



# WEST VIRGINIA EROSION AND SEDIMENT CONTROL FIELD MANUAL

Office of Oil and Gas

Charleston, WV



west virginia department of environmental protection

## **INTRODUCTION**

Presented herein are best management practices (BMP'S) for alleviating soil-disturbing operations conducted during oil and gas industry activities in the state of West Virginia. These practices are required by the Department of Environmental Protection (DEP), Office of Oil and Gas.

The manual is divided into five sections, each with its own index as applicable:

- I. Planning
- II. Construction
- III. Reclamation
- IV. Revegetation
- V. Maintenance

BMP's discussed herein are to be used as required; certain practices may not always be applicable in all situations. Also, the DEP may from time to time, require additional practices not discussed here.

In the case of an uncontrolled site condition, a waiver may be required from the DEP to change a standard on a site-specific basis. Variation from the practices outlined in the manual may only be employed upon approval and documentation of such a variance by the district county oil and gas inspector.

Operations may also require permit coverage from the Office of Land and Streams of the West Virginia Division of Natural Resources, the US Army Corps of Engineers, the Division of Water and Waste Management of the DEP, the Municipalities, and/or the Division of Highways.

## Section I PLANNING

Prior to beginning construction of roads and well locations for oil and gas drilling, a plan must be developed. Planning involves a preplanning stage and development of the "Construction and Reclamation Plan," Form WW-9 (See pages 4-5) is to be used.

During the preplanning stage, the operator should meet with and work with landowners to determine the best access routes and minimize damage and inconvenience to the landowner. This critical contact can make the ensuing development of the well a much easier job.

### A. Preplanning Guide

1. Locate available maps of the area, such as USGS topo sheets, soils maps (SCS), aerial maps or photos (ASCS, DOH, etc).
2. Locate wellsite and nearest available road on a USGS topographic map.
3. Contact landowner
4. Determine the different types of soil that may be encountered in developing the site.
5. Identify significant features that may control plan elements:
  - a. Streams and wetlands
  - b. Utilities
  - c. Roads
  - d. Drainageways
  - e. Ridges
  - f. Steep areas
  - g. Soil Limitations – slips, erodible, undrainable clays, etc.
  - h. Stream crossings
  - i. Rock outcrops
  - j. Land use and cover
  - k. Property boundaries and fence lines
6. Lay out access road on topo map:
  - a. Plan road from state route to the location.
  - b. Plan road within 20 percent grade.
  - c. Avoid long continuous erodible road grades.
  - d. Road drainage – side ditches, culverts, broad-based dips, outlet protection.
  - e. With hill slopes 60 percent or greater, road width will be in all cut. Due to the steepness of the out slope, the fill will not contribute to the road width.
7. Determine surface water control for site areas by diverting or conveying runoff:
  - a. Diversions
  - b. Drainage ditches
  - c. Land grading
  - d. Culverts
8. Determine need for sediment controls:
  - a. Hay or straw bales
  - b. Earth or stone berms or dikes
  - c. Sediment basins
  - d. Silt fences
  - e. Vegetative filter strips
  - f. Brush piles
  - g. Rip rap
9. Determine revegetation needs:
  - a. Temporary vegetation
    - (1) Prepare seedbed
    - (2) Seed mixture from Table IV-1.
  - b. Permanent vegetation
    - (1) Apply lime and fertilizer according to Table IV-3.
    - (2) Prepare seedbed
    - (3) Apply seed mixture from Table IV-2.
    - (4) Mulch all seedings from Table IV-4.
    - (5) Maintain as needed.

**STATE OF WEST VIRGINIA  
DEPARTMENT OF ENVIRONMENTAL PROTECTION  
OFFICE OF OIL AND GAS**

**CONSTRUCTION AND RECLAMATION PLAN AND SITE REGISTRATION APPLICATION FORM  
GENERAL PERMIT FOR OIL AND GAS PIT WASTE DISCHARGE**

Operator Name \_\_\_\_\_ OP Code \_\_\_\_\_

Watershed \_\_\_\_\_ Quadrangle \_\_\_\_\_

Elevation \_\_\_\_\_ County \_\_\_\_\_ District \_\_\_\_\_

Description of anticipated Pit Waste: \_\_\_\_\_

Do you anticipate using more than 5,000 bbls of water to complete the proposed well work? Yes \_\_\_\_\_ No \_\_\_\_\_

Will a synthetic liner be used in the pit? \_\_\_\_\_. If so, what ml.? \_\_\_\_\_

Proposed Disposal Method For Treated Pit Wastes:

- \_\_\_\_\_ Land Application
- \_\_\_\_\_ Underground Injection ( UIC Permit Number \_\_\_\_\_ )
- \_\_\_\_\_ Reuse (at API Number \_\_\_\_\_ )
- \_\_\_\_\_ Off Site Disposal (Supply form WW-9 for disposal location)
- \_\_\_\_\_ Other (Explain \_\_\_\_\_)

Drilling medium anticipated for this well? Air, freshwater, oil based, etc. \_\_\_\_\_

-If oil based, what type? Synthetic, petroleum, etc. \_\_\_\_\_

Additives to be used? \_\_\_\_\_

Drill cuttings disposal method? Leave in pit, landfill, removed offsite, etc. \_\_\_\_\_

-If left in pit and plan to solidify what medium will be used? Cement, lime, sawdust \_\_\_\_\_

-Landfill or offsite name/permit number? \_\_\_\_\_

I certify that I understand and agree to the terms and conditions of the GENERAL WATER POLLUTION PERMIT issued on August 1, 2005, by the Office of Oil and Gas of the West Virginia Department of Environmental Protection. I understand that the provisions of the permit are enforceable by law. Violations of any term or condition of the general permit and/or other applicable law or regulation can lead to enforcement action.

I certify under penalty of law that I have personally examined and am familiar with the information submitted on this application form and all attachments thereto and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment.

Company Official Signature \_\_\_\_\_

Company Official (Typed Name) \_\_\_\_\_

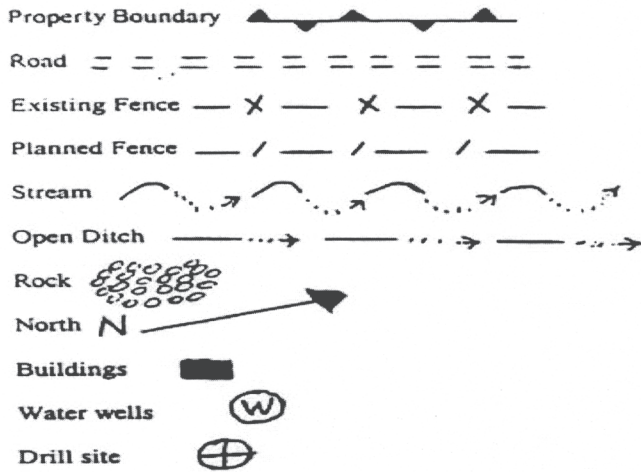
Company Official Title \_\_\_\_\_

Subscribed and sworn before me this \_\_\_\_\_ day of \_\_\_\_\_, 20 \_\_\_\_\_

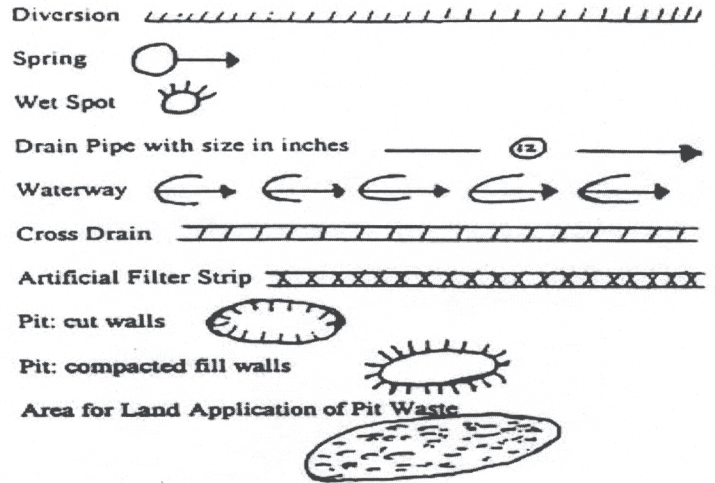
\_\_\_\_\_  
Notary Public

My commission expires \_\_\_\_\_





**LEGEND**



Proposed Revegetation Treatment: Acres Disturbed \_\_\_\_\_ Prevegetation pH \_\_\_\_\_

Lime \_\_\_\_\_ Tons/acre or to correct to pH \_\_\_\_\_

Fertilizer (10-20-20 or equivalent) \_\_\_\_\_ lbs/acre (500 lbs minimum)

Mulch \_\_\_\_\_ Tons/acre

Seed Mixtures

Seed Type	Area I	Area II
	lbs/acre	lbs/acre
_____	_____	_____
_____	_____	_____
_____	_____	_____

Attach:  
Drawing(s) of road, location, pit and proposed area for land application.

Photocopied section of involved 7.5' topographic sheet.

Plan Approved by: \_\_\_\_\_

Comments: \_\_\_\_\_

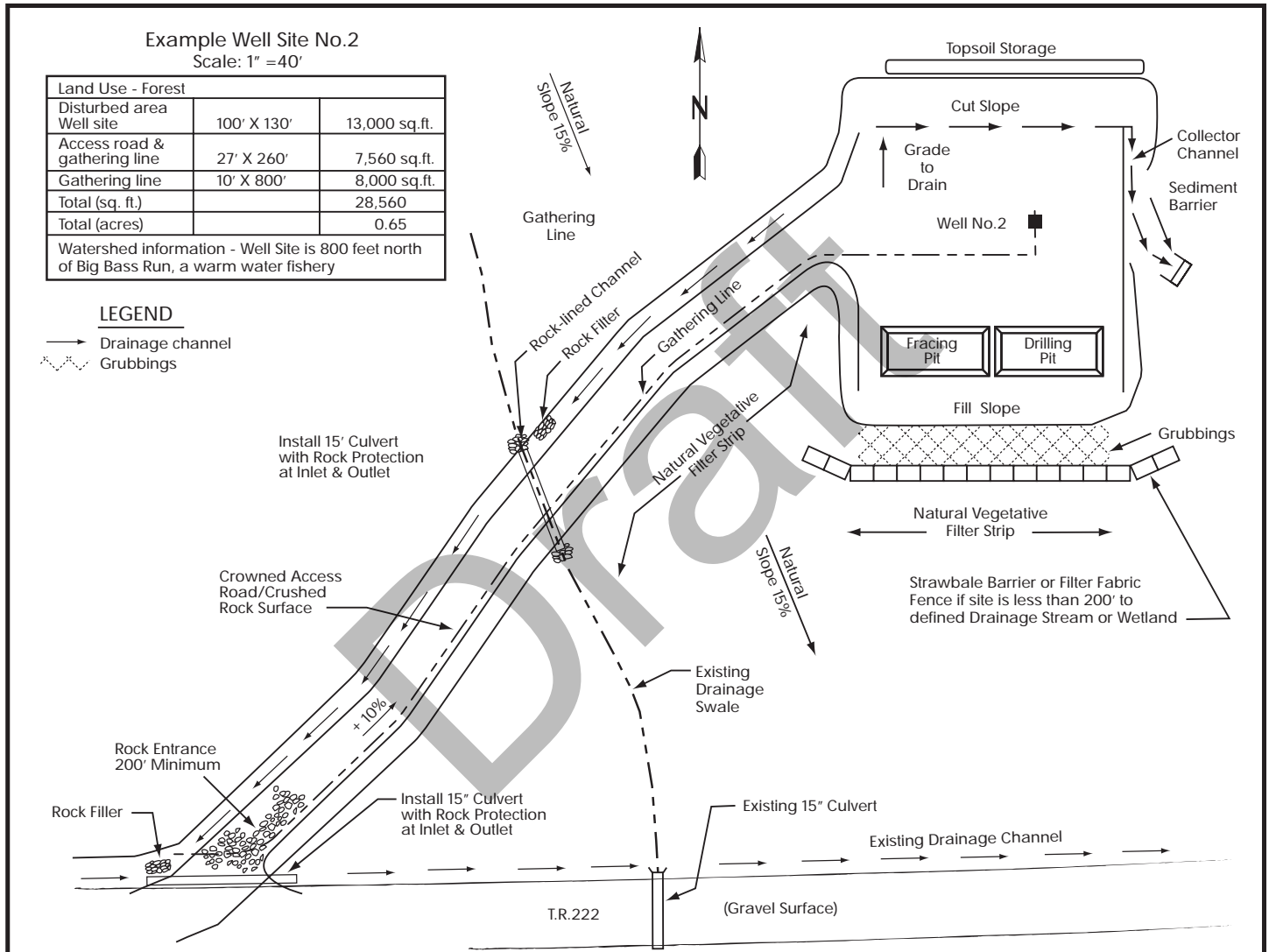
Title: \_\_\_\_\_ Date: \_\_\_\_\_

Field Reviewed? ( ) Yes ( ) No

**B. Construction and Reclamation Plan Preparation**

The Construction and Reclamation Plan is drawn up and submitted on Form WW-9 to the DEP, Office of Oil and Gas, with a well work permit application. This plan must include drawings of the access road showing total road distance and slope and/or well location showing existing and proposed structures (including all pits) with approximate dimensions in accordance with the legend on said plan. Once the plan is completed the county oil and gas inspector must be notified for field review and/or approval of the plan.

**Access Road and Location Drawing**



Section II  
**EROSION & SEDIMENT CONTROL FOR ACCESS  
ROAD & WELLSITE CONSTRUCTION**

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## A. Access Road Construction

### 1. Access Roadway

Description: A roadway constructed to provide access to the wellsite. Any modification or reconstruction of an existing road, open to public use or private, shall be considered part of the access road and subject to the criteria defined herein.

#### a. Design Criteria:

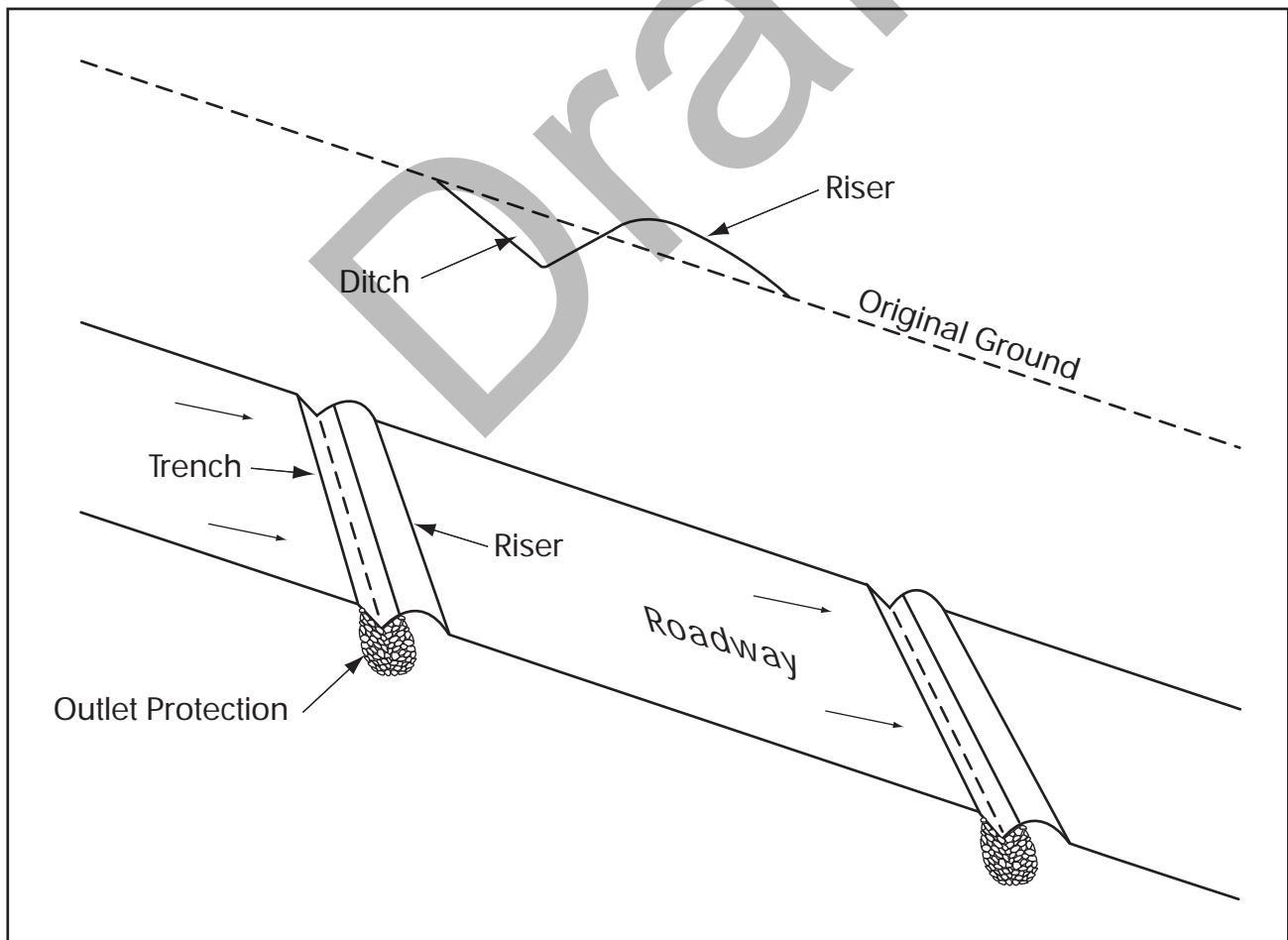
1. Maximum road grade will be 20%; Inspector may approve a waiver for grades in excess of 20% on a case by case basis. The installation of additional sediment controls with use of cross drains and stoning may be necessary when road grades exceed 15%.
2. Minimum width will be 10 feet for a single lane and 20 feet for a double lane.
3. Side slopes for excavated cuts will be in accordance with information listed in Table II-1.
4. Earth fill slopes should be no steeper than 2 to 1.
5. Side ditches will be installed on sections of roads, in cut where surface drainage impinges the fill areas.
6. Culverts will be installed to carry waters under the road from the ditches and natural drainage ways.
7. Cross ditches and broad based dips shall be installed to control road surface water. Refer to Tables II-4 and II-5.
8. Well access roads that intersect public roads must have installed gravel or other aggregates for at least 200 feet from the public road to keep mud off the highway.

#### b. Construction Specifications:

1. The areas to be excavated or occupied by fill, shall be cleared and grubbed of all trees, stumps, large roots, boulders, and debris. All such material will be disposed of by stacking, piling, windrowing, burning (in accordance with WV Forest Fire Laws), removal from site, or other methods approved by the Inspector.

2. Road surface stabilization may be required in excessively wet or soft areas, by use of stone and/or stone and fiber matting.
  3. When crossing pipelines or other underground utilities, adequate protection should be provided. For assistance in location underground utilities in WV call 1-800-245-4848 (Miss Utility of WV).
  4. When leaving a County or State Road Right-of-Way, a "Road Approach Permit" is required by the WV Division of Highways. Refer to the DOH Manual for specifications.
2. Drainage Ditch
- Description: An open drainage ditch constructed to a specific size and grade, along the road, to collect and convey surface water.
- a. Design Criteria:
1. Ditch side slopes will not be steeper than 2:1, when excavated in soil. Refer to Table II-1 for allowable side slopes in other types of material.
  2. For allowable velocities, refer to Table II-2. Capacity of ditch shall be based on handling 0.1 cfs per acre of drainage. Refer to Table II-3 for sizing of ditch. Minimum depth shall be 1 foot.
  3. Cross section of the ditch shall be V-shaped.
  4. All ditches should have erosion protection and/or stabilizing measures. See Figure II-6
  5. Ditch stabilizing measures can be seeding and mulching, rock ditch check dams, lining with stone etc., depending upon ditch grade and expected velocity.
  6. Ditch outlets shall have adequate erosion and sediment control.
3. Cross Drain/Waterbar
- Description: An open ditch, constructed across the roadway, to carry off road surface water. They are not intended to replace culverts. See Figure II-1.

FIGURE II-1: Cross Drain/Waterbar



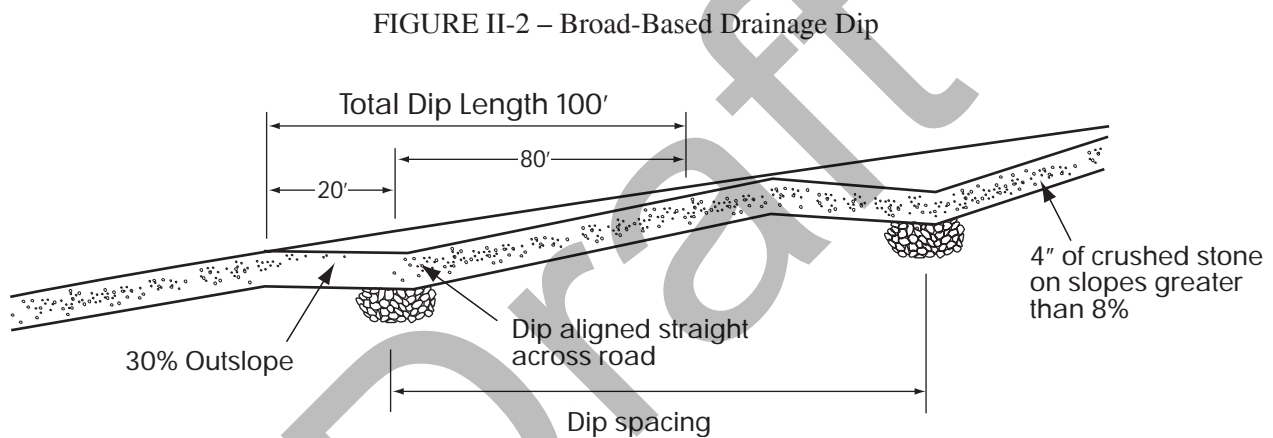


- a. Design Criteria:
  1. Minimum depth – 8 inches
  2. Minimum width – 2 feet
  3. Ditch will be angled approximately 30 degrees at a grade of ½ inch per foot of length.
  4. Velocity will not exceed the permissible velocity listed for the particular soil type. See Table II-2.
  5. Proper outlet protection will be provided to prevent erosion and control sedimentation from the ditch discharge. Material for the outlet can be rock, logs, concrete, or metal with the appropriate sediment barrier.
  6. Stabilization: Cross drains may need to be lined with erosion resistant materials, such as rock riprap.
  7. Spacing: Refer to Table II-4.

4. Broad-Based Dip

Description: A constructed dip or swale, across the road surface, sloped to the outslope for drainage of the road surface. See Figure II-2.

- a. Design Criteria:
  1. Maximum road grade on which dips can be constructed is 10%
  2. A 3% reverse grade should be constructed in the existing roadbed, by cutting upgrade of the dip location.
  3. Stone lining may be needed.
  4. Drainage outlet protection shall be provided with appropriate sediment barrier structures.
  5. Spacing: Refer to Table II-5.



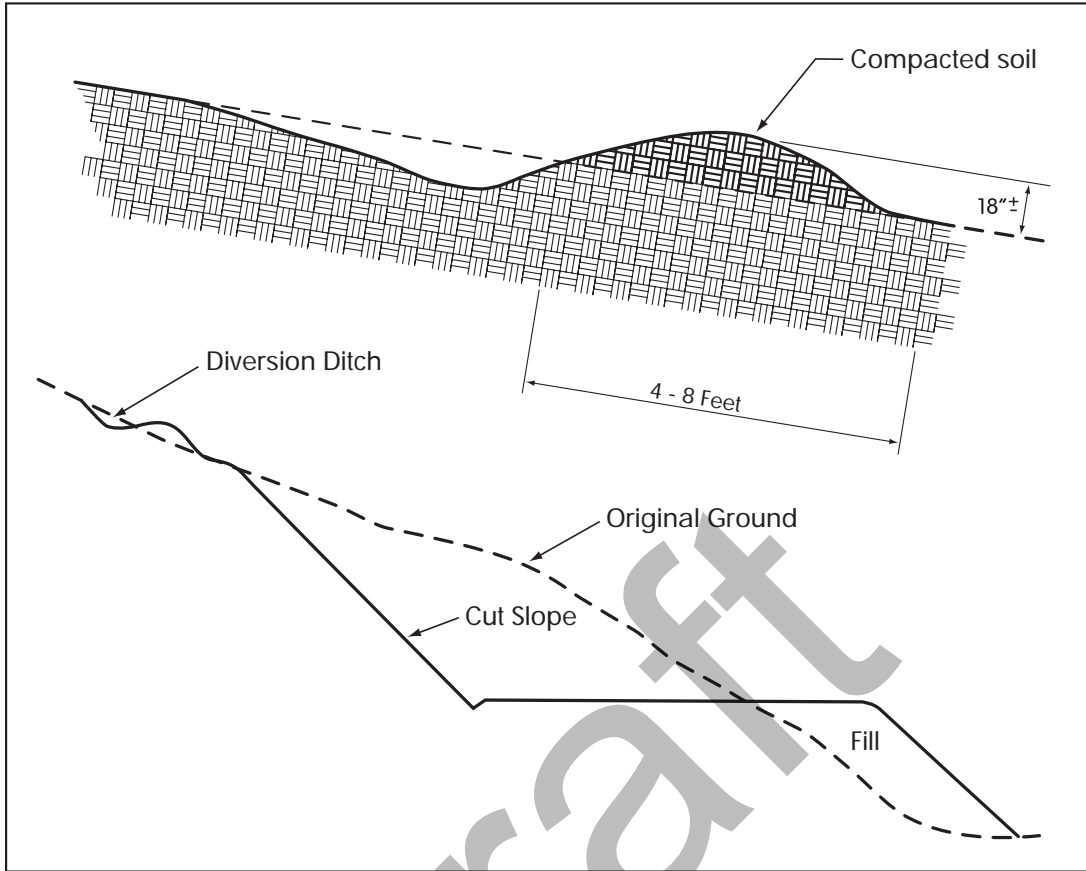
5. Diversion Ditch – Temporary

Description: A channel or ridge constructed across a slope for diverting surface runoff. See Figure II-3.

- a. Purpose: To intercept surface water before it enters an erodible area and convey the runoff to a safe outlet.
- b. Design Criteria:
  1. For drainage areas less than 10 acres (See Figure II-3)
    - a. Minimum depth – 18 inches
    - b. Minimum top width – 8 feet
    - c. Maximum ditch grade – 2 percent
    - d. Ditch outlets shall have erosion and sediment control. (See outlet protection pg. 16).
  2. Drainage area greater than 10 acres
    - a. Capacity of ditch: will handle a 2-year frequency storm, 24-hour duration. For further design information, contact the local Natural Resource Conservation Service Field Office.
    - b. Velocity of water will not be greater than the permissible shown in Table II-2.
  3. Diverted run-off must outlet to a stabilized area.
  4. All ditches should have erosion protection and/or stabilizing measures as well as outlet protection.



FIGURE II-3 – Diversion Ditch – Temporary



6. Culvert

Description: Buried pipe, under the roadway, to carry water from the ditches and natural drainageways. See Figure II-4.

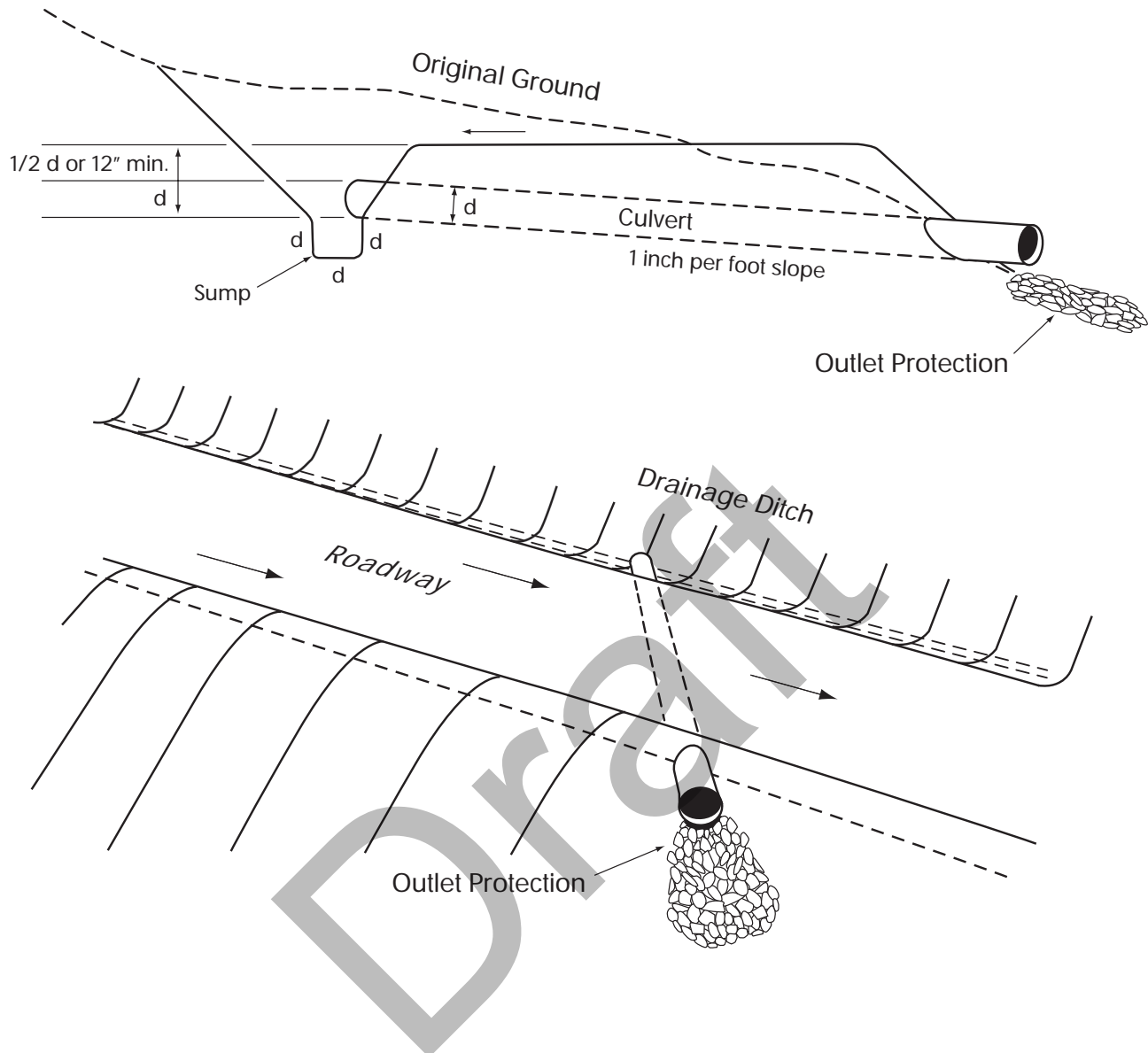
a. Type Material

1. Steel
2. Aluminum
3. Concrete
4. Plastic

b. Design Criteria:

1. Minimum size diameter will be 12 inches.
2. For culvert sizes, based on drainage areas, refer to Table II-6.
3. Culverts will be located at approximately 30 degrees downgrade.
4. Culvert grade shall not be less than  $\frac{1}{2}$  inch per foot of length.
5. Culverts will have at least 12 inches of soil cover, or  $\frac{1}{2}$  pipe diameter, whichever is greater. Additional stabilization may be required.
6. Culverts will have adequate headwalls or drop inlets, at their inlet areas.
7. Outlet protection shall be provided, to prevent erosion from the culvert discharge.
8. Situations may warrant the use of "open top culverts" in some areas.
9. Culvert Spacing: Refer to Table II-7.

FIGURE II-4 – Ditch Relief Culvert



c. Construction Specifications:

1. Culverts will be installed to specified line and grade.
2. Ditch will be excavated to a depth and grade to ensure proper cover for the culvert.
3. Ditch bottom will have a firm foundation for the culvert. Gravel may be used to stabilize the ditch bottom.
4. The culvert will be backfilled with material free of large rocks, which may cause damage to it.
5. Stone may be needed for further surface stabilization.
6. Recommended installation is with a backhoe rather than a dozer.
7. Culverts will have outlet protection (i.e. field rock or riprap, and sediment barriers) as well as natural filter strip areas.



Figure II-5 Rock Ditch Check Dams Example



#### 7. Rock Check Dams- Design Criteria

Small temporary stone dams constructed across a ditch used to reduce the velocity of storm water flows, thereby reducing erosion of the channel and trapping sediment. This practice is the replacement for the traditionally mis-used hay/straw bales and silt fence ditch checks. Constructing a small dugout “trap” upstream of the structure can enhance the sediment trapping efficiency. See Figure II-6.

##### Conditions Where Practice Applies

This practice, utilizing a combination of stone sizes, is limited to use in small open channels that drain 5 acres or less. It is NEVER used in live streams. Check dams can be useful in the following instances:

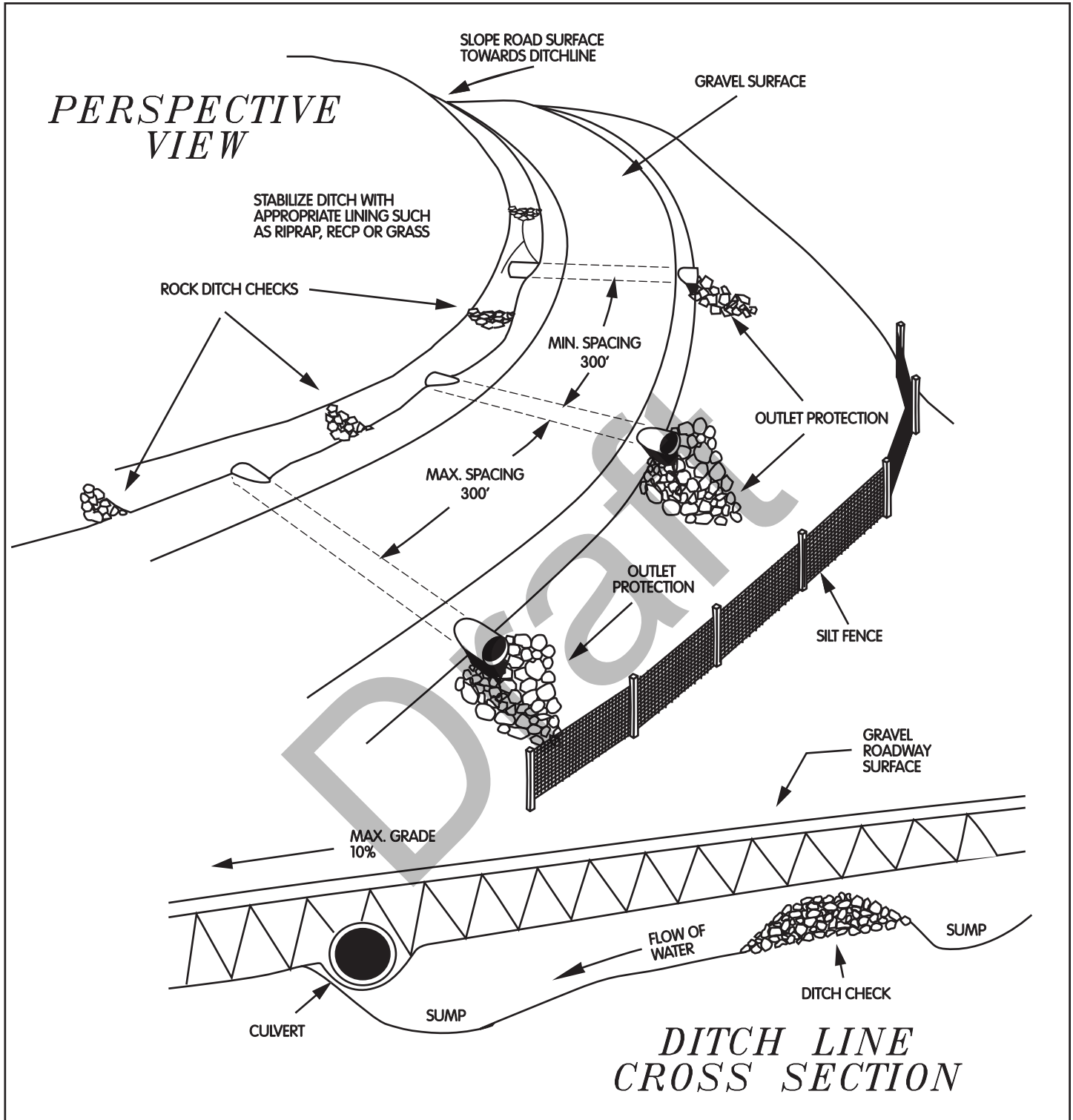
- a. Temporary ditches or swales
- b. Permanent ditches or swales that won't be stabilized with permanent protection until the end of the project.
- c. Temporary or permanent ditches and swales which need protection during the establishment of grass linings.
- d. This practice is NOT a substitute for major perimeter trapping measures such as a SEDIMENT TRAP or a SEDIMENT BASIN.

##### Construction Specifications

No formal design is required for a check dam however the following conditions should be adhered to.

- a. The drainage area of the ditch or swale being protected shall not exceed 2 acres when 2 to 4 inch aggregate is used alone; and shall not exceed 5 acres when a combination of 4 to 8 inch aggregate (added for stability) and the smaller aggregate is used. Refer to drawing for orientation of stone and a cross-sectional view of the measure. An effort should be made to extend the stone to the top of channel banks.
- b. The maximum height of the dam should be 3.0 feet.
- c. The center of the check dam must be at least 6 inches lower than the outer edges. This is the single most important aspect in the proper installation of the rock check dam. High flows must go over the center of the dam, not around the edges where severe erosion can occur.

FIGURE II-6 – Sediment and Erosion Control for Access Roads



8. Filter Strip

Description: A natural vegetative strip, left undisturbed, between the disturbed construction area and a water course. The filter strip acts as a buffer area to catch sediment before it enters the water course.

a. Design Criteria:

1. Roads and other disturbed areas located above a stream require a filter strip in addition to other applicable sediment control. The width of the filter strip depends on the slope of the land between the disturbed area and the stream. Refer to Table II-8. The filter strip area shall not be disturbed.



## 9. Sediment Barriers

Description: A temporary restriction or barrier across a slope, at the toe of a slope, or at drainage outlets designed to trap sediment from a disturbed area by retarding and filtering water runoff. See Figure II-8, 9, 10, 10a and 10b.

### a. Types of Barriers

1. Hay or straw bales
2. Silt fences
3. Brush piles and tree stumps
4. Temporary earth or rock berms or dikes
5. Sediment trap

### b. Construction Specifications:

1. Hay or straw bales should be placed on the contour and tied with either wire or nylon string. Anchor each bale with two wood or metal stakes. Wooden stakes should be at least 2 inch X 2 inch and driven in the ground, a minimum of 1½ feet. Bales should be keyed in the ground 4 inches. Bales shall be placed in a row with the ends tightly abutting to the adjacent one.
2. Silt fences should be placed on the contour. Fence posts shall not be spaced greater than 10 feet apart. If woven wire fence is used, it shall be fastened securely on the upstream side of the fence posts. Filter cloth, when used, shall be secured on the upstream side of the fence posts and anchored at the bottom. The filter cloth shall be embedded in the soil at least 4 inches and the soil compacted around it.
3. Brush piles shall be a minimum of 3 feet in height and 5 feet in width at the base. They may be constructed as single pile units or windrowed, along the contour or at the base of a slope. The brush should be cut so it can be compacted somewhat tightly together. Sizes of brush barriers may vary considerably based upon the amount of material available. See Figure II- 9.
4. Earth or rock barriers should not be more than 2 feet in height and have side slopes of 3:1 or less.
5. A sediment trap is a temporary ponding area formed by constructing an embankment or excavation at the outlet of ditches and other perimeter sediment controls that will trap the flow of sediment- laden runoff. Sediment traps are appropriate for drainage areas of five acres or less.

Figures II-7 Sediment Barrier Examples







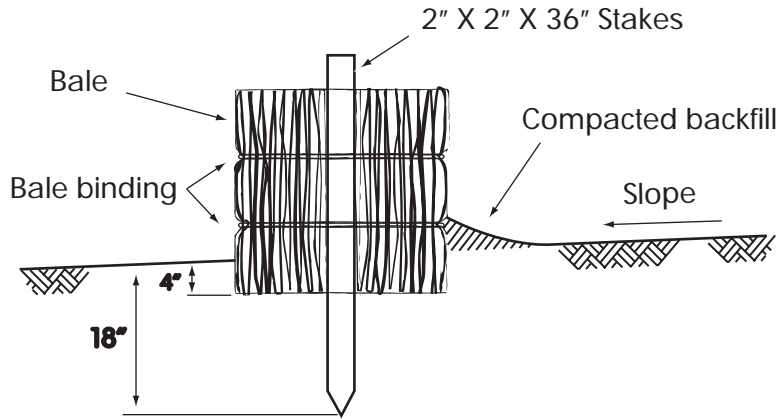
10. Outlet Protection: All culvert outlets shall have some type of erosion protection such as: boulders, tree stumps or rock riprap.
- Boulders (large ungraded field stone or shot rock).
  - Tree stumps larger than 6 inch diameter.
  - Rock riprap consisting of fieldstone or rough un-hewn quarry stone; must be hard, angular and of a quality resistant to weathering and disintegration. The minimum thickness shall be two times the maximum stone diameter, but not less than six inches.

#### OUTLET PROTECTION EXAMPLES





FIGURE II-8: Straw Bale Dike Sediment Barrier



### Straw Bale Barriers

Straw Bale barriers should not be used for more than 3 months or in areas where rock prevents full and uniform anchoring of the bales. Bales should be installed in an anchoring trench. Two support stakes should be driven through each bale to the depth of 18" below the ground surface. The excavated soil should be backfilled and compacted on the upslope side of the bales.

Straw Bale Barriers shall be placed at existing level grade. Both ends of the barrier shall be extended at least 8 feet up slope at 45 degrees to the main barrier alignment.

Sediment shall be removed when accumulations reach 1/3 the above ground height of the barrier.

FIGURE II-9: Brush Pile Sediment Barrier

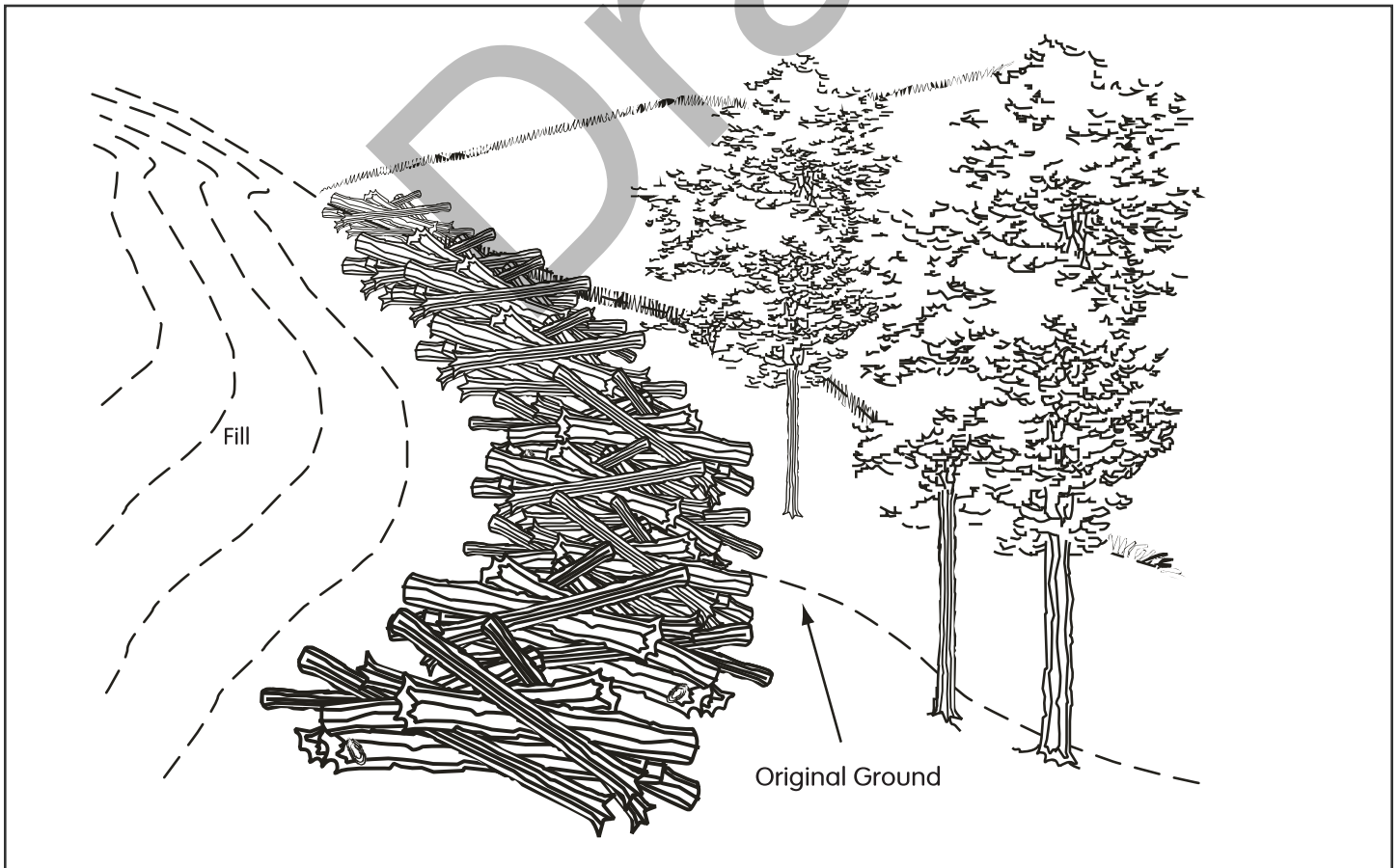
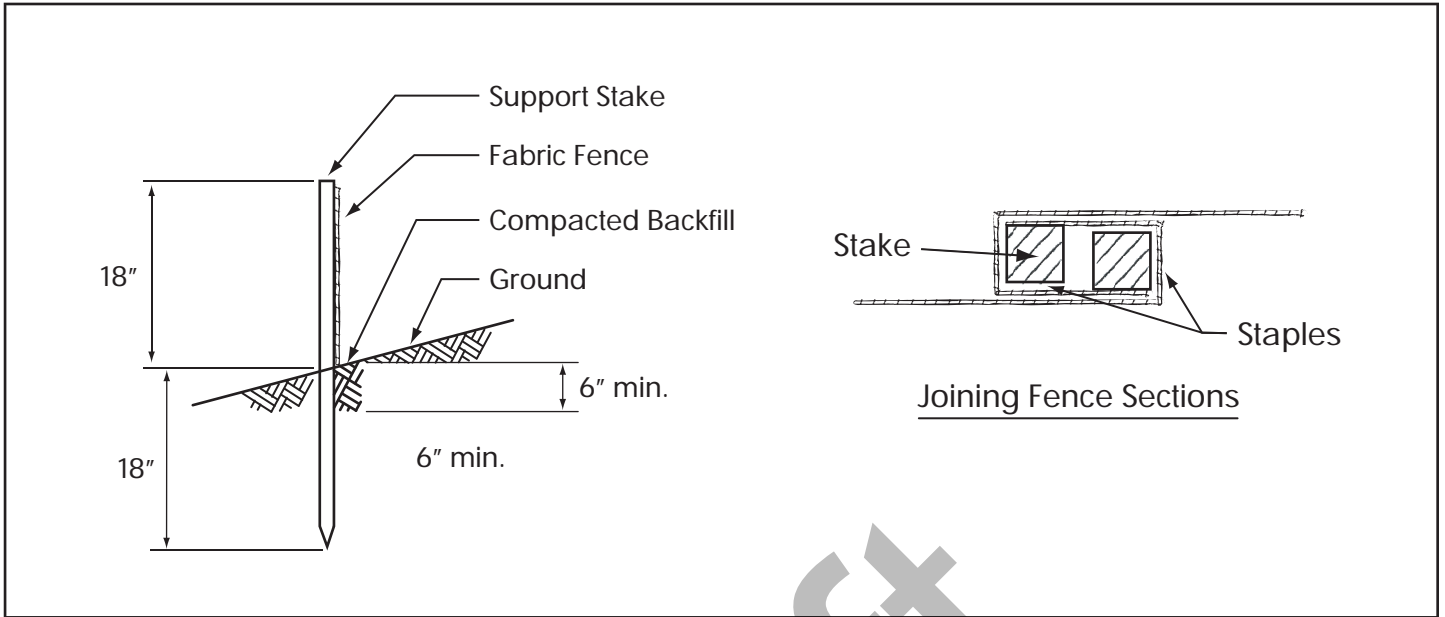


FIGURE II-10: Silt Fence Sediment



Standard Filter Fabric Fence and Reinforced Filter Fabric Fence (30" high)

Standard Filter Fabric Fence must be placed at existing level grade. Both ends of the barrier must be extended at least 8 feet up slope at 45 degrees to the main barrier alignment.

Sediment shall be removed when accumulations reach 1/2 the above ground height of the fence. Any section of the straw bale barrier which has been undermined or topped must be immediately replaced with a rock filter outlet.

FIGURE II-10a: Silt Fence Sediment

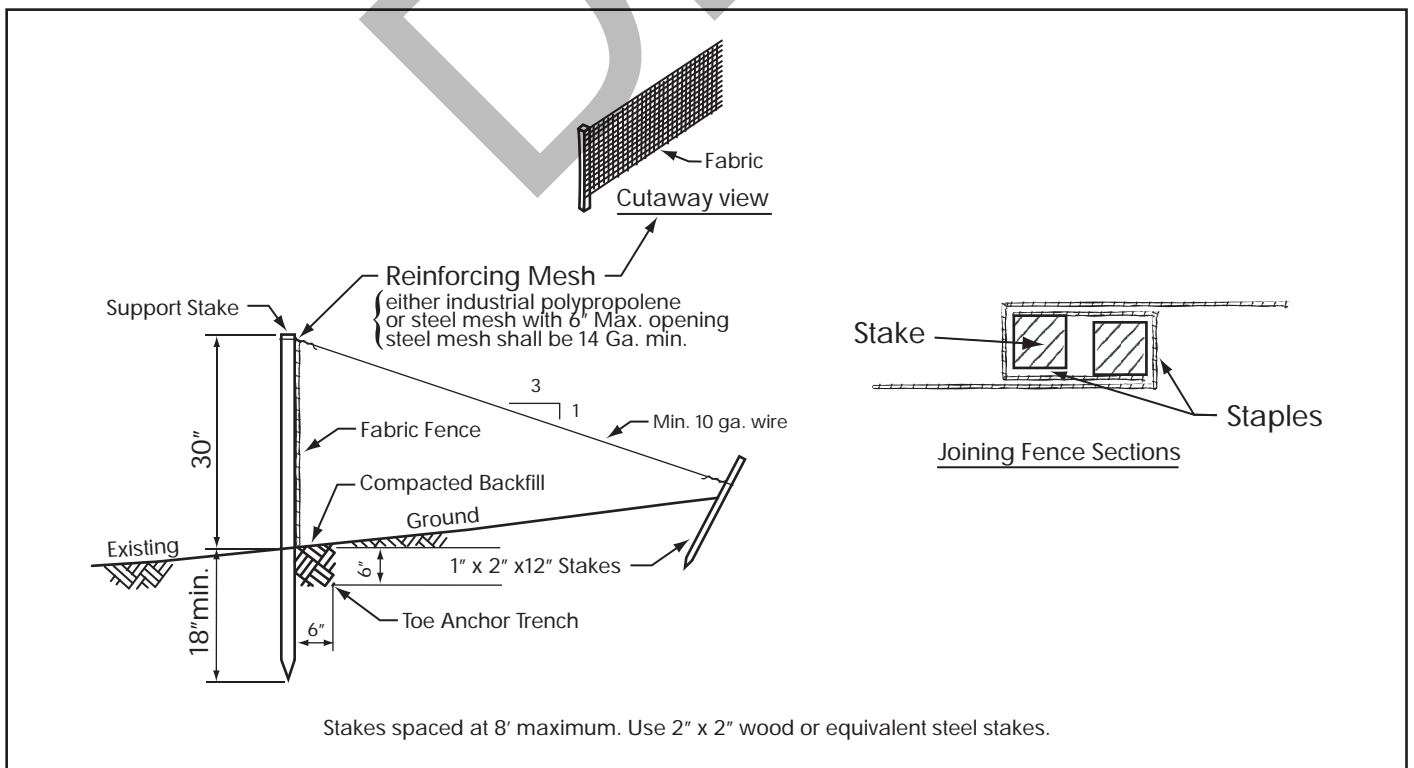
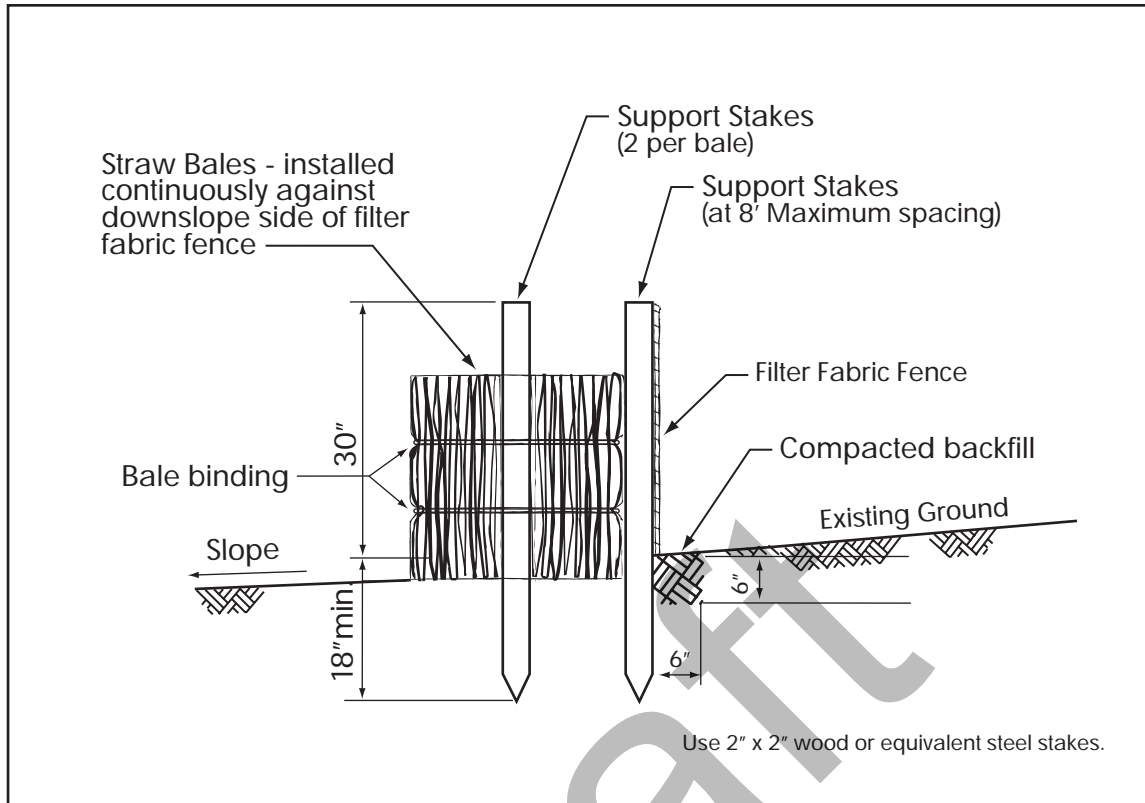


FIGURE II-10b: Filter Fabric Fence Reinforced by Staked Straw Bales

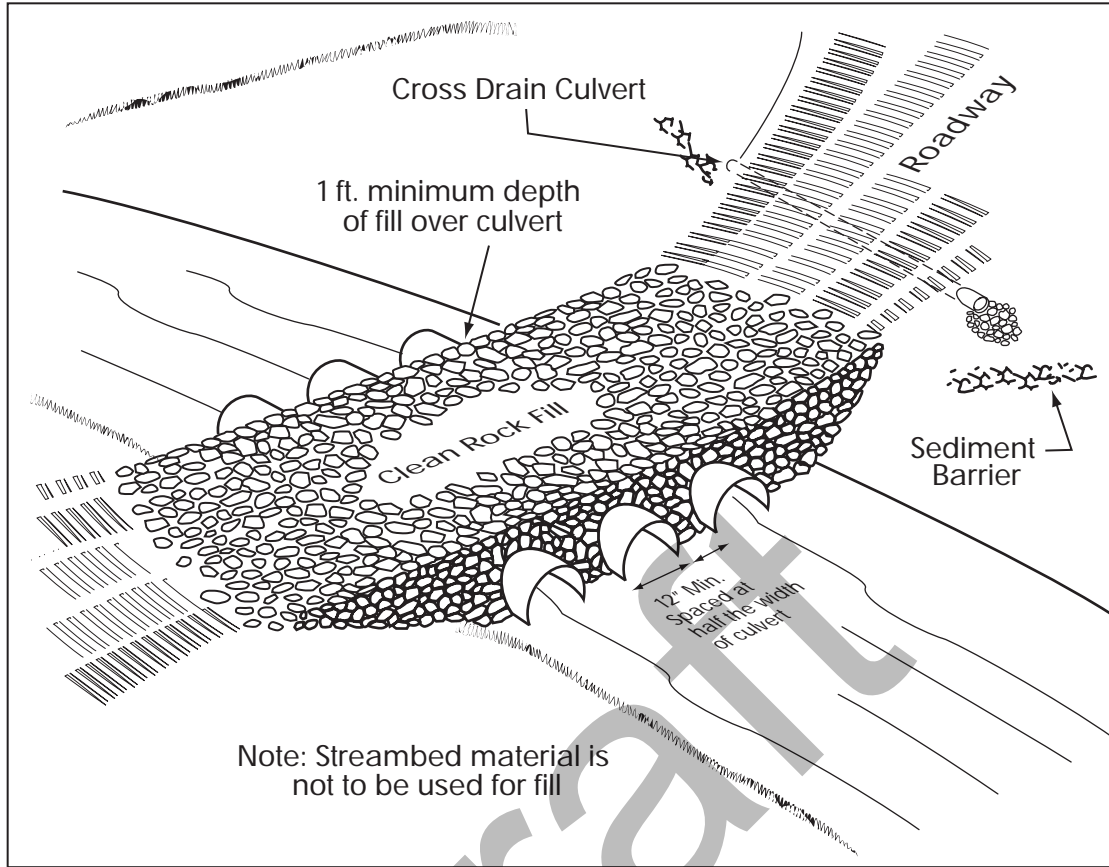


#### Filter Fabric Fence Reinforced by Staked Straw Bales

Filter Fabric Fence must be placed at existing level grade. Both ends of each fence section must be extended at least 8 feet up slope at 45 degrees to the main barrier alignment.

Sediment shall be removed when accumulations reach 1/2 the above ground height of the fence. Any section of the straw bale barrier which has been undermined or topped must be immediately replaced with a rock filter outlet.

FIGURE II-12: Stream Crossing – Temporary, with Culvert



#### 11. Stream Crossing – Temporary

Description: A temporary structural span installed across a flowing watercourse, for use of construction traffic, drilling equipment, etc., so as to provide a means to cross the stream without damaging the stream and to prevent sediment from entering the stream. See Figure II-12.

##### a. Types:

1. Culverts
2. Bridge
3. Stone base

##### b. Design Criteria:

1. The structure shall be large enough to handle a 1-year frequency storm, 24 hour duration.
2. Depth of cover over culverts shall be  $\frac{1}{2}$  the diameter of the culverts used or 12 inches, whichever is greater.
3. Multi-culverts should be installed with spaces between them, equal to  $\frac{1}{2}$  the pipe diameter.
4. Low water crossings may be used, if protected when overflowing occurs. This can be accomplished by using rock and concrete.
5. Cross cribbing of the downstream side of culvert installations may be needed to aid in reducing structural damage during high velocity water overflow periods.
6. If culverts or bridges are not used and a stone base doesn't exist, stone shall be installed, with the entrance and exit being stoned for approximately 100 feet.
7. Ditch line exit points at stream crossings must have sediment controls.

Permanent stream crossing structures may require a "Stream Activity Permit" from the WV Office of Land and Streams (formally the Public Lands Corporation) of the West Virginia Division of Natural Resources (304) 558-3225 and Fax (304)558-6048.

Temporary structures may also require a "Stream Activity Permit".



## 12. Sediment Traps – Temporary

Description: A trap constructed to collect water runoff, with adequate retention time to allow sediment to settle.

### a. Design Criteria:

1. Water containing sediment from any disturbed area is diverted to the trap.
2. The trapbasin shall have adequate overflow pipes and/or spillways installed, with outlet protection.
3. Maximum height of embankment shall be 5 feet.

## B. Wellsite Construction

1. General – Choose the site carefully to minimize the amount of area disturbed and size the site to accommodate the equipment used.

- a. Clear any woody material, brush and trees, within the proposed site.
- b. Trees shall be cut and logs stacked. Smaller trees, brush, and stumps shall be cut and/or grubbed and piled in appropriate areas for use as sediment barriers at water drainage outlets, windrowed below the wellsite, for wildlife habitat, burned (as per WV Forest Fire Laws), removed from site, or disposed by other methods approved by DEP.
- c. Topsoil shall be removed and stockpiled in agricultural areas. In woodland areas, tree stumps, large roots, large rocks, tree and leaf debris, and ground vegetation shall be removed prior to actual site construction.
- d. The fill material shall be clean mineral soil, free of roots, woody vegetation, stumps, sod, large rocks, or other objectionable material. Any embankment material should contain 20% clay particles by weight and should contain the proper amount of moisture to ensure that compaction will be achieved. Fill material will be placed in lifts or layers over the length of the fill. Compaction shall be obtained by compaction equipment or by routing the hauling equipment over the fill so the entire surface off each fill lift is compacted by at least one wheel or tread track of equipment or by a compactor.
- e. Plan to divert surface water runoff around the site. Surface water diversion ditches should be constructed above the disturbed area to intercept water. If the situation warrants, a diversion ditch may be constructed below the disturbed area to aid in sediment control.







- f. In areas of steep terrain, a terraced bench constructed at the base of the slope where fill is to be placed, may be desirable to create a toe foundation, to aid in holding the fill.
- g. Drainage ditches should be constructed at the base of highwalls or as needed on location to aid in water control on the construction site.
- h. Sediment barriers shall be installed at drainage outlets and below the construction site.
  - 1. Hay or straw bales
  - 2. Silt fences
  - 3. Brush piles
  - 4. Earthen or rock berms
  - 5. Sediment Trap
  - 6. Vegetative filter strips should be utilized where possible.
- i. In situations of extended time lapse between construction and reclamation, temporary seeding and mulching of slopes will be needed to reduce erosion and stream sedimentation potential.
- j. Well site fill slopes need runoff protection. Measures such as berms, pipe slope drains, or diversions directed to stabilized ditches should be considered.



FIGURE II-13: Well site Cross Section View

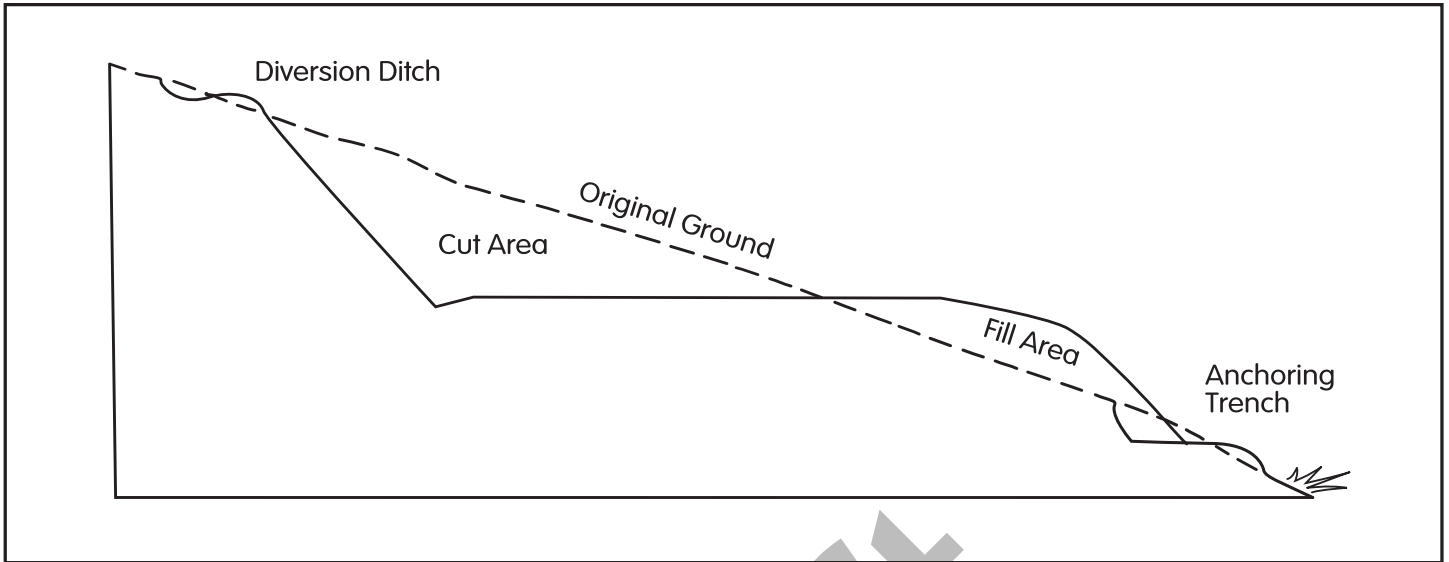
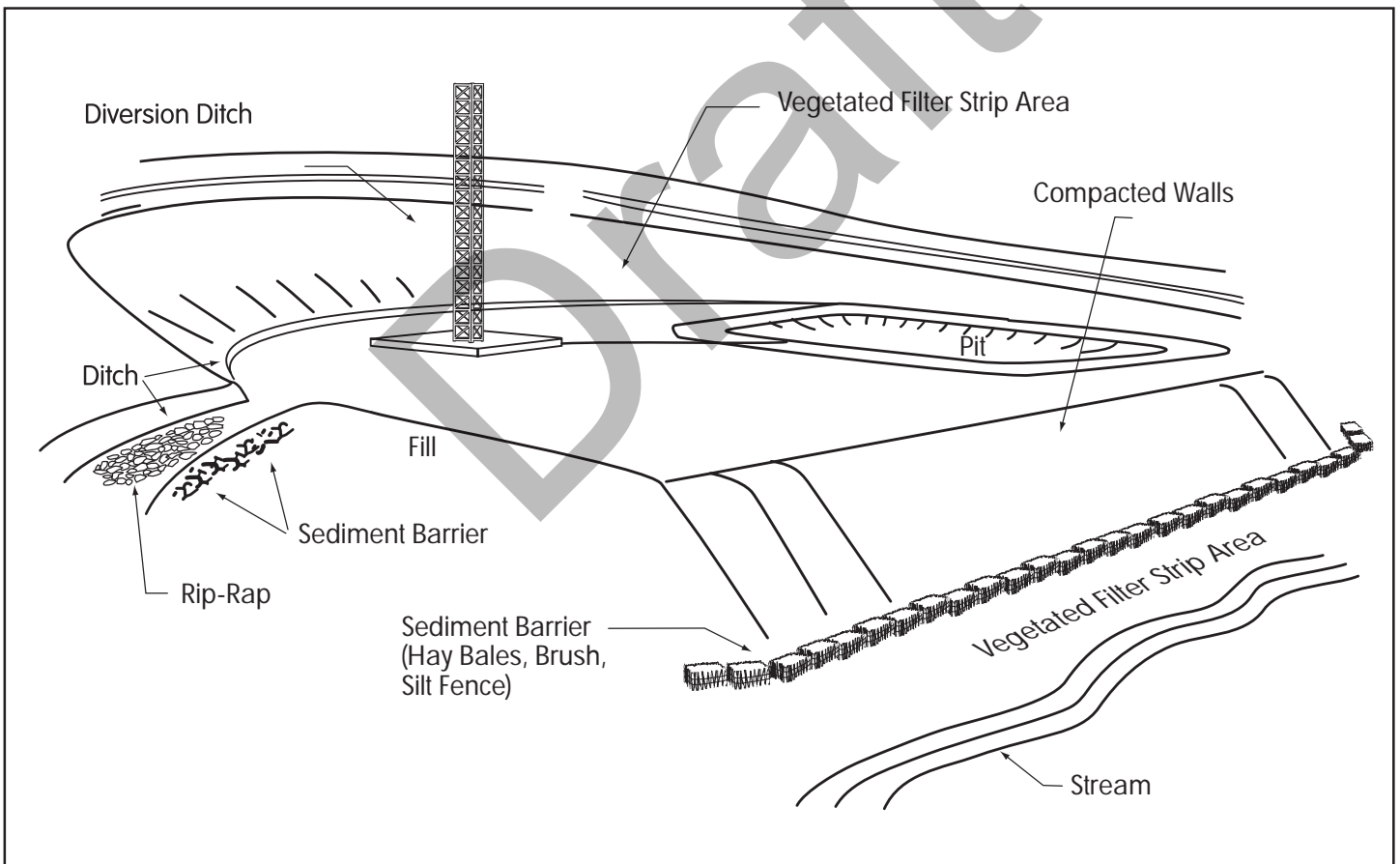


FIGURE II-14: Well site Construction View



2. Pit Construction

- a. Site Selection: The pit shall be constructed in an area with adequate room, so it can handle the projected drilling and frac fluids, plus allowing for adequate freeboard during heavy rainfall. Avoid excessive steep areas, wet seepage areas, swamps, and excessive rocky areas, when possible.
- b. The pit shall be constructed and maintained so as to prevent seepage, leakage, and overflows.

- c. Pits should be constructed below surface ground level, when possible. Any aboveground pit walls, as is the case with pits constructed in the lower slope areas of the wellsite, shall be compacted, with a side slope being maintained that will preserve the structural integrity. The fill material should contain the proper amount of moisture to ensure that compaction will be achieved.
- d. Areas under the proposed pit walls or embankments shall be cleared, grubbed and stripped of topsoil to remove trees, vegetation, and other objectionable material. The fill material shall be clean mineral soil, free of roots, woody vegetation, stumps, sod, oversized stones, rocks, or other unwanted material.
- e. Surface water must be diverted from the pit.
- f. For the earthen pit to be impervious, a plastic synthetic liner shall be used. On a site specific basis other methods may be approved. Various materials protecting synthetic liners may be necessary, such as:
  - 1. Gel & pit sealant
  - 2. Hay or straw bedding
  - 3. Clay
  - 4. Fiber matting
- g. Pits constructed on location, shall be constructed in solid ground, preferably on the cut or highwall side, not in the fill area. Adequate room shall be allowed between the base of any highwalls and the pit, for the construction of a surface water drainage ditch.
- h. Steel pits may be used as an alternative to earthen pits.
- i. Construction of pits and impoundments with capacity greater than five thousand (5,000) barrels\*:

All pits and impoundments used in association with an oil and gas operation, whether permitted or not, shall be constructed only in locations appropriate for the storage of water, including wastewater, and shall be designed, constructed, located, maintained, and used in accordance with Title 35CSR4.21 and in such a manner as to minimize adverse environmental impacts and to assure safety to the public. Notice of construction of all pits and impoundments shall be provided to the Office of Oil and Gas prior to construction. Such notice shall identify the location and dimensions of the pit or impoundment. The Office of Oil and Gas shall have the authority for inspection of these sites and the enforcement according to Title 35CSR4.21.

\*(See Title 35CSR4.21 Requirements for design, construction, inspections, and other authority provisions).





### C. Gathering Pipeline Construction\*



\* ( See 35CSR4.16.7, Requirements for Production and Gathering Pipelines )

This section addresses pipelines associated with oil and gas wells such as gathering lines, injection lines, and water supply lines for enhanced recovery operations where the primary method of excavation is with a backhoe or trench excavator.

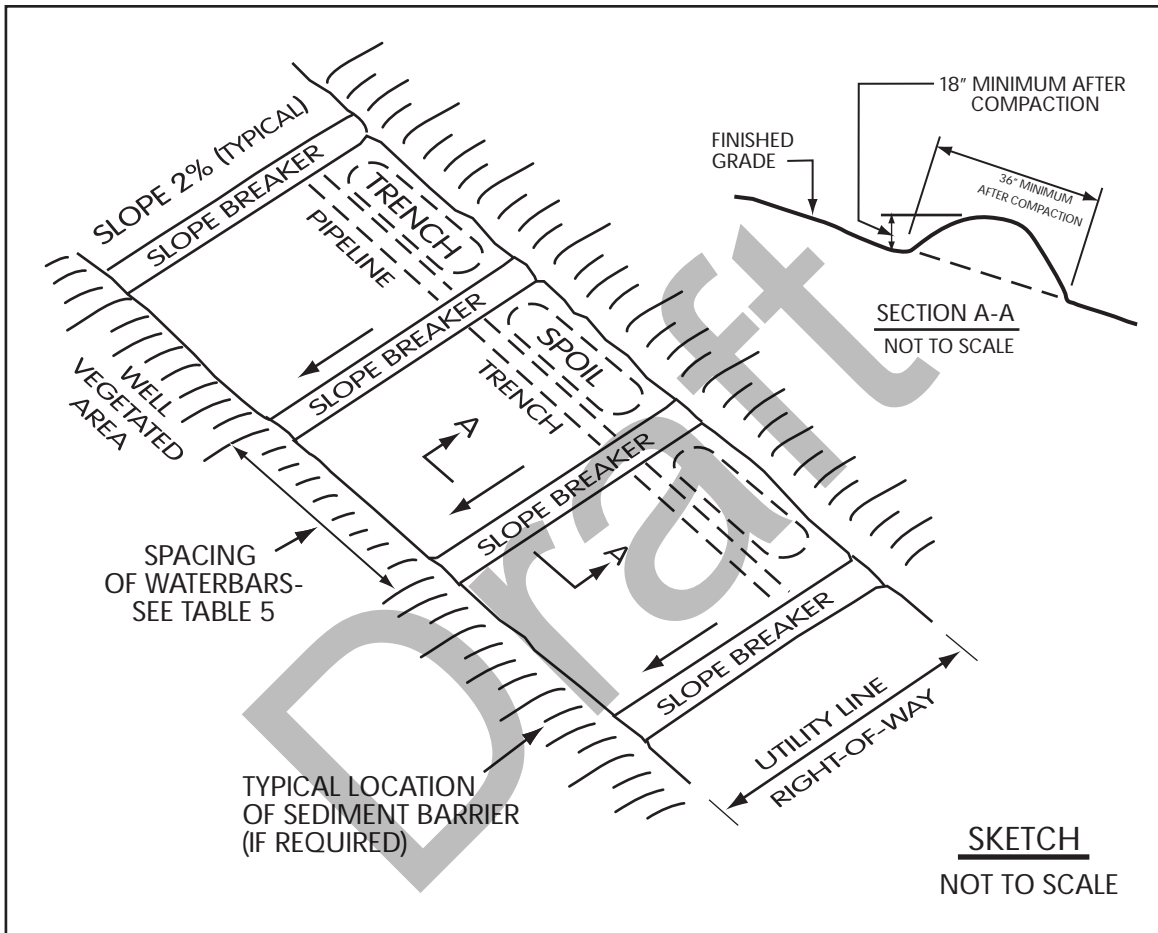
1. Lines shall be buried where practical and reasonable.
  - a. Where the line crosses agricultural land.
  - b. Where an unburied line would prohibit use of a pre-existing private roadway or other means of access to a part of or all of surface land.
  - c. Where the line cannot more practically and reasonably be securely suspended to cross stream beds.
  - d. Where the line crosses a public road, in which event it shall be buried and otherwise installed in accordance with the rules of the WVDOH having jurisdiction over the road.
  - e. Where the chief decides prior to installation that burial would be practical and reasonable.
2. All buried lines shall be installed with a minimum of eighteen (18) inches of cover, except where solid rock is encountered in which case the minimum cover shall be six (6) inches.
3. Whenever a buried line crosses a pre-existing public or private roadway, the location of the line shall be clearly marked at the point of crossing by an appropriate marker.
4. A suitable conductive wire shall be installed with plastic pipe to facilitate locating it with an electronic pipe locator; provided, that any other suitable material or means for accomplishing this purpose may be employed.

D. Pipeline Structures

1. Pipeline right-of-way diversion

Description: A ridge of dirt or a ridge and a channel combination constructed on an angle across a utility right-of-way to reduce the erosive force of water or to direct water away from critical resources. It can be both a temporary and permanent structure. See Fig. II-15

Figure II-15. Diversion Installation (Waterbar) on a Backfilled Right-of-Way





2. Pipeline Trench Plugs: Trench plugs must be installed when crossing streams, wetland, or other water bodies, see Figure II-16. Trench plugs should be placed on both sides of the crossing. Refer to Table II-10 for required spacings and materials for trench plugs.

Figure II-16. Typical Trench Plug Installation

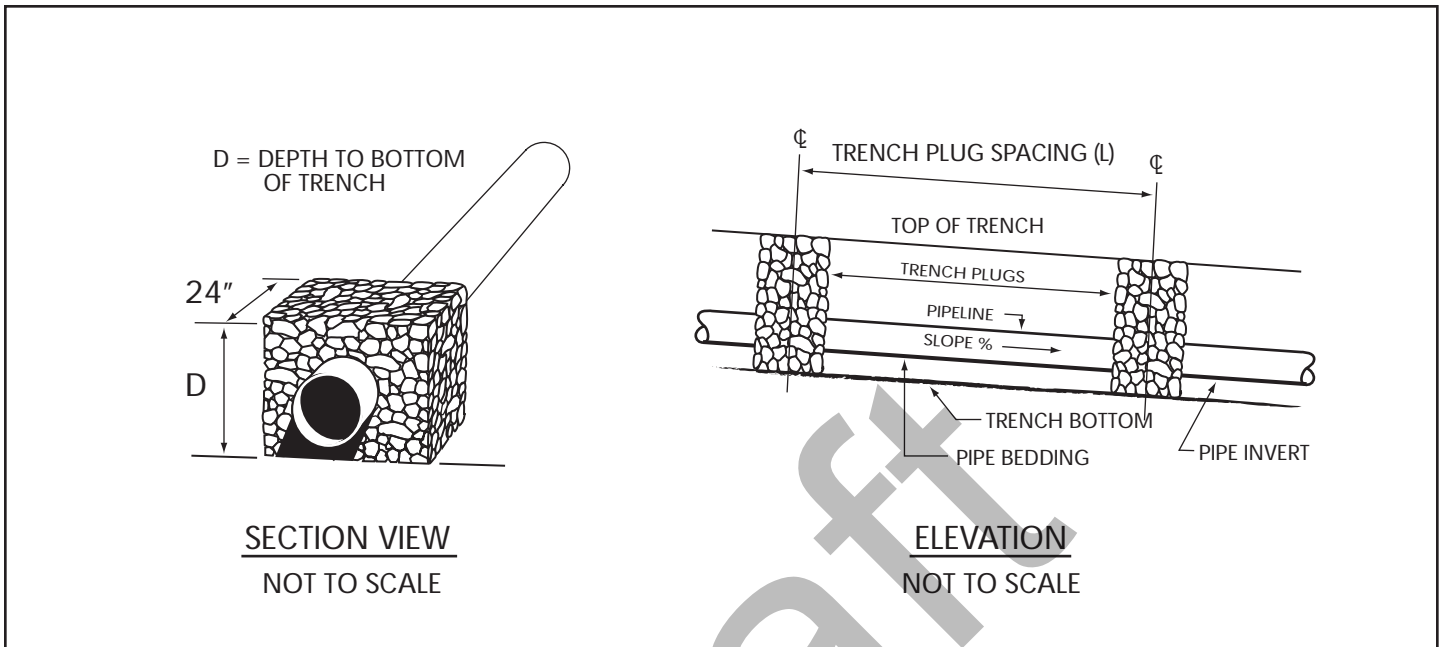


Table II-1  
Allowable Side Slopes

Material	Slope Horizontal-Vertical
Soil (clay – silt)	2:1
Sand (clean)	2:1
Shale	1:1
Rock	½ :1

Table II-2  
Permissible Velocities

Soil Texture	Maximum Velocity Ft./sec.
Stand and sandy loam (noncolloidal)	2.5
Silt loam (also high lime clay)	3.0
Sandy clay loam	3.5
Clay loam	4.0
Stiff clay, fine gravel, graded loam to gravel	5.0
Graded silt to cobbles (colloidal)	5.5
Shale, hardpan and coarse gravel	6.0

Table II-3  
V-Ditch

Depth (ft)	Ditch 0.2%		Grade 0.5%		(2:1 side slopes) 1.0%		(N-.04) 2.0%	
	V	Q	V	Q	V	Q	V	Q
1.0	1.0	2.0	1.5	3.0	2.2	4.4	3.0	6.0
1.5	1.3	5.9	2.1	9.5	2.9	13.0	4.1	18.5



Table II-4  
Spacing of Cross Drains

Road Grade (%)	Distance Between Drains (Ft)
1	400
2	250
5	135
10	80
15	60
20	45

Table II-5  
Spacing of Broad-Based Dips

Road Grade (%)	Distance Between Drains (Ft)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140

Table II-6  
Pipe Sizes for Culverts Across Roads

Drainage Area (Ac)	Pipe Diameter (In)	Pipe Capacity (Cfs)
10	15	5
20	18	9
30	21	12
50	24	18
80	27	24
100	30	29
300	36	60
500	42	85

Table II-7  
Spacing of Culverts

Road Grade (%)	Distance (Ft)
2-5	500-300
6-10	300-200
11-15	200-100
16-20	100

Table II-8  
Recommended Widths for Vegetation  
Strips between Earthmoving Activities  
and Streams

Slope of Land Between Earthmoving Activities Road Grade (%)		Width Of Filtration Strip
Percent	Degree	Feet
0	0	25
10	6	45
20	12	65
30	17	85
40	22	105
50	27	125
60	31	145
70	35	165
70 Plus	35 Plus	165 Plus

Table II-9  
Spacing of Pipeline Right-Of-Way Diversions

Space Between Waterbars in Feet		
Pipeline Grade	>200' from Streams	<200' from Streams
2-5%	400	200
6-12%	300	150
13-21%	200	100
22-34%	100	50
35-50%	50	25

\*It is difficult to install diversions on slopes steeper than 35%. Other control measures may be required.

Table II-10.  
Required Spacing and Materials for Trench Plugs

Trench Slope (%)	Spacing (FT)	Plug Material
< 5	*	*
5 – 15	500	** Earth Filled Sacks
15 – 25	300	** Earth Filled Sacks
25 – 35	200	** Earth Filled Sacks
35 – 100	100	** Earth Filled Sacks
> 100	50	Cement Filled Bags (Wetted) or Mortared Stone

\* Trench Plugs are required at all stream, river, or water-body crossings regardless of trench slope. Otherwise not required.

### Section III Reclamation

All disturbed areas used in connection with the oil and gas operation shall be reclaimed, as per state requirements. Reclamation shall include activities such as backfilling, installing permanent drainage structures, and revegetation.

#### Index

- A. Wellsite Reclamation
- B. Access Road Reclamation
- C. General Notes
- D. Tank Dike Construction

#### Figures

- Figure III-1: Bulldozer Tracking Procedure
- Figure III-2: Pit Treatment/Circulation
- Figure III-3: Pit Fluid Discharge
- Figure III-4: Dike Design Data, 100 Bbl. Tank

#### Table

- Table III-1: Dike Design Data

Draft

## A. Wellsite Reclamation



1. Pit water treatment and disposal (as per “General Water Pollution Control Permit”) See Figures III-2 and III -3
2. Pit backfilling: Drill cuttings shall be adequately covered with soil (minimum of three feet coverage), and recontoured; drill cuttings and associated pit material must remain under this cover. Filling with dirt and recontouring. No brush, trees, tree tops, or stumps, nor aretrashes are to be buried in the pits.
3. The wellsite is to be backfilled, recontoured, or terraced.
4. Topsoil should be re-spread over disturbed area, or used as top dressing in areas where it has been stockpiled.
5. Installation of permanent water drainage and diversion ditches. In areas of long slopes, it may be desirable to install angled diversion ditches to aid in controlling water runoff and erosion.
6. Bulldozer tracking, (up and down slopes), to roughen and loosen soil for compaction and seed bed preparation, is desirable. See Figure III-1.
7. Sediment barriers shall be maintained until vegetation is reestablished. Maintaining sediment barriers is critical until vegetation is reestablished. Temporary devices such as synthetic fencing shall be removed.

## B. Access Road Reclamation

1. Road surfaces shall be stabilized and/or reseeded.
2. Permanent side ditches will be installed where needed and where the site will allow.
3. Permanent culverts, cross drains, and broad-based dips shall be installed, based on criteria in Construction (Section II).
4. Side slopes of excavated cuts and outslopes shall be maintained, where the site allows, as per criteria in Section II.
5. Sediment barriers shall be maintained until vegetation is reestablished. Temporary devices such as synthetic fencing shall be removed.



FIGURE III-1: Bulldozer Tracking Procedure

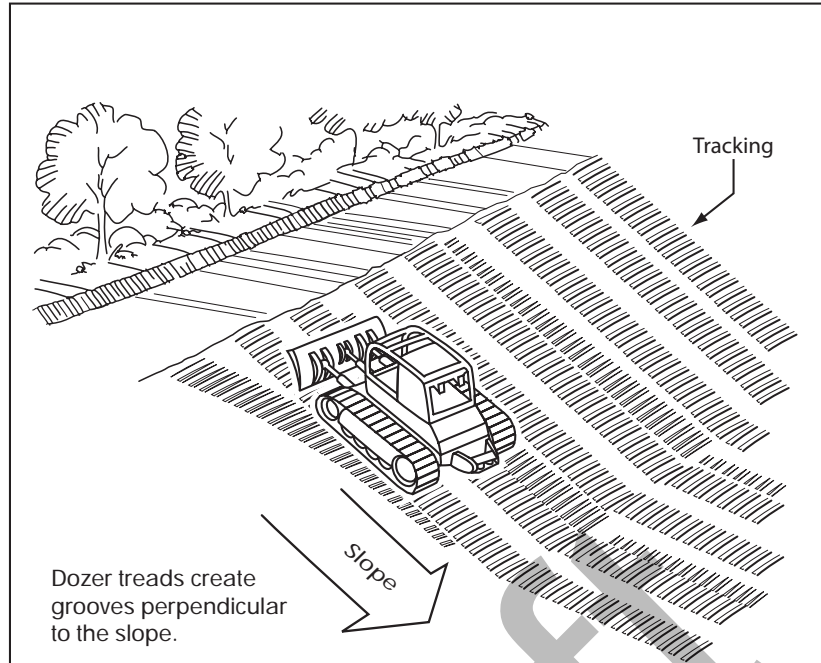


FIGURE III-2: Pit Treatment/Circulation





FIGURE III-3: Pit Fluid Discharge



C. General Notes Regarding Reclamation

1. Pipelines: Pipeline Any disturbed areas created by pipeline installation shall be reclaimed in accordance with state requirements.
2. Tank Batteries, Power lines: Any disturbed areas created by the installation of tank batteries or powerlines, even if out of the immediate construction site shall be reclaimed in accordance with state requirements, as these operations are in connection with the “Permitted” operation.
3. Well Maintenance: Disturbed areas created due to well maintenance, workover, etc. shall be reclaimed to reduce erosion and sedimentation.
4. API Numbers: API Identification Numbers shall be displayed at the well, in accordance with state requirements.

D. Tank Dike Construction

Tank dike construction or secondary containment structures, shall be in accordance with federal and state S.P.C.C. Regulations. See Figure III-4.

1. Secondary containment area shall be large enough to contain the contents of the single largest tank, per battery, plus 10%.
2. Containment area shall be impervious and be compatible with the potential spill material.
3. Dike walls can be constructed with earthen material, concrete, or other impervious material.
4. Earthen dike walls should be compacted and sloped. Height of dike walls need added dimensions for allowances in compaction, weathering and erosion considerations. Wall construction is recommended with a height of 3 feet and a top width of 2 feet design to allow for settlement over time and adequate freeboard. Material used shall be free of roots, rocks, and debris.
5. It is recommended that secondary containment structures be constructed above ground for ease in maintenance. Accumulations of fresh water can be disposed of more readily from these structures, thus keeping the area available for emergency containment.
6. Below ground containment areas, moat type, are acceptable but not recommended, due to greater maintenance required to keep free of fresh water accumulations.

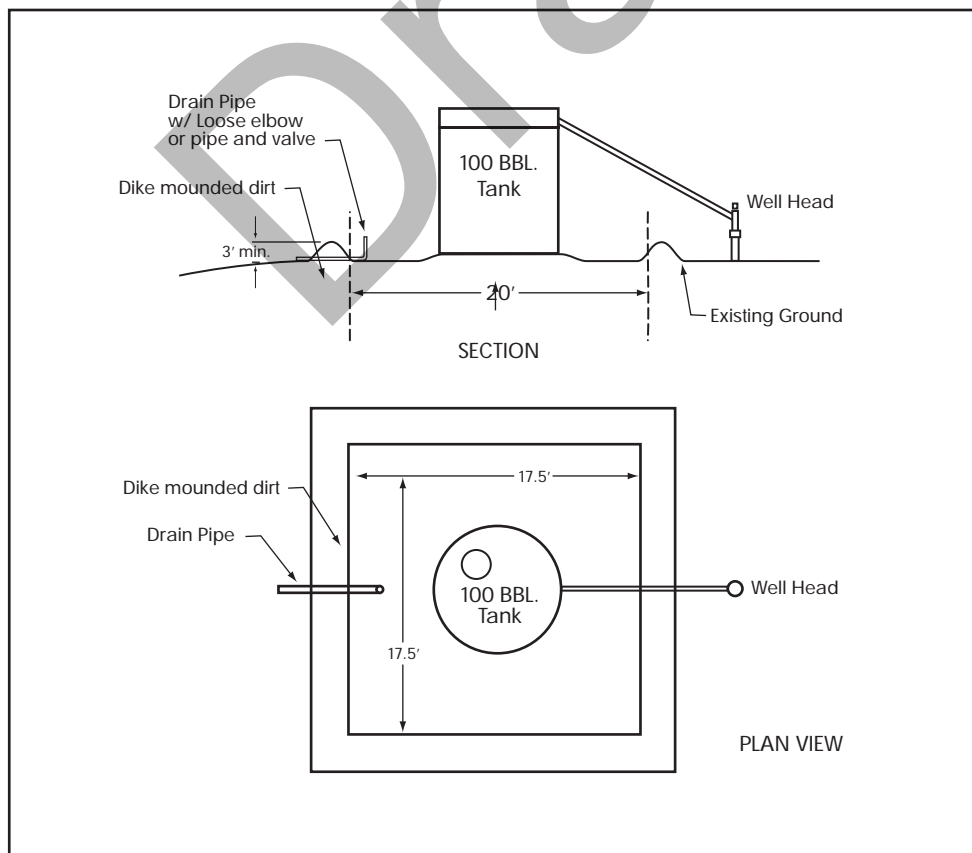
7. Sealed fresh water drains with outside valves may be installed, for the removal of uncontaminated fresh water.
8. Refer to Table III-1, minimum standards shown.

For further information and specifications, refer to “WV Miscellaneous Water Pollution Control Regulations” WV Legislative Rule Title 35 Series 1 and “Oil Pollution Prevention Regulations” Federal Title 40, Part 112 concerning S.P.C.C.

Table III-1 Dike Design Data		
Tank Size (Bbl. Capacity)	110% of Tank Vol. (Cubic Feet)	General Reference INSIDE DIMENSIONS LxWxD*
50 Bbl. (SkidMount)	308	12.4' x 12.4' x 2' = 308 cu ft
100 Bbl.	618	17.6' x 17.6' x 2' = 618 cu
210 Bbl.	1297	25.5' x 25.5' x 2' = 1297 cu ft
250 Bbl.	1544	27.8' x 27.8' x 2' = 1544 cu ft

\*Length x Width x Depth – All measurements are inside dimensions of dike base. Other dike dimensions are acceptable such as rectangular or circular shapes, provided the area contained is at least equal to that indicated above.

FIGURE III-4 – Dike Design Data, 100 Bbl. Tank





SECTION IV  
REVEGETATION

- A. General
  - 1. Objectives.....
  - 2. Acreage Calculations.....
- B. Site Preparation
  - 1. Water Control.....
  - 2. Seedbed Preparation.....
- C. Seeding
  - 1. Temporary Seeding .....
  - a. General .....
  - b. Seed Mixtures.....
  - c. Establishment .....
  - 2. Permanent Seeding.....
  - a. General.....
  - b. Lime and Fertilizer.....
    - (1) Lime .....
    - (2) Fertilizer .....
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- D. Mulching
  - 1. General.....
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- E. Fencing

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- IV-1 Temporary Seedings For Critical Areas.....
- IV-2 Permanent Seedings For All Disturbed Areas.....
- IV-3 Lime and Fertilizer Application.....
- IV-4 Mulch Materials, Rates, and Uses .....

A. General

1. Objectives

This section provides planning and establishment of temporary and permanent vegetative cover on all disturbed areas. The objective is to provide sufficient vegetation to control erosion and sedimentation on and off the site. Considerations for the improvement of water quality and wildlife habitat are incorporated into this section. With prior and documented approval, these standards may be adjusted and modified to meet individual site requirements.

2. Acreage Calculation:

Application rates listed in this section are on a “per acre” basis. To calculate acreage, the planner must measure the average length and width (in feet) of each area to be treated. Acreage is determined by multiplying the length by the width, then dividing the total by 43,560.

Example: 430 feet long x 310 feet wide=133,300 sq. ft.

Then: 133,300 divided by 43,560 = 3.06 acres.

B. Site Preparation

1. Water Control

Install needed surface water control measures. See Section II, Construction, for guidance.

2. Seedbed Preparation:

The seedbed must be loose at the time of seeding. Applications of seed on hard ground will result in a poor stand of vegetation. The seedbed must be loosened by disking on the contour, or by bulldozer tracking up and down the slope. Backblading is acceptable on gentle slopes such as the bench or road bed.

C. Seeding

1. Temporary Seeding

a. General

Temporary vegetative cover must be established where runoff will go directly into a stream. Immediately upon construction of the site (site includes road and location), vegetation must be established on road bank and location slopes when reclamation cannot be completed within the prescribed 6 months.

b. Seed Mixtures

Table 1 gives recommended types of temporary vegetation, corresponding rates of application, and planting seasons. In situations where another cover is desired contact the local soil conservation district for seeding recommendations. Approval of the oil and gas inspector is needed.

c. Establishment

Apply seed by broadcasting, drilling, or hydraulic applications according to the rate indicated in Table IV-1. Perform all planting operations at right angles to the slopes.

2. Permanent Seeding:

a. General

Planting of permanent vegetative covers shall be performed on all disturbed areas. After proper grading and seedbed preparation, the vegetation will reestablish ground cover for the control of surface water runoff and erosion.

b. Lime and Fertilizer

1. Lime shall be applied to all permanent seedings. The pH of the soil is to be determined and lime applied accordingly. Once the pH is known, select the amount of lime to be applied from Table IV-3.

2. Fertilizer shall be applied in all permanent seedings. Apply the equivalent of 500 lbs. minimum 10-20-20 fertilizer per acre.

3. Application: For best results and maximum benefits the lime and fertilizer are to be applied at the time of seedbed preparation.

c. Seed Mixtures

Selection: From Table IV-2, select seed mixtures that are best suited for conditions at the site.

d. Seeding for Wildlife Habitat

When developing construction and reclamation plans for sites, planners are encouraged to consider the needs of wildlife. To insure the development of a successful wildlife management program, operators should enlist the technical assistance of a professional wildlife biologist in the planning process.

D. Mulching

1. General

Mulch can be used alone for temporary erosion control or in conjunction with other structural or vegetative control measures. Mulch must be applied to all temporary and permanent seedings on all disturbed areas. Mulch helps to conserve moisture, and to prevent sun scald and freezing of the new growth of seedings.



2. Specifications:

From Table IV-4 select the type of mulch and rate of application that will best suit the conditions at the site.

3. Anchoring

Depending on the field situation, mulch may not stay in place because of wind action or rapid water runoff. In such cases, mulch is to be anchored mechanically or with mulch netting.

a. Mechanical Anchoring

Apply mulch and pull a mulch anchoring tool over the mulch. When a disk is used, set the disk straight and pull across the slope. Mulch material should be tucked into the soil about three inches.

b. Mulch Netting

Follow manufacturer's recommendations when positioning and stapling the mulch netting to the soil surface.

E. Fencing

Newly seeded areas may need protected from livestock with temporary fencing until grass is reestablished. Where livestock are present, operator should consult with the affected landowner to coordinate the fence type and layout.

Also, permanent fencing may need installed as a protective measure around well site fixtures.

Table IV-1  
Temporary Seedings for Critical Areas

Seed	Rates in lbs. Per Acre	Recommended Date
Annual Ryegrass	40	Mar. 1 to June 1 Aug. 15 to Sept. 15
Spring Oats	96	Mar. 1 to June 15
Rye Grain	140	Aug. 15 to Oct. 15
Annual Ryegrass	26	Mar. 1 to June 15
Spring Oats	64	Mar. 1 to June 15

Table IV-2  
Permanent Seedings for all Disturbed Areas

Seed	Rates in lbs. Per Acre	Notes
Tall Fescue	40	Best Used in Wooded
Ladino Clover	5	Area or Pasture.
Tall Fescue	30	Wooded or Pasture over
Birdsfoot Trefoil	10	1500 elev.
Tall Fescue	30	Wooded areas, steep banks
Crownvetch	10	Low maintenance
Orchardgrass	12	Meadow elev. over 1500
Birdsfoot Trefoil	10	
Orchardgrass	12	Meadow
Ladino	3	
Kentucky Bluegrass	20	Pasture
Redtop	5	
White Cover	2	
Kentucky Bluegrass	20	Pasture Elev. Over 1500
Redtop	5	
Birdsfoot Trefoil	10	

Seeding is not recommended during the month of November

Use only Endophyte-Free variety of tall fescue

Inoculate all legume seeds

Use 4 times the inoculants when hydroseeding.

Table IV-3  
Lime and Fertilizer Application Table

pH of Soil	Lime in Tons Per Acre	Fertilizer, Lbs., per Acre 10-20-20- or Equivalent
Above 6.0	2	500
5.0 to 6.0	3	500
Below 5.0	4	500

The pH can be determined with a portable pH testing kit or by sending the soil samples to a soil testing laboratory. When 4 tons of lime per acre are applied it must be incorporated into the soil by disking, backblading or tracking up and down the slope.

Table IV-4  
Mulch Materials Rates and Uses

Material	Minimum Rates Per Acre	Coverage	Remarks
Hay or Straw	2 to 3 Tons 100 to 150 Bales	Cover 75% to 90% of Surface	Subject to Wind blowing or washing unless tied down
Wood Fiber Pulp Fiber Wood-Cellulose Recirculated Paper	1000 to 1500 lbs	Cover all Disturbed Areas	For Hydroseeding



## SECTION V Maintenance

### Index

- A. Long term maintenance
  - 1. General
- B. Description of Grasses and Legumes for use in Revegetation
  - 1. Temporary seeding
  - 2. Permanent seeding – Perennial Grasses and legumes

### A. Long Term Maintenance

#### 1. General

All revegetated access roads and well sites are to be maintained throughout the life of the well. Culverts, road ditches, broad-based dips, and diversion ditches must be maintained in proper working order. Whenever the soil is disturbed on any well or road by well-related activity, it will be revegetated according to this manual.

### B. Description of Grasses and Legumes for use in Revegetation

#### 1. Temporary Seeding – Annual Grass

- a. Oats (*Avena Sativa*): A cool season annual grass primarily grown for animal feed and human consumption, but also used for soil stabilization. Oats are usually seeded in early spring. Seeding rates are 3 bushels (100 lbs.) per acre or 2 lbs. Per 1,000 square feet.
- b. Annual Ryegrass (*Lolium Multiflorum*): An annual bunch-grass that grows from one to two feet tall. Rye grasses cross-pollinate, so “common ryegrass” may be a mixture of annual and perennial species. Annual Ryegrass is adaptable throughout West Virginia. It grows best on dark, rich soils in mild climates. A firm, mellow surface over compact subsoil gives good results. It does not withstand dry, hot weather or severe winters. It will tolerate wet soils with good surface drainage. Annual Ryegrass germinates rapidly, which makes it particularly suited to disturbed-area stabilization and temporary seeding. However, it should not be used where volunteers will cause problems later. Seeding rates are 60 lbs. per acre or 1 ½ lbs. Per 1,000 square feet; lesser amounts are suitable in mixtures, depending on the characteristics or the companion species.

#### 2. Permanent Seeding – Perennial Grasses and Legumes

- a. Kentucky Bluegrass (*Poa Pretense*): A long-lived, cool-season perennial which forms a dense sod; it may be used to stabilize waterways, slopes, cuts and fills, as well as lawns, athletic fields, golf courses and playgrounds. It is well adapted to well-drained, fertile soils and the climate throughout West Virginia. The optimum soil pH ranges from 6.0 to 7.0. Bluegrass is essentially dormant during dry or hot weather, but it will survive severe drought. It requires a firm, weed-free seedbed, and adequate fertilizer (liberal phosphorous) and lime are important. The minimum mowing height is 1 ½ inches; critical erosion areas may be mowed only once a year. Several varieties of bluegrass may be used together to ensure good stand survival.
- b. Tall Fescue (*Festuca arundinacea*): A cool-season perennial that is commonly used for pastures, hay, recreational areas and low maintenance lawns as well as for stabilization or waterways banks, slopes cuts, fills and spoils. Tall/Fescue is currently the most widely used grass for stabilizing large disturbed areas. It is a robust, long-lived, deep-rooted bunchy grass which may have short rhizomes (underground stems). It is adaptable throughout West Virginia to a wide range of climate conditions. The optimum soil pH is from 6.0 to 7.0, but it will tolerate pH from 3.0 to 8.0. This grass will grow on shallow and claypan soils if they are moist. Growth is limited more by moisture than by temperature extremes, but it will tolerate drought, infertile soils and moderate shade. Tall fescue requires a firm seedbed. Hydroseeding can be used successfully. Legumes are difficult to maintain in fescue stands due to the aggressive growth habits of this grass. Mowing is desirable on critical erosion areas, at least once every two years; lack of periodic mowing will encourage clumpiness. Some varieties of tall fescue are host to an endophyte fungus damaging to livestock, so an endophyte free variety should be used when seeding near pasture areas.
- c. Redtop (*Agrostis Alba*): A coarse, cool-season, short lived perennial grass with rhizomes; used for pasture, companion grass in turf seedings, and stabilization of ditch and channel banks, grassed waterways and other disturbed areas, it will grow from 30 to 60 inches high. No improved varieties have been developed. Redtop is adaptable throughout West Virginia, but it grows best in the cool humid parts of the state. It will grow

under a wide variety soil and moisture conditions. It grows on very acid soils (pH 4.0 to 7.5) and poor clayey soils of low fertility. It is drought resistant, but it is also a useful wetland grass. Redtop has very small seeds and requires a compact seedbed. It is not recommended for seeding alone. Adequate fertilization is essential on critical erosion areas to obtain good cover rapidly. Redtop will disappear from a stand under frequent low mowing.

- d. Orchardgrass (*Dactylis Glomerata*): A long-lived cool-season bunch-type grass commonly grown for hay or pasture. It is an early maturing grass, adapted well to conditions throughout the Northeast. Orchardgrass performs best on soils that are adequately supported with lime and a complete fertilizer. It is not well adapted to tight, poorly drained soils.
- e. Crown Vetch (*Coronilla varia*): A cool-season perennial herbaceous legume with a reclining growth habit. It reaches 2 to 3 feet in height, and it does not climb or twine. Crown Vetch is used primarily for erosion control of critical areas such as steep roadbanks, surface mine spoil, and industrial waste areas. It is also useful as residential ground cover. It is deep-rooted, winter-hardy, and drought tolerant. It also tolerates moderate shade. It grows best on well-drained soils with a pH range of from 5.5 to 8.3. It will persist on more acid soils for a prolonged period once established. It is not adapted to soils with poor drainage. The varieties Chemung, Penngift and Emerald are commonly used in West Virginia. Only inoculated seed should be used. Crown Vetch requires at least 500 lbs. Per acre of 5-10-10 fertilizer, or the area should be fertilized according to soil test results. Soil acidity must be raised above a pH of 5.5. Crown Vetch will not persist under frequent mowing.
- f. White Clover & Ladino Clover (*Trifolium repens*): A cool-season perennial legume. There are two types of White Clover. One is Ladino White Clover, which is the large-growing type commonly used for hay and silage in mixture with a grass. The other is the Common White Clover used mostly for pasture, whose thick growing and spreading characteristics makes it ideal for erosion control. The common type has a prostrate type of growth, while the Ladino is more upright. Both spread by stolons and by roots at the nodes. Representative common varieties used in West Virginia are Tilman, Common and White Dutch. Ladino is the only cultivar for the large type. White Clover thrives in cool climates and on moist, rich soils with full sun. It will not tolerate extremes of cold or drought. Where soil is not adequate, Ladino is short lived. Optimum soil pH is 6.5, but it will grow in a pH range of from 5.0 to 7.5. Common White clover volunteers readily in bluegrass mixtures where moderate to high fertility is maintained. Stands are persistent. Ladino Clover requires inoculation, fertilizing and liming for successful growth. Phosphorous and potash are the key fertilizer elements required. Ladino makes a good companion crop with grasses such as orchardgrass, broomgrass, tall fescue and timothy. These grasses will normally crowd out the Ladino after 2 to 3 years. Seed should be planted (drilled or broadcast) at shallow depths, and firm seedbed is desirable.
- g. Birdsfoot Trefoil (*Lotus corniculatus*): A perennial legume used for pasture, hay, erosion control, wildlife food and cover. It has a well developed tap-like root with many roots near the surface. It is best adapted to higher elevations on a variety of soil conditions. It grows poorly on poorly drained soils. The best pH range is 6.0 to 6.5. Will not survive in continually pastured areas.

## Summary

These are BMP's, as related to the oil and gas industry in West Virginia, prepared for average conditions. The BMP's are to be used as requirements and the DEP may, from time to time, require additional practices not discussed here. Also a request for a waiver to change a standard due to an uncontrolled site condition may be made to DEP, on a site-specific basis.

It is recognized that some of the standards for structures may not be utilized during the actual drilling operation, while a large amount of heavy equipment traffic is occurring, but rather will be utilized during the reclamation phase. For example, it may be difficult to maintain a broad-based dip or a water bar in an access road with heavy equipment traffic, however, perimeter sediment controls should still be in place.

The erosion and sediment control structures described in this manual offer an effective means of reducing erosion and preventing damage to both the construction area and off-site properties.

All structures should be inspected regularly and repairs of any damage should be completed as promptly as possible. With correct installation and proper maintenance, the erosion and sedimentation control structures should provide effective control of accelerated erosion and the resulting sedimentation.

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