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REVIEW OF PART OF THE EIS OF THE SEPIK DEVELOPMENT PROJECT

for

Centre for Environmental Law and Community Rights (CELCOR), Inc., Friends of the Earth Papua New Guinea
Your reference: Megan Kessler

by

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AN ASSESSMENT OF THE SEPIK DEVELOPMENT PROJECT ENVIRONMENTAL IMPACT STATEMENT

1 **Prepared by Ian Cordery ME, PhD**. Honorary Associate Professor, School of Civil and Environmental Engineering, The University of New South Wales.

2 I have been requested by the "Centre for Environmental Law and Community Rights, Inc., (CELCOR) to provide expert advice in relation to surface water impacts discussed in the "Sepik Development Project Environmental Impact Statement". As requested by CELCOR I have read the Australian Federal Court Rules and the Expert Evidence Practice Note and agree to be bound by it.

3 My qualifications to provide such advice are that I have been teaching and researching surface water hydrology and water resources for 50 years, mainly at the University of New South Wales, but also for short periods in Switzerland, UK and USA. My research and writings have concerned flooding, and its causes and effects, flood modelling, flood forecasting, stormwater pollution and control, long term forecasting of rainfall and more recently effects of climate change on water resources. I am author of one water resources textbook, author of chapters on floods in two hydrology/water resources Handbooks, author of about 50 research papers published in international journals and about 100 international conference papers. I have completed numerous expert witness reviews for litigants and written a few published opinion pieces.

INTRODUCTION

4 In the following pages I have listed a number of issues discussed in the EIS which I think need further attention. Some are minor issues which relate to the thoroughness of parts of the EIS investigation, others are more substantive matters which have potential to have long term effects on the environment of the Sepik River valley and its inhabitants. Perhaps the most important issue is that of free erosion of many millions of tonnes of waste and surface washoff material which will enter the Frieda River in the early construction phase of the mine, prior to completion of the Integrated Storage facility (ISF).This delivery of material to the river will immediately change the characteristics of the river and its floodplain and these effects will continue long into the future.

5 My responses are listed below.

SEPIK DEVELOPMENT PROJECT CHAPTER 5

Section 5.6.11

6 The sentiments expressed in this section are commendable and what are expected from an ethical, environmentally responsible company. The NSW Dams Safety Committee, with which I had many years of involvement, would have been very supportive of the ideas listed and of the proposed requirements for monitoring of the listed activities.

7 However, one wonders if all these policies will actually be implemented, especially those stated to be needed after closure of the mine. Once the Mining Company has concluded its extractive activities and has left the site how will ongoing water treatment (from the mine pit) and safety surveillance

activities for the ISF dam be funded and organised? Who will take responsibility for these vital works, made necessary by the 35+ years of mining activity? For example, how will flood warnings (both during the life of mining and for a very long time afterwards) be formulated and then communicated, in a timely manner, to downstream residents? Note that the ISF impoundment will be one of the largest man-made reservoirs in the world and if it were to fail (very unlikely, but possible) it would put at great danger of death, practically all residents of the Frieda River valley and most residents of the whole of the Sepik River valley floodplain.

8 Will a communication system be developed? If yes, will it continue to operate after mine closure? I would suggest funding for this, and the other safety/environmental surveillance requirements that have been stated as necessary in this Chapter for post mining, would need to be collected from the mining company and independently preserved – perhaps for 100+ years in the case of dam safety. Ongoing activities post mine closure, such a treatment of water from the mine pit prior to discharge into the Frieda River system, and dam safety surveillance are expensive activities, especially in remote regions.

SEPIK DEVELOPMENT PROJECT CHAPTER 8

9 There appear to be three significant issues which are not appropriately dealt with in this chapter. All appear to be quite deliberate decisions by the mine or project proponents as they are mentioned numerous times in the chapter as set out in the detailed comments below.

10 The three issues which I think are inadequately dealt with, or which have been rationalised as being acceptable are:

1) During construction of the mine, in years -5 to -1, prior to completion of the ISF dam the construction waste heap (very large and growing daily) will be allowed to erode into Ok Binai and Ubai Creek and the washoff will pass unrestrained into Frieda River and Sepik R. The washoff sediment load will be large, as stated in the Chapter and will be deposited by the rapid turbulent flows on the bed and floodplain of the two larger rivers. Bed

deposition will raise the riverbed levels (by 3 metres in parts of the Frieda R) to the point where overbank flow will occur on the Frieda River floodplain much more frequently than under undisturbed conditions. Flow velocities over the floodplain are likely to be quite small and as a result much of the finer sediment material will be deposited on the floodplain. This deposition will probably be many centimetres deep and will render the floodplain unproductive for a number of years. Any villages on the floodplain of the Frieda River will be uninhabitable and their gardens will cease production for a considerable time.

In my opinion, the Project proponents should be required to develop a construction plan which avoids or prevents this potential disaster.

2) During mining operations concentrations of toxic dissolved metals (copper and aluminium) in the Frieda River are expected to be very much in excess of those acceptable for drinking water. Presumably, villagers along the Frieda River drink the river water and consume fish and crustaceans caught from the river. These fauna are likely to have accumulated the toxic metals in their tissues and will deliver significant toxic loads to the human consumers. I am not expert on the effects of prolonged ingestion of high concentrations of copper and aluminium but I suggest it would be important to seek advice of suitably qualified experts to assess whether the ingestion levels are important for the well- being of a population who are likely to ingest these toxins daily for considerably more than 30 years.
It would seem important that the risks of this long term, continuous ingestion by the local population should be investigated so that mitigation measures may be specified.

3) A number of water treatment processes are stated to be needed after mining ends at year 30. If mining has ceased and the mining company has vacated the site, how will the required water treatment processes be funded and activated? There is no mention of who will fund and undertake this activity. The EIS does not mention any provision being made for these expensive, ongoing (stated in this chapter to be required for 50+ years

after mine closure) activities. It is unclear whether they would be the responsibility of the Provincial government, the National Government, or the local people.

There is a need for provision of funding and managing of these operations to be put into any Conditions of Approval for the mining activity.

11 An issue that is never mentioned in Chapter 8 is that of general mine and project supervision. This Chapter sets out many rules and requirements of the mine and site operators and their employees, but there is no mention of any independent supervisory staff who will attempt to ensure adherence to the statements and operational plans and requirements of the Chapter. Who will undertake this large and important function? How will they be funded? How will their independence be ensured?

12 Detailed observations on Chapter 8 now follow.

13 Table 8.23. Sediment management measures and control. There is no mention of supervision. Who will inspect, and how often to ensure this long list of restrictions on activities will be faithfully implemented?

14 Table 8.24. Who will supervise and ensure these measures are undertaken in a timely manner during operations and after mine closure? There is need for a very specific plan and funding – especially for many years after mine closure.

15 MM051 – Proper treatment of encampment waste – e.g. sewage. There needs to be at least a sizeable secondary sewage treatment plant. Here and in the Appendices, it is suggested there will be a workforce of up to 3500 with about 1500 for the long term. No mention is made of provision for sewage treatment.

16 Table 8.25. Why are percentage differences in dry weather flows pre and post operations different from the values shown in columns 3 and 6? The percentage differences for average and wet conditions appear to be consistent with the values shown in columns 4 and 7 and in columns 5 and 8.

This is a technical issue related to modelling credibility, which suggests some of the modelling should be rechecked.

17 Page 59. Who will maintain and ensure the safety of the ISF dam wall after the closure of mining? The wall is 250m high and failure would have enormous consequences for populations, no matter how small, along the Frieda and Sepik Rivers.

18 Page 62. Sediment from the spoil dump adjacent to the limestone quarry will be unconstrained for 4 years before completion of the ISF. This will contribute very large volumes of sediment to Ok Binai and Ubai Creek and onwards to Frieda River and Sepik R. In a region where the annual rainfall is of the order of 7000mm this lack of restraint on movement of sediment from the (constructed) waste dump is unacceptable. Minor sedimentation ponds at the toe of spoil piles will not be adequate. Significant works will be needed to prevent the escape of solids from the piles. This may require some rethinking of the layout and considerable expense early in the mine construction. In Chapter 8 it is stated " …during early construction sediment is expected to be 3g/l in normal flows and much higher during high flows….". The creeks will not be flowing water but rather a slurry of (mainly fine) sediment.

19 These sediments will settle on the bottom of the Frieda River and raise the stream bed, reducing the cross-section of the river channel and thereby increasing overbank flow. Overbank flow on the Frieda River floodplain will be at lower velocities than flow in the main channel, allowing much of the carried sediment to settle among the vegetation on the floodplain. The deposited fine material is likely to build up to depths of at least several centimetres, smothering vegetation on the floodplain and affecting villagers' food gardens. Once significant sediment has been deposited on the flood-plain it is virtually impossible to remove, so it is there for a long time. (Similar situation occurred downstream of the Ok Tedi mine). After the ISF is completed most sediment will be trapped in the ISF and the downstream discharge of sediments will be largely controlled. However, by then severe long-term damage will have been

sustained by the Frieda River flood plain. Minor deposition is also likely in the Sepik River but as the Frieda River only contributes about 8% of the Sepik River flow the effects are unlikely to be large.

20 There is comment on Page 63 that erosion of the waste dump will totally change the character of Ok Binai. With no population along Ok Binai this devastation appears to be one of the “acceptable” environmental consequences of a major project like this.

21 Page 65. It is claimed that with the closure of the ISF (effectively closure of the works diverting flows around the ISF dam construction site) the bed level of the Frieda River will be lowered. This is probably correct – at least at the upper end of the Frieda R, but it means carriage of large sediment volumes down the Frieda River to the Sepik River will continue long after completion of the ISF wall.

22 Page 67. Expectations of negligible overbank deposition of sediments on the Frieda River and Sepik River floodplains during and post mining are probably correct. However, as noted above in years -5 to -1 there will be a huge sediment load and this will certainly have adverse effects on flora and fauna in the rivers and in the off-river lakes on the flood plains during these 4 years and for some years afterward.

23 Page 72 and Table 8.26. Some of the toxic metals concentrations are admitted to exceed drinking water standards during high (P90) flows and in some cases for average conditions. The concentrations expected depend very much on the processes of deposition and re-mobilisation of particles in the ISF (e.g. aluminium adhering to micro flocculate particles). Since water residence time in the ISF during high flows is expected to be as low as 2 days, with considerable opportunity for micro particles to be disturbed from the bed and re-entrained in the water column, it would appear to be likely that slugs of very high concentrations of toxins will be swept into the Frieda River Some of those particles will be deposited on the bed of the Frieda River and Sepik River and

will be available for mobilisation into the water column long into the future. Any disturbance of the bed, by floods, human activity and bottom feeding fish and crustaceans will encourage mobilisation of micro particulate toxins into the river flow long into the future – for perhaps hundreds of years. Expert opinion should be sought to consider the re-mobilisation of micro-particulates from the bed of the ISF. These issues are within my span of knowledge but outside my area of expertise.

24 Page 79 Even with modifying criteria the aluminium (Al) and copper (Cu) concentrations are very high. They may be acceptable for short term ingestion but for the 30+ years of mine operation these toxins will be ingested by all who drink the water or consume food sourced from the rivers. These conditions may slowly poison all inhabitants of the Frieda River floodplain. Sepik River inhabitants will likely be unaffected due to the large dilution effects of the larger flows.

25 Page 97. Open pit water is to be treated with lime for 50 years after mine closure. Who will undertake this work? Who will fund this expensive operation? Report says 50 – 70 t/day of lime will be required. This is a totally unrealistic expectation unless funds are collected (and preserved) for this purpose during the life of the mining operations.

26 Page 99. The proposed lower standard for trigger values for aluminium and copper at AP7 seem to undermine the aims of environmental care and protection of humans dependent on the Frieda River. The values chosen (0.3 mg/l for AL and 0.02 mg/l as suggested by the USEPA) are much higher than those recommended in Australia and New Zealand quoted in this EIS (6 times higher for Al and 20 times higher for Cu) and appear to be chosen for financial convenience rather than protection of the local people. For a project with a life of 30 years and after-effects lasting a similar length of time I suggest these levels are much too high, much higher than recommended in Australia and New Zealand.

27 Page 103. How frequently will Al and Cu monitoring be conducted at AP7? Will samples be collected and locally tested daily? Less frequent sampling would make no sense if these results are to be used to prevent high concentrations of toxins passing down the river. For how long will sampling continue? In my opinion, they will be needed for at least 50 years from the start of mining activities. There is no mention of these specific requirements, nor of who will conduct the tests or what authority they will have to request modification of mine operations to ensure compliance. Investigation of further water treatment options sounds responsible, but at the moment excessive toxins are observed it is already too late for rescue – measures are needed as part of the original water management plan, not after (the almost inevitable) problems are observed. Presumably these issues are referred to in Chapter 11.

28 Page 119. In my opinion, most of the huge load of sediment and TSS (total suspended solids) generated upstream of the ISF –presumably an unavoidable part of a major development in tropical rainforest – are tolerable due to their limited spatial extent above the ISF. But as discussed above, the escape of these huge sediment loads during the first 3 or 4 years of construction, before the closure of the main dam and its diversion tunnel is not acceptable. The very destructive generation of sediment, though inevitable, should not be permitted to affect the downstream environment (the Frieda R). The report states that up to 4 million tonnes (Mt) of sediment will be deposited in the Frieda River. In my opinion, the figure of 4 Mt is a gross underestimate. It is expected the 4 Mt will raise the bed of the Frieda River by 4 metres. The deposited material will be rich in Al and Cu and this deposited material will then erode and be swept down the Frieda River for many years into the future. This sediment and its contained heavy metal toxins will affect river flora and fauna and the human population of the area long into the future, as discussed earlier. As stated earlier, I am not expert on the effects of heavy metals on humans, and I suggest expert advice be sought on the likely effects of long term (50+ years) ingestion of Cu and Al.

29 It is really important that means be in place to intercept the mine construction sediments. For example, it could be a requirement of any approval that the ISF should be completed before any other mine construction activity is permitted.

30 Page 121. Construction of infrastructure prior to ISF completion and mining. Higher sediment loads compared to natural conditions are inevitable. However experience shows much washoff could be prevented by attention to details, and appointment of a sediment reduction operator. This operator would need access to light earthmoving equipment and would need to patrol the site and quickly adjust/repair larger sediment loss areas before they become major sources of sediment delivery to the streams.

31 Page 122. As discussed earlier, the uncontrolled erosion of the Cu and Al rich spoil dump adjacent to the limestone quarry should not be permitted. Measures should be put in place prior to development of the spoil dump, such as a large sediment trap downslope of the dump. If no measures are taken a minor version of the catastrophe of the Ok Tedi spoil/tailings disposal is likely. The increase in sediment loss from the site from 9 Mt under natural conditions to 13 Mt would appear to be a large under-estimate. The figure needs justification. A very rough estimate of the sediment movement during the 5.5 years of activity prior to mining would perhaps be as large as 18 Mt.

32 Page 125. There is much dependence on statements such as “provided road maintenance and erosion and sediment control measures are implemented and maintained”. Who is expected to be responsible for this activity and who will be responsible for ensuring it will be done? It is not clear who will improve and then maintain the road from the mine site to Vanimo.

33 Page 133. There is mention of a braided channel reach of the Frieda River. This is an area where deposition of spoil heap washoff (in years -5 to -1) and where the whole flow regime may be changed. During the mining and post mining period the 50 m^3/s (minimum environmental flow) may pass through

this changed braided area very differently from the way it flows currently, probably giving rise to unexpected consequences.

34 Page 134. After the end of all extraction activities who will pay for and continue the treatment of the open pit water that will be directed to Ubai Creek? It is unclear whether this will fall to the National Govt, Provincial Govt or the local people? Presumably the mine operator will be gone.

35 Page 137. Concentrations of metals in fish tissue. Expert fish biologist opinion is needed.

36 Page 142. Sections 8.6 to 8.10 are outside my area of expertise and therefore I have no comment to make on them.

SEPIK DEVELOPMENT PROJECT CHAPTER 10

37 My only comment on this Chapter concerns Section 10.4.2. It states that effects of the project on Sepik River suspended sediment levels will be small. This may be true for most of the project duration, but it is not true for years -5 to -1, the period of high sediment production from the spoil waste dump adjacent to the limestone quarry before closure of the ISF. Sepik River sediment loads will not be exceptionally high during this period, but they will be significantly higher than usual. The claim that TSS concentrations will be small during this period is false.

38 I have no other comments on this Chapter. Some of my observations on Chapter 8 and Appendices apply also to this Chapter.

SEPIK DEVELOPMENT PROJECT CHAPTER 11 WATER MANAGEMENT SUB-PLAN

39 The establishment of an independent advisory committee, as suggested, is really essential. The long list of potential members may be overkill, but a key issue is how many members will actively participate and how often

committee members will visit the site of operations. Remote oversite has little or no value for a field operation such as this.

40 Table 11.3 states that various events must be recorded. Recorded where? Who will have control of this data base and what will be the criteria for access?

41 Conflict of interest appears to be a problem in this Chapter. In some instances of the lists of those having responsibility in the Tables 11.1 to 11.5 there appear to be many (at least partial) conflicts of interest. It would appear to be worthwhile for some independent inspection to be set up, either by a totally independent inspector, or PNG Govt. officer to assist in checking compliance with all the admirable specifications in Tables 11.1 to 11.5.

42 Section 11.6 provides a good summary of the aims of water management. Most of the responsibilities for ensuring compliance appear to rest with the SHE Manager, but as stated earlier this manager already has conflicts of interest and more are added here. I suggest there is a strong case for some independent, on-site, oversight.

43 The Section on Project Closure has a commendable list of requirements. Since the HEP is not expected to close for up to 100 years, statements about the ISF after this time are realistically generalised.

44 Provision for flood management seems to be adequate but what will be done (and by whom) if the ISF is damaged, perhaps due to seismic activity? If the dam wall is compromised at any time it is likely the reservoir water level will need to be lowered and the waste rock/tailings stored (permanently) therein may be exposed to the atmosphere. As is discussed elsewhere in the EIS, exposure of acid sulphate rocks to the atmosphere leads to rapid chemical change, producing large amounts of (sulphuric) acid. As stated, naturally inflowing sediments will eventually cover these dangerous debris that will have been deposited in the ISF. But when will that process be complete? And what

if lowering of ISF water level becomes necessary long before coverage has occurred? Escape of acid material due to reservoir lowering would affect the whole of the Frieda and Sepik Rivers with potentially catastrophic effects on all flora and fauna (including human) located there. The reservoir safety and coverage of the acid forming waste material may need to be monitored long into the future. The material in the bottom of the reservoir, 40m below full supply level and 100m above the former riverbed, should probably be monitored and guarded. There are similarities between the importance of long-term maintenance of the integrity of this hazardous material storage and the long-term management of low-level nuclear waste material.

SEPIK DEVELOPMENT PROJECT APPENDIX 5

45 It is acknowledged elsewhere in the EIS that the very limited site measurements and observation of rainfalls, flows and sediment movements (no bed load observations) make modelling of flows in the streams and movement and carriage of sediment very approximate. Estimation of existing conditions and particularly of conditions during mining must be regarded as indications only. The report acknowledges this.

46 In my reading of this Appendix there are two issues which are not adequately addressed.

1) There is little attempt to model the sediment transport during mine construction. This is particularly important as the report states there will be a huge volume of sediment entering the river system in years -5 to -1. The primary source of the “above natural” sediment is stated to be the washoff from the waste spoil dump adjacent to the limestone quarry. This spoil dump (of many millions of tonnes of material) will be allowed to erode into Ok Binai in a completely unconstrained manner from year -5 to about year 20. From year -1 onwards this situation is probably acceptable since the sediments will all be carried into the ISF where they will largely be deposited on the bed of the ISF semi permanently. However during years -5 to -1 these sediments will all pass through the development site into the Frieda River and thence to the Sepik R. The effect of this huge sediment

load on the Sepik River will be minimal since the Frieda River contributes only 6-8% of the Sepik River volumes. However, the report states that during these years the deposition of these sediments on the bed of the Frieda River is likely to cause this streambed to rise by 3 to 4 metres. Such a large rise will reduce the flow capacity of the Frieda River channel and force overbank flows to occur much more frequently than under natural conditions. On average, overbank flow could be expected to occur about 3 times in the four-year construction period. (Worldwide observation of overbank flows suggests they occur with a frequency between once a year and once in two years, Woodyer [1968], Williams, [1978]). With the stream bed raised several metres overbank flow can be expected many more times (perhaps 20 to 30 times, but a very uncertain number) during the four-year construction period. Adding to the environmental concern is that the average TSS (total suspended solids concentration) of the river water during construction is expected to be about 750 mg/l, or about 5 times the natural condition concentration. However, this means that during brief floods, when overbank flows occur, the TSS is likely to be much higher – as stated in the EIS, - perhaps averaging 3000 mg/l. As a result of the overbank flow moving at very low velocity among thick vegetation much of the suspended sediment carried in the overland flow will be deposited on the floodplain. Over the four years this deposition is likely to produce a considerable depth of very fine sediment which would overwhelm newly emerging plants, ground dwelling fauna and any food gardens located on the flood plain. After closure of the ISF the TSS in the river will be much lower, but also no (or very few) overbank flows will occur since the ISF will mitigate flood flows and so material deposited on the flood plain will remain in place. Note also that, as stated in Chapter 8 of the EIS the overbank flows in years -5 to -1 will have high levels of Al and Cu toxins adhering to the fine silt and clay particles which will have been deposited on the flood plain.

Similar events will be experienced by off-river water bodies along the Frieda River during years -5 to -1. In floods the Frieda River contributes water to these water bodies and during these four years the contributed water will have high sediment loads (TSS) and be heavily contaminated with Cu and Al toxins which will tend to remain in these water bodies.

2) It is stated that on-site sediment control measures will lower the magnitude of the sediment delivery to the rivers. Apart from the ISF, which is a major sediment trap, there is no suggestion of a plan to implement this aim. Where will sediment traps need to be? Who will initiate construction of these? Who will oversee them to ensure they are constructed, maintained and reconstructed or replaced as necessary? Who will ensure this program is implemented and continued through the life of the project?

REFERENCES

47 Williams,G.P. (1978) "Bankfull discharge of rivers". Water Resources Research 14:1141-1154.

48 Woodyer,K.D. (1968) "Bankfull frequency of rivers". Water Resources Research 6:114-142.

SEPIK DEVELOPMENT PROJECT APPENDIX 6A

49 In Appendix 6a there are four items which I find surprising.

1) In Table 4.1 it is strange that the 90^{th} percentile flows at all the estimation points (AP1 to AP13) are close to 1.95 times the mean flow at the same site. Certainly a modelling exercise is being reported, but the different characteristics of the catchments upstream of each estimation location and the different rainfall over each catchment would make it extremely unlikely that the mean and 90% flows would have the same proportionality at all locations. Perhaps the modelling was carried out for one or two locations only and the results were extrapolated to the other locations? However, it is claimed modelling was carried out for each location, though the reported results suggest otherwise.

2) Similar to the above paragraph the average flow for all of AP1 to AP7 are proportional to catchment area. In reality this is most unlikely. The results suggest perhaps one catchment was modelled and the results were extrapolated or inferred from this one exercise. The results may be as

good as could be obtained and be acceptable, but the clear statement of how data was achieved tends to undermine the integrity of the reporting.

3) In Table 4.2 and the supporting text the flood flows downstream of the ISF are shown to be higher post-construction of the ISF than under natural conditions. This is particularly true for the two locations in the Sepik River (AP11 and AP12). However the effect of a large storage without outlet controls, such as spillway gates, is always to reduce peak flood flows. In the text it is acknowledged that the values shown in Table 4.2 are strange (unexpected) and it is suggested they are the result of a “single realisation”. The meaning of “single realisation” is not clear – perhaps it is the outcome of a single stochastic data generation run? However, the fact that the 90% flow in the Sepik River after construction of the ISF is 20% higher than natural condition flows suggests some anomaly or error in the modelling exercise which should demand thorough checking. Perhaps the modelling exercise was flawed? Should all the modelling be reviewed?

4) Section 4 of this Appendix suggests the likelihood of the $50m^3/s$ environmental flow in the Frieda River below the ISF may not be met relatively frequently. However in the 5th dot point of the Conclusion it is stated there is only a 0.025% chance of this requirement not being met. Which statement is correct? 0.025% chance implies only once in 4000 occurrences or that the environmental flow will not be met on only one day in 11 years. Perhaps the Conclusion should read “0.025 chance” (one day in 40, or approximately 9 days per year) and not “0.025% chance”?

50 The four items above do not have large implications for the EIS but they do suggest this hydrological/sediment movement study may not have been very thorough and as a result work based on it may lack some certainty.

SEPIK DEVELOPMENT PROJECT ATTACHMENT 2 (INCLUDING 2A TO 2F)

51 In Attachment 2, which covers monitoring and lines of supervisory responsibilities, most of the monitoring plans look satisfactory except for the proposals for frequency of sampling and reporting and the keeping of monitoring records.

52 Will a monitoring and incident data base be set up? How accessible will any data base be? Presumably it will be accessible to those making observations and reporting, and the managers, such as the Safety, Health and Environment (SHE) Manager. In view of the common practice of companies to regard monitoring records being “commercial-in-confidence” would there be open (perhaps read only) access to the environmental monitoring data? If not, would it be accessible to representatives of downstream residents?

53 The frequency of some of the reporting is far too low. For example it is stated that “monitoring reports will be submitted to CEPA and others -…….- normally in the form of an annual environment report”. This “annual” report will be far too late if riverside residents have been drinking water with toxic levels of copper and aluminium for up to 12 months. If high levels of toxicity are observed they will need to be reported and acted upon immediately to prevent exposure and possible long term adverse health effects on residents. Specific action plans need to be in place for dealing with poor quality water and warning of downstream residents of the dangers and protective actions they should take during periods of risk to their health and well-being. I commented on the need for frequent water quality sampling and reporting earlier in this report.

Dr Ian Cordery
ME, PhD.

APPENDIX A

Curriculum Vitae

Expert Opinion Services

CURRICULUM VITAE	Dr Ian CORDERY

Qualifications

- B.E., Hons Class II, The University of New South Wales, 1963.
- M.E., The University of New South Wales, 1967.
- Ph.D., The University of New South Wales, 1970.

Present Position

Visiting Associate Professor
School of Civil and Environmental Engineering
The University of New South Wales

Areas of Expertise/ Special Interests

- Hydrology
- Flood estimation/review
- Water resources
- Reservoir design
- Environmental issues for floods
- Flood plain rules
- Urban flooding

Relevant Work Experience

- Professor Cordery has 40 years experience in hydrological design and investigations in a number of countries. Most experience has been in Australia, India and U.S.A. Projects undertaken have involved development and operation of flood forecasting systems, operation of data collection networks, estimation of design floods for spillways, diversion works, bridges and major housing and commercial developments and advising on magnitudes and frequency of dilution flows. In 1992 he was contracted by the World Meteorological Organisation to undertake the terminal review of a UNDP funded project to develop flood forecasting services for the whole of Bangladesh. In 1994 he worked on a UNDP funded project on analysis of hydrological data for the Indian National Institute of Hydrology. In recent years he has conducted research on forecasting of drought using global information such as SOI and ocean temperatures.

- Author of about 150 journals and other learned papers on hydrological science and hydrological design. He is author of chapters on floods and flood estimation in three currently widely used engineering handbooks.

Visiting

- Visiting Professor, Department of Civil Engineering, Indian Institute of Science, Bangalore, India, December 1976–March 1977.
- Visiting Professor, School of Hydrology, University of Roorkee, Roorkee, India, December 1980–May 1981.
- Visiting Professor, Department of Agricultural Engineering, Washington State University, U.S.A., July, 1986–January 1987.
- Visiting Fellow, University of Wollongong, July–December 1990.
- Visiting Fellow, Swiss Federal Institute of Technology, Zurich, July–October 1994.
- Visiting Scientist, National Institute of Hydrology, Roorkee, India, November–December 1994.
- Visiting Professor, University of Asmara, Eritrea, March–April 1998.
- Visiting Scientist, Institute of Hydrology, Wallingford, UK, May–July 1998.

Professional Experience

1981 – 2001 **Associate Professor**
School of Civil and Environmental Engineering
The University of New South Wales

1971 – 1980 **Lecturer, Senior Lecturer**
School of Civil and Environmental Engineering
The University of New South Wales

1969 – 1970 **Research Fellow**
Department of Civil Engineering
Imperial College
University of London

1966 – 1968 **Research Fellow**
School of Civil Engineering
The University of New South Wales

1964 – 1966 **Engineer Class II**
Commonwealth Bureau of Meteorology
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1963 - 1964 **Teaching Fellow**
School of Civil Engineering
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