Northern Territory Government

DEPARTMENT OF LAND RESOURCE MANAGEMENT

Darwin Harbour Region
Report Card 2012

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Darwin Harbour Region
Report Card 2012

This report was prepared by the Aquatic Health Unit, Department of Land Resource Management, Palmerston NT 0831.

Website: www.nt.gov.au/lrm/water/aquatic/index.html

Annual publication

ISSN 1838-4625 (Print)

ISSN 1838-4633 (Online)

Report No. 18/2012D

Cover: Mangrove lined Blessers Creek, Flat back turtle *(Protonibea diacanthus),* Indo-pacific humpback dolphin *(Sousa chinensis),* Western Rainbowfish *(Melanotaenia australis),* Coral *(Tubastrea sp.).*

Acknowledgements

We thank the many people who contributed photographs. Data in this report were obtained from projects funded by the Northern Territory Government, PowerWater Corporation, the Aquaculture industry and the Darwin International Airport.

Symbols are courtesy of the Integration and Application Network (ian.umces.edu/symbols/), University of Maryland Centre for Environmental Science, USA. Several conceptual symbols were adapted from base diagrams from the Integration and Application Network.

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Message from the Minister for Land Resource Management

Darwin Harbour's water quality is generally of good to excellent condition. Residents and visitors to the Darwin Region live next to a harbour that supports a diversity of plants and animals, provides a wonderful place for fishing and other recreation activities, and has cultural significance to us all.

Extensive water quality monitoring has been undertaken by the Department of Land Resource Management for the evaluation of the Harbour's health. This year's Report Card also uses monitoring data from the Power and Water Corporation. The Darwin International Airport Corporation has also contributed by providing data for Rapid Creek, and the aquaculture industry provided estuarine data. Darwin's beaches were monitored throughout the swimming season by the Department of Health and were suitable for swimming.

There are at least 20 environmental monitoring programs in the Darwin Harbour Region. These include monitoring the sediment, mangroves, seagrass and dolphins; not just water quality. This monitoring is conducted by industry and Government, and with their support, an integrated approach to monitoring can be developed to provide more comprehensive Report Cards in the future.

Willem Westra Van Holthe

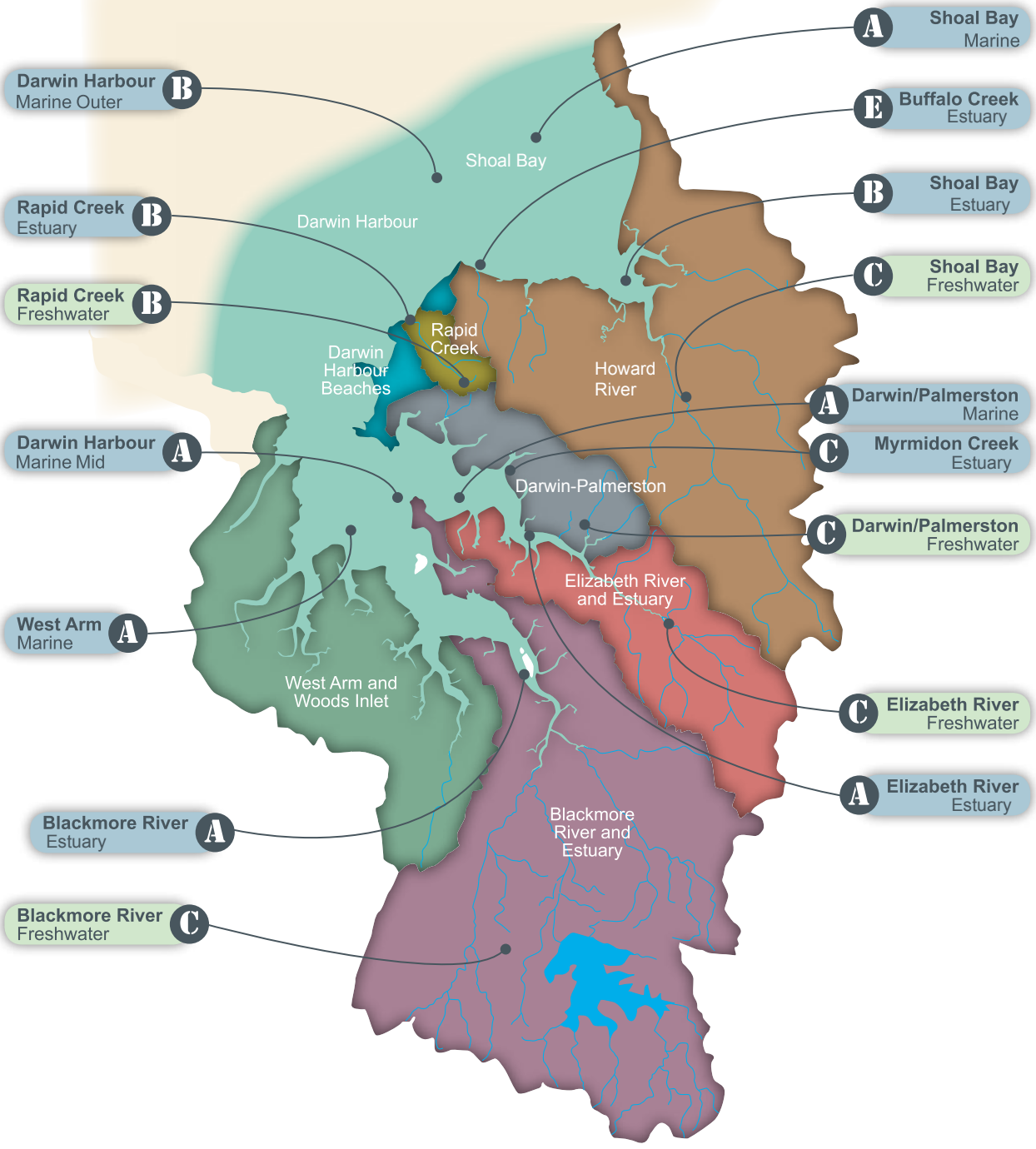
Minister for Land Resource Management

Summary of freshwater and marine water quality grades

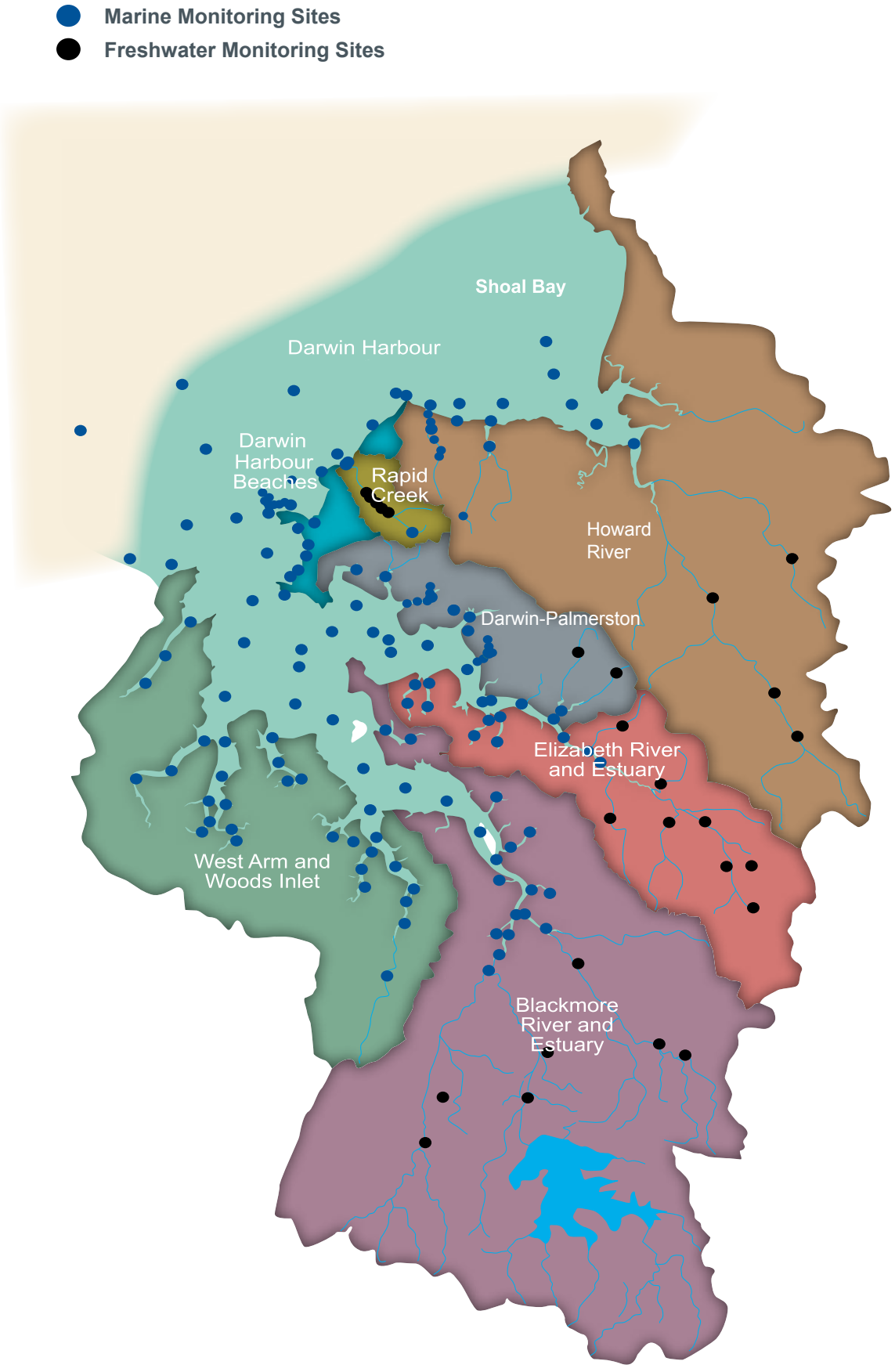
Aquatic Health Technician Stephen Cusack lowering a Seabird water quality instrument into the waters of Darwin Harbour

Summary

Water quality in Darwin Harbour and its catchment is generally good to excellent. Buffalo Creek remains in very poor condition, whilst Myrmidon Creek is graded as good; both of these tidal creeks receive treated sewage. The results are similar to past years, but do vary. These differences between years, and even within the region in the one year, are mainly natural and a result of the way the grades are calculated rather than pollution. To enhance the ability of the grades to distinguish between naturally occurring variability and human impacts on water quality, the way the grades are being scored and the underlying water quality objectives are being reviewed.



Water quality monitoring sites 2012



Water quality monitoring

Water quality monitoring has been undertaken in Darwin Harbour and its catchment by the Department of Land Resource Management (DLRM) since 2001.

This Report Card provides a snapshot of water quality at 29 freshwater sites and 151 estuarine sites monitored between the mid-dry season of 2011 and 2012. The water quality of each site has been assigned a grade, from A to E, depending on compliance with local water quality objectives.

Data has been provided by the PowerWater Corporation for estuarine sites along the foreshore associated with treated sewage discharges, aquaculture discharges in the upper parts of the harbour, and Rapid Creek monitoring by Darwin International Airport.

This Report Card reports on freshwater data collected in May 2012.

Water quality results

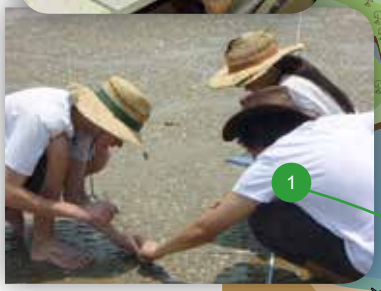
Darwin Harbour and its catchment received the following scorecard:

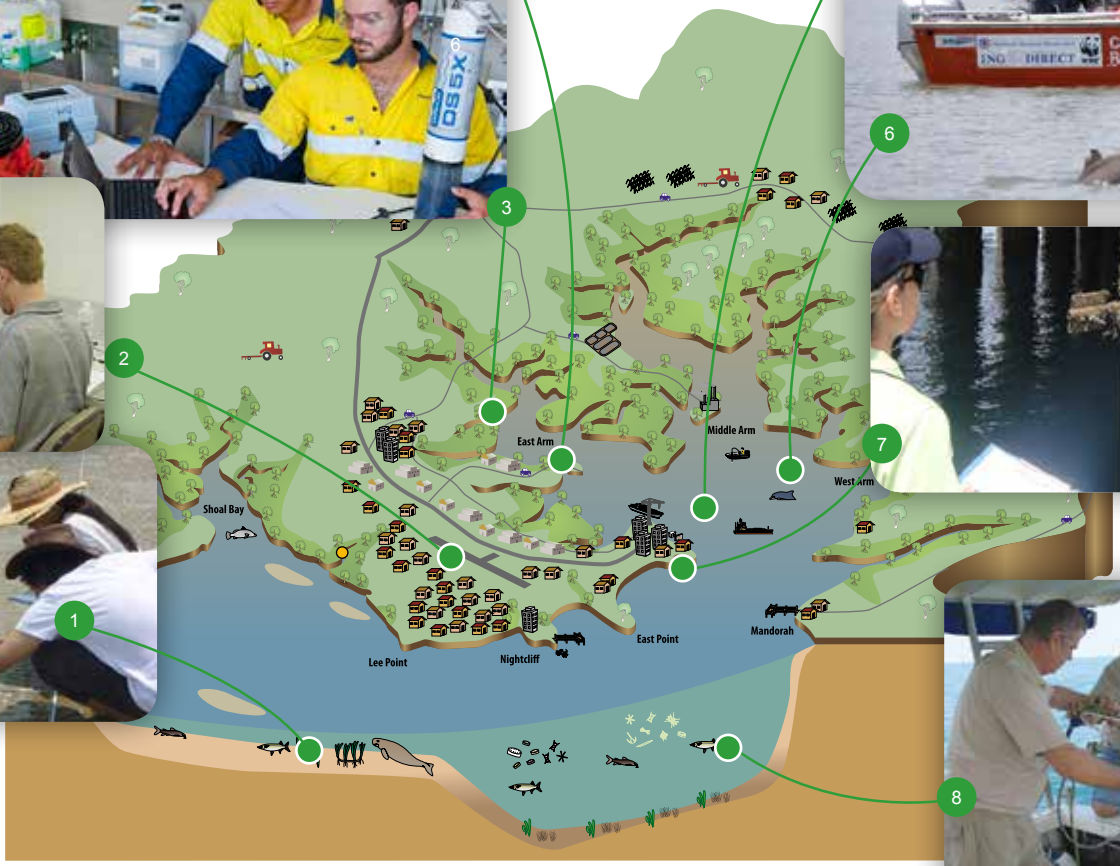
A (Excellent)	**Darwin Harbour mid (marine)** **Darwin – Palmerston (marine)** **Blackmore Estuary** **Elizabeth Estuary** **West Arm and Woods inlet (marine)** **Shoal Bay (marine)**
B (Very good)	**Darwin Harbour outer (marine)** **Rapid Creek Estuary** **Shoal Bay Estuary** **Rapid Creek (freshwater)**
C (Moderate)	**Myrmidon Estuary** **Blackmore River (freshwater)** **Darwin – Palmerston (freshwater)** **Elizabeth River (freshwater)** **Shoal Bay (freshwater)**
D (Poor)	**None**
E (Very poor)	**Buffalo Creek Estuary**

Monitoring and base-line data collection programs are currently in place for water and sediment quality, mangrove plants, mangrove sediment fauna, aquatic pests, fish, seagrass, algae, coral and dolphins. There is also microbiological monitoring of Darwin and Mandorah beaches, as well as Lake Alexander, for their suitability for swimming. Most monitoring is undertaken in the estuarine and marine waters, rather than the rivers and streams.

Harbour Monitoring

1. Seagrass
2. Macroinvertebrates
3. Wastewater treatment plants
4. Mangrove communities
5. Water and sediment quality
6. Dolphin surveys
7. Aquatic pests
8. Baseline fish surveys





Monitoring programs contributing to the Report Cards

The Northern Territory Government undertakes water quality monitoring and testing throughout the Darwin Harbour region. While most of this monitoring is undertaken to determine ecosystem health of the region, monitoring is also undertaken to determine the suitability of beaches for swimming.

The Darwin Harbour Region Report Card includes data collected from the following monitoring programs.

Marine and estuarine water quality monitoring

Between June 2011 and June 2012, DLRM monitored water quality at 151 sites in Darwin Harbour. Marine and estuarine sampling for the 2012 reporting year is detailed below:

Report Card	Estuary region and class*	Number of sites sampled quarterly	Number of sites with other sample frequencies	Collaborator contribution***
Darwin Harbour	Outer	5	9	10
Darwin Harbour	Mid	5	12	
Darwin – Palmerston	Upper	4	4	5
Myrmidon	Upper	1		8
Elizabeth	Upper	3	16	
Blackmore	Upper	8	31	10
West Arm and Woods Inlet	Upper	4	18	
Rapid Creek	Upper	1		
Shoal Bay	Outer	2	4	4
Shoal Bay	Upper	3	3	5
Buffalo Creek	Upper	1	1	7

*Water class is typically derived from the sites location in the estuary, water quality and the hydrodynamic characteristics (flushing) it is subject to and have different water quality objectives.

*** PowerWater Corporation, Aquaculture industry and Darwin International Airport data.

Freshwater monitoring

DLRM monitored water quality during recessional flows at 28 freshwater sites in 2012 within the Darwin Harbour catchment. The number of sites monitored during May 2012 for each reporting catchment were:

Report Card catchment	Freshwater routine site	Other freshwater sites
Darwin-Palmerston	2	
Elizabeth	9	
Blackmore	7	
Rapid Creek	3	3*
Shoal Bay	4	

* data supplied by Darwin International Airport

Taking water samples on Darwin Harbour

Interpreting the Report Cards

Measuring flow as part of annual monitoring

Introduction

This section contains information to help interpret the Report Card. The methods used to assess water quality (compliance against local water quality objectives) are used in other regions of Australia. State and regional water quality objectives are considered more appropriate for water quality assessments than national guidelines. The methods used for this Report Card have been established under the National Water Quality Management Strategy.

Interpreting the Report Cards

Water quality indicators

The following indicators were measured at the freshwater and estuarine water quality monitoring sites. Surface samples were collected from a depth of 25–50cm.

Indicator	What it represents	Why it is used as an indicator
Electrical conductivity	A measure of amount of dissolved salts.	Inhibits plant and animal growth if too high.
Turbidity	Cloudiness in water.	A measure of the light scattering by material suspended in water. This affects the amount of light available for photosynthesis.
pH	Indicator of how alkaline or acidic the water is.	Important to chemical and biological processes.
Dissolved oxygen (% saturation)	A measure of the amount of oxygen in the water. Varies with temperature and salinity.	Critical for aquatic organisms to survive. Low dissolved oxygen is the major cause of freshwater fish kills.
Total suspended solids	Particulate material in the water column.	Indicator of eroded material such as sediment. Travels in water.
Chlorophyll *a*	The green component of plants used in photosynthesis.	Is used as an index of the amount (biomass) of algae.
NO_x	Nitrate + nitrite (dissolved) forms of nitrogen.	Stimulates plant growth. Travels with water in solution.
Ammonia	Total ammonia is the sum of un-ionised ammonia and the ammonium forms of nitrogen.	Readily used by aquatic plants. Decomposition and excretion product. High ammonia concentrations can be toxic to biota.
Total nitrogen	Nitrogen.	Nitrogen is essential for living organisms. Includes all forms of nitrogen.
Total phosphorus	Phosphorus.	Phosphorus is essential for living organisms.
Filterable reactive phosphorus	Fraction of phosphorus that passes through a fine filter.	Stimulates aquatic plant growth. Travels with water in solution.
Enterococci	A group of bacteria common to the faecal matter of warm-blooded animals, including humans (NHMRC* 2008).	Enterococci are recommended for the assessment of marine waters for swimming by the NHMRC.

* National Health and Medical Research Council

Water quality objectives

Water quality objectives are assessed under Part 7 of the *Water Act* as a local guideline level. Water quality objectives describe the water quality needed to protect human uses and aquatic ecosystem values identified by the community (Beneficial Uses). The water quality objectives help guide planning and water management.

Water quality objectives for nutrients, total suspended solids, electrical conductivity, turbidity and chlorophyll *a* were calculated from the 80th percentile of ambient water sampling results from reference sites in the region. Water quality objectives for dissolved oxygen (% saturation) and pH were calculated using the 20th to 80th percentile range of ambient water sampling results from reference sites. Different water quality objectives apply for the outer, mid and upper estuarine regions of the harbour due to different residence times (flushing rates). Separate water quality objectives apply for freshwater.

Compliance

A tick indicates that water quality at a site for an indicator was equal to or better than the water quality objective. A cross indicates that the current water quality at a site for an indicator is worse than the water quality objective. Water quality measurements were calculated as the median of data collected over a one year period. Assessment for Dissolved Oxygen and Total Suspended Sediment have not been undertaken because the water quality objectives are under review. Darwin Harbour objectives are presented below.

Indicator and units	Water quality objective	Compliance
pH	6–8.5	✓ or ✗
Chlorophyll *a* (µg/L)	<4	✓ or ✗
NOx (µg N/L)	<20	✓ or ✗
Ammonia (µg N/L)	<20	✓ or ✗
Total nitrogen (µg N/L)	<300	✓ or ✗
Total phosphorus (µg P/L)	<30	✓ or ✗
Filterable reactive phosphorus (µg P/L)	<10	✓ or ✗
Number of samples		

Water quality grading

Water quality grades were assigned for each region using the degree of compliance with water quality objectives. A grade of A is considered excellent water quality, while a grade of E was considered very poor water quality. This grading system was also used in the 2009 to 2011 Report Cards. For these Report Cards, the total suspended sediment and dissolved oxygen (%) data were excluded from the marine water compliance and water quality grades.

Water quality grade	What the grade means	Compliance and method
	Excellent	100% of indicators comply with water quality objectives
	Very Good	85% to <100% of indicators comply with water quality objectives
	Good	50% to 80% of indicators comply with water quality objectives
	Poor	30% to <50% of indicators comply with water quality objectives
	Very Poor	<30% of indicators comply with water quality objectives

Biological indicators

Organisms living in streams and rivers can tell us about the condition or "health" of waterways. Diverse communities of macroinvertebrates (or water-bugs) indicate a stream in good condition, while simple communities of few water-bug types indicate a degraded stream. Water scientists monitored the health of Rapid Creek using an assessment system known as AUSRIVAS. This stands for Australian River Assessment System, and works by comparing the water-bugs present in a stream (O, Observed) with those expected (E, expected) to be present in reference streams of a similar type. The AUSRIVAS methodology produces a score or band (see table below). These Report Cards used a genus-level model, which was based on 192 taxa and 114 reference sites within the Darwin-Daly region.

Band	Description	What it represents
X	More biologically diverse than reference	More types found than expected. Potential biodiversity "hot-spot" or mild organic enrichment.
A	Similar to reference	Observed to Expected ratio (O/E) scores range found at 80% of the reference sites, or equivalent to reference condition.
B	Significantly impaired	Potential impact either on water and/or habitat quality resulting in a loss of types.
C	Severely impaired	Many fewer types than expected. Loss of water and/or habitat quality.
D	Extremely impaired	Few of the expected types and only the hardy, pollution tolerant families remain.

Sampling for water bugs as part of annual monitoring

Rocky outcrop offshore of Nightcliff beach area


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour

Darwin Harbour marine water quality

Indicator and units	Water quality objective outer area	Compliance outer area	Water quality objective mid area	Compliance mid area
pH	7.0–8.5	7.9-8.2 ✓	7.0–8.5	7.1-8.2 ✓
Chlorophyll *a* (µg/L)	<1	0.7 ✓	<2	0.5 ✓
NOx (µg N/L)	<10	7.5 ✓	<20	5 ✓
Ammonia (µg N/L)	<20	2.5 ✓	<20	12 ✓
Total nitrogen (µg N/L)	<440	280 ✓	<270	160 ✓
Total phosphorus (µg P/L)	<20	30 ✗	<20	10 ✓
Filterable reactive phosphorus (µg P/L)	<10	8 ✓	<5	2 ✓
Number of samples		141		30
2012 grade		B		A
2011 grade		A		A
2010 grade		A		B
2009 grade		A		A

Mangroves, Bleesers Creek


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour
Rapid Creek

Rapid Creek catchment freshwater and estuarine water quality

Indicator and units	Water quality objective freshwater	Compliance freshwater	Water quality objective estuarine	Compliance estuarine
Electrical conductivity (µS/cm)	<200	45.5 ✓	NA	
Turbidity (NTU)	<20	0.9 ✓	NA	
pH	6.0–7.5	6.0-6.2 ✓	6–8.5	7.7-8.3 ✓
Dissolved oxygen (%)	50–100	77-89 ✓	80–100	*
Total suspended solids (mg/L)	<5	2.5 ✓	<10	*
Chlorophyll *a* (µg/L)	<2	0.5 ✓	<4	0.5 ✓
NOx (µg N/L)	<8	19.5 ✗	<20	3.5 ✓
Ammonia (µg N/L)	NA		<20	15 ✓
Total nitrogen (µg N/L)	<230	90 ✓	<300	135 ✓
Total phosphorus (µg P/L)	<10	5 ✓	<30	2.6 ✓
Filterable reactive phosphorus (µg P/L)	<5	5 ✓	<10	1.25 ✓
Number of samples		12		4
2012 grade		B		A
2011 grade		A		A
2009 grade		B		**

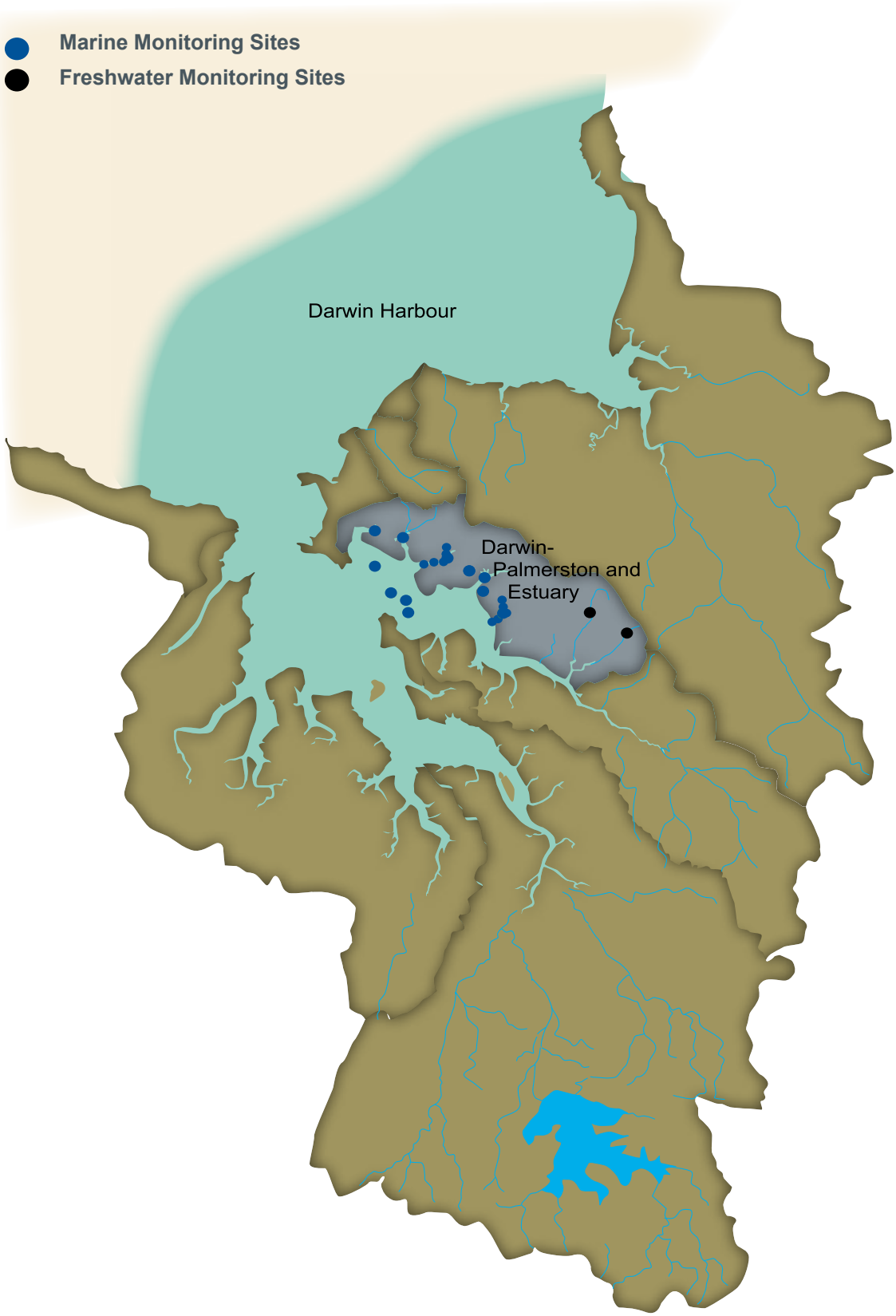
Note: Four sites included the data from sites at Kimmorley Bridge, Yankee Pools, Henry Wrigley Bridge and DW21. Data for Kimmorley Bridge, Yankee Pools, Henry Wrigley Bridge and Mitigation Weir were supplied by Darwin International Airport.
Note: (NA). Not applicable, no WQO developed

* WQO currently under revision.

**No grades for 2010, no estuarine grades for 2009 (Limited data)

Biological health using the AUSRIVAS score

Site	2010	2012	Change
Upstream of weir	C	C	No Change


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour
Darwin-
Palmerston and
Estuary

Darwin-Palmerston freshwater and estuarine water quality

Indicator and units	Water quality objective freshwater	Compliance freshwater	Water quality objective marine	Compliance Darwin-Palmerston marine	Compliance Myrmidon Ck estuarine
Electrical conductivity (µS/cm)	<200	86 ✓	NA		
Turbidity (NTU)	<20	153.5 ✗	NA		
pH	6.0–7.5	6.5-6.6 ✓	6–8.5	7.4-7.9 ✓	7.5-7.8 ✓
Dissolved oxygen (%)	50–100	93-96.5 ✓	80–100	*	*
Total suspended solids (mg/L)	<5	69 ✗	<10	*	*
Chlorophyll *a* (µg/L)	<2	1.5 ✓	<4	2.93 ✓	3.82 ✓
NOx (µg N/L)	<8	140 ✓	<20	4 ✓	7.5 ✓
Ammonia (µg N/L)	NA		<20	5 ✓	8 ✓
Total nitrogen (µg N/L)	<230	145 ✓	<300	300 ✓	380 ✗
Total phosphorus (µg P/L)	<10	47.5 ✗	<30	27.5 ✓	45 ✗
Filterable reactive phosphorus (µg P/L)	<5	0.5 ✓	<10	4 ✓	13 ✗
Number of samples		2		78	99
2012 grade		C		A	C
2011 grade		A		A	**
2010 grade		A		A	D
2009 grade		A		B	**

Note (NA). Not applicable, no WQO developed * WQO currently under revision.

** No grade

Freshwater compliance was constrained by the small sample number in 2012 and high results for the Mitchell Creek site which heavily skewed the data. Turbidity, Total Suspended Sediment and nutrients were high at the time of sampling.


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour
Elizabeth River
and Estuary

Elizabeth River freshwater and estuarine water quality

Indicator and units	Freshwater		Estuarine	
	Water quality objective	Compliance	Water quality objective	Compliance
Electrical conductivity (µS/cm)	<200	26 ✓	NA	
Turbidity (NTU)	<20	2.68 ✓	NA	
pH	6.0–7.5	6.5-6.7 ✓	6–8.5	7.4-8.1 ✓
Dissolved oxygen (%)	50–100	87-94.6 ✓	80–100	*
Total suspended solids (mg/L)	<5	7 ✗	<10	*
Chlorophyll *a* (µg/L)	<2	2 ✓	<4	1.42 ✓
NOx (µg N/L)	<8	13 ✓	<20	4 ✓
Ammonia (µg N/L)	NA		<20	11 ✓
Total nitrogen (µg N/L)	<230	140 ✓	<300	180 ✓
Total phosphorus (µg P/L)	<10	35 ✗	<30	15 ✓
Filterable reactive phosphorus (µg P/L)	<5	0.5 ✓	<10	0.25 ✓
Number of samples		9		25
2012 grade		C		A
2011 grade		B		A
2010 grade		A		A
2009 grade		A		C

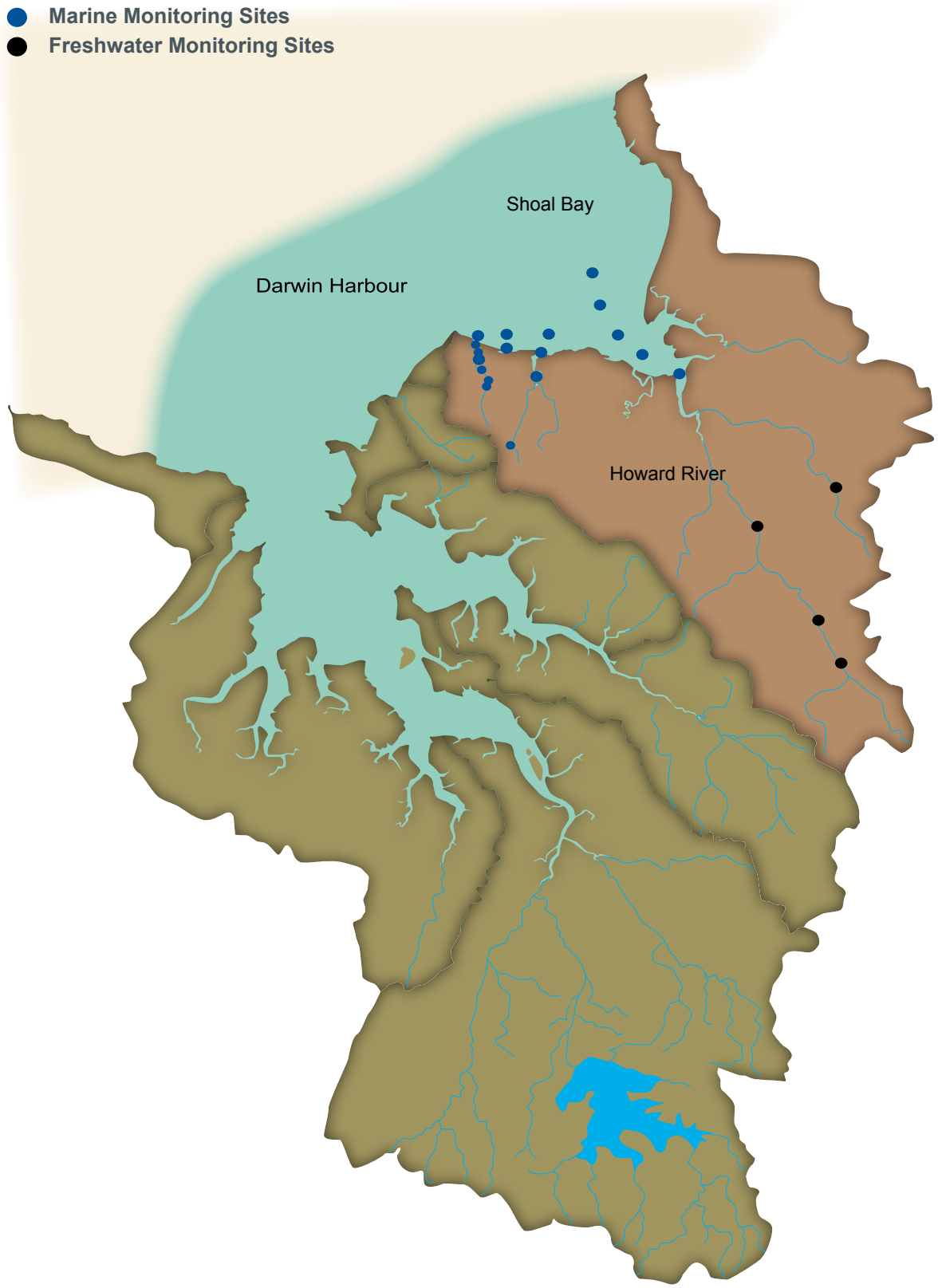
Note: (NA). Not applicable, no WQO developed * WQO currently under revision.


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour
Blackmore
River and
Estuary

Blackmore River freshwater and estuarine water quality

Indicator and units	Freshwater		Estuarine	
	Water quality objective	Compliance	Water quality objective	Compliance
Electrical conductivity (µS/cm)	<200	38 ✓	NA	
Turbidity (NTU)	<20	3 ✓	NA	
pH	6.0–7.5	6.6-7.0 ✓	6–8.5	7.3-7.8 ✓
Dissolved oxygen (%)	50–100	65-85 ✓	80–100	*
Total suspended solids (mg/L)	<5	8 ✗	<10	*
Chlorophyll *a* (µg/L)	<2	0.5 ✓	<4	3 ✓
NOx (µg N/L)	<8	27.5 ✗	<20	15 ✓
Ammonia (µg N/L)	NA		<20	15 ✓
Total nitrogen (µg N/L)	<230	220 ✓	<300	207.5 ✓
Total phosphorus (µg P/L)	<10	37.5 ✗	<30	15 ✓
Filterable reactive phosphorus (µg P/L)	<5	0.5 ✓	<10	5 ✓
Number of samples		8		84
2012 grade		C		A
2011 grade		C		C
2010 grade		C		B
2009 grade		B		B

Note: (NA). Not applicable, no WQO developed * WQO currently under revision.


Marine Monitoring Sites
Freshwater Monitoring Sites
Shoal Bay
Darwin Harbour
Howard River

Shoal Bay and Howard River freshwater and marine water quality

Indicator and units	Freshwater		Outer Marine		Estuary	
	Water quality objective	Compliance	Water quality objective	Compliance	Water quality objective	Compliance
Electrical conductivity (µS/cm)	<200	37 ✓	NA		NA	
Turbidity (NTU)	<20	9.45 ✓	NA		NA	
pH	6.0–7.5	6.4-6.6 ✓	7.0–8.5	7.2-8 ✓	6–8.5	6.8-8.1 ✓
Dissolved oxygen (%)	50–100	82-86.6 ✓	80–100	*	80–100	*
Total suspended solids (mg/L)	<5	11 ✗	<10	*	<10	*
Chlorophyll *a* (µg/L)	<2	0.5 ✓	<2	0.5 ✓	<4	3 ✓
NOx (µg N/L)	<8	30 ✓	<20	4.5 ✓	<20	9.5 ✓
Ammonia (µg N/L)	NA		<20	13 ✓	<20	12 ✓
Total nitrogen (µg N/L)	<230	280 ✗	<270	160 ✓	<300	300 ✓
Total phosphorus (µg P/L)	<10	32.5 ✗	<20	5 ✓	<30	32.5 ✗
Filterable reactive phosphorus (µg P/L)	<5	0.5 ✓	<5	0.25 ✓	<10	3.5 ✓
Number of samples		4		7		12
2012 grade		C		A		B
2011 grade		B		A		C
2010 grade		B		A		C
2009 grade		C		A		C

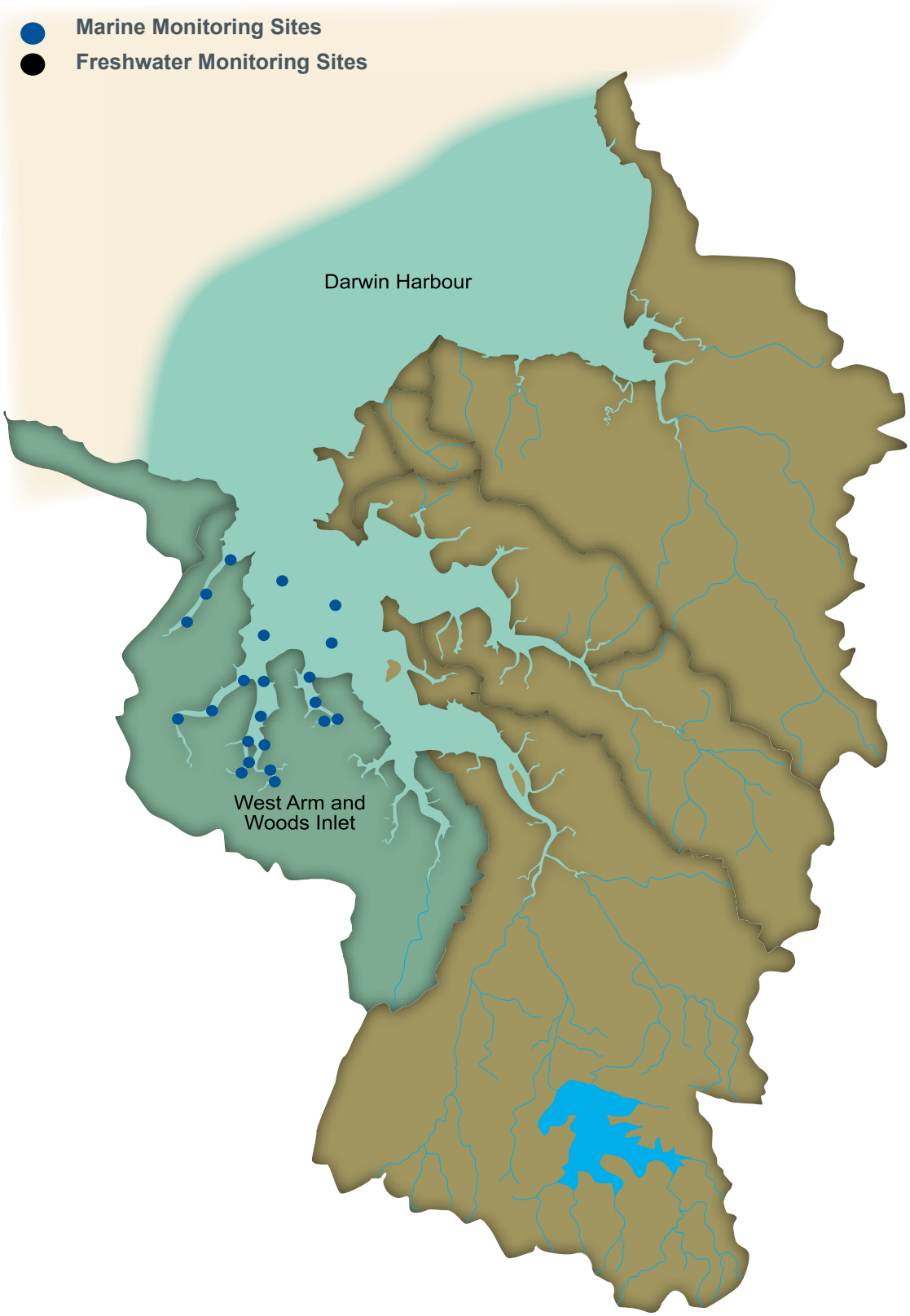
Note: (NA). Not applicable, no WQO developed * WQO currently under revision.

Buffalo Creek estuarine water quality

Indicator and units	Water quality objective	Compliance
pH	6–8.5	7.3–8.0 ✓
Chlorophyll *a* (µg/L)	<4	37.6 ✗
NOx (µg N/L)	<20	35.5 ✗
Ammonia (µg N/L)	<20	71.5 ✗
Total nitrogen (µg N/L)	<300	1630 ✗
Total phosphorus (µg P/L)	<30	287 ✗
Filterable reactive phosphorus (µg P/L)	<10	87.5 ✗
Number of samples		109
2012 grade		E
2011 grade		E
2010 grade		E
2009 grade		E

* WQO currently under revision.
The Buffalo Creek monitoring site in the estuary is influenced by the treated wastewater discharged from the Leanyer-Sanderson sewage treatment plant outfall. The treatment plant is subject to a Waste Discharge Licence. The licensed mixing zone is yet to be fully determined. It is possible that the Buffalo Creek monitoring sites are located within the discharge mixing zone, and that the water quality objectives may not apply to this site. The Leanyer-Sanderson wastewater is treated by waste stabilisation lagoons utilising a combination of sunlight, micro-organisms and algae to break down the raw wastewater. The presence of elevated concentrations of chlorophyll in Buffalo Creek may be largely due to the algae present in the treated wastewater discharge.

Mangroves are a feature of Shoal Bay


Marine Monitoring Sites
Freshwater Monitoring Sites
Darwin Harbour
West Arm and
Woods Inlet

West Arm and Woods Inlet marine water quality

Indicator and units	Water quality objective	Compliance
pH	6–8.5	7.0-8.1 ✓
Chlorophyll *a* (µg/L)	<4	1 ✓
NOx (µg N/L)	<20	6 ✓
Ammonia (µg N/L)	<20	12 ✓
Total nitrogen (µg N/L)	<300	185 ✓
Total phosphorus (µg P/L)	<30	10 ✓
Filterable reactive phosphorus (µg P/L)	<10	0.37 ✓
Number of samples		30
2012 grade		A
2011 grade		A
2010 grade		A

Note: (NA). Not applicable, no WQO developed.
No data for 2009.

Beach water quality

Darwin and Mandorah beaches were suitable for swimming throughout the 2012 dry season, with no beach closures. The Department of Health, supported by the Department of Land Resource Management, undertake regular microbiological monitoring between June 1st and September 30th when the beaches are open for recreation. At other times of the year, the beaches are closed due to the risk of box jellyfish stings.

For full details of sampling results and guidelines see the Department of Health website.
http://www.health.nt.gov.au/Environmental_Health/Beach_Water_Quality/index.aspx#beach_water_quality

Further reading

Darwin Harbour Region Report Cards from 2009 to 2012:

http://www.lrm.nt.gov.au/water/aquatic/reportcards

Darwin beaches water quality:

http://www.health.nt.gov.au/

http://www.health.nt.gov.au/Environmental_Health/Beach_Water_Quality/index.aspx#beach_water_quality

Reports on water quality and biological health by the Aquatic Health Unit:

http://www.lrm.nt.gov.au/water/aquatic/publications

http://www.lrm.nt.gov.au/water/aquatic/ausrivas

Back cover: Indo-pacific dolphins *(Sousa chinesis)* are residents of Darwin Harbour. They frequent the harbour for foraging, calving and raising young. Photo: Catherine Orme.