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Appendix H: Ok Tedi Riverine Disposal Case Study

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Contents

1 Introduction

The Ok Tedi Mine in Papua New Guinea (PNG) is one of the mines where riverine disposal is currently being practised. It is one of the world's largest gold-copper mines and was owned by BHP Billiton (52%), the State of Papua New Guinea (30%) and Inmet Mining Corporation (18%). Of the state's interest, 15% is held on behalf of the nation, 12.5% on behalf of the people of the Western Province and 2.5% on behalf of the local landowners.[1] BHP Billiton have recently withdrawn from the project and its equity has been transferred to the Sustainable Development Program Company.[2]

Ok Tedi Mining Limited (OTML) has attracted a lot of publicity, not only because of the consequences of riverine disposal, but also the socio-economic impacts to the local community. After having been involved in a number of highly publicised compensation claims and following the most recent round of scientific predictions of environmental impacts from the mine, BHP Billiton proposed to the State that a valid compromise between the economic needs of the State and communities, on the one hand, and environmental values on the other, would be to work towards closure by 2005, five years earlier than otherwise planned. This was not acceptable to the State, which wants to see the mine continue for its maximum economic life. This is attributed to the fact that the mine is the largest industrial and commercial enterprise in the country and constitutes a major source of PNG's foreign exchange earnings. In 2000, export sales from the mine were worth K1025.6 million and represented about 18% of PNG's foreign exchange earnings.[3] It has also contributed to social and infrastructure development in one of the remotest region in the country. In these circumstances BHP Billiton decided that continued involved with the mine was inconsistent with its Charter, and negotiated with the State and Inmet to withdraw from OTML.

This paper discusses the sustainable development issues of riverine disposal on the Ok Tedi region and the PNG as a whole.

2 Background

2.1 Physical Setting

The Ok Tedi mine is found in the Star Mountains region in the interior of the Western Province of PNG, adjacent to the border with Irian Jaya, Indonesia (Figure H1). The Ok Tedi open pit operations are located on Mount Fubilan, about 1,800 m above sea level. The mine is situated in the Fly River catchment, in the headwaters of the Ok Tedi River in the Star Mountains. The Fly River System which drains southwards has three primary branches, the Ok Tedi, the Fly and the Strickland (Figure H2). The Ok Tedi joins the Fly at the

[1] BHP (1999) BHP and Ok Tedi, Discussion. Website http://wwwbhp.com.au/oktedi

[2] Ok Tedi Mining Limited *Ok Tedi Ready to Continue Without BHP Billiton*. Media Statement, February 2002.

[3] See Ok Tedi Mining Limited, website at http://www.oktedi.com/aboutus/index.php (Accessed April 2002.)

Figure H1. Location of the Ok Tedi Mine within Papua New Guinea

D'Albertis Junction, about 846 river km from the delta at the coast. The confluence of the Strickland and Fly Rivers is about 6 m above sea level. Below this junction, the Fly River flows another 432 km to the delta mouth (Dietrich *et al*., 1999).

In this region, landslides occur on almost a daily basis. This is attributed to two forces, besides gravity, that generate the high energy, erosional landscape; the high torrential rainfall and the high frequency of earth tremors and earthquakes. The earthquakes often measure more than 7 on the Richter scale and they regularly trigger massive rock falls and landslides (Minerals Council of Australia, 2000).

Papua New Guinea has an equatorial climate with nearly uniform temperatures throughout the year, averaging 26^{0}C (Clarke, 1996). The region where the mine is located is one of the wettest areas in the world. It experiences extremely high rainfall of over 10,000 mm per year (Murray *et al.*, 2000). This is evenly distributed throughout the year.

2.2 *Socio-Economic Setting*

The Star Mountains region of PNG was one of the last regions in the country to develop. At the time the ore body was discovered, local villagers lived a subsistence life style based on traditional gardening and hunting. There was little assistance in terms of infrastructure, health care or education, though the church missions played and continue to play a pivotal role in the provision of health and educational services.

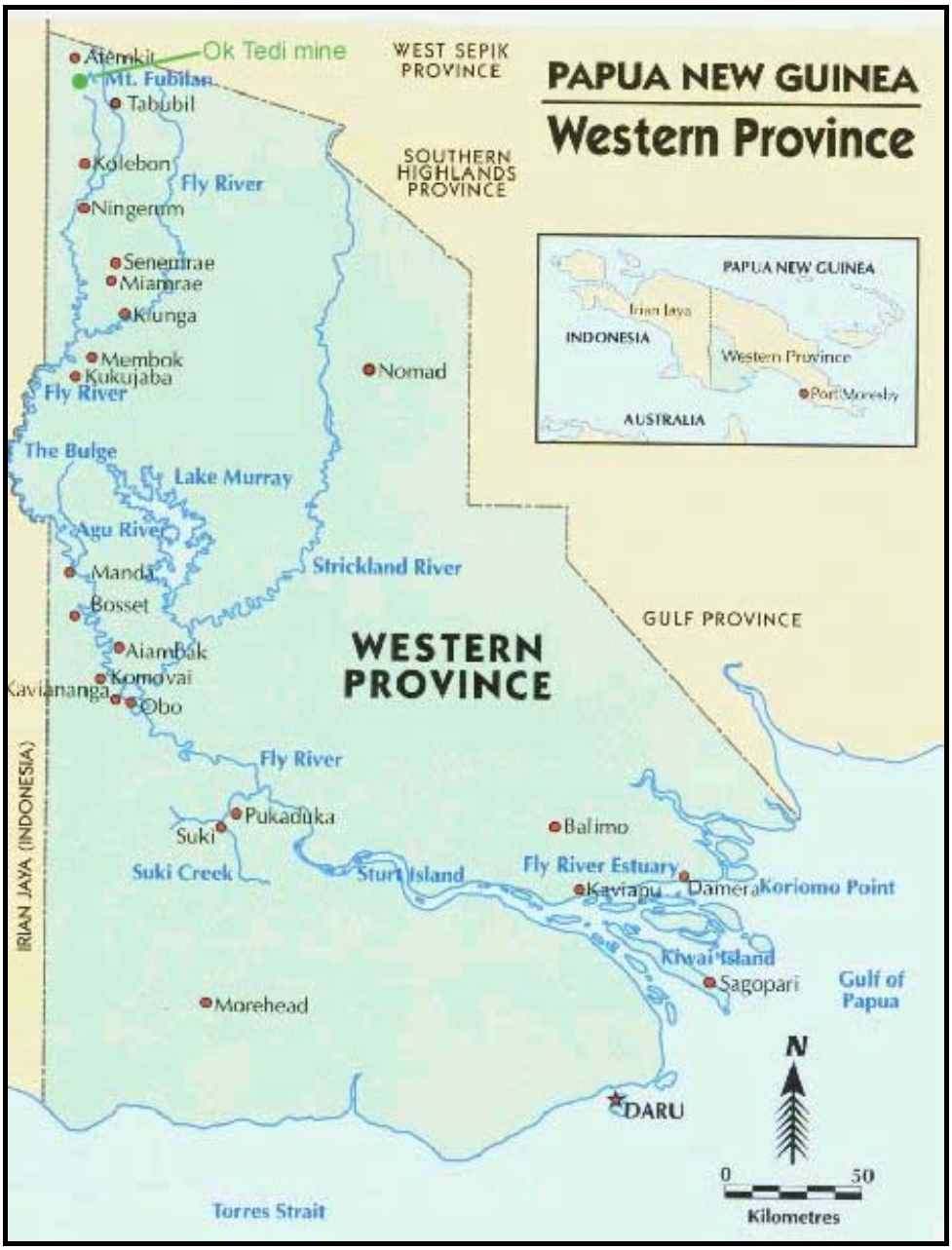


Figure **H**2. Location of the Ok Tedi Mine in relation to the Fly River Catchment

In 1980 it was estimated that 73,500 people lived in the Ok Tedi/Fly River drainage area. Of these, OTML's compensation and community improvement programmes include around 50,000 people (Buhupe, 1998). Approximately 10,000 people live in the company township of Tabubil and about 5,000 additional people have created settlements on the eastern edge of the town, outside the boundary of the OTML lease.[4]

[4] BHP (1999) BHP and Ok Tedi, Discussion. Website http://wwwbhp.com.au/oktedi

2.3 Mining Operations at Ok Tedi

The mountains of the Western Province consist of Mesozoic and Cainozoic marine sediments. The older sediments at the base of the mountains are mudstones and sandstones, strongly bedded, structurally weak and easily erodable. Overlying these strata are various limestones and other calcareous rocks (Minerals Council of Australia, 2000). These limestones were injected with volcanic intrusions that make up the orebody (Box H1). The intrusion that forms the Mt Fubilan ore body consisted of a gold gossan cap which had been leached of copper, underlain by a porphyry copper and skarn ore. On average, the orebody is less than 1 km^2 in area and about 800 m deep.

Box H1. Geologic formation of the Ok Tedi ore body

During Miocene, the geological era that lasted from the 23 to the 3 million years age, volcanic intrusions injected a variety of molten igneous and other materials into the limestone. Mt Fubilan contains two intrusions that occurred about 2.5 million years ago. The larger intrusion is the ore deposit being mined by OTML. This is known as the Fubilan Monzonite Porphyry. Subsequent intrusions injected further materials and enriched the mineral forming processes that formed chalcopyrite, bornite and gold. As the mountain weathered, chemical leaching in the surface layers caused a separation of the copper and gold. The upper layer of the intrusion was leached of copper leaving a gold gossan (Minerals Council of Australia, 2000). This limonite material of 50 million tonnes with 2.4 grams of gold per tonne was mined out during the first few years of mine life (Hettler *et al*., 1997). Beneath the concentrated gold cap, rich ores of copper (now being mined) are contained in the form of chalcopyrite and digenite minerals.

The Mt Fubilan orebody was discovered in 1963 by a government patrol leader who noticed signs of copper mineralisation. In 1976 the Mining (Ok Tedi Agreement) Act was passed by parliament which outlined all the obligations and rights pertaining to the development of the Mt Fubilan deposit. The PNG Government granted permission for a consortium of mining companies, that later became the Ok Tedi Mining Limited (OTML), to develop the Ok Tedi mine in 1980, with an understanding that conventional environmental controls such as stable dumps, to contain most (80%) of the waste rock, and a tailings storage facility would be included.

Conventional open pit mining techniques are used to extract about 30 million tonnes of ore and 55 million tonnes of waste rock annually (BHP, 1999). On average, the mine produces ore at a rate of 80,000 tonnes per day and waste rock at a rate of 152,000 tonnes per day.

During the first four years of production, the Ok Tedi mine consisted of a closed circuit cyanide leach and carbon-in-pulp recovery system to extract the gold from the leached cap. The tailings were treated with hydrogen peroxide to destroy the residual cyanide. In 1997, copper processing began with the commissioning of a sulphide flotation and concentrator plant. Gold production ceased in 1988 and the gold now reports to the copper

concentrate. The concentrator plant has a gold recovery of 70% and copper 80% (Hettler *et al.*, 1997).

After processing the concentrate, containing approximately 34% copper and 20 grams of gold per tonne, is pumped through a pipeline to the river port of Kiunga. Here the concentrate is dried and loaded on to 3,000 tonnes river barges for transport to a silo vessel stationed in the Gulf of Papua. Approximately 50,000 tonnes of concentrate is loaded from the silo ship to export vessels each month. Annual Production data for the Ok Tedi Mine are shown in Table H1.

Table H1. Annual production at the Ok Tedi Mine

Year	Waste rock	Tailings	Copper in waste	Copper product	Gold product
	(thousand tonnes)				(ounces)
1984	96.750	1,731	0.1	–	32,399
1985	904.419	5,945	1	–	523,847
1986	10,347	7,770	1	–	601,476
1987	13,852	9,719	20	39.488	583,918
1988	25,946	14,935	42	52.677	580,135
1989	29,955	23,596	63	135.309	512,975
1990	32,722	27,463	67	170.210	443,766
1991	36,013	27,011	67	204.459	355,864
1992	27,348	26,742	65	193.359	337,415
1993	17,385	28,621	55	203.184	394,039
1994	32,693	29,667	73	207.236	476,643
1995	41,897	30,689	98	212.737	482,132
1996	44,019	28,504	118	185.665	425,611
1997	29,211	15,469	95	111.515	265,758
1998	42,378	22,286	80	151.556	413,265
Total	384,767.169	300,148	845.1	1,867.395	6,429,243

Source: BHP (1999)

2.4 Waste Disposal at the Ok Tedi Mine

The feasibility study for the Ok Tedi mine incorporated two stable facilities to contain about 80% of the waste rock, a conventional tailings storage facility on the Ok Ma, a tributary of the Ok Tedi, and a hydroelectric dam on the Ok Menga. In 1983, prior to the commencement of gold production, construction of the tailings dam began on the Ok Ma, about 15 km south of the mine. It was planned that the tailings would be piped through a tunnel to this facility and that the decant water would then be discharged to the Ok Ma (Minerals Council of Australia, 2000).

During the early stages of construction, in early 1984, a massive landslide destroyed the foundations of the tailings dam. To keep production on schedule, an Interim Tailings

Scheme was proposed by OTML, and accepted by the PNG Government. This Scheme allowed OTML to commence mining and discharge tailings to the river after removal of the sand fraction (25%), which was stored in a stable dump in the Ok Ningi Valley. This was on condition that the company investigate the possibilities for alternative sites for the eventual construction of a permanent tailings storage facility. In 1988, the government withdrew the Interim Tailings Licence because the facility had reached maximum capacity.

During the period that the Interim Tailings Licence was in effect, the Mining (Ok Tedi Agreement) Act was modified with the Fifth and then the Sixth Supplemental Agreements. The Sixth Supplemental Agreement, which was signed in 1986, contained provisions for the management of waste from the mining and processing operations. One of the main features of the environmental provisions was the deferral of the construction of permanent waste retention facilities until 1990, to enable the construction and commissioning of the copper plant. This meant that all of the tailings and some of the waste rock from the failing dumps were discharged into the river system. OTML was required to conduct an environmental study to assess the impact of these discharges in order to enable the Government to establish an acceptable level of sediment, the Acceptable Particulate Level (APL), for the Fly River to ensure that the mining operations do not cause unacceptable environmental damage (OTML, 1986). In 1990, a maximum APL limit of 940 mg/l was set by the State and a monitoring programme introduced to check compliance. Under this programme, OTML was required to monitor and report to the Government on a series of environmental parameters measuring the response of the entire system to the mine waste.

The construction of the tailings storage facility on the Ok Ma was abandoned because OTML's shareholders and the PNG Government were concerned that any major dam constructed in the area would run the risk of being destroyed by future landslides or earthquakes. All mine waste (waste rock and tailings) is currently being placed into the headwaters of the Ok Tedi. This has had significant impacts on the Fly River System. Aside from the negative environmental impacts, there have been both social and economic impacts some of which have been negative but the majority beneficial to the community and country as a whole.

3 Environmental Impacts

The environmental impacts of the Ok Tedi mine are very visible and very controversial. PNG has become the focus of attention because of these impacts and legal claims by traditional landowners affected by the environmental changes. The risk assessment commissioned by OTML and undertaken in 1999 confirmed that the environmental impacts of the mine operation were significant and were far greater than initially anticipated (World Bank, 2000).

The subsequent sections of this case study present the major environmental impacts of the OTML mine including, increased sedimentation, degradation of the forest, toxicity, impacts on underground and surface water and decrease in fish communities.

3.1 Sedimentation

Since the beginning of 1984, when mining commenced, waste rock and tailings have been discharged into the headwaters of the Ok Tedi. Before the Ok Tedi mine, the Fly River carried about 100 ppm (parts per million) of natural sediment. Since mining began, the suspended sediment load of the river has risen to 450–500 ppm from disposal of mine waste (Minerals Council of Australia, 2000).

As well as the increased sediment load in the Ok Tedi, the disposal of waste rock and tailings has led to aggradation (the build up of sediment in the river bed). By 1992 the total input of sediments associated with the mine was about 501 million tonnes. It was estimated that if the mine continued at the same rate, the total sediment introduced during the life of the mine, scheduled to close in 2010, would be 1,720 million tonnes.

There have been a number of changes in the Ok Tedi due to the mine-derived sediment load. In the upper Ok Tedi, up to 5–6 metres of waste rock has been deposited in places, raising the level of the river bed. The forest floor on the adjoining banks, within the limits of the floodplain, has also been buried. It has been predicted that, with time, the aggressive erosion processes will wash away the deposited material and the valley will eventually recover. In the lower Ok Tedi, aggradation has led to an increased frequency and duration of over-bank flooding resulting in the deposition of sediment on the floodplains (BHP, 1999). The flooding carries the sediments through the riverside rainforest with deposits of up to one metre, causing dieback in the vegetation.

The process of overbank flooding and sediment deposition also occurs in the Fly River, but to a much lesser extent. There is a slight increase in the frequency of flooding and lower rates of deposition.

3.2 Impact on Vegetation

The most obvious consequence of sedimentation in the river system is the destruction of vegetation. Sediment accumulation in the river beds of the Ok Mani, Ok Tedi and middle Fly reduces their in channel flow capacity and increases the incidents and severity of overbank flooding. Water logging and sedimentation reduces the oxygen levels in the soil thereby starving the roots of oxygen, stressing the vegetation and in the worst cases killing it. This phenomenon is known as dieback (Figure H3).

The main area of vegetation dieback is found on the lower Ok Tedi, between Komokpin and the D'Albertis junction and in the upper forested section of the middle Fly. The amount of dieback has increased steadily over the life of the mine and is predicted to continue long after the mine closes. It was noted that the area affected by dieback increased from about 18 km^2 in 1992 and to about 480 km^2 in 2000 (World Bank, 2000). According to the risk assessment carried out by OTML, the estimated area ultimately susceptible to dieback induced by mining operations (i.e. the Maximum Impact Area) ranges from 1,278 km^2 to 2,725 km^2.

Photo credit S. Kirsch

Figure H3. Dieback of vegetation in the Ok Tedi River Catchment, 1996.

To minimise the effects of the dieback, OTML carried out an 18-month trial dredging operation along a section of the Ok Tedi, which commenced in 1998 (Murray *et al*., 2000). This involved excavating the riverbed and creating a slot of 800 m long, 240 m wide and 10 m deep. The waste material from the mine collected in this slot from where it is then dredged. The dredged material is pumped into constructed storage cells on the east bank. The dredging operation was designed to remove about 20 million tonnes of sediment per year.

There have been visible improvements in the floodplain, 15–20 km above and below the dredge site, since dredging commenced. The exercise has reduced the frequency and duration of flooding and as a result, vegetation is progressively re-colonising some areas. Landsat images taken in 1998 and 2000 (see Annex H1) show there has been some recovery in the lower Ok Tedi, though there have not been significant changes in the upper middle Fly River and dieback has continued to spread in this area. The spread of dieback in the Middle Fly is attributed to the existing sediments and a prolonged La Nina event, which has resulted in abnormally high rainfall thereby exacerbating flooding.

During the OTML risk assessment a model was created to estimate the extent of the dieback during mine life. Four development options were then suggested for the best way to manage dieback which included; ceasing mining, continuation of riverine disposal, cease dredging and continuation of dredging. Depending on the assumptions used, three levels of prediction were established for the four development options (Table H2). From these predictions, it was concluded that cessation of dredging could have a greater adverse effect on dieback than any of the other options. It was also noted that even if the mine was closed tomorrow, the waste from the mine would continue to cause dieback for some time.

Table H2. Predicted area of dieback for each of the four development options, expressed in km^2 (and percentage change on existing area).

Scenario	Development option			
	Cease mining	Tailings option	Cease dredging	Continue dredging
Pessimistic	1,259 (260%)	1,314 (270%)	1,374 (290%)	1,275 (270%)
Likely	820 (170%)	848 (280%)	887 (190%)	829 (170%)
Optimistic	608 (130%)	633 (130%)	665 (140%)	614 (130%)

Source: BHP

Dieback not only reflects a loss of the floodplain ecosystem, but also loss of subsistence gardening/hunting land for people residing in downstream areas that may lead to the displacement of communities. The dredging trial was scheduled to terminate in March 2000 but is continuing at the request of the PNG Government.

3.3 Toxicity and Water Quality

Although copper, gold and silver are a natural component in the rocks in the Star Mountain, their presence in rivers has been minor (Mineral Council of Australia, 2000). Before mining commenced, water in both the Ok Tedi and Fly Rivers was characterised by a moderately high content of alkaline minerals, reflecting the drainage from a predominantly limestone catchment. The 80,000 tonnes of tailings and 120,000 tonnes of waste rock discharged daily contain quantities of metals not recovered by the mining operation (see Table H2). The floatation process extracts about 80% copper and 70% gold and the rest is discharged into the river in the waste.

Most of the copper in the waste is in particulate form and very little is released to the dissolved phase because the river water is alkaline. Dissolved copper levels throughout the Ok Tedi and Fly River sometimes exceed 0.02 mg/l. While this exceeds earlier predictions, on which the Acceptable Particulate Level was based, they are well within international water quality standards (Mineral Council of Australia, 2000). It has been noted that the plants and animals do not absorb this form of copper because of the natural chemistry of the water and the naturally high organic carbon content in the sediments limits the amount of copper that can be dissolved. The copper becomes chemically attached to the organic carbon making it not bio-available (BHP, 1999).

Acid Drainage (AD) is another potential problem at the Ok Tedi mine and the river system. Due to the sulphide orebody, there is potential for acid generation in the failing waste dumps and the dredged material in the Ok Tedi. AD may accelerate the release of metals from the waste such as lead, zinc, copper, arsenic, selenium, mercury and cadmium, into ground and surface waters (OTML PRG, 2000). The extent and long-term possible impacts

of acid drainage from deposits of mine wastes at the Ok Tedi mine is unknown. This problem is controllable during mining because of the presence of limestone in the ore but these conditions will not continue after mine closure. It has been suggested that the predicted reduction in limestone content in the waste over the remaining life of the mine could be resolved by mining additional limestone from nearby and mixing it with the mine waste. In particular, it has been suggested that limestone additions would help avert the very serious risk of major and widespread toxicity (OTML PRG, 2000).

3.4 Decrease in Fish Stocks

It was noted that the number of fish caught in the Ok Tedi has declined by 90% since dumping of waste commenced (BHP, 1999). Fish declines are said to be the result of direct or indirect exposure to stress. This stress may be chemical, predominantly the increased copper concentration or the physical loss of spawning habitats by sedimentation, loss of food due to loss of plant habitat also from sedimentation and total suspended solids, which can be expected to adversely affect both plants and animals.

Since suspended sediment levels in the Ok Tedi and Fly River have shown a four to five fold increase since mining commenced, fish catches in the Ok Tedi have greatly reduced and some species previously recorded are no longer found. It is possible that some fish species avoid the 'smell' of copper and the increased sediment levels by remaining in the floodplain swamps and tributary streams (Minerals Council of Australia, 2000). It is predicted that these displaced species that are still found in the tributary streams and the Fly River, will return to the Ok Tedi when mining ceases and the suspended solids revert to their former levels.

Monitoring of metal concentrations in freshwater fish downstream of the mine in the Ok Tedi show increases in copper concentrations in the liver and kidney tissues, but not in the flesh. The people of the Fly River System consume all parts of the fish they catch, but it has been estimated that they would need to consume at least 2.6 kg of fish liver per day in order to exceed the World Health Organisation's guidelines for copper intake. This is equivalent to the livers from a quarter of a tonne of fish per person per day (Minerals Council of Australia, 2000).

4 Socio-Economic Impacts

From the outset, the people of Western Province have expected to benefit from the mine through business opportunities and jobs with the company. The Ok Tedi mine is the only agent of development in the Western Province. Nearly half of Western Province's funding comes from the mine. Since 1982, OTML has provided substantial amounts of revenue, through royalties and taxes, to the PNG Government, the Western Provincial Government and the local landowners (Table H3). OTML contributes an estimated 20% to PNG's exports (Low & Gleeson, 1998), and 10% to its Gross Domestic Product (BHP, 1999). BHP also makes regular compensation payments, especially to the landowners affected by the mine.

Table H3. Total amount of taxes and royalties received by the PNG and Western Province Governments, and Local Landowners, 1982–2000.

Taxes and royalties	Amounts (million Kina)
Royalties to PNG Government	21.9
Royalties to Western Province	42.8
Royalties to landowners	17.6
Company tax	91.8
Customs duties	121.2
Withholding taxes	37.2
Pay as you earn tax	173.1
Total taxes and royalties	505.6

1:00 Kina = US $ 0.307996 (2001)
Source: BHP (1999)

In addition to the financial benefits, OTML has contributed to the employment sector of the country (Table H4). At present, the combined OTML operations directly employ almost 2,000 Papua New Guinean nationals who represent about 92% of the total workforce. Another 1,000 work for contractors providing support services to the project.

Table H4. Direct employment by OTML

Year	PNG nationals	Expatriates	Total	% Nationals
1985	1,111	254	1,365	81
1986	1,398	379	1,777	79
1987	2,100	661	2,761	76
1988	1,960	508	2,468	79
1989	1,841	298	2,139	86
1990	1,746	270	2,016	87
1991	1,671	259	1,930	87
1992	1,644	231	1,875	88
1993	1,594	213	1,807	88
1994	1,736	192	1,928	90
1995	1,747	198	1,945	90
1996	1,787	206	1,993	90
1997	1,752	184	1,936	90
1998	1,698	163	1,861	91
1999	1,756	149	1,905	92
2000	1,894	154	2,048	92

Source: OTML

OTML invests considerable resources in the training and development of its Papua New Guinea employees, with the Ok Tedi training centre said to be the best of its kind in PNG.

A total of 685 apprentices and trade trainees have been accepted into training programmes and a further 757 scholarships have been awarded to enable students to complete training and education programmes (BHP, 1999).

The project has provided additional benefits to the community through the Fly River Development Trust (BHP, 1999). This was established in 1990 after OTML became aware that the benefits of royalties paid to the Provincial Government were not reaching the village people. Downstream residents living along the Fly River were not benefiting from the wealth being generated upstream and were not receiving adequate compensation for changes and damage to habitats and livelihood.

The Trust area covers about 107 villages, extending from Ningerum on the Ok Tedi to the islands in the Fly River delta. The Trust Board includes representatives of the Papua New Guinea and Western Province Governments, as well as OTML and villagers (Minerals Council of Australia, 2000). The aim of the Trust was to make direct payments to villages for infrastructure and business developments. The fund began with a grant from OTML of nearly US $2.5 million and in 1995 had increased to over US $3 million annually. It has overseen the construction of 133 community halls, more than 40 classrooms, 2 school libraries, almost 400 solar lights and pumps, more than 600 water tanks, 23 women's clubs and 15 aid posts (BHP, 1999).

Considerable effort has also been invested by OTML's Rural and Economic Development Department in sponsoring the development of locally owned businesses. At present there are 70 locally owned businesses with a gross annual turnover of 120 million Kina (about US$37 million) providing support services to the mine. One of the most successful investments is the construction of a rubber processing plant at Kiunga and the encouragement given to local farmers to grow rubber as a cash crop. The rubber processing plant was opened in 1994 and is owned by the Fly River Development Trust (50%) and by local investors (50%). In 2000, the rubber factory paid more than US$104,000 directly in cash to farmers in 25 villages upon delivery of their rubber to the factory. North Fly Rubber and OTML's Rural & Economic Development Department, with funding from the Fly River Development Trust, have embarked on an ambitious 10 year rubber planting program to ensure the rubber industry survives beyond mine closure (North Fly Rubber, 2001).

Another community development enterprise and long term investment is commercial fishing. OTML has constructed and installed freezer storage plants in the villages of Obo and Bosset. As the local people catch fish (mainly barramundi and black bass), they are filleted, frozen, stored and sold to catering and food outlets in Tabubil (Minerals Council of Australia, 2000). Although market outlets now include Kiunga and Port Moresby, it is recognised that these businesses are largely dependent on the continued operation of the mine. Recently the Obo Fish Company has received an export licence and has shipped its first order overseas, to Australia. OTML is making efforts to invest now in the development of businesses such as forestry, agriculture, ecotourism and fishing, that will be sustainable when the mine closes (Wissink, 2000).

The other main social benefit of the Ok Tedi project has been the improvement in the health status of the community. Long-term studies on the communities have shown that infant mortality has fallen from around 27% to less than 2% and average life expectancy at

birth has improved from around 30 years to over 50 years, because of the improved health benefits (BHP, 1999).

The negative social impacts have been direct physical impacts associated with sediment deposited by overbank flooding which has damaged garden crops and forced the villagers to move their gardens further from the river. The aggradation has also caused the river to flow faster than before. As a result, in some places canoe transport has become more difficult. The decrease in fish population in the Ok Tedi has forced villagers to find other fishing grounds. A further consequence of the project is the potential for progressive loss of traditional agricultural practices as people shift to a cash economy, purchasing their food in supermarkets (BHP, 1999).

5 Governance and Drivers Behind Decision Making at Ok Tedi

An important issue in the governance structure at Ok Tedi is the growth in the range of recognised 'stakeholders' involved in the minerals industry in PNG. Under the original legislation the only interested parties were the mining company and the National Government, with a minor role for provincial governments introduced after 1977. As mining has progressed, a range of other parties have become involved including downstream landowners, lawyers, academics and both national and international NGOs (Banks and Ballard, 1997).

All these different parties play important roles in the governance of the region. BHP, the majority shareholder, operates the mine and is responsible for compensation payments for the affected landowners. The PNG Government as well as being a shareholder, has the responsibility of also being the regulator. The decision to exploit the Mt Fubilan deposit was made after PNG achieved independence but before the country had formulated its own mining legislation. Therefore, in 1976 the Mining (Ok Tedi Agreement) Act was passed by parliament which outlined all the obligations and rights pertaining to the development of the Mt Fubilan deposit. This Act has subsequently been amended via a series of 'supplemental agreements'. The sixth supplemental agreement is critical to the environmental management of the Ok Tedi mine.

In addition to the above legislation, since BHP is a multinational company, the Mineral Policy Institute, Australia noted that its code of conduct in PNG is supposed to reflect the conduct in its country of origin i.e. if OTML were in Australia, it would be expected to; stop dumping waste into the river, be responsible for cleaning up all the damage from the mine for as long as the damage lasts (i.e. even after mine closure) and provide full information and consult with all affected communities.

In 1996, OTML set up a Mine Waste Management Project to undertake a two year study of the engineering, environmental, social and risk components involved in mitigating the environmental impacts of the mine waste. The project also included a two year dredging trial in the lower Ok Tedi to investigate the effectiveness of dredging as a measure to reduce sediment build up in the river system.

After reviewing a large number of mine waste management possibilities, four possible options to deal with the mine waste issues were examined in detail. These were:

- **To dredge** – the continuation of the current dredging trial in the lower Ok Tedi.
- **To dredge and install a tailings pipeline** – to continue to dredge but also to pipe the tailings to a storage facility on land. This involved using the dredge spoils to construct a tailings dam on the banks of the lower Ok Tedi.
- **To do nothing** – to discontinue the dredging trials and continue to discharge the mine waste into the river system.
- **To close the mine early** – discontinuing all mining operations in the year 2000.

OTML assessed the four options and concluded that none of them provided a clear solution. They noted that dredging would not have the environmental benefits originally anticipated and impacts in the river system would continue to worsen with or without dredging. In their view, early closure of the mine appeared to be the only option that would significantly limit the projected environmental impacts of the mine. It was also noted that, from a social and economic perspective, early closure appeared to be the least attractive option, effectively stopping the benefits that would accrue from continued operation. They concluded that continued mine operation would also give all stakeholders time to implement a mine closure plan, focused on sustainability after mining, and allowed time for the company to assist the local community move towards self reliance.

A Peer Review Group (PRG) was formed in 1997, to provide advice, recommendations and peer reviews related to a Human and Ecological Risk Assessment (HERA) of the terrestrial and aquatic ecosystems of the Ok Tedi/Fly River system downstream of the mine. There are five members of the PRG;

- Dr. Peter Chapman, EVS Environment Consultant, North Vancouver
- Professor Margaret Burchett, University of Technology, Sydney
- Professor William Campbell, University du Quebec
- Professor William Dietrich, University of California, Berkely
- Professor Barry Hart, Water Studies Centre, Monash University

Their terms of reference included; advising OTML management on the HERA programme, with particular focus on the approach (conceptual basis and methodology), the screening level risk assessment, and the final detailed risk assessment; recommending additional scientific studies necessary to ensure that the HERA has an adequate information base; reviewing key reports and individual projects related to the HERA programme as referred to the Peer Review Group by OTML management and providing further advice as requested by OTML (OTML PRG, 2000).

The local community also take an active role in the day-to-day running of the mine. They have been able to voice their concerns about the impacts the mine is having on their livelihoods. This was highlighted in the litigation case against BHP. In 1989, several landowners started advocating for some action to be taken to prevent the dumping of tailings

directly into the river system, because it was having adverse impacts on the environment, and for compensation for the damage caused.

In 1992, 30,000 landowners approached the Australian firm Slater and Gordon for assistance in getting the case heard in court. In June 1996, the parties reached an out of court settlement of US$500 million. The settlement was divided into four parts; US$90 million in cash for the 30,000 people living along the Ok Tedi and Fly River, to be paid out over the life of the mine; a special package worth about US$35 million, for the people of the lower Ok Tedi who have been most affected by the mine; 10% equity shares in the mine, held by the National Government in trust for the people of Western Province; and a commitment to implement the most practical tailings containment option as recommended by the PNG Government; based on studies to be carried out by OTML (Harkinson, 1999).

In April 2000, four years after the first court settlement, representatives of the landowners brought another litigation case against BHP. Their argument was that BHP was still dumping up to 90,000 tonnes of tailings in the river each day despite the agreement to stop. The landowners were seeking unspecified damages and an order for reasonable tailings mitigation.[5] The case is expected to be heard in 2001. The history of the court cases is presented in Annex H2. Due to public pressure, BHP last year endorsed a new policy not to practice riverine disposal at any of its future sites (Box H2).

Box H2. Statement made by BHP on riverine disposal practice

BHP Position on Riverine Waste Disposal

BHP will not commit to a new mining project that disposes of waste rock or tailings into a river.This position does not apply to:

- The disposal of waste rock and tailings materials in conventional waste rock dumps or tailings dams which may be constructed within the catchment of a river system where such structures are designed to retain and store the waste materials.
- Discharge of water from tailings dams or waste rock dumps (of a quality acceptable for downstream beneficial uses)

Source: Rea (2000)

Since the most feasible option in terms of mitigating environmental impacts was to close down the mine, OTML left this decision to the PNG Government. The Government decided that the Ok Tedi mine should continue and BHP has now withdrawn from the project.

[5] See Slater and Gordon website at http://www.slatergordon.com.au/HTML/major_cases_oktedi.htm (accessed April 2000)

6 Conclusions

The PNG Government and the people in the Ok Tedi region had welcomed the development of the mine because of its economic and social benefits. Even after the examination /analysis of the environmental impacts and recommendations from international communities, the World Bank and NGOs for the closure of the mine, the PNG Government is very reluctant to close the mine earlier than 2010. On the other hand, BHP, the majority owner would have liked to close the mine early after endorsing a statement that the company would refrain from the practice of riverine disposal in future projects.

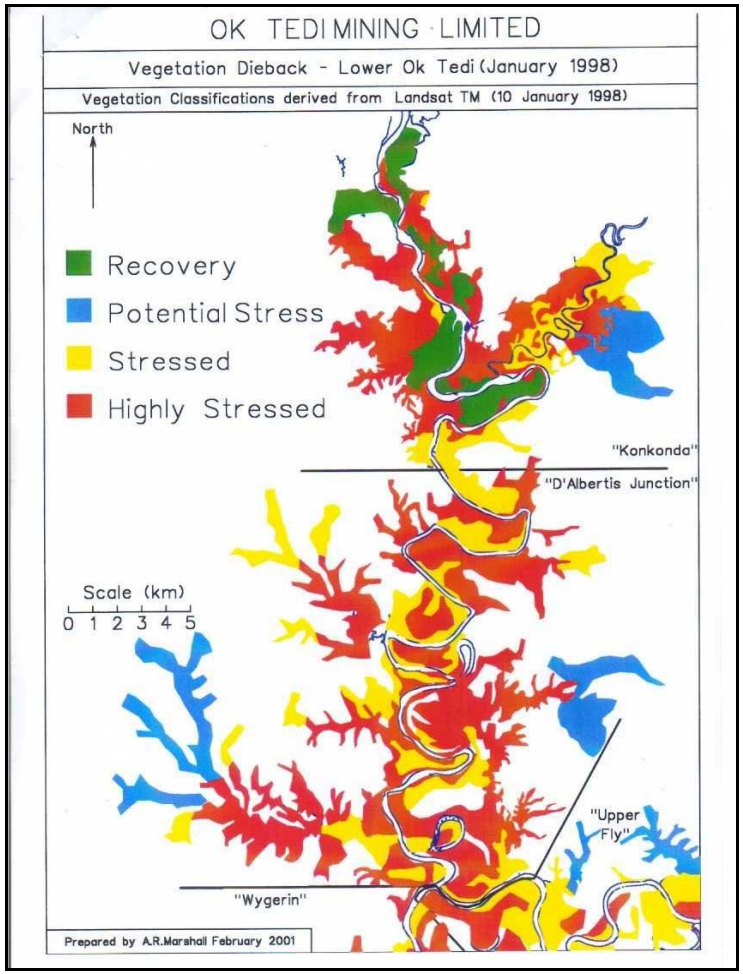
The Ok Tedi case highlights conflicts between local interests and the international community. It also highlights the different perspectives of both the developed and developing world. Whereas the PNG Government is willing to accept the environmental impacts because the mine provides foreign exchange, employment and promotes regional development, the international community, most especially NGOs in the developed world, are advocating for its closure.

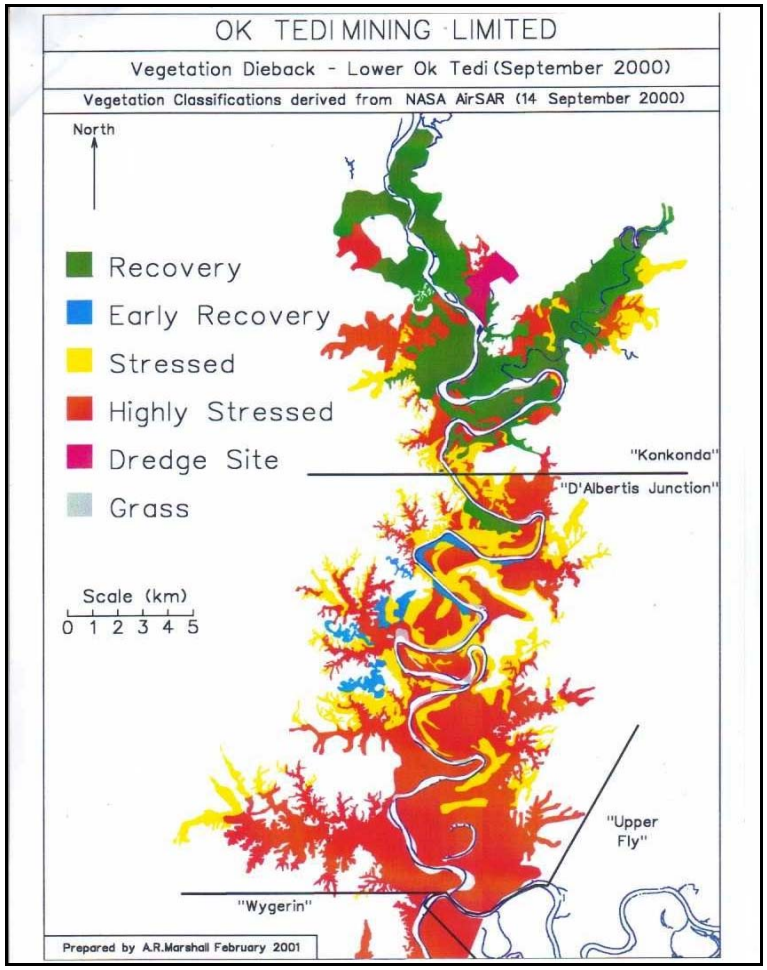
This raises a major question of who makes the final decision on what is to happen in such a case. Should the decision be based on a set of best management practices, as supported by the international community (in this case permanent closure) or should this decision be left to the PNG Government and the local community? With BHP Billiton's withdrawal from the project this, in effect, is what has happened.

References

See separate References for the Main Report and Appendices.

Annex H1. Landsat Diagrams of the Ok Tedi Dieback in 1998 and 2000





Source: BHP, in 2001

Annex H2. Litigation History of the Ok Tedi Mine

Year	History
1976	BHP buys rights to Ok Tedi (sells 30% to German company, 30% to AMOCO, and gives 20% to PNG government).
1983	Tailings dam constructed as per agreement with PNG government.
1984	Dam collapses; BHP gets permission to dump 90,000 tons of waste each day into Ok Tedi River.
1984	Series of accidental cyanide releases into river.
1987	German & US interests withdraw. Landowners serve a petition demanding recognition of the damage.
1990	Mine briefly closes as 2000 protest damage to river and demand compensation.
1994: May 5	Writs filed against BHP and Ok Tedi Mining Ltd in the Supreme Court of Victoria.
1994: June 16	Court awards judgement in favour of Ok Tedi landowners after BHP's lawyers fail to lodge their defence by the 30-day deadline.
1994: June 20	BHP seeks leave to file their defence; this is granted a week later.
1994: July 5	BHP seeks to have the case struck out; in November the Supreme Court of Victoria rules that the case can go ahead.
1994: September	Slater & Gordon's PNG lawyer Rimbink Pato quits after being threatened; Dair Gabara becomes the firm's PNG representative and files 1056 writs in Port Moresby before the Statute of Limitations expires.
1994: November	Supreme Court rejects BHP's contempt proceedings against Slater & Gordon's Nick Styant-Browne and John Gordon for commenting on the case in two radio interviews; Justice Byrne also rejects BHP application that the PNG landowners should deposit an estimated $2 million with the court to cover legal costs if they lose.
1995: February	Court rejects BHP application that the Victorian Supreme Court had no jurisdiction to hear the case.
1995: April	Inconclusive private meeting in Melbourne between Slater & Gordon and PNG Mines Minister John Giheno.
1995: August	After BHP offers $110 million in compensation, its lawyers are exposed for helping draft PNG legislation to impose huge fines on anyone initiating foreign litigation against BHP.
1995: September	BHP begins a TV, radio and newspaper advertising campaign with claims that the tailings released into the Ok Tedi River were "virtually identical" to natural materials that found their way into the river; that only 20 km of the river's 1000 km were affected; that fish "seem to be increasing again"; and of the social benefits from the mine (accompanied by TV images of healthy smiling children).
1995: September 19	Justice Cummins of Supreme Court of Victoria finds BHP in contempt of court for interfering with the administration of justice in Victoria by co-operating with the PNG government in drafting the Ok Tedi Eighth Supplemental Agreement legislation, which would make criminals in PNG of anyone suing BHP in Victoria.

1995: September 20	BHP advised the court that, under 1994 changes to Victorian law, only the Attorney General could authorise proceedings for contempt of court.
1995: September 22	Justice Cummins ruled that the changes were unconstitutional and that BHP was still guilty of contempt.
1995: December 15	BHP's first victory: the Appeal Court ruled by a margin of 3-2 that the 1994 law was valid, that only Attorney-General Jan Wade could prosecute for contempt of court.
1996: March 4	Mrs Wade announces that, on the advice of Solicitor-General Douglas Graham, she will not prosecute BHP; Parliament is later told, in October 1996, that Mrs Wade holds BHP shares and Mr Graham is a director of companies which hold BHP shares.
1995: October 11	Solicitor John Gordon arrested on arrival at Port Moresby; detained then deported. PNG Court finds Immigration officials in contempt of the court's habeas corpus order.
1995: Oct-Nov	Supreme Court of Victoria warns BHP that its advertising could be in contempt; also rules that the case can proceed but that the court did not have the power to order BHP to build a new tailings dam.
1995: December 15	PNG Parliament passes the Compensation (Prohibition of Foreign Legal Proceedings) Act 1995. PNG villagers have 60 days to withdraw their legal action against BHP or face arrest. Gazettal is delayed after an appeal by Australia Foreign Minister Gareth Evans.
1996: April	The PNG legislation became law. BHP began modest payments to villagers. But by the end of the month clan leaders representing 31,488 Ok Tedi and Fly people had opted out of the BHP compensation plan.
1996: June 7	BHP, its subsidiary OTML, plaintiffs and their lawyers reach agreement.
1996: June 11	Settlement announced. This includes: $110 Million a further $40 million to the worst affected areas a commitment to put an end to tailings from the mine polluting the river legal costs the withdrawal of court action in Victoria and PNG Environmental measures, including dredging the river and a proposed 130 km pipeline, were expected to cost $400 million.
1999: June	OTML reacts to preliminary results from environmental studies on waste from the mine. The results predict the environmental impact of the mine will be significantly greater than previously expected. OTML flags the early closure of the mine as option for dealing with the problem.
1999: August	OTML releases scientific reports on the environmental effects of the Ok Tedi mine. BHP says the mine is not compatible with its environmental values and company should not have become involved in the mine.
2000: March	The World Bank says the Ok Tedi mine should be closed without delay. The bank expresses concern at delays by BHP and the PNG government to deal with the environmental problems caused by the mine.
2000: April 11	Ok Tedi 2. Legal action seeks compensation and reasonable tailings mitigation.

Source: Slater &Gordon