GENCAPD PROJECT

SUMMARY REPORT
On
ENVIRONMENTAL ISSUES SURROUNDING ALLUVIAL GOLD AND DIAMOND MINING IN GUYANA

June 2003 to January 2004

By
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January 2004
Georgetown

ACKNOWLEDGEMENTS

I would like to thank Mr. Robeson Benn, Commissioner, Guyana Geology and Mines Commission, and Mr. Edward Shields, Executive Secretary, Guyana Gold and Diamond Miners Association for their guidance during this project.

Thanks to Ms. Karen Livan, Manager of the Environment Division and Ms. Dianne McDonald, Manager (ag.) of the Mines Division for their advice, and support given by their staff in making this project a success.

Thanks to Mr. Ayalew Legesse, Field Manager, GENCAPD, for the support and the opportunity to be involved in this project.

To all the miners who have listened, made suggestions, and who were basically receptive and supportive of our efforts, thanks and keep working positively.

To Mr. Jack Morgan, Clinton Butters, Kerion Husbands, and The Mines Officers on whose advice and support I so much depended, it was my pleasure.

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1.0 BACKGROUND

Mining activities by the small and medium scale operations in the alluvial gold and diamond industry in Guyana can have negative effects on the environment. These effects can be identified by, and include, damage to the forest due to unrestrained flow of tailings discharges, turbid waterways by direct tailings discharge to our waterways or turbid tailings effluents merging with our waterway, mercury pollution due to improper use of mercury or mercury released from the land during jetting operations then migrating to our waterways, and the scarred landscape (especially the stagnant water bodies of partly filled mined out excavations). (See Photographs 1 to 7).

To address this problem, The Government of Guyana through the Guyana Geology and Mines Commission is in process of reviewing and amending the mining-environmental regulations, with the intentions of upgrading them towards international expectations.

This new thrust has led to the Guyana Gold and Diamond Miners Association recognizing the need for technical assistance and sensitization of its members, at the same time, the Guyana Geology and Mines Commission, in its role as regulator, was willing to provide some engineering and technical support, hence, the assistance from the Guyana Environmental Capacity Development Project.

As laid out in the "Terms of Reference", the intentions of the Guyana Geology and Mines Commission (GGMC) and the Guyana Gold and Diamond Miners Association (GGDMA), with support of the CIDA-Guyana Environmental Capacity Development Project (GENCAPD) is to implement the best environmental mining practices in the gold and diamond mining industry. The key component of this process being, training of miners in progressing towards more environmentally friendly mining practices.

To facilitate this process, the services of an Environmental Officer was sought to work with the miners in enhancing their environmental mining practices. This programme commenced in August 2002, with the hiring of the previous Environmental Officer, Mr. Christopher Curnow, who left after a short two-month period. Mr. Curnow worked exclusively in the Upper Mazaruni (Imbaimadai/Wariquima-Jawalla/Kamarang) and North West District (10 Mile, 26 Mile, Arakaka, Big Creek, Kamwatta Creek (Eyelash), Tiger Creek and Five Star) areas.

In June 2003, the author was contracted, for a six-month work period, as the new Miners Environment Officer, to complete this programme.

2.0 INTRODUCTION

The central activities of this project were the completion of four (4) field trips to the Mahdia, North West, Kurupung and Aremu mining districts, during the period June to December 2003. These mining districts, all lying within the confines of the Administrative Regions No. 1, 7 and 8 of the Regional Democratic Council System, are located in the north-western quadrant of Guyana that is dominated by the gold and diamond mining activities.

Access the mining districts were by small aircraft, speedboats, via vehicles on all-weather roads, or a combination of methods. Small speedboats and land cruisers were the preferred method of transportation between mining operations located within a district. All Terrain Vehicles (ATVs) were rapidly becoming of critical importance for transporting both miners and supplies to distant and difficult to access areas.

For the areas visited, mining activities were centralized either in riverain floodplains, on the lower slopes of hills and mountains, or in narrow to relatively wide ravines, which basically serve as the erosion channels for water flowing down and between the mountain ranges.

The lithologies of these alluvial mining deposits are predominantly clays, sands, gravels and fragmented rocks that were weathered and eroded from surrounding uplifted base rocks, then transported and deposited at their present locations. The colour and particle size grading are variable, but could be distinct for localized areas.

Hydraulicking, that is the removal of pay material and overburden (where necessary) by streams of water (under high-pressure) from hand-held water monitors (jets), is the preferred mode of operation for small and medium scale gold and diamond miners in Guyana. More recently, with the advent of backhoe excavators at some operations, hydraulicking is being regulated to that of removal of the pay material only, as backhoe allows dry stripping of the overburden material.

3.0 PROJECT OBJECTIVES

The main objectives of this project, as detailed in the terms of reference were:

To evaluate the impacts of mining activities in respect to turbidity, mercury contamination and other environmental concerns during field trips to mining areas.

To advise and teach miners on land reclamation/backfilling of mined out places and on preparation of settling ponds during field trips.

To identify environmental problems, disclose steps taken to correct them, and measures suggested to ensure that the regulations are respected.

To advice miners on maintaining environmentally friendly mining operations and promote the philosophy of sustainable mining.

To enlighten miners of the direction and purpose of the new mining-environmental regulations.

To make a comprehensive assessment on the current use of technology transferred to miners through the GENCAPD Project demonstration exercises (use of mercury retorts by miners, and gold and diamond recovery practices).

To provide advise, recommend modifications, and suggest new concept or ideas for better environmental management, based on experiences from field trips.

These objectives were expanded to include:

To investigate the probability of establishing functional "Self-Monitoring Environmental Groups" within the mining districts.

The distribution of fact sheets on the Mercury Retort, safe usage and handling of mercury and other appropriate information.

4.0 METHODOLOGY

The key elements of the programme were the sensitization and information transfer to miners during field visits to the mining locations. This was approached in the following manner:

1. Audience was sought with the owner, General Manager or senior operator on site.

2. An Explanation (as laid out in the objectives) was given for the general purpose of the site visit.

3. The fact-sheet on GGMC/GENCAPD's mercury retort was explained and distributed to miners. The importance of using mercury retorts was made explicit. Miners were made aware that it was illegal to spike pits and sluice boxes with mercury.

4. In company with the owner, General Manager or senior operator on site, critical observations of the mining operations were made, with special emphasis on proper usage and handling of mercury and the disposal of tailings, in such a manner, as to provide a safe and environmentally friendly operation. During this process, discussions were held with mine operators to identify problems and arrive at viable solutions. Analyses were made of methodologies successfully applied to the local situations.

5. Generally, the benefits of dry-stripping methods and the "closed-circuit" water recycle system were explained and their implementation encouraged.

6. Where appropriate, miners were informed of the availability and use of synthetic silt-fencing material used to confine tailings.

7. The use of the turbidity wedge to monitor the quality of water returned to the environment was demonstrated to miners. The turbidity of surrounding waters was noted and where appropriate, turbidity readings and/or water samples were taken.

8. A few copies of Style's "Sluice box Design and Operations Booklet" were distributed as appropriate.

9. Other relevant information, including location of the mine pit, basic geology of the area, equipment utilized and safety concerns were noted.

5.0 ACTIVITIES

Environmental awareness field trips were conducted at twenty-one (21) general mining locations within four (4) mining districts, during the project period June to December 2003. The districts were Mahdia, North West, Kurupung-Eping and Aremu. (See Figure 1).

A total of one hundred and two (102) gold and diamond mining operations were visited. This included, seventy-three (73) land dredging gold operations, twenty-eight (28) land dredging diamond operations, and one (1) small river dredge operation on the Kurupung River. (See Tables 1 to 5 for detailed information).

One (1) Evening Group Discussion Session was held at Arakaka, North West Mining District and one (1) at Baramalli, Aremu Mining District.

Date	Location	Operations Visited	Comments
11-06-2003	Block 27 & GGMC Dam	1	GGMC Dam refers to an experiment dam with silt fencing confining earth fill.
12-06-2003	White Hole & St. Elizabeth	1	Observed one (1) cutter-suction dredge in operation.
13 to 15-2003	Block 27 & GGMC Dam		
	Total	**2**	

TABLE 1: Activities During Field Trip to Mahdia, (10 to 16 June, 2003)

Date	Location	Operations Visited	Comments
07-07-2003	10 Miles	1	One hydraulicking operation and a Series of vertical shafts
08-07-2003	Eyelash	3	
09-07 to 11-07-2003	Arakaka and Purple Heart	13	One Evening Discussion Session
12-07 to 13-07-2003	13 Miles and 14 Miles	15	
16-07 to 18-07-2003	Five Star	3	
19-07 to 20-07-2003	Papaya	1	
	Total	**36**	

TABLE 2: Activities During Field Trip to North West District, (07 to 21 July, 2003)

Date	Location	Operations Visited	Comments
09-10-2003	Middle Takuba Creek	5	
10-10-2003	Upper Takuba and Chance Creek	7	
11 to 12-10-2003 & 17 to 19-10-2003	Barlow	6	
13-10-2003	Eping River	2	
14-10-2003 15 to 16-10-2003	Kurupung Olive Creek & Kurupung River	8 1	 One medium-scale gold mining operation at Olive Creek
20-10-2003	Enachu and Mazaruni River	1	
21-12-2003	Upper Kurupung River		Observed the long-term effect of river dredging on the river environment and flora & fauna.
	Total	**30**	

TABLE 3: Activities During Field Trip to Kurupung , (08to 22 Oct., 2003)

Date	Location	Operations Visited	Comments
06-12 to 10-12-2003	Baramalli	14	One evening group discussion session; initiated "Self-Monitoring Environmental Group"; visited two mined-out sites
11-12-2003	Quartz Stone	3	
12-12-2003	Arawak	6	
13-12-2003	Middle Aremu	5	
15-12-2003	Oko	5	
16-12-2003 17-12-2003	Middle Aremu Middle Aremu	1 -	One small group discussion Session One small group discussion Session
	Total	**34**	

TABLE 4: Activities During Field Trip to Aremu District, (04 to18 Dec., 2003)

Mining District	Locations within Districts	Dredging Operations		River Dredge	Total Number of Operations	Evening Sessions
		Gold	Diamond			
Mahdia	2	2	-	-	**2**	-
North West	7	36	-	-	**36**	1
Kurupung	7	1	28	1	**30**	-
Aremu	5	34	-	-	**34**	1
Total	**21**	**73**	**28**	**1**	**102**	**2**

TABLE 5: Project Summary of Field Activities, (June – December, 2003)

Detailed reports on each field trip, which included methods of operation, analyses of the environmental situation, and other critical observations, were complied and submitted.

On 22 January 2004, a presentation of the project findings was made at GGMC's Boardroom, Georgetown, Guyana. The major stakeholders, the miners through the GGDMA and the GGMC, were the intended audience. (See list of attendees in the Appendices).

6.0 RESULTS

Basic information of the operating system of mining operations visited are listed in Tables 6 to Table 9 for the mining districts of Mahdia, North West, Kurupung, and Aremu, respectively. Table 10 gives a summary of these operating systems for the project.

Mining Location	Pits Visited	Backhoe		Closed-Circuit	Back-filling	Recycling	Have Retort	Riffle Sections	
		Stripping /mining	Land Prep. Others					Angle iron	Expanded Metal
Block 27	1	1	-	1	-	-	-		
White Hole	1	1	-	-	-	1	-		1
Total	**2**	**2**	**-**	**1**	**-**	**1**	**-**	**Data not complete**	

TABLE 6: Summary of Basic Operating Systems – Mahdia

Mining Location	Pits Visited	Backhoe		Closed-Circuit	Back-filling	Recycling	Have Retort	Riffle Sections	
		Stripping /mining	Land Prep. Others					Angle iron	Expanded Metal
10 Miles	1	-	-	-	1	-	-		
Eyelash	3	1	-	3	-	-	1		
Arakaka/Purple-Heart	13	2	1	2	3	1	Fume Hood		
14 Miles	11	3	1	-	2	2	1		1
13 Miles	4	1	-	-	-	1	-		1
Five Star	3	1	-	-	2	1	-	1	1
Papaya	1	1	-	-	-	1	-		
Total	**36**	**9**	**2**	**6**	**8**	**6**	**2**	**Data not complete**	

TABLE 7: Summary of Basic Operating Systems – North West

Mining Location	Pits Visited	Backhoe		Closed-Circuit	Back-filling	Recycling	Have Retort	Riffle Sections	
		Stripping /mining	Land Prep. Others					Angle iron	Expanded Metal
Middle Takuba	5	-	-	1	1	2	N/A	N/A	N/A
Upper Takuba – Chance Creek	7	-	-	2	2	3	N/A	N/A	N/A
Barlow	6	1	-	4	1	2	N/A	N/A	N/A
Eping	2	1	-	2	2	-	N/A	N/A	N/A
Kurupung	8	-	-	4	-	-	N/A	N/A	N/A
Olive Creek	1	-	-	1	1	-	1	1	-
Enachu	1	-	-	-	-	-	N/A	N/A	N/A
Total	**30**	**2**	**-**	**14**	**7**	**7**	**1**	**1**	

TABLE 8: Summary of Basic Operating Systems - Kurupung

Mining Location	Pits Visited	Backhoe		Closed-Circuit	Back-filling	Recycling	Have Retort	Riffle Sections	
		Stripping /mining	Land Prep. Others					Angle iron	Expanded Metal
Baramalli	**14**	4	1	5	6	4	3	-	12
Quartz Stone	**3**	-	-	-	3	3	-	2	1
Arawak	**6**	4	-	-	3	-	-	3	4
Aremu	**6**	5	-	3	5	-	2	2	6
Oko	**5**	3	-	-	3	-	-	-	4
Total	**34**	**16**	**1**	**8**	**20**	**7**	**5**	**7**	**27**

TABLE 9: Summary of Basic Operating Systems - Aremu

Mining District	Pits Visited	Backhoe		Closed-Circuit	Back-filling	Recycling	Have Retort	Riffle Sections	
		Stripping /mining	Land Prep. Others					Angle iron	Expanded Metal
Mahdia	2	2	-	1	-	1	-		1
North West	36	9	2	6	8	6	2	incomplete	incomplete
Kurupung	30	12	-	14	7	7	1	1	-
Aremu	34	17	1	8	13	7	5	7	27
Total	**102**	**40**	**3**	**29**	**28**	**21**	**8**	**Data not complete**	

TABLE 10: Project Summary of Basic Operating Systems

WATER SAMPLING

Results of turbidity, Total Suspended Solids (TSS), and pH on water samples taken at Kurupung and Aremu are listed in Tables 11 and 12, respectively.

Sample ID	Date	pH	TSS (mg/L)
Kurupung River, above Takuba Creek	16/10/2003	4.25	1.00
Kurupung River, below Takuba Creek	16/10/2003	5.20	434.00
Takuba Creek mouth	16/10/2003	5.20	1588.00
Black Water Creek, Upper Takuba	09/10/2003	5.70	2.00
Mazaruni River, above Kurupung River	16/10/2003	4.90	6.50
Mazaruni River, below Kurupung River	16/10/2003	4.10	33.50
Eping River, below Landing	13/10/2003	4.80	10.00
Eping River, ~ 400 ft. below Landing	13/10/2003	4.40	3.50
Eping River, below Barlow Landing	13/10/2003	4.70	9.50
Makreba Falls, Upper Kurupung River	21/10/2003	4.05	2.00
Water to Feed Pump, "Closed-Circuit" Operation by Raimundo DaSilva, Upper Takuba	10/10/2003	4.90	322.50

TABLE 11: Results of Water Sampling - Kurupung

Sample					TSS (mg/L)		
	Ref.	GPS Coordinates			Wedge		L
Location	ID	21 N	UTM	Date	(cm)	NTU	-
Aremu Ck. by Benn's shop, (Baramalli)	Bm1	0266906	0714639	06/12/2003	4	240	
Overflow from Filhio's Operation, (Baramalli)	Bm2	0265435	0715086	06/12/2003	0	>1350	
Aremu Ck., ~ ¾ mile below Benn's shop	Bm7	0266389	0715211	06/12/2003	3	310	
Aremu Ck. above De Maria's operation, (Baramalli)	Bm8	0266256	0711658	07/12/2003	21	<38	
Aremu Ck. ~ ½ mile below De Maria's operation, (Baramalli)*	Bm10	No position		07/12/2003	2	450	
Ck. Through L. Hopkinson's operation, (Quartz Stone)	Bm17	0252742	0734001	11/12/2003	2	240	
Above Fraser's operation, (Arawak)	Bm24	0286581	0715876	12/12/2003	21	<38	
Below Prass's operations, (Arawak)	Bm29	0287038	0716777	12/12/2003	-		
Aremu Creek at bridge		No position		13/12/2003	-		
Feed water for Chan, (Oko)	Bm35	0275092	0704274		-		
Above Robinson's, (Aremu)	Bm40	0274172	0723956	11/12/2003	6	160	

TABLE 12: Results of Water Sampling – Aremu

7.0 OBSERVATIONS/DISCUSSIONS

7.1 ENVIRONMENTAL AWARENESS

From field discussions, it was evident that some miners and local residents were aware of the environmental issues surrounding the small and medium scale gold and diamond industry. This evidence is supported by adherence to regulations and efforts to operate in an environmentally friendly manner. (See Photographs 8 to 10).

Because the number of operations visited, one hundred and two (102) is small compared to the thousands, purportedly operating in Guyana, and the fact that some miners operated in an environmentally unfriendly manner, one would, by deduction, assume that there are still miners out there operating in an environmentally unfriendly manner, either due to the lack of information or commitment.

The miners were, generally, very receptive of information divulged during field visits, especially when such information could lead to operational and economic benefits, while meeting environmental expectations.

One of the problems experienced during field visits was effective/direct communication with Brazilian miners, especially in the odd cases, where no English speaking person was on site. This problem could be addressed by, mandatory employment of a percentage of Guyanese at Brazilian operations, and officials of the regulating and other bodies needing to interact with the Brazilian miners being taught Portuguese.

7.2 OPERATIONAL AND TAILINGS MANAGEMENT SYSTEMS

There is wide variation of operation and tailings management systems employed within the small and medium-scale alluvial gold and diamond mining industry (Photo. 11 to 24). But basically, these activities could be classed into three (3) groups, namely; **closed circuit recycled water systems,** where tailings effluents are not released to the environment during normal operations; **recycled water system (open circuit)**, where the water recycled to the feed water pump for hydraulicking operation is being diluted by a constant inflow of fresh water, with a corresponding outflow of tailings effluents to the environment; and the system with separated feed water and tailings discharge circuits.

Of these options, the closed circuit recycled water system is recommended as the total confinement of the operations, minimizes or prevents pollution of our waterways. It is evident that miners have latched unto this system, and in combination with the utilization of backhoes for dry overburden removal, significant improvements will continue to be made.

Techniques and materials used for construction of retaining structures were also widely variable. These materials included pieces of canvas, plaited cocorite leaves, board, fibrous roots, branches and tree trunks, all pinned in their vertical position by wooden stakes. These were mainly earth filled by manual means or backhoes, where available, Tailings solids were also used as a dam fill material, by the sluice box discharging directly within the confines of the retaining structures. But, utilization of mined-out pits was the most frequently used method of trapping tailings solids.

These retaining structures were also used to control the direction of the flow of tailings and to trap coarse tailings solids, but these systems were ineffective in trapping fine suspended solids. Hence, the high turbidity levels when these materials are used a filtration medium for tailings discharges. It should be not that there is a possibility that tightly bound fibrous roots (which will effectively close the pore spaces of this medium) will increase effectiveness of this filtration medium.

The advocated used of synthe tic silt (filter) fence material could be considerably more effective in trapping finer particle sizes in effluent discharges, though there are doubts over its effectiveness over a long period of time, due clogging of the pore spaces in the material. In addition, the rate which water will percolate through this material, if used as a rapid filtration medium, must be confirmed.

Land reclamation activities were mainly limited to backfilling of mined-out pits with tailings, except for the operation at Five Star, which utilized a small dozer to replace overacted overburden piles (Photo. 23). Large excavations (as seen in Photo. 25), will continue to be created, unless the issue of reclamation is urgently addressed, and moves apace with implementation of dry overburden removal (backhoe stripping).

The introduction of vertical shaft and adit mining, following gold mineralization, creates two problems. The safety of the shaft operations and possible mercury contamination, from the use of mercury plates, (as part of the crusher processing system) needs to be addressed. (See Photo. 26 and 27). Miners will have to be schooled in the art of artificial ventilation and in the installation of shallow underground (shaft/adit) support systems.

7.3 EVENING SESSIONS

Evening discussion sessions could be used to discuss and teach new and important mining related principle and policies, and to provide opportunities for groups of miners and residents to interact with regulators and officials of the mining industry. From theses sessions, it could be easier appreciate the common position taken on particular issues. But, the greatest benefits are direct feedback and an effective means of information transfer.

It should be noted, that after a tiring day under harsh working conditions miners might be required to make special efforts to attend Evening Group Discussion Sessions. Therefore, facilitating such sessions should be based on evidence of such a need. Other influencing factors could be by the length of time spent in an area, the ability to communicate freely with the intended audience, and the centralization of mining activities.

7.4 MERCURY and The RETORT

By all account, a lot of work (investigative and sensitization) was done on the issue of mercury and its effects on the environment. Miners have varying depths of understanding of the dangers associated with improper use of mercury. But, even though the majority of them are fully aware of the illegality of using mercury in open circuits (that is, in mine pits and sluice boxes), there are evidence and reports of the resurgence of this practice.

Of all the operations visited, none was in possession of a GGMC/GENCAPD mercury retort. Of the eight (8) operations in possession of a mercury retort, one (1) utilized a retort that closely resembles GGMC / GENCAPD model, while the other seven (7) possessed Brazilian type mercury retorts. However, some miners were aware of the existence and purpose of mercury retorts. What is needed, is for the authorities (GGMC/GGDMA) to make these retorts readily available.

It was evident that most miners felt safe in burning gold amalgam in some contraption (that does not meet the basic safety requirements) a short distance away from the camp. Continuous efforts will have to be made to encourage miners to desist from the age-old custom.

7.5 SLUICE BOXES

Sluice box designs varied in dimensions, riffles selection, choice of mattings and the number of sections. Preferences were apparently based on customs and what was proven successful in similar conditions. Except for one (1) operation at 14 Miles, Arakaka, that closely followed Clarkson's suggested modifications, most miners employed portions of these suggestions that they were comfortable with.

From the suggested modifications, the most popular implementation was a section of expanded metal secured over Nomad mat, which (by miners' opinions) has proven to be more efficient when working lithologies consisting predominantly of sand and gravel, or, as indicated by Styles, may be associated to the fineness of the gold.

It was noted that in addition to the boil box, most sluices boxes were of a single length or of two sections. The exception was the addition of a shorter, narrower third section ("bladai") from which the trapped gold is distributed among the workers.

7.6 SELF-MONITORING GROUPS

In terms of access roads to the interior, there is an opportunity for the mining industry to piggyback on the timber industry. Coupled to the fact that the introduction of the All Terrain Vehicles (ATVs) now makes previously difficult and distant work grounds more easily accessible, it will become increasingly more challenging for the GGMC to monitor all mining activities. The formation of "Self-Monitoring Environmental Groups" to monitor mining activities, would be of substantial benefits under such scenarios especially if they are close to residential communities.

Based on good rapport and a common purpose between miners and residents, and among miners themselves, Self-Monitoring Environmental Groups could also play a pivotal role in encouraging mining practices consistent with sustainable mining policies.

The composition of such bodies, as suggested by some miners and residents, must include representatives from GGMC, the miners, and the local community.

7.7 RIVER DREDGING

In terms of river dredging operations, only one small one was observed working on the Kurupung River. Examination of (Photo. 28) would reveal that the tailings discharge from the dredge was angled towards the river channel. This indicates a probably reason for tailings piles (sand bars) encroached on some river channels (Photo. 29), and the need for proper dredge positioning and sequencing of river dredging operations.

A river dredge was fitted with lengths of pipes at the discharge end (to perform as a bailer by repositioning tailings solids) at a land locked operation at Olive Creek (See Photo. 30). This modification, if adopted, could provide substantial benefits, by allowing for proper placement of tailings discharges in order to prevent the encroachment of river channels, and could be used as a means of systematically clearing current blockages.

Observation of the previously dredged Upper Kurupung River indicated that the negative effects of river dredging on the aquatic life and water quality are short-termed, as evident by the pristine water (Photo. 31), the abundance of fish, and the surrounding wildlife. However, in the long-term, improper placement of tailings piles (sand bars) results in severe restrictions and hardship on river transportation to riverain communities and the gold and diamond fields, especially in the dry season.

7.8 OTHER ISSUES

Bad road condition, as exhibited by the main access to Baramalli (Photo. 32 and 33) can result in severe economic hardships to miners and residents. Such deplorable conditions pose a risk to both vehicles and people.

Probable reasons for bad road conditions are; lack of maintenance; the inability to provide adequate equipment to impose proper drainage systems, at these far reaching

locations; and the effects of heavier backhoes and tractor-trailers with deep tracks traversing the man access road. A good policy would be for tractor-trailers and backhoes to use roads parallel to the main access, where possible.

8.0 PROPOSED/ACCEPTABLE TAILINGS MANAGEMENT SYSTEMS

Effective tailings management, as applied to the small and medium scale alluvial gold and diamond industry, can be achieved by two means: i). Totally enclosed operation as in the "closed circuit" system; and ii). To provide efficient systems of rapidly filtering tailings effluents to achieve the desirable quality, when process water is released to the environment. Central to the effectiveness of both systems is the prerequisite and ability to contain tailings from initial mining activities.

Some Established and proposed tailings management systems are listed.

Photo 11 – A closed circuit recycled water system established at a hydraulicking operation at Baramalli. Note, a baranka (a piece of in situ ground) left in place to separate the active pit from the mine-out excavation utilized to contain the tailings.

Photo 12 – A closed circuit recycle water system established at an operation employing a backhoe to strip the overburden, at Baramalli. System consists of clean mining pit, good pit definition and mine configuration. The previous mined-out pit was utilized to contain the tailings. An added feature was the earthen outer perimeter dam that totally enclosed the entire operations.

Photo 13 – A closed circuit recycle water system established at an operation employing a backhoe to strip the overburden (25 to 30ft. deep), at Middle Aremu. Good pit configuration, along with well-defined pit faces was displayed. Wider baranka (as pit separator) and good quality of return water were noted.

Photo 15 – An earthen dam made to bridge a depression, thus forming the tailings confinement dam as part of the closed circuit recycled water system at Barlow. The large enclosed area could allow adequate of the tailings effluents.

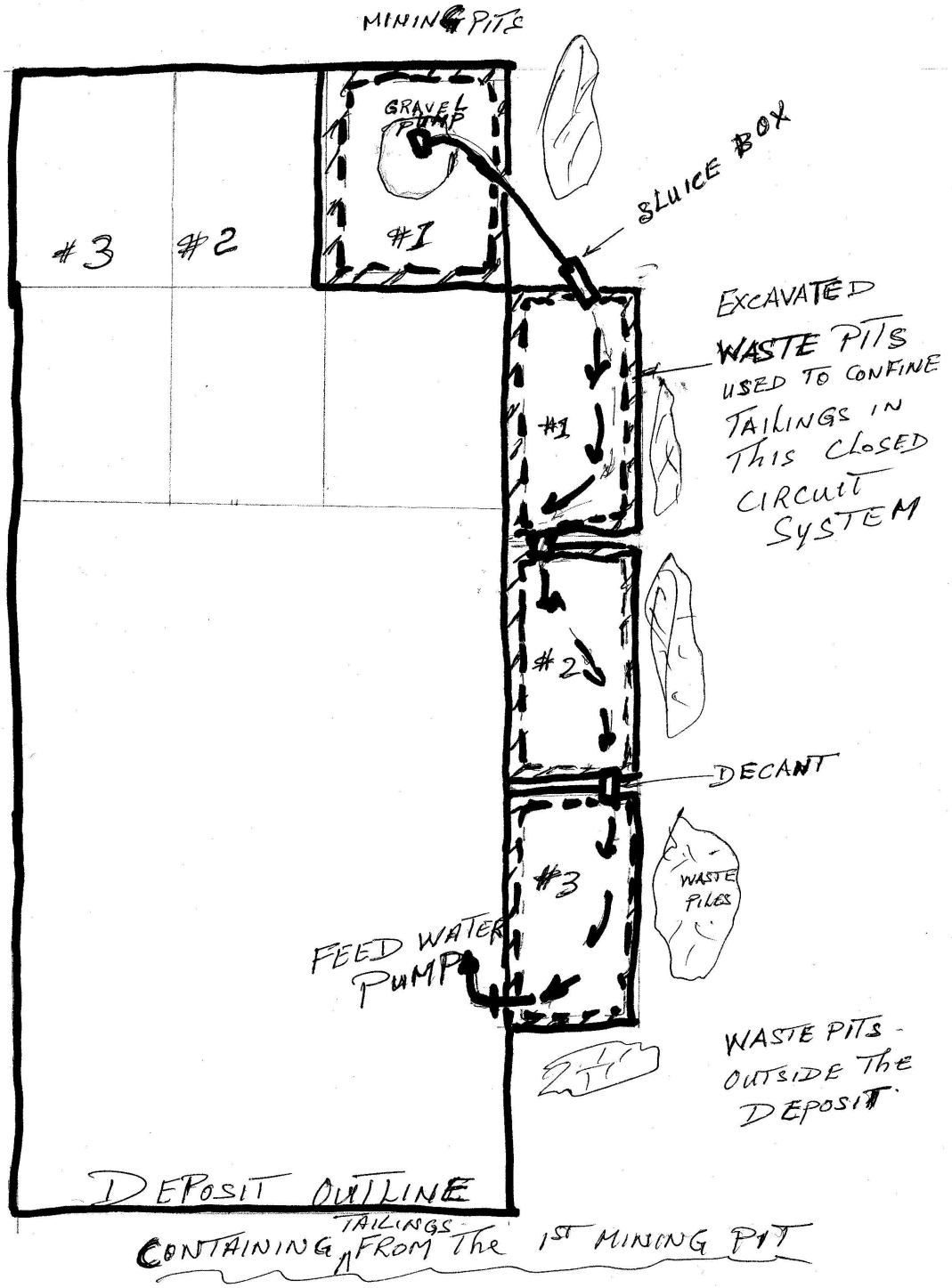
Photo 16 – Construction of a low stop-off dam, made from indigenous material, to confine tailings within an old mined-out pit, as part of a closed circuit system at Upper Takuba Creek.

Photo 20 - Tailings impoundment system employed at 10 Miles, where tailings are routed through a series of mined-out pits, thus allowing partially settled water to be decanted (at point center, bottom) to nearby stream.

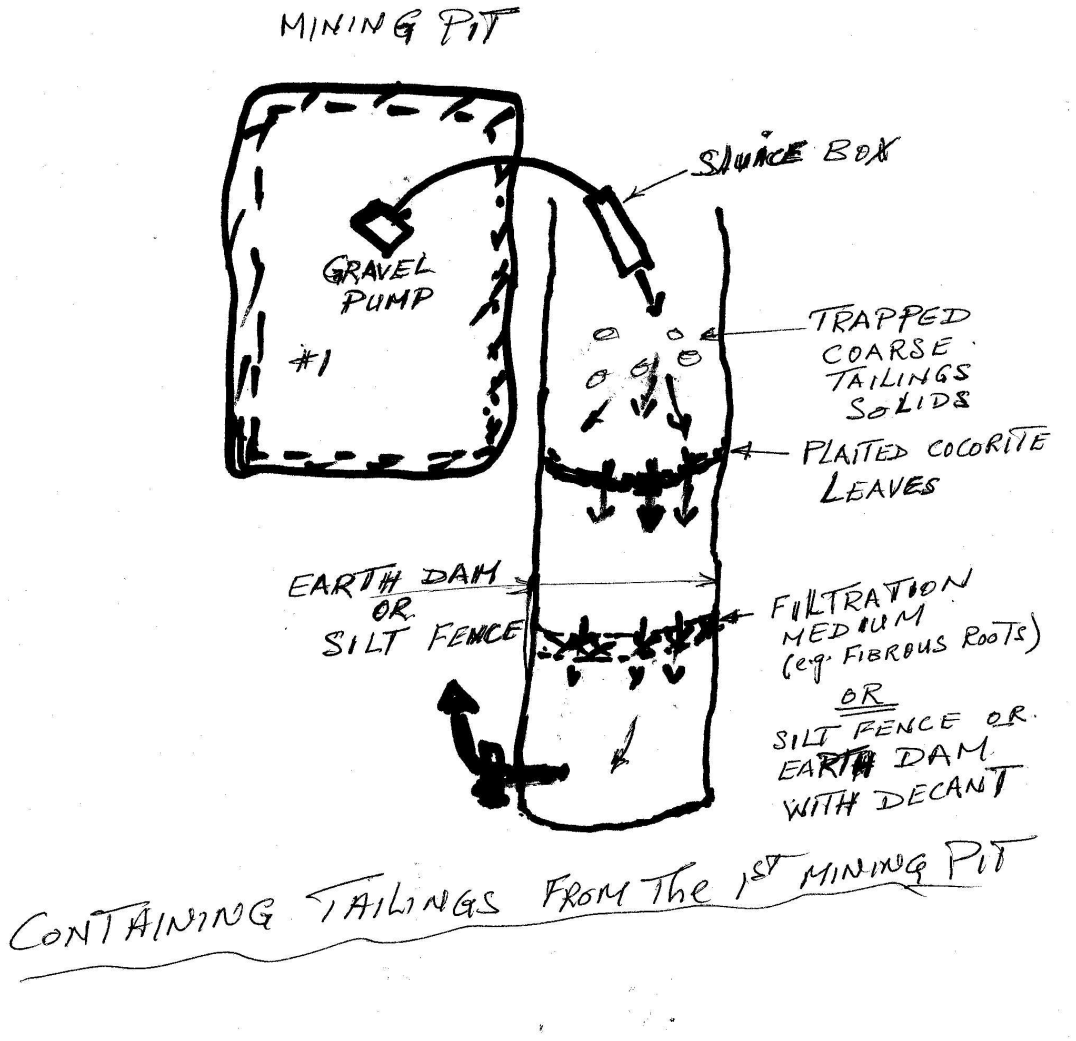
Photo 22 – Old mined-out pits used to establish a closed circuit recycle water system at Arakaka. Confinement area was large enough to allow settlement of tailings effluents to be used as return water. Suggested improvements were raising of the internal separation dam to act as a silt control dam and allow for improved settlement, and to relocate the feed water pump to the left of the suggested silt control dam.

Sketch 1: Depicts a conceptual design for establishment of a closed circuit recycle water System. This design would be applicable to situations where the location of the pay material is known, and where a backhoe is available to excava ted waste pits (used to retaining tailings from the first mining pit).

Sketch 2: This design illustrates the same concept of confinement of tailings from the first stages of mining activities, but is adoptable for **complete hydraulicking operations** (jetting of both overburden and pay material, with no backhoe available) and where the ore-body has **NOT** been Demarcated. An essential feature could be the sequential or staged trapping of tailings solids to maximized to settlement, in limited confinement area.



Sketch 1: A System For Retaining Tailings From the First Mining Pit, With Ore-body Demarcated and Backhoe Available



Sketch 2: A System For Retaining Tailings From the First Mining Pit, For a **Strictly Hydraulicking** Operation and Ore-body **NOT** Demarcated.

9.0 CONCLUSIONS

The programme was successful in raising the level of awareness of miners, and in enlightening others, by means of information transfer through discourse and the provision of relevant available documentations.

The number of mining operations visited during this project period would be considered as minimal, when compared to the number of dredges purportedly operating in Guyana.

It is imperative that the Brazilian miners within this industry be aware of the requirements and objectives of mining-environmental regulations.

In relation to tailings management, small and medium-scale gold and diamond mining activities could be classed into three (3) groups, namely; **closed circuit recycled water systems, open circuit recycled water system**; and the system with **separate feed water and tailings discharge circuits**

It is evident that miners have latched unto the closed circuit recycled water system, which minimizes or prevents pollution of our waterways, and in combination with overburden removal by dry stripping methods (backhoes for example), significant improvements will continue to be made.

"Closed Circuit" water systems are more efficient during the drier season where there is a shortage of water or the water levels in the mining pits are lower. However, in the wet season where there is an excess of water due to runoff from rainfall, there is need to have systems (such *as rapid filtration medium placed in spillways*) to ensure water discharged from mining operations to the environment is of acceptable standards.

Crude indigenous systems, such as plaited cocorite leaves and constructions of leaves, branches and tree trunks are effective in trapping coarse tailings solids, only. By observation, there wais improvement when loosely placed fibrous (predominantly seen in the Kurupung-Eping area), roots were used, but generally these structures are not efficient in trapping fine suspended solids in tailings effluents. Thus the high turbidity levels when these materials are used as filtration medium for tailings effluents.

The advocated used of synthetic silt (filter) fence material could be considerably more effective in trapping finer particle sizes in effluent discharges, though there are doubts over its effectiveness over a long period of time, when used a filtration medium.

The main source of mining related water pollution problems remain as; the development of acceptable techniques (applicable to the various mining scenarios) to confine the tailings from the first mining pits; and the development of rapid filtration systems to achieve the desired quality of effluents released to the environment.

Lack of water for continuous operations during the dry season forces the adoption of some form of closed circuit water system, an indication that miners are willing to adjust due to economic or operational considerations.

Evening group discussion sessions is an effective means of information transfer and feedback system, and provides a forum for reinforcing issues that are applicable to a wider cross-section of individuals, including local residents.

Individuals may be required to make special efforts to attend Evening Group Discussion Sessions. Holding of such sessions would be influenced by the length of time spent in an area, the ability to communicate freely with the intended audience, centralization of mining activities, and evidence of such needs.

Even though some miners are aware of the existence and purpose of GGMC/GENCAPD mercury retort, and retorts in general, of the operations visited, no one was in possession of the GGMC/ GENCAPD model.

It was evident that most miners felt comfortable in the custom of burning gold amalgam in some contraption (that does not meet the basic safety requirements) a short distance away from the camp.

A wide variety of sluice box designs (in terms of dimensions, riffles, mattings and the number of pieces) were observed. Preferences being based on customs and what had proven to be successful in similar conditions.

From the suggested modifications, the most popular implementation was a section of expanded metal secured over Nomad, which (by miners' opinions) has proven to be more efficient when working lithologies consisting predominantly of sand and gravel.

Opinions on the formation of "Self-Monitoring Environmental Groups" were mainly positive, with suggestions that the composition of these groups should include representatives from GGMC, the miners, and the local community, among others.

Individual interest and commitment, good rapport and good communication are key elements for successful functioning of such bodies.

Observation of the previously dredged Upper Kurupung River indicated that the negative effects of river dredging on the aquatic life and water quality are short-termed, as evident by the pristine water, the abundance of fish, and the surrounding wildlife. However, in the long-term, improper placement of tailings piles (sand bars) results in severe restrictions and hardship on river transportation to riverain communities and the gold and diamond fields, especially in the dry season.

10.0 RECOMMENDATIONS

The environmental awareness programme should be extended, with the continuation of field trips with the sole purpose of meeting as many miners as possible. New mining areas, such as Berbice, should be targeted to inculcate the desired culture of sustainable mining in miners. Special emphasis should be placed on the indoctrination of concession and claim holders, rangers and dredge owners in order to obtain their support in the implementation of environmentally friendly mining practices.

Miners have successfully latched unto the closed circuit recycled water system introduced into hydraulicking operations of the small and medium-scale gold and diamond mining industry, especially where dry overburden removal (by backhoe excavator) is practiced, therefore this thrust must be continued. Overburden removal by dry methods, for example by backhoe excavators, should be encouraged.

To complement the gains in technological advances, pilot projects demonstrating the practicality of establishing systems to contain tailings and to adequately control the quality of effluents released from the first mining pits should be under taken. This should included testing of materials to function as rapid filtration medium including, synthetic silt fence material, fibrous roots, and graded gravel outlets.

Progressive land reclamation should be the preferred option of returning mining grounds to an acceptable state. Never the less, suggested pilot projects on the implementation of

post mining land reclamation activities is strongly encouraged. These needs are urgent with the increasing utilization of the more capable and productive backhoe excavators.

Available literature, for example, fact sheets on mercury, mercury retort, tailings management systems, and sluice box operation should be made available to miners as this would improve their knowledge and support new concepts and requirement.

The authorities (GGMC and GGDMA) should ensure that mercury retorts are readily available to miners at affordable prices.

The implications of fitting "Extended Floating Tailings Discharge Pipes" to ordinary river dredges should be investigated with the intention of implementing this change. If feasible, this modification could prevent further encroachment of river channels by tailings piles and could be utilized as an option to clear river channels.

The idea of establishing "**Self Monitoring Environment Groups**" within mining communities should be pursued, as substantial benefits could be derived if they should function effectively.

Lloyd Stephen
Miners Environmental Officer

APPENDICES

Location Map of Guyana

List of attendees at Project Presentation

Detailed Information on Operating Systems

Photographs (1 to 33)

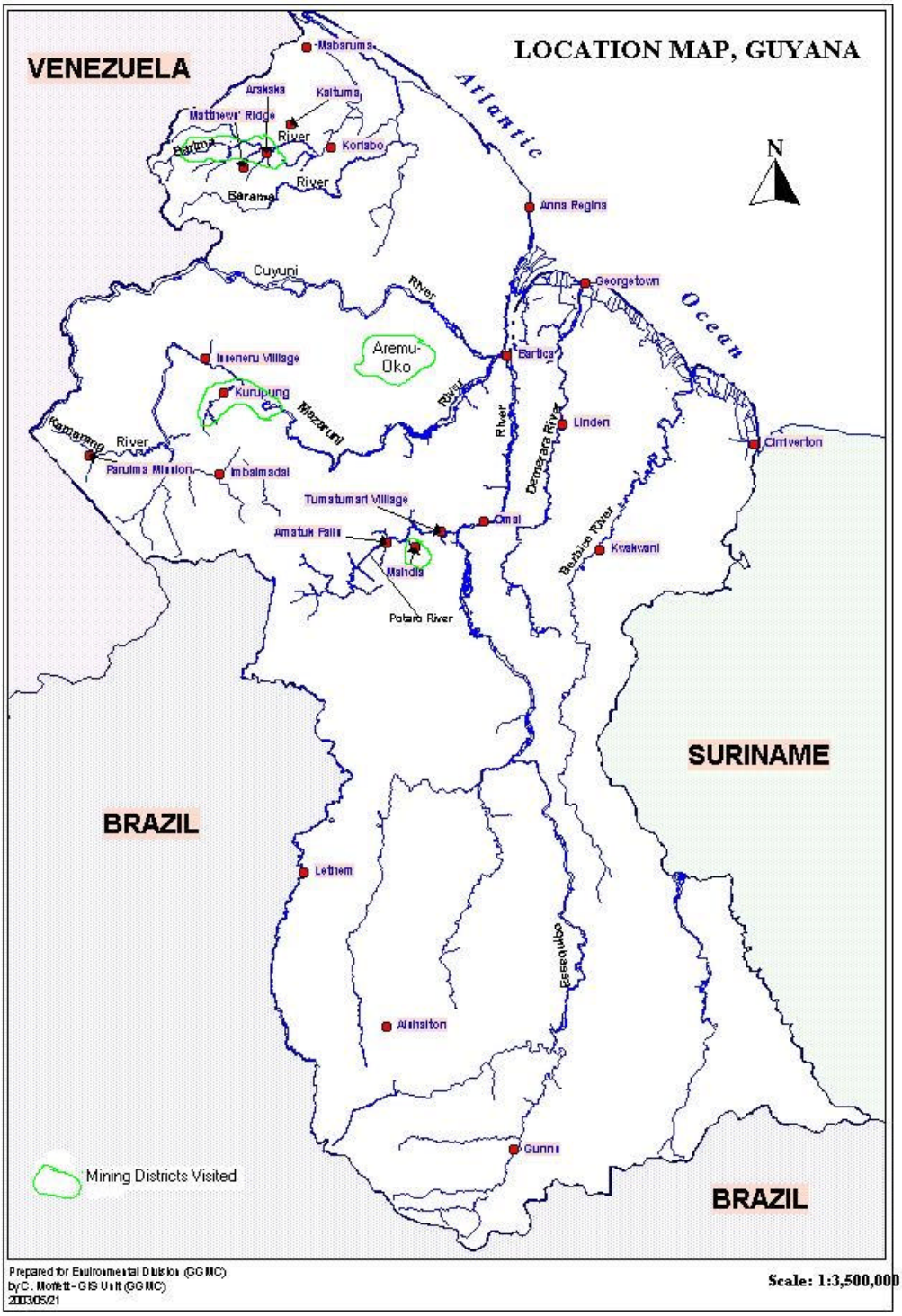


Figure 1: Location of Mining Districts Visited

List of Attendees at Project Presentation

No.	Mr./Mrs.	Name	Designation	Organization/ Department
1	Mr.	Ayalew Legesse	Field Manager	GENCAPD
2	Mr.	William Woolford	Deputy Commissioner	GGMC
3	Mr.	Sydney Edwards		GGMC
4	Ms.	E. Watson	Senior Environmental Officer II	GGMC - Environment
5	Mr.	R. Smith	Environment Technician	GGMC - Environment
6	Mr.	K. Husbands	Environment Technician	GGMC - Environment
7	Ms.	Dianne McDonald	Mines Manager (ag.)	GGMC - Mines
8	Mr.	R. Glasgow	Senior Engineer	GGMC - Mines
9	Mr.	C. Butters	Senior Mines Officer	GGMC - Mines
10	Mr.	Mohan Persaud	Senior Mines Officer	GGMC - Mines
11	Mr.	R, Veeren	Mines Officer	GGMC - Mines
12	Mr.	T. Hurry	Engineer	GGMC - Mines
13	Mr.	P. Callender	Engineer	GGMC - Mines
14	Mr.	K. Ramdas	Engineer	GGMC - Mines
15	Mr.	A. Ramcharran	Survey Technician	GGMC - Mines
16	Mr.	B. Ramkelawan	Survey Technician	GGMC - Mines
17	Mr.	C. Duncan	Survey Technician	GGMC - Mines
18	Mr.	A. Paul	Geo. Technician	GGMC - Mines
19	Ms.	Aretha Crawford	Geologist	GGMC - Geoservices
20	Mr.	Khalid Alladin	Environment Officer II	EPA - Environment

DETAILED INFORMATION ON OPERATING SYSTEMS - MAHDIA

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
Block 27	Deodatt Singh	Pit #1 Pump fed by backhoe jetting	Closed circuit	Earthen dam	No			Rain	Good	Decant to release build up of excess water
Block 27	Deodatt Singh	Pit #2 Pump fed by backhoe and dozer, jetting	No	Earthen dam	No			Same	Same	Ground slui
White Hole	Deo Ramdas	Pump fed by backhoe jetting	Yes	Tailings dyke	No	Expand-ed metal	Nomad			Dyke has a large catch-ment area

DETAILED INFORMATION ON OPERATING SYSTEMS - NORTH WEST

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
10 Miles	John Rodrigues	Vertical shafts without support	N/A	N/A	No	N/A	N/A	Rain Ravine	Good Fair	Hard rock and saprolite
10 Miles	John Rodrigues	Jetting , backfilling old pits	No	Mined-out pits	No			Same	Same	Visited by MEO Curnow
Eyelash	Edenilson Pereira	Supported vertical shaft	No	Mined-out pits	Made in Brazil	N/A – mercury plate used for collection of gold particles.		Rain	Good	Excess flowing to ravine
Eyelash	McKinnon	Jetting	No	Mined-out pits						No one on site
Eyelash	M. Omar	Backhoe, stripping, jetting	Closed circuit	Mined-out pits	No					Backhoe down
Arakaka	Monica “Amy” Chan	Jetting	No	Plaited Cocorite leaves	NO					
Arakaka	Rodrigues Family	Pit #1 Jetting	Partly recycling	Tailings dyke	No	Not utilizing Clarkson’s modifications				Tailings to swamp
Arakaka	Rodrigues Family	Backhoe ripping ore, Jetting	No	Tailings dyke	No	Not utilizing Clarkson’s modifications				Deep “Glory Hole”
Arakaka	Brian Phillips	Two pits Jetting	No	No	No					Swampy area
Arakaka Arakaka	Paul “Pablo” Rodrigues Marlon Trotz	Jetting Jetting	No Closed circuit in dry season	No Mined-out pits	No No					Swampy area Swampy area
Arakaka	J. Jairam	Crusher processing hard rock	Yes	Mined-out pits	No	N/A – mercury plate used for collection of gold particles.		Settled water	Clear	Utilized a backhoe
Arakaka	Desmond Perreira	Jetting , backfilling old pits	No	Wood and old canvas	No			Stream	Fair	
Arakaka	Philbert Miggins	Jetting , backfilling old pits	Closed circuit in dry season	Mined-out pits	No			Stream	Fair	
Arakaka	James Lowe	Jetting	No	Plaited Cocorite leaves	No			Creek Stream	Black water	
Arakaka	Elispram Lopes	Jetting	No	No	No			Well	Fair	Cease work ordered
Arakaka	Kenneth Joaquin	Backhoe stripping, Jetting	Closed circuit	Mined-out pits	No					

DETAILED INFORMATION ON OPERATING SYSTEMS - NORTH WEST
Cont'd

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
Arakaka	Brian Phillips	Jetting	No	No	Fume hood					Polluting nearby creek
Arakaka	Brian Phillips	Jetting	No	No	No					Tailings to swamp
14 Miles	Dennis Dojoi	Pit #1 Backhoe, jetting	Closed circuit	Mined-out pits	No			Spring	Good	Land-locked basin
14 Miles	Dennis Dojoi	Pit #2 Swampy jetting	No	No	No					Ditched water outlet
14 Miles	Souza Martin	Crusher processing hard rock	No	Mined-out pits	No	N/A – mercury plate used for collection of gold particles.				Utilized a backhoe
14 Miles	Joshua De Souza	Jetting	Yes	Plaited Cocorite leaves	No			Well	Could improve	
14 Miles	Hymundo De Souza	Jetting, New operation	Setting up closed circuit	No				Rain	Good	
14 Miles	Joao Assuncao Souza	Jetting	No	Earthen dam	No			Rain Ravine	Good Fair	Check dam to capture water
14 Miles	Glendon Hudson	Jetting, backfilling	NO	Mined-out pits						
14 Miles	Gordon Daniels	Jetting	Closed-circuit	Mined-out pits						Minimal Water available
14 Miles	Milton Seenarine	Backhoe stripping, jetting	No	Waste pits	No	Closely followed Clarkson's sluice modifications		Rain	Good	Ditched waste pits to confine tailings
14 Miles	Paulao Guidas	Backhoe stripping, jetting	Yes	Board and canvas	No					
14 Miles	Lloyd Cameron	Jetting	No	No	Yes	Expand-ed metal	Magic mat			Guilty of mercury pollution
13 Miles	Marlon Williams	Setting up new operations								To recycle
13 Miles	Carmen Deluz	Setting up new operations						Creek	Good	

DETAILED INFORMATION ON OPERATING SYSTEMS - NORTH WEST
Cont'd

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
13 Miles	Peter "Brown Boy" Ward	Not operating								
13 Miles	Elroy "Chinee" Allan	Backhoe stripping, jetting	Yes	Mined-out pits	No	Expand-ed metal	Nomad and Magic mats			
Five Star	Claude Adams	Backhoe stripping, jetting	Yes	Mined-out pits	No	Angle iron and expand-ed metal	Nomad and Brazilian mats	Rain Stream	Good Coloured	Dozer for land prep. and reclama-tion
Five Star	Gavin Blacks	Jetting	No	Canvas-lined check dam	No					Backfille d mined-out area
Five Star	Claude Adams	Jetting	No	No	No					Tailings to swamp
Papaya	Fredrick Obermuller	Crusher processing hard rock	Yes	Earthen dam	No	N/A – mercury plate used for collection of gold particles.				Utilized a backhoe

DETAILED INFORMATION ON OPERATING SYSTEMS - KURUPUNG

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
Middle Takuba	N. Fraser and B. Hodge	Diamond, jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Two pumps in pit
Middle Takuba	M. O. Correia Snr.	Diamond, jetting, backfilling	No	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Tailings trickling to creek
Middle Takuba	GDTC	Diamond, jetting diverted creek bed	Tailings to Takuba Creek	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Operated 2 of 3 pits
Middle Takuba	Wayne Miller	Shallow diamond, jetting	Yes	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				2-3ft thick on slope of hill
Middle Takuba	R. Ramlagan	Shallow diamond, jetting	Yes	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Slope of hill
Upper Takuba	Clement Flue	Reworking tailings, diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Tailings through brush to old pits
Upper Takuba	Brigido Gomes	Reworking tailings, diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Tailings through swampy lands
Upper Takuba	Raimundo Braga Dos Santos	Shallow diamond, jetting	Yes	Earthen stop-off dam	N/A	Not Applicable "LAVADOR" used for separation of diamonds				2-3ft thick on slope of hill
Upper Takuba	Raimundo Da Silva	Diamond, jetting	Closed circuit	Fibrous tree roots & earthen dam	N/A	Not Applicable "LAVADOR" used for separation of diamonds				6-8ft thick at foot of hill
Upper Takuba	Randolph Baker	Shallow Diamond, jetting	Yes	Fibrous tree roots stop-off dam	N/A	Not Applicable "LAVADOR" used for separation of diamonds				2-3ft thick on slope of hill
Upper Takuba	Wayne Viera	Shallow Diamond, jetting, backfilling	Closed-circuit	Fibrous tree roots check dam	N/A	Not Applicable "LAVADOR" used for separation of diamonds				2-3ft thick on slope of hill
Upper Takuba	Luiz Lagoin	Diamond, backhoe stripping, Jetting, backfilled	Yes	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				To relocate
Barlow	SANMIK Civil Works	Diamond, backhoe stripping & mining, Jetting	Closed-circuit	Tailings settlement pond	N/A	Not Applicable Separation of diamonds with four (4) PANAM jigs in series with one (1) Brazilian jig.				drained and backfilled mined-out pits
Barlow	Winston Andrews	Diamond, Jetting	Yes	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Poor quality of water

GDTC –Guyana Diamond Trading Company

DETAILED INFORMATION ON OPERATING SYSTEMS – KURUPUNG Cont'd

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		Other
						Riffle Type(s)	Matting Types(s)	Source	Quality	
Barlow	Winston Andrews	Diamond, Jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Re-located
Barlow	Antonio Da Silva	Diamond, Jetting	Yes	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				
Barlow	Carlos De Aguiar	Diamond, Jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Tree stumps in place
Barlow	De Assis Lopes	Diamond, Jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				
Eping	Antonio Pinheiro	Diamond, shallow, jetting, Backfilling	Closed circuit	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				To relocate
Eping	Roy Morrison	Diamond, jetting, Backfilling	Closed circuit	Mined-out pits, leaves, shrub	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Limited water of poor quality
Kurupung	Renude Deluz	Diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Pump down for repairs
Kurupung	Mario Mendonca	Diamond, jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Limited water supply
Kurupung	Ashton Fernandes	Diamond, jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Tailings 10 - 15ft thick
Kurupung	Altair Gomes	Diamond, jetting	Closed circuit	Earthfilled, Check dam supported By wood	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Dam overflow polluted River
Kurupung	John Bowen	Diamond, jetting	Closed circuit	Mined-out pits	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Quick settle-ment
Kurupung	Renude Deluz	Diamond, river dredge	N/A	N/A	N/A	Not Applicable Jig used for separation of diamonds				
Kurupung	Renude Deluz	Diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Polluted Kurupun g River
Kurupung	Roger Baxter	Diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				Unstable 15-20ft pit face
Olive Creek	Correia Mining Corporation	Gold, missile dredge	Closed circuit	Enclosed work ground	Yes, fabri-cated	Angle iron	Ribbed matting			Explora-tion activities
Enachu	Leyland Cruicshank	Diamond, jetting	No	No	N/A	Not Applicable "LAVADOR" used for separation of diamonds				20-30ft pit face close to the river bank

DETAILED INFORMATION ON OPERATING SYSTEMS - AREMU

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		
						Riffle Type(s)	Matting Types(s)	Source	Quality	Other
Baramalli	Da Silva Filhio	Jetting , backfilling old pits	Yes	Cocorite leaves & tree trunks	No	Expand-ed metal	Miracle	Rain	Good	Excess flowing to ravine
Baramalli	Carlito	Mined-out, relocating								No English
Baramalli	G. Costa	Jetting , backfilling old pits	Yes	Cocorite leaves & tree trunks	No			Rain	Good	Excess flowing to ravine
Baramalli	Aliveira da Silva	Jetting	Closed circuit	Mined-out pits	No	Expand-ed metal	Brazilian mat	Rain	Good	Could improve feed water
Baramalli	Jimmy Corneiro	Jetting	Closed circuit	Old pits, Cocorite leaves & tree trunks	Made in Brazil	Expand-ed metal	Brazilian mat	Rain Creek	Good murky	Could improve feed water
Baramalli	Leite da Silva	Jetting , backfilling old pits	Yes	Old pits, Cocorite leaves & tree trunks	Made in Brazil	Expand-ed metal	Brazilian mat	Rain	Good	
Baramalli	Francisco Dias De Maria	Jetting	No	No	No	Expand-ed metal	Miracle mat	Rain Creek	Good good	Tailings Polluting creek
Baramalli	J. Dejun	Backhoe, stripping, jetting	No	Earthen dam & Cocorite leaves	No	Expand-ed metal	Magic mat and riffle mat	Rain Stream	Good Fair	Tailings on slope of ravine
Baramalli	Jaldo da Silva	Jetting , backfilling old pits	No	Old pits Cocorite leaves	No	Expand-ed metal	Brazilian mat	Rain	Fair	Tailings on slope of ravine
Baramalli	C. A. Almeida	Land prep. with backhoe, Jetting	Closed circuit	Earthen dam	No	Expand-ed metal	Brazilian mat	Rain Well	Good Fair	
Baramalli	Nihuse	Backhoe, stripping, jetting	Closed circuit	Earthen dam	No	Expand-ed metal	Brazilian mat	Rain	Good	
Baramalli	Estvo de Sena	Backhoe, stripping, jetting	No	No	Made in Brazil	Expand-ed metal	Brazilian mat	Rain	Good	Tailings among trees
Baramalli	Sebastian Dias	Jetting , backfilling old pits	Yes	No	No	Expand-ed metal	Brazilian mat	Rain	Good	
Baramalli	Carlito	Backhoe, stripping, jetting	Closed circuit	Earthen perimeter dam	No	Expand-ed metal	Brazilian mat	Rain Creek	Good Fair	
Quartz Stone	Lenno x Hopkinson	Jetting ,	Yes	Mined-out pits	No	Iron riffle	Nomad and Black mats	Rain Stream	Good Fair	Tailings to fill swamp
Quartz Stone	Neil Hopkinson	Jetting , backfilling old pits	Yes	Mined-out pits	No	Vertical riffle	Magic and riffle mats	Rain Stream	Good Fair	Could improve feed water

DETAILED INFORMATION ON OPERATING SYSTEMS – AREMU Cont'd

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		
						Riffle Type(s)	Matting Types(s)	Source	Quality	Other
Quartz Stone	Collin Hopkinson	Jetting , backfilling old pits	Yes	Mined-out pits	No	Brazilian riffle mesh	Magic and riffle mats	Rain Stream	Good Fair	Excess flowing to ravine
Arawak	Maurice Hopkinson	Backhoe Stripping, new ops.	No	No	No	Expand-ed metal	Magic and Black mats	Rain Stream	Good Good	To closed-circuit
Arawak	N. Munroe and Culpepper	Jetting	No	No	No			Rain Stream	Good Good	To make Stop-off dam
Arawak	Anthony David	To strip with Backhoe	closed circuit	Mined-out pits	No	Iron riffle	Magic and Fur mats	Rain Stream	Good Fair	New operation
Arawak	Philbert Fraser	Backhoe stripping, jetting	No	No	No	Riffle, Expand-ed metal	Magic and Black mats	Rain Stream	Good Fair	Tailings polluting creek
Arawak	Joseph Prass	Backhoe stripping, jetting,	No	Mined-out pits	No	Riffle, Expand-ed metal	Miracle mat	Rain	Good	Back-filling old pits
Arawak	Dexter Bryan	Jetting, backfilling old pits	No	Mined-out pits	No	Expand-ed metal	Magic mat	Rain	Good	
Aremu	Moises de Olivera	Backhoe stripping, jetting, backfilling old pits	No	Mined-out pits	Not using his retort	Iron riffle and expand-ed metal	Nomad mats	Rain	Good	Effluent runoff to swamp
Aremu	Raimundo A. Costa	Backhoe stripping	Closed circuit	Mined-out pits	Rents retort	Expand-ed metal	Nomad mats	Rain Pond	Good Clear	Good operation
Aremu Aremu	Raimundo de Araujo Clinton Alphonso	Backhoe stripping Backhoe stripping	Closed circuit Closed circuit	Mined-out pits Mined-out pits	Brazil made Fab-ricated device	Expand-ed metal Expand-ed metal	Nomad mats Rubberized and black mats	Rain Pond Rain Pond	Good Clear Good Clear	Good operation Good operation
Aremu	Terry Singh	Backhoe stripping, backfilling old pits	No	Mined-out pits	No	Expand-ed metal	Magic mats	Rain Pond	Good Clear	Well defined pit
Aremu	Peter Robinson	Backhoe stripping, jetting	No	No	No	Iron riffle, Expand-ed metal	Magic mat	Rain Creek	Good fair	Tailings used to build new camp ground
Oko	Joseph Chan	Jetting	No	No	No	None	None	Rain	Good	Guilty of mercury and tailings pollution
Oko	J. Amorim and K. Ross	Jetting	No	Plaited cocorite leaves	No	Brazilian mesh	Magic mat	Rain	Good	Guilty of mercury and tailings pollution

DETAILED INFORMATION ON OPERATING SYSTEMS – AREMU Cont'd

Area	Owner / Operator	Type of operation	Tailings Pond Recycling (Y/N)	Silt fence or Trapping Device (Y/N)	Retort used (Y/N)	Sluice Box		Drinking/Domestic Water		
						Riffle Type(s)	Matting Types(s)	Source	Quality	Other
Oko	Getulio Da Silva Freire	Backhoe stripping, jetting, backfilling old pits	No	Mined-out pits	No	Expand-ed metal	Matting	Rain Creek	Good ?	Clear feed water from old pit
Oko	Roy Mosanto	Backhoe stripping, jetting,	No	Mined-out pits	No	Expand-ed metal	Rubber matting	Rain Creek	Good ?	To improve on tailings control
Oko	Joses M. G. Da Silva	Backhoe stripping, jetting, backfilling old pits	No	Mined-out pits	No	Expand-ed metal	Carpet matting	Rain Creek	Good ?	Clear feed water from old pit

Photo 1 – Uncontrolled flow of tailings into bushes at Arawak.

Photo 2 – Tailings Discharged Directly into Kurupung River

Photo 3 – Extremely turbid water of Aremu River, at bridge before GGMC's camp.

Photo 4 - Mercury being handled with bare hand at 14 Miles

Photo 5 – A series of partly filled mined-out pits at Aremu

Photo 6 – Unsafe operating pit conditions, at Baramalli.

Photo 7 – Undermined Trees Left Standing in a Mined-Out Pit, at Chance Creek.

Photo 8 – Old mined-out pit being backfilled at Quartz Stone.

Photo 9 – A relatively Clean, Orderly and Shallow Mine Pit at Barlow.

Photo 10 – Retorting Shed Consisting of Mercury Retort, Jig Box and Shaking Table for Proper Processing of Gold Amalgam and Black Sands at Olive Creek.

Photo 11 – A closed circuit recycled water system established at a hydraulicking operation at Baramalli.

Photo 12 – An operation consisting of clean mining pit, good pit definition and mine configuration and a closed circuit recycle water system totally enclosed within an outer perimeter dam at Baramalli.

Photo 13 – Good pit configuration with, well-defined pit faces at Middle Aremu. Note, vertical pit faces (25 to 30ft.) deep with overburden overcastted close to the edge of the mining face.

Photo 14 – Crude system of indigenous material used to confine tailings solids at Baramalli.

Photo 15 – Tailings Confinement Dam as Part of The Closed Circuit Recycled Water System at Barlow.

Photo 16 – Construction of Tailings Confinement Dam From Indigenous Material, as Part of a Closed Circuit System at Upper Takuba Creek.

Photo 17 – A Filtration Dam Constructed From Fibrous Roots and supported by Tree Trunks, as Part of a Closed-Circuit Recycled Water System at Upper Takuba Creek.

Photo 18 - Damming of Arakaka Creek by Confining Tailings Discharged Directly Between Two Rows of Plaited "Cocorite" Leaves Supported by Stakes.

Photo 19 - GGMC's Experimental Dam – Local Filter Linings Pinned by Wooden Stakes

Photo 20 - Tailings Impoundment System Employed at 10 Miles, where Tailings is Routed Through Mined-Out Pit allowing Partially Settled Water to be Decanted to Nearby Stream.

Photo 21 - The use of a Cat. Backhoe, at Five Star, that Resulted in Clean and Stable Pit Walls, and Jetting of Pay Material Only.

Photo 22 – Old Mined-out Pits Used to Establish Closed Circuit Recycle Water System at Arakaka

Photo 23 - A Small Cat. Dozer, at Five Star, Enabled Better and Safer Ground Preparation as well as some Land Reclamation.

Photo 24 - A Typical Land Dredging Operation at Arakaka, where both Overburden and Pay Material are Removed by Jetting and Routed Through Sluice Box.

Photo 25 – Large Mined-Out Area (Settling Pond) at Baramalli. Interest for use as an Aquaculture Farm.

Photo 26 – Mercury Plate For Gold Amalgamation in Crusher Processing System at Eyelash. Note brown spots indicating loss of mercury.

Photo 27 – Mercury Plate in Operation at Eyelash.

Photo 28 – Improper Positioning of River Dredge, with Tailings Discharge Angled Towards River Channel, Kurupung River.

Photo 29 – Narrowing of River Channel by Tailings Solids from Previous River Dredging Operations. Kurupung River.

Photo 30 – Extended Discharge Pipeline, CMC's Operations, Olive Creek

Photo 31 – Pristine Water of Previously Dredged Area, in the Vicinity of "Crapo Rock", Upper Kurupung River.

Photo 32 – The deplorable main access road to Baramalli.

Photo 33 – Pink Hill or is “This Punishment Hill”? on route to Baramalli.