Mining Environmental Management

CODES OF PRACTICE

Waste Management and Disposal

Guyana Geology and Mines Commission
Brickdam, Georgetown, Guyana

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Rev – 0

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1.0 Introduction

This Code of Practice for **Waste Management** and Disposal in small and medium-scale gold and diamond mines is intended to provide environmental management guidance and promote the related best management practices. It is not a design manual[1].

1.1 Regulatory Authority/Mandate

The Mining (Amendment) Regulations 2005[2] were promulgated in 2004. Regulation 248 of the Mining (Amendment) Regulations 2005 stipulated that the Guyana Geology and Mines Commission (GGMC) prepare Codes of Practice for Mining Environmental Management prior to their incorporation into the Regulations.

The Codes of Practice were intended to provide critical environmental management guidance to the Mining Industry, particularly small and medium-scale gold mines. The importance of the codes was even more enhanced by the development of the Low Carbon Development Strategy.

The following ten (10) provisions of the Codes of Practice for Environmental Management were indentified:

- Use of Mercury
- Tailings Management
- Contingency and Emergency Response Plans
- Mine Effluents
- Mine Reclamation and Closure Plans
- Mine Waste Management and Disposal
- Environmental Effects Monitoring Program
- Quarrying
- Sand and Loam Mining
- Use of Small Dams for the Control of Water and Tailings

1.2 Justification for the Waste Management and Disposal Code of Practice

Mining generates a disproportionally high levels of waste compared with other industries. Because the concentration of valuable material is so small (especially in metal and diamond mining), most of ore rock extracted is turned into waste that must be managed and disposed of.

These wastes include waste rock, tailings and overburden. In open-pit operations, the volume of waste rock and overburden that must be removed (the stripping ratio) is often 3 to 6 times higher than the

[1] This document is **NOT** a design manual. Users of this document shall assume full responsibility for the design of facilities and for any action taken as a result of the information contained in this document.

[2] The Mining Regulations, made under the Mining Act (1989), was amended by the Mining (Amendment) Regulations 2005: Collectively they address all the important aspects of mining environmental management.

amount of ore. One result is that waste rock dumps and tailings ponds and facilities are usually the most visual landforms left after mining. These wastes can be a source of pollution if not managed effectively.

Small and medium scale gold and diamond mining generates large amounts of tailings through the excavation,(including by hydraulicking) and processing of surficial alluvial, eluvial and saprolitic material that, if unmitigated, usually end up in the watercourses, causing turbidity plumes as well as mercury mobilization. For these reasons, careful planning before and during construction is essential to prevent excessive erosion, and generation of acid rock drainage while ensuring a stable and safe landform amenable to rehabilitation/revegetation.

There are also wastes generated by non-extractive support activities and processes that must be addressed or managed. These include household wastes, construction wastes and hazardous wastes. The Code of Practice provides the necessary guidance for management of these wastes.

This Code of Practice provides important environmental management guidance to mine owners, operators and regulators on the Waste Management and Disposal Regulations.

This Code reflects sound management practices followed in other countries. Its principles and approaches are also taken from various sources; It is the result of a comprehensive literature review.

1.3 Administration of Codes and Responsibilities of Owners and Workers

A useful strategy for sustainable environmental management in the small and medium-scale gold and diamond mining is co-regulation by the various stakeholders including the GGMC, and the Miners, and Mining Industry.

GGMC's mandate or role as defined by the Mining Act 1989 and the Mining (Amendment) Regulations 2005 is to develop, administer and enforce the mining regulations. Specific responsibilities include:

- Development and upgrading of the codes of practice
- Consultations with the stakeholders in the mining industry including mining organizations and miners on the development, and utility of the Codes 0f Practice.
- Public education, orientation and training
- Enforcement of, and monitoring compliance with, the Mining (Amendment) Regulations 2005

The prime responsibility for the implementation of, and compliance with, the Mining (Amendment) Regulations 2005, and the application of sound environmental management practices rests with the Mine Owners and operators. Specifically, with the respect to the Waste Management, the Mine Owners and operators must:

- Manage their operations in compliance with the Mining (Amendment) Regulations 2005, the related Codes of Practices and Guidelines
- Prepare and implement a waste management and disposal plan
- Provide their employees with required training and orientation on the Waste Management and disposal, and the related the regulations, best management OHS practices, codes and guidelines

2.0 Glossary of Terms

Acid Rock Drainage (ARD)	Drainage of acid water containing dissolved metals as a result of natural oxidation of sulphides found in waste rock, ore and tailings exposed to wind, air, and water.
Best practice	The best way of doing things. The objective of best practices is to prevent or (when that is not possible) minimize risks to human health, as well as adverse environmental, social and economic impacts.
Co-Regulation	The mechanism whereby a *Community legislative act* entrusts the attainment of the objectives defined by *the legislative authority* to parties which are recognized in the field (such as economic operators, the social partners, non-governmental organizations, or related industry associations).
Code of practice	Means the Environmental Code of Practice for the operation of mines that is published by the Commission and which shall be read as part of the Mining (Amendment) Regulations 2005. (A collection of rules and ethical principles related to a specific field of activity. A code of practice describes procedures and sets out standards considered to be best practices in the said field of activity. The code may be voluntary or mandatory).
Effluent	Means any fluid including airborne particles of matter and other substances in suspension or solution in the fluid and includes mine de-watering discharges , site runoff , discharges from a tailings basin or settling pond, discharges from a processing plant or dredging operation which is released to the surface or ground water and other substances such as colloids , in solution or suspension.
Encapsulation:	A disposal process whereby a mining waste I covered and enclosed in such a way that no leakage can occur under normal circumstances.
Guidelines	A non-binding document, usually designed to provide users with information, explanations, guidance and help with respect to a specific topic. Guidelines are a tool frequently used to enforce new regulations. Users can be either the Regulator itself or the industry.
Medium-scale mine	A mine for which a mining permit has been issued and from which a volume in excess of 200 m3, but less than 1 000 m3, of material, including any overburden, excavated or processed as an aggregate in any continuous 24-hour period.

Mine closure	A whole of mine life process which typically culminates in tenement relinquishment. Closure includes decommissioning and rehabilitation. This term is often used interchangeably with Mine decommissioning.
Mine decommissioning	The process that begins near, or at, the cessation of mineral production. This term is often used interchangeably with Mine Closure.
Open circuit	Any process whereby the ore that has been in contact with mercury, the water used in processing or the mercury itself may enter a waterway or infiltrate into the soil. It also includes the vaporization of mercury into the atmosphere.
Overburden	Loose soil, sand, gravel, etc. that lies above the bedrock or above a deposit of useful materials, ores, or coal. Also called burden, capping, cover, drift, mantle, and surface. It may or may not include topsoil.
Reclamation (rehabilitation)	The return of the disturbed land to a stable, productive and self-sustaining condition, taking into account beneficial uses of the site and surrounding land.
Regulations	A type of "delegated legislation" enacted by a state or federal or local government agency given authority to do so by the appropriate legislature. Regulations are generally very specific and are also referred to as rules or simply administrative law. Regulations are official rules and must be followed.
Small-scale mine	A mine for which a claim license has been issued and from which a volume in excess of $20m^3$, but less than $200m^3$, of material, inclusive of any overburden, is excavated or processed as an aggregate in any continuous Twenty-four hour period.
Stripping	The removal of earth or non-ore rock materials as required to gain access to the desired coal, ore, or mineral materials; the process of removing overburden or waste material in a surface mining operation.
Stripping ratio	The unit amount of spoil or overburden that must be of overburden to raw tons of mineral material.
Sustainable Development (SD)	Development that meets present-day needs without compromising the ability of future generations to meet their needs.
Tailings	The gangue and other waste material resulting from the washing, concentration, or treatment of ground ore. Also those portions of washed ore that are regarded as too poor to be treated further

Tailings dam	Impoundment to which tailings are transported, the solids settling while the liquid may be withdrawn.
Turbidity	The state, condition or quality of opaqueness, cloudiness or reduced clarity of a fluid, due to the presence of suspended material.

3.0 Mission and Objectives

3.1 Mission Statement

The following is the Code's mission statement:

To foster sustainable waste management and disposal practices so as to prevent and minimize adverse environmental (physical, social and economic) impacts generated by small- and medium-scale mines in Guyana, and to create a stable landform suitable for some agreed post mining land use.

3.2 Objectives

1) Ensure that all mine-related wastes including waste rock dumps, and overburden and topsoil piles, household and hazardous wastes are managed in a safe and sustainable manner through:

   - Characterization and inventory of waste
   - Management of waste dumps through:
     - Wind and water erosion control
     - Ensuring their physical stability
     - Restoration of the waste piles

2) Improve the level of awareness and education of all parties on the importance of introducing sound and sustainable mining waste management and disposal practices.

3) Ensure that waste management and disposal practices are flexible and dynamic over time.

4) Ensure that waste management and disposal practices are credible and verifiable.

4.0 Scope

This Code of Practice is a mandatory code that applies to gold and diamond mining operations ranging in size from small-scale to medium-scale. It addresses mining waste, i.e. overburden and waste rock generated within the context of land-based extraction and/or treatment of mineral resources, with the exception of tailings (addressed by a specific Code of Practice on tailings management).

It also addresses wastes that are not specific to the extractive process such as hazardous wastes and household wastes. Hazardous wastes includes petroleum products and other chemicals, materials labeled as hazardous, and those with hazardous characteristics (corrosive, toxic, ignitable or, reactive)

Reclamation considerations are covered by this Code of Practice even though they are the subject of a specific Code of Practice on reclamation and mine closure. The reason for this apparent duplication of effort is that progressive reclamation is an essential part of mine waste management.

Tailings, which are also mine wastes and are only referenced here, are more appropriately addressed in the Tailings Management Code of Practice.

This Code is subordinate to the Mining (Amendment) Regulations 2005 and is intended to complement regulatory requirements, not to replace them. Compliance with the rules, regulations and laws is therefore necessary.

No guarantee is made in connection with the application of the Code to prevent hazards, accidents, incidents, or injury to workers and/or members of the public at any specific site where mine reclamation is carried out.

5.0 Principles and Standards of Practice

Waste management and disposal should be addressed in the preliminary stages of mine planning. The projected types and volumes of wastes guide the development a waste management plan. Each category of mine wastes should be tracked from source to disposal.

The general types of wastes in small and medium scale mines include:

- Top soil and Overburden
- Waste rock
- Hazardous Wastes
- Household wastes

A hierarchy of waste management practices should be applied to the management of all materials used at a mine. In order of preference, options selected should be:

- Waste avoidance - practices that prevent the generation of waste altogether
- Waste reduction – practices that reduce waste
- Waste reuse – direct reuse of waste materials for the same grade of use
- Waste recycling or reclamation – using valuable components of waste in other processes
- Waste treatment – to reduce hazard or nuisance, preferably at the site of generation
- Waste disposal.

(For further details on how the following principles may be implemented, the readers should refer to ***Section 6 Code Implementation***).

5.1 Waste Dumps

Principle: Ensure that waste dumps are adequately located, designed, managed and reclaimed.

Standards of practice

5.1.1 Locate waste dumps away from surface waters, springs, seeps and wetlands (swamps and marshes).
5.1.2 Take preventive measures to minimize water and wind erosion.
5.1.3 Enhance the long-term mass stability of a dump by locating and constructing it so that the potential of failure is minimized.
5.1.4 Characterize the waste material prior to construction of the dump.
5.1.5 Take preventive measures to avoid ARD generation.
5.1.6 Avoid ARD being dispersed into the environment.
5.1.7 Create appropriate conditions for rapid revegetation after mining has ceased

5.2 Top Soil & Overburden Piles

Principle: Ensure that topsoil and overburden piles are adequately located, designed, managed and reutilized for revegetation works.

Standards of practice

5.2.1 Build separate piles for topsoil and overburden material.
5.2.2 Locate topsoil and overburden piles as far from surface waters, springs, seeps and wetlands (swamps and marshes) as possible.
5.2.3 Enhance the long-term mass stability of piles by locating and constructing them so that the potential of failure is minimized.
5.2.4 Take preventive measures to avoid water and wind erosion.
5.2.5 Keep topsoil biologically active to retain its value as a plant growth medium.
5.2.6 Ensure proper debushing prior to removal of top soil.

5.3 Hazardous Waste

For the purpose of the present Code of Practice, hazardous wastes also include hydrocarbons (fuels and lubricants).

Principle: Protect communities and the environment from exposure to, and contamination from hazardous substance in the mining environment by effectively managing their handling, storage, transportation and disposal .

Standards of practice

5.3.1 Identify materials and prepare hazardous waste inventories
5.3.2 Describe methods for transport, storage and handling of hazardous waste.
5.3.3 Identify options for disposal and long term storage of hazardous waste.
5.3.4 Prepare an Awareness and Preparedness Emergency plan at Local Level (APELL)
5.3.5 Provide training on hazardous waste handling and storage for workers

5.4 Household Waste

Household waste includes all other materials such as paper, glass, plastics, wood, food and vegetation.

Principle: Foster the application of waste minimization principles so as to
Reduce the amount of household wastes that are disposed of and ensure that
sound waste disposal practices are implemented.

Standards of practice

5.4.1 Promote waste avoidance, reduction, reuse and recycling practices.
5.4.2 Compost organic waste such as food, leaves, and roots. This compost could be used for revegetating the site.
5.4.3 Bury non-recyclable and non-compostable waste in an appropriate landfill complying with corresponding national or local landfill regulations.
5.4.4 Develop and implement an awareness program on waste minimization for mine workers.

6.0 Code Implementation

Development of a waste management plan would effectively address most of the concerns of mine waste management and disposal. The plan should address and include:

- Projection of the sources and types of waste
- Waste prevention and reduction
- Inventory and control of hazardous substances
- Health and safety provisions
- Worker safety and required training
- Treatment and disposal strategy and facilities
- Location of facilities and stockpiles
- Tailings and effluent management.
- Stability and other risk factors associated with stockpiles and dams
- Control of hazardous substances

Table 1.0 , Sources and Types of Mines Wastes, summarizes the general sources and management strategies for mine wastes generated by small and medium-scale mines in Guyana.

Table 1.0 Sources and Types of Mine Wastes

Mining Activity	Source & Types of Wastes	Waste Management Strategies	Notes
Excavation	• Overburden • Top soil • Leachate and drainage from stockpiles	• Segregation, Stockpile, Isolation, Backfilling and Reuse • Keep top soil active and reuse • Segregate, temporary covers, diversion and Leachate collection	Overburden represents the largest portion of mine waste
Sluicing, Physical Processing, Milling	Tailings, effluent, Milling Wastes Petroleum Products	• Settling /Tailing Ponds Disposal, Backfilling • Stockpile • Disposal as Hazardous Waste, or burn	See Effluent Control and Mine Closure and Reclamation Provisions : Environmental Code of Practice Workers should be trained in the handling and disposal of

Mining Activity	Source & Types of Wastes	Waste Management Strategies	Notes
			waste
Chemical Processing/Extraction	Contaminated effluents Hazardous Substances Petroleum Products Chemical spills and contamination	• Waste Reduction, Treatment, Disposal • Waste Reduction, treatment, isolation disposal • Disposal as Hazardous Waste, or burn • Segregation, Stabilization, Isolation , Treatment, Disposal	See Code of Practice - Waste Management & Disposal Some Chemical and Substances added during Processing Use approved container and disposal practices Use Trained Personnel Disposal of petroleum products of other hazardous material in the river , the marine environment, or on land is an office and prohibited
Housing & Worker Support Services	Household Wastes	Waste Minimization, Segregation and Disposal	Identify Disposal Sites in Mine Planning

6.1 Waste Dumps

6.1.1 When selecting the location of any waste dump:

- Take into account property boundaries;
- Don't interrupt significant drainage lines;
- Blend the dumps into natural hill sides if possible;
- Choose a location that will not be in the way of any possible future pit cut back or any other development;
- Make sure the toe of any waste dump is not closer to the pit than the abandonment bund for that pit;
- Design the pit abandonment bund according to international standards

6.1.2 Before construction of the waste dump commences, it is essential to know the types of material that will be placed in the dump, so that their location within the dump can be planned. Materials that:

- Have ARD potential
- Have high salinity
- Have potentially polluting Leachate
- Are highly dispersive
- Could/should be appropriately encapsulated in the dump

6.1.3 Where characterization indicates that ARD may be generated, prevention measures should be taken. These measures may include impermeable caps and liners, surface water diversions (see APPENDIX A), and/or blending acid consumption materials such as limestone with wastes.

6.1.4 Where preventive measures are impractical, water treatment will be necessary until acidic discharge meets water quality standards, a process that may last decades.

6.1.5 The material that will be used for the outer surfaces, when covered with topsoil should be suitable for revegetation.

6.1.6 Design the profile of the dump (e.g. height and slope angles) to ensure that the final structure is safe, stable and not prone to significant erosion. Factors that should be considered in the design are material types, proposed vegetation cover, natural topography and climate.

6.1.7 Construct the dump in successive lifts, starting at the toe. A single lift should not exceed fifteen (15) metres or fifty (50) feet in height.

6.1.8 It is essential to design and construct drainage control measures that will handle expected rainfall events. Minimizing slope lengths will help reduce water velocity and its resulting erosion potential (see APPENDIX B).

6.1.9 Any water that runs off the surface of a dump should be diverted behind siltation berms, into catch basins, into sediment ponds, or through silt fences (see APPENDIX C).

6.1.10 Previously cleared topsoil should be spread over all surfaces at a thickness of about 5-20 cm (depending on the nature of the underlying waste rock). The surfaces should then be scarified (see APPENDIX D and E).

6.1.11 Direct seeding at the optimal time for the region will maximize the benefit of annual rainfall events. Select the seed mix that consist of local native species and which will give maximum diversity. Post-mining land use will have a bearing on the seed mix chosen (see APPENDIX E).

6.2 Top Soil and Overburden Piles

6.2.1 Runoff collection and dispersion as well as sediment collection structures should be implemented in order to prevent suspended material from being discharged into water streams.

6.2.2 Keep the topsoil biologically active for further use in revegetating the site. This can be achieved by moving the soil to allow the introduction of oxygen or by seeding.

6.3 Hazardous Wastes

All hazardous material must be packaged appropriately and disposed of at approved facilities or onsite locations.

6.3.1 The hazardous substance inventory should have the Material Data and Safety Sheet (MSDS) and names of all the chemicals on site, including:

- The Chemical name
- Typical quantities maintained at the site;
- Operating procedures incorporating handling precautions, storage requirements, safety equipment needed, training required and
- Specific instructions for clean-up of spills

6.3.2 All hazardous wastes storage facilities should be designed with protection of the environment as well as health and safety in mind.

6.3.3 Procedures should be developed and implemented to prevent contaminated storm-water being discharged in this way. Some interception device which would trap the contaminant and therefore prevent this contaminated water entering the environment should be incorporated.

6.3.4 Where storage or transport systems are not clearly visible, as with underground tanks or buried pipes, additional protective measures are needed. Material balances and inventory reconciliation should be used on a regular basis to detect any unaccounted loss of material. Regulation 132

6.3.5 If the storage or disposal area is on the site, it needs inspection to ensure sufficient protection is installed to prevent escape of the material to the environment.

6.3.6 Any disposal area should be clearly identified and labeled.

6.3.7 Disposal areas should be adequately monitored to permit identification of any leakage. In keeping with Regulation 131

6.3.8 Training programs should include appropriate information about he environmental hazards of materials.

6.4 Household Wastes

Waste reduction, re-use, sorting and recycling should be strongly emphasized at the mine site in order to minimize waste generation and to reduce management and disposal costs

6.4.2 As much as possible, vegetation from debushing should be used for constructing facilities and equipment such as tables and other furniture, posts, sediment collection structures (e.g. brush barrier), soil stabilization structures, etc. The amount of vegetation from debushing that is not used should be kept to a minimum.

6.4.3 Cleared vegetation that is not used should be piled up and burnt.

7.0 Monitoring and Surveillance

Site monitoring and surveillance programs should be developed and implemented with focus on:

- Leakages and discharges from waste piles and hazardous waste disposal areas
- Stability of waste piles
- Effectiveness of runoff and drainage control structures
- Waste disposal practices

8.0 Emergency Measures

There are no additional emergency measures or considerations related to the implementation of this code of practice outside of the Contingency and Response Plan.

9.0 References

Aubertin, M. and Bussière, B., *Meeting Environmental Challenges for Mine Waste Management,* Geotechnical News, sept. 2001, 6 p

Beak International Inc., Literature Review of Chemistry and Toxicity of Mercury, Cadmium, Selenium and Antimony in Metal Mining Effluents. *TIME*, *Network,* 142 p*.,* 2002.

Environment Australia, Best Practice – Environmental Management in Mining. Commonwealth of Australia, August 2002.

GENCAP Mining (2004), Draft Codes of Practice, Mine Waste Management and Disposal Small and Medium Scale-Mines (Guyana), 2003

GENCAPD Mining (2000), *Workshop on Mercury Use in the Mining Industry in Guyana. Summary Report,* July 17, 2003.

GENCAPD Mining, *Workshop on Producing Environmental Codes of Practice for the Mining Industry of Guyana. Summary Report.* September 30, 2003.

Global Mercury Project, *Newsletter* No.1, January 2003.

Government of Guyana, *Regulations made under the Mining Act (No. 20 of 1989). Proposed amendments, 2002.*

Guyana Forestry Commission, *Code of Practice for Timber Harvesting.* 92 p. (2002).

International Cyanide Management Institute, *International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold.* May 2002.

Medina Cruz, G., *Mitigación del mercurio en la minería artesanal y pequeña minería aurífera del Perú.* Jornada Internacional sobre el impacto ambiental del mercurio utilizado por la minería aurífera artesanal en Iberoamérica., 9 p., 2001.

The Mining Association of Canada, *A Guide to the Management of Tailings Facilities.* Ottawa, Canada, 1998.

Veiga, M.M., *Introducing New Technologies for Abatement of Global Mercury Pollution in Latin America.* UNIDO, UBC and CETEM, 63 p., 1997.

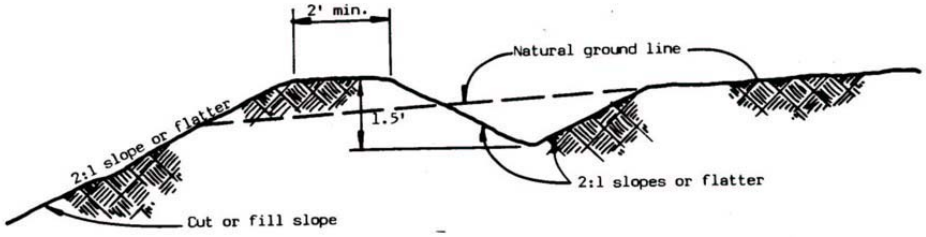
Wotruba, H., Hentschel, T., Hruschka, F. and Priester, M., *Manejo ambiental en la pequeña minería*. Edición MEDMIN-COSUDE, La Paz, Bolivia, 302 p., 1998.

Web sites
http://rainbow.ldgo.columbia.edu/edf/text/mercury.html
http://www.gama-peru.org/jornada-hg/index.htm
http://www.hruschka.com/hg-net/

http://www.facome.uqam.ca/facome/home/home_e.html
http://planeta.terra.com.br/educacao/br_recursosminerais/meioambiente.html
http://www.casmsite.org/programs.html

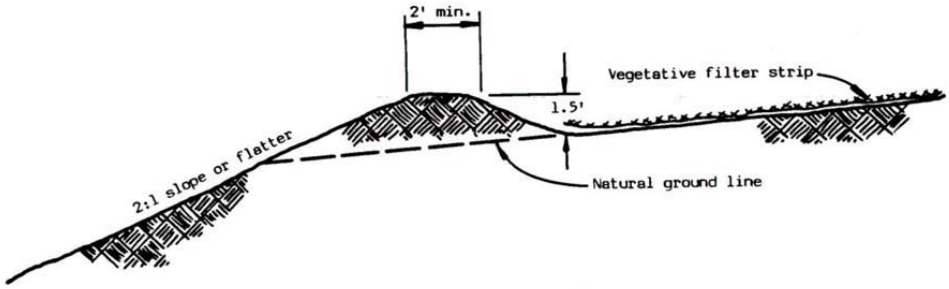
Appendix A: Runoff Control Structures

Diversion Dike/Ditch



NOTE: Bed of dike to be riprapped.

SECTION

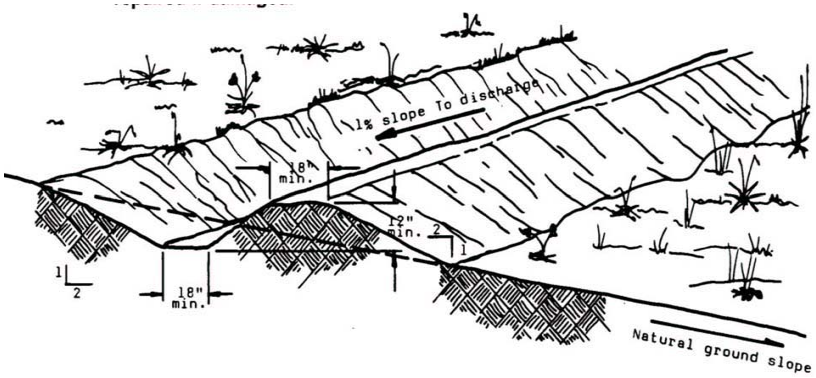


NOTES: 1) Dike constructed by dozer moving soil upslope and dumping at top of slope.
2) Outlet to stabilized vegetated soil.

SECTION

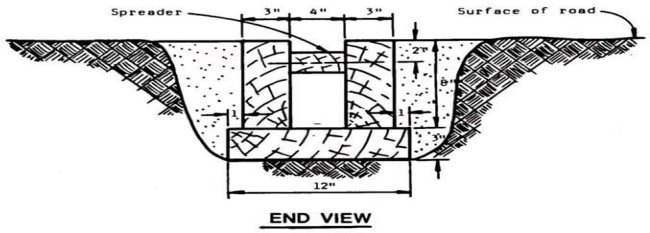
After Idaho Department of Lands, 1992

Interceptor Trench

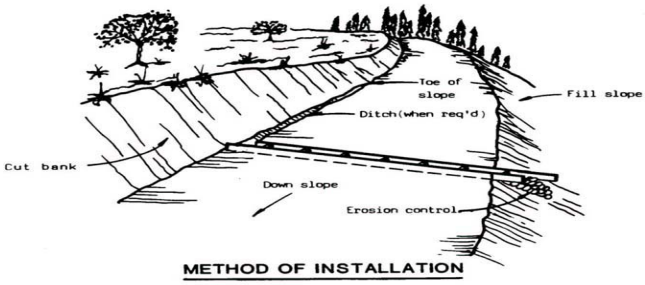


After Idaho Department of Lands, 1992

Open Top Box Culvert



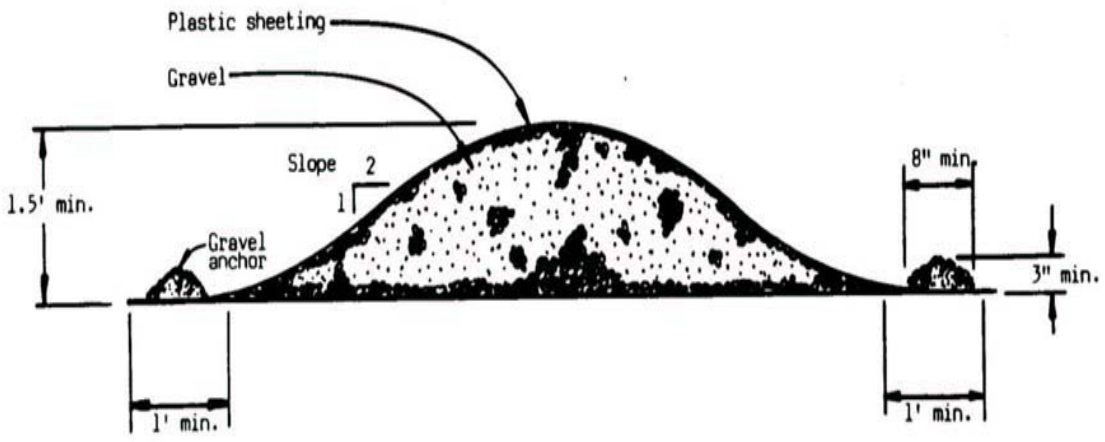
END VIEW



METHOD OF INSTALLATION

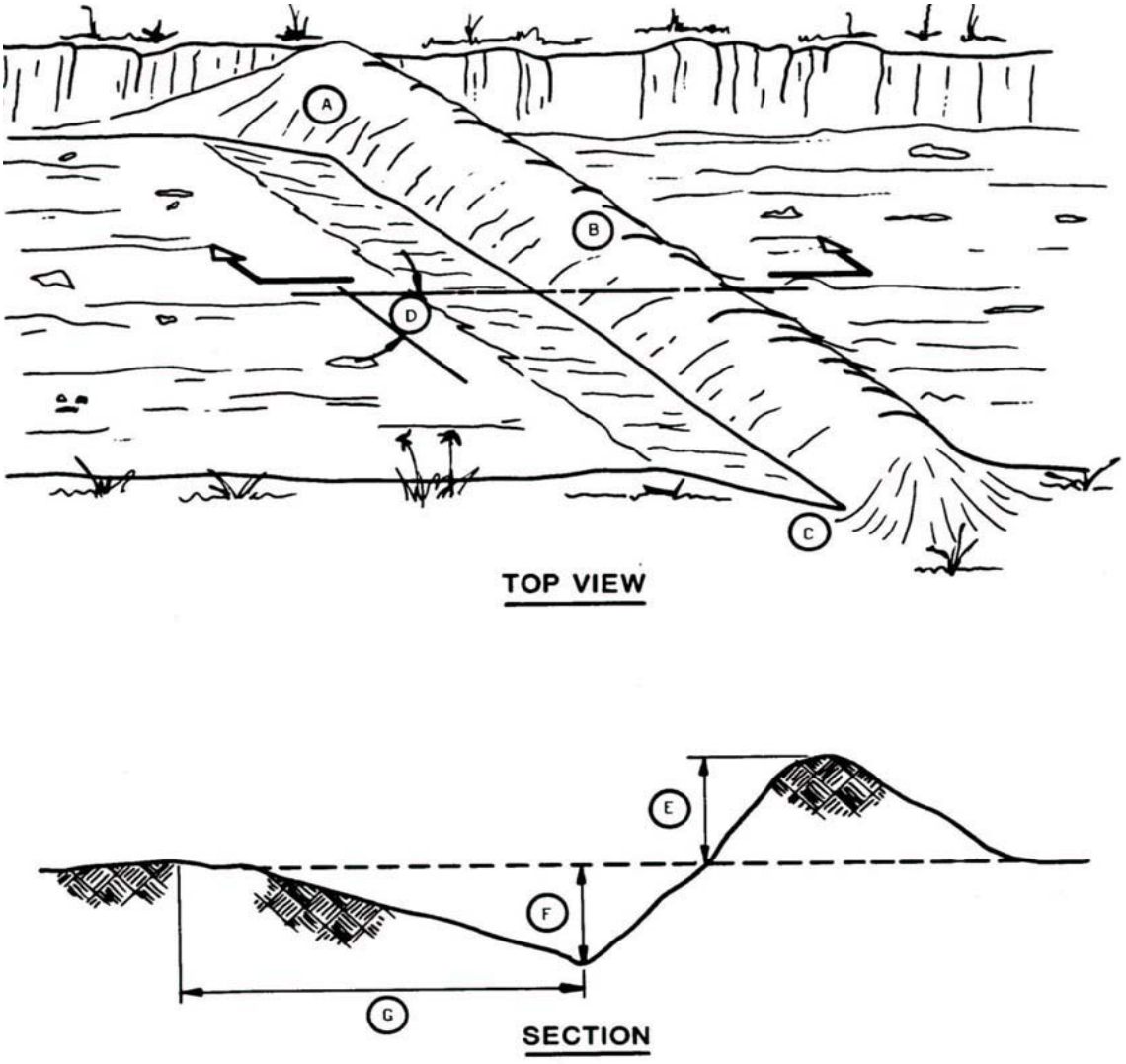
After Idaho Department of Lands, 1992

Siltation Berm



After Idaho Department of Lands, 1992

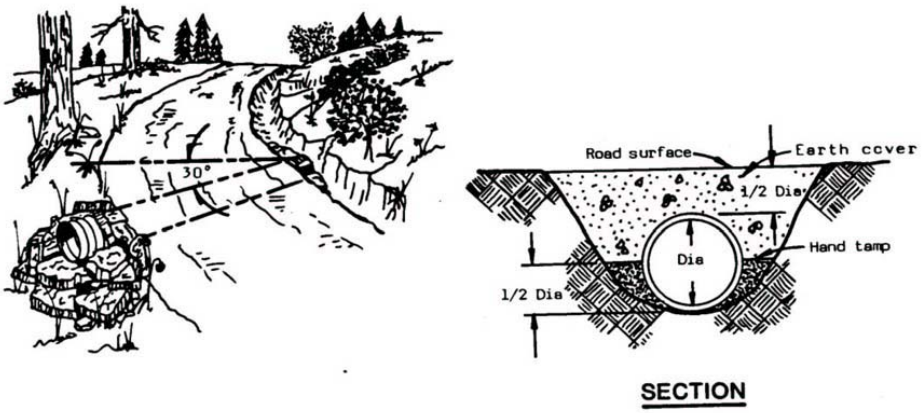
Waterbars



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.

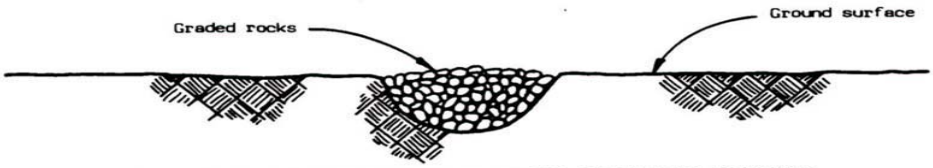
After Idaho Department of Lands, 1992

Culvert Installation

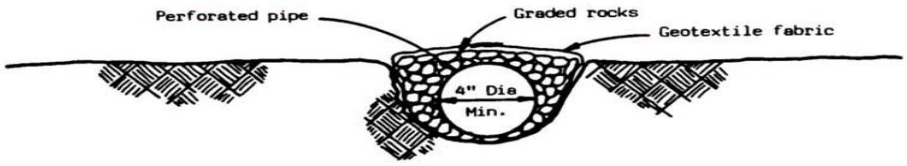


After Idaho Department of Lands, 1992

Drain Fields

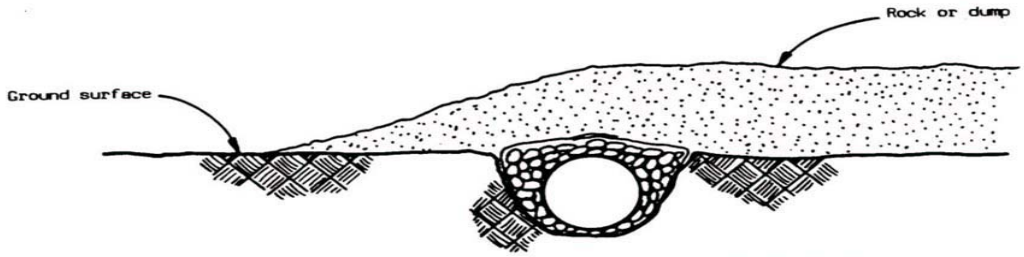


DRAIN FIELD TRENCH LINED WITH GRADED ROCKS



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

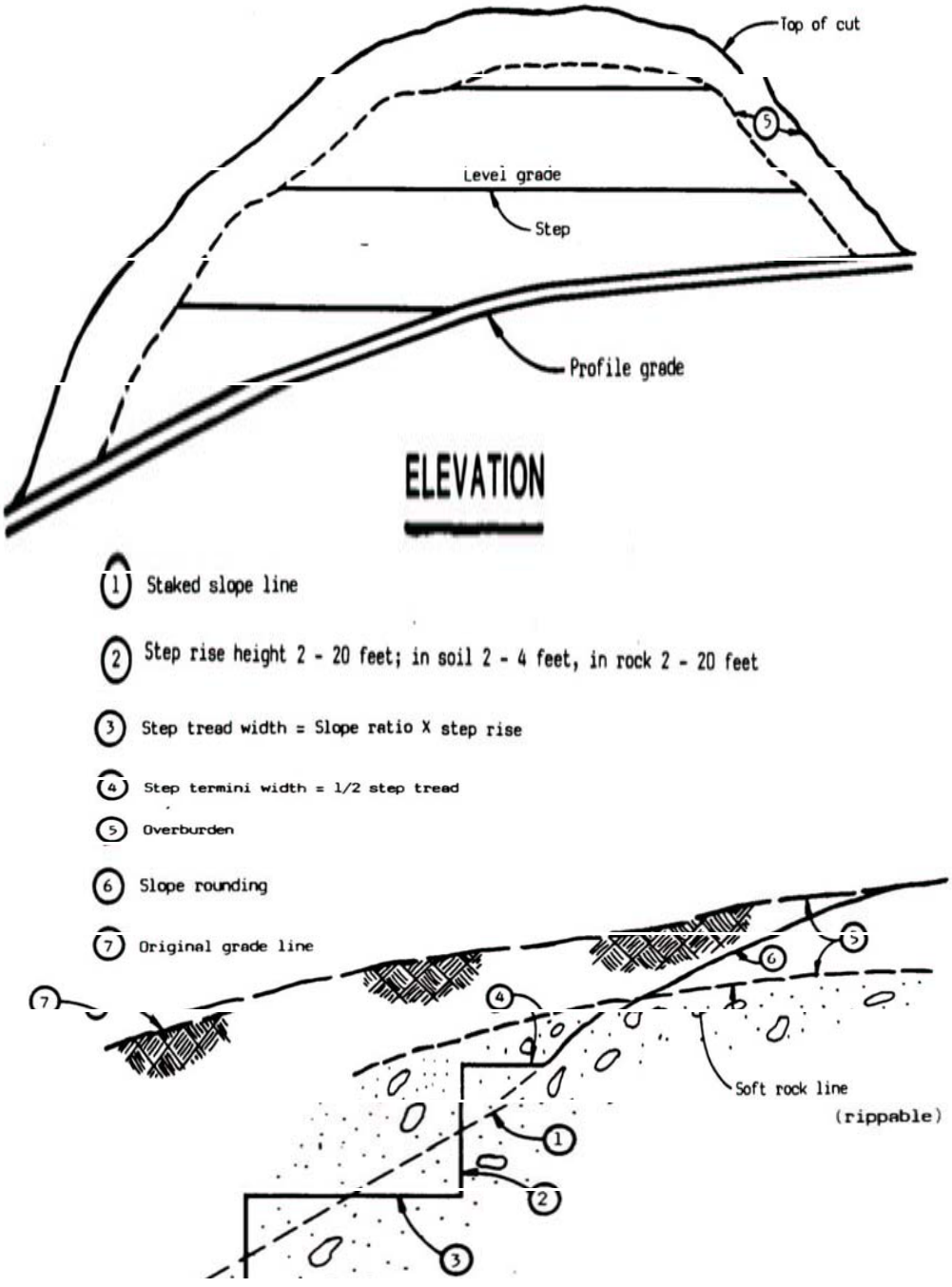
After Idaho Department of Lands, 1992

Road Sloping

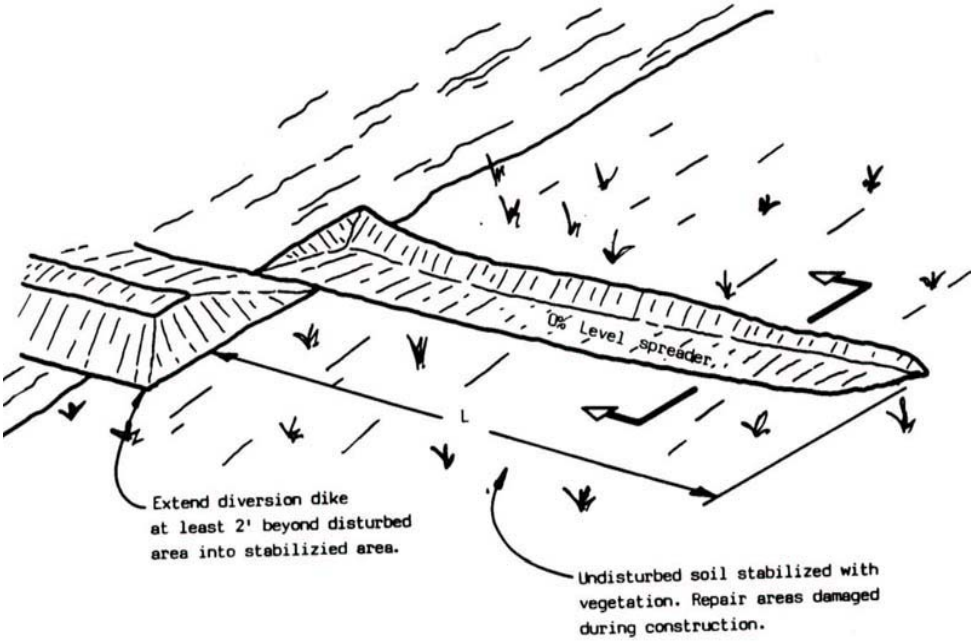
After Idaho Department of Lands, 1992

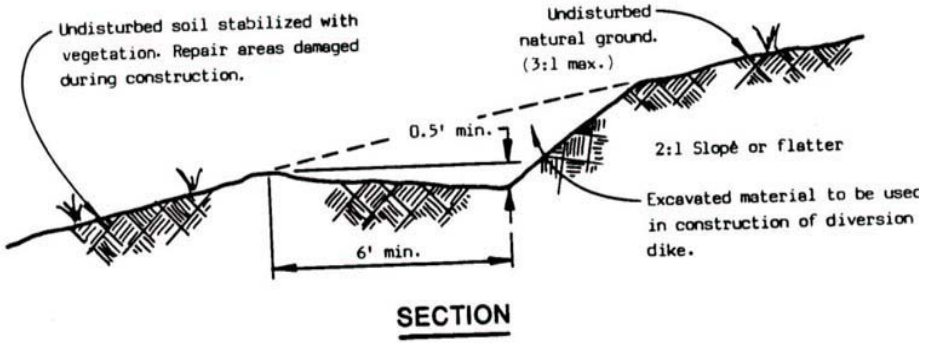
Appendix B: Runoff Dispersion Structures

Benched Slopes



Level Spreader



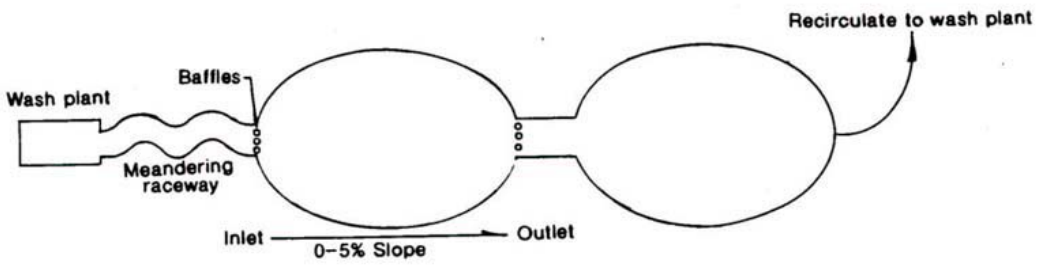


SECTION

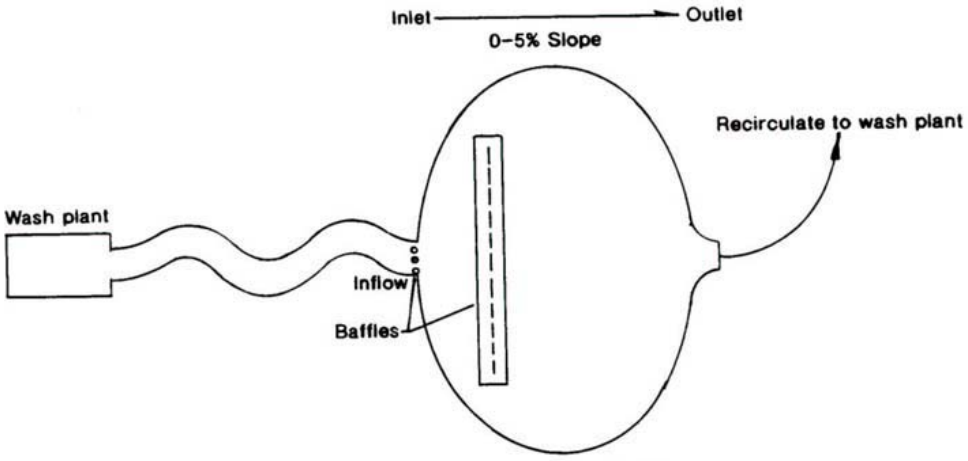
After Idaho Department of Lands, 1992

Appendix C: Sediment Collection Structures

Diagram of Settling Ponds for Placer Mining



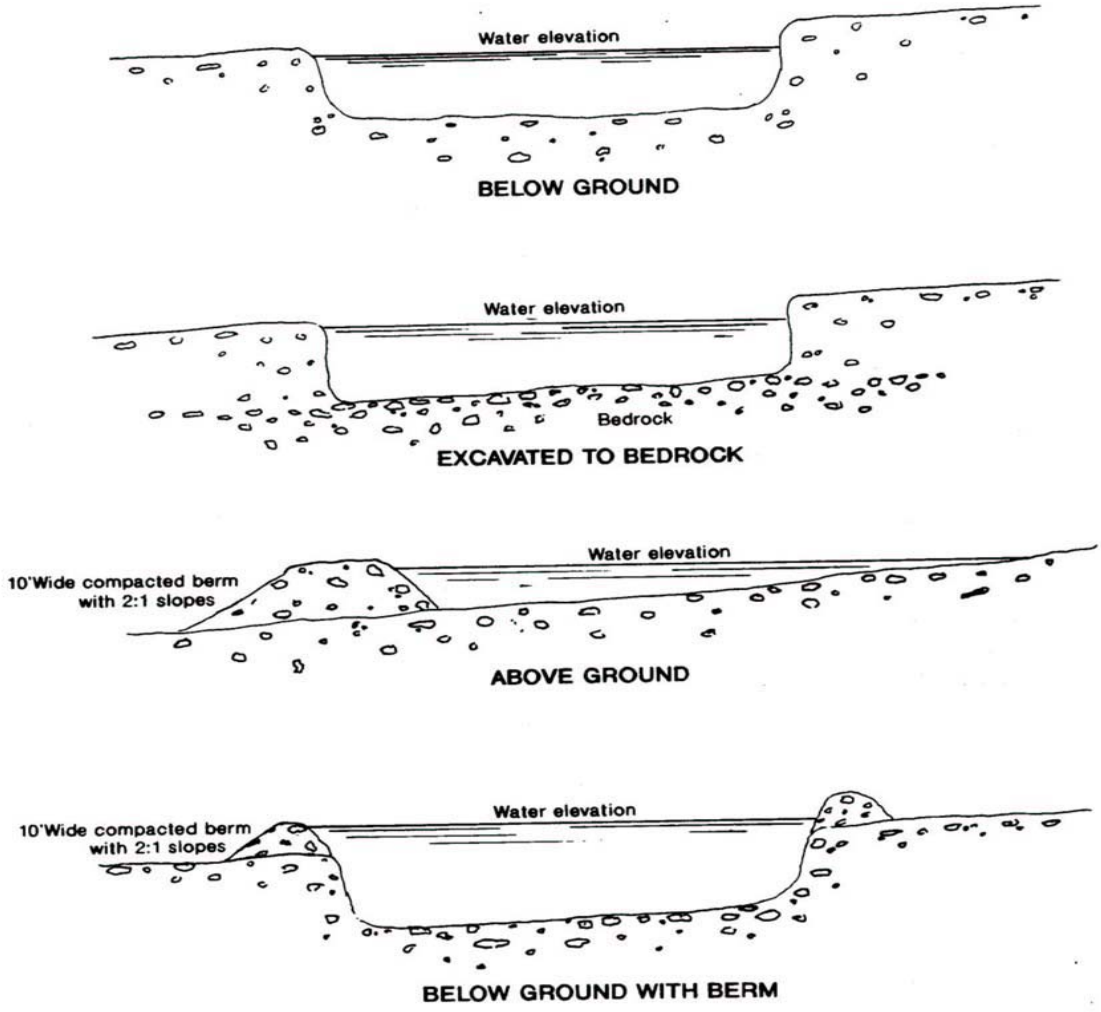
STANDARD SETTLING PONDS IN SERIES



SETTLING POND WITH BAFFLES

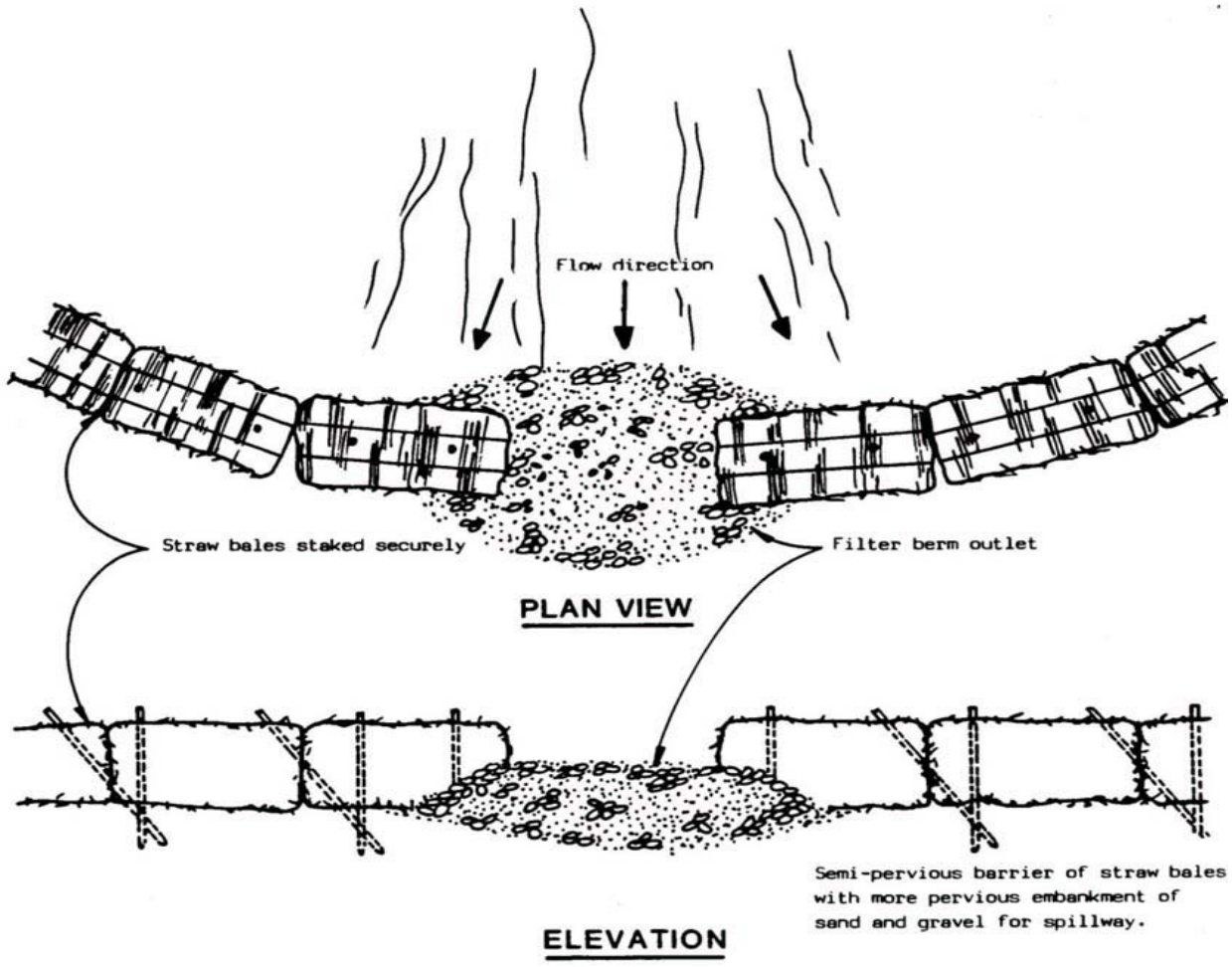
After Idaho Department of Lands, 1992

Settling Pond Construction Options



After Idaho Department of Lands, 1992

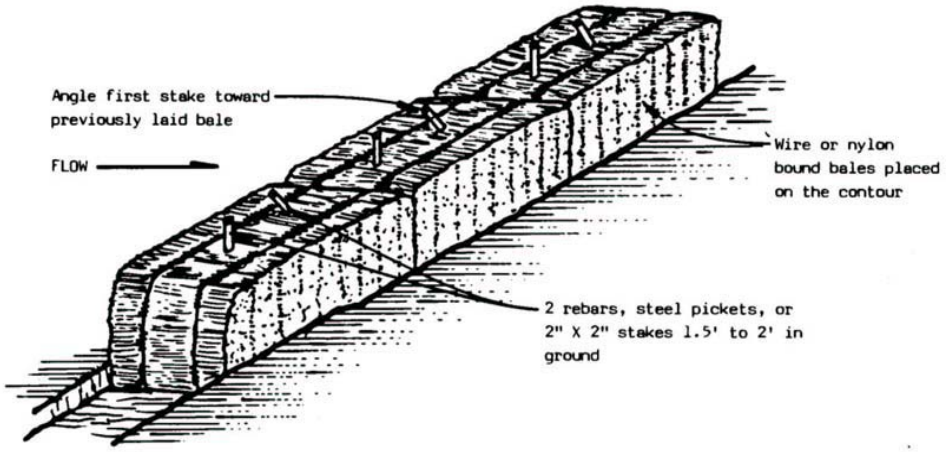
Straw Bale Sediment Barrier



After Idaho Department of Lands, 1992

Straw Bale Sediment Barrier *(cont'd)*

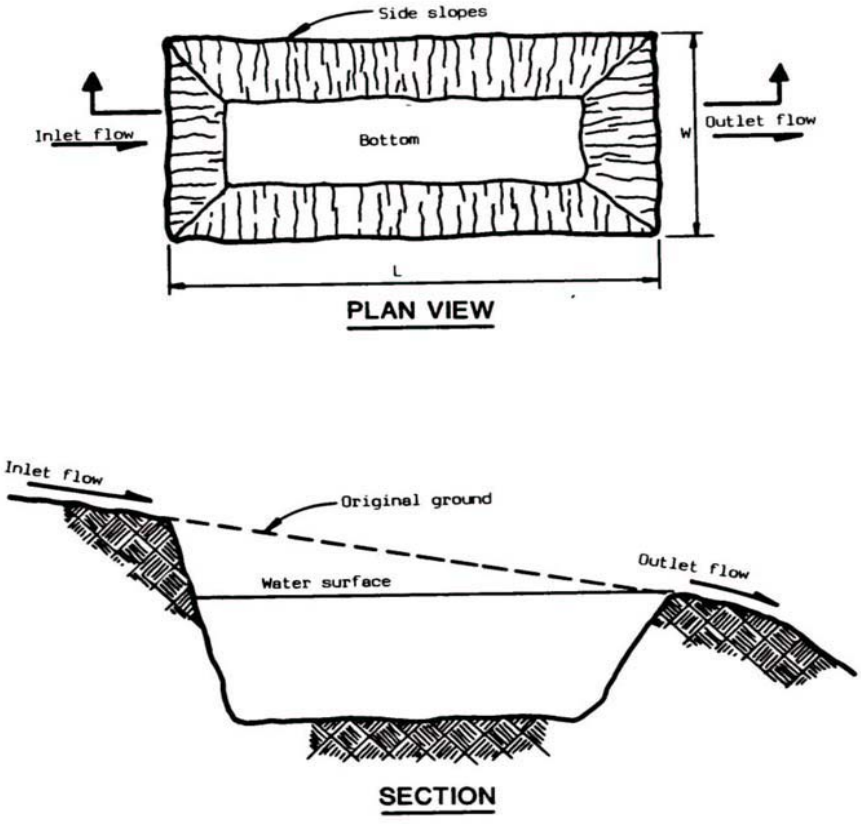
EMBEDDING DETAIL



ANCHORING DETAIL

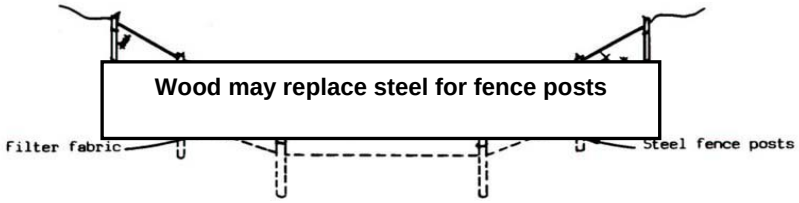
After Idaho Department of Lands, 1992

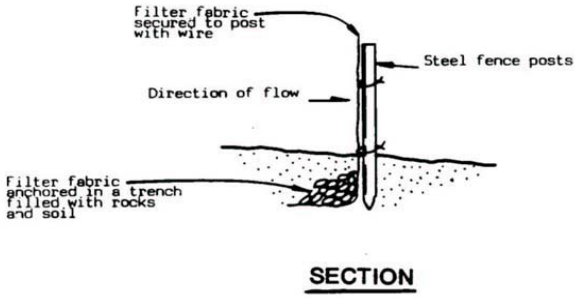
Sediment Traps or Catch Basins



After Idaho Department of Lands, 1992

Silt Fence/Filter Fence

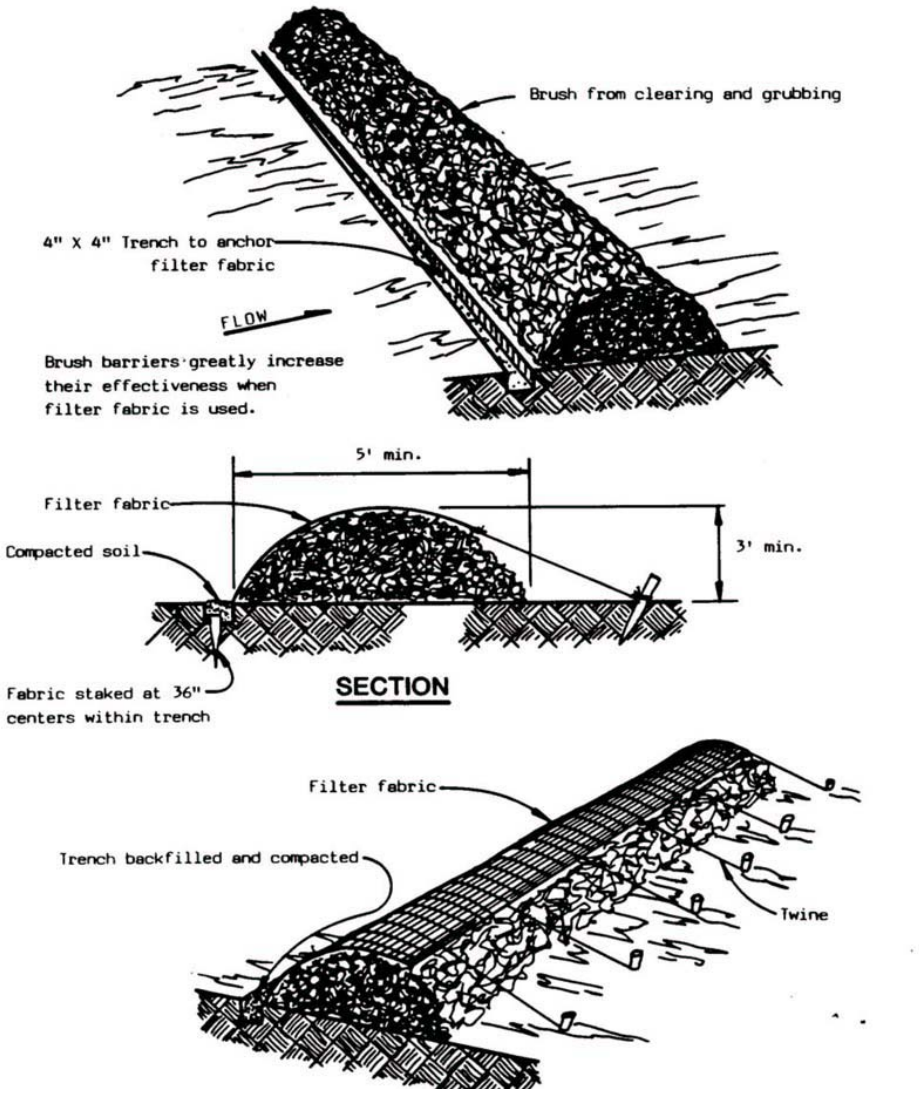




SECTION

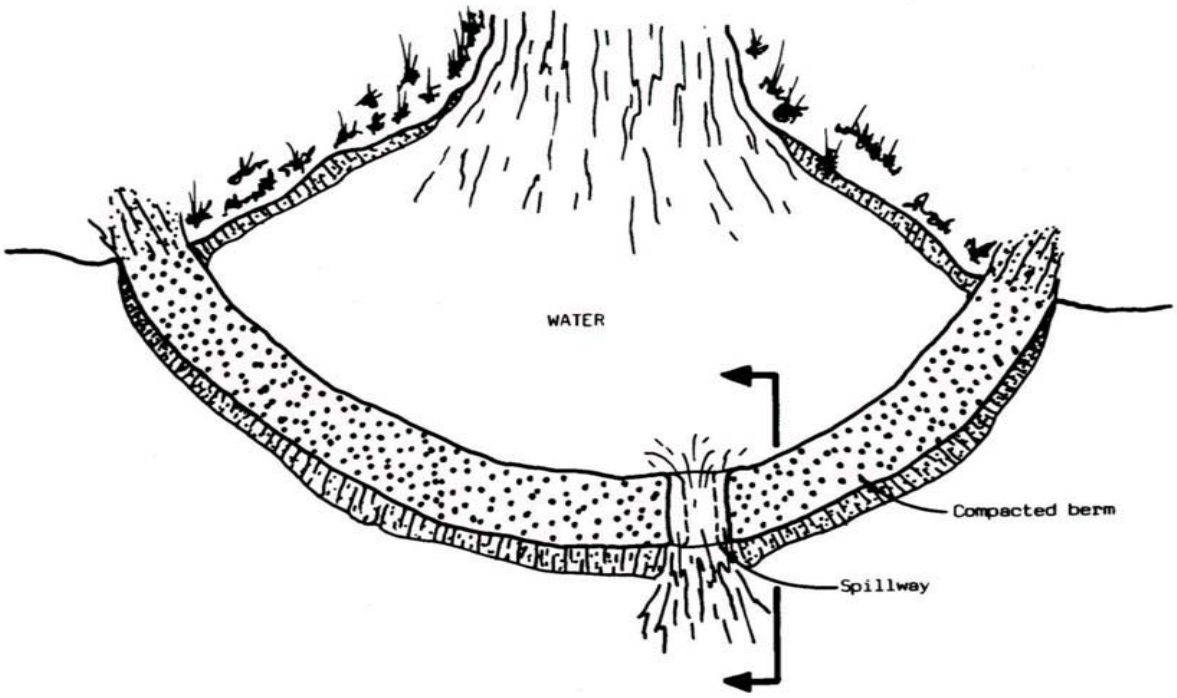
After Idaho Department of Lands, 1992

Brush Sediment Barrier

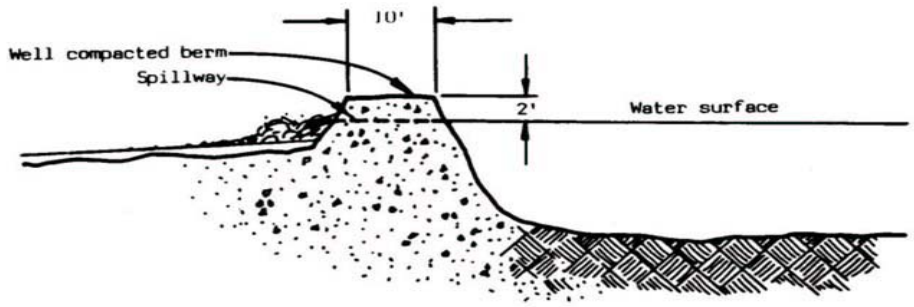


After Idaho Department of Lands, 1992

Sediment/Settling Pond



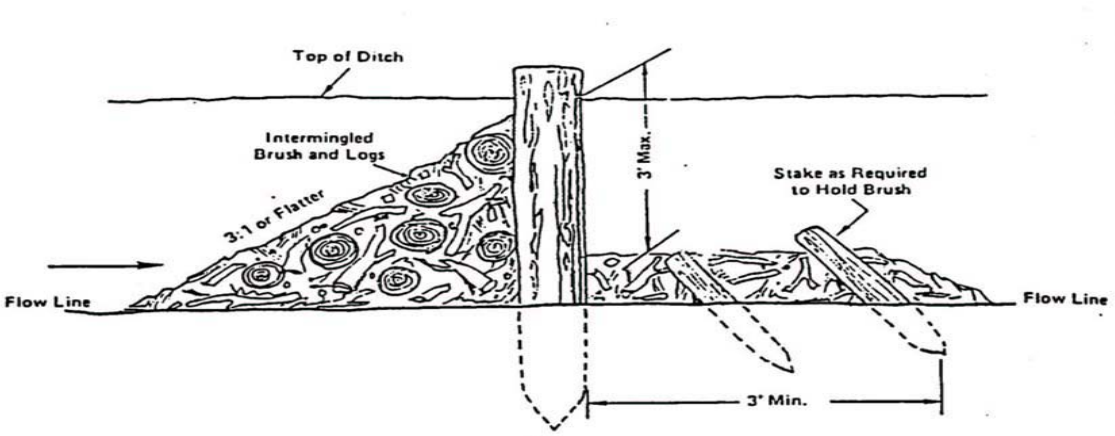
PLAN VIEW



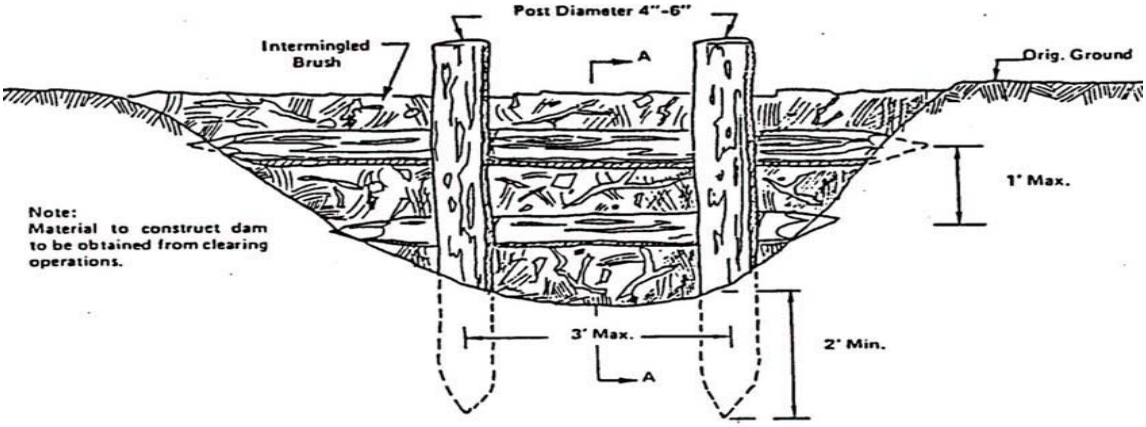
CROSS SECTION

After Idaho Department of Lands, 1992

Log and Brush Check Dam



SECTION A-A

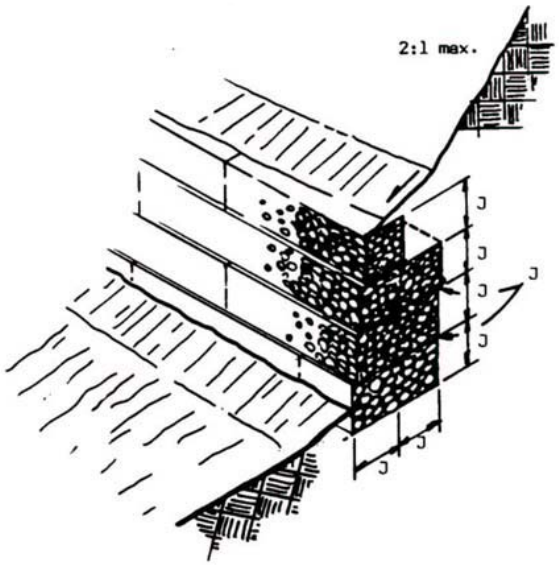


ELEVATION VIEW

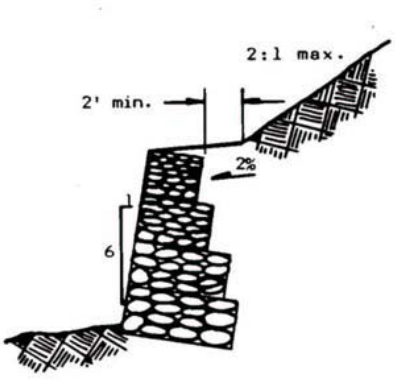
After Idaho Department of Lands, 199

Appendix D: Permanent Soil Stabilization Techniques

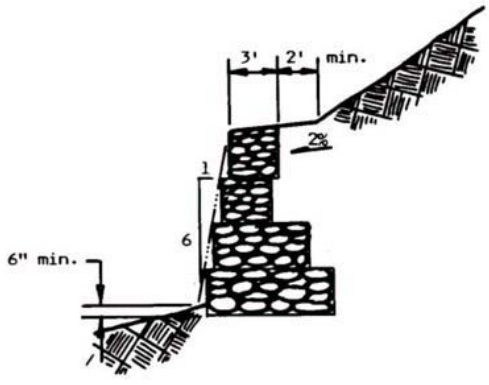
Gabions



3-DIMENSIONAL

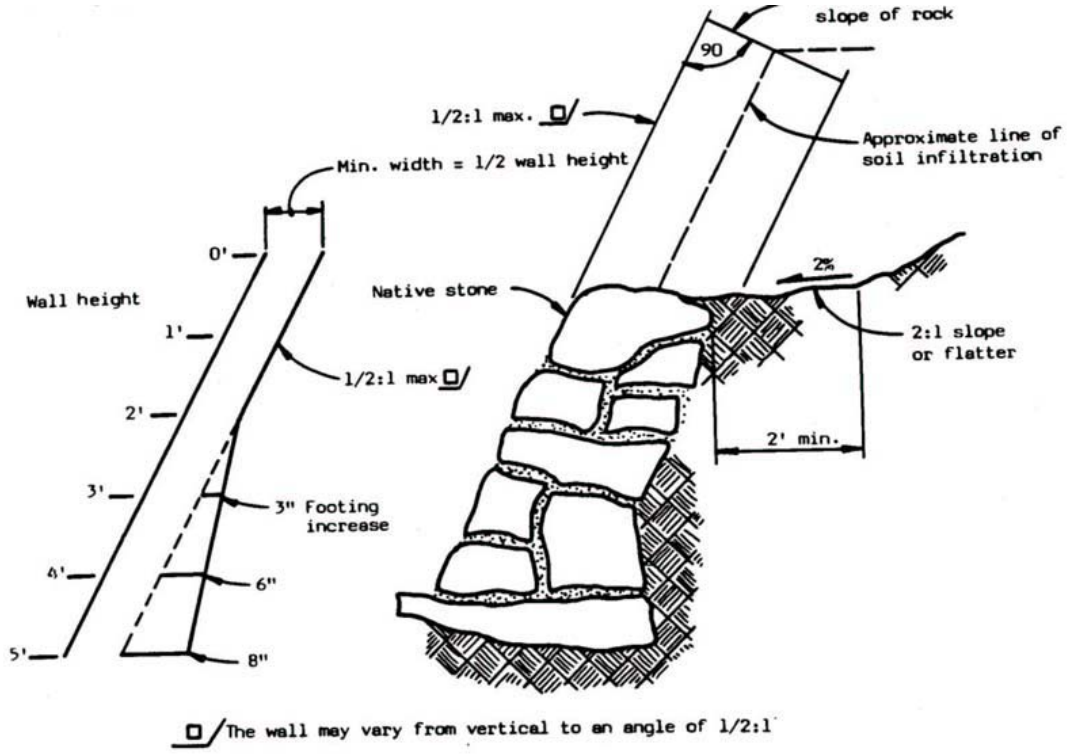


SECTION



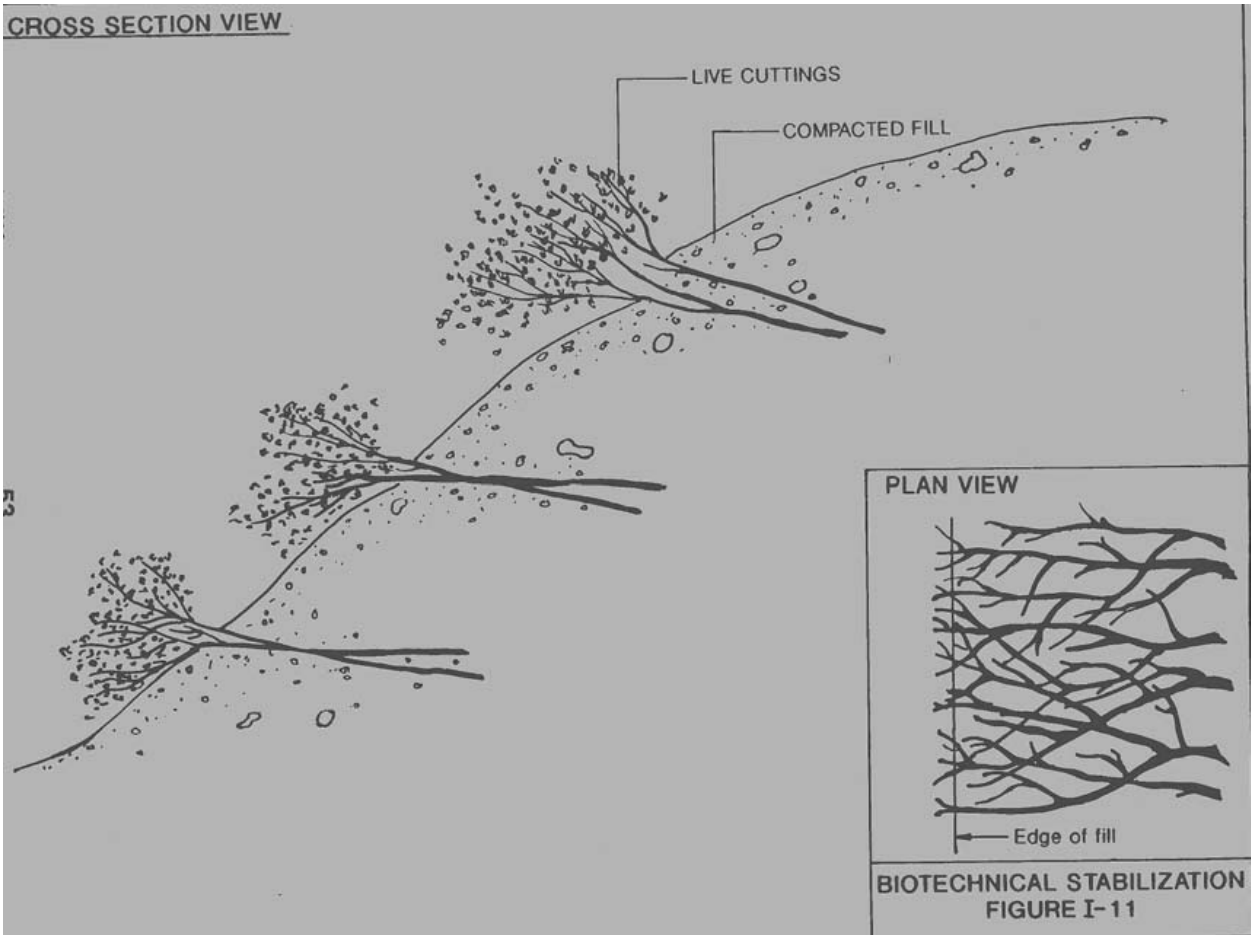
SECTION

Native Rock Retaining Wall



Biotechnical Stabilization

(five layers of brush imbedded in the ground)



Appendix E: Seeding and Revegetation Techniques

Topsoiling

Topsoiling is the placement of topsoil or other suitable plant growth material over a prepared-topsoil.

Purpose: To provide a suitable soil medium for vegetative growth.

Seedbed Preparation

Seedbed preparation entails preparing the soil by ripping, discing, scarifying, and adding soil amendments to make the soil more productive and enhance revegetation efforts.

Purpose: To promote successful revegetation efforts by preparing the soil for planting and creating propped seedbed conditions.

Broadcast Seeding

Broadcast seeding is the process of uniformly casting seeds and fertilizer on the soil by hand or mechanical means.

Purpose: Broadcast seeding is employed when seeding grasses, shrubs, forbs, or trees on flat surfaces and slopes where other seeding methods are not appropriate. Broadcast seeding is well suited for use on steep slopes, rocky areas, abandoned roadways, sites with limited access, and where hand labor is used.

Drill Seeding

Drill seeding is the process of planting seed and fertilizer using an agricultural or rangeland drill seeder.

Purpose: This method is most effective on flat, non-rocky surfaces. Drill seeding provides the maximum possibility for successful germination and growth, with a minimum investment in fertilizer, seed, and labor because seeds are not damaged or carried away by wind, water, animals, or birds.

Vegetative Panting

Vegetative planting means the establishment of vegetation by planting trees and shrubs from nursery stock and transplants.

Purpose: Planting vegetation is an effective means of promoting soil stability and controlling erosion; however, until establishment is complete the site is vulnerable to erosion. Trees and shrubs should be planted in conjunction with grasses and legumes to enhance the overall effectiveness of soil stabilization efforts and erosion control measures.