Topic: Nonhazardous Industrial Solid Waste Surface Impoundments

Applicability

In accordance with Title 30 Texas Administrative Code (TAC) Section 335.3, the Texas Commission on Environmental Quality (TCEQ) prepared this technical guideline to promote the proper collection, handling, storage, processing, and disposal of nonhazardous industrial solid waste in surface impoundments.

Pursuant to Texas Health and Safety Code (THSC) Section 361.090(a) and 30 TAC Section 335.2(d), no solid waste permit is required for the collection, handling, storage, processing, and disposal of nonhazardous industrial solid waste that is disposed of within the boundaries of a tract of land that is:

(1) Owned or otherwise effectively controlled by the owners or operators of the particular industrial plant, manufacturing plant, mining operation, or agricultural operation from which the waste results or is produced; and

(2) Located within 50 miles from the plant or operation that is the source of the industrial solid waste.

This technical guideline (TG 4) does not include all requirements applicable to hazardous waste surface impoundments. Title 30 TAC Chapter 335, Subchapter F, contains specific requirements for industrial hazardous waste surface impoundments. Please note that hazardous wastes are also prohibited from land disposal unless they meet the Land Disposal Restriction standards in 30 TAC Chapter 335, Subchapter O. In addition, hazardous waste surface impoundments are subject to many requirements that are not discussed in this guideline.

Purpose

TG 4 provides recommendations for siting, design, operation, and closure of nonhazardous waste surface impoundments notification requirements detailed in 30 TAC Section 335.6. Please note, pursuant to THSC Section 361.090(c), compliance with this technical guideline does not relieve the owner or operator of the facility from compliance with other requirements under Chapter 26, of the Texas Water Code.

Introduction

Surface impoundments are generally used for management of industrial wastewater including: storage, treatment through aeration, equalization, neutralization, and other methods. The relative simplicity and low operating costs of surface impoundments have made them a frequently utilized technology for industrial waste handling, processing, and disposal in select instances. Processing and disposal of industrial wastes in a properly located, constructed, maintained, operated, and closed surface impoundment is an environmentally sound waste management practice. The TCEQ Draft Technical Guideline No. 2 Industrial Solid Waste Landfill Site Selection should be consulted as many of these criteria also apply to surface impoundments. For a Class 1 industrial solid waste surface impoundment which is to be located in the recharge zone of a regional aquifer, a hydrogeologic report should be prepared which documents the potential effects, if any, on the regional aquifer in

the event of a release from the waste containment system

The potential for ground and surface water contamination from a surface impoundment depends on a number of factors, including:

(1) siting considerations;

(2) composition, mobility, and compatibility of the waste material;

(3) geology, hydrology, and climate of the site and surrounding area;

(4) construction of the surface impoundment;

(5) operation and maintenance of the total facility once the surface impoundment is constructed; and,

(6) closure and post-closure of the unit.

This guideline describes the TCEQ recommendations in each of these areas for construction, operation, and maintenance of all nonhazardous surface impoundments.

Siting Considerations

The TCEQ Draft Technical Guideline No. 2 Industrial Solid Waste Landfill Site Selection should be consulted as many of these criteria also apply to surface impoundments.

Waste Composition and Compatibility

The composition of the waste is an important consideration when designing a surface impoundment. All wastes should be evaluated by the generator and classified in accordance with 30 TAC Chapter 335, Subchapter R. This evaluation and classification will assist the generator in determining the approach to waste containment needed. All wastes should be evaluated to determine compatibility with each other and with any materials the waste will contact. The construction section of this guideline (TG 4) discusses waste compatibility with different types of liners.

Two other technical guidelines provide more information in this area: TCEQ RG-22 Guidelines for the Classification and Coding of Industrial and Hazardous Wastes; and Draft TG 9 Incompatible Wastes should be consulted.

Geology, Hydrology, and Climate

The physical aspects of the site are especially important when impounding a waste containing free liquids. Liquid wastes, having lower viscosities, cause greater risk to groundwater or surface water if placed in faulty or poorly-designed impoundments. Geology, hydrology, and climate should be considered in determining the potential for surface and groundwater contamination from any surface impoundment, regardless of whether it is lined and diked or not. Emergency procedures and design criteria for the impoundment can then be developed to mitigate any potential adverse effects.

Geology

A surface impoundment should be located in a thick, homogeneous, relatively impermeable formation such as a massive clay bed, with a large vertical separation from any associated aquifers. To determine the suitability of any geologic formation, soil borings must be collected, permeabilities calculated (which may require undisturbed samples) and the lithology must be determined. The minimum number of borings per acre are specified in Table 1.

Table 1 Number of Soil Borings for Geologic Investigation

Size of Surface Impoundment, Acres	Number of Borings*
1 to 5	4
to 10	6
10 to 15	10

*Add 1 boring per 1.5 acres for each additional acre over 15. Borings should be of adequate depth to penetrate, identify and define the uppermost permeable water-bearing stratum as well as the lower confining layer. In cases of impoundments over 100 acres, fewer borings may be sufficient if it can be demonstrated that the underlying formations are homogeneous.

Lithology should be determined for each distinct unit in each soil boring. The Unified Soil Classification System should be used to complete a written description of the lithology.

Permeability should be determined for each distinct lithologic unit. Where soil conditions permit, it is strongly recommended that field permeability tests be conducted. This will provide a better understanding of the behavior of the soils and substrata when subjected to a hydraulic head similar to the one which may be encountered during operation of the facility. If field testing is not possible, undisturbed samples may be used for laboratory testing of permeability. Be aware that laboratory permeability tests generally produce results that imply lower permeabilities than actual field permeabilities. If laboratory permeabilities are submitted, they will be evaluated accordingly. Permeability test methods should be included with all submitted test results.

Hydrology

Groundwater and surface water hydrology should be evaluated when designing a surface impoundment. This evaluation should include consideration of the depth to groundwater, the movement of groundwater, the patterns of storm water run-on and runoff, local stream patterns, and the location of the 100-year flood plain.

The movement of groundwater should be determined for all facilities with surface impoundments managing Class 1 and 2 industrial solid wastes. This should include groundwater flow direction, gradient, and transmissivity of the first saturated stratum.

Surface impoundments should not be located in flood plains, shore lands, or groundwater recharge zones. Significant hydraulic connection (surface or subsurface) between the site and surface water and/or groundwater should be avoided.

Climate

Climatic extremes, as well as normal conditions, should be considered when designing a solid waste surface impoundment. Hurricanes, flooding, and heavy rainfall are common occurrences in the eastern half of Texas, and may influence the design details of the impoundment. In all cases, if records of rainfall and temperature data are available, they should be examined and climate extremes should be addressed in the design phase of the impoundment.

The water balance should be calculated for the region in which the facility is to be located. Any net yearly gain, or seasonal peaks, should be incorporated into the total capacity of the surface impoundment.

For Class 1 and 2 industrial solid waste surface impoundments located within the 100-year flood plain, surface water diversion dikes with a minimum height equal to two (2) feet above the 100-year flood water elevation should be constructed around the surface impoundment. This dike prevents inundation of the impoundment and washout of the waste from the unit.

For Class 1 and 2 industrial solid waste facilities located above the 100-year flood water elevation, surface water diversion dikes should be constructed that are, at a minimum, capable of diverting all rainfall run-on and run-off from a 24-hour, 25-year storm.

In hurricane flood surge areas, facilities should have dikes built to withstand wave action. The dike crest should be above the level of wave run-up.

TCEQ Draft Technical Guideline No. 2 Industrial Solid Waste Landfill Site Selection should be consulted for a detailed discussion of climatic factors and active geologic processes.

Construction

Three aspects of impoundment construction are of primary importance in water resource protection: liner(s), the leak detection systems, and the dike system. The choice of construction materials and methods for each component depends on the site and type of waste managed.

Liner Selection

When choosing a liner for a surface impoundment many criteria must be evaluated. The choice between a soil liner and a geosynthetic liner is not always obvious. The term "soil liners" means a liner constructed of clays meeting the standards set forth in Table 2. In some cases, barrow soils and in-situ soils do not have sufficient properties for a constructed soil liner and a geosynthetic liner or a composite geosynthetic and clay liner system should be considered. If a geosynthetic liner is needed for a particular impoundment, then the type of geosynthetic liner must be evaluated and a geosynthetic liner chosen that is compatible with the specific waste and site characteristics. The primary consideration when choosing a liner is the physical and chemical characteristics of the waste. The waste classification gives a general idea of the waste characteristics. Table 3 outlines the recommended liner systems for each waste class.

Table 2 Soil/Clay Liner Standards

Permeability, cm/sec	$< 1 \times 10^{-7}$
% Passing No. 200 Sieve	> 30
Liquid Limit	> 30
Plasticity Index	> 15

Table 3 Recommended Liner Systems

Waste Classification	Liner System Type (minimum thickness)
Class 1	**Double Liner System:** 1. Primary liner - geomembrane (polyethylene 60 mil, other types 30 mil); 2. Leak detection system (see Leak Detection and Groundwater Monitoring Systems); and 3. Secondary liner: (a) Composite - geomembrane (polyethylene 60 mil, other types 30 mil) with compacted clay (3 feet), equivalent in-situ clay, or geosynthetic clay liner (GCL); **or** (b) Compacted clay (3 feet), equivalent in-situ clay, or GCL
Class 2	Geomembrane (polyethylene 60 mil, other types 30 mil) and underlying leak detection system; or Compacted clay (3 feet); or In-situ clay, equivalent to 3 feet of compacted clay; or GCL overlain by protective soil (1 foot), equivalent to 3 feet of compacted clay

A more detailed description of waste characteristics can be used to choose a liner according to its compatibility with the waste. In cases where an impoundment contains a waste with several characteristics, a liner must be chosen that is compatible with all of the waste characteristics. If information is not available, then EPA Test Method 9090 (EPA SW-846 Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods) should be used to determine compatibility of the liner with the waste. In addition to advancements in manufacturing of liners using polyethylene resin which are resistant to a wide variety of chemicals, extensive studies have been done demonstrating compatibility of leachate with the liner system. To verify compatibility of leachate with the liner system, the surface impoundment facilities may submit alternate demonstration in lieu of EPA Test Method 9090.

In addition to assessing waste characteristics and liner compatibility, other factors to be considered in selecting an appropriate liner are the distance to the water table, the permeability of the saturated and unsaturated zones, the amount of pressure head on the base of the impoundment, and the intended life of the impoundment. The owner or operator should use a value for each of the above variables that will maximize the calculated rate of leachate migration, and determine the potential for ground and surface water contamination from the impoundment to evaluate the suitability of the liner system described in Table 3. TCEQ Draft Technical Guideline No. 2 Industrial Solid Waste Landfill Site Selection and Draft Technical Guideline No. 3 Landfills should be consulted for this assessment.

Geosynthetic liners usually have permeabilities that are several orders of magnitude less than soil

liners. In most cases a properly installed and maintained geosynthetic liner will contain a compatible waste for a longer period of time than a soil liner. However, geosynthetic liners and sealants can react with a waste in an unexpected manner. Therefore, geosynthetic liner materials should be tested with the waste before a liner is chosen.

If natural in-place soils or imported, amended, recompacted, or reworked soils are to be utilized as liners for surface impoundments, then the Table 2 parameters should be met.

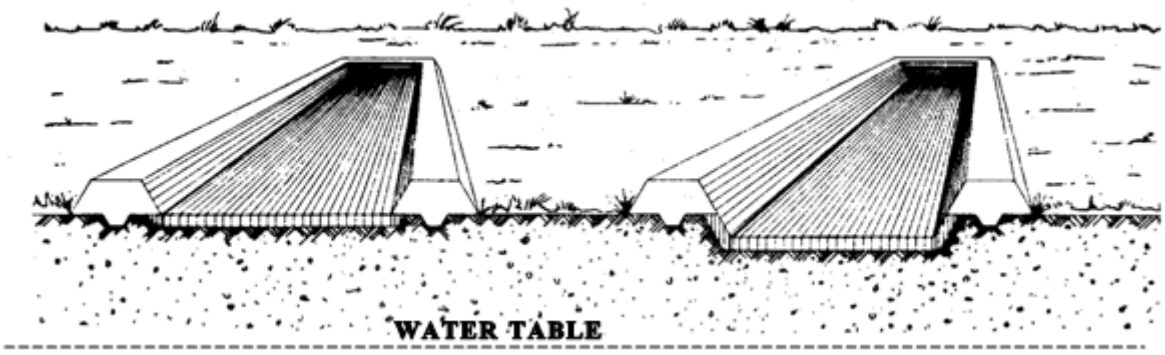
Impoundment Design

One of two common methods are typically used for surface impoundment construction. These methods are (1) the "above-ground" surface impoundment; and 2) the "below-ground" surface impoundment. While the actual construction techniques are quite different, the end result is much the same; i.e., the creation of a structure capable of containing a finite volume of liquids and/or solids. A brief description of the two types of surface impoundments and the necessary water pollution prevention considerations are given below.

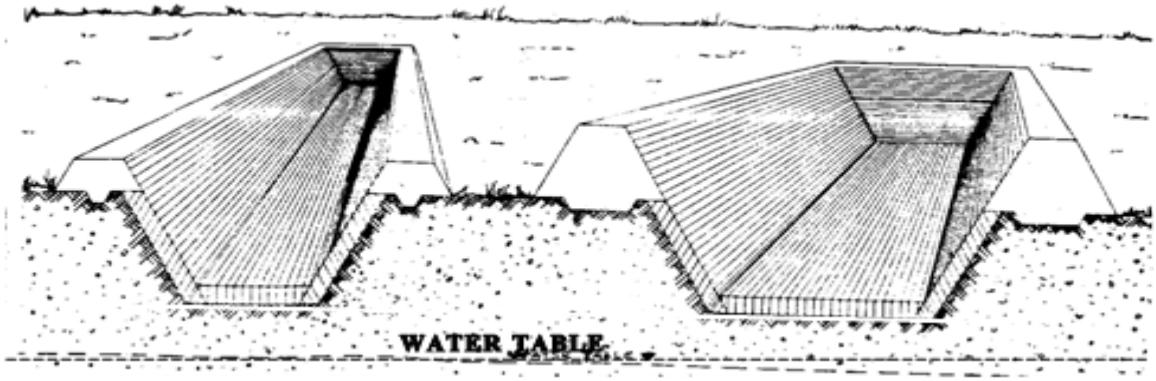
(1) Above-ground surface impoundments - The above-ground method of constructing a surface impoundment consists of building dikes around an area without excavating into the ground (see Impoundment A - Figure 1). This method of surface impoundment construction is well suited for use in areas with high water table conditions. The dike height and width will be determined by the intended use of the surface impoundment (volume to be retained, method of delivery of wastes to the surface impoundment, etc.).

(2) Below-ground surface impoundments - The below-ground method of constructing a surface impoundment consists of excavating an area and building dikes around the excavation (see Impoundments B, C, and D - Figure 1). Below-ground surface impoundment construction is suitable for use in areas where the water table is not close to the surface. The dike height and width will be determined by the intended use of the surface impoundment (volume to be retained, method of filling, wind and wave action, etc.).

The waste level in Surface Impoundment C would normally rest at ground level or below, thus greatly reducing the risk of wastes flowing out of the unit and into area drainage features in the event the dike is breached. The waste level in Surface Impoundments A, B, or D would normally occur some distance above ground level thus resulting in waste flow out of the surface impoundment into area drainage features in the event the dike is breached. In situations where surface waters are in immediate threat from a potential catastrophic failure of the dikes of Type A, B, or D construction, drainage should be controlled to prevent escape of wastes from the facility in the event the dike is breached. A backup, secondary, dike or other methods may be used as a method of emergency containment. The containment structure should be designed and constructed to ensure that the area within the structure is capable of retaining a minimum of 1.25 times the volume of waste material retained above ground level within the primary dikes. In addition, the owner or operator should remove the impoundment from service when the level of liquids in the unit suddenly drops and the drop is not due to the change in waste flows into or out of the impoundment. The owner or operator should stop the waste flow to the impoundment, contain any surface leakage, repair the leaks, and take any other necessary steps to prevent catastrophic dike failure. When the impoundment is removed from service for repairs in response to the dike failure, the dike's structural integrity should be reassessed by a qualified individual before the impoundment is put back into service.



Impoundment A Impoundment B



Impoundment C Impoundment D

Figure 1 - Surface Impoundment Design

All permanent earthen dikes which are used to retain waste or waste waters above ground level, such as in the case of an "above-ground" type of impoundment, should have a top width of at least eight (8) feet and side slopes which are no steeper than one (1) foot vertical to three (3) feet horizontal. The factor of safety against dike slope failure should be at least 1.4. In situations where a backup system is not used for potential catastrophic failure of the dikes, the minimum factor of safety should be 1.5.

In order to minimize the erosion of earthen dikes by wind and water, it is suggested that, where practical, all earthen dikes should be stabilized by establishing a protective "cover" such as, but not limited to, grass, shell, rock, etc., over the top and sides of the exposed portions of the dikes.

Liner Construction/Installation

The performance and lifetime of the most carefully selected liners can be severely degraded by improper construction and installation procedures. The construction quality assurance guidelines in EPA publication EPA/600/R-93/182 entitled Quality Assurance and Quality Control for Waste Containment Facilities should be consulted for construction of all liner systems. A Quality Assurance/Quality Control (QA/QC) Plan should be written prior to construction and followed throughout the construction phase. The QA/QC Plan should also address how any problems during construction and changes to the original plan are to be handled.

All liners and dikes should be installed on a firm base which is free of roots, stumps, rocks, and vegetation. Soil liners/dikes should be constructed of clay-rich soil material with the properties given in Table 2 which is capable of achieving a permeability of 1×10^{-7} cm/sec or less when compacted to 95% standard proctor density at a moisture content at or above the optimum moisture content, or to 90% modified proctor density at a moisture content 1% dry of optimum or above. The soil material should be free of foreign material such as trash, brush, or rocks greater than one inch in size, roots, vegetation, and other debris. The soil should be placed in loose lifts no thicker than the pads or feet of the compactor. The top of each compacted lift should be scarified prior to placement of the succeeding lift to facilitate bonding between lifts. The clod size should be reduced to a maximum size of one inch by disk or pulverizer prior to addition of water, which should be thoroughly mixed into the soil (allowing adequate time for hydration) prior to compaction. Compaction should be done only with a pad/tamping-foot or prong-foot roller.

If in-place soils are used as liner material, the top six inches should be scarified and recompacted. If any fractures, joints, or discontinuities which may have permeabilities greater than the liner standard (1×10^{-7} cm/sec) are present, they should be excavated over the liner thickness and replaced with compacted soil constructed as described above.

Before installing any geosynthetic liner, the installation procedure and quality assurance standards for that particular liner should be thoroughly understood by the owner or consulting engineer. This is to ensure that the contractor installing the liner maintains strict quality control/quality assurance procedures. Each liner type has specific and unique installation procedures and if these are followed carefully the liner should provide excellent groundwater protection.

Material, construction, and quality assurance standards for geomembrane liners can be found in the following sources: EPA/600/R-93/182 (described above); Geosynthetic Research Institute (GRI) Test Method GM13 (manufacturer's standards for high density polyethylene geomembrane); GRI Test Method GM17 (manufacturer's standards for linear low density polyethylene geomembrane); International Association of Geosynthetic Installers, HDPE Geomembrane Installation Specification; PVC Geomembrane Institute PGI 1197, and Specification for PVC Geomembrane. Additional information regarding material and construction standards for geomembranes can be obtained by contacting the manufacturers of the geomembrane products.

Recommendations for material, construction, and quality assurance standards for GCL can be provided by the manufacturers of the GCL products and by the TCEQ upon request.

In many cases geosynthetic liners require a protective cover, which is usually a layer of soil. This will protect the liner from heavy equipment traffic, ozone, and ultraviolet light.

Leak Detection and Groundwater Monitoring Systems

A leak detection system should be installed in any surface impoundment accepting Class 1 waste and any Class 2 surface impoundment utilizing a geomembrane liner alone. The leak detection system should be installed over a relatively impermeable base, and checked on a routine basis. There are many types of leak detection systems.

A drainage layer consisting of granular material (sand or gravel) or synthetic drain (geonet/geocomposite) should be installed to direct flow to a collection pipe(s) and/or trenche(s) and sump(s). The drainage layer should be sloped at least 1% toward the collection points. The granular drainage materials should have a permeability of 1×10^{-1} cm/sec or more, and a thickness of at least 12 inches (30.5 cm). The synthetic drainage materials should have a transmissivity of 3×10^{-4} m^2 /sec or greater. A liquid removal system (e.g., pumps) of sufficient size should be provided to collect and remove liquids from the sump and prevent liquids from backing up into the drainage layer(s).

The design of each sump and removal system should provide a method for measuring and recording the volume of liquids present in the sump and of liquids removed. All pumpable liquids in the sumps should be removed to minimize the head on the bottom liner. All liquids removed from the leak detection system should be collected and managed at an authorized industrial solid waste management facility.

When a leak is detected, the location, size, and cause of the leak should be determined to the extent practicable. Subsequently, it should be determined whether waste flow to the impoundment should be stopped, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether or not the unit should be closed. In situations where leaks must be pinpointed and fixed quickly an electronic leak detection survey may be used.

Groundwater monitoring wells are recommended for all Class 1 and Class 2 sites, in addition to leak detection systems. Unless it can be demonstrated that there is no potential for migration of waste constituents to the uppermost water-bearing zone during the active life of the unit, including the closure period and the post-closure care period, a sufficient number of wells should be installed for Class 1 and Class 2 surface impoundments at appropriate locations and depths to yield groundwater samples. At least three wells would be needed to determine the groundwater flow direction. The number of wells needed to detect releases from the unit varies depending on factors, including but not limited to, the area of the surface impoundment, depth to groundwater, geologic characteristics of underlying formations, and the groundwater gradient. The wells should be located in a manner which allows the detection of releases of waste and waste constituents that have migrated from the surface impoundment to the uppermost water-bearing zone at the earliest practicable time. Semi-annual groundwater monitoring is recommended during the active life and post-closure of the unit. More extensive guidance concerning groundwater monitoring and procedures can be found in TCEQ Draft Technical Guidance No. 6 Ground-Water Monitoring.

Notification

Title 30 TAC Section 335.6(a) requires that any person who intends to store, process or dispose of industrial solid waste without a permit, as authorized by 30 TAC Sections 335.2(d), (e), (f) or (h) or 335.24, notify the executive director in writing or using electronic notification software provided by the executive director, that storage, processing or disposal activities are planned, at least 90 days prior to engaging in such activities. The executive director may require submission of information necessary to determine whether storage, processing or disposal is compliant with the terms of 30

TAC Chapter 335. Required information may include, but is not limited to, information concerning waste composition, waste management methods, facility engineering plans and specifications, or the geology where the facility is located. In addition, other regulations may apply to the surface impoundment.

Maintenance and Recordkeeping

Routine maintenance of all facilities at the surface impoundment site, such as roads, ditches, fences, freeboard markers, liners, leak detection systems, groundwater monitoring systems, etc, and especially the dikes (primary and secondary), is essential to maintain a clean, orderly, safe, and environmentally acceptable operation.

All needed maintenance or corrective action necessary to restore the dikes or liners to original conditions should be accomplished expeditiously due to the potential serious consequences that could result.

All surface impoundments, regardless of their contents, should maintain adequate freeboard. Recommended freeboard is two (2) feet from the top of the dike. Surface impoundments containing liquids, as opposed to sludges, may be subject to greater freeboard requirements due to the possibility of wave action within the surface impoundments being generated by strong winds, thus possibly allowing wastewaters to pass over the surface impoundment dike.

Periodic inspections should be performed for the purpose of detecting and correcting any deterioration in the surface impoundment liner and leak detection systems, groundwater monitoring system, dikes, surface drainage systems, etc. In addition, the waste level in the surface impoundment should be inspected to insure that adequate freeboard is maintained at all times.

Records of all inspection and maintenance activities should be kept at the facility for a minimum of three years.

All spills should be reported to the TCEQ. If there is any change in the type of wastes generated, or in the treatment, storage, or disposal method used, the Commission should be notified in accordance with 30 TAC Section 335.6.

Professional Certification

All engineering plans, specifications, and related documents submitted to the TCEQ shall be prepared by, or under the supervision of, a qualified Texas licensed professional engineer (Texas P.E.), and shall be signed, sealed, and dated by the Texas P.E., as required by the Texas Engineering Practice Act.

All geoscientific information submitted to the TCEQ shall be prepared by, or under the supervision of, a qualified Texas licensed professional geoscientist (Texas P.G.), and shall be signed, sealed, and dated by the Texas P.G., as required by the Texas Geoscience Practice Act.

Closure and Post-Closure

Nonhazardous industrial solid waste surface impoundments must be closed in accordance with 30 TAC Section 335.8. Timely notification of closure must be provided to TCEQ in accordance with applicable regulations. Upon closure, the owner or operator should attempt to remove or decontaminate all waste and waste residues, contaminated design and operating system components

such as liners, leak detection systems, dikes, and contaminated media in accordance with 30 TAC Section 335.8.

If contamination remains in place, it is recommended that a geosynthetic and/or clay-rich soil cap (with a permeability and thickness equivalent to the underlying liners) be placed over the waste and the cap be graded, contoured, and overlain by a vegetated topsoil to prevent erosion. Groundwater monitoring, leak detection (if the system is left in place), and site maintenance should continue during the post-closure period. Refer to TCEQ Draft Technical Guideline No. 3 Landfills for recommendations on final cap design and construction.