TCEQ REGULATORY GUIDANCE
Waste Permits Division
RG-417 ● Revised May 2018

Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill

Contents

Introduction

This guidance is suitable for landfill permit applications that will be processed under Title 30 Texas Administrative Code (30 TAC), Chapter 330 rules effective March 27, 2006. Part 1 of this guide is also suitable for composting facilities that require a permit under 30 TAC Chapter 332.

This guide provides recommended procedures and suggestions for preparing a surface water drainage report required in 30 TAC Chapter 330, Section 330.63(c) (30 TAC 330.63(c)). Part 1 of the guide focuses on hydrology and drainage issues that should be considered in preparing the demonstration required by 30 TAC 330.63(c) and 330.305(a), that the existing drainage patterns will not be adversely altered by the proposed municipal solid waste (MSW) facility. Part 2 of this guide discusses erosional stability during all landfill phases required in 30 TAC 330.305(d). Information addressing erosional stability should be provided in the surface water drainage report.

To view the TCEQ rules referenced in this document, go to <www.tceq.texas.gov/rules> and select the "Download TCEQ Rules" link under the "Current Rules and Regulations" heading.

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Part 1—Preparing a Surface Water Drainage Report

1.1 Submitting an Application

When submitting an application for a Type I MSW landfill, Type IV MSW landfill, or a compost facility requiring a permit, you must provide a surface water drainage report under 30 TAC 330.63(c) that contains everything listed in this section (Section 1.1 of this guidance).

A drainage analysis must include:

- A statement that the facility design complies with the requirements of 30 TAC 330.303.
- Drawings showing the drainage areas and drainage calculations.
- Designs of all drainage structures within the facility area, including such features as typical cross-sectional areas, ditch grades, flow rates, water surface

elevations, and channelized flow velocities along the entire length of the channel.

- Sample calculations provided to verify that existing drainage patterns will not be adversely altered.
- A description of the hydrologic method and calculations used to estimate peak flow rates and runoff volumes including justification of necessary assumptions.
- The 25-year rainfall intensity used for facility design including the source of the data. All other data and necessary input parameters used in conjunction with the selected hydrologic method and their sources must be documented and described.
- Hydraulic calculations and designs for sizing the necessary collection, drainage, and detention or storage facilities.
- Discussion and analyses to demonstrate that existing drainage patterns will not be adversely altered by the proposed landfill development.
- Structural designs of the collection, drainage, and detention or storage facilities.

Additionally, you must include a point-by-point analysis of the surface water drainage conditions to demonstrate that existing drainage patterns will not be adversely altered (consistent with 30 TAC 330.63(c)(1)(C) and 330.305(a) for landfills). This analysis must:

1. Determine the specific discharge points for the runoff with respect to existing conditions at the permit boundary (refer to Section 1.2 of this guidance for the definition of existing conditions). Discharge points include the locations where storm water runoff leaves the permit boundary by open channel flow, overland flow, flow through hydraulic structures, etc.
2. Determine drainage subareas, and calculate the peak flow rates for existing conditions for each of the discharge points.
3. Calculate the volume of the runoff for the design storm event for each of the discharge points for existing conditions.
4. Determine the velocity of the peak runoff at each of the discharge points for existing conditions.
5. Determine the areas offsite that contribute flows onto the permit boundary (run-on), and calculate the peak flow rate, velocity, and volume of run-on from each offsite area onto the site for existing conditions.

Repeat these five steps for each discharge point with respect to the proposed site closure conditions. Compare the information (peak flow rate, velocity, and volume) calculated for each discharge point under existing and post-development conditions. Please see Section 1.3 of this guidance for additional information.

In the design process for the proposed stormwater drainage system, the following steps should be performed and the design of all drainage structures must be included in the application.

- Determine the conveyance method(s) to carry the runoff to the discharge points. The design must be for non-erodible velocities or erosion control lining of conveyance structures must be provided.
- Determine the need for detention or retention of any excess runoff that is generated by post-development conditions.
- Calculate the size of each detention pond and retention pond, and any other structure that will be used to reduce the peak flow rate and runoff volume at each discharge point.

You must provide calculations and design drawings for each detention pond and retention pond to document the relationship between water surface elevation, water inflow, outflow, and storage under peak design conditions.

All facility drainage structures should be located onsite. If conditions dictate that a drainage structure that is to be considered a component part of the facility drainage system must be constructed outside of the permit boundary, then the drainage structure must be covered by an easement or restrictive covenant that will allow the TCEQ access to the area for inspections during the facility's active life and post-closure care period.

1.2 Defining Existing Drainage Patterns

The existing drainage patterns for a new landfill or compost facility are the drainage patterns at the time the application is submitted (e.g. the drainage patterns at existing or pre-development conditions). Existing drainage patterns may reflect previous development activities on the site that have changed the natural drainage patterns.

For expansions of an existing permitted facility requiring a permit amendment, the existing drainage patterns (i.e., existing permitted drainage patterns) are the drainage patterns at the currently permitted site closure conditions. For purposes of clarity the drainage patterns described in this paragraph will also be referred to as existing drainage patterns.

Post-development or proposed development drainage patterns for new landfills, compost facilities, and for expansions of an existing permitted facility are the drainage patterns which occur at the proposed site closure conditions (i.e., post-development conditions) for these facilities. For purposes of clarity the drainage patterns described in this paragraph will be referred to as post-development drainage patterns.

You must conduct an analysis of the existing drainage patterns of the site to provide, (1) a baseline for comparison with the post-development drainage patterns of the facility and (2) a basis for the demonstration that the existing drainage patterns will not be adversely altered.

1.3 Demonstrating that Existing or Permitted Drainage Patterns Will Not Be Adversely Altered

An objective of the surface water drainage report is to demonstrate that the proposed development of the MSW facility will not adversely alter the existing drainage patterns. You may demonstrate this objective by comparing existing drainage patterns with post-development drainage patterns.

To achieve this objective, you should properly locate and design drainage features (such as letdown structures, detention pond outlet structures, and velocity-dissipation devices) upstream from the stormwater discharge points.

There is no defined number or percent of change to existing drainage patterns that can be set to indicate an adverse alteration, as some areas tolerate a change better than others. For each permit boundary discharge point you need to demonstrate that drainage patterns will not be adversely altered because of the site development on (1) peak flows, (2) velocities, and (3) volumes. More information regarding whether changes to peak flow rates, velocities, and volumes are adverse alterations are discussed in Sections 1.3.1 through 1.3.3 of this guidance.

1.3.1 Peak Flows

It is important to consider how alterations to drainage patterns will affect changes in the magnitude of peak flows (i.e., peak flow rates). The drainage report must include a discussion and calculations regarding the peak flow rates from a 25-year, 24-hour rainfall event.

To properly evaluate the effects of changes in the magnitude of peak flows, you must consider the timing of peak flows from the site and their contribution to peak flow rates at each facility discharge point, and in receiving streams or channels located outside of the permit boundary. Peak flow rates are generally controlled using appropriately designed stormwater detention ponds.

As noted above, the meaning of “adversely altered” depends on site-specific features. For example, an increase in the peak flow rate at a discharge point that empties into a large receiving stream may have little to no impact on the water surface elevation of the receiving stream. In this case, you may conclude that the increase in flow rate due to site development does not have an adverse impact. Conversely, if a stormwater discharge point empties into a small, sensitive receiving stream, an increase in the peak flow rate for post-development conditions may be an adverse impact. In this case you may need to ensure that the peak flow rate for post-development conditions matches the peak flow rate for existing conditions to demonstrate that drainage patterns are not adversely altered.

1.3.2 Velocities

The facility’s stormwater drainage system should be designed so that the velocity of the flow exiting the site at each discharge point is maintained at a low, non-erodible velocity. This may be demonstrated by a designed maximum velocity being smaller than the maximum non-erodible velocity, which is determined based on the conditions at the discharge point and the receiving channel.

Velocities are a function of the following:

- Flow rate.
- Drainage way cross-section geometry and surfacing (geomembrane, grass, concrete, and other surface types).
- Slope along the flow line.

The three separate items associated with the discharge point are: (1) geometry, (2) surfacing (e.g. grass, soil, concrete), and (3) flow-line slope. In the following example it is assumed that the geometry of the drainage way, the surfacing conditions, and flow-line slope at the permit boundary have not changed from existing to post-development conditions. In this case, the velocity of run-off is dependent on the flow rate. Moreover, if the peak flow rate at the discharge point is reduced from existing to post-development conditions, the peak velocity will also be reduced from existing to post-development conditions. However, when the peak flow rate at the discharge point increases from existing to post-development conditions, the peak velocity will also increase from existing to post-development conditions. An increase in the post-development flow rate may be acceptable if the post-development velocity is not increased to a point considered erosive (typically velocities are considered erosive when they are over 5 feet per second, depending on the characteristics of the existing drainage feature).

1.3.3 Volumes

The drainage report must include calculations regarding the peak volume of runoff from a 25-year, 24-hour storm event at each discharge point for existing and post-development conditions.

The drainage report should also include a discussion and analyses of any changes to existing drainage patterns due to changes in the peak volume of stormwater runoff, along with the potential impacts resulting from such changes. Stormwater runoff volume is a function of the area draining to a discharge point and the amount of precipitation losses for a given design storm.

The runoff volume may be modeled using *HEC-HMS* or *HEC-1* software developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (USACE), available at <www.hec.usace.army.mil>, or by using other unit hydrograph based software. You may also use the National Resources Conservation Service (NRCS) Runoff Curve Number Method developed by the NRCS (formerly known as the Soil Conservation Service) of the U.S. Department of Agriculture. The Texas Department of Transportation's Hydraulic Design Manual at <onlinemanuals.txdot.gov/txdotmanuals/hyd/index.htm> may also be a useful resource when preparing the drainage report.

You must demonstrate that any increase or decrease (change) in the peak volume of runoff from existing to post-development conditions is not an adverse alteration of existing drainage patterns. For example, a change in the volume of runoff for post-development conditions may possibly be demonstrated to not be adverse if: (1) the change in volume is released at a rate that will not adversely alter the existing drainage pattern, or (2) the change in the volume which is discharged from the permit boundary will not have an adverse impact on downstream water receiving rights and uses.

1.4 Calculating Run-on and Runoff

There are four major areas to be considered for drainage calculations:

1. Run-on of stormwater from off-site areas onto the waste management area.
2. Run-on of stormwater from the upgradient areas within the permit boundary onto the working face.
3. Runoff of contaminated water from the working face.
4. Runoff of stormwater from the permit boundary.

Accepted methods for calculating stormwater runoff are outlined in Section 1.4.1 of this guidance.

1.4.1 Calculation Methods

1.4.1.1 Rational Method

The Rational Method is acceptable for drainage areas of less than 200 acres (note that the 200-acre standard includes the total area of the landfill permit boundary and upland areas). Since the drainage areas for most sites are larger than 200 acres, programs developed by the USACE Hydrologic Engineering Center (HEC) are typically used (see Section 1.4.1.2 below).

However, the Rational Method can be used for the design of the working face containment berm design or specific structures that are part of the site's stormwater management system (e.g., final cover swales or letdown structures).

The Rational Method [Q = CIA] is partially a function of the average, or design, rainfall intensity (*I*) for a certain rainfall duration and frequency. In the Rational Method, the duration is assumed to be equal to the time of concentration. Therefore, *I* is calculated for a certain rainfall frequency (e.g., 25-year) and time of concentration. The *e*, *b*, and *d* coefficients used in the equation for *I* are available for specific rainfall frequencies (e.g., 25-year) for counties in Texas and were based on data contained in National Weather Service *Technical Paper 40* (TP 40), available at <www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf>.

Because of the lack of volume runoff determination and hydrograph development, the Rational Method is limited in providing the information required to show that existing drainage patterns have not been adversely altered. To compensate for the limitations of the Rational Method, you must determine the runoff volume by using one of the methods from NRCS *Technical Release 55* (TR-55), available at <www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf>, or from Texas Department of Transportation (TxDOT) *Hydraulic Design Manual*, available at <onlinemanuals.txdot.gov/txdotmanuals/hyd/index.htm>.

1.4.1.2 HEC Models

For areas larger than 200 acres, the models typically used for the design of the stormwater management system are: HEC-HMS, HEC-1, HEC-RAS, and HEC-2, which were developed by USACE HEC and are available at <www.hec.usace.army.mil/software/>. Each of these models are acceptable when appropriately applied. Input data files, output data files, all assumptions, and the rationale for selection of input parameters must be provided in the surface water drainage report.

1.4.1.3 Other Methods

You can also use an alternative equivalent method approved by the TCEQ.

For methods other than the ones discussed in Sections 1.4.1.1 or 1.4.1.2, you should submit a request for TCEQ approval *prior* to submitting your application. Your alternative method must be shown to result in runoff values equal or greater than values achieved using the Rational Method, or a USACE HEC Model.

1.4.2 Required Precipitation Data

Include precipitation design data, along with sources that are documented and described in your drainage analysis. *TP-40* is an acceptable precipitation data reference. *TP-40* presents maps of rainfall frequency in the Eastern U.S. for selected durations from 30 minutes to 24 hours, and for return periods from 1 to 100 years.

- TP-40—Rainfall Frequency Atlas of the United States <www.nws.noaa.gov/oh/hdsc/PF_documents/TechnicalPaper_No40.pdf>.
- TxDOT 5-1301-01-1—Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas, an update of TP-40 providing 24-hour rainfall depth versus frequency for Texas counties <pubs.usgs.gov/sir/2004/5041/pdf/sir2004-5041.pdf>.

1.4.3 Determining Water Loss

An acceptable method for determining the volume of water lost and excess volume runoff is the NRCS Runoff Curve Number Method. This method can be found in *TR-55*, available at <www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf>.

A typical curve number for an undeveloped site may vary between 65 for a sandy soil that is located near a coastal region to 84 in a hilly region with clay soils in North Central Texas. Typical curve number values for final cover systems range from 85 to 90. Therefore, if the drainage subarea does not change for a specific discharge point, the expected volume increase could vary from 5 percent to 60 percent.

1.4.4 Establishment of Direct Runoff

Direct runoff is the fraction of total precipitation that is not lost as hydrologic abstraction (effective precipitation), but flows overland, through drainage structures, and to the facility boundary. Direct runoff is expressed in terms of specific depth of stormwater spread uniformly over the sub-drainage area of interest after subtraction of all abstractions. Direct runoff depth depends on rainfall duration, frequency, and total abstraction. It is necessary for estimation of runoff volumes and peak discharge rates.

Most landfill drainage areas are categorized, in a hydrologic sense, under small or midsized catchments. Direct runoff for these areas may be estimated using procedures based on the Runoff Curve Number method as described in *TR-55* and the *WinTR-20* computer model available at <www.nrcs.usda.gov/wps/portal/nrcs/detailfull/null/?cid=stelprdb1042793>, as well as various unit hydrograph techniques and stream channel routing procedures found in *HEC-1* and *HEC-HMS* computer models.

Distributed runoff methods are also acceptable for use. Methods typically used for landfill drainage design are Kinematic Wave and Muskingum-Cunge methods. Distributed runoff methods are used to estimate peak flow and runoff volume. These methods can be found in *HEC Reference Manuals* available at <www.hec.usace.army.mil/software/>.

For example, both Kinematic Wave and Muskingum-Cunge methods apply to small-water catchments with uniform slopes, channels, and drainage patterns. Landfill final cover areas generally consist of relatively short overland flow lengths that drain into landfill final cover swales.

Methods for estimating direct runoff are generally applicable to final cover areas of landfills, because the distributed runoff methods were developed for uniform slopes that drain to collection channels and networks of relatively small drainage subareas.

- Uniform slopes that drain to collection channels. For a landfill final cover area, this translates to overland flow segments, which typically have a 4-horizontal to 1-vertical slope that drains to a swale.
- A network of relatively small drainage subareas. In designing the various final cover erosion control structures and perimeter channels, landfill drainage subareas need to be subdivided to obtain a peak flow at several points.

1.4.5 What Storm Event to Use

The 25-year, 24-hour storm event must be used for:

- Calculations and designs of drainage structures to address runoff control in accordance with 30 TAC 330.305(c).
- Calculations and designs of drainage structures to address run-on control in accordance with 30 TAC 330.63(c)(1)(D)(i) and 330.305(b).
- Calculating maximum velocities required in 30 TAC 330.305(d)(1).
- Any other drainage design aspects requiring a storm frequency and duration to address 30 TAC 330.303 and 330.305.

1.5 Facility Location with Respect to 100-Year Floodplain

Provide information documenting whether the site is located within a 100-year floodplain as a separate, but related, requirement of the surface water drainage report.

The required information is specified in 30 TAC 330.63(c)(2). As noted in the rule, Federal Emergency Management Agency (FEMA) maps are prima facie evidence of floodplain locations. For a facility where construction is proposed within a 100-year floodplain, provide the information required in 30 TAC 330.63(c)(2)(C) and (D) and 30 TAC 330.307.

1.6 Incorporating County and Local Government Regulations

Where there are county or local government drainage regulations that pertain to a site, these requirements must be addressed in the landfill design, analysis, and demonstrations. Designs based on less stringent county or local regulations will not suffice in demonstrating compliance with TCEQ regulations.

Part 2—Demonstrating Erosional Stability During All Phases of Landfill Operation

2.1 Introduction

You must prepare a landfill design that provides effective erosional stability to top dome surfaces and external embankment side slopes during all phases of landfill operation, closure, and post-closure care, in accordance with 30 TAC 330.305(d). Furthermore, you must demonstrate adequate control of erosion and sedimentation using interim controls for phased development, as required by 30 TAC 330.305(e)(2).

Section 2.2 of this guidance discusses accepted designs and calculations on specific erosion and sediment controls. These designs and calculations can be used before and after establishment of vegetation on intermediate cover top dome surfaces and external embankment side slopes.

The intent of 30 TAC 330.305(d) is found in the preamble to the rules adopted to be effective March 27, 2006, which states:

> The commission requires, in 30 TAC 330.305(d), that the owner or operator provide long-term erosional stability for the landfill unit during all phases of unit operation, closure, and post-closure care from the previous requirement in 30 TAC 330.55(b)(8), which only requires long-term erosional stability for the final cover design (31 Texas Register page 2502).

Accordingly, you must submit a report demonstrating erosional stability during all phases of landfill operations. The purpose of this report is to control soil loss and sediment transport from top dome surfaces and external embankment side slopes and minimize the offsite discharge of suspended sediment in stormwater runoff.

For the purposes of compliance with 30 TAC 330.305(d), top dome surfaces and external embankment side slopes are those above grade slopes that:

- Directly drain to the site perimeter stormwater management system (i.e., areas where the stormwater directly flows to a perimeter channel or detention pond designed in accordance with 30 TAC 330.63(c), 330.303, and 330.305).
- Have received intermediate or final cover.
- Have either reached their permitted elevation, or will subsequently remain inactive for longer than 180 days.

Slopes that are not considered external side slopes are those that drain to:

- Areas with ongoing waste placement.
- Areas excavated for future operations.
- Areas that have received only daily cover.
- Areas under construction that have not received waste.

Modern landfill development can span decades, and interim top dome surfaces and external embankment side slopes may exist for years before placement of the final cover system with permanent drainage and erosion control features. Some past landfill practices have not provided adequate erosion protection, leading to serious erosion and off-site discharge of sediment.

Management practices used for erosion and sediment control may be broadly categorized as nonstructural controls and structural controls.

Nonstructural controls include:

- Plans and designs to minimize disruption of the natural features, drainage, topography, and vegetative cover features.
- Phased development to minimize the area of bare soil exposed at any given time.
- Scheduling of construction activities during the time of year with the least erosion potential.
- Specific plans for the stabilization of exposed surfaces in a timely manner.

Structural controls include:

- Vegetative and non-vegetative stabilization of exposed surfaces.
- Landfill side slope and perimeter drainage control structures.
- Sediment traps and basins.
- Silt fences and other barriers.

Stormwater discharges from MSW landfill facilities must be addressed by either coverage through the TCEQ Multi-Sector General Stormwater Permit (TXR 05000), or by an individual stormwater discharge permit. You should include information to demonstrate compliance with 30 TAC 330.305 in the Stormwater Pollution Prevention Plan that is required by the facility's stormwater permit.

2.2 Designs and Typical Calculations

Provide designs and calculations demonstrating erosional stability of intermediate cover in the facility's surface water drainage report. Demonstrate the landfill final cover erosional stability in the facility's closure and post-closure plans, as required in 30 TAC Chapter 330, Subchapter K.

The demonstration of erosional stability must include:

- Sample calculations and designs for sizing the necessary stormwater collection, conveyance, sediment retention, and detention structures in accordance with 30 TAC 330.63(c).
- Description of proposed soil stabilization practices, perimeter controls, top and side slope runoff controls, and collection, conveyance, and containment structures that will be installed during the intermediate cover phase on top dome surfaces and external embankment side slopes.

- Description of the hydrologic method and calculations used to estimate peak flow rates, velocities, and runoff volumes. Provide information to demonstrate that estimated velocities are below permissible non-erodible velocities under similar conditions. The term “similar conditions” means similar soil, vegetation, topography, slope, etc., as the subject surface.
- Soil erosion loss calculations, using the Natural Resource Conservation Service of the United States Department of Agriculture's Universal Soil Loss Equation or equivalent or better methods approved by the executive director.
    - You must provide information to demonstrate that the estimated potential soil loss from the intermediate cover phase top dome surfaces and external embankment slopes does not exceed the permissible soil loss for comparable soil-slope lengths and soil-cover conditions.
    - The maximum soil loss values for intermediate and final cover are discussed in Section 2.5 of this guidance.
    - The demonstration of erosional stability for intermediate and final cover conditions should consist of:
        - Descriptions and drawings of where structural controls will be installed, including maximum slope angle.
        - Slope lengths and berm spacing for lateral swales.
        - General locations and maximum spacing of down-chutes.
        - Maximum spacing of silt fencing.
    - Parameters for nonstructural controls should be described, including:
        - Types of vegetation to be used for erosion control.
        - Planting schedules.
        - Vegetation maintenance.
    - Specific configurations or development scenarios showing specific locations of structural controls are not required.
    - The controls proposed to keep soil loss below this maximum soil loss in Section 2.5 should be installed within 180 days after the intermediate cover is constructed.
    - Applicants with sediment capture facilities may incorporate the use of sediment capture and intermediate cover replenishment procedures to demonstrate that the net annual soil loss for that facility is less than the maximum acceptable amount.

2.3 Erosion and Sediment Control Practices and Specifications

The following materials and procedures are considered best management practices and should be considered and addressed in the demonstration of erosional stability.

- **Side Slope Controls.** Use of benches, terraces, berms, or swales to decrease downslope velocities of runoff that could cause erosion. Benches, terraces, and berms should direct the flow to a protected drainage system (downchute) and outlet. These structures should be spaced to ensure soil loss during both the intermediate cover phase and the final cover phase does not exceed the limits specified in Section 2.5 of this guidance. The estimated peak velocity should be less than the permissible non-erodible velocity under similar conditions.
- **Seeding and Sodding.** Establishment of vegetation on the top dome surfaces and the external embankment side slopes remains the preferred surface protection practice for control of erosion. Studies show that perennial vegetative cover significantly removes suspended solids from stormwater runoff. A goal of at least 60 percent vegetative cover is recommended.
- **Lining for Conveyance Structures.** If runoff may cause erosion in a conveyance structure, line the structure using grass or sod, turf reinforcement mats, riprap, concrete surfacing, gabions, or other appropriate material. Provide details of temporary and permanent surface stabilization measures for all stormwater conveyance structures.
- **Silt Fences.** Use silt fences or fabric filter fences where there is sheet flow. The maximum drainage area to the fence should not exceed the manufacturer's specification; the maximum drainage area must not be greater than 0.5 acre per 100 feet of fence.
- **Stabilization Schedule.** Provide a plan and schedule for proposed stabilization actions.
- **Wind Erosion Control Measures.** Describe the procedures to minimize wind erosion.
- **Climate and Weather.** If appropriate, include a discussion of how climate and weather patterns at the site will be considered in the scheduling of landfill development to take advantage of those patterns to minimize soil erosion.

2.4 Inspection, Maintenance, and Recordkeeping

Include these related items in the demonstration of erosional stability during all phases:

- An inspection and recordkeeping schedule for evaluating the effectiveness of erosion control structures and practices, and for documenting required maintenance in accordance with 30 TAC 330.165(g) and (h).

- Provisions for training of appropriate landfill personnel in the installation, inspection, maintenance, and recordkeeping of erosion control structures and practices.
- Plans for the removal of temporary erosion control structures and replacement with permanent erosion and sediment control structures.

2.5 Permissible Soil Loss and Non-Erodible Velocity

This section provides information on permissible non-erodible velocity and soil loss for intermediate and final cover phases of a landfill.

- **Permissible non-erodible velocity**, as referenced in 30 TAC 330.305(d)(1), should be related to the type of soil (erodible vs. non-erodible) and the type of vegetation (or cover) over which the flow occurs. Sources of information include the USDA's published data on permissible non-erodible velocities based on the soil and vegetation cover type, and manufacturers' specifications for allowable non-erodible velocities associated with synthetic or other manufactured erosion control materials.
- **Permissible soil loss for the intermediate cover phase** is greater than the permissible soil loss that is considered acceptable for the final cover phase. The intermediate phase is an interim condition that can last for decades. However, unlike the final cover phase, the landfill is still operational during the intermediate cover phase. During this phase you should:
    - Ensure that sufficient soil, personnel, and equipment are available to restore eroded cover.
    - Install structures within the site that prevent eroded soil from leaving the site. For example: the use of silt screens installed on benches, channels, perimeter ditches, and other locations to trap eroded materials prior to reaching the sedimentation basin; or a sedimentation basin and an analysis showing that the sediments will be recovered prior to the flow moving offsite.
    - Ensure the soil loss for the intermediate cover phase will not exceed 50 tons per acre per year.
- **Permissible soil loss for the final cover phase** is based on information provided by the NRCS for major soil types in the United States. Permissible soil loss for the final cover phase should not exceed three tons per acre per year.