacity of water management systems to deal with change responsively and fairly. Under this Initiative, the Territory must progress further reforms in water management that will ensure:

- clear and nationally-compatible characteristics for secure water access entitlements;
- transparent, statutory based water planning;
- statutory provision for environmental and other public benefit outcomes and improved environmental management practices;

- complete the return of all currently over allocated or overused systems to environmentally sustainable levels of extraction;
- progress removal of barriers of trade in water and meeting other requirements to facilitate the broadening and deepening of the water market, with an open trading market to be in place;
- clarity around the assignment of risk arising from future changes in the availability of water from the consumptive pool;
- water accounting which is able to meet the information needs of different water systems in respect to planning, monitoring, trading, environmental management and on-farm management;
- policy settings which facilitate water use efficiency and innovation in urban and rural areas
- addressing future adjustment issues that may impact on water users and communities; and
- recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource.

The policy framework within which water resources are allocated between broadly non-consumptive environmental and cultural uses and the consumptive requirement of public water supply, irrigation, aquaculture, industry and stock and domestic users has been developed to satisfy the national agreements reached through the Council of Australian Governments.

This water allocation planning framework is summarised as follows:

Northern Territory Water Allocation Planning Framework

<table>
<tr><th colspan="2">TOP END (NORTHERN ONE THIRD OF NT)</th></tr>
<tr><td colspan="2">All available scientific research directly related to environmental and cultural water requirements for the water resource will be applied in setting non-consumptive water provisions as the first priority, with allocations for consumptive use made subsequently within the remaining available water resource.</td></tr>
<tr><td colspan="2">In the absence of scientific research directly related to environmental and cultural water requirements, the following contingent allocations are made:</td></tr>
<tr><td>Rivers
at least 80% of flow at any time in any part of a river is allocated for environmental and cultural water provisions;

<u>and</u>

no more than 20% of flow may be diverted at any time in any part of a river</td><td>Aquifers
at least 80% of annual recharge is allocated for environmental and cultural water provisions;

<u>and</u>

annual extraction will be equivalent to no more than 20% of annual recharge</td></tr>
<tr><td colspan="2">In the event that current and/or projected consumptive use exceeds the 20% threshold levels, then:</td></tr>
<tr><td>New Surface Water Licences
will not be granted unless supported by directly related scientific research into environmental water requirements.</td><td>New Groundwater Licences
will not be granted unless supported either by:
directly related scientific research into the groundwater dependent ecosystems and/or cultural water requirements;

<u>or</u>

hydrologic modelling confirming that groundwater discharge is reduced by no more than 20%.</td></tr>
</table>

<table>
<tr><th colspan="2">ARID CENTRE (SOUTHERN TWO THIRDS OF NT)</th></tr>
<tr><td colspan="2">All available scientific research directly related to environmental and cultural water requirements for the water resource will be applied in setting non-consumptive water provisions as the first priority, with allocations for consumptive use made subsequently within the remaining available water resource.</td></tr>
<tr><td colspan="2">In the absence of scientific research directly related to environmental and cultural water requirements, the following contingent allocations are made:</td></tr>
<tr><td>Rivers
at least 95% of flow at any time in any part of a river is allocated for environmental and cultural water provisions;

<u>and</u>

no more than 5% of flow may be diverted at any time in any part of a river</td><td>Aquifers
there will be no deleterious change in groundwater discharges to wetlands;

<u>and</u>

total extraction over a period of not less than 100 years will not exceed 80% of aquifer storage at start of extraction</td></tr>
<tr><td colspan="2">In the event that current and/or projected consumptive use exceeds the threshold levels of 5% for river flow or 80% for aquifer storage, or groundwater discharges to wetlands are impacted, then:</td></tr>
<tr><td>New Surface Water Licences
will not be granted unless supported by directly related scientific research into environmental and/or cultural water requirements.</td><td>New Groundwater Licences
will not be granted unless supported by: directly related scientific research into the groundwater dependent ecosystems and/or cultural water requirements;</td></tr>
</table>

The development, implementation and review of regional Water Allocation Plans, incorporating all elements necessary for the sustainable use of water resources and maintenance of aquatic and groundwater dependent ecosystems will continue to provide the core management response for the Territory's Inland Waters. The immediate targets are to complete water allocation plans based on the water control districts in the Darwin, Katherine/Daly River and Alice Springs regions. Similarly, there will be continued development of the integrated catchment management plans for Darwin Harbour and the Mary River.

Developed in close consultation with regional communities, these regional plans will clearly set the limits and regulatory controls that will be placed water resource extractions. They will also identify and prioritise the ongoing water resource assessment and research work necessary to fill gaps in knowledge about environmental and cultural water requirements and to improve water balance models, with particular emphasis on the interactions and interdependencies between surface water resources and groundwater. The plans will also specify the work necessary to improve the monitoring of regional water resources for both environmental health and response to increasing use.

The Territory's regional water allocation plans and catchment management plans are implemented and reviewed by stakeholder based regional advisory committees. Active community participation is

encouraged throughout the operation of each regional plan, with particular emphasis placed on assistance and participation in water quality and environmental monitoring. In past years, Waterwatch has supported over 50 groups, involving thousands of individuals monitoring around 200 sites throughout the Territory. Key areas for monitoring include Alice Springs, Coomalie, Darwin, Katherine and North East Arnhem Land.

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