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APPENDIX 6.1.2-1 CLOSURE AND POST-CLOSURE MONITORING PLAN

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1.0 INTRODUCTION

Monitoring of the WCS LLRW is an important activity that will provide assurance that the site performs as designed and as required by the TCEQ. Monitoring of the site has already begun, and will continue, as appropriate, to the end of the Institutional Control Period. There are several monitoring plans, periods, and timeframes, as shown in Figure 6.1.2-1-1.

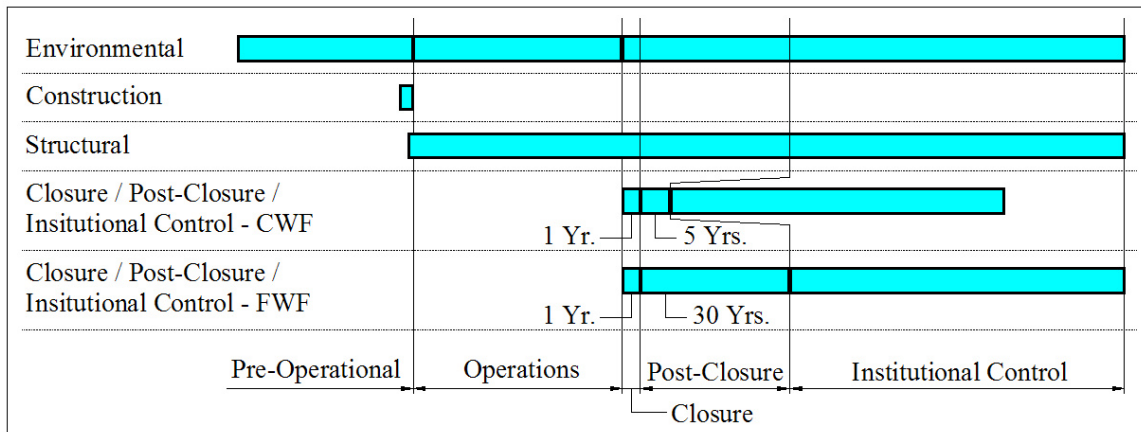


Figure 6.1.2-1-1. Timeline of Monitoring Plans

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

- Environmental Monitoring Plans – Appendix 2.10.1-2, Appendix 2.10.2-2
- Construction Environmental Monitoring – Section 4 under subsection 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

As the figure shows, during the closure period several monitoring plans will be in effect. They are mentioned in this appendix, but more fully covered elsewhere in the LA, as noted.

2.0 ENVIRONMENTAL MONITORING PLAN

Environmental monitoring will be an ongoing activity throughout the life of the LLRW facility. Monitoring activities have already begun, to assist in establishing baseline values. It will continue during the Construction, Operation, Closure, Post-Closure, and Institutional Control Periods. However, the program phases are called Pre-Operational, Operational, and Post-Operational, as shown in Figure 6.1.2-1-1. These plans are discussed briefly in this appendix.

2.1 Purpose and Scope

The purpose of this plan is to provide guidance and direction on the environmental monitoring program for the LLRW disposal facility. The primary objective of environmental monitoring is to ensure that the performance objectives in 30 TAC 336.708(a)(10) and 10 CFR Part 61 are met. The environmental monitoring program consists of the collection of samples and measurement of concentrations of radioactivity, radionuclides, direct radiation, chemicals, and other physical properties of specific media in the environs of the LLRW disposal site during all phases of facility operation. The monitoring program includes all phases of operation for the disposal site. Non-radiological and physical parameters are included in the monitoring because they serve as indicators for waste migration and for site characterization.

2.2 Environmental Monitoring Program Phases

Environmental monitoring has three major phases; preoperational, operational, and post-operational (also called institutional control). Preoperational monitoring occurs during the period before license application and will continue during the application review period. Operational monitoring occurs from the beginning of facility construction through the period when waste is no longer accepted and the facility is closed. A construction phase is identified between preoperational and operational phases. This is included to identify the performance monitoring of all materials used in constructing the facility. Following the operational phase there will be a facility closure period that is anticipated to take five years. Monitoring during this period will consist of the discontinuation of monitoring required during operations and phase into the monitoring required for post-closure and institutional control. Post-operational monitoring occurs from closure through the long-term care period. Although monitoring during each phase is related to the performance objectives, the emphasis, scope, and intensity of monitoring will vary from phase to phase. The monitoring program is planned so that the data collected during each phase will be compatible with and supplemental to data collected during previous and subsequent phases. A timeline for the monitoring plans is shown in Figure 6.1.2-1-1.

2.2.1 *Preoperational Environmental Monitoring*

The preoperational monitoring program is outlined in detail in Section 2, subsection 2.10 of the License Application (LA). The preoperational monitoring plan will establish the location of baseline monitoring programs described in this section.

2.2.2 *Operational Environmental Monitoring*

The principal objective of the operational monitoring program is to:

- Demonstrate compliance with applicable environmental standards.
- Obtain data on critical pathway parameters to allow more accurate evaluation of radiation doses to the general public.
- Provide records for regulatory review. The records from operational monitoring may be used to assess the impact and overall performance of the disposal facility features.

The purposes of the operational monitoring program are to monitor site performance and to demonstrate compliance with applicable standards. Some of the preoperational monitoring will

be carried over through the construction phase of the disposal facility. During initial construction, no radioactive materials will have been disposed of at the site, therefore environmental monitoring covers mainly the non-radiological impacts of facility construction on the environment, such as dust generation, soil erosion, traffic, and noise. Non-radiological constituents are discussed only to the extent that they affect transport of radionuclides and are good indicators for early warning of waste migration into groundwater.

Operational monitoring will be conducted during the entire time that waste is being buried, a period estimated to be 35 years. Appropriate records and data will be submitted to TCEQ during periodic license renewal action to demonstrate compliance with regulatory standards for continued operation and will be used to assess the effectiveness of the operations.

2.2.2.1 Critical Nuclides and Groups

The critical nuclides are those radionuclides most subject to release, and the critical groups are those population groups potentially subject to the greatest exposure. The critical nuclides identified are in Appendix 2.10.1-2, "Radiological Environmental Monitoring Plan." This plan outlines the objectives of preoperation, operation, and postoperation monitoring and provides the key radionuclides for the facility as well as sampling frequency for ambient gamma monitoring, airborne particulate sampling, radon, water sampling, soil sampling, and vegetation sampling. Investigation levels (ILs) and action levels (ALs) are also identified.

2.2.2.2 Physical Parameters

Data collection to characterize the physical parameters of the site such as surface surveillance, stability monitoring, structural performance monitoring, and leachate detection monitoring will be conducted. Table 6.1.2-1-1 outlines the various monitoring that will occur during construction, operations, closure, and post-closure periods. Meteorological data will also be collected from on-site wind speed, wind direction, and atmospheric stability instrumentation to determine movement of air releases during routine or accident situations. Precipitation, temperature, and evaporation data will be measured on site to determine water budget. Groundwater direction and velocity will be evaluated every five years to determine water use, or other changes in the hydrogeologic process on site.

2.2.3 *Postoperational Environmental Monitoring*

After closure of the disposal site, the facility buildings and land will have been properly decommissioned and residual contamination will have been mitigated to acceptable levels. Disposal units will be capped to limit infiltration, protect intruders, and prevent biotic intruders. The site will then be placed under institutional control. The postoperational monitoring program will:

- Demonstrate compliance with site-closure requirements.
- Provide data to support long-term impact evaluation, such as long-term impacts on groundwater.
- Provide records for site closure and for regulatory review.

At this time, most of the environmental sampling can be terminated or reduced except for groundwater monitoring, which must be carried on to provide data to support long-term impact evaluation. Table 6.1.2-1-1 provides the major monitoring events and an indication of their duration during postoperational activities.

2.2.3.1 Physical Surveillance

Physical surveillance will be conducted periodically after site closure. The surveillance program will provide for physical inspection of the site and the performance of any required repairs to maintain the site integrity. This inspection includes monitoring the perimeter fence, backfilling subsidence, and repairing damage caused by erosion.

2.2.3.2 Environmental Sampling Media

After site closure, the primary path for radionuclide release to the environment is through groundwater. The groundwater monitoring program for the operational phase will be continued during the initial period after site closure but will gradually be reduced if no radionuclide or chemical constituent migrations are identified. The analysis of radioactive materials is found in Appendix 2.10.1-2; the analysis of chemical indicators is found in Appendix 2.10.2-2.

**APPLICATION FOR LICENSE TO AUTHORIZE NEAR-SURFACE
LAND DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE
Appendix 6.1.2-1: Closure and Post-Closure Monitoring Plan**

Table 6.1.2-1-1. Monitoring

Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
Surface Surveillance/ Visual Monitoring			
Visual Inspections	Visual inspections will be performed semiannually and after severe weather events to ensure haul roads, ditches, fence lines, and other areas are clean, sound, and functional.	Visual inspections will continue on an annual basis and following severe weather events to ensure fence lines are clean and functional and erosion is minimized.	Visual inspections will occur once every two years or following severe weather events and inspect surfaces for erosion.
Drainage/Diversion Channels	Particular attention will be focused on drainage channels and diversion ditches to ensure that storm water flows away from the disposal units, that outfalls are kept clean and free flowing, and that riprap and other corrective action is added in evidence of scouring or erosion in channels.	N/A - All diversion ditches and channels will be filled and recontoured. Finished slopes will closely match original slopes that direct all water flow away from the disposal units.	N/A
General Visual Inspections	Visual inspections of the facilities will ensure that required routine maintenance is scheduled and performed. Maintenance will be conducted to remove deep-rooted vegetation from undesired areas, clean up litter and other debris on site, remove burrowing animals from the site, inspect fence lines, ensure proper operation of gates, and visually inspect monitoring points for proper operation. Photographs of pertinent features will be documented. These will occur monthly.	Visual inspection of the disposal units will be performed to ensure settlement/subsidence is not present, litter is removed, burrowing animals are not present, and security fence lines are intact and properly maintained. A review of historic photographs of pertinent features or problems will be conducted to assist in the inspection. These will occur quarterly.	Visual inspection of the disposal units will be performed to ensure settlement/subsidence is not present, burrowing animals are not present, and security fence lines are intact and properly maintained. These will occur semiannually.

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Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
<p>Meteorological Data Collection</p> <ul style="list-style-type: none"> • Precipitation • Temperature • Evaporation • Transpiration • Wind Speed • Wind Direction • Atmospheric • Stability 	Data acquired on a monthly basis to determine water balance.	Data acquired on an annual basis to track water balance and determine local changes to hydrogeologic and climatological processes.	Data acquired on an annual basis to track water balance and determine local changes to hydrogeologic and climatological processes.
Stability and Structural Performance Monitoring			
Settlement/Subsidence Monitoring	Settlement plates will be installed on top of the final cover as it is constructed (see Dwg. C0.4 for locations). In addition, interim settlement plates will be installed on the backfill between the final lifts of canisters to observe settlement during operations.	Permanent settlement plates installed on top of the cover will continue to be monitored annually for subsidence to the cover system. Temporary settlement plates used along the exposed face of the trenches will be dismantled and abandoned.	Permanent settlement plates installed on top of the cover will continue to be monitored every two years.
Vertical Alignment Monitoring	Interim monument pins will be installed at the top of the canisters on a 50-ft grid. These will then be surveyed monthly to establish a baseline and monitor potential vertical displacement of the canisters in their final configuration. Variations outside of acceptable limits will invoke the specified remediation.	The vertical alignment monitoring will not be required once the disposal units are closed. The monitoring pins will be abandoned in place and vertical alignment monitoring will cease after closure.	Not required after closure.

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Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
Infiltration Monitoring	Infiltration measurements will be conducted during operations as the disposal unit cover is placed to ensure that the performance cover is operating correctly. Infiltration monitoring will consist of neutron moisture probes being placed in the performance cover system to measure water infiltrating into the cover. In addition, evapotranspiration data will be acquired on the cover surface to provide an estimate of the amount of water that could potentially infiltrate into the cover system.	Moisture probes will be removed or abandoned in place during closure of the facility and infiltration will no longer be monitored. It is anticipated that over the 35-year period of operations adjustments to the performance cover will be made as required from the data collected during operations that will ensure the performance cover functions as required. Records of evapotranspiration will be reviewed on an annual basis to ensure that the performance cover is not overloaded in any postoperational year.	Records of evapotranspiration will be reviewed on an annual basis to ensure that the performance cover is not overloaded in any postoperational year.

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Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
Construction Materials Performance Monitoring (for surface building floors and shotcrete cover)	<p>During initial and subsequent construction of the facility all materials performance monitoring will be conducted in accordance with the written specifications. Such monitoring includes, but is not limited to the following:</p> <ul style="list-style-type: none"> • Moisture content of fill material • Density testing of fill material • Compaction of fill • Flowable fill performance testing • Slump testing of concrete • Strength testing of concrete • Required testing of shotcrete • Required testing of pumps and piping • Inspection of FML joints • QA inspections of all building materials • QA testing of canister fabrication 	N/A	N/A

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Table 6.1.2-1-1. Monitoring

Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
Leachate Monitoring			
Leachate Detection Pipe	Leachate detection piping will be constructed in the trenches at the lowest elevation to ensure any leachate is collected and detected at this point. Initially the leachate collection pipes will be used to test and remove storm water that collected in the open disposal units during operations. Also, during operations, leachate will be collected from the closed cells and transported to the leachate collection tanks for appropriate management. Once a disposal unit is closed, the leachate piping will be used to monitor the performance of the cover system.	The leachate detection piping will be monitored on a monthly basis to verify the proper performance of the cover system. When and if leachate is detected in the disposal unit, it will be analyzed for radionuclides and disposed of appropriately.. If necessary, further investigation will be conducted to pinpoint the location of potential problems.	Continued quarterly monitoring of the leachate collection piping and system will ensure the facility is functioning properly. The monitoring frequency may be reduced in subsequent years based on previous results.
Environmental Monitoring			
Radiological Environmental Monitoring	Radiological environmental monitoring data will be collected from: <ul style="list-style-type: none"> • Weekly particulate air samples • Quarterly composite particulate air samples • Quarterly radon monitoring • Quarterly groundwater monitoring • Quarterly TLD • Quarterly dose rate surveys 	Radiological environmental monitoring data will be collected from: <ul style="list-style-type: none"> • Weekly particulate air samples • Quarterly composite particulate air samples • Quarterly radon monitoring • Quarterly groundwater monitoring • Quarterly TLD • Quarterly dose rate surveys • Semiannual surface soil • Semiannual vegetation 	Radiological monitoring data will be collected from: <ul style="list-style-type: none"> • Semiannual groundwater monitoring • Quarterly TLD • Quarterly dose rate surveys • Annual surface soil • Annual vegetation

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Table 6.1.2-1-1. Monitoring

Description	Operations (35 yrs)	Closure (5 yrs)	Post Closure / Institutional Control (130 yrs)
	<p>The radiological monitoring program is provided in Appendix 2.10.1-2, page 2.10.1-2-33 through page 2.10.1-2-35.</p>	<p>The radiological monitoring program is provided in Appendix 2.10.1-2, page 2.10.1-2-33 through page 2.10.1-2-35.</p>	<p>The sampling frequency may be reduced in subsequent years based on previous results, as specified in Appendix 2.10.1-2.</p>
<p>Nonradiological Environmental Monitoring</p>	<p>Nonradiological environmental monitoring data will be collected from:</p> <ul style="list-style-type: none"> • One-time surface soil volatiles, semi-volatiles and metals • Biannual groundwater water quality parameters <p>The non-radiological monitoring program is provided in Appendix 2.10.2-2, page 2.10.2-2-9.</p>	<p>Nonradiological environmental monitoring data will be collected from:</p> <ul style="list-style-type: none"> • Annual surface soil volatiles, semi-volatiles and metals • Biannual groundwater water quality parameters • Annual vegetation volatiles, semivolatiles and metals <p>The nonradiological monitoring program is provided in Appendix 2.10.2-2, page 2.10.2-2-21.</p>	<p>Non-radiological monitoring data will be collected from:</p> <ul style="list-style-type: none"> • Annual surface soil volatiles, semi-volatiles and metals • Biannual groundwater water quality parameters • Annual vegetation volatiles, semivolatiles and metals <p>The sampling frequency may be reduced in subsequent years based on previous results as specified in Appendix 2.10.2-2.</p>

2.3 ENVIRONMENTAL MONITORING REPORTS

Valid data will be maintained in an environmental monitoring data system. An annual Radiological Environmental Monitoring Report will be prepared at the conclusion of each calendar year that summarizes the data, evaluated trends, discusses anomalies and any elevated levels, and evaluates potential impact on the environment. This report will be made available to the appropriate regulatory body. These reports are discussed in subsections A and B of Section VIII of Appendix 2.10.1-2, and in Section 6.0 of Appendix 2.10.2-2.

Radiological and nonradiological monitoring results will include the following:

- Data and location of sampling event or observations
- Monitored media
- Laboratory performing the analysis (if applicable)
- Reference for the analytical method
- Data of analysis
- Comments on analysis
- Quality control data
- Analysis results including error estimates and established detection limits
- Written summary of the monitoring program and data

3.0 CLOSURE AND POST-CLOSURE MONITORING ACTIVITIES

The objective of closure and post-closure monitoring is to ensure that the site is meeting performance objectives. In other words, it is to ensure that the designed components are functioning as designed and that the designed components are preventing any migration of radionuclides or chemical constituents from the disposal cells.

3.1 Purpose and Scope

Construction and structural monitoring work in conjunction with the Corrective Action Plan and other LLRW monitoring plans for the purpose of meeting the objectives of 10 CFR Part 61 subpart C and 30 TAC 336.708(a)(10).

The Structural Performance Monitoring and Remediation Action Plan provides guidance and direction in the monitoring of and remediation action for the structural components of the LLRW disposal facility to ensure the structural components of the LLRW disposal facility are satisfactorily meeting the design parameters related to the safety and performance of the facility. The Structural Performance Monitoring and Remediation Action Plan will be used in the monitoring for possible final cover settlement including soil slumping/sink holes, strain in the concrete barrier, movement in the concrete joints, vadose zone moisture content, and erosion.

Settlement monitoring will be performed by surveying the tops of the canisters as prescribed in Table 6.1.2-1-1, "Monitoring," of this appendix.

The guideline for development of this plan is NUREG/CR-5041, 2.6.2.8, Remediation Action Plan and the Early Warning and Corrective Action Plan in Section 7.

The Structural Performance Monitoring Plan is given as Appendix 4.4-1 and the Structural Remediation Action Plan is given as Appendix 4.4-2.

4.0 DATA ANALYSIS AND RESPONSE SYSTEM

4.1 Routine Data Analysis

WCS is committed to reviewing all monitoring data to determine if the results exceed any investigation or action level, verifying the analytical results for completeness with the required analysis, and identifying results requiring corrective actions. Follow-up evaluations are performed for samples showing results with questionable results, such as abnormal results (compared with the typical range of values) and high error values. Corrective actions are taken, as necessary, in response to questionable or elevated values of monitoring data. Such actions include recalculation of results, comparison of replicate samples, reanalysis, and resampling.

In the event an off-site environmental impact indicator sample exceeds an investigation level, a follow-up evaluation and verification is required. When an off-site environmental impact indicator sample result exceeds an AL, TDSHS and TCEQ will be notified of the results and planned evaluation or corrective actions.

4.2 Corrective Action Plan

The corrective action plan is a necessary part of the facility's monitoring program. The plan establishes actions that will be taken by WCS if monitoring results exceed pre-established levels. The corrective action plan for post-closure and institutional control is described in Appendix 7.3.2. Data analysis and response will be managed through the environmental monitoring plans included in Appendices 2.10.1-2 and 2.10.2-2. Statistical methods for monitoring data evaluation are described in Section 5.1.1 of Appendix 7.3.2. Under the two-tiered monitoring response program (investigation and action levels) described in this section. ILs are established as an early indication that results are outside the norm for the types of samples and analyses performed. ALs are established at a level of concern where corrective actions may be warranted to ensure continued operations remain within regulatory standards. Due to natural background variation and analytical difficulties, an environmental sample exceeding an IL or AL is not in and of itself conclusive of a problem.

An IL is set at a point above the baseline mean that is considered statistically significant, i.e., at a value that is considered above the background variation. ILs are established specifically for each radionuclide and type of environmental media sampled. For radionuclides where there is a measurable background level, the IL is set at three standard deviations above the background average value. The determination of the average background level and its standard deviation is based on the baseline data. For those radionuclides that do not have a natural background component, the IL is set at any positive measurement at the 95% confidence level. There may be

exceptions to the above criteria, such as tritium in air, where the background level is measurable, but at such a low and radiologically insignificant level that a higher IL is warranted.

An AL is based on some percent of the applicable pathway regulatory standard. For almost all radionuclides, the AL is set at 10% of the applicable regulatory limit. There are, however, a few radionuclides where the background levels and/or variation approaches or exceeds the applicable limits. For these radionuclides, alternative bases for AL have been developed using two approaches. In the first approach, the AL is based on the corresponding regulatory standard value plus a background contribution. This approach is suitable for most situations but is impractical for radionuclides where the variation also exceeds the regulatory standard value. The second approach is suitable when, for example, the natural levels and variation of lead 210 (^{210}Pb) in soil and groundwater do not allow easy differentiation of the corresponding regulatory standard from background and its variation. For these situations, a precursor, or indicator radionuclide, is used for indicating potential level of concern. In the case of ^{210}Pb , the parent radionuclide ^{226}Ra is used.

4.2.1 Investigation Level Responses

IL responses are those activities to be undertaken by WCS if an IL for an environmental sample is exceeded. For a sample with measurable levels above an IL, WCS will undertake an investigation with the intent of validating the analysis and, as appropriate, identifying its cause. An investigation may include comparisons with regional data, investigations of possible climatic or off-site phenomena that could have caused the elevated sample result, resampling and/or reanalysis, increased frequency of sampling, and escalated analysis (in the case of gross alpha and gross beta results). Gross alpha and beta are indicator parameters and are therefore assigned ILs only. Exceeding the IL for these parameters requires an appropriate isotopic analysis as a minimum. An additional investigation may be dictated by the results of the isotopic analysis.

The investigation will attempt to determine the cause to the extent practicable. Reasons may include but are not limited to: (a) sample collection quality control problems; (b) laboratory quality control during their evaluation process; (c) abnormal environmental variation; or (d) a true increase attributable to facility operation, which would require further actions for minimizing future impact. A permanent record of the evaluation will be made, which may include a calculation of dose to the worker or public. A summary will be included in the Annual REMP Report.

4.2.2 Action Level Responses

An off-site environmental impact indicator result exceeding a prescribed AL requires a prompt report to the responsible regulatory agency. Prompt notification may be made by telephone or facsimile to the designated contact. Within 30 days of a confirmed sample result exceeding the AL, 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, as well as mitigating activities involving permanent changes in facility design and engineering, as well as structures emplaced for the sole purpose of mitigation.