

APPENDIX 7.1.1 POST-CLOSURE PLAN

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POST-CLOSURE PLAN

1.0 INTRODUCTION

Once the Compact Waste Facility (CWF) and Federal Waste Facility (FWF) are closed according to provisions of this Closure Plan, Waste Control Specialists LLC (WCS) will carry out necessary maintenance and repairs. WCS will observe and monitor the closed facilities to demonstrate that each facility is performing as required and that the performance objectives will continue to be met. The post-closure activities are estimated to span a 5-year time frame for the CWF and a 30-year time frame for the FWF.

The disposal facilities are designed so that active maintenance is not necessary following closure, as required by 30 TAC 336.727. If, however, maintenance activities are required, they may involve remedial activity during the period of post-closure to maintain a reasonable assurance that the performance objectives stated in 30 TAC 336.724 will continue to be met. Other possible maintenance activities could include the pumping and treatment of water from a disposal unit or one-time measures such as replacement of a disposal unit cover.

However, if post-closure surveillance reveals that portions of the final cover have experienced subsidence or erosion outside of expected values, investigations will be initiated to discover the cause or source of this degradation. Moreover, the cover will be repaired to the original contours specified in the cover-grading plan. Certainly, the activities that WCS will conduct during the post-closure period will include those necessary to detect the need for repairs and other remedial actions.

The post-closure care period provides a means of ensuring the continued safe and effective function of the disposal facilities following facility closure. WCS will perform activities not considered to be active maintenance during the post-closure period. Such activities include surveillance (observation of the disposal site to detect the need for maintenance, post-closure care, evidence of intrusion, and evidence of compliance with all license conditions and regulatory requirements) and post-closure care (repair of fencing, repair or replacement of monitoring equipment, revegetation, minor additions to soil cover, minor repair of disposal unit covers, and general disposal site upkeep, such as landscape maintenance). Some of these activities will also be performed during facility closure as discussed in License Application (LA) Section 6.0.

WCS will coordinate with the TCEQ to determine the times at which WCS will prepare and submit applications to transfer responsibility for the LLRW disposal site to the designated custodial agency (CA). For the CWF, this time might occur as early as five years after completion of closure activities, but could be delayed for several years until confidence exists that the facility characteristics and performance have stabilized and that the facility will continue to satisfy performance objectives.

WCS will continue surveillance and post-closure care activities until responsibility for the site and facilities is transferred to the designated custodial agencies.

The Institutional Control Period will follow post-closure monitoring, maintenance, and transfer of the facility to the CA.

The costs of conducting post-closure surveillance and post-closure care activities have been estimated in order to determine what financial assurances are required for the post-closure care fund. This costs estimate is located in Appendix 7.1.3.

Descriptions of the plans for carrying out surveillance and post-closure care activities for these two facilities are presented in the following sections.

2.0 SURFACE DRAINAGE AND EROSION PROTECTION

The disposal unit covers are designed to minimized infiltration of water into the disposal unit, to direct percolating or surface water away from disposed waste, and to resist degradation by surface geologic processes and biotic activity. The designs and calculations to support these measures are described below.

2.1 Hydrologic Analysis

The top layer of the final cover system was specifically designed to meet the recommendations of NUREG-1623 for a 1,000 year erosion barrier. The calculations included in Attachment 3.0-3.18 were performed to evaluate the potential for erosion for the native topsoil and sand layers (evapotranspiration cover) directly beneath the erosion barrier, in the event that they are exposed directly to surface precipitation. WCS estimated erosion initially using the USLE deterministic equation but also performed a more complex analysis using the Soil and Water Assessment Tool (SWAT) developed by the USDA Agricultural Research Service at the Grassland, Soil and Water Research Laboratory in Temple, Texas.

Various scenarios were developed and performed in order to account for possible long-term trends of variable meteorological periods. Graphing the normalized cumulative losses, it is calculated that over the first 50,000 years following facility closure, total gravel mulch cover loss due to erosion is calculated by SWAT to be 4.26 inches (0.355 feet). The SWAT calculation is Attachment 3.0-3.29.

2.2 Erosion and Flooding Prevention

To meet the design objectives established by the regulations and standards, the design of erosion protection can be significantly affected by several natural phenomena and consideration of the following was exercised in the design calculations:

- Selection of an appropriate design basis flood or rainfall event
- Control of gully initiation and gully development
- Occurrence of flow concentrations and drainage network development
- Effectiveness of vegetation in arid areas
- Appropriate use of permissible velocity and tractive force methods
- Long-term durability of rock erosion protection

Erosion protection was calculated using the shear stress (tractive force) methods as prescribed in NUREG-1623, *Design of Erosion Protection for Long-Term Stabilization*. This calculation is provided in Appendix 3.0-3.14 and presents the requirement for the top layer of the final cover to minimize long-term water erosion. The steepness of slope, the length of slope, and the rainfall intensity were the controlling factors for the tractive force method. The maximum calculated

rainfall intensity was chosen to provide the most conservative solution. The slopes were chosen for their steepness, length, and the combination of steepness and length. The calculations concluded that a 1-1/2-inch layer of 1-1/2-inch minus, uniformly graded gravel mulch placed as the top layer of the final cover exceeds the requirements in NUREG-1623 to provide protection from water erosion.

Also, WCS performed an assessment of erosion at the LLRW disposal site. It has been determined that the site currently has stable topsoil and that the site is aggrading and generally speaking erosion is not an active process on the site (see Appendix 6.4-3 of Appendix 2.6-1).

2.3 Disposal Unit Final Site Grading

The final site contours following closure of the facility will not look much different from the initial site before excavation and construction occurs, except that contours will be re-graded to ensure that overland flow of water is directed away from the disposal site without erosion. The Final Site Grading Plan is provided in Drawing C0.11 of the LA.

2.4 Peak Flood Calculations

The peak flood calculation used to determine the maximum rainfall intensity was performed in the Final Cover Calculation package found in Appendix 3.0-3.14. A PMP storm event was used to produce an estimated rainfall intensity value which was used in determining the gradation and size of the gravel mulch specified in the calculation package. Given the final slope of the site and the gradation of the gravel mulch, velocities of flooding effects will be low enough to prevent erosion of the final cover thereby maintaining the constraint to minimize active maintenance on the site.

3.0 GEOTECHNICAL STABILITY

Information on the geotechnical stability aspects of the post-closure plan are provided in this section in accordance with 10 CFR 61 performance objectives and technical requirements. Information is provided on the design and construction of the disposal unit cover systems, overall site cover, and related monitoring program.

The facility is designed for long-term stability and to prevent inadvertent intrusion. Because the design incorporates a cover ranging in thickness from 25 feet to 45 feet, designed conditions will favor waste isolation. An additional design feature is the inclusion of long-term volumetric stability of the waste array by the use of concrete canisters, controlled low-strength material (CLSM) grout, and reserve red bed fill material in the cover system. These components will provide additional assurance that active maintenance will not be required after facility closure. Modular concrete canisters will be used for waste that may degrade with time, and all accessible voids will be filled by flowable grout as these waste packages are filled with waste. Each waste layer will also have flowable sand fill placed in the interstices between canisters which is designed to insure minimal yet uniform settlement, and to direct water away from the waste array. The cover system will also have a reserve volume of compacted clay that will be capable of reforming and flowing to close any fractures or cracks that could develop, even though the potential for such failures are likely to be mitigated by other design elements.

Both passive and active design features will be used to protect the inadvertent intruder. A fence will be constructed around the facility to prevent intrusion. Durable markers will also be used to

alert potential intruders that the site contains radioactive waste, and to delineate the extent of the subsurface waste array. These markers will be located at each corner of the disposal unit, and at each corner of the buffer area. These features are intended to alert the casual intruder of the previous activities at the site.

The incorporation of a shotcrete header above the topmost layer of canisters in the CWF also serves as an indication of human activity. While the grout in both the FWF-CDU and CWF may pose a minimal challenge for drilling equipment, the presence of visibly alternating layers that can be readily identified from the red bed clay host formation will be a reliable indicator. The waste matrix itself should provide a similar indication for most waste streams as well.

Final revegetation will be based on studies undertaken during the facility operation period, and is likely to favor native vegetation and succession. Current concepts for revegetation suggest shallow-rooted grasses or vegetative cover are preferable, but a systematic evaluation of candidate species will be conducted during the operational phase of the facility, and will consider scientific advances in developing sustainable covers for the Permian Basin region. Deep-rooted plants will be controlled throughout post-closure and institutional control to maintain the vegetative cover, and supplemental watering will be used to establish initial vegetative species so that undesirable species are thwarted during the initial decade of post-closure.

The detailed elements of the disposal unit cover system are outlined below:

3.1 Disposal Unit Cover

The Disposal Unit Cover system is an optimal design to provide the best assurance to meet performance objectives of the regulation. The cover system is shown in Figure 3.1-1 for the FWF disposal unit and in Figure 3.1-2 for the CWF disposal unit. The cover system consists of a shotcrete layer, an interim cover of clay fill, the performance cover, a lateral drainage layer, a leveling fill, biobarrier, and evapotranspiration cover. Each of the components is described in detail below. The design computations for all elements of the cover system are found in Attachment 3.0-3 of the LA. The construction of all features of the cover system and other appurtenances including the leachate collection system are contained in Section 4, Construction, of the LA. Lift thicknesses, degree of compaction, moisture content, and other required specifications for each cover system and associated elements are referenced in Appendix 4.2.3 of the LA.

3.1.1 Interim Cover/Red Bed Clay Leveling Fill (Lower Layer)

The lower layer of red bed clay fill is placed directly on top of the waste for the FWF-NCDU and on top of the Shotcrete layer for the CWF and FWF-CDU. The lower layer consists of red bed clay with intersperses of sandstone. The red bed clay is highly consolidated reddish purple silty clay with an average combined (red bed clay and sandstone) low permeability of 1×10^{-9} cm/sec. The thickness of this layer ranges from 0 feet at the very edge of the layer to 19 feet at the center of the layer and will be compacted to 95% of standard proctor. The red bed clay fill will be placed initially as an interim cover and eventually be used as a leveling layer on top of the waste to properly grade the disposal cell for placement of the performance cover and lateral drainage layer. The lower layer of red bed clay fill provides additional, redundant hydraulic protection from moisture infiltration.

3.1.2 Shotcrete Layer

Once the top layer of waste canisters have been placed and the leveling fill placed above the canisters in the CWF and FWF-CDU, a one-foot concrete layer will be constructed. The concrete layer will be constructed in place using shotcrete techniques with two layers of welded wire fabric. The permeabilities of both this top shotcrete layer and the bottom shotcrete barrier layer will be equal. Therefore, any water that could enter the disposal unit through the top barrier could also leave the disposal unit through the bottom barrier. This will help prevent “bathtubbing” in the disposal units.

3.1.3 Performance Cover

The performance cover for both disposal units is a 3-foot thick layer of compacted, select clay. The performance cover is placed on top of the red bed clay fill layer at a slope of 3% (FWF). A 60-mil HDPE FML will be placed on and in direct contact with the low-permeability red bed clay in the FWF, but this synthetic membrane is not specified for the CWF. The performance cover clay material consists entirely of select red bed clay, without interspersed sandstone. The performance cover red bed clay will be compacted to 95% of optimal density. Specifications related to emplacement and testing are provided in Appendix 4.2.3. The general layout of the performance cover is provided in Appendix 3.5.2. The performance cover will have a permeability of $1.0E-09$ cm/sec.

3.1.4 Lateral Drainage Layer

The 2-foot thick lateral drainage layer is placed above the performance cover at the same slope of 3% (FWF). The lateral drainage layer consists of hard, durable, angular pieces of sand and gravel having a specific gravity of no less than 2.65 and conforming gradation as specified in Appendix 4.2.3. The lateral drainage layer will permit water to flow at a minimum of 1 cm/sec. A 10-oz geotextile filter fabric will be installed above and below the sand and gravel material to prevent the red bed fine particles from filling in the void spaces of the lateral drainage. The geotextile filter fabric is a non-woven needle punched, staple fiber, and polypropylene product. The lateral drainage layer provides a flow path for any water that may percolate through the upper red bed clay layer (described later) to run laterally into the existing sand and gravel the OAG formation. The thickness, grade, and material composition of the lateral drainage layer are designed following U.S. Environmental Protection Agency (EPA) guidelines for covers and impoundments.

3.1.5 Red Bed Clay Leveling Fill (Upper Layer)

Above the lateral drainage layer is another layer of red bed clay fill (upper layer). The upper layer of red bed clay fill consists of red bed clay and interspersed sandstone. The red bed clay is highly consolidated reddish purple silty clay with an average combined (red bed clay and sandstone) permeability of $1.0E-09$ cm/sec. The upper red bed clay fill is approximately 8 to 33 feet thick and will be compacted to 95% of standard proctor. The red bed clay is used as a leveling fill material and provides another redundant low permeability cover over the disposed waste.

3.1.6 Biobarrier

Above the upper red bed clay fill material is a protective layer and intruder barrier. The intruder protection requirement for the waste disposal unit is met in the placement of a minimum of 5 meters of earthen cover material over the waste. Waste in the FWF is covered with an average of 35 feet of material (almost 11 meters). Included in this 35-foot cover, at the base of the Evapotranspiration cover and above the red bed clay fill is a 6-oz geotextile filter fabric, 3-foot layer of cobble, and 3 to 6-foot layer of caliche rock. The geotextile filter fabric is a non-woven, needle punched, staple fiber, polypropylene filter fabric used to control migration of finer materials from entering the voids of the cobble protection. The cobble ranges in diameter from 6 to 12-inches as specified. The caliche rocks range in diameter from 1.5 feet to 3 feet and are cemented sands, gravels and agglomerated limestone rock which is difficult to fracture. This zone of cobble acts as a biobarrier to protect against burrowing animals and roots from vegetation as research indicates in DePoorter, 1982. The addition of the agglomerated caliche rock will provide protection that exceeds the recommended intrusion barrier depth recommended by Cline, 1979, Cline et al., 1982, and Hakonson, 1986.

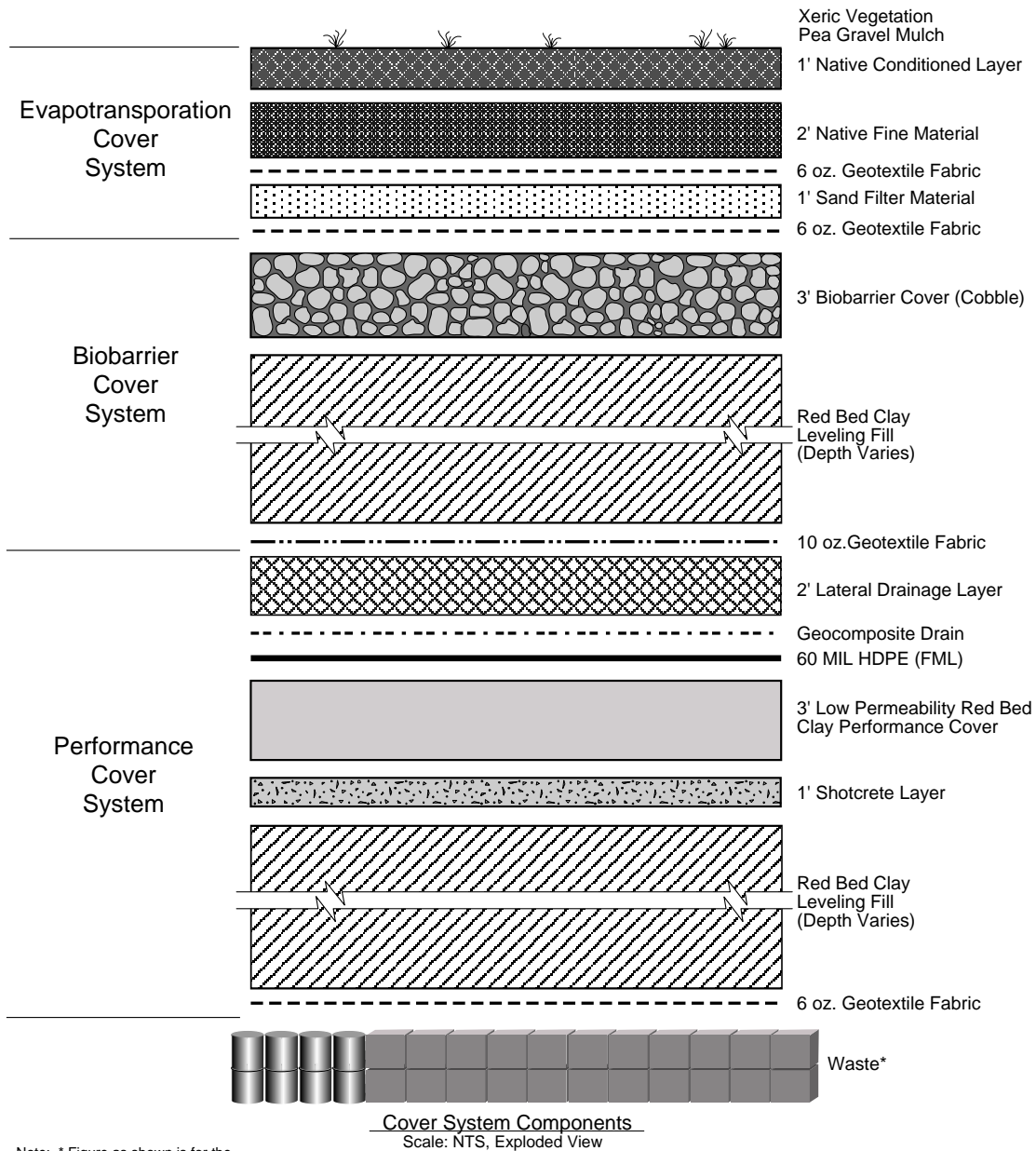
3.1.7 Evapotranspiration (ET) Cover

The ET cover is an alternative cover system designed to store water until it is either transpired through vegetation or evaporated from the soil surface. There are three layers that comprise the ET cover. The upper layer is a one-foot course of native material conditioned to support native vegetation at the site. This conditioned layer provides a growth zone for vegetation. The ET cover will be vegetated with locally hardy grasses, such as Side Oats Grama, Switchgrass, Blue Grama, Plains Bristlegrass, Sand Dropseed, Buffalo grass, or similar varieties. For further description of the site flora refer to the Ecological Assessment (Appendix 2.9.1). Due to the arid climate and difficulty maintaining vegetation in the area, the cover surface will also receive a 1-inch thick layer of 1/4-inch gravel to act as a stone armor to reduce initial moisture loss, wind/soil erosion, and loss of seeds during the first several seasons of germination. Organic material is added to the gravel mulch to promote initial plant germination. This top layer of the ET cover provides a sufficient barrier to withstand erosion and complements the site aesthetics and ecological environment.

The next layer in the ET cover is a 2-foot thick moisture retention layer of native fine material. This layer is intended to provide a moisture retention layer for surface plant root development, which is important for transpiration and minimizing surface erosion. The layers of the ET cover will be placed at a maximum compaction of 85% of standard proctor.

Below the moisture retention soil will be a one-foot thick layer of graded sand to provide a capillary break between the topsoil layers and the underlying clay materials. This layer also serves as a zone for congregation of plant roots that can utilize this water for growth, returning it to the atmosphere as water vapor. The gradation of this layer is specified as gravelly sand filter material, and will be free from organic matter.

**APPLICATION FOR LICENSE TO AUTHORIZE NEAR-SURFACE
LAND DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE
Appendix 7.1.1: Post-Closure Plan**



Note: * Figure as shown is for the FWF - CDU concrete canisters replaced by non-canister waste in the FWF - NCDU.

Figure 3.1-1. FWF-CDU and FWF-NCDU Cover System

**APPLICATION FOR LICENSE TO AUTHORIZE NEAR-SURFACE
LAND DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE
Appendix 7.1.1: Post-Closure Plan**

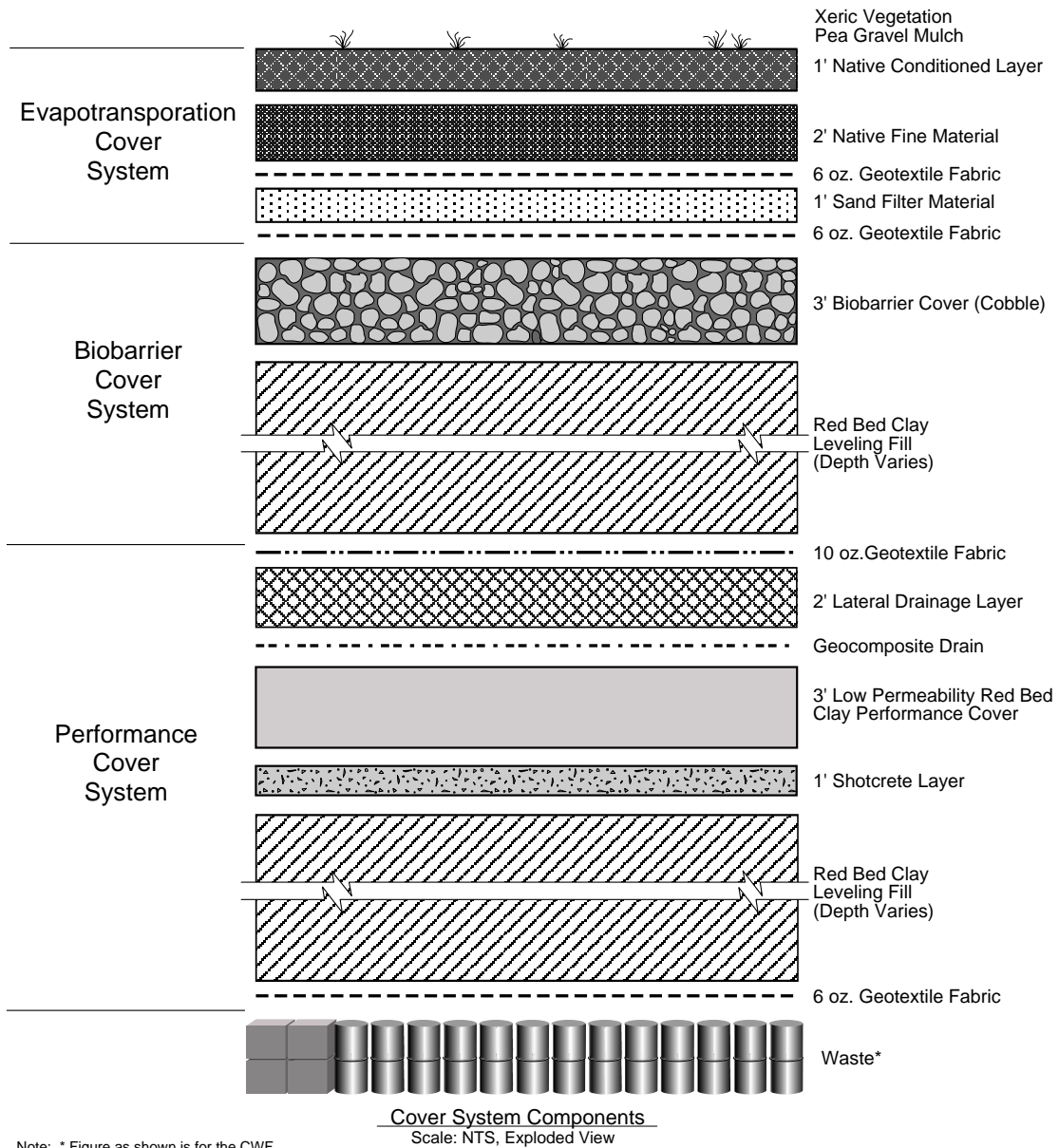


Figure 3.1-2. CWF Cover System

4.0 POST-CLOSURE MONITORING

This section provides a description of the Post-Closure Monitoring Program, including radioactive and chemical parameters, and plan for taking corrective measures if migration of radionuclides or chemical constituents is discovered.

As shown in the figure below, WCS will employ several different monitoring plans that will be in effect at different periods of time. Elements of the closure monitoring program are outlined in Appendix 6.1.2-1 and discussed in this section.

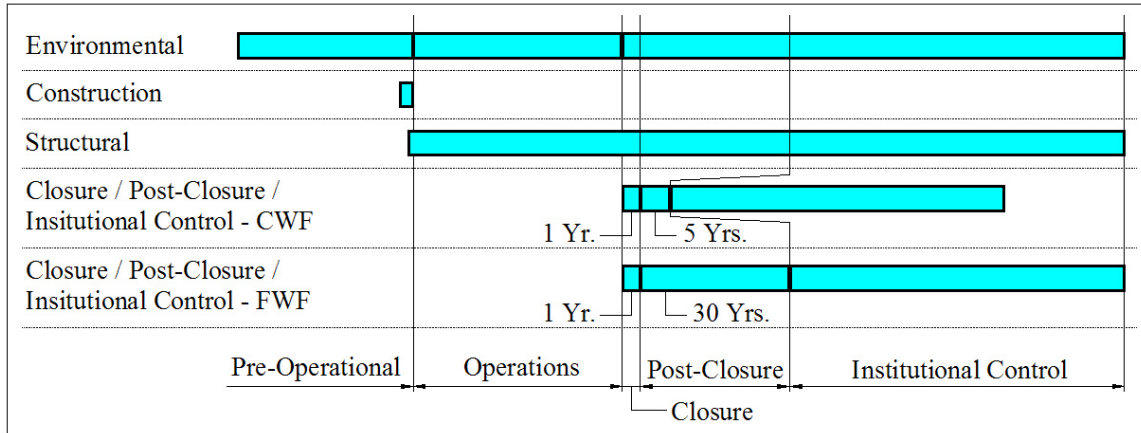


Figure 4.1-1. Timeline of Monitoring Plans

The following list shows where the monitoring plans above can be found in the LA.

- Environmental Monitoring Plans – Appendix 2.10.1-2, Appendix 2.10.2-2
- Construction Monitoring Plan – Section 4.4
- Structural Monitoring Plan – Appendix 4.4-1
- Closure Monitoring – Appendix 6.1.2-1
- Post-Closure Monitoring – Appendix 7.1.1
- Institutional Control Monitoring – Appendix 7.2.2

Planned post-operational monitoring locations are identified in Appendix 2.10.1-2 and, for groundwater, in Section 6.3 of Appendix 2.6.1. Planned matrices, analyses and frequencies are identified in Appendices 2.10.1-2 and 2.10.2-2. The post-operational radiological groundwater monitoring program for the Federal and Compact facilities as described in the current site REMP contained in Appendix 2.10.1-2 will be revised to be consistent with the approved groundwater monitoring program prior to initiation of operations under the LLRW disposal license. The proposed monitoring locations for the post-closure period may be adjusted as appropriate based on the results of the ongoing operational monitoring program and as authorized by TCEQ.

The frequency of sampling and extent of laboratory analyses may be reduced during the post-closure monitoring period as approved by the TCEQ based on the extent that monitoring data confirms that the site and facilities are performing as projected and as required. WCS will continue to monitor in such a way as to ensure that any migration of radioactive or hazardous

constituents or any unexpected behavior of environmental media will be detected. In the event that such changes are detected, the sampling frequency and extent of laboratory analyses can be modified as deemed appropriate.

Groundwater monitoring will continue to provide data to support long-term impact evaluation. In addition, if water is present, the surface water at Baker Spring may continue to be sampled as part of Station 23-TW. A background sample will be collected and analyzed with each round of sampling.

Soil and vegetation will continue to be sampled through the off-site environmental indicator measurements, as specified in Appendix 2.10.1-2. The sampling methods and laboratory analyses will be unchanged. A background sample will be collected and analyzed with each round of sampling. Air sampling methods and laboratory analyses will also remain unchanged, although methods may be technologically upgraded based on industry standards.

External gamma radiation levels will continue to be measured and recorded using thermoluminescent dosimeters (TLDs) and survey meter mapping. The TLDs are located throughout the area as listed on Table 2.10.1-3 in Section 2. The control station (Station 9) will continue to provide background information. The TLDs will be collected and processed quarterly along with a set of control TLDs. Micro-R survey measurements will be performed quarterly at each TLD location and dose rate mapping also will be conducted over the WCS disposal site and immediately adjacent areas. The on-site grid system used during operations for micro-R surveys will continue to be used during the post-closure period. A micro-R survey will be performed annually on a 50-meter grid to record external gamma radiation levels throughout the post-closure period. Radon levels will also be monitored during the post-closure period.

4.1 Surveillance Monitoring

4.1.1 Surveillance

Surveillance is observation of the disposal site for purposes of visually detecting the need for maintenance, post-closure care, evidence of intrusion, and evidence of compliance with other license and regulatory requirements. Following facility closure and until the TCEQ terminates WCS' disposal license and transfers responsibility for the facilities to the designated custodial agencies, WCS will carry out appropriate surveillance activities to ensure that these objectives are met, as described in the following sections.

4.1.2 Physical Surveillance

Physical surveillance will be conducted periodically during the post-operational and closure period. The site will be physically inspected for needed maintenance and repairs performed to maintain integrity of the waste and safety for the post-closure work force. This includes inspection of remaining facilities, fences, landfill cap and monitoring for erosion by water or wind.

As described in Section 7.3.2, WCS will maintain surveillance over and provide post-closure care of the closed site and facilities during the post-closure period to determine whether the site and facilities are performing as projected and whether active maintenance is required. The program relies on information gathered from the pre-operational and operational monitoring

programs to provide a baseline of natural site and disposal unit performance characteristics. It is designed to be flexible to incorporate information from pre-operational and operational data.

4.1.3 Periodic Walkover Inspections

Following facility closure, periodic walkover inspections will be conducted of the facilities on a monthly basis to ensure that no conditions are encountered that indicate a need for more intense surveillance. Walkover inspections are estimated to occur on a monthly basis throughout the Post-Closure Period, but could be revised if evidence reveals that the frequency is too little or too much.

The purpose of these walkover inspections is to identify processes and conditions that are not as planned or that could compromise the ability of the closed facility to continue to meet performance objectives. During these inspections, the following characteristics and conditions will be examined:

- Evidence of subsidence, settlement, and differential settlement
- Evidence of wind or water erosion
- Evidence of biotic intrusion activity, such as burrowing and establishment of deep-rooted vegetation
- Evidence of other intrusive activities, including inadvertent intruders
- Integrity of perimeter fencing

These periodic walkover inspections will utilize instructions and data sheets that will prescribe the course to be followed, the examinations to be made, the evidence to be collected, and the observations to be recorded. Among the evidence to be collected will be photographs of prescribed and other locations and features, physical measurements, and examinations of results of the various components of Post-Operational Monitoring Program.

4.1.4 Interpretation of Surveillance Results

WCS will consolidate data, information, photographs, records, monitoring results, and other information gathered by surveillance activities. The resulting database will be used to support analyses and evaluation of observed site conditions and processes. Each year during the Post-Closure Period, an annual surveillance report will be prepared that presents and justifies a comprehensive portrayal of conditions at the closed facilities and the extent to which assurance is accumulating that performance objectives are likely to continue to be met. The annual surveillance report will also identify revisions to surveillance activities needed to better monitor the facilities' closed conditions.

4.2 Structural Monitoring

The Structural Performance Monitoring Plan (SPMP), given as Appendix 4.4-1, contains specific information on the structural monitoring activities that will occur during the Post-Closure Period. The SPMP spans the Construction, Closure, Post-Closure, and Institutional Control Periods, and is mentioned only briefly here.

4.2.1 Settlement Monitoring

WCS will examine the final cover placed over the disposal unit cells using industry standard and approved survey methods each year for five years following facility closure for both the CWF and FWF. The surveys of topography and settlement monitors will be used to determine the extent to which any subsidence may have occurred and whether further investigation or active maintenance is required. Institutional control of the CWF was assumed following post-closure monitoring, maintenance, and transfer of the facility to the CA.

For the FWF, RCRA requires a nominal period of 30 years for land surveys. If the site is meeting performance objectives and applicable RCRA requirements, WCS can apply to terminate its RCRA permit before the site has been closed for 30 years. This application for termination could happen earlier than the nominal 30-year period following facility closure. As necessary, WCS will continue conducting land surveys every month until the license and permit have been terminated and/or responsibility transferred to the designated CA.

Settlement monitors are placed in the center of each phased cell as shown in Drawing C0.4 and the settlement monitor construction details are found in Drawing C0.13. Plans for monitoring settlement are contained in the Structural Performance Monitoring Plan, Appendix 4.4-1.

4.2.2 In-Situ Sensors

During operations in-situ sensors (strain gauges) will be installed in the concrete barrier. These sensors will be monitored during operations, closure, and post-closure activities to obtain a level of confidence that the canisters are performing as designed. The duration and frequency of monitoring in-situ devices is described in the Structural Performance Monitoring Plan, Appendix 4.4-1. Since the life expectancy of these sensors is not completely known, if the sensors fail it may be impractical to replace them.

4.3 Infiltration Monitoring

4.3.1 Leak Detection Monitoring

As a further safeguard at the FWF, WCS will monitor performance of the leak detection system during and after closure to monitor that the leachate collection system is performing as designed. WCS will monitor and record the volume of liquid (if any) removed from each leak detection system in the FWF according to the following schedule:

Activity	Phase I Years 1-2	Phase II Years 3-5	Phase III		Phase IV Years 16-30
			Years 6-10	Years 11-15	
Leakage Detection Monitoring	Monthly	Quarterly	Semiannual		

If, at any time during the post-closure care period, the pump operating level is exceeded, the monitoring returns immediately to monthly recording of amounts of liquids removed from that sump until the liquid level again stays below the pump operating level for two consecutive months. Should the pump operating level be exceeded, monitoring frequency returns to monthly. Monitoring frequency then decreases to quarterly and semiannually as long as the water level remains below the pump operating level for at least two consecutive monitoring periods.

The designed leachate collection system for the FWF and CWF disposal units are shown on Drawings C1.10, C1.11, C1.12, C2.22, and C2.23 in Appendix 3.0-2. The design for the FWF disposal unit incorporates a large diameter leachate collection pipe from which leachate water (if

present) can be pumped. The large diameter pipe allows pumps to be placed relatively easy and inhibit clogging. This high-density polyethylene pipe will be resistant to chemical constituents within the waste matrix. There is also a separate leachate collection system designed to detect leachate under the waste disposal unit. This is due to the RCRA double containment system required. The CWF disposal unit does not require a double lined system and therefore has only a leachate detection/collection pipe from which monitoring and collection will be achieved. Specifications for pipe, embedment, equipment, materials, and their respective installation and inspection requirements are contained in the construction specifications found in Appendix 4.2.3.

The potential for contaminated leachate to be present following closure of the facility is very small, but will still be monitored. If contaminated leachate is discovered in the collection sumps of the disposal cells during routine scheduled monitoring after final site closure, it will be sampled and analyzed for radionuclides to determine the disposition. The water will then be pumped into a tanker truck and disposed off-site based on the sample results. All leachate pumped after final site closure will be transported off-site for disposal.

For further information about the leak detection system and the leachate collection removal system and applicable regulations, see Section 6.3 of this appendix.

Also, the vadose (unsaturated) zone under the disposal cells will be monitored for excessive moisture. If a saturated condition is observed in an isolated area, it could indicate a leak. Plans to monitor the vadose zone are contained in the Structural Performance Monitoring Plan, Appendix 4.4-1.

4.3.2 Groundwater Monitoring

Groundwater is the major pathway for potential human exposure from the contaminants in the FWF and CWF after closure. Groundwater analysis can provide early warning of contaminant migration before it reaches the site boundary. Groundwater wells are located within the site boundary and will provide early warning before the groundwater could potentially exit the site boundary.

The leachate collection and analysis program described in Section 5.3.4 of Appendix 7.3.2 coupled with the groundwater monitoring system will provide data to determine the source and nature of the contaminants. The specific isotopes and concentrations identified in the groundwater or the leachate collection system will provide a basis for reviewing waste inventory locations in order to identify areas where more detailed sampling and analyses and cover inspections should be conducted. The groundwater monitoring program is discussed in detail in Appendix 2.10.1-2, "Radiological Environmental Monitoring Program," which is in effect during the Post-Closure Period.

4.4 Database Tracking and Data Analysis

WCS will continue to use the database system it developed and used during operations throughout the post-closure period. Moreover, these data and all associated records will be maintained as required following closure to enable research and investigation. This approach to record keeping will ensure that all information relevant to the performance of the site and facilities will be retained and available as required to support continuing review and evaluation.

WCS will periodically review and verify all environmental data collected under the various stages of its monitoring programs. The purposes of such review will be to identify the need for changes, whether involving revisions to the monitoring programs or corrective actions to address unacceptable or undesirable conditions. Data verification will ensure the accuracy of the results and may include re-calculation of the results, comparison of the results from replicate samples, review of quality control used for sampling, other analyses, and/or comparison to other parametric analyses. Following verification, the significance of the sample results will usually be assessed to determine the need for corrective action.

As data are collected, WCS will perform trend analyses and report findings to the TCEQ, as required. Trend analyses will consist of statistical evaluations of subsets of the data to determine the extent to which the data are within the background/baseline population. The trend analysis also will include interpretation of the data and analyses based on a standard environmental statistical approach.

4.5 Radiological and Chemical Waste Characteristics

The detailed radiological and chemical waste characteristics will have been documented in detail at site closure. Estimates of the waste inventories and characteristics at the beginning of the site development are found in Appendices 8.0-1 and 8.0-2.

4.6 Detection Monitoring Program

Data analysis and response will be managed through the environmental monitoring plans included in Appendices 2.10.1-2 and 2.10.2-2 of the LA. The detection monitoring program establishes the methods to be used to determine whether there is statistically significant evidence of contamination for any parameter monitored for at the WCS monitoring location. Detection monitoring does not include the investigation phase that will be conducted if statistically significant evidence is found that a release has occurred from WCS. Should a release occur, then the substantive requirements of 30 TAC 335 will be met and corrective action initiated.

The statistical methods for monitoring data evaluation are described in Section 5.1.5.1 of Appendix 7.3.2, "Early Warning and Corrective Action Plan."

5.0 EARLY WARNING RELEASE FEATURES

Several features have been designed to provide early warning of release of radioactive materials or evidence of potential release of radioactive materials. These have been described in detail above. They include the leachate detection system, strain gauge monitoring in the canisters, and groundwater monitoring wells placed around the disposal sites and offsite to monitor for potential releases into groundwater. Early warning detection can also include unexpected contamination discovered in vegetation or other environmental media. In addition, visual inspections on the surface along with periodic surveys of monuments and settlement plates can manifest potential problems within the waste matrix when major differential settlement occurs.

5.1 Hypothetical Accident Scenarios

The proposed CWF, FWF-CDU, and FWF-NCDU have been designed to satisfy the performance objectives stated in 30 TAC 336.24 through 336.27. Notwithstanding the great care WCS has taken in these preparations, the possibility remains, however remote, that the disposal

systems (site, facilities, and waste) will not perform as planned and required. Examples of ways the disposal systems may fail to perform as planned and as required include the following:

- Unexpected erosion in the cover system;
- Unexpected biotic intrusion in the form of animal burrows or presence of deep-rooted vegetation;
- Unexpected internal erosion within the cover system leading to excessive settlement, differential settlement, and damage to the performance cover;
- Unexpected amounts of water in the leachate collection system and/or the leakage detection system;
- Unexpected concentrations of radioactive or hazardous constituents in groundwater monitoring wells; and
- Unexpected concentrations of radioactive or hazardous constituents in vegetation or other environmental media adjacent to the closed disposal units.

Analyses that address the impacts of these types of failure to perform as expected are reported in LA Section 8.3. As demonstrated in those sections, no failure of the disposal system that has been quantitatively analyzed leads to failure to meet the performance objectives.

Despite the favorable demonstrations of risk analyses presented in LA Section 8, WCS has postulated a range of corrective actions that would require financial assurances and estimated the cost to accomplish the most costly corrective action (refer to LA Section 7.3.3).

5.2 Corrective Action Monitoring Program

There are two degrees of care taken if a constituent is found to be above a prescribed amount. The lesser degree is called the Investigation Limit (IL), which when exceeded will prompt an investigation to determine the cause of the heightened level. If a constituent is found to exceed the Action Level (AL), a corrective action must be instigated (Appendix 2.10.1-2 and Table 8.2.7-1 of Appendix 11.1.1). In this case, prompt notification will be made to the TCEQ by telephone or facsimile to the designated contact. Within 30 days of a confirmed sample result exceeding the control limit, a formal written report will be prepared evaluating the cause and describing planned corrective actions. The report will include an evaluation of the significance of the result within the context of the facility performance assessment and an evaluation of the regulatory significance. Such corrective actions may include, separately or in combination, procedural changes and escalated data evaluations, administrative changes, engineering studies and additional investigations. Corrective actions will be based on the results of engineering studies and additional investigations.

In conjunction with a corrective action program, a corrective action monitoring program will be implemented to demonstrate the effectiveness of the corrective action. If following implementation of corrective action, values fall below the prediction limit for two consecutive sampling events, the monitoring will return to routine detection monitoring (40CFR 264 Subpart F). WCS will use Sen's test (a common operation in statistics) to evaluate trends (declining) to demonstrate effectiveness of corrective action.

6.0 POST-CLOSURE CARE

Whereas the surveillance activities described above have the purpose of identifying the need for maintenance or repair, post-closure care provides this needed support. Post-closure care consists of simple maintenance activities that would be carried out at any conventional facility, regardless of its characteristics or past activities. Post-closure care activities do not constitute active maintenance as defined in 30 TAC 336.2 and include such activities as repairing fences, repairing or replacing monitoring equipment, re-establishing vegetation, addressing minor subsidence or erosion, making minor repairs to disposal unit covers, and generally maintaining the grounds of the disposal site by mowing grass and removing deep-rooted vegetation.

The staff, equipment, and supplies required to enable post-closure care activities are so small and relatively infrequent that they will be provided by an outside professional organization under contract to WCS. A typical surveillance campaign will require crews of two persons each and appropriate management and administrative support.

Post-closure care equipment requirements are likewise small. Required equipment will be provided by the outside professional organization and may include:

- Four-wheel-drive pickup truck
- Small tractor
- Tractor implements including front-end loader, backhoe, mower, and post-hole auger
- Dump truck

Supplies will include those necessary to allow minor backfilling, stabilization, fencing, and plumbing activities with appropriate administrative and management support.

WCS will maintain a long-term environmental monitoring program in compliance with its licenses and permits. This monitoring program will be capable of providing early warning of releases of radionuclides and chemical constituents before they leave the proposed land site boundary. The objectives of the post-operational monitoring program are to:

- Ensure that the closed disposal units continue to meet closure requirements. This objective will be met through site surveillance and media sampling.
- Provide data to support long-term impact evaluations. The results from continued and focused media sampling will enable analyses to confirm predictions of disposal site performance, as necessary.
- Provide records for review. The records from post-operational monitoring serve to document site closure information and to provide required information for public consideration.

6.1 Qualification of Personnel

Personnel working on site during post-operations will be required to follow the same qualification requirements found in the WCS Training and Qualification Program.

6.2 Preparation for License Transfer to Custodial Agency

A major objective of the post-closure activities will be to develop information to demonstrate that the facility continues to satisfy performance objectives and that responsibility for the closed

facilities can be safely transferred to the designated custodial agencies. Conditions that must be demonstrated include the following:

- The closure of the disposal site conforms with WCS' disposal site closure plan, as amended and approved
- WCS has provided reasonable assurance that the performance objectives are likely to continue to be met
- Any funds and necessary records for care are available for transfer to the CA
- The post-closure monitoring program is operational and the Institutional Control Plan is ready to be implemented by the CA
- The custodial agencies are prepared to assume responsibility and ensure that the institutional requirements will be met

WCS will ensure that the information necessary to make these required demonstrations will be developed during the post-closure period and included in the final post-closure plan. The surveillance and post-closure care activities described above will provide the information necessary to make these demonstrations.

6.3 Mixed Waste Compliance

Since WCS intends to dispose of mixed waste at the FWF under a TSD permit issued by TCEQ, WCS will comply with all post-closure requirements contained in 30 TAC §335.174, including maintenance and monitoring throughout the post-closure care period for the FWF. Upon closure of any FWF cell, WCS will cover the cell with an interim cover system designed and constructed to protect disposed waste from direct exposure to weather,

Upon final closure of the FWF, a final cover system will be constructed as described in LA Section 3.5. This cover system satisfies all requirements of a cover system applicable to a landfill disposal unit including:

- Minimizing migration of liquids through the closed landfill
- Minimizing the need for active maintenance
- Promoting drainage while minimizing the potential for cover erosion or abrasion
- Ensuring the cover's integrity is maintained without failure or compromised performance as a results of settlement, differential settlement, or subsidence
- Having permeability less than or equal to the permeability of bottom liner system or natural subsoils

After closure, WCS will comply with all post-closure requirements contained in 40 Code of Federal Regulations §§264.117 through 264.120, including maintenance and monitoring throughout the post-closure care period. WCS has assumed that post-closure surveillance and care will be required for 30 years following FWF closure under these regulations. WCS will:

- Maintain the integrity and effectiveness of the final cover, and make repairs to the cap to address the effects of settling, subsidence, erosion, or other events as necessary (refer to LA Sections 3.4 and 3.5)
- Operate the leachate collection system effectively until leachate is no longer detected or until the permit is terminated, whichever occurs first (refer to LA Section 3.6)

- Maintain and monitor the leak detection system and comply with applicable leak detection system requirements (refer to LA Sections 3.1.2 and 3.6)
- Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements (refer to LA Section 5.7)
- Prevent run-on and run-off from eroding or otherwise damaging the final cover (refer to LA Section 3.6 and Appendix 3.0-2)
- Protect and maintain surveyed benchmarks used (refer to Drawing C0.4 in Appendix 3.0-2 of this LA)

WCS' plans to maintain and monitor the site throughout post-closure care period are discussed in LA Sections 7.1.1 and 7.2.1. The site closure plan and cover design is discussed in LA Sections 6.0 and 3.0, respectively.

7.0 CORRECTIVE ACTION

7.1 Unplanned Events

If a substantive failure (e.g., liner or cover system breach) or release of material is encountered, a Corrective Action Plan will be prepared that specifically addresses the deficiency. Additional information is provided in Appendix 7.3.2, "Early Warning and Corrective Action Plan."

7.2 Corrective Measures

The details of a realistic Corrective Action Plan will depend upon observed failures and the details of what actions must be taken. Based on the ways the disposal system may fail, corrective measures that might be employed have been identified and evaluated. Reasonable corrective measures include the following:

- Regrading and reconstruction to remedy excessive erosion
- Removal and reconstruction of portions of the evapotranspiration (ET) cover
- Removal and reconstruction of portions of the ET cover and portions of the biobarrier, fill, and performance cover
- Removal and reconstruction of portions of the ET cover, portions of the biobarrier, fill, and performance cover, and retrieval of waste packages in the upper waste lifts within a failed disposal cell
- Removal and disposal of leachate from leachate collection system for an extended period of time
- Pump and treat contaminated groundwater and re-inject

These potential corrective measures are expounded upon in the evaluation of the corrective action presented in Appendix 7.3.2.

8.0 COST ESTIMATE

The costs to conduct corrective actions will strongly depend on the nature of the corrective actions. In order to overstate the costs of potential corrective actions, the conservative assumption was made that a major portion of the disposed waste would have to be retrieved immediately at closure of the facilities. Costs are presented in Appendix 7.1.3.

9.0 TRANSFER TO CUSTODIAL AGENCY

Once it has been determined that the site is meeting performance objectives, WCS will apply to transfer responsibility to a custodial agency. This will be done in accordance with Texas Code.