Ok Tedi Mining Limited

PROPOSED ENVIRONMENTAL REGIME

Report: ENV010914
Environment Department

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EXECUTIVE SUMMARY

Ok Tedi Mining Limited's (OTML) current environmental regime was introduced in 1990 after the Sixth Supplemental Agreement became law. On the basis of the Environmental Study forming part of the Sixth Supplemental Agreement, the regulator established an APL (Acceptable Particulate Level) and OTML and the regulator developed a protocol for monitoring, and reporting APL compliance (or otherwise) and investigating and recording a number of other non binding environmental parameters. These included suspended solids, fish biomass, dissolved and particulate copper and navigability at specified locations within the Fly River system.

While OTML has consistently operated below the APL set in 1990, it has, with the regulator's agreement, exceeded the predictive levels for most of the other non binding environmental parameters.

Numerous risk assessments and reviews have been undertaken over the last six years. Key amongst these were the Human Health and Ecological Risk Assessment (HERA), a peer review group's (PRG) report of the HERA process and findings, and a technical report commissioned by the State (Timperley, 1999). Their findings have been implemented in this proposal.

After discussions with the State it was agreed in late 2000 that work would commence on the design of a new environmental regime. Pending the adoption of the new regime, the State in a Change Notice in September 2000, suspended the requirement for continued monitoring of the non-binding environmental parameters, but leaving in place the mandatory APL limit.

The proposed Regime

This document presents to the State the proposed revised OTML environmental regime hereafter referred to as the "Regime" to assist the State to decide whether the presently predicted social and environmental impacts are unacceptable and as a consequence the mine should close before the end of its economic life; or the predicted social and environmental impacts are acceptable and that the mine should continue on the basis of the proposed revised Regime or some other regime acceptable to the State. In this context, the Regime ensures that:

a) the State receives the level of information and commentary it needs to make informed decisions about the operation of the mine as it proceeds; and

b) there is reasonable clarity as to what OTML must do to comply.

OTML's monitoring activities under the existing regime have been criticised because they devote too many resources to measuring effects and not enough to studying cause and effect relationships. The statistical results produced have built up a good database and served progressively to inform the State of the trends in both the binding and non binding environmental parameters and associated impacts. The database has also served as the basis for a number of predictive models, These models predict that if the mine continues through to the end of its economic life, its negative environmental impacts will increase as will the off-setting social benefits.

If at the end of their current reviews the communities and Governments conclude that the appropriate balance between environmental and social issues makes it desirable that the mine should continue despite the predicted environmental impacts, then the new permitting arrangements and Regime will have deemed such predicted impacts acceptable. It is therefore suggested that, rather than measurement of the impacts alone, it would be of greater assistance to the State to receive an appreciation of causes and effects - giving a continually updating picture of the ecological health of the river system and the opportunity to respond to emerging issues that might help mitigate the predicted impacts or vary arrangements if predicted impacts are exceeded.

This proposal is based on the concept that the State should have statistical measures of those impacts considered important to decision making in the remaining ten years of mine life, but substantial effort should also go towards evaluation of ecological cause and effect relationships.

This proposal has been developed using the following Environmental Values to which, it is suggested, the Regime should be directed.

- Water quality is to a drinkable standard downstream of the mining operation following settlement of the total suspended solids;
- The water-based resources of the Ok Tedi and Fly Rivers downstream of the mining operation are available to meet normal community requirements;
- Fish and other aquatic resources of the Ok Tedi, Fly River and Gulf of Papua receiving environment are safe to eat;
- The land and land-based resources of the Ok Tedi and Fly River floodplains downstream of the mining operation are available to meet normal community requirements;
- Crops and natural forest resources included in the normal dietary intake of the local community are safe to eat; and

- The main river channels of the Lower Ok Tedi and Fly River are navigable for village craft and commercial shipping.

Organisation of the proposal

The Environmental Values driving the co-ordinated proposal are the environmental expectations of persons living along the Ok Tedi / Fly River system. Adopting an ecological approach, a number of component programs are proposed. These are listed and discussed below.

Objectives of the proposal

The objective of this proposal is to enable the State to make informed judgements concerning the mine's continuing operations based on the effects on downriver communities and the receiving environment. It is designed:

- to understand the impact of the Ok Tedi mining operation on the receiving environment in both human health and ecological terms; and

- to identify and assess possible mitigation options that could either limit or reverse those impacts.

Structure of the proposal

The co-ordinated proposal recognises that knowledge will evolve and is structured around four programs: the management of acid rock drainage (ARD); the ecological investigation of the aquatic riverine system; the ecological investigation of the terrestrial riverine system; and the environmental management of OTML's industrial areas.

<u>The ARD Management Program</u>

The primary goal of the ARD Management Program is to ensure that there are no adverse changes relating to river chemistry as a result of OTML's mining operations that are unacceptable to the State, because they go beyond the impacts predicted when the State determines the mine should continue and establishes the Regime. The specific objectives of this program relate to an evaluation of the acid-forming potential of waste rock and tailings; the determination of ARD potential as a result of dredging at Bige; the determination of the potential acid and metal loads from exposed mine-derived materials deposited in the Ok Tedi / Fly River system; and the identification, evaluation and implementation of management options for controlling or mitigating the risk of adverse impacts from sulphide oxidation in mine waste materials.

<u>The Riverine Aquatic Ecology Management Program</u>

The Riverine Aquatic Ecology Management Program's goal is to ensure that there are no adverse changes relating to the existing health of the communities and the aquatic ecosystem of the receiving environment, consistent with the environmental values driving the Regime which are unacceptable to the State because they go beyond the impacts predicted when the State determines the mine should continue and establishes the Regime. This program's objectives are the assessment of the ecological health of the receiving aquatic environment, specifically in terms of water drinkability, the availability of fish and other aquatic fauna, and the edibility of aquatic food stocks; the identification, trial and implementation, where appropriate, of mitigation actions relating to the environmental values; and the monitoring of the Ok Tedi and Fly River channels for navigability.

The Riverine Terrestrial Ecology Management Program

The primary goal of the Riverine Terrestrial Ecology Management Program is to ensure that there are no adverse changes relating to the existing well-being of the communities and the terrestrial ecosystem of the receiving environment, consistent with the environmental values guiding this proposed Regime which are unacceptable to the State because they go beyond the impacts predicted at the time the State determines the mine should continue and establishes the Regime. Specifically, this program's objectives are the determination of the cause and extent of forest dieback and recovery; the determination of the cause, frequency and extent of floodplain inundation and its effect on community access to, and use of, floodplain land and resources; the determination of the ecological health of the receiving terrestrial environment and specifically the edibility of crops and other natural forest resources; and the identification, trial and implementation, where appropriate, of mitigation actions relating to environmental values.

The Industrial Site Monitoring Program

The Industrial Site Monitoring Program details the environmental management of the various OTML operations such as the mill, the mine, the pipeline, facilities in Tabubil and the Kiunga facility. This program is consistent with principles and practices that would be expected at any open-cut mine which claims good environmental management. The objectives of this program are to ensure environmental best practice applies to the OTML operation and its monitoring, management and recording of potential operational impacts.

Each of the first three programs is divided into domains, or ecologically based study areas, with environmental activity addressing the relevant Environmental Values within each domain. The Industrial Site Monitoring Program's domains are organised around specific operational areas.

The successful implementation of the Regime programs relies on support from three key areas relating to analytical services, hydrological services and community liaison services.

Analytical Support Services

The Analytical Support Services group will provide laboratory services to the various programs within the proposed Regime, undertaking chemical and physical analyses of water, sediment, fauna and flora samples. It will also assist in research activities and the provision of technical expertise aimed at addressing specific issues in understanding river chemistry.

Catchment Support Services

The Catchment Support Services group will be responsible for collecting, collating and analysing meteorological, hydrological, and sedimentological data for input into the various proposed Regime's programs. Of specific relevance is the use of this data for the various models that OTML uses to track sediment transport, dieback onset and recovery and climatic conditions.

Community Liaison Support Services

The Community Liaison Support Services will be responsible for informing the downriver communities and other OTML relevant groups of the ecological status of the river system and other environmental issues. This support group will also collect and collate information required by the proposed Regime's activities to address ongoing concerns that members of the various communities may have.

Continuous Improvement

Fundamental to the Regime is the development of appropriate mitigation options to attempt to reduce or eliminate any adverse mine-related impacts which, affecting the stated Environmental Values, may be unacceptable to the State. Consequently, the continuous improvement process requires action plans to be developed, based on the results of investigations conducted during the implementation of the programs. These action plans will be aimed at identifying, trialling and implementing appropriate mitigation strategies.

The proposed Regime is a dynamic process operating within a changing ecosystem. The implementation of the Regime's co-ordinated programs will necessarily involve the evolution of direction, priorities and activities subject to changing environmental and community expectations. It is readily anticipated that the emphasis of programs, and indeed the very programs themselves, may well change over time. The results of this review process will be provided in an annual report to the State, with an indication of

activities proposed within each program for the following year and annual State approval of the activities proposed.

Compliance Strategy

The proposed Regime also presents a compliance strategy built around the Environmental Values to inform the State of the effect of mining operations on the riverine ecosystem. Reflecting the human health issues associated with the environmental values, specific criteria relate to the monitoring of:

- water potability
- fish and forest crop edibility
- fish biomass, diversity and abundance
- river water dissolved and bioavailable copper concentrations
- ecotoxicological monitoring of river water
- dieback
- ARD
- river bed levels

A schedule for compliance is also presented for consideration.

TABLE OF CONTENTS

1 INTRODUCTION

The current environmental regime at Ok Tedi Mining Limited (OTML) is based on environmental investigations conducted for the Sixth Supplemental Agreement (SSA) Environmental Study. These studies commenced in 1986 and were completed in 1989. Under the SSA the State extended approvals for tailings and waste rock riverine disposal, pending the determination of a binding Acceptable Particulate Level (APL), which was set in 1990. At the same time, an environmental monitoring program was designed to compare actual impacts with 12 other predicted but non-binding levels. The rationale was that the predicted levels for the non-binding parameters would not be exceeded provided the APL was not exceeded. This program was detailed in the document *Acceptable Particulate Level Compliance and Additional Monitoring Program* (OTML 1990).

While the acceptable particulate level of total suspended solids is measured at Nukumba, the whole regime has been generically referred to as the APL program. This document will use the term APLCMP (the APL Compliance Monitoring Program) when referring to the overall regime.

By 1996, 11 of the non-binding parameters set out in the APLCMP had been exceeded and it was clear that compliance with the APL had not prevented environmental impacts occurring beyond those predicted when the APLCMP was adopted.

In 1998 OTML began an integrated risk assessment of its operations. This included social, engineering, and ecological assessments of mine waste management alternatives. One component was the Human Health and Ecological Risk Assessment (HERA) (Parametrix, 1999), which was conducted according to USEPA guidelines and completed in December 1999. The integrated risk assessment and supporting studies were reviewed by the State, the World Bank and shareholders. The HERA was reviewed by an independent peer review group of independent world experts(PRG) established by OTML at the outset of investigations.

The results of this risk assessment process concluded that none of the proposed management options offered a clear way forward – closing the mine was ecologically the best option, but had significant social and economic consequences. The World Bank reached similar conclusions and commented that while OTML's ecological studies were first rate, emphasis needed to be placed on mine closure planning.

The PRG recommended that a single document be prepared in which the key environmental issues be identified within the context of the Ok Tedi / Fly River ecosystem, and that this be developed as an annually updated knowledge strategy.

A technical review commissioned by the State in 1999 (Timperley, 1999) concluded that the APLCMP was no longer relevant and that the State required a new approach to

managing the environmental effects of and risks associated with the continued operation of the Ok Tedi mine.

After discussions with the State it was agreed in late 2000 that work would commence on designing the Regime to replace the APLCMP.

Consistent with this, in Change Notice 42/4.2; 18/29.2 in September 2000, the State suspended the operation of the additional environmental monitoring, leaving in place the mandatory APL limit.

This document presents to the State the proposed revised OTML Regime.

Primarily, this document:

- presents the philosophy behind the Regime, discussing linkages with the current legal and other obligations and the current monitoring and investigative work. These are presented in Section 2.

- The purpose of the revised environmental Regime is discussed in Section 3 and describes the set of environmental values that drive the Regime.

- Section 4 describes the organisation of the proposed Regime and the different works programs that will be adopted, and reviewed annually.

- The implementation of the Regime is described in Section 5. As review is part of a continuous improvement process, it is likely that activity will change from year to year. Included in Section 5 is a proposal to report findings of program activities annually to the State.

- To specifically inform the State of the effect of mining operations on the receiving riverine environment, a Regime compliance proposal is presented in Section 6. The activity to be undertaken under this compliance forms Schedule I of this Regime document.

The activities to be undertaken in the Regime's first year, as described in Section 5, are summarised in tabulated form in Schedule II, which is attached to this document. As these activities will be reviewed and modified, if appropriate, on an annual basis, it is proposed to annually submit this schedule to the State to seek its sign off for environmental activity to be conducted for the coming year.

2 BACKGROUND

2.1 Current Obligations

2.1.1 Legal Requirements

OTML's obligations are documented in a series of Acts of Parliament, Approval of Proposals, Agreements and Change Notices. While a total of thirty four documents make up the regulatory regime only four are relevant to the present environmental compliance requirements. These are:

- Mining (Ok Tedi Agreement) Act 1976.
- The Mining (Ok Tedi Sixth Supplemental Agreement) Act.
- Change Notice 43/4.2; 18/29.2. Tailings System Further Amendment.
- Change Notice 44/4.2; 19.29.2. Environmental Monitoring and Environmental facilities.

Under the SSA, the State suspended OTML's obligation to construct a permanent tailings dam and engineered waste dumps and required OTML to undertake a rigorous environmental impact study of the effects of riverine tailings and waste on the Fly River system below the Ok Tedi confluence. On the basis of the study and certain criteria adopted by the State, which included the State's desire to ensure unacceptable environmental damage did not occur in the Fly River and its desire for the project to proceed, the State set an APL for suspended particulate matter in the Fly River System.

2.1.2 Detailed APLCMP Requirements

The 1989 SSA Environmental Studies contained predictions for three mine waste management options. These were:

- Continued disposal of waste rock to the failing waste dump and tailings to Ok Mani, at the same time maximising efficiency and copper recovery from the ore;
- A low Lukwi Dam for tailings retention; and
- A high Lukwi Dam for both tailings and waste rock retention.

The State accepted the first option and established, effective from 28 September 1989, an APL limit of 940 mg/L at Nukumba.

The National Executive Council stated: "*In accepting an APL of 940 mg/L, the State recognises that a risk of environmental damage exists and also that estimates of this risk are very uncertain. The State however requires actual damage not exceed that now predicted from extrapolation of present data. Accordingly, the State requires a monitoring program designed to ensure that the conditions given below are met at all*

times in the future. This program is to be designed by OTML in consultation with the State, to meet the State's specification and approval."

The conditions set by the State were:

- A useful and viable subsistence fish resource should be maintained in all parts of the Fly River channel by ensuring that:
  - actual fish catches at sites reasonably specified by the State do not, prior to and including 1994, decline below those predicted in the Predictions for 1994, and after 1994 below predictions for each subsequent year; and
  - copper contamination in the Fly River channel does not exceed predictions;
- The capacity of the off-river water bodies, to ensure the early recovery of the Fly River fish resource, should be protected by ensuring that not more than 20% of the area of a representative selection of off-river water bodies, chosen by the State, in consultation with the Company, on the basis of their assumed biological value to the Fly River system, is influenced by copper from mine wastes;
- The biological resources of the Fly River delta, the Gulf of Papua and the Torres Strait should be protected by ensuring that the concentration of particulate copper entering the Fly River delta does not exceed predictions; and
- The navigability, to an acceptable extent, of the Fly River should be protected by ensuring that the actual aggradation of the Fly River does not exceed the Predictions over the life of the mine.

2.1.3 APLCMP Monitoring Requirements

To achieve the conditions associated with the APL, monitoring of one binding and twelve non-binding parameters was nominated dealing with suspended solids, riverine dissolved and particulate copper, fish sampling, estuarine benthic particulate copper, and navigability.

2.2 Current Monitoring and Investigative Work

Within the current regime, OTML environmental activity can be separated into three components:

1. APLCMP Compliance Monitoring
2. APLCMP Additional Monitoring
3. OTML Additional Monitoring

2.2.1 APLCMP and Compliance Testing Monitoring

There are thirteen predicted level monitors including the APL and they are listed in Table 2.1.

The APL is the measure of suspended sediment concentrations at Nukumba. This is determined weekly and the 90% confidence limit of the mean calculated over the previous 30 weeks should not exceed 940 mg/L. The remaining twelve monitors were suspended from September 2000, i.e. from the date of the State's Change Notice: 42/4.2;18/29.2.

Table 2.1: Summary of APLCMP Compliance Monitors

Location	Monitor	Frequency	1989 EIS Prediction	1998/1999 Average	1999/2000 Average	Within Prediction[2]
Nukamba[1]	Suspended Solids	Weekly	< 940 mg/L	439 mg/L	450 mg/L	✓
Nukumba	Dissolved Cu	Weekly	< 3 ug/L	16.1 ug/L	14.9 ug/L	×
Nukumba	Particulate Cu	Weekly	<562 mg/Kg	1439 mg/Kg	1407 mg/Kg	×
Nukumba	Fish Sample	Monthly	> 49 Kg	22 Kg	18 Kg	×
Kuambit	Bed level	Quarterly	< 1.3 m	2.25 m	2.50 m	×
MF F/P	Particulate Cu	Annual	< 20% sites	42%	43%	×
Obo	Dissolved Cu	Monthly	< 4 ug/L	14.9 ug/L	14.7 ug/L	×
Obo	Particulate Cu	Monthly	<544 mg/Kg	1161 mg/Kg	1131 mg/Kg	×
Obo	Fish Sample	Quarterly	> 119 Kg	70 Kg	75 Kg	×
Ogwa	Dissolved Cu	Monthly	< 1 ug/L	6.2 ug/L	5.5 ug/L	×
Ogwa	Particulate Cu	Monthly	<253 mg/Kg	301 mg/Kg	306 mg/Kg	×
Ogwa	Fish Sample	Quarterly	>147 Kg	110 Kg	92 Kg	×
Estuary	Benthic pCu	Quarterly	<190 mg/Kg	44 mg/Kg	51 mg/Kg	✓

[1] APL Monitor
[2] tests against predictions are made with reference to 90% CL of measured mean

Monitoring of the Ok Tedi, was not included in the APL definition of the river system.

The two monitors that do not exceed predictions are:
- APL suspended sediment monitor at Nukumba
- Estuary benthic particulate copper levels

The APL limit at Nukumba is unlikely to be ever exceeded. This is because current mine delivery of silts are approximately 30 Mt/a which, for average flow conditions, equates to about 450 mg/L – a dry year would yield about 550 mg/L.

Adherence to this weekly monitor can constitute up to approximately 10% of OTML's environmental monitoring effort.

2.2.2 APL Additional Monitoring

The additional APLCMP monitoring is outlined in the APL Compliance and Additional Environmental Program, 1999. Figure 2.1 maps key locations where monitoring occurs.

It is estimated that this additional monitoring program constitutes up to approximately 35% of OTML's environmental monitoring task.

2.2.3 OTML Additional Monitoring

In addition to the APLCMP monitors and the additional monitoring program, OTML undertakes considerable supplementary monitoring to support further investigations and to refine the current APLCMP additional monitoring program. Table 2.2 details the additional APLCMP monitoring undertaken by OTML's biology, chemistry and hydrology sections.

Table 2.3 details the additional monitoring undertaken by OTML's biology and chemistry sections while Table 2.4 details that undertaken by OTML's hydrology section. The additional hydrological sampling effort is extensive. In addition to the monitoring listed in Table 2.4, aerial photography is undertaken of the southern dumps to estimate erosion rates and of the dieback areas to estimate the spread and recovery of forest dieback. There is also monitoring for ARD in the Ok Tedi / Fly River system including the dredge spoil area.

This additional monitoring constitutes approximately 55% of OTML's environmental monitoring task.

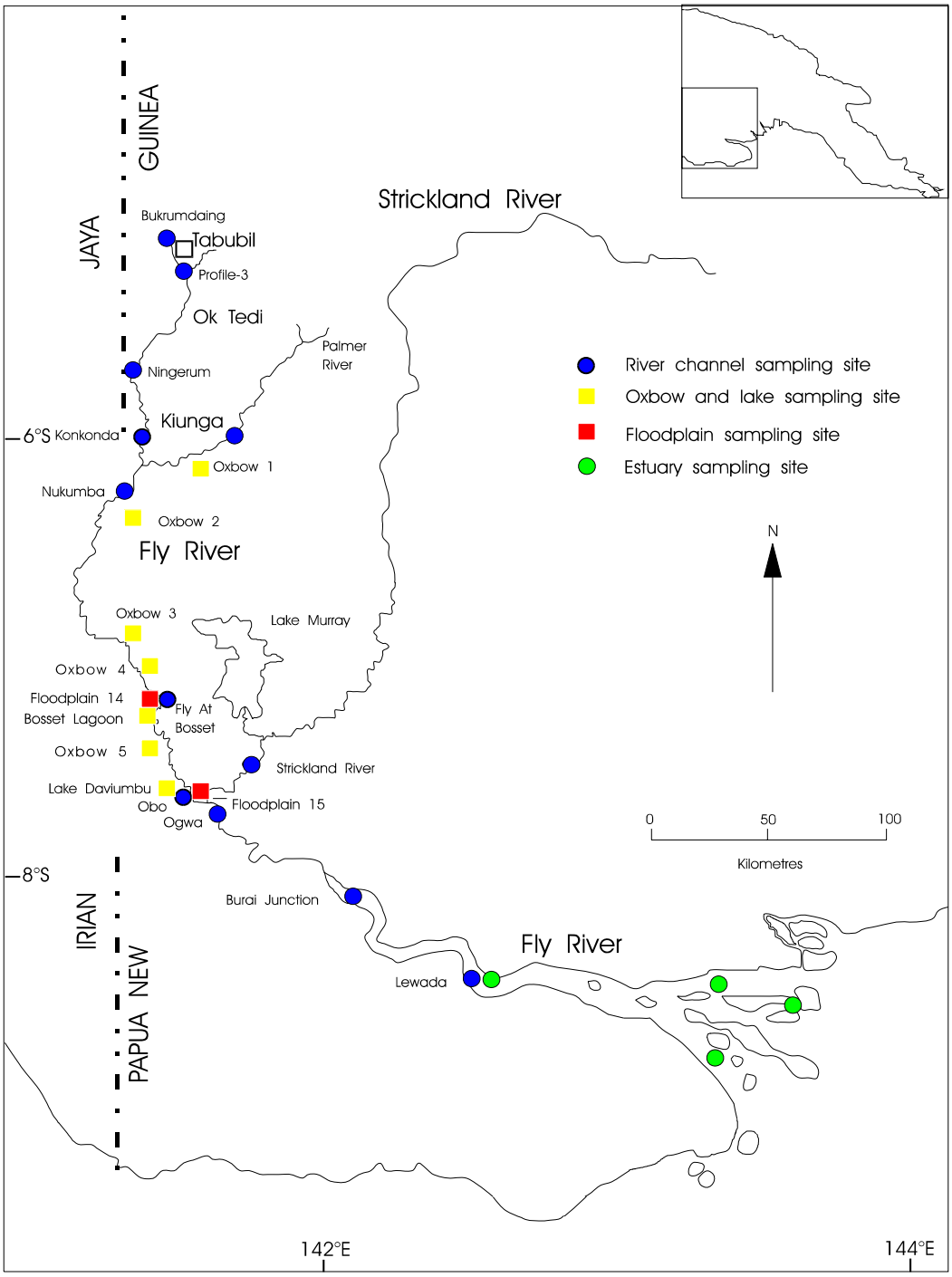

Figure 2.1 – APL Compliance and Additional Environmental Monitoring Key Locations

Table 2.2: Detailed APL Monitoring Requirements

	Ok Tedi	Upper Fly	Middle Fly	Strickland	Lower Fly	Estuary
BIOLOGY						
Sampling	**1; 6**	**1; 3**	**1; 3**x7 sites; **6**x3 sites	**3**	**3**	
Metals/Tissues	**1; 3**		**3; 12**x10 sites	**12**	**3**	
Processing	**6**					
Barramundi						**6**
Prawns						**6**x4 sites
Fish						**3**x4 sites
Crabs						**3**x4 sites
CHEMISTRY						
Type 1	**1**x3 sites	**1**	**1**x3 sites	**1**	**1**	
Type 1A		**1**	**1**x3 sites			
Type 2	**3**x 3 sites	**3**x2 sites	**3**x8 sites	**3**	**3**	
Type 3					3x2 sites	3x4 sites
Type 4			**1**x2 sites			
HYDROLOGY						
Water level	**C**x2 sites	**C**x2 sites	**C**x2 sites	**C**		
Flow	**1**x2 sites	**1**	**1; 3**x2 sites	**3**	**3; 6; 12**	
Bed samples	**1**	**1**	**1; 3**x2 sites	**3**	**3; 6; 12**	
Suspended solids	**1**x2 sites	**1**	**1; 3**x2 sites	**3**	**3; 6; 12**	
Cross section	**1**	**1**	**1; 3**x2 sites	**3**	**3; 6; 12**	

Notes:
Type 1: pH, alkalinity, conductivity, suspended solids, DO, dissolved Ca, Mg, Cu, Zn, Fe, Mn; particulate Ca, Mg, Cu, Zn, Fe, Mn
Type 1A: dissolved component of Type 1
Type 2: Type 1 analysis plus dissolved organic carbon, total organic carbon, particulate aluminium, particulate sulphur
Type 3: Type 2 analysis plus dissolved Na, K, silica, sulphate & chloride
Type 4: pH, conductivity, alkalinity, DO
Numbers in bold print denote months between sampling; C denotes continuous recording
Processing denotes die analysis and condition indices
Metals denotes metals in tissues and organs
Sampling denotes fish catch statistics

Table 2.3: Additional APLCMP Monitoring Requirements

	Ok Tedi	Upper Fly	Middle Fly	Strickland	Lower Fly	Estuary
BIOLOGY						
Sampling	**2**x2 sites	**1; 3**	**1; 3**x6 sites	**3**	**3**x5 sites	
Fish / crab / prawn						**3**x6 sites
Barramundi						**12**
Barnacle mud clam						**12**x10 sites
Barnacle only						**12**
Mud clam only						**12**x6 sites
Fish tissues		**12**x2 sites	**12**x7 sites	**12**	**12**x5 sites	
CHEMISTRY						
Type 1	**1**x2 sites		**1**			
Type 1A			**1**x2 sites			
Type 2	**3**x2 sites		**3**x4 sites			
pCu (benthic)						**6; 12**
pCu (suspended)						**6**

Notes:
Type 1: pH, alkalinity, conductivity, suspended solids, DO, dissolved Ca, Mg, Cu, Zn, Fe, Mn; particulate Ca, Mg, Cu, Zn, Fe, Mn
Type 1A: dissolved component of Type 1
Type 2: Type 1 analysis plus dissolved organic carbon, total organic carbon, particulate aluminium, particulate sulphur
Numbers in bold print denote months between sampling;
Fish tissues denotes metals in tissues and organs
Sampling denotes fish catch statistics

Table 2.4: Summary of Additional Monitoring Conducted by Hydrology Section

Monitor	Ok Tedi	Upper Fly	Middle Fly	Strickland	Lower Fly
Water Level					
APL	2	1	2	1	0
Additional	17	2	69	3	2
Flow					
APL	2	1	3	1	3
Additional	10	3	69	3	3
Bed samples					
APL	1	1	3	1	3
Additional	15	3	69	3	4
Suspended Sediment					
APL	2	1	3	1	3
Additional	15	3	69	3	4
X-sections					
APL	1	1	3	1	3
Additional	38	12	31	13	6
Rainfall					
APL	0	0	0	0	0
Additional	13	3	16	0	0

Note: numbers refer to number of sites for each activity

2.3 Third Party Reviews and Recommendations

A significant number of workshops, reports and reviews have been conducted by OTML's staff and international consultants over the past 5 years. They add to dozens more in conducted in earlier years. Those which contain recommendations or detailed comment regarding OTML's environmental monitoring and investigation programs are listed in Table 2.5.

Table 2.5: Key Reports

Report	Date	Comment
1996 Risk Assessment	1996	Risk Assessment recommended trial dredging
An Assessment of OTML's Environmental Monitoring and Analysis activities and statistical analysis of the Environmental database	1996	CSIRO Biometrics Unit (Fox, 1996)
Summary of Results of Monitoring and Research conducted in Fly Estuary, Gulf of Papua and Torres Strait with Recommendations for Change	July 1997	Ridd & Tenakanai, 1997
Cu/ARD Workshop	1997	Workshop called because of reported dCu spikes.
HERA Workshop Minutes	July 1998	First workshop dealing with new risk assessment
2nd PRG report	July 1998	
HERA report	1999	SLRA, DLRA, data
4th PRG Report	1999	5 key issues identified
Proposed Revisions to Biological Monitoring Program	Nov 1999	Smith & Storey, 1999
Timperley Report	Dec 1999	State Govt technical report (Timperley 1999)
5th PRG report	2000	
1999 Detailed Level Risk Assessment	1999	
Cu Workshop	Jan 2000	CSIRO Cu Model questioned
Sediment Workshop	Feb 2000	Lower Middle Fly sedimentation
ARD Workshop	Nov 2000	

Most consultants agree that as the predicted levels set out in the current regime have for the most part been exceeded, the utility of the APL and Additional Monitoring Program has been superseded.

3 PURPOSE OF A REVISED ENVIRONMENTAL REGIME

Compliance with the APL has not prevented the occurrence of impacts in excess of those contemplated by the State in 1990.

The State is considering whether the presently predicted impacts are acceptable, or whether the mine should close before the end of its economic life.

This proposed Regime is predicated on the State deciding that the predicted impacts are acceptable and that the mine should continue.

In this context, the Regime should ensure that:

a) the State receives the level of information and commentary it needs to make informed decisions about the operation of the mine as it proceeds; and

b) there is reasonable clarity as to what OTML must do to comply.

For reasons discussed elsewhere, the current monitoring activities are now considered less than optimal, because they devote too many resources to measuring effects and not enough to studying cause and effect relationships. The statistical results produced have built up a good database and served progressively to inform the State of trends in both the binding and non-binding environmental parameters and associated impacts. The database has also served as the basis for a number of predictive models. These models predict that if the mine continues through to the end of its economic life, its negative environmental impacts will increase as will the off-setting social benefits.

If at the end of their current reviews the communities and Governments conclude that the appropriate balance between environmental and social issues makes it desirable that the mine should continue despite the predicted environmental impacts, then the new permitting arrangements and Regime will have deemed such predicted impacts acceptable. It is therefore suggested that, rather than measurement of the impacts alone, it would be of greater assistance to the State to receive an appreciation of causes and effects - giving a continually updating picture of the ecological health of the river system and the opportunity to respond to emerging issues that might help mitigate the predicted impacts or vary arrangements if predicted impacts are exceeded.

This proposal is based on this concept. The State should have statistical measures of those impacts considered important to decision making in the remaining ten years of mine life, but substantial effort should also go towards evaluation of ecological cause and effect relationships and informing the State on mitigation options and programs.

3.1 Process-based approach

The current APLCMP is a compliance monitoring program whereas it is suggested that the revised regime should be a cause-effect-mitigation process.

Figure 3.1, extracted from the draft ANZECC 2000 guidelines, demonstrates the differences between a compliance regulatory strategy and a process-based strategy – the former lends itself to reactive based management whereas the latter pursues proactive management. The main difference is the inclusion of key processes in the process-based strategy approach. Key processes define the relationships of "cause and effect". The Regime deliberately aims to take this further by introducing an assessment of mitigation options.

The draft ANZECC guidelines add that, while the compliance-based strategy focuses on attainment, its inherent inflexibility can undermine understanding of the key ecosystem processes. The process-based strategy is designed to be iterative and accordingly flexible. This flexibility facilitates development of an operational (cause-effect) model that is progressively refined with each iteration.

The draft guidelines suggest that inclusion of both a compliance-based and process-based strategy is an effective approach in developing an environmental monitoring and investigation program. This approach is adopted in the proposed Regime.

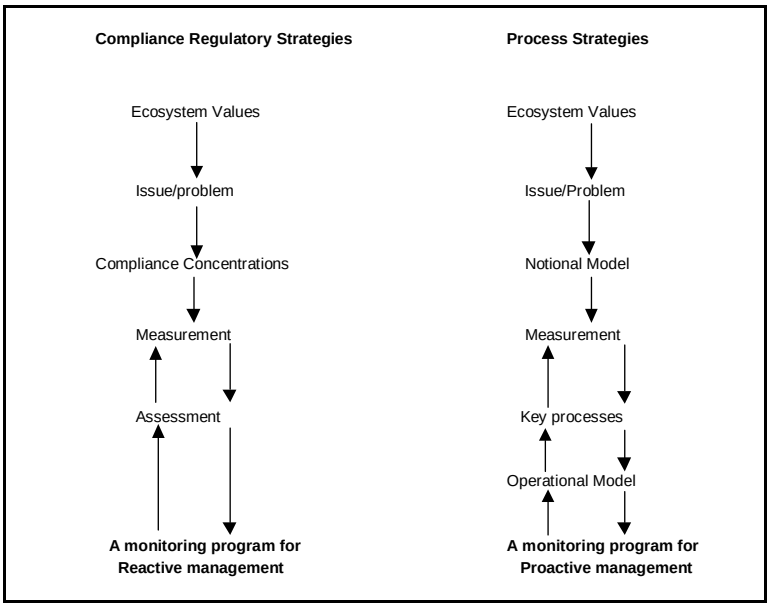

Figure 3.1: Comparison of Compliance vs Process-Based Approaches (Draft ANZECC Guidelines, 2000)

3.2 Process-based cause-effect approach

It has been briefly discussed how a cause-effect model can be used to focus programs on the key issues. Indeed, cause-effect models were prepared as part of the OTML integrated risk assessment. Timperley broadened the model to include impacts on human health / nutrition and the economy of PNG. He identified five ultimate effects as consequences of the environmental changes being caused by the mine. These effects fell into three groups: effects on the local people, effects on the country and effects on the international community. This model has been expanded in this proposal to include the dredge site as a discharge component, and to emphasise the potential for acid rock drainage risk.

The modified Timperley cause-effect model is shown in Figure 3.2. The model traces the three discharge components (sediments, metals and dredge stockpile) to their possible ultimate effects. The local effects relate to economic hardship, nutritional deficiencies and the potential for increased disease incidence.

Regarding Timperley's hierarchy of effects: initial effects are obvious and most have been observed. The intermediate group is more speculative, although some effects have been detected. The ultimate effects are purely speculative and have not been observed. He adds that these effects, if they occurred, are probably unacceptable to the State.

Timperley states that while higher order effects are extreme, they need to be included to "ensure the lower order effects are put into proper perspective. Also it is necessary to find the "bottom line" for the State if a compliance monitoring program is to be established".

Importantly Timperley proposed the following options for compliance monitoring:

- Retain the existing APLCMP program but add additional variables to track key effects. Notification points would be identified from the cause-effect model to identify the stage where an unacceptable level of impact was reached.

- Assume that the effects hierarchy as outlined in the cause-effect model will occur. The State should then plan for contingencies to break the sequence of effects. Using this approach the monitoring program would be designed around monitoring the ultimate effects (e.g. the nutritional status of the local people, international concern etc). Where thresholds are exceeded the State would execute its contingency plans. Timperley uses the example: if the availability of fish to meet subsistence needs decreased to the point where serious protein deficiencies were widespread among the floodplain people, a possible State intervention would be to ensure a supply of tinned fish or meat until either the aquatic ecosystem recovered or an alternative source of protein could be established. In this approach, the monitoring program would be designed to include some measure of the nutritional status of the local people. An appropriate value would be set and if, or when it was reached, the State's contingency plan would be implemented.

- The third option is to control the occurrence of the ultimate effects, without worrying about the intermediate effects. This would involve undertaking periodic surveys of nutritional status of the people, international concern etc. There would be no requirement for OTML to monitor and report water quality and biological variables.

The approach adopted in this proposal, while being a combination of these options, takes the cause-effect model further by examining possible mitigation options.

Figure 3.2, showing the modified Timperley cause-effect model, fits here. Because of its size, it has been attached as a separate file titled:
"Regime Fig 3.2 pg 16"

3.3 Environmental Values

This proposal has been developed using a set of Environmental Values, to which it is suggested a replacement environmental regime should be directed.

The Environmental Values below were identified taking into account comments from the State, the communities of the Ok Tedi and Fly River and recommendations of the HERA and PRG.

- Water quality is to a drinkable standard downstream of the mining operation following settlement of the total suspended solids;
- The water-based resources of the Ok Tedi and Fly Rivers downstream of the mining operation are available to meet normal community requirements;
- Fish and other aquatic resources of the Ok Tedi, Fly River and Gulf of Papua receiving environment are safe to eat;
- The land and land-based resources of the Ok Tedi and Fly River floodplains downstream of the mining operation are available to meet normal community requirements;
- Crops and natural forest resources included in the normal dietary intake of the local community are safe to eat;
- The main river channels of the Lower Ok Tedi and Fly River are navigable for village craft and commercial shipping.

Obviously, there are non-mine land uses, such as local village and State run sewerage schemes and timber harvesting operations, that may impact on these values.

The five impact assessment components that were identified from the cause-effect analysis in HERA are:

- Community Impacts
- Economic Impacts
- Ecological Impacts
- International Concern
- Operational Impacts

The issues identified to address each impact assessment component are presented in Table 3.1. and their relationship with the Environmental Values is also given.

Table 3.1: Relationship between Components, Issues and Environmental Values

Component	Issue	Environmental Value					
		Drinkable Water	Aquatic Avail	Aquatic Edible	Terrestrial Avail	Terrestrial Edible	Navigation
Community	Economic Hardship	✓	✓	✓	✓	✓	✓
	Health & Nutrition	✓	✓	✓	✓	✓	
	Increased disease	✓	✓	✓	✓	✓	
Economic	Navigability of Middle Fly						✓
Ecological	Sedimentation	✓	✓		✓		✓
	Dieback				✓		
	Acid Rock Drainage	✓	✓	✓	✓	✓	
	Copper Toxicity	✓	✓	✓	✓	✓	
	Fish Biomass/ Species Loss		✓				
International	Biodiversity Loss		✓	✓	✓	✓	✓
	Indonesia Impact	✓	✓	✓	✓	✓	✓
	Torres Strait	✓	✓	✓	✓	✓	✓
	NGO Communications	✓	✓	✓	✓	✓	✓
Operational	Site Management	✓					
	Rehabilitation	✓			✓	✓	
	Mine Closure Planning	✓			✓	✓	

The PRG recommended future environmental effort be focussed on copper toxicity, sedimentation, acid rock drainage, dieback and fish biomass. It should be noted that the PRG primary issues are associated with the ecological components in Table 3.1. This table also illustrates how each of these issues is associated with the six different Environmental Values.

Timperley's ultimate effects are demonstrated in Table 3.2 to also be closely aligned with the nominated Environmental Values.

Table 3.2: Relationship between Timperley's Ultimate Effects and the Environmental Values (Note: the detail in this table is taken from Timperley, 1999)

Timperley's Ultimate Effect	**Drinkable water**	**Availability of water based resources**	**Edibility of water based resources**	**Availability of land based resources**	**Edibility of land based resources**	**Navigability of river channels**
Local Economic hardship		aggradation		aggradation		aggradation
Nutritional deficiencies		protein loss	protein loss	dieback decline of soil structure	protein loss	
Increased disease incidence	lack of clean water perception of "unhealthy" water	poor nutrition	poor nutrition	poor nutrition	poor nutrition	
National Early mine closure						
International Forest dieback leading to loss of biodiversity				loss of tropical rainforest atmospheric carbon dioxide forest biodiversity		

The next section, Section 4, describes the organisation of the proposed Regime and demonstrates how environmental activity at OTML will be organised to address these Environmental Values.

4 ORGANISATION OF THE PROPOSED REGIME

As discussed in the previous Section 3, this co-ordinated proposal been developed as a replacement for the outdated APLCMP.

The Environmental Values driving the co-ordinated proposal are the environmental expectations of persons living along the Ok Tedi / Fly River system.

Adopting an ecological approach to organization, a number of programs are proposed and are listed and discussed below. (Each program is discussed in Section 5).

The co-ordinated proposal recognises that knowledge will evolve. As an internal management tool, a Program Management Plan (PMP) has been formulated for each of the four programs in the proposal. Each PMP, which will be updated annually, will state the activity and methodologies to be conducted and it will form the basis for assessing progress and review. The reporting and review process is discussed at the end of Section 5.

An environmental compliance proposal, for the measurement and reporting of specific criteria and the Environment Values, is presented in Section 6. The activity to be undertaken to comply with this criteria, is presented in Schedule I.

The annual activities contained within the PMP's are summarised and tabulated in Schedule II.

4.1 Proposal's Objective

The objective of this proposal is to enable the State to make informed judgements concerning mine operations based on the effects on downriver communities and the receiving environment. It is designed:

- to understand the impact of the Ok Tedi mining operation on the receiving environment in both human health and ecological terms; and

- to identify and assess possible mitigation options that could either limit or reverse those impacts.

4.2 Proposal's Structure

Based on the Environmental Values, the proposal is structured around the management of ARD, the ecological investigation of the riverine system, and the environmental management of OTML's industrial areas.

4.2.1 The Programs

The initial implementation of the proposed environmental Regime is centred on the following four programs:

I. The ARD Management Program. (This program covers all domains impacted by OTML operations and in particular the Upper Ok Tedi)

II. The Riverine Aquatic Ecology Management Program. (This program includes all aquatic environments within the Ok Tedi / Fly River system impacted by OTML operations but with particular emphasis on the Ok Tedi and Fly Rivers from Ningerum to the Gulf of Papua)

III. The Riverine Terrestrial Ecology Management Program. (This program includes all terrestrial environments within the Ok Tedi / Fly River system impacted by OTML operations but with particular emphasis on those reaches lying between Ningerum and the Gulf of Papua)

IV. The Industrial Site Management Program. (This program centres on the operational aspects including the mine, the mill, the pipeline, certain facilities at Tabubil and the Kiunga load-out facility that have a direct discharge potential into the receiving environment. This program encapsulates the aspects which are usually the subject of environmental management at any normal open-cut mining operation which practices good environmental management)

Each of the four programs are organised on a domain (ecological study area) basis, through which the environmental effort is focussed. Based on the Environmental Values, specific aspects are investigated within each domain. Each program has to be reviewed annually and, if appropriate, modified to address changing issues or knowledge. Consequently, the activities within each program will vary from year to year. Therefore, it is proposed to present a revised Schedule II (tabulated statement of Regime activity) to the State on an annual basis and seek its concurrence for those activities to be undertaken during the following year.

4.2.2 The Support Services

In addition to the Program Management Plans, the proposal depends on the delivery of support services from three significant service areas. These are:

i Analytical Support Services
ii Catchment Support Services
iii Community Liaison Support Services

The role that each of these Support Services plays in assisting the successful implementation of the proposed Regime is discussed in Section 5.

4.3 Rationale for each Program

4.3.1 The ARD Management Program

Acid rock drainage (ARD) is a natural process that results from the combined chemical and biological oxidation of sulphide minerals and the release of direct oxidation products such as acid, sulphate, iron and copper and associated metals such as aluminium and manganese. Mine waste rock and tailings that contain sulphide minerals, such as those released into the Ok Tedi by OTML, may react with atmospheric oxygen and water to produce sulphuric acid. In many situations, the waste rock and tailings contain sufficient neutralising materials to prevent the development of acid conditions however, where the content of neutralising material is limited, acid conditions can develop resulting in the generation of ARD. Acid drainage resulting from sulphidic materials may impact on the immediate and wider environment, not only through the release of acid but also its ability to generate significant amounts of potentially toxic metal leachate into the receiving environment, even in neutral waters.

Having recognised the potential for acid drainage, OTML has adopted risk management strategies which, successfully developed and carefully implemented at Ok Tedi over many years, are designed to minimise the impacts of ARD on the environment. Central to this strategy is the ARD Management Program. Building on work started before mining began, this program comprises a broad range of site investigations, modelling to enable prediction of future acid and alkalinity loads, and the design and testing of any mitigation and control measures that may be required.

The specific objectives of this program are discussed in Section 5. The proposed activities to be undertaken within this program during the Regime's first year are summarised in Schedule II.

4.3.2 The Riverine Aquatic Ecology Management Program

OTML has, through the years since operations began, conducted systematic monitoring of a range of environmental parameters to better understand the nature and magnitude of riverine impact.

The principal rationale for this program is that it fits with the dual objectives to:

- Assess the nature and extent of mine-related impacts on the riverine aquatic environment

- Identify and investigate potential mitigation options to address these impacts

The program of works presented is consistent with the Environmental Values. Section 5 discusses the specific objectives of this program and lists the aquatic domains in which this program will operate. The proposed activities to be undertaken within this program during the Regime's first year are summarised in Schedule II.

4.3.3 The Riverine Terrestrial Ecology Management Program

The rationale of this program is identical to the Riverine Aquatic Ecology Management Program.

Section 5 discusses the specific objectives of this program and lists the terrestrial domains in which this program will operate. The proposed activities to be undertaken within this program during the Regime's first year are summarised in Schedule II.

4.3.4 The Industrial Site Management Program

Historically, OTML's environment department has concentrated largely on monitoring and predicting the impact of the tailings and waste rock discharges into the Ok Tedi and Fly River Systems. Specific site (operational) environmental monitoring programs were commenced at OTML in 1997, to co-ordinate and expand on the existing mechanisms for monitoring non process / mine waste discharges into the external environment from the project.

To date, the industrial site environmental management program has assessed environmental performance relating to the mining operation and associated infrastructure that were not covered by the APLCMP requirements. The program has focused on water monitoring, incident response and site inspections to follow up environmental audit findings and to evaluate environmental performance.

In its Environmental Policy, OTML states that it strives "to achieve a high standard of environmental care in conducting its business as a resources and industrial company contributing to society's material needs. OTML's approach to environmental management seeks continuous improvement in performance by taking account of evolving scientific knowledge and community expectations."

The proposed Industrial Site Management Program encapsulates best practice applied to the various components of the OTML operation.

The specific objectives of this program are discussed in Section 5. The proposed activities to be undertaken within this program during the Regime's first year are summarised in Schedule II.

4.4 Timing and Reporting

The following sequence is proposed:

- for consistency with other OTML operations, it is proposed to organise the Regime around the normal financial year, commencing July 1;

- the Regime's programs will be internally reviewed each year to scope the activities proposed to be undertaken. These activities will be submitted to the State as a Schedule II table;

- the findings for each program will be annually reported to the State by 30 September. This is explained in detail in Section 5.8. It is proposed to have a formal reply from the State indicating its sign off of the annual report and the proposed environmental activity for the following twelve months. However, due to time delays between the commencement of the programs, the reporting of the previous year's findings and the State's sign off, activities will necessarily commence prior to receiving that sign off. Obviously, if there is any conflict, it will have to be resolved prior to the State giving sign off.

5 IMPLEMENTATION

Section 4 discussed the organisation of the Regime and its objectives. It detailed the Regime's structure, explaining the rationale of the four programs. This Section discusses the specific program objectives and details the domains used to implement the programs and the aspects under which the programs' activities are organised.

The role of the proposed Regime's three support services groups are also discussed.

Towards the end of this section, the Regime's continuous improvement process is detailed, along with reporting requirements.

5.1 The ARD Management Program

5.1.1 Program Objectives

The primary goal of the ARD Management Program is to ensure that there are no adverse changes which are unacceptable to the State, relating to river chemistry as a result of OTML mining operations.

The specific objectives of the program are:

- To evaluate the acid-base and acid-forming potential of waste rock and tailings to be discharged from the mine from 1999 to the end of mine life;
- To evaluate the acid-base and acid forming potential of materials deposited in the Ok Mani, Ok Gilor, Ok Tedi and Fly River catchments;
- To determine the risk of developing acid drainage from the mine and river deposited materials stockpiled as a result of dredging at Bige;
- To determine potential acid and metal loads from exposed materials and the acidity / alkalinity balance;
- To identify and evaluate management options for controlling or mitigating the risk of adverse impacts from sulphide oxidation in mine waste materials.

5.1.2 Program Domains

The principal domains covered by this program include all those areas subject to the influence of mining and mine-related activities where sulphide-bearing materials may potentially become exposed to the atmosphere. As such, the majority of activities are focused on those areas of greatest mine impact at the present time; namely:

- Ok Tedi mine
- Mill
- Waste rock dumps and storage areas
- Upper Ok Tedi
- Bige dredge sand stockpile
- Lower Ok Tedi channel and flood plain
- Fly River channel and flood plain

5.1.3 Domain Aspects

The aspects to be investigated in each of the domains within the ARD Management Program are:

- Geochemistry
- Hydrogeochemistry
- Hydrology
- Sedimentology / Geology
- Modelling

The purpose of each of these aspects, as they are to be managed in each of the domains within the ARD Management Program, are listed below.

Geochemistry

- to characterise the geochemistry of ores and waste materials
- to geochemically characterise tailings generated during mining
- to determine the geochemistry of river deposited sediments permitting assessment of acid rock drainage and metal contamination potential in waters draining into the Ok Tedi
- to evaluate the risk of acid formation and metal leaching from the dredged sand stockpiles and to provide strategies to minimise or eliminate these risks
- to assess the potential for acid rock drainage and metal contamination in waters draining into the Fly River from river and floodplain deposited sediments

Hydrogeochemistry

- to characterise the chemistry of contact and ground waters associated with rocks exposed in the Ok Tedi mine pit
- to provide information on the oxidation kinetics and copper leaching characteristics of ex-mill tailings
- to identify possible oxidation and / or neutralisation products resulting from sulphide oxidation in contact with groundwaters associated with sediments in waste rock dumps and deposited in the channel and floodplain of the Ok Tedi and Fly Rivers

Hydrology

- to develop a hydrological model to predict the rate of filling of the final void
- to determine the quantities and flow paths for the principal water types entering and leaving the mine pit during the remainder of the operation and after mine closure
- to develop a hydrologic model of the dredge stockpiles to enable a prediction of their future behaviour
- to establish a monitoring program on the dredged stockpiles to enable comparison of predicted performance with actual behaviour, followed by optimisation and refinement of the hydrologic (seepage) model for use in future stockpile design and ARD minimisation

Sedimentology / Geology

- to systematically map representative bar deposits in the upper and lower Ok Tedi to provide information on the areal extent of PAF zones, the oxidation depth, and the history of bar formation and sulphide mineral deposition
- to systematically map bar deposits and areas of sedimentation on the adjacent river banks and floodplain along the Fly River to provide information on the areal extent of PAF zones, the oxidation depth, and the history of bar formation and sedimentation and sulphide mineral deposition

Modelling

- to develop a pit water quality model to predict pit water quality in the final void following mine closure
- to develop a model for prediction of acid and alkalinity loads in the receiving environment

The activities proposed for the ARD program within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed within this program will be reviewed and approved on an annual basis.

5.2 The Riverine Aquatic Ecology Management Program

5.2.1 Program Objectives

The primary goal of the Riverine Aquatic Ecology Management Program is to ensure that there are no adverse changes which are unacceptable to the State relating to the existing health of the communities and ecosystem of the receiving environment, consistent with the Environmental Values driving the proposed Regime.

The specific objectives of the program are:

- To assess the ecological health of the receiving aquatic environment, specifically in terms of water drinkability, the availability of fish and other aquatic fauna, and the edibility of aquatic food stocks

- To identify, trial and implement mitigation actions relating to the environmental values, where appropriate

- To monitor the Ok Tedi and Fly River channels for navigability

5.2.2 Program Domains

The principal domains covered by this program include all those areas which are subject to the influence of mining and mine-related activities in the Ok Tedi and Fly Rivers. Specifically, these domains are:

- Ok Tedi River Channel (extending from Ningerum downstream to D'Albertis Junction)
- Fly River Channel
- Fly River Oxbow Lakes
- Fly River Blocked Valley Lakes
- Fly River Estuary
- Gulf of Papua/Torres Strait

5.2.3 Domain Aspects

The aspects to be investigated in each of the domains within the Riverine Aquatic Ecology Management Program are constructed around specific environmental values. These aspects are:

- Navigation
- Fish and other aquatic fauna availability
- Aquatic flora and fauna edibility
- Water drinkability

The purpose of each of these aspects, as they are to be managed in each of the domains within the Riverine Aquatic Ecology Management Program, are listed below.

<u>Navigation</u>

- to monitor the navigability of the Ok Tedi and Fly River channels, and associated tie channels, for all users
- to identify, trial and implement mitigation options where appropriate

Fish and other aquatic fauna availability

- to monitor the ecological health of the Ok Tedi and Fly River channels, and oxbow and blocked valley lakes
- to determine the degree, extent and processes through which the mine is impacting on the availability of aquatic fauna within the Ok Tedi, Fly River, oxbow and blocked valley lakes
- to identify, trial and implement mitigation options where appropriate

Aquatic flora and fauna edibility

- to determine the degree and extent of mine impact on the edibility of aquatic fauna in the Ok Tedi and Fly Rivers, and in the Fly River oxbow and blocked valley lakes
- to identify, trial and implement mitigation options where appropriate

Water drinkability

- to determine if the mine is impacting on the water quality of the Ok Tedi, Fly River, and oxbow and blocked valley lakes with respect to human usage
- to identify, trial and implement mitigation options where appropriate

The activities proposed for the riverine aquatic program within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed within this program will be reviewed and approved on an annual basis.

5.3 The Riverine Terrestrial Ecology Management Program

5.3.1 Program Objectives

The primary goal of the Riverine Terrestrial Ecology Management Program is to ensure that there are no adverse changes which are unacceptable to the State relating to the existing well-being of the communities and ecosystem of the receiving environment, consistent with the Environmental Values guiding this proposed Regime.

The specific objectives of this program are:

- To determine the cause and extent of forest dieback;

- To determine the cause, frequency and extent of floodplain inundation and its effect on community access to, and use of floodplain land and resources;

- To determine the ecological health of the receiving terrestrial environment and specifically the edibility of crops and other natural forest resources;

- To identify, trial and implement mitigation actions relating to environmental values, where appropriate.

5.3.2 Program Domains

The principal domains covered by this program include all those terrestrial areas of the Ok Tedi and Fly River catchment downstream of the mine and specifically those floodplain environments that are subject to the influence of OTML mining and mine-related activities.

For this program the following domains are defined:

- Forested Floodplain (extending from Bige downstream to Manda)

- Grassed Floodplain (extending downstream of Manda on the Fly River)

5.3.4 Domain Aspects

The aspects adopted in each of the domains within the Riverine Terrestrial Ecology Management Program are constructed around specific environmental values. These aspects are:

- Vegetative dieback
- Floodplain access
- Floodplain resource availability
- Food edibility

The purpose of each of these aspects, as they are to be managed in each of the domains within the Riverine Terrestrial Ecology Management Program, are listed below.

<u>Vegetative dieback</u>

- to determine the cause, extent, severity and significance of vegetation dieback on the forested and grassed floodplains
- to identify, trial and implement mitigation options where appropriate

<u>Floodplain access</u>

- to determine the cause, extent, severity and significance of floodplain inundation in relation to OTML activities

- to identify, trial and implement mitigation options where appropriate

Floodplain resource availability

- to determine the cause, extent, severity and significance of changes in forested and grassed floodplain resource availability
- to identify, trial and implement mitigation options where appropriate

Food edibility

- to determine the edibility of crops and other forested and grassed floodplain food sources
- to identify, trial and implement mitigation options where appropriate

The activities proposed for the riverine terrestrial program within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed within this program will be reviewed and approved on an annual basis.

5.4 The Industrial Site Management Program

5.4.1 Program Objectives

The Industrial Site Management Program details the environmental management of the various OTML operations such as the mill, the mine, the pipeline, facilities in Tabubil and the Kiunga facility. This program is consistent with best practice principles. This program provides OTML with a working baseline for environmental performance monitoring of the operation.

The objectives of the program are:

- To ensure OTML's operations comply with environmental best practice
- To monitor potential impact of OTML operations on the external environment;
- To ensure that best practice is established for the monitoring and recording of potential impacts;
- To establish guidelines for the standardisation of this performance reporting procedure across OTML and the operational domains;

- To outline the operational elements to be monitored as part of OTML's operational performance reporting;

- To provide the possible framework and guidelines for the performance reporting of the operation;

- To ensure that reports prepared by OTML employees or consultants contain adequate and accurate information to enable efficient assessment by external auditors or regulators;

5.4.2 Program Domains

Each domain within this program reflects a significant part of the OTML operation. Potential discharges from these domains are possible. This program reflects the environmental management of these domains consistent with industry best practice. These domains are:

- Mine open pit
- Processing plant and associated facilities
- Tabubil township and associated facilities;
- Kiunga wharf and associated facilities
- Bige dredge site

5.4.3 Domain Aspects

The aspects to be investigated in each of the domains within the Industrial Site Management Program are constructed around specific mine site environmental management issues. Improper management of these can potentially impact on some of the environmental values. These aspects are:

- Hazardous chemicals
- Spill response and reporting
- Hydrocarbon management
- Rehabilitation and revegetation
- Air quality emissions
- Waste stream monitoring
- Contaminated site assessment and mitigation

The purpose of each of these aspects, as they are to be managed in each of the domains within the Industrial Site Management Program, are listed below.

<u>Hazardous chemicals</u>

- to prevent environmental damage
- to know which hazardous materials are present on site
- to allocate clear responsibilities for managing hazardous materials
- to understand the actual or potential risks and environmental impacts of transporting, storing, using and disposing of these hazardous materials
- to minimise the use and/or generation of hazardous materials
- to construct storage facilities that will contain the materials in all foreseeable circumstances
- to dispose of waste materials in a way that eliminates or minimises environmental impacts
- to implement physical controls and procedural measures to ensure that no hazardous material escapes during normal or abnormal operation
- to have emergency response plans in place to ensure immediate action to minimise environmental impacts should an accidental release occur; to monitor any discharges in the environment to detect any escape of hazardous materials and to measure any subsequent impacts
- to keep adequate records and review them regularly so future environmental problems are anticipated and avoided

Spill response and reporting

- to determine the causes of environmental incidents and accidents through structured investigation procedures
- to provide for corrective action to prevent further incidents and accidents
- to formalise the procedures for environmental incident response to reduce potential adverse environmental impacts and potential risks

Hydrocarbon management

- to manage the operation's hydrocarbons in a manner that is environmentally responsible, complies with guidelines or best practices and reduces potential adverse environmental and safety risks
- to develop an inventory of hydrocarbons which would permit the identification of where potential losses are occurring
- to allocate clear responsibilities for managing hydocarbons
- to understand the actual or potential risks and environmental impacts of transporting, storing, using and disposing of these materials
- to construct storage facilities that will contain the materials in all foreseeable circumstances
- to dispose of hydrocarbon contaminated waste material in a way that eliminates or minimises environmental impacts

- to implement physical controls and procedural measures to ensure that no materials escape during normal or abnormal operation
- to have emergency response plans in place to ensure immediate action to minimise environmental impacts should an accidental release occur; to monitor any discharges in the environment to detect any escape of materials and to measure any subsequent impacts
- to keep adequate records and review them regularly so future environmental problems are anticipated and avoided

Waste management

- to manage waste streams in a manner that is environmentally responsible, complies with guidelines and agreements and reduces liability

Rehabilitation and revegetation

- to return disturbed lands to a stable condition capable, through vegetation successional processes, of facilitating the development of a land use approximating the pre-mine land use or an agreed post disturbance land use
- to provide acceptable post mine landforms suitable for the proposed final land use
- to develop stable landforms that cater for long term stability of the agreed post mine land use
- to establish rapid vegetation cover to minimise erosion potential
- to visually enhance the post mine landform
- to produce a stable self sustaining landform to mitigate the potential for post closure liability

Air quality emission

- to identify and control the areas of potential generation of dust on-site (where applicable)
- to minimise adverse effects of the operation on the amenity of the area
- to minimise any potential personal, and/or public, safety issues
- to limit the individual and potential cumulative effects of air pollutants on regional air quality

Waste stream monitoring program

- to determine whether selected water management strategies are adequate and effective.

Contaminated site investigations

- to determine the presence/absence of contamination at nominated sites

- to determine whether site contamination poses an actual or potential risk to human health and/or the environment
- to determine whether the extent of contamination is such that remediation is required

The activities proposed for the industrial sites program within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed within this program will be reviewed and approved on an annual basis.

5.5 Compatibility Summary

The key Environmental Values are fundamental to the operation of the proposed Regime. Table 5.1 summarises the Regime's programs, illustrating how each of the Environmental Values is addressed through the various program domains.

Table 5.1: Relationship between Program Domains and Environmental Values

Program	Domain	Environmental Value					
		Drinkable Water	Aquatic Avail	Aquatic Edible	Terrestrial Avail	Terrestrial Edible	Navigation
ARD	Mine	✓		✓			
	Mill	✓		✓			
	Waste rock storage areas	✓		✓			
	Upper Ok Tedi	✓	✓	✓			
	Dredge sand stockpile	✓	✓	✓	✓	✓	
	Lower Ok Tedi channel and floodplain	✓	✓	✓	✓	✓	
	Fly River channel and floodplain	✓	✓	✓	✓	✓	
Aquatic	Ok Tedi river channel	✓	✓	✓			✓
	Fly River channel	✓	✓	✓			✓
	Fly River oxbow lakes	✓	✓	✓			
	Fly River blocked valley lakes	✓	✓	✓			
	Estuary		✓	✓			
	Gulf / Torres Strait			✓			
Terrestrial	Forested floodplain				✓	✓	
	Grassed floodplain				✓	✓	
On-site	Mine open pit	✓		✓			
	Processing plant	✓		✓			
	Tabubil facilities	✓		✓		✓	
	Kiunga facilities	✓		✓			
	Bige dredge site	✓			✓	✓	

The Environmental Values drive the proposal concept. However, they are also integral to the activity undertaken within each of the program's domains. While some programs are aimed at the management of specific Values (i.e. these Values form the aspects for the two riverine ecology management programs) nonetheless all of the programs have a role in protecting a number of the Values.

5.6 The Support Services

The implementation of the proposed Regime programs relies on three main support areas relating to analytical services, hydrological services and community liaison services. These are discussed briefly below.

5.6.1 Analytical Support Services

The OTML environmental laboratory conducts chemical, biological and geochemical analyses. It is NATA registered. Consequently, it adheres to strict standard analytical procedures.

Purpose

The Analytical Support Services group will provide analytical services to the various programs within the Regime, undertaking chemical and physical analyses of water, sediment, fauna and flora samples. It will also assist in research activities and the provision of technical expertise aimed at addressing specific issues in understanding river chemistry. On occasions, it will co-ordinate the use of external laboratories to provide services which are beyond the scope of the OTML environmental laboratory.

Role

It is envisaged that that the Analytical Support Services group will provide specific analytical support and technical expertise in the following ways:

- Water will be tested for potability which includes analyses of TSS, dissolved and particulate metals and ASV labile copper. ASV labile copper measurements will be carried out by CSIRO while other analyses will be carried out on site by the OTML environmental laboratory

- Algal and bacterial toxicity testing will be conducted in collaboration with CSIRO

- Stable isotope studies to differentiate algal carbon from the river channel and the floodplains may be conducted in collaboration with CSIRO

- Studies to determine whether or not copper uptake occurs through the gills of fish or through the stomach by way of sediment ingestion will involve the analyses of dissolved and particulate metals and the pH of fish gut content

- Fish edibility testing will involve the analyses of Cu, Pb, Cd and Zn

- Food crop edibility testing will involve a suite of metal analyses

- NAG, ANC and NAPP testing will be undertaken for the ARD program

- The analytical requirements for the Catchment Support Services will involve the analyses of TSS and particle size distribution

- The analytical requirements of the Community Support Services will likely occur on an ad hoc basis such as checking village drinking water supply or in response to complaints raised by local communities

The activities proposed for the analytical support within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed to be undertaken by this support service will be reviewed and approved on an annual basis.

5.6.2 Catchment Support Services

Meteorological, hydrological, and sedimentological data are collected, analysed and used in the decision making process at OTML. For example, there has been the need to evaluate and forecast impacts of mine waste on the environment downstream of the mine, as mine overburden and mill tailings are directly discharged into the river. Sedimentation models were developed as early as 1978 to forecast these impacts. The original sedimentation model was a gravel model which has been maintained to the present time and expanded to include a sand model which deals with the sand bed reaches of the river. With the transfer of mine impacts downstream of the upper Ok Tedi after 1992, vegetation dieback associated with overbank flooding induced by river bed aggradation required investigation and forecasting for sound decision making. A hydraulic model was developed in 1997 for the reach below the upper Ok Tedi to evaluate riverbed aggradation and associated overbank flooding and its effects on vegetation dieback. A dieback model was developed to evaluate and forecast the dieback expansion by 1998. Outputs of the hydraulic and the sedimentation model plus field data are used in the dieback modelling.

Other predictive functions have been developed for providing input into management decisions including weather forecasting, flood warning and forecasting, river navigability

and the evaluation of mitigation options such as the dredging in the Lower Ok Tedi and the river bed fluidisation project at shallow reaches of the Fly River at Wygerin and Mugumugu.

Purpose

The Catchment Support Services group will be responsible for providing the above services as input into the various Regime programs. Additionally, drawing from its technical support capabilities and knowledge base, it will provide logistical, technical and consultancy support (e.g. by providing mitigation recommendations associated with adverse effects of sedimentation and associated flooding).

Role

The main function of the Catchment Support Services group will be to collect, analyse and interpret data. Ultimately, these services fall within the categories of meteorology, hydrology, and sedimentology, and are detailed as follows:

■ Meteorological support

This involves the monitoring and collection of climatic data which includes: rainfall, temperature (minimum, maximum and average), humidity, sunshine, cloud cover, evaporation, visibility and, wind speed and direction. These data may be collected continuously (automated and/or telemetered) or periodically. The data is collected mainly for the following purposes:

- Climatic forecasting (e.g. onset of El Nino conditions)
- Rainfall trends
- Feed of data into climatic model for long term forecasts

■ Hydrological support

This involves the monitoring and collection of data associated with the hydrological cycle including: rainfall, runoff, water level, discharge, flow velocity, water surface slope, bed slope and stage-discharge ratings. These data are collected mainly for the following purposes:

- Provision of a flow budget (flow partitioning and total flow budget for the catchment)
- Flood/water level duration analysis for flooding and their effects
- Flood analysis and forecasting (e.g. shipping and dredging)
- Transportation navigation (river levels, fluidisation, shallows, pathways, etc)
- Flood analysis for land availability for use in effected areas
- Feed of flow and water level regime data into the hydrological/hydraulic, sedimentation and dieback models

■ Sedimentalogical support

This involves the monitoring and collection of data associated with the movement of sediment through the river system. These data include suspended sediment, river bed material, bulk and dry densities, temporary waste storage volumes and areas, and river cross-sections for the definition of volumes and mass. The main outputs of this work are:

- Quantification of sedimentation impacts due to mining and mitigation activities such as dredging
- Providing input into other programs such as the impact of suspended solids on aquatic fauna/flora and the sedimentation on aquatic and terrestrial habitat
- Provision of a sediment budget to define aggradation/degradation of the river channel and sediment deposition on the floodplain
- Quantification of sedimentation rates and dispersal patterns on the tie-channels, off-river water bodies (oxbow and blocked valley lakes) and the general floodplain
- Transportation / navigation (river levels, fluidisation, shallows, pathways, etc)
- Provision of data for feed in to hydrological/hydraulic, sediment and dieback models

In addition, the Catchment Support Services group will provide topographical and geomorphological data as described below:

■ Topographical and geomorphological support

The services here will include cross-sectional and bathymetric surveys, long profiles, surveys to quantify valley wall erosion, aerial photographic (colour, infra-red, and radar) surveys to quantify volume and areal changes in river sedimentation and vegetation dieback. These main outputs of this work are:

- River channel physical response (aggradation/degradation; channel avulsion)
- Quantifying dieback extent and expansion/recovery
- Quantifying backwater effects on tributaries and the main channel from sediment build up and damming
- Quantifying temporary mine waste storage and associated valley wall erosion in the Ok Mani/Sulphide and Ok Gilor creeks
- Island and bar formation and migration rates
- Dispersal patterns of mine derived sediment in the estuary

The activities proposed for the catchment support within the Regime's first twelve months are summarised in tabular form in Schedule II attached to this document. It is proposed to submit this Schedule each year to seek the State's approval. Consequently, the activity proposed to be undertaken by this support service will be reviewed and approved on an annual basis.

5.6.3 Community Liaison Support Services

Consistent with its charter, OTML is a partnership of shareholders, workforce and communities, working together to create a balance between mining operations, environmental effects and sustainable development. To achieve this, open and transparent communication is required between all parties. In particular, downriver communities need to be informed of the status of the environmental values driving the Regime and how this status relates to them. This includes information being disseminated regarding the cause, extent and significance of environmental impacts related to either OTML operations or other factors, and possible mitigation options. It also includes feedback from communities to OTML.

Purpose

The Community Liaison Support Services will be responsible for the process through which the downriver communities and other OTML relevant groups are informed of the ecological status of the river system and other environmental issues. The process will:

- Ensure open and transparent communication with the downriver communities regarding environmental impacts on the receiving environment
- Ensure that all information regarding community concerns is made available to the downriver communities in a process and format they can access and understand
- Ensure those communities impacted by OTML activities are aware that the environmental activity undertaken by the company is aimed at minimising impact and maintaining and improving the quality of life
- Seek feedback on community concerns and expectations in respect of environmental values
- Foster community understanding of the new Regime

Role

The services provided by this support group will governed by:

- what information is required by the communities in respect of the environmental impacts and activities resulting from the OTML operation

- what information is required by the Regime to address ongoing concerns that the members of the various communities may have

In replying to community concerns, scientific information will be prepared by this support group, in consultation with the various program managers, and will be provided to the communities through face to face meetings, via briefs, written material and other appropriate channels (including existing publications such as Komuniti Niusleta, Tok Tedi, North Flyer). The communication of environmental information and issues to the

wider communities will also utilise other OTML services, such as the Media Relations, Community Relations, OTML Foundation, and Media Strategies teams.

Community feedback will be used to guide further Regime activity and to evaluate potential mitigation options.

In addition to co-ordinating this two way dissemination of information, this support group will also assist the implementation of the Regime through activities associated with securing sites for sampling / monitoring on traditional land, river and floodplain locations.

5.7 The Regime's Continuous Improvement Process

The dynamic nature of the Regime insists that the programs are reviewed regularly and are updated on an annual basis. This review process will follow the continuous improvement model presented in Figure 5.1.

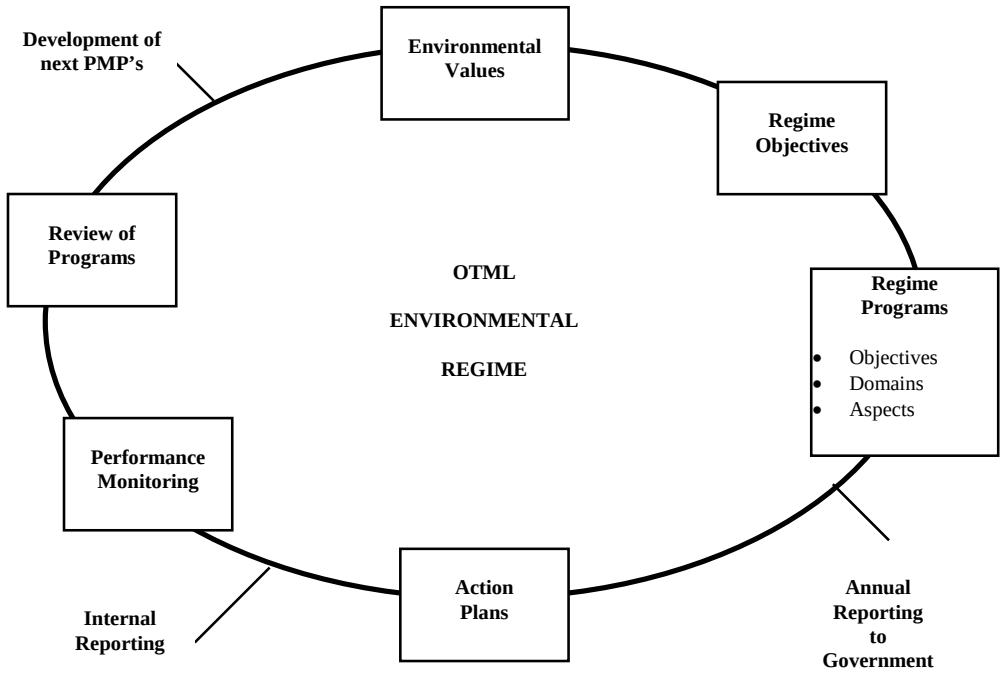

Figure 5.1: The regime's Continuous Improvement Process

Initiating this process, the Environmental Values, together with the OTML Environmental Policy and Charter, formulate the Regime objectives which in turn focus the individual program objectives. To achieve these objectives, ecological domains are identified through which activities are undertaken to address the individual values.

The work programs are formulated for a twelve month period, commensurate with the financial year from July to June. At the end of this period, the findings of the various programs, especially as they relate to the Environmental Values, will be reported to the State (this is discussed below in Section 5.8).

Fundamental to the proposed Regime is the development of appropriate mitigation options to attempt to reduce or eliminate any adverse mine-related impacts which may be unacceptable to the State as they may affect the stated Environmental Values. Consequently, the continuous improvement process requires action plans to be developed, based on the results of investigations conducted during the implementation of the programs. These action plans will be aimed at identifying, trialling and implementing appropriate mitigation strategies.

Under the proposal, each Regime program will undergo regular performance monitoring to assess the success or otherwise of its meeting its objectives. Specific measures and targets, by which this performance assessment will be determined, are identified for each program. Where performance does not meet stated targets, active management intervention will occur to remedy the situation.

The proposed Regime is a dynamic process operating within a changing ecosystem. The implementation of the Regime's programs will necessarily involve the evolution of direction, priorities and activities subject to changing State, environmental and community expectations. It is readily anticipated that the emphasis of programs, and indeed the very programs themselves, may well change over time. This could be brought about for example, through the response to developing knowledge, or the identification of emerging issues as they become relevant. Therefore, a comprehensive annual review of each program will take place, including the degree to which program activities are aligned to the fundamental Environmental Values guiding the proposed Regime. The results of this review process will be provided in the annual report to the State.

As described earlier, it is proposed that the State signs off on activity to be undertaken on an annual basis. This activity will be presented to the State by 30 June each year for commencement within the following year's program. This presentation will be similar each year to the Schedule II attached to this proposed Regime document. It is perceived that this activity will commence prior to the State giving sign off, which can only effectively occur after review of the previous year's annual report. If there is conflict arising, it will need to be resolved in order to gain State sign off.

5.8 Reporting

As indicated in the previous discussion on continuous improvement, the results of activity under the proposed Regime will be reported to the State on an annual basis. With the Regime following a July to June year, this annual report will be produced by 30 September each year. It will comprise a discussion of results and long term trends relating to each of the six Environmental Values guiding this Regime.

It is not anticipated that the reports will contain all of the data collected by OTML over the preceding twelve months (although obviously this will always be available for inspection by the State). Rather, the annual report will discuss the status of the individual Environmental Values, any impact the OTML operation may be having on that value, and the mitigation strategies proposed / undertaken to address that impact.

This report will also detail the results of the specific compliance criteria monitoring. A suggested compliance strategy is discussed in Section 6 of this document with associated activity described in Schedule I. In the absence of any compliance being imposed by the State, OTML proposes to implement this strategy and report its outcome annually to the State as a measure of the status of the Environmental Values.

6 REGIME COMPLIANCE

6.1 Introduction

1) To inform the State of the effect of mining operations on the riverine ecosystem OTML shall undertake to carry out the following performance-based and process related environmental management activities to monitor, assess, and report on the continued effect of the mining operation.

    a. OTML shall monitor the quality of settled river waters on a regular basis at the localities shown in Schedule I and will compare these qualities against the National Health and Medical Research Council (Australia) 1996 Drinking Water Guidelines and will investigate and report to the State on any exceedance against these guidelines, and management measures, within five (5) working days of any exceedance being reported by the analytical laboratory. (Any exceedance attributed to the presence of any sewage or sewage related matter will be excluded from consideration).

    b. OTML shall monitor the edibility of fresh water fish on a regular basis at the localities shown in Schedule I along the river system for copper, lead, zinc and cadmium, and will compare these concentrations against the Australian and New Zealand Food Authority (1996) Food standards Code guidelines and will investigate and report to the State on any exceedances against these guidelines, and proposed management measures, within five (5) working days of any exceedance reported by the analytical laboratory.

    c. OTML shall investigate on an annual basis the edibility of a common range of garden crops and natural plants grown along the river system at localities identified in Schedule I to identify the range of concentrations of copper, lead, zinc and cadmium in these plants and to compare these concentrations against the Australian and New Zealand Food Authority (1996) Food Standards Code guidelines and will investigate and report to the State on any exceedances against these guidelines, and proposed management measures, within five (5) working days of any exceedance reported by the analytical laboratory.

    d. OTML shall monitor the river bed level on a regular basis and at locations shown in Schedule I and will use this data, predicted mine inputs to the river system, and climatic forecasts, to predict and report to the State on an annual basis the navigability of the river for the following 12 months, and will propose management measures should the navigability of the river be predicted to significantly impact the mining operation.

    e. OTML shall develop and implement a monitoring program for the regular measurement of dissolved and bioavailable copper concentrations at the

locations shown in Schedule I and will investigate and report the results to the State on an annual basis.

f. OTML shall develop and implement an ecologically relevant ecotoxicological monitoring program to investigate the quality of water at the locations shown in Schedule I utilising metal sensitive micro-organisms isolated from the Fly River system and the results of this monitoring program will be reported to the State on an annual basis.

g. OTML shall monitor on a regular basis the diversity, abundance and biomass of fish along the main river system at the locations shown in Schedule I and will report to the State the results of the monitoring program on a regular basis.

h. OTML shall conduct annual surveys to monitor the extent of vegetation dieback along the river system and will report the results of the surveys to the State on an annual basis.

i. OTML shall conduct investigations at the mine and along the river system to determine the potential of acid formation and neutralisation within the mine and along the river system and will report the results of these investigations to the State on an annual basis.

2) OTML shall report the results of the monitoring programs identified in Condition 1 (a-i) inclusive in an Annual Environmental Management Report to be submitted to the State on an annual basis on 30 September.

3) Notwithstanding that OTML will submit Annual Environmental Management Reports, the Company shall submit reports of any exceedances as specified in Conditions 1 (a-c) inclusive.

6.2 Schedule I

Schedule I below lists the location and frequency of the above compliance monitors. The choice of compliance locations is deliberate and is based on the following discussion.

The intensive environmental monitoring and measurement which has been conducted by OTML since 1990 has generated a voluminous database. The interrogation of this data permits a refinement of compliance locations. There are three principles driving this refinement. They are:

i) Nukumba is located approximately ten kilometres downstream of D'Albertis Junction, where the Ok Tedi meets the Fly River. Each of the suggested compliance monitors relating to the condition of the environment are proposed to be measured at Nukumba. This adopts the rationale that, if the value of the monitor is acceptable at this location,

then it should not worsen down catchment as the result of any impact from mine related activity. It should be noted however, that these same monitors are proposed upstream for either Ningerum or Atkamba to cater for any impact along the Ok Tedi. They are also proposed downstream for Aiambak or Obo to ensure that this rationale is not compromised.

ii) Likewise, despite all of the past environmental monitoring and measurement in the Fly River estuary and the Gulf of Papua, OTML can confidently state that there is no significant chemical impact on aquatic biota within these zones as the result of any mine related activity. Consequently, it is proposed to use the compliance monitors at Lewada as the southern most location. This is based on the rationale that if values remain insignificant at Lewada, there will be no increase to the south in terms of impact on the environment.

iii) Fundamental to these two principles above is the intention of increasing location and / or frequency of monitoring if the data ever revealed a worsening trend. It should also be appreciated that, just because monitoring does not appear in the schedule, this is not to be interpreted as no other monitoring occurring. The content within the annual Program Management Plans will indicate this increased coverage on an annual basis.

SCHEDULE I

CONDITION	**LOCATION and FREQUENCY**							
	Ningerum	Atkamba	Nukumba / Kuambit	Bosset	Obo	Ogwa	Lewada	System
Condition 1a (water drinkability)		monthly	monthly					
Condition 1b (fish edibility)			annually	annually		annually		
Condition 1c (garden crop edibility)		annually	annually					
Condition1d (river navigability)								annually
Condition 1e (dissolved copper)	monthly		monthly		monthly	monthly	quarterly	
Condition 1e (bioavailable copper)	quarterly		quarterly		quarterly		quarterly	
Condition 1f (biological assays)	annually		annually		annually		annually	
Condition 1g (fish diversity, abundance, biomass)			half yearly	half yearly		half yearly		
Condition 1h (dieback mapping)								annually
Condition 1I (acid investigation)								annually

7 REFERENCES

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Schedule II

A list of proposed activities to be undertaken in FY02