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Chapter 3.0 - Surface Water Quality

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3.0 Surface Water Quality

3.1 Overview

The proposed KBP is located within the catchments of Cubberla Creek, the Brisbane River inter-catchment area and Moggill Creek, which drain directly to the Brisbane River (approximate 20/50/30 split, respectively) as shown in Figure 3.1. The objective of this chapter is to describe existing water quality trends within these catchments, determine any impacts of the proposed project on surrounding and downstream water quality and to recommend mitigation strategies in order to reduce identified impacts.

3.2 Approach and Methodology

Surface water quality within and downstream of the KBP corridor was assessed by undertaking a desktop review and visual inspection of the project corridor.

A desktop review of surface water quality data and current environmental values was conducted utilising:

- Historical Environmental Protection Agency (EPA) and Brisbane City Council (BCC) reports; and
- Ecosystem Health Monitoring Program (EHMP) data collected on a monthly basis during the last five years (i.e. July 2003 - June 2008) from the Brisbane River.

The EHMP samples were collected at 0.2 m water depth from sites located downstream of the KBP (706), at Fig Tree Pocket (707), opposite Moggill Creek (708) and upstream of the KBP (EHMP reference site 709) (Figure 3.1). Data was examined to determine long-term fluctuations and patterns in pH, dissolved oxygen, nutrients (total nitrogen (TN) and total phosphorus (TP)), phytoplankton (chlorophyll-a) and water clarity (turbidity and secchi depth). Parameters were compared against their respective Water Quality Objectives (WQO) as defined under the *Environmental Protection (Water) Policy 1997 (EPP (Water))*.

A visual inspection of riparian bed and bank condition was undertaken in August 2008 by Maunsell environmental scientists. This involved a walk-through of the proposed KBP corridor and thorough inspection at the locations shown in Figure 3.1 with respect to:

- local drainage patterns;
- presence and extent of erosion, litter and/or riparian weeds; and
- upstream and downstream land uses.

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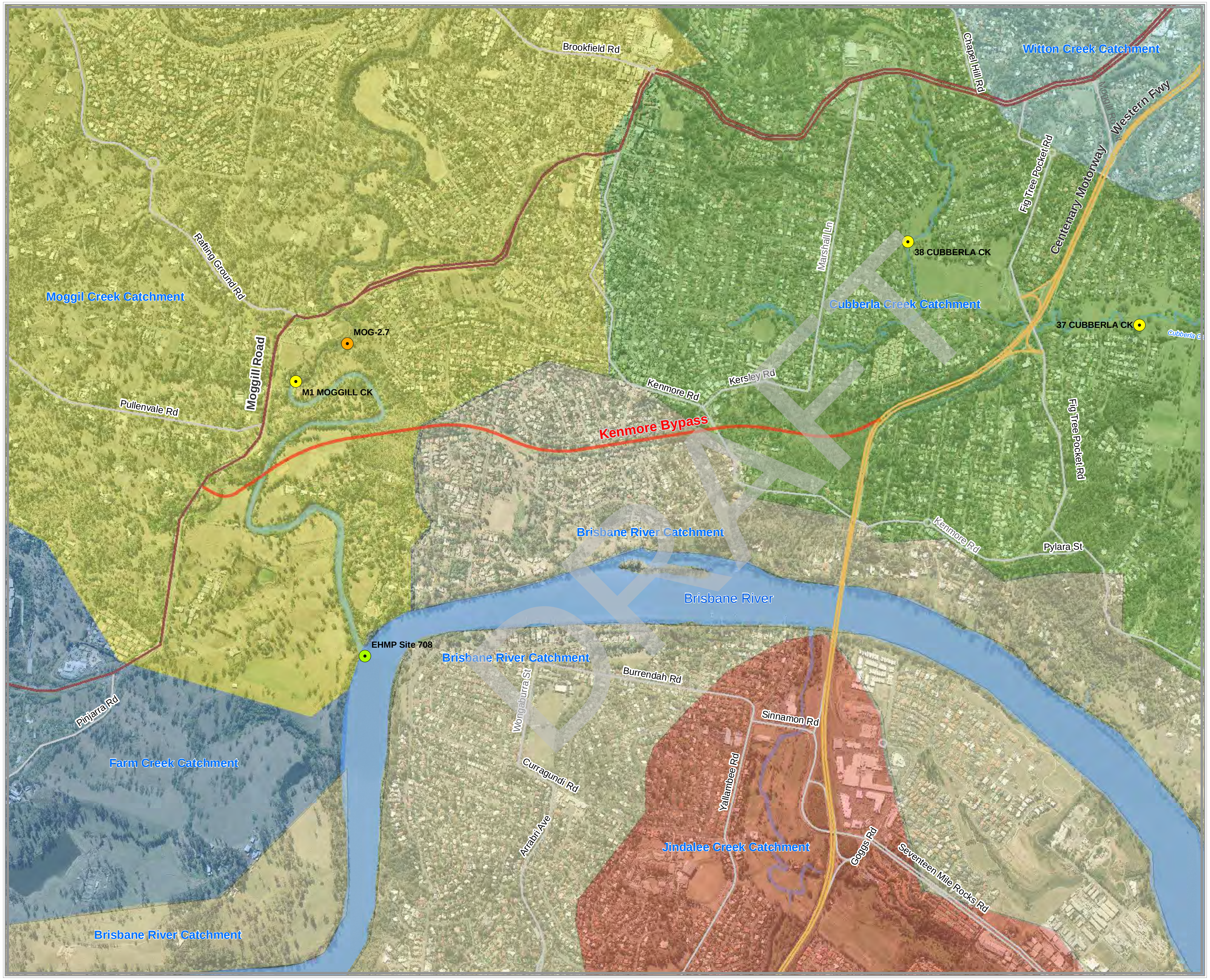

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Legend

- Webb (2001) Sites
- EHMP Sites
- Couniham and Webb (2001) Site
- Centenary Motorway
- Kenmore Bypass
- River/creek
- Moggill Road

Major Waterway Catchments

- Brisbane River
- Cubberla Creek
- Farm Creek
- Jindalee Creek
- Moggil Creek
- Witton Creek

Data sources:
Roads, railway, rivers etc - Copyright 2006, MapData Sciences PTY LTD, PSMA

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Air Quality Information provided by ENSR Australia, Brisbane for the Kenmore Bypass Environmental Study.

KENMORE BYPASS SURFACE WATER

Catchment Boundaries and Sample Locations

Figure 3.1

3.3 Description of Environmental Values

3.3.1 Catchment Overview

3.3.1.1 Cubberla Creek

Cubberla Creek Catchment is a smaller catchment in relation to the neighbouring Moggill Creek Catchment, covering an approximate area of 10.5 km² (BCC 2008a). It extends from the foothills of Mt Coot-tha Reserve to the Brisbane River at Fig Tree Pocket and includes all or part of the suburbs of Indooroopilly, Fig Tree Pocket, Chapel Hill, Kenmore and Kenmore Hills. The KBP crosses a tributary to Cubberla Creek that runs parallel to Kersely Road (Figure 3.1). Its main tributaries are the Boblynne Street branch (north of Moggill Road at Chapel Hill) and the Akuna Street branch, otherwise known as Little Gubberley Creek.

Similar to the Moggill Creek Catchment, historical land use within Cubberla Creek Catchment has evolved from traditional aboriginal uses to a variety of European land uses with the arrival of settlers in the mid-1800s (BCC 2008a). Logging was the first major activity to take place within the catchment, aided by the catchment's close proximity to the Brisbane River, a major transport route. Logging allowed dairy farming, grazing of sheep and cattle and small-scale agriculture to occur. Broad-scale residential development commenced after WWII in the 1950s, with a major roadway (now known as the Centenary Motorway) being constructed in the early 1970s. During the region's development, Cubberla Creek was diverted to enable the construction of a sports oval off Burns Parade and also for flood mitigation.

Present land use is dominated by residential properties with lesser areas of grazing, sporting fields, recreational reserves and remnant rainforest (e.g. Rainbow Forest Park at Indooroopilly, Merri Merri Park at Chapel Hill and along Gubberley Creek, Kenmore). Further development of the area is currently restricted due to flood concerns.

A catchment management plan was prepared for Cubberla Creek by BCC in 2001. The Plan was formulated as part of BCC's *Urban Stormwater Management Strategy* and to provide a framework of strategies to assist Council in meeting key Waterway Outcomes in its Corporate Plan for 2000-01. Like that of Moggill Creek, the Plan has now been superseded (in terms of guiding strategic decisions by BCC concerning the management of Cubberla Creek) by the *Integrated Water Management Strategy for Brisbane* (see Section 3.3.1.2 for more detail).

The catchment management plan describes water quality within Cubberla Creek as being 'very good' despite the cumulative effects of human impacts, such as riparian vegetation modification and removal, filling of the floodplain and piping, straightening and channelisation of the waterway. The main water quality issues identified were low dissolved oxygen levels and salinity. However, it was suspected that the high salinity levels were due to naturally occurring geology rather than any anthropogenic effect. The Plan specifically mentions the Kersely Road tributary as having value in terms of providing a link to adjacent vegetated greenspace. The Plan recommends that a 30 m corridor be established on both sides of the waterway from its source to the Centenary Motorway in order to maintain that connectivity. The KBP is likely to maintain drainage flows from the Kersely Road tributary to Cubberla Creek (refer to Chapter 5, Hydrology and Hydraulics for more detail).

Cubberla-Witton Catchments Network Inc is the local catchment management group. Their aim is to:

- facilitate communication with various Queensland and local government organisations;
- enable the collective groups to achieve catchments-wide representation when applying for funding; and
- facilitate strategic planning across the two catchments.

There are 11 active Habitat Brisbane groups working within the Cubberla-Witton Creek Catchment (BCC 2008a).

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Several restoration projects have been carried out by BCC and the Cubberla-Witton Catchments Network Inc. In 2002, BCC began work to restore a degraded section of Cubberla Creek downstream of Moggill Road using natural channel design principles. Restoration projects are aimed at achieving the community vision for Cubberla Creek (as outlined in the Cubberla Creek Waterway Management Plan), which is, "*... to retain its greenspace character, to protect and enhance biodiversity in balance with other waterway values as a continuous riparian corridor from Mt Coot-tha to the Brisbane River*" (BCC 2001, 2008a).

3.3.1.2 Lower Brisbane River Catchment

The Lower Brisbane River Catchment includes the Cubberla Creek and Moggill Creek Catchments, as well as the Brisbane River intercatchment area (the area of land that drains directly into the Brisbane River). The intercatchment area includes a drain that runs from within the proposed alignment, crossing Sunset Road and flowing through Kingfisher Park before discharging into the Brisbane River as shown in Figure 3.1.

Water quality within the Lower Brisbane River Catchment has historically been poor. The EHMP report card[1] has rated the Brisbane River as a 'D-' each year from 2002-2006. It is generally characterised by large stormwater events, waste water treatment plant (WWTP) discharge, urban runoff and long residence times (outside of storm events) (EHMP 2008). Water quality within the river did show slight improvement in nitrogen and dissolved oxygen levels in the 2007 EHMP report card where it received an improved rating of 'D+'.

Water quality within the Lower Brisbane River Catchment is managed at a state level through the *EPP (Water)*. The *EPP (Water)* identifies waters within the Lower Brisbane River Catchment as having the Environmental Values (EV) specified below in Table 3.1. EV are a reflection of water resource use and of the importance placed on that use. WQO are specified under the *EPP (Water)* to protect each EV. The purpose of EV and WQO under the *EPP (Water)* is to establish a single set of agreed long-term water quality targets for statutory and non-statutory planning and water quality management. They are likely to be relevant to the project, as they would be considered by Queensland government agencies and departments, and local governments when making planning decisions concerning Environmentally Relevant Activities (ERA) under the *Environmental Protection Act 1994* and/or Water Resource Plans under the *Water Act 2000*. Where more than one EV applies to a water body (e.g. aquatic ecosystem and recreational use), the most stringent WQO for each water quality indicator applies; this then protects all identified EV (EPA 2007). In most instances, this is the WQO for aquatic ecosystem protection (hence the use of this type of WQO in Section 3.3.2).

Table 3.1: Summary of EV of Waters within the Lower Brisbane River Catchment under the *EPP (Water)*

Environmental Value	Cubberla Creek[2]	Brisbane River	Moggill Creek[3]
Sustaining aquatic ecosystems	✓	✓	✓
Human consumption of aquatic foods (e.g. fish)	X	✓	✓
Primary recreation (e.g. swimming)	X	✓	✓
Secondary recreation (e.g. boating, fishing)	✓	✓	✓
Visual recreation (e.g. walking, picnicking)	✓	✓	✓
Indigenous and non-indigenous cultural heritage values	✓	✓	✓
Irrigation (freshwater component only, presumably for local sporting fields)	✓	X	X
Industrial use[4]	X	✓	X

[1] The EHMP reports the health of streams on the basis of a traditional school report card with respect to ecosystem health indicators. In this context an "A" is a high score that indicates that the ecosystem heath is similar to minimally disturbed reference ecosystems, the intermediate ratings of "B" through to "D" are a decreasing scale of health, and an "F" designates a total failure of ecosystem health. Plus (+) and minus(-) designators are added to provide greater resolution.

[2] Freshwater and estuarine

[3] Estuarine

On a local basis, water quality within the Lower Brisbane River Catchment is managed by BCC through a water strategy plan entitled *Water for Today and Tomorrow: An Integrated Water Management Strategy for Brisbane* (BCC 2004). The Strategy encourages the concept of 'total water cycle management' and aims to provide a sustainable water future for Brisbane. As part of the Strategy, BCC in partnership with bodies such as the Moreton Bay Waterways and Catchments Partnership aim to refine the current WQO and set sustainable ecological limits/indicators by 2010. This may have implications for the KBP in terms of revision of what ecological limits are used before and during construction to assess impact. The Strategy also encourages improving stormwater quality through the implementation of water sensitive urban design (WSUD) and enhancing the function of riparian corridors.

No wetlands of international significance (RAMSAR) or State classified wetlands[5] are present within the catchment surrounding the KBP. The nearest recognised wetland is Moreton Bay, which is located approximately 50 km downstream from the study area. It is unlikely that the KBP will significantly impact the water quality of Moreton Bay if appropriate water quality controls are implemented in the Environment Management Plan (Construction) (EMP (C)) and in the design of drainage structures (refer to Section 3.4.1).

3.3.1.3 Moggill Creek

Moggill Creek Catchment covers an approximate area of 57.6 km² and includes all or part of the suburbs of Mt Coot-tha, Kenmore, Kenmore Hills, Pinjarra Hills, Brookfield, Pullenvale, Upper Brookfield (BCC 2008b). The creek itself is approximately 25 km in length and flows from the southern edge of Brisbane Forest Park near Upper Brookfield and joins the Brisbane River at Kenmore. It is tidally influenced from its confluence with the Brisbane River to approximately 1.5 km upstream from the creek mouth (Counihan & Web 2001). The KBP alignment crosses Moggill Creek approximately 1.2 km from its confluence with the Brisbane River. Significant tributaries of Moggill Creek include McKay Brook and Gap, Wonga, and Gold Creeks.

Historical land use within Moggill Creek Catchment has evolved from traditional Aboriginal uses to various European land uses with the arrival of the first settlers in the mid-1800s (BCC 2008b). Initial European land uses were mainly grazing and timber felling (an activity responsible for the depletion of many of the area's mature cedars, hoop pines and eucalypts). The logs were floated down Moggill Creek and into the Brisbane River via the area now known as 'Rafting Ground Reserve'. By 1870, most suitable land along Moggill and Gold Creeks had been cleared and used for agriculture. Gold exploration and mining took place at a number of sites around the catchment (including Gold Creek) with little success throughout the 1860s and again in the 1920s and 1930s. Major population expansion within the area did not take place until after WWII with the introduction of greater services and subdivision of large farm estates. In 2001, the population within Moggill Creek Catchment was estimated to be 12,400 and growing (Counihan & Webb 2001).

Present land use within the lower catchments is largely urban-residential with lesser areas of grazing (horse and cattle), sporting fields and recreational reserves (including Brookfield Recreation Reserve, Creekside Street Park and Gap Creek and Rafting Ground Reserves). Land use in the upper catchment areas is dominated by rural-residential, grazing and bushland.

A catchment management plan was written for Moggill Creek in 1997 by the BCC Catchment Management Unit. The Plan was formulated as part of Council's *Urban Stormwater Management Strategy*. The Plan comments that water quality within Moggill Creek was generally of a high standard (when compared to ANZECC Guidelines for aquatic ecosystem protection) and that this was suspected to be largely attributable to the non-urbanised nature of the catchment. Issues identified for future water quality were a likely increase in nutrients, runoff, erosion and sedimentation from low density urbanisation and subdivisional developments particularly in the lower catchment area. The

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[4] Where the water would generally be treated to meet industry-specific needs before use.

[5] Includes EPA Remnant Ecosystem descriptions and Queensland Wetland Mapping and Classification, which is currently in development under the Queensland Wetlands Programme (refer to www.epa.qld.gov.au for more information).

Plan has now been superseded (in terms of guiding strategic decisions by Council concerning the management of Moggill Creek) by the *Integrated Water Management Strategy for Brisbane* (see Section 3.3.1.2 for more detail).

The Moggill Creek Catchment Group (MCCG) is the local catchment management group. MCCG is a volunteer action community group aiming to conserve and improve the natural environment of the catchment on both private and public land (MCCG 2003). The group formed in 1997 divides the catchment into 13 sub-catchments and working groups (BCC 2008b). The MCCG Strategic Plan outlines several key goals and accompanying strategies for the catchment.

There are also nine active Habitat Brisbane groups within the Moggill Creek Catchment (BCC 2008b). This is a BCC-based program that is carried out by volunteers within the local community to restore the environment along creeks by:

- removing weeds and other rubbish and establishing native plants;
- spreading the word in the general community through newsletters, open days, displays and presentations to schools and clubs;
- reducing illegal dumping through community awareness and education;
- improving the attractiveness of natural areas for visitors; and
- drawing people together to create an increased sense of community (BCC 2008b).

3.3.2 Water Quality Trends

3.3.2.1 Overview of Monitoring Practices

Water quality monitoring within the catchments has been carried out since the early 1970s, initially by the (now) Department of Natural Resources and Water (DNRW) and then by BCC and the EPA from 1995 to 2001. Regular monitoring within Cubberla and Moggill Creeks appears to have ceased in 2001 with the introduction of the EHMP (although community-based monitoring is likely to have continued). BCC commenced a city-wide Local Waterway Health Assessment Program in 2006 that is likely to cover Cubberla and Moggill Creeks; however, a report card is yet to be published (the first is due for release in 2009 (BCC 2008a)). Water quality within the Brisbane River is presently monitored under the EHMP (Figure 3.1).

3.3.2.2 Historic Water Quality (pre-2003)

Historical water quality within the Cubberla and Moggill Creek catchments has been generally described as ‘good’; that is, meeting or exceeding Queensland Water Quality Guideline values (now replaced by waterway-specific WQO, see Section3.3.1.2) (Counihan & Webb 2001, Webb 2001). The only indicators found not to meet guideline values in studies by Counihan and Webb (2001) and Webb (2001) were dissolved oxygen in the ephemeral upper catchment areas (Table 3.2) and concentrations of the pesticide, chlordane, in Moggill Creek (Table 3.3). Couniham and Webb suggested that the pesticide concentrations were most likely due to historical rather than current use within the wider catchment. Concentrations of trace metals and organic contaminants (excluding chlordane) in sediments from Moggill Creek were found to comply with current WQO (Table 3.3). However, many of the samples were unable to be analysed to a level of detail to allow conclusive comparison with WQO values.

Table 3.2 shows median values of water quality samples taken from Moggill Creek between October 1999 and April 2000. Results that are noncompliant against the respective WQO are bolded in red.

Table 3.3 shows mean concentrations of selected trace metals and organic contaminants in sediment samples from Moggill Creek taken in November 1998 at a site approximately 1.5 km upstream from the proposed KBP (Counihan & Webb 2001). Results that are noncompliant against the respective WQO are in bolded in red. Where compliance could not be determined, values are shown in grey shading.

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Table 3.2: Median Values of Water Quality Monitoring Data

Parameter	37 Cubberla Ck[6]	38 Cubberla Ck[6]	M1 Moggill Ck[7]	M2 Moggill Ck[7]	WQO (if applicable)
pH	7.2	6.9	7.4	7.4	6.5-8.5
Dissolved Oxygen (% saturation)	**77**	**63**	80	87	80-105
Conductivity (mS/cm)	0.840	0.666	0.449	0.432	-
Turbidity (NTU)	2.5	2	3	2	<20
Suspended Solids (mg/L)	1	3	1	1	<15
Chlorophyll-a (µg/L)	0.8	0.8	1.2	1.5	<8
Total N (mg/L)	0.236	0.326	0.335	0.335	<0.65
Total P (mg/L)	0.021	0.024	0.034	0.034	<0.07

Table 3.3: Mean Concentrations of Selected Trace Metals and Organic Contaminants

	Parameter	Mean Concentration	WQO (if available)
Trace metals (mg/kg)	Antimony	<10	<2
	Arsenic	<15	<20
	Cadmium	<1	<1.5
	Chromium	35	<80
	Copper	16	<65
	Lead	<10	<50
	Mercury	<0.2	<0.15
	Nickel	17	<21
	Zinc	52	<200
Organic contaminants (µg/kg)	Aldrin	<1.67	-
	Chlordane	**1.6**	**<0.5**
	DDT	1.28	<1.6
	DDD	<1.67	<2
	DDE	0.33	<2.2
	Dicofol	<1.7	-
	Dieldrin	<1.67	<0.02
	Endosulfan	<3.33	-
	Endrin	<1.67	<0.02
	HCH-Gamma (Lindane)	<1.67	<0.32
	Heptachlor	<3.3	-
	Methoxychlor	<1.7	-
	PCB	<167	<23

[6] (n=4); sampled on 25 Oct-18 Nov 1999, 14-21 Dec 1999, 20-23 Mar 2000 and 13-18 Apr 2000. All sampling was conducted during dry weather, targeting base-flow conditions to complement BCC's stormwater program. This involved avoiding sampling on rainy days or any days after significant rainfall (greater than 10mm).

[7] (n=12); sampled monthly between January and December 1999.

In 2000, BCC undertook a Waterway Health Assessment of Cubberla Creek (BCC 2008a). Overall, water quality within Cubberla Creek was found to be 'very good' with the only issue being low dissolved oxygen levels thought to be associated with increased water temperature (caused by the removal of riparian vegetation) and low water levels (at the time).

3.3.2.3 Recent Water Quality (2003-2008)

Baseline water quality downstream of the KBP was determined from EHMP monitoring data collected from the Brisbane River during the last five years (i.e. July 2003- June 2008). Table 3.4 shows the results of this assessment in terms of the percentage of monthly water quality observations that complied with its respective WQO. Refer to Appendix 3-A for graphed time series of the data, which has been summarised in the 'Comments' column of Table 3.4.

Generally, water quality of the Brisbane River upstream and downstream of the KBP during the last five years has met the WQO for pH and chlorophyll-a; although compliance to the WQO for chlorophyll-a is most likely due to photosynthetic limitations from generally poor water clarity. Other parameters, including dissolved oxygen, turbidity, Secchi depth and particularly total nutrients (nitrogen and phosphorus) have generally not met the WQO. These non-compliances are most likely due to the Bremer River, the presence of an upstream waste water treatment plant (WWTP) (Oxley, Carole Park, Wacol and Redbank), urban runoff, runoff from exposed areas within the catchment and long residence times within the estuary (EHMP 2008).

Even though the EHMP data does not include analysis of trace metals or petroleum derivatives, it is likely that the current contribution made by the Cubberla and Moggill Creek Catchments with respect to these parameters within the Brisbane River is low. This is inferred by previous reports by Webb (2001) and Counihan and Webb (2001) and current land use within the catchments. There is likely to be a flux of trace metal (particularly copper, lead and zinc) and petroleum derivative concentrations after prolonged periods of little rainfall, which allows their accumulation on major roads within the catchments (e.g. Moggill and Kenmore Roads and the Centenary Motorway). However, the flux is likely to be brief and of little impact to the EV of downstream waters.

3.3.3 Riparian Bed and Bank Condition

An inspection of riparian bed and bank conditions of five sites within the KBP has showed that these water bodies are generally in good condition with respect to water quality, despite anthropogenic modification (e.g. concrete scour protection and channel narrowing) and disturbance (e.g. introduction of weeds and litter). Little or no erosion was observed at the sites. This was mostly due to 80-100% ground coverage by vegetation (mostly weed species, but effective in that respect nonetheless) and in part, attributable to the relatively small catchment areas of some sites. No oily films were observed; however, recent rainfall may have flushed them from the site. Refer to Appendix 3-B for more detailed results.

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Table 3.4: Summary of EHMP Water Quality Data for Aquatic Ecosystem Protection

Parameter	Relevance	WQO*	Upstream (709)		Opposite Moggill Ck (708)		Fig Tree Pocket (707)		Downstream (706)		Comments
			Median	% Compliance to WQO	Median	% Compliance to WQO	Median	% Compliance to WQO	Median	% Compliance to WQO	
pH	Influences the solubility of certain metals (e.g. iron and aluminium) and species composition (e.g. nitrifying bacteria such as *Nitrosomonas* and *Nitrobacter*).	6.5-8.5	7.8	98	7.7	100	7.6	100	7.7	100	• Good WQO compliance. • Large falls and rises in pH generally associated with large rain events or prolonged absence of rain, respectively.
Dissolved oxygen (DO) (% sat)	Low concentrations of DO usually indicate the presence of excessive organic loads in the system, while high values can indicate eutrophication.	≥80	76	37	73	32	70	27	72	28	• Poor WQO compliance. • Non-compliance generally caused by spikes in chlorophyll-a growth and prolonged absence of rain.
Total phosphorus (TP) (µg/L)	High concentrations indicate a potential for excessive weed and algal growth. Originates from both natural and anthropogenic sources.	≤60	900	0	950	0	890	0	740	0	• Very poor WQO compliance. • High nutrient loads in system, most likely sourced from upstream WWTP and urban runoff.
Total nitrogen	As per TP.	≤450	1500	0	1600	0	1900	0	1600	0	• Very poor WQO compliance. • Although a decreasing trend is evident

Parameter	Relevance	WQO*	Upstream (709)		Opposite Moggill Ck (708)		Fig Tree Pocket (707)		Downstream (706)		Comments
			Median	% Compliance to WQO	Median	% Compliance to WQO	Median	% Compliance to WQO	Median	% Compliance to WQO	
(TN) (µg/L)											during last three years across all sites, e.g. from Oct-05 to Jul-08, Fig Tree Pocket (707) has significantly reduced from 3500 µg/L to 1200 µg/L. • Likely to be attributable to upstream WWTP upgrades (EHMP 2008).
Chlorophyll-a (µg/L)	An indicator of algal biomass in water. An increase in chlorophyll-a indicates potential eutrophication of the system.	≤10	1.8	97	1.7	93	1.2	97	1.3	98	• Good WQO compliance. • Large non-compliance in August, 2007, where values measured 34-80 µg/L. Accompanied by a spike in TP and organic N. • Given the generally high level of nutrients, it is likely that algal growth is limited by poor light penetration due to the elevated turbidity.
Turbidity (NTU)	An indication of the amount of suspended solids in the water. High turbidity levels can inhibit light penetration and plant growth in the water column.	≤20	82	8	54	10	50	7	42	15	• Poor WQO compliance. • Non-compliance generally caused by large rainfall events washing exposed sediment into stormwater drains and disturbing waterway bed and banks.
Secchi depth (m)	An indicator of water clarity, similar to turbidity.	>0.5	0.3	13	0.3	20	0.3	10	0.4	35	• As per turbidity.

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3.4 Potential Impacts and Mitigation Measures

3.4.1 By Project Phase

The potential impacts from the design phase of the KBP are likely to be associated with the design of drainage and bridge structures. These structures have the potential to alter hydrologic regimes and increase road-based pollutant loads within the Cubberla and Moggill Creek Catchments and the Brisbane River. Important management strategies for the design phase should include the incorporation of regional standards for WSUD as specified in the Healthy Waterways' WSUD Action Plan (Management Strategy WQ.01), and careful selection of drainage structures to maintain aquatic connectivity and to minimise creek bank and bed disturbance (Management Strategy WQ.02).

Particular areas of focus for WSUD implementation should be those that intercept road runoff water before it enters the Cubberla Creek tributary, the Kingfisher Park drainage line and/or Moggill Creek. There is high value and good opportunity to implement a succession of WSUD measures along the drainage line in Kingfisher Park given the availability of space, recreational land use and the fact that a large proportion of corridor runoff will drain to this location. For example, this may include the implementation of gross pollutant traps leading into an artificial wetland established within the pre-existing drainage line. Such a measure will also have flow-on benefits with respect to flora and fauna conservation through the provision of habitat (particularly for local native frog populations, refer to Chapter 6, Fauna) and for scenic amenity values.

Construction of the KBP has the potential to cause increased turbidity and suspended solid content in Cubberla and Moggill Creeks and the Brisbane River as a result of earthworks, uncontrolled discharge of wash-down waters and bridge/drainage works.

There is also a risk of increased hydrocarbon content within these same waterbodies from accidental oil and fuel spillages and/or leakage from machinery and on-site oil and fuel storage areas.

Construction of the KBP is likely to be undertaken by a construction contractor who will be required to work in accordance with an EMP (C) that includes the following with respect to water quality:

- location of potentially affected water bodies;
- listing of construction activities and their potential contaminants;
- water quality performance criteria;
- monitoring locations;
- site erosion, drainage and sediment (EDS) control plan; and
- procedures for chemical and fuel management (including spill response).

It is recommended that in addition to these standard measures, the measures outlined under Management Strategy WQ.03, as documented in Table 3.6, are included in the construction contractor's EMP (C), as a minimum, to manage on-site EDS control during construction.

Potential impacts from the operation of the KBP with respect to water quality will be similar to those of other major roadways within SEQ. There is potential that concentrations of copper, lead and zinc will increase in downstream waters that directly receive runoff from the KBP. These metals are sourced from:

- copper - brake lining wear;
- lead - vehicle emissions, tyre wear (lead oxide is added as filler material), lubricating oil and grease and bearing wear; and
- zinc - mostly tyre wear with minor amounts coming from lubricating oil and grease (Kumar et al 2002).

Generally, the dissolved component of these metals in runoff is low when compared to the particulate fraction (Kern et al 1992). Petroleum hydrocarbons from leaking crankcase oil, hydraulic systems and unburnt fuel are likely to be mainly found in first-flush runoff waters as shown in studies by Barrett *et*

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al. (1995) and Kumar *et al.* (2002). Concentrations of metals and petroleum hydrocarbons will be greatly reduced through the implementation and maintenance of WSUD devices as recommended under Management Strategy WQ.01 and WQ.04, documented in Table 3.6.

3.4.2 Sourcing Water for Construction

Depending on the level of water restrictions in effect at the time of construction, reticulated (town) water may not be available for construction activities, except where written approval from the local water supplier (Brisbane Water) has been obtained. Construction activities include but are not exclusive to dust suppression, earthworks, road and service construction and landscaping. The restriction is in effect under the current level of restrictions and is likely to continue under potential future restrictions (QWC 2007 and 2008).

The taking of water from local watercourses is not recommended given the quantity of water required for construction and associated impacts on the riverine environment and community perception. If water is sourced from local waterways such as the Brisbane River, a permit will be required from the DNRW in accordance with s237 of the *Water Act 2000*.

Recycled water (i.e. treated effluent) can be used as an alternative source of water for construction, if appropriate health and safety measures are undertaken. The *Queensland Water Recycling Guidelines* (EPA 2005) recommend that Class A recycled water or better should be used where workers or passing cars may be subject to intermittent spray drift. Unlike lower classes of recycled water, Class A has less *E. coli* and suspended solid content.

Discharges of recycled water will be subject to the construction contractor's general environmental duty not to cause environmental harm (in the absence of conditions stated in a development approval from the EPA or other approval body). Recycled water, even Class A, contains high levels of nutrients that if discharged into local waterways may result in an increase in the biological oxygen demand and death of aquatic organisms.

3.4.3 Water Quality Monitoring Requirements

It is recommended that water quality monitoring:

- commence approximately six weeks prior to the commencement of construction;
- focus on sites located at accessible locations downstream and upstream of the KBP influence along Cubberla and Moggill Creeks, and downstream of the Kingfisher Park drainage line (upstream monitoring will not be possible due to its location within the alignment);
- adopt "no-worsening" water quality performance criteria for upstream verse downstream values as a result of construction activities;
- ensures waters requiring discharge from site meet the minimum requirements specified in Table 3.5; and
- conduct event-based monitoring when rainfall exceeds 25 mm in a 24 hour period.

Table 3.5: **Recommended Water Quality Monitoring Parameters for Waters Discharged from Site**

Parameter	Recommended Compliance Requirement
pH	Not to exceed ±0.5 pH units of receiving waters.
Electrical conductivity (for freshwater receiving water only)	Not to exceed +10% that of receiving freshwaters.
Turbidity	Not to exceed 50 NTU.
Oils, scum, foam, litter	No visible oil, scum, foam or litter present.

Note: It is more challenging to define the baseline of the receiving waters in marine or tidally influenced environments.

Table 3.6 below summarises the potential impacts posed by the KBP and recommended mitigation strategies by project phase for surface water quality.

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Table 3.6: Potential Impacts and Mitigation Measures

Reference Code	Project Phase	Potential Impact	Potential Mitigation Measures
WQ.01	Design	Change in frequency of hydrologic and water quality disturbance to aquatic ecosystems as a result of increased hardstand area and road-based pollutant loads.	Implement, where practicable, the regional standards imposed by the *WSUD Action Plan* (part of the *South East Queensland Healthy Waterways Strategy 2007-2012*). This may include gross pollutant traps, grassed swales and buffer strips, sedimentation basins, bioretention basins and/or constructed wetlands (subject to availability of space within the KBP corridor). Particular areas of focus for WSUD implementation should be those that intercept road runoff water before it enters Cubberla and Moggill Creek tributaries and the Kingfisher Park drainage line. There is high value and good opportunity to implement a succession of WSUD measures along the drainage line in Kingfisher Park given the availability of space, recreational land use and the fact that a large proportion of corridor runoff will drain to this location.
WQ.02		Disturbance to creek bed and banks, particularly at the crossing of the Kingfisher Park drainage line and Moggill Creek.	Avoid the use of in-stream structures where practicable. If these cannot be avoided, utilise structures that minimise afflux and localised scouring, e.g. by positioning pylons away from creek bed and banks.
WQ.03	Construction	Increased turbidity and suspended solid loads in Cubberla and Moggill Creeks and the Brisbane River as a result of earthworks, uncontrolled discharge of wash-down waters and bridge/drainage works.	The following measures are to be included in the EMP (C), as a minimum, to manage on-site EDS control during construction: • design of EDS control structures to be consistent with the *Soil Erosion and Sediment Guidelines for Queensland Construction Sites* (IEAust 1996) and/or *Best Practice Erosion and Sediment Control* (ICEA Australasia, November 2008); • schedule/stage construction works to minimise the area of exposed soil at any one time and to ensure that vegetation clearing and earthworks are carried out during low rainfall periods; • develop and implement site-specific EDS Control Plans in accordance with relevant standards and guidelines for construction activities that pose unacceptable risk of uncontrolled off-site discharge (e.g. bridge and drainage works); • vehicles and equipment to be washed in designated wash-bay areas that are appropriately contained and the water treated before discharge; • where possible all material stockpiles and storage areas are to be located a minimum distance of 30 metres from waterways and drainage lines; • if a soil stockpile is to be stored for a period greater than two weeks it is to be treated with cover of mulch, hydromulch and/or jutemat; and • revegetation measures or a stabilised surface on exposed areas shall be established

Reference Code	Project Phase	Potential Impact	Potential Mitigation Measures
			as soon as practicable.
WQ.04		Increased hydrocarbon content in Cubberla and Moggill Creeks and the Brisbane River from accidental oil and fuel spillages and/or leakage from machinery and on-site oil and fuel storage areas.	The following measures are to be included in the EMP (C), as a minimum, to manage on-site fuel and oil storage and spill response/prevention during construction: • ensure machinery is appropriately maintained; • ensure spill response equipment is readily accessible; • equipment refuelling should be carried out in a bunded area or off-site; and • specify work procedures for on-site spill response, site remediation and equipment refuelling.
WQ.05	Construction	Changes to existing water quality.	It is recommended that water quality monitoring: • commence approximately six weeks prior to the commencement of construction; • focus on sites located at accessible locations downstream and upstream of the KBP influence along Cubberla and Moggill Creeks, and downstream of the Kingfisher Park drainage line (upstream monitoring will not be possible due to its location within the alignment); • adopt "no-worsening" water quality performance criteria for upstream verse downstream values as a result of construction activities; • ensures waters requiring discharge from site meet the minimum requirements specified in Table 3.5; and • conduct event-based monitoring when rainfall exceeds 25 mm in a 24 hour period.
WQ.06	Operation	Increase in contaminants including copper, lead, zinc and petroleum derivatives from: • vehicle emissions; • vehicular wear; • atmospheric fallout; • pavement degradation; and • road maintenance.	Effective implementation and maintenance of WSUD measures in accordance with design objectives in the Healthy Waterways' WSUD Action Plan (see WQ.01).

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3.5 Summary

The KBP has the potential to impact surface water quality of the Cubberla and Moggill Creek Catchments, as well as the downstream Brisbane River without the implementation of mitigation measures. Historical reports, monitoring and a site inspection of waters within the Cubberla and Moggill Creek Catchments suggest that existing water quality generally meets the WQO specified under the *EPP (Water)*. Water quality within the Brisbane River, immediately downstream of these creeks, is poorer and generally fails to meet WQO with respect to dissolved oxygen, turbidity and total nutrients. However, current water quality information for the area suggests that the poor water quality of the Brisbane River is attributable to upstream land uses and point source discharges rather than from any significant contributions from Cubberla or Moggill Creeks.

Potential impacts from the design phase of the KBP are likely to be associated with road runoff and the design of drainage and bridge structures. Important mitigation strategies for the design phase should include the incorporation of regional standards for WSUD as specified in the Healthy Waterways' WSUD Action Plan (Mitigation Strategy WQ.01), and careful selection of drainage structures to maintain aquatic connectivity and minimise creek bank and bed disturbance (Mitigation Strategy WQ.02).

Construction of the KBP has the potential to cause increased turbidity, suspended solid and hydrocarbon concentrations within Cubberla Creek, the Brisbane River and Moggill Creek. These potential impacts can be managed through the inclusion of additional EDS and hydrocarbon control measures in the EMP (C) as outlined in Mitigation Strategies WQ.03 and WQ.04.

Potential impacts from the operation of the KBP with respect to water quality are likely to be similar to those of other major roadways within SEQ. It is likely that concentrations of hydrocarbons, copper, lead and zinc will increase in downstream waters that directly receive runoff from the KBP. These concentrations can be reduced through the implementation and maintenance of WSUD devices as recommended under Mitigation Strategy WQ.01 and WQ.04.

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