Reaching Site Closure For Groundwater Under Multiple Regulatory Agencies

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ABSTRACT

Groundwater at the Connecticut Yankee Atomic Power Company (CYAPCO) Haddam Neck Plant (HNP) has been impacted by both radionuclides and chemical constituents. Furthermore, the cleanup standards and closure requirements for HNP are regulated both by federal and state agencies. The only consistent requirement is the development of a site conceptual model and an understanding of the hydrogeologic conditions that will govern contaminant transport and identify potential receptors.

The cleanup criteria to reach site closure for radionuclides is regulated by both the Nuclear Regulatory Commission (NRC) and the Connecticut Department of Environmental Protection (CTDEP) Bureau of Air Management, Radiological Division. For license termination under the NRC, the total effective dose equivalent (TEDE) for all media can not exceed 25 milliRem per year (mRem/yr) plus As Low as Reasonably Achievable (ALARA). The CTDEP has a similar requirement with the TEDE not to exceed 19 mRem/yr plus ALARA. To reach these criteria, derived concentration guideline levels (DCGLs) were developed for radiological exposures from three (3) media components; soil, existing groundwater and future groundwater from left-in place foundations or footings. Based on current conditions, the target dose contribution from existing and future groundwater is not to exceed 2 mRem/yr TEDE. After source (soil) remediation is complete, the NRC requires two (2) years of quarterly monitoring to demonstrate that groundwater quality meets the DCGLs and does not show an upward trend. CYAPCO's NRC License Termination Plan (LTP) specifies a minimum 18-month period of groundwater monitoring, as long as samples are collected during two spring/high water seasons, to verify the efficacy of remedial actions at HNP.

In addition to the 19 mRem/yr criteria, the CTDEP also requires groundwater to be in compliance with the Remediation Standards Regulation (RSRs). There are no published criteria for radionuclides in the RSRs, however CTDEP has approved the United States Environmental Protection Agency's (USEPA's) Maximum Contaminant Levels (MCLs) as the clean up standards for individual constituents. After remediation of an identified

contamination source, the RSRs require that at least one groundwater monitoring well, hydraulically downgradient of the remediation area, be sampled to confirm that the remediation has not impacted groundwater quality. After four quarters of groundwater monitoring with results below the MCLs, additional groundwater sampling must continue for up to three years to reach site closure in accordance with the RSRs.

The cleanup criteria for chemical constituents, including boron, are regulated by the USEPA under the Resource Conservation and Recovery Act (RCRA) and the CTDEP Bureau of Water Protection and Land Reuse. The USEPA, however, has accepted the CTDEP RSRs as the cleanup criteria for RCRA. Therefore attainment of the CTDEP RSRs is the only set of criteria needed to reach closure, but both agencies retain oversight, interpretation, and closure authority. As stated above, under the RSRs, groundwater must be monitored following a source remediation for a minimum of four quarters. After demonstrating that the remediation was successful, then additional groundwater sampling is required for up to three additional years. However, the number of monitoring wells and frequency of sampling are not defined in the RSRs and must be negotiated with CTDEP.

To successfully reach closure, the conceptual site model, groundwater transport mechanisms, and potential receptors must be defined. Once the hydrogeology is understood, a long term groundwater monitoring program can then be coordinated to meet each agencies requirement to both terminate the NRC license and reach site closure under RCRA.

INTRODUCTION

Groundwater at the Connecticut Yankee Atomic Power Company (CYAPCO) Haddam Neck Plant (HNP) requires investigation of both radionuclides and chemical constituents in order to achieve closure. Cleanup criteria for groundwater are regulated both by federal and state agencies. These requirements vary in both numerical values as well as the duration of post remediation monitoring. The only consistent requirement is the development of a site conceptual model and an understanding of the hydrogeologic conditions that will govern contaminant transport and identify potential receptors.

BACKGROUND

The HNP was a 600 megawatt nuclear reactor that generated power from 1968 through 1996. The plant is located on the Connecticut River in Haddam, Connecticut in an area that is surrounded by open space, rural residential properties, and state parks. During operations, the plant held a Nuclear Regulatory Commission (NRC) license, and Resource Conservation and Recovery Act (RCRA) permits for the generation and storage of hazardous wastes. Once power generation ceased, CYAPCO began decommissioning with a goal of demolishing buildings and releasing the land for unrestricted reuse.

As part of the closure process, CYAPCO has completed extensive investigations to understand the nature and extent of both chemicals and radionuclides in soil and groundwater. As part of this effort, over 60 conventional wells and 5 multi-port systems have been installed to characterize the geology, hydrogeology, and groundwater quality. Following these investigations, CYAPCO completed several soil remediations, both above and below the water table, to remove soils impacted by site-related constituents. To date, approximately 47,000 cubic yards of soil have been removed and disposed off site from 14 discrete areas across the HNP.

REGULATORY REQUIREMENTS

Because the HNP held both an NRC license and RCRA permit, site closure activities are regulated by both the NRC and USEPA. Additionally, there are two departments at the CTDEP that also regulate site closure. The federal and state agencies that oversee site closure at HNP include:

- Nuclear Regulatory Commission (NRC)
- State of Connecticut Department of Environmental Protection – Bureau of Air Management, Radiological Division (CTDEP-RD)
- United States Environmental Protection Agency (USEPA)
- Connecticut Department of Environmental Protection - Bureau of Water Protection and Land Reuse (CTDEP–LR).

Although several of the agencies have similar criteria, by understanding each of the requirements and identifying the lowest common denominator, the closure process for each regulatory authority can be integrated to streamline the closure process.

Each agency requires an initial review of potential and known releases. Each of these areas are then investigated to determine if site-related compounds were released to the environment. These investigations also require an understanding of the hydrogeology. To evaluate if groundwater has been impacted, it is critical to understand the different water bearing zones as well as the velocity and directions of groundwater flow. If soil and groundwater remediation are warranted, then post remediation groundwater monitoring is required to demonstrate compliance with each regulatory closure requirement.

The specific requirements for each agency for post remediation groundwater monitoring are summarized below.

NRC To terminate the NRC license, all media must be below the Derived Concentration Guideline Levels (DCGLs) established in CYAPCO's License Termination Plan (LTP), which are based on the 25 mRem/yr Total Effective Dose Equivalent (TEDE) plus *As Low As Reasonably Achievable* (ALARA) criteria. To demonstrate that the groundwater meets the required criteria, quarterly sampling must be completed for 18 months, including two spring/high water seasons. This sampling begins after dewatering systems

used to support the remediation are removed and the groundwater table has returned to static conditions. Groundwater monitoring is complete when all data are below the DCGL fraction for groundwater (current target is 2 mRem/yr) and the data are either stable or show a decreasing trend.

CTDEP-RD The CTDEP-RD criteria are similar to the NRC, however they require DCGLs based on 19 mRem/yr plus ALARA. The post remediation groundwater monitoring requirements are the same as the NRC.

USEPA The RCRA Program under the USEPA does not regulate radionuclides. However, if groundwater concentrations exceed they Maximum Contaminant Levels (MCLs) at the time of License Termination, the NRC has agreed in a Memorandum of Understanding (MOU) to hold a consultation with the USEPA. At this time, if necessary, the USEPA can then regulate closure under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

CTDEP-LR In 1996, the CTDEP-LR promulgated the Remediation Standard Regulations (RSRs). Under these regulations, all establishments in corrective action (i.e. with RCRA Permits) must meet the RSRs to comply with the Property Transfer Act. The RSRs provide both lookup criteria for environmental media and define specific requirements for post remediation groundwater monitoring. Under the RSRs, radionuclides are considered an Alternate Polluting Substance. Because of this definition, the RSRs are applicable.

RSR soil criteria include:

- Residential Direct Exposure Criteria - Protective of human health for children and adults.
- Industrial/Commercial Direct Exposure Criteria – Protective of human health for areas where future use scenarios do not include residential properties.
- Pollutant Mobility Criteria – Criteria applied to soils within the Vadose zone (above the water table) to protect potential impacts from soil to the groundwater below.

RSR groundwater criteria include:

- Groundwater Protection Criteria – Protective of human health.
- Surface Water Protection Criteria – Protective of ecological receptors and applicable to groundwater where it discharges to surface water bodies.
- Volatilization Criteria – Protective of human health, applicable to groundwater below current or future structures.

The CTDEP-LR has approved 19 mRem/yr TEDE plus ALARA for the RSR criteria for soils. Because the DCGLs account for the residential farmer scenario, they are protective for both the Residential and Industrial/Commercial Direct Exposure Criteria.

The DCGLs also consider impacts to groundwater, therefore the 19 mRem/yr TEDE plus ALARA is also accepted as the Pollutant Mobility Criteria.

For groundwater, CTDEP has accepted the USEPA MCLs for the individual radionuclides. CYAPCO has also shown that for the site related constituents in groundwater that may discharge to surface water, the screening criteria protective of human health are also protective of ecological receptors. There are no compounds where volatilization is a concern at HNP, therefore the MCLs approved as the Groundwater Protection Criteria are protective for all pathways and all receptors.

The final caveat in the RSRs states that if groundwater is remediated (including soils remediated below the water table) groundwater criteria must be equal to background. Because this is not feasible for HNP, CYAPCO intends to request a variance for Technical Impracticability if required to do so by the CTDEP.

To achieve site closure and demonstrate compliance with the RSRs, post remediation groundwater monitoring must be performed. Following all soil remediations (either above or below the water table) and backfill, groundwater must be sampled from downgradient wells quarterly for at least one year. All data must be below the RSR criteria (i.e., the MCLs) for four consecutive quarters. After this has been achieved, quarterly sampling must continue for one year if there are four quarters of data that are non-detect or below background, or three years if all data are below the RSRs (MCL) criteria.

GROUNDWATER MONITORING AND REACHING SITE CLOSURE

Each of the regulatory agencies have both similar and unique requirements. The similarities include developing a comprehensive site conceptual model that identifies and characterizes the nature and extent of site related constituents in all environmental media. Groundwater monitoring wells must be installed and maintained in appropriate locations to support both characterization and site closure. Following any remediation, groundwater monitoring must be completed using downgradient wells to demonstrate compliance with each of the agencies.

For the NRC and CTDEP-RD, post remediation groundwater monitoring may begin after dewatering systems are removed and the water table has returned to static conditions. Groundwater quality must comply with a fraction of the 25 mRem/yr and 19 mRem/yr TEDE plus ALARA at the completion of the 18 month monitoring period and the data must show stable conditions or a downward trend.

For the USEPA and CTDEP-LR, post remediation groundwater monitoring may begin after all remediation and backfill is complete. Data must comply with the RSR/MCL criteria and must be monitored for at least two years if data are at or below background values, or four years if the data are below the RSRs/MCLs.

SUMMARY

To successfully reach closure, the conceptual site model, groundwater transport mechanisms, and potential receptors must be defined. Once the hydrogeology is understood, a long term groundwater program can then be coordinated to meet each regulatory agency requirement to both terminate the NRC license and reach site closure under RCRA.

Based on the different criteria, the CTDEP-LR (or RSR criteria) are not only bounding, but also requires the longest duration. As with most decommissioning efforts, regulatory attention is focused on the NRC, however, with the recent industry initiatives based on concern of tritium releases to groundwater at other plants, it is likely that the USEPA and state agencies may continue to drive site investigations. By recognizing these differences, data quality objectives can include all agency requirements, thus minimizing rework or duplicative efforts.

CYAPCO intends to complete groundwater monitoring for the NRC and CTDEP-RD by July 2007. However, because shallow remediations are still being conducted, site closure under USEPA and CTDEP-LR is projected to be late 2011.