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PO Box 1777
Thuringowa, Qld, 4817, AUSTRALIA
Tel: +61 (0) 7 4725 3751
Mob: +61 (0) 417 635 032
info@candrconsulting.com.au
www.candrconsulting.com.au

ECO@JUMRUM ESTATE

Water Management Plan

REPORT PREPARED FOR:
Jim Papas Civil Engineering Designer Pty Ltd

Date:
December 2014

DISCLAIMER

C&R Consulting Pty Ltd do not accept any responsibility in relation to any financial and/or business decisions made for any other property or development other than that for which this information has been provided.

Dr Chris Cuff Director	Dr Cecily Rasmussen Director
12 February 2015 Date	12 February 2015 Date

SUMMARY OF RELEVANT INFORMATION

Project Title	Water Management Plan
Property Location	Lot 72 on RP903071, Kuranda, Qld
Property Description	Residential estate
Project Purpose	Outline surface water monitoring requirements to protect downstream environmental values during the construction phase
Applicants Details	
Nominated Representative	Jim Papas
Title/Position	Project Manager / Director
Company	Jim Papas Civil Engineering Designer Pty Ltd
Postal Address	PO Box 2347 Mareeba, Qld 4880
Telephone	0408 770 394
Email	jim@jpced.com.au

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1. INTRODUCTION

C&R Consulting Pty Ltd were contracted by Jim Papas Civil Engineering Designer Pty Ltd, on behalf of SteveTaylor & Partners Pty Ltd, to create a Water Management Plan (WMP) for the eco@jumrum development located ~3 km south of Kuranda on Lot 72 on RP903071. The proposed development aims to subdivide Lot 72 on RP903071 into 83 lots creating an eco-friendly estate. Note the number of subdivided lots has been amended from the initially proposed 84 lots to 83 to help satisfy EPBC requirements.

The purpose of this WMP is to fulfil specific conditions of approval as stipulated by the Department of Environment (DoE) under sections 130(1) and 133 of the *Environment Protection and Biodiversity Act 1999*. The conditions addressed within this WMP target the proposed action of the "*construction of a residential subdivision of 84 lots, from a 45.71 hectare parcel of land on Lot 72, RP 903071, 3 km south west of Kuranda, Queensland*" as stipulated by EPBC Ref 2011/5939. Hence, this WMP outlines specific measures and strategies to manage water quality within the receiving environment to be implemented during the construction of these lots. No water quality management objectives or strategies have been outlined after construction of the development. It is assumed that water quality management objectives post construction will be achieved through the construction and implementation of water management structures, approved by Local, State and Federal governments and adhering to best practice standards, such as bio-retention swales and sedimentation basins.

Therefore, this report solely addresses condition 3 of the DoE approval of 5 August 2014 and condition 2 of the correction notice of 13 August 2014 (EPBC Ref 2011/5939) which states:

"For the protection of the Myola Palm (Archontophoenix myolens): The Kuranda Tree Frog (Litoria myola): Waterfall Frog (Litoria nannotis): Common Mistfrog (Litoria rheocola) and Lace-eyed Tree Frog (Nyctimystes dayi) the approval holder must submit to the ***Minister*** *for approval, at least 3 months prior to the proposed* ***commencement of the action****, a water Management Plan for the* ***Jumrum Creek system*** *to maintain or improve water quality and to maintain the natural water flow regime on and downstream of the* ***subject site****.*

The WMP must include at least the following

1. *Water quality and flow regime maintenance objectives*
2. *specific physical structures and construction methods that will be implemented to minimise sediment and other pollutants entering the stormwater drains and the Jumrum Creek system*
3. *Details of the water monitoring network to be established including:*
    1. *At least one monitoring point upstream of all potential inflows from the* ***subject site*** *and no more than 50m from each point where the* ***Jumrum creek system*** *enters the* ***subject site***
    2. *At least one monitoring point downstream of all potential inflows from the* ***subject site*** *and no more than 50m from each point where the* ***Jumrum creek system*** *enters the* ***subject site***
    3. *At least one monitoring point on the* ***Jumrum Creek system*** *approximately half way between each of the points where the* ***Jumrum Creek system*** *enters and exits the* ***subject site****.*
4. *Detail of monitoring methods to be used, including frequency and timing. Monitoring must begin at least three months prior to the commencement of the action to establish practicability of the monitoring regime and to provide baseline*

data. A higher frequency of monitoring is required for the first 12 months following the commencement of the action: following heavy rain events and during the main breeding season for the above named frog species.

5. ***Corrective action**, catalyst and timing trigger of implementation of **corrective actions**, and the parties responsible for implementing **corrective actions** and*

6. *Content and timing of submission to the Department of monitoring reports and **corrective actions**.*

*The action must not **commence** until the WMP is approved by the **Minister**. The approved WMP must be implemented."* [1]

[1] **Commencement of the action / Commenced** – The clearing of any vegetation or construction of any infrastructure, including road works, stormwater and water infrastructure, drainage, earthworks and sewerage infrastructure on the subject site.
Corrective actions – actions taken in response to performance criteria and or objectives falling outside of set objectives.
Jumrum Creek system – Jumrum Creek and its tributaries.
Minister – The Minister administering the *Environment Protection and Biodiversity Conservation Act 1999* and includes a delegate of the Minister.
Subject Site – Lot 72 RP 903071 situated at 1593 Kennedy Highway, Kuranda, Queensland and as shown by map at Appendix A of the approval (Refer to Figure 2).

2. CONTEXT

2.1 SITE LOCATION AND DEVELOPMENT PROPOSAL

The proposed development site is situated 27.5 km north-west of Cairns in the Australian Wet Tropics in the township of Kuranda. The development site is situated in the mid catchment of Jumrum Creek; a small, steep, freshwater rainforest creek. After traversing the site Jumrum Creek reports to the Barron River ~3 km downstream (Figure 1).

Jumrum Creek occurs in the mid catchment of Barron River. The topography of the site is variable ranging in height from 350m AHD to 390m AHD. All surface flows associated with the development site are captured by Jumrum Creek or small tributaries that flow into Jumrum Creek.

The aim of the development is to subdivide Lot 72 on RP903071 into 83 separate lots; creating an eco-friendly estate where homes are designed and developed in response to the local climate and ecology. The estate will be developed in a staged approach. Stage 1 of the development will create eleven allotments with a maximum clearing of 2000 m^2 to account for building envelopes and driveway access, adjacent to Fallon Road (Figure 2).

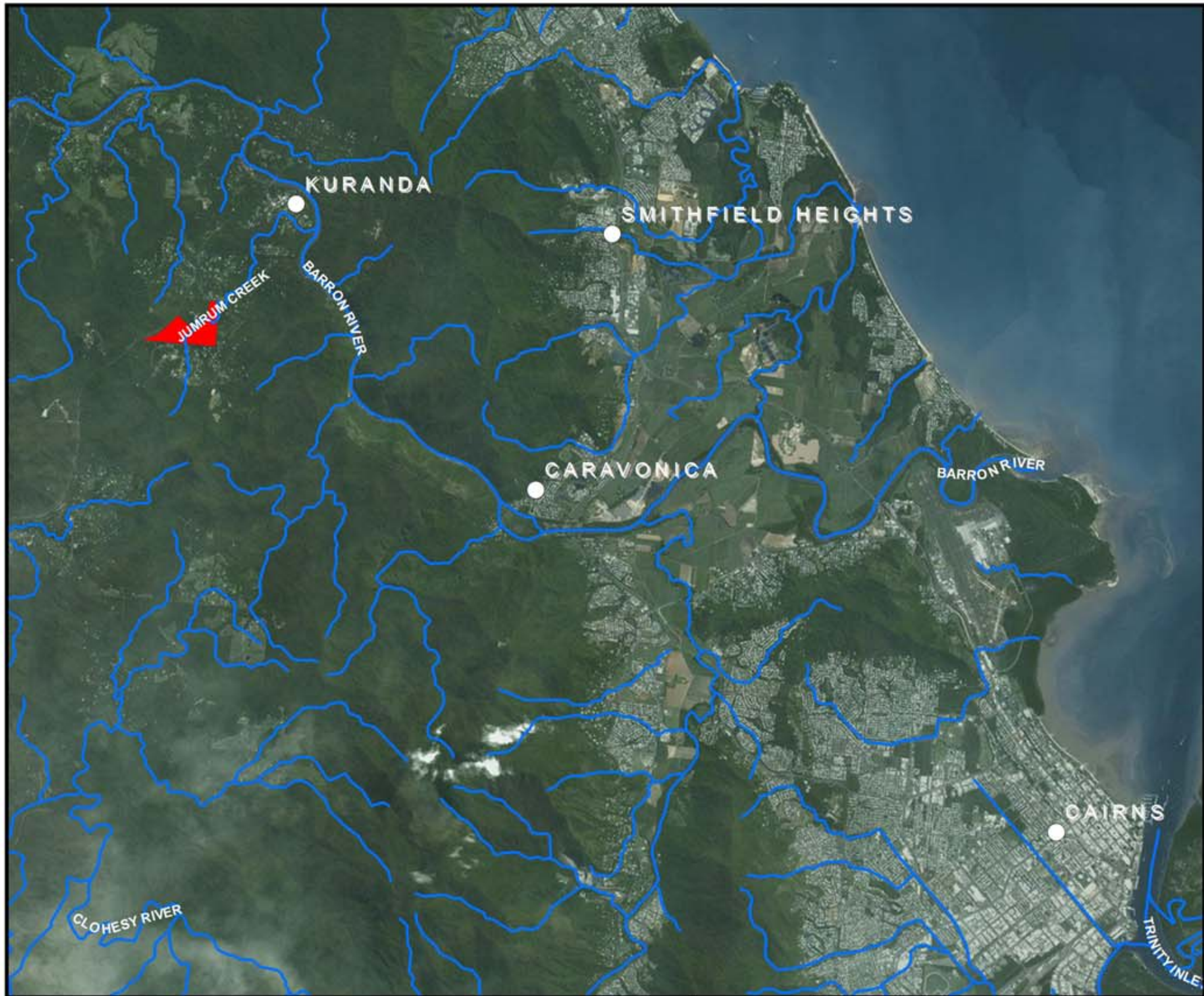
Construction of the development will include limited cut and fill to elevate the main roadway and construct an embankment crossing of Jumrum Creek. This will involve a steel arch crossing of Jumrum Creek. A temporary crossing of the creek will firstly be required in order to create the more permanent crossing.

Proximity of building envelopes to Jumrum Creek is restricted across the whole development site by the establishment of a special covenant that protects all areas outside of the designated building envelopes from any form of disturbance. This type of covenant attached the estate title is an Australian first and ensures the protection of the area (including riparian zones) into the future.

2.2 CLIMATE

Understanding the climate of the region is critical to understanding the flow regime, possible impacts, threats and mitigation measures applicable to matters of national environmental significance located immediately downstream of the eco@jumrum development.

The climate of the Kuranda region is characterised by hot humid summers and mild dry winters. Rainfall distribution is highly seasonal with an average of 70% of yearly rainfall occurring between January – April (the wet season). The Kuranda region receives a high volume of rainfall with an average yearly total of 2094 mm (Figure 3). Up to 75% of all years have received yearly total rainfalls between 1460 mm and 2700mm which are within 30% (i.e. approximately $\pm$630 mm) of the average yearly total (Figure 4). However, the rainfall record is also characterised by extreme variations of yearly rainfall with 10% of all years having recorded rainfall values over 3,000 mm (Figure 3).



Legend

- Populated Places
- Watercourse Lines
- Development Site

0 1,500 3,000 6,000
Meters

1 cm = 1,000 meters

DRAWN BY: REECE FRASER

DATE: 01/12/2014

PROJECT: WATER MANAGEMENT PLAN

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eco@jumrum
The ultimate Kuranda address

Figure 1: Proposed development location

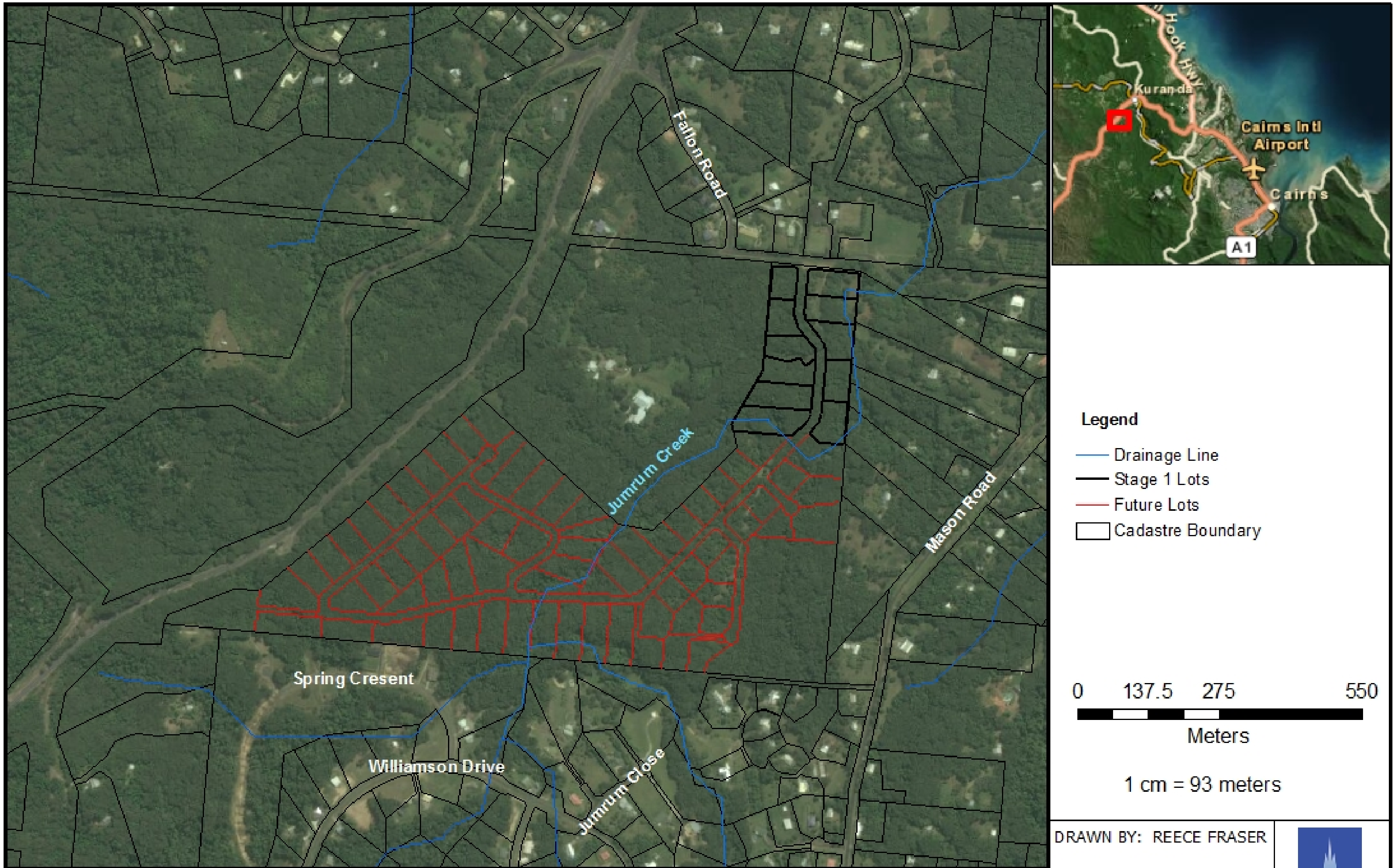

Figure 2: **Overview of the proposed development**

DRAWN BY: REECE FRASER

DATE: 01/12/2014

PROJECT: WATER MANAGEMENT PLAN

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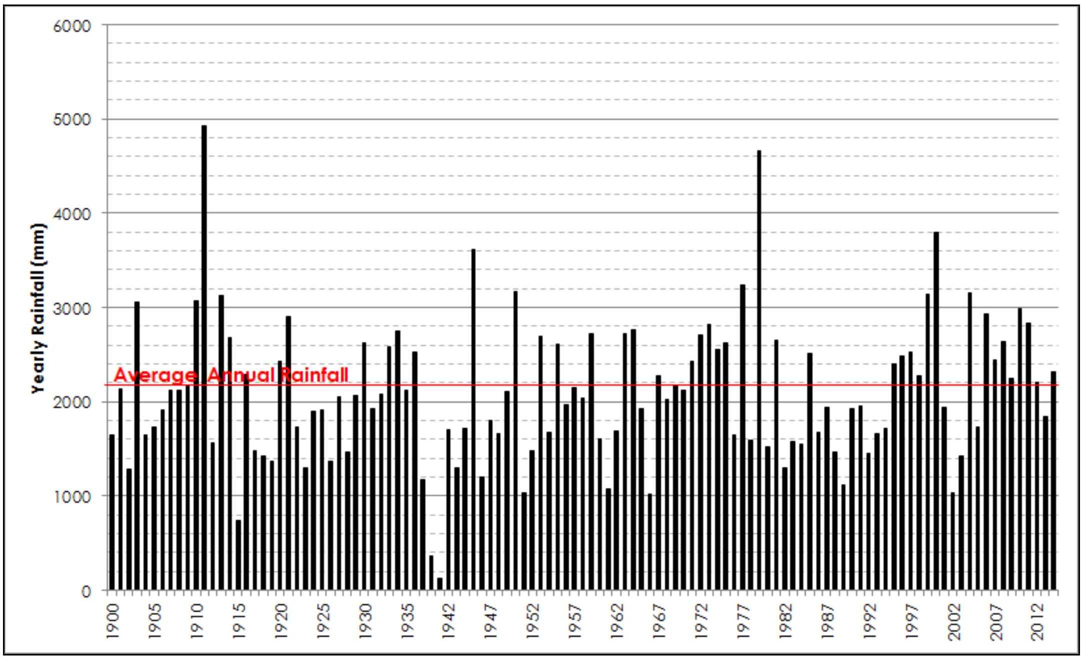

Figure 3: Yearly rainfall totals for the Kuranda Railway Station gauge (BOM 2014)

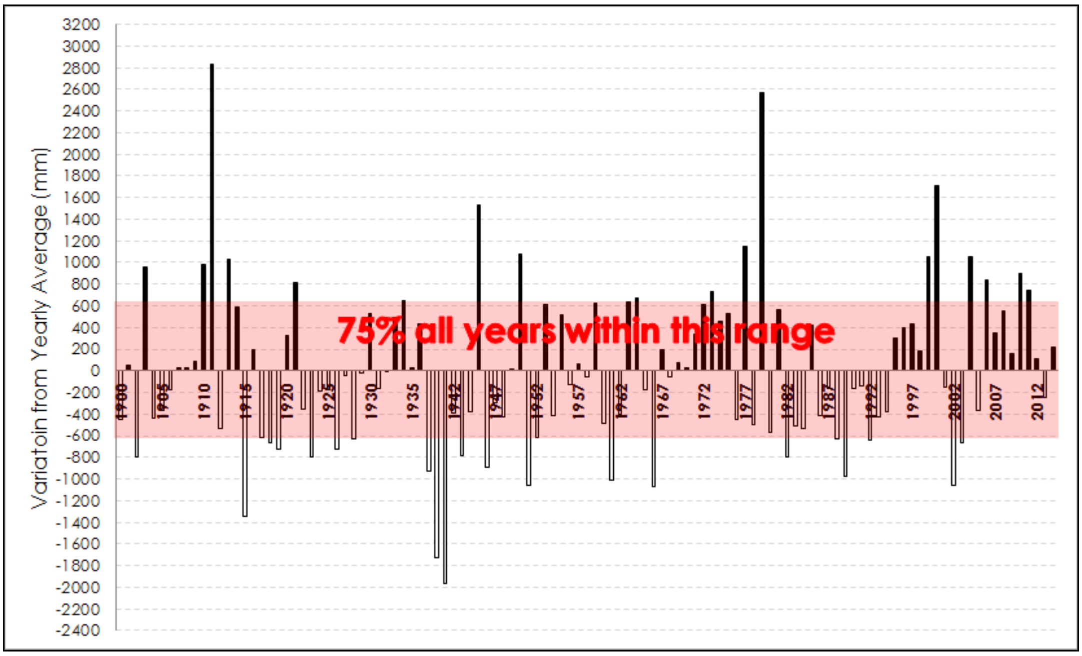

Figure 4: Variation of yearly rainfall from average

It is only in the height of the dry season, June – November, where evaporation greatly exceeds precipitation (Figure 5). In the peak of wet season months precipitation exceeds evaporation by a factor of up to three times.

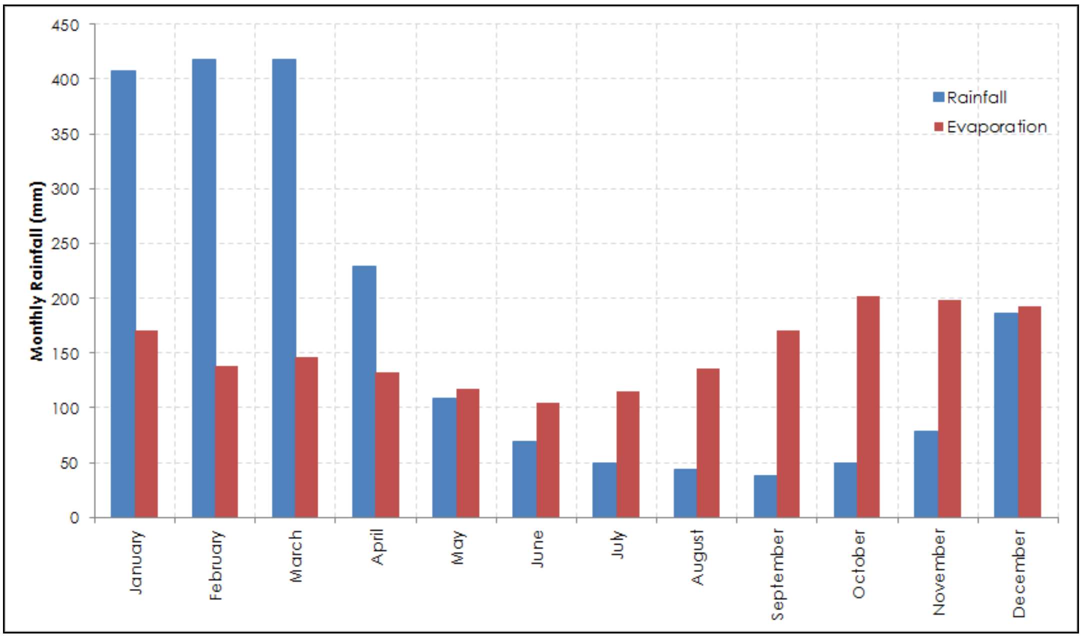

Figure 5: Monthly average rainfall and evaporation rate for the Kuranda Railway Station (BOM 2014)

Rainfall at Kuranda is relatively regular, being at the top of the escarpment and surrounded by the Wet Tropics. Data from the Kuranda Railway Station gauge (BOM 2014) was analysed to determine the average number of days between rainfall events greater than a certain size. On average, there is roughly fifty days between rainfall events that are $\geq$50mm, and approximately 150 days between rainfall events that are $\geq$100mm (Figure 6). However, rainfall is much more common place during the wet season. During wet season months there is roughly only 20 days between rainfall events $\geq$50mm and 50 days between rainfall events $\geq$100mm. This shows that stream flow at Jumrum Creek will be relatively constant and that rainfall event-based triggers for monitoring will require careful consideration of the rainfall record.

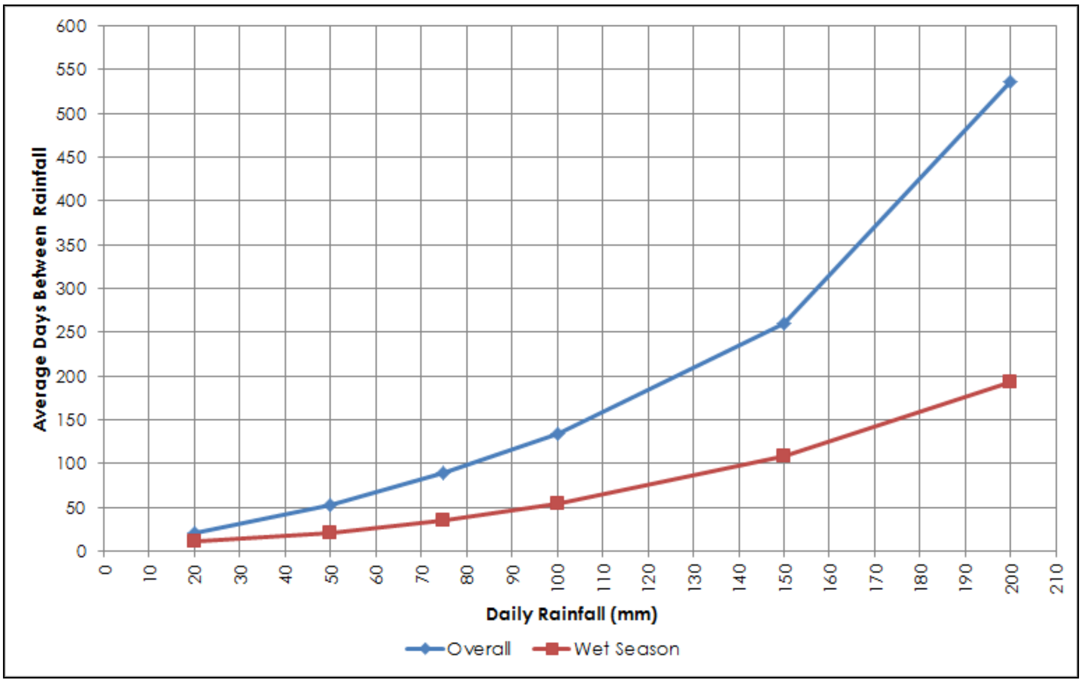

Figure 6: Average number of days between rainfall greater than a specified value

2.3 VEGETATION

The majority of the development site has previously been cleared and is largely made up of non-remnant vegetation. This clearing occurred some time ago as the site is predominantly covered with established rainforest regrowth, including the riparian habitat present on the site. There is a patch of remnant vegetation present in the south eastern corner of the proposed development described as regional ecosystem 7.11.1a which is described as a Simple-complex mesophyll to notophyll vine forest on moderately to poorly drained metamorphics (excluding amphibolites) of moderate fertility of the moist and wet lowlands, foothills and uplands. Lowlands and foothills on xanthozems and red and yellow podzolic soils of metamorphic origin. The regional ecosystem 7.11.1a has a Vegetation Management Act class of Least Concern and a biodiversity status of No Concern at present.

2.4 SOILS

The nature of soils in the area will influence the required mitigation measures for soil erosion and sediment control. Broadly the soils of the area are described by CSIRO as:

"*Elevated low hilly plateaux which may have steep-scarped margins; areas of lesser or stronger relief also occur on the plateaux surfaces; dominant soils are moderately deep to deep yellowish red or yellow friable loams; red friable loams area also common and in some areas are locally dominant. Similarly loamy soils are the chief associates in the southern part of the unit, while in the northern extremities uniform friable clays become increasingly common. A range of moderately deep to deep friable earths occur throughout the unit and are more common on the drier western slopes*."

Effluent investigations carried out by Golder Associates (July 2011) across the site found low to medium plasticity, silty clays with trace medium to coarse gravels to a depth of 2.0 m below ground level. These clays are usually overlayed by a layer of organic rich material that varies in thickness. This organic rich layer is generally stable although the underlying clayey sub soils are dispersive and erosive. If the organic rich surface layer is disturbed and the sub soils below are exposed than there is a high likelihood that erosion will occur causing sedimentation and increased turbidity in waterways.

No other soil information can be found for the area as the more detailed state mapping does not cover this area.

2.5 THREATENED SPECIES

There are a number of threatened species that may occur within the vicinity of, or have the potential to be impacted by, construction activities at the eco@jumrum estate, including:

- Waterfall Frog *(Litoria nannotis)*;
- Kuranda Tree Frog *(Litoria myola)*;
- Common Mistfrog (*Litoria rheocola*);
- Lace-Eyed Tree Frog *(Nyctimystes dayi)*; and
- Myola Palm *(Archontophoenix myolens)*.

This section of the report summarises sections of the Ecosmart Ecology - Threatened Frog Report eco@jumrum, Kuranda, March 2012. A brief summary of the conservation status, home range and habitat type, occurrence and possible threats to the above species has been included in this report. For more information on these species please refer to the Ecosmart Ecology - Threatened Frog Report eco@jumrum, Kuranda, March 2012.

One of the greatest threats to all frog species in the area is the disease chytridiomycosis caused by the fungal pathogen *Batrachochytrium dendrobatidis*. The pathogen has caused significant declines in the populations of all of the frog species listed above. The pathogen is temperature sensitive, restricting the altitude ranges available for (re)colonisation by the frog species, often limiting the frogs' natural home range altitudes to lower elevations.

2.5.1 KURANDA TREE FROG

The Kuranda Tree Frog (*Litoria myola*) is restricted to twelve populations in five streams covering a total area of approximately 3.5 km^2. The largest population occurs in the lower portions of Jumrum Creek, downstream of the eco@jumrum estate.

Population surveys undertaken between 2000 and 2008 have shown that the population in Jumrum Creek has declined from 500 to 200 individuals. It is not clear whether these declines have been a result of human interference or natural fluctuations or perturbations. Peak breeding season for this species is between October and March.

Threats to the Kuranda Tree Frog include changes to water quality and water flow as a result of urban development. Particular changes to water quality that may impact the frog species include sedimentation, fertilisers, detergents and oils.

2.5.2 WATERFALL FROG

Waterfall frogs spend the majority of their time in moist crevices and in splash zones around waterfalls and fast flowing rocky sections of streams. The frogs are relatively inactive and remain close to waterfalls for the majority of their time, occasionally foraging for short distances from the stream. Breeding is known to occur all year round but is the most intense between November and March.

The main threat to the Waterfall Frog is chytridiomycosis which has caused populations to decline since the early 1990's.

2.5.3 COMMON MISTFROG

The Common Mistfrog has a preference for fast, shallow, rocky sections of streams and typically avoids deeper slow moving pools. Males of the species are relatively sedentary, remaining in the one place, waiting for females to move to the stream to lay eggs. Breeding occurs all year round but is most intensive in spring (September – November). Overall the species is rarely observed 10m from the stream but longitudinal movements up to 20m along the stream may occur.

The main threat to the Common Mistfrog is population decrease due to chytridiomycosis. Some studies have suggested that the numbers and health of the Common Mistfrog are also affected by noise and contaminants from highways. Higher population numbers have generally been observed with increasing distance from roads. Noise generated from roads may potentially affect the calls of males.

2.5.4 LACE-EYED TREE FROG

The Lace-eyed Tree Frog (or Australian Lace-lid) is endemic to the wet tropics. It is unclear how closely associated with streams the species is, as it is known to move away from the stream to forage. Like the Common Mistfrog, the Lace-Eyed Tree Frog prefers shallow, fast moving sections of the stream and will avoid slow moving, deeper pools. Breeding occurs from October to April.

Again, the main threat to the Lace-eyed Tree Frog is population decrease due to chytridiomycosis. Other potential impacts to the Lace-eyed Tree Frog include loss of habitat and fragmentation as a result of development, modifications to flow regimes and alterations to water quality.

2.5.5 MYOLA PALM

The following is a summary of relevant information taken from the Commonwealth Conservation Advice on *Archontophoenix myolensis* (The Myola Palm) (Department of Environment 2008). The Myola Palm has a solitary, straight trunk up to 30 cm in diameter, growing up to 20 m tall. The species is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999*, *Nature Conservation Act 1992* and as Vulnerable on the World Conservation Union's IUCN Red List of Threatened Species.

It is estimated that fewer than 100 mature palms remain in an area less than 10km^2 along creeks in the wet tropics rainforests generally between the altitudes of 350-400 m. Approximately 75% of all known individuals occur along the banks of Warrill Creek, with the remaining 25% occurring along the Barron River.

The main threat to the Myola Palm is clearing. Alteration to flow regimes within inhabited watercourses is also likely to have deleterious effects on the species.

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3. WATER QUALITY AND FLOW MAINTENANCE OBJECTIVES

3.1 WATER QUALITY OBJECTIVES

The Environmental Protection Act 1994 and the subsequent Environmental Protection (Water) Policy 2009 (EPP Water) outline a framework for establishing environmental values and management goals for Queensland waters as well as detailing Water Quality Objectives (WQOs) to protect those environmental values.

Environmental values and WQOs have been defined for the Barron River catchment and subcatchments (EHP, 2014). Environmental values that are applicable to Jumrum Creek specifically include:

- Aquatic Ecosystem.
- Irrigation.
- Farm Supply.
- Stock Watering.
- Aquaculture.
- Human Consumption.
- Primary Recreation.
- Secondary Recreation.
- Visual Appreciation.
- Drinking Water.
- Cultural and Spiritual.

The water type outlined for Jumrum Creek is Slightly Disturbed in undeveloped areas, such as state forests and national parks, and Moderately Disturbed in developed areas (EHP 2014). The development site has previously been cleared, receives waters from a developed area with the area immediately downstream of the site also developed. Subsequently, WQOs for Moderately disturbed waters were determine to be applicable to activities associated with the eco@jumrum development and are allocated in Table 1.

Table 1: Water Quality Objectives recommended for Jumrum Creek

Parameter	Objective	Representing	Source of Objective
Field Measured Parameters			
Dissolved Oxygen (% saturation)	20th Percentile: 85 80th Percentile: 120	Moderately disturbed waters	Barron River Environmental Values (EHP, 2014)
pH	20th Percentile: 6.0 80th Percentile: 8.0		
Electrical Conductivity (µS/cm)	20th Percentile: 47 50th Percentile: 72 80th Percentile: 106		
Turbidity (NTU)	<15		
Laboratory Parameters			
Total Suspended Solids (TSS) (mg/L)	<8 during low flow **During High Flow** 20th Percentile: 4 50th Percentile: 20 80th Percentile: 52	Moderately disturbed waters	Barron River Environmental Values (EHP, 2014)

Parameter	Objective	Representing	Source of Objective
Nutrients			
Ammonia as N (µg/L)	<10 during low / medium flow **During High Flow** 20th Percentile: 4 50th Percentile: 8 80th Percentile: 13	Moderately disturbed waters	Barron River Environmental Values (EHP, 2014)
Total Nitrogen (µg/L)	<340 during low flow **During High Flow** 20th Percentile: 229 50th Percentile: 370 80th Percentile: 688		
Filterable reactive phosphorous (µg/L)	<8		
Total Phosphorous (µg/L)	<25 during low flow **During High Flow** 20th Percentile: 10 50th Percentile: 20 80th Percentile: 70		
SiO_2 (mg/L)*	20th Percentile: 10.1 50th Percentile: 14.1 80th Percentile: 21.1		
Cations and Anions			
Sodium (mg/L)	20th Percentile: 5 (40%) 50th Percentile: 7 (51%) 80th Percentile: 11 (66%)	Surface waters in the Queensland Wet Tropics region	Barron River Environmental Values (EHP, 2014)
Calcium (mg/L)	20th Percentile: 2 (16%) 50th Percentile: 3 (22%) 80th Percentile: 5 (28%)		
Magnesium (mg/L)	20th Percentile: 1 (17%) 50th Percentile: 2 (26%) 80th Percentile: 4 (34%)		
Bicarbonate as HCO_3 (mg/L)	20th Percentile: 14 (47% 50th Percentile: 25 (59%) 80th Percentile: 40 (68%)		
Chloride (mg/L)	20th Percentile: 6 (28%) 50th Percentile: 9 (36%) 80th Percentile: 14 (48%)		

Parameter	Objective	Representing	Source of Objective
Sulphate (mg/L)	20th Percentile: 1 (2%) 50th Percentile: 1 (3%) 80th Percentile: 2 (6%)		
Fluoride (mg/L)	20th Percentile: 0.010 50th Percentile: 0.060 80th Percentile: 0.110		
Metals (dissolved)			
Iron (mg/L)	20th Percentile: 0.010 50th Percentile: 0.050 80th Percentile: 0.200	Surface waters in the Queensland Wet Tropics region	Barron River Environmental Values (EHP, 2014)
Manganese (mg/L)	80th Percentile: 0.010		
Zinc (mg/L)	50th Percentile: 0.010 80th Percentile: 0.020		
Copper (mg/L)	50th Percentile: 0.010 80th Percentile: 0.030		
Aluminium (mg/L)	<0.055	95% Species Protection Level	ANZECC (2000) Water Quality Guidelines
Arsenic (mg/L)	<0.024		
Cadmium (mg/L)	<0.0002		
Chromium (VI) (mg/L)	<0.001		
Lead (mg/L)	<0.0034		
Mercury (mg/L)	<0.0006		
Nickel (mg/L)	<0.0011		
Silver (mg/L)	<0.05		
Petroleum Hydrocarbons			
C6 - C10 Fraction (mg/L)	NA	NA	Site specific WQOs need to be calculated based on baseline data
>C10 - C40 Fraction (sum) (mg/L)	NA		
Benzene (mg/L)	<0.950	95% Species Protection Level	ANZECC (2000) Water Quality Guidelines
Toluene (mg/L)	NA	NA	Site specific WQOs need to be calculated based on baseline data
Ethylbenzene (mg/L)	NA		
Meta- & para-Xylene (mg/L)	NA		

Parameter	Objective	Representing	Source of Objective
Ortho-Xylene (mg/L)	<0.350	95% Species Protection Level	ANZECC (2000) Water Quality Guidelines
Total Xylenes (mg/L)	NA	NA	Site specific WQOs need to be calculated based on baseline data
Naphthalene (mg/L)	<0.016	95% Species Protection Level	ANZECC (2000) Water Quality Guidelines

* If analysed as Si (e.g. ICPMS/AES) then covert results to SiO_2 using the following equation:

$$Si \times (60.086/28.086) = SiO_2.$$

3.2 FLOW OBJECTIVES

The stormwater calculations shown in the *Stormwater Drainage Report for eco@jumrum a rural residential subdivision at Fallon, Road Kuranda* under taken by Jim Papas Drafting Pty Ltd (2012) suggests there will be negligible change in flow as a result of the development. Nevertheless, during the construction phase, the following flow maintenance objectives are nominated:

- Flows in Jumrum Creek or tributaries will not be interrupted, ceased or reduced as a result of construction works.
- Any concentrated overland flows entering Jumrum Creek or its tributaries from construction sites must first pass through erosion and sediment control measures detailed within this report.

4. THREATS

There are a number of direct and indirect threats, in relation to water, to the species listed in Section 2 that have the potential to be exacerbated by the eco@jumrum development. The major threat is perceived as increased sedimentation from construction activities.

4.1 SEDIMENTATION

4.1.1 BACKGROUND, PROCESSES AND RATIONALE

The greatest risk to frog populations will be from sedimentation during the construction phase. Sedimentation is the process by which excess sediment, disturbed by cut, fill and building activities, enters drainage lines and waterways. The excess sediment can smother bed and edge habitat, decreasing the growth rate of aquatic vegetation and infill small cracks and crevices. It can also lead to decreases in dissolved oxygen concentrations within the water column, especially if widespread. Excess sedimentation of fine material can smother eggs of many amphibians and alter/reduce food sources.

Soils of the area have developed through the rapid breakdown of host rock as a result of the moisture rich climate, as well as the breakdown of organic matter from high volumes of leaf litter. Subsequently, the surface layers of the soil profile have a high percentage of organic matter and organic carbon which act to bind the soil particles together, increasing the resilience to erosion. This results in waters within creeks and drainage lines in the Wet Tropics area typically being very clear, showing relatively low suspended sediment concentrations, especially compared to the coastal lowlands, where soil profiles display a much lower resilience to erosion.

If the soil profile is disturbed beyond these organically rich top layers, the exposed sub soil is far more dispersive and mobile. Across the site these sub soils are generally a silty clay, silty loam or clay loam. The velocity of water required to mobilise these soil particles is relatively small, especially considering that the climate is too moist for the silty clays to form crusts of any type. Therefore, the risk of sedimentation within waterways is relatively high.

4.1.2 SPECIFIC EXAMPLES EXISTING ON THE SITE

Road crossings present one of the largest vulnerabilities of increasing sedimentation within Jumrum Creek. There are two existing road crossings (installed prior to the purchase of the land by the developer), a low level dirt crossing in Lot 6 and an elevated roadway between Lot 3 and Lot 9. The specific sedimentation issues at these two locations are vastly different and a result of different processes.

4.1.2.1 Low Level Crossing

The low level crossing was constructed by the previous owners of the property that ran a cattle and orchid farm. The developer now uses the crossing to allow vehicle access to Stage 2 and Stage 3 of the estate. The low level crossing is typical of a 4wd crossing of small creeks. Cobbles and pebbles have been placed in the base of the creek to provide stability to 4wd vehicles using the crossing.

Despite these measures the soil profile has been disturbed to create the crossing. This has exposed dispersive sediments directly to flow which is blanketing the creek and creating a visible sediment cloud for approximately 15-30 m downstream (Figure 7).

The volume of sediment transported downstream is relatively minimal, although dispersion and transport is constant year round, while there is flow (note photographs in Figure 7 were taken in November 2014, prior to any wet season rains). In its current state, during a high flow event the crossing will be damaged further. In spite of this, the volume of sediment disturbed by the crossing would be relatively minimal compared to the volume of sediment already within the water column at the time of the high flow event. Conversely, during base flow/low flow events the volume of sediment already within the water column is minimal. Subsequently, the dispersion and transport of fine material has a relatively high impact during these low flow conditions, effectively smothering the downstream habitat until a higher energy event flushes the system.

Figure 7: Sediment plume at the low level road crossing (top); and immediately downstream (bottom)

Water quality samples were taken from upstream of the crossing, immediately downstream of the crossing and approximately 30m downstream of the crossing and analysed for Total Suspended Solids (TSS). The results show that dispersal of sediment through the water column is increasing suspended sediment concentrations downstream of the crossing above the water quality objective (Figure 8).

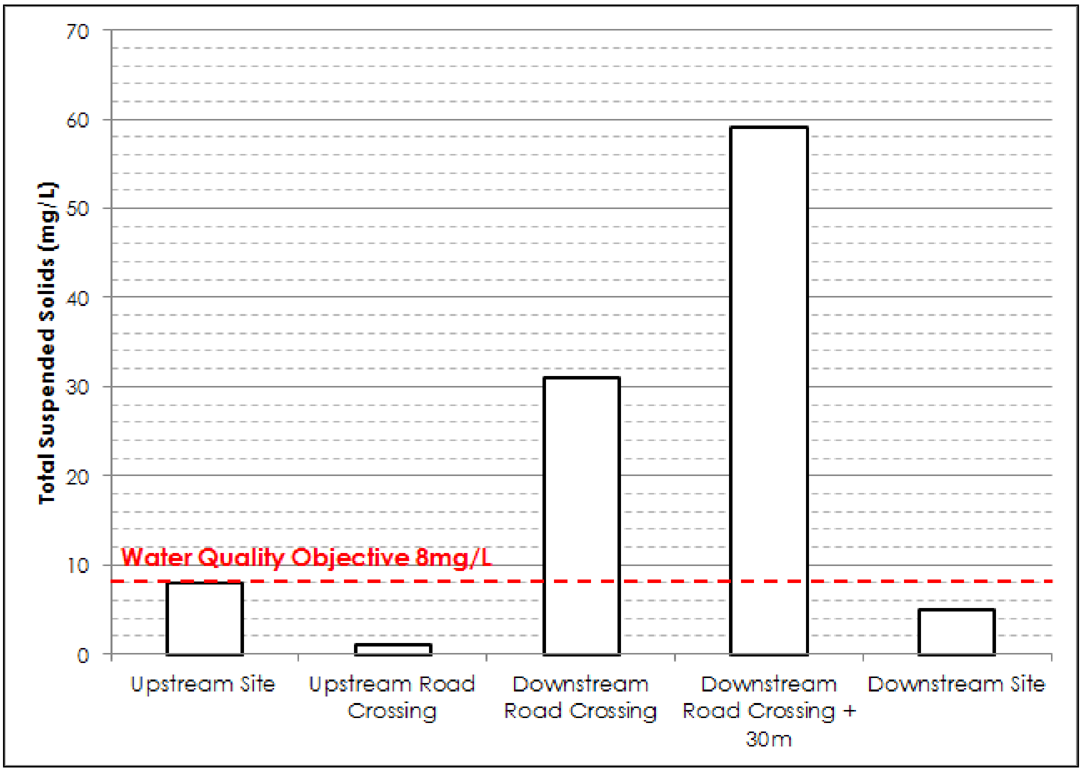


Figure 8: Total suspended sediment concentrations during sampling

Since the home range of the majority of endangered frogs is not known, but movements appear to be relatively small (i.e. approximately 20m along the creek) it is recommended that mitigation measures are installed to prevent the downstream migration of fine dispersive material and to reduce the effects of sedimentation. The developer is aware of these issues and has already commissioned a contractor to place 150 mmØ rocks within the crossing to stabilise the bed. However, this is seen as a short/quick fix especially when heavy vehicles will require access to the site during the construction phase. As such, the developer has outlined a process to address these issues, which has already been discussed with the administering authorities. This includes the installation of Reno-mattresses to stabilise and preserve the creek bed during the construction phase, with the entire low-level crossing removed once construction is complete.

4.1.2.2 Road Crossing and Culvert

A road crossing has been constructed, by previous owners, across a drainage line entering Jumrum Creek to allow vehicle movements. A culvert has been installed beneath the road crossing to allow flows to progress.

Erosion downstream of a culvert is generally considered the 'norm' and should be expected. However, the erosion occurring downstream of the culvert at the development site appears to be quite significant as a scour hole has developed (Figure 9). While this scour hole will act as an energy dissipation mechanism, significant erosion is still expected to continue.

The developer is aware of the issues associated with this crossing and has commissioned a contractor to place geo-textile fabric within the scour hole downstream of the culverts to stabilise the bed and reduce bank erosion. The geo-textile fabric is then to be armoured with rock (of appropriate diameter) to as an energy dissipation mechanism and further reduce any erosion that is currently occurring. This armouring will also be placed up the bank and around the culvert outlets to limit undercutting.

Figure 9: Scour hole on downstream side of culvert

4.2 HYDROCARBONS AND CHEMICALS

4.2.1 BACKGROUND, PROCESSES AND RATIONALE

Another threat to frog populations may be from hydrocarbons (oils and fuels) and chemicals used on site during the construction phase. Oils and a reduction in water quality via chemical modification have been identified as some of the ongoing threats contributing to the reduction in frog population’s (refer to Section 2.5). General maintenance of equipment and machinery on-site without appropriate controls in place can cause environmental degradation. This generally occurs as a result of spillages of oil, lubricant or fuels that subsequently get washed into watercourses adversely impacting water quality and ecosystem values. Unintentional releases of contaminants to waterways can also occur as a result of cleaning vehicles or equipment. Although the risk of large volumes of oil or chemical release to waterways is likely to be low the consequences of such a release are likely to be significant.

4.3 EUTROPHICATION

4.3.1 BACKGROUND, PROCESSES AND RATIONALE

General reductions in water quality have been identified as a threat to any frog species that may be present on the site or in downstream reaches. Eutrophication can cause a reduction in water quality by facilitating algal blooms and/or bacterial production, subsequently reducing the amount of dissolved oxygen available. Predominantly eutrophication is associated with high levels of nutrients that may be present in soil, the threats of which have been identified in Section 4.1. An additional source of nutrients present during the construction phase is the storage of human waste. The inappropriate management or disposal of effluent on the site during the construction phase may result in a significant reduction in the water quality values present within Jumrum Creek and the downstream receiving environment.

4.4 GENERAL WASTE

4.4.1 BACKGROUND, PROCESSES AND RATIONALE

Additional reductions in water quality can occur from poor waste management practices. Inappropriate waste management regimes are likely to adversely impact waters through runoff of contaminants. Additional there is the potential for wildlife to ingest or become entangled in litter that has been disposed of inappropriately. There are also aesthetic impacts associated with litter and waste as well as economic impacts through poorly managed waste practices.

5. CONTROLS

Controls are measures that can be implemented to minimise the threats as nominated in Section 4. The majority of controls relevant to the eco@jumrum estate are the provision and implementation of adequate erosion and sediment control devices as well as policies and procedures for maintaining equipment, effluent disposal and general waste management across the site.

5.1 Erosion and Sediment Controls

5.1.1 General Principles

- Work schedules should be co-ordinated to ensure there are no delays in construction activities, preventing disturbed land from remaining un-stabilised for long time periods.
- Should there be a pause in construction, the site must be stabilised (i.e. mulched, ripped and/or seeded).
- Areas of disturbance must be minimised at all times. Work areas are to be sectioned into small, manageable components.
- Disturbed areas must be stabilised within 7 days of completion of works.
- Extra sediment traps, sediment fences, silt curtains and/or hay bales should be stored on site for use if required during unexpected storm activity.
- Construction should aim to be undertaken during periods of expected low rainfall (i.e. limit construction activities during the wet season; December – April).

5.1.2 Clean Water Diversion

The most effective way of managing erosion and reducing sediment loads from disturbance is to divert all clean water, not impacted in any way from construction activities, away from any storage or disturbance on the site.

Design specifications for clean water diversion drains include:

- Size to the 1 in 1 year (1 AEP) critical duration / time of concentration event if the structure is to have a design life of less than 6 months;
- Size to the 1 in 2 year (0.5 AEP) critical duration / time of concentration event if the structure is to have a design life of greater than 6 months;
- Limit gradients where possible; and
- Minimum specifications of 1.0m width, 0.5m depth, trapezoidal or circular shape.

Drains installed in dispersive soils can require high degrees of maintenance, can fail, or exacerbate erosion. If drains are to be installed in dispersive soils, they must be lined with a non-dispersive material.

5.1.3 Temporary Contour Banks and Catch Drains

Contour banks are small walls of earthen material installed along the contour (Figure 10). These reduce the velocity of overland flow down a slope. The presence of these contour banks minimises the chances for rill and gully erosion to develop by intercepting the downward flow of the waters especially in cleared areas, such as building envelopes.

Contour banks are often stand-alone features used to minimise runoff velocities. However, they can be used to deliver sediment-laden water to more permanent, armoured drop structures travelling normal to the contour.

It is recommend that contour banks should be designed for the 10 minute Q10 ARI (0.1 AEP) storm event. The size (height) of the contour bank will determine its effectiveness in preventing erosion down-slope.

Figure 10: Unlined catch drains to reduce erosion processes

5.1.4 Sediment Trapping Devices

Hay bales, sediment traps and/or sediment fences are temporary measures installed to minimise sediment loads within runoff generally during earthworks. These structures are designed to intercept flow and encourage deposition. However, hay bales can also be used to slow velocities in areas of concentrated flow, to reduce the risk of damage.

Hay bales should be installed at intervals no greater than 50 m in areas where flow velocities must be reduced. The bales should be secured with star pickets where necessary.

In areas of heavy concentrated flow sediment fences or sediment traps can be used in conjunction with hay bales to improve water retention. However, since both of these structures are only designed to be temporary, they may be prone to damage if subjected to large flow events.

Design guidelines for sediment fences include:

- Flow rate is less than 50 L/sec through the structure;
- Star pickets with a spacing of no more than 2 m;
- Sediment fence must extend 0.2 m into the ground at a minimum; and
- Height should be limited to 0.6m above ground.

Typically hay bales are installed with sediment fences to ensure that the flow rate is less than 50 L/sec (0.05m^3/sec) through the structure, limiting the risk of damage or dislodgement during flow events. Note; rock check walls are an acceptable alternative to hay bales.

5.1.5 ROADWAYS

Construction of temporary roadways can exacerbate erosion as vegetation is removed and soil is exposed directly to rainfall/runoff. There are several different methods for limiting the erosion processes and subsequent amount of sediment laden water running off temporary roads and tracks. Figure 11 displays some general designs for drains and sediment ponds to minimise soil erosion from temporary roads / tracks.

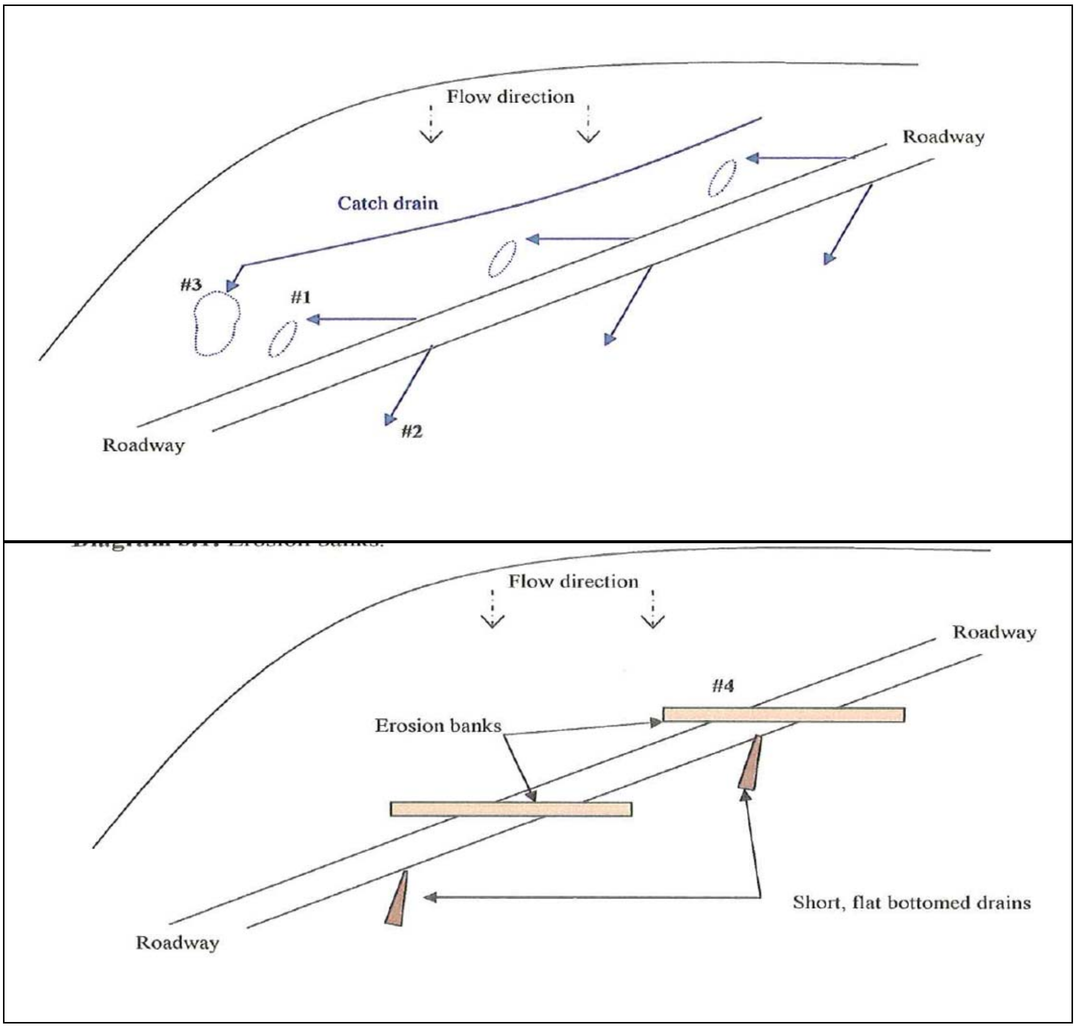


Figure 11: Desired construction method for temporary roadways associated with construction activities (plan view)

5.1.6 CREEK CROSSINGS

It has been identified that during the construction phase a creek crossing will be installed. As discussed in Section 4.1.2, creek crossings already established at the site are adversely impacting downstream water quality. Therefore, the developer must ensure all creek crossings are installed in a way that can maintain the downstream flow and WQOs.

The flow objective states that flow in Jumrum Creek or its tributaries will not be interrupted, ceased or reduced as a result of construction works. All dry crossings, temporary or permanent, must be adequately designed by a qualified engineer to maintain natural flows. For this to occur culverts of a suitable dimension will have to be installed at all dry crossings. At both the upstream and downstream ends of the culvert, cobble stones (i.e. rock protection) must be placed in the bed of the creek to reduce the possibility of scour around the culverts. On the downstream side of the culvert this cobble must extend for a distance of approximately 8.5 m (as per approved engineering drawings). During the construction of the crossing a permeable silt curtain (or sediment fence) should be installed at the downstream end of the 8.5 m cobble section to reduce any turbidity that is present within the water column. A further 1 m of reach of cobble must also be place in the bed of the creek downstream of the installed silt curtain.

Further, it is recommended that any fill material used in the construction of culverts is course material that is unlikely to create a sediment plume. It is essential that all works for any crossings are conducted during the dry season when flows are reduced. During the construction phase of the development the creek crossings will have to be inspected on a daily basis to ensure that scour is not occurring around the culvert, the permeable silt curtain is functioning properly and to monitor the sedimentation on the upstream side of the silt curtain. If there is a significant build-up of sediments on the upstream side of the silt curtain then this sediment will have to be removed and disposed of away from the creek.

5.1.7 SOIL STABILISATION

There are multiple soil stabilisation techniques that can be used to minimise the loss of topsoil and enhance sediment deposition. These include:

- Mulching;
- Immediate revegetation and limitation of site disturbance;
- The use of erosion control mats; and
- The use of grass filter strips.

It is recommended these works be used to reduce the volume of soil lost from cleared areas when developing the site. The approved engineering drawings state that the back of all kerb and channel areas will have at least a 400 mm wide turf strip installed. The remaining disturbed areas (including verges, batters of cut and fill, etc.) within lots will be either seeded or hydro-mulched as appropriate to promote vegetation growth; similar to that shown in Figure 12.

Figure 12: Use of a grassed filter strip for erosion control and sedimentation

5.2 Equipment Maintenance

5.2.1 General Principles

While it is expected that no extensive servicing of machinery or equipment will occur on-site, there is the possibility that oils, lubricants or other chemicals could adversely impact water quality and ecosystem values if not appropriately managed. The following polices must be adopted across the site:

- Refuelling on the site will be limited. If any refuelling does need to occur on site, it must be undertaken within an appropriately bunded area at least 50 m from any drainage line. There will be no long-term storage of fuel, oil or chemicals on the site and any storage will be in accordance with AS1940 Storage and Handling of Flammable and Combustible Liquids;
- Safe handling techniques must be adopted during refuelling and other activities involving chemicals; such as the use of hoses, funnels or siphons to prevent/limit spillage;
- The volume of fuels and chemicals stored on-site will be limited to the minimum volumes required to conduct business on a week-week basis;
- On-site maintenance of equipment will be limited to minor works only in order to prepare machinery and/or equipment requiring works to be transported off-site. Major equipment maintenance works will be conducted off-site in an appropriate facility;
- Any personnel conducting minor maintenance works must be familiar with appropriate clean up procedures in case of a spill (refer to Section 5.2.2);
- All equipment when not in use will be stored in designated areas at least 50 m away from any drainage channel;
- Refuelling, minor maintenance and storage areas will be kept free from accumulation of spilled hydrocarbons and other waste material;
- Wash down of plant and/or equipment should be limited on the site. If wash down of plant and/or equipment must occur on site it must be confined to a designated area (preferably grassed) at least 50 m away from any drainage channel; and
- Before any equipment is used on site it must be thoroughly checked to insure it is in good working order and clean of large amounts of exposed grease and oils.

5.2.2 Corrective Actions

In the event of a spill, the following corrective actions must be taken:

- Ensure any additional spill is prevented (such as closing valves, inverting damaged containers, plugging leak, etc.) if safe to do so;
- Clean up excess spilled material using easily removable absorptive material such as saw dust;
- Contaminated land/water will be contained and contaminated material placed into a secure water tank, water truck or other storage device to prevent the migration of the contaminant into the surrounding landscape before disposal at the nearest appropriately licensed disposal facility; and
- If the spill occurs outside of the bunded area or breaches the bunded area seek professional advise from qualified land contamination and remediation experts and undertake their recommendations.

Please be advised that the developer/site manager should have more detailed Standard Operating Procedures (SOPs) for corrective actions associated with spills. The measures outlined above are considered additional to those within the SOP, as they outline site specific requirements.

5.3 ABLUTION FACILITIES

No permanent ablution facilities are currently present within the development area. During the construction phase of the development an adequate amount of portable ablution facilities will be installed onsite. These ablution facilities will be located at a minimum of 50 m from any drainage channel and serviced by qualified personnel. All wastes created by these ablution facilities will be transported offsite. All effluent will be contained within the portable amenity facilities and disposed of via an approved disposal system, in accordance with any conditions imposed by relevant authorities.

5.4 WASTE

To adequately deal with waste management, the development will enforce the following policies/procedures:

- All staff will be adequately trained in environmentally responsible waste treatment and disposal;
- Purchase of new materials or products for use at the site will be controlled to prevent accumulation of unwanted products and generation of excess waste;
- Any cleared vegetation will be chipped and reused for mulch to protect the soil from erosion and promote rehabilitation works;
- Adequate and appropriate waste receptacles will be provided on site for all potential types of waste generated during the construction phase;
- All domestic and industrial waste generated at the site will be removed from the site and disposed at the nearest licensed disposal facility, as required;
- All waste will be removed from the site in an environmentally responsible and lawful manner in accordance with the requirements of the relevant authorities;
- Ensure that solid waste storage containers do not allow the seepage of leachate and that liquid waste containers do not leak; and
- Ensure wastes are stored only in designated areas where pollution can be controlled in case of accidental spills or leaks.

6. MONITORING PROGRAM

6.1 WATER QUALITY

The detailed Water Quality Monitoring Program for the development site is included as Appendix 1.

6.2 SEDIMENTATION

6.2.1 BACKGROUND

Signs of sedimentation include:

- Bed smothering – where everything on the bed of the river (i.e. woody debris, rocks, etc.) is coated in a layer of fine sediment (Figure 13).
- Turbid flows – where the clarity of water is greatly decreased downstream of a disturbance (Figure 14). However, during high flow events it is expected that the turbidity of waters within the stream will greatly increase. During these times there may not be a noticeable difference between upstream and downstream of the disturbance. During low flow periods waters within the stream should be mostly clear in shallow sections (Figure 15) and deeply dark for deeper sections (Figure 16).

Figure 13: Example of bed smothering

Figure 14: Example of turbid water associated with sedimentation in the waterway

Figure 15: Example of typical conditions (non turbid) in a shallow section of stream - slight milkiness and high clarity

Figure 16: Example of typical conditions (non-turbid) in a deep section of stream - clear in shallow sections and dark in deeper pools

6.2.2 ROLES AND RESPONSIBILITIES

Monitoring of sedimentation will be via visual inspection by the earthmoving contractor as well as the supervising civil engineer.

6.2.3 FREQUENCY

- Daily checks of sedimentation will be required for all creek crossings or any other earthworks that directly interfere with Jumrum Creek or any of its tributaries.
- Soil erosion and sediment control facilities should be inspected on a weekly basis, and during storm events, and the results of these inspections summarised in the monthly construction report.
- Silt fences and silt curtains should be checked regularly, especially following storm events, with silt cleaned out from behind silt fences and other sediment control devices.
- Discharges from erosion and sediment control facilities should be sampled following significant storm events and analysed for suspended solids. If suspended sediment levels exceed specified WQOs during construction, any non-compliance should be reported to the administering authority.

7. CORRECTIVE MEASURES

7.1 BREACH OF WATER QUALITY OBJECTIVES

The following conditions / actions are proposed to be implemented at the eco@jumrum development site with respect to analysis of water quality samples:

1. Upon receipt of water quality results from SGS Australia, all results must be assessed against the WQOs as outlined in Table 1, page 16.
2. If the quality characteristics of the downstream site exceed any of the WQOs as outlined in Table 1, page 16, compare the downstream results to upstream results during the same event.
3. If downstream results do not exceed upstream results no further action is required.
4. If downstream results exceed upstream results, comparison of downstream results to all historical upstream results (within the previous 2 years) must be undertaken. If downstream results do not exceed all upstream results, then no further action is to be taken.
5. If downstream results exceed all upstream results collected in the previous 2 years, then the developer must conduct (and record) an audit of the site to determine if there are any sources of contaminants entering the waterway as a result of construction activities. The audit may require additional sampling to identify points in the creek system where contaminants are entering. The Minister must be notified within no later than 2 business days of becoming aware of the breach and with the findings of the audit within ten (10) business days of the developer becoming aware of the exceedance.

7.2 SEDIMENTATION

These corrective actions apply if the earthmoving contractor or site manager, observe sedimentation effects within Jumrum Creek or any of its tributaries:

1. Locate the source / activity that caused sedimentation (if possible);
2. Cease the activity or prevent excess sediments from entering the creek;
3. Undertake sampling for Total Suspended Solids (TSS) using green non preservative bottles. Obtain a sample from upstream of the sedimentation impact and downstream of the sedimentation impact. Record locations. Send samples to a NATA accredited laboratory for testing of TSS (approx. $12 per sample);
4. Implement any additional controls required to prevent sediments from entering Jumrum; and
5. Once TSS results are obtained from the laboratory the Site Manager must then follow the steps outlined in Section 7.1 for further assessment.

8. REPORTING REQUIREMENTS

8.1 REPORTING

The developer must provide a **yearly** report to the Minister in accordance with condition 8 of the approval dated 5 August 2014 and condition 7 of the correction notice dated 13 August 2014.

8.1.1 CONTENT

The content of the yearly report must include:

- Progress with construction activities to-date;
- Detail all water quality sampling undertaken since inception of the monitoring program;
- If the proposed water quality monitoring regime was altered in any way, provide justification for the alterations;
- Comparison of all water quality results to Water Quality Objectives outlined in Table 1, page 16;
- Any exceedances of water quality objectives, comparison of information to upstream sites and actions taken to ensure compliance with objectives. Information included must include:
  - The time, date and duration of the non-compliance;
  - Details of corrective measures implemented; and
  - Details of management practices that have led to increased environmental performance;
- Results of sedimentation monitoring visual inspections; and
- Projected works for the upcoming year.

8.2 RESPONSIBILITIES

Responsibilities for communication, monitoring, reporting and implementation of mitigation and corrective measures are outlined in Table 2.

Table 2: Summary of environmental management responsibilities

Action / Function	Daily	Quarterly
Construction Activities Management	Site Manager	Site Manager
Environmental Monitoring	Site Manager	Developer or nominated representative
Environmental Reporting	Site Manager	Developer or nominated representative
Internal Environmental Audit	Site Manager	Developer or nominated representative
Independent Review	N/A	Developer's nominated representative

9. REFERENCES

Department of Environment. 2008. *Approved Conservation Advice for* Archontophoenix myolensis *(Myola Archontophoenix).*

Department of Environment. 2009. *Approved Conservation Advice for* Litoria myola *(Kuranda Tree Frog) (s266B of the Environment Protection and Biodiversity Conservation Act 1999).*

EHP. 2014. *Barron River Basin Enviornmental Values and Water Quality Objectives – Basin No. 100 and adjacent coastal waters*.

Ecosmart Ecology. 2012. *Threatened Frog Report – eco@jumrum, Kuranda*. Prepared for Steve Tailor and Partners Pty Ltd

APPENDIX 1 – WATER MONITORING PROGRAM

A1.1 MONITORING SITES

There are three monitoring sites nominated for the eco@jumrum development in accordance with EPBC conditions. The monitoring points have been strategically located to detect changes in ambient water quality as a result of the proposed development.

Site selection has been based on the principles outlined in the EPBC Approval in that an upstream, downstream and mid-point have been chosen as the monitoring sites. However, site access during periods of increased flow was also taken into consideration. The locations of the monitoring points are provided in Table 3 and Figure 17.

Table 3: Monitoring locations

Site	Easting (MGA 94; Zone 55)	Northing (MGA 94; Zone 55)
Upstream	0352744	8137337
Mid	0353021	8137587
Downstream	0353517	8138092

A1.1.1 UPSTREAM SITE

The upstream monitoring point is situated approximately 150 m from the property boundary of Lot 72 on RP903071. This point is easily accessible and although it does not comply with the 50 m upstream requirement of the EPBC approval (as access could not be gained 50 m upstream), it will effectively monitor the quality of waters entering the site.

Access is already provided to the monitoring point from parkland associated with Spring Close. The parkland occurs on easement B/SP214824 and C/SP214824 at 4 and 6 Spring Crescent respectively and is outlined in Figure 18.

There is a pathway and bridge crossing over Jumrum Creek allowing direct access to the creek a further 40 m closer to the site Figure 18.

The site will capture inflows from the rural-residential development along Spring Close. Two other tributaries enter the site nearby to the designated upstream site. However, access to these locations via publically owned land is not available.

A1.1.2 MID SITE

As required by EPBC conditions there is a monitoring site designated approximately half way along the section of Jumrum Creek within the development's footprint. The site is situated in Lot 17 in Stage 2C, approximately 40 m from the boundary of the allotment with the adjacent property – Lot 73 on RP903071, 1593 Kennedy Highway. Data from this monitoring point will show:

- Any additional contaminants entering Jumrum Creek from lots associated with Jumrum Close, Penny Close and Williamson Drive; and
- Any additional contaminants entering Jumrum Creek from Stage 2C and sections of Stage 3E and 3A.

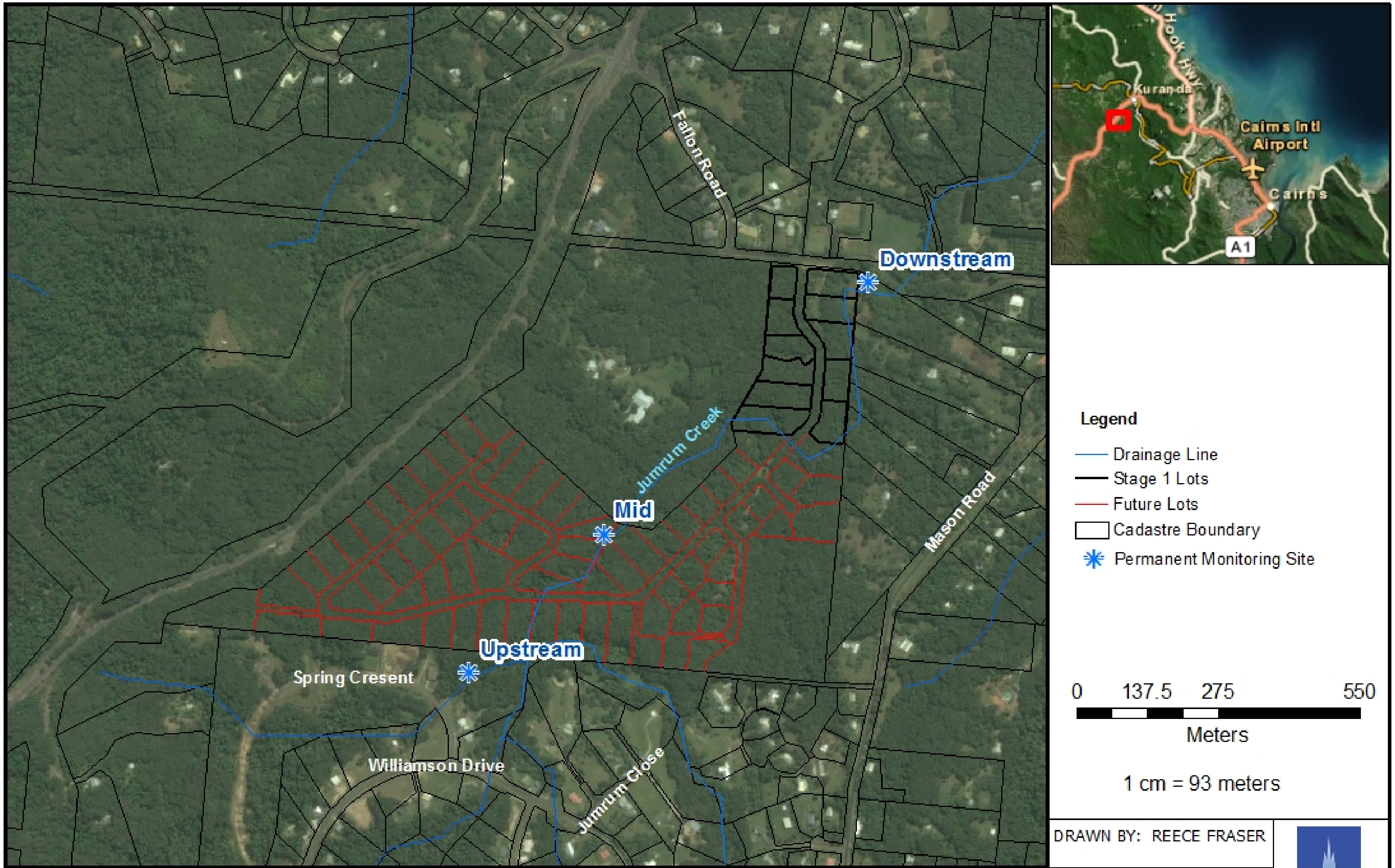


Figure 17: Location of monitoring points

Figure 18: Upstream monitoring site, including the view from Spring Crescent (upper left); the boardwalk over Jumrum Creek (upper right); the walkway to monitoring point (lower left); and the monitoring location (lower right)

A1.1.3 DOWNSTREAM SITE

The downstream monitoring point is situated 45m from the boundary of Lot 11 and is adjacent to 26 Masons Road, Kuranda (Figure 19). Access is provided by walking through a small section of parkland to Jumrum Creek (Figure 19).

The site has been placed at this location so that it is upstream of any impacts caused by Fallon Road on water quality. C&R's experience is that road crossings of creeks can have a minor, local impact immediately downstream. Macroinvertebrate numbers can be reduced in a local area as a result of hydrocarbons washing off the road. Hence, the monitoring point has been located upstream of Fallon Road so that impacts such as this are not attributed to the development of the eco@jumrum estate.

Figure 19: Downstream monitoring site including the entrance from Fallon Road (upper left); the right hand turn after the entrance (upper right); and the monitoring point (bottom)

A1.2 MONITORING PARAMETERS

Water quality samples must be collected from all monitoring sites and lodged with a NATA accredited laboratory for analysis. At the client's request SGS Australia will be used to analyse water quality as they have a local laboratory in Cairns. Additionally, while collecting laboratory samples, in-situ measurements of various physical water quality characteristics must be taken with a calibrated water quality meter.

Table 4 outlines the analytes recommended for analysis.

Table 4: Water quality monitoring parameters

Type	Parameters
In-situ testing	
Physical	pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Temperature & Turbidity (if capable)
Laboratory testing	
Physical	pH, EC, Turbidity (if not tested in-situ & Total Suspended Solids (TSS)
Cations / Anions	Ca, Mg, Na, K, Cl, SO_4, Alkalinity & F
Metals (Dissolved and Total)	Fe, Mn, Z, Cu, Al, As, Cd, Cr, Pb, Hg & Ni
Nutrients	Total Nitrogen, Total Phosphorous, Ammonia as N & Filterable reactive phosphorous, Silica (reactive).
Petroleum Hydrocarbons	TPH/TRH, BTEXN

A1.2.1 EQUIPMENT

Equipment required for water quality sampling will include:

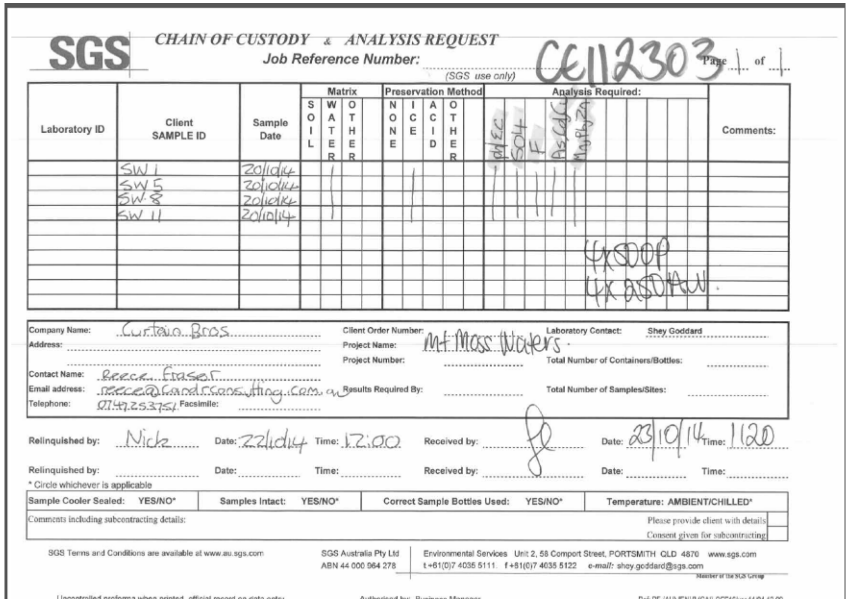
- Telescopic sampling pole;
- Calibrated in-situ water quality meter and associated probes;
- Sampling bottles provided by the laboratory;
- Field filters and syringes;
- Esky and ice bricks;
- Chain of custody;
- Powder-free latex gloves; and
- Camera (a mobile phone camera can be used if necessary).

Full descriptions on each of these pieces of equipment are provided in Table 5.

Table 5: Equipment needed for water quality sampling

Equipment	Description / Use	Number / Comment	Photograph
Sampling Pole (desirable)	The sampling pole is used to lower a sample bottle into the water column from a distance. This can be used to sample the water column away from the bank.	1x Used to access water column	
Sampling Bottles	Sampling bottles are provided by SGS Cairns. Different bottles will be required depending on the types of analyses undertaken. Some analyses (i.e. hydrocarbons, metals, nutrients) require that the bottles are pre-treated with preservative.	**Per Sample** 1x 500ml NP Plastic Gen – Chem 1x Blue Micro Bottle Cairns 1x Acid Wash Twin Pack Metals (Red) 1x 1L Amber Glass Organics	
Field Filters and Syringe	A 0.45µm filter to be placed on the end of a syringe is required to filter waters before being placed in one "Acid Wash Twin Pack – Metals" bottle. This is for	Approx. 10x field filters per sampling trip 1x syringe for each	SGS Australia to provide field filters and syringes.

Equipment	Description / Use	Number / Comment	Photograph
	dissolved metals. Multiple filters may be required per sample.	sampling site	
Esky	Sample bottles are put into an esky with ice bricks to keep cool and prevent over-heating.	1x – enough to hold all sample bottles	SGS Australia to provide Esky
Ice Bricks	Ice bricks are required to cool the samples.	Multiple	SGS Australia to provide Ice Bricks. If not, frozen water bottles or commercially available ice bricks may be used.
In-situ meter (pH, EC, Temperature, Turbidity, Dissolved Oxygen)	Not all parameters monitored can be analysed by the laboratory as they will change with increasing time within the sample bottles. Subsequently an in-situ meter is required to measure pH, electrical conductivity, , temperature, turbidity and dissolved oxygen		 *NOTE: This is an example only. Water quality meters can be purchased from outlets such as Hydroterra, John Morris Scientific or Thermofisher.*

Equipment	Description / Use	Number / Comment	Photograph
Chain of Custody Documentation	Chain of Custody (COC) documents are provided by the SGS Laboratory. The samples and types of analyses are nominated on the COC documents and handed to the laboratory when delivering the samples.		

SGS **CHAIN OF CUSTODY & ANALYSIS REQUEST**

Job Reference Number: CE112303 (SGS use only) Page 1 of 1

Laboratory ID	Client SAMPLE ID	Sample Date	Matrix: SOIL	Matrix: WATER	Matrix: OTHER	Preservation Method: NONE	Preservation Method: ICE	Preservation Method: ACID	Preservation Method: OTHER	Analysis Required: pH/EC	SO4	F	As,Cd,Cu	Mg,Pb,Zn	Comments:
	SW 1	20/10/14		✓			✓			✓	✓	✓	✓	✓	
	SW 5	20/10/14		✓			✓			✓	✓	✓	✓	✓	
	SW 8	20/10/14		✓			✓			✓	✓	✓	✓	✓	
	SW 11	20/10/14		✓			✓			✓	✓	✓	✓	✓	

4x500P
4x 250 HAW

Company Name: Curtain Bros
Address:
Contact Name: Reece Fraser
Email address: reece@candrconsulting.com.au
Telephone: 0747253751 Facsimile:
Client Order Number:
Project Name: Mt Moss Waters
Project Number:
Results Required By:
Laboratory Contact: Shey Goddard
Total Number of Containers/Bottles:
Total Number of Samples/Sites:

Relinquished by: Nick Date: 22/10/14 Time: 12:00 Received by: [signature] Date: 23/10/14 Time: 1120
Relinquished by: Date: Time: Received by: Date: Time:
* Circle whichever is applicable

Sample Cooler Sealed: YES/NO* | Samples Intact: YES/NO* | Correct Sample Bottles Used: YES/NO* | Temperature: AMBIENT/CHILLED*

Comments including subcontracting details:
Please provide client with details
Consent given for subcontracting

SGS Terms and Conditions are available at www.au.sgs.com
SGS Australia Pty Ltd ABN 44 000 964 278
Environmental Services Unit 2, 58 Comport Street, PORTSMITH QLD 4870 www.sgs.com
t +61(0)7 4035 5111 f +61(0)7 4035 5122 e-mail: shey.goddard@sgs.com
Member of the SGS Group

A1.2.2 PROCEDURE

The following numbered points outline the procedure to follow when sampling at each monitoring point:

1. Ensure in-situ water meter is charged and calibrated prior to field trip. .
2. Once at the monitoring site set bottles up for filling.
3. Rinse the sampling pole in the water to be sampled.
4. Attach the large green sample bottle on to the end of the sampling pole.
5. When inserting the sample jar into the water place it open side down so no water can initially enter then when ~20cm below the surface rotate the pole so the sample bottle releases the captured air and fills. Use this large green bottle to fill all other sample bottles from the same site. This may require several insertions into the target water body.
6. Fill all other the sample bottles from the 1x Green Labelled Non-Preservative Plastic bottle. Make sure the correct lids are on the correct bottles. Don't sit the lids on the ground. Please ensure:
   (a) For dissolved metals a syringe must be filled, a 0.45µm filter attached, and then the syringe discharged into one of the 1x Acid Wash Twin Pack bottles. Repeat until filled. This only has to occur with one of the two acid wash twin pack bottles.
   (b) The 1L Amber Glass bottle must be filled with zero headspace minimising the exposure to air. This means that there can be no air between the cap of the bottle and the water surface within the bottle. Care must be taken to not overfill the amber glass vials and spill the sample as well as this will reduce the amount of preservative in the bottle.
7. After filling, write on the bottles site location, time, date, sampler and company.
8. Put samples on ice / ice bricks within the eskies.
9. Use the in-situ water meter to measure pH, Dissolved Oxygen, Temperature and EC (turbidity can also be measured here if the meter is capable, although it can also be measured in the lab).
10. The in-situ reading should also be taken at a depth of ~20cm below the surface of the water body.
11. Ensure the results stabilise on the screen prior to recording on field sheets.
12. Complete COCs prior to dropping samples off at the laboratory.
13. All samples are to be sent to a NATA accredited laboratory for testing of the required parameters.
14. Please note, if wearing sunscreen or insect repellent use powder-free latex gloves when sampling and handling bottles.

A1.2.3 MONITORING FREQUENCY

As outlined in the EPBC approval, monitoring must "*begin at least three months prior to the commencement of the action to establish practicability of the monitoring regime and to provide baseline data. A higher frequency of monitoring is required for the first twelve months following commencement of the action; following heavy rainfall events and during the main breeding seasons for the above named frog species*".

Subsequently the peak breeding seasons for the threatened and endangered frog species requiring EPBC approval are outlined in Table 6,as reported by Ecosmart Ecology (2012).

Table 6: Breeding seasons for threatened and endangered frog species

	January	February	March	April	May	June	July	August	September	October	November	December
Kuranda Tree Frog			■							■		
Waterfall Frog			■								■	
Common Mistfrog									■	■	■	
Lace Eyed Tree Frog	■	■	■	■						■	■	■

The main seasons to increase water quality sampling effort for the eco@jumrum estate will be Spring and Summer or more accurately between September and April (Table 6). This corresponds roughly to the wet season, although peak rainfall for the wet season occurs in January – March.

Therefore, the following monitoring program is proposed:

- Samples are collected and analysed from all monitoring points at least every two (2) weeks during the September – April period for the first 12 months during construction activity.
- Samples are collected and analysed from all monitoring points at least every four (4) weeks during the May – August period for the first 12 months during construction.
- Samples are collected and analysed from all monitoring points at least every four (4) weeks during the September – April period after the initial 12 month construction period, until construction works have finalised for the entire estate.
- Samples are collected and analysed from all monitoring points at least every eight (8) weeks during the May – August period after the initial 12 month construction period, until construction works have finalised for the entire estate.
- As per the EPBC Approval it is recommended that samples are collected and analysed from all monitoring points at least every two (2) weeks in the 3 months prior to any construction activity to assist in establishing a baseline for the area.

APPENDIX 2 – WATER QUALITY NOTES

Water quality samples of the upstream and downstream site were collected on 06 November 2014 and analysed for a range of parameters. The purpose of this sampling was to generally screen the waters in Jumrum Creek for a range of contaminants to:

- Identify any quality characteristics already occurring above regional Water Quality Objectives; and
- Screen for contaminants that may not occur in Jumrum Creek in reportable quantities.

Results of the water quality sampling are provided overleaf. From this sampling it is evident that:

- The upstream sample is not compliant with all water quality objectives nominated for Jumrum Creek in the Barron River Environmental Values Document (EHP, 2014), including;
  - Sodium Adsorption Ratio;
  - Electrical Conductivity;
  - Total Hardness;
  - Calcium;
  - Magnesium;
  - Sodium;
  - Chloride;
  - Sulphate;
  - Dissolved chromium;
  - Dissolved iron; and
  - Dissolved silicon.

  Of the above parameters, all values are within acceptable ranges for outside the Wet Tropics region and applicable in National ANZECC (2000) guidelines (i.e. 250mg/L sulphate is commonly applied drinking water standard; 1,000µS/cm is a commonly applied electrical conductivity standard, etc.).
- At the downstream site, almost all parameters are below the concentration at the upstream site. Subsequently, under the corrective measures framework applied in this WMP, there is no action required for these parameters even though downstream water quality results exceed the WQOs.
- Any Total Petroleum Hydrocarbons (TPH) or Total Recoverable Hydrocarbons (TRH), Organochlorine Pesticides (OCs) or Organophosphorous Pesticides (OPs) were not recorded above the limit of reporting at either the upstream or downstream monitoring points.

Parameter	Units	LOR	Water Quality Objective	Upstream		Downstream	
Physical Parameters							
pH Value	pH Unit	0.01	6-8	**6.99**		**7.39**	
Sodium Adsorption Ratio	-	0.01	0.6-0.95	**1.91**		**1.29**	
Electrical Conductivity @ 25°C	µS/cm	1	47	**266**		**139**	
Total Dissolved Solids (Calc.)	mg/L	1		**173**		**90**	
Suspended Solids (SS)	mg/L	1	8	**8**		**5**	
Total Hardness as CaCO3	mg/L	1	8-29	**53**		**29**	
Cations / Anions							
Calcium	mg/L	1	5	**8**		**5**	
Magnesium	mg/L	1	4	**8**		**4**	
Sodium	mg/L	1	11	**32**		**16**	
Potassium	mg/L	1		**1**		<1	
Chloride	mg/L	1	6-14	**55**		**20**	
Sulphate as SO_4	mg/L	1	1-2	**11**		<10	
Fluoride	mg/L	0.1	0.01-0.11			<0.1	
Bromide	mg/L	0.010		**0.183**		**0.077**	
Hydroxide Alkalinity as $CaCO_3$	mg/L	1				<1	
Carbonate Alkalinity as $CaCO_3$	mg/L	1				<1	
Bicarbonate Alkalinity as $CaCO_3$	mg/L	1				**31**	
Total Alkalinity as $CaCO_3$	mg/L	1				**31**	
Metals				**Dissolved**	**Total**	**Dissolved**	**Total**
Aluminium	mg/L	0.01	0.055[#]	<0.01	0.01	**0.02**	**0.03**
Arsenic	mg/L	0.001	0.024[#]	<0.001	0.001	**0.001**	**0.002**
Beryllium	mg/L	0.001		<0.001	0.001	<0.001	<0.001
Barium	mg/L	0.001		**0.018**	0.001	**0.008**	**0.012**
Cadmium	mg/L	0.0001		<0.0001	0.0001	<0.0001	<0.0001

Parameter	Units	LOR	Water Quality Objective	Upstream		Downstream	
Chromium	mg/L	0.001	0.001#	**0.005**	0.001	**0.004**	<0.001
Cobalt	mg/L	0.001		<0.001	0.001	<0.001	<0.001
Copper	mg/L	0.001	0.030	<0.001	0.001	<0.001	<0.001
Lead	mg/L	0.001	0.0034	<0.001	0.001	<0.001	<0.001
Manganese	mg/L	0.001	1.9#	**0.002**	0.001	**0.003**	**0.115**
Molybdenum	mg/L	0.001		<0.001	0.001	<0.001	<0.001
Nickel	mg/L	0.001	0.011#	**0.004**	0.001	**0.003**	<0.001
Selenium	mg/L	0.01		<0.01	0.01	<0.01	<0.01
Strontium	mg/L	0.001		**0.078**	0.001	**0.037**	**0.043**
Vanadium	mg/L	0.01		<0.01	0.01	<0.01	<0.01
Zinc	mg/L	0.005	0.02#	<0.005	0.005	<0.005	<0.005
Boron	mg/L	0.05		<0.05	0.05	<0.05	<0.05
Iron	mg/L	0.05	0.2#	**1.08**	0.05	**0.87**	**1.29**
Mercury	mg/L	0.0001	0.0006	<0.0001	0.0001	<0.0001	<0.0001
Silicon as SiO2	mg/L	0.1	10-21#	**30.8**		**24**	
Nutrients							
Nitrite as N	mg/L	0.01		<0.01		<0.01	
Nitrate as N	mg/L	0.01		**0.01**		**0.02**	
Nitrite + Nitrate as N	mg/L	0.01		**0.01**		**0.02**	
Total Kjeldahl Nitrogen as N	mg/L	0.1		**0.4**		**0.3**	
Total Nitrogen as N	mg/L	0.1	0.229-0.688	**0.4**		**0.3**	
Total Phosphorus as P	mg/L	0.01	0.01-0.07	<0.01		<0.01	
Organochlorine Pesticides							
alpha-BHC	µg/L	0.5		<0.5		<0.5	
Hexachlorobenzene (HCB)	µg/L	0.5		<0.5		<0.5	
beta-BHC	µg/L	0.5		<0.5		<0.5	

Parameter	Units	LOR	Water Quality Objective	Upstream	Downstream
gamma-BHC	µg/L	0.5		<0.5	<0.5
delta-BHC	µg/L	0.5		<0.5	<0.5
Heptachlor	µg/L	0.5		<0.5	<0.5
Aldrin	µg/L	0.5		<0.5	<0.5
Heptachlor epoxide	µg/L	0.5		<0.5	<0.5
trans-Chlordane	µg/L	0.5		<0.5	<0.5
alpha-Endosulfan	µg/L	0.5		<0.5	<0.5
cis-Chlordane	µg/L	0.5		<0.5	<0.5
Dieldrin	µg/L	0.5		<0.5	<0.5
4.4`-DDE	µg/L	0.5		<0.5	<0.5
Endrin	µg/L	0.5		<0.5	<0.5
beta-Endosulfan	µg/L	0.5		<0.5	<0.5
4.4`-DDD	µg/L	0.5		<0.5	<0.5
Endrin aldehyde	µg/L	0.5		<0.5	<0.5
Endosulfan sulfate	µg/L	0.5		<0.5	<0.5
4.4`-DDT	µg/L	2.0		<2.0	<2.0
Endrin ketone	µg/L	0.5		<0.5	<0.5
Methoxychlor	µg/L	2.0		<2.0	<2.0
Total Chlordane (sum)	µg/L	0.5		<0.5	<0.5
Sum of DDD + DDE + DDT	µg/L	0.5		<0.5	<0.5
Sum of Aldrin + Dieldrin	µg/L	0.5		<0.5	<0.5
Organophosphorous Pesticides					
Dichlorvos	µg/L	0.5		<0.5	<0.5
Demeton-S-methyl	µg/L	0.5		<0.5	<0.5
Monocrotophos	µg/L	2.0		<2.0	<2.0
Dimethoate	µg/L	0.5		<0.5	<0.5

Parameter	Units	LOR	Water Quality Objective	Upstream	Downstream
Diazinon	µg/L	0.5		<0.5	<0.5
Chlorpyrifos-methyl	µg/L	0.5		<0.5	<0.5
Parathion-methyl	µg/L	2.0		<2.0	<2.0
Malathion	µg/L	0.5		<0.5	<0.5
Fenthion	µg/L	0.5		<0.5	<0.5
Chlorpyrifos	µg/L	0.5		<0.5	<0.5
Parathion	µg/L	2.0		<2.0	<2.0
Pirimphos-ethyl	µg/L	0.5		<0.5	<0.5
Chlorfenvinphos	µg/L	0.5		<0.5	<0.5
Bromophos-ethyl	µg/L	0.5		<0.5	<0.5
Fenamiphos	µg/L	0.5		<0.5	<0.5
Prothiofos	µg/L	0.5		<0.5	<0.5
Ethion	µg/L	0.5		<0.5	<0.5
Carbophenothion	µg/L	0.5		<0.5	<0.5
Azinphos Methyl	µg/L	0.5		<0.5	<0.5
TPH					
C6 - C9 Fraction	µg/L	20		<20	<20
C10 - C14 Fraction	µg/L	50		<50	<50
C15 - C28 Fraction	µg/L	100		<100	<100
C29 - C36 Fraction	µg/L	50		<50	<50
C10 - C36 Fraction (sum)	µg/L	50		<50	<50
TRH					
C6 - C10 Fraction	µg/L	20		<20	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20		<20	<20
>C10 - C16 Fraction	µg/L	100		<100	<100
>C16 - C34 Fraction	µg/L	100		<100	<100

Parameter	Units	LOR	Water Quality Objective	Upstream		Downstream	
>C34 - C40 Fraction	µg/L	100		<100		<100	
>C10 - C40 Fraction (sum)	µg/L	100		<100		<100	
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	100		<100		<100	
BTEX							
Benzene	µg/L	1		<1		<1	
Toluene	µg/L	2		<2		<2	
Ethylbenzene	µg/L	2		<2		<2	
meta- & para-Xylene	µg/L	2		<2		<2	
ortho-Xylene	µg/L	2		<2		<2	
Total Xylenes	µg/L	2		<2		<2	
Sum of BTEX	µg/L	1		<1		<1	
Naphthalene	µg/L	5		<5		<5	

Water Quality Objectives are for dissolved metals and should not be applied to total metals.