

**Review of environmental limits used by Latin American and
Caribbean countries and introduction to interim limits for
mining environmental guidelines in Guyana inland waters.**

The case of Total Suspended Solids and Mercury

A discussion paper

**Richard Couture
Canmet
and
Karen Livan
Manager, Environmental Division
Guyana Geology and Mines Commission**

May 2001

FORWARD

On May 9th 2001, GENCAPD held a Main Stakeholder meeting in the boardroom of the Guyana Geology and Mines Commission (GGMC). The development of Interim limits for future Mining Environmental Guidelines was on the agenda.

Mr. Woolford, Deputy Commissioner of GGMC, insisted that CANMET should co-lead with GGMC in the production of such interim limits. Although the nature and content of those limits was not thoroughly addressed, May 31th 2001, was set as a deadline for the production of a draft discussion paper to be written by CANMET. The present report is the original answer to this request.

This report is structured in the following way. Chapter 1 provides an introduction where context and objectives are detailed. Chapter 2 is an insertion of a document produced by Dave Latoski of Indian and Northern Affairs. Chapter 3 provides environmental limits for Total suspended solids and Mercury concentration tolerated in aquatic systems and in use by neighbouring Latin American and Caribbean countries. These limits are not restricted to Placer gold mining activities but to any activity that could impact on fish habitat and human population. The case of the Yukon (Canada) is also included. Chapter 4 introduces the concept of interim limits for alluvial gold mining in Guyana regarding Total Suspended Solids and Mercury in the aquatic system. Finally, chapter 5 assembles all documents used in assessing neighbouring countries limits used for their respective mining activities and related impact on the aquatic system.

Chapter 1 – Introduction

Context and objectives

In 2001, the Government of Guyana (GOG) wishes to pass Environmental Mining Regulations in order to set the rules by which mining activities will be performed with respect to the environment. The Environmental Mining Regulation will provide the government with the power to enact all appropriate legislation for the protection of the environment.

To apply the Environmental Mining regulations, guidelines are needed to give direction, explanation, or specifications regarding laws and their accompanying regulations. Guidelines provide straight guidance not principles. To set up guidelines, and in this case for alluvial gold mining, knowledge of the different components of the mining activities and its affect on the biophysical nature of receiving environment is essential in order to define environmental limits. For instance, if the mining activities impacts in a negative way on the receiving environment, limits must be set to prohibit or minimize these impacts. For example, if dredging for alluvial gold increases the mass of suspended solids in an aquatic system, to a point where fish may be prevented from reaching its spawning grounds, limits on the suspended load must be imposed to the mining effluents. Even if natural extreme events (e.g. rainy seasons), may introduce equal or even superior load of suspended solids then mining does, limits must be set with respect with the timing of ecological activities. In fact, natural extreme events have had their own frequencies for decades and even centuries and ecosystem components (e.g. fish spawning) has adapted in order to match their life cycle outside these natural extreme events. Mining is a potential cause of miss match for the environment and in such a case, limits must be imposed.

During the last two years, the inland waters of Guyana have been subject to considerable environmental research; baseline environmental data is been gathered at a high pace. Decoding this information in a meaningful way is not for tomorrow; trial and error is the key for understanding the true impact of alluvial gold mining activity on the environment and this takes time. Today, mining has caused obvious negative impacts that have been reported by different observers. The GOG must act immediately and in wanting so has decided to introduce interim limits regarding to what extend an environmental variable can be modified by alluvial gold mining activity in Guyana. In this paper, interim limits are defined as limits already in use in other countries having similar environmental structures that can be imported and adapted to Guyana inland waters reality.

The purpose of this discussion paper is to introduce the notion of interim limits regarding to what extend an environmental variable can be modified by alluvial gold mining activity in Guyana's inland waters. More specifically, this paper will focus on proposing interim limits for the most urgent environmental issues regarding mining activity in Guyana: Turbidity and Mercury for Guyana inland waters.

Chapter 2 – Semantics for the development of sound regulatory regime in Guyana. *By Dave Latoski*

This chapter has been inserted mainly to reduce confusion in the reader's mind regarding the semantics for environmental enforcement. The notion of interim limits is not discussed *per se* but is the main tool for the mining inspectors responsible for the compliance of the Environmental Mining Regulation.

All of the following instruments would ideally be developed through adequate consultation with all stakeholders which would include but not be limited to: the industry, other government departments and/or agencies, non-government agencies, environmental groups, First Nations or aboriginal groups and the public. The key here is consultation and consultation pertaining to this exercise may possibly be defined: Providing to the party to be consulted, notice of the matter to be decided in sufficient form and detail to allow that party to prepare its views on the matter; provide a reasonable period of time in which the party to be consulted may prepare its views on the matter, and an opportunity to present such views to the party obliged to consult and to provide full and fair consideration by the party obliged to consult of any views presented.

Industry and government committee should be established to be pro-active regarding the identification of key mining issues, development of government policy, legislation and regulations, creating technical committees as required to carry out in-depth studies and reviews proposing options towards resolution of issues; reviewing existing and proposed government policy, regulatory and legislative initiatives.

I would suggest that environmental assessment and the regulatory regime be kept distinct from each other in that environmental assessment not be regulatory and be part of the planning process of a project only. The regulatory process would take into account the environmental assessment process and ensure that the proper mitigation is implemented to ensure that any environmental impacts are mitigated with known technology. The assessment and regulatory environment including the administrative procedures must be made transparent, time sensitive and consistent. The assessment and regulatory agencies must have adequate resources and have the capacity to meet their mandates and obligations. The roles of other regulatory agencies need to be properly coordinated within the overall process to reduce or eliminate uncertainty. The proper policy context and leadership regarding mineral development must be provided to those involved in assessment and regulatory activities; those involved in assessment and regulation must be properly informed about the nature of the proposed activity and its history, the assessment and regulatory processes should then be conducted within this context; resources applied by government to environmental assessment and regulation must be balanced and reflective of the significance of the proposed undertaking; government must achieve a proper balance between its conservation and development mandates. Also, I would suggest that there

be a clear policy or mission statement from government regarding the development of Guyana's mineral resources for the benefit of all Guyanese peoples and society.

The following is in no way an exhaustive review of the headings but in the context of my experience here in Yukon region and my visit to Guyana may offer some assistance to the development of a sound regulatory regime in Guyana.

Law

That which is laid down, ordained, or established. A rule or method according to which phenomena or actions co-exist or follow each other. Law, in its generic sense, is a body of rules of action or conduct prescribed by controlling authority and having binding force. That which must be obeyed and followed by citizens subject to sanctions or legal consequences is a law. Law is a solemn expression of the will of the supreme power of the state. A law, or an Act, is an act of parliament.

In old English jurisprudence, law is used to signify an oath, or the privilege of being sworn; as in the phrases "to wage one's law," "to lose one's law." The word may mean or embrace: body of principles, standards and rules promulgated by government, commands which obliges a person or persons generally to act. With reference to its origin, "law" is derived either from judicial precedents, from legislation, or from custom.

Emphasis being given to the later portion of the bolded part above. The spirit or intent of the law can be and should be agreed to by all the stakeholders (in the Guyanese case the mining industry itself in that laws are required to guide both government and the industry in conducting the business of mining in Guyana.)

Regulation

Regulation is rule or order having force of law issued by executive authority of government. The act of regulating; a rule or order prescribed for management or government; a regulating principle; a precept. A rule of order prescribed by superior or competent authority relating to action of those under its control. To regulate means to fix, establish, or control; to adjust by rule, method, or established mode; to direct by rule or restriction; to subject to governing principles or laws. The power of parliament to regulate mining is the power to enact all appropriate legislation for its protection or advancement; to adopt measures to promote its growth and insure its safety; to foster, protect, control and restrain. It can also be said that it is also the power to prescribe rule by which, in this case mining, is to be governed, and embraces prohibitory regulations. Regulate means to govern or direct according to rule or to bring under control of constituted authority to limit and prohibit, to arrange in proper order and to control that which already exists.

Regulations are issued by various governmental departments to carry out the intent of the law. Agencies issue regulations to guide the activity of those regulated by the agency and of their own employees and to ensure uniform application of the law.

Policy

Policies can be defined as the general principles by which a government is guided in its management of the legislation it is empowered to enforce. The purpose of policies are to outline a certain principle or course of action to take or adopted practice when administrating legislation. It clarifies for the person who administers the legislation what action could be taken in relation to that legislation.

Code of Practices and Code of Best Practice

I like to call them Best Management Practices or BMPs and this phrase is the most common used both in Canada and the United States. BMP's are guides to minimizing impacts and greatly assist those in the decision making process. They provide basic instruction (emphasis added), guidelines, and technology to miners and regulatory agencies as well as inform the public about mining operations. These are usually published with consideration given to engineering, economics, the environment, laws, regulations and the reality of accomplishment. The intent is to make the document instructive and easily understood, brief and informative and to provide sources of professional assistance. There should be a disclaimer in the document that it being only a guide and adherence to the suggested practices would not constitute a defense in a case of non-compliance (i.e. constitute a "due diligence defense"). Whereas "due diligence" can be defined as the measure of prudence, care and caution as is properly to be expected from, and ordinarily exercised by, a reasonable and prudent person under the particular circumstances; not measured by any absolute standard, but dependent on the relative facts of the situation. Exercising this degree of diligence would entitle the person to the protection of the law in respect to rights growing out of that situation or to avoid being left without redress on the account of their own culpable carelessness or negligence.

Guidelines and Directives

Guidelines can be simply defined as giving direction, explanation, or specifications regarding laws and their accompanying regulations. These can be for both government officials as well as the public but mainly are intended for government officials. Where policy involve principles guidelines are simpler in not giving principles but straight guidance. Directives are intended specifically for government officials and their purpose is just that to give direction for specific instruments such as legislation.

Chapter 3 – Review of environmental limits applied by other countries.

Approach

At this point, the baseline data from Guyana's inland waters is very regional and not sufficient for input even in interim limits. For that reason, limits applied by neighbouring countries have been reviewed.

Time permitting, values have been obtained through known scientists and managers involved in similar work. This information was received mostly through e-mail, fax and web sites. Chapter 5 provides all the raw information.

From this information, Table 3.1 was assembled to give an overview of the environmental limits currently in use in neighbouring countries and in Yukon (Canada).

Review

In Table 3.1, Total Suspended Solids (TSS) are expressed in mg/L and Mercury in mg of total mercury /L. TSS variable was used rather than turbidity.

Since turbidity integrates the effect of both colour and TSS, different waters from different countries could generate different turbidity values with equal TSS concentrations. For example, Trinidad inland waters are less colored than Guyana inland waters. For that reason, a TSS value of 50 mg/L in Trinidad would give a lower turbidity value than a TSS 50 mg/L value in Guyana. So using turbidity values from Trinidad as an indicator for Guyana's inland waters could seriously handicap the Guyana mining activity even at levels that do not impact on the environment. Turbidity values should only be used as an indicator only if they are Guyanese values.

Mercury values shown in table 3.1 are taken as Total-mercury numbers, since there were no other indications .

The information was not available (at the time of printing) all countries listed in Table 3.1. Information for Argentina and Venezuela is still expected.

In the 3rd column of Table 3.1, some countries have adopted different group limits corresponding to different use of the water. On the average, Group A refers to fish spawning streams; Group B refers to fish rearing streams; Group C refers to streams where fish are used by Amerindians or contributing to biological diversity; Group D refers to streams with fish having no significant use by Amerindians or not

TABLE 3.1 Guyana's neighbouring countries Total Suspended Solids and Mercury limits for inland waters.

Variables	Country	Priority use					Reference	
		Group A	Group B	Group C	Group D	Group E		Unspecified
TSS (mg/L)	Argentina							
	Bolivia	10			100			1
	Brazil							
	Chile	30	50	80				2
	Columbia							
	Dom.Republic							
	French Guyana						Upstream = Downstream	3
	Jamaica						Max.Day = 150; Month aver. = 50	4
	Peru						Max.Day = 50; Year aver. = 25	5
	Suriname						100	4
	Trinidad						50	4
	Venezuela							
	Yukon (CDN)						25	6
Mercury (mgT-Hg/L)	Argentina							
	Bolivia						0.001	1
	Brazil						0.002	4
	Chile	0.0001	0.0001	0.001				2
	Columbia							
	Dom.Republic		0.001	0.005	0.01			4
	French Guyana						No reject in water; use of retorts	3
	Jamaica						0.02	4
	Peru	0.0001	0.0002	0.002	0.01			7
	Suriname						0.0001	4
	Trinidad						0.01	4
	Venezuela							
	Yukon (CDN)						Mercury recuperated and used far from water bodies	

contributing to biological activities; and Group E refers to other streams. The 4th column provides values that do not discriminate according to the water use.

Finally, column 5 refers to the reference number where the values were taken and points to the document inserted in Chapter 5.

For TSS, values range from 10-100 (Group A to D) to 150 mg/L (Maximum daily concentration with a monthly average of 50 mg/L) respectively for Bolivia and Jamaica. The median TSS value for these numbers, all countries joined, is about 50 mg/L. This median value exceeds maximum concentrations allowed for spawning grounds (Group A). As shown, Bolivia and Chile (respectively 10 and 30 mg/L) do not use the same limit of TSS for the same water usage i.-e. spawning grounds. This could be attributable to fish species specific tolerance to TSS, suspended matter size spectra or even an arbitrary decision. Finally, let us not forget that these values are not put in the context of the natural background levels of TSS. If in Bolivia and Chile, natural background levels were respectively 5 and 15 mg/L, then the regulators provided equal doubling rates.

But of all the values listed for TSS, French Guyana appears to be most strict in terms of acceptable TSS levels in the aquatic system. French Guyana stipulates that TSS concentrations, as an indicator of inland water quality, measured downstream from a mining operation can not exceed the concentration measured upstream from that same operation. Unfortunately, the *Arrêté en conseil* (Reference 3; Chapter 5), does not provide the distance downstream from the mining operation this limit is fixed.

Jamaica and Peru provide a compromise to the mining industry. It accepts a maximum daily discharge over a monthly or yearly average that should not be exceeded. It makes room for rare incidents considering the lack of infrastructure available to the mining industry to comply with environmental limits. But in the same time, it assures that these incidents to not become a habit.

On the second half of Table 3.1, mercury limits applied by different countries are presented in a manner similar to the TSS values. These limits are for water content of inland circulating (not stagnant) waters. Mercury values range from 0,0001 to 0,02 mg/L. For Groups A to D the limits vary by two orders of magnitude, Peru and Chile having set strict limits for fish spawning grounds (0,0001 mg T-Hg/L).

Not knowing what the natural background mercury values are for most of these countries, it is difficult to identify the most reasonable limit. However, French Guyana (Ref.# 3) and Yukon (Latoski, pers.com.) seem to have dealt with this problem by prohibiting the discharge of mercury from mining operations. This gives the advantage of not having to identify the source of mercury found in inland waters. In both cases (to be investigated) miners pool their ore to a cooperative for burning the amalgam.

Chapter 4 – Open discussion leading to the establishment of interim limits for Total Suspended Matter and Mercury in Guyana inland waters.

Preamble

This chapter will approach the issue of interim limits that will permit to add specifications to Environmental Mining Guidelines for Guyana. Suggestions for interim limits are included and under the initiative of the author as an individual. The Government of Canada was not consulted during this exercise.

The documentation available from Guyana and for the paper is composed of references # 8 and more. Other documentation was not provided at this time.

Hypothesis

In order to define interim limits the following assumptions were made:

- Total Suspended Solids data from Guyana is a more appropriate variable than Turbidity for comparable reasons when support values are imported from other countries;
- Total Suspended Solids and mercury in aquatic systems are the main environmental issues associated to alluvial gold mining in Guyana;
- Regional baseline data obtained in Guyana inland waters on Total Suspended Solids and Mercury permit to adjust values imported from neighbouring countries;
- Interim limits are measured at the point of interest (fish spawning and rearing grounds, local populations fishing grounds) rather than at the mouth of the mining effluent.

Total suspended Solids

Total suspended solids (TSS) is an internationally accepted variable and when used in large numbers, illustrates variability of sediment load on aquatic life. For Guyana inland waters, this type of impact on the environment is routinely measured using a turbidity meter rather than TSS through filtration. Turbidity measures the cumulative effect of colour and suspended solids on light penetration in the water body while TSS measures seston (living and dead particles) in the water column.

Watson *et al.* (2001; in preparation) made TSS and turbidity measurements on the Potaro river. Figure 3.1 shows relation between these two variables.

For turbidity values ranging between 10 and 70 NTU, the authors were not able to find a relationship when plotted against TSS. Other promising work is being done by Samaro (2001) and hopefully, a relationship between TSS and Turbidity will be established for Guyana inland waters.

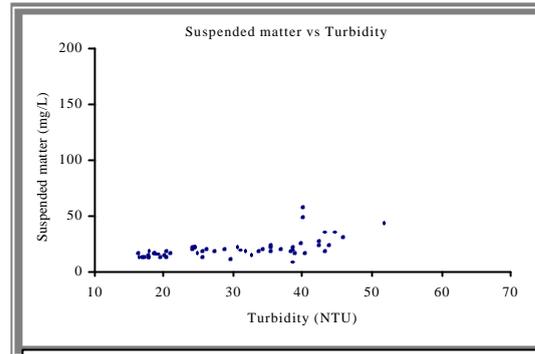


Figure 3.1 – Relationship between TSS and Turbidity found on the Potaro river during February 2001

TSS measurements are more complex to perform than turbidity readings. For instance, TSS size spectra should be considered when treating data. For example, two litres of inland water each containing a mass of 25 mg/L can respectively hold particles with different settling rates. This can impact differently on the downstream ecological components. Finally, the effect of filter clogging from samples taken downstream of mining effluents could render TSS measurements obsolete (Watson, 2001). TSS measurements require time to sample and filtrations must be done in a field laboratory. As for turbidity, it is a more straightforward measurement and generates numbers in a short time period. Its drawback is its significance limited to a very local spatial scale or between areas with identical nature of substrate.

Consequently, there is no easy solution. Still, TSS values are referred to in this section due to its wide international acceptance and for comparison reason between regions and countries.

Interim limits for alluvial mining effluent discharge in Guyana inland waters:

- must assure the protection of aquatic life in a sustainable way for the local populations. Local populations depend on fish harvesting for their dietary proteins. In that context, the fish habitat protection is a priority.
- must be compatible with the low yearly TSS values usually observed during the dry season in undisturbed areas. High TSS values obtained during the rainy season cannot be taken as a reference for setting yearly interim limits. Like in all ecosystems, aquatic life has had sufficient time to adapt its lifecycle to this natural perturbation. Spawning and rearing strategies of inland fish have adapted with time. Alluvial mining is recent on that time scale.
- must use the precautionary approach Spawning and rearing zones and reproductive timing are not documented for Guyana inland waters. Setting downstream turbidity plume limits and effluent discharge calendars requires better ecosystem understanding.

In table 3.1, Group C limit refers to TSS in streams or creeks for conditions where local populations harvest fish. The only available value (at this time) for Group C in Latin America comes from Chile. The limit suggested is 80 mg/L of TSS. This limit does not assure appropriate spawning and rearing grounds which are respectively set for Chile at 30 and 50 mg/L of TSS.

Assuming that Guyana inland waters fish life cycle are not unique, spawning and rearing activities are presumably done in creeks while feeding and maturing occurs in rivers.

For those reasons, the following interim limit is proposed for TSS in Guyana inland waters downstream from alluvial mining effluents :

- ***creeks receiving alluvial mining effluents should not exceed a daily average concentration of 80 mg/L of TSS at the mouth of the stream or creek during low water conditions (Group C; Table 3.1). The receiving river should provide sufficient dilution of the creek TSS to regain river concentration on the edge of the creek delta. The foremost downstream mining operations near the creek should not be penalized by upstream mining operations.***
- ***adjacent creeks within a reasonable number and distance should be exempt of any mining activities and provide potential spawning and rearing fish habitat compensation.***
- ***river receiving creek waters should not exceed 25 mg/L immediately downstream of the mining creek delta or natural background TSS river values for that time of the year. This limit is not based on Guyana inland waters scientific arguments but on international accepted TSS limits.***

Mercury

Mercury is a heavy metal found in the environment. It is of anthropogenic and/or natural origin. Mercury measurements are of significance only if they impact on environmental elements. Watson *et al.* (2001) found maximum mercury concentrations exceeding 0,0015 ppm in the Potaro river which surpasses Group A and B (Table 3.1) for water column limits. They also found that more than 50% of the carnivorous fish contained mercury levels exceeding 0,5 ppm, threshold consumption level defined by the World Health Organization. These findings are in accordance with Singh *et al.* (2001) for other carnivorous fish sampled in Guyana inland waters.

Since the source of mercury is not yet identified for Guyana inland waters but is a feasible project (Garrett, pers.comm.), limits can not be set for different sinks in aquatic systems (water, sediments, TSS, etc.). Rather, interim limits must be set at the origine and end point.

For that reason the following proposal is suggested for interim limits regarding mercury use in alluvial gold mining:

- mercury amalgamation is done at a regional workshop or cooperative away from any water ways and in secure containers.
- refining the amalgam is done using a retort in all circumstances.
- local populations are provided dietary alternatives to carnivorous fish.

Chapter 5 – Supporting documents

(not available electronically)