Cosmo Howley Project Area
Biological Monitoring Plan 2022
(Macroinvertebrate, Sediment and Ecotoxicity)

Oct 2022

AGNICO EAGLE

TABLE OF CONTENTS

TABLES

FIGURES

Abbreviations

Acronym	Description
ANZECC	Australia and New Zealand Environmental and Conservation Council
AS	Australian Standards
AUSRIVAS	Australian River Assessment System
PCPA	Pine Creek Project Area
NTMO	Northern Territory Mining Operations Pty Ltd
DENR	Department of Environment and Natural Resources
DPIR	Department of Primary Industry and Resources
EMP	Environmental Management Plan
MMP	Mining Management Plan
PET	Potential Evapotranspiration
NT	Northern Territory
SOP	Standard Operating Procedure
SSTV	Site Specific Trigger Values
SQG	Sediment Quality Guidelines
WDL	Waste Discharge License

1. INTRODUCTION

1.1 Background

The Cosmo Howley Project Area (CHPA) catchment lies within the Adelaide River catchment to the north and the Daly River catchment to the south of the site. Howley Creek is the main sub-catchment system and is fed by creeks including unnamed tributaries draining the CHPA as well Zapopan Creek and Burgan Creek that drain from the BCPA. Other minor sub-catchments in the CHPA are Hayes Creek and Bridge Creek.

Howley Creek flows into the Margaret River which then flows into the Adelaide River, approximately 65 km northwest of the CHPA. The upper reaches of Bridge and Howley Creeks are approximately 210 km from the mouth of the Adelaide River. The regional drainage pathway and catchment plan of the Howley Creek sub-catchment is described in detail in the CHPA Rehabilitation Plan (2021). The creeks and associated tributaries draining the catchments are ephemeral - flowing only during the wet season. Stream flows are highly variable and extremely responsive to rainfall, reaching peak levels between January and March.

NT Mining Operations (NTMO) have adopted an integrated, multiple lines of evidence approach to managing the environmental influences from active and passive discharges entering Howley Creek. This approach includes surface water monitoring, ecotoxicological assessment, macroinvertebrate and sediment monitoring programs; the results of which are used to assess the effects to aquatic ecosystems from active and passive discharges. This integrated environmental assessment also provides information to assist with calculation and applicability of site specific trigger values (SSTVs) in accordance with the guidance provided in ANZECC (2000).

The most important aspect of the multiple lines of evidence approach to environmental monitoring and management is the macroinvertebrate monitoring results and ecotoxicity assessments. By monitoring macroinvertebrates and assessing actual toxicity, an integrated assessment of long-term impacts from exposure to treated mine water can be determined.

1.2 Scope

This Biological Monitoring Plan applies to all personnel and work activities conducted under the direction of NTMO at the CHPA.

This plan specifically discusses assessment of macroinvertebrates, sediment, ecotoxicity and their habitats that are exposed to mine water discharge following the wet season. The biological sampling program is run in conjunction with the Sediment Monitoring Program annually.

1.3 Purpose

The purpose of this plan is to develop on previous biological monitoring and to identify improvements to implement in upcoming monitoring.

NTMO has procedures relating to specific aspects of environmental monitoring and this document provides an overarching plan for the biological monitoring of the integrated environmental monitoring program.

1.4 Strategies

Strategies of this Biological EMP are:

- Ensure compliance with the forth coming WDL180 for Cosmo Howley Project Area;

- Ensure thorough investigations are carried out within Howley Creek receiving system through completing water and biological monitoring and integration of associated plans;
- Ensuring a balance is maintained between mine discharge requirements and storm water accumulation through effective and efficient discharges at opportune times into Howley Creek during active /passive discharges; and
- Ensure discharge is undertaken in a manner that enables appropriate environmental safeguards and controls in accordance with the WDL 180.

2. LEGAL AND OTHER REQUIREMENTS

2.1 Legislation

Applicable legislation to Biological Monitoring at the PCPA includes:

Mining Management Act;

Environment Protection and Biodiversity Conservation Act 1999;

Environmental Offences and Penalties Act;

Water Act 1992;

Waste Management and Pollution Control Act 1998

2.2 Guidelines

The Darwin-Daly regional AusRivAS model has been developed by NTEPA as a user's manual for biological sampling in the Northern Territory.

AUSRIVAS Sampling and Processing Manual, has also been sourced as a useful document for the NTMO SOP.

Surface water quality is assessed against the Australian and New Zealand Environmental and Conservation Council (ANZECC) Water Quality Guidelines 2000.

Cosmo Howley Project Area Waste Discharge Licence

2.3 NTMO Standard Operating Procedures

NTMO Standard Operating Procedures (SOP) applicable to biological management within the project area includes:

- NTMO ES – SOP 01 Surface Water Sampling Procedure;
- NTMO ES – SOP 03 Water Sampling, Packaging and Delivery Procedure;
- NTMO ES – SOP 06 Sampling Remote Sites;
- NTMO ES – SOP 07 YSI Quatro Meter;
- NTMO ES – SOP 13 Sediment Sampling;
- NTMO ES – SOP 31 Incidents and Notification Reporting, and
- NTMO ES – SOP 38 Macroinvertebrate Sampling

2.4 Approval Conditions

Waste Discharge Licence 180 for the discharge of waste waters from the NTMO Cosmo Howley Project Area.

3. BIOLOGICAL MONITORING

3.1 Study Design

The biological Monitoring program outlined in table 1 aims to provide comprehensive data over consecutive years at the same locations. Sampling frequency for macroinvertebrate and sediment is proposed to occur annually at the end of the wet season. These samples will be undertaken during wet season recessional flow period so as to capture the potential effects of mine site runoff.

Table 1 Howley Creek sampling site details

Site Code	Site type	Description	Zone	Easting	Northing	SW*	Macro*	Seds*	Ecotox
CHCK01	Upstream	Howley Creek Upstream water quality control point of Cosmo Howley Mine site	52L	765996	8506947	Y	Y	Y	N
CHCK02	Downstream	On the Stuart Hwy, upstream of the confluence with Howley Creek	52L	757789	8505652	Y	Y	Y	N
CHCK03	Downstream	Tributary of Howley Creek downstream of Acid Ponds and adjacent to haul road.	52L	756770	8506992	Y	Y	Y	N
MTSW02	Downstream	Tributary of Howley Creek, on the Stuart Hwy, heading towards Darwin. Overflow of SFD	52L	755272	8508888	Y	Y	Y	N
CHCK05	Downstream	Stuart Hwy crossing upstream of Howley Creek confluence	52L	756770	8506992	Y	Y	Y	N
CHCK06	Downstream	Howley Creek Downstream Compliance Monitoring Point of Cosmo Howley Mine site	52L	754707	8509826	Y	Y	Y	Y
CHCK04A	Downstream	Unnamed tributary of Daly River, adjacent to Dorat Rd	52L	757366	8501452	Y	Y	Y	N
CHCK04C	Downstream	Hayes Creek, approximately 1 km downstream of the Mine Lease Boundary, within the Douglas Daly catchment.	52L	756837	8500358	Y	Y	Y	N
Cosmo Pit	Upstream Pit	Cosmo Pit Wet Cap	52L	757338	8501934	Y	N	N	Y
Dam 3	Upstream Dam	Storage/Holding Dam	52L	756106	8506370	Y	N	N	Y

Y=Yes, N=No SW* is surface water sampling, Marco* is macroinvertebrate sampling (Annually), Seds* is sediment sampling (Annually)

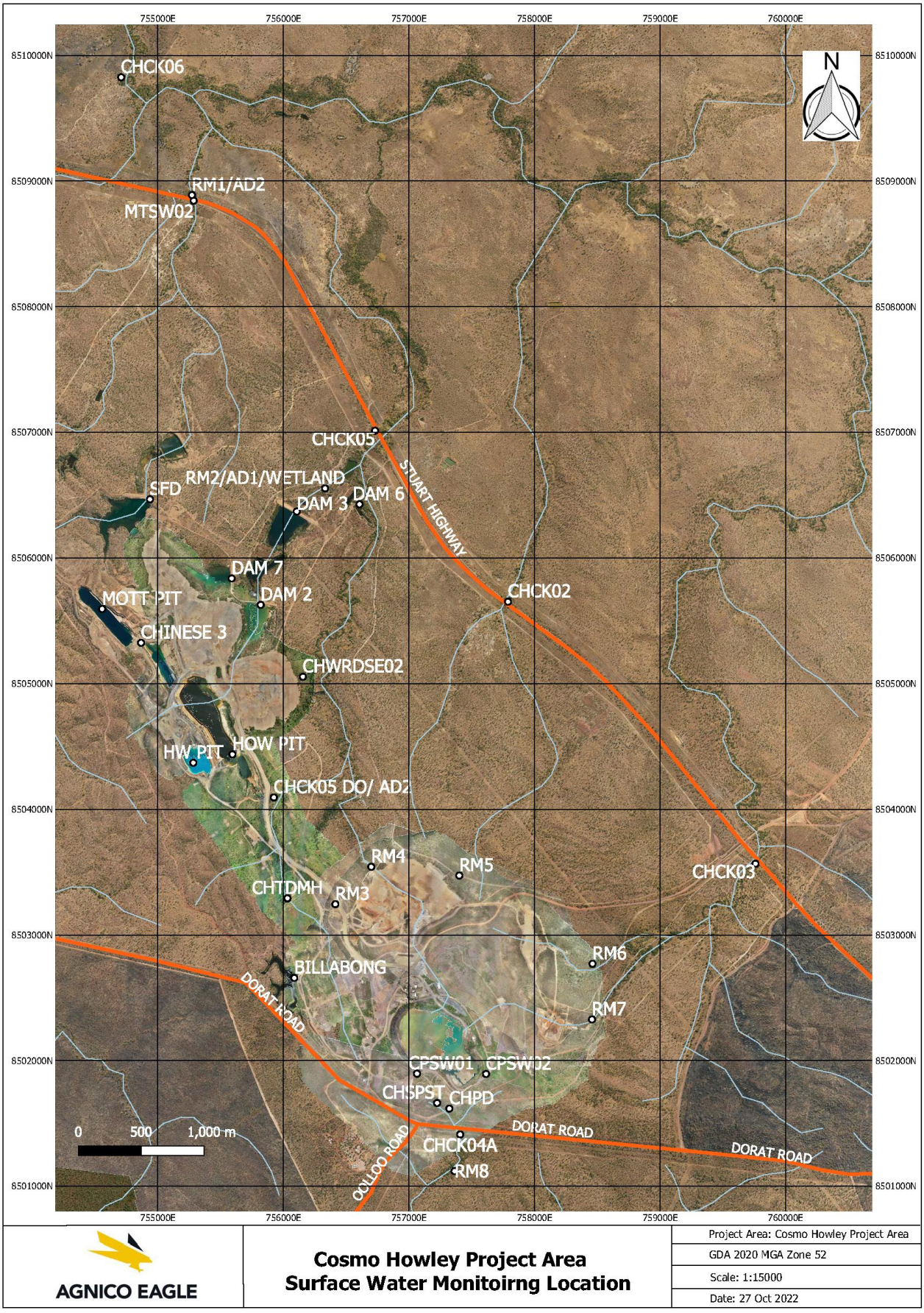

Figure 1 Location of CHPA monitoring sites

4. Macroinvertebrate Sampling Methodology

4.1 Sampling Collection

Sampling of macroinvertebrates under stable conditions allows for a robust characterisation of the macroinvertebrate community of the receiving waters and is consistent with the methodology stated in the NT Darwin Daly AUSRIVAS Sampling and Processing Manual (Lamche 2007). For consistency between years and to meet the guidelines set out by Lamche (2007)

Sampling has routinely been conducted in the post-wet season during the recessional flow period, to capture the potential effects of mine site runoff during the preceding wet season. The timing of sampling has generally been undertaken in late April to mid-May.

4.2 Physical Habitat Assessment

Descriptions of habitat conditions are to be recorded at each site following the criteria listed in the Northern Territory AUSRIVAS "Darwin-Daly Region Model" field sheets (Lamche, 2007). Habitat assessments will be undertaken in consideration of the whole reach sampled (100 m longitudinal section of the creeks) and include:

- Site description
- Water quality
- Characteristics of macroinvertebrate habitat
- Instream physical characteristics (flow velocity and depth, instream habitat characteristics, bank height, riparian width)
- Riparian vegetation characteristics (types, %cover, exotic species, erosion, land use)
- Water quality observations (clarity, odour, oils, foam/scum, plumes etc.)
- Sketches of the site, including a cross-section of the reach

The information recorded is used to help interpret biological data and to provide input data for the Northern Territory AUSRIVAS model. Data recorded is also used in conjunction with the biological community information as the basis of the overall health assessment.

Photos are to be taken of upstream and downstream portions of the reach sampled, as well as bank habitat and other key habitat features. This will further characterise the habitat conditions at each site, serving as a pictorial record of site conditions that can be tracked over time using photos taken from the same photo points.

4.3 Water and Sediment Quality

The physico-chemical parameters of the water at each site is to be measured in-situ using a calibrated multi-parameter water quality meter. In situ parameters to be recorded on the AUSRIVAS proforma are:

- pH
- Electrical conductivity (EC) (µS/cm)
- Water temperature (°C)
- Dissolved oxygen (DO) concentrations (mg/L and % saturation)
- Turbidity

As per the WDL, field environmental data and sample collection must be undertaken in accordance with recognised Australian Standards and guidelines. Water quality grab samples are to be collected at the same time as macroinvertebrate samples during the annual monitoring event. Sediment sampling requirements are located in the Sediment SOP.

4.4 Collection Method

The following methodology relates to macroinvertebrate samples collected using AUSRIVAS protocols. Macroinvertebrate monitoring has been previously selected as the bioindicator for biological monitoring in relation to the PCPA, and for consistency, it will be used in future programs to assess the impacts of the treated mine water discharge on the receiving ecosystem in the Edith River.

The macroinvertebrate monitoring techniques are based on AUSRIVAS Manual for the Darwin-Daly Region protocols (Lamche 2007). The following elements are discussed in Lamche (2007) and will be considered in relation to biological monitoring:

- Habitat sampled
- Collection procedure and equipment
- Sample replication
- Field processing method (e.g. live-pick or bulk)
- Lab processing method (e.g. sub-sorting)
- Level of identification
- Quality assurance

Macroinvertebrate samples will be in accordance with the Darwin-Daly AUSRIVAS (Australian Rivers Assessment System) protocols. AUSRIVAS is a rapid prediction system used to assess the biological health of Australian rivers. The protocols for sampling ensure that the temporal and spatial analyses are comparable amongst sites through repeatable and consistent sampling techniques.

The Darwin-Daly AUSRIVAS Early-Family-Edge Habitat model (Lamche, 2007) was selected as the appropriate model for data analysis due to:

- The locality of the study area within the catchment
- The timing of the surveys in the early dry season
- The level of identification applied (Family level)

Three replicate samples are to be collected at each site to increase the statistical power of any analyses required. All samples will be collected by trained environmental scientists.

Darwin-Daly AUSRIVAS sampling protocols involve the collection of a sample by disturbing the substrate, benthos and overlying habitat using a three-pronged rake and then capturing organisms via a 250 µm mesh dip net that is swept through the water column in the area adjacent the area disturbed by the rake. In order to provide sample replication for statistical analysis, three replicate AUSRIVAS sweep net samples will be collected per site.

Areas of riffle or fast flowing habitat, Pandanus roots and severe bank undercuts are to be avoided when collecting edge habitat samples.

Once collected, samples were washed through 10 mm and 250 µm mesh sieves. The coarse mesh sieve was examined for large, conspicuous taxa, and these were placed in the labelled sample container. The sample collected in the fine mesh sieve was also placed in the labelled sample container and filled with 70% ethanol. All samples were sent to the laboratory for further processing and macroinvertebrate identification.

Environmental variables were also recorded at each site on a standard Darwin-Daly AUSRIVAS field sheet (Lamche 2007). Habitat variables measured included flow and *in situ* water quality, as well as a description of the riparian zone and geomorphology at each site.

4.5 Laboratory Processing

Each sample receiver by the nominated macroinvertebrate laboratory will follow standard procedures for processing as set out by Lamche (2007).

Samples are to be washed through a series of sieves (10 mm, 500 µm and 250 µm mesh sizes). Any large, conspicuous taxa identified in the 10 mm mesh sieve are separated to be identified separately. The contents of the 500 µm mesh sieve are retained for macroinvertebrate identification and enumeration, while the 250 µm fraction is retained as sample residue for quality assurance purposes. The contents of the 500 µm mesh fraction is poured into a Marchant sub-sampler (Marchant, 1989) and extractions made randomly from cells (aliquots) in this apparatus. These extractions are placed under a microscope and the taxa identified and counted.

This process continues until either all aliquots are examined, or a total of 200 individuals have been counted and identified (excluding those from the 10 mm fraction). The number of aliquots required to be processed to obtain a minimum 200 individual sub-sample is recorded in order to calculate abundance.

Taxa are identified to family level where possible, with the exception of key taxa identified in Lamche (2007) as either requiring identification to sub-family level (e.g. Chironomidae) or only to order level (e.g. Acarina). All taxa are identified using the keys specified in Hawking (2000). Following identification, taxa counts are to be recorded in a database and samples preserved and archived.

Quality assurance is to be maintained by ensuring that identifiers are adequately trained and qualified. As specified in AUSRIVAS (Lamche 2007), 5% of samples identified in the laboratory are verified by a secondary check undertaken by a senior taxonomist.

4.6 Data Analyses

The macroinvertebrate data collected will be analysed using univariate and multivariate statistical techniques. Univariate metrics provide an indication of waterway ‘health’, whilst multivariate analysis focusses on variability in community composition between sites.

Univariate Techniques

Univariate measures (biotic indices) are used to assess the ‘health’ status of the macroinvertebrate community at each site. For each analysis, replicate samples are combined to provide an overall site community. The macroinvertebrate community biotic indices used for this study will include:

- Abundance
- Taxonomic Richness
- PET Richness
- SIGNAL-2
- Northern Territory AUSRIVAS Observed over Expected (O/E) scores and bandings

Abundance is the count of macroinvertebrates per sample, this is an applicable index in this program as sampling methods are quantitative. To derive whole of sample abundance counts, the percentage of the total sample counted is used with the count in the subsample to calculate the number of macroinvertebrates in the entire sample. This index can be useful in detecting impacts on pollution-affected sites if counts are significantly different between control and impact sites. It can also indicate declines in habitat availability and therefore will be interpreted with a degree of caution, in conjunction with other indices.

Taxonomic Richness refers to the number of different taxa contained in a sample. In theory, the higher the taxa richness value, the healthier a community is, but there are some instances where anthropogenic activities promote taxa richness

through increased supply of nutrients or habitat (e.g. riffles through additional flows). Therefore, taxa richness data needs to be interpreted on a case by case basis.

EPT Richness refers to the proportional representation of key macroinvertebrate taxa belonging to the sensitive macroinvertebrate orders of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). High EPT richness is indicative of a healthy macroinvertebrate community, though it must be noted that some EPT taxa have more tolerance to pollution than others, so generally EPT richness data is interpreted together with other data such as community composition and SIGNAL score information (discussed further below). It should be noted that in the Northern Territory there are no known Plecoptera species, so in this study, the number of EPT taxa is limited to the number of ephemeropteran and trichopteran families.

SIGNAL 2 Scores (Stream Invertebrate Grade Number – Average Level) are based on the sensitivity of each macroinvertebrate family to environmental conditions, including forms of water pollution (Chessman 2003). Macroinvertebrate families are assigned a pollution sensitivity grade between 1 (most tolerant) and 10 (most sensitive). Families in a sample that have not been assigned a grade are excluded from the analysis. This assessment allows an additional line of evidence for assessing the potential impacts of water quality. Lamche (2007) cautions against the use of the SIGNAL 2 index for assessing the status of Northern Territory macroinvertebrate communities, however, GHD still view the assessment of pollution-sensitive versus pollution-tolerant species as a useful indicator to provide some insight to the level of stress that the macroinvertebrate community is experiencing.

For this program, macroinvertebrate data will be assessed using the NT AUSRIVAS Darwin-Daly Early (dry season) Family level Edge habitat model.

Table 3 provides a summary of the univariate macroinvertebrate indices assessed as part of this study and, where relevant, a description of how to interpret results relating to those indices.

Table 2 Macroinvertebrate indices

Macroinvertebrate Index	Description
Abundance	The total number of individual taxa observed at each site. Generally increased abundance can be taken to mean better conditions and increased access to habitat and food resources. However, high abundances can also occur under degraded conditions where pollution-tolerant taxa proliferate. Hence, abundance is a measure that must be interpreted with caution and in context with other metrics and community composition data. Abundance was calculated based on the multiplication of raw abundance data by the inverse of the proportion of sample processed.
Taxa Richness	The total number of taxa present at each site is a direct measure of diversity. It assumes that a high number of taxa within a site indicate that the various water quality, habitat and food requirements of taxa have been met (though this could also occur through anthropogenic effects that increase food or habitat supply). A negative environmental impact would normally result in the loss of taxa and a decline in Taxa Richness at a site.
PET Richness	PET Richness was calculated as the total number of families[1] from three orders of macroinvertebrates; Ephemeroptera (mayflies); Plecoptera (stoneflies); and Trichoptera (caddisflies). PET taxa include taxa that are very sensitive to disturbance (though some have moderate tolerances to pollution). Higher numbers of PET taxa indicate are generally taken to indicate a lower level of disturbance.

[1] Some specimens (particularly juveniles) could only be identified to order level. Hence, PET richness here refers to both family and order level PET richness. This is consistent with previous sampling rounds

Signal-2	SIGNAL-2 is a biotic index that allocates a value to each macroinvertebrate family based upon their sensitivity to pollution. A macroinvertebrate family with a value of 10 indicates high sensitivity whilst a value of 1 indicates high pollution tolerance (Chessman, 1995). SIGNAL-2 represents the average pollution sensitivity SIGNAL-2 rating within a given sample, which in turn, represents the relative proportion of pollution-tolerant and pollution-sensitive taxa in a sample. Higher SIGNAL-2 scores indicate a higher proportion of pollution-sensitive taxa in a sample.

AUSRIVAS OE50

The AUSRIVAS model is a predictive system that uses macroinvertebrates to assess the biological health of rivers in the Darwin-Daly Region (Lamche 2007). AUSRIVAS uses site-specific predictions of the macroinvertebrate fauna expected to be present in the absence of environmental stress. The expected (E) fauna from reference sites with similar sets of predictor variables (physical and chemical characteristics which cannot be influenced due to human activities, e.g. altitude) are then compared to the observed (O) fauna that were actually collected at a given site and the ratio derived is then used to indicate the extent of any impact. Both O and E measures relate to macroinvertebrates that have a predicted probability greater than 50% of occurring at the site if it is in reference condition. Hence, the critical metric in the AUSRIVAS model in called OE50. The OE50 ratio can range from zero, when none of the expected taxa are found at a site, to >1, when either all the expected taxa are found in a sample or when more families are found in a sample than predicted by the model. The scores derived from the model can be placed in bands delineated by the Monitoring River Health Initiative which allows assessment of the level of environmental health at a site.

Table 3 Key to OE50 AUSRIVAS Scores and Bands

Band	OE50 Upper Limit	Condition	Band Description
Band X	O/E greater than 90th percentile of reference sites used to create the model.	More biologically diverse than reference sites	More families found than expected. Potential biodiversity "hot-spot" or mild organic enrichment. Continuous irrigation flow in a normally intermittent stream.
Band A	O/E within range of central 80% of reference sites used to create the model.	Reference condition	Expected number of families within the range found at 80% of the reference sites.
Band B	O/E below 10th percentile of reference sites used to create the model. Same width as band A.	Significantly impaired	Potential impact either on water and/or habitat quality resulting in a loss of families.
Band C	O/E below band B. Same width as band A.	Severely impaired	Many fewer families than expected. Loss of families from substantial impairment of expected biota caused by water and/or habitat quality.
Band D	O/E below band C down to zero.	Extremely impaired	Few of the expected families and only the hardy, pollution tolerant families remain. Severe impairment.

Assessment of Impacts

Assessment of impacts from mine affected water release will consider the following:

- Qualitative assessment of community composition and sensitivity metrics
- Comparison of macroinvertebrate metrics and community composition between sites upstream and downstream of the release points

- Comparison of community composition and sensitivity metrics to historic data collected prior to commencement of releases
- Comparison of macroinvertebrate metrics to water quality and sediment quality collected at the time of sampling

The use of statistical analysis techniques such as Analysis of Variance (ANOVA) will be considered when determining impacts to macroinvertebrate metrics between sites upstream or downstream of release points as part of a hypothesis testing framework. Multivariate techniques such as ordination and cluster analysis may assist in identifying complex patterns in biological data between sites, while community composition can be compared statistically between sites using techniques such as Analysis of Similarities (ANOSIM) or PERMANOVA. The use of these statistical methods will only be employed where sufficient and appropriate data are available. All statistical methodology used will be explained and justified.

4.7 Reporting

The Biological Monitoring will be reported to the DENR within the WDL annual monitoring report. The report will include:

- Clearly stated objectives of the study and predicted outcomes
- The date, time and location of sample collection
- A clear description of sampling and analysis methods, detailing quality assurance and controls
- Flow and hydrological information and environmental conditions in the interpretation of water quality and biological data
- Results of all monitoring conducted and samples analysed including the use of visual aids such as graphs and tables
- Application of guidelines from ANZECC & ARMCANZ (2000) and other relevant guideline documents, including comparisons to long-term water quality objectives and SSTVs
- A comparison of macroinvertebrate based metrics and community composition between sites upstream and downstream of release points and at the mining lease boundary
- Evaluation of the current study design and its ability to meet the objectives of the monitoring program
- Recommendations of improvements (if any) to be made for future monitoring

5. Sediment Sampling Methodology

5.1 Sample Methodology

As per the WDL, field environmental data and sample collection must be undertaken in accordance with recognised Australian Standards and guidelines. Sediment samples will be collected from each site in accordance with this Sediment Monitoring Plan and NTMO ES-SOP13 Sediment Sampling. The methods used are in accordance with those outlined in ANZECC (2000) and Simpson and Batley (2016):

- The collection of multiple sub-samples using a spade made from inert material.
- Compositing the sub-samples into a receptacle (also of inert material) and mixing the contents.
- Collecting a sub-sample from the mixture and placing it into a laboratory supplied container, labelled with site and sample details.
- Keeping samples in chilled eskies.

- Supplying the chilled samples to a NATA accredited laboratory for testing.
- The collection of one QA/QC duplicate sample per project area to validate results.

Under WDL conditions the following information for each sample collected is retained:

- The date on which the sample was collected
- The time at which the sample was collected
- The location at which the sample was collected
- The name of the person who collected the sample
- The chain of custody forms relating to the sample
- The field measurements (if any) and analytical results (if any) relating to the sample
- Laboratory quality assurance and quality control documentation

At each discrete site, three sediment samples are to be collected from each of three transects running from bank to bank. Each transect should be approximately 10 m apart if practical. Sediment samples are to be collected using a small trowel to a maximum depth of 5 cm, rinsing the trowel between samples with stream water. The nine sediment samples from each site are to be combined in a large container and mixed up as a composite sample. The composite sample is then to be split into three sub samples, placed in a labelled zip lock bag on ice in an esky for delivery to the laboratory.

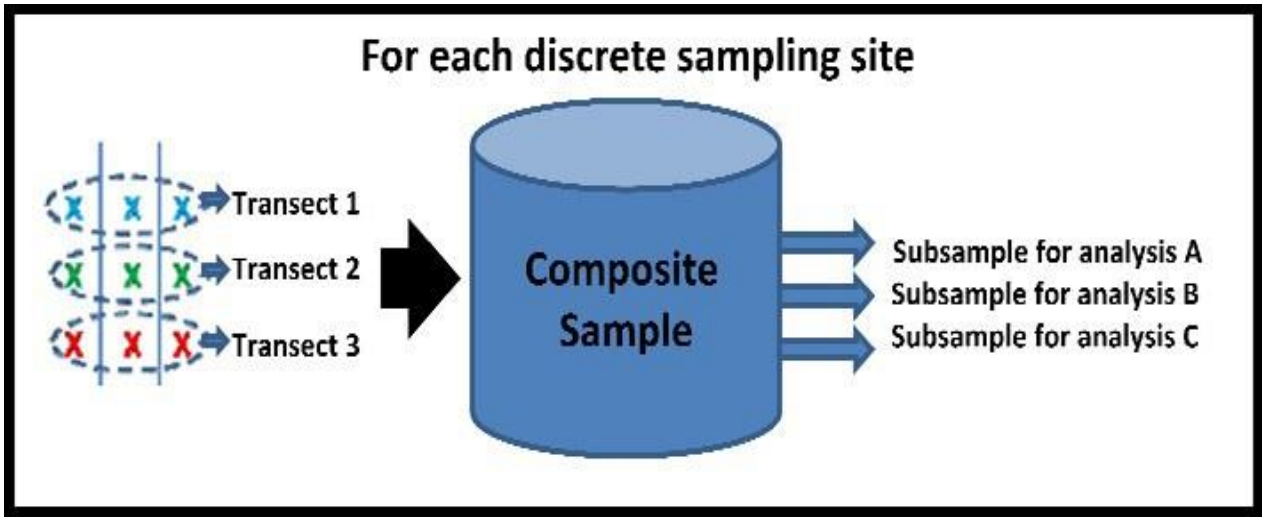

Figure 2 Sediment Composite Sample Illustration

5.2 Sediment Sampling QA/QC

To avoid cross-contamination between samples and sampling locations, all reusable sampling equipment should be decontaminated prior to, and at completion of, sampling at each sample location in accordance with WA DER's water- only decontamination approach (WA DER 2017). The decontamination process can comprise of a decontamination solution or detergent (e.g. Decon 90).

The decontamination process should comprise the following:

- washed and scrubbed in tap water + detergent; followed by
- rinse with deionised water.

All samples should be handled by field staff using clean disposable nitrile gloves, which are replaced between each sample.

The ASC NEPM (NEPC 2013) outlines a recommended approach to be adopted for QC sampling. The QC samples to be collected during the program are described as follows and shown in Table 4:

- Blind duplicate: Blind duplicate samples are used to identify the variation in the analyte concentration between samples from the same sampling point. One blind duplicate per 20 samples (5%) or one per day of sampling for sample numbers less than 20 per day.
- Rinsate blanks: Rinsate blank samples are used to estimate the amount of contamination introduced during the re-use of sampling equipment. One rinsate blank per day.

Table 4 QA Sample numbers

QA Sample	Numbers
Blind duplicate	1 per 20 samples (5%) or 1 per day (<20 samples)
Rinsate blank	Pre-start for each new piece of equipment and 1 per day

5.3 Sediment Data Analysis

Bioavailable metals data (from 1M HCl dilute acid digestion analysis) will be assessed against the Simpson and Batley (2016) Sediment Quality Guideline Values (SQGVs). Three effect ranges can be determined from comparison of sediment results against SQGVs:

- Below the SQGV - adverse effects are rarely observed
- Equal to or above the SQGV but below the SQG-high - adverse effects may be occasionally observed
- Equal to or above the SQG-high - adverse effects may frequently occur.

Within each project area, comparisons are to be made between results from upstream and downstream of release points.

Particle size distribution (PSD) and total organic carbon (TOC) information will be used in the interpretation of metals results, as metals are known to bind preferentially to fine sediment particles and to organic carbon material.

Samples will be analysed in the laboratory for the parameters shown in Table 5.

Table 5 SEDIMENT PARAMETERS

	Analytes
Metals: 1 M HCl acid digest Total metals	Al, As, Cd, Co, Cu, Fe, Mn, Ni, Zn
Ions	Total sulfur, sulfate, sulfide
Others	Particle size distribution (PSD), saturated pH, total organic carbon (TOC)

6. Macroinvertebrate Sampling Methodology

6.1 Background

NT Mining Operations (NTMO) have submitted an application to the NT Department of Northern Territory Environment Protection Authority (NTEPA) for a new Waste Discharge Licence (WDL) for the Cosmo Howley Project Area (CHPA). This WDL will manage the controlled discharge of treated mine water based on an electrical conductivity (EC) SSTV of 700 µS/cm.

This Ecotoxicological Plan (EP) outlines the Ecotoxicity Monitoring Program for the CHPA to monitor and manage the effects of the increased EC on the receiving waterway in Howley Creek. This plan has been prepared to guide the assessment of the potential impacts of the active/passive discharge of treated mine water.

6.2 Strategies

Strategies of this Ecotoxicological EMP are to ensure:

- Ecotoxicological testing conducted to date has shown that an EC of 700 µS/cm will not result in detectable adverse impacts on exposed organisms. However, during discharge an assessment of potential impacts / validation of the application of an increase in the treated water discharge EC of 700 µS/cm will be undertaken.
- On-going assessment of stream water quality toxicity and chemistry during discharge.
- Investigations are undertaken for the Howley Creek through implementing the integrated environmental monitoring plans;
- Mine dewatering requirements and mine site catchment flows are effectively managed though a coordinated and quantified discharge program into the Howley Creek; and
- Water discharge is undertaken in a manner that enables appropriate environmental safeguards and controls in accordance with the CHPA MMP and WDL.

6.3 Screening Bioassays

Screening bioassays are used to assess the toxicity of natural waterways where the water quality is not expected to show toxicity. The screening bioassays use an undiluted water sample from each site for the assessment. The results of the screening bioassay are compared to an upstream sample and a laboratory control water sample. A result of >80% when compared to controls indicates that the water quality shows no significant toxicity. The screening results can also be used to compare water chemistry and toxicity spatially across a site and temporally if historical results are available. Test parameter include:

- Microalgal 72 hour % growth
- Duckweed 96 hour % growth
- Cladoceran 8day % reproduction
- Hydra 96 hour growth % growth
- Fish 96 hour larval imbalance % unaffected
- Elevated analytes

Where a dilution series is identified the following geometric progression series is recommended:

100% sample, 50%, 25%, 12.5%, 6.25%, 3.13%, site control and laboratory control. An additional low concentration has been included to provide sufficient data to improve the EC10 95% confidence limits.

All bioassays listed in Table 4-1 are NATA accredited and, as such, are regulated to ensure quality assurance. Each bioassay is conducted with a laboratory control (the water in which the organisms are grown), diluent control and a reference toxicant.

Table 6 Quality Assurance Criteria

Bioassay	QA/QC Parameter	Criteria
Duckweed	Control specific growth rate	>0.231
	Reference toxicant (within Cusum chart limits)	Currently 5.7 – 61 mg/L Mg
Cladoceran	Control mean % unaffected	≥80%
	Control mean number of young /adult	≥15.0
	Reference toxicant (within Cusum chart limits)	Currently 187 – 249 mg/L KCl

6.4 Treated Water Toxicity

Direct toxicity assessment (DTA) is used to determine the ecotoxicity of compound mixtures in ambient waters. The method provides an integrated measure of effects and accounts for interactions (synergistic, additive and ameliorative) within a mixture, therefore closely simulating the effects in the receiving waterway. A complex effluent such as treated mine water requires assessment of its potential toxicity by using bioassays in a DTA combined with a comprehensive chemical analysis.

Table 7 Species used in the Ecotoxicological Assessment of Dam 3 and Cosmo Pit Water

Test Organism	**Test Duration**	**Test Endpoint**
Chlorella vulgaris (green alga)	72 hour (chronic)	Growth inhibition
Lemna aequinoctialis (duckweed)	96 hour (chronic)	Growth (frond number)
Ceriodaphnia dubia (cladoceran)	3 brood (chronic)	Reproduction
Hydra viridissima Pallas (green hydra)	96 hour (chronic)	Population growth

Melanotaenia splendida splendida (rainbowfish)	96 hour (chronic)	Imbalance
Melanotaenia splendida splendida (rainbowfish)	12 day (chronic)	Embryonic development and post hatch survival

6.1 Ecotoxicity Testing Program

Table 8 shows a full DTA for the treated Cosmo Pit and Dam 3 that is required to determine a dilution factor so that the SSTV for EC (and other SSTVs for metals) are met at CHCK06 and the toxicities of Cosmo Pit and Dam 3 water are reduced at CHCK06. These bioassays will, therefore, also provide information from screening bioassays (100% creek water) to assist in characterising the toxicity of the CHCK06 water.

The program considers all aspects of treated water toxicity, toxicity at downstream locations and variations in toxicity during the wet season Table 8 shows the proposed testing regime and rationale.

Table 8 Ecotoxicity Program

Site	Diluent	Bioassay	Type	Rationale
Treated Cosmo Pit	Laboratory	Cadoceran and Duckweed	Dilution series for the two bioassays	To assess if the proposed EC of 700 µS/cm will also meet metal SSTVs and be non-toxic at CHCK06.
Dam 3	Laboratory	Cladoceran and Duckweed	Dilution series for the two bioassays	To assess if the proposed EC of 700 µS/cm will also meet metal SSTVs and be non-toxic at CHCK06.
CHCK06	Nil	Cladoceran and Duckweed	Screening	Assess toxicity during adequate flow event

7. REFERENCES

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