PART B –AEIS

16 SURFACE WATER QUALITY

16.1 Environmental values and water quality objectives

At the time of submission of the EIS, the Dawson River and its tributaries were not listed under Schedule 1 of the Environmental Protection (Water) Policy 2009 (EPP (Water)), and as such a generic set of environmental values based on the Australian Water Quality Guidelines (AWQG) (ANZECC 2000) were adopted for assessment as part of the EIS.

In September 2011, the environmental values (EVs) and water quality objectives (WQOs) for Fitzroy Basin waters were finalised and included in Schedule 1 of the Policy and the document, *Environmental Protection (Water) Policy 2009: Dawson River Sub-basin Environmental Values and Water Quality Objectives* (DEHP 2011) was published (herein referred to as the Dawson River guidelines). The document sets WQOs that are the minimum levels required to protect all of the EVs of associated waterways. The EVs, as defined in the EPP (Water) 2009, are described in Section 16.1.2.2 of the EIS.

The Dawson River guidelines separate the Dawson River into the Upper Dawson River and the Lower Dawson River sub-basins, and lakes and reservoirs (weir pools, for example). Glebe Weir wall is the boundary between the Upper Dawson River and Lower Dawson River sub-basins. The proposed Nathan Dam water storage area will extend both upstream and downstream of the existing Glebe Weir. With the exception of Spring Creek (which will flow into the water storage area from the Lower Dawson sub-basin), the watercourses flowing directly into the water storage area are located in the Upper Dawson sub-basin and are within the main channel or southern tributaries. The receiving environment downstream of the proposed dam is the main channel of the Lower Dawson sub-basin. Should the Project be approved it may be appropriate to re-locate the boundary between the sub-basins to the Nathan Dam wall. The EVs that apply to the Upper Dawson main channel and southern tributaries, and to the Lower Dawson main channel are listed in **Table 16-1**.

A comparison of the WQOs for all applicable EV's was conducted, and the most stringent WQOs were selected for protection of all environmental values of a waterway. The WQOs for protection of a moderately disturbed aquatic ecosystem and for the supply of raw drinking water are provided in **Table 16-2** and **Table 16-3** respectively. WQOs are provided for surface fresh waters of the Upper Dawson River sub-basin waters (herein referred to as the Upper Dawson) and Lower Dawson River sub-basin waters (herein referred to as the Lower Dawson), and for lakes and reservoirs, which applies to water storage areas. WQOs for the Dawson River sub-basins are derived from local data (Dawson River guidelines); the WQOs for lakes and reservoirs are based on Central Coast regional data and serve as a subregional guideline for the Mackay-Whitsunday area specified in the Queensland Water Quality Guidelines (QWQG) (DEHP 2009).

The WQOs for metals remain those listed in the AWQG (ANZECC 2000) for the protection of slightly to moderately disturbed aquatic ecosystems for 95% protection of species (**Table 16-4**). These are more stringent than the above WQOs and protect water used for irrigation and stock watering as cited in the Dawson River guidelines.

The application of the EVs and WQOs of the Dawson River guidelines has resulted in several WQOs changing from those available at the time of submission of the EIS. In summary, there has been an increase in the upper range of pH (from 7.5 to 8.5 for riverine waters); the threshold for turbidity (25 to 50 NTU for riverine waters); the threshold for conductivity (from 340 to 370 µS/cm for the Upper Dawson); and the threshold concentrations of total and dissolved nitrogen and phosphorus (**Table 16-2**). The WQOs have also introduced additional indicators including total suspended solids, sulphate, sodium, and other potential contaminants of drinking water supplies (**Table 16-3**).

This chapter assesses the WQOs from the Dawson River Guidelines that apply to indicators of water quality that are obtained from water samples or in-situ monitoring, and include physico-chemical parameters, toxicants, phytoplankton, bacteria and chlorophyll. The Dawson River guidelines also cite macroinvertebrates and fish as biological indicators, both of which require specific sampling methodologies (DEHP 2009). WQOs for indicators of fish and macroinvertebrate include values of community composition and diversity which were addressed in Chapter 13 of the EIS.

Table 16-1 Environmental Values for Dawson River sub-basin waters

Environmental Value	Upper Dawson main channel and southern tributaries	Lower Dawson River main channel (regulated)	Lower Dawson River main channel (unregulated)
Aquatic ecosystems	✓	✓	✓
Primary Recreation	✓	✓	✓
Secondary Recreation	✓	✓	✓
Human Consumer	✓	✓	✓
Drinking Water	✓	✓	✓
Visual recreation	✓	✓	✓
Farm Supply	✓	✓	✓
Irrigation	✓	✓	✓
Cultural heritage	✓	✓	✓
Industrial use	✓	✓	✓
Stock water	✓	✓	✓
Aquaculture	×	✓	×

Source: Dawson River guidelines (DEHP 2011).

Table 16-2 Water Quality Objectives for Dawson River sub-basin waters

Parameter		WQO for Upper Dawson River sub-basin waters	WQO for Lower Dawson River sub-basin waters	WQO for freshwater lakes/reservoirs
Ammonia Nitrogen (µg/L)		<20	<20	<10
Oxidised Nitrogen (µg/L)		<60	<60	<10
Organic Nitrogen (µg/L)		<420	<420	<330
Total Nitrogen (µg/L)		<620	<500	<350
Filterable Reactive Phosphorus (µg/L)		<20	<20	<5
Total Phosphorus (µg/L)		<70	<50	<10
Chlorophyll a (µg/L)		<5.0	<5.0	<5.0
Dissolved oxygen (% saturation)	Lower	85	85	90
	Upper	110	110	110
Turbidity (NTU)		<50	<50	1 - 20
Suspended solids mg/L		<30	<10	nd
pH	Lower	6.5	6 5	6.5
	Upper	8.5	8.5	8.0
Conductivity µS/cm		<370 (baseflow) <210 (high flow)	<340 (baseflow) <210 (high flow)	<250
Sulphate (mg/L)		< 5	< 25	-

Source: Dawson River guidelines (DEHP 2011): protection of moderately disturbed aquatic ecosystems. “nd” indicates insufficient data available, “-“ indicates value not listed in guidelines.

Table 16-3 Water Quality Objectives for the protection of drinking water supply

Indicator	Water Quality Objective
*Giardia**	0 cysts
Cryptosporidium *	0 cysts
Blue-green algae (cyanobacteria) *	< 5,000 cells/mL
Algal toxin	Level 1[1]: > 1 µg/L *Microcystin* * Level 2[2]: >10 µg/L *Microcystin**
Turbidity	Level 1[1]: >500 NTU Level 2[2]: >1000 NTU
Colour*	Level 1[1]: 50 Hazen Units No Level 2
pH	6.5-8.5
Total hardness*	Level 1[1] > 150 mg/L Level2[2] > 200 mg/L
Conductivity	Level 1[1]: > 400 µS/cm $^{-1}$ Level 2[2] same as Level 1 (no treatment options to remove salt)
Sodium*	30 mg/L
Sulphate	200 mg/L
Dissolved oxygen	Level 1[1]: < 4 mg/L at surface No Level 2

Source: Dawson River guidelines (DERM 2011h). *indicates a WQO more stringent than for protection of aquatic ecosystem or one not covered by the aquatic ecosystem environmental value. 1. Level 1 denotes Level 1 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required to ensure water quality and quantity to customers is not compromised. 2. Level 2 denotes Level 2 Hazard and Critical Control Point (HACCP) response rating, namely: treatment-plant-process-change required but water quality and quantity to customers may still be compromised.

Table 16-4 Water quality guidelines for metals for protection of aquatic ecosystems*

Parameter	Units	ANZECC and ARMCANZ (2000) Guideline
Aluminium	µg/L	55 (pH >6.5)
Arsenic (As III)	µg/L	24
Arsenic (As V)	µg/L	13
Boron	µg/L	370
Cadmium	µg/L	0.2
Chromium (CrVI)	µg/L	1.0
Copper	µg/L	1.4
Lead	µg/L	3.4
Manganese	µg/L	1900
Mercury (inorganic)	µg/L	0.6
Nickel	µg/L	11
Selenium (total)	µg/L	11
Silver	µg/L	0.05
Zinc	µg/L	8.0

* Guidelines for the protection of slightly to moderately disturbed aquatic ecosystems for 95% protection of species.

16.2 Application of Dawson River guidelines and data update

Comparison with the Dawson River guidelines was undertaken based on water quality data presented in the section 16.1.4.4 of the EIS, and updated with more recent data for the following sites:

- DNRM monitoring sites upstream and downstream of the proposed dam (**Table 16-5** to **Table 16-12**), presented in order of upstream to downstream, with site locations shown in **Figure 16-1** (excluding Beckers which is 12 km downstream of the Neville Hewitt Weir site);
- SunWater "baseline" monitoring sites upstream and downstream of the proposed dam with metadata for survey dates, sites and water quality parameters sampled (**Table 16-13** and **Table 16-14**), and full data sets (**Appendix B16-A**), with site locations shown in **Figure 16-2** (2007-2008) and **Figure 16-3** (2012); and
- SunWater "regular" monitoring sites for Glebe Weir (**Table 16-15**) and for Gyranda Weir (**Table 16-16**) with site locations that correspond with SunWater baseline survey sites shown in **Figure 16-3**.

The data sets consist of the discrete measurements for a range of indicators from manual water quality sampling. The data sets from DNRM monitoring sites and SunWater "regular" monitoring sites at Glebe Weir and Gyranda Weir are long term; for evaluation against WQOs in accordance with the QWQG (DEHP 2009), physicochemical parameters are expressed as medians and metals (toxins) are expressed as percentiles.

For Glebe Weir, SunWater water quality sampling results are derived from three sites, these include:

- an inflow site for which data only exists as monthly surface data between October 2007 and May 2008;
- a tailwater site (GS 130345A) immediately downstream of the weir, with surface spot data collected quarterly from December 2001 to September 2004, no data for 2005 - 2006, then monthly from September 2007, and;
- a headwater site (GS 130338A) immediately upstream of the weir, with grab or profile data quarterly from September 2001 to September 2004 and monthly data since.

Since publication of the EIS, data has been updated to include data from 2009 to 2013. For Glebe and Gyranda Weirs where vertical profiles of WQ was taken, the surface water value (< 1 m) was used. Data for Glebe Weir was pooled from both sources (defined above) for each site to provide medians, ranges and counts as given in **Table 16-15**.

Appendix D of the QWQG (DEHP 2009) suggest to compare the 95th percentiles from data sets of metals against the WQOs for moderately disturbed ecosystems. The data for concentrations of metals obtained from DNRM water monitoring sites was provided with 90th rather than 95th percentiles, consequently metal concentrations approaching the WQOs have been identified in the tables. For the Dawson River baseline monitoring (Ecowise 2008a,b; frc 2008; ALS 2012, GHD 2012; frc 2013) individual values of water quality parameters were compared against relevant WQOs for moderately disturbed ecosystems with a level of 95% protection.

The updated WQOs and data sets have not resulted in any substantial change to the interpretation of the water quality data presented for these sites in the EIS. WQOs were exceeded particularly for turbidity, nutrient concentrations (total and dissolved nitrogen and phosphorus) and for concentrations of dissolved metals (aluminium, copper and zinc) at water monitoring sites upstream of Glebe Weir for both riverine and weir environments, and this trend was consistent at downstream water quality monitoring sites (**Table 16-5** to **Table 16-16**). The trigger values for metals were not corrected for hardness (applicable to cadmium, chromium, copper, lead, nickel and zinc, ANZECC 2000) which is important where concentrations are close to trigger values. Additionally, metal concentrations provided in the baseline surveys (Ecowise 2008a,b; ALS 2012, GHD 2012; frc 2013) were for total concentrations only, whilst the trigger values apply to dissolved concentrations. However, these factors are not expected to affect interpretation of the results due to the frequent and very high exceedance of trigger values for concentrations of aluminium, copper and zinc, with the exception of the July – August 2012 baseline survey (GHD 2012).

The application of WQOs for drinking water supply derived from Wivenhoe Dam (Section 16.1.2.3 of the EIS) were used in the absence of the Dawson River Guidelines, which are now available and provide local referenced WQOs. The Upper Dawson River sub-basin currently provides water of a suitable standard for all existing and proposed uses. It is highly unlikely that the dam will have a negative impact upon drinking water supply and this is discussed further in **Section 16.8**.

Table 16-5 Water quality at Utopia Downs (130324A, AMTD 453 km) with water quality objectives (Upper Dawson)

Physico-Chemical	Upper Dawson	Median	Min.	Max.	Count	Start	End
Conductivity @ 25°C (uS/cm)	370	289	78	584	144	20/11/1964	13/10/2011
Turbidity (NTU)	50	15.5	1	930	108	24/03/1981	13/10/2011
True Colour (Hazen units)	-	12	0	501	101	8/02/1981	13/10/2011
Water Temperature (°C)	-	22	8	77	135	24/04/1971	13/10/2011
pH	6.5 – 8.5	7.9	7.0	8.5	144	20/11/1964	13/10/2011
Hardness as $CaCO_3$ (mg/L)	-	69.1	20	145	142	20/11/1964	13/10/2011
Total Suspended Solids (mg/L)	30	19	0	2460	128	14/04/1973	13/10/2011
Nitrate as NO_3 (ug/L)	-	500	0	7800	105	20/11/1964	13/10/2011
Total Nitrogen (ug/L)	620	320	100	1637	42	8/10/1998	13/10/2011
Nitrate+Nitrite as N soluble (ug/L)	60	17	2	1600	70	31/08/1994	13/10/2011
Ammonia as N soluble (ug/L)	20	20	3	150	69	31/08/1994	13/10/2011
Dissolved Oxygen (mg/L)	-	7.4	3.5	11.5	63	10/02/1995	13/10/2011
Total Phosphorus as P (ug/L)	70	58.5	3	550	73	31/08/1994	13/10/2011
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	20	11	2	100	69	31/08/1994	13/10/2011
Sodium as Na (mg/L)	-	33	7.5	112	142	20/11/1964	13/10/2011
Sulphate as SO_4 (mg/L)	5	2	0	13	110	20/11/1964	13/10/2011
Chlorophyll-a (ug/L)	5	4	1	20	25	23/09/1994	6/07/1999
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	8700	1600	15000	142	20/11/1964	13/10/2011
Aluminium, dissolved (ug/L)	55	50	0	880	79	3/12/1989	13/10/2011
Arsenic, total (ug/L)	24	-	1.9	2	3	21/04/2010	24/01/2011
Boron, total (ug/L)	370	100	0	200	87	14/04/1973	13/10/2011
Cadmium, total (ug/L)	0.2	-	0.1	0.1	3.0	21/04/2010	24/01/2011
Chromium, total (ug/L)	1	-	1	1	3	21/04/2010	24/01/2011
Copper, dissolved (ug/L)	1.4	50	0	70	81	3/12/1989	13/10/2011
Iron, dissolved (ug/L)	-	160	0	1900	95	11/08/1973	13/10/2011
Lead, total (ug/L)	3.4	-	1.8	2.8	3	21/04/2010	24/01/2011
Manganese, dissolved (ug/L)	1900	30	0	30	75	18/10/1985	13/10/2011
Zinc, dissolved (ug/L)	8	40	0	180	77	3/12/1989	13/10/2011

'**red** value' indicates value exceeds WQO. 'blue value' indicates 90th percentile is approaching trigger value for metals. '-'indicates value not available.

Table 16-6 Water quality at Taroom (130302A, AMTD 385 km) with water quality objectives (Upper Dawson)

Physico-Chemical	Upper Dawson	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	370	266	87	666	156	1/12/1963	11/10/2011
Turbidity (NTU)	50	77	0.7	2790	121	24/07/1981	11/10/2011
True Colour (Hazen units)	-	17	0	150	111	24/07/1981	11/10/2011
Water Temperature (°C)	-	23	9	31	160	3/02/1966	11/10/2011
pH	6.5 – 8.5	7.7	6.5	8.5	156	1/12/1963	11/10/2011
Hardness as $CaCO_3$ (mg/L)	-	67	17	157	155	1/12/1963	11/10/2011
Total Suspended Solids (mg/L)	30	52	2	4900	142	13/04/1973	11/10/2011
Nitrate as NO_3 (ug/L)	-	1000	0	10000	123	13/04/1973	11/10/2011
Total Nitrogen (ug/L)	620	704	181.1	3808	65	20/08/1998	11/10/2011
Nitrate+Nitrite as N soluble (ug/L)	60	90	1.6	1100	70	31/08/1994	11/10/2011
Ammonia as N soluble (ug/L)	20	32	4.3	163	70	31/08/1994	11/10/2011
Dissolved Oxygen (mg/L)	-	5.2	0.9	10.6	86	25/10/1994	11/10/2011
Total Phosphorus as P (ug/L)	70	139	4	1387	88	31/08/1994	11/10/2011
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	20	40	3.1	341	70	31/08/1994	11/10/2011
Sodium as Na (mg/L)	-	30	8	118	156	1/12/1963	11/10/2011
Sulphate as SO_4 (mg/L)	5	2	0	11	131	1/12/1963	11/10/2011
Chlorophyll-a (ug/L)	5	-	2	7	3	25/10/1994	17/07/2001
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	8400	1400	13000	156	1/12/1963	11/10/2011
Aluminium, dissolved (ug/L)	55	217	0	1230	94	15/11/1990	11/10/2011
Arsenic, total (ug/L)	24	-	1.7	1.7	1	25/01/2011	25/01/2011
Boron, total (ug/L)	370	100	0	1000	111	13/04/1973	11/10/2011
Cadmium, total (ug/L)	0.2	-	0.1	0.1	1	25/01/2011	25/01/2011
Chromium, total (ug/L)	1	-	0.9	0.9	1	25/01/2011	25/01/2011
Copper, dissolved (ug/L)	1.4	50	0	50	96	15/11/1990	11/10/2011
Iron, dissolved (ug/L)	-	391	0	4600	120	13/04/1973	11/10/2011
Lead, total (ug/L)	3.4	-	2.7	2.7	1	25/01/2011	25/01/2011
Manganese, dissolved (ug/L)	1900	30	0	1000	93	29/07/1984	11/10/2011
Zinc, dissolved (ug/L)	8	51	0	700	90	3/12/1990	11/10/2011

'**red** value' indicates value exceeds WQO. '-'indicates value not available.

Table 16-7 Water quality at Glebe Weir Headwater (130338A, AMTD 326 km) with water quality objectives (lakes and reservoirs)

Physico-Chemical	Dawson (lakes and reservoirs)	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	250	164	118	340	39	22/01/1982	25/10/2005
Turbidity (NTU)	1 – 20	168	2.2	887	36	22/01/1982	25/10/2005
True Colour (Hazen units)	-	26	7	208	33	25/05/1983	25/10/2005
Water Temperature (°C)	-	25.1	15.7	30.8	30	10/10/1983	4/12/2007
pH	6.5 – 8.0	7.5	6.5	8.3	39	22/01/1982	25/10/2005
Hardness as $CaCO_3$ (mg/L)	-	40	27	84	39	22/01/1982	25/10/2005
Total Suspended Solids (mg/L)	nd	123	0	800	39	22/01/1982	25/10/2005
Nitrate as NO_3 (ug/L)	-	1305	0	4600	38	22/01/1982	25/10/2005
Total Nitrogen (ug/L)	350	964	605	1593	10	9/10/1998	25/10/2005
Nitrate+Nitrite as N soluble (ug/L)	10	105	2	1300	26	26/03/1996	27/02/2001
Ammonia as N soluble (ug/L)	10	35	4	130	26	26/03/1996	27/02/2001
Dissolved Oxygen (mg/L)	-	5.9	3.4	10.0	19	28/03/1995	4/12/2007
Total Phosphorus as P (ug/L)	10	320	7	740	29	28/03/1995	25/10/2005
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	5	89	9	172	26	26/03/1996	27/02/2001
Sodium as Na (mg/L)	-	15	9.8	35	39	22/01/1982	25/10/2005
Sulphate as SO_4 (mg/L)	-	2	1.1	20	34	22/01/1982	25/10/2005
Chlorophyll-a (ug/L)	5	-	8	28	4	7/07/1999	27/02/2001
Metals	**ANZECC**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	4480	1900	7200	39	22/01/1982	25/10/2005
Aluminium, dissolved (ug/L)	55	132	0	330	29	2/08/1991	25/10/2005
Arsenic, total (ug/L)	24	-	-	-	-	-	-
Boron, total (ug/L)	370	100	0	100	36	25/05/1983	25/10/2005
Cadmium, total (ug/L)	0.2	-	0.2	0.2	1	13/04/1999	13/04/1999
Chromium, total (ug/L)	1	-	2	2	1	13/04/1999	13/04/1999
Copper, dissolved (ug/L)	1.4	50	0	50	24	28/03/1995	25/10/2005
Iron, dissolved (ug/L)	-	1900	0	4900	36	25/05/1983	25/10/2005
Lead, total (ug/L)	3.4	-	2	2	1	13/04/1999	13/04/1999
Manganese, dissolved (ug/L)	1900	99	0	160	32	25/05/1983	25/10/2005
Zinc, dissolved (ug/L)	8	95	0	180	26	28/03/1995	25/10/2005

'**red** value' indicates value exceeds WQO. '-'indicates value not available.

Table 16-8 Water quality at Glebe Tail Water (130345, AMTD 326 km) with water quality objectives (Lower Dawson)

Physico-Chemical	Lower Dawson	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	340	190	135	313	36	22/08/1975	9/05/2007
Turbidity (NTU)	50	100	17	1260	24	21/06/1984	9/05/2007
True Colour (Hazen units)	-	30	3	100	19	21/06/1984	9/05/2007
Water Temperature (°C)	-	24.0	10.0	30.0	42	17/08/1982	9/05/2007
pH	6.5 – 8.5	7.6	7	8.2	36	22/08/1975	9/05/2007
Hardness as $CaCO_3$ (mg/L)	-	51	33	79	36	22/08/1975	9/05/2007
Total Suspended Solids (mg/L)	10	91	10	970	36	22/08/1975	9/05/2007
Nitrate as NO_3 (ug/L)	-	1800	500	6500	28	21/06/1984	9/05/2007
Total Nitrogen (ug/L)	500	-	1614	2556	3	8/09/2006	9/05/2007
Nitrate+Nitrite as N soluble (ug/L)	60	-	115	1100	2	3/12/1996	10/06/1997
Ammonia as N soluble (ug/L)	20	-	20	52	2	3/12/1996	10/06/1997
Dissolved Oxygen (mg/L)	-	8.1	5.5	10.0	13	28/03/1995	9/05/2007
Total Phosphorus as P (ug/L)	50	-	110	755	6	3/12/1996	9/05/2007
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	20	-	17	84	2	3/12/1996	10/06/1997
Sodium as Na (mg/L)	-	17.5	10.8	31.4	36	22/08/1975	9/05/2007
Sulphate as SO_4 (mg/L)	25	3	1.0	6	30	21/06/1984	9/05/2007
Chlorophyll-a (ug/L)	5	-	-	-	-	-	-
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	5500	2500	6300	36	22/08/1975	9/05/2007
Aluminium, dissolved (ug/L)	55	585	20	2400	14	5/12/1989	9/05/2007
Arsenic, total (ug/L)	24	-	-	-	-	-	-
Boron, total (ug/L)	370	95	0	160	22	21/06/1984	9/05/2007
Cadmium, total (ug/L)	0.2	-	-	-	-	-	-
Chromium, total (ug/L)	1	-	-	-	-	-	-
Copper, dissolved (ug/L)	1.4	50	10	60	15	5/12/1989	9/05/2007
Iron, dissolved (ug/L)	-	1000	10	2350	28	21/06/1984	9/05/2007
Lead, total (ug/L)	3.4	-	-	-	-	-	-
Manganese, dissolved (ug/L)	1900	21	0	30	10	4/07/1985	9/05/2007
Zinc, dissolved (ug/L)	8	-	0	120	9	5/12/1989	9/05/2007

'**red** value' indicates value exceeds WQO. '-'indicates value not available.

Table 16-9 Water quality at Theodore Weir (130305, AMTD 230 km) with water quality objectives (lakes and reservoirs)

Physico-Chemical	Dawson (lakes and reservoirs)	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	250	216	109.6	450	112	4/12/1963	10/01/2001
Turbidity (NTU)	1 – 20	100	3	912	57	2/01/1985	10/01/2001
True Colour (Hazen units)	-	30	1	147	59	29/04/1983	10/01/2001
Water Temperature (°C)	-	26.1	14.1	32.3	47	13/08/1973	10/01/2001
pH	6.5 – 8.0	7.5	6.7	8.4	118	4/12/1963	10/01/2001
Hardness as $CaCO_3$ (mg/L)	-	59.5	22.7	222.0	110	4/12/1963	10/01/2001
Total Suspended Solids (mg/L)	nd	40	3	970	70	16/04/1973	10/01/2001
Nitrate as NO_3 (ug/L)	-	1405	0	6000	66	7/11/1964	10/01/2001
Total Nitrogen (ug/L)	350	890	458	1058	11	9/12/1998	10/01/2001
Nitrate+Nitrite as N soluble (ug/L)	10	156	0	1385	52	11/08/1994	10/01/2001
Ammonia as N soluble (ug/L)	10	20.85	0	205	52	11/08/1994	10/01/2001
Dissolved Oxygen (mg/L)	-	5.8	0.6	10.5	38	26/10/1994	10/01/2001
Total Phosphorus as P (ug/L)	10	234	36	941	53	11/08/1994	10/01/2001
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	5	71	3	335	52	11/08/1994	10/01/2001
Sodium as Na (mg/L)	-	21	11	56	110	4/12/1963	10/01/2001
Sulphate as SO_4 (mg/L)	-	3	1	36	83	4/12/1963	10/01/2001
Chlorophyll-a (ug/L)	5	14	0	60	26	1/09/1994	2/12/1996
Metals	**ANZECC**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	9540	1700	32000	110	4/12/1963	10/01/2001
Aluminium, dissolved (ug/L)	55	418	0	2320	50	11/08/1994	10/01/2001
Arsenic, total (ug/L)	24	-	-	-	-	-	-
Boron, total (ug/L)	370	100	0	100	59	16/04/1973	10/01/2001
Cadmium, total (ug/L)	0.2	-	0.1	0.1	1.0	13/04/1999	13/04/1999
Chromium, total (ug/L)	1	-	3	3	1	13/04/1999	13/04/1999
Copper, dissolved (ug/L)	1.4	51	0	150	50	11/08/1994	10/01/2001
Iron, dissolved (ug/L)	-	844	0	6000	62	15/12/1970	10/01/2001
Lead, total (ug/L)	3.4	-	3	3	1	13/04/1999	13/04/1999
Manganese, dissolved (ug/L)	1900	20	0	20	53	2/01/1985	10/01/2001
Zinc, dissolved (ug/L)	8	51	0	80	50	11/08/1994	10/01/2001

'**red** value' indicates value exceeds WQO. '-'indicates value not available.

Table 16-10 Water quality at Woodleigh (130317, AMTD 194 km) with water quality objectives (Lower Dawson)

Physico-Chemical	Lower Dawson	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	340	276	68	604	84	15/10/1985	18/11/2009
Turbidity (NTU)	50	89	1	2418	80	15/10/1985	18/11/2009
True Colour (Hazen units)	-	26	1	122	83	15/10/1985	18/11/2009
Water Temperature (°C)	-	25.35	13	33.2	92	15/10/1985	15/09/2010
pH	6.5 – 8.5	7.7	6.9	8.5	84	15/10/1985	18/11/2009
Hardness as $CaCO_3$ (mg/L)	-	67.3	16.5	138.0	84	15/10/1985	18/11/2009
Total Suspended Solids (mg/L)	10	40	0	2103	84	15/10/1985	18/11/2009
Nitrate as NO_3 (ug/L)	-	1100	0	18600	70	15/10/1985	18/11/2009
Total Nitrogen (ug/L)	500	691	130	4738	36	17/11/1998	18/11/2009
Nitrate+Nitrite as N soluble (ug/L)	60	218	0	3596	35	1/12/1994	18/11/2009
Ammonia as N soluble (ug/L)	20	21	0	126	35	1/12/1994	18/11/2009
Dissolved Oxygen (mg/L)	-	6.5	0	11.2	60	27/03/1995	15/09/2010
Total Phosphorus as P (ug/L)	50	245	30.9	1500	58	1/12/1994	18/11/2009
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	20	95	11.8	290	35	1/12/1994	18/11/2009
Sodium as Na (mg/L)	-	26	6	70.5	84	15/10/1985	18/11/2009
Sulphate as SO_4 (mg/L)	25	3.85	0	12.5	84	15/10/1985	18/11/2009
Chlorophyll-a (ug/L)	5	-	0	4	2	20/02/1995	27/11/1995
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	9310	1500	13000	84	15/10/1985	18/11/2009
Aluminium, dissolved (ug/L)	55	140	0	900	64	6/12/1989	18/11/2009
Arsenic, total (ug/L)	24	-	-	-	-	-	-
Boron, total (ug/L)	370	100	0	200	78	15/10/1985	18/11/2009
Cadmium, total (ug/L)	0.2	-	0.1	2.8	4	1/12/1994	20/04/1999
Chromium, total (ug/L)	1	-	0	5	4	1/12/1994	20/04/1999
Copper, dissolved (ug/L)	1.4	50	0	70	67	6/12/1989	18/11/2009
Iron, dissolved (ug/L)	-	195	0	710	76	15/10/1985	18/11/2009
Lead, total (ug/L)	3.4	-	0	10	4	1/12/1994	20/04/1999
Manganese, dissolved (ug/L)	1900	30	0	30	61	15/10/1985	18/11/2009
Zinc, dissolved (ug/L)	8	50	0	110	62	6/12/1989	18/11/2009

'**red** value' indicates value exceeds WQO. '-'indicates value not available.

Table 16-11 Water quality at Neville Hewitt Weir (130304B, AMTD 83 km) with water quality objectives (lakes and reservoirs)

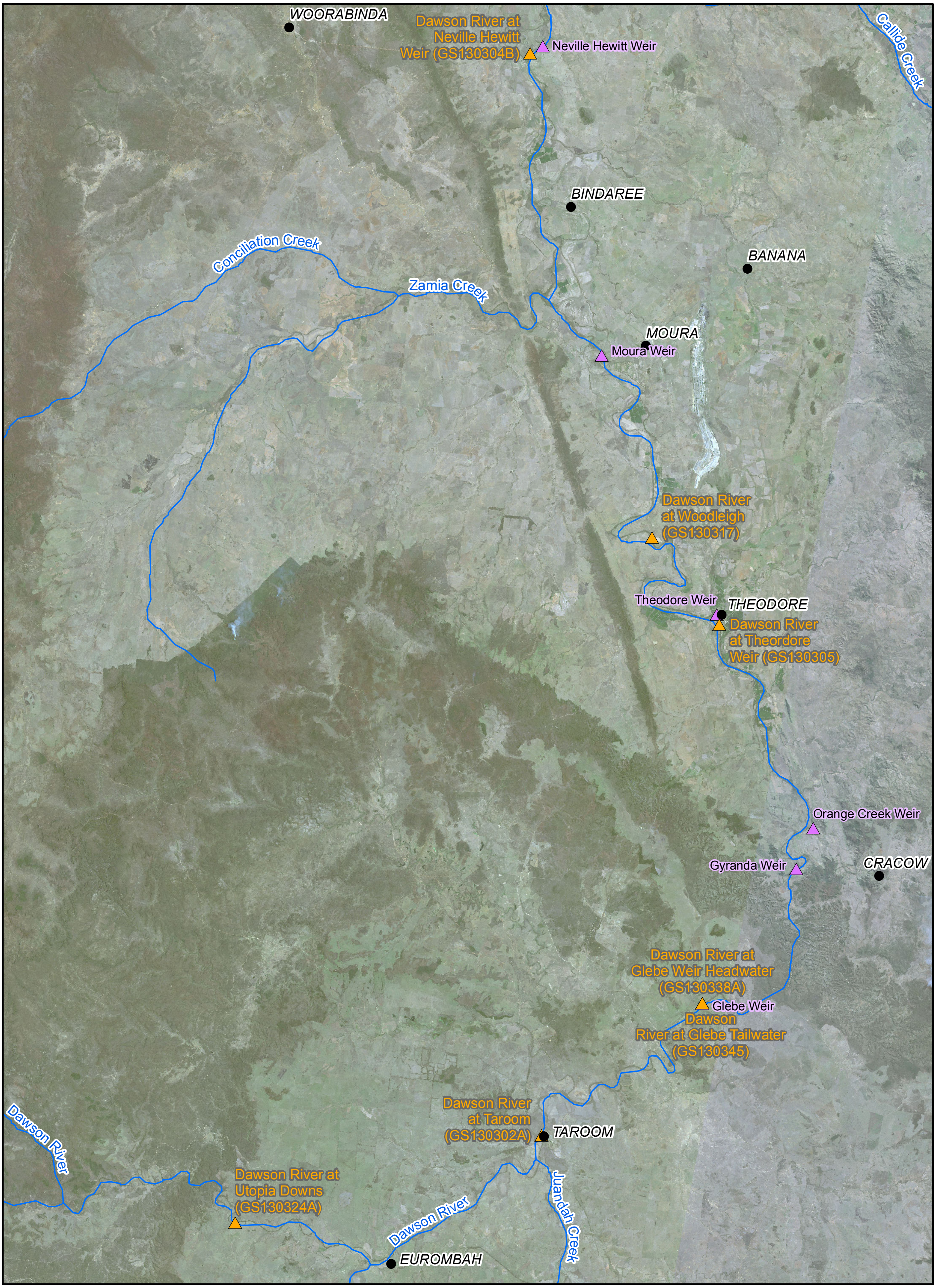
Physico-Chemical	Dawson (lakes and reservoirs)	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	250	122	100	258	60	24/10/1994	8/09/1998
Turbidity (NTU)	1 – 20	630	12	1860	60	24/10/1994	8/09/1998
True Colour (Hazen units)	-	-	5	22	5	24/10/1994	8/09/1998
Water Temperature (°C)	-	26.2	18.1	32.6	19	24/10/1994	26/03/2000
pH	6.5 – 8.0	-	6.9	7.7	5	24/10/1994	8/09/1998
Hardness as $CaCO_3$ (mg/L)	-	34	18	85	60	24/10/1994	8/09/1998
Total Suspended Solids (mg/L)	nd	390	140	1420	59	1/09/1998	8/09/1998
Nitrate as NO_3 (ug/L)	-	-	100	2300	5	24/10/1994	8/09/1998
Total Nitrogen (ug/L)	350	1200	670	1600	11	5/09/1998	26/03/2000
Nitrate+Nitrite as N soluble (ug/L)	10	-	2	270	5	24/10/1994	5/09/1999
Ammonia as N soluble (ug/L)	10	-	7	41	5	24/10/1994	5/09/1999
Dissolved Oxygen (mg/L)	-	6.1	4.9	8.2	18	4/12/1995	26/03/2000
Total Phosphorus as P (ug/L)	10	649.3	42.0	1492.3	26	24/10/1994	26/03/2000
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	5	-	2	190	5	24/10/1994	5/09/1999
Sodium as Na (mg/L)	-	-	11.5	19.6	5	24/10/1994	8/09/1998
Sulphate as SO_4 (mg/L)	-	-	1.3	3.2	5	24/10/1994	8/09/1998
Chlorophyll-a (ug/L)	5	-	14	14	1	24/10/1994	24/10/1994
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	3200	1400	7400	60	24/10/1994	8/09/1998
Aluminium, dissolved (ug/L)	55	-	50	50	4	1/09/1998	8/09/1998
Arsenic, total (ug/L)	24	-	-	-	-	-	-
Boron, total (ug/L)	370	-	100	100	4	1/09/1998	8/09/1998
Cadmium, total (ug/L)	0.2	-	-	-	-	-	-
Chromium, total (ug/L)	1	-	-	-	-	-	-
Copper, dissolved (ug/L)	1.4	-	30	50	5	24/10/1994	8/09/1998
Iron, dissolved (ug/L)	-	-	20	20	4	1/09/1998	8/09/1998
Lead, total (ug/L)	3.4	-	-	-	-	-	-
Manganese, dissolved (ug/L)	1900	-	20	20	4	1/09/1998	8/09/1998
Zinc, dissolved (ug/L)	8	-	10	50	5	24/10/1994	8/09/1998

'-'indicates value not available. '**red** value' indicates value exceeds WQO. 'blue value' indicates 90th percentile is approaching trigger value for metals.

Table 16-12 Water quality at Beckers (130322, AMTD 71 km) with water quality objectives (Lower Dawson)

Physico-Chemical	Lower Dawson	Median	Min.	Max.	Count	Start	End
Conductivity @ 25C (uS/cm)	340	192	70	790	123	26/11/1964	15/07/2009
Turbidity (NTU)	50	100	1	1120	80	1/06/1984	15/07/2009
True Colour (Hazen units)	-	21	2	300	73	1/06/1984	15/07/2009
Water Temperature (°C)	-	26	13	34	105	8/06/1971	14/09/2010
pH	6.5 – 8.5	7.6	6.8	8.2	123	26/11/1964	15/07/2009
Hardness as $CaCO_3$ (mg/L)	-	53	12	142	123	26/11/1964	15/07/2009
Total Suspended Solids (mg/L)	10	50	2	682	96	9/04/1973	15/07/2009
Nitrate as NO_3 (ug/L)	-	1500	0	5500	85	26/11/1964	15/07/2009
Total Nitrogen (ug/L)	500	924	410	1970	26	16/11/1998	15/07/2009
Nitrate+Nitrite as N soluble (ug/L)	60	210	0	4400	58	24/10/1993	15/07/2009
Ammonia as N soluble (ug/L)	20	23	2	580	58	24/10/1993	15/07/2009
Dissolved Oxygen (mg/L)	-	6.8	2.9	12.5	53	9/02/1995	14/09/2010
Total Phosphorus as P (ug/L)	50	240	32	720	61	24/10/1993	15/07/2009
Total Reactive Phosphorus (Ortho P) - soluble (ug/L)	20	64	2	720	58	24/10/1993	15/07/2009
Sodium as Na (mg/L)	-	17	6.9	110	123	26/11/1964	15/07/2009
Sulphate as SO_4 (mg/L)	25	3	1	37	101	26/11/1964	15/07/2009
Chlorophyll-a (ug/L)	5	6	0	130	32	1/09/1994	13/07/1999
Metals	**ANZECC (2000)**	**90^{th} %ile**	**Min.**	**Max.**	**Count**	**Start**	**End**
Magnesium, dissolved (ug/L)	-	6960	1000	15000	123	26/11/1964	15/07/2009
Aluminium, dissolved (ug/L)	55	338	0	1400	65	19/03/1990	15/07/2009
Arsenic, total (ug/L)	24	-	0	0	1	18/11/2002	18/11/2002
Boron, total (ug/L)	370	100	0	200	75	9/04/1973	15/07/2009
Cadmium, total (ug/L)	0.2	-	-	-	-	-	-
Chromium, total (ug/L)	1	-	-	-	-	-	-
Copper, dissolved (ug/L)	1.4	50	0	70	65	19/03/1990	15/07/2009
Iron, dissolved (ug/L)	-	714	0	4200	84	23/11/1969	15/07/2009
Lead, total (ug/L)	3.4	-	-	-	-	-	-
Manganese, dissolved (ug/L)	1900	30	0	90	62	23/08/1984	15/07/2009
Zinc, dissolved (ug/L)	8	50	0	210	61	19/03/1990	15/07/2009

'**red** value' indicates value exceeds WQO. '-'indicates value not available.



LEGEND

- Towns
- DNRM Water Quality Sampling Site
- Weir
- Watercourse

Projection: GDA94 Zone 56

Figure 16-1

0 2.5 5 10
Kilometres

N

Scale 1:750,000 (at A4)

SKM SunWater Making Water Work

NATHAN DAM EIS SUPPLEMENTARY REPORT

DNRM Monitoring Sites

Table 16-13 Survey year, data source and sub-basin water type for the Dawson River baseline survey sites

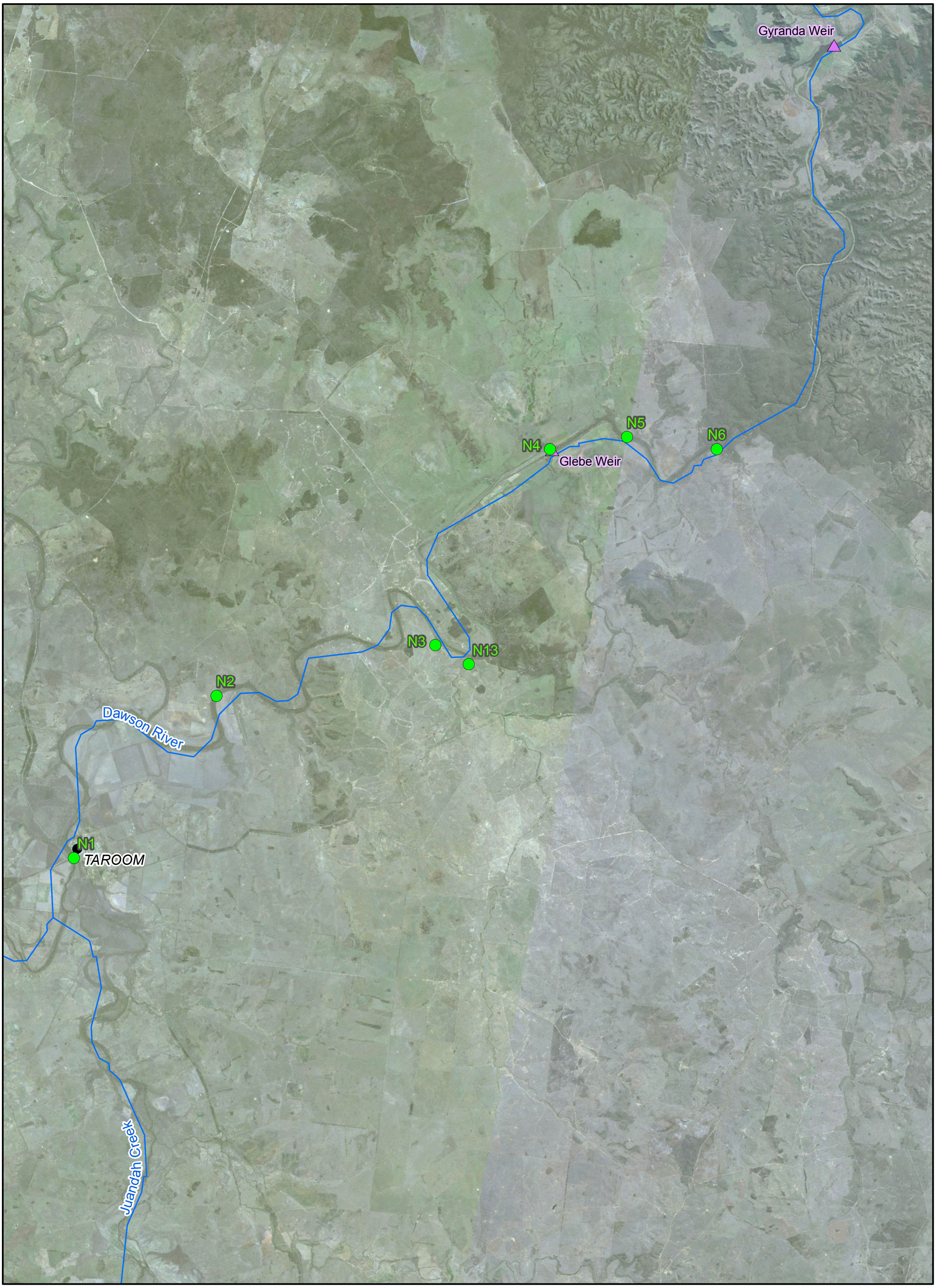
	Dawson River sub-basin water type		
Survey year and data source	Upper Dawson	Lower Dawson	Dawson lakes and reservoirs
2007 (frc 2008)*	N1*	N6	N3 (Glebe Weir)
2008 (Ecowise 2008a, b)	N2*		N4* (Glebe Weir)
	N13		N5 (Glebe Weir)
2012 (ALS 2012), (GHD 2012), (frc 2013)	WS02	WS06	WS05 (Glebe Weir)
	WS03	WS08	WS07 (Gyranda Weir)
	WS04	WS10	WS09 (Theodore Weir)

Sites from 2007/2008 and 2012 surveys with the same location are N1 and WS03, N2 and WSO4, N5 and WS05, N6 and WS06 (Ecowise 2008a,b; ALS 2012, GHD 2012; frc 2013). *indicatates sites surveyed in 2007 by frc (2008).

Table 16-14 Water quality parameters sampled for the Dawson River baseline surveys

	2007		2008		2012		
Parameter	Nov Base flow	Dec High flow	Jun Base flow	Oct Base flow	Feb High flow	Jul-Aug Base flow	Nov Base flow
water temperature (ºC)	✓	✓	✓	✓	✓	✓	✓
pH	✓	✓	✓	✓	✓	✓	✓
dissolved oxygen (mg/L and % saturation)	✓	×	✓	✓	✓	✓	✓
electrical conductivity (µS/cm)	✓	✓	✓	✓	✓	✓	✓
turbidity (NTU)	✓	✓	✓	✓	✓	✓	✓
Total Suspended Solids (mg/L)	×	×	✓	✓	✓	✓	✓
salinity (mg/L)	×	×	✓	✓	✓	✓	✓
Total Hardness (mg/L)	×	×	✓	✓	✓	✓	✓
alkalinity (CaCO3; mg/L)	×	×	✓	✓	✓	✓	✓
Total Nitrogen plus NO2; NO3; NH3+ (mg/L)	×	×	✓	✓	✓	✓	✓
Total Phosphorus and Reactive Phosphorus (mg/L)	×	×	✓	✓	✓	✓	✓
major cations and anions (mg/L)	×	×	×	×	✓	✓	✓
sulphate(mg/L)	×	×	×	×	✓	✓	✓
Phenoxy Acid Herbicides (µg/L)	×	×	✓	✓	✓	✓	✓
glyphosate &AMPA (µg/L)	×	×	✓	✓	✓	✓	✓
organo-chlorine (and organo-phosphorus pesticides (µg /L)	×	×	✓	✓	✓	✓	✓
faecal coliforms (MPN)	×	×	✓	✓	✓	✓	✓
Total Metal full scan (µg /L, mg/L)	×	×	✓	✓	✓	✓	✓
Mercury µg /L	×	×	✓	✓	✓	✓	✓
total petroleum hydrocarbons	×	×	×	×	×	×	✓

Data sources as follows. 2007: frc (2008) 2008. June and October, Ecowise (2008a,b). 2012: February ALS (2012); July-August GHD (2012); November frc (2013).



LEGEND

- Towns
- Monitoring Site - SunWater
- Weir
- Watercourse

Projection: GDA94 Zone 56

Figure 16-2

0 1 2 4
Kilometres

N

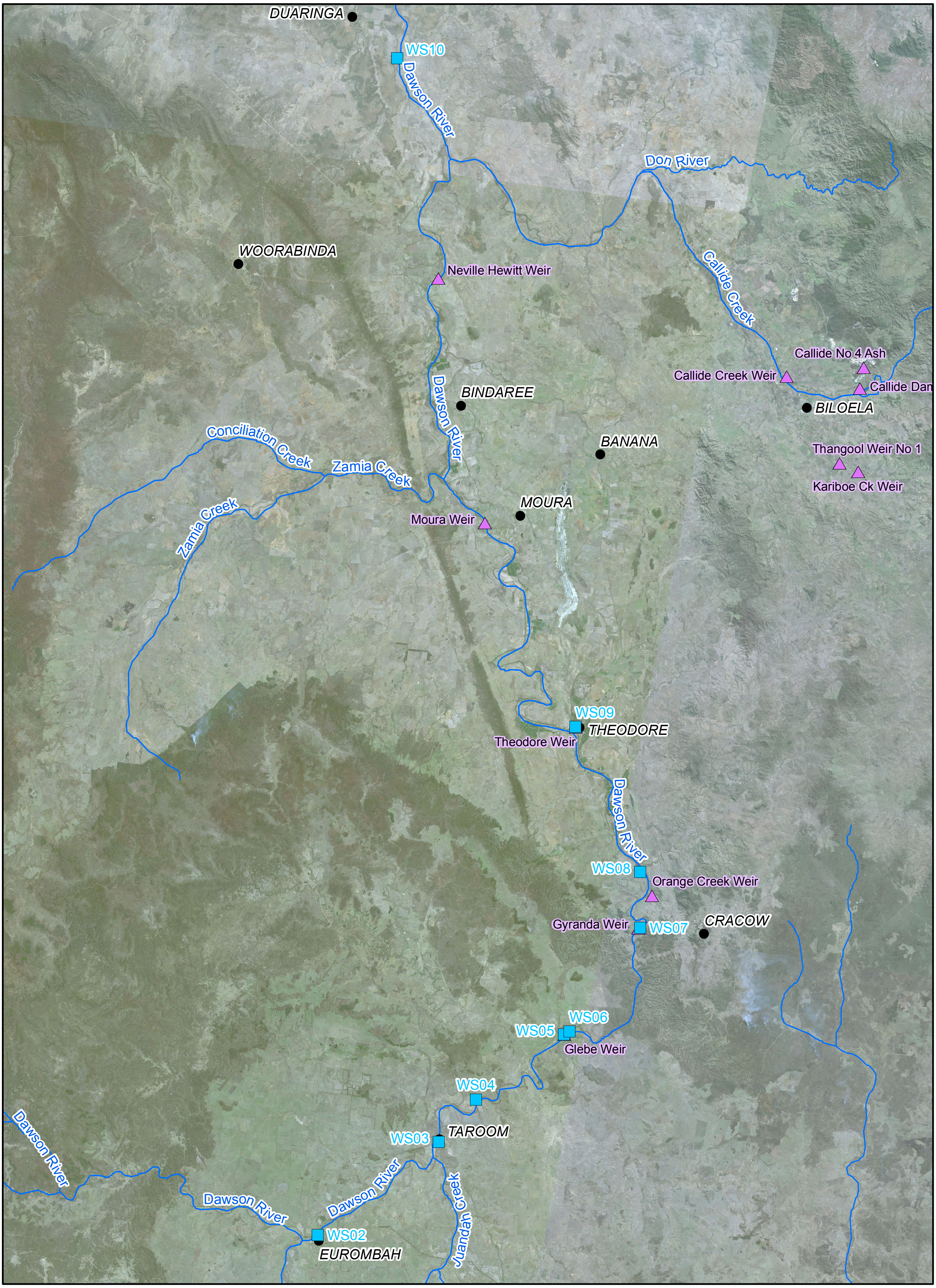
Scale 1:250,000 (at A4)

SKM SunWater Making Water Work

ADDITIONAL INFORMATION TO THE NATHAN DAM EIS

SunWater Monitoring Sites - 2007/2008

Path: I:\QENV2\Projects\QE06601\QE06601.280 Spatial\ArcGIS\Figures\Final\Additional Information to the Nathan Dam EIS\160415_Figure_16-2_Marine_SunWater2007_2008MonitoringSites.mxd Produced: 15/04/2016



LEGEND

- Towns
- Monitoring Site - SunWater
- Weir
- Watercourse

Projection: GDA94 Zone 56

Figure 16-3

0 5 10 20
Kilometres

Scale 1:950,000 (at A4)

N

SKM SunWater Making Water Work

ADDITIONAL INFORMATION TO THE NATHAN DAM EIS

SunWater Monitoring Sites - 2012

Path: I:\QENV2\Projects\QE06601\QE06601.280 Spatial\ArcGIS\Figures\Final\Additional Information to the Nathan Dam EIS\160415_Figure_16-3_Marine_SunWater2012MonitoringSites.mxd Produced: 15/04/2016

Table 16-15 Summary of SunWater "regular" water quality data and WQOs for Glebe Weir, inflow and outflow

Parameter	Dawson (lakes and reservoirs)	Inflow ("baseline" Site WS04)				Glebe Weir ("baseline" Site WS05)				Lower Dawson	Outflow ("baseline" Site WS06)			
		Median	*Minimum*	*Maximum*	*Count*	*Median*	*Minimum*	*Maximum*	*Count*		*Median*	*Minimum*	*Maximum*	*Count*
pH	6.5 – 8.0	7.8	7.1	8.6	37	7.8	7	9.1	79	6.5 – 8.5	7.7	6.9	8.6	52
Conductivity (µS/cm)	250	309	0	739	41	221.5	0	738	80	340	221.5	0	728	56
Dissolved Oxygen (mg/L)	-	6.35	0	10.6	38	6.05	0.85	19.1	77	-	7.8	1.1	19.7	49
Water Temperature (°C)	-	24	11.7	30.2	37	24	12	31	79	-	24.85	11	29.8	52
Total Nitrogen (µg/L)	350	655	300	1680	34	1000	300	4200	77	500	900	360	2830	51
Total Phosphorus (µg/L)	10	125.5	0	418	34	267.5	32	930	76	50	210	38	507	50
Turbidity (NTU)	1 – 20	292	38	745	5	447	80	1400	45	50	507	44	1293	14
Suspended Solids (mg/L)	nd	-	-	-	-	285.5	3	1400	12	10	291.5	72	700	10
Chlorophyll-a (µg/L)	5	-	-	-	-	2	0	24	9	5	1	0	6	9
Sulphide (mg/L)	-	-	-	-	-	-	-	-	-	-	0.02	0.01	0.13	34

'red value' indicates value exceeds WQO. '-' indicates no value or data available

Table 16-16 Summary of SunWater "regular" water quality and WQOs for Gyranda Weir, inflow and outflow

Parameter	Dawson (lakes and reservoirs)	Inflow				Gyranda Weir ("baseline" site WS07)				Lower Dawson	Outflow			
		Median	*Minimum*	*Maximum*	*Count*	*Median*	*Minimum*	*Maximum*	*Count*		*Median*	*Minimum*	*Maximum*	*Count*
pH	6.5 – 8.0	7.7	6.9	8.3	31	7.6	6.8	8.4	36	6.5 – 8.5	7.65	7.1	8.7	34
Conductivity (µS/cm)	250	235	0	580	35	234.5	0	577	40	340	222	0	603	38
Dissolved Oxygen (mg/L)	-	7.6	2.8	13.3	31	5.85	0.25	10.6	36	-	7.75	4.5	16	34
Water Temperature (°C)	-	26.7	16.7	33.6	31	25.75	13.4	31.9	36	-	26.05	15	33.5	34
Total Nitrogen (µg/L)	350	700	340	2030	31	755	440	1300	36	500	735	370	1900	34
Total Phosphorus (µg/L)	10	166	23	482	30	177	27	485	35	50	210	39	491	33
Turbidity (NTU)	1 – 20	-	-	-	-	-	-	-	-	50	-	-	-	-
Suspended Solids (mg/L)	nd	-	-	-	-	-	-	-	-	10	-	-	-	-
Chlorophyll-a (µg/L)	5	-	-	-	-	-	-	-	-	5	0.02	0.01	0.12	34
Sulphide (mg/L)	-	7.7	6.9	8.3	31	7.6	6.8	8.4	36	-	7.65	7.1	8.7	34

'red value' indicates value exceeds WQO. '-' indicates no value or data available.

16.3 Condition assessment and spatial and temporal representation

The water quality data listed in Table 16-7 of the EIS have been updated in response to a submission requesting that more extensive water quality data should be incorporated to evaluate spatial and temporal variation. The update includes the addition of the data sets shown above.

An assessment of available time series “AT” data in the Stream Gauging Station Index (DNRM 2012) was also completed. Long term records with a sampling frequency suitable for time series of water quality and quantity for sites were identified for Taroom, upstream of the proposed dam, and for Woodleigh, downstream of the proposed dam, from the DNRM water monitoring data portal (DNRM 2013a) and consisted of electrical conductivity (EC) and discharge. Other water quality variables of interest, including turbidity were not available as time series data. The available data for turbidity is from manual sampling and is too infrequent for assessment of temporal trends. For example Taroom has 121 manual turbidity samples taken over a 30 year period with a range of 0.7 to 2790 NTU (**Table 16-6**); whilst Woodleigh has 80 samples over 24 years (**Table 16-10**). Summaries of water quality data including times series for these sites are provided in **Appendix B16-B**.

Medians of the time series data EC have been compared with the WQOs from the Dawson River guidelines. Values for Taroom (306.2 µS/cm) and Woodleigh (311.1 µS/cm) were below the WQOs for low flows (<370 µS/cm and < 340 µS/cm, respectively).

For evaluation of the time series, EC and streamflow (m^3/s + 1 to allow for the logarithmic scale) were extracted as daily means; the time series of EC and discharge, and the correlations of EC against discharge (Log_{10} transformed) are presented in **Figure 16-4** and **Figure 16-5** for Taroom and Woodleigh monitoring sites, respectively. Temporal patterns and correlations of EC with discharge were similar at both gauging stations. The time series shows that mean daily ECs have tended to have higher maximum values more recently (2010 onwards), with the highest values occurring during dry season baseflows. Correlations between EC and discharge show that EC was consistently below 500 µS/cm at flows exceeding ~100 m^3/s, and EC is much more variable at lower flows. The high flow and low flow demarcations for EC WQOs were defined using flow duration curves for Taroom and Woodleigh (DNRM 2013a) with high flows considered to be discharges exceeded 10% of the time (Taroom > 8 m^3/s, Woodleigh > 14 m^3/s), in accordance with the QWQG (DEHP 2009). Exceedances of WQOs frequently occur at both monitoring sites for both high and low flow periods, although the proportion of samples exceeding WQOs is substantially higher for Woodleigh during high flow periods (**Table 16-17**). Time series monitoring of EC at Woodleigh, which commenced in 2003 compared to Taroom in 1993, has coincided with the trend of increasing EC at both monitoring sites. From examination of the same sampling period for both sites (2003 – 2012), the higher percentage of WQO exceedances for high flows at Woodleigh indicates a trend of higher EC in waters downstream of the proposed dam during high flow events, however this pattern is not apparent during low flow periods. Interactions between EC and discharge are complex (Harvey and Jones 2003) and there are a range of potential causes for higher EC values including increased catchment salt mobilisation, increased evaporation, increased inputs of high EC waters due to land use activities including mining activities, and saline groundwater inflows particularly during periods of low flow.

Despite the occurrence of a possible temporal trend, the median values of EC recorded at monitoring sites upstream of the proposed dam comply with the Dawson River guidelines for all existing and proposed uses, and are substantially below the WQO's for protection of aquatic ecosystems (**Table 16-5** to **Table 16-8**). The land use upstream of the proposed dam is agricultural based and dominated by cattle grazing; it does not include operating mines (Geoscience Australia 2012). Given that the Dawson River catchment salinity zone is classified as moderate and is not considered variable (DEHP 2009), the risks associated with high EC levels for waters in Upper Dawson are very low and are not likely to be a significant issue of the area.

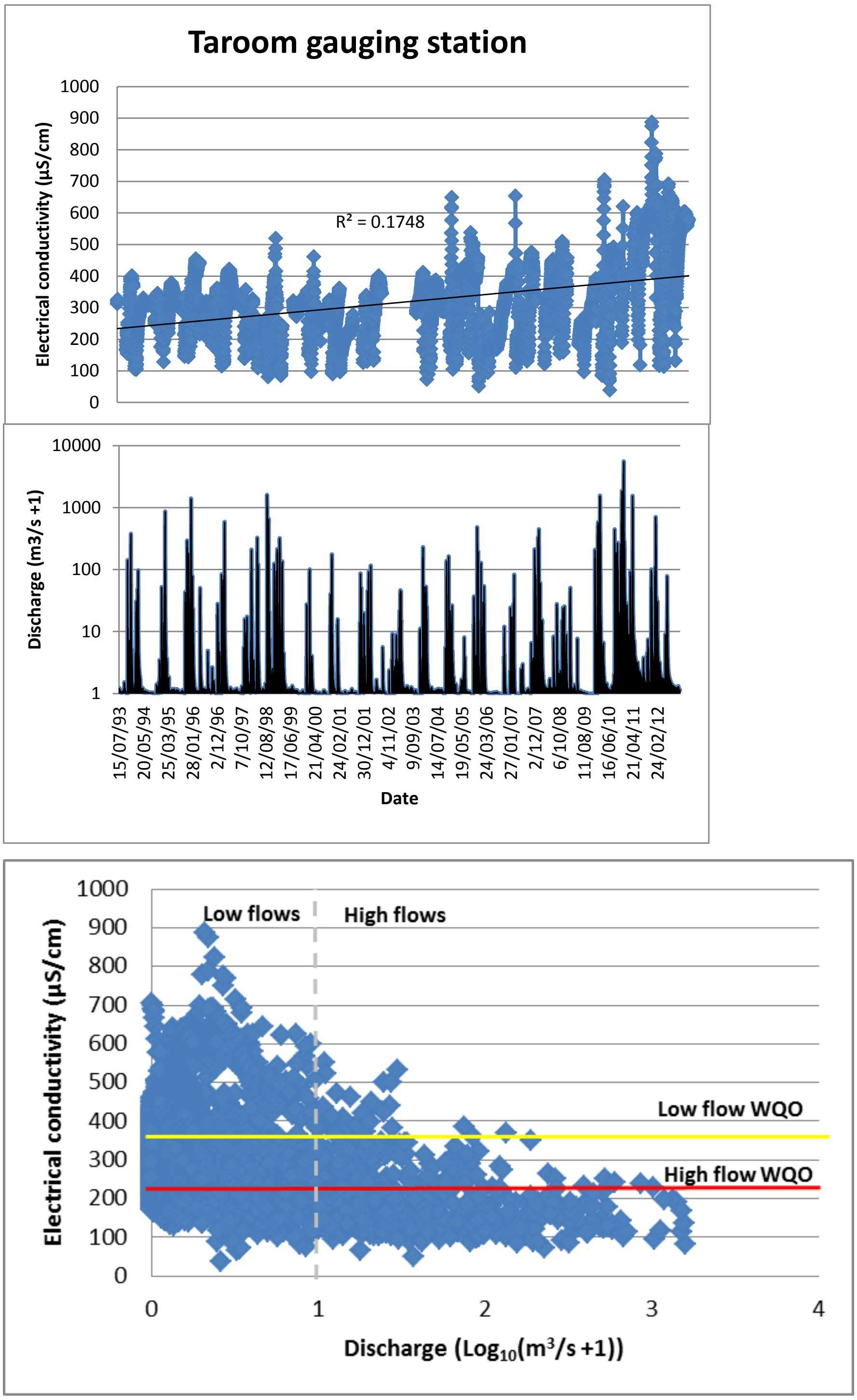


Figure 16-4 Time series and correlation of electrical conductivity and streamflow at Taroom

Data extracted from Queensland Government water monitoring data portal (https://water-monitoring.information.qld.gov.au/host.htm).

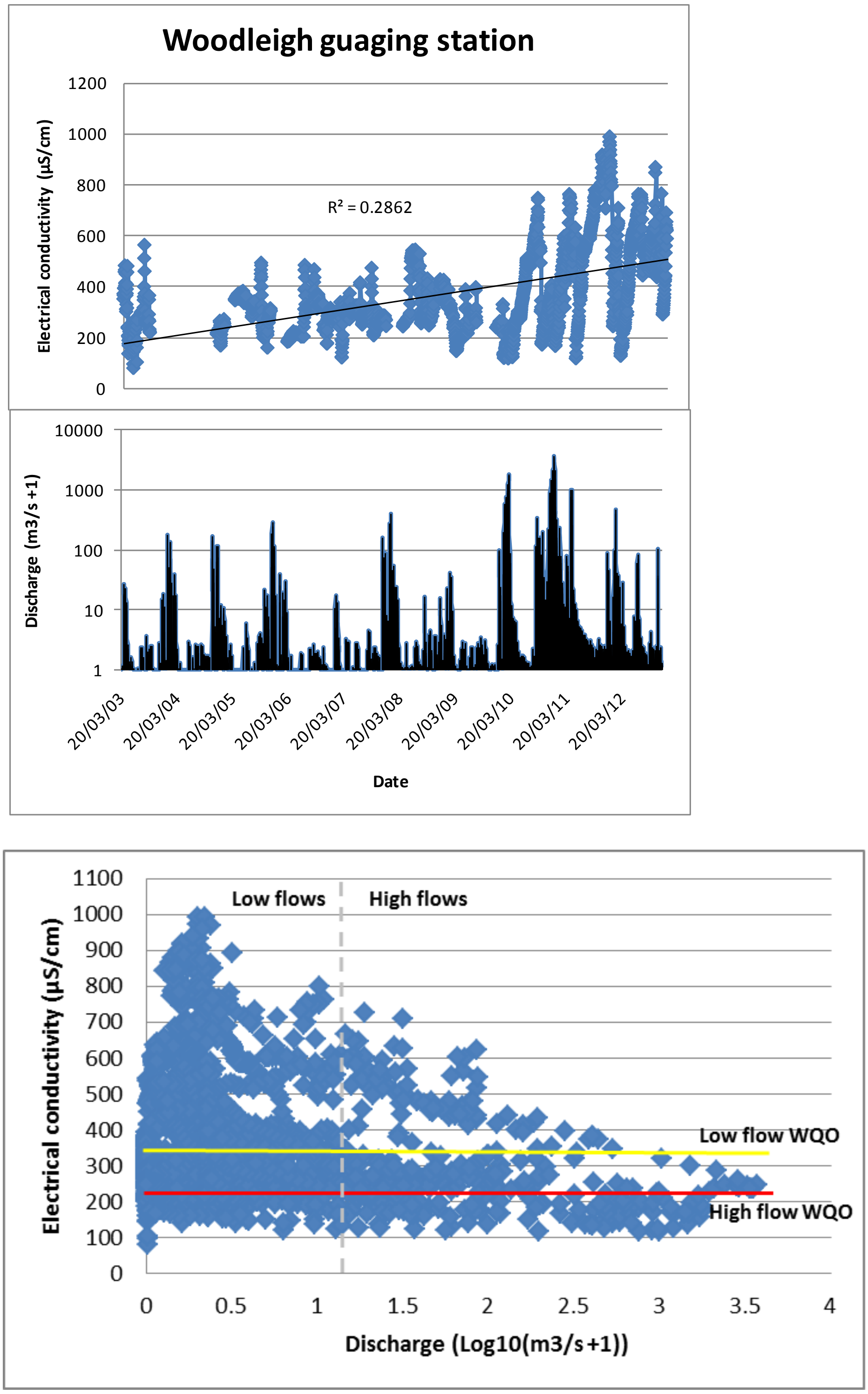


Figure 16-5 Time series and correlation of electrical conductivity and streamflow at Woodleigh

Data extracted from Queensland Government water monitoring data portal (https://water-monitoring.information.qld.gov.au/host.htm).

Table 16-17 EC in relation to low and high flow demarcations and WQO for Taroom and Woodleigh water monitoring sites

Monitoring site	Flow	WQO EC µS/cm	Number of samples	Percentage of samples within WQO	Sample period
Taroom	Low	370	5024	72.1%	16/07/1993 - 12/11/2012
	High	210	549	66.8%	16/07/1993 - 12/11/2012
Taroom	Low	370	2492	53.0%	23/03/2003 - 12/11/2012
	High	210	276	55.4%	23/03/2003 - 12/11/2012
Woodleigh	Low	340	2229	58.3%	23/03/2003 - 09/12/2012
	High	210	464	22.8%	23/03/2003 - 09/12/2012

Data sourced from DNRM (2013a). High flows considered to be discharges exceeded 10% of the time (Taroom > 8 m^3/s, Woodleigh > 14 m^3/s).

The DNRM monitoring sites provide an evaluation of spatial variation of water quality from long term data sets at sites located upstream, within, and downstream of the proposed dam (**Table 16-5** to **Table 16-12**). The results show consistently high concentrations of nitrogen and phosphorus and high turbidity at all sites with the exception of the most upstream monitoring site (Utopia Downs, approximately 120 km upstream of the proposed dam), and indicates less land use impacts on the Dawson River higher up in the catchment. There were no spatial trends evident of other water quality parameters from the data set including EC.

Baseline surveys of the Dawson River were conducted in 2008 during post wet and pre-wet baseflows (Ecowise 2008a,b), in 2012 during high flows (ALS 2012) and during post wet and pre-wet season baseflows (GHD 2012; frc 2013, respectively). Physicochemistry only, was monitored in 2007 just before and during a high flow event (frc 2008). The presence of metal contaminants, particularly aluminium (sampled during 2008 only), copper and zinc, exceeded trigger values at riverine and weir sites upstream and downstream during all survey events for 2008 and 2012 (**Appendix B16-A**). However despite differences in concentrations between sites there was no spatial pattern evident relating to metal contaminant concentrations. Turbidity tended to increase and exceed WQOs at sites within and downstream of Glebe Weir during baseflow conditions in 2012. There was no spatial trend for total suspended solids (TSS), EC or for dissolved oxygen (DO) concentrations which were generally below WQOs at all sites.

Seasonal variation was evident when comparing the high flow and baseflow surveys during 2007 and 2012. Exceedances of EC were more prevalent late in the dry season possibly due to evaporation and ground water discharge, and turbidity tended to increase following the onset of high flow conditions. During 2012 the number of sites with exceedances of chromium, copper and zinc concentrations was substantially lower during the pre-wet (late dry) season compared to the wet season with higher flow conditions. Conversely, cadmium exceedances occurred at all sites for the pre-wet season and were below trigger values for the wet season and post-wet season. As stated in the EIS (Section 16.1), there were no detectable concentrations of herbicides or pesticides during the 2008 surveys and there were none detected during the 2012 surveys (**Appendix B16-A**).

A comparison of Glebe Weir with Gyranda Weir, located approximately 45 km downstream (**Table 16-15** and **Table 16-16**), shows EC values are higher upstream, as are total nitrogen (TN) and total phosphorus (TP) concentrations, with the exception of inflow sites where nutrient concentrations were higher at Gyranda Weir.

These differences may relate to variation of physical, chemical and biological conditions between the storages and their upstream catchments.

16.4 Dewatering and the influence of springs on water quality

A submission requested an assessment of the current influence of springs on water quality and the likely effect of dewatering on water quality. The influence of springs on water quality was discussed within Section 15.1.3.9 of the EIS. Potential issues, risk and mitigation strategies associated with dewatering during construction were assessed in Section 15.2.3 of the EIS. The Dawson River downstream of the proposed dam wall is considered to be a gaining stream (groundwater discharges to the river) and naturally receives inputs directly from groundwater as well as discharge from springs (Section 15.2.3 of the EIS). The springs potentially affected by dewatering are classified as recharge and are fed from the Precipice Sandstone aquifers (Table 15.8 of the EIS). While highly variable, water quality from the Precipice Sandstone in the area where dewatering is to take place is typically fresh and neutral pH, with a mean electrical conductivity (EC) of 359 $\mu S\ cm^{-1}$ and mean pH of 7.5 (Section 15.1.3.9 of the EIS). It is possible that groundwater inputs from the Precipice Sandstone aquifers influenced the moderate increase in EC (152 – 230 $\mu S\ cm^{-1}$) during the dry season as observed at the site downstream of the proposed dam wall (site N6, refer to Tables 16.12, 16.13 and Figure 16.1 of the EIS).

The majority of springs both upstream and downstream of the dam are unaffected by the short term dewatering program which occurs over a period of 50 days (Figure 15-8 of the EIS), and of those impacted, they are affected by a drawdown of <20 cm (Figure 15-7 of the EIS). The potential decrease of discharge from affected springs is localised and represents a minor contribution to river baseflows. The groundwater modelling and risk assessment concluded that there would be no impact on baseflow of streams from the dewatering and lowering of the water level in the springs over the 50 day period (Section 15.2.3 and Table 15-11 of the EIS), and as such it is not expected that the dewatering process will alter riverine water quality.

It is anticipated that dewatering bores will be located around the excavation with some drilled into the Alluvium and others drilled deeper into the underlying Precipice Sandstone (Section 15.2.3 of the EIS). While water quality may not be significantly different from river water, in recognition of any potential differences, particularly related to salinity, metals, TSS, turbidity and dissolved nutrients, it is planned to store the water temporarily in sedimentation ponds. These ponds are also used to capture site runoff. Water in the ponds will then be re-used, as was noted in Section 15.2.3 of the EIS. Re-use purposes may include on-site dust suppression, conditioning of earthfill (to the appropriate moisture content), watering of rehabilitation areas, concrete batching, or as grey water for use in on-site facilities.

Section 15.2.3 of the EIS also suggested that the water in the ponds may be disposed of back to the river under a water management plan or used to water any spring vegetation showing signs of desiccation as a result of dewatering. This process would continue until groundwater levels in the area recover following cessation of dewatering. The water would be analysed to ensure it was fit-for-purpose for any use under the water management plan. In the unlikely event that the water quality of the water obtained from dewatering was significantly poorer than that captured in site runoff it could be stored separately and watering of spring vegetation, if required, could utilise the water captured in site runoff.

Wetlands affected as part of the dewatering process are not part of the EPBC listed community of GAB springs according to the Recovery Plan and Queensland Springs Database, and Fensham *et al.* (2012).

16.5 Water quality and flow scenarios during construction, filling and operation phases

Two submissions requested clarification of water quality variation and risk management for flows under varying scenarios including extended dry periods during construction and operation of the dam. The EIS specifically raised and discussed impacts in the context of flow scenarios associated with downstream water quality during construction (Section 16.2.1.1), water quality within the dam during the initial filling stage (Section 16.2.1.2.), water quality within the dam (16.2.1.3) and downstream water quality (Section 16.2.1.6).

The assessment of water quality variation within the dam and surrounds and the downstream receiving environment during construction of the dam will be detailed in the Project Water Quality Monitoring Plan (PWQMP) as described in the draft Environmental Management Plan (EMP) (**Appendix B29**). Key water quality parameters will be assessed against the WQOs from the Dawson River guidelines. The PWQMP may refer to other local guidelines relevant to the Dawson sub-basin, including the Model for Water Condition for Coal Mines in the Fitzroy Basin (DEHP 2013) and the Streamlined Model Conditions for Petroleum Activities (DEHP 2014), and identify other water quality indicators from these documents for assessment of potential risk of contamination due to land use activities including coal mine and coal seam gas activities.

16.5.1 Quality of water during construction and initial filling phase

Section 16.2.1.2 of the EIS considered potential water quality impacts during filling including nutrient loading and increased nutrient concentrations, low dissolved oxygen concentrations, and increased turbidity and organic matter. The following consideration is provided to address potential risk of water quality decline for the initial filling of the proposed dam occurring during extended dry periods.

During construction of the dam and specifically during periods of extended low flow it is anticipated that water quality will not differ significantly from those under current conditions. Under these circumstances, the dam can be considered an enlargement of the existing Glebe Weir. As such it is anticipated that elevated turbidity and associated concentrations of suspended solids will decline, particulate nutrient concentrations will also likely decline and there may be some minor thermal and oxygen stratification depending on depth.

Modelling for the time to fill analysis was beyond worst case because it assumed demands on the storage were fully active from the first day of simulation whereas in reality this will not occur. This also meant that downstream users were supplied and key environmental flow criteria were met such that the filling dam did not simply represent a plug in the system. The modelling showed that in a median probability scenario the dam would reach minimum operating volume in about 44 days while in a 90th percentile scenario (a dry period) it would reach that level in just over 1 year. The possibility of the dam becoming operational during a dry period with very low inflows (EIS Section 14.2.2.5) would result in a 50% probability of worst case scenarios occurring, with periods of between 44 days and two years required for the storage to reach the minimum operating volume (MOV), and one to five years required to trigger the first post winter flow (FPWF) and seasonal baseflow (SBF) releases. During extended dry periods water quality would be expected to deteriorate for a range parameters and would likely include higher EC from evaporation and groundwater inputs, low dissolved oxygen concentrations, and increased potential for algal blooms. This deterioration in water quality, however, would also be expected to occur in the existing environment of the Dawson River including Glebe Weir during extreme dry periods. During a slow fill scenario, the ponded area within the dam will be small and the functioning of much of the river and adjoining watercourses will remain. During the onset of storms and first flush events, which are characterised by high suspended sediment loads and nutrient concentrations, the dam will capture and store the water. It is likely that water quality condition will improve due to sedimentation of suspended solids prior to its release.

When the dam is first filling it will need to reach certain specified minimum levels (set by SunWater) before SunWater can start pipeline releases, downstream order releases or environmental releases (including operation of the fishway). In the unlikely event that these storage levels are not met for an extended period of time, the first release strategy, designed specifically to minimise water quality impacts downstream as detailed in the EIS, will be implemented (Section 16.2.1.2 of the EIS). During the filling stage of the dam, potential impacts on the quantity and quality of water in the downstream environment are possible. Management of these risks is to be addressed with the implementation of the transitional operational strategy to maintain water quantity for downstream users and key environmental flows (Section 14.2.2.5 of the EIS), and the PWQMP which aims to maintain water quality for downstream environmental values and users (**Section 9.8** of the draft EMP in **Appendix B29**).

16.5.2 Quality of water within the water storage area during normal operations

Possible sources of nutrients during operation will primarily occur from land use practices within the upstream catchments and naturally occurring sedimentation (Section 16.2.1.3 of the EIS). The fact that SunWater aims to use parts of the catchment for rehabilitation and 'environmental offsets' (with limited grazing and significant reforestation) it is anticipated that the sediment and nutrient runoff rate to the dam during normal operations will be higher pre-construction than will occur post-construction (Section 16.2.1.3 of the EIS).

Large water storages promote sedimentation which can reduce turbidity and concentrations of total suspended solids and particulate forms of nutrients and metals (Bonneville, Collett *et al.* 2012). In addition to water storage processes, the multi-level offtake provides a mechanism for selective delivery of water which can promote a potentially higher quality of water to the receiving environment than the water quality of the inflows to the water storage.

Dry periods will result in low streamflows into the dam and could potentially affect water quality. The potential impacts of the dam on downstream environmental values during extended dry periods are expected to differ from the existing conditions. During dry periods the greater storing capacity of the dam compared to the existing storage capacity of Glebe Weir will provide increased low flow duration (Section 14.2.2.2 of the EIS) due to the low flow release strategies adopted. These low flow releases will contribute to maintaining water quality in the downstream environments during dry periods, and the provision of flows are likely to reduce occurrences of low dissolved oxygen concentrations and increases in EC that often occur within standing water. Management of potential risks relating to downstream water quality is to be addressed with the implementation of the preliminary and final operational strategies to maintain water quantity for downstream users and key environmental flows (Section 14.2.2 of the EIS), and the PWQMP which aims to maintain water quality for downstream environmental values and users (Section 29.10.6 of the EIS). The legal obligations for monitoring are included within SunWaters Resource Operations Licence and operations manuals.

As stated in Section 2.3.1.7 of the EIS, featured in the design of the dam will be a multi-level offtake. The selective withdrawal system, providing for both downstream and pipeline releases, consists of a series of baulks which can be removed to allow water to flow from the required level. Multi-level offtakes enable flexibility when water quality differs vertically through the water column as may occur under normal conditions, when the dam is stratified or in the short term after an inflow or turn-over event. As discussed in Section 16.2.1.6 of the EIS, use of this multi-level offtake system will allow dam operators to avoid accessing water of 'poor quality' for downstream users and environmental flows, ensuring that the best quality water is released through the outlet works. These are standard operating procedures for large water impoundments. The current system has no such flexibility with respect to management actions. As outlined in Section 2.6.1.2 and Section 14.1.1 of the EIS, all release's made from the dam must be made in accordance with requirements specified in the Fitzroy Basin ROP (2014) and the Resource Operations Licence (ROL).

16.6 Water quality variation for flow scenarios and land use developments

The quantification of effects of other existing and proposed projects and land use activities on the environmental values and water quality of the water storage was raised in a submission in response to the EIS. There are no operating mines upstream of the proposed dam (Geoscience Australia 2012). There are four operating mines in the Lower Dawson including the Dawson North, Dawson Central and Dawson South mines (Anglo American Australia) between Theodore and Moura, and Baralaba Central Mine (Cockatoo Coal) at Baralaba (Geoscience Australia 2012). In terms of discharge and cumulative impacts the mines in the Dawson River sub-catchment rated as very low risk, whilst high risk and medium risk mines were located in the northern sub-catchments of the Fitzroy Basin, where background EC levels are higher (DERM 2009e). Given that upstream of the proposed dam operating mines are absent, agricultural land use is dominated by cattle grazing and that the Dawson River catchment salinity zone is classified as moderate (DEHP 2009) the risks associated with salinity and high EC levels in the Upper Dawson are very low and are not a significant issue of the area.

In the Upper Dawson proposed mining projects have either had their Coordinated Project declarations cancelled (Taroom Open-Cut coal mine, Collingwood coal mine, both Cockatoo Coal), or are on hold (Wandoan coal mine, Glencore). Proposed projects for liquid petroleum include two leases (Santos) (DNRM 2013b). In the event that these projects proceed, it is expected that they, and other activities external to the Nathan Dam Project, will be regulated to comply with their specific environmental requirements and will therefore not impact upon the environmental values and water quality of the water storage. This expectation is demonstrated in a recent environmental authority approval for release of treated coal seam gas (CSG) water in the Upper Dawson, upstream of the proposed dam. Treatment of water prior to release is subject to processes including desalination by reverse osmosis, softening, filtration, and the plant design will facilitate oxygenation and temperature management of water. The quality of the treated water released into the Dawson River is to comply with trigger values for water quality indicators defined in the Environmental Authority. The development and implementation of receiving environment management programs (REMP's) provide a monitoring and management framework for contaminants in water released under environmental authorities.

It is highly unlikely that potential impacts from releases of CSG water will coincide with those of the dam since it will only be constructed if CSG water can no longer support existing demand. Given that the Project does not propose to supply additional water for agricultural purposes (other than by way of a compensation option to water harvesters who otherwise would lose their current level of access) there will be no increase in agriculture due to the dam. Consequently any potential risks to water quality that can result from agriculture development, such as increased nutrient, pesticide and turbidity loads, will not occur as a result of the Project.

A submission raised the issue of the influence of Nathan Dam on the downstream releases made under Environmental Authorities which are conditioned to release water during times of high flow. There are four operating mines that discharge into the Dawson River sub-basin downstream of the proposed dam (DNRM, 2013b). The timing and volume of releases from coal mines is predominantly determined by the EC of the water to be released and minimum stream flow triggers (DEHP 2013). The closest downstream mine (Dawson South) is approximately 100 km distant and the furthest (Baralaba Central) is 240 km distant, by adopted middle thread distance (AMTD) of the watercourse. Tributaries of the Lower Dawson downstream of the proposed dam add substantially to river flows, contributing approximately 22% of discharge in the Dawson River between Glebe Weir tailwater and Theodore monitoring sites as recorded for the period 1982-2002 (DNRM 2013a). Substantial flows from tributaries into the Dawson River occur further downstream of Theodore, including Zamia Creek, which joins the Dawson River upstream of Baralaba. The cumulative impacts due to discharge from these mines was rated as very low risk due to the low EC levels of the sub-catchment and infrequent and minimal discharges from the mines (DERM 2009e). The risk of reduced frequency of low and moderate flows will be greatest during the first filling stage of the dam. This may reduce opportunities for the downstream mines to release during periods of extended dry periods and low rainfall. However, discharges of poor water quality from mines under the existing release conditions are set to coincide with periods of high flow stream conditions (DEHP 2013) and it is usually during high rainfall and flood events that mines require to make releases; as such it is unlikely that mining discharges will occur during extended dry periods. Due to the relatively low EC level of the Dawson River and the very low risk category for cumulative impacts of the downstream mines it is expected that the potential impact of the dam upon opportunities for downstream releases are minimal.

16.7 Potential impacts associated with the pipeline

Submissions were made requesting further assessment of potential impacts associated with the pipeline, including watercourse crossings, spoil management and releases related to scouring and pigging

16.7.1 Watercourse crossings

All named watercourses crossed by the pipeline were listed and located in Appendix 2-B of the EIS while those associated with dam works were identified in Appendix 2-A. Watercourses impacted by proposed road works were identified in Appendix 2-C. Water quality monitoring locations outlined in Chapter 16 were cross referenced to the sub consultant report in Appendix 12-D wherein the sites were named, mapped, photographed and described but GDA94 coordinates were not provided. Proposed significant watercourse crossing sites are outlined in **Table 16-18**. These are nominated because they are the only locations that may contain water when crossed. The water quality monitoring data for the pipeline creek crossings (frc, 2009), as reported in Chapter 16 of the EIS, have been compared with contemporary WQOs (**Table 16-19**). Pipeline significant watercourse crossings are all located in the Condamine catchment. Since WQOs for waters in the Condamine catchment have not been released, the broad regional values from ANZECC (2000) for the protection of moderately disturbed aquatic ecosystem were used, as recommended by the QWQG (DEHP, 2009).

Table 16-18 Significant watercourse crossings for the pipeline route

Watercourse crossing	Distance (km)	Sub-basin	Stream order	Monitoring site (frc 2009)
Bottle Tree Creek	119.44	Condamine	3	
L Tree Creek	128.84	Condamine	4	(P3)
Bottle Tree Creek	133.78	Condamine	5	
Dogwood Creek	140.17	Condamine	5	(P4)
Charleys Creek	182.75	Condamine	5	

Table 16-19 Pipeline route baseline water quality monitoring and water quality objectives

Parameter	WQO	*Site*				
	Condamine	*P3*	*P4*	*P6*	*P7*	*P8*
Temperature (°C)	-	23.0	30.9	28.3	33.5	32.6
pH	6.5-7.5	5.89	6.75	5.62	6.27	7.89
Conductivity (µS/cm)	<30-350	305	64	53	122	257
DO (mg/L)	-	4.03	1.36	2.80	4.15	6.32
DO(% sat)	90-110%	49.2	25.1	32.3	61.5	91.4
Turbidity (NTU)	2-25	2600	195	124	18	40

Data is sourced from frc (2009). The water quality objectives for the Condamine River Basin have been derived from ANZECC 2000 (south east-Australia) as recommended by the Queensland Water Quality Guidelines (DERM) 2009 for protection of the aquatic ecosystem. 'red value' indicates value exceeds ANZECC (2000) guideline. '-' indicates no value or data available

The creek crossing sites on the proposed pipeline route that were included in the monitoring for the EIS (frc 2009) were on creeks with a stream order of 3, 4 and 5. The natural flow regime in the north east Condamine catchment is classified as intermittent with highest flows during the summer with flow ceasing during the dry season (winter) (Kennard *et al.* 2009). Watercourses of stream orders of four or less are likely to be dry during the dry season with very little surface water persisting late into the season even in creeks of stream order 4, as was observed at monitoring sites for the EIS (Appendix 12D of the EIS, frc 2009). Appendix 12D of the EIS shows that flowing water was not present at any site when surveyed although larger isolated pools were present at sites with a stream order of 5. The construction procedure to be employed when water is present at the crossing site is detailed in Section 2.4.3.2 of the EIS although avoiding such situations (by slight realignment) was noted as the preferred approach. The extent of works necessary to minimise suspended sediment loads will vary between sites as noted in the EIS. As these watercourses are ephemeral or intermittent it is unlikely that these streams will be flowing when works are undertaken. If watercourses are flowing, upstream water will be by-passed around the works area to avoid contamination. This will be achieved by siphoning or pumping as necessary.

Background turbidity (or other water quality parameters) monitoring is not proposed for any pipeline crossing where the pipe will be installed without intersecting standing water. Where installation will intersect standing water, the approach outlined below is proposed. This will be detailed further in the Construction Environmental Management Plan (CEMP) (refer to **Appendix B29**).

The watercourses to be crossed are within an agricultural landscape (grazing and / or cropping) so their suspended sediment load will be highly variable across space and over time and not representative of reference conditions. The data presented in Table 16-16 of the EIS showed turbidity sampled across the nine sites ranged from 18 to 2600 NTU with only one site complying with the water quality objective for this parameter. SunWater suggests that no specific water quality criteria exist for such sites and crossings should be treated on a case by case basis with the aim of minimising turbidity in any discharged waters, using practical and cost effective methods. Using turbidity as a water quality indicator is preferred to using TSS because TSS takes several days to get back from the laboratory by which time the crossing will be finished, whilst turbidity provides instantaneous readings and an ability to respond. Background turbidity values taken upstream of the creek crossing will provide a guideline as to effectiveness of management strategies used to minimise suspended sediment inputs as a result of works. Given that watercourse crossings will be completed in just a few days in other than problematic cases, the risk of significant water quality impacts is considered low and the control measures nominated are commensurate with that risk. To develop local guidelines or any more extensive background data for each site would be disproportionate to the risk.

16.7.2 Spoil management

The management of spoil was addressed in Section 29.9.4 of the EIS and is further discussed in **Chapter 6** and **29**.

16.7.3 Releases related to scouring and pigging

The process of scouring and pigging was described in Section 2.5.2.2 of the EIS. The source of water would be Nathan Dam. No chemical additives are used in the process. Both scouring and pigging result in the release of small volumes of water, being the volume between one scour point and the next or the volume between a scour point and a pig retrieval point. Typically, major pipelines are pigged once per year, however, pigging can occur more or less frequently if conditions dictate. The volume of water discharged at any scour valve during regular maintenance was described as “small” and it varies between valves because the distance between valves is not fixed. The volume is generally in the order of a few thousand litres. The water is discharged into a constructed scour pit (Figure 2-23 of the EIS was an example) which dissipates the energy of the discharge. The released water either slowly discharges from the pit and soaks into surrounding soils (within the easement or a dedicated drainage easement) or evaporates. Any volume reaching a watercourse would be inconsequential and risks to ambient water quality are considered negligible.

16.7.4 Management of cleared vegetation and rehabilitation of riparian areas

A submission requested additional detail regarding management of cleared vegetation and rehabilitation of riparian areas. Clearing of riparian vegetation will be conducted in accordance with the vegetation clearing strategy (**Section 9.9** of the draft EMP in **Appendix B29**) and Sediment and Erosion Control Plan (**Section 9.4** in **Appendix B29**) and will be consistent with recommendations in Australian Pipeline Industry Association Code of Environmental Practice (APIA, 2013) (where applicable). Management of the works is also governed by conditions within Riverine Protection permits, Waterway Barrier Works approvals and Operational Works Approval for Clearing Vegetation (where applicable). The conditions of such permits are standard and SunWater envisages no difficulty in complying with them.

16.8 Drinking water

A submitter requested further information on the management of drinking water. The closest downstream offtake for drinking water from the proposed dam is at Theodore. A comparison of the median values from the DNRM water monitoring site at Theodore (**Table 16-9**) with the WQOs for drinking water supply which apply to waters in the vicinity of offtakes (**Table 16-3**) shows that water quality is compliant with the WQOs. The median dissolved oxygen concentration of 5.8 mg/L is, however, only slightly above the WQO of > 4 mg/L. The dam may influence water quality at Theodore, particularly by increased capture and retention of first flush flows and by longer low flow duration. These alterations to flows can potentially reduce turbidity due to increased sedimentation and increase concentrations of dissolved oxygen due to extended low flows. The multi-level offtake provides a mechanism for selective release of water and can potentially deliver water to Theodore with an improved quality compared to the existing conditions, and is likely to promote higher concentrations of dissolved oxygen. SunWater will be providing raw water for a range of potential purposes. It is the responsibility of the water purchaser to treat this water, as necessary, to ensure it is fit for purpose. SunWater will monitor water quality at the offtake and make that data available to users. In accordance with SunWater's Environmental Management System (EMS), a process has been established to warn users of any major change to raw water quality, such as a blue-green algal bloom. With respect to drinking water, local downstream urban supplies currently obtain their raw water from the Dawson River and this will not change other than having Nathan Dam replace Glebe weir. It is extremely unlikely that raw water provided from the dam would be of a lower standard or require any significantly different treatment to current supplies.