Independent Expert Review for the
Sepik Development Project Environmental Impact Statement

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1. Background

This report has been prepared following a request from the Papua New Guinea (PNG) Centre for Environmental Law and Community Rights (CELCOR) for the provision of expert advice in relation to the Sepik Development Project Environmental Impact Statement (EIS). The request for advice is detailed in CELCOR's Expert Brief 30 October 2019. The brief makes the following requests:

a) Please provide a plain English summary of the key issues raised by the Project EIS, relevant to your area of expertise.
b) In your opinion, was the assessment of environmental impacts, as far as it relates to your areas of expertise, appropriate and sufficient?
c) What, if any, concerns do you have about the environmental impacts of Project, bearing in mind the mitigation measures proposed?
d) Provide any further observations or opinions which you consider to be relevant.

My areas of expertise as applied in this report primarily relate to my qualifications as a scientist with an honours degree in geology and my experience as a gold exploration geologist and environmental scientist. I also apply my post-graduate qualifications in development and anthropology and my experience with landowning communities in PNG who have been impacted by both the Ok Tedi mine in Western Province, and the PNG LNG project in Hela Province. I do not have direct experience with the landowning communities associated with the Sepik Development Project, and I therefore do not provide detailed and culturally-specific advice in relation to the Social Impact Assessment (SIA) component of the EIS. My advice in relation to the SIA is based on knowledge of what an SIA should contain and social issues that are found to be common around resource extraction projects across PNG.

The EIS is a large and complex document that runs to 7,138 pages. The EIS is supported by 23 specialist reports that relate to specific areas of the project. Although the EIS states that its main report is a "stand-alone document that can generally be understood without reference to the supporting technical studies upon which it is based" (Vol. B, p. 1-11), for the purposes of expert review this is not the case. The technical reports contain essential information that is material to the formation of expert opinion and the provision of expert advice. The EIS is dated 7 November 2018 and was made publicly available around September - October 2019. Submissions to the EIS are due by 31 March 2020, and this report has been prepared to allow time for dissemination prior to that date. The time allowed for expert review of such a large and complex document is limited and this report therefore prioritises what are, in my opinion, the most important aspects of the project as they relate to my areas of expertise. This report is based on the information that I have been able to digest given the limited time available.

I have prepared this report in accordance with Division 23.02 of Part 23 of the Australian Federal Court Rules and the Expert Evidence Practice Note including the associated Annexures ("Practice Note"). I have read the Practice Note and agree to be bound by it. In particular, in accordance with clause 2 of the Expert Witness Code of Conduct, this report has been provided on the basis that I have a paramount duty to provide advice impartially on matters relevant to my area of expertise.

2. Overview

A crucial perspective to bring to a review of the EIS is to be aware that the EIS is describing a project that does not yet exist. The EIS imagines a project as it has been proposed and bases its conclusions on environmental and social impacts that it predicts are likely to occur into the future. In the case of the Sepik Development Project, the EIS makes predictions for many decades and even centuries into the future. It can be assumed that, should the project be developed, its realisation will differ from the project described by the EIS, and many of its impacts will differ also. Many of these differences are likely to be of minor significance, but others are likely to be of major significance and this is especially the case for a project of such size, scale and duration. It is therefore important that the EIS accounts for the full range of scenarios that may reasonably be predicted to play out into the future.

The impacts that are addressed by the EIS can be broadly divided into three distinct phases: the construction phase that is predicted to last 7 years; the operational phase of the mine that is assumed to be 33 years, albeit with the possibility of extension for an unspecified period of time; and the post-closure phase that describes a period of time with no theoretical end. Many of the issues and impacts to be considered differ markedly during each of these three phases, although these risks are also connected and cumulative. The majority of the environmental risk associated with this project is in the post-closure phase, and there are a number of factors in support of this opinion that I detail below.

The risk profile of the project is dominated by a single issue, which is how to manage the mine waste and tailings that will be continuously produced throughout the life of the mine. All mines throughout the world have this issue, but the context of the Sepik Development Project is such that the consequences of inappropriate management of mine waste and tailings are extremely severe, and possibly more so than any other proposed mine in the world. Many other impacts and risks associated with the construction and operation of the project are unusually significant due to the remoteness of the location, the unstable geology of the mine area, the need for a great deal of supporting infrastructure, very high rainfall, the presence of vulnerable communities that rely on subsistence agriculture and the quality of land and river water, and a high-value ecological setting that includes many rare species, several that were new to Western science when identified during the surveys for the EIS, and almost certainly many that remain unknown to Western science.

3. Life of Mine

The EIS is based on the assumption of a 33 year life of mine during which a total of 2,640 million tonnes (Mt) of ore will be mined and processed. The EIS does state that the potential exists for mine life extension. However, the EIS and especially its accompanying technical reports are based on the currently proposed mine life and volume of ore to be mined. It is important from the outset to scrutinise what is meant by the proposed 33 year life of mine. Many of the assumptions in the EIS, such as the amount of mine waste and tailings that will be produced, the amount of mine water that will require treatment and discharge into the Frieda River, the size and extent of open cut operations, the amount of waste to the incinerator and landfill, and the effectiveness of the sub-aqueous deposition of mine waste and tailings, are all based on calculations that relate to the currently proposed mine. It is therefore worth explaining in some detail how life of mine is calculated.

The size of the mineral resource, as stated in the EIS, is reported according to the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves, also known as the Joint Ore Reserves Committee Code (JORC). This is one of a number of mineral resource classification codes used around the world for the purpose of financial reporting, especially to stock markets. Mineral resource classification codes are one of the few ways in which mining corporations are effectively regulated across the world. The mineral resources are reported in terms of measured, indicated, inferred, and potential reserves. The EIS reproduces the currently measured, indicated and inferred resources to include proven and probable ore reserves in its assumptions about the project. The methodology for calculating ore reserves is illustrated in the following diagram.

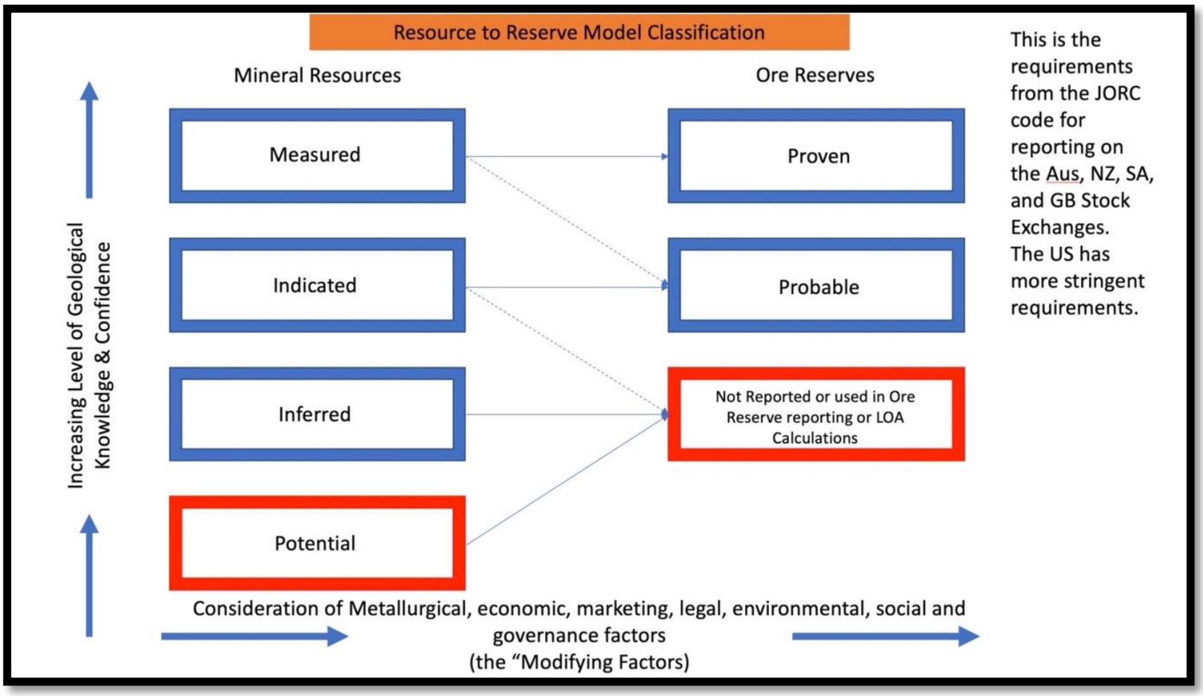

Figure 1: Resource to Reserve Model Classification (Source: BHP internal training document)

There is a difference between the mineral resource, i.e., what actually exists in the ground, and the amount of ore that is able to be mined. The size of the mineral resource is calculated based on drilling results, plus other exploration methods such as gravity surveys, magnetic surveys, geological mapping, etc. There is always a difference between the reality of what actually exists in the ground, and the geological modelling of what exists in the ground. There are varying levels of confidence in understanding what exists in the ground, based on what has been directly measured, what is strongly indicated by the data, what is inferred by the data, and what remains as potential. The difference between the modelled size of the mineral resource and the size of the ore reserve relates to the logistics around the mining operation itself. For example, a mineral resource that is located in the middle of a desert in a politically stable environment is much easier to mine than a resource that is located in a mountain range and where sensitive receptors such as important rivers are at risk. The easier it is for a resource to be mined, the greater the proportion of mineral resource can be classified as ore reserve. A complex set of modifying factors are therefore included in the calculations that convert mineral resources to ore reserves. In 2017 PanAust reported the same 2,640 Mt mineral resource for an ore reserve of 686 Mt. In 2018 PanAust revised its reported ore reserve, which nearly doubled to 1,365 Mt. This increase in ore reserve was based entirely on a single change to the modifying factors in the calculations. This change was the relocation of the Integrated Storage Facility (ISF) from the Nena River to the Frieda River. The new location of the ISF increased the size of the reservoir so that the storage capacity for mine waste and tailings increased from 0.9 billion cubic metres (Bm^3) to 3.3 Bm^3.

Life of mine is best thought of as an enabling fiction. Prior to the current design of the ISF, the problem of managing mine waste and tailings was the limiting factor on the size of the mine. The current proposal only requires 2.17 Bm^3 to be stored in the ISF, leaving room for an extra 1.13 Bm^3. There is a relationship between the amount of mine waste and tailings capacity of the ISF and the functionality of the hydroelectric plant that I describe below. The ISF means that mine waste and tailings are no longer limiting factors for the current size and life of the mine. Comparison can be made with the nearby Ok Tedi mine, which is geologically very similar to the Sepik Development Project. Mine tailings are not a limiting factor for Ok Tedi because riverine tailings disposal is allowed for that mine. Ok Tedi is the only mine in PNG that is not regulated by the Environment Act. The original life of the Ok Tedi mine was 26 years to 2010 (OTML 2019). Mine closure and therefore the amount of ore to be mined and the physical size of the mine have since increased several times over the years. The current life of mine is 41 years to 2025 and Ok Tedi is due to submit its fourth mine closure plan to the PNG state (OTML 2019). However, Ok Tedi is currently looking at the feasibility of extending its mine life to 2030 (James, 2017). The reason for these mine extensions is that further exploration is continuously undertaken during the life of a mine, and the ore body becomes better defined and understood as it is mined. Furthermore, as the mine progresses, new technologies are developed and more capital may become available to invest in expansion of the mine. There is no reason to assume that the Sepik Development Project will not follow a similar course at least until the current capacity of the ISF has been reached. This means that current site balance loadings and many of the assumptions about mine impact are likely to bear little or no relation to reality as it will play out into the future. The EIS makes it clear that further mine life extensions are possible, and the Project Selection Phase Study (Appendix 2a) states that “The tailings and waste rock disposal strategy is sufficient for LOM production without sterilising opportunities for future expansion” (p. 11).

If the mine is extended and the ISF is filled to its stated capacity of 3.3 Bm^3 then the limiting factor will become the ISF itself. If that point is reached then the PNG state may find itself in a situation where it will need to decide whether to close the mine and leave vast amounts of resource wealth in the ground or find some other method of tailings disposal in order to keep the mine operating.

Summary of Key Observations

- Much of the EIS is based on the presumption of a 33 year life of mine and the production volumes that follow. This assumption is based on an enabling fiction and the life of mine and production volumes are likely to be much greater.
- The EIS does not take the consequences of a much larger mine sufficiently into account.
- It is possible that the ISF will be filled to capacity before the ore reserves are depleted. The EIS does not take that scenario into account.

4. Acid and Metalliferous Drainage

The leaching of acid and dissolved metals from the proposed mine as well as the mine waste and tailings, a process known as Acid and Metalliferous Drainage (AMD), is by far the most significant environmental concern for the project. The EIS has sought to characterise (i.e. clearly describe) the potential for and nature of AMD that is likely to result from mining operations. AMD is a ubiquitous problem for metalliferous mines all over the world. Mines are located in areas of the earth’s crust where metals have concentrated into ore bodies. The concentration of metals has resulted from geological processes at great depths that produce metal-rich fluids at high temperature and pressure. These fluids contain not only metals, but sulphur, and other minerals such as silicon that forms into quartz. These fluids have flowed through faults and complex geological structures where they have concentrated, cooled and precipitated the minerals that are found in the ground today. The metals being mined generally occur not as metallic elements, but as chemical compounds with sulphur. In the case of the Sepik Development Project, copper occurs in the ground largely as a mineral called chalcopyrite, which is copper iron sulphide. There are many other metal-sulphide minerals present and the overall mineralogy is highly complex. These minerals mostly exist at depths where the groundwater is depleted in dissolved oxygen. This is known as a reducing environment. Closer to the surface groundwater contains more dissolved oxygen, enough to cause iron-rich minerals to oxidise (rust) to form red iron-oxide complexes, and this is known as an oxidising environment. During mining operations the sulphide minerals are dug out of their reducing environment and exposed to the atmosphere, which is an oxidising environment. This causes the sulphur to react with oxygen in the air and with water from rain or a flowing river and turn into sulphuric acid. The sulphuric acid in the water dissolves the other metals in the ore so that the water can become highly toxic to both human and ecological health.

The results reported in the EIS show the orebody of the Sepik Development Project to have very high acid producing potential, which is labelled Potentially Acid Forming (PAF) in the report. The other relevant measurement is the Acid Neutralising Capacity (ANC) of the material. Waste rock that produces acid sulphate can also contain minerals that serve to neutralise the acid that is produced, and the ability of the material to neutralise the acid is referred to as its ANC. The results of the EIS show that the waste rock and tailings have very low ANC. The risks associated with the management of mine waste and tailings from the Sepik Development Project are therefore extremely high. The only possible way to manage the risk of AMD is to store the waste and tailings under water where it will not be exposed to oxygen. It is also vitally important, as pointed out in the EIS, that the waste and tailings are moved very quickly because they will start to form AMD very rapidly once exposed to the air.

The mine waste and tailings are not the only source for AMD. The exposed walls of the open cut mine will produce AMD, which will collect and require constant removal from the mine as it is dewatered during operations. The mine water will therefore require treatment before it is discharged into Ubai Creek. The mine will continue to produce AMD long after it is closed, and this is further addressed below. The EIS provides clear indication of how the mine water can be effectively managed. All of the modelling, however, is based on the proposed 33 year mine life and assumptions around the size of the mine after closure. It is highly likely that the volumes of water requiring treatment will increase as the size of the mine comes to exceed its current predictions. The area of exposed rock producing AMD is also likely to increase and the scale of post-closure management is likely to exceed current assumptions. The proposed project does include scope for potential expansion of the mine and extension of the life of mine, and the EIS makes reference to that. However, none of its modelling is based on this possible scenario. The project, as proposed, has a minimum 33 year life of mine, and the EIS is based on this low-end scenario. This raises the question, should the EIS be based on the minimum likely impact of the project, as is currently the case, or should it model a reasonable range of impacts that are based on the stated potential for mine expansion? It seems clear that the potential for mine expansion is integral to the currently proposed project, and the EIS should undertake its modelling accordingly.

Summary of Key Observations

- The proposed mine will generate very high amounts of water contaminated with acid sulphate and metals from the mine waste, tailings, and the exposed walls of the open pit. This is well documented in the EIS.
- The acid and metalliferous drainage from the mine, mine waste, and tailings is the most significant environmental concern for the project and the most important concern for the EIS. Storage of mine waste and tailings under a permanent cover of water is the only known way to manage this risk. The consequences of mismanagement are potentially catastrophic.
- The EIS models the amounts of acid and metalliferous drainage that will need to be managed based on the assumed 33 year mine life. The actual amounts are likely to be much larger.

5. Water treatment and discharge

The EIS proposes that mine water be treated with quicklime or hydrated lime to neutralise the acid and precipitate the dissolved metals before the water is discharged into Ubai Creek. From Ubai Creek it will flow into the ISF, where it will become diluted before flowing through the hydroelectric plant or over the spillway and into the Frieda River. Table 5.15 on page 5-29 of the EIS Volume B shows the amount of lime required for treatment steadily increasing throughout the life of the mine as the area of exposed material generating AMD becomes ever larger. The table also shows that mine water will require treatment for many decades after mine closure, with an open-ended prediction of “at least 50 years.” It is extremely difficult to predict, in the real world, exactly how much AMD will be produced and how much will require to be treated and discharged. Although the EIS states that the size of the mine is likely to increase, all of its modelling is predicated on the base case scenario of a 33 year mine life.

The discharge from the ISF into the Frieda River is not expected to meet water quality guidelines.[1] Instead, the EIS proposes a mixing zone in the Frieda River where discharged water will become diluted until it meets the guidelines further downstream. The EIS (Volume B p. 8-46) states, "in PNG a mixing zone can be included in an environment permit under the Environment Act." Mixing zones are permitted under the *Environment (Water Quality Criteria) Regulation 2002*. This regulation states, "The terms and conditions of a permit may provide for a mixing zone where, after exploring all methods of waste avoidance and minimization, it is not viable or practicable to further reduce the level of waste prior to its discharge or emission." A "scientifically established" mixing zone is proposed for the environment permit that will be applied for under the Environment Act. As stated in the EIS, "scientifically established mixing zones" are allowed for under IFC Effluent Discharge Guidelines. However, the IFC guidelines do not provide guidance on how a mixing zone should be scientifically established. The EIS does not take measures to scientifically establish a mixing zone, rather a single monitoring point located 4km downstream of the ISF spillway has been chosen as the point of compliance. The proposed mixing zone is therefore 4km in length. In response to the need for guidance on the establishment of mixing zones, the European Commission has produced *Technical Guidelines for the Identification of Mixing Zones* (EC, 2010). These guidelines provide advice on site-specific considerations for the establishment of mixing zones such as the identification of sensitive receptors in the mixing zone, and the significance of any impact. The mixing zone proposed by the EIS does not appear to have been scientifically established. The purpose of scientifically establishing a mixing zone is to obtain sufficient information so that the appropriateness of the selected mixing zone can be determined. For example, if the chosen mixing zone contains endangered species that are at risk of being wiped out if exposed to polluted discharge, then the site of the mixing zone may not be appropriate. The EIS provides no information as to the suitability of the proposed mixing zone because it has not been scientifically established.

Outside the mixing zone, the Health Impact Assessment (HIA) (Appendix 13, p. A1-78) concludes "that the relevant contaminant metal values will not exceed the health-based WHO drinking water guidelines during mine-life or after closure in downstream receiving water bodies due to project discharges." Health impact assessments of this nature are necessarily very large and complex documents and time does not permit fine-grained analysis

[1] These include: PNG Ambient Water Quality Standards, PNG Standards for Drinking Water, WHO Guidelines for Drinking Water Quality, ANZECC/ARMCANZ (2000) aquatic ecosystem trigger values; and, IFC discharge criteria.

and explanation of the reporting. The HIA takes a conservative approach, which is the industry standard for these types of assessments. The HIA does take into consideration a comprehensive range of potential contaminant issues for the project, and its characterisation of potentially impacted populations, exposure pathways, and contaminant criteria appears to be appropriate. A major caveat associated with the HIA is that its conclusions depend on the operations of the Sepik Development Project proceeding exactly as planned. That is, sub-aqueous deposition of tailings and treatment of mine water must operate as predicted. Furthermore, as stated in the HIA, the greatest risk to communities is via unforeseen events such as pipeline ruptures, major floods, or earthquake damage and the project must plan for and respond to such incidents. This risk is permanent, and will continue not only during the operation of the mine, but after the mine has closed and for all generations to come. The SIA does stipulate measures to be taken in the event of failure of the ISF. These include an early warning surveillance and alert and communications system, evacuation plan and emergency services plan for downstream communities (Appendix 13, p.138). These measures must remain in place for as long as people are living downstream from the ISF. The project is located in one of the most remote and under-developed regions in the world. It is difficult to understand how downstream communities are going to be able to adequately respond to warnings, and how an evacuation plan would work. Access is difficult and, for many people, there do not exist emergency services to respond. It would be beyond the capacity of both the mine operator and the state to maintain sufficient emergency services to respond quickly across such a large area containing so many villages.

Summary of Key Observations

- The proposed mine will continue to generate acid and metalliferous drainage for many decades after closure, however, at this stage, there is no way of knowing how much and for how long.
- The EIS plans to discharge contaminated water into the Frieda River and has designated a "scientifically established" mixing zone where contaminated water will become diluted, however, the EIS takes no measures to scientifically establish a mixing zone and provides no indication as to how a mixing zone will be scientifically established.
- The Health Impact Assessment indicates that impact to human and ecological health will be acceptable, provided the project operates according to plan. However,

unforeseen accidents over decades of mining operations do have the potential to cause unacceptable impacts. Mitigation measures in place to respond to unforeseen events must also remain in place in perpetuity and not just for the life of the mine.

- It is unlikely that the state and the developer have the capacity to provide sufficient emergency response to catastrophic events.

6. Earthquake risk

The Sepik Development Project is located in one of the most earthquake-prone regions of the world and the likelihood that the ISF will be subject to major earthquake events in the future presents the largest single risk associated with the project. Earthquake risk is covered in the Selection Phase Study (SPS) provided in Appendix 2a, and this is arguably the most important document in the EIS. As stated in the SPS, "Papua New Guinea is located on the Pacific 'Rim of Fire' and is influenced by the interactive tectonic boundary between the Indo-Australian Plate to the south and the oceanic Pacific Plate to the north." The SPS refers to the dam break analysis[2] on the consequences of dam failure due to seismic activity or other reasons such as design fault. The analysis takes into account risk to the social and natural environment and well as economic impact. The Frieda River Hydroelectric Project (FRHEP) is classified as "extreme consequence", which is the highest classification criteria. However, the dam break analysis is not included in the EIS, even though other supporting reports undertaken by SRK, such as the limnology study, are included. The dam break analysis is unquestionably the most important component of the EIS and should be made publicly available.

The dam is designed to withstand the Maximum Credible Earthquake (MCE) that could be expected in the area. For engineering purposes, earthquake size is commonly measured as Peak Ground Acceleration (PGA). The most commonly recognised measure of earthquake size is its magnitude according to the Richter Scale. The Richter Scale is a measure of the amount of energy released by an earthquake, whereas PGA is a measure of the amount of ground movement that occurs during an earthquake. PGA is therefore a more relevant measure of the likely damage to built infrastructure. PGA is influenced by local geology including rock types, the presence of faults either beneath the facility or near to the facility, and the type and likely behaviour of faults. Earthquakes are notoriously difficult to predict, and each new earthquake is a source of data that provides new insights into local and

[2] SRK 2018, Frieda River Hydroelectric Project Dam Break Analysis.

regional geologies. The SPS includes detailed analysis of the local geology and regional earthquake history and calculates a MCE PGA of 1.09g. ‘g’ stands for ‘gravity’ and is the earth’s gravitational force expressed as the acceleration of an object as it falls to the earth ($9.81m/s^2$). PGA is expressed as a multiple of that constant. 1.09g therefore means 1.09 x $9.81m/s^2 = 10.7m/s^2$. 1.09g is arguably the most important number in the EIS.

According to the SPS the FRHEP is unique in the world. There is no other example of a hydroelectric facility that has the dual role of storing mine waste and tailings. My expert opinion does not include expertise in earthquake engineering or seismology, and for the purpose of my assessment here I assume that the analysis of earthquake risk and design of the FRHEP are adequate provided that the facility is properly maintained. The PGA is based on a large amount of geological data that is available because of the long history of minerals exploration in the area. It is important to understand that the ISF is stated to be is designed so that it will not catastrophically fail in the event of a maximum credible earthquake. The ISF is not designed so that it will not be damaged by a MCE, and the SPS makes this clear on p. 36 where it states, “deformations must be within serviceability limits”. That means that the dam must be able to be repaired following a major earthquake. It is unlikely that it is possible to design the ISF so that it will not need to be repaired following a MCE. Damage may include leakage that would result in atmospheric exposure of the mine waste and tailings should the ISF not be repaired in time. The ISF will therefore require inspection, maintenance, and occasional repairs, not for as long as it is in operation, but for the rest of human history. The SPS assumes a design life for the FRHEP of 200 years. At the same time the SPS states that, due to the requirement to maintain a permanent water cover over the mine waste and tailings, the dam embankment must exist “in perpetuity” (p. 12). In other words, whilst the hydroelectric power station is expected to run for 200 years, the ISF that supports it and contains the tailings will need to exist forever. Income generated from the sale of electricity that is needed to maintain the ISF is planned to cease after 200 years, even though that same income is needed to maintain the storage facility that holds the tailings. Storage of the mine waste and tailings therefore creates a situation of permanent risk of catastrophic consequences should the ISF fail. The main report of the EIS does not include the words “in perpetuity” that are stated several times in the SPS, however these words are crucial to a comprehensive understanding of the risks associated with the project. The EIS main report does not refer to this reality at all. The risk of a very large earthquake event will persist for as long as the Indo-Australian Plate is interacting with the Pacific Plate, which will be many millions of years.

Summary of Key Observations

- The single largest risk associated with the project is failure of the proposed dam. The single largest risk to the dam is the likelihood of a major earthquake. An extreme consequence dam is proposed to be constructed in one of the most earthquake-prone regions in the world.
- The dam break analysis is the most important component of the EIS, but has not been included in the EIS. This document must be made available for public review.
- The dam is not designed to escape damage in the event of a major earthquake. The dam is only designed to avoid collapse and catastrophic failure in the event of a major earthquake. It is normal for dams to be designed this way, but it is important to understand that the dam will need to be repaired in the event of a major earthquake.
- The dam will require ongoing management and maintenance in perpetuity by highly skilled and specialist engineers and other professional staff. Failure to maintain the dam will likely result in leakage and exposure of the acid sulphate producing material stored in the ISF. Failure to maintain the dam may eventually result in failure of the dam.
- The dam is unique in the world because it is both a hydroelectric facility and a tailings storage facility. There are no other examples that can be used for comparison.
- The mine waste and tailings stored in the ISF will need to remain under water for the rest of human history. The ISF is a facility of permanent risk of catastrophic consequence.
- The risk of a major earthquake causing damage to the ISF will persist for many millions of years. There will never be a time when the dam will not require maintenance and management.

7. Ongoing Management and Maintenance

The Sepik Development Project is comprised of a number of large and sophisticated facilities that will require ongoing management and maintenance. From an environmental and social impact point of view, the project is not designed for acceptable impact without constant attention to monitoring, repair, and response to unforeseen events. Major components that will require ongoing management both during mining operations and after the mine has closed include the open cut mine itself, the ISF, and the landfill.

7.1 Mine Water

Modelling has been undertaken to estimate the amount and duration of mine water runoff that will require treatment with lime before being discharged into the ISF. Treatment will create a sludge that will be combined with the tailings to be disposed into the ISF. During operations the combined amount of quicklime and hydrated lime is estimated to reach a maximum of 172 tonnes per day during year 25 of mining operations. Estimations have also been made of the amount of sulphide depletion that will occur over time after the mine is closed, and therefore the amount of treatment that will be required in the decades that follow. These estimates are at best an educated guess and it is not possible to provide even a remotely accurate idea of the amount and quality of mine water post-closure. The reasons for this are the fact that the final size and extent of open pit operations is not known, the rate of erosion of the pit walls is not known, concentrations of sulphide in the post-closure pit walls, and the nature of cracks and voids in the pit walls are also not known. The EIS does highlight these uncertainties and states that there is not enough information to determine treatment volumes (p. 8-95). Mine water can be treated for as long as there is finance in place to pay for it. The adequacy of the EIS in addressing post-closure requirements is fundamentally linked to the post-closure economics. Furthermore, the EIS does acknowledge the potential for further expansion of the life of mine, but it does not plan for it. It is unclear whether the current EIS has jurisdiction over all possible future scenarios, or if an extended mine life will trigger the requirement for another EIS. If the former is true then it is difficult to separate the current proposal from potential future scenarios. It is not possible to say whether ongoing treatment will be required for decades or centuries and it is not possible to say, with any degree of accuracy, how much treatment will be required. It is reasonable to predict that mine water will require constant treatment with large amounts of lime and quicklime over a very long period of time.

7.2 Landfills and Incinerators

Several landfills appear to be proposed to service separate components of the project. These include the mine and the hydroelectric plant, the Vanimo ocean port, the Vanimo to Hotmin road, and the Green River airport. Each of these components has a separate Waste Management Sub-plan, and each sub-plan includes a landfill. The EIS mainly refers to "the project landfill" in the singular, but occasionally "landfills" are referred to in the report. The project landfill appears to be the largest landfill, which will be located in the mine area, and that will service the mine and hydroelectric plant. More than one waste incinerator is also proposed, although it is less than clear how many. “Incinerators” are occasionally referred to in the plural, but mostly in the singular and it is likely that the largest incinerator will be associated with the project landfill. This highlights a major issue with any EIS prepared for a project of this size and scale. The Sepik Development Project is not a single project, but rather several different projects that are located far apart from each other and are conceptually linked together. This has resulted in a vast and unwieldy EIS report. It would be more appropriate for each project to be considered as a different Level 3 activity and for each to have a separate EIS, as the nature of each project and the issues associated with each project differ markedly.

A major issue with landfills is rainwater that percolates through the landfill, dissolving toxic materials contained in the landfill, and leaching out the bottom of the landfill into the groundwater and surface water. The contaminated water that emerges from a landfill is called leachate. Proposals for industrial waste landfills normally require ongoing monitoring of leachate. Landfills may also require maintenance and repair as they age and degrade. According to the EIS the project landfill will be used to dispose of a combination of “domestic and industrial waste, medical and laboratory waste, and hydrocarbon impacted soil”. All the landfills are proposed to be designed according to the PNG *Environmental Code of Practice for Sanitary Landfill Sites*. The EIS states that the landfill (presumably the project landfill) will be designed with a leachate management system and that leachate production will be minimised. There is no description of the proposed leachate management system in the EIS. A landfill leachate management system normally includes a leachate sump where any leachate can be collected and pumped out for treatment and disposal. The Waste Management Sub-Plans do include the requirement for monitoring of groundwater during operations, but no ongoing groundwater monitoring is proposed as part of the conceptual mine closure plan. The potential impact of a landfill does depend on the sensitivity of nearby receptors, such as waterways, and human populations. The EIS assesses the risk to surface water and groundwater from the landfill to be low because the landfill will be designed and constructed in such a way that leachate is kept to a minimum (vol. B p. 8-33). The EIS states that any impact of leachate seepage would be highly localised given the “abundance of surface water contribution”. In other words, any leachate would be diluted by high rainfall. Yet the very high rainfall also means that the landfill will be subject to the forces of erosion and degradation following closure of the mine. The location, size and specific design of the landfill has not been determined as its design will be part of Frieda

River Ltd's Waste Management Plan. It is important to understand that landfills are engineered facilities that do degrade and require monitoring and maintenance over time. The Conceptual Mine Closure Plan states that the landfill will be capped, but no ongoing monitoring is proposed. This is problematic. Industrial waste landfills are environmental liabilities and the plan to simply cap and abandon the landfill does not represent best practice environmental management of closed landfill sites.

Waste incinerators are notorious for their potential to produce toxic emissions, particularly dioxins, which are extremely hazardous to human health. This issue is identified in the Air Quality Assessment in Appendix 11, p. 47 of the EIS. This assessment goes on to state, "Given the significant distance to any sensitive receptors, a stack emission sampling programme is also not proposed for the waste incinerator(s). However, it is recommended that the incinerator stacks be fitted with suitable stack testing ports to allow safe and suitable access for flow and concentration measurements should it ever be required in the future" (p. 102). The assessment does not appear to know whether there will be one, or more than one, incinerator producing emissions, yet it does know that the incinerator(s) will be located away from sensitive receptors, however many incinerators there may be. The project as a whole does not appear to have sufficient understanding of its own waste management requirements at this stage. This is possibly a consequence of the attempt to bind together what are several different projects into a singular whole, as described above.

7.3 The Dam

As stated in the SPS, "The FRHEP is a large, complex project that requires the expertise of a Tier 1 dam building contractor. Some construction risks have been ranked High to Extremely High and careful planning and control will be required to ensure compliance with the FRHEP objectives" (p. ix). The current proposal will deliver to the state of PNG a large and complex facility that poses extreme risk to the Frieda and Sepik river systems and downstream populations. This risk will, by design, continue forever and can only be mitigated by periodic intervention to ensure that the facility remains viable. The facility will need to be managed and maintained and this will require personnel with sufficient expertise and experience. According to the SPS,

> "The FRHEP will require a site-specific and ongoing stewardship program committed during construction and operation that must be continued in perpetuity… The combination of hydroelectric power supply and storage of

> tailings and waste in the impounded reservoir makes the FRHEP a unique project. Therefore, the construction, operation and closure of the facility will require a level of stewardship exceeding that which is implemented elsewhere. The stewardship program must address the responsibility of normal hydroelectric dam safety standards while also providing a management / oversight structure for tailings and waste from the mine operations and downstream water quality and should be developed as part of further studies." (p. 512)

After mining operations have ceased the facility will therefore exist as a constant economic burden, and the same is true for the post-closure mine and landfill. For example, the current price of lime is approximately USD$80 per tonne. Post-closure treatment is expected to begin in year 37, where it will require 128 tonnes of hydrated lime and quicklime per day, which equates to USD$10,240 per day, and over USD$3.7 million in today's prices. In year 55, 22 years after the mine is modelled to have closed, treatment of mine water is expected to require 89 tonnes of hydrated lime and quicklime per day. This equates to USD$7,120 per day in today's prices, or almost USD$2.6 million for year 55 in materials alone in the management of just one component of the mine's legacy. Other costs associated with the FRHEP will include labour, specialist engineering and environmental professional services, replacement parts and transport costs. It is proposed that income will be generated from sale of the hydroelectric power, and a portion of this income will need to be set aside for maintaining the facility. As stated below, concerns exist about the reliability of hydroelectric power generation during periods of drought. A power line is proposed to be constructed via Vanimo to the Indonesian border. It is proposed that a "third party power provider" will "connect and sell electricity to communities along the infrastructure corridor" (p. 5-66). The EIS acknowledges that these communities will only provide a small market, and the sale of power across the border to Indonesia is suggested as part of a potential "Stage 2" of the Sepik Power Grid Project. On the basis of information provided in the EIS, the economic viability of the FRHEP appears to be highly speculative.

The EIS refers to an economic analysis undertaken by Acil Allen. The report by Acil Allen appears to be confidential and it is therefore not clear if any analysis has been done on the post-closure economic burden of the mine and the ISF. Furthermore, if the hydroelectric facility is relied upon to provide the income for maintenance and management, then operation of the facility may never be allowed to cease. If ongoing maintenance and management of the ISF is allowed to cease then the ISF may eventually fail and the consequences will be catastrophic. It is vitally important that the economic modelling undertaken for this project is made publicly available.

Summary of Key Observations

- The project will create a legacy of facilities that will require ongoing management and maintenance. These include the open cut mine, the dam and the landfill.
- The open cut mine will continue to produce water contaminated with acid sulphate and metals. This will require treatment for many decades to come. The EIS is not able to predict how much treatment and for how long it will be required, but the current estimates almost certainly drastically underestimate what will be the reality. These estimates are not reliable because:
    - The final size and extent of open pit operations is not known
    - The rate of erosion of the pit walls is not known
    - Concentrations of sulphide in the post-closure pit walls, and the nature of cracks and voids in the pit walls are not known.
- Therefore, it is not possible to say whether ongoing treatment will be required for decades or centuries. And it is not possible to say, with any degree of accuracy, how much treatment will be required.
- Several landfills are proposed, however the EIS mostly refers to what is presumably the largest landfill, which will be located near to the mine. Several incinerators are also proposed, although it is not clear how many. Incinerators can potentially emit highly toxic fumes and emissions should be monitored, however the EIS proposes not to monitor emissions because the stacks will be located in remote areas. However, the EIS is not clear on how many incinerators there will be, or where they will be located.
- The landfill is likely to produce contaminated leachate that will impact groundwater and nearby surface waters. The EIS claims that the landfill will be designed with a leachate management system, but does not describe this system.
- Landfills should include a leachate sump and groundwater monitoring wells that are monitored post-closure of the mine and its associated landfill. The

EIS assumes risk from the landfill to be low, however there appears to be little basis for this assumption. The landfill will also require ongoing management to prevent degradation.

- The dam will require a strict regime of ongoing management that utilises expert professional services. The hydroelectric project is not expected to operate forever, but the dam must operate forever to protect the Sepik river system.
- Ongoing management and maintenance will incur significant and ongoing cost to the PNG state. These costs should be included in any economic modelling of the project. The economic modelling undertaken by Acil Allen needs to be made publicly available.

8. The Frieda River Hydroelectric project

As stated in the SPS, the design objective for the FRHEP and the ISF is for a facility that is "required to store a total of 2.17 Bm^3 (1.5 Bt tailings, 1.6 Bt waste rock and 44 Mt fugitive sediment) over a 33-year LOM" (p. ii). In order for the hydroelectric project to work, the dam needs to provide a sufficient static head of pressure to force water through the turbines. If the water level of the dam drops too low then there will not be enough water in the dam to produce electricity. Water levels in the dam during periods of drought are predicted to fall to levels that will force the hydroelectric power station to shut down. Shut down during El Niño induced drought events are predicted to last many months. The SPS asserts that the 1997 El Niño drought was a once in a century event, and that it is possible that droughts of such magnitude will become once in twenty-year events, presumably due to the effects of climate change (p. 269). The engineers who wrote the SPS might be referring to a report by the Intergovernmental Panel on Climate Change, which predicts an increase in both the frequency and intensity of floods and droughts of varying magnitude across Asia (Hijioka, et. al., 2014). The FRHEP is therefore not expected to provide a reliable source of power in all conditions and alternative sources of power will need to be relied upon during periods of intense drought. The FRHEP is also expected to be shut down during periods of intense flooding (p. 12). This is because flooding may cause high levels of sediment that will cause damage to the turbines.

The economic viability of the FRHEP is significantly impacted by a combination of geological and meteorological factors, each of which is fundamentally unpredictable. A salient example is the 2015 shut down of the nearby Ok Tedi mine due to drought and low water levels in the Fly River that prevented the passage of ships to transport the products of the mine. Ok Tedi was also shut down for a period of six months in 1997-1998 for the same reason. Ok Tedi was also temporarily shut down after the earthquake of 26 February, 2018. The FRHEP will be subject to the same unpredictable events of earthquake, drought, and flood, each of which has the potential to shut down operations for unspecified, and often very lengthy, periods of time. The EIS does not adequately assess the risk to the economic viability of the FRHEP, which is directly related to the capacity for the environmental risks to be mitigated following closure of the mine.

Summary of Key Observations

- The hydroelectric project needs a sufficient amount of stored water in the dam to operate. The project is not expected to operate in the event of severe drought. Severe droughts are predicted to become more common and more severe due to climate change. The FRHEP will not always be able to provide a reliable source of power to its customers.
- The FRHEP will be subject to forced closure due to floods that increase sediment in the dam, and also earthquakes. The risk that economic loss due to shut down will impact the ability of the project to service its environmental obligations is not adequately addressed in the EIS.

9. Limnology

In theory, the practice of storing mine waste and tailings beneath a permanent cover of water should provide sufficient protection against the production of AMD. The risks associated with this disposal method are in the handling and transport of PAF material from the mine to the bottom of the ISF. This material must be transported quickly, and the logistics of mining operations, unforeseeable events such as accidents, earthquakes, and equipment breakdown must be managed so that material that must be stored in the ISF is not left to oxidise. The other risks are associated with the process of depositing the material into the ISF, and the behaviour of fine particles in the ISF.

Limnology is the study of lakes, and the Limnology Study in Appendix 2b is the study of how the mine waste and tailings are likely to behave in the reservoir that is the ISF. This behaviour may be influenced by storm events that create waves, by underwater collapse of the deposited material that creates waves and currents, by seismic activity, and by the physical behaviour of fine particles as the material is being dumped. The Limnology Study in Appendix 2b is clear about the uncertainties and risks associated with the proposed disposal strategy, and these are worth highlighting. Firstly, as this project is unique in the world, the modelling cannot be validated against any similar project in another part of the world. The Limnology Study provides a succinct summary of the uncertainties and risks on page v and it is worthwhile drawing the reader's attention to these.

The study states that "there is uncertainty associated with all elements of the scoping phase study" because "the model cannot be calibrated and validated." The study calls for "further, more detailed studies" before the risks can be adequately understood. One uncertainty that is given specific mention is "the critical shear stress at which waste rock and tailings mobilise and the rate of erosion that results." The study warns of "key uncertainties associated with the mobility of the waste rock and tailings particles". And that scenarios such as "failure of tailings pipes" should be modelled. Although the FRHEP is modelled to last for 200 years, the Limnology Study states, "Long-term changes (e.g. up to 100 years) in the limnological behaviour that occur in response to changes in flow and meteorology have not been considered in this report, but should be given consideration in future investigations." The study warns of risks associated with storage of waste "in the upper reaches of the Nena arm", which reduces the theoretical maximum capacity of the ISF as mentioned above. The study also warns that "the operational rules of the FRHEP" are an important component of the overall risk to the reservoir.

Based on the information provided in the EIS, the proposal to dispose of mine waste and tailings in the ISF is an untested experiment. In my opinion, the risks cannot be adequately characterised because there is no precedent for comparison, and the limnology study appears to be of the same opinion. At this stage there does not appear to be enough information to support disposal of mine waste and tailings to the ISF. The uncertainties in the limnological study make clear that success depends on a very large number of factors working together and that all of these factors must operate according to predictions. Consideration has not been given to the long term operation of the ISF even though the entire project is dependent on the ISF operating in perpetuity. It will not be possible to reverse the decision to dispose of mine waste and tailings and the ISF will exist as a risk of extreme consequence before its real ability to function is properly understood.

Summary of Key Observations

- There are many risks and unknowns associated with the deposition and storage of mine waste and tailings in the ISF. Gaps in the modelling are highlighted in the limnology study.
- Much of the most important critique of the risks and uncertainties associated with disposal of mine waste and tailings in the ISF are stated directly in the limnology study. These include:
    - The model cannot be calibrated and validated.
    - Further, more detailed studies are required before risks can be adequately understood.
    - Unforeseen events such as the failure of tailings pipes should be modelled.
    - Long term changes have not been modelled and these should be considered in future. This is especially important since the ISF is expected to operate "in perpetuity."
    - The extremities of the ISF should not be filled, such as the upper reaches of the Nena arm. These extremities are included in the maximum theoretical storage capacity.
    - The operational rules of the hydroelectric project will be an important component of the management of the ISF.
- The ISF is an untested experiment that will require more investigation to understand whether or not it will work as required. This is especially important since there can be no turning back once the ISF is in operation, and the consequences of failure will be catastrophic.

10. Social Impact Assessment

The copper deposits of what is geologically termed the Frieda River Intrusive Complex were first discovered by the Australian Bureau of Mineral Resources in 1966 while conducting a geological mapping exercise (Bainbridge, et. al., 1998). Since that time there has been constant interest in the resource from several different mining companies, and constant awareness of the mining companies' activities by landowning populations. The resource is located in one of the most remote and impoverished parts of PNG, and landowners have been desirous of a mining project that will contribute to their economic development for several decades. Landowner desires for a mining project to bring development since the 1960s is documented in the 1996 SIA prepared for Highlands Gold Pty Ltd (Gardener, 1996). Gardener describes the desire for a mining project as “something everyone favours, at least in the abstract” (p. 2). What is desired is development itself, and a mining project is viewed as a way of achieving this goal. The desire for a mining project and development windfall has been the common experience of mining projects across PNG, as mining is commonly the only development option that is on offer. Gardener also points out that since the Ok Tedi project, many landowning communities, and especially those who live downstream along the Sepik River, are fearful that their river system will face the same fate as the Ok Tedi and Fly Rivers (p. 14). There is therefore a great deal of ambivalence towards the project, especially since many of the experiences of other resource extraction projects across PNG have been characterised by disappointment, unmet expectations, social disruption, and sometimes violence. During my own fieldwork conducted along the Fly River in 2014 I documented similar feelings towards the Ok Tedi mine. Mining royalties and development were desired while environmental degradation of the river system was regretted, and these tensions were kept in delicate balance by the Community Mine Continuation Agreements signed between the mine and downstream communities. Gardener documents an immensely more complex social environment around the Sepik Development project than exists for the Ok Tedi mine, and this complexity is not reflected in the SIA provided in the EIS.

The Social Impact Assessment (SIA) contained in the EIS is very sparse in terms of culturally specific information on the wide diversity of landowning groups in the project area. The social complexity of the mine area is highlighted in Gardener (1996), “The cultural characteristics of the area are extremely rich” (p. 15) and the report has as its first recommendation, “The developer should acknowledge the cultural diversity of the impact area and commit itself to taking cultural specificity into account in its planning and responses to community concerns” (p. 3). The Sepik Development Project is much larger than anything previously proposed and includes a far greater and more diverse population than was covered in the 1996 SIA. Yet the SIA provided in the EIS, which covers the same cultural groups as the 1996 SIA, plus many more, contains less detail than the 1996 SIA. If the history of mining in PNG have taught the mining industry just one lesson, it is that social and cultural issues around mining projects are not to be taken lightly. The SIA appears to be inadequate for a project of such size and complexity. Rather than build on previous studies, the SIA diminishes the amount of information that is available to it.

The SIA selectively quotes a report prepared by Filer (2007) to Xstrata providing advice on how best to manage potential community issues associated with the then Frieda River Project: “Filer (2007) noted that the TCS [Tax Credit Scheme] had an added advantage for resource developers, enabling them to finance development projects for stakeholders who were in greatest need (irrespective of the project’s impacts) and/or who posed a threat to the developer’s harmonious operation” (p. 140). However, Filer goes on to warn that the TCS also has the tendency to produce white elephants because of the PNG government’s “persistent refusal to grant tax credits for the staffing or maintenance of the facilities built under the scheme.” I have witnessed and written about this problem associated with the Papua New Guinea Liquefied Natural Gas (PNG LNG) project, and it is a problem that has beset many projects across PNG. Filer’s report to Xstrata contains many warnings and lessons from other mining projects, and the SIA would benefit from paying attention to these. For example, the SIA advocates for giving priority to the employment of local workers, which is an adoption of PNG’s ‘preferred area’ policy. Filer warns that “serious problems” could arise from the implementation of this policy because the original Ok Tedi agreement assumed that the Ok Tedi and Frieda deposits would be developed together and Telefomin were therefore included in the preferred area for Frieda as well as Ok Tedi. The implications for this are that the Telefomin community is likely to react angrily to being left out of the preferred area policy as implemented for the project. This issue is not addressed in the SIA.

It should also be noted that there does appear to be an uneven distribution of risks and benefits from this project. The majority of the benefits will go towards the mine area and new road corridor to Green River. The majority of the risk is borne by those downstream along the Sepik River. This was the same scenario for Ok Tedi where communities downstream along the Fly River were initially not considered as beneficiaries because they were located far from the mine.

A more detailed review of the SIA is to be completed by another reviewer, and I will not venture too deeply into the SIA other than to observe that there does exist a vast amount of important information that has not been considered by the SIA for the Sepik Development Project. The project is located in an immensely complex cultural setting of which I have no personal experience, however I do have experience of immensely complex cultural settings around resource development projects in other parts of PNG. Deficiencies in the SIA include sparse information on leadership roles and practices, the nature and causes of conflict between groups, and especially the issue of sorcery that is only likely to increase as a result of the project. The SIA states, “It is important to note that social values can change and sometimes do so rapidly, as key stakeholders in the Project have themselves initiated quite radical change (and continue at present to experience the consequences of such change) in relatively recent times. Consequently, caution is warranted in assigning significance to expressions of those values centred on culture and traditional leadership which may well evolve in different ways during the life of the Project" (p. ii). That culture and traditional leadership are subject to change, and sometimes quite rapid change as a result of large development projects, is certainly true. However, in order to understand the nature of change, it is vital to understand what it is that is undergoing change. The SIA is notably uncurious about the existing social environments that will be impacted by the project. For example, Gardener writes of the importance of totemic links between Iwam and other groups across a wide area for maintaining links and good relations between villages that may be many days walk apart. Increased movement of people means that these links are likely to become more important, and this is especially vital in the event that the project results in an increase in sorcery accusations, as has occurred around other mines in PNG, most notably Porgera. Change does not mean that things disappear. The SIA makes no mention of sorcery, except as a passing reference in the attached Cultural Heritage Baseline and Impact Assessment report, which does little more than state that sorcery is still practiced, and then briefly describes the practice as if it is a cultural artefact to be documented. It is very often the case that change means that certain cultural aspects are enhanced. Gardener (1996) makes this phenomenon explicit when he writes, "Since the advent of mineral exploration these inter-cultural relations have been made more complex; indeed, mineral exploration over the last twenty-five years has to a large extent constituted the cultural groups of the area as a significant social entity" (p. 21).

11. Conclusion

This review is focused on the long-term risks and consequences associated with the Sepik Development Project. The majority of the risk is mortgaged to the future generations that will live downstream from the mine, and to the future state of PNG that will have to manage the legacy that will be left by this project. The project will, by design, create a situation of potentially catastrophic risk that will require constant human intervention to mitigate that risk. No other project in the history of PNG has created such a facility. It is difficult to conclude that the benefits of this project outweigh the risks. Even if the engineering design and construction of this project is flawless, the facilities still depend on human intervention over time to prevent catastrophic failure. Time is the crucial element for understanding the risk profile of this project. The likelihood of accident, or damage caused by natural phenomena such as earthquakes and floods, only increases over time. The history of resource extraction projects in PNG have shown that these projects are fraught with difficulty; social and economic development benefits have been disappointing, environmental impacts are often severe, development promises are often broken, projects are sometimes beset by violence, and development outcomes such as schools and health care facilities are unable to be maintained after mine closure.

Contrast can be made in the approach of the engineers who designed the ISF and FRHEP and those economists who forecast the social, economic and development impacts of the project. Out of necessity the engineers have looked to the past, to the climate and earthquake history of the area, and assumed that the future will resemble the past in order to learn the lessons they need to apply in the design of the project. The socio-economic proponents of the project have largely ignored the lessons of the past, and have instead looked to the future and assumed that this time things will be different to the past. The engineers have assumed that a maximum credible earthquake event will happen again. The socio-economic consultants have assumed that the Sepik Development Project will be the first mine in the history of PNG to fulfill its development promises and successfully mitigate its social and environmental risks. In my opinion, this project is by far the riskiest proposal in the history of resource extraction in PNG. It is a project of immense risk both socially and environmentally, and it is difficult to see how the project complies with the development aspirations of PNG. In addressing this last point I refer to the Department of Environment and Conservation Information Guideline: *Guideline For Conduct of Environmental Impact Assessment & Preparation of Environmental Impact Statement*, DEC Publication: GL-Env/02/2004. I have reviewed the requirements contained in the information guideline against the EIS and accordingly include the following table:

Guideline requirement	**Adequacy of EIS**
Developers undertaking Level 3 activities must meet the legal obligations in Section 51 and 53 of the *Environment Act 2000*, including where "The Act gives effect to the National Goals and Directive Principles in the National Constitution, in particular the fourth goal on Natural Resources and Environment."	The proposed project does not meet the requirements of the fourth goal of the constitution in that the proposed project does not constitute "wise use of our natural resources and the environment… in the interests of our development and in trust for future generations" The EIS does not "take all necessary steps" in the protection of PNG's "valued birds, animals, fish, insects, plants and trees." In my opinion this project is unwise due to its extremely social and

	environmental high risk and doubtful long term benefits because of the ongoing nature of those risks. The EIS does not take all necessary steps to protect the natural environment for future generations.
The developer must submit an Environmental Impact Statement that provides a full documentation of all environmental and social issues and committing to the employment of relevant mitigation measures in relation to the development activity.	The EIS does not fully document all environmental and social issues, as highlighted in this report.
The EIS must include, among other things, information on the extent of landowner and/or resource owner support, including a copy of the formal written approval of their consent, details of the life-span and development phases of the project.	The EIS does not include evidence of formal consent from landowners. This would be a very complex undertaking given the location and extent of the project, but the extent of landowner consent versus landowner concerns is currently unknown and the EIS makes no attempt to rectify that. The EIS does not provide adequate details of the life-span of the project given the residual impacts of the project as proposed. When considering the ISF and the hydroelectric facility, this is a project with no theoretical end.

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