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Decommissioning Project Final Report
Building 690-N, Process Heat Exchanger Repair Facility

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History of Revisions

Revision	**Date**	**Revised Section**	**Change**
0	05/18/21	N/A	Initial Issue

Acronym List

ARAR	Applicable, Relevant, and Appropriate Requirement
ARRA	American Recovery and Reinvestment Act
bgs	Below Ground Surface
CM	Contaminant Migration
cm	centimeter
COC	Constituents of Concern
COPC	Constituents of Potential Concern
DAF	Dilution Attenuation Factor
D&D	Deactivation and Decommissioning
DPFR	Decommissioning Project Final Report
EC&ACP	Environmental Compliance & Area Completion Projects
ECODS	Early Construction and Operational Disposal Site
FDE	Facility Decommissioning Evaluation
FFA	Federal Facility Agreement
ft	foot
HEPA	High Efficiency Particulate Air
in.	inch
kg	kilogram
L	liter
m	meter
MCL	Maximum Contaminant Level
mg	milligram
msl	mean sea level
MLSSL	Mass-Limited Soil Screening Limit
NAPL	non-aqueous phase liquid
OU	Operable Unit
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
ppb	parts per billion
ppm	parts per million
PRG	Preliminary Remediation Goal
psi	pounds per square inch
RCOC	Refined Constituent of Concern
RCRA	Resource Conservation and Recovery Act
RSL	Regional Screening Level
S&M	Surveillance and Maintenance
SCDHEC	South Carolina Department of Health and Environmental Control
SRS	Savannah River Site
SSL	soil screening limit
TSCA	Toxic Substances Control Act
USEPA	U. S. Environmental Protection Agency
VZCOMML©	Vadose Zone Contaminant Migration Model - Multi-Layered©

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1.0 SUMMARY

Building 690-N, Process Heat Exchanger Repair Facility (aka Ford Building) was classified as an "Other Industrial" facility in the Savannah River Nuclear Solutions "Standards/Requirements Identification Document Facility List" (Reference 8.01). It was used primarily as a machining repair/rework shop for contaminated Savannah River Site (SRS) reactor process water (i.e., deuterium oxide) heat exchangers.

The original (Revision 0 and 1) scope of the Facility Decommissioning Evaluation (FDE) included Building 690-N, Process Heat Exchanger Repair Facility and three ancillary structures (remnants of 13.8 kV Substation 652-44N, Excess Equipment Yard 745-N and contents, and the Fuel Oil Tank Concrete Containment Dike). The Excess Equipment Yard 754-N was removed from the Revision 2 FDE scope, since in 2011 and 2012 the 49 heat exchangers stored on the concrete pad and the pad itself were characterized and disposed of in the SRS Solid Waste Burial Ground (E-Area) as part of an American Recovery and Reinvestment Act (ARRA) deactivation project. The building remnant and all three ancillary structures will be addressed as a subunit of the Early Construction and Operational Disposal Site (ECODS) N-1, Central Shops Scrap Lumber Pile (631-2G) and Building 690-N, Process Heat Exchanger Repair Facility (Ford Building) Operable Unit (OU).

As indicated by the enhanced characterization results documented in the *Characterization Report Building 690-N (Ford Building) and Ancillary Equipment and Facilities*, SDD-2014-00054, Rev. 1, August 18, 2014, (Reference 8.02) and the *Human Health Risk Screening Evaluation for the 690-N Ford Building,* SDD-2019-00030, Rev. 0, April 11, 2019*,* (Reference 8.03) the majority of the facility did not represent a contamination concern; however, polychlorinated biphenyls (PCBs) and fixed radiological contamination are present in the concrete floor slab at levels that warrant further evaluation. Minimal radiological, PCB, and Resource Conservation and Recovery Act (RCRA) hazardous contamination was present in the concrete floor slab, soils below the concrete floor slab, steel hut containment walls, and the ancillary equipment and facility. Based on the FDE (Reference 8.04) Part 2 Evaluation checklist and the sample data in the 2014 characterization report, SRS determined that the Integrated Sampling Model was the appropriate model for decommissioning of Building 690-N. SRS proposed and obtained regulatory concurrence to proceed with the decommissioning of Building 690-N by installing a temporary protective cover over the slab prior to demolition, which would prohibit disturbance and potential spread of PCB contamination during demolition and removal activities. Post-decommissioning facility remnants (i.e., building slab, compacted crusher run base material for cap slab, cap slab, and fuel oil tank concrete containment dike) will be incorporated into the remedial assessment and decision under the Federal Facility Agreement (FFA) for the ECODS N-1, Central Shops Scrap Lumber Pile (631-2G) and Building 690-N, Process Heat Exchanger Repair Facility (Ford Building) OU. A Post-Decommissioning Action Plan was prepared and issued, addressing Surveillance & Maintenance (S&M) and any continuing monitoring requirements following decommissioning. Responsible personnel, costs, and frequency of S&M/monitoring activities were addressed in the Post-Decommissioning Action Plan, to the extent possible. This approach physically and administratively separated the slab from the rest of the structure allowing SRS to take advantage of increased near-term program funding to remove the structure under decommissioning while providing the opportunity to evaluate remedial action alternatives for final disposition of the building remnants.

The decommissioning end-state for Building 690-N was demolition of the building structure to its concrete slab. All interfacing utilities were isolated, disconnected and plugged. Sumps and other floor openings were filled with cementitious material to achieve a uniform surface. Surrounding soil, disturbed during decommissioning, was repaired. The end-state includes a 6-inch thick Toxic Substances Control Act (TSCA)-compliant reinforced concrete cap slab installed over the building footprint after demolition. The decommissioning end-state for the ancillary Fuel Oil Tank Concrete Containment Dike was partial removal (i.e., cleaving) of its concrete wall to allow drainage of rainwater.

Building 690-N is unique in that it was identified as an Integrated Sampling Model, but final verification samples were not necessary and were not collected because soil and concrete samples were collected in a 2014 characterization event. The associated results, as presented in the *Characterization Report Building 690-N (Ford Building) and Ancillary Equipment and Facilities* (Reference 8.02) and the *Human Health Risk Screening Evaluation for 690-N Ford Building* (Reference 8.03), were used to identify PCBs and cesium-137 (Cs-137) as contaminants within the concrete media. Risks based on maximum detected concentration were calculated as follows: Aroclor 1254 residential risk = 6.3E-06, industrial worker risk = 1.5E-06; Aroclor 1260 residential risk = 2.3E-06, industrial worker risk = <1E-06; and Cs-137 residential risk = 2.8E-05, industrial worker risk = 1.7E-05. An unrestrained 6-inch minimum thickness, structural, reinforced concrete cap has been placed over the existing concrete slab that was housed inside the building footprint. The 6-inch concrete cap thickness is designed to be compliant with PCB capping requirements found in TSCA (40CFR761.61(1)(7)). The 6-inch concrete cap breaks the direct exposure pathway to PCBs and Cs-137 for human receptors. There is no human health risk under the current configuration.

The vadose zone contaminant fate and transport model (Vadose Zone Contaminant Migration Model - Multi-Layered© [VZCOMML©][a]) was used to assess the potential impact from residual contamination that could leach from the concrete slab into groundwater within a 1,000 year period. No constituents in concrete or soil beneath the concrete are predicted to impact groundwater at concentrations exceeding Maximum Contaminant Levels (MCLs) within 1,000 years.

2.0 PURPOSE AND SCOPE

The purpose of this report is to document what was done to the facility as a part of the decommissioning project, and the condition the facility was left in at the completion of decommissioning. The requirement for this report is found in the Facility Disposition Manual 1C, Procedure 506, “Preparing a Decommissioning Project Final Report”.

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[a] VZCOMML© is a spreadsheet-based calculation developed by SRS. The calculation simulates the migration of vadose zone contaminants to groundwater using one-dimensional flow, average flow over the period of interest, and an infinite mass of contaminants. The calculation is consistent with applicable USEPA guidance and protocols.

2.01 Facility Description

Building 690-N, Process Heat Exchanger Repair Facility was classified as an "Other Industrial" facility in the Savannah River Nuclear Solutions "Standards/Requirements Identification Document Facility List" (Reference 8.01). It was used primarily as a machining repair/rework shop for contaminated SRS reactor process water (i.e. Deuterium Oxide) heat exchangers.

Building 690-N, Process Heat Exchanger Repair Facility, built in the 1950s, was a one-story metal frame structure on a concrete slab covering approximately 9,700 square feet. It was located in the extreme southeastern tip of the Central Shops (N-Area) near the center of SRS. The primary building footprint consisted of a machine shop with offices, storage rooms, restrooms and service area, which could be accessed only from the outside of the building on the north side. This facility was used during the 1950s exclusively for testing of Ford Motor Company manufactured motor control packages for control rod drive mechanisms prior to their installation in the SRS reactors. During the early 1960s, the SRS reactors were operating at higher power levels and failure (i.e., leakage) of heat exchangers prompted conversion of this facility for heat exchanger maintenance repair/rework. In the mid-1960s, building modifications to change the mission for Building 690-N from a clean facility to a heat exchanger maintenance/repair facility included installation of an inner building sealed containment shell and High Efficiency Particulate Air (HEPA) filter system to maintain a slight negative pressure within the shell. This precluded radiological contamination of the clean portions of the building and environmental media outside the facility, allowing the facility to serve as a repair shop for leaking SRS reactor contaminated process water heat exchangers.

Prior to installation of the inner shell and HEPA Filter Systems, 690-N was a "clean" facility, ventilated in Summer months by eave fans E.P. 20901-A (East End) and E.P. 20901-B (West End). Exhaust fans were blocked off during cold months of the year. When the building was modified for the heat exchanger maintenance/repair mission, the West eave fan was relocated to the new West wall. Both fans continued to ventilate hot air from the attic and other clean portions of the main building until the building was shut down.

This mission continued until the early 1980s when the procurement of new heat exchangers for the SRS reactors terminated the maintenance repair mission of the facility. In the early through mid-1980s, it housed Construction crews that performed final assembly and testing of new, clean heat exchangers. For the remainder of the 1980s, the building was used to store equipment and miscellaneous supplies. During the early 1990s, the K-Reactor had a minor leak in a heat exchanger that resulted in reactivating the facility. The facility operated again as a heat exchanger repair facility for about six months and was subsequently closed. It was then utilized to store excess equipment (in waste containers [e.g., Sealands] and/or bagged/wrapped in plastic) that was chemically and/or radiologically contaminated. Cleanup activities that began in 1998 prompted the removal of stored excess equipment (Reference 8.05).

The HEPA equipment was removed in 2012 as part of an American Recovery and Reinvestment Act (ARRA) deactivation project. The ground in the area was covered with plastic and huts erected to contain any contamination. HEPA Housings, filters, and ductwork were loaded into Sealand containers and disposed of in the SRS Solid Waste Burial Ground (E-Area). Following removal of the HEPA Housings, the curbed concrete containment pads (i.e., sumps) beneath them were sampled and found to be slightly contaminated. The curbed containment pads and sumps were filled with concrete and each capped with a reinforced concrete slab. Radiological monitoring and sampling throughout the removal iteration showed non-detect readings except on the concrete of the curbed sumps which are now filled in and covered with concrete.

The shop area also contained a single 1'-6" x 1'-6" x 1'-0" sump located near the east end of the shop area, between the two sets of railroad tracks, at the radial drill.

Deactivation & Decommissioning (D&D) actions were conducted at the following ancillary facility associated with 690-N:

- The Fuel Oil Tank Concrete Containment Dike, located to the south of Building 690-N, contained a fuel oil tank that had been previously removed. The fuel oil tank was used to supply the 690-N Building heating systems.

Services and utilities to and or from the facility included plant air, fuel oil, domestic water, fire water, electrical power, sanitary sewer and process sewer. All services to 690-N and its ancillary facility were isolated and air-gapped, rendering the facilities "cold and dark."

Appendix A, Photos 1 and 2 depict 690-N before and after decommissioning, respectively. Appendix A, Photos 3 and 4 depict the ancillary Fuel Oil Tank Concrete Containment Dike before and after decommissioning, respectively. Appendix A, Figures 1 and 2 depict the Building 690-N Heat Exchanger Repair Facility location and its floor plan.

2.02 New Facility Information

SRS identified no new facility information during or as a result of the facility decommissioning.

3.0 DECOMMISSIONING MODEL APPROVAL

The facility was decommissioned using the Integrated Sampling Model as described in Facility Disposition Manual 1C. The selection of the model was based on a FDE (Reference 8.04). The regulatory walkdown of the facility occurred on August 25, 2009. The FDE received United States Environmental Protection Agency (USEPA) concurrence on June 24, 2019 (Reference 8.06). FDE concurrence was received from South Carolina Department of Health and Environmental Control (SCDHEC) on June 26, 2019 (Reference 8.07).

4.0 DECOMMISSIONING ACTIVITIES COMPLETED

Execution of the 690-N decommissioning project was planned and described in the FDE (Reference 8.04), the Deactivation End Points Document (Reference 8.08) and the Decommissioning End Points Document (Reference 8.09). As discussed in Sections 1.0 and 2.0, decommissioning of 690-N involved demolition of the building structure down to, but not including, the building slab. Sumps and other floor openings were filled with cementitious material. The overall decommissioning project included completing installation of a protective cover over the existing floor slab prior to demolition to prohibit disturbance and potential spread of PCB contamination during demolition and removal activities, performing asbestos abatement, performing dismantlement and removal activities, performing demolition activities, and completing project closure activities. Interfacing utilities had been isolated, disconnected and plugged or capped in conjunction with building cleanup activities approximately twenty years prior to the start of decommissioning. Following demolition, SRS installed a 6-inch thick TSCA-compliant reinforced concrete cap slab over the entire building footprint. The concrete wall of the ancillary Fuel Oil Tank Concrete Containment Dike was partially removed (i.e., cleaved) to allow drainage of rainwater. Surrounding soil disturbed during deactivation and/or decommissioning was restored to its original grade. No changes were required to the original planning for decommissioning.

5.0 WASTE MANAGEMENT

5.01 Salvage and Reuse

Thirty-six (36) cubic yards of scrap metal from the 690-N decommissioning were transferred to 741-N, Salvage and Reclamation Building, for recycling.

5.02 Waste Disposal

Table 1: Waste Generation

Waste Classification	Waste Source	Disposed to	Total Volume
LLW	*Structure and components from process area, job control waste, non-friable asbestos (contaminated/potentially contaminated), ductwork*	*SRS E-Area Slit Trenches*	*3732 cu yd*
ACM	*Clean non-friable asbestos waste*	*C&D Landfill*	*90 cu yd*
PCB	*Ballasts*	*SRS HWSF**	*0.27 cu yd*
UW	*Assorted Lamps*	*Universal Waste Recycler – 725-1N Recycle Facility*	*0.75 cu yd*
CSR	*Wood, conduit, miscellaneous piping, & job control waste*	*C&D Landfill*	*6 cu yd*
GIC	*Plastics, etc.*	*Three Rivers Landfill*	*6 cu yd*
Recycle Metals	*Scrap Steel & aluminum*	*741-N for transfer to recycle metals vendor*	*36 cu yd*

LLW – Low level radioactive waste
ACM – Asbestos-containing material
PCB – Polychlorinated biphenyl
UW – Universal Waste
CSR – Clean Structural Rubble
GIC – Green Is Clean Waste
HWSF – Hazardous Waste Storage Facility

* Due to small volumes generated these wastes were consolidated with similar decommissioning wastes and are being managed in accordance with state and federal regulations until shipment to offsite treatment and disposal and/or recycle, as appropriate.

6.0 FINAL FACILITY CONDITION

6.01 Final Facility Condition and Remaining Hazards

Demolition of the 690-N Process Heat Exchanger Repair Facility to its concrete floor slab is complete. The entire building foundation (i.e., footprint) has been covered with an average thickness of twenty-one inches (21”) of compacted crusher run material and a six inch (6”) thick 4000 psi reinforced concrete cap slab. With exception of normal surface disruption caused by construction equipment, the surrounding areas remain undisturbed. All interfacing utilities (e.g., electrical power, communications, and building mechanical services) were isolated, disconnected, and plugged/capped prior to decommissioning, as documented in Reference 8.10.

All decommissioning activities have been completed including waste disposal, in accordance with State and Federal regulations. Even though the concrete cap slab is slightly above surrounding grade, there are no physical hazards associated with the remaining structure since it is not located in a trafficked area. No further decommissioning action is required.

Based on a post-demolition radiological survey, no soil contamination occurred during deactivation and demolition of the building. In the absence of D&D-related soil contamination at the site and with a clean concrete cap slab over the former building slab, no final verification survey sampling was required or conducted.

Post-decommissioning facility remnants (i.e., building slab, compacted crusher run base material for cap slab, cap slab, and fuel oil tank concrete containment dike) will be included in the remedial assessment of ECODS N-1, Central Shops Scrap Lumber Pile (631-2G) and Building 690-N, Process Heat Exchanger Repair Facility (Ford Building) OU under the FFA.

6.02 Risk Assessment Summary

6.02.01 Human Health Risk Assessment

Building 690-N is unique in that it was identified as an Integrated Sampling Model, but final verification samples were not necessary and were not collected because soil and concrete samples were collected in a 2014 characterization event with results presented in the *Characterization Report Building 690-N (Ford Building) and Ancillary Equipment and Facilities* (Reference 8.02) and *Human Health Risk Screening Evaluation for 690-N Ford Building* (Reference 8.03). These documents support the *Facility Decommissioning Evaluation for Building 690-N, Process Heat Exchanger Repair Facility* (Reference 8.04).

Soil samples and concrete samples were collected from 21 locations at the 690-N Ford Building in 2014 as described in the Characterization Report (Reference 8.02). The samples from the concrete slab were collected from two intervals: 0- to 15-centimeters (cm) and 15- to 30-cm (0- to 6-inches [in.] and 6- to 12-in.); the soil samples were collected from 0- to 15-cm and 15- to 30-cm (0- to 6-in. and 6- to 12-in.) below the concrete slab. Human health risk and contaminant migration screening evaluations were performed using the characterization data from the 690-N Ford Building concrete slab and underlying soil (Reference 8.03), as summarized below.

Constituents with concentrations that exceeded human health screening levels for soil and concrete were further evaluated in an uncertainty (i.e., weight of evidence) discussion. Only PCBs (maximum in concrete = 15 parts per million [ppm]) and cesium-137 (maximum in concrete = 1.75 picocuries per gram [pCi/g]) are present in the 690-N Ford Building at levels that warrant concern with respect to human health.

Aroclor 1254: There are no Regional Screening Level (RSL) exceedances in the soil media beneath the concrete slab for either the resident or industrial worker scenarios. The maximum detected concentration (15,000 ppb) in concrete exceeds both the resident (2,400 ppb) and industrial worker (10,000 ppb) thresholds for concrete media. Using the maximum detected concentration, the residential risk = 6.3E-06 and an industrial worker risk =1.5E-06. Aroclor 1254 was detected in all of the concrete samples (42 total, 0- to 15.2-cm [0- to 6-in.] and 15.2- to 30.4-cm [6-to 12-in.]).

Aroclor 1260: There are no RSL exceedances in the soil media beneath the concrete slab for either the resident or industrial worker scenarios. The maximum detected concentration (5,500 ppb) in concrete exceeds the resident (2,400 ppb) threshold for concrete media only. The residential risk estimate based on the maximum detected concentration = 2.3E-06. Aroclor 1260 was detected in all of the concrete samples (42 total, 0 to 15.2 cm [0 to 6 in.] and 15.2 to 30.4 cm [6 to 12 in.])

In addition, the Aroclor 1254 and Aroclor 1260 concrete sample results exceed the Applicable, Relevant, and Appropriate Requirement (ARAR) concentration of 1 ppm for PCB required for free release. For purposes of cleaning, decontaminating or removing PCB remediation waste, cleanup levels are based on the kind of material (i.e., bulk PCB contamination, non-porous surfaces, porous surfaces, or liquids) and the potential exposure to PCBs left after cleanup is completed. USEPA has established a <1 ppm limit for PCBs in high-occupancy areas, and a <25 ppm limit for PCBs in low-occupancy areas.

Aroclor 1254 and 1260 are known waste streams at the 690-N Ford Building, and their presence is consistent with the historical use of the unit. PCBs were components of hydraulic fluid used in machine tools. Therefore, it is recommended that Aroclor 1254 and 1260 be identified as contaminants within the concrete media, with the following preliminary decommissioning objective:

- Prevent residential and industrial exposure to Aroclor 1254 and 1260 in concrete media that exceed the PCB ARAR of 1 ppm for free release and 1E-06 risk.

Cesium-137(+D): Was not detected in the soil media beneath the concrete slab. Concentrations in concrete (maximum = 1.75 pCi/g) exceed both the resident (0.0625 pCi/g) and industrial worker (0.104 pCi/g) screening levels. Using the maximum detected concentration results in a residential risk = 2.8E-05 and an industrial worker risk = 1.7E-05. Cesium-137 was detected in 9 of 21 surface concrete samples (0- to 15.2-cm [0- to 6-in.]), and 4 of 21 samples from the 15.2- to 30.4-cm [6- to 12-in.) interval.

Cesium-137 is a result of nuclear fission. It does not occur naturally in soil. However, cesium-137 is common in SRS background soils as a result of fallout from nuclear weapons testing. Maximum background concentration in SRS soils is 3.3 pCi/g and mean concentration is 0.142 pCi/g (Reference 8.11). However, its presence at the 690-N Ford Building is not due to atmospheric fallout, but is attributable to unit operations (i.e., servicing heat exchangers). Therefore, it is recommended that cesium-137 be identified as a contaminant within the concrete media, with the following preliminary decommissioning objective:

- Prevent residential and industrial exposure to cesium-137(+D) in concrete media that exceeds the 1E-06 risk level.

Although the RSL and Preliminary Remediation Goal (PRG) values have been updated since the 2014 characterization, there are no significant changes in the screening thresholds that would change the preliminary conclusions of this evaluation (Reference 8.03).

HHRA Conclusion

The 690-N Ford Building has been decommissioned, dismantled and the existing slab at ground level has been capped in place to prevent spread of PCB contamination fixed to the existing slab surface. An unrestrained 6-inch minimum thickness, structural, reinforced concrete cap and an average 21-inch thickness of compacted crusher run base material have been placed over the existing concrete slab that was housed inside the building footprint. The 6-inch concrete cap thickness is designed to be compliant with PCB capping requirements found in TSCA (40CFR761.61(1)(7)). The concrete cap and 21-inch average thickness crusher run base break the direct exposure pathway to PCBs and Cs-137 in concrete media for human receptors. There is no human health risk under the current configuration. The concrete cap is free of physical, chemical, and radiological hazard and poses no threat to human health or the environment.

6.02.02 Contaminant Migration Analysis

In order to evaluate the possibility for unit constituents to migrate to the water table and impact groundwater at concentrations exceeding regulatory limits, the data were evaluated using the VZCOMML 4.0 spreadsheet model (Rucker 2009). Maximum detections were input separately for soil and concrete, assuming a 14-meter (45-feet) thick vadose zone, and a Dilution/Attenuation Factor of 1.28. Results show that no constituents in soil or concrete are predicted to impact groundwater at concentrations exceeding MCLs/RSLs within 1,000 years.

The groundwater impact contaminant migration level is defined as the maximum allowable contaminant concentration in the concrete or soil that will not exceed, within a 1,000 year evaluation period, the groundwater Safe Drinking Water Act MCL or USEPA RSLs (in the absence of an MCL). The analysis does not take credit for the TSCA-compliant closure cap that is currently in place. The contaminant migration analysis is presented in Appendix B.

Contaminant Migration Conclusion

No constituents in the concrete slab or sub-slab soil beneath the concrete are predicted to impact groundwater at concentrations exceeding MCL/RSLs within 1,000 years.

6.03 Post Decommissioning Requirements

The remaining structure is free of physical hazards, and project cleanliness criteria have been met. Therefore, the remaining structure (i.e., original slab/foundation, average 21” thick crusher run base, and 6” thick 4000 psi reinforced concrete cap slab) needs no further decommissioning action. S&M inspections of the cap slab will be performed at regular (i.e., 12 month) intervals to identify any breaches (i.e., cracks) which would impair the integrity of the cap. To ensure facility remnants are addressed, Building 690-N will be added to Appendix C.4 of the FFA and is a subunit of the ECODS N-1, Central Shops Scrap Lumber Pile (631-2G) and Building 690-N, Process Heat Exchanger Repair Facility (Ford Building) OU.

7.0 CONCLUSIONS/RECOMMENDATIONS.

Building 690-N was demolished, and the foundation/slab has been left in place. The entire building foundation (i.e., footprint) has been covered with an average twenty-one inch (21”) thick compacted crusher run base and a six inch (6”) thick 4000 psi reinforced concrete cap slab. All decommissioning activities have been completed, including waste disposal in accordance with Federal and State regulations. The facility remnants (i.e., building slab, compacted crusher run base material for cap slab, cap slab, and fuel oil tank concrete containment dike) need no further decommissioning action. The 6-inch concrete cap system breaks the direct exposure pathway to PCBs and Cs-137 for human receptors. There is no human health risk under the current configuration.

S&M inspections of the cap slab will be performed at regular (i.e., 12 month) intervals to identify any breaches (i.e., cracks) which would impair the integrity of the cap.

In accordance with the “Memorandum of Agreement for Achieving an Accelerated Cleanup Vision at the Savannah River Site”, this report will be maintained as a record for reference and use in the ECODS N-1, Central Shops Scrap Lumber Pile (631-2G) and Building 690-N, Process Heat Exchanger Repair Facility (Ford Building) OU, Record of Decision. To ensure facility remnants (i.e., building slab, compacted crusher run base material for cap slab, cap slab, and fuel oil tank concrete containment dike) are addressed during the completion process, 690-N Ford Building remnants will be added to Appendix C.4 of the Federal Facility Agreement for the SRS.

8.0 REFERENCES

8.01 "SRNS-RP-2008-00086-000-M&O, "Standards/Requirements Identification Document, Functional Area 00, S/RID Purpose and Development, Revision 19-01-MO, February 14, 2019.

8.02 C. P. Hopkins, "Characterization Report Building 690-N (Ford Building) and Ancillary Equipment and Facilities", SDD-2014-00054, Rev. 1, August 18, 2014.

8.03 "Human Health Risk Screening Evaluation for the 690-N Ford Building (U)", SDD-2019-00030, Rev. 0, April 11, 2019.

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9.0 APPENDICES

Appendix A – Photographs / Figures

Appendix B - Contaminant Migration Analysis

Appendix A – Photographs / Figures

Appendix A – Photographs / Figures

Photo 1 – Building 690-N, Process Heat Exchanger Repair Facility (Looking Southeast) Before Decommissioning

Photo 2 – Building 690-N, Process Heat Exchanger Repair Facility (Looking Northeast) After Decommissioning and Installation of Cap Slab

Photo 3 -Fuel Oil Tank Concrete Containment Dike (Looking East) Before Decommissioning

Photo 4 -Fuel Oil Tank Concrete Containment Dike (Looking East) After Decommissioning

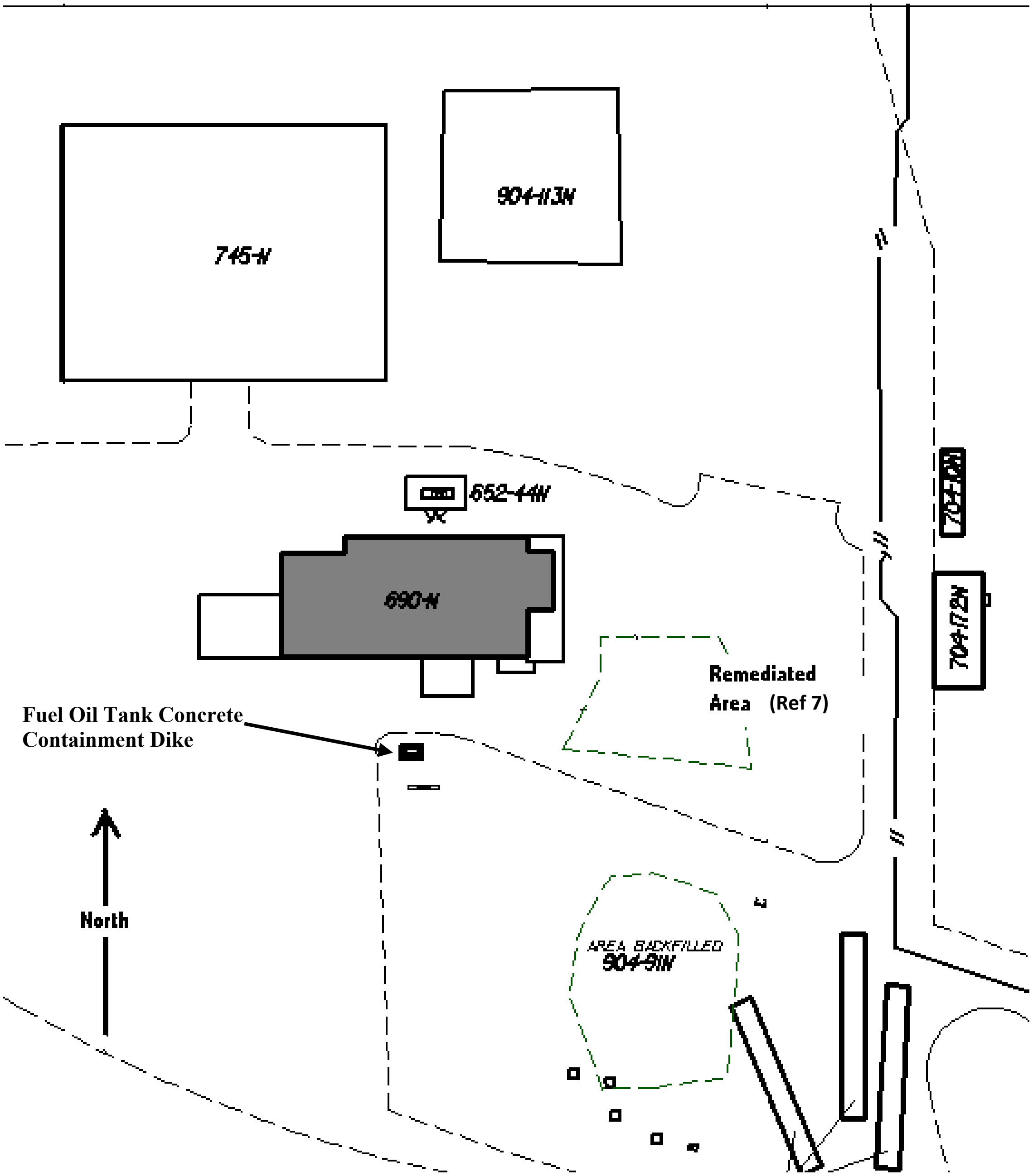

Figure 1 – Building 690-N, Process Heat Exchanger Repair Facility (Location)[b]

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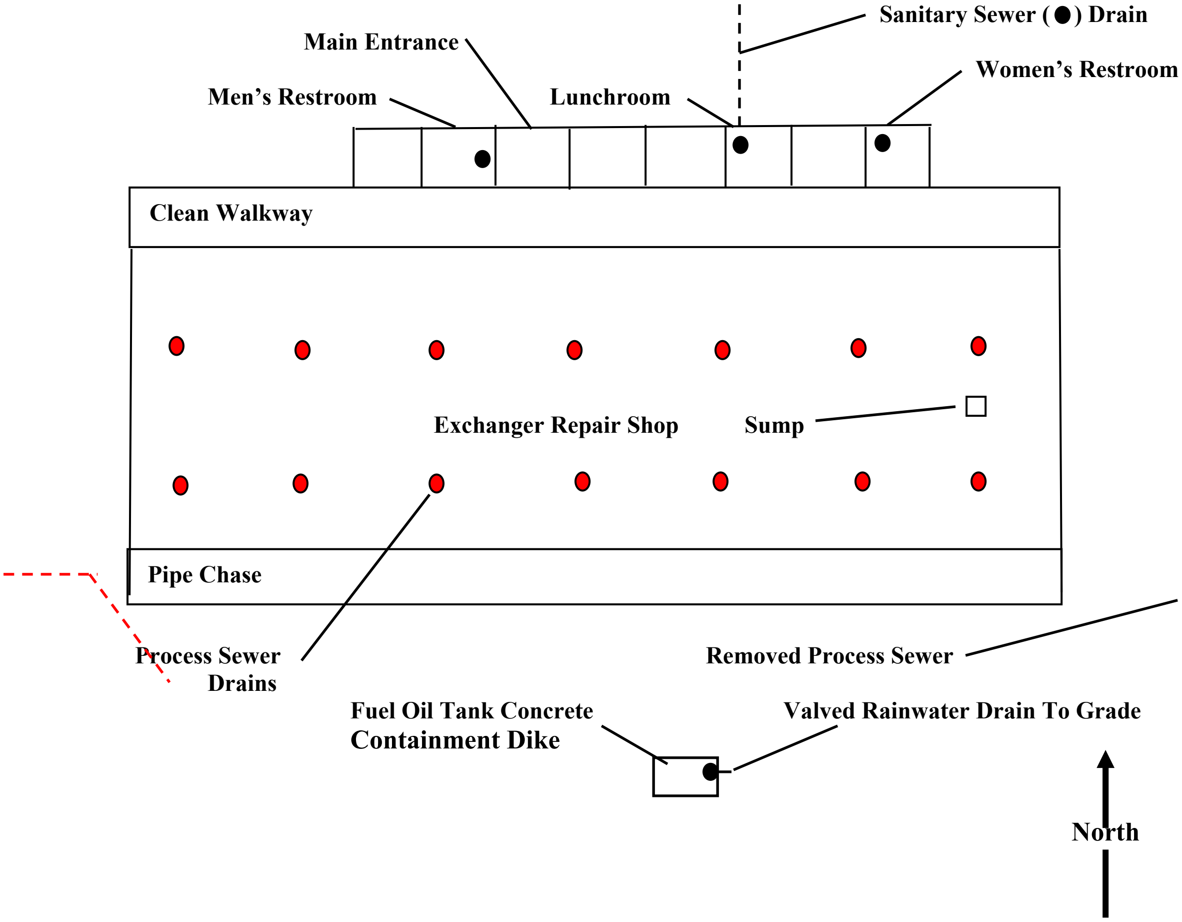
[b] Building 690-N was located in the southeast corner of N-Area and approximately 1,000' south of Road 3.

Not To Scale



(See Reference 8.05 for previous cleanup effort involving the removed process sewer.)

Figure 2 – Building 690-N, Process Heat Exchanger Repair Facility (Floor Plan)

Appendix B - Contaminant Migration Analysis

Table of Contents

B-1. CONTAMINANT FATE AND TRANSPORT

The purpose of this Appendix is to present the fate and transport of contaminants associated with the Ford Building (690-N), including contaminants within and below the concrete slab.

The analysis was performed using the spreadsheet model VZCOMML© (V.4.2)[c], which accounts for decay processes, infiltration rate, soil properties, vadose zone thickness, and chemical behavior. Soil screening limits (SSLs) were calculated by the model and an exceedance of an SSL by a vadose zone constituent indicates that the resultant maximum groundwater concentration has the potential to exceed the regulatory limits (e.g., maximum contaminant levels [MCLs]).

B-2. CONTAMINANT MIGRATION MODEL

B-2.1. Background

The Ford Building is in southeast N Area (Central Shops) in relatively flat terrain. Ground surface elevations in the vicinity of the unit are ~91.4-m (300-ft) above mean sea level (msl) (WSRC 1997). Topography slopes very gently to the southeast. In general, a formation of sand mixed with silts and clays is present in the surface soils which extend down into the shallow subsurface layer. Clays became more prevalent in the deeper subsurface strata with a thick layer of clay present approximately 3 m (10 ft) below ground surface (bgs).

A potentiometric map of the water table aquifer was generated in July 1996 for Central Shops using synchronous water table elevations in monitoring wells screened in the water table aquifer. The map indicates that the unconfined groundwater in the vicinity of the Ford Building (690-N) flows from northeast to southwest (Figure B-1) with the water table in the area at ~13- to 16-m (43- to 53-ft) bgs (SRNS 2020).

Contamination was found in both the original slab and sub slab soils as described in the Characterization Report (SRNS 2014). As such, two sperate models were generated one pertaining to contaminants found in the slab, the other for contaminants in sub slab soils. The maximum detected values from the Characterization report were used for the respective model's source zone

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[c] Vadose Zone Contaminant Migration Multi-Layered Model (VZCOMML©) Version 4.2, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Services, LLC.

contaminant concentrations. For both models, the concrete slab was assumed to be the limiting layer for infiltration in the vadose zone. The infiltration used rate was 5.62 inches per year, a conservative value based on an average estimated infiltration for concrete over a 1000-year period, which accounts for slab deterioration (SRNL, 2009). The 6-inch concrete cap placed on top of the original slab was not included within the models but would further limit contaminant transport to groundwater. The depth to groundwater, (14 m) 45 ft, was determined using the facility location and potentiometric maps of the surrounding area (Figure B-1), where the facility and water table are at elevations of approximately 92 m (300 ft) and 78 m (255 ft), respectively.

B-2.2. Screening Methods

This section describes screening methods used for identifying contaminant migration (CM) constituents of potential concern (COPCs) and CM constituents of concern (COCs). The identification of CM COPCs and CM COCs is facilitated by the program VZCOMML$^{©}$ V4.2.

This CM evaluation follows the protocols and guidelines established in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2012). For the Tier I screening, each subunit was modeled under the most conservative assumptions including maximum constituent concentrations at the maximum sample depth (i.e., shortest travel time distance in the vadose zone to water table). Constituents predicted by the model to impact groundwater at concentrations exceeding action levels were retained as Tier I CM COPCs. A less conservative set of assumptions was used for the Tier II analysis to impact groundwater at concentrations exceeding action levels within the evaluation time of 1,000 years.

Both the Tier I and Tier II screens include infinite source mass and limited source mass calculations. In reality, the consideration of an infinite source mass is not reasonable, so the mass-limited calculations (default mass-limited SSLs and SRS site-specific mass-limited SSLs [MLSSL]) $T_{1/2}$s consider the entire release of the source mass within a 70-year exposure period. This prevents a source mass balance error (i.e., releasing more contaminant mass than is actually contained in the source) in the calculation, which is likely with the infinite source scenario. Equations used to calculate Tier I SSLs and MLSSLs, and Tier II SSL $_{T1/2}$s and MLSSL $_{T1/2}$s are provided below in the following Section.

The spreadsheet model VZCOMML© (V.4.2) was developed at SRS to facilitate SSL calculations and Tier I/Tier II soil data screens. VZCOMML© V4.2 simultaneously calculates SSLs for Target Analyte List and Target Compound List constituents, and for specified radionuclides (a total of 219 constituents). VZCOMML© compares user-entered soil concentrations to SSLs and identifies constituents that are Tier I CM COPCs and Tier II CM COCs. Chemical properties of analytes used by VZCOMML© (e.g., soil/water distribution coefficient, Henry's Law constant, etc.) are listed in Table B-1. VZCOMML© also contains assigned hydraulic functions for different types of soil layers (e.g., source layer, soil layer, or engineered barrier layer) and texture classifications (e.g., sand, loamy sand, clay, concrete) within the soil column. VZCOMML© calculates groundwater concentrations and migration times from input data and compares and evaluates user-entered concentrations to SSLs to identify constituents that are CM COPCs and CM COCs.

If CM COCs are identified, it is up to the user to evaluate results and apply professional judgment, other modeling approaches, and/or knowledge of site conditions and geochemistry to further refine the list of CM COCs. The CM refined COCs (RCOCs) include those constituents that are mobile at that waste unit and can leach to the aquifer within a 1,000-year travel time (per the Federal Facility Agreement protocols) and exceed drinking water standards at a receptor well located adjacent to the edge of the unit.

B-2.3. Soil Screening Equations

Equations used by VZCOMML© are consistent with U.S. Environmental Protection Agency (USEPA) Soil Screening Guidance (USEPA 1996, 2000). A conceptual framework of the model and vadose zone and screening parameters for VZCOMML© is provided in Figure B-2. Model assumptions include:

1. A receptor drinking water well at the downgradient edge of the source zone with the well screen located in the plume

2. Linear equilibrium isotherms are used rather than exponential isotherms (this is typically a conservative estimate [i.e., likely transports more contaminant to water table] of partitioning into the aqueous phase of a moving front)

3. Uniformly distributed contamination in the subsurface (this is also typically a conservative estimate using the highest measured concentration value; however, limited soil sampling in an area with widely varying, heterogeneous contaminant distributions may lead to underprediction of localized contaminant transport)

4. Instantaneous equilibrium partitioning within soil, vapor, and liquid phases (this is typically a conservative estimate [i.e., likely transports more contaminant to water table] of partitioning into the aqueous phase of a moving front for compounds that have lower Henry's Law constants)

Generally, the source zone layer thickness represents the vertical extent of contamination. The vadose zone beneath the source zone was simulated with multiple layers to account for soil heterogeneity in the soil column. These layers can accommodate different hydraulic functions, soil textures, properties, and layer thicknesses for up to five soil layers. The aquifer layer represents the shallowest water table aquifer. The following is a discussion of the equations used by VZCOMML© for the soil screening process.

B-2.3.1. Dilution Attenuation Factor

The dilution attenuation factor (DAF) represents leachate dilution in the water table aquifer. The DAF calculation assumes that the aquifer is unconfined, unconsolidated, isotropic and homogeneous. The minimum DAF is one, which indicates no dilution occurs in the aquifer. The USEPA recommends a default DAF of 20 for sites up to 0.2 hectares (0.5 acres) whenever site-specific data are not available (USEPA 1996). The DAF (dimensionless) is calculated as follows:

$$DAF = 1 + \frac{K_a \cdot i \cdot d}{I \cdot L}$$

where;

K_a = saturated zone (aquifer) hydraulic conductivity (ft/year)

i = saturated zone (aquifer) hydraulic gradient (ft/ft)

I = infiltration rate through vadose zone (ft/year)

L = length of the source (parallel to groundwater flow) (ft)

d_a = measured saturated zone (aquifer) thickness (ft)

d_i = calculated mixing zone depth (ft)

d = mixing zone depth (minimum of d_i and d_a) (ft)

If the input infiltration rate through the vadose zone is greater than any of the individual vadose zone layer saturated hydraulic conductivities, then the infiltration rate is adjusted to the maximum of the individual vadose zone layer saturated hydraulic conductivities. The mixing zone depth (d) is calculated as follows:

$$d_i = \sqrt{0.0112 \cdot L^2} + d_a\left(1 - e^{\left(-L \cdot I/(K_a \cdot i \cdot d_a)\right)}\right)$$

The d_i calculated value cannot exceed the actual aquifer thickness. Therefore, the mixing zone depth is the minimum of d_i or d_a. This can tend to underpredict localized contaminant concentrations in groundwater by immediately diluting the concentrations over the full aquifer extent when the contaminant reaches groundwater but is adjustable to accommodate mixing or lack thereof.

B-2.3.2. Soil Partitioning

The SSL soil concentration is back calculated by two methods: 1) SSL (infinite source) and 2) MLSSL (finite source). The Tier I SSL assumes an infinite source and uses a linear equilibrium soil-water partitioning isotherm. The Tier I SSL is calculated for organic contaminants and mercury (with vapor phase) as follows:

$$Tier1SSL = \frac{MCL}{1000} \cdot DAF \cdot \left[K_d + \frac{(\theta_w + \theta_a \cdot H)}{\rho_b}\right]$$

where;

MCL = water-phase concentration limit standard (i.e., MCL or RSL) micrograms per liter (µg/L)

K_d = soil-water partitioning coefficient (L/kilogram [kg])

θ_w = water-filled soil porosity (fraction)

θ_a = air-filled soil porosity (fraction), $\theta_a = n_t - \theta_w$

n_t = total porosity (fraction)

H = Henry's Law constant (dimensionless)

ρ_b = dry soil bulk density (kg/L)

The Tier I SSL equation for inorganic contaminants (without vapor phase) is;

$$Tier1SSL = \frac{MCL}{1000} \times DAF \times \left(K_d + \frac{\theta_w}{\rho_b}\right)$$

And for radionuclides;

$$Tier1SSL = DefaultSSL \times \left(\frac{\lambda t}{1 - e^{(-\lambda t)}}\right)$$

where;

t = time of exposure (USEPA default value of 30 years)

λ = decay rate constant [$\ln(2)/t_{1/2}\ \mathrm{yr}^{-1}$]

$t_{½}$ = half-life (years)

For organic constituents, the soil-water partitioning coefficient (K_d) (L/kg) is defined by:

$$K_d = f_{OC} \cdot K_{OC}$$

where;

f_{oc} = soil organic carbon content as mass fraction (fraction)

K_{oc} = organic carbon partitioning coefficient (L/kg)

For metals or radionuclides, the K_d is taken from literature and is dependent on the chemical form that exists and the geochemical environment at each site. Normally, the K_d is derived from laboratory column studies. The water-filled porosity (θ_w) is based on a weighted average for all vadose zone layers and calculated as follows:

$$\theta_w = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \theta_{wi}$$

where;

T_{hi} = layer *i* vertical thickness (ft)

T_c = total depth of soil column (ft), = (ds + Lv)

L_v = length from the bottom of the source zone to the top of the water table (ft)

θ_{wi} = layer *i* water-filled soil porosity (fraction)

The soil texture is determined for the different layers or soil types observed in the vadose zone, and the soil layer parameters are used to calculate the volumetric water content as follows:

$$\theta_{wi} = n_{ti} \left(\frac{I}{K_{si}}\right)^{\left[\frac{1}{(2b_i+3)}\right]}$$

where;

n_{ti} = layer *i* total porosity (fraction)

K_{si} = layer *i* Clapp and Hornberger “K” parameter based on soil texture (ft/year)

b_i = layer *i* Clapp and Hornberger “b” parameter based on soil texture (dimensionless)

The vadose zone total porosity (n_t, fraction) and vadose zone effective porosity (n_e, fraction) are both based on a weighted average for all vadose zone layers and calculated as follows:

$$n_t = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times n_{ti}$$

$$n_e = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times n_{ei}$$

where;

n_{ei} = layer *i* effective porosity (fraction)

The effective moisture content θ_e (fraction) is a weighted average for all vadose zone layers as follows;

$$\theta_e = \sum_{i=1}^{n} \left(\frac{T_{hi}}{T_c}\right) \times \theta_{ei}$$

where;

θ_{ei} = layer *i* effective moisture content (fraction)

To solve the mass-balance violations inherent in the infinite source equation, USEPA developed the MLSSL (Tier I, milligram/kilogram [mg/kg]) for organics and metals as follows:

$$Tier1MLSSL = \frac{MCL}{1000} \cdot DAF \cdot \frac{I \times ED}{(\rho_b \times d_s)}$$

where;

ED = exposure duration in years (USEPA default value of 70 years)

ds = average source thickness (ft)

The MLSSL equation for radionuclides is:

$$Tier1MLSSL = DefaultMLSSL \cdot \left(\frac{\lambda t}{1 - e^{(-\lambda t)}}\right)$$

B-2.3.3. Mean Travel Time

The mean travel time (T_{Mean} or T_t, years) through the vadose zone layers below the source is calculated in VZCOMML© as follows:

$$T_{Mean} = \frac{L_v \cdot R}{V_s}$$

The retardation coefficient (R, dimensionless) is calculated as:

$$R = 1 + \frac{(K_d \cdot \rho_\beta)}{\theta_e}$$

The mean pore water velocity in the vadose zone (V_s, ft/year) is a weighted average calculated by:

$$V_s = \sum_{i=1}^{n} \left(\frac{T_{ti}}{T_t}\right) \cdot V_{si}$$

where;

V_{si} = layer *i* mean pore water velocity (ft/year)

T_{ti} = layer *i* mean travel time (years)

T_t = Travel Time (years)

By applying Darcy's Law in the unsaturated zone and assuming steady-state conditions;

$$V_{si} = \frac{\mathrm{I}}{\theta_{wi}}$$

Darcy's Law is not applicable to unstable vadose zone flow, which typically exhibits fingering and other nonlinear behavior, however over most areas this method will typically be a conservative one (i.e., likely transports more contaminant on average to the water table) assuming appropriate hydraulic conductivity values are selected. One pitfall is that preferential pathways are not uncommon and can rapidly transport water (and contaminant) faster than Darcy derived flow in small, localized areas.

B-2.3.4. Incorporating Decay

To account for the radioactive decay, chemical degradation, hydrolysis, or biodegradation of constituents and for redistribution of mass in the vadose zone, the Tier I SSLs and Tier I MLSSLs are adjusted using first-order equations in the Tier II SSL $_{T1/2}$ and Tier II MLSSL$_{T1/2}$ as follows:

$$TierIISSL_{T1/2} = \left(\frac{TierISSL}{e^{(-\lambda T_{mean})}}\right) \cdot \left(\frac{T_c}{d_s}\right)$$

$$TierIIMLSSL_{T1/2} = \frac{TierIMLSSL}{e^{(-\lambda ED)}}$$

A half-life for a chemical compound is largely determined from literature sources. Because there is usually variability of the reported half-life of a chemical compound (e.g., aerobic and anaerobic rates), the most conservative (longest) half-life is selected as the rate constant in the equations. The rate constants used in the VZCOMML© model are primarily derived from the publications of P. H. Howard, et al and D. McKay, et al, but other references were also used such as USEPA's Estimation Program Interface Suite software and USEPA's Human Health Risk Assessment Parameters database.

VZCOMML© assumes equilibration, mass redistribution, and conservation of mass in the source zone between phases (i.e., volatilized, dissolved, or sorbed) and throughout the entire vadose zone volume. This results in 'more realistic' SSLs, which accounts for vadose zone thickness, travel time, and chemical behavior in the subsurface.

The VZCOMML© screening decision logic for a constituent 'fails' if; 1) the mean travel time (TMean) through the vadose zone is less than 1,000 years, and 2) the source concentration exceeds the Tier II MLSSL and 3) the groundwater concentration exceeds an action level (i.e., the calculated concentration in groundwater would exceed the regulatory limit; MCLs or RSLs). In this case, the constituent would be retained as a CM COC and subject to further CM COC refinement steps.

B-2.3.5. Saturation Concentration

For organic (non-radioactive) constituents, the saturation concentration (C_{sat}) (mg/kg) is calculated from the solubility constant in water (S) (mg/L) as follows:

$$C_{sat=}\frac{S}{\rho_b}\cdot(K_d+\rho_b+\theta_w+H\cdot\theta_a)$$

The C_{sat} is a theoretical concentration that represents a pure non-aqueous phase liquid (NAPL) or solid threshold concentration in soil. The C_{sat} is compared to the detected concentration to predict if a NAPL phase compound is present in the soil.

B-2.3.6. Groundwater Concentration

The concentration of constituents in groundwater in the water table aquifer is directly calculated by VZCOMML© for comparison to groundwater regulatory limits. The groundwater concentration (C_{gw}, µg/L) is calculated as follows (Rucker 2011):

For organic contaminants (including mercury with vapor phase);

$$C_{gw}=\frac{\left(\frac{C_t\cdot 1000}{DAF}\right)\times e^{(-\lambda T_{Mean})}}{\left(K_d+\frac{(\theta_w+H\cdot\theta_a)}{\rho_b}\right)\times\left(\frac{\lambda t}{1-e^{(-\lambda t)}}\right)}\cdot\left(\frac{d_s}{T_c}\right)$$

where;

T_c = Thickness of soil column (ft)

For inorganic contaminants (including metals [note: metals use an infinite half-life] and radionuclides and excluding mercury with vapor phase);

$$C_{gw}=\frac{\left(\frac{C_t\cdot 1000}{DAF}\right)\cdot e^{(-\lambda T_{Mean})}}{\left(K_d+\frac{\theta_w}{\rho_b}\right)\cdot\left(\frac{\lambda t}{1-e^{(-\lambda t)}}\right)}\cdot\left(\frac{d_s}{T_c}\right)$$

VZCOMML© assumes equilibration, redistribution, and conservation of mass of the source between phases (i.e., volatilized, dissolved, or sorbed) and distribution throughout the entire vadose zone volume. The concentration of constituents in groundwater in the water table aquifer is directly calculated by VZCOMML© for comparison to groundwater regulatory limits or standards.

B-2.4. 690-N Modeling Parameters

Vadose zone contaminant migration simulations are presented in this section for the Ford building slab and sub slab soils using the VZCOMML© spreadsheet. The vadose zone was modeled as a five-layer system based on the lithology from the RFI/RI Work Plan (SRNS, 2020):

- Layer 1 is the 0.15 m (6 in) original concrete slab, the source area for contamination within the slab

- Layer 2 is a 0.3 m (1 ft) layer of sandy clay loam, which is the source layer for soils beneath the slab

- Layer 3 is a sandy clay loam and extends down to 3 m (9 ft) bgs

- Layer 4 is a 4 m (14 ft) clay layer that extends from the bottom of Layer 3 to 22 ft bgs

- Layer 5 is sandy loam, which extends from the base of Layer 4 down to the water table at 14 m (45 ft) bgs

These steps are used to perform the CM analysis, for each subunit:

1. Analytical soil data are compiled and evaluated. The data are processed to purge all quality assurance data and rejected (R qualified) data. The data were further processed to select the maximum detected concentration for each analyte.

2. A conceptual site model is developed for the waste unit, which includes depth of contamination (source zone; Layers 1 & 2), vadose zone thickness below the source (Layers 3-5), and assigned values for several hydrogeological parameters.

3. VZCOMML© Tier I screening is performed, using two conservative assumptions: a) for each analyte, the maximum detected concrete and soil concentration is used to represent the source zone concentration (C_t). The thickness of the source zone is assumed to be equal to the depth of the slab or the deepest available soil sample (0.3 m [1 ft]). An analyte was retained as a Tier I CM COPC if the source zone concentration was greater than both the Tier I Source-Specific SSL and the Tier I MLSSL.

4. VZCOMML© Tier II Simulation 1 is run, using two conservative assumptions: (a) for each analyte, the maximum detected concrete or soil concentration is used to represent the source zone concentration (C_t). The thickness of the source zone is assumed to be equal to the depth of the slab or the deepest available soil sample (0.3 m [1 ft]). Analytes predicted to impact groundwater at concentrations exceeding action levels within the evaluation time of 1,000 years, under the conservative conditions simulated, are retained as Tier II CM COPCs. Action levels refer to the Tier II $SSL_{T/12}$, the Tier II $MLSSL_{T1/2}$, and either the May 2018 USEPA MCL or Tapwater Standard. For an analyte to be retained as a Tier II CM COPC in VZCOMML©, the "predicted concentration in aquifer" must be greater than all 3 action levels and the analyte must have a mean travel time of less than 1,000 years.

Table B-1 presents chemical and nuclear property parameters for each evaluated analyte. These parameters include organic carbon partitioning coefficient, soil-water partitioning coefficient, half-life (biological degradation for organics; radioactive decay for radionuclides), Henry's Law constant, solubility, and regulatory action level. In addition to chemical parameters, several physical parameters are also employed in CM simulations. These are presented in Table B-2.

B-2.5. Results of the Tier I and Tier II Analyses

In this section, results of the Tier I and Tier II screening are presented for each of two models relating to 690-N.

B-2.5.1. 690-N Slab

<u>B-2.5.1.1 Tier I Analysis</u>

The Tier I analysis identified thirteen constituents as CM COPCs for the 690-N slab: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Bis(2-

ethylhexyl) phthalate, Indeno(1,2,3-c,d)pyrene, Naphthalene, PCB 1254, PCB 1260, Potassium-40, Strontium-90, Uranium-233/234, and Uranium-238 (Table B-3).

B-2.5.1.2 Tier II Analysis

The thirteen constituents, which failed Tier I screening, were evaluated in a Tier II simulation. No constituents were identified as Tier II CM COPCs (Table B-4).

B-2.5.2. 690-N Sub Slab Soils

B-2.5.2.1 Tier I Analysis

The Tier I analysis identified three constituents as CM COPCs for the 690-N sub slab soils: Bis(2-ethylhexyl) phthalate, PCB 1254, and PCB 1260 (Table B-5).

B-2.5.2.2 Tier II Analysis

The three constituents, which failed Tier I screening were evaluated in a Tier II simulation. No constituents were identified as Tier II CM COCs (Table B-6).

B-2.6. Conclusions

This contaminant migration analysis performed using VZCOMML© revealed no slab or sub slab contaminants with the potential to migrate to groundwater and exceed groundwater action levels within 1,000 years. No constituents qualified as CM RCOCs for either the slab or the soils beneath the slab. The addition of the concrete cap on top of the original slab will only further minimize contaminant transport to groundwater.

B-3. REFERENCES

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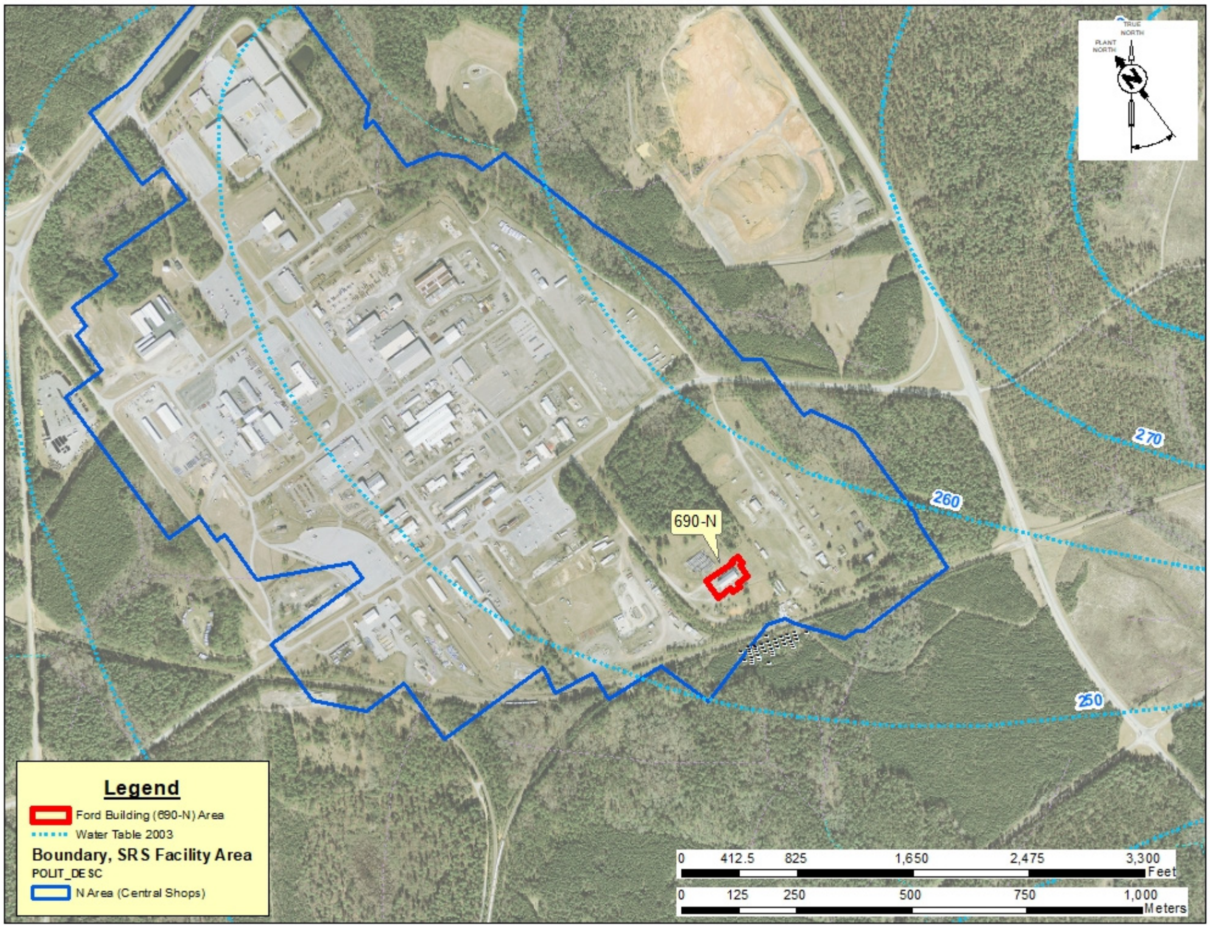

Figure B-1. Ford Building Location and N-Area Potentiometric Surface

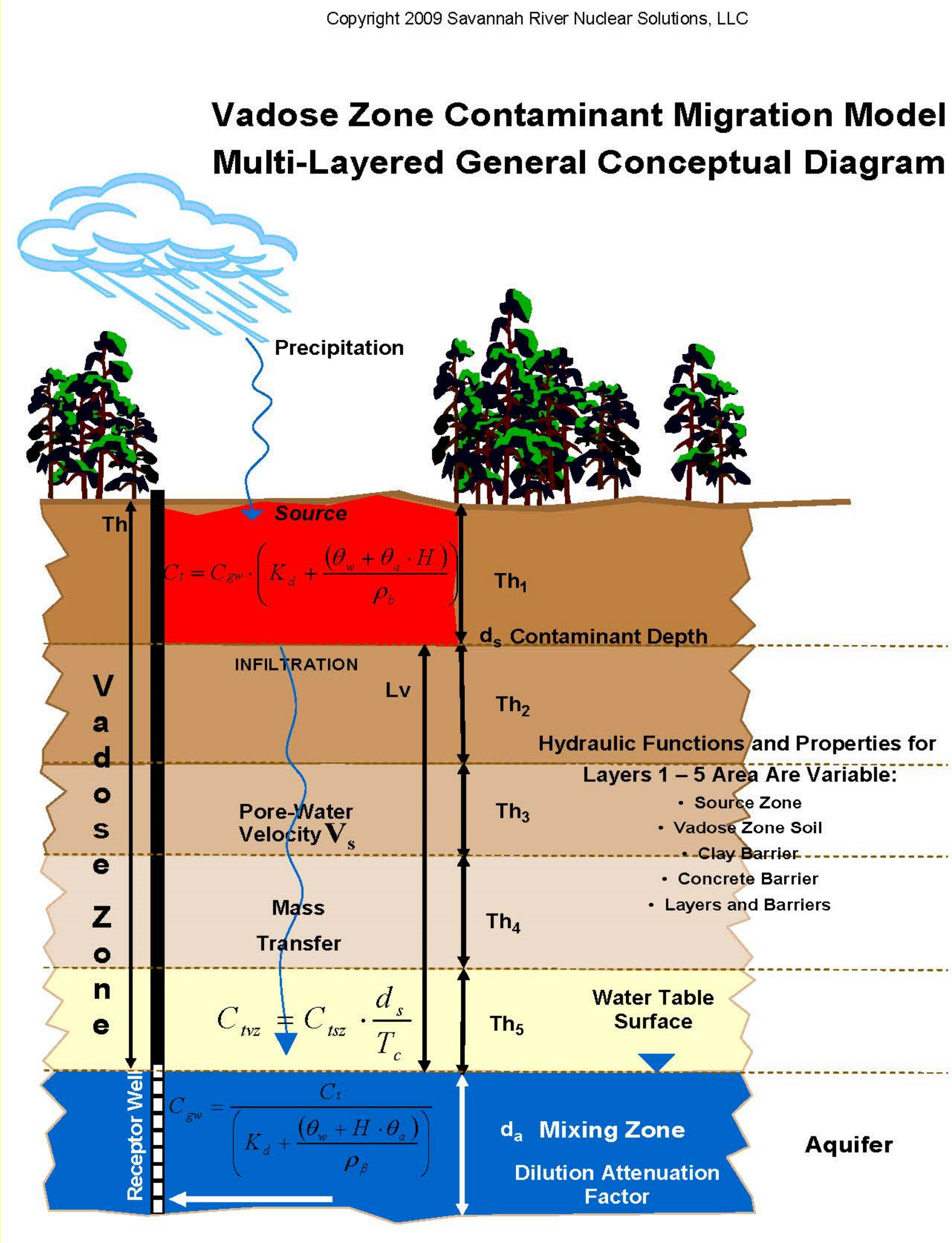

Figure B-2. VZCOMML© Contamination Migration Conceptual Diagram

Table B-1. Chemical Parameters Used for Screening

Analyte	K_{oc}	K_d	Half-life	H	Solubility	Standard
	(L/kg)		(yr-1)	(-)	(mg/L)	(µg/L or pCi/L)
Ethylbenzene	2.04E+02	2.04E-02	2.70E-02	3.23E-01	1.69E+02	7.00E+02
Tetrachloroethylene	1.55E+02	1.55E-02	1.00E+01	7.54E-01	2.00E+02	5.00E+00
Toluene	1.40E+02	1.40E-02	6.00E-02	2.72E-01	5.26E+02	1.00E+03
Trichloroethylene	1.66E+02	1.66E-02	1.00E+01	4.22E-01	1.10E+03	5.00E+00
Benzo(a)anthracene	3.58E+05	3.58E+01	1.86E+00	1.37E-04	9.40E-03	3.00E-02
Benzo(a)pyrene	9.69E+05	9.69E+01	1.45E+00	4.63E-05	1.62E-03	2.00E-01
Benzo(b)fluoranthene	1.23E+06	1.23E+02	1.67E+00	4.55E-03	1.50E-03	2.50E-01
Benzo(g,h,i)perylene	1.60E+06	1.60E+02	1.78E+00	5.13E-06	3.00E-04	NA
Benzo(k)fluoranthene	1.23E+06	1.23E+02	5.86E+00	3.40E-05	8.00E-04	2.50E+00
Bis(2-ethylhexyl) phthalate	1.11E+05	1.11E+01	6.30E-02	4.18E-06	3.40E-01	6.00E+02
Carbazole	3.39E+03	3.39E-01	8.22E-02	6.26E-07	1.80E+00	NA
Chrysene	3.98E+05	3.98E+01	2.72E+00	3.88E-03	1.60E-03	2.50E+01
Dibenzofuran	9.12E+03	9.12E-01	7.70E-02	3.05E-05	1.00E+01	7.90E+00
Fluoranthene	4.90E+04	4.90E+00	1.21E+00	6.60E-04	2.06E-01	8.00E+02
Fluorene	7.71E+03	7.71E-01	1.64E-01	2.61E-03	1.98E+00	2.90E+02
Indeno(1,2,3-c,d)pyrene	3.74E+06	3.74E+02	2.00E+00	6.56E-05	2.20E-05	2.90E-02
Naphthalene	1.19E+03	1.19E-01	1.32E-01	1.98E-02	3.10E+01	1.70E-01
Phenanthrene	1.40E+04	1.40E+00	5.48E-01	1.60E-03	1.29E+00	NA

Pyrene	6.80E+04	6.80E+00	5.20E+00	4.51E-04	1.35E-01	1.20E+02
PCB 1254	3.09E+05	6.18E+01	3.42E+04	8.20E-03	4.10E-02	7.80E-03
PCB 1260	3.09E+05	6.18E+01	3.42E+04	1.03E-02	1.44E-02	7.80E-03
Americium-241	NA	1.00E+02	7.38E03	None	None	1.50E+01
Americium-243	NA	1.00E+02	7.38E03	None	None	1.50E+01
Cesium-137	NA	5.00E+02	3.02E+01	None	None	8.00E+01
Europium-155	NA	2.45E+02	4.96E+00	None	None	6.00E+02
Nickel-63	NA	2.57E+02	1.00E+02	None	None	5.00E+01
Plutonium-238	NA	1.00E+02	8.78E+01	None	None	1.50E+01
Plutonium-239/240	NA	1.00E+02	2.41E+04	None	None	1.50E+01
Potassium-40	NA	7.50E+01	1.28E+09	None	None	2.14E+00
Strontium-90	NA	3.00E+00	2.86E+01	None	None	8.00E+00
Technicium-99	NA	1.00E-01	2.17E+05	None	None	9.00E+02
Tritium	NA	0.00E00	1.23E+01	None	None	2.00E+04
Uranium-233/234	NA	4.00E+01	2.45E+05	None	None	1.00E+01
Uranium-238	NA	4.00E+01	4.47E+09	None	None	1.00E+01

Table B-2. Physical Parameters Used for Screening

Parameter	Symbol	Value	Units	Reference
Aquifer saturated horizontal hydraulic conductivity	K_a	16,425	ft/y	WSRC, 2000c
Aquifer Thickness	d_a	10	ft	VZCOMML Default Value
Infiltration Rate	I	5.62	in/yr	SRNL, 2009
Source Length Parallel to Groundwater Flow	L	50	ft	Estimated from building parameters
Depth to water	Ly	45	ft	Estimated from potentiometric surface
Horizontal hydraulic gradient	i	0.005	ft/ft	Estimated from potentiometric surface
Soil classification	NA	Sandy Clay Loam/Clay, Sandy Loam	NA	Estimated from lithology (SRNS 2020)
Total porosity	n_r	0.39	Decimal fraction	NUREG, 1999
Effective porosity	n_e	0.289	Decimal fraction	NUREG, 1999
Saturated vertical hydraulic conductivity	K_s	131	ft/y	Rucker, 2009
Exposure duration	ED	70	y	USEPA, 2000
Evaluation time	T_e	1,000	y	WSRC, 1998
Dry bulk density	ρ_b	1.7	kg/L	Rucker, 2009
Fraction organic carbon	f_{oc}	0.0002	Decimal fraction	Rucker, 2009

Table B-3. Tier I Screening Results for the 690-N Slab

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	(mg/kg or pCi/g)			
Ethylbenzene	7.10E-03	2.00E-01	3.46E+01	
Toluene	7.50E-02	2.64E-01	4.95E+01	
2-Methylnaphthalene	2.90E-01	8.04E-02	1.78E+00	
Acenaphthene	3.40E-01	7.72E-01	2.62E+01	
Acenaphthene	3.40E-01	7.72E-01	2.62E+01	
Anthracene	7.40E-01	1.12E+01	8.91E+01	
Benzo(a)anthracene	2.10E+00	2.75E-03	1.48E-03	Benzo(a)anthracene
Benzo(a)pyrene	1.10E+00	4.96E-02	9.90E-03	Benzo(a)pyrene
Benzo(b)fluoranthene	2.00E+00	7.87E-02	1.24E-02	Benzo(b)fluoranthene
Benzo(g,h,i)perylene	5.70E-01	NA	NA	
Benzo(k)fluoranthene	8.10E-01	7.87E-01	1.24E-01	Benzo(k)fluoranthene
Bis(2-ethylhexyl) phthalate	1.20E+00	1.72E-01	2.97E-01	Bis(2-ethylhexyl) phthalate
Carbazole	8.40E-01	NA	NA	
Chrysene	2.40E+00	2.55E+00	1.24E+00	
Dibenzofuran	3.60E-01	2.00E-02	3.91E-01	
Fluoranthene	4.90E+00	1.02E+01	3.96E+01	
Fluorene	1.90E-01	6.31E-01	1.44E+01	
Indeno(1,2,3-c,d)pyrene	5.20E-01	2.77E-02	1.44E-03	Indeno(1,2,3-c,d)pyrene
Naphthalene	3.00E-01	8.65E-05	8.41E-03	Naphthalene
Phenanthrene	4.40E+00	NA	NA	
Pyrene	3.50E+00	2.11E+00	5.94E+00	
PCB 1254	1.50E+01	6.18E-04	3.86E-04	PCB 1254

PCB 1260	5.50E+00	6.18E-04	3.86E-04	PCB 1260
Americium-241	2.30E-01	1.97E+00	7.60E-01	
Americium-243	7.00E-02	1.92E+00	7.43E-01	
Cesium-137	1.75E+00	1.77E+02	1.37E+01	
Europium-155	2.50E-01	8.01E+02	1.26E+02	
Nickel-63	4.24E+00	1.82E+01	2.74E+00	
Plutonium-238	1.10E-01	2.16E+00	8.34E-01	
Plutonium-239/240	1.10E-01	1.92E+00	7.43E-01	
Potassium-40	1.83E+01	2.06E-01	1.06E-01	Potassium-40
Strontium-90	1.35E+00	4.55E-02	5.57E-01	Strontium-90
Technetium-99	7.24E-01	2.98E-01	4.45E+01	
Tritium	1.82E+02	9.90E+02	8.40E+00	
Uranium-233/234	1.25E+00	5.14E-01	4.95E-01	Uranium-233/234
Uranium-238	1.20E+00	5.14E-01	4.95E-01	Uranium-238

* Constituents did not undergo SSL calculations. These constituents lacked both MCLs and USEPA RSLs. These analytes did not undergo CM COC evaluation and were listed as “NA”.

Table B-4. Tier II Simulation Results for the 690-N Slab

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II SSL$_{T1/2}$	Tier II MLSSL$_{T1/2}$
	(Unitless)	*(years)*	*(µg/L or pCi/L)*			*(mg/kg or pCi/g)*	
Benzo(a)anthracene	5.56E+02	4.73E+04		3.00E-02		Infinite	Infinite
Benzo(a)pyrene	1.50E+03	1.28E+05		2.00E-01		Infinite	Infinite
Benzo(b)fluoranthene	1.91E+03	1.62E+05		2.50E-01		Infinite	Infinite
Benzo(k)fluoranthene	1.91E+03	1.62E+05		2.50E+00		Infinite	Infinite
Bis(2-ethylhexyl) phthalate	1.73E+02	1.47E+04		6.00E+00		Infinite	Infinite
Indeno(1,2,3-c,d)pyrene	5.80E+03	4.93E+05		2.90E-02		Infinite	Infinite
Naphthalene	2.85E+00	2.42E+02		1.70E-01		Infinite	Infinite
PCB 1254	4.80E+02	4.08E+04	9.10E-01	7.80E-03		1.29E-01	3.87E-04
PCB 1260	4.80E+02	4.08E+04	3.34E-01	7.80E-03		1.29E-01	3.87E-04
Potassium-40	5.82E+02	4.95E+04	2.09E+00	2.14E+00		1.87E+01	1.06E-01
Strontium-90	2.43E+01	2.06E+03		8.00E+00		Infinite	3.04E+00
Uranium-233/234	3.11E+02	2.64E+04	2.48E-01	1.00E+01		5.04E+01	4.95E-01
Uranium-238	3.11E+02	2.64E+04	2.57E-01	1.00E+01		4.67E+01	4.95E-01

Infinite indicates the model concentration exceeds unity: >1E+6mg/kg or >1E+12 pCi/g. Blanks indicate result is <1E-06 µg/L.

Table B-5. Tier I Screening Results for the 690-N Sub Slab Soils

Analyte	Source Zone Concentration	Tier I Source-Specific SSL	Tier I Mass Limit SSL	Failing Analytes
	(mg/kg or pCi/g)			
Tetrachloroethylene	1.00E-03	1.58E-03	1.24E-01	
Toluene	2.50E-02	2.66E-01	2.47E+01	
Trichloroethylene	4.90E-04	1.43E-03	1.24E-01	
2-Methylnaphthalene	2.90E-01	8.05E-02	8.91E-01	
Acenaphthene	3.40E-01	7.73E-01	1.31E+01	
Anthracene	7.40E-01	1.12E+01	4.45E+01	
Bis(2-ethylhexyl) phthalate	3.60E-01	1.72E-01	1.48E-01	Bis(2-ethylhexyl) phthalate
PCB 1254	2.50E-02	6.18E-04	1.93E-04	PCB 1254
PCB 1260	8.70E-03	6.18E-04	1.93E-04	PCB 1260
Americium-243	5.00E-02	1.92E+00	3.72E-01	
Europium-155	1.50E-01	8.01E+02	6.32E+01	
Plutonium-238	7.00E-02	2.16E+00	4.17E-01	
Plutonium-239/240	2.00E-02	1.92E+00	3.71E-01	
Tritium	4.51E+01	4.95E+02	8.45E+00	
Uranium-233/234	2.90E-01	5.14E-01	2.47E-01	
Uranium-238	3.00E-01	5.14E-01	2.47E-01	

Table B-6. Tier II Simulation Results for the 690-N Sub Slab Soils

Analyte	Retardation	Mean Travel Time	Predicted Concentration in Aquifer	Action Level	Failing Analytes	Tier II $SSL_{T1/2}$	Tier II $MLSSL_{T1/2}$
	(Unitless)	*(years)*	*(µg/L or pCi/L)*			*(mg/kg or pCi/g)*	
Bis(2-ethylhexyl) phthalate	1.72E+02	4.37E+03		6.00E+00		Infinite	Infinite
PCB 1254	4.77E+02	1.21E+04	5.49E-03	7.80E-03		3.55E-02	1.93E-04
PCB 1260	4.77E+02	1.21E+04	1.91E-03	7.80E-03		3.55E-02	1.93E-04

Infinite indicates the model concentration exceeds unity: >1E+6mg/kg or >1E+12 pCi/g. Blanks indicate result is <1E-06 µg/L.

Table B-7. Summary Table of Tier I and Tier II Screening Results

Model	# of Tier I COPCs	Tier I COPCs	Tier II COPCs	CM COCs
690-N Slab	13	Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Bis(2-ethylhexyl) phthalate, Indeno(1,2,3-c,d)pyrene, Naphthalene, PCB 1254, PCB 1260, Potassium-40, Strontium-90, Uranium-233/234, Uranium-238	None	None
690-N Sub Slab Soils	3	Bis(2-ethylhexyl) phthalate, PCB 1254, PCB 1260	None	None