TCEQ REGULATORY GUIDANCE
Waste Permits Division
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TCEQ

Guidelines for Preparing a Surface Water Drainage Report for a Municipal Solid Waste Facility*

*This guide is suitable for landfill permit applications that will be processed under the new Chapter 330 rules effective March 27, 2006 and compost units of Chapter 332 which must be permitted.

Contents

1. Introduction

This guide is intended for those who operate or apply to operate municipal solid waste (MSW) landfill facilities in Texas and compost units which require a permit. The Texas Commission on Environmental Quality (TCEQ) regulates these facilities under Title 30 of the Texas Administrative Code (30 TAC), Section (§)330.63(c) and §330 Subchapter E. These rules require facilities to have a surface water drainage report.

The purpose of this guide is to provide suggestions for preparing an adequate surface water drainage report based on published sources and on staff knowledge and experience. The guide focuses on hydrology issues that can be used to demonstrate that there is no adverse alteration in the drainage pattern at the MSW facility. Other drainage issues—such as compliance with floodplain location restrictions or the design of the final-cover erosion layer—are either addressed in the MSW rules or in other TCEQ guidelines.

1.1 Where to Get More Information

For more information on applicable sections from rules in 30 TAC Sections 330.55 and 330.56 (Subchapter E), go to the TCEQ Web site, **www.tceq.state.tx.us**. Follow the "Rules, Policy & Legislation" link to "Rules and Rulemaking" and "Download Rules."

You can contact the Municipal Solid Waste Permits Section in the following ways:

Phone: 512/239-2334
Mail: Municipal Solid Waster Permits Section, MC 124
Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711-3087
Fax: 512/239-6000
Web: **www.tceq.state.tx.us/permitting/waste_permits/msw_permits/msw_contact.html**

2. Maintaining Existing Drainage Patterns

An objective of the surface water drainage report is to show that the development of the MSW facility will not adversely alter the existing drainage patterns of the watershed that will be affected by the proposed development to include potential impacts due to sedimentation. The owner/operator demonstrates this objective by comparing predevelopment conditions and post development conditions.

A focus of a storm water management system design for an MSW facility should be to return the storm water flow to its predevelopment condition before it leaves the facility boundary—an objective that is also consistent with maintaining existing drainage patterns. To achieve this goal, the owner or operator should locate let-down structures, detention pond outlet structures and other velocity-dissipation devices upstream from the storm water discharge point to allow flow to return to the predevelopment condition at the facility boundary.

2.1 Peak Flows

According to Sections 330.63(c)(i)(c) and 330.305(a), existing drainage patterns must not be adversely altered as a result of the proposed development of the facility. The owner or operator shall evaluate the significance of changes to drainage patterns and erosional stability based on the impacts of changes on the following:

- Receiving streams or channels.
- Downstream flooding potential.
- Sedimentation transport and deposition potential.
- Adjacent and downstream properties.
- Downstream water rights and uses.

There is no clear-cut number or percent of change that can be set to indicate an adverse change. However, the owner or operator should demonstrate that drainage patterns will not be significantly altered because of the effect of the site development on (1) peak flows, (2) volumes, and (3) velocities from each permit boundary discharge point. Each is discussed in the following sections.

It is important to consider how alterations to drainage patterns will affect changes in the magnitude of peak flows. In order to properly evaluate the effects of changes in the magnitude of peak flows, the owner or operator should consider the timing of peak flows from the site and their contribution to peak-flow rates in receiving streams or channels.

The owner or operator should provide calculations regarding the peak discharge from a 25-year rainfall event. Since storms of shorter duration will generally have higher rainfall intensity than storms of a longer duration, the owner or operator should evaluate several durations (e.g., 1-hour, 6-hour, 12-hour, and 24-hour) of 25-year rainfall events to determine the peak discharge for the site-specific conditions. The owner or operator should use the worst-case peak discharge.

The meaning of "adversely altered" depends on the sensitivity of the area of study; some areas tolerate a change in drainage patterns better than others. For example, a 1-percent deviation of 1,000 cubic feet per second (cfs) is 10 cfs and may be considered "significant" if the area of the study is sensitive; whereas, 10 percent of 1,000 cfs is 100 cfs and may be considered an insignificant alteration in a different, less sensitive setting.

What is considered "adverse" is a subjective term that cannot be defined as a specific, objective criterion. An adverse change would be a large percent for the Brazos River, but a small percent for a 20-foot-wide creek that has intermittent flow. Therefore, the "adversely altered" issue is best determined on a case-by-case basis and is one of professional judgment.

2.2 Volumes

In preparing the drainage report, the owner or operator should also consider alterations to drainage patterns caused by increased or decreased volumes of water discharged at various points resulting from the design storm, along with the potential impacts resulting from such changes. The design storm is the 24-hour, 25-year storm event as delineated in 30 TAC Section 305(c). While peak flow can be controlled by detention pond volumes, storm water runoff volumes are a function of the area draining to a discharge point, as well as the amount of precipitation losses for a given design storm.

The precipitation losses for solid waste facilities typically result in a comparison between the losses in the predevelopment condition and the expected losses from the final configuration of the proposed landfill. The precipitation losses may be modeled using HEC-HMS, software developed by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers (**www.hec.usace.army.mil**). You can also use a similar program, the Curve Number Method—also known as the Soil Conservation Service, or SCS Curve Number Method. It was developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service) of the U.S. Department of Agriculture. For more information, see the Texas Department of Transportation's *Hydraulic Design Manual* at **www.dot.state.tx.us/services/general_services/manuals.htm**. In Chapter 5, go to "Section 7, NRCS Runoff Curve Number Methods."

The owner or operator must demonstrate that any volume increase (or decrease) is not an adverse alteration. Typical methods for addressing this issue are listed below:

- Demonstrate that there is no increase or decrease in volume at a discharge point.
- Demonstrate that the additional or reduced volume will be release at a rate that will not significantly affect the downstream receiving water body. For example, the total volume increase may be 30 percent more for the post development condition, compared to the predevelopment condition. However, this increase may be demonstrated to be adverse if the additional volume of water will be released at a rate that will not adversely affect the downstream receiving water body.
- Demonstrate that there will be no adverse impacts from sedimentation on downstream receiving water bodies.
- Demonstrate that any change in the volumes of water discharged from the permit boundary discharge points will not have an adverse effect on downstream water rights and uses.

2.3 Velocities

Another way to show that there is no adverse alteration in existing drainage patterns is to demonstrate that the velocity of the flow exiting the site at the discharge point along the permit boundary does not cause an increase in erosion. For example, maximum velocities in grass-lined channels are typically set at 5.0 feet per second.

Velocities are a function of the following:

- Flow rate.
- Drainage way cross-section geometry.
- Surface.
- Slope along the flow line.

As stated in Section 2.1.1, the owner or operator should evaluate several storm durations to determine the worst case peak velocity when calculating erodible velocities of storm water.

2.4 Incorporating Local Government Regulations

Where there are local government drainage regulations or manuals that pertain to a site, follow local government requirements in developing the landfill design, analysis, and demonstrations. In no case should less stringent local regulations supersede requirements of Chapter 330.

3. Defining Existing and Post Development Conditions

In designing a municipal solid waste facility, the owner or operator must conduct an analysis of the existing condition of the site. This will provide a baseline for comparison with the post development condition of the facility and a basis for the demonstration that the existing drainage conditions have not been adversely altered. Please refer to rules in Sections 330.63(c) and 330.305.

If the site has been previously altered by a well-established development such as an old sand mine or an existing permitted landfill, then the owner or operator may consider evaluating the impacts of the proposed facility development by comparing conditions at the time of permit application with the proposed post development conditions. For expansions or modifications of existing facilities, the appropriate comparison should be between the currently approved (permitted) site closure condition and the proposed post development condition at closure. An exception to this could, for example, be if a relatively new sand or gravel mine exists on the site. In this case, the relevant predevelopment or existing condition may be before the sand or gravel mine was developed.

Permit modifications allow changes to improve drainage conditions for existing permitted sites.

The existing condition of a landfill or compost facility is the topography and drainage conditions before grading, excavating, or filling operations, or any combination of these activities at the time the application is submitted. If no development has taken place, the existing conditions are those that naturally occur. However, existing conditions may reflect any previous development activities on the tract that may have changed the natural drainage patterns.

4. Facility Erosion Control

The owner or operator 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 car, in accordance with Section 330.305(d). Furthermore, the owner or operator must control erosion and sedimentation using interim controls for phased development, as required by Section 330.305(e)(2).

The owner or operator should specify the interim construction stages when temporary drainage structures will be installed and when components of the final drainage structures will be installed. The stages at which temporary or intermediate drainage structures and controls are to be installed must be clearly specified as to be easily identified during inspection. While the sizing of the final drainage structures will be based on peak discharges from the final design contours and cover, the temporary/intermediate drainage structures must account for peak discharges from landfill portions that are not yet in the final constructed form. The owner or operator should focus on preventing erodible velocities in areas that have not received or established final cover, whether vegetative or other cover exist. The runoff assumptions and calculations should account for the interim conditions of the drainage areas and the anticipated increased potential for erosion.

The owner or operator must also minimize erosion from and prevent off-site sediment transport of soil piles.

The owner or operator will use the peak flows and maximum velocities established in Sections 2.1 and 2.3 when addressing erosion prevention. In addition to the design of erosion controls, the owner or operator should also address the inspection and maintenance of erosion controls in Part IV of the application, the site operating plan, that is required by Section 330.65.

If the approved erosion controls are ever deemed inadequate, the owner or operator remains under the continuing obligation to provide effective erosion and sedimentation control and should outline short-term steps to implement improved control. The owner or operator should then request a permit modification or amendment to make necessary corrections and enhancements to the approved erosion controls.

5. Submitting an Application

When submitting an application for a Type I and Type IV MSW landfill facility or compost unit to be permitted, the owner or operator should provide the following information, in accordance with §330.63(c):

- Description of the hydrologic method and calculations used to estimate peak-flow rates and runoff volumes, including justification of necessary assumptions.
- The worst case 25-year rainfall intensity used for facility design,

including the source of the data, and all other data and necessary input parameters (documented and described) used in conjunction with the selected hydrologic method, hydraulic calculations, and designs for sizing the necessary collection, drainage, and/or detention facilities.

- Discussion and analysis to demonstrate that natural drainage patterns will not be significantly altered as a result of the proposed landfill development.
- Contour maps of existing or permitted conditions and the proposed post development conditions at closure.
- Structural designs of storm water collection, drainage, and/or storage facilities, and results of all field tests to ensure design compatibility with soils.
- Maintenance plan for ensuring the continued operation of storm water collection, drainage, and/or storage facilities, as designed, along with the plan for restoration and repair in the event of a washout or failure (in Part IV of the application, the site operating plan, in accordance with Section 330.65).
- Erosion and sedimentation controls including design plans showing temporary/interim controls for phased development.

6. Demonstrating That Drainage Is Not Adversely Altered

Use the following to conduct a point-by-point analysis of the surface water. Also, provide a discussion of the results of the analysis:

1. Determine the specific discharge points for the runoff, or determine the overland (sheet) flow direction for predevelopment conditions from the permit boundary.
2. Determine drainage subareas, and calculate the peak flow rates—units in cfs or cubic meters per second (m^3/s)—for predevelopment conditions for each of the discharge points and/or the overland flow.
3. Calculate the volume of the runoff—units in cubic feet (ft^3), acre-feet, or cubic meters (m^3)—for the storm event for each of the discharge points for predevelopment conditions.
4. Determine the maximum velocity (ft/s or m/s) of the peak runoff at each of the discharge points for predevelopment conditions.
5. Determine the areas off site that contribute flows onto the permit boundary (run-on), and calculate the peak-flow rate, velocity, and volume of run-on from each off-site area onto the site for predevelopment conditions.
6. Determine discharge points for the post development condition at the permit boundary.
7. Determine drainage subareas, and calculate the peak flow rates for post development conditions for each of the discharge points.
8. Calculate the volume of the runoff for the storm event for each of the discharge points for post development conditions.

9. Evaluate several storm durations to determine the maximum velocity of the peak runoff of the drainage areas and at each of the discharge points for during all phases of landfill operation, closure, and post closure. Ensure non-erodible velocities.
10. Determine the areas off site that contribute flows onto the permit boundary (run-on), and calculate the peak flow rate, velocity, and volume of run-on from each off-site area onto the site for post development conditions.
11. Compare the information for Item 1 to Item 6; Item 2 to Item 7; Item 3 to Item 8; and Item 4 to Item 9. Discuss differences in these values in terms of whether the changes are significant.
12. Determine the conveyance method to carry the runoff to the discharge points.
13. Determine the need for detention and retention of any excess runoff that is generated by the post development conditions.
14. Calculate the size of any pond, ditch, or other feature that will be used to reduce the peak-flow rate and runoff volume at each discharge point at the permit boundary.
15. Determine the need for feature(s) that will be used to control the velocity to maintain a discharge velocity that does not represent an adverse alteration of the value from Item 4.
16. Determine the need for features that will be used to manage the off-site run-on flows that may be diverted around the filled area for Items 5 and 10.

All facility drainage features should be located onsite. If conditions dictate that a drainage feature that is to be considered a component part of the facility drainage system must be situated off-site, then the drainage feature must be accessible through an easement or restrictive covenant. This will allow the TCEQ to access the area for inspections during the active life of the landfill, as well as for the closure and post closure period.

7. Calculating Runoff

Several methods of calculating runoff are available and are appropriate to use. Some methods are more limited than others.

7.1 *Rational Method Versus Computer Models*

Because of the lack of volume runoff determination and hydrograph development, the Rational Method is recognized as being limited in providing information that is required to show that there is no significant change to natural drainage patterns. To compensate for the limitations of the Rational Method, the owner/operator must determine the runoff volume by using one of the methods from the NRCS *Technical Release 55* (*TR-55*). You can also find the release in TxDOT's *Hydraulic Design Manual*, which is available at **www.dot.state.tx.us/services/general services/manuals.htm** . In Chapter 5, go to "Section 7, NRCS Runoff Curve Number Methods."

The Rational Method is needed for small drainage areas of less than 200 acres (note that the 200-acre standard applies to the total area of the watershed(s) above and including the proposed landfill permit boundary).

For areas larger than 200 acres, you can demonstrate that there is no significant alteration to natural drainage patterns using the HEC computer programs developed through the Hydrologic Engineering Center of the United States Army Corps of Engineers (**www.hec.usace.army.mil**). Both HEC-HMS and HEC-RAS are acceptable and preferred methods since they have superseded the old HEC-1 and HEC-2.

The owner or operator can also use an equivalent or better method approved by the TCEQ executive director.

7.2 What Precipitation Data to Provide

The drainage analysis should include precipitation design data, along with sources that are documented and described. Acceptable precipitation data references include *Technical Paper 40* (*TP-40*) and *Hydro-35*. *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* is currently out of print and is superseded in part by two publications: *Hydro-35* and *Atlas 2* of the National Oceanic and Atmospheric Administration (NOAA). You can get copies and electronic copies of *TP-40* from many sources, including the following Web sites: **http://manuals.dot.state.tx.us/docs/colbridg/forms/hyd_apxB.pdf** and **www.srh.noaa.gov/lub/wx/precip_freq/precip_index.htm**.

For durations of 1 hour or less, *Hydro-35* supersedes *TP-40* for the eastern two-thirds of the United States; Texas is included in this area. NOAA *Atlas 2* supersedes *TP-40* for the western one-third of the U.S.

7.3 How to Determine Water Loss

An acceptable method for determining the volume of water lost and excess volume runoff is the Runoff Curve Method. It was established by the NRCS and was formerly known as the Soil Conservation Service (SCS) Method. You can find this method in the *TR-55*.

7.4 How to Establish Direct Runoff

The method typically used in drainage analysis is the Kinematic Wave Method. It is one of the methods the HEC-HMS computer model uses to estimate peak flow and runoff volume. This method can be found in the *TR-55* or the *HEC-HMS Reference Manual*.

Direct runoff methods—for example, both Kinematic Wave and Muskingum-Cunge methods—are applicable 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 for the following reasons:

- Direct runoff methods were developed for uniform slopes that drain to collection channels. For a landfill final-cover area, this translates to overland flow segments, which typically have a slope that drains to a swale and perimeter dikes of 3H:IV or 4H:IV slope that drain to a swale.
- Direct runoff methods were developed for 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.
- Direct runoff methods are applied readily to small watersheds because they are based on physical parameters of the watershed, as opposed to other methods. Those other methods generally are developed empirically for various terrains in different climates, and are conservative because flow attenuation is not considered.

7.5 What Storm Event to Use

The design storm event for volume containment calculators is the 24-hour, 25-year storm event as specified in Section 330.305(c).

For determinations of peak discharges as required by Section 330.63(1)(D)(i) and 330.305(b) and maximum erodible velocities, the owner or operator must evaluate several storm durations (e.g., 1-hour, 6-hour, 12-hour, and 24-hour) of the 25-year storm events.