EIA Report on Land Dredge Operations in Small-Scale and Medium-Scale Mining in Guyana

(with Special Emphasis on Mitigation Approaches to Reduce Effluents impact)

Georgetown, Guyana

Report

NRCan (CANMET) – GENCAPD Mining Project

Our File: M-6763-6 (603430)

February 2004

SNC·LAVALIN Environment

Member of the SNC·LAVALIN Group

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March 2, 2004

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SUBJECT: EIA Report on Land Dredge Operations and Mitigation Approaches to Reduce Effluents Impact in Small- and Medium-Scale Mining in Guyana
PWGSC contract No. 23440-021003
Our file: M-6763-6 (603430)

Sir:

In compliance with deliverables for item 2.2 of our contract, please find enclosed the EIA Report on Land Dredge Operations with special emphasis on mitigation approaches to reduce impact of effluents. This document also contains a chapter on the involvement of miners and local community representatives.

Should you have further questions or comments please do not hesitate to contact the undersigned.

Yours sincerely,

SNC-LAVALIN ENVIRONMENT INC.

Marc Arpin, M.Sc., P.Geo.
Project Director

MA/lj

Encl.

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DISCLAIMER

The primary purpose of this publication is to provide a EIA Report on land dredge operations in small-scale and medium-scale mining in Guyana. It expresses the professional opinion of SNC-LAVALIN INC. (SLI) regarding the matters set out herein, based on SLI's professional judgment and reasonable due diligence. It is to be read in the context of the agreement of August 4, 2003 (the Agreement) between SLI and Natural Resources Canada (the Client), and in accordance with the methodology, procedures and techniques that SLI used, the assumptions SLI made, and the circumstances and constraints under which SLI carried out its mandate. This document is meant to be read as a whole, and sections or parts thereof should therefore not be read or relied upon out of context.

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1. INTRODUCTION

1.1 Rationale

The Cumulative Environmental Effects Assessment (CEEA), conducted in January-February 2004 by the GENCAPD Mining project and SNC-LAVALIN ENVIRONMENT INC. in the Mahdia area, provided an outstanding opportunity for the systematization of existing information and knowledge on the impacts of small-scale and medium-scale mining on the environment and the community[1]. Because of the important small-scale and medium-scale mining taking place on its territory, the Mahdia area can be seen as the poster region of land dredge mining in Guyana and, as such, is highly representative of what is going on elsewhere in the country.

1.2 Methodology

For the present work, the results from the Mahdia Cumulative Environmental Effects Appraisal[2] (CEEA) have been used to illustrate the impacts of small and medium-scale mining on the environment and the community. Land dredge mining-related environmental problems in Mahdia are the same as in any other gold mining districts we visited in Guyana. Cumulative effects may obviously vary from one area to another but the impacts are basically the same everywhere.

Mitigation measures to alleviate impacts on Valued Ecosystem Components (VEC) will be discussed for every VEC. We will strongly focus on low cost/high benefits techniques that are amenable to small miners. As the purpose of the present report is to emphasize mitigation approaches to reducing effluent impact, appendices on runoff and sediments collection structures have also been provided. These appendices are essentially the same as those that form part of the Code of Practice on Mine Effluents.

[1] See SNC-LAVALIN ENVIRONMENT INC. (2004)a.

[2] Idem.

2. ENVIRONMENTAL IMPACTS ASSESSMENT

Environmental impacts from land dredge mining are summarized in Table 2-1. The significance of every impact, before and after mitigation, has been estimated[3]. Special emphasis was put on the following VECs, which are the most affected by mining actions:

- Water quality in rivers and creeks.
- Groundwater regime and quality.
- Quality and availability of soils.
- Abundance and quality of carnivorous fish.
- Wildlife habitat.
- Vegetal biodiversity.
- Aesthetics.
- Community health.

2.1 Discussion on impacts and mitigation measures

2.1.1 Water quality in rivers and creeks

Water quality in rivers and creeks is by far the VEC that is most affected by land dredge mining. Except for operation of equipment, every mining action ha an impact on it. Most significant impacts are related to sediments and contaminants discharge into the waterways. Sampling, stripping of overburden, hydraulicking, tailings disposal and ultimately the closure of the mine lead to increased erosion and mobilization of sediments thus resulting in a reduction of surface water quality. The most problematic mining activities are those that lead to the discharge of sediments and mercury into the waterways. The perverse effect of hydraulicking is that it not only discharges large amount of suspended solids, but it also contributes to the emission of naturally occurring mercury (attached to fines), that would otherwise remain in the soils.

[3] The reader should refer to SNC-LAVALIN ENVIRONMENT INC. (2004) for explanations on methodology.

Therefore, controlling turbidity contributes to a large extent to the reduction of mercury that is found in the recipient watercourses.

2.1.1.1 Mitigation measure

All measures contributing to the reduction of suspended materials in the effluent is likely to demonstrate a high rate of return in terms of the environmental cost/benefits ratio. One such measure is a settling pond, preferably in series of two or three (see Appendix A). Settling ponds are used as:

- Impoundments for process contaminated water, washing plants or sluicing, or other forms of placer mining that can deposit significant amounts of sediment into surface water.
- Impoundments for sediment laden water running off excavated or stripped lands.
- Impoundments designed for percolation, infiltration or evaporation of water.

For operations which cannot rely on heavy equipment, sediments traps (e.g. silt fence, brush barrier, etc.) are simple, efficient and easily constructed facilities. Examples of sediments traps are shown in Appendix A.

Controlling runoff is another way of substantially and easily reducing the discharge of suspended material into the rivers and creeks. We have provided a number of examples in Appendix B.

A combination of runoff and sediments collection structures could reach in excess of 90% effectiveness in decreasing the turbidity in the watercourses. The use of amalgamation drums and retorts would prevent the release of mercury from the gold amalgamation process.

2.1.2 Groundwater regime and quality

The only actions that may strongly impact on groundwater quality are related to open circuit amalgamation, open air burning of amalgam and improper disposal of industrial and hazardous waste. Excavation of pits may cause local disruption of the water table.

2.1.2.1 Mitigation measure

An amalgamation drum (operated at a low rpm to avoid overmilling of mercury) should be used for amalgamating gold particles. Burning of amalgam should be performed with a retort so as to avoid vapourization (followed by condensation) of mercury.

2.1.3 Quality and availability of soils

The availability of soils is adversely affected by all activities that foster runoff and erosion (debushing, stripping, trenching, hydraulicking). Exposed soil on steep slopes under a rain forest environment make up the conditions for extreme erosion. Runoff velocities must be reduced, slopes smoothened and as much vegetation cover as possible be left on the ground. Some examples of runoff dispersion structures are provided in Appendix C.

2.1.4 Air quality

The main impact on air quality is related to vapourization of mercury during open air burning of gold amalgam. Occasional dust emissions are considered more a nuisance than a genuine impact.

2.1.4.1 Mitigation measure

The use of a retort to burn gold amalgam would mitigate almost 100% of mercury emission into the atmosphere.

2.1.5 Quality and abundance of carnivorous fish

The large size predator fishes are highly reliant on the water quality of rivers and creeks. Therefore, any action that cause turbidity and discharge of mercury (and both) will have an incidence on the abundance and quality of fish. As a consequence, mitigation measures will be related to management of effluents and of mercury.

2.1.5.1 Mitigation measures

Same as 2.1.1.1 above.

2.1.6 Wildlife habitat

Mining actions adversely impact on wildlife habitats. Deforestation, noise, flooding, discharge of sediments on land (tailings) are all contributing to a reduction of habitat. Testimonies from local residents confirm that hunters have to go increasingly farther to bag game.

2.1.6.1 Mitigation measures

In order to protect wildlife habitats, debushing has to be selective rather than systematic. A continuity in the vegetation must be preserved so that an uninterrupted forested corridor is maintained.

2.1.7 Vegetal biodiversity

Impacts on vegetal biodiversity are linked to the same actions that affect wildlife habitats. Some rare and sensitive vegetal species might be adversely affected.

2.1.7.1 Mitigation measures

Selective debushing and protection of vegetal cover as mush as possible.

Table 2-1

Summary of impacts and mitigation measures for land dredge mining

(Adapted from SNC-LAVALIN ENVIRONMENT INC. (2004)a)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
PHYSICAL SETTING								
Water quality in rivers and creeks	**MINING**							
	Road Construction	Increased concentration of suspended solids in recipient waters	M	L	S	L	Leave a 30 meters wide vegetated border on each side of the road	L
	Line cutting/mobilization	Increased concentration of suspended solids in recipient waters	M	L	S	L	Runoff collection structures	L
	Debushing and burning	Increased concentration of suspended solids in recipient waters	H	L	M	H	Selective debushing; runoff collection structures	L
	Stripping of overburden and stockpiling	Increased concentration of suspended solids in recipient waters	H	L	M	H	Runoff collection structures; sediments collection structures (settling ponds) slopes stabilization and flattening of soils piles	L
	Sampling trenching and pitting	Increased concentration of suspended solids in recipient waters	M	L	S	L	Runoff collection structures and sediments collection structures	L
	Ore extraction (hydraulicking)	Increased concentration of suspended solids in recipient waters Release of naturally occuring mercury into recipient waters	VH	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Ore extraction (dry mining)	Increased concentration of suspended solids in recipient waters	L	L	L	L	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Concentration (sluice box)	Increased concentration of suspended solids in recipient waters	H	L	L	H	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Amalgamation and burning	Increased concentration of mercury in recipient waters (open-circuit amalgamation and open-air burning)	VH	L	S	H	Use of amalgamating drum and retort	VL
	Tailings disposal	Increased concentration of suspended solids in recipient waters	VH	L	L	H	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Industrial waste disposal	Increased contaminants levels in recipient waters	VH	L	S	H	Transport and disposal in approved disposal site	VL
	Domestic waste disposal	Increased contaminants levels in recipient waters	M	L	S	L	Use of appropriate landfill	L
	Hazardous waste disposal	Increased contaminants levels in recipient waters	VH	L	S	H	Transport and disposal in approved disposal site	VL
	Demolition of buildings and removal of infrastructures	Increased concentration of suspended solids in recipient waters	VH	L	S	H	Runoff collection structures; settling pond and revegetation	VL
	NON MINING							
	Settlements (squatting)	Increased contaminants levels in recipient waters	L	L	L	L	Construction of social housing; use of latrines	L
	Transportation (road)	Increased concentration of suspended solids in recipient waters	L	L	L	L	Runoff dispersion structures (brush, remnants of crops) on each side of the road to favour water penetration	L
	Transportation (river)	Increased contaminants levels in recipient waters	L	L	L	L	Proper maintenance of outboard boats. Enforcement of river transportation regulations	VL
	Agriculture (slash and burn)	Increased concentration of suspended solids in recipient waters	L	L	L	L	Selective debushing to leave a vegetal cover	L
	Logging (small scale)	Increased concentration of suspended solids in recipient waters	L	L	L	L	Selective debushing to leave a vegetal cover	L

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
Groundwater regime and quality	**MINING**							
	Stripping of overburden and stockpiling	Seepage of mercury-carrying surface waters towards groundwater table	M	L	L	L		
	Ore extraction (hydraulicking)	Seepage of mercury-carrying surface waters towards groundwater table	L	L	L	L	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Ore extraction (dry mining)	Seepage of mercury-carrying surface waters towards groundwater table	L	L	L	L	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Amalgamation and burning	Seepage of mercury-carrying surface waters towards groundwater table (open-circuit amalgamation and open-air burning)	VH	L	S	H	Use of amalgamating drum and retort	VL
	Industrial waste disposal	Increased contaminants levels in recipient waters	VH	L	S	H	Transport and disposal in approved disposal site	VL
	Domestic waste disposal	Increased contaminants levels in recipient waters	M	L	S	L	Use of appropriate landfill	VL
	Hazardous waste disposal	Increased contaminants levels in recipient waters	VH	L	S	H	Transport and disposal in approved disposal site	VL
Quality and availability of soils	**MINING**							
	Line cutting/mobilization	Exposure of soils to hydric erosion and sedimentary transport	M	L	S	L	Remants of vegetation left on the ground to foster water penetration instead of runoff	VL
	Debushing and burning	Exposure of soils to hydric erosion and sedimentary transport	L	L	M	L	Selective debushing	VL
	Stripping of overburden and stockpiling	Exposure of soils to hydric erosion and sedimentary transport	M	L	M	M	Stockpiling of soils for reuse and slope stabilization and flattening of the soil pile to prevent erosion	L
	Sampling trenching and pitting	Exposure of soils to hydric erosion and sedimentary transport	VH	L	S	H	Segregation and stockpiling of soils	L
	Ore extraction (hydraulicking)	Washing-out of soils into drainage pathways	H	L	L	H	Dry mining instead of hydraulicking. Segregation and stockpiling of soils prior to commencement of hydraulicking	L
	Ore extraction (dry mining)	Exposure of soils to hydric erosion and sedimentary transport	H	L	L	H	Segregation and stockpiling of soils prior to commencement of hydraulicking	L
	Amalgamation and burning	Accumulation of amalgamation mercury in exposed soils subjected to hydric erosion and sedimentary transport (open-circuit amalgamation and open-air burning) In-situ methylation	H	L	S	M	Use of amalgamating drum and retort	L
	Tailings disposal	Discharge of mercury-bearing sediments onto natural soils	H	L	L	H	Construction of a proper, watertight tailings disposal area.	VL
	Industrial waste disposal	Potential seepage of contaminants into soil	H	L	S	M	Transport and disposal in approved disposal site	VL
	Hazardous waste disposal	Potential seepage of contaminants into soil	VH	L	S	H	Transport and disposal in approved disposal site	VL
	Demolition of buildings and removal of infrastructures	Exposure of soils to hydric erosion and sedimentary transport	VH	L	S	H	Revegetation	VL
	NON-MINING							
	Settlements (squatting)	Exposure of soils to hydric erosion and sedimentary transport	L	L	L	L	Construction of social housing	VL
	Agriculture (slash and burn)	Exposure of soils to hydric erosion and sedimentary transport	L	L	L	L	Selective slash	VL
	Logging (small scale)	Exposure of soils to hydric erosion and sedimentary transport	L	L	L	L	Selective debushing	L

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
Air quality	**MINING**							
	Road construction	Exposure of mercury-bearing soils to aeolian erosion and release of dust	H	L	S	M	Leave a 30 meters wide vegetated border on each side of the road. Decrease speed of vehicles. Use dust abatement (water spraying)	L
	Debushing and burning	Release of wood-burning gases into the air (emission of APH)	M	L	M	M	Allow burning only when weather conditions are adequate (wind direction opposite settlements)	VL
	Stripping of overburden and stockpiling	Exposure of mercury-bearing soils to aeolian erosion and release of dust	M	L	M	L		
	Amalgamation and burning	Release of mercury vapors into the air (open-air burning)	VH	L	S	H	Use of retort	VL
	Operating equipment	Release of fuel combustion gases into the air	M	L	S	L	Proper maintenance of engine	VL
	Hazardous waste disposal	Release of toxic vapors into the air	L	L	L	L	Transport and disposal in approved disposal site	VL
BIOLOGICAL SETTING								
Quality of carnivorous fish	**MINING**							
	Ore extraction (hydraulicking)	Accumulation of methylated mercury in fish tissues	VH	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Concentration (sluice box)	Accumulation of methylated mercury in fish tissues	L	L	L	L	Never pour mercury into the sluice box. Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Amalgamation and burning	Accumulation of methylated mercury in fish tissues	VH	L	S	H	Use amalgamating drums and retorts	VL
	Tailings disposal	Accumulation of methylated mercury in fish tissues	H	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Industrial waste disposal	Potential accumulation of industrial contaminants in fish tissues	L	L	L	L	Transport and disposal in approved disposal site	VL
	Hazardous waste disposal	Potential accumulation of hazardous contaminants in fish tissues	M	L	L	M	Transport and disposal in approved disposal site	VL
Abundance of carnivorous fish	**MINING**							
	Road construction	Suffocation following decreased oxygen availability in recipient waters	H	L	S	M	Leave a 30 meters wide vegetated border on each side of the road	L
	Stripping of overburden and stockpiling	Suffocation following decreased oxygen availability in recipient waters	M	L	M	M	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Ore extraction (hydraulicking)	Suffocation following decreased oxygen availability in recipient waters Eventual intoxication by methylated mercury forms Siltation of spawning-grounds and decreasing spawn production	VH	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Concentration (sluice box)	Suffocation following decreased oxygen availability in recipient waters Eventual intoxication by methylated mercury forms Siltation of spawning-grounds and decreasing spawn production	H	L	L	H	Construction of watertight tailings pond. Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Tailings disposal	Suffocation following decreased oxygen availability in recipient waters Eventual intoxication by methylated mercury forms Siltation of spawning-grounds and decreasing spawn production	VH	L	L	VH	Construction of watertight tailings pond. Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Industrial waste disposal	Intoxication, contaminant-related diseases or mutations	M	L	L	M	Transport and disposal in approved disposal site	
	Hazardous waste disposal	Intoxication, contaminant-related diseases or mutations	H	L	L	H	Transport and disposal in approved disposal site	

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
	NON-MINING							
	Fishing	Decrease of fish populations by extensive fishing or by migration of fishes towards less disturbed watercourses	H	L	L	H	Controlled fishing	VL
	MINING							
	Road construction	Potential partial loss of habitat or habitat disturbance	VH	L	S	H	Keep a forested border on each side of the road	L
	Line cutting/mobilization	Potential partial loss of habitat or habitat disturbance	H	L	S	M	Selective slashing	M
	Debushing and burning	Potential loss of habitat and disturbance of neighboring habitats by air pollution	H	L	M	H	Selective slashing to ensure a continuity in vegetation	L
	Stripping of overburden and stockpiling	Potential loss of habitat or habitat disturbance	H	L	M	H	Selective slashing to ensure a continuity in vegetation	L-M
	Sampling trenching and pitting	Potential partial loss of habitat or habitat disturbance	VH	L	S	H	Selective slashing to ensure a continuity in vegetation	M
	Ore extraction (hydraulicking)	Potential loss of habitat or habitat disturbance	H	L	L	H	Keep a 30-meter forested border around pits	M
	Ore extraction (dry mining)	Potential loss of habitat or habitat disturbance	H	L	L	H	Keep a 30-meter forested border around pits	M
	Concentration (sluice box)	Potential loss of habitat or habitat disturbance by sediments accumulation	H	L	L	H		H
Wildlife habitat	Tailings disposal	Potential loss of habitat or habitat disturbance by sediments accumulation	H	L	L	H		H
	Operating equipment	Disturbance to wildlife by noise and combustion gas emissions	H	L	L	H		H
	Industrial waste disposal	Habitat disturbance by waste accumulation	L	L	L	L	Transport and disposal in approved disposal site	L
	NON MINING							
	Settlements (squatting)	Potential loss of habitat and disturbance of neighboring habitats by noise and air pollution	M	L	L	M	Construct social housing	VL
	Transportation (road)	Potential loss of habitat and disturbance of neighboring habitats by noise and air pollution	H	L	L	H	Install culverts and passageways for small animal species	M
	Agriculture (slash and burn)	Potential loss of habitat and disturbance of neighboring habitats by noise and air pollution	M	L	L	M		
	Logging (small scale)	Potential loss of habitat or habitat disturbance	H	L	L	H	Selective slashing	M-L
	Hunting	Reduced wildlife populations by extensive hunting or by migrating species towards less disturbed habitats	L	L	L	L		

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
Vegetal biodiversity	**MINING**							
	Road construction	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	VH	L	S	H	Restrict debushing to the road width	M
	Line cutting/mobilization	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	H	L	S	M	Selective debushing	L
	Debushing and burning	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	H	L	M	H	Selective rather than systematic debushing	M
	Stripping of overburden and stockpiling	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	H	L	M	H	Minimize soil removal. Stockpile soils for future use and keep it biologically active	M
	Ore extraction (hydraulicking)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	H	L	L	H	Leave a forested border on the pit margins	M
	Ore extraction (dry mining)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	H	L	L	H	Leave a forested border on the pit margins	M
	Tailings disposal	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity. Risk of mercury contamination of vegetal species.(appearance of prairie species at the expense of forest species)	H	L	L	H	Construct watertight tailings impoundment	M
	Industrial waste disposal	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	M	L	S	L	Transport and disposal in approved disposal site	L
	NON MINING							
	Settlements (squatting)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	M	L	L	M		
	Transportation (road)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	L	L	L	L		
	Agriculture (slash and burn)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	L	L	L	L		
	Logging (small scale)	Potential perturbations of the rain forest ecosystem occurring as local reduction of biodiversity (appearance of prairie species at the expense of forest species)	L	L	L	L	Selective debushing	L

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
HUMAN SETTING								
Quality of the immediate environment of the community	**MINING**							
	Ore extraction (hydraulicking)	Degradation of life environment quality and natural resources of the community	H	L	L	H	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Tailings disposal	Degradation of life environment quality and natural resources of the community	M	L	L	M	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	L
	Hazardous waste disposal	Degradation of life environment quality and natural resources of the community	H	L	L	H	Transport and disposal in approved disposal site	VL
	NON-MINING							
	Logging (small scale)	Degradation of life environment quality and natural resources of the community	M	L	L	M	Selective slashing	L
Aesthetics	**MINING**							
	Stripping of overburden and stockpiling	Degradation of the visual aspect of the environment	VH	L	M	VH	Leave a forested border on the pit margins./ Reclamation	M/L
	Sampling trenching and pitting	Degradation of the visual aspect of the environment	VH	L	S	H	Backfill pits./Reclamation	M/L
	Ore extraction (hydraulicking)	Degradation of the visual aspect of the environment	VH	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures. Reclamation (including revegetation)	L
	Ore extraction (dry mining)	Degradation of the visual aspect of the environment	VH	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures. Reclamation (including revegetation)	L
	Concentration (sluice box)	Degradation of the visual aspect of the environment	VH	L	L	VH	Construct tailings pond. Reclamation	L
	Tailings disposal	Degradation of the visual aspect of the environment	VH	L	L	VH	Construct tailings pond. Reclamation	L
	Hazardous waste disposal	Degradation of the visual aspect of the environment	H	L	L	VH	Transport and disposal in approved disposal site	VL
	Demolition of buildings and removal of infrastructures	Degradation of the visual aspect of the environment	VH	L	S	H	Reclamation (including revegetation)	L
	NON-MINING							
	Settlements (squatting)	Degradation of the visual aspect of the environment	H	L	L	H	Construct social housing	L
Agriculture and ecotourism	**MINING**							
	Stripping of overburden and stockpiling	Degradation of the environment and loss of agricultural and touristic potential	L	L	M	L	Soils segregation and stockpiling	VL
	Ore extraction (hydraulicking)	Degradation of the environment and loss of agricultural and touristic potential	L	L	L	L	Soils segregation and stockpiling	VL
	Ore extraction (dry mining)	Degradation of the environment and loss of agricultural and touristic potential	L	L	L	L	Soils segregation and stockpiling	VL
	NON-MINING							
	Settlements (squatting)	Degradation of the environment and loss of agricultural and touristic potential	H	L	L	H	Construct housing	VL
	Transportation (road)	Enhanced ecotourism and rural economic activities				L(P)	Positive impact	

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
	Transportation (river)	Enhanced ecotourism and rural economic activities				L(P)	Positive impact	
	Agriculture (slash and burn)	Enhanced rural economic activities				H(P)	Positive impact	
Community health	**MINING**							
	Ore extraction (hydraulicking)	Intake of mercury through fish consumption; proliferation of malaria and dengue fever	H	L	L	VH	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	M
	Ore extraction (dry mining)	Intake of mercury through fish consumption; proliferation of malaria and dengue fever	L	L	L	L	Sediments collection structures (settling ponds); runoff collection structures and runoff dispersion structures	M
	Amalgamation and burning	Mercury intoxication by workers around mining camp	VH	L	S	H	Use of amalgamating drums and retorts	VL
	Tailings disposal	Potentially mercury contaminated material discharged onto soils and into rivers can lead to intake from population	H	L	L	VH	Construct tailings impoundment	L
	Hazardous waste disposal	Intake of hazardous contaminants through fish consumption or direct exposure	H	L	S	H	Transport and disposal in approved disposal site	VL
	NON-MINING							
	Settlements (squatting)	Transmission of STDs, and proliferation of malaria and water-born diseases	H	L	L	H		
	Ecotourism	Transmission of STDs, and proliferation of malaria and water-born diseases	H	L	L	L		
Security	**MINING**							
	Road construction	Increased criminality level	M	L	S	L	Better law enforcement	VL
	NON-MINING							
	Transportation (road)	Increased criminality level	M	L	L	M	Better law enforcement	VL
Utilities	**MINING**							
	Road construction	Providing access to the mining sites				M(P)	Positive impact	
OH&S	**MINING**							
	Ore extraction (hydraulicking)	Improper working conditions and environment	H	L	L	VH	Use individual safety gear and equipment. Reduce working hours	M
	Ore extraction (dry mining)	Improper working conditions and environment	L	L	L	L	Use individual safety gear and equipment. Reduce working hours	VL
	Concentration (sluice box)	Improper working conditions and environment	H	L	L	VH	Use individual safety gear and equipment. Reduce working hours	M
	Hazardous waste disposal	Improper working conditions and environment	VH	L	S	H	Transport and disposal in approved disposal site	

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
Preservation of Aboriginal culture and heritage	**MINING**							
	Road construction	Disturbance to aboriginal heritage sites and community	VH	L	S	H	Better coordination and dialogue with local Aboriginal associations	M
	Stripping of overburden and stockpiling	Disturbance to aboriginal heritage sites and community	L	L	M	L		
	Ore extraction (hydraulicking)	Disturbance to aboriginal heritage sites and community	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	M
	Ore extraction (dry mining)	Disturbance to aboriginal heritage sites and community	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	M
	Concentration (sluice box)	Disturbance to aboriginal heritage sites and community	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	M
	NON-MINING							
	Settlements (squatting)	Disturbance to aboriginal heritage sites and community	H	L	L	H	Construct social housing	L
	Transportation (road)	Disturbance to aboriginal community	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	
	Transportation (river)	Disturbance to aboriginal community	L	L	L	L	Better coordination and dialogue with local Aboriginal associations	
	Logging (small scale)	Disturbance to aboriginal community	L	L	L	L	Better coordination and dialogue with local Aboriginal associations	
	Hunting	Disturbance to aboriginal community and resources	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	
	Fishing	Disturbance to aboriginal community and resources	H	L	L	H	Better coordination and dialogue with local Aboriginal associations	
	Ecotourism	Disturbance to aboriginal community and resources	M	L	L	M	Better coordination and dialogue with local Aboriginal associations	
Salaries and wages	**MINING**							
	Ore extraction (hydraulicking)	Income for the workers				H(p)	Positive impact	
	Ore extraction (dry mining)	Income for the workers				H(p)	Positive impact	
	NON-MINING							
	Transportation (road)	Income for the truck drivers				H(p)	Positive impact	
	Transportation (river)	Income for the boat owners				L(p)	Positive impact	
	Logging (small scale)	Income for the loggers				L(p)	Positive impact	
Sound local development	**MINING**							
	Road construction	Increased economic activities				H(p)	Positive impact	
	Ore extraction (hydraulicking)	Increased economic activities				L(p)	Positive impact	

Table 2-1 (Cont'd)

VECs	Activity Source of Impact	Impact Description	Impact Assessment				Mitigation Measures	Residual Impact Significance[5]
			Intensity[1]	Extent[2]	Duration[3]	Significance[4]		
	Ore extraction (dry mining)	Increased economic activities				L(p)	Positive impact	
	Tailings disposal	Increased economic activities				L(p)	Positive impact	
	Hazardous waste disposal	Potential hazard to the community when improperly managed	H	L	L	H	Transport and disposal in approved disposal site	VL
	NON-MINING							
	Settlements (squatting)	Anarchic settlement impairs social development and organization of the community	H	L	L	H	Construct social housing	L
	Logging (small scale)	Potential loss of future/actual resources when slashing is uncontrolled	H	L	L	H	Selective slashing	M
	Ecotourism	Increased economic activities				L(p)		
Quality and abundance of employment	**MINING**							
	Road construction	Major source of employment				H(p)	Positive impact	
	Ore extraction (hydraulicking)	Major source of employment, low employment quality				M(p)	Positive impact	
	Ore extraction (dry mining)	Source of employment (?), low employment quality				M(p)	Positive impact	
	NON-MINING							
	Transportation (road)	Major source of employment				H(p)	Positive impact	
	Transportation (river)	Minor source of employment				L(p)	Positive impact	
	Ecotourism	Minor source of employment				L(p)	Positive impact	

Notes:

1) Impact intensity (VH = very high, H = high, M = medium, L = low).
2) Impact extent (R = regional, L = local, I = immediate).
3) Impact duration (L = long, M = medium, S = short).
4) Impact significance (VH = very high, H = high, M = medium, L = low, VL = very low, I = indeterminate).
5) See 4.

Photo 2-1
Land dredge mining

Photo 2-2
Hydraulicking

Photo 2-3
Sluicing

Photo 2-4
Settling pond

2.1.8 Aesthetics

The visual aspect of landscape is severely altered by a placer operation and related activities. Remnants of vegetation, water ponds, muddy access tracks, domestic and industrial waste, common characteristic of untidy operations, offer an unpleasant sight that may last for many years before natural recovery starts healing the scars.

2.1.8.1 Mitigation measures

During the operation period, proper management of tailings and effluents will make the site look dramatically better. Good housekeeping will also help in preventing diseases through a sound waste and sewage management. However, lasting results will be achieved only through reclamation. Backfilling of pits and settling ponds, revegetation, contouring and flattening of slopes, blending with natural topography, restoration of natural drainage, etc. will concur in helping the natural healing process.

2.1.9 Community health

Community health is affected by mining in various ways. Stagnant waters in pits and around the mine site are ideal breeding grounds for mosquitoes that are vectors of transmission for tropical diseases like malaria and dengue fever. Promiscuity in mining camp also plays an important role in the propagation of malaria Discharge of suspended materials into watercourses causes mercury contamination in water and large predator fishes, a staple food for Amerindian communities. Water borne diseases like typhoid and cholera are also common because of water well contamination with *E. coli* bacteria from improperly managed sewage. Incidence of sexually transmitted diseases and of HIV-Aids is very high in mining districts and prostitution is thriving.

2.1.9.1 Mitigation measures

A sound runoff, effluent and tailings management will substantially decrease the mosquitoes problem by channelling waters to one single area instead of having numerous pools scattered al over the mine site. Individual bedrooms fitted with metallic nets and mattresses instead of collective dormitory and hummocks would also be a major improvement to curb propagation of malaria. Appropriate latrines equipped with

quicklime and simple carbon-activated water filter (easily made out of burnt wood) would bring dramatic improvements.

Table 2-2
Overall impact rating matrix

(Adapted from SNC-LAVALIN ENVIRONMENT INC. (2004))

Actions \ VECs	Water quality in rivers and creeks	Groundwater regime and quality	Quality and availability of soils	Air quality	Quality of carnivorous fish	Abundance of carnivorous fish	Wildlife habitat	Vegetal biodiversity	Quality of the immediate environment of the community	Aesthetics	Agriculture and ecotourism	Community health	Security	Utilities	OH&S	Preservation of aboriginal culture and heritage	Salaries and wages	Sound local development	Quality and abundance of employment
MINING																			
Road construction	L		L	M		M	H	H				L	L	Mp		H	Mp	Hp	Hp
Line cutting/mobilization	L		L				M	M											
Debushing and burning	H		L	M			H	H											
Stripping of overburden and stockpiling	H	M	M	L		M	H	H		H	L					L			
Sampling trenching and pitting	L		H				H			H									
Ore extraction (hydraulicking)	H	L	H		H	H	H	H	H	H	L	H			H	H	Hp	Lp	Mp
Ore extraction (dry mining)	L	L	H				H	H	L	H	L	L			L	H	Hp	Lp	Mp
Concentration (sluice box)	H	L	H		L	H	H	H	H	H					H	H			
Amalgamation and burning	H	H	M	H	H	L			L			H							
Tailings disposal	H		H		H	H	H	H	M	H	M	H						Lp	
Operating equipment				L			H		L										
Industrial waste disposal	H	H	M		L	M	L	L											
Domestic waste disposal	L	L																	
Hazardous waste disposal	H	H	H	L	M	H			H	H		H			H			H	
Demolition of buildings and removal of infrastructures	H	L	H	L		L			L	H	H								
NON-MINING																			
Settlements (squatting)	L		L	L			M	M		H	L	H				H		H	
Transportation (road)	L		L	L			H	L			Lp		M			H	Hp		Hp
Transportation (river)	L					L					Lp		L			L	Lp		Lp
Agriculture (slash and burn)	L		L	L			M	L			Hp						Lp		
Logging (small scale)	L		L				H	L	M							L		H	
Hunting							L									H			
Fishing						H										H			
Ecotourism												L				M	Hp	Lp	Lp

Significance coding

L	Low significance	Lp	Positive effect on VEC, low
M	Moderate significance	Mp	Positive effect on VEC, moderate
H	High/Very high significance	Hp	Positive effect on VEC, high

3. INVOLVEMENT OF MINERS AND COMMUNITY

3.1.1 Communities

Owing to the fact that the both the EIA on land dredge mining and the CEEA on Mahdia were not conducted in the field but mostly in Georgetown, active involvement of local communities and miners could not be achieved. The limited time available for conducting a CEEA and providing training did not permit a long stay in the field.

3.1.2 Miners

Although miners were not actively involved in the EIA and CEEA processes, the Guyana Gold and Diamond Miners Association (GGDMA) has been invited to participate in the different activities throughout SNC-LAVALIN ENVIRONMENT INC.'s assignment with GENCAPD. GGDMA's environmental officer, Mr. Lloyd Stephen, has attended all workshops on validating the Codes of Practice and made a substantial contribution to their review.

This report has been prepared par Marc Arpin, M.Sc., P.Geo., project manager and reviewed by Benoit Demers, M.Sc.A., Eng., Director, Mining and Environment.

SNC-LAVALIN ENVIRONMENT INC.

Marc Arpin, M.Sc., P.Geo.
Project Manager

Verified for conformity
with ISO 9001 by : _____

Benoît Demers, M.A.Sc., Eng.
Director
Mining and Environment

MA/lj

Distribution:

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4. REFERENCES

SNC-LAVALIN ENVIRONMENT INC., (2004)a. Appraisal of Cumulative Environmental Effects of Small and Medium-Scale Mining in the Mahdia Region. GENCAPD Mining Project.

SNC-LAVALIN ENVIRONMENT INC., (2004)b. Practical Guide for Preparing Cumulative Environmental Effects Assessment. GENCAPD Mining Project 69 p.

SNC-LAVALIN ENVIRONMENT INC., (2003)a. Code of Practice for Mine Effluents in Guyana's Small- and Medium-Scale Mining Industry. GENCAPD Mining Project, 39 p.

SNC-LAVALIN ENVIRONMENT INC., (2003)b. Code of Practice for the Use of Mercury in Guyana's Mining Industry. GENCAPD Mining Project, 23 p.

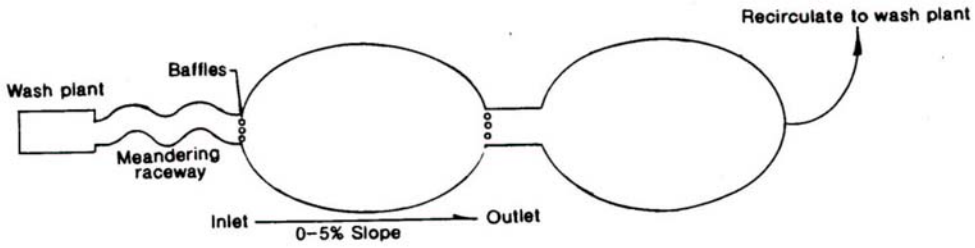
SNC-LAVALIN ENVIRONMENT INC., (2003)c. Code of Practice on Mine Effluents in Guyana's Small and Medium-Scale Mining Industry. GENCAPD Mining Project, 39 p.

SNC-LAVALIN ENVIRONMENT INC., (2003)d. Code of Practice for Mine Reclamation and Closure Plans in Guyana's Small and Medium-Scale Mining. GENCAPD Mining Project, 34 p.

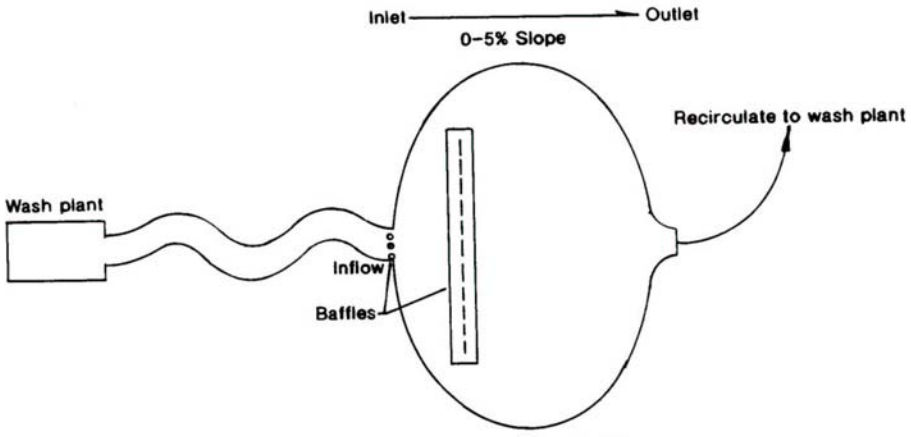
APPENDIX A

Sediments Collection Structures

Diagram of Settling Ponds for Placer Mining



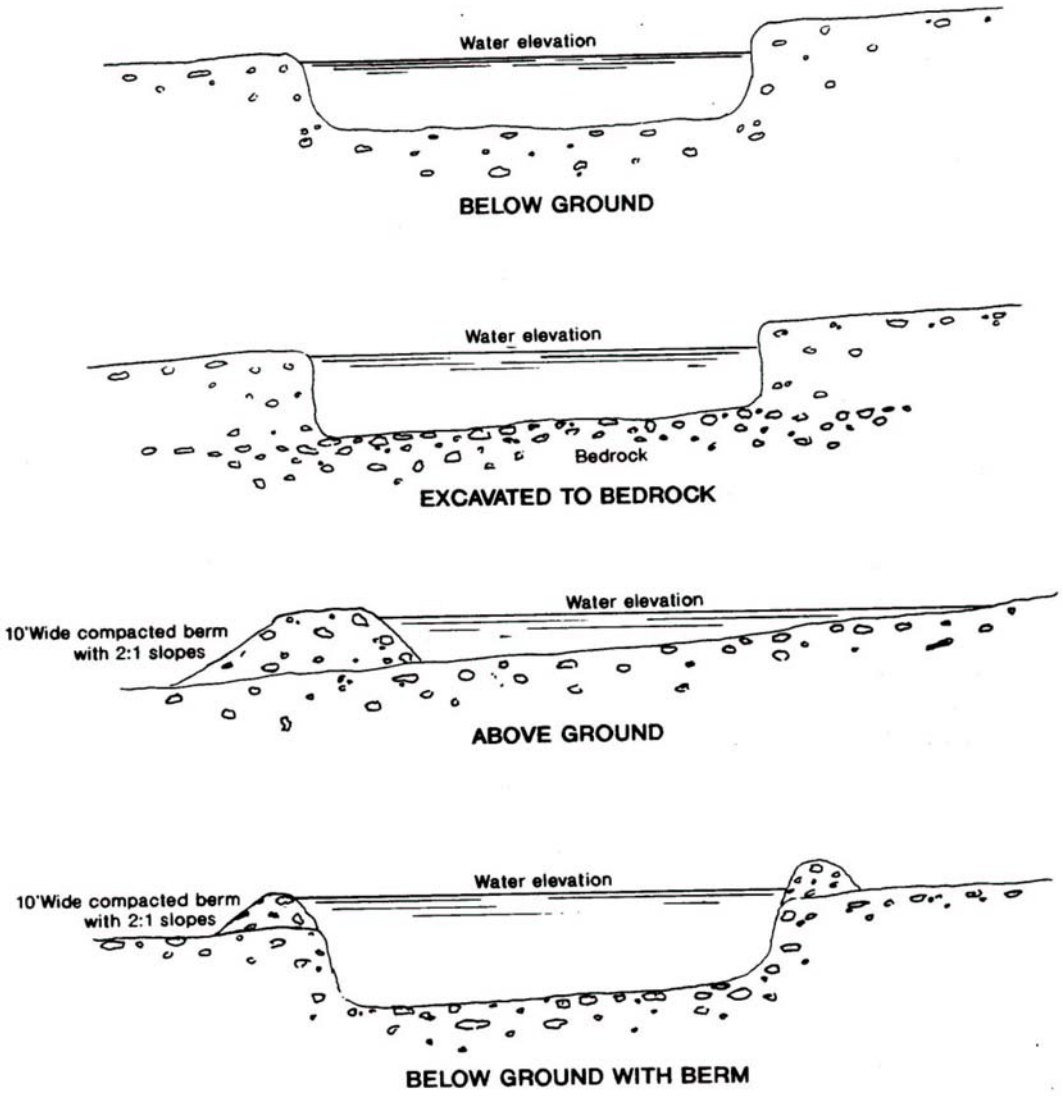
STANDARD SETTLING PONDS IN SERIES



SETTLING POND WITH BAFFLES

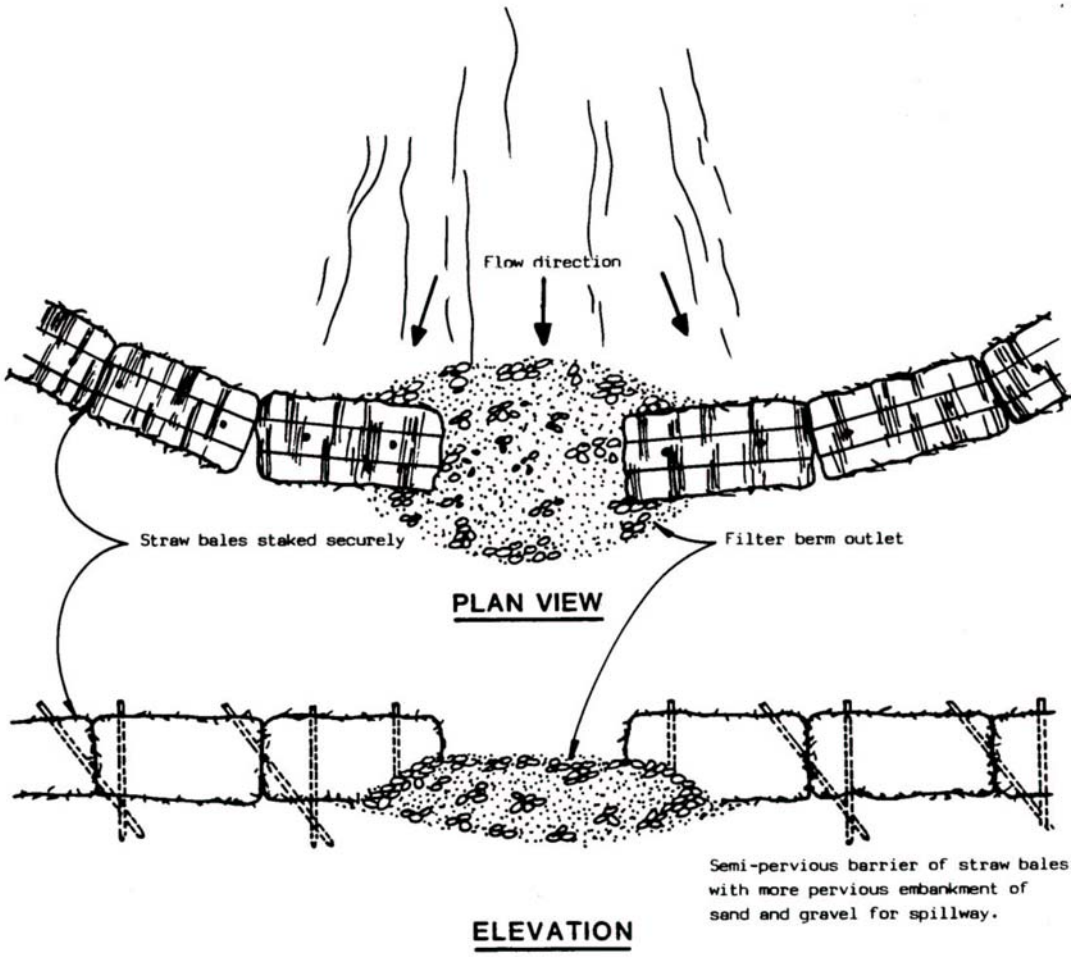
After Idaho Department of Lands, 1992

Settling Pond Construction Options



After Idaho Department of Lands, 1992

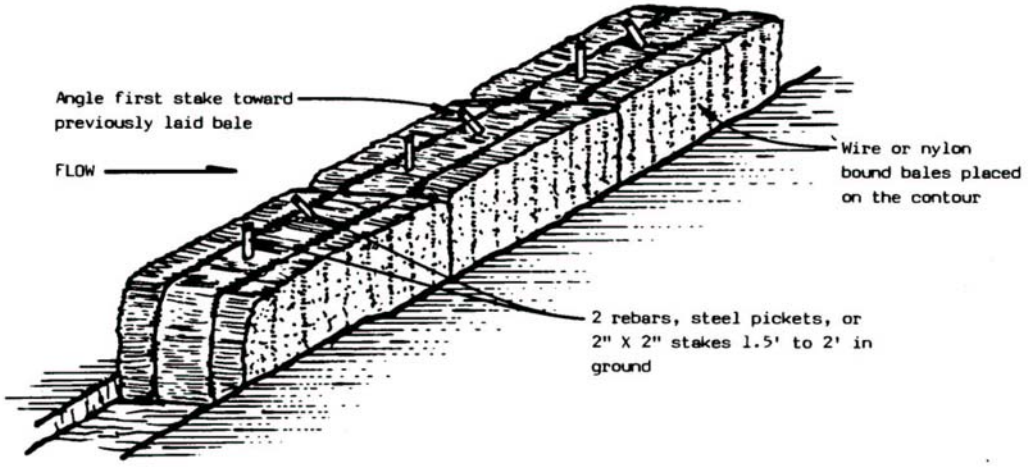
Straw Bale Sediment Barrier



After Idaho Department of Lands, 1992

Straw Bale Sediment Barrier *(cont'd)*

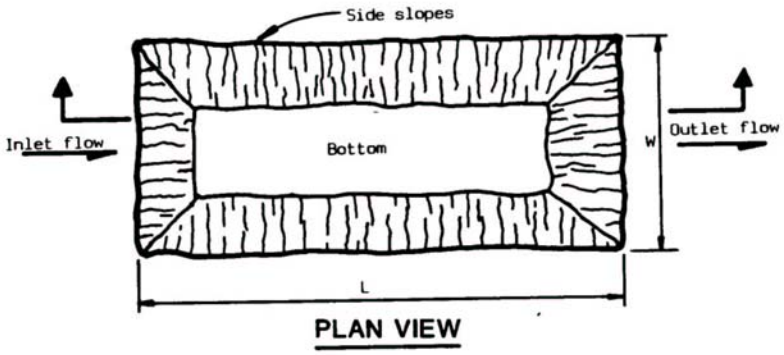
EMBEDDING DETAIL



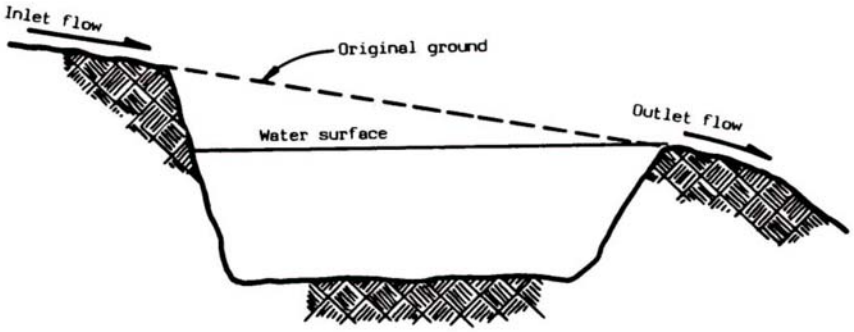
ANCHORING DETAIL

After Idaho Department of Lands, 1992

Sediment Traps or Catch Basins



PLAN VIEW

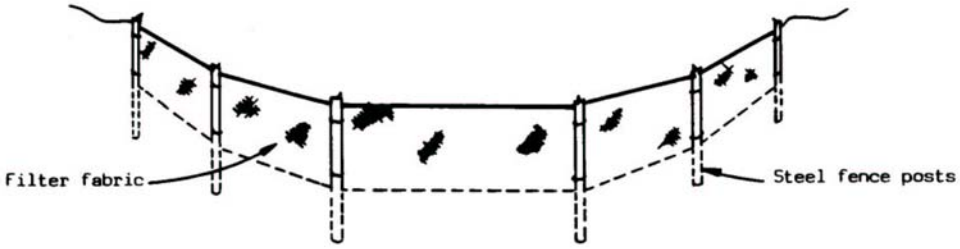


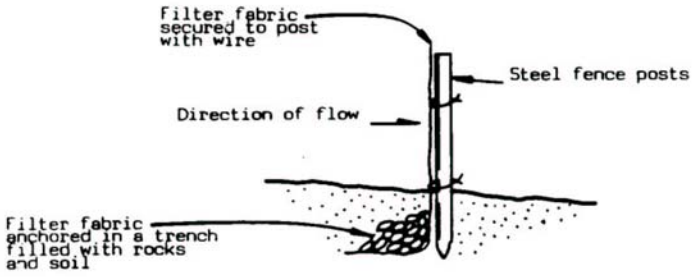
SECTION

After Idaho Department of Lands, 1992

Silt Fence/Filter Fence

Wood may replace steel for fence posts

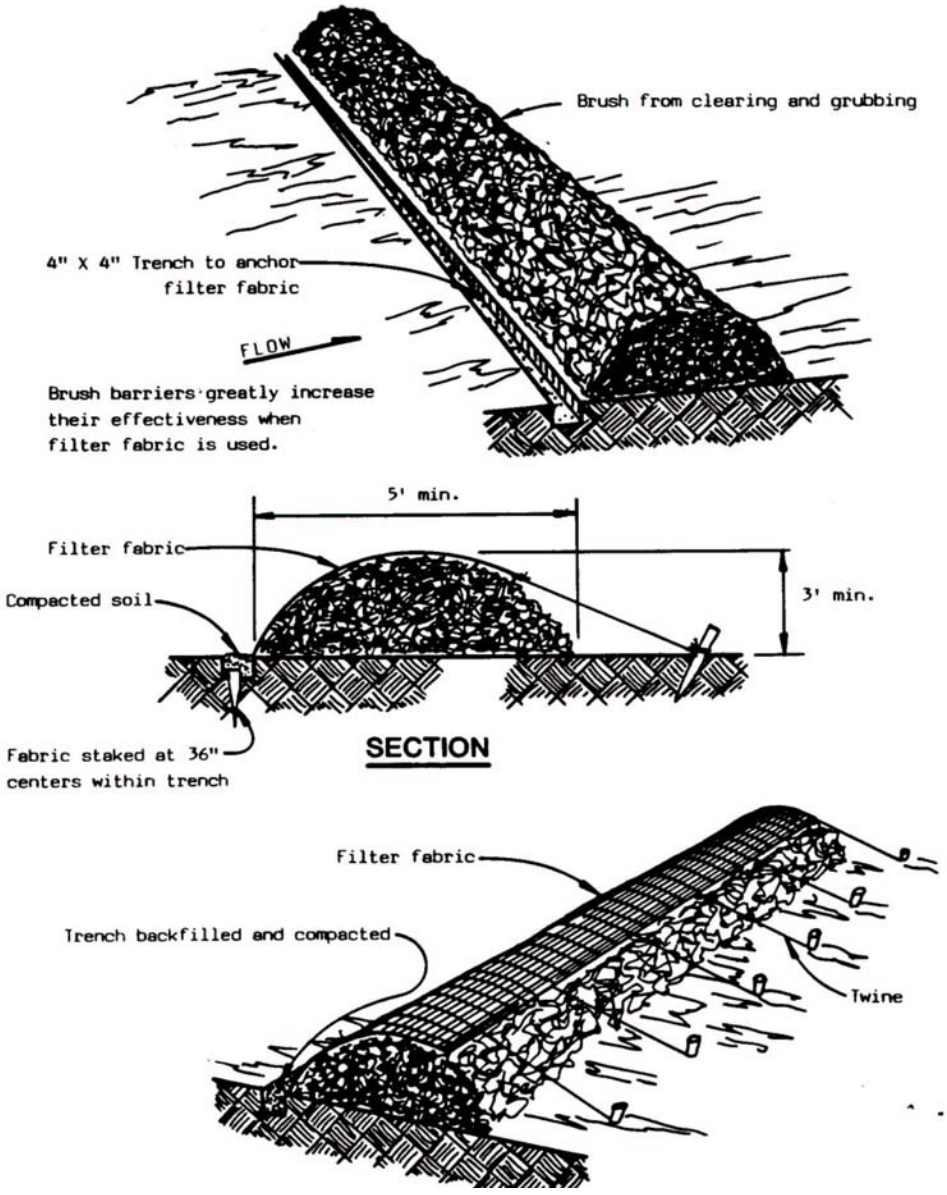




SECTION

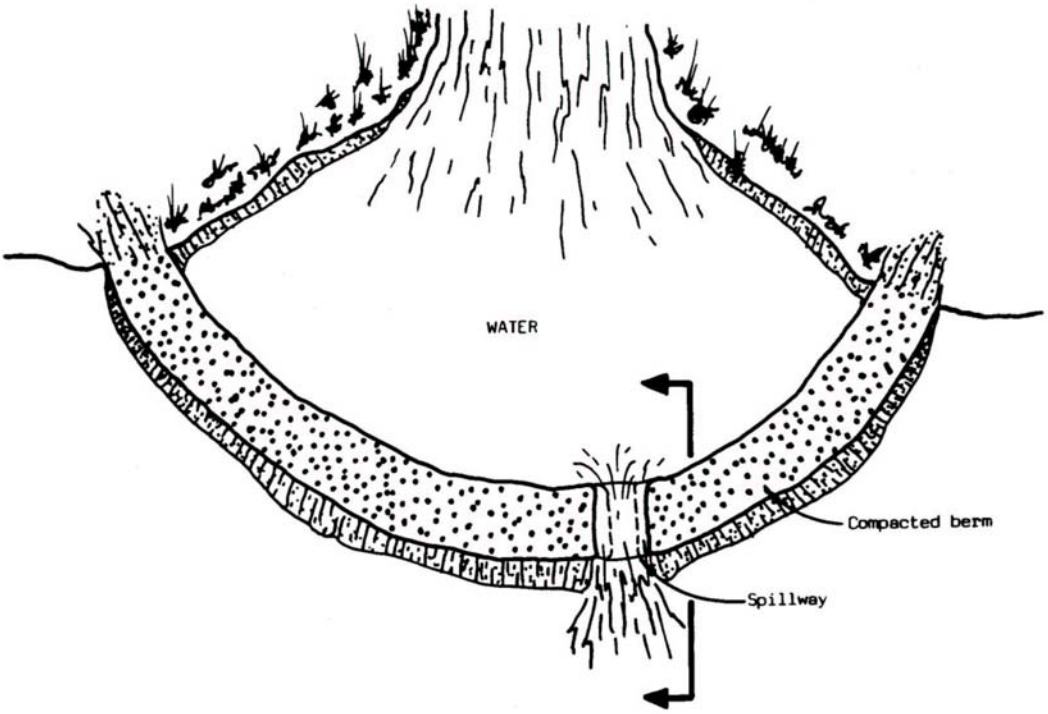
After Idaho Department of Lands, 1992

Brush Sediment Barrier

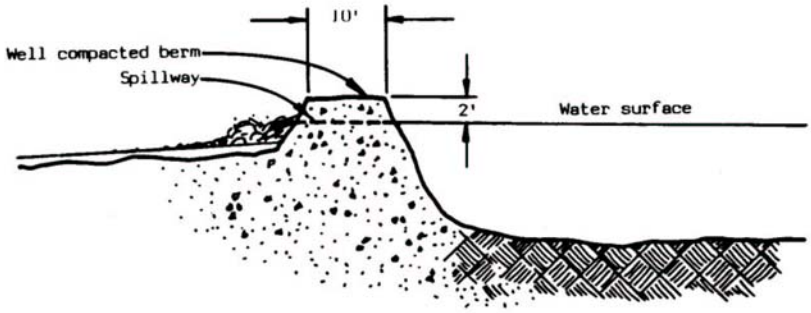


After Idaho Department of Lands, 1992

Sediment/Settling Pond



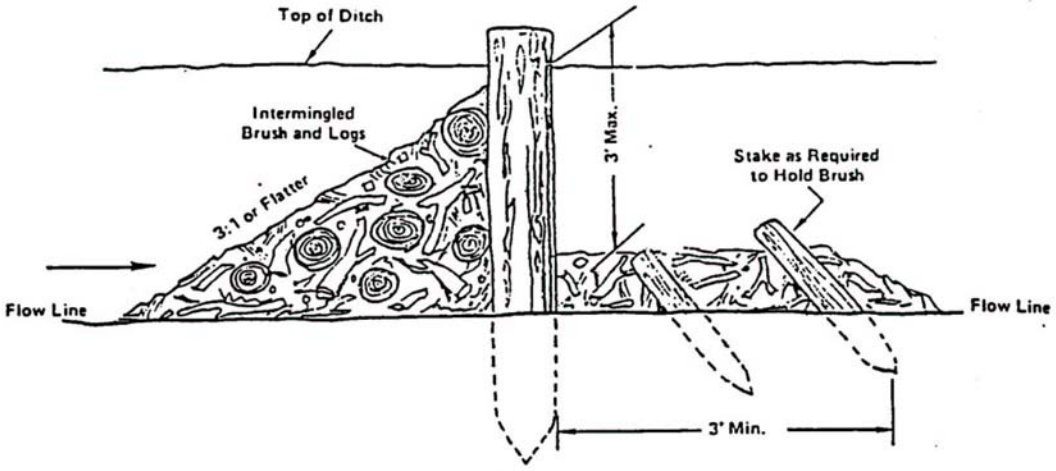
PLAN VIEW



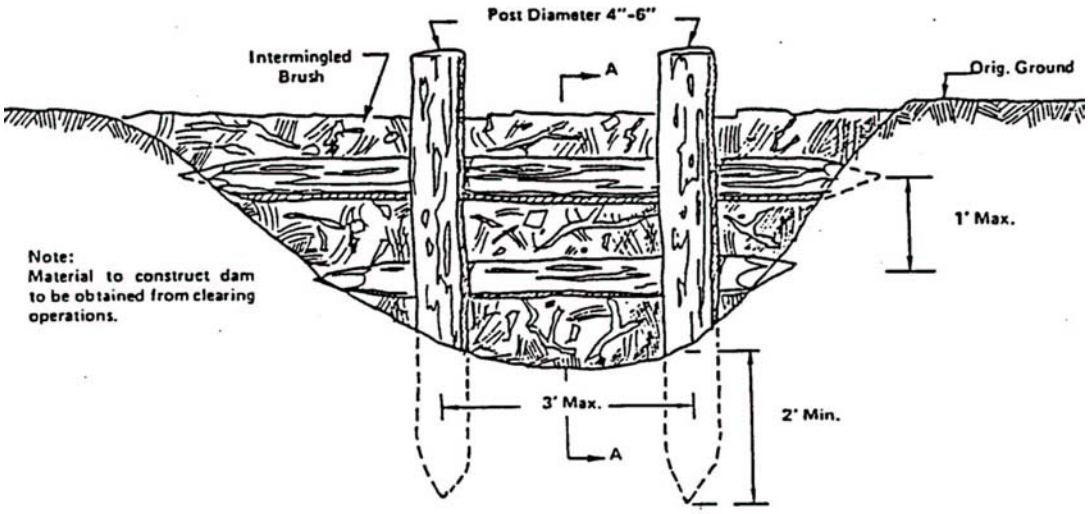
CROSS SECTION

After Idaho Department of Lands, 1992

Log and Brush Check Dam



SECTION A-A



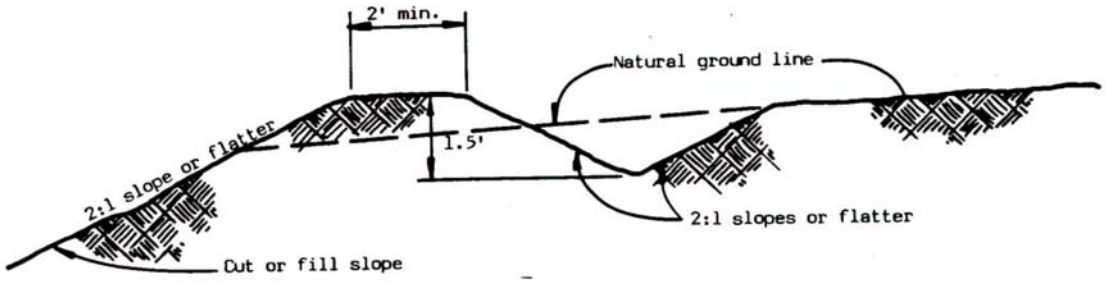
ELEVATION VIEW

After Idaho Department of Lands, 1992

APPENDIX B

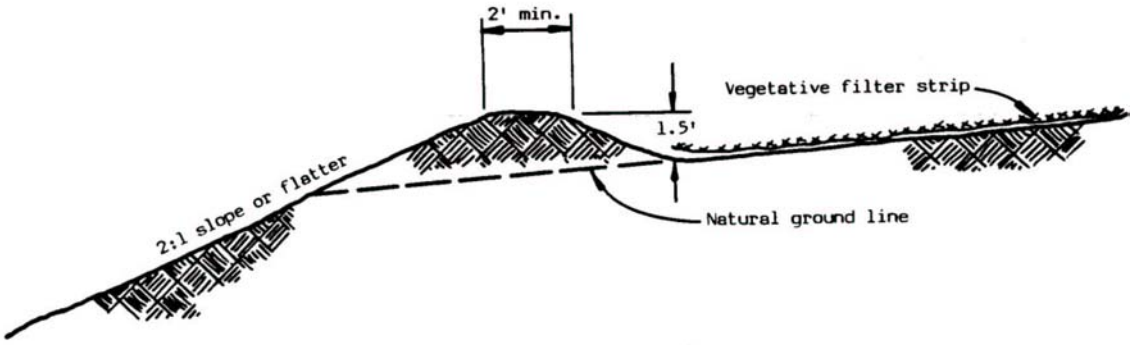
Runoff Collection Structures

Diversion Dike/Ditch



NOTE: Bed of dike to be riprapped.

SECTION

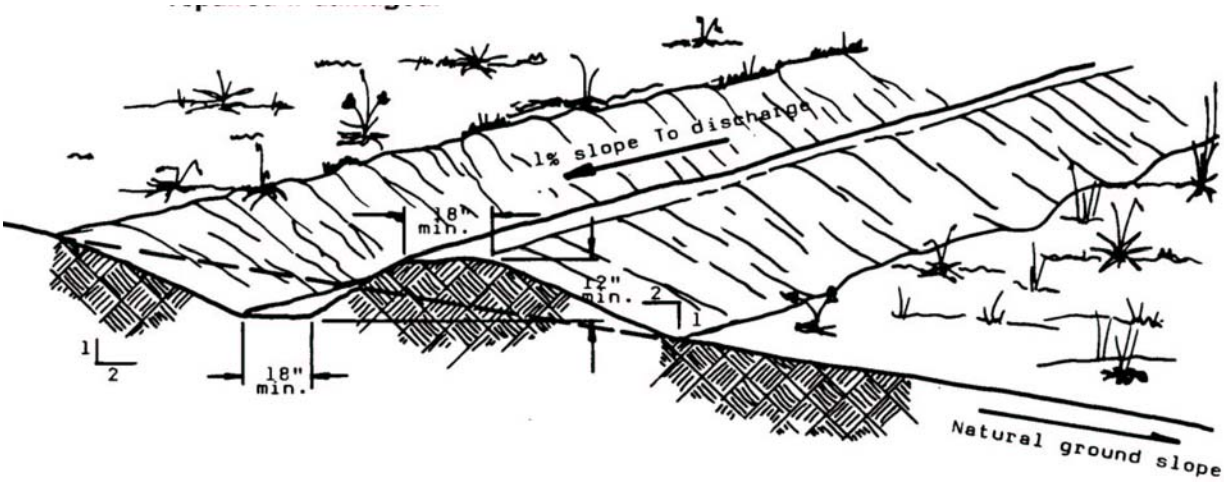


NOTES: 1) Dike constructed by dozer moving soil upslope and dumping at top of slope.
2) Outlet to stabilized vegetated soil.

SECTION

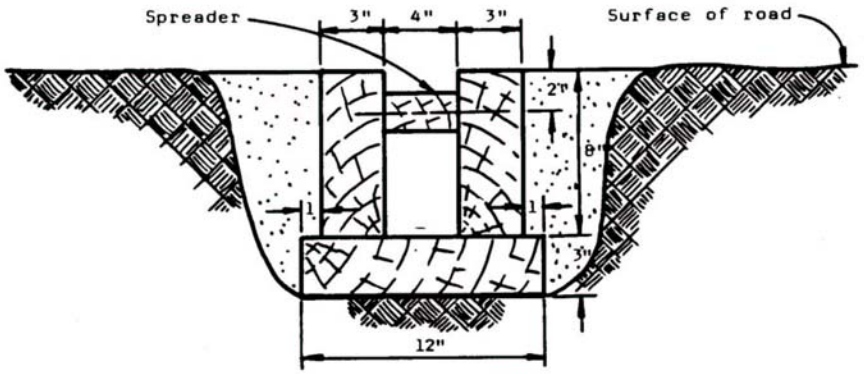
After Idaho Department of Lands, 1992

Interceptor Trench

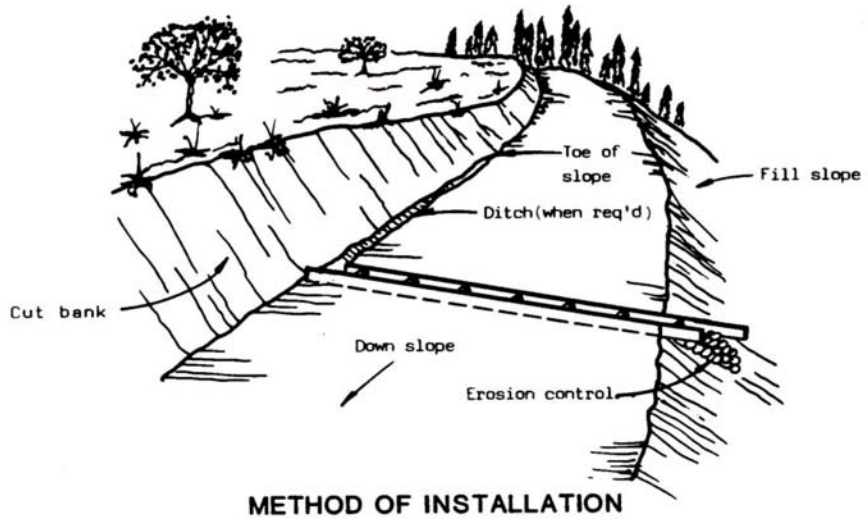


After Idaho Department of Lands, 1992

Open Top Box Culvert



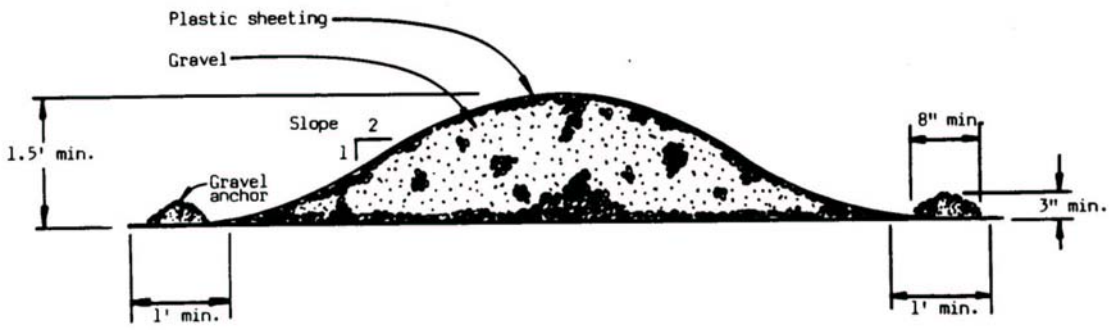
END VIEW



METHOD OF INSTALLATION

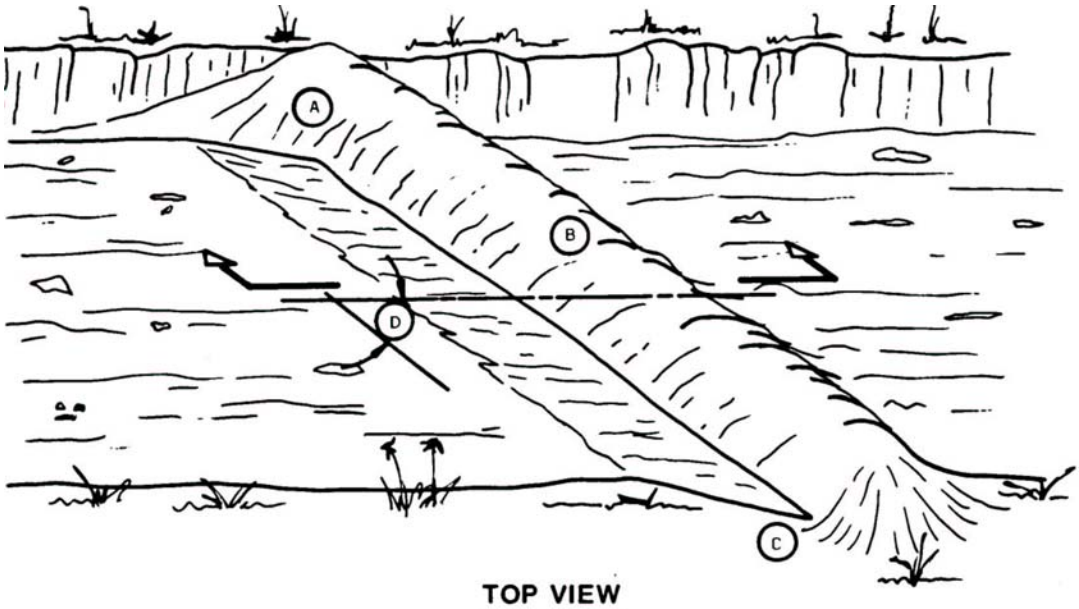
After Idaho Department of Lands, 1992

Siltation Berm

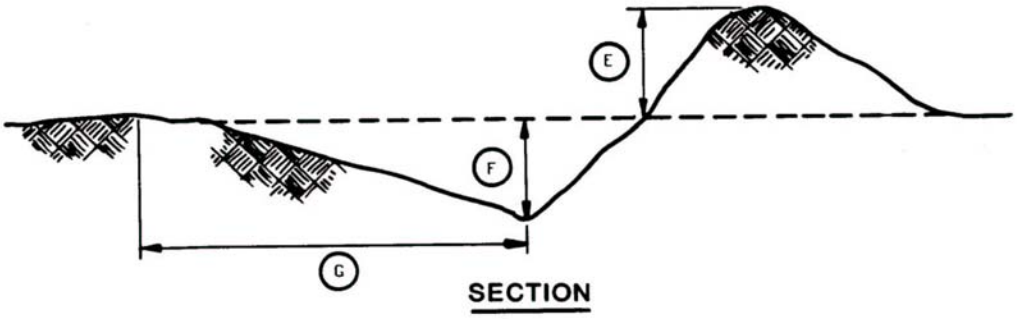


After Idaho Department of Lands, 1992

Waterbars



TOP VIEW

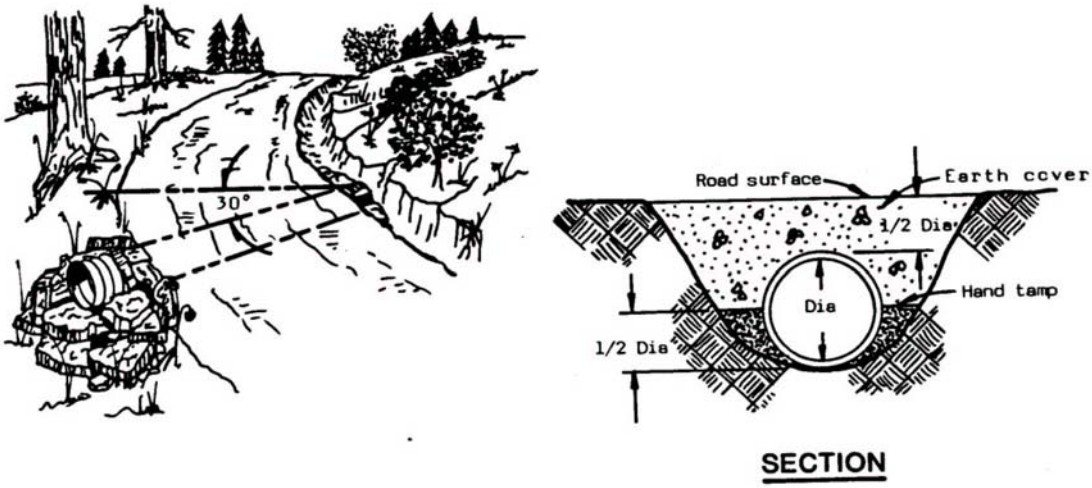


SECTION

WATERBAR (CROSSDITCH). Construction for unpaved forest roads with limited or restricted traffic. Specifications are average and may be adjusted to gradient and other conditions. A, bank tie-in point cut 6 to 12 in. into roadbed; B, cross drain berm height 12 to 24 in. above roadbed; C, drain outlet cut 8 to 16 in. into roadbed; D, angle drain 30 to 40 degrees downward with road centerline; E, height up to 24 in; F, depth to 18 in; G, 36-48 in.

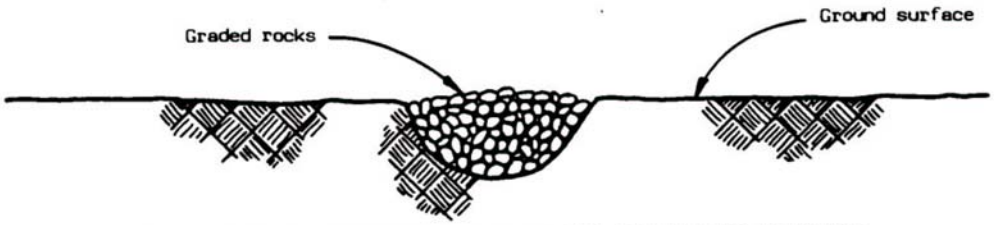
After Idaho Department of Lands, 1992

Culvert Installation

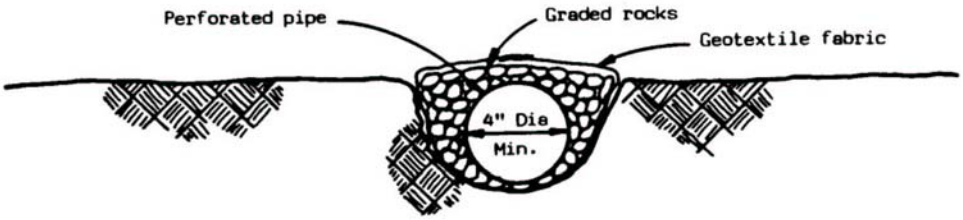


After Idaho Department of Lands, 1992

Drain Fields

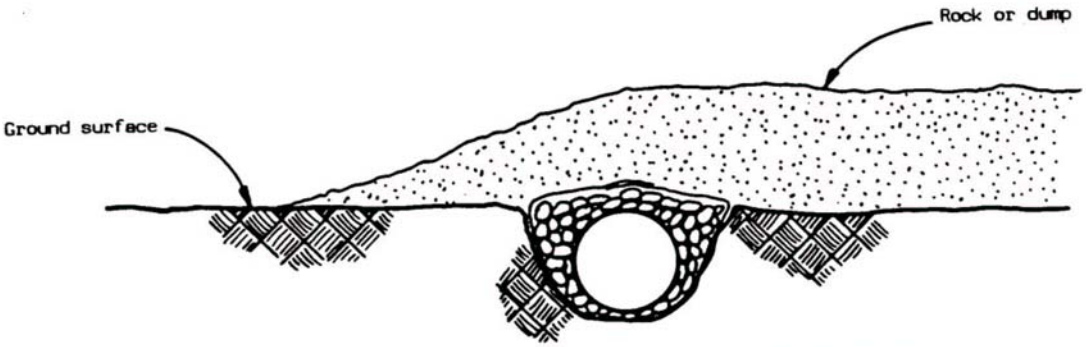


DRAIN FIELD TRENCH LINED WITH GRADED ROCKS



NOTE: Diameter of pipe to be based on the amount of water to be drained.

TRENCH LINED WITH GEOTEXTILE FABRIC, GRADED ROCK AND PERFORATED PIPE



SURFACE WASTE OR DUMP TO BE PLACED OVER UNDERDRAIN AFTER CONSTRUCTION

After Idaho Department of Lands, 1992

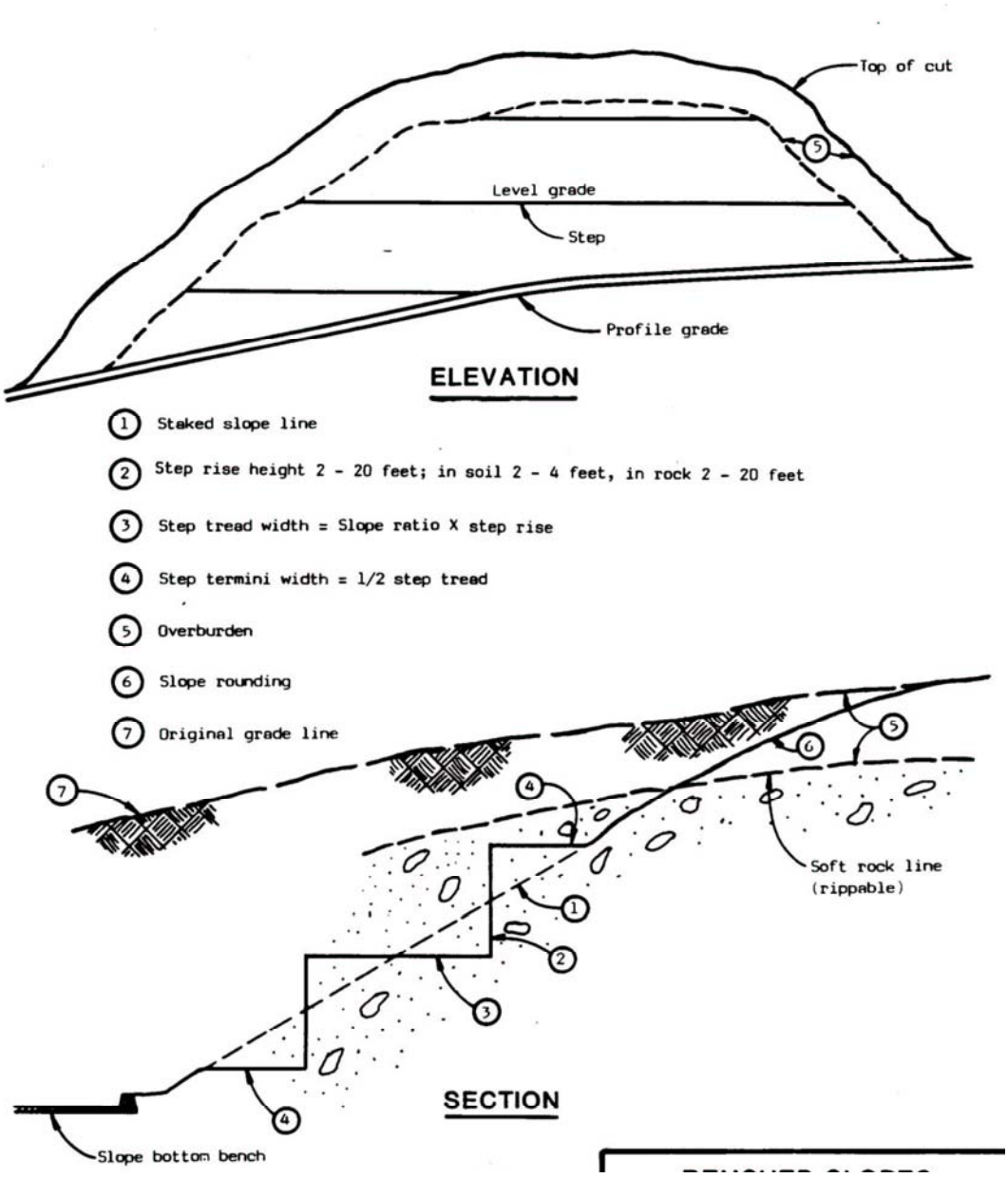
Road Sloping

After Idaho Department of Lands, 1992

APPENDIX C

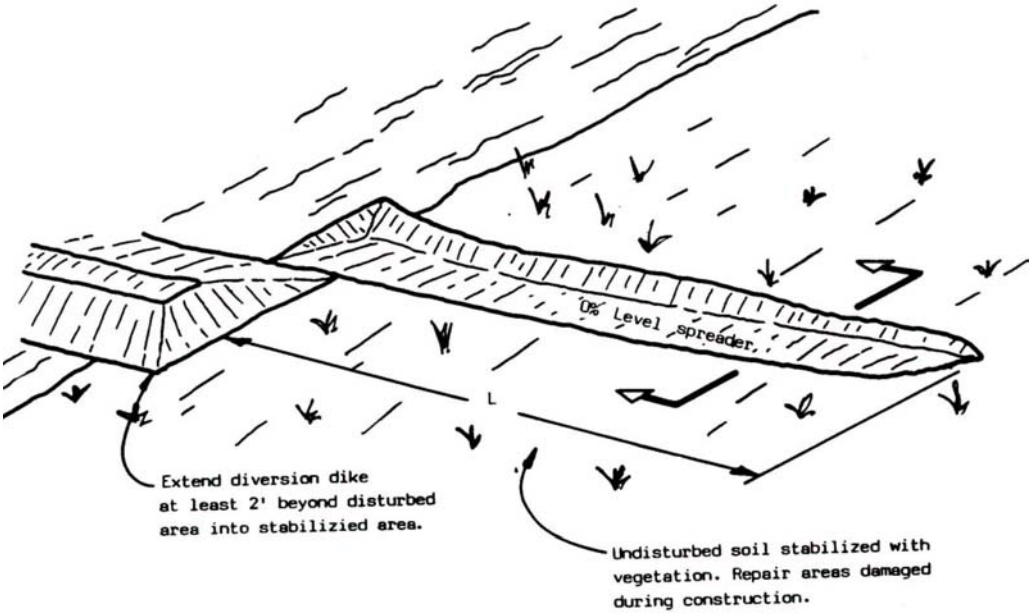
Runoff Dispersion Structures

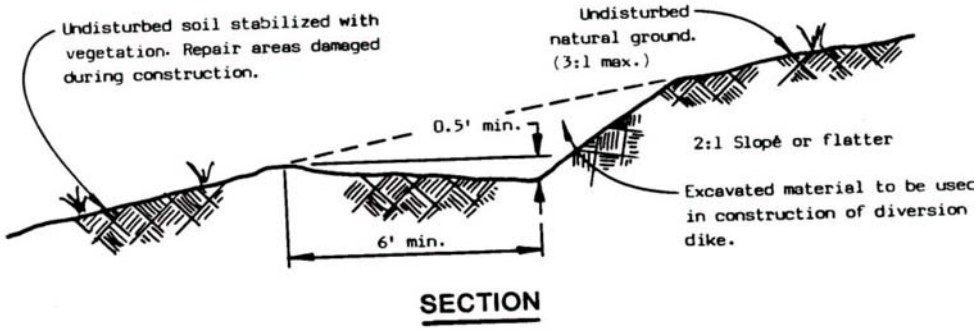
Benched Slopes



After Idaho Department of Lands, 1992

Level Spreader





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