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AN ECOLOGICAL STATE ASSESSMENT OF THE AQUATIC ECOSYSTEMS

GALAXY GOLD MINE

GALAXY GOLD REEFS (PTY) LTD

MAY 2011

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EXECUTIVE SUMMARY

Digby Wells Environmental (Digby Wells) was commissioned to conduct an assessment of the aquatic ecosystems associated with the headwaters of the Suidkaap River on the Concession and Pioneers Creeks in the mountain catchment southwest of Barberton in the Mpumalanga Province.

This study constitutes an aquatic assessment of the Concession and Pioneer Creeks in order to determine a baseline of the integrity of the system. The objectives of the study were to determine the condition or health of the river system by implementing accredited fresh surface water assessment methodologies.

In order to determine the ecological integrity of the aquatic environment, individual biophysical attributes of the streams were assessed. These biophysical attributes refer to the drivers and biological responses of the aquatic ecosystem. Methodologies formulated by the River Health Programme (RHP) have been adopted for this survey to conduct the aquatic biological assessment of the system.

The aquatic assessment was conducted on a total of four sites, with three sites being selected on the Concession Creek, adjacent to and downstream of the mining operation; and a fourth site was selected on the Pioneer Creek in the upper mountain catchment area. The fourth site was selected to serve as a reference site for the study, with the remaining three sites selected as monitoring sites within the same catchment area.

The general *in situ* water quality for all four sites was determined to be in a largely natural state. The overall quality of habitat for the reach of the system assessed was determined to be moderately modified for the riparian areas and largely natural for the in-stream habitats. Modifications to the riparian zones are largely due to vegetation removal for infrastructure which includes the roads and bridges.

A total of four of the six expected fish species were recorded for the survey. The sampled fish species are considered intolerant to poor water quality and the species have relatively specific habitat and water velocity preferences. The overall fish community associated with the system was determined to be in a largely natural state.

The macro-invertebrate community for the reference site was determined to be in a largely natural state. In addition to this, the community structures associated with the three sites adjacent to and downstream of the mining operation were determined to be in a moderately modified state. Findings from the macro-invertebrate assessment indicate that modifications to the community structure are primarily due to altered habitat quality, but impaired water quality may be a contributing factor.

The state of the riparian vegetation associated with the reference site was in a largely natural state, which may be expected for a reference site. The state of the riparian areas associated

with the three monitoring sites was determined to be in a moderately modified state. This is primarily due to the removal of selected areas for the placement of infrastructure.

In conclusion, the ecological state of the system is in a largely natural state for the reference site only. The remaining three sites were determined to be in a moderately modified state.

Modifications to the system may be attributed to the mining project which has impacted predominantly on the available riparian habitats, as well as the water quality of the system. The short term management objective for the system recommended to be achieved within a year is to manage the system from a moderately modified state to a largely natural state. The long term objective for the system is to then maintain and establish the system in a largely natural state during a five year programme.

The continued operation of the mine and proposed tailings storage facility are not expected to impact considerably on the system, with the potential impact to water quality being the primary concern. In light of this, recommendations and mitigations measures have been provided in support of the short term and long term objectives.

It has also been recommended that a bi-annual biomonitoring and toxicity assessment be conducted for the project area.

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ACRONYMS

AEMC	Attainable ecological management class
ASPT	Average score per taxon
CV	Curriculum vitae
DEMC	Default ecological management class
DWA	Department of Water Affairs
DWAF	Ex-Department of Water Affairs and Forestry
Digby Wells	Digby Wells Environmental
DO	Dissolved oxygen
EC	Ecological classification
EISC	Ecological importance and sensitivity category
FRAI	Fish response assessment index
GPS	Geographical positioning system
GSM	Gravel, sand and mud
IHAS	Invertebrate Habitat Assessment System
IHI	Index of Habitat Integrity
NWA	National Water Act
MIRAI	Maccroinvertebrate assessment index
PESC	Present ecological status category
RHP	River health programme
SASS5	South African scoring system (version 5)
TDS	Total dissolved solids
TIE	Toxicity identification evaluation
VEGRAI	Riparian vegetation assessment index
WMA	Water management area

1 INTRODUCTION

The national River Health Programme (RHP) of South Africa was implemented during the assessment in order to determine the integrity (health) of the aquatic surface ecosystem associated with the Galaxy Gold Mine. The RHP is the national monitoring programme used to monitor and assess the freshwater resources within South Africa. Roux (2001) stated that the RHP methodology entails the selection and use of reference sites as opposed to monitoring sites.

The monitoring focus is when selecting sampling sites is based on the assessment of biological indicators and relevant drivers to assess the condition or "health" of the aquatic ecosystem. Ecological Classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of aquatic ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). These biophysical attributes refer to the drivers and biological responses of an aquatic ecosystem. The selected biophysical attributes for this study include:

The abiotic driver assessment:

- The assessment of physio-chemical variables of the water; and
- Habitat indices:
  - Index of Habitat Integrity (IHI)
  - Invertebrate Habitat Assessment System (IHAS)

The biotic response indicator assessment:

- Macroinvertebrate Response Assessment Index (MIRAI);
- Fish Response Assessment Index (FRAI); and
- Riparian Vegetation Assessment Index (VEGRAI).

The results from the individual indices are presented in the form of ecological state categories, these categories range from an "A" to an "F" state. The ecological state category as well as the rating and description per category are presented in Table 1-1.

According to Kleynhans and Louw (2007) the A to F scale represents a continuum and that the boundaries between categories are notional, artificially-defined points along the continuum. As a result of this there may be uncertainty regarding which category a particular entity belongs to. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson et al., 2004). For practical purposes these situations are referred to as boundary categories and are denoted as B/C, C/D, and so on. An illustration of the distribution of the ecological categories on a continuum (Kleynhans and Louw, 2007) is presented in Figure 1-1.

Table 1-1: The ecological state categories, categories, key colours and category descriptions (modified from Kleynhans, 1996 & Kleynhans, 1999)

Category	Score (%)	Rating	Category description
A	90 - 100	Excellent	Unmodified state – Un-impacted state, conditions natural.
B	80 - 89	Very good	Largely natural – Small change in community characteristics, most aspects natural.
C	60 - 79	Moderate	Moderately modified – Clear community modifications, some impairment of health evident.
D	40 - 59	Low	Largely modified – Impairment of health clearly evident. Unacceptably impacted state.
E	20 - 39	Very low	Seriously modified – Most community characteristics seriously modified. Unacceptable state.
F	0 - 19	Critical	Critically modified – Extremely low species diversity. Unacceptable state.

Figure 1-1: An illustration of the distribution of the ecological categories on a continuum

This report presents the results obtained from the surface aquatic ecosystem assessment conducted during the high flow (April 2011) period. The report is comprised of an aquatic assessment of which the results within this report include an assessment of habitat, *in situ* water quality, ichthyofauna, aquatic macro-invertebrates and riparian vegetation.

2 TERMS OF REFERENCE

Digby Wells Environmental (Digby Wells) was commissioned by Galaxy Gold Reefs (Pty) Ltd (Galaxy Gold) to conduct an aquatic state assessment of the aquatic ecosystem associated with the Galaxy Gold Mine. The scope of work encompasses an aquatic assessment of selected reaches of the Concession and Pioneer Creeks, situated within the headwaters of the Suidkaap River.

This assessment was designed to determine the present ecological integrity (health) of the aquatic ecosystem associated with the project area and characterise the baseline of the catchment area.

This survey supports the following regulations and regulatory procedures:

- Section 19 of the National Water Act (Act 36, 1998);
- Section 21 (c), (g) and (i) of the National Water Act (Act 36 of 1998);
- Section 21 of the Environment Conservation Act, 1989;
- Section 24 of the Constitution – Environment (Act 108 of 1996); and
- Section 5 of the National Environmental Management Act (Act 108 of 1998).

3 KNOWLEDGE GAPS

A Level III EcoStatus assessment was conducted and results of the study should therefore be considered in light of this. Findings of the study are for a single high-flow survey only. No knowledge gaps are identified for this project.

4 STUDY AREA

The study area is located approximately 10 km southwest of Barberton in the Mpumalanga Province. Aquatic sampling sites were selected in the headwaters of the Suidkaap River catchment area on the Concession and Pioneer Creek tributaries within the system. The study area is located within the Inkomati Water Management Area (WMA 5) and is situated in the quaternary catchment X23F. The Level I Ecoregion is the north eastern Highlands (lower) and the associated Level II Ecoregion is 4.05. A total of four aquatic sampling sites were selected for the project and the location of the sites in relation to the project area is presented in Plan 1.

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) categories (Kleynhans, 2000) for systems are based on the main-stem streams in the respective quaternary catchments and as a result, sub-quaternary tributaries may have a different PES-EIS. In light of this, the PES-EIS category described for the quaternary catchment X23F was considered for the study. According to the ecological importance and sensitivity classification for the quaternary catchment (X23F), the system is classified as a moderately modified system which in its present ecological status category can be considered to be a Class B (largely natural) system. The default ecological management class for the system is described as moderately sensitive. The attainable ecological management class for the system is a Class B (largely natural). A summary of the ecological integrity (health) and management categories for the Suidkaap River system in quaternary catchment X23F are presented in Table 4-1.

Plan 1

Table 4-1: The ecological and management categories for quaternary catchment B32G (Kleynhans, 2000)

Category	Description	State
EISC	Ecological importance and sensitivity category	Moderate
DEMC	Default ecological management class	Moderately sensitive systems
PESC	Present ecological status category	Class B: Largely natural
AEMC	Attainable ecological management class	Class B: Largely natural

A total of three monitoring sites were selected on the Concession Creek and a reference site was selected on the Pioneer Creek in the upper catchment area. The Pioneer Creek is situated in the headwaters of Concession Creek which is a tributary of the Queens River. The Queens River flows into the Suidkaap River. The global positioning satellite (GPS) recordings for each selected site and a brief description is provided in Table 4-2. Photographs of the upstream and downstream areas associated with the six sampling sites are presented in Table 4-3.

Table 4-2: GPS coordinates of the four sampling points and a description of each

Site name	GPS Coordinates	Description
Site 1	25° 50’ 05.03” S 30° 57’ 49.26” E	Situated on the Pioneer Creek in the upper catchment. The site was dominated by fast shallow areas with biotopes such as riffles, runs and rapids. The riparian area was well developed with no identifiable impacts to the system.
Site 2	25° 50’ 00.51” S 30° 58’ 08.25” E	Situated at the confluence of the Mamba and Pioneer Creeks. The site was characterised by fast shallow habitat types with an average stream width of approximately 4 m. Impacts associated with bridges and culverts were evident.
Site 3	25° 49’ 45.73” S 30° 58’ 37.46” E	The site was fast deep and shallow habitat types such as rapids, riffles and cascades. A weir was identified within the reach, creating a deep pool. The riparian was less developed at this reach of the system.
Site 4	25° 49’ 10.53” S 31° 00’ 13.25” E	An access road transects the assessed reach. The site is characterised by fast shallow habitat types, such as riffles, runs and rapids. The riparian area is well developed. A deep pool was present at the site. The average width of the stream was 5 m.

Table 4-3: Photographs of the four sampling both upstream and downstream of the sites

Site	Upstream	Downstream
Reference site *Pioneer Creek* **- Site 1 -**		
Monitoring site *Concession Creek* **- Site 2 -**		
Monitoring site *Concession Creek* **- Site 3 -**		
Monitoring site *Concession Creek* **- Site 4 -**		

5 EXPERTISE OF THE SPECIALIST

A curriculum vitae (CV) and declaration of independence is attached in Appendix A.

6 AIMS AND OBJECTIVES

The aim of the aquatic assessment is to determine the current ecological integrity of the aquatic ecosystems downstream of the project area. In order to achieve this aim the following objectives were considered:

- Characterise the current ecological state of the aquatic ecosystem by making use of selected driver indices which address the habitat and *in situ* water quality state;

- Characterise the current ecological state of the aquatic ecosystem by making use of selected responder indices which address macroinvertebrate and ichthyofauna population attributes as well as riparian vegetation state;
- Make recommendations on the management and conservation of the system in order to increase the ecological integrity of potentially impacted aquatic ecosystems and to conserve the ecological integrity of healthy ecosystems; and
- Make recommendations on a medium term monitoring programme that should be implemented.

7 METHODOLOGY

In order to determine the ecological integrity of the aquatic environment, individual biophysical attributes of the streams had to be assessed. These biophysical attributes refer to the drivers and biological responses of an aquatic ecosystem. This methodology, described for use in the River Health Programme (RHP, 2001) was developed for lotic systems (rivers and streams) and is not applicable to lentic ecosystems (dams, lakes, pans etc.). Overviews of the methods implemented for this study are present in the subsequent sections. The selected drivers and biological responses for this study include:

Drivers

- *In situ* water quality; and
- Habitat Indicators.

Response Indicators

- Ichthyofauna;
- Aquatic macro-invertebrates; and
- Riparian vegetation.

7.1 Water quality

The sustainable integrity of an aquatic system considers various water quality parameters which are taken *in situ*. These parameters include pH, oxygen content and oxygen saturation, temperature and total dissolved salts (TDS) using accredited calibrated water quality meters (Orion 5 Star). Detailed water quality analysis was also undertaken by Digby Wells (surface water quality assessment) and this should be seen in collaboration to this specialist study.

7.2 Habitat assessment

The quality and diversity of the available habitat was assessed by means of the Index of Habitat Integrity (Kleynhans, 1999) and the Invertebrate Habitat Assessment System (McMillan, 1999).

7.2.1 General habitat integrity

According to Kleynhans *et al* (2008) the integrity of aquatic habitat is approached from an in-stream and riparian zone perspective. These two zones are formulated according to metric groups, each with a number of metrics that enable the assessment of habitat integrity. The assessment of habitat integrity is based on an interpretation of the deviation from the reference condition. Specification of the reference condition follows an impact based approach where the intensity and extent of anthropogenic changes are used to interpret the impact on the habitat integrity of the system.

The method classifies habitat metrics into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

The associated integrity classes are presented in Table 7-1. This index assesses the number and severity of anthropogenic perturbations and the damage they potentially inflict on the habitat integrity.

Table 7-1: The IHI integrity classes and short descriptions of each class (Kleynhans et al, 2008).

Category	Rating	Description
None	0	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
Small	0.5 – 1.0	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are very small.
Moderate	1.5 – 2.0	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are limited.
Large	2.5 – 3.0	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are not influenced.
Serious	3.5 – 4.0	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.
Critical	4.5 – 5.0	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.

7.2.2 Habitat for aquatic macroinvertebrates

The IHAS (version 2) was specifically designed to be used in conjunction with SASS5 benthic macro-invertebrate studies. IHAS measures the availability and integrity of each biotope (stones, vegetation and gravel, sand and mud) as well as physical stream integrity. As a result of IHAS being used to assess the quality of the habitat that is available to aquatic macro-invertebrates, this allows SASS5 scores to be modified where suitable habitat is not available. A percentage is used to express the quality and suitability of each biotope, whereby ideal habitat availability is represented by a score of 100%. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1999) as follows:

- < 65% inadequate for supporting a diverse aquatic macro-invertebrate community;
- 65% - 75% adequate for supporting a diverse aquatic macro-invertebrate community; and
- > 75% highly suited for supporting a diverse aquatic macro-invertebrate community.

7.3 Fish assessment

Information pertinent to this component is used in an index known as the FRAI (Kleynhans, 2007) with the information gained being an indication of the present ecological state of the river based on the fish assemblage structures observed. Fish were collected by means of electro-fishing. Each site was surveyed for a specific time frame. All fish were identified in the field and released at the point of capture.

Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). An expected fish species list for X23F was derived from Kleynhans *et al.* (2007). In addition to this, expert knowledge and historical documentation were jointly considered to derive a list for the study area. Palmer (2007) conducted a specialist study on Concession Creek which was considered to support the reference list findings.

A total of six fish species are expected to occur within quaternary catchment X23F (Kleynhans, 2011). The expected fish species list was developed from a literature survey and included sources such as (Kleynhans *et al.,* 2007) and Skelton (2001), as well as personal communication with recognised experts. The expected species list compiled for the region is presented in Table 7-2.

Table 7-2: A list of expected fish species to be found in quaternary catchment X23F (Kleynhans et al, 2007)

Abbreviation	Scientific name	Common name
ANAT	*Amphilius natalensis*	Natal Mountain Catfish
AURA	*Amphilius uranoscopus*	Stargazer Mountain Catfish
BEUT	*Barbus eutaenia*	Orangefin Barb
BTRI	*Barbus trimaculatus*	Threespot Barb
CPRE	*Chiloglanis pretoriae*	Shortspine Suckermouth
VNEL	*Varicorhinus nelspruitensis*	Incomati Chiselmouth

7.4 Aquatic invertebrate assessment

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macro invertebrates in South Africa. The sensitivity scales were derived from the tolerances to pollution as used in the South African Scoring System 5 (Dickens & Graham, 2002). According to Thirion (2007) a broad explanation of the sensitivity scales will be as follows:

- 12 – 15 High requirement for unmodified physico-chemical conditions
- 7 - 11 Moderate requirement for unmodified physico-chemical conditions
- 4 - 6 Low requirement for unmodified physico-chemical conditions
- 1 - 3 Very low requirement for unmodified physico-chemical conditions

Guidelines for the interpretation of SASS5 and ASPT scores described by Chutter (1998) were also considered. All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the relevant eco-region, namely the north eastern highland (lower). SASS results are expressed both as an index score (SASS score) and the average score per recorded taxon (ASPT value). From this data it is possible to establish the integrity or health of a river system.

SASS5 was designed as a rapid bio-assessment protocol for the evaluation of South African lotic systems. A specific area was surveyed by net for a specific timeframe. Sampled invertebrates were then identified using the Aquatic Invertebrates of South African Rivers Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al*., 1995; Davies & Day, 1998; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

The aim of the MIRAI is to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the reference condition. This does not

preclude the calculation of SASS scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic organisms are as follows:

- Flow regime,
- Physical habitat structure,
- Water quality, and
- Energy inputs from the watershed Riparian vegetation assessment

7.5 Riparian vegetation assessment

The metrics in VEGRAI first describe the status of riparian vegetation in both its current and reference states and second, compare differences between the two states as a measure of vegetation response to an impact regime. For the Level III VEGRAI EcoStatus assessment version, the lower and upper zones were combined to form the non-marginal metric group (zone).

8 RESULTS AND DISCUSSION

The results of each component are addressed in the subsequent sections. Discussions on the results have also been provided for each study component.

8.1 Water quality

The overall water quality for all the sites was determined to be in a considerably good state with none of the measured parameters considered to have a limiting factor on aquatic biota. The water quality results for the four surveyed sites are listed in Table 8-1. The measurements recorded for each water quality parameter for each sample site is presented in Figure 8-1.

Table 8-1: Results of the different water variables assessed for each site during the survey.

Site	pH	Temp (°C)	TDS (mg/l)	Conductivity (mS/m)	DO (mg/l)	DO (%)
Range	6.5 – 8.5	5 - 30	< 1000	± 70	> 5.0	80 - 120
Site1	7.3	17.8	65	13.3	20.3	240.2
Site 2	7.5	18.1	83	16.9	20.3	241.3
Site 3	7.6	18.2	85	17.4	9.78	115.3
Site 4	7.61	19.3	185	37.8	22.4	246.5

Note: (Blue) Within the desired range suitable for aquatic biota

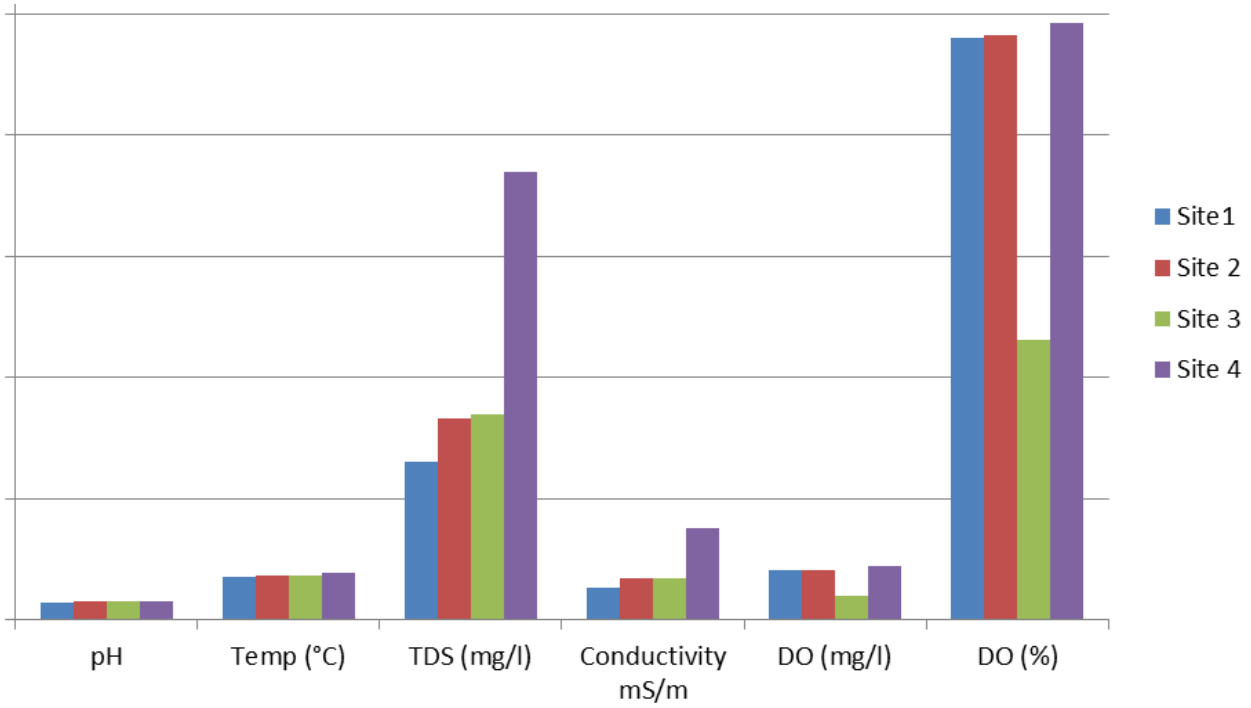

Figure 8-1: Graphical representation of the measured water quality parameters for the four sample sites

According to South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996), both geology and the atmosphere has an influence on the pH of natural waters. Fresh water systems are mostly well buffered and more or less neutral, with a range from 6.5 to 8.5. As a result of the presence of bicarbonates of the alkali and alkaline earth metals most fresh water systems are slightly alkaline (Bath, 1989). According to Alabaster and Lloyd (1980) important physiological features function normally within a maximum pH of 9. The pH values for all four sites were similar and slightly alkaline. The pH values for all four sites are considered to be acceptable.

According to South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996), the temperature of water plays an important role for aquatic ecosystems by affecting rates of chemical reactions and therefore also the metabolic rates of organisms. The rate of development, reproductive periods and emergence time of organisms are all affected by temperature. The temperatures of inland waters in South Africa generally range from 5 - 30˚C (DWAF, 1996). The temperature of the water for all four sites was within an acceptable range.

The South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996) indicates that macro-invertebrate fauna appear to be sensitive to salinity, with acute toxic effects likely to occur in most of the sensitive species at salinities in excess of 1000 mg/l. The TDS concentrations for all four surveyed sites were below this level. TDS for the sampled sites would not be a limiting factor for aquatic biota. The TDS value for Site 4 was slightly higher than the

remaining three sites, but it is still below the maximum allowable concentration. The increase in the TDS value at Site 4 may be attributed to the discharge of pumped water from the underground workings upstream of the site.

Electrical conductivity (EC) estimates the total amount of dissolved ions in the water. EC is also a measure of salinity. The conductivity readings varied between 13.3 mS/m and 37.8 mS/m. The conductivity values were considerably lower than the Target Water Quality Range (TWQR) for aquatic ecosystems (EC of ±70 mS/m), according to the South African Water Quality Guidelines (DWAF, 1996). Conductivity for all four sites is considered to be low and may be as a result of catchment geology; however, the low values would not have a limiting factor on aquatic biota. The highest EC value was recorded at Site 4 and this again may be attributed to the discharge of pumped water from the underground workings upstream of the site.

According to Mason (1991), dissolved oxygen (DO) is possibly the most important measure of water quality, especially for aquatic life. Both the survival and functioning of aquatic biota is dependent on the maintenance of aquatic DO concentrations because it is required for the respirations of all aerobic organisms. Thus it may be stated that DO concentrations provide a useful measure of ecosystem health (DWAF, 1996). The median guideline for DO for the protection of aquatic biota is >5.0 mg/l (Kempster *et al.,* 1980). The DO concentrations recorded for all four sites were beyond the minimum requirement. The lower DO concentration recorded at Site 3 may be attributed to impacted water quality from the surrounding land uses and associated activities, but the severity of this is negligible.

According to the South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996), the target water quality range for an aquatic ecosystem is between 80% and 120% of DO saturation. The *in situ* DO saturation for only Site 3 was within the recommended range for saturation, with the remaining three sites indicating elevated levels of DO saturation. The elevated saturation levels recorded at the remaining three sites may be attributed to the nature of the system which is characterised by riffles and rapids, which contribute to the high DO saturation levels. Additionally, the possibility of impacted water quality encountered at Site 3 would be the source of the reduce DO saturation levels at this site, due to the decomposition of material.

The overall *in situ* water quality for the four sampled sites is in a healthy state, in spite of the surrounding activities and the mining operation. However, impacts to water quality were evident at Site 3 (reduced dissolved oxygen levels) and Site 4 (increased EC and TDS levels) which may be attributed to the surrounding activities, but the severity of these impacts is considered to be negligible. Potential water quality variables of concern could be a sulphate driven increase in TDS (salinity) and potential increases in aluminium and manganese, given the findings of analysis undertaken in a Digby Wells surface water study.

This is important to consider when regarding the downstream water users dependant on the system, namely Moodies Estates and the town of Barberton. The goods and services provided

by the system may include drinking water for domestic and agricultural use as well as water for cropping activities and ecosystem/biodiversity maintenance.

8.2 Habitat assessment

8.2.1 General habitat integrity

The IHI was applied to all of four sampled sites collectively during the high flow survey. The upstream catchment area took into consideration the upstream mountain catchment, which included the Galaxy Gold project area, as well as the surrounding plantations. The IHI scores for the sampled sites are presented in Table 8-2.

Table 8-2: Summary of the application of the IHI index to the study area

Component	Rating	Description
Instream IHI %	89.6	Largely natural
Instream Category	A/B	
Riparian IHI %	65.1	Moderately modified
Riparian Category	C	

The project area is situated in the upper catchment area of the system and as a result, the severity of impacts of any upstream activities is negligible. Owing to the fact that the IHI considers anthropogenic activities upstream of the study area, as well as taking into consideration the location of the study area in the upper mountain catchment area, activities along the survey sites were also considered for this component.

The primary activities within the catchment area are associated with the Galaxy Gold Mine, Moodies Estates and a privatised saw-mill. The primary activities identified consist of roads and bridges, impediment/impounding, water abstraction, discharge, run-off, erosion, vegetation removal and nutrient input into the system. In spite of the regularity of these activities, the severity of each is considered to be small. The most notable impact was to the riparian areas which were determined to be moderately modified (Class C). This is primarily due to the removal of these areas for the various activities. Encouragingly, the impacts to the in-stream habitats are negligible as these areas were determined to be largely natural (Class A/B).

8.3 Fish assessment

A total of four fish species were recorded for the survey. No exotic fish species are expected to occur within the upper catchment area. The different fish species sampled at the four sites is presented in Table 8-3. A total of four fish species were sampled from Site 4 with only *A. uranoscopus* and *C. pretoriae* being sampled from the remaining three sites.

Table 8-3: The fish species sampled from the four sample sites

Scientific name	Site1	Site2	Site3	Site4
Amphilius natalensis	×	×	×	×
Amphilius uranoscopus	✓	✓	✓	✓
Barbus eutaenia	×	×	×	✓
Barbus trimaculatus	×	×	×	✓
Chiloglanis pretoriae	✓	✓	✓	✓
Varicorhinus nelspruitensis	×	×	×	×

The findings of the FRAI for the study are presented in Table 8-4. The sampled fish species have a high preference for fast flowing systems dominated by rocky substrate for cover. The four sampled fish species are intolerant of impacted water quality. A description of the biology and habitat preferences according to Skelton (2001) has been provided for the fish species sampled during the survey period:

- *Amphilius uranoscopus* (Stargazer Mountain Catfish) is considered to prefer clear, flowing water with rocky substrate (Skelton, 2001). *A. uranoscopus* has a high preference for fast-deep and fast-shallow systems with rocky habitat. This species is intolerant of poor water quality;
- *Barbus eutaenia* (Orangefin Barb) prefers flowing clear water streams, usually in the headwaters of the catchment with rocky habitat (Skelton, 2001);
- *Barbus trimaculatus* (Threespot Barb) is a hardy species which is common and found in a large variety of habitat types, especially where vegetation occurs (Skelton, 2001); and
- *Chiloglanis pretoriae* (Shortspine Suckermouth) occurs in shallow rocky reaches, riffles and rapids of permanent rivers (Skelton, 2001). This species has a high preference for fast-shallow systems with rocky habitat. In addition to this, *C. pretoriae* is intolerant to poor water quality.

Table 8-4: The findings and ecological category of the fish assessment

Component	Site 1	Site 2	Site 3	Site 4
FRAI (%)	88.8	80.5	80.3	82.7
EC: FRAI	A/B	B/C	B/C	B
Category	Largely natural	Largely natural	Largely natural	Largely natural

The sampling of the rheophilic (prefer to live in fast flowing water) fish species *A. uranoscpous* and *C.pretoriae* from all the sites is indicative of a healthy system due to the sensitivity of these species (Kleynhans, 2011). The presence of these two species indicates the system to be perennial with cool unperturbed physico-chemical conditions. The FRAI finding indicates the suitability of the rocky substrate for the sampled fish species, and suggests that the substrate is clean with minimal embeddedness and siltation.

Owing to the sensitivity of the sampled fish species to water quality, flow and substrate, the conclusion by FRAI that the system is in a largely natural state (Table 8-3) is indicative that the surrounding and upstream land uses are not largely impacting on the integrity of the system. There is a small change in community characteristics but for the greater part, most aspects remain natural. Photographs of the sampled fish are presented in Figure 8-2.

Amphilius uranoscopus

Barbus eutaenia

Barbus trimaculatus

Chiloglanis pretoriae

Figure 8-2: Photographs of the sampled fish species for the study

8.4 Aquatic invertebrate assessment

As a result of aquatic macroinvertebrates integrating the effects of physical and chemical changes, they are good, short-term indicators of ecological integrity. Integration of biological indicators (like aquatic invertebrates) with chemical and physical indicators will ultimately provide information on the ecological status of the river (RHP, 2001).

8.4.1 Habitat for aquatic macroinvertebrates

The sites which were assessed consisted of a variety of biotopes with on all four sites comprising similar river make-up and structure. The system is characterised by fast-shallow reaches, dominated by rocky substrate. The system make-up consisted of riffles, runs, rapids as well as pools. Aquatic vegetation was limited with marginal vegetation abundant at all four sites. The available biotopes which were sampled at the four sample sites are presented in Table 8-5.

The IHAS was applied to all four sampled sites for the survey. The results for the IHAS component are presented in Table 8-6.

Table 8-5: Biotopes present at the surveyed sites

Biotope	Site1	Site2	Site3	Site4
Stones in current	✓	✓	✓	✓
Vegetation	✓	✓	✓	✓
Stones out of current	✓	✓	✓	✓
Gravel	✓	✓	✓	✓
Sand	✓	✓	✓	✓
Mud	×	×	×	×
Bedrock	✓	✓	✓	✓

Table 8-6: The IHAS application results for the macroinvertebrate assessment

IHAS Component	Site			
	Site1	Site2	Site3	Site4
Sampling Habitat				
Stones-in-current	25	20	23	24
Vegetation	12	10	11	7
Other habitat/general	15	12	12	13
Physical				
Stream condition	40	33	35	37
Total score (%)	**92**	**75**	**81**	**81**
Suitability	**Highly suited**			
Note: > 75% highly suited for supporting a diverse aquatic macro-invertebrate community				

All four sites were determined to consist of “highly suited” habitat diversity and quality for macroinvertebrate diversity. An important contributor for such a classification was the good quality of rocky and stones biotopes in varying water depths and velocities. Overall, the stream condition for each site was in a good state and this is evident in the considerably good IHAS scores.

It is evident that the surrounding land uses and associated activities have not impacted considerably on the in-stream habitats. The most notable impact to the system is the loss of riparian areas due to development requirements, but the severity of this impact is marginal.

Findings from the IHAS assessment indicate that the best quality and quantity of habitat available for macroinvertebrate diversity is situated at Site 1. This is to be expected due the proximity of the site being upstream of any disturbances and the site being considered for a reference site. Site 3 and Site 4 have similar quality habitat available and Site 2 was considered to have the lowest quality of suitable habitat available. The low score for Site 2 may be attributed to the bridge, culverts and bank modifications at the site which have all impacted on the quality of available habitat, but the severity of these impacts is negligible.

The SASS5 was implemented for each of the four sites and findings for the assessment are presented in Table 8-7.

Table 8-7: The SASS5 results of the sampled sites

Taxa	Sensitivity	Site1	Site2	Site3	Site4
Aeshnidae	8	✓	✓	✓	✓
Athericidae	10	✓		✓	✓
Beatidae (1sp)	4		✓		
Beatidae (>2sp)	12	✓		✓	✓
Belostomatidae	5		✓		
Caenidae	6		✓	✓	✓
Chironomidae	2	✓		✓	✓
Chlorocyphidae	10				✓
Coenagrionidae	4				✓
Cordulidae	8				✓
Dytiscidae	5		✓		
Elmidae	8	✓			
Gerridae	5		✓	✓	✓
Gyrinidae	5	✓		✓	✓
Heptageniidae	13	✓	✓	✓	
Hydropsychidae (2sp)	6	✓	✓	✓	✓
Leptoceridae	6		✓		

Taxa	Sensitivity	Site1	Site2	Site3	Site4
Leptophlebiidae	9		✓		
Oligochaeta	1	✓		✓	
Perlidae	12	✓			
Potamonautidae	3	✓	✓	✓	
Psephenidae	10	✓			
Psychodidae	1		✓		
Simulidae	5		✓		
Tabanidae	5	✓		✓	
Trycorythidae	9	✓	✓	✓	
Turbellaria	3	✓			
Veliidae	5				✓
SASS		107	85	85	81
No of taxa		15	14	13	14
ASPT		7.1	6.0	6.5	5.8
Biological band		**A**	**B**	**B**	**C**

According to the SASS5 Data Interpretation Guidelines (Dallas, 2007), the macroinvertebrate community at Site 1 was determined to natural (Class A) and the two communities at Site 2 and Site 3 were determined to be largely natural (Class B). The most notable difference from reference conditions was evident at Site 4 where the macroinvertebrate community was determined to be in a moderately modified state (Class C). Considering the classification system that was described by Chutter (1998) and presented in Table 8-8, the SASS and ASPT scores indicates that only Site 1 had water quality considered being natural and high habitat diversity. Site 2 and Site 3 also consisted of water quality considered to be natural but the overall habitat diversity has been reduced. Only Site 4 indicated some deterioration in water quality for the system.

Table 8-8: The suggested SASS5 and ASPT interpretations (Chutter, 1998)

SASS5	ASPT	Suggested interpretation
> 100	> 6	Water quality natural, habitat diversity high.
< 100	> 6	Water quality natural, habitat diversity reduced.

SASS5	ASPT	Suggested interpretation
> 100	< 6	Borderline case between water quality natural and some deterioration in water quality.
50 – 100	< 6	Some deterioration in water quality.
< 50	Variable	Major deterioration in water quality.

Dickens and Graham (2002) stated that in general, a low ASPT is a reflection of poor water quality. Where habitat change is the main cause of changes in community structure, SASS scores will be low but, the ASPT will be less affected. Taking this into consideration as well as the IHAS results (Table 8-6), the reason for the noticeably lower SASS scores at Site 2, Site 3 and Site 4 may be attributed to reduced habitat diversity and quality. A contributing factor may be impaired water quality due to the mining operation which was indicated by the SASS5 findings at Site 4, downstream of the operational area.

The majority of the invertebrates that were sampled during the survey have a low (weight 4-6) to moderate (weight 7-11) requirement for unmodified physic-chemical conditions. In addition to this, some macroinvertebrates such as Heptageniidae and Perlidae with a high requirement for unmodified physic-chemical conditions were also sampled, which further indicates that water quality of the system is in a good state. The positioning of the sites with reference to the SASS and ASPT scores within the biological band for the lower north eastern Highlands is presented in Figure 8-3.

8.4.2 The Macroinvertebrate assessment response index

The MIRAI was implanted for each of the four sampled sites and findings from the assessment are presented in Table 8-9. The macroinvertebrate community at Site 1 was determined to be in a largely natural state (Class B) with the communities at the remaining three sites determined to be in a moderately modified state (Class C). These changes to the community structure from the reference conditions may be attributed to changes in habitat structure and flows. Findings from this assessment indicate that the activities associated with the mining operation have impacted on the macroinvertebrate community structure for the system.

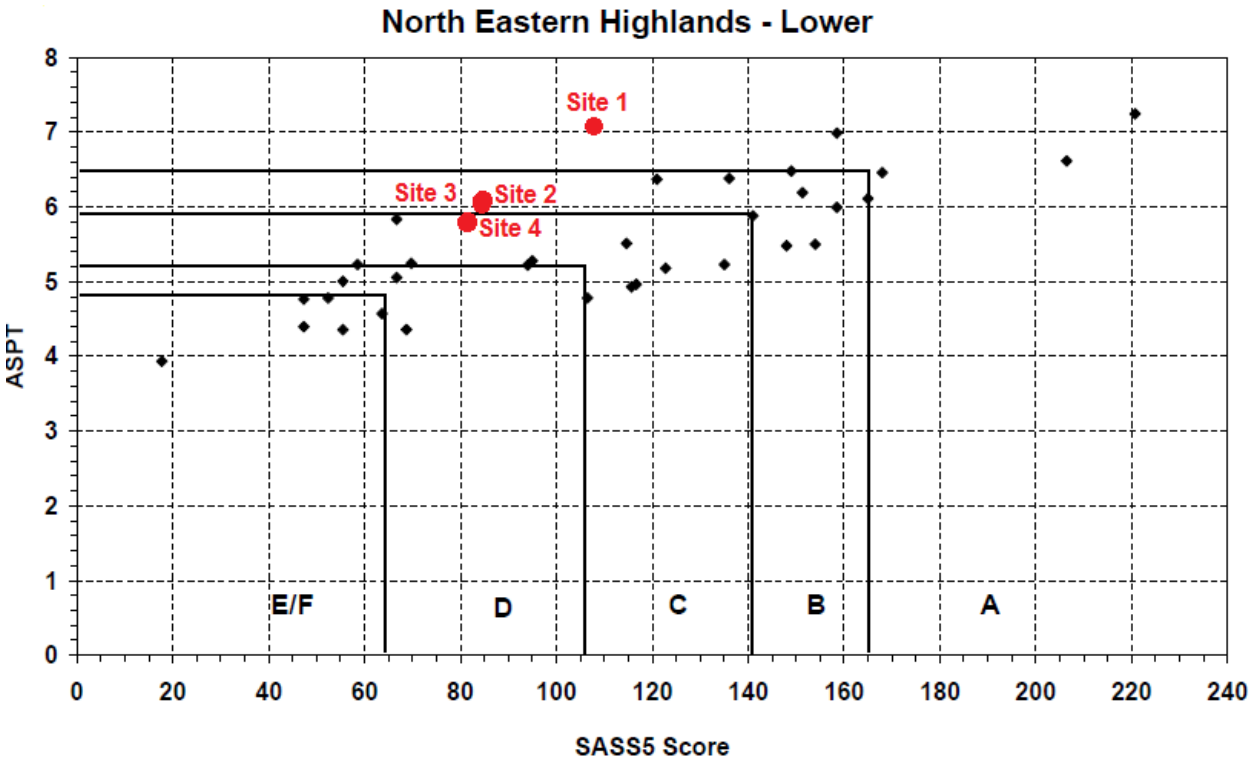

Figure 8-3: The SASS5 and ASPT scores of the sampling sites positioned with the biological bands for the lower north eastern Highlands region

Table 8-9: The findings and ecological category for each sampled site for MIRAI

Component	Site1	Site2	Site3	Site4
MIRAI (%)	85.8	77.2	75.1	72.8
EC: MIRAI	B	C	C	C
Category	Largely natural	Moderately modified	Moderately modified	Moderately modified

8.5 Riparian vegetation assessment

Findings of the VEGRAI assessment are presented in Table 8-10. After application of the VEGRAI it was found that the riparian zones at Site 1 were in a largely natural state (Class B). The status of the riparian zones associated with Site 2, Site 3 and Site 4 were in a moderately modified state (Class C). The largely natural state associated with Site 1 may be attributed to the fact that this site is upstream of the surrounding land uses in the mountain catchment area. Additionally, the disturbances at the remaining three sites may be attributed to the surrounding

land uses and associated activities which have resulted in the removal of riparian areas and the encroachment of exotic species into these areas. The primary disturbances may be attributed to road and bridge infrastructure at these three selected sites.

Table 8-10: The findings and ecological category of the fish assessment

Component	Site1	Site2	Site3	Site3
VEGRAI (%)	87.2	67.8	73.2	75.1
EC: VEGRAI	B	C	C	C
Category	Largely natural	Moderately modified	Moderately modified	Moderately modified

9 INTEGRATED ECOLOGICAL STATE

The ecological category for each study component as represented on the continuum (Kleynhans and Louw, 2007) and the respective symbols have also been presented. The ecological status (EcoStatus) for each sampled site has also been presented in Table 9-1. EcoStatus is defined as the following: *'The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services'.*

Table 9-1: The ecological classification of study components and the resulting EcoStatus

Component	Symbol	Site1	Site2	Site3	Site4
Water quality		B	B	B	B
Habitat		A	A/B	A/B	A/B
Fish		A/B	A/B	A/B	A/B
Invertebrates		B	C	C	C
Vegetation		B	C	C	C
EcoStatus		**B**	**C**	**C**	**C**

The EcoStatus for Site 1 was determined to be largely natural. This is to be expected as this site serves as the reference site for the study and is situated in the upper catchment headwaters, upstream of the mining operation and associated activities.

The EcoStatus of the remaining three sites was determined to be moderately modified when compared to reference conditions. The most notable impacts to these sites were to the macroinvertebrate community structure and riparian areas.

This is an indication that the mining operation is impacting on the system. Impacts to the system were identified to be altered habitat and impaired water quality. In addition to this, impacts also included the removal of riparian areas to accommodate the development of the area.

10 MANAGEMENT

The aquatic assessment determined the integrity of the Pioneer Creek system (reference site) to be in a largely natural state. The integrity of the three monitoring sites on the Concession Creek was determined to be moderately modified (Class C). The integrity of the monitoring sites reflects the current ecological status of the system. The current as well as the recommended management class for the system is presented in Table 10-1.

Table 10-1: The ecological management classes identified and described for the system

Category	Description	State
EISC	Ecological importance and sensitivity category	Moderate
DEMC	Default ecological management class	Moderately sensitive systems
PESC	Present ecological status category	Class B: Largely natural
AEMC	Attainable ecological management class	Class B: Largely natural
Ecological status of the system		Class C: Moderately modified
Short term management objective		Class B/C: Largely natural
Long term management objective		Class B: Largely natural

The default ecological management class for the catchment system considers the system to be moderately sensitive. In addition to this, the system is considered to be moderately ecologically important and sensitive. The current ecological status of the system was determined to be moderately modified. The recommended attainable ecological management class for the system is largely natural.

Taking into consideration the current ecological state of the system and the attainable ecological management class, short-term and long-term management objectives have been prescribed.

The short term management objective for the system was determined to be largely natural (Class B/C). Additionally, the long term management objective was determined to be largely natural (Class B).

The short term objective should be achieved within a year of application. The long term objective should be achieved within five years after successfully achieving the short term objective.

In order to achieve these recommended management classes, the following management objectives are provided:

- No road crossing should be allowed to dissect the aquatic ecosystems, suitable bridges should be constructed to minimise impacts to habitat and surface hydrology. This is recommended with particular reference to Site 4;
- Alien vegetation should be removed from the riparian areas of the system with the implementation of an alien plant eradication management programme;
- Barriers preventing the migration of aquatic biota should either be removed or altered to accommodate migratory patterns;
- Culverts should be cleared of debris and sunken into the river bed to prevent obstructions to water flow and avoid artificial barriers for migration of aquatic biota. This is recommended with particular reference to Site 2; and
- Ensure that dirty water is not being released into the system from the mining operation. Dirty water should be recycled and treated before being discharged into the system. This is recommended with particular reference to Site 2 and Site 4.

11 CUMULATIVE IMPACTS

The project area is in the headwaters of the Concession Creek mountain catchment. The Galaxy Gold mining operation has been operational in the area in excess of 125 years. In spite of this, the severity of the *impacts to the system has been negligible*, with the system still in a largely natural state. The severity of the cumulative impact considered for the new tailings facility as well as the continued operation of the mine is also negligible. The tailings facility will not impact directly on the system and the current operation should continue to be managed and monitored so as to ensure no potential impacts to the system. The primary impacts to the system are largely associated with infrastructure and it is unlikely that the severity of the impacts will increase. Recommendations have been provided which may contribute to the improvement of the overall integrity of the system, in spite of the operational mine and proposed tailings facility.

12 MONITORING PROGRAMME

In order to directly measure, assess and report on the current health status and long term trends of the state of the aquatic ecosystem associated with the Galaxy Gold mining activities assessed in the study area, the establishment of an aquatic monitoring programme is recommended. An additional purpose of a monitoring program can be to facilitate activities by obtaining and monitoring compliance of for water user licenses. These licenses relate to the legal requirement of water users to adhere to Source Directed Control (SDC) measures which are related to the established Resource Quality Objectives according the aquatic reserve for catchments (National Water Act (Act 36, 1998)).

To ensure that the future Resource Quality Objectives, to be designated for the catchment, are attained, it is recommended that a responsibility-driven approach towards the management of the aquatic ecosystem associated with the study area be followed. The purpose for such a monitoring strategy will be to examine the long-term environmental trends of the aquatic resources associated with the mining activities in a practical and achievable manner.

The proposed indices for the monitoring strategy include IHI, IHAS, SASS5, FRAI, MIRAI and VEGRAI and basic *in situ* water chemistry. In addition to this, toxicant screening should also be implemented and where toxicants are identified definitive analysis carried out. Biomonitoring and toxicity testing are recommended by DWAF as best practice guidelines for water monitoring (DWAF, 2006). The frequency for such a monitoring programme should be implemented bi-annually (twice a year) during the operation of the project. Thereafter, any non-compliance with the Resource Quality Objectives should be identified and mitigated accordingly.

In the unlikely event of any pollution event occurring it is strongly suggested that a Pollution Action Plan be implemented and the frequency of the monitoring strategy should be adjusted accordingly. This will help to identify the source of the event and mitigation can be formulated accordingly. It is strongly recommended that an assessment of the aquatic ecosystem be conducted as soon as possible after such an event. This will help to identify the magnitude and severity of such an event on the health of the aquatic ecosystem. A follow-up survey should be conducted approximately two months after the event in order to determine the effectiveness of the applied mitigation measures.

13 IMPACT ASSESSMENT

Water quality

Impact description: The discharge of mercury, cyanide, arsenic, sulfuric acid, and methyl mercury which are used or liberated in various stages of the operation should be prevented. In spite of tailings being used to dispose these chemicals into the water bodies, possibilities of leakage are always present. When the leaked chemicals slowly percolate through the layers of the earth, they reach the groundwater and pollute it. The results from the baseline surface water quality study indicated water quality upstream and downstream of the operation to be ideal to

acceptable. However, an assessment of the potential impacts of the proposed mining activities on the surface water resources revealed medium impacts. The proposed tailings facility will be situated a considerable distance away from the Concession Creek and risks are expected to arise during the rainy seasons.

Mitigation: Dirty water should not be released back into the Concession Creek system. Dirty water should be treated to meet DWA water quality standards for an aquatic ecosystem before being released. Alternatively, dirty water could be recycled for the operation. The tailings facility should also be lined in order to prevent seepage of the fines, suspended solids and dirty water. A return water dam should be implemented to trap dirty water. The current water quality programme appears to be effective as indicated in the baseline findings and it should be amended to consider the proposed tailings facility. In addition to this, water quality monitoring which should include cyanide, mercury and arsenic should be conducted on a quarterly basis. The severity of the impact for proposed tailings facility to the water quality of the system is considered to be low.

Habitat

Impact description: The overall integrity of the in-stream habitat was determined to be largely natural. The current operation is impacting on the integrity of the in-stream habitat at Site 4 due to the stream crossing at this site. This impact is considered to be site specific and the severity is negligible. In addition to this, segments of riparian areas have been removed to accommodate the development of the catchment for the operation. This disturbance has resulted in the encroachment of alien vegetation into these riparian zones. The impacted riparian zones are evident throughout the catchment area adjacent to the operation and were determined to be moderately modified. The proposed tailings facility is not expected to impact directly on the integrity of the in-stream and riparian habitats.

Mitigation: A formal stream crossing should be constructed at Site 4 to prevent the continued crossing of the system through the Concession Creek. The crossing supports should ensure continued flow of the system, even during low flow, and not result in inundation of the upstream area. An engineer and aquatic ecologist should be consulted prior to the design and construction of the crossing. An alien vegetation management and eradication programme should be formulated specifically for the riparian areas and implemented. This will result in the removal of alien invasive species from the catchment.

14 CONCLUSION

Following the findings of this aquatic assessment, the impacts of the activities associated with the Galaxy Gold operation to the local aquatic ecosystem are negligible. Primary impacts to the system are associated with mining infrastructure such as bridges and roads. These impacts have largely only impacted on the riparian zones with minimal impacts incurred in-stream of the system.

The largest impacts to the integrity of the system are to habitat quality and quantity. The aim of the management plan is to maintain the existing healthy ecosystems. Monitoring of the system should be initiated in order to determine temporal and spatial trends of the system. Management should primarily consider the ecosystem driver component with reference to both water quality and habitat, ensuring these components are not further impacted on, and where possible, improved upon. Effective management of the surrounding activities will help to achieve both the short term and long term management objectives which have been prescribed.

15 RECOMMENDATIONS

Due to the findings of this survey as well as owing to the fact that only an indicator of water quality was used and *in situ* measurements recorded, it is recommended that a comprehensive analysis of the water resource be conducted.

Biological toxicity testing is described in the DWAF Best Practice Guidelines (G3) (DWAF, 2006) and this additional component will result in compliance with these guidelines. An assessment of the water quality will assist to identify what the water quality based stressors are. Recommended water quality test would include the TIE's (toxicity identification evaluation), this is to be conducted in combination with fish and macroinvertebrate sampling. Based on the findings of the integrated toxicity assessment, management measures would then need to be formulated to assist with achieving the prescribed short term and long term management objectives.

The largest potential impact for the Galaxy Gold Mining Project would be the discharge of cyanide, mercury and metal (e.g. aluminium, manganese, iron) rich tailings into the Concession Creek. According to Tarras-Wahlberg (2001) cyanide causes a direct lethal effect on biota close to the source and metal contaminants considerably reduce aquatic biodiversity further downstream away from the source. In light of this, it is recommended that monitoring specifically includes cyanide, mercury and arsenic in addition to analysis referred to in the surface water study.

16 SUMMARY TABLE

The aim of the aquatic assessment was to determine the ecological integrity of the aquatic ecosystem related to the project area and to describe the baseline condition of the system associated with the project. The status of each objective and the reference to the relevant section in the document is listed in Table 16-1.

Table 16-1: Summary table for the aquatic assessment

Objective	Status	Section
In situ water quality assessment	Complete	Section 8.1
Water quality assessment	Complete	Digby Wells specialist report
Habitat assessment	Complete	Section 8.2
Fish assessment	Complete	Section 8.3
Macroinvertebrate assessment	Complete	Section 8.4
Riparian assessment	Complete	Section 8.5
EcoStatus	Complete	Section 9
Management	Complete	Section 10
Cumulative impacts	Complete	Section 11
Monitoring programme	Complete	Section 12
Conclusion	Complete	Section 13
Recommendations	Complete	Section 14

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APPENDIX A

CURRICULUM VITAE AND DECLARATION OF INDEPENDENCE

DIGBY WELLS
ENVIRONMENTAL

SPECIALIST DECLARATION OF INDEPENDENCE

I, Andrew Husted, declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the proposed project Aquatic Assessment, Galxy Gold Mining Project;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- Do no have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Impact Assessment Regulations, 2006;

Andrew Husted
Name of the specalist

Signature of the specalist

Digby Wells & Associates
Name of company

23 May 2011
Date