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"Technical Support for Grassroots Public Interest Groups"

Review of the Technical Aspects of the Sepon Project Environmental and Social Impact Analysis (ESIA) and Environmental Management Plan (EMP)

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EXECUTIVE SUMMARY

While the amount of information available presented in the ESIA and supporting documents, and the quality of the work for this environmental analysis from a technical perspective is generally very good, it is also quite apparent that a number of the important technical documents were still in a preliminary form, and do not provide enough detail form which to properly assess the potential impacts of the project.

These documents include the reclamation plan (e.g. the final design of the covers for potentially acid-generating waste; and, the total cost of the reclamation, which is needed to establish a reclamation bond for the project), the plan for the diversion of the Nam Khiang River, a detailed Monitoring Plan, a detailed Spill Response Plan, etc.

Also, the number of samples that should have been collected for use in determining the acid-generating potential of the waste rock is inadequate.

There is also concern about some of the decisions that have been made regarding mitigating the potential impacts of the discharge of mine effluent into the Nam Kok River system.

The concerns are further complicated by the fact that at the Sepon Project:

(1) This is a low to medium grade gold deposit. There is not a lot of financial room to maneuver should problems arise.

(2) This is the first major metal mine in Laos, so there is likely little regulatory experience with this type of mining, and hence little experience with operational problems that are likely to arise;

(3) The mine is to be operated by a junior mining company. Junior companies do not have the depth of technical expertise that is available to major companies to address technical problems that will inevitably arise during operation. In areas where mining has a long history of operation, experience from previous operations can be used to anticipate and avoid problems. But in virgin areas these problems can cause significant financial hardship for the company, or environmental or social hardships for the local communities if the problems are not addressed

(4) Junior mining companies generally do not have the financial resources to deal with significant environmental problems, should they arise. The need for long-term water treatment, either for the discharge from the tailings pond, or from groundwater contamination from waste rock, is a problem that could arise at Sepon that a junior company could not financially manage. In this case it would be the government that would be the final guarantor of environmental remediation or mitigation; or, as often happens in both the developed as well as the undeveloped world, an 'environmental sacrifice' area is created, and local people bear the environmental and social costs of the impacts.

Based on the review of the ESIA, the following Recommendations for the Project are proposed:

1. Water quality ‘guidelines’ should be formalized in a permit, or permits, that regulate surface water, groundwater, and air discharges. Use of Laotian, Australian, Canadian, and/or USEPA guidelines would be more protective of the water and air resources than World Bank Guidelines.
2. Using a measurement of Total Recoverable metals for water quality measurements, rather than Filterable, would be more protective of the environment and human health.
3. If dilution with the Nam Kok River is to be utilized, a pipeline from the Environmental Dam to the river should be used for the discharge, rather than discharging into the tributary. The discharge flow limit should be based on the 5th percentile flow of the Nam Kok River. If real time flow monitoring is utilized, then the volume of the discharge can be directly regulated to the river flow in order to insure the required dilution.
4. Water quality monitoring should demonstrate that discharges from all sources, especially pit water and waste rock dump seepage, meet water quality guidelines before the discharges are routed to sediment ponds.
5. If a mixing zone in the Nam Kok River is necessary, the size of the mixing zone should be no large than absolutely necessary. The size should be determined through rigorous technical analysis. There should be no acute levels of cyanide (i.e. 0.022 mg/l or above) in the river.
6. Monitoring for the levels of cyanate and thiocyanate in the discharge from the Environmental Dam should be performed, as proposed in the ESIA.
7. Maximum residence time for effluent in the Environmental Dam should be required to allow natural degradation of ammonia. Residence time can be increased by installing baffles or channels in the Dam that increase the amount of flow time between discharge from the mill and overflow into the river. The permit should prohibit discharges above the adopted guideline.
8. Careful measurement of background should be undertaken to establish whether seasonal variations exist in the natural level of silver in the river. The permit guideline should be based on the lowest natural level of silver in the river.
9. Given the great inherent risk if something were to go wrong with the bioaccumulation of mercury, the level of mercury in the discharge should meet strict guidelines. Eliminating the mercury from the discharge, and hence the river, is the only way to insure that mercury cannot bioaccumulate.
10. A permit guideline for cyanide of 5.2 ug/l should be adopted, with as small (or no) mixing zone as possible.
11. Point source discharges should meet Total Suspended Solids (TSS) discharge guidelines. Maximum effort should be made to minimize non-point sources (secondary construction effects, soil erosion, etc.) A monitoring scheme could be developed where turbidity is continuously monitored as a surrogate for TSS. Continuous turbidity monitoring can be accomplished with a simple, inexpensive, instrument.
12. A continuous discharge, rather than a once-a-week discharge, from the Environmental Dam would help mitigate potential impacts from TSS, and for instantaneous exceedances for Sb, and Hg.
13. Diversion of the Nam Khiang River could have major social and environmental implications. Technical plans for the diversion of the Nam Khiang River, and the potential impacts environmental and social impacts, should be disclosed and thoroughly discussed before a decision to divert the river is made.

14. Paving the road in the vicinity of any habitations should be required, either by the project or/and the government. In combination with watering, this should keep the dust level within standards.

15. Frequent sampling should be preformed on waste rock to determine its acid-generating potential, so that it can be segregated from non acid-generating material. Disposal of acid-generating waste in the tailings pond, as well as in the permanently saturated portions of abandoned pits, should be investigated.

16. It is recommended weekly monitoring for toxic contaminants in the effluent discharges be required for the Sepon Project discharges. In addition to the constituents recommended for sampling in the ESIA, monitoring should also be done for nitrate/nitrite (breakdown products of cyanide decomposition, and also a typical constituents of blasting agents), and for sulfate.

17. During operations it is recommended that analysis for trace metals be done twice per year for groundwater. Flows and constituents can vary according to the influx of water. One sampling event should take place at the end of the dry season, and one at the then of the wet season.

18. Trace metals should also be a part of the analysis for runoff from the waste rock dumps – including selenium, arsenic, antimony, thallium, and zinc, metals that can often be present in significant quantities in neutral pH environments.

19. As a part of a Monitoring Plan, post-closure monitoring parameters, locations, etc., must be specified. A post-closure trust fund should be established to pay for this post-closure monitoring, and for post-closure maintenance.

20. A Rehabilitation/Reclamation Plan, with a level of commitment to closure techniques and enough detail to allow closure costs and a bond amount to be estimated, should be prepared and reviewed before the project is undertaken.

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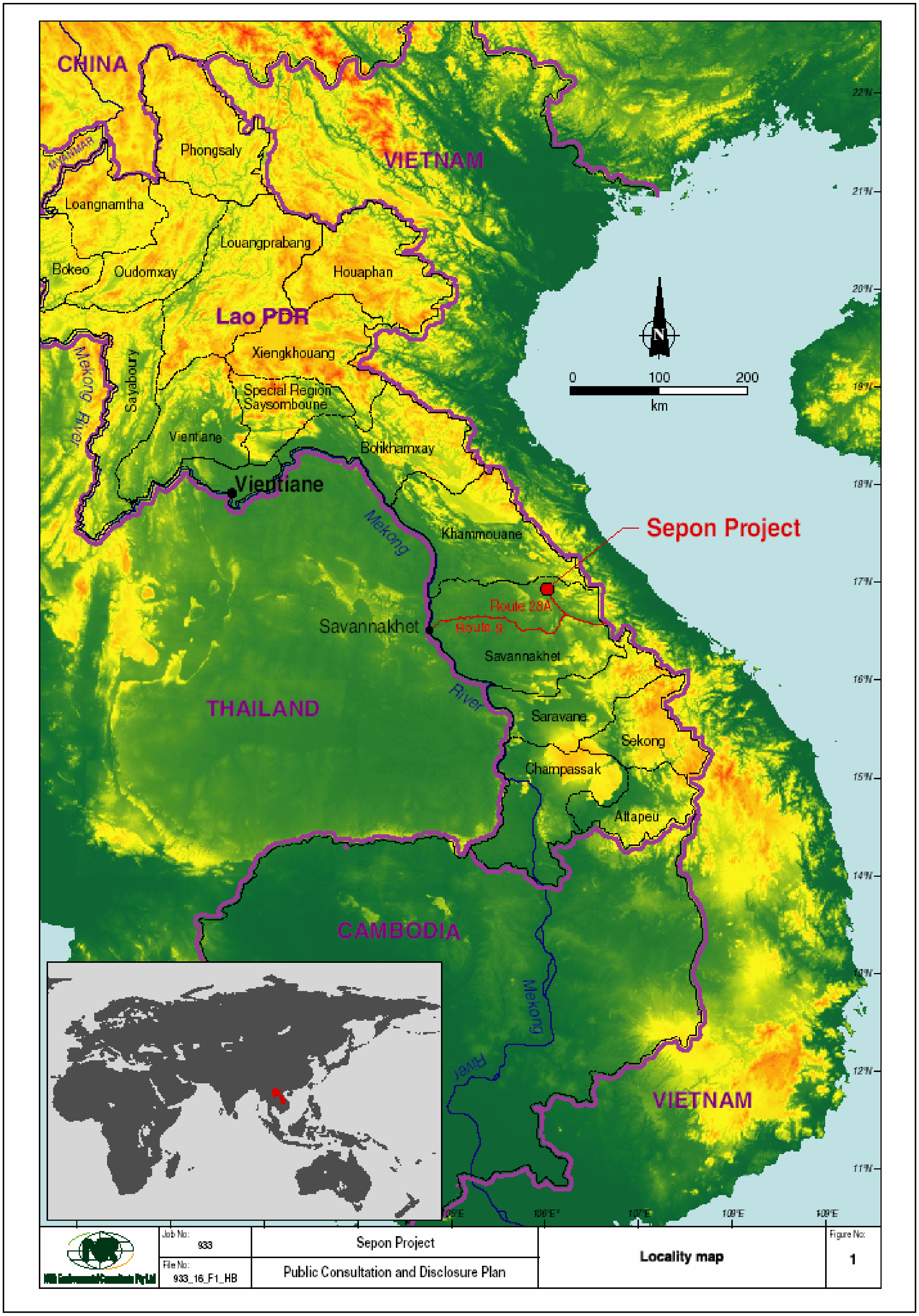
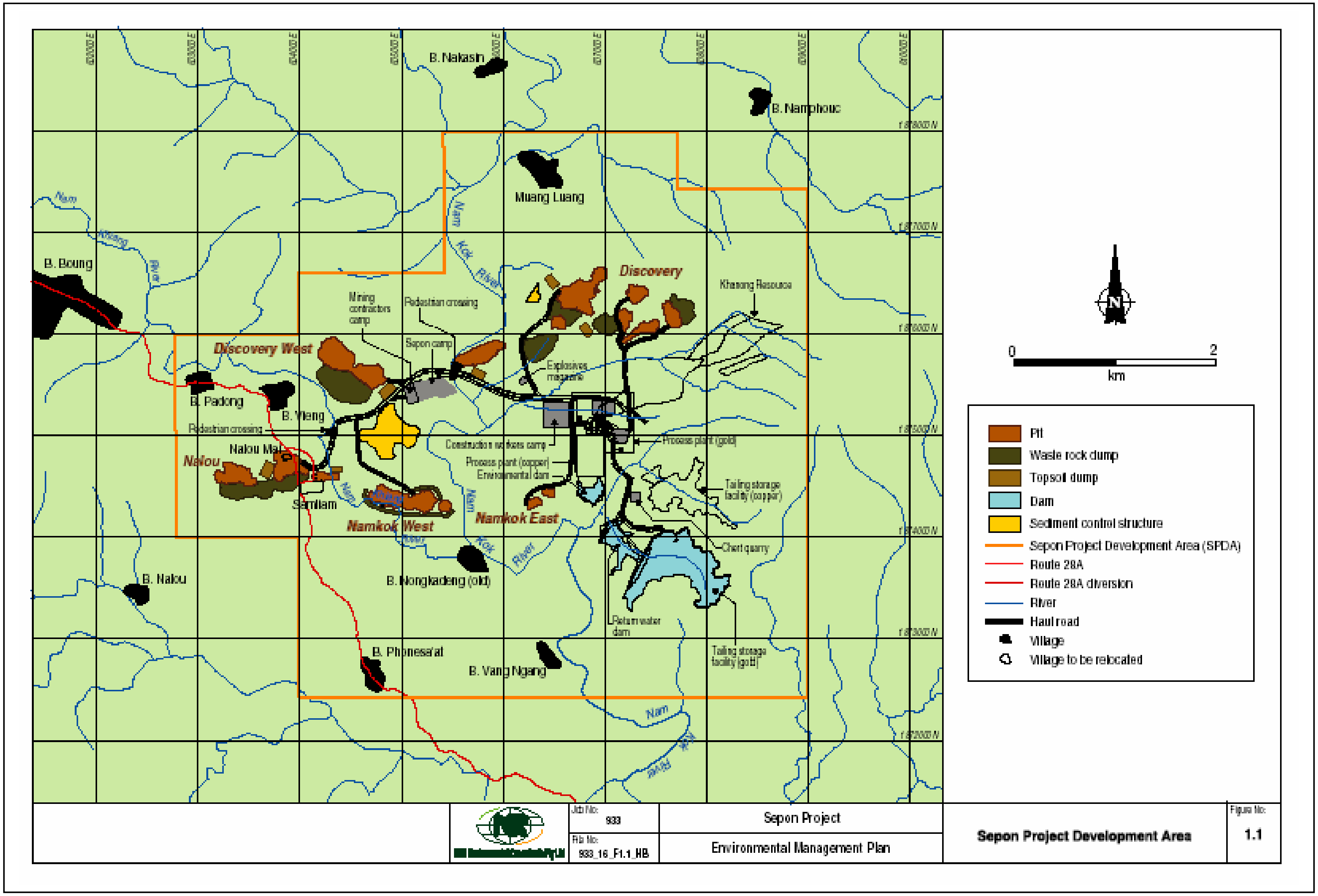


Sepon Project Location



Mine facilities locations – Figure 1.1 from Sepon Project Environmental Management Plan

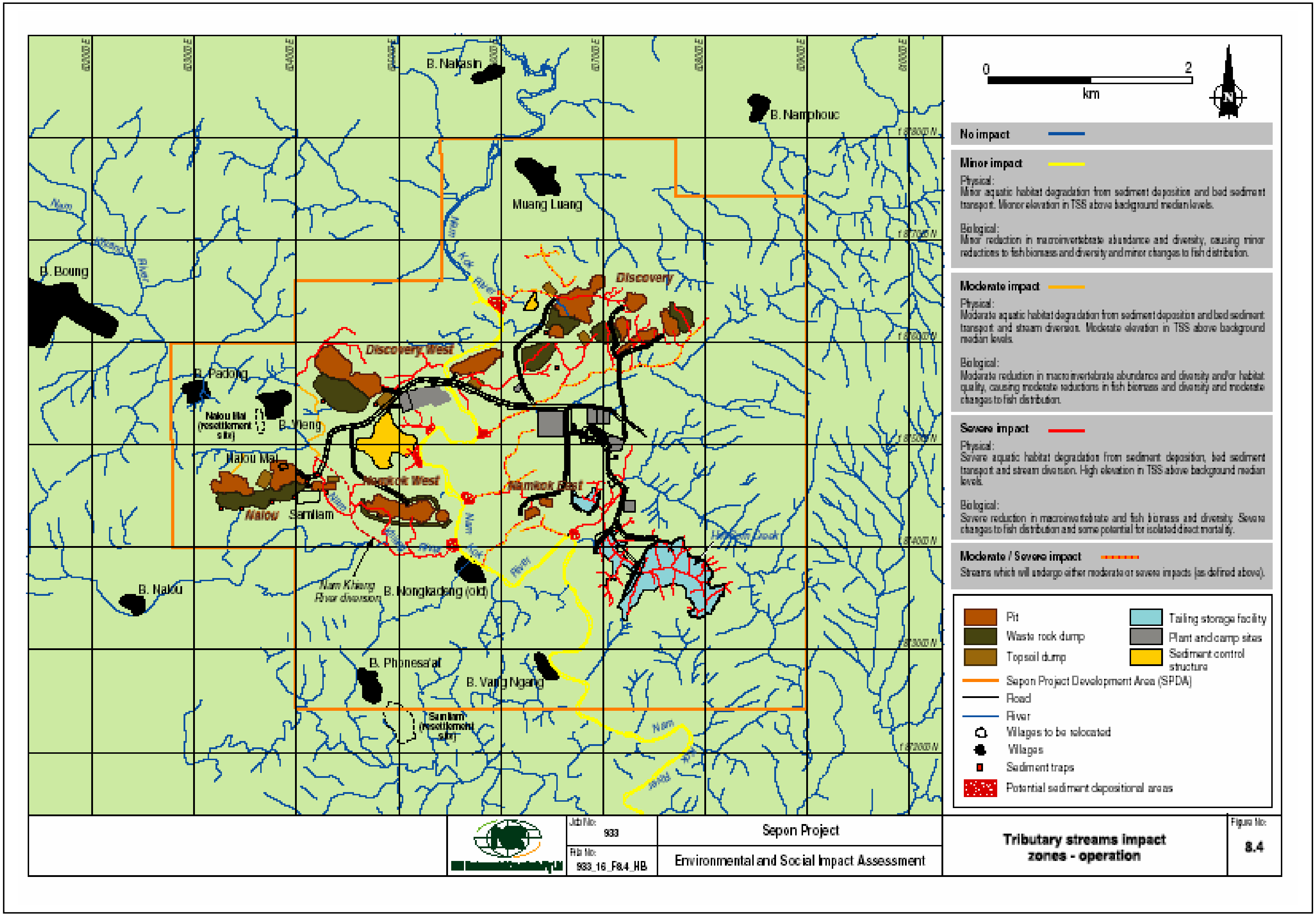


Figure 8.4 from the Sepon Project ESIA. Note the streams predicted to have 'severe' and 'moderate/severe' impact during project operation

DETAILED COMMENTS on the SEPON PROJECT ENVIRONMENTAL and SOCIAL IMPACT ANALYSIS and ENVIRONMENTAL MANAGEMENT PLAN

GENERAL OBSERVATIONS on the ESIA and EMP

The amount of information available presented in the ESIA and supporting documents, and the quality of the work for this environmental analysis from a technical perspective is generally very good. There was a substantial amount of information to review, as evidenced by the voluminous nature of the CD containing the reports.

However, it is also quite apparent that a number of the important technical documents were still in a preliminary form, and do not provide enough detail form which to properly assess the potential impacts of the project. This includes the reclamation plan (e.g. the final design of the covers for potentially acid-generating waste; and, the total cost of the reclamation, which is needed to establish a reclamation bond for the project), the plan for the diversion of the Nam Khiang River, a detailed Monitoring Plan, a detailed Spill Response Plan, etc. Also, the number of samples that should have been collected for use in determining the acid-generating potential of the waste rock is inadequate.

It has been my experience that in the United States, and in Great Britain, enough information must be provided during the permitting stage of a proposed project to make a judgment of what the final environmental and social impacts of the project will be. This means reclamation procedures, monitoring plans, water quality standards, closure and post-closure financial sureties must be clearly specified. This does not mean that elements of these items cannot be changed, but it does mean there is a concrete ‘project’ to analyze.

The Sepon Project appears to follow the approach to permitting that I have observed in British Columbia (Canada), where a detailed outline of the project is submitted, permits are issued, and the project design and operational details are filled in as the project is constructed and operated. While this approach leads to expedited project permitting, it also increases the uncertainty in the final outcome of the environmental and social impacts of the project.

I also have some concern about some of the decisions that have been made regarding mitigating the potential impacts of the discharge of mine effluent into the Nam Kok River system.

> *“Any impacts on the Nam Kok River are yet to be fully determined, however, it is possible that the mine could affect the current water and resource use for downstream users. The development of water and waste management plans are likely to be an essential part of controlling the impacts of the proposed development on the local population. Monitoring of the Nam Kok River will be required during construction and operation of the project.” (ESIA App. 11, p. 5)*

Mine discharges typically present a potential threat to aquatic organisms. At Sepon people depend on the river directly for subsistence food and drinking water.

Significant problems, both documented and undocumented, from mine discharges make headlines in papers on virtually every continent. It is in the best interest both of the people who live near the mine, and of the mine operators, to make every effort to minimize the potential for problems with discharges from the mine.

However, the approach that I observe in a number of the recommendations for operating procedures in the ESIA and EMP are clearly aimed at maximizing operational efficiency, not at preventing environmental potential problems. For example:

> *"The final option adopted by the project for the management of potentially acid generating waste rock and minimisation of acid drainage will depend upon an assessment by LXML of technical and financial feasibility and predictions of environmental impact." (ESIA, p. 7-31)*

Other examples include a reluctance to reduce Total Suspended Solids (which contain potential contaminants) to a minimum, and the lack of clearly defined water quality standards (which is primarily a regulatory issue, not an mine operator's issue) are two additional examples.

The concerns expressed are further complicated by the fact that at the Sepon Project:

(1) This is a low to medium grade gold deposit. There is not a lot of financial room to maneuver should problems arise.

(2) This is the first major metal mine in Laos, so there is likely little regulatory experience with this type of mining, and hence little experience with operational problems that are likely to arise;

(3) The mine is to be operated by a junior mining company. Junior companies do not have the depth of technical expertise that is available to major companies to address technical problems that will inevitably arise during operation. In areas where mining has a long history of operation, experience from previous operations can be used to anticipate and avoid problems. But in virgin areas these problems can cause significant financial hardship for the company, or environmental or social hardships for the local communities if the problems are not addressed

(4) Junior mining companies generally do not have the financial resources to deal with significant environmental problems, should they arise. The need for long-term water treatment, either for the discharge from the tailings pond, or from groundwater contamination from waste rock, is a problem that could arise at Sepon that a junior company could not financially manage. In this case it would be the government that would be the final guarantor of environmental remediation or mitigation; or, as often happens in both the developed as well as the undeveloped world, an 'environmental sacrifice' area is created, and local people bear the environmental and social costs of the impacts.

COMMENTS on the DISCHARGE to GROUNDWATER:

Mining at Sepon has the potential to impact groundwater in the long term, and groundwater quantity/availability in the short term.

> *"Groundwater is used as a water resource for many of the villages. Wells in the SPDA are generally shallow and, for some, water supply is ephemeral. The water table (where measured) is also generally shallow." (ESIA, p. 6-58)*

and;

> *"Groundwater from advance dewatering, which will involve drilling bores around the pit and pumping in advance of mining to depress the local water table to below the level of the pit floor, will be discharged directly to the Nam Kok River." (ESIA, p. 8-25)*

Groundwater quantity/availability should be a problem that can be mitigated. Dewatering will cause a cone of depression to form around the pits, which will lower the water levels in any wells in the immediate vicinity. In addition, pit dewatering will cause a gradient that will induce groundwater to flow toward the pit. The source of the groundwater flow will include subterranean flow from the rivers.

> *"Namkok East and West are close to the river and, due to their strong hydraulic connections, will receive considerable riverine recharge." (ESIA, p. 6-58)*

While this subterranean flow should not affect appreciably the river, it could increase the costs of pumping the pits. After mining is completed, groundwater should return to its approximate pre-mining levels.

Long-term groundwater quality could be more problematic. There will inevitably be some contamination of groundwater due to mining. The sources of this contamination will be the waste rock dumps, abandoned pits, and tailings pond, probably in that order of significance.

Even if acid mine drainage is not an issue, which has not been determined at this point, there will definitely be elevated levels of sulfate and some metals, including arsenic and selenium, that accompany the development of sulfide-bearing rock. This contamination should be limited to the groundwater basins in which the waste is located, so it is important to confine waste disposal to well defined hydrologic boundaries (usually following topographic lines), and to acknowledge that any human or agricultural use of water from these areas may be impacted.

Contamination from the pits could also affect groundwater.

> *"Lowering of the groundwater table associated with open pit excavation will also expose some rock that remains insitu (ie pit walls) to a more oxidising environment. If the watertable is lowered to a level that exposes partially oxidised and primary material some acid leachate and metal mobilisation may develop within the pit. This water will probably require treatment with neutralising reagents prior to discharge or will require pumping to the tailings dam which will contain alkaline water." (ESIA App. 1, p. 26)*

A long-term concern is that contamination from the pits, waste rock, and/or tailings could reach the river and impact aquatic organisms. While the likelihood of this is low, because of the large volume of water in the river compared to the to contribution of local groundwater sources to the river's flow, steps should be taken to minimize the possibility of this happening because it would be very expensive, if not technically impossible, to correct. Steps would include minimizing contamination from the waste rock dumps and tailings pond by (1) carefully identifying problematic waste before it is placed in storage, and (2) designing waste encapsulation measures that will slow the production of contamination.

At this time, given the preliminary nature of the monitoring and reclamation proposals, I have serious questions about the adequacy of preparations for this likelihood.

Contamination from the pits, if it occurs, could be even more difficult to mitigate. Some of the pits are immediately adjacent to the river. (see Figure 1.1) Even backfilling the pits to cover acid-generating material exposed in the walls has proven unsuccessful in some locations. The pit's proximity to the river could mean some unmanageable discharge of contaminants to the river. This must be recognized as a risk of the project.

COMMENTS on the DISCHARGE to SURFACE WATERS:

The potential for impacts to surface waters in the vicinity of the mine are significant.

> *"Impacts to macroinvertebrate communities in tributary streams affected by the project are expected to be severe, although the length of these impacted reaches will be limited to the reaches between the mine component and the Nam Kok River, which at most is some 2 to 3 km. In-stream deposition is likely to bury benthic macroinvertebrates and their food resources (e.g., benthic algae and detritus) and cause a loss or degradation of bottom habitat through infilling. This impact is expected to be most pronounced during the construction phase. The reductions in the macroinvertebrate abundance and diversity in affected tributary streams are expected to have consequential effects on fish since benthic macroinvertebrates form an important component of the diet of many fishes expected to utilise the tributary stream habitats." (ESIA, p. 8-42) (emphasis added)*

and;

> *"Approximately 18% of fish caught by villagers in the IIA is from tributaries (Appendix 3). The downstream reaches of approximately half of the tributaries in the SPDA will be severely impacted by the development of the project (see Figure 8.3) and there is minimal potential for the recovery of the downstream portions of these tributaries from the construction phase to the operation phase. Fish catch rates in impacted sections of tributaries are expected to be severely reduced. Based on the number of affected tributaries as a proportion of the total number of tributaries between the town of Sepon and Ban Nahoy, the affected fish catch represents 1% of the total fish catch in the IIA. Further, access to some sites may be restricted by the mine." (ESIA, p. 8-44) (emphasis added)*

and;

> *"Approximately 21% of households in the SDPA use the Nam Kok River as a source of drinking water (Muang Luang, Samliam and Nalou Mai) and 27% as a source of water for washing (Muang Luang, Ban Padong, Ban Vang Ngang and Ban Phonesa'at) (see Section 6.2.5)." (ESIA, p. 8-44)*[1]

and;

> *"Comparison of … metal concentrations with background sediment concentrations in the Nam Kok River and (where available) sediment quality guidelines suggests that, should this*

[1] Area households get their drinking water from: Nam Kok River – 21%, Other Rivers – 10%, Wells – 42%, and Groundwater (hand operated pumps, etc) – 27%. See Table 6.11, ESIA p. 6-87.

material form permanent deposits on stream beds, the possibility of adverse toxicological impacts on aquatic biota would require further investigation.

However, as described above, only temporary deposition is predicted to occur in the main channel, with remobilisation occurring at high flow." (ESIA, p. 8-27)

During construction, 'moderate' impacts are expected to occur for approximately 15 kilometers downstream on the mine, and 'minor' impacts for another 15 kilometers. During operation, impacts are predicted to be 'minor' for 15 kilometers below the mine (see Figures 8.4., included in this report). Since TSS, metals, and other potential contaminant discharges could directly affect drinking water and subsistence fishing, all reasonable efforts should be taken to minimize the impacts from the discharges, as would be done if this mine were to be permitted in North America, or other developed-world jurisdictions.

It should also be noted that there are many stream segments that are predicted to suffer 'severe' impacts during mine operation, including most of the lower portion of the Nam Khiang River (see Figure 8.4). The honesty and candor of the ESIA's authors is appreciated. However, it should be possible to avoid many, if not most, of these potential impacts.

ESIA CHOICE of WORLD BANK GUIDELINES for WATER DISCHARGES

A mix of water and air quality guidelines – including Laotian (where they apply), World Bank, Australian, Canadian, and US Environmental Protection Agency (USEPA) – have been chosen as 'standards' in the ESIA for use in the project. This is appropriate because the Laotian standards do not exist for a number of contaminants that will be discharged, and because Laos does not have mining-related standards.

Experience has shown that if 'guidelines' are left as such, without being formalized as standards or limits, then when exceedances occur, resolution of these problems can be significantly delayed, as well as being politically controversial.

Specifying the limits, points of compliance, and measures to be taken when a limit is exceeded, including penalties and regulatory actions for noncompliance, will significantly expedite the resolution of any problem.

"Results for the treatment using DTC on the Nalou tailing are shown in Table 7.8. Metal removal treatment using DTC successfully reduced the Cu concentration to less than the WBG discharge limit and reduced the Hg concentration to 0.008 mg/L compared to the WBG discharge limit of 0.002 mg/L. Further optimisation of the DTC treatment is in progress to reduce Hg concentrations to less than the WBG discharge limit." (ESIA, p. 7-44)

The guidelines as expressed by the World Bank are not as strict as the Effluent Limitation Guidelines published by the USEPA. Many of the World Bank Guidelines appear to use the EPA guideline number that sets the limit for a single exceedance in a one-month period. However, EPA sets its permit limitations on the monthly average, which is generally one-half of the amount allowed by the World Bank. This would allow dischargers meeting the World Bank guidelines to discharge twice as much pollution as under the EPA guidelines.

The treated discharges with dilution already meet almost all of the strictest standards -- USEPA Chronic & Acute – for freshwater ecosystems (USEPA 1999), and the ANZECC/ARMCANZ –

protection of freshwater ecosystems (ANZECC/ARMCANZ 2000). So, meeting this requirement for the discharge should not pose a major financial problem for the operator.

The one major exception is cyanide. However, the testing done for the ESIA has already indicated that the effectiveness of the cyanide treatment with the INCO and Hydrogen Peroxide processes is very effective in removing cyanide from the effluent. Combining the proven effectiveness of these processes (which has been borne out in mines elsewhere), plus dilution in the Environmental Dam from non-tailings diversions and direct precipitation, avoiding acute levels of cyanide in the discharge should be achievable.

Recommendation: 'Guidelines' should be formalized in a permit, or permits, that regulate surface water, groundwater, and air discharges. Use of Laotian, Australian, Canadian, and/or USEPA guidelines would be more protective of the water and air resources than World Bank Guidelines.

ESIA CHOICE of METALS SPECIES for CHARACTERIZATION

> *"The assessment of metals is based on filterable concentrations since water quality criteria/guidelines for protection of aquatic ecosystems are generally applicable to metals associated with this phase." (ESIA Appendix 6, Tailing Characterisation and Decant Water Discharge Assessment, p. 35)*

While Filterable concentrations are appropriate for measurement in groundwater, Total concentrations are often used for surface waters since fish and other aquatic organisms can ingest suspended particles and dissolve the metals in their digestive systems.[2]

The effect of using Total instead of Filterable would be that the measured amount of metal in a given sample would be larger.

Recommendation: Using Total, rather than Filterable, would be more protective of the environment and human health.

ESIA CHOICE of ACUTE VERSUS CHRONIC GUIDELINES

> *"One set of international water quality criteria that takes into account intermittent exposure similar to that which will occur with the Sepon Project are those developed by the USEPA. These include two values: a maximum concentration that is protective of organisms exposed to toxicants for short periods of time (acute) and a continuous concentration for long-term exposure (chronic). The USEPA acute criteria is primarily used in the following assessment, although comparisons with other guidelines/criteria/standards are also undertaken." (ESIA Appendix 6, Tailing Characterisation and Decant Water Discharge Assessment, p. 35) (emphasis added)*

The authors of this report appear to have mistakenly interpreted the USEPA 'chronic' guidelines as being related to 'continuous' exposure. USEPA's chronic guidelines do indeed apply to short-term exposure (4-day average not to be exceeded more than once every three years), but are aimed at chronic (i.e. some adverse, non-lethal, but noticeable) impact. Unfortunately, this

[2] Total concentration measures all of the metals in a sample, including those metals present as suspended particles. Filterable concentration measures metals after most of the suspended material in a sample has been filtered out.

mistaken assumption seems to have influenced a number of report recommendations on water management alternatives.

In determining permit limits in the US, the EPA requires the use of the most restrictive of either the chronic (i.e. a 'measurable' effect on an organism) or acute (i.e. a lethal) effect. By choosing to use acute instead of chronic guidelines, a given standard is probably less protective than if the both the chronic and acute guideline had been considered.

In addition, the USEPA strongly discourages the discharge of acute toxins in acute amounts for dilution, and will not issue a permit itself with an acute mixing zone. By choosing to use acute aquatic standards for evaluation instead of chronic standards, any mixing zone based on acute standards will in effect be a "kill zone" where the more sensitive organisms will not survive.

See Table 7.8, below, for a comparison of the predicted levels of contaminants in the discharge from the Environmental Dam, after treatment (column 4), with World Bank water quality guidelines (column 5), and USEPA guidelines (column 6).

From ESIA Table 7.8 Metal concentrations in Nalou samples *(with additions)*

Parameters	After Primary Detoxification (SO_2/air)	After Secondary Detoxification (H_2O_2)	After Secondary Detoxification and Metal Removal Treatment (DTC at pH 9)	World Bank	*USEPA Chronic Toxicity Water Quality Guidelines**
Ag	0.88	0.42	0.07	-	*0.0034*
As	0.08	0.006	-	1	*0.000018*
Cd	0.02	<0.005	-	0.1	*0.0022*
Co	0.02	0.08	-	-	*-*
Cr	0.02	0.03	-	1	*0.011*
Cu	20	5.2	0.02	0.3	*0.009*
Fe	<0.05	<0.05	<0.1	2 (total)	*1.0*
Hg	0.49	0.10	0.008	0.002	*0.00005*
Mn	<0.02	0.01	-	-	*(0.050)*
Ni	0.46	0.23	<0.02	0.5	*0.052*
Pb	<0.005	<0.005	-	0.6	*0.0025*
Sb	0.23	0.08	-	-	*0.014*
Se	0.049	0.066	-	-	*0.005*
Zn	9.5	0.02	0.03	1	*0.12*

** The USEPA standards, which are applicable to mining discharges into water bodies that contain fish and other aquatic organisms, and also consider human health (carcinogenic) effects, are added for comparison. (EPA 822-Z-99-001, April 1999)*

Recommendation: The USEPA requires the most restrictive guideline in any given category (i.e. chronic aquatic, acute aquatic, human health, etc.) to be used in developing permit limitations. This approach should be used at Sepon. Guidelines/standards should not be based on acute aquatic limits if they are not the most protective of the resource, which they seldom are.

MIXING ZONE / DILUTION FACTOR

A mixing zone is an area of the receiving water where water quality standards are intentionally exceeded. In these zones contaminants are allowed to 'dilute' to meet standards. Since water quality standards are exceeded in a mixing zone, impacts to organisms may occur.

Treated effluent from the Environmental Dam is to be discharged into the Nam Kok River. Dilution of the effluent will be required in order to meet the applicable water quality guidelines. In the US the Clean Water Act, the legislation that drives the development of water quality standards and the issuance of permits for pollution discharges, is silent on the issue of mixing zones. The USEPA leaves the designation of mixing zones up to each individual state. It does, however, strongly discourage the discharge of toxic substances in acutely toxic amounts in mixing zones, and also requires that mixing zones be no larger than 'necessary.'

If dilution is to be used in the US, the EPA requires that the lowest 5th percentile (i.e. the lowest flow that could be expected in an extreme, but not the extreme, dry period). This is viewed as being most protective of the environment. If average flow is used (i.e. 50th percentile), then half the time the dilution water required would not be available, and the mixing zone would be larger than planned. As can be seen in Table 12 below, the 50th percentile flow provides more than twice the dilution than the 5th percentile flow.

Table 12 Dilution of one in seven day ED discharge upon mixing with Nam Kok River

Percentile	Dilution factor
Minimum	14.9
5th percentile	22.6
10th percentile	24.6
50th percentile	52.1
90th percentile	3807
95th percentile	4575
Maximum	6402

Table 12 is taken from the Sepon Project Environmental and Social Impact Statement, Appendix 6, NSR Environmental Consultants Pty Ltd, 27 Sep 01.

In addition, the Environmental Dam does not discharge directly to the Nam Kok River, but to a tributary, Hin Som Creek, that runs for approximately 0.5 kilometers before entering the river. If the treated effluent from the Environmental Dam is discharged directly into Hin Som Creek, aquatic life in the creek will be significantly impacted, if not totally eliminated, because there will not be enough natural flow to provide the necessary dilution in that stretch of water.

Recommendation: If dilution with the Nam Kok River is to be utilized, a pipeline from the Environmental Dam to the river should be used for the discharge, rather than discharging into the tributary. The discharge flow limit should be based on the 5th percentile flow of the Nam Kok River, or if real time flow monitoring is utilized, then the volume of the discharge can be directly regulated to the river flow in order to insure the required dilution.

DISCHARGE from SETTLING PONDS

> *"'Dirty' water from the in-pit sumps will be directed to one of the two primary sediment control structures, where sediment will be removed and the water will either evaporate, seep into the ground and hence join with the local groundwater table, or flow to the Nam Kok River." (ESIA, p. 8-25)*

Sediment ponds are designed to allow water that contains suspended sediment, but otherwise no other contaminants, time to precipitate before being discharged. At a mine, this includes runoff from areas of the mine that have not been disturbed by mining, roads, and the surface runoff from waste dumps and other mine facilities that have been reclaimed.

Water from working areas of the mine – the pits, the mill, and any seepage from waste rock dumps – is usually collected and routed to the tailings pond because it may contain metals, blasting agents, and other mining-related contaminants.

Recommendation: Water quality monitoring should demonstrate that discharges from all sources, especially pit water and waste rock dump seepage, meet water quality guidelines before routing to sediment ponds.

COMMENTS on the DISCHARGE of INDIVIDUAL CONTAMINANTS:

CYANIDE:

> *"'In no case should the (cyanide) concentration in the receiving water outside of a designated mixing zone exceed 0.022 mg/L' (World Bank 1995; as cited in Appendix 6). This value is the same as the USEPA acute value for cyanide." (ESIA, p. 8-29)*

and,

> *"The free CN concentration upon mixing of the ED discharge with the Nam Kok River under the <u>10th</u> <u>percentile</u> <u>scenario</u> (7 µg/L) marginally exceeds the Lao tentative standard1 (5 µg/L) and USEPA chronic criterion (5.2 µg/L)." (ESIA, Appendix 6, p. 37) (<u>emphasis added</u>)*

The 5^{th} percentile scenario for low flow should be used for mixing zone modeling.

The goal for the discharge should be to never exceed the chronic criteria of 0.0052 mg/l. This is the most protective standard for the discharge. The research done for the ESIA has shown that the two cyanide destruction processes being utilized are very effective in bringing the level of cyanide in the discharge down. Further research should show that the dilution present in the Environmental Dam, plus maximization of residence time in the Dam would lead to more natural degradation, and could bring the cyanide level down the chronic limit before discharge to the Nam Kok River.

Recommendation: If a mixing zone is necessary, the size of the mixing zone should be no large than absolutely necessary. The size should be determined through rigorous technical analysis. There should be no acute levels of cyanide (i.e. 0.022 mg/l or above) in the river. This is what would be required of a discharge permit in the US.

CYANATE AND THIOCYANATE:

> *"Detoxification and natural degradation transforms cyanide and cyanide complexes to thiocyanate (SCN) and cyanate (CNO). The toxicity of these species is considerably lower than that attributed to free cyanide. This is readily evident in the fact that detoxification of ingested or inhaled sublethal quantities of cyanide in both mammalian and fish systems occurs primarily via biotransformation of cyanide into thiocyanate, with subsequent urinary excretion. No discharge or ambient guidelines are available for these two variables to assess the risk associated with concentrations measured after two-stage detoxification." (ESIA, p. 8-31)*

Two cyanide destruction processes are proposed for treatment of the mine effluent before discharge to the Nam Kok River. One of these processes, the INCO cyanide destruction process, converts many cyanide compounds to cyanate and thiocyanate. Thiocyanate concentrations of 168 to 680 mg/L have been detected in effluents following such treatment.[3]

Cyanate may persist in water for significant, but undefined periods of time. Ingles and Scott (1987) report cyanates to be toxic to trout at concentrations ranging from 13 to 82 mg/L cyanate.[4]

Ingles and Scott (1987) also report thiocyanate toxicity for fish to range between 90 and 200milligrams per liter. Heming and Thurston (1985),[5] and Heming and others (1985)[6] report toxicity to be between 24 to 70 mg/L thiocyanate, SCN^-, for brook trout. Heming and Blumhagen (1989)[7] report that thiocyanates cause "sudden death syndrome" in trout, partly as a response to stress, and because thiocyanate is accumulated – contrary to much previously published literature. Lanno and Dixon (1994), report that juvenile fathead minnows showed numerous negative effects after chronic (124 days) exposure to thiocyanate: thyroid tissue changes started as low as 1.1 mg/L; reproduction effects were noted at 7.3 mg/L and above; overt goiter was noted as low as 7.3 mg/L. Many of these effects are believed to be controlled by the antithyroid activity of thiocyanate.

Thus, while the toxicity of cyanate and thiocyanate are indeed less than that for cyanide itself, the toxicities are not insignificant. In addition, in spite of the research quoted above, relatively little is known about these toxicities and what synergistic effects these contaminants may have.

Recommendation: Monitor for the levels of cyanate and thiocyanate in the discharge from the Environmental Dam (this has been proposed in the ESIA).

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[3] Lanno, R., and D.G. Dixon, 1994, Chronic Toxicity of Waterborne Thiocyanate to the Fathead Minnow (*Pimephales promelas*): a Partial Life-Cycle Study. Environmental Toxicology and Chemistry, 13: 1423-1432.
[4] Ingles, J. and J. S. Scott, 1987, State-of –the-Art Processes for the Treatment of Gold Mill effluents: Industrial Programs Branch, Environment Canada, Ottawa, Canada.
[5] Heming, T., R.V. Thurston, E. L. Meyn, and R. Zajdel, 1985, Acute Toxicity of Thiocyanate to Trout: Trans. Am. Fish Soc., V.114, p. 895-905.
[6] Heming, T. and R.V. Thurston, 1985, Physiological and Toxic Effects of Cyanides to Fishes: a Review and Recent Advances, *in* Cyanide and the Environment, Proc. Of a Conf., D. Van Zyl (ed.), Dec. 1984,Colo. State Univ., Ft. Collins, CO, Geotechn. Engineering Program, Dept. Civil Engineering, v. 1,p 85-104.
[7] Heming, T. A. and K. A. Blumhagen, 1989, Factors Influencing Thiocyanate Toxicity in Rainbow Trout *Salmo gairdneri*: Bull. Environ. Contam. Toxicol. V. 43, pg. 363-369.

AMMONIA

> *"The ammonia concentration upon mixing of the ED discharge with the Nam Kok River under the 10th percentile scenario (1800 µg/L) exceeds the ANZECC/ARMCANZ (2000) guideline value (1470 µg/L)." (ESIA, Appendix 6, p. 37) (emphasis added)*

The 5th percentile scenario for low flow should be used for mixing zone modeling.

Ammonia can be very toxic to fish, and the toxicity of ammonia increases as temperature and pH increase. That means that the highest risk would probably occur in warm-weather, low-flow of the river.

Recommendation**:** Maximum residence time in the Environmental Dam should be required to allow natural degradation of ammonia. Residence time can be increased by installing baffles or channels in the Dam that increase the amount of flow time between discharge from the mill and overflow into the river. Discharges above the guideline should not be allowed by permit.

SILVER

> *"The extremely low trigger value recommended by ANZECC/ARMCANZ (2000) for Ag is exceeded at all dilution ratios. This is mainly attributable to the background concentration (<0.2 µg/L) being greater than the trigger value (0.05 µg/L)." (ESIA, Appendix 6, p. 37)*

Silver is another metal that is extremely toxic to aquatic organisms. Since the background level of silver in the river is naturally elevated, the procedure for a permit in the US would be to allow discharge at the background level.[8]

Recommendation: Careful measurement of background should be undertaken to establish whether seasonal variations exist in the natural level of silver in the river. The permit guideline should be based on the lowest natural level of silver in the river.

MERCURY

The level of mercury in the discharge (0.008 mg/l) is expected to exceed all of the appropriate guidelines, including those of the World Bank (0.002 mg.l).[9] The USEPA permit guideline for mercury, which is a human health based guideline, calculated on the basis of both the consumption of fish and drinking water, is 0.00005 mg/l.[10]

Mercury is known to bioaccumulate, and to impact humans. Since fish is an important source of food for people living in the vicinity of the mine, and the river is also utilized as a source of drinking water, great care should be exercised in keeping this contaminant out of the food chain.

It has been proposed in the ESIA that rather than adopt a limit for the level of mercury in the discharge, that monitoring of aquatic organisms be directly monitored for bioaccumulation.

> *"… monitoring will be undertaken to determine if there is a risk to human consumers due to bioaccumulation of metals in aquatic biota. Existing evidence from analyses of Hg in fish*

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[8] While the ESIA states that background levels of silver are high, this is not apparent from the water quality data presented in Appendix 4, Physico-chemical Characterization of Water, Sediments and Fish, Oxiana Resources, August 2001. See Tables 19, 20, 21, 22, 23, 24 and Table 3 of Attachment 2 – River Monitoring Data.

[9] From ESIA Table 7.8

[10] EPA 822-Z-99-001, April 1999

> *tissue sampled from the Nam Kok River indicates that Hg accumulation in fish is unlikely to be problematic." (ESIA, Appendix 6, p. 39)*

Such monitoring, while appropriate in some instances, would have to be very rigorously applied in order to insure the safety of the people utilizing the river as a food and drinking water source. Any program would have to include frequent sampling of both aquatic and human bioreceptors. The details of such monitoring are not given in the ESIA or EMP.

Recommendation: Given the great inherent risk if something were to go wrong with the bioaccumulation of mercury, it would be more prudent to require that the level of mercury in the discharge meet strict guidelines. The total load of mercury entering the river is a consideration, even if bioaccumulation is not occurring in this stretch of the river. If the mercury is present, it is possible that it can be converted into a form that may bioaccumulate. Eliminating the mercury from the discharge, and hence the river, is the only way to insure that mercury cannot bioaccumulate.

SELENIUM

> *"The selenium concentration upon mixing of the ED discharge with the Nam Kok River under the 10th percentile scenario (5.2 µg/L) marginally exceeds the USEPA chronic criterion (5 µg/L)." (ESIA, Appendix 6, p. 38) (emphasis added)*

The 5th percentile scenario for low flow should be used for mixing zone modeling.

Selenium uptake has also been known to be enhanced by the presence of ammonia.

Recommendation: A permit guideline of 5.2 ug/l should be adopted, with as small (or no) mixing zone as possible.

TOTAL SUSPENDED SOLIDS (TSS)

In the ESIA it is stated that there could be significant impacts on aquatic resources due to sediment.

> *"Development of the Sepon Project is expected to result in sediment impacts to aquatic fauna directly and indirectly by causing:*
>
> *• Physical alteration of aquatic habitats (in-stream deposition/stream diversion and flow alteration in tributaries).*
> *• Changes in water quality (increased TSS).*
> *• Changes in stream trophic structure including fish and macroinvertebrate food supplies." (ESIA, p. 8-32)*
>
> and;
>
> *"The predicted physical impacts of in-stream sedimentation on the aquatic habitats of the Nam Kok River mainstream are alteration of the microhabitat of interstitial spaces, increase in bed sediment transport causing a shifting/smothering of substratum, or dilution of natural sediments and associated particulate organic matter." (ESIA, p. 8-33)*
>
> and;

> *"Sediment impacts are expected to cause a reduction in the abundance and diversity of benthic macroinvertebrates inhabiting sediment-impacted reaches of the river." (ESIA, p. 8-36)*

> and;

> *"In-stream sedimentation has the potential to directly impact the fish community within the SPDA by reducing the survival of substrate-attached eggs and early-life stages." (ESIA, p. 8-37)*

Due to the nature of the soils in the mine area, suspended sediment in the discharge from the Environmental Dam is expected to exceed many of the international guidelines.

> *"Concentrations of TSS in the thickener overflow are expected to be about 500 mg/L, but possibly ranging up to 2000 mg/L (see Section 3.1.3). The assumption has been made that this range of concentrations is also likely to occur in the tailing decant water. Testwork has shown that it is possible to reduce TSS concentrations in the thickener overflow to levels less than WBG discharge limits by the addition of coagulant and flocculant.*
>
> *However, compliance with the WBG discharge limit may not be appropriate at all times, since natural TSS concentrations in receiving waters will be much higher than this value during periods of high flow." (ESIA, Appendix 6, p. 40)*

and;

> *"The USEPA water quality criterion for TSS for protection of aquatic ecosystems is that suspended solids should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm." (ESIA, Appendix 6, p. 40)*

In fact, USEPA has adopted a special TSS guideline for mining, which the report authors may not have been aware of. USEPA limits TSS from mining discharges to 20 mg/l. (40 CFR 440.102) In this regulation USEPA has stated that settling in ponds, with the application of flocculants if required, can meet this limit. In the US, no mixing is allowed TSS. This discharge guideline also applies to placer mining, which almost always takes place in sediments with soil particles that tend to stay in suspension.

However, like it does with metals, if the natural background for TSS in the receiving stream is higher than 20 mg/l, then the discharge only has to be no lower than the level in the receiving stream.

In the ESIA it is proposed that Canadian guidelines for TSS be followed.

> *"Canadian guidelines have been adopted for the assessment of TSS concentrations in ambient waters for the Sepon Project. …Based upon these guidelines and dilution modelling, a concentration of 350 mg/L is considered a suitable target value for TSS concentrations in discharges from the ED." (ESIA, p. 8-32)*

One viable alternative for TSS discharge is real-time TSS monitoring, so that the TSS of the discharge can be compared directly to the TSS in the river. In the ESIA this scheme is discussed, but was not adopted.

> *"Depending on the turbidity of the Nam Kok River, higher TSS concentrations in the discharge may be acceptable and a more dynamic operational regime that incorporates real-*

> *time turbidity monitoring (as a TSS surrogate) and variable TSS concentrations in the ED discharge may be appropriate." (ESIA, p. 8-32)*

Recommendation: Point source discharges should meet TSS discharge guidelines. Maximum effort should be made to minimize non-point sources (secondary construction effects, soil erosion, etc.) A number of such 'Potential sediment depositional areas' are depicted on Figure 8.4. A monitoring scheme could be developed where turbidity is continuously monitored as a surrogate for TSS. A few simple tests can establish this relationship. Continuous turbidity monitoring can be accomplished with a simple, inexpensive, instrument.

PHYSICAL IMPACTS

TIMING of the EFFLUENT DISCHARGE to the NAM KOK RIVER

The current strategy proposed for the discharge of effluent into the Nam Kok River is release effluent once a week, except in the dry season when no discharge would be necessary.

> *"As described in Section 7.4.5, the current strategy is to release water from the ED to Hin Som Creek every seventh day throughout the wet season and in the early dry season months. The discharge will then cease during the latter part of the dry season." (ESIA, p. 8-29)*

A continuous discharge is evaluated in Appendix 6 of the ESIA. While an intermittent discharge has some advantages, including allowing the receiving water to recover for a period of time, a continuous should nominally have less impact. A continuous discharge would also allow larger quantities of effluent to be discharged in the event that flows from the Environmental Dam should be greater than anticipated, which experience has shown is often the case

Recommendation: A continuous discharge, rather than a once-a-week discharge, would help mitigate potential impacts from TSS, and for instantaneous exceedances for Sb, and Hg (but would not affect the total load of contaminants to the river).

DIVERSION of the NAM KHIANG RIVER

It appears that the Nam Khiang River will be diverted around the Nalou/Namkok West pit complex (see Figure 8.4).

> *"The most likely option is to dig a diversion channel to take the watercourse away from the pits. …Should the diversion be required, the assessment of the potential impacts will be completed at a later date as required." (ESIA, p. 7-6)*

The discussion of this diversion is limited to several short paragraphs throughout the ESIA. However, this diversion could have potentially significant environment and/or social impacts. For example:

> *"Diversion of streams will impact aquatic habitats, rendering sections of a stream and the habitats therein unusable. The follow-on impact from this may be severe for macroinvertebrates that are unable to relocate, but less severe for fish that may locate to similar alternative habitat upstream." (ESIA, p. 8-39)*

and;

> *"The diverted streams may flow over areas that are unsuitable for colonisation by macroinvertebrates and fish. In addition, changes to the flow regime of diverted streams is*

> *likely to have some impact on macroinvertebrate colonisation in particular." (ESIA, Appendix 8, p. 40)*

The ESIA reader has no idea how fishing in the river might be impacted, which requires not only survey data on fish, but on how the fish in those portions of the river to be impacted are utilized; and, will hydrologic resources will be altered, e.g. might changes in the groundwater tables occur?

Recommendation: Diversion of the Nam Khiang River could have major social and environmental implications. Technical plans for the diversion of the Nam Khiang River, and the potential impacts environmental and social impacts, should be disclosed and thoroughly discussed before a decision to divert the river is made.

AIR QUALITY

> *"An increased number of vehicles will be using Route 28A, which will cause air quality to exceed the above standards for those communities adjacent to Route 28A. To manage the increase in dust generation, LXML will devote a full-time water truck to dust suppression along Route 28A." (ESIA, p. 8-49)*

and;

> *"Residences adjacent to Route 28A are within 10 m of the roadside and will therefore be affected by the increased traffic movement due to the construction of the proposed development." (ESIA, p. 8-57)*

Dust suppression with water normally requires several passes per day over the affected road. This does not pose a significant increase in the type or frequency of traffic on a minesite. However, this will probably be a significant factor on a public road. In addition, if the water tanker is not available because of maintenance problems, dust can become a significant irritant and health concern until the water tanker returns.

Recommendation: Paving the road in the vicinity of any habitations should be required, either by the project or/and the government. In combination with watering, this should keep the dust level within standards.

WASTE ROCK

> *"Checks will be carried out as the pits progress to identify any waste rock with potential to form acid in the waste rock dumps. Any such waste will be mined and placed separately to allow its encapsulation in the waste rock dumps (see Section 7.4.3)." (ESIA, p. 7-20)*

Identifying potentially acid-generating waste is extremely important, especially given the rapid acid-generating capability that waste from this mine seems to have *(ESIA App. 1, p. 26).* Frequent, real-time sampling will be required in order to accomplish this goal. One approach to get timely, inexpensive results for potentially acid-generating rock is to use a paste pH, or a similar test. These tests must be 'calibrated' to each rock type on the project, since it is not a true test of acid-generating ability. The drill hole samples that are used to distinguish between ore and waste can be utilized for this testing. Sample density for this test should be the same as that utilized to determine waste from ore.

Waste rock is to be stored in dumps constructed as valley fill containments. Acid-generating or potentially acid-generating waste rock will be identified during mining and selectively placed in the middle of each dump. (ESIA, p. 7-32) While this waste storage approach confines the material to one drainage, and is a stable construction configuration, it also has the disadvantage of covering an existing water course that will try to reestablish itself over time. The old watercourse also often acts as a source of water and a conduit for contaminants.

A waste storage option that should be discussed is that of placing acid-generating waste in the tailings impoundment with the tailings. This should place the waste in a low oxygen environment.

Potentially acid-generating waste might also be placed at the bottom of mined out pits.[11] In portions of the pits that will remain permanently below the water table, oxygen availability to sulfides in the waste will be minimized. However, pits close to the river probably should not be considered for the disposal of acid-generating waste.

The staged schedule for mining of the multiple pits in this project could allow backfill to be accomplished at minimum cost.

Recommendation: Frequent, real-time sampling should be preformed on waste rock to determine its acid-generating potential, so that it can be segregated from non acid-generating material. Sample density for this test should be the same as that utilized to determine waste from ore. Disposal of acid-generating waste in the tailings pond, as well as in the permanently saturated portions of abandoned pits, should be investigated.

[11] This option is briefly discussed in the ESIA, but no conclusions are reached.

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

(also referred to as an Environmental and Social Action Plan (ESAP))

GENERAL COMMENTS ON THE EMP MONITORING:

Although a number of monitoring commitments have been made, there is no Monitoring Plan to specify how, when and who will fulfill these commitments. In order to address these issues, a full Monitoring Plan should be developed and disclosed prior to mine operation.

The Monitoring Plan should specify:

- each monitoring location,
- the constituents to be monitored at each site,
- when the monitoring is to occur,
- the procedures the monitoring technician will take in collecting, preserving, transporting the samples to the analytical lab
- the accuracies for the individual constituents for the analytical methods employed

The Monitoring Plan should also clearly define when a trigger value or water quality guideline has been exceeded, and what will be done to rectify the problem when this occurs. This process helps eliminate arguments over whether an exceedance of standards is significant, and more importantly, exactly what actions will be taken when an exceedance occurs.[12]

Lacking this Monitoring Plan, there is a paucity of specificity and assurance that sampling and monitoring will be carried out as outlined in the Environmental Management Plan and ESIA.

Regulatory experience with mining can also be an important issue in environmental enforcement. Especially important for this project will be regulatory personnel familiar with: (1) geochemistry – for water quality monitoring; (2) hydrology – for monitoring groundwater drawdown and potential groundwater contamination paths; (3) aquatic biology – to monitor the potential impacts on stream resources; and, (4) mining engineering – to assist agency officials in determining whether proposals for changes in operating procedure (which always occur) are reasonable in terms technical implementation and economic viability, and in terms of the application of best practices/available technology.

These people should either be staff of the monitoring agency, or consultants hired directly by the regulatory agency. The mine operator, or its consultants will most probably collect the monitoring data. These same consultants should not be used by the regulators to interpret monitoring data. Interpretation of data for the agency needs to be done by an independent source with reporting responsibility to the regulatory agency.

It is also appropriate to do a limited amount of independent sampling, especially for water quality data. This means that the regulatory agency needs to have personnel that are qualified to collect water quality samples, and the agency needs to have access to an independent laboratory (i.e. a qualified laboratory that does not analyze samples for the mine) to analyze the samples.

[12] For example, actions can range from resampling to immediately ceasing the discharge.

SPECIFIC COMMENTS ON THE EMP MONITORING:

ENVIRONMENTAL DAM

> *"The contents of the ED will be discharged to the Nam Kok River via Hin Som Creek as required, with the highest frequency of discharge currently planned to be once every seven-days during the wet season. To ensure compliance with WBG emission guidelines, the ED contents will be sampled and analysed for the following variables:*
>
> *• pH, conductivity, turbidity, TSS, WAD CN." (EMP, pp. 23-24) (emphasis added)*
>
> *"Selected samples will also be analysed for:*
>
> *• Unfiltered and filtered (<0.45 µm) trace metals.*
> *• TCN, free CN, CNO, SCN, NH3." (EMP, p. 24)*

Recommendation: It is important to monitor these toxic contaminants frequently. In the United States, permits for effluent discharges to stream waters typically require weekly monitoring for metals and CN complexes. These results are reported as a monthly average. It is recommended that a similar reporting schedule be required for the Sepon Project discharges. In addition to the constituents mentioned above, monitoring should also be done for nitrate/nitrite (breakdown products of cyanide decomposition, and also a typical constituents of blasting agents), and for sulfate.

TSF SEEPAGE (TSF = Tailings Storage Facility)

> *"The TSF will be constructed to minimise seepage from the storage and through the containment embankment. Seepage is expected to occur through the foundation rocks of the facility and will percolate into the downstream RWD* (RWD = Return Water Dam)*, where any further seepage is also expected to occur through the dam foundations as opposed to through the embankment." (EMP, p. 24)*
>
> …
>
> *"Monitoring during operations will involve:*
>
> …
>
> *• Quarterly sampling and analysis of major ions.*
> *• Annual sampling and analysis for trace metals." (EMP, p. 24)*

Recommendation: During operations it is recommended that analysis for trace metals be done twice per year. Flows and constituents can vary according to the influx of water. One sampling event should take place at the end of the dry season, and one at the then of the wet season.

RUNOFF FROM WASTE ROCK DUMP/TSF EMBANKMENT/WATER MANAGEMENT DAM EMBANKMENTS/PIT WALLS

> *"Monitoring is a critical component of managing acid drainage. Identifying acid drainage or the likelihood of acid drainage at an early stage may provide advance warning of more significant problems. This will enable pro-active control and possibly treatment strategies to be adopted. Monitoring of pit water and the various emplacements that include waste rock will involve:*

- *pH, EC, acidity, sulfate, Fe, Al and Mn in pit sumps, and in runoff and seepage from the TSF and waste dumps.*
- *These same indicators in surface waters and groundwaters upstream and downstream of the TSF and waste dumps." (EMP, p. 25)*

Recommendation: Trace metals should also be a part of the analysis, including selenium, arsenic, antimony, thallium, and zinc, metals that can often be present in significant quantities in neutral pH environments.

POST-DECOMMISSIONING MONITORING

> *"After decommissioning, discharge and ambient monitoring will continue until a 'steady state' has been achieved. The monitoring program will then continue on seepage quality (if appropriate) and rehabilitation success until it becomes apparent that:*
>
> - *Active decommissioning and rehabilitation measures have achieved their aims and are no longer required.*
> - *Normal vegetation growth over time is occurring and for the rehabilitation objective has been achieved."*
>
> *"When ore processing ends, some areas of the project will have been under rehabilitation for almost eight years. Performance, in terms of erosion control and vegetation regrowth, should be well-understood across a range of climatic conditions. It should therefore be possible to establish that runoff to the outside environment will meet all requirements in the long term." (EMP, p. 28)*

Again, as a part of a Monitoring Plan, post-closure monitoring parameters, locations, etc., must be specified. Some sort of post-closure trust fund should be established to pay for this post-closure monitoring, and for the inevitable post-closure maintenance that will occur on waste dump slopes, dam faces, and roads, in a high rainfall environment.

It is not reasonable to assume that there will be no Monitoring or Maintenance requirements at the site once the reclamation is completed. Most mines in North America are setting up funds for such costs.

Recommendation: As a part of a Monitoring Plan, post-closure monitoring parameters, locations, etc., must be specified. A post-closure trust fund should be established to pay for this post-closure monitoring, and for post-closure maintenance.

GENERAL COMMENTS on the EMP REHABILITATION and MINE CLOSURE PLAN

> *"The detailed Rehabilitation and Mine Closure Plan (RMCP), to be prepared once the decision to proceed with the Sepon Project has been made, will be a dynamic document that will undergo a number of revisions to take into account issues as they develop throughout the life of the mine." (EMP, p. 33)*

There are a number of proposed features for rehabilitation (reclamation) and mine closure mentioned in both the ESIA and EMP. While the concept of a conceptual reclamation plan has merit, there is still a need for more specificity in pre-mine reclamation planning.

Specifically, there must be enough detail to make engineering cost estimates for the reclamation. Most political jurisdictions require a surety for reclamation in case the operator goes bankrupt before completing the project – something that happens all too often.

In order to calculate the amount of this surety, reasonable engineering details on what will be done during reclamation to make these estimates. The largest reclamation costs are usually those associated with reclaiming waste storage facilities, and for water treatment, if required. It is recognized that reclamation details will probably change over the life of the project, but those changes can be built into the re-evaluation of the reclamation surety, which should take place at least every 5 years, and in some cases is done on an annual basis.

Recommendation: A Rehabilitation/Reclamation Plan, with a level of commitment to closure techniques and enough detail to allow closure costs and a bond amount to be estimated, should be prepared and reviewed before the project is undertaken.

GEOCHEMICAL CHARACTERISATION of WASTE & TAILINGS for the SEPON PROJECT GOLD DEPOSITS, (APPENDIX 1 of the ESIA)

Earth Systems, September 2001

3.0 Waste Rock

The evaluation of the waste rock was thorough, and in general I agree with the conclusions about the acid-generating potential of the waste rock and tailings. There is significant potential for acid-generation at Sepon.

> *"Potentially acid generating and acid generating waste will need to be managed so as to minimise the risk of development of acid drainage and the consequent cost of treatment. If this rock material is not managed appropriately the onset of acid drainage from at least some of this material is likely to be rapid (ie. within months)." (ESIA App. 1, p. 26)*

However, there is one significant potential shortcoming with the study. Acid-base accounting, which is the process used to estimate the acid-generating capability of the waste, was performed on a total of 24 samples.[13] The Draft Acid Rock Drainage Technical Guide, British Columbia Acid Mine Drainage Task Force, May 1990, Figure 4.3-1, which is generally recognized as the best source for recommending the number of samples for testing acid-generation potential, would recommend that a total of 195 samples be utilized to determine the ARD potential.[14]

This suggests that the interpretations in the report were based on significantly less data than would normally be recommended (24 samples instead of 195 samples).

3.1 Nalou

> *"The resource has been estimated at 10.3 Mt @ 2.9 g/t Au using a cut-off of 1.0 g/t. … Pit modelling by AMDAD indicates that there will be 6,310,399 tonnes of waste rock." (ESIA, App. 1, p. 27)*

Approximately 20% of the waste rock for the Nalou deposits has been categorized as acid generating or potentially acid-generating.

3.2 Discovery

> *"The oxide and partial oxide gold resource has been estimated at 3.5 Mt @ 3.2 g/t Au using a cut-off of 1.0 g/t. ... Pit modelling by AMDAD indicates that there will be 4,276,645 tonnes of waste rock." (ESIA, App. 1, p. 21)*

Approximately 5% of the waste rock for the Discovery deposits has been categorized as acid generating or potentially acid-generating.

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[13] Nalou deposit – 8 samples, Discovery deposit – 8 samples, Discovery West deposit – 4 samples, Namkok deposits – 4 samples.

[14] The number of samples is determined from a graph with "Mass of the Geologic Unit" on one axis, and "Recommended Minimum Number of Samples" on the other. This leads to: Nalou deposit – 50 samples, Discovery deposit – 60 samples, Discovery West deposit – 25 samples, Namkok deposits – 60 samples.

3.3 Discovery West

"The resource has been estimated at 4.2 Mt at 2.9 g/t using a 1.0 g/t cut off grade. …Preliminary pit modelling by AMDAD indicates that there will be 5,722,271 tonnes of waste rock." (ESIA, App. 1, p. 33)

Approximately 14% of the waste rock for the Discovery West deposits has been categorized as acid generating or potentially acid-generating.

3.4 Namkok

"The resource has been estimated at 0.9 Mt @ 1.3 g/t Au for Namkok East and 3.2 Mt @ 1.8 g/t for Namkok West using a cut-off of 1.0 g/t. … Preliminary estimations indicate 837,832 tonnes of waste from the Namkok West resource. …For the Namkok East resource, preliminary estimations indicate that there will be only 106,950 tonnes of waste." (ESIA, App. 1, p. 39)

Only a 2500 tons of the waste rock for the Namkok deposits has been categorized as potentially acid-generating.

4.0 Tailings

The composite tailings sample was assessed with a slightly positive net acid-consuming potential. The average sulfur content is 0.16%, which is not high. However, the author of the report did express some concern that the tailings could become acid-generating after mine closure, and recommended column leach testing for potential post-closure acid generation. (ESIA, App. 1, p. 50)

I concur with this analysis and recommendation.

5.2 Management Options

Three management options for acid-generating waste are discussed:

Option 1: Subaqueous disposal of acid-generating waste, probably below the water table in a abandoned pit.

The author of the report correctly points out that there is the possibility of the water in the pit becoming contaminated by either the waste, or possibly by leachate from the walls of the pit. In either case, a contingency plan would need to be put into effect to isolate and treat the contaminated water.

The pits could also be overtopped by stormwaters, or possibly by the river itself, with contamination spread to the river. This possibility would have to be carefully weighed (and a good water balance performed) before deciding on this option.

In addition to placing the acid generating waste below the water permanent water table, as recommend in the report, it would also be prudent to place a layer of non acid-generating waste on top of any acid-generating material to act as a physical and hydrologic buffer.

Option 2: Encapsulation of the acid-generating waste in non acid-generating waste, with a cover on the waste to limit infiltration of water.

Because some of the waste appears to be highly acid generating, it is probably risky to depend on this approach to prevent acid mine drainage. In fact, the author of the report states:

> *"For Option 2, it is expected that there will be a high risk of acid drainage from waste rock dumps containing sulphidic materials." (ESIA, App. 1, p.57)*

If contamination becomes a problem in the waste dumps, collecting (and treating) the contaminated water would be expensive. A barrier well field would likely need to be installed, if drawing in large amounts of uncontaminated water would not prevent this. Pumping and treatment costs would be high. A barrier wall to prevent migration and to collect the contaminated water could also be constructed, but again installation and treatment costs are high.

Option 3: Waste rock encapsulation plus blending acid-consuming material in with the acid-generating material.

While the author of the report rates this combination option (Option 2 plus blending) as having "*… moderate to low risk of acid drainage from waste dumps containing sulphidic materials, due to the likely development of preferential flow paths*." (ESIA, App. 1, p. 57), it is our experience that blending has had mixed results at best, and that it would not be expected to raise the risk of acid mine drainage from 'risky' to 'moderate to low risk.'

I would endorse the 'risky' assessment for both Option 2 and Option 3, with Option 3 being slightly less risky than Option 2. Again, the 'risky' assessment is directly linked to the rather significant contamination produced in the test work on the acid-generating samples of the Sepon waste rock.

One Final Caution

As the report notes, "*The geology of the Khanong copper resource is different from the Sepon gold deposits and its environmental geochemistry will need to be separately assessed if it is planned to mine the copper resource*." Much of the waste rock, and possibly the tailings, of the copper deposit may be acid generating.

Waste disposal for the Khanong copper project, should it go forward, could prove far more potentially hazardous than the waste for the gold project.

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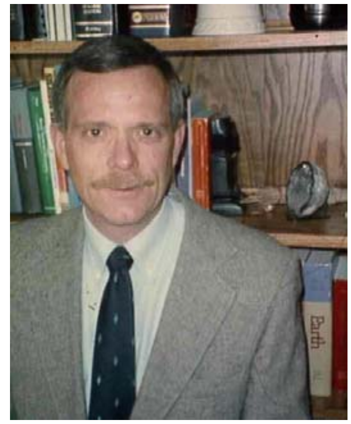
DAVID M. CHAMBERS – BIO



Dr. Chambers is the president and executive director of the CENTER for SCIENCE in PUBLIC PARTICIPATION, a non-profit corporation formed to provide technical assistance on mining and water quality to public interest groups and tribal governments.

David Chambers has 15 years of management and technical experience in the mineral exploration industry, and for the past 10 years has served as an advisor on the environmental effects of mining projects both nationally and internationally. He is a registered professional geophysicist (California # GP 972) with a Masters Degree in Geophysics from Berkeley, and Professional Engineering Degree in Physics from the Colorado School of Mines.

Dr. Chambers received his Ph.D. in Environmental Planning from the University of California at Berkeley. His doctoral dissertation analyzed the U.S. Forest Service's efforts to plan for and manage minerals on the National Forests.

He has provided assistance to citizen groups on proposed, operating, and abandoned mines in Alaska, Arizona, California, Colorado, Idaho, Missouri, Montana, Nevada, Oregon, South Carolina, South Dakota, Utah, Washington, and Wisconsin, British Columbia, Labrador, Kyrgyzstan, and Northern Ireland. This assistance has often been in the form of technical reviews to assist groups in submitting comments on the environmental deficiencies of proposed mines as a part of Permit or Environmental Impact Statement reviews, as well as suggesting mine-development alternatives that are more environmentally sound than the developer’s proposals. Much of this assistance has focused on analyzing the potential adverse affects on surface and groundwater quality of acid mine drainage from tailings pond discharges and runoff from waste rock piles.

Dr. Chambers has also been involved with negotiating with mine owners, developers, and federal and state regulators, to gain major environmental improvements to proposed projects through agreements both on proposed mines and on the reclamation of abandoned mines. He has also played a key role in negotiating complex agreements on several mining issues, including alternative development plans for mine proposals, and technical studies related to placer mining in Alaska.

Dr. Chambers has worked with the State of Alaska Departments of Natural Resources and Environmental Conservation on mining, reclamation, cyanide and solid waste regulations. He is presently a member of the University of Alaska-Fairbanks School of Mineral Engineering Advisory Board. He was also a member of the Western Governors' Association Abandoned Mine Waste Working Group, and of the EPA's RCRA Policy Dialogue Committee, a group of industry, environmental and government representatives who worked to develop regulations for mining wastes under the authority of RCRA Subtitle D.