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SCE&G®
A SCANA COMPANY

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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

ATTN: Document Control Desk

Subject: Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3 Combined License Application (COLA) - Docket Numbers 52-027 and 52-028 Additional Response to NRC Request for Additional Information (RAI) Letter No. 044

Reference:
1. Letter from Ravindra G. Joshi (NRC) to Alfred M. Paglia (SCE&G), Request for Additional Information Letter No. 044 Related to SRP Section 2.4.13 for the Virgil C. Summer Nuclear Station Units 2 and 3 Combined License Application, dated April 7, 2009.

2. Letter from Ronald B. Clary (SCE&G) to Document Control Desk (NRC), Response to NRC Request for Additional Information (RAI) Letter No. 044, dated May 04, 2009 (NND-09-0115).

The enclosure to this letter provides the South Carolina Electric & Gas Company (SCE&G) final response to RAI item 02.04.13-2 included in the above referenced letter from the NRC dated April 7, 2009. The enclosure supersedes the information provided to the NRC by SCE&G in letter NND-09-0115 dated May 04, 2009. The enclosure identifies any associated changes that will be incorporated in a future revision of the VCSNS Units 2 and 3 COLA.

The response also provides information requested during the Environmental Report (ER) audit conducted by the NRC during the week of March 9, 2009. Specifically the information addresses ER Information Needs GW-2 and 3.

Should you have any questions, please contact Mr. Al Paglia by telephone at (803) 345-4191, or by email at apaglia@scana.com.

D083
NRO

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 24TH day of JUNE, 2009.

Sincerely,

Stephen A. Byrne
Senior Vice President,
Generation

AMM/RBC/jf

Enclosure

c (w/o enclosure):
- Luis A. Reyes
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NRC RAI Letter No. 044 Dated April 7, 2009

SRP Section: 2.4.13 – Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

Questions from Hydrologic Engineering Branch (RHEB)

NRC RAI Number: 02.04.13-2

In order to show compliance with 10 CFR 100.20(c) which requires consideration of the physical characteristics of the site, please provide a description of the process used to evaluate the conceptual site model of the subsurface environment. The description should include how this process was used as the basis for the calculation of the radionuclide transport in FSAR Section 2.4.13, and how the most conservative conceptual model from the set of plausible conceptual models was applied for the radionuclide transport analysis. Staff also request that the applicant explain how the conservative assumptions employed in the conceptual site model compensate for observed spatial and temporal variability and the resulting uncertainty in describing the subsurface radionuclide transport analysis.

VCSNS RESPONSE:

The first step of site model conceptualization involved formulating an understanding of the hydrogeologic conditions in Fairfield County and the surrounding counties by reviewing regional geologic and hydrogeologic information from the United States Geological Survey (USGS) and the State of South Carolina. The research concentrated on the hydrogeologic conditions of the Piedmont and Blue Ridge Aquifer systems within the Piedmont Physiographic Province. The available information indicates groundwater in these regions occurs in joints and fractures in underlying crystalline bedrock or in the residual soil overburden. Recharge is primarily from precipitation falling on upland areas that percolates to the water table in the soils and to the underlying jointed bedrock. The groundwater table, in general, follows the land surface but with more subdued relief. Groundwater discharges as seeps and springs and/or percolates through the ground to bedrock, discharging to deeper incised creeks and streams. Well yields from the igneous and metamorphic formations of the Piedmont are relatively small, generally less than 50 gpm. Localized larger yields are possible depending on the density of fractures present in the bedrock.

The regional information was used to evaluate geologic structures, hydrogeologic properties, flow paths, regional sources and sinks, water use, and surface water interactions within the site vicinity. Due to the scale of the regional conceptual model, an additional second step was needed to understand the local flow system in the vicinity of the VCSNS site.

The second step in developing a site conceptual model involved a review of available information regarding the local hydrogeologic conditions. Documentation associated with VCS Unit 1 provided local geologic, geotechnical and hydrogeologic information.

Limited geologic and geotechnical information from a pre-COLA, Units 2 & 3 siting study provided insight as to the depth to bedrock, unconsolidated material composition, and the density of bedrock fracturing that could be expected in the vicinity of Units 2 & 3.

By combining the local information with regional concepts, it was concluded that groundwater could be encountered within the saprolite with the probability that the more permeable material would be encountered near the interface with highly weathered bedrock. The occurrence of fracture bedrock flow was considered a possibility.

The third step involved incorporating information gathered from the site-specific Units 2 & 3 subsurface site investigation (SI). The SI included geotechnical borings, cone penetration tests, geotechnical laboratory tests, installation of groundwater observation wells, water level monitoring, and aquifer tests. The hydrogeologic zones encountered during the SI were generally consistent with those identified during the regional literature review.

The fourth step involved evaluation of the SI field data and comparison with the regional and local information, and historical VCS Unit 1 information. This included evaluation of:

- regional & local groundwater movement;
- vertical gradients between the aquifers;
- site-specific slug test results

From this effort, site-specific data were integrated with the regional information to formulate the conceptual site model presented in FSAR Sections 2.4.12 and 2.4.13.

From these investigations, it was concluded that potential radionuclide transport is primarily in the more permeable lenses of the saprolite and weathered bedrock (referred to as the saprolite/shallow bedrock zone). Transport in the less weathered bedrock (referred to as the deep bedrock zone) is less likely due to the limited amount of fractures and low hydraulic conductivity of the deep bedrock characterized during the SI program (FSAR Section 2.4.12, FSAR Section 2.5.4).

The potentiometric surface of the saprolite/shallow bedrock zone indicates that groundwater flows from the ridgetops toward drainage swales, mimicking the topography. Large springs have not been identified within the VCSNS property that would be indicative of a densely fractured groundwater flow system.

Based on the groundwater potentiometric maps, aquifer test (slug test) results, and the geotechnical characteristics of the unconsolidated and crystalline subsurface material at the site, it was determined that the nearest groundwater discharge points from Units 2 and 3 would be the on-site ravines west of the site. This scenario is postulated to be the most plausible groundwater discharge point of compliance. An alternate conceptual model assuming a groundwater pathway to the east toward Mayo Creek has also been evaluated. Based on the potentiometric maps developed from the data collected during the site investigation the eastern

pathway is considered less plausible for effluent releases from the auxiliary building of Units 2 and 3. Evaluations include both saprolite and bedrock pathway analyses. These evaluations employ a realistic approach to determining radionuclide concentrations that includes all processes of groundwater transport.

In addition to the pathways through the saprolite / shallow bedrock zone presented above and in FSAR Section 2.4.13, several possible groundwater pathways from the VCSNS site of Units 2 and 3 through the deep bedrock zone to points of discharge have been evaluated. As mentioned above, the groundwater pathways through the saprolite / shallow bedrock zone to the unnamed creeks near Units 2 and 3 are considered to be the most probable routes for radionuclide transport in the event of an accident (FSAR Section 2.4.13). The groundwater pathways through the deep bedrock zone that have been evaluated include:

- A western pathway through deep bedrock that discharges into the Broad River.
- An eastern pathway through deep bedrock that discharges into Mayo Creek.
- A hypothetical eastern pathway through deep bedrock that passes beneath Mayo Creek and is intercepted by a postulated private well located on SCE&G's property line east of Mayo Creek.

The results of the analysis for the two potential groundwater pathways through the saprolite and the three groundwater pathways through the bedrock are presented in the revised FSAR Section 2.4.13. These results show that for all plausible groundwater pathways for an accidental liquid release of effluents either into the saprolite or in the deep bedrock zone the concentrations at the boundary of the controlled area (SCE&G property boundary) will be in compliance with the 10 CFR Part 20 limits for radionuclide concentrations.

This response is PLANT SPECIFIC.

ASSOCIATED VCSNS COLA REVISIONS:

The following changes to the FSAR will be incorporated in a future revision of the VCSNS Units 2 and 3 COLA:

2.4.13. ACCIDENTAL RELEASES OF RADIOACTIVE LIQUID EFFLUENTS IN GROUND AND SURFACE WATERS

2.4.13.1. Accidental Releases to Groundwater

The assumed accidental release scenario has been selected based on information developed by Westinghouse to assist in evaluating the accidental liquid release of effluents (Reference 252). The scenario assumes an instantaneous release from one of the two effluent holdup tanks located in the lowest level of the AP1000 auxiliary building.

There are two effluent holdup tanks for each unit, each with a capacity of 28,000 gallons. These tanks have both the highest potential radionuclide concentrations and the largest volume. Therefore, they have been selected as the limiting tanks for evaluating an accidental release of liquid effluents that could lead to the most adverse contamination of groundwater or surface water, via the groundwater pathway.

The estimated radionuclide concentration of the effluent holdup tanks is assumed to be equal to 101% of the reactor coolant concentration. Westinghouse determined that the radionuclide concentrations in the reactor coolant itself should be estimated as follows:

- For tritium (H-3), a coolant concentration of 1.0 μCi/g should be used.
- Corrosion products (Cr-51, Mn-54, Mn-56, Fe-55, Fe-59, Co-58 and Co-60) should be taken directly from the AP1000 DCD, Table 11.1-2, *Design Basis Reactor Coolant Activity*.
- Other radionuclides should be based on the AP1000 DCD, Table 11.1-2 multiplied by 0.12/0.25 to adjust the failed fuel rate from the design basis to a conservatively bounding value for this analysis.

Based on these recommendations, the expected radionuclide concentrations in the effluent holdup tanks have been calculated, and the results are summarized in Table 2.4-225.

The assessment of a potential release of radioactive liquids following the postulated failure of a tank and its components, located outside of containment, and the impacts of the release of radioactive materials at the nearest potable water supply, located in an unrestricted area, presented in this subsection follows the guidance provided in Branch Technical Position 11-6 (Reference 247).

2.4.13.1.1. Conceptual Model

Figure 2.4-251 illustrates the conceptual model used to evaluate an accidental release of liquid effluent to groundwater through the saprolite material, or to surface water via the groundwater pathway. The groundwater pathways from the two Units discharge to two nearby unnamed creeks, one to the north-northwest of Unit 2 and the other to the south-southwest of Unit 3. Besides these pathways, several other hypothetical, less likely alternative groundwater pathways were analyzed. They are:

1. Saprolite pathway to the east discharging in Mayo Creek;
2. Bedrock pathway to the west discharging in the Broad River;
3. Bedrock pathway to the east discharging in Mayo Creek; and

4. Bedrock pathway to the east continuing beyond Mayo Creek and intercepted by a postulated receptor well at the nearest SCE&G property boundary

The key elements and assumptions embodied in the conceptual model of the most plausible pathway through the saprolite to the two nearby unnamed creeks, as well as in the alternative hypothetical conceptual models, are described and discussed below.

In the following discussion the term "pathway" is used to describe travel through a specific geologic medium (e.g. saprolite or bedrock) and in a general direction (e.g. east or west). The term "pathline" is used to describe a specific course followed from the release to the receptor point.

For each alternative groundwater pathway, two pathlines were analyzed: One from Unit 2 to the nearest point of discharge, and the other from Unit 3 to the nearest point of discharge. To simplify the presentation, only the analysis and results of the most conservative, and therefore bounding, pathline is presented for each alternative groundwater pathway. All other factors being equal, the most conservative pathline for each alternative groundwater pathway is the one having the shortest travel time through the groundwater, and consequently the least time for radioactive decay and adsorption. This was confirmed by completing analysis of all groundwater pathlines.

As indicated above, the effluent holdup tanks are assumed to be the source of the release, with each tank having a capacity of 28,000 gallons and radionuclide concentrations as summarized in Table 2.4-225. These tanks are located at the lowest level of the auxiliary building of each unit, which has a building slab elevation of 366.5 feet NAVD88 and a base of concrete elevation of 360.5 feet NAVD88, and is about 5 to 7 feet below the 2007 groundwater levels and approximately 17 feet below the maximum water table level. One of these tanks is postulated to rupture, and 80% of the liquid volume (22,400 gallons is assumed to be released in accordance with NUREG-0800, BTP 11-6). Flow from a tank rupture would initially flood the tank room, and begin to flow to the auxiliary building radiologically controlled area sump via floor drains, as described in Subsection 3.4.1.2.2.2 of the DCD. It is assumed that the sump pumps are inoperable during the release. According to the DCD, this would result in the 22,400-gallon release flooding the balance of Level 1 of the auxiliary building via the interconnecting floor drains. Once Level 1 is flooded, it is assumed that a pathway is created that would allow the entire 22,400 gallons to enter the groundwater (unconfined aquifer) instantaneously. This assumption is very conservative because it requires failure of the floor drain system, plus it ignores the barriers presented by the 6-foot-thick basemat and the sealed, 3-foot-thick exterior walls of the auxiliary building.

As already mentioned, the slab of the floor where effluent holdup tanks are located is well below the water table (about 5 to 7 feet below the 2007 groundwater levels and 17 feet below the maximum water level). Therefore, any cracks in the foundation would result in an influx of uncontaminated groundwater ~~to~~ into the auxiliary building as opposed to an efflux of radioactive water out of the building and to the subsurface. Considering the release of nuclides, despite this flow condition that would tend to prevent it, adds conservatism to the present analysis.

With the postulated instantaneous release of the contents of an effluent holdup tank to groundwater, radionuclides would enter the saprolite/shallow bedrock zone and migrate with the groundwater in the direction of decreasing the hydraulic head. The hydraulic head contour map for the saprolite/shallow bedrock zone presented on Figure 2.4-252 indicates that the groundwater pathway from ~~a~~ the postulated point of release in either of the auxiliary buildings would be either towards the unnamed creek north-northwest of Unit 2, or south-southwest of Unit 3 towards an unnamed creek as illustrated conceptually in Figure 2.4-251. Cross sections were developed roughly along these groundwater pathways as indicated in Figure 2.4-253. These cross sections, shown in Figures 2.4-254 and 2.4-255, represent the profile along the pathways from Unit 2 and Unit 3, respectively, to the nearest groundwater discharge point. These cross sections indicate that flow from the source to the release point would be primarily through the saprolite material. During saturated zone transport, radionuclide concentrations of the liquid released to the water table would be reduced by the processes of adsorption, hydrodynamic dispersion, and radioactive decay. Upon discharge to either of the two unnamed creeks, radionuclides would mix with uncontaminated surface water in the creeks and eventually discharge into the Broad River, leading to further reduction of concentrations.

As already discussed, the groundwater data collected during the site investigation suggest that the direction groundwater flows through the saprolite from the point of a potential effluent release from Unit 2 is to the north-northwest and for a release from Unit 3 is to the south-southwest. Units 2 and 3 are close to a groundwater high under the ridge where Units 2 and 3 are located. In the unlikely event that the groundwater high shifts laterally to the west, the postulated effluent release points will be on the east side of the groundwater high, and the effluent will move to the east. To account for this possibility an eastward pathway through the saprolite was included in the analysis. This pathway is assumed to lead directly to Mayo Creek. To add conservatism to the analysis, the eastern pathway through the saprolite was assumed along the shortest distance from each Unit to Mayo Creek (see Figure 2.4-252).

~~An~~ Other alternative conceptual ~~model~~ models for nuclide transport are for ~~flow~~ groundwater pathways through the bedrock as stated above. This would be consistent with the downward hydraulic gradient at the site. However, as discussed in Subsection 2.4.12.3.3~~, on the properties of the different subsurface materials at the site~~, the saprolite material has a much higher hydraulic conductivity, ~~and therefore provides the fastest groundwater pathway~~ indicating radionuclides would likely preferentially flow through the saprolite. ~~Therefore, the alternative conceptual model through the bedrock would provide lower nuclide concentrations at the groundwater discharge points. Similarly, other alternative conceptual models, for example groundwater discharge to other nearby creeks, would result in longer pathways and longer travel times. The pathways selected for analysis bound the set of plausible alternatives because they combine the shortest distance from the point of release to the point of groundwater discharge to the surface with the material—saprolite, which has the highest hydraulic conductivity of all other materials found at the site. This combination provides the shortest travel time, therefore bounding all plausible alternatives.~~

The piezometric level data in the bedrock collected during the site investigation suggest that in the vicinity of the potential effluent release points, i.e. the auxiliary buildings of Units 2 and 3, the general direction of groundwater flow through the bedrock is to the west. Therefore, a groundwater pathway to the west discharging in the Broad River was included. As with the saprolite, in the unlikely event that the groundwater high should shift to the west, groundwater flow in the bedrock could shift to the east. Therefore, a groundwater pathway through the bedrock to the east and discharging in Mayo Creek was also included.

An additional pathway to the east was hypothesized, by assuming that the groundwater flow through the bedrock continues in the same direction, i.e. to the east, beyond Mayo Creek (Figure 2.4-257). In this case, it is assumed that this pathway continues all the way to the SCE&G property line, where a hypothetical well may act as receptor of radionuclides transported by the groundwater. This groundwater pathway is considered implausible. Figure 2.4-259 shows the ground surface elevations along this pathline, which is shown in plan view in Figure 2.4-260. Figure 2.4-259 clearly shows that the ground surface elevation increases substantially to the east of Mayo Creek. Groundwater levels in water table aquifer systems generally mimic the topography, but with more subdued relief. Therefore, it is expected that the water table and piezometric levels in the bedrock also increase to the east of Mayo Creek. This will result in a reversal of the hydraulic gradient and the flow of groundwater east of Mayo Creek being toward the creek. The expected direction of groundwater flow is illustrated in Figure 2.4-259. There is no evidence of any special geologic features under Mayo Creek, such as a confined bedrock aquifer dipping downward to the east, that could conceivably result in eastward groundwater movement to the east of Mayo Creek. Even though it is considered implausible, this pathway was analyzed to demonstrate the conservatism of the safety analysis.

There are no existing water supply wells between the postulated release points and the points where groundwater discharges. Surface water users downstream of VCSNS on the Broad River are discussed in Subsection 2.4.1.2.3 and are listed in Table 2.4-205. Figure 2.4-209 shows the rivers and lakes where the downstream water users listed in Table 2.4-205 are located.

Potable groundwater resources on SCE&G property and under the control of SCE&G have not been analyzed. In the event of an accidental tank rupture event, SCE&G will monitor and control these sources in accordance with regulatory limits.

2.4.13.1.2. Radionuclide Transport Analysis

2.4.13.1.2.1. Modeling Approach

A radionuclide transport analysis was conducted to estimate the radionuclide concentrations that might impact existing and future water users in the vicinity of Units 2 and 3 based on an instantaneous release of the radioactive material contents of an effluent holdup tank.

The analysis of nuclide transport commences with the simplest of models, using radioactive decay only, and ignoring adsorption and dispersion. Radionuclide concentrations resulting from the preliminary analysis are then compared against the maximum permissible concentrations

identified in 10 CFR Part 20, Appendix B, Table 2, Column 2 to determine acceptability. If required, further analysis ~~using~~ accounting for adsorption in the subsurface will be completed. If the concentrations still exceed ~~an acceptable level~~ regulatory limits after evaluation using radioactive decay and adsorption, further analysis will be completed accounting for dilution in surface water. If the concentrations still exceed regulatory limits after evaluation using radioactive decay and adsorption, and dilution in surface water, then further analysis will be completed to account for longitudinal and lateral dispersion in groundwater.

This analysis accounts for the parent radionuclides expected to be present in the radwaste tank plus progeny radionuclides that would be generated subsequently during transport. The analysis considered all progeny in the decay chain sequences that are important for dosimetric purposes. The International Commission on Radiation Protection Publication 38 (Reference 210) was used to identify the member for which the decay chain sequence can be truncated. For some of the radionuclides expected to be present in an effluent holdup tank, consideration of up to three members of the decay chain sequence was required. The derivation of the equations governing the transport of the parent and progeny radionuclides follows.

Radionuclide transport along a groundwater pathline is governed by the advection-dispersion-reaction equation (Reference 215):

$$\cancel{R\frac{\partial C}{\partial t} = D\frac{\partial^2 C}{\partial y^2} - v\frac{\partial C}{\partial x} - \lambda RC}$$

$$R\frac{\partial C}{\partial t} = D_x\frac{\partial^2 C}{\partial x^2} + D_y\frac{\partial^2 C}{\partial y^2} - v\frac{\partial C}{\partial x} - \lambda RC \qquad \text{(Equation 2.4-1)}$$

where: C = radionuclide concentration; R = retardation factor; ~~D~~ D_x = coefficient of longitudinal ~~hydrodynamic~~ dispersion; D_y = coefficient of lateral dispersion; v = average linear groundwater velocity; ~~and~~ λ = radioactive decay constant, x = horizontal direction of groundwater flow and y = horizontal direction normal to the direction of groundwater flow. The retardation factor is defined from the relationship:

$$R = 1 + \frac{\rho_b K_d}{n_e} \qquad \text{(Equation 2.4-2)}$$

where: ρ_b is the bulk density; K_d is the distribution coefficient; n_e is the effective porosity. The average linear groundwater velocity is determined using Darcy's law, i.e.:

$$v = -\frac{K}{n_e}\frac{dh}{dx} \qquad \text{(Equation 2.4-3)}$$

where: K is the hydraulic conductivity; and dh/dx is the hydraulic gradient. The radioactive decay constant can be written as:

$$\lambda = \frac{\ln 2}{t_{1/2}} \qquad \text{(Equation 2.4-4)}$$

where $t_{1/2}$ is the radionuclide half-life.

The dispersion coefficients, neglecting molecular diffusion, are estimated by:

$$D_x = \alpha_x \cdot v \; ; \; D_y = \alpha_y \cdot v, \qquad \text{(Equation 2.4-5)}$$

where α_x and α_y are the longitudinal and lateral dispersivity, respectively. Based on the estimated dispersivities for the eastern pathway, the products $\alpha_x \cdot v$ and $\alpha_y \cdot v$ are at least three to four orders of magnitudes higher than the molecular diffusion coefficient. Therefore, the contribution of molecular diffusion to the dispersion coefficient is negligible.

Using the method of characteristics approach, the material derivative of concentration can be written as:

$$\frac{dC}{dt} = \frac{\partial C}{\partial t} + \frac{dx}{dt}\frac{\partial C}{\partial x} \qquad \text{(Equation ~~2.4-5~~ 2.4-6)}$$

Conservatively neglecting hydrodynamic dispersion, the characteristic equations for Equation 2.4-1 can be expressed as follows:

$$\frac{dC}{dt} = -\lambda C \qquad \text{(Equation ~~2.4-6~~ 2.4-7)}$$

$$\frac{dx}{dt} = \frac{v}{R} \qquad \text{(Equation ~~2.4-7~~ 2.4-8)}$$

The solutions of the system of equations comprising Equations ~~2.4-6 and 2.4-7~~ 2.4-7 and 2.4-8 can be obtained by integration to yield the characteristic curves of Equation 2.4-1. For the parent radionuclide, the equations representing the characteristic curves can be obtained as:

$$C_1 = C_{10} \exp(-\lambda_1 t) \qquad \text{(Equation ~~2.4-8~~ 2.4-9)}$$

$$t = R_1 L / v \qquad \text{(Equation ~~2.4-9~~ 2.4-10)}$$

where: C_1 is the activity concentration of the parent radionuclide; C_{10} is the initial activity concentration of the parent radionuclide; λ_1 is the radioactive decay constant for the parent

radionuclide; R_1 is the retardation factor for the parent radionuclide; and L is the groundwater pathline length.

Similar equations can be written for the progeny radionuclides. For the first progeny in the decay chain, the advection-dispersion-reaction equation is written as:

$$\cancel{R_2 \frac{\partial C_2}{\partial t} = D \frac{\partial^2 C_2}{\partial x^2} - v \frac{\partial C_2}{\partial x} + d_{12} \lambda_1 R_1 C_1 - \lambda_2 R_2 C_2}$$

$$\underline{R_2 \frac{\partial C_2}{\partial t} = D_x \frac{\partial^2 C_2}{\partial x^2} + D_y \frac{\partial^2 C_2}{\partial y^2} - v \frac{\partial C_2}{\partial x} + d_{12} \lambda_1 R_1 C_1 - \lambda_2 R_2 C_2} \qquad \text{(Equation } \cancel{2.4\text{-}10}\ \underline{2.4\text{-}11}\text{)}$$

where the subscript 2 denotes the first progeny radionuclide; and d_{12} is the fraction of parent radionuclide transitions that result in production of progeny radionuclides. The characteristic equations for Equation ~~2.4-10~~ 2.4-11, assuming $R_1 \approx R_2$ and again conservatively neglecting hydrodynamic dispersion, can be derived as:

$$\cancel{\frac{dC_2}{dt} = d_{12} \lambda_1' C_1 - \lambda_2 C_2}$$

$$\underline{\frac{dC_2}{dt} = d_{12} \lambda_1 C_1 - \lambda_2 C_2} \qquad \text{(Equation } \cancel{2.4\text{-}11}\ \underline{2.4\text{-}12}\text{)}$$

$$\frac{dx}{dt} = \frac{v}{R_2} \qquad \text{(Equation } \cancel{2.4\text{-}12}\ \underline{2.4\text{-}13}\text{)}$$

~~where:~~ $\cancel{\lambda_1' = \lambda_1 R_1 / R_2}$. Recognizing that Equation ~~2.4-11~~ 2.4-12 is formally similar to Equation B.43 of Reference 216, these equations can be integrated to yield an expression for the activity concentration of the first progeny radionuclide:

$$\cancel{C_2 = K_1 \exp(-\lambda_1' t) + K_2 \exp(-\lambda_2 t)}$$

$$\underline{C_2 = K_1 \exp(-\lambda_1 t) + K_2 \exp(-\lambda_2 t)} \qquad \text{(Equation } \cancel{2.4\text{-}13}\ \underline{2.4\text{-}14}\text{)}$$

$$t = R_2 L / v \qquad \text{(Equation } \cancel{2.4\text{-}14}\ \underline{2.4\text{-}15}\text{)}$$

for which

$$\cancel{K_1 = \frac{d_{12} \lambda_2 C_{10}}{\lambda_2 - \lambda_1'}}$$

$$K_1 = \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$$ (Equation 2.4-16)

$$\cancel{K_2 = C_{20} - \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1'}}$$

$$K_2 = C_{20} - \frac{d_{12}\lambda_2 C_{10}}{\lambda_2 - \lambda_1}$$ (Equation 2.4-17)

The advection-dispersion-reaction equation for the second progeny in the decay chain is:

$$\cancel{R_3 \frac{\partial C_3}{\partial t} = D\frac{\partial^2 C_3}{\partial x^2} - v\frac{\partial C_3}{\partial x} + d_{13}\lambda_1 R_1 C_1 + d_{23}\lambda_2 R_2 C_2 - \lambda_3 R_3 C_3}$$

$$R_3 \frac{\partial C_3}{\partial t} = D_x \frac{\partial^2 C_3}{\partial x^2} + D_y \frac{\partial^2 C_3}{\partial y^2} - v\frac{\partial C_3}{\partial x} + d_{13}\lambda_1 R_1 C_1 + d_{23}\lambda_2 R_2 C_2 - \lambda_3 R_3 C_3$$ (Equation ~~2.4-15~~ 2.4-18)

where: subscript 3 denotes the second progeny radionuclide; d_{13} is the fraction of parent radionuclide transitions that result in production of second progeny radionuclide; and d_{23} is the fraction of the first progeny radionuclide transitions that result in production of the second progeny radionuclide. The characteristic equations for Equation ~~2.4-15~~ 2.4-18, assuming $R_1 \approx R_2 \approx R_3$ and again conservatively neglecting hydrodynamic dispersion, can be derived as:

$$\cancel{\frac{dC_3}{dt} = d_{13}\lambda_1' C_1 + d_{23}\lambda_2' C_2 - \lambda_3 C_3}$$

$$\frac{dC_3}{dt} = d_{13}\lambda_1 C_1 + d_{23}\lambda_2 C_2 - \lambda_3 C_3$$ (Equation ~~2.4-16~~ 2.4-19)

$$\frac{dx}{dt} = \frac{v}{R_3}$$ (Equation ~~2.4-17~~ 2.4-20)

~~where: $\lambda_1' = \lambda_1 R_1 / R_3$; and $\lambda_2' = \lambda_2 R_2 / R_3$.~~ Considering the formal similarity of Equation ~~2.4-16~~ 2.4-19 to Equation B.54 of Reference 216, Equations ~~2.4-16 and 2.4-17~~ 2.4-19 and 2.4-20 can be integrated to yield an expression for the activity concentration of the second progeny of the parent radionuclide:

$$\cancel{C_3 = K_1 \exp(-\lambda_1' t) + K_2 \exp(-\lambda_2' t) + K_3 \exp(-\lambda_3 t)}$$

$$C_3 = K_1 \exp(-\lambda_1 t) + K_2 \exp(-\lambda_2 t) + K_3 \exp(-\lambda_3 t)$$ (Equation ~~2.4-18~~ 2.4-21)

$$t = R_3 L / v$$ (Equation ~~2.4-19~~ 2.4-22)

for which:

$$\cancel{K_1 = \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1'} + \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1')(\lambda_2' - \lambda_1')}}$$

$$K_1 = \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_2 - \lambda_1)}$$ (Equation 2.4-23)

$$\cancel{K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2'} - \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_2')(\lambda_2' - \lambda_1')}}$$

$$K_2 = \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} - \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_2)(\lambda_2 - \lambda_1)}$$ (Equation 2.4-24)

$$\cancel{K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1'} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2'} + \frac{d_{23}\lambda_2' d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1')(\lambda_3 - \lambda_2')}}$$

$$K_3 = C_{30} - \frac{d_{13}\lambda_3 C_{10}}{\lambda_3 - \lambda_1} - \frac{d_{23}\lambda_3 C_{20}}{\lambda_3 - \lambda_2} + \frac{d_{23}\lambda_2 d_{12}\lambda_3 C_{10}}{(\lambda_3 - \lambda_1)(\lambda_3 - \lambda_2)}$$ (Equation 2.4-25)

To estimate the radionuclide concentrations in groundwater discharging to the surface, Equations ~~2.4-8, 2.4-13, and 2.4-18~~ 2.4-9, 2.4-14, and 2.4-21 were applied as appropriate along the groundwater pathline that would originate at either of the liquid effluent release points beneath the auxiliary buildings and terminate at the points of groundwater discharge~~ in the two nearby creeks~~. First, a screening analysis was completed considering radioactive decay only. Then, those radionuclides that exceeded 1% of their maximum permissible concentrations were included in the next step of the analysis, which accounted for radioactive decay as well as retardation because of adsorption. Following this, the effect of dilution was also considered for pathways discharging to surface waters and containing nuclide concentrations in excess of 1% of their maximum permissible concentrations. Finally, for the hypothesized eastern pathway to a postulated private well for which there was no dilution, further analysis was performed to account for longitudinal and lateral dispersion in groundwater. The effects of dispersion were analyzed using the analytic solution of the two-dimensional advection-dispersion equation presented by Codell and Duguid (Equation 4.33 in Reference 256) for transport in a vertically averaged layer of thickness b, and an instantaneous release of activity *M* uniformly distributed over width *w*. Using this method, the concentration, *C*, at the location of the private well (at a

distance of x = 5400 ft from the release point) at time t is calculated as a function of the total initial radionuclide activity concentration, M as:

$$C(x,t) = \frac{M}{n_e R_d} X_1 Y_2 Z_2 \qquad \text{(Equation 2.4-26)}$$

where X_1, Y_2, and Z_2 are given by the expressions:

$$X_1 = \frac{1}{\sqrt{4\pi D_x t/R_d}} \exp\left[-\frac{(x - U_x t/R_d)^2}{4D_x t/R_d} - \lambda t\right] \qquad \text{(Equation 2.4-27)}$$

$$Y_2 = \frac{1}{2w}\left\{erf\left[\frac{(w/2+y)}{\sqrt{4D_y t/R_d}}\right] + erf\left[\frac{(w/2-y)}{\sqrt{4D_y t/R_d}}\right]\right\} \qquad \text{(Equation 2.4-28)}$$

$$Z_2 = \frac{1}{b} \qquad \text{(Equation 2.4-29)}$$

The released activity M is equal to the activity concentration of each nuclide in the effluent times the postulated volume of the effluent release (22,400 gal).

The longitudinal dispersivity is estimated using the following two methods from the literature. Based on a critical review and evaluation of a large number of dispersivity data presented by Gelhar et al. (Reference 254), the dispersivity is estimated as:

$$\alpha_x = 0.1x \qquad \text{(Equation 2.4-30)}$$

An alternative estimate of the dispersivity is computed using Equation 14b from Xu and Eckstein (Reference 259):

$$\alpha_x = 0.83 Log_{10}(x)^{2.414} \qquad \text{(Equation 2.4-31)}$$

where x and α_x are in units of meters. In both cases, the lateral dispersivity is estimated to be one tenth of the longitudinal dispersivity, i.e., $\alpha_y = 0.1\alpha_x$, based on Reference 260.

These ~~two~~ steps are described in more detail in the ~~next two~~ following subsections, first for the most plausible pathway, i.e. the western pathway through the saprolite, and then for the four alternative pathways.

2.4.13.1.2.2. Most Plausible Pathway: Western Pathway through the Saprolite

2.4.13.1.2.2.1. Screening Analysis: Transport Considering Radioactive Decay Only

In the initial screening analysis, the concentrations of the radionuclides appearing in Table 2.4-225 were decayed for a period equal to the groundwater travel time from the point of release to each of the two nearby creeks using Equations ~~2.4-8, 2.4-13, or 2.4-18~~ 2.4-9, 2.4-14, or 2.4-21, as appropriate, with $R_1 = R_2 = R_3 = 1$. The travel times in the saprolite / shallow bedrock zone between each of the two auxiliary buildings and the nearest creek where groundwater discharges were conservatively determined based on site-specific data that is summarized in Subsection 2.4.12.3.3. The horizontal hydraulic gradients were calculated as shown in Table 2.4-226. For all of the potential groundwater pathways considered, the most conservative (i.e. the steepest) hydraulic gradients are used based on groundwater levels measured at the site between June 2006 and June 2007.

For the unnamed creek to the north-northwest of ~~the site~~ Unit 2 (Figure 2.4-252, groundwater discharge point A), the average advective velocity is calculated using the following parameters:

- hydraulic conductivity K = 1.7 feet/day (75th percentile hydraulic conductivity value from the slug test data in the saprolite material).
- effective porosity n_e = ~~0.39~~ 0.18 (The effective porosity of the saprolite was estimated using Figure 2.17 of Reference 211; this estimated value was then reduced further for additional conservatism as suggested in Reference 258. A 33% reduction was used for this purpose.)
- horizontal hydraulic gradient $\frac{dh}{dx}$ = ~~-0.0307~~ -0.0319 ft/ft.

Substituting these values in Equation 2.4-3 yields:

$$\cancel{v = -\frac{K}{n_e}\frac{dh}{dx} = -\frac{1.7\,ft/day}{0.39}(-0.0307\,ft/ft) = 0.134\,ft/day \approx 48.9\,ft/yr}$$

$$v = -\frac{K}{n_e}\frac{dh}{dx} = -\frac{1.7\,ft/day}{0.18}(-0.0319\,ft/ft) = 0.302\,ft/day \approx 110\,ft/yr$$

The straight-line distance from the auxiliary building of Unit 2 to the unnamed creek to the north-northwest of the site is about L = 850 feet, which results in a conservatively estimated groundwater travel time of:

$$\cancel{t = \frac{LR}{v} = \frac{850\,ft \times 1}{48.9\,ft/yr} \approx 17.4\,yrs}$$

$$t = \frac{LR}{v} = \frac{850\,ft \times 1}{110\,ft/yr} \approx 7.71\,yrs$$

For the unnamed creek to the south-southwest of ~~the site~~ Unit 3 (Figure 2.4-252, groundwater discharge point B), the average advective velocity is calculated using the following parameters:

- hydraulic conductivity K = 1.7 feet/day (75th percentile hydraulic conductivity value from the slug test data in the saprolite material)
- effective porosity n_e = ~~0.39~~ 0.18
- horizontal hydraulic gradient $\frac{dh}{dx}$ = ~~-0.0369~~ -0.0375 ft/ft.

Substituting these values in Equation 2.4-3 yields:

$$\cancel{v = -\frac{K}{n_e}\frac{dh}{dx} = -\frac{1.7\,ft/day}{0.39}(-0.0369\,ft/ft) = 0.161\,ft/day \approx 58.8\,ft/yr}$$

$$v = -\frac{K}{n_e}\frac{dh}{dx} = -\frac{1.7\,ft/day}{0.18}(-0.0375\,ft/ft) = 0.354\,ft/day \approx 129\,ft/yr$$

The straight-line distance from the auxiliary building of Unit 3 to the unnamed creek south-southwest of the site is about L = 1727 feet, which results in a conservatively estimated groundwater travel time of:

$$\cancel{t = \frac{LR}{v} = \frac{1727\,ft \times 1}{58.8\,ft/yr} \approx 29.4\,yrs}$$

$$t = \frac{LR}{v} = \frac{1727\,ft \times 1}{129\,ft/yr} \approx 13.3\,yrs$$

The estimated concentrations at the end of the pathways originating from each of the two potential release points are given in Table 2.4-227 and Table 2.4-228. Most of the estimated radionuclide concentrations shown in these tables have concentrations less than 1% of their respective maximum permissible concentrations and are eliminated from further consideration because their concentrations would be well below their regulatory limits. Table 2.4-227 and Table 2.4-228 identify the radionuclides that exceed 1% of their maximum permissible concentration. These are H-3, Mn-54, Fe-55, Co 60, Sr-90, Y-90, Ag-110m, I-129, Cs-134, ~~and~~ Cs-137, and Ce-144 for a travel time of ~~17.4~~ 7.71 years and H-3, Fe-55, Co 60, Sr-90, Y-90, I-129, Cs-134, and Cs-137 for a travel time of ~~29.4~~ 13.3 years. These radionuclides are ~~retained for~~ further ~~evaluation~~ evaluated in the following subsection in which adsorption is considered, in addition to radioactive decay.

~~2.4.13.1.2.3~~

2.4.13.1.2.2.2. Transport Considering Radioactive Decay and Adsorption

The radionuclides retained from the screening analysis (H-3, Mn-54, Fe-55, Co-60, Sr-90, Y-90, Ag-110m, I-129, Cs-134, ~~and~~ Cs-137, and Ce-144) were further evaluated considering adsorption and retardation in addition to radioactive decay. Laboratory measurements of onsite materials were used to establish K_d values for Cobalt (Co-60), Strontium (Sr-90), and Cesium (Cs-134 and Cs-137) in saprolite as reported in Attachment H of Reference 217. The lowest reported value within the saprolite material for each radionuclide was used in this analysis (Table 2.4-229). The distribution coefficients for H-3 and I-129 were taken equal to zero because of their chemical characteristics. Because no site-specific data for the distribution coefficients of Mn-54, Fe-55, Ag-110m, ~~and~~ Y-90, and Ce-144 was available, the distribution coefficients for these ~~two~~ nuclides were conservatively taken as equal to zero. Retardation factors were then calculated using Equation 2.4-2 with an effective porosity of n_e = ~~0.39~~ 0.18 and bulk density of ρ_b = 1.41 g/cm^3, based on information provided in Subsection 2.4.12.3.3.

Concentrations were then determined at the point of groundwater discharge in the two unnamed creeks, north-northwest of Unit 2 and south-southwest of Unit 3, using Equations ~~2.4-8, 2.4-13, or 2.4-18~~ 2.4-9, 2.4-14, or 2.4-21 with the appropriate retardation factors. Table 2.4-230 and Table 2.4-231 provide the calculations and results for Units 2 and 3, respectively. The radionuclides with concentrations greater than 1% of their respective maximum permissible concentrations are H-3, Mn-54, Fe-55, Ag-110m, ~~and~~ I-129, and Ce-144 for Unit 2. For Unit 3, the radionuclides with concentrations greater than 1% of their respective maximum permissible concentrations are H-3, Fe-55, and I-129. The transport of H-3, Mn-54, Fe-55, Ag-110m, ~~and~~ I-129, and Ce-144 is analyzed further for Unit 2 and the transport of H-3, Fe-55, and I-129 is analyzed further for Unit 3. Subsection ~~2.4.13.1.2.4.~~ 2.4.13.1.2.2.3 follows the transport of these nuclides through the respective unnamed creeks downstream of the point of the groundwater discharge and into the Broad River.

~~2.4.13.1.2.4~~

2.4.13.1.2.2.3. Transport Considering Radioactive Decay, Adsorption, and Dilution

The ~~H-3, Fe-55, and I-129~~ radionuclides discharging with the groundwater to the two unnamed creeks near the site of Units 2 and 3 would mix with uncontaminated groundwater discharging into the creeks and into the Broad River, leading to further reduction of concentrations. As determined in Subsection ~~2.4.13.1.2.3~~ 2.4.13.1.2.2.2, H-3, Mn-54, Fe-55, Ag-110m, ~~and~~ I-129, and Ce-144 would be discharged from the local groundwater in the unnamed creek north-northwest of Unit 2, and H-3, Fe-55, and I-129 would be discharged from the local groundwater in the unnamed creek south-southwest of Unit 3, as shown on Figure 2.4-252.

For the purpose of evaluating the effects of an accidental release of radioactive liquid effluents on the surface water systems downstream of the discharge point, the average concentration and discharge of the highly diluted liquid effluent discharged from the aquifer was determined. The present analysis is based on the conservative assumption that there is no transverse or longitudinal dispersion in the subsurface.

It is assumed that in the event of an accidental release of the contents of the effluent holdup tank, the liquid will directly enter the saprolite, the most permeable material under Units 2 and 3. The rate at which a release from an effluent holdup tank discharges to surface water is determined by the transport characteristics of the saprolite. A release from an effluent holdup tank would travel through the saturated saprolite to the release points in the two unnamed creeks as shown on Figure 2.4-252.

The discharge rate itself is a function of the Darcy velocity, and the assumed volume and dimensions of the resulting contaminant slug. For Unit 2, the Darcy velocity was calculated to be ~~0.0522~~ 0.0543 feet/day, using a hydraulic conductivity of 1.7 feet/day and a hydraulic gradient of ~~0.0307~~ 0.0319 ft/ft. For Unit 3, the Darcy velocity was calculated to be ~~0.0627~~ 0.0638 feet/day, using a hydraulic conductivity of 1.7 feet/day and a hydraulic gradient of ~~0.0369~~ 0.0375 ft/ft. These values are based on the hydrogeologic characteristics of the saprolite as described previously. The hydraulic gradients are the most conservative based on groundwater levels measured at the site between June 2006 and June 2007. The volume of the liquid release has been assumed to be 22,400 gallons (approximately 2,995 ft^3), which represents 80% of the 28,000-gallon capacity of one effluent holdup tank (NUREG-0800, BTP 11-6 recommends that 80% of the liquid volume be considered in this analysis). Considering the effective porosity of the saprolite (~~0.39~~ 0.18), the volume of the saturated saprolite that would be occupied by the release is:

$$\cancel{V_{saprolite} = \frac{V_{release}}{n_e} = \frac{2{,}995\,ft^3}{0.39} = 7679\,ft^3}$$

$$V_{saprolite} = \frac{V_{release}}{n_e} = \frac{(22{,}400/7.4805)\,ft^3}{0.18} = 16{,}636\,ft^3$$

The shape of the resulting contaminant slug is assumed to be square in plan view and extend vertically throughout the entire saturated thickness of the saprolite. Using 10 feet as a representative saturated thickness (water table to base of saprolite), the slug would have an area of about ~~767.9~~ 1,663.6 square feet in plan view and a width of about ~~27.7~~ 40.8 feet. The cross-sectional area of the contaminant slug normal to the groundwater flow direction would therefore be equal to the product of the saturated thickness, *b* (=10 ft), and the width, *w* (=40.8 ft). This conceptual model of the contaminant slug dimensions in the aquifer is illustrated in Figure 2.4-261. The cross-sectional area of the contaminant slug normal to the groundwater flow direction would therefore be:

A = 10 x ~~27.7~~ 40.8 = ~~277~~ 408 ft^2

The total flow through this area from Unit 2 toward the nearest unnamed creek is estimated to discharge into the unnamed creek to the north-northwest of Unit 2 at a rate, Q_2, of about:

~~$Q_2 = AU_2 = 277 \times 0.0522 \cong 14.46\ ft^3/day \cong 1.67 \times 10^{-4}$ cfs~~

$Q_2 = AU_2 = 408 \times 0.0543 \cong 22.1\ ft^3/day \cong 2.56 \times 10^{-4}$ cfs

The total flow through this area from Unit 3 toward the nearest unnamed creek is estimated to discharge into the unnamed creek to the south-southwest of Unit 3 at a rate, Q_3, of about:

~~$Q_3 = AU_3 = 277 \times 0.0627 \cong 17.37\ ft^3/day \cong 2.01 \times 10^{-4}$ cfs~~

$Q_3 = AU_3 = 408 \times 0.0638 \cong 26.0\ ft^3/day \cong 3.01 \times 10^{-4}$ cfs

These are the flow rates of groundwater contaminated with ~~H-3, Fe-55, and I-129~~ radionuclides that would flow to the unnamed creek at each location. Before reaching the Broad River, the spill would be further diluted by water originating from uncontaminated portions of the local groundwater regime that is flowing into the unnamed creeks downstream of discharge points in the two unnamed creeks.

Upon reaching the Broad River, further dilution of an accidental release of radioactive liquid effluents would result from the natural stream flow into the Parr Reservoir. ~~To add conservatism to the analysis, t~~The 100-year ~~daily~~ low annual mean ~~low~~ flow in the Broad River is used to estimate the dilution factor. ~~This is very conservative because the time scale for groundwater transport is much greater than a day. Therefore, the associated flow rate in the river that would mix with the groundwater discharge would also be greater over a longer duration.~~ The 100-year ~~daily~~ low annual mean ~~low~~ flow in the Broad River at Parr Shoals Dam is ~~125~~ 1,543 cfs, based on a frequency analysis of observed annual flows. Assuming that the accidental liquid effluent release occurs during the 100-year low annual mean flow in the Broad River, the corresponding dilution factor would be equal to ~~$1.67 \times 10^{-4}/125 \cong 1.34 \times 10^{-6}$~~ $2.56 \times 10^{-4} / 1{,}543 \approx 1.66 \times 10^{-7}$ for Unit 2 and ~~$2.01 \times 10^{-4}/125 \cong > 1.61 \times 10^{-6}$~~ $3.01 \times 10^{-4} / 1{,}543 \approx 1.95 \times 10^{-7}$ for Unit 3. Calculation of the dilution factor is illustrated in Table 2.4-232 and Table 2.4-233 for Units 2 and 3, respectively.

This dilution factor is applied to the ~~H-3, Fe-55, and I-129~~ radionuclides concentrations reported in Table 2.4-230 and Table 2.4-231 to account for dilution in addition to radioactive decay and adsorption. Table 2.4-234 summarizes the resulting concentrations, which would represent the concentrations in the surface water at Parr Shoals Dam.

The above analysis of an accidental release of radioactive liquid effluents reaching the surface water system has conservatively neglected the initial dilution provided by the water impounded in the Parr Reservoir. Even at its minimum pool elevation of 256 feet the Parr Reservoir has a storage volume of 2,500 acre-feet available for dilution. Credit for the additional dilution provided by tributary inflow at downstream locations along the Broad River has also not been considered.

2.4.13.1.2.3. Alternative Pathways

2.4.13.1.2.3.1. Screening Analysis: Transport Considering Radioactive Decay Only

For the alternative groundwater pathways discussed in Subsection 2.4.13.1.1, the hypothesized accidental release scenario is identical to that used for the most plausible pathway analyzed in Subsection 2.4.13.1.2.2. The only difference is that for the deep bedrock pathways, it was assumed that the entire 22,400 gallon volume of liquid effluent is instantaneously released directly into the deep bedrock zone, instead of the saprolite as it was in Subsection 2.4.13.1.2.2. The travel time through the floor slab, and saprolite / shallow bedrock zone is neglected, which increases the conservatism of the analysis.

For the alternative eastern pathway through the saprolite to Mayo Creek, the same hydraulic conductivity (K=1.7 ft/day) and effective porosity (n_e = 0.18) were applied as for the western saprolite pathways considered in Subsection 2.4.13.1.2.2.

For the alternative pathways through the deep bedrock zone, a hydraulic conductivity of K=0.4 ft/day and an effective porosity of n_e=0.04 were used. The selected bedrock hydraulic conductivity was measured in the more fractured, upper portion of the deep bedrock zone where hydraulic conductivities are highest and any transport through bedrock would be expected to occur. Measured hydraulic conductivities in the bedrock decline with increasing depth below ground, indicating that the upper part of the bedrock is the most fractured. The value of the effective porosity for the deep bedrock was based on the assumption that the total porosity of the bedrock is 0.05. This value is the mean of four measured porosity values in the bedrock at depth of about 70 feet elsewhere in the Piedmont, the physiographic region where the VCSNS site is located (Reference 261). The effective porosity was assumed to be smaller than the total porosity.

The piezometric level at the point of discharge for the alternative pathway to the Broad River was estimated to be 266 ft above mean sea level (msl), which is the normal water surface in the Parr Reservoir. The piezometric level at the point of discharge to Mayo Creek was estimated to be and 320 ft msl, the approximate elevation of the Mayo Creek channel at the discharge point for this pathway.

As in Subsection 2.4.13.1.2.2.1, the average horizontal hydraulic gradient, dh/dx, was calculated for each groundwater pathway from its length, L, and from the hydraulic head at its beginning (at Unit 2 or at Unit 3), h_0, and at its end (point of discharge), h_1, using the expression $\frac{dh}{dx} = \frac{h_1 - h_0}{L}$. The resulting hydraulic gradients were entered into Equation 2.4-3 to determine the average linear groundwater velocity for each pathline. Straight-line distances were used in these calculations in order to obtain conservative estimates of the hydraulic gradients and groundwater velocities. Initial groundwater travel times were conservatively calculated from these lengths and velocities using Equation 2.4-10 with R_1 = 1. The input parameters and resulting hydraulic gradients, groundwater velocities, and travel times are given in Table 2.4-237. It may be seen

from this table that the pathlines to the unnamed creeks nearest to Units 2 and 3 have the steepest hydraulic gradients and the shortest travel times.

For the case of an alternative eastern pathline to a hypothetical private well on the SCE&G property line, it was assumed that the hydraulic gradient and groundwater velocity between Unit 2 and Mayo Creek could be extrapolated to the east of Mayo Creek. The distance from Unit 2 to the hypothetical eastern well was estimated to be 5400 ft. Using this distance, and the same bedrock K and n_e values as above, travel time from Unit 2 to the private well was estimated to be 93.1 years. As mentioned above, this alternative groundwater pathway is considered implausible. Nevertheless, it is analyzed to demonstrate the conservatism of the safety analysis.

The estimated concentrations at the endpoint of each of the alternative pathlines originating from the postulated release points are given in Table 2.4-242, Table 2.4-247, Table 2.4-252, Table 2.4-257. Most of the estimated radionuclide concentrations shown in these tables have concentrations less than 1% of their respective maximum permissible concentrations. Table 2.4-243, Table 2.4-248, Table 2.4-253, and Table 2.4-258 identify the radionuclides that exceed 1% of their maximum permissible concentration. These radionuclides are summarized in Table 2.4-238.

Table 2.4-237 and Table 2.4-238 show that, when only radioactive decay is considered, the pathlines with the shortest travel times have the most radionuclides with concentrations in excess of their maximum permissible concentrations. The transport of nuclides listed in Table 2.4-238 is further analyzed for transport considering the effect of adsorption.

2.4.13.1.2.3.2. Transport Considering Radioactive Decay and Adsorption

For the eastern pathway through the saprolite, the retardation factors are discussed in Subsection 2.4.13.1.2.2.2. Retardation factors for the bedrock were calculated using Equation 2.4-2 with an effective porosity of n_e = 0.04 and bulk density of ρ_b = 2.65 g/cm^3. The bulk density for bedrock was estimated from the specific gravity for saprolite (G_s = 2.79, from Table 2.4-220) using the expression $\rho_b^{Bedrock} = G_s \times (1 - n_{Bedrock})$, where $n_{Bedrock}$ is 0.05 (Reference 261).

Using the same approach as above, the concentration of each radionuclide at the point of groundwater discharge was determined for the alternative pathways using Equations 2.4-9, 2.4-14, or 2.4-21 and the appropriate initial concentration, decay rate, and retardation factor. Laboratory measurements of onsite materials were used to establish K_d values for Cobalt (Co-60), Strontium (Sr-90), and Cesium (Cs-134 and Cs-137) in bedrock as reported in Attachment H of Reference 217. K_d values for other radionuclides, for which onsite measurements were not available, are set to zero. Retardation factors for bedrock were then calculated using Equation 2.4-2 with an effective porosity of n_e = 0.04 and bulk density of □$_b$ = 2.65 g/cm^3.

The radionuclides with resulting concentrations greater than 1% of their respective maximum permissible concentrations are H-3 and I-129 for the alternative pathways, as summarized in

Table 2.4-239. Their concentrations for each of the the alternative pathways are reported in Table 2.4-243, Table 2.4-248, Table 2.4-253, and Table 2.4-258. The transport of H-3 and I-129 through the western bedrock pathway and through the two eastern pathways discharging into Mayo Creek is analyzed further for these pathways in Subsection 2.4.13.1.2.3.3 to account for the effect of dilution into surface waters. The transport of H-3 and I-129 through the eastern bedrock pathway to a hypothetical well on the SCE&G property line, which is not subject to dilution in surface water, is analyzed further in Subsection 2.4.13.1.2.3.4 to account for the effect of dispersion in groundwater.

2.4.13.1.2.3.3. Transport Considering Radioactive Decay, Adsorption, and Dilution

The dilution factors and resulting surface water concentrations for radionuclides discharging from the alternative groundwater pathways were calculated following the same approach and equations for the discharge rates as in Subsection 2.4.13.1.2.2.3.

For the eastern groundwater pathways discharging to Mayo Creek, compliance is evaluated where the creek crosses Parr Road. For the eastern groundwater pathway to a future private well on the SCE&G property line, compliance with 10 CFR Part 20 is evaluated at the hypothetical well.

As discussed in Subsection 2.4.13.1.2.2.3, estimating the dilution to surface waters requires first the calculation of the dimensions and the effluent slug in the subsurface and the corresponding rate of groundwater discharge that would carry the effluent into the receiving surface water body. The computation of the contaminant slug dimensions is shown in Table 2.4-240 for the saprolite and bedrock pathway. The cross-sectional areas, *A*, shown in Table 2.4-240 are used in the calculation of the discharge rates from the saprolite and bedrock aquifers for the various groundwater pathlines.

As stated in Subsection 2.4.13.1.2.2.3, the 100-year low annual mean flow in the Broad River at Parr Shoals Dam is 1,543 cfs. The 100-year low annual mean flow in Mayo Creek at Parr Road is 0.39 cfs. This flow was estimated from a regional regression analysis of annual flow records for small watersheds in the Piedmont physiographic region of South Carolina. The dilution factors are calculated using the 100-year low annual mean flow in the receiving stream. Calculation of the dilution factors is illustrated in Table 2.4-244, Table 2.4-249, and Table 2.4-254 for the alternative groundwater pathways. This calculation is also summarized in Table 2.4-241. The alternative pathway to the hypothetical private well is not listed in this table because dilution is not applicable to this case.

The dilution factors shown in Table 2.4-241 are applied to the radionuclides whose concentrations exceed one percent of their maximum permissible concentrations as reported in Table 2.4-243, Table 2.4-248, and Table 2.4-253 for the three alternative pathways discharging in surface waters, to account for dilution in addition to radioactive decay and adsorption. The resulting groundwater concentrations (before dilution) and surface water concentrations (after dilution) are shown in Table 2.4-245, Table 2.4-250, and Table 2.4-255. These tables show that

all radionuclide concentrations are below their respective maximum permissible concentrations for the three alternative groundwater pathways discharging in surface waters.

2.4.13.1.2.3.4. Transport Considering Radioactive Decay, Adsorption, and Dispersion

This subsection considers the effects of radioactive decay, adsorption, and dispersion for the groundwater pathway through the deep bedrock zone to a hypothetical private well at the SCE&G property boundary to the east of Mayo Creek. No dilution to surface water would occur in this case. Results presented in Table 2.4-258 indicate that if only the effect of radioactive decay and adsorption is taken into account, the groundwater concentration of I-129 at this location would be about 3.6% as large as the maximum permissible concentration for Units 2, which is acceptable. However, the groundwater concentration of H-3 (tritium) at this location would exceed its maximum permissible concentration by a factor of 5.42 for a release from Unit 2. The sum of the ratios of the concentrations of each nuclide over its corresponding maximum permissible concentration for the eastern pathway through the bedrock to a well east of Mayo Creek is 5.46 for an accidental effluent release from Unit 2. The difference between this result and the results for the other pathways is due to the lack of dilution to surface water for this pathway.

Because of this result, a more realistic approach to the analysis of the bedrock pathway to the hypothetical well on the eastern SCE&G property boundary was used to account for the effect of dispersion, which was neglected in the analysis of all other pathways.

The analytical solution of the two-dimensional mass transport equation given by Equation 2.4-26 was used to calculate tritium concentrations at the eastern SCE&G property boundary. Equation 2.4-26 accounts for advection, radioactive decay, adsorption and longitudinal and lateral dispersion. This modeling approach is still conservative, because it neglects the effect of dispersion in the vertical direction, which would further reduce the radionuclide concentrations. For tritium there is no retardation due to adsorption, i.e. $R_d = 1$.

The longitudinal dispersion coefficient was estimated as the product of the dispersivity and the transport velocity. The dispersivity is a function of the scale of transport. A critical review and evaluation of a large number of dispersivity data presented by Gelhar, et al (Reference 254) suggests that the longitudinal dispersivity is approximately equal to 10 percent of the travel distance. Using this relationship for the distance of the receptor point from the source (5400 ft), a longitudinal dispersivity of $\square_x = 540$ ft is obtained. Using Equation (32) in Reference 255 for a distance of 5400 ft, a longitudinal dispersivity equal to 400 ft is calculated. Xu and Eckstein (Reference 259) statistically evaluated the relationship between distance from the source and dispersivity. Using Equation (14b) from their work (provided as Equation 2.4-31 above) for a distance of 5400 ft, a longitudinal dispersivity of $\square_x = 45.7$ ft is obtained. Based on these results, it was decided to consider the range of estimated dispersivities (45.7 to 540 ft) to identify conditions leading to the most adverse contamination. For two-dimensional solute transport, the lateral dispersivity must also be estimated. Bear (Reference 260) indicates that the ratio of longitudinal to transverse dispersivity ranges from 5 to 24. In the lateral direction, D was

therefore reduced by a factor of 10. Since a two-dimensional equation was selected, vertical dispersion is not considered.

Plots of the resulting predicted H-3 concentrations in the groundwater at the eastern SCE&G property boundary are shown in Figure 2.4-262 for the two bounding dispersivity values mentioned above (540 and 45.7 ft) as functions of time since the occurrence of an accidental effluent release.

Figure 2.4-262 shows that the maximum predicted H-3 concentration at the eastern SCE&G property boundary is about 5.55×10^{-5} µCi/cm^3 for a dispersivity value of 45.7 ft. This peak concentration is approximately 5.6% of the maximum permissible concentration of 1×10^{-3} µCi/cm^3, which is acceptable. It is noted that using a higher dispersivity value (540 ft) produces an earlier, but lower, peak H-3 concentration than the dispersivity of 45.7 ft. This is because, in the case of higher dispersion, the H-3 plume will be spread over a larger area, leading to earlier arrival of H-3 at the SCE&G boundary.

The analysis of nuclides with much longer half-lives suggests that the effect of dispersion is more pronounced in this case. Figure 2.4-263 shows the concentration of I-129 at the SCE&G site boundary. In this case where radioactive decay is not a factor (the half-life of I-129 is 1.57×10^7 years), the effect of higher dispersivity is more apparent. Increasing the longitudinal dispersivity from 45.7 to 540 ft, while maintaining the 10:1 ratio between longitudinal and lateral values, reduces the peak concentration of I-129 by a factor of about 10.7.

The sum of the ratios of the concentrations of each nuclide over the corresponding maximum permissible concentration for the eastern pathway through the bedrock to the eastern SCE&G property boundary is 0.0277 for an accidental effluent release from Unit 2 and a dispersivity of 540 ft, and is 0.0562 for a dispersivity of 45.7 ft. Only Unit 2 was examined using the analytical model because it is located closer to the eastern SCE&G property boundary and its hydraulic gradient to Mayo Creek is steeper. The concentrations from an effluent release from Unit 3 would be lower because of its longer distance from the eastern SEC&G property boundary..

In conclusion, it has been determined that an accidental liquid release of effluents into the deep bedrock zone of the groundwater system at the VCSNS site would not exceed 10 CFR Part 20 limits for radionuclide concentrations in a private well located at the SCE&G property boundary to the east of Mayo Creek.

2.4.13.2. Accidental Releases to Surface Waters

2.4.13.2.1. Direct Releases to Surface Waters

No outdoor tanks contain radioactivity in the AP1000 design (Reference 252). In particular, the AP1000 design does not require boron changes for load follow and does not recycle boric acid or reactor coolant water, so the boric acid tank is not radioactive.

2.4.13.3. Compliance with 10 CFR Part 20

Compliance with 10 CFR Part 20 is required for the nearest potable water supply in an unrestricted area. There are no potable water supplies between Units 2 and 3 and the Broad River. The nearest downstream potable water supply is the Columbia Canal Water Plant, located approximately 28 miles downstream. Therefore, compliance with 10 CFR Part 20 is evaluated in the Broad River downstream of the site.

The radionuclide transport analysis presented above demonstrates that each of the radionuclides that could be accidentally released to the groundwater is individually below its maximum permissible concentration. 10 CFR Part 20, Appendix B, Table 2 imposes additional requirements when the identity and concentration of each radionuclide in a mixture are known. In this case, the ratio present in the mixture and the concentration otherwise established in Appendix B for the specific radionuclide not in a mixture must be determined. The sum of such ratios for all of the radionuclides in the mixture may not exceed "1" (i.e., "unity").

This sum-of-fractions approach has been applied to the radionuclide concentrations conservatively estimated above for each of the potential groundwater pathways considered. Results are summarized in ~~Table 2.4-235 and Table 2.4-236~~ Table 2.4-260. ~~The~~ For the saprolite pathways to the nearby unnamed creeks, the sum of the ratios of the concentration of each nuclide over the corresponding maximum permissible concentration for Units 2 and 3 are ~~5.32×10^{-4}~~ 2.10×10^{-4} and ~~3.01×10^{-3}~~ 7.38×10^{-4} respectively, which is below unity. The ratios for other alternative pathways are also below unity, as may be seen from Table 2.4-260. Therefore, it is concluded that an accidental liquid release of effluents in groundwater would not exceed 10 CFR Part 20 limits.

No other hazards exist close to the site that could affect the radioactive concentration from the postulated tank failure related to accidental release of radioactive liquid effluents to ground and surface waters for the ~~proposed~~ plant site. This includes both seismic and non-seismic events.

The following references will be modified or added to FSAR Section 2.4.13:

252. Westinghouse: Liquid Tank Rupture Evaluation (COL Item 15.7.6), AP1000 Calculation Note Number APP-WLS-M3C-021, Rev. 1, ~~2006~~2007.

253. Not Used.

254. Gelhar, L. W., C. Welty, and K. R. Rehfeldt, A critical review of data on field-scale dispersion in aquifers, Water Resources Research, 28(7), 1955-1974, 1992.

255. Neuman,S . P., Universal scaling of hydraulic conductivities and dispersivities in geologic media, Water Resources Research, 26(8), 1749-1758, 1990.

256. Codell, R.B., and J.D. Duguid, Chapter 4 - Transport of Radionuclides in Groundwater, in NUREG/CR-3332, Part 1 of 2: Radiological Assessment: A Textbook on Environmental Dose

Analysis, J.E. Till and H.R. Meyer, eds., prepared for U.S. Nuclear Regulatory Commission, Sept. 1983.

257. Not Used.

258. Stephens, D.B., K. Hsu, M.A. Prieksat, M.D. Ankeny, N. Blandford, T.L. Roth, J.A. Kelsey, and J.R. Whitworth, A comparison of estimated and calculated effective porosity, *Hydrogeology Journal*, Volume 6, pages 156-165, 1998.

259. Xu, M., and Y. Eckstein, Use of Weighted Least-Squares Method in Evaluation of the Relationship between Dispersivity and Field Scale, Ground-Water, 33(6), 905-908, 1995.

260. Bear, J., *Hydraulics of Groundwater*, McGraw-Hill, 1979.

261. Harned, D.A., and C.C. Daniel III, "The Transition Zone between Bedrock and Regolith: Conduit for Contamination?" in *Ground Water in the Piedmont*, edited by C.C. Daniel III, R.K. White, and P.A. Stone, published by Clemson University, Clemson, SC, Oct. 1989.

The following Revised FSAR Tables are attached:

FSAR Table 2.4-225
FSAR Table 2.4-226
FSAR Table 2.4-227
FSAR Table 2.4-228
FSAR Table 2.4-229
FSAR Table 2.4-230
FSAR Table 2.4-231
FSAR Table 2.4-232
FSAR Table 2.4-233
FSAR Table 2.4-234
FSAR Table 2.4-235
FSAR Table 2.4-236

The following new FSAR Tables are attached:

FSAR Table 2.4-237
FSAR Table 2.4-238
FSAR Table 2.4-239
FSAR Table 2.4-240
FSAR Table 2.4-241
FSAR Table 2.4-242
FSAR Table 2.4-243
FSAR Table 2.4-244
FSAR Table 2.4-245
FSAR Table 2.4-246

FSAR Table 2.4-247
FSAR Table 2.4-248
FSAR Table 2.4-249
FSAR Table 2.4-250
FSAR Table 2.4-251
FSAR Table 2.4-252
FSAR Table 2.4-253
FSAR Table 2.4-254
FSAR Table 2.4-255
FSAR Table 2.4-256
FSAR Table 2.4-257
FSAR Table 2.4-258
FSAR Table 2.4-259
FSAR Table 2.4-260

The Following FSAR Figures will be modified:

FSAR Figure 2.4-251
FSAR Figure 2.4-252
FSAR Figure 2.4-253
FSAR Figure 2.4-254
FSAR Figure 2.4-255

The Following New FSAR Figures will be added:

FSAR Figure 2.4-256
FSAR Figure 2.4-257
FSAR Figure 2.4-258
FSAR Figure 2.4-259
FSAR Figure 2.4-260
FSAR Figure 2.4-261
FSAR Figure 2.4-262
FSAR Figure 2.4-263

ASSOCIATED ATTACHMENTS:

FSAR Table 2.4-225
FSAR Table 2.4-226
FSAR Table 2.4-227
FSAR Table 2.4-228
FSAR Table 2.4-229
FSAR Table 2.4-230
FSAR Table 2.4-231
FSAR Table 2.4-232
FSAR Table 2.4-233

FSAR Table 2.4-234
FSAR Table 2.4-235
FSAR Table 2.4-236
FSAR Table 2.4-237
FSAR Table 2.4-238
FSAR Table 2.4-239
FSAR Table 2.4-240
FSAR Table 2.4-241
FSAR Table 2.4-242
FSAR Table 2.4-243
FSAR Table 2.4-244
FSAR Table 2.4-245
FSAR Table 2.4-246
FSAR Table 2.4-247
FSAR Table 2.4-248
FSAR Table 2.4-249
FSAR Table 2.4-250
FSAR Table 2.4-251
FSAR Table 2.4-252
FSAR Table 2.4-253
FSAR Table 2.4-254
FSAR Table 2.4-255
FSAR Table 2.4-256
FSAR Table 2.4-257
FSAR Table 2.4-258
FSAR Table 2.4-259
FSAR Table 2.4-260

FSAR Figure 2.4-251
FSAR Figure 2.4-252
FSAR Figure 2.4-253
FSAR Figure 2.4-254
FSAR Figure 2.4-255
FSAR Figure 2.4-256
FSAR Figure 2.4-257
FSAR Figure 2.4-258
FSAR Figure 2.4-259
FSAR Figure 2.4-260
FSAR Figure 2.4-261
FSAR Figure 2.4-262
FSAR Figure 2.4-263

Table 2.4-225 Radionuclide Inventory for Tank Rupture

Radionuclide	Design Basis Reactor Coolant Activity[a] (□Ci/g)	Reactor Coolant Concentration[b] (□Ci/cm^3)	Effluent Holdup Tank Concentration[c] (□Ci/cm^3)
H-3	1.00E+00	1.00E+00	1.01E+00
Cr-51	1.30E-03	1.30E-03	1.31E-03
Mn-54	6.70E-04	6.70E-04	6.77E-04
Mn-56	1.70E-01	1.70E-01	1.72E-01
Fe-55	5.00E-04	5.00E-04	5.05E-04
Fe-59	1.30E-04	1.30E-04	1.31E-04
Co-58	1.90E-03	1.90E-03	1.92E-03
Co-60	2.20E-04	2.20E-04	2.22E-04
Br-83	3.20E-02	1.54E-02	1.55E-02
Br-84	1.70E-02	8.16E-03	8.24E-03
Br-85	2.00E-03	9.60E-04	9.70E-04
Rb-88	1.50E+00	7.20E-01	7.27E-01
Rb-89	6.90E-02	3.31E-02	3.35E-02
Sr-89	1.10E-03	5.28E-04	5.33E-04
Sr-90	4.90E-05	2.35E-05	2.38E-05
Sr-91	1.70E-03	8.16E-04	8.24E-04
Sr-92	4.10E-04	1.97E-04	1.99E-04
Y-90	1.30E-05	6.24E-06	6.30E-06
Y-91m	9.20E-04	4.42E-04	4.46E-04
Y-91	1.40E-04	6.72E-05	6.79E-05
Y-92	3.40E-04	1.63E-04	1.65E-04
Y-93	1.10E-04	5.28E-05	5.33E-05
Nb-95	1.60E-04	7.68E-05	7.76E-05
Zr-95	1.60E-04	7.68E-05	7.76E-05
Mo-99	2.10E-01	1.01E-01	1.02E-01
Tc-99m	2.00E-01	9.60E-02	9.70E-02
Ru-103	1.40E-04	6.72E-05	6.79E-05
Rh-103m	1.40E-04	6.72E-05	6.79E-05
Rh-106	4.50E-05	2.16E-05	2.18E-05
Ag-110m	4.00E-04	1.92E-04	1.94E-04
Te-127m	7.60E-04	3.65E-04	3.68E-04
Te-129m	2.60E-03	1.25E-03	1.26E-03
Te-129	3.80E-03	1.82E-03	1.84E-03
Te-131m	6.70E-03	3.22E-03	3.25E-03
Te-131	4.30E-03	2.06E-03	2.08E-03
Te-132	7.90E-02	3.79E-02	3.83E-02
Te-134	1.10E-02	5.28E-03	5.33E-03
I-129	1.50E-08	7.20E-09	7.27E-09
I-130	1.10E-02	5.28E-03	5.33E-03
I-131	7.10E-01	3.41E-01	3.44E-01
I-132	9.40E-01	4.51E-01	4.56E-01
I-133	1.30E+00	6.24E-01	6.30E-01

Table 2.4-225 (Continued, page 2 of 2)

Radionuclide	Design Basis Reactor Coolant Activity[a] (□Ci/g)	Reactor Coolant Concentration[b] (□Ci/cm^3)	Effluent Holdup Tank Concentration[c] (□Ci/cm^3)
I-134	2.20E-01	1.06E-01	1.07E-01
I-135	7.80E-01	3.74E-01	3.78E-01
Cs-134	6.90E-01	3.31E-01	3.35E-01
Cs-136	1.00E+00	4.80E-01	4.85E-01
Cs-137	5.00E-01	2.40E-01	2.42E-01
Cs-138	3.70E-01	1.78E-01	1.79E-01
Ba-137m	4.70E-01	2.26E-01	2.28E-01
Ba-140	1.00E-03	4.80E-04	4.85E-04
La-140	3.10E-04	1.49E-04	1.50E-04
Ce-141	1.60E-04	7.68E-05	7.76E-05
Ce-143	1.40E-04	6.72E-05	6.79E-05
Pr-143	1.50E-04	7.20E-05	7.27E-05
Ce-144	1.20E-04	5.76E-05	5.82E-05
Pr-144	1.20E-04	5.76E-05	5.82E-05

[a] Values from AP1000 DCD, Table 11.1-2.
[b] For tritium (H-3) a coolant concentration of 1.0 µCi/g is used; corrosion products (Cr-51, Mn-54, Mn-56, Fe-55, Fe-59, Co-58 and Co-60) are taken directly from the AP1000 DCD, Table 11.1-2; and other radionuclides are based on the AP1000 DCD, Table 11.1-2 multiplied by 0.12/0.25. The density of all liquids is assumed to be 1 g/cm^3.

[c] Values are 101% of the reactor coolant concentrations.

Replace FSAR Tables 2.4-226 through 2.4-236 with the following equivalent new tables, which contain revised data:

Table 2.4-226 Hydraulic Gradient Calculation from Units 2 and 3 to the Nearby Unnamed Creeks

Unit 2 - Calculation of Hydraulic Gradient						
*using maximum observed groundwater level						
Boring	**Northing**	**Easting**	**Distance**			**WL Elevation**
			(ft)			(ft)
OW-205b	892842	1903193				367.15
Groundwater discharge point at unnamed creek to the north-northwest of Unit 2 (Point A)			850			340
					Change in Head =	27.15
					Hydraulic Gradient =	**0.0319**
Unit 3 - Calculation of Hydraulic Gradient						
*using maximum observed hydraulic gradient between OW-305 and OW-618.						
Boring	**Northing**	**Easting**	**Distance**			**WL Elevation**
			(ft)			(ft)
OW-305	891997	1902858				368.35
OW-618 (Point B)	890956	1901480	1727			303.55
					Change in Head =	64.8
					Hydraulic Gradient =	**0.0375**

Table 2.4-227 Results of Transport Analysis with Radioactive Decay Only - Discharge to Unnamed Creek to North-Northwest from Unit 2 (travel time of 7.71 years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics							Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	MPC[e] (μCi/cm^3)	C_0[c] (μCi/cm^3)	K1	K2	K3	C[d] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				6.55E-01	6.55E+02
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				3.13E-34	6.27E-31
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				1.32E-06	4.40E-02
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				6.97E-05	6.97E-01
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				1.14E-23	1.14E-18
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				2.01E-15	1.00E-10
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				8.07E-05	2.69E+01
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		8.63E-21	1.08E-15
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				1.98E-05	3.96E+01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		1.98E-05	2.83E+00
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	2.34E-19	2.92E-14
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
0	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				4.33E-18	2.17E-13
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		3.21E-20	1.07E-15
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	9.63E-18	3.21E-13
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				1.77E-26	5.91E-22
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		1.77E-26	2.95E-24
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				7.85E-08	1.31E-02
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		1.04E-09	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				6.08E-12	6.76E-07
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		5.96E-12	5.96E-08
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				7.18E-29	1.03E-23
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		4.67E-29	1.17E-25
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	1.09E-106	1.09E-100
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				2.50E-262	2.77E-257
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		2.57E-262	2.57E-258
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	2.44E-163	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				2.50E-02	2.78E+04
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				8.65E-66	1.44E-60
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				2.03E-01	2.03E+05
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		1.92E-01	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				7.90E-71	9.88E-66
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		9.11E-71	1.01E-65
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				6.18E-31	2.06E-26
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		2.25E-67	1.13E-62
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				6.00E-08	2.00E-02
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		1.07E-09	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	6.00E-08	1.00E-04

(a) Values are taken from ~~Table E.1 of NUREG/CR-5512 (Reference 216), with the exception of Sr-92, Rh-106, Ba-137m, Ag-110, Xe-133, Xe-133m, Xe-135m, and PR-144m, which are taken~~ from ICRP Publication 38 (Reference 210)
(b) Values calculated from Equation 2.4-4.
(c) Values from ~~10 CFR Part 20, Appendix B, Table 2, Column 2~~ Table 2.4-225.
(d) Values calculated from ~~Table 2.4-225.~~ Equation 2.4-9, 2.4-14, or 2.4-21 depending on position in decay chain.
(e) Values ~~calculated~~ from ~~Equation 2.4-8, 2.4-13, or 2.4-18 depending on position in decay chain~~ 10 CFR Part 20, Appendix B, Table 2, Column 2.
(f) Maximum Permissible Concentration (MPC) is not available.
Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-228 Results of Transport Analysis with Radioactive Decay Only - Discharge to Unnamed Creek to South-Southwest from Unit 3 (Travel Time of 13.3 Years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics							Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	MPC[e] (μCi/cm^3)	C_0[c] (μCi/cm^3)	K1	K2	K3	C[d] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				4.78E-01	4.78E+02
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				1.52E-56	3.03E-53
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				1.40E-08	4.66E-04
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				1.64E-05	1.64E-01
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				1.46E-37	1.46E-32
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				3.73E-24	1.87E-19
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				3.86E-05	1.29E+01
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		4.96E-33	6.20E-28
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				1.73E-05	3.46E+01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		1.73E-05	2.47E+00
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	6.34E-30	7.93E-25
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				9.51E-28	4.75E-23
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		7.05E-30	2.35E-25
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	2.11E-27	7.05E-23
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				3.31E-42	1.10E-37
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		3.31E-42	5.51E-40
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				2.64E-10	4.41E-05
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		3.52E-12	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				1.30E-17	1.44E-12
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		1.27E-17	1.27E-13
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				2.88E-47	4.11E-42
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		1.87E-47	4.68E-44
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	1.43E-183	1.43E-177
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				0.00E+00	0.00E+00
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		0.00E+00	0.00E+00
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	3.42E-281	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				3.78E-03	4.20E+03
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				5.63E-113	9.39E-108
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				1.78E-01	1.78E+05
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		1.68E-01	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				1.68E-119	2.10E-114
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		1.94E-119	2.15E-114
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				5.91E-50	1.97E-45
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		5.85E-113	2.92E-108
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				4.00E-10	1.33E-04
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		7.11E-12	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	4.00E-10	6.66E-07

Notes (a) to (f): See notes below Table 2.4-227.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-229 Co, Sr, and Cs K_d values from Laboratory Testing

SRNL ID #	Boring	Lithology	K_d (mL/g) **Co**	K_d (mL/g) **Sr**	K_d (mL/g) **Cs**
401	B-205 (98-100 bgs)	Bedrock	493.9	13.8	106.4
402		Bedrock	74.1	1.9	3.0
403	B-212/212a (86-96 bgs)	Bedrock	735.6	34.4	110.2
404		Bedrock	24.6	0.9	2.1
405		Bedrock	300.3	8.3	8.5
406		Bedrock	359.5	7.6	11.2
407		Bedrock	252.6	2.3	3.0
408		Bedrock	26.1	0.7	1.0
409	B-305 (64-64.5 bgs)	Bedrock	549.5	14.2	24.7
410		Bedrock	19.2	8.2	6.5
411	B-305 (59-60 bgs)	MWR	788.7	83.5	140.2
412	B-327 (56-59 bgs)	MWR	658.1	86.8	99.7
413	B-333 (63-65 bgs)	PWR	1433.4	134.8	730.4
414	B-627 (66.5 -76.5 bgs)	Bedrock	387.7	33.9	1035.1
415		Bedrock	4.4	13.4	93.8
416	B-212/212a (#14 (48.5-50 bgs)	Saprolite	676.1	62.0	89.3
417	B-212/212a (#18 (58.5-60 bgs)	PWR	390.8	45.0	81.5
418	B-620 #12 (38.5-40 bgs)	Saprolite	415.9	38.5	71.0
419	B-627 #9 (23.5-25 bgs)	Saprolite	1576.4	67.9	512.6
420	B-627 #14 (47-48.5bgs); #15 (53.5-55 bgs)	PWR	1105.3	63.9	2240.3
	Minimum reported K_d in Saprolite =		415.9	38.5	71.0
	Minimum reported K_d in Bedrock (and lowest overall) =		4.4	0.7	1.0

Values from Mactec Data Report Attachment H – Kd Distribution Coefficient Test Results Table 5 (Reference 217).
bgs = below ground surface; MWR = moderately weathered rock; PWR = partially weathered rock.

Table 2.4-230 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 2 – Saprolite Pathway to Unnamed Creek to North-Northwest

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (μCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (μCi/cm^3)	MPC[e] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	6.55E-01	1.00E-03	65501%
Mn-54		3.13E+02				2.21E-03	6.77E-04	0.00	1.00	1.32E-06	3.00E-05	4%
Fe-55		9.86E+02				7.03E-04	5.05E-04	0.00	1.00	6.97E-05	1.00E-04	70%
Co-60		1.93E+03				3.59E-04	2.22E-04	415.90	3249.64	0.00E+00	3.00E-06	0%
Sr-90		1.06E+04				6.54E-05	2.38E-05	38.50	301.73	1.71E-29	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	1.85E-29	7.00E-06	0%
Ag-110m		2.50E+02				2.77E-03	1.94E-04	0.00	1.00	7.85E-08	6.00E-06	1%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-134		7.53E+02				9.21E-04	3.35E-01	71.00	555.59	0.00E+00	9.00E-07	0%
Cs-137		1.10E+04				6.30E-05	2.42E-01	71.00	555.59	3.49E-44	1.00E-06	0%
Ce-144		2.84E+02				2.44E-03	5.82E-05	0.00	1.00	6.00E-08	3.00E-06	2%

Travel time = 7.71 years
Effective porosity = 0.18
Bulk density = 1.41 g/cm^3

Notes:
a) Values from ~~Table E.1, NUREG/CR-5512~~ ICRP Publication 38 (Reference ~~216~~ 210).
b) Values calculated from Equation 2.4-4.
c) Values from Table 2.4-225.
d) ~~Values calculated from Equation 2.4-2.~~ Values calculated from Equation 2.4-9, 2.4-14, or 2.4-21 depending on position in decay chain.
e) ~~Values calculated from Equation 2.4-8, 2.4-13, or 2.4-18 depending on position in decay chain.~~ Values from 10 CFR Part 20, Appendix B, Table 2, Column 2.
f) ~~Values from 10 CFR Part 20, Appendix B, Table 2, Column 2.~~ Values calculated from Equation 2.4-2.
Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-231 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 3 – Saprolite Pathway to Unnamed Creek to South-Southwest

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (µCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (µCi/cm^3)	MPC[e] (µCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	4.78E-01	1.00E-03	47774%
Fe-55		9.86E+02				7.03E-04	5.05E-04	0.00	1.00	1.64E-05	1.00E-04	16%
Co-60		1.93E+03				3.59E-04	2.22E-04	415.90	3249.64	0.00E+00	3.00E-06	0%
Sr-90		1.06E+04				6.54E-05	2.38E-05	38.50	301.73	4.34E-47	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	4.69E-47	7.00E-06	0%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-134		7.53E+02				9.21E-04	3.35E-01	71.00	555.59	0.00E+00	9.00E-07	0%
Cs-137		1.10E+04				6.30E-05	2.42E-01	71.00	555.59	2.10E-75	1.00E-06	0%

Travel time = 13.3 years
Effective porosity = 0.18
Bulk density = 1.41 g/cm$_3$

Notes (a) to (f): See notes below Table 2.4-230.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-232 Calculation of Dilution Factor by the Broad River for Unit 2 – Saprolite Pathways

Tank volume	28,000	gallons
Spill volume (80% tank volume)	22,400	gallons
	2994	cf
Contaminated Aquifer Volume	16636	cf
Contaminated Aquifer Area	1663.6	ft^2
Effective Porosity	0.18	
Darcy velocity	0.0543	ft/day
Unit thickness (i.e. saprolite layer)	10	ft
Contaminanted Aquifer Width	40.8	ft
Contaminated cross-sectional area	408	ft^2
Flow Rate	22.1	cf/day
	2.56E-04	cfs
	1.15E-01	gpm
Minimium River flow[1]	1543	cfs
Dilution Factor	**1.66E-07**	

Notes:
1. 100-year low annual mean flow of the Broad River at Parr Shoals Dam.

Table 2.4-233 Calculation of Dilution Factor by the Broad River for Unit 3– Saprolite Pathways

Tank volume	28,000	gallons
Spill volume (80% tank volume)	22,400	gallons
	2994.44	cf
Contaminated Aquifer Volume	16635.80	cf
Contaminated Aquifer Area	1663.58	ft^2
Effective Porosity	0.18	
Darcy velocity	0.0638	ft/day
Unit thickness	10	ft
Contaminanted Aquifer Width	40.8	ft
Contaminated cross-sectional area	408	ft^2
Flow Rate	26.0	cf/day
	3.01E-04	cfs
	1.35E-01	gpm
Minimium River flow[1]	1543	cfs
Dilution Factor	**1.95E-07**	

Notes:
1. 100-year low annual mean flow of the Broad River at Parr Shoals Dam.

Table 2.4-234 Transport Analysis Considering Radioactive Decay, Adsorption, and Dilution – Saprolite Pathways to the Unnamed Creeks

Unit 2				
Radionuclide	MPC[1] (μCi/cm^3)	Ground Water Concentration[2] (μCi/cm^3)	Surface Water Concentration[3] (μCi/cm^3)	Surface Water Concentration / MPC
H-3	1.00E-03	6.55E-01	1.09E-07	1.09E-04
Mn-54	3.00E-05	1.32E-06	2.19E-13	7.31E-09
Fe-55	1.00E-04	6.97E-05	1.16E-11	1.16E-07
Ag-110m	6.00E-06	7.85E-08	1.30E-14	2.17E-09
I-129	2.00E-07	7.28E-09	1.21E-15	6.04E-09
Ce-144	3.00E-06	6.00E-08	9.97E-15	3.32E-09

1. 10 CFR Part 20, Appendix B, Table 2, Column 2
2. Table 2.4-230
3. Surface water concentration = groundwater concentration*dilution factor.

Unit 3				
Radionuclide	MPC[1] (μCi/cm^3)	Ground Water Concentration[2] (μCi/cm^3)	Surface Water Concentration[3] (μCi/cm^3)	Surface Water Concentration / MPC
H-3	1.00E-03	4.78E-01	9.33E-08	9.33E-05
Fe-55	1.00E-04	1.64E-05	3.21E-12	3.21E-08
I-129	2.00E-07	7.28E-09	1.42E-15	7.10E-09

1. 10 CFR Part 20, Appendix B, Table 2, Column 2
2. Table 2.4-231
3. Surface water concentration = groundwater concentration*dilution factor.

Table 2.4-235 Compliance with 10 CFR Part 20 for Unit 2 for the saprolite pathway to the unnamed creeks

Parent Radionuclide	Progeny in Chain	Radioactive Decay	Radioactive Decay + Retardation	Radioactive Decay + Retardation + Dilution	Minimum C/MPC
H-3		6.55E+02	6.55E+02	1.09E-04	1.09E-04
Cr-51		6.27E-31			6.27E-31
Mn-54		4.40E-02	4.40E-02	7.31115E-09	7.31E-09
Mn-56		0.00E+00			0.00E+00
Fe-55		6.97E-01	6.97E-01	1.16E-07	1.16E-07
Fe-59		1.14E-18			1.14E-18
Co-58		1.00E-10			1.00E-10
Co-60		2.69E+01	0.00E+00		0.00E+00
Br-83		0.00E+00			0.00E+00
	Kr-83m				0.00E+00
Br-84		0.00E+00			0.00E+00
Br-85					0.00E+00
Rb-88		0.00E+00			0.00E+00
Rb-89		0.00E+00			0.00E+00
	Sr-89	1.08E-15			1.08E-15
Sr-90		3.96E+01	3.42E-23		3.42E-23
	Y-90	2.83E+00	2.64E-24		2.64E-24
Sr-91		0.00E+00			0.00E+00
	Y-91m	0.00E+00			0.00E+00
	Y-91	2.92E-14			2.92E-14
Sr-92		0.00E+00			0.00E+00
	Y-92	0.00E+00			0.00E+00
Y-93		0.00E+00			0.00E+00
Zr-95		2.17E-13			2.17E-13
	Nb-95m	1.07E-15			1.07E-15
	Nb-95	3.21E-13			3.21E-13
Mo-99		0.00E+00			0.00E+00
	Tc-99m	0.00E+00			0.00E+00
Ru-103		5.91E-22			5.91E-22
	Rh-103m	2.95E-24			2.95E-24
Rh-106					0.00E+00
Ag-110m		1.31E-02	1.31E-02	2.17404E-09	2.17E-09
	Ag-110				0.00E+00
Te-127m		6.76E-07			6.76E-07
	Te-127	5.96E-08			5.96E-08
Te-129m		1.03E-23			1.03E-23
	Te-129	1.17E-25			1.17E-25
	I-129	3.64E-02	3.64E-02	6.04E-09	6.04E-09
Te-131m		0.00E+00			0.00E+00
	Te-131	0.00E+00			0.00E+00
	I-131	1.09E-100			1.09E-100
Te-132		2.77E-257			2.77E-257
	I-132	2.57E-258			2.57E-258
Te-134		0.00E+00			0.00E+00
	I-134	0.00E+00			0.00E+00
I-130		0.00E+00			0.00E+00
I-133		0.00E+00			0.00E+00
	Xe-133m				0.00E+00
	Xe-133				0.00E+00
I-135		0.00E+00			0.00E+00
	Xe-135m				0.00E+00
	Xe-135				0.00E+00
Cs-134		2.78E+04	0.00E+00		0.00E+00
Cs-136		1.44E-60			1.44E-60
Cs-137		2.03E+05	3.49E-38		3.49E-38
	Ba-137m				0.00E+00
Cs-138		0.00E+00			0.00E+00
Ba-140		9.88E-66			9.88E-66
	La-140	1.01E-65			1.01E-65
Ce-141		2.06E-26			2.06E-26
Ce-143		0.00E+00			0.00E+00
	Pr-143	1.13E-62			1.13E-62
Ce-144		2.00E-02	2.00E-02	3.32355E-09	3.32E-09
	Pr-144m				0.00E+00
	Pr-144	1.00E-04			1.00E-04
				Sum =	2.10E-04

Yellow-highlighted cells indicate nuclides whose C/MPC ratios exceed 1% at the specified level of analysis.

Table 2.4-236 Compliance with 10 CFR Part 20 for Unit 3 for the saprolite pathway to the unnamed creeks

Parent Radionuclide	Progeny in Chain	Radioactive Decay	Radioactive Decay + Retardation	Radioactive Decay + Retardation + Dilution	Minimum C/MPC
H-3		4.78E+02	4.78E+02	9.33E-05	9.33E-05
Cr-51		3.03E-53			3.03E-53
Mn-54		4.66E-04			4.66E-04
Mn-56		0.00E+00			0.00E+00
Fe-55		1.64E-01	1.64E-01	3.21E-08	3.21E-08
Fe-59		1.46E-32			1.46E-32
Co-58		1.87E-19			1.87E-19
Co-60		1.29E+01	0.00E+00		0.00E+00
Br-83		0.00E+00			0.00E+00
	Kr-83m				0.00E+00
Br-84		0.00E+00			0.00E+00
Br-85					0.00E+00
Rb-88		0.00E+00			0.00E+00
Rb-89		0.00E+00			0.00E+00
	Sr-89	6.20E-28			6.20E-28
Sr-90		3.46E+01	8.67E-41		8.67E-41
	Y-90	2.47E+00	6.70E-42		6.70E-42
Sr-91		0.00E+00			0.00E+00
	Y-91m	0.00E+00			0.00E+00
	Y-91	7.93E-25			7.93E-25
Sr-92		0.00E+00			0.00E+00
	Y-92	0.00E+00			0.00E+00
Y-93		0.00E+00			0.00E+00
Zr-95		4.75E-23			4.75E-23
	Nb-95m	2.35E-25			2.35E-25
	Nb-95	7.05E-23			7.05E-23
Mo-99		0.00E+00			0.00E+00
	Tc-99m	0.00E+00			0.00E+00
Ru-103		1.10E-37			1.10E-37
	Rh-103m	5.51E-40			5.51E-40
Rh-106					0.00E+00
Ag-110m		4.41E-05			4.41E-05
	Ag-110				0.00E+00
Te-127m		1.44E-12			1.44E-12
	Te-127	1.27E-13			1.27E-13
Te-129m		4.11E-42			4.11E-42
	Te-129	4.68E-44			4.68E-44
	I-129	3.64E-02	3.64E-02	7.10E-09	7.10E-09
Te-131m		0.00E+00			0.00E+00
	Te-131	0.00E+00			0.00E+00
	I-131	1.43E-177			1.43E-177
Te-132		0.00E+00			0.00E+00
	I-132	0.00E+00			0.00E+00
Te-134		0.00E+00			0.00E+00
	I-134	0.00E+00			0.00E+00
I-130		0.00E+00			0.00E+00
I-133		0.00E+00			0.00E+00
	Xe-133m				0.00E+00
	Xe-133				0.00E+00
I-135		0.00E+00			0.00E+00
	Xe-135m				0.00E+00
	Xe-135				0.00E+00
Cs-134		4.20E+03	0.00E+00		0.00E+00
Cs-136		9.39E-108			9.39E-108
Cs-137		1.78E+05	2.10E-69		2.10E-69
	Ba-137m				0.00E+00
Cs-138		0.00E+00			0.00E+00
Ba-140		2.10E-114			2.10E-114
	La-140	2.15E-114			2.15E-114
Ce-141		1.97E-45			1.97E-45
Ce-143		0.00E+00			0.00E+00
	Pr-143	2.92E-108			2.92E-108
Ce-144		1.33E-04			1.33E-04
	Pr-144m				0.00E+00
	Pr-144	6.66E-07			6.66E-07
				Sum =	7.38E-04

Yellow-highlighted cells indicate nuclides whose C/MPC ratios exceed 1% at the specified level of analysis.

Insert the following new tables after the last table in Section 2.4 in the FSAR:

Table 2.4-237 Calculated Hydraulic Gradients, Groundwater Velocities, and Travel Times.

Source:	Unit 2	Unit 3	Unit 2	Unit 3	Unit 2
Transport zone:	Saprolite			Bedrock	
Discharges to: (point in Figures 2.4-252 & 2.4-258)	unnamed creeks A	B	Mayo Creek C	Broad River D	Mayo Creek C
L (feet)	850	1,727	2,970	3,850	2,970
K (ft/day)	1.7	1.7	1.7	0.40	0.40
n_e	0.18	0.18	0.18	0.04	0.04
h_0 (feet)	367.15	368.35	367.15	368.35	367.15
h_1 (feet)	340	303.55	320	266	320
dh/dx	-0.0319	-0.0375	-0.0159	-0.0266	-0.0159
Velocity, U_x (ft/year)	110	129	54.8	97.1	58.0
Travel time, ***t*** (yrs)	7.71	13.3	54.2	39.7	51.2

Table 2.4-238 Summary of Results for the Transport Analysis Considering Only Radioactive Decay.

Source	Material	Discharge Point	Radionuclides with C/MPC > 1%
Unit 2	Saprolite	Unnamed creek (northwest)	H-3, Mn-54, Fe-55, Co-60, Sr-90, Y-90, Ag-110m, I-129, Cs-134, Cs-137, and Ce-144
Unit 3	Saprolite	Unnamed creek (southwest)	H-3, Fe-55, Co-60, Sr-90, Y-90, I-129, Cs-134, and Cs-137
Unit 2	Saprolite	Mayo Creek (east)	H-3, Co-60, Sr-90, Y-90, I-129, and Cs-137
Unit 3	Bedrock	Broad River (west)	H-3, Co-60, Sr-90, Y-90, I-129, Cs-134, and Cs-137
Unit 2	Bedrock	Mayo Creek (east)	H-3, Co-60, Sr-90, Y-90, I-129, Cs-134, and Cs-137
Unit 2	Bedrock	Private well (east)	H-3, Sr-90, Y-90, I-129, and Cs-137

Table 2.4-239 Summary of Results for the Transport Analysis Considering Only Radioactive Decay and Adsorption.

Source	Material	Discharge Point	Radionuclides with C/MPC > 1%
Unit 2	Saprolite	Unnamed creek (northwest)	H-3, Mn-54, Fe-55, Ag-110m, I-129, and Ce-144
Unit 3	Saprolite	Unnamed creek (southwest)	H-3, Fe-55, & I-129
Unit 2	Saprolite	Mayo Creek (east)	H-3 and I-129
Unit 3	Bedrock	Broad River (west)	H-3 and I-129
Unit 2	Bedrock	Mayo Creek (east)	H-3 and I-129
Unit 2	Bedrock	Private well (east)	H-3 and I-129

Table 2.4-240 Conceptual Model of the Contaminant Slug Dimensions in the Saprolite and Bedrock Aquifers

Parameter	Saprolite	Bedrock
n_e	0.18	0.04
Volume in aquifer: V, ft^3	16,636	74,861
Vertical thickness: b, ft	10	10
Planar area: V/b, ft^2	1,663	7,486
Cross-sectional width: $w = (V/b)^{0.5}$, ft	40.8	86.5
Cross-sectional area: $A = b \times w$, ft	408	865

Table 2.4-241 Calculation of Effluent Discharge Rates and Dilution Factors.

Source:		Unit 2	Unit 3	Unit 2	Unit 3	Unit 2
Transport zone:		Saprolite			Bedrock	
Discharges to: (point in Figures 2.4-252 & 2.4-258)		unnamed creeks		Mayo Creek	Broad River	Mayo Creek
		A	B	C	D	C
K	ft/day	1.7	1.7	1.7	0.40	0.40
dh/dx	ft/ft	-0.0319	-0.0375	-0.0159	-0.0266	-0.0159
Darcy velocity, U_d	ft/day	0.0543	0.0638	0.0270	0.0106	0.0064
Cross-sectional area, A	ft^2	408	408	408	865	865
Effluent discharge * Q	ft^3/day	22.1	26.0	11.0	9.20	5.49
	cfs	2.56E-04	3.01E-04	1.27E-04	1.06E-04	6.36E-05
100-yr low annual mean flow	cfs	1,543	1,543	0.39	1,543	0.39
Dilution factor, d_f		1.66E-07	1.95E-07	3.27E-04	6.90E-08	1.63E-04

Q is the flow rate of the liquid effluent released to the ground water and discharging into the surface water.

Table 2.4-242 Results of Transport Analysis with Radioactive Decay Only – Saprolite Discharge to Mayo Creek, East from Unit 2 (travel time of 54.2 years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics							Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	MPC[c] (μCi/cm^3)	C_0[c] (μCi/cm^3)	K1	K2	K3	C[d] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				4.81E-02	4.81E+01
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				7.02E-219	1.40E-215
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				6.02E-23	2.01E-18
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				4.53E-10	4.53E-06
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				1.31E-138	1.31E-133
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				1.15E-87	5.74E-83
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				1.81E-07	6.02E-02
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		4.50E-122	5.63E-117
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				6.52E-06	1.30E+01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		6.52E-06	9.31E-01
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	8.64E-107	1.08E-101
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
0	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				5.22E-98	2.61E-93
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		3.88E-100	1.29E-95
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	1.16E-97	3.87E-93
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				1.26E-156	4.21E-152
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		1.26E-156	2.10E-154
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				2.73E-28	4.55E-23
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		3.63E-30	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				7.24E-59	8.04E-54
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		7.09E-59	7.09E-55
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				4.27E-181	6.10E-176
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		2.78E-181	6.95E-178
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	0.00E+00	0.00E+00
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				0.00E+00	0.00E+00
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		0.00E+00	0.00E+00
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	0.00E+00	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				4.04E-09	4.49E-03
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				0.00E+00	0.00E+00
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				6.95E-02	6.95E+04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		6.57E-02	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				0.00E+00	0.00E+00
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		0.00E+00	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				2.59E-188	8.63E-184
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		0.00E+00	0.00E+00
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				5.87E-26	1.96E-20
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		1.04E-27	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	5.87E-26	9.78E-23

Notes (a) to (f): See notes below Table 2.4-227.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-243 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 2 – Saprolite Pathway to Mayo Creek

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (μCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (μCi/cm^3)	MPC[e] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	4.81E-02	1.00E-03	4810%
Co-60		1.93E+03				3.59E-04	2.22E-04	415.90	3249.64	0.00E+00	3.00E-06	0%
Sr-90		1.06E+04				6.54E-05	2.38E-05	38.50	301.73	4.37E-175	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	4.73E-175	7.00E-06	0%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-137		1.10E+04				6.30E-05	2.42E-01	71.00	555.59	1.60E-302	1.00E-06	0%

Travel time = 54.2 years
Effective porosity = 0.18
Bulk density = 1.41 g/cm^3

Notes (a) to (f): See notes below Table 2.4-230.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-244 Calculation of Dilution Factor by Mayo Creek for Unit 2 – Saprolite Pathway

Tank volume	28,000	gallons
Spill volume (80% tank volume)	22,400	gallons
	2994	cf
Contaminated Aquifer Volume	16636	cf
Contaminated Aquifer Area	1663.6	ft^2
Effective Porosity	0.18	
Darcy velocity	0.0270	ft/day
Unit thickness (i.e. saprolite layer)	10	ft
Contaminanted Aquifer Width	40.8	ft
Contaminated cross-sectional area	408	ft^2
Flow Rate	11.0	cf/day
	1.27E-04	cfs
	5.72E-02	gpm
Minimium River flow[1]	0.39	cfs
Dilution Factor	**3.27E-04**	

Notes:
1. 100-year low annual mean flow of Mayo Creek at Parr Road.

Table 2.4-245 Transport Analysis Considering Radioactive Decay, Adsorption, and Dilution – Saprolite Pathway to Mayo Creek

Unit 2				
Radionuclide	MPC[1] (μCi/cm^3)	Ground Water Concentration[2] (μCi/cm^3)	Surface Water Concentration[3] (μCi/cm^3)	Surface Water Concentration / MPC
H-3	1.00E-03	4.81E-02	1.57E-05	1.57E-02
I-129	2.00E-07	7.28E-09	2.38E-12	1.19E-05

1. 10 CFR Part 20, Appendix B, Table 2, Column 2

2. Table 2.4-243

3. Surface water concentration = groundwater concentration*dilution factor.

Table 2.4-246 Compliance with 10 CFR Part 20 for Unit 2 for the Saprolite Pathway to Mayo Creek

Parent Radionuclide	Progeny in Chain	Radioactive Decay	Radioactive Decay + Retardation	Radioactive Decay + Retardation + Dilution	Minimum C/MPC
H-3		4.81E+01	4.81E+01	1.57E-02	1.57E-02
Cr-51		1.40E-215			1.40E-215
Mn-54		2.01E-18			2.01E-18
Mn-56		0.00E+00			0.00E+00
Fe-55		4.53E-06			4.53E-06
Fe-59		1.31E-133			1.31E-133
Co-58		5.74E-83			5.74E-83
Co-60		6.02E-02	0.00E+00		0.00E+00
Br-83		0.00E+00			0.00E+00
	Kr-83m				0.00E+00
Br-84		0.00E+00			0.00E+00
Br-85					0.00E+00
Rb-88		0.00E+00			0.00E+00
Rb-89		0.00E+00			0.00E+00
	Sr-89	5.63E-117			5.63E-117
Sr-90		1.30E+01	8.74E-169		8.74E-169
	Y-90	9.31E-01	6.76E-170		6.76E-170
Sr-91		0.00E+00			0.00E+00
	Y-91m	0.00E+00			0.00E+00
	Y-91	1.08E-101			1.08E-101
Sr-92		0.00E+00			0.00E+00
	Y-92	0.00E+00			0.00E+00
Y-93		0.00E+00			0.00E+00
Zr-95		2.61E-93			2.61E-93
	Nb-95m	1.29E-95			1.29E-95
	Nb-95	3.87E-93			3.87E-93
Mo-99		0.00E+00			0.00E+00
	Tc-99m	0.00E+00			0.00E+00
Ru-103		4.21E-152			4.21E-152
	Rh-103m	2.10E-154			2.10E-154
Rh-106					0.00E+00
Ag-110m		4.55E-23			4.55E-23
	Ag-110				0.00E+00
Te-127m		8.04E-54			8.04E-54
	Te-127	7.09E-55			7.09E-55
Te-129m		6.10E-176			6.10E-176
	Te-129	6.95E-178			6.95E-178
	I-129	3.64E-02	3.64E-02	1.19E-05	1.19E-05
Te-131m		0.00E+00			0.00E+00
	Te-131	0.00E+00			0.00E+00
	I-131	0.00E+00			0.00E+00
Te-132		0.00E+00			0.00E+00
	I-132	0.00E+00			0.00E+00
Te-134		0.00E+00			0.00E+00
	I-134	0.00E+00			0.00E+00
I-130		0.00E+00			0.00E+00
I-133		0.00E+00			0.00E+00
	Xe-133m				0.00E+00
	Xe-133				0.00E+00
I-135		0.00E+00			0.00E+00
	Xe-135m				0.00E+00
	Xe-135				0.00E+00
Cs-134		4.49E-03			4.49E-03
Cs-136		0.00E+00			0.00E+00
Cs-137		6.95E+04	1.60E-296		1.60E-296
	Ba-137m				0.00E+00
Cs-138		0.00E+00			0.00E+00
Ba-140		0.00E+00			0.00E+00
	La-140	0.00E+00			0.00E+00
Ce-141		8.63E-184			8.63E-184
Ce-143		0.00E+00			0.00E+00
	Pr-143	0.00E+00			0.00E+00
Ce-144		1.96E-20			1.96E-20
	Pr-144m				0.00E+00
	Pr-144	9.78E-23			9.78E-23
				Sum=	2.02E-02

Yellow-highlighted cells indicate nuclides whose C/MPC ratios exceed 1% at the specified level of analysis.

Table 2.4-247 Results of Transport Analysis with Radioactive Decay Only – Bedrock Discharge to the Broad River from Unit 3 (travel time of 39.7 years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics						C_o[c] (µCi/cm³)	Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days⁻¹)	MPC[e] (µCi/cm³)		K1	K2	K3	C[d] (µCi/cm³)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				1.09E-01	1.09E+02
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				5.40E-161	1.08E-157
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				7.98E-18	2.66E-13
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				1.91E-08	1.91E-04
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				1.41E-102	1.41E-97
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				5.10E-65	2.55E-60
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				1.22E-06	4.08E-01
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		2.54E-90	3.17E-85
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				9.23E-06	1.85E+01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		9.23E-06	1.32E+00
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	2.22E-79	2.77E-74
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				5.91E-73	2.96E-68
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		4.38E-75	1.46E-70
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	1.31E-72	4.38E-68
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				7.97E-116	2.66E-111
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		7.95E-116	1.33E-113
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				7.07E-22	1.18E-16
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		9.41E-24	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				3.71E-44	4.13E-39
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		3.64E-44	3.64E-40
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				2.25E-133	3.21E-128
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		1.46E-133	3.65E-130
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	0.00E+00	0.00E+00
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				0.00E+00	0.00E+00
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		0.00E+00	0.00E+00
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	0.00E+00	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				5.44E-07	6.04E-01
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				0.00E+00	0.00E+00
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				9.72E-02	9.72E+04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		9.19E-02	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				0.00E+00	0.00E+00
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		0.00E+00	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				5.61E-139	1.87E-134
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		0.00E+00	0.00E+00
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				2.60E-20	8.65E-15
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		4.62E-22	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	2.60E-20	4.33E-17

Notes (a) to (f): See notes below Table 2.4-227.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-248 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 3 through Bedrock to the Broad River

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (μCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (μCi/cm^3)	MPC[e] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	1.09E-01	1.00E-03	10906%
Co-60		1.93E+03				3.59E-04	2.22E-04	4.40	292.56	0.00E+00	3.00E-06	0%
Sr-90		1.06E+04				6.54E-05	2.38E-05	0.70	47.38	7.74E-25	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	7.83E-25	7.00E-06	0%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-134		7.53E+02				9.21E-04	3.35E-01	1.00	67.26	0.00E+00	9.00E-07	0%
Cs-137		1.10E+04				6.30E-05	2.42E-01	1.00	67.26	5.32E-28	1.00E-06	0%

Travel time = 39.7 years
Effective porosity = 0.04
Bulk density = 2.65 g/cm^3

Notes (a) to (f): See notes below Table 2.4-230.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-249 Calculation of Dilution Factor by the Broad River for Unit 3– Bedrock Pathway

Tank volume	28,000	gallons
Spill volume (80% tank volume)	22,400	gallons
	2994.44	cf
Contaminated Aquifer Volume	74861.12	cf
Contaminated Aquifer Area	7486.11	ft^2
Effective Porosity	0.04	
Darcy velocity	0.0106	ft/day
Unit thickness	10	ft
Contaminanted Aquifer Width	86.52	ft
Contaminated cross-sectional area	865.2	ft^2
Flow Rate	9.20	cf/day
	1.06E-04	cfs
	4.78E-02	gpm
Minimium River flow[1]	1543	cfs
Dilution Factor	**6.90E-08**	

Notes:
1. 100-year low annual mean flow of the Broad River at Parr Shoals Dam.

Table 2.4-250 Transport Analysis Considering Radioactive Decay, Adsorption, and Dilution – Bedrock Pathway to the Broad River

Unit 3				
Radionuclide	MPC[1] (μCi/cm^3)	Ground Water Concentration[2] (μCi/cm^3)	Surface Water Concentration[3] (μCi/cm^3)	Surface Water Concentration / MPC
H-3	1.00E-03	1.09E-01	7.53E-09	7.53E-06
I-129	2.00E-07	7.28E-09	5.02E-16	2.51E-09

1. 10 CFR Part 20, Appendix B, Table 2, Column 2
2. Table 2.4-248
3. Surface water concentration = groundwater concentration*dilution factor.

Table 2.4-251 Compliance with 10 CFR Part 20 for Unit 3 for the Bedrock Pathway to the Broad River

Parent Radionuclide	Progeny in Chain	Radioactive Decay	Radioactive Decay + Retardation	Radioactive Decay + Retardation + Dilution	Minimum C/MPC
H-3		1.09E+02	1.09E+02	7.53E-06	7.53E-06
Cr-51		1.08E-157			1.08E-157
Mn-54		2.66E-13			2.66E-13
Mn-56		0.00E+00			0.00E+00
Fe-55		1.91E-04			1.91E-04
Fe-59		1.41E-97			1.41E-97
Co-58		2.55E-60			2.55E-60
Co-60		4.08E-01	0.00E+00		0.00E+00
Br-83		0.00E+00			0.00E+00
	Kr-83m				0.00E+00
Br-84		0.00E+00			0.00E+00
Br-85					0.00E+00
Rb-88		0.00E+00			0.00E+00
Rb-89		0.00E+00			0.00E+00
	Sr-89	3.17E-85			3.17E-85
Sr-90		1.85E+01	1.55E-18		1.55E-18
	Y-90	1.32E+00	1.12E-19		1.12E-19
Sr-91		0.00E+00			0.00E+00
	Y-91m	0.00E+00			0.00E+00
	Y-91	2.77E-74			2.77E-74
Sr-92		0.00E+00			0.00E+00
	Y-92	0.00E+00			0.00E+00
Y-93		0.00E+00			0.00E+00
Zr-95		2.96E-68			2.96E-68
	Nb-95m	1.46E-70			1.46E-70
	Nb-95	4.38E-68			4.38E-68
Mo-99		0.00E+00			0.00E+00
	Tc-99m	0.00E+00			0.00E+00
Ru-103		2.66E-111			2.66E-111
	Rh-103m	1.33E-113			1.33E-113
Rh-106					0.00E+00
Ag-110m		1.18E-16			1.18E-16
	Ag-110				0.00E+00
Te-127m		4.13E-39			4.13E-39
	Te-127	3.64E-40			3.64E-40
Te-129m		3.21E-128			3.21E-128
	Te-129	3.65E-130			3.65E-130
	I-129	3.64E-02	3.64E-02	2.51E-09	2.51E-09
Te-131m		0.00E+00			0.00E+00
	Te-131	0.00E+00			0.00E+00
	I-131	0.00E+00			0.00E+00
Te-132		0.00E+00			0.00E+00
	I-132	0.00E+00			0.00E+00
Te-134		0.00E+00			0.00E+00
	I-134	0.00E+00			0.00E+00
I-130		0.00E+00			0.00E+00
I-133		0.00E+00			0.00E+00
	Xe-133m				0.00E+00
	Xe-133				0.00E+00
I-135		0.00E+00			0.00E+00
	Xe-135m				0.00E+00
	Xe-135				0.00E+00
Cs-134		6.04E-01	0.00E+00		0.00E+00
Cs-136		0.00E+00			0.00E+00
Cs-137		9.72E+04	5.32E-22		5.32E-22
	Ba-137m				0.00E+00
Cs-138		0.00E+00			0.00E+00
Ba-140		0.00E+00			0.00E+00
	La-140	0.00E+00			0.00E+00
Ce-141		1.87E-134			1.87E-134
Ce-143		0.00E+00			0.00E+00
	Pr-143	0.00E+00			0.00E+00
Ce-144		8.65E-15			8.65E-15
	Pr-144m				0.00E+00
	Pr-144	4.33E-17			4.33E-17
				Sum =	1.99E-04

Yellow-highlighted cells indicate nuclides whose C/MPC ratios exceed 1% at the specified level of analysis.

Table 2.4-252 Results of Transport Analysis with Radioactive Decay Only – Bedrock Discharge to Mayo Creek from Unit 2 (travel time of 51.2 years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics							Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	MPC[e] (μCi/cm^3)	C_0[c] (μCi/cm^3)	K1	K2	K3	C[d] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				5.70E-02	5.70E+01
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				6.40E-207	1.28E-203
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				6.88E-22	2.29E-17
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				9.81E-10	9.81E-06
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				3.65E-131	3.65E-126
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				5.49E-83	2.74E-78
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				2.68E-07	8.94E-02
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		1.63E-115	2.04E-110
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				7.00E-06	1.40E+01
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		7.00E-06	1.00E+00
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	3.97E-101	4.97E-96
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
0	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				7.84E-93	3.92E-88
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		5.82E-95	1.94E-90
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	1.74E-92	5.81E-88
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				3.40E-148	1.13E-143
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		3.39E-148	5.65E-146
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				5.77E-27	9.61E-22
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		7.67E-29	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				7.92E-56	8.80E-51
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		7.76E-56	7.76E-52
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				3.09E-171	4.41E-166
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		2.01E-171	5.03E-168
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	0.00E+00	0.00E+00
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				0.00E+00	0.00E+00
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		0.00E+00	0.00E+00
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	0.00E+00	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				1.11E-08	1.24E-02
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				0.00E+00	0.00E+00
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				7.44E-02	7.44E+04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		7.04E-02	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				0.00E+00	0.00E+00
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		0.00E+00	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				4.04E-178	1.35E-173
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		0.00E+00	0.00E+00
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				8.61E-25	2.87E-19
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		1.53E-26	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	8.61E-25	1.43E-21

Notes (a) to (f): See notes below Table 2.4-227.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-253 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 2 through Bedrock to Mayo Creek

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (μCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (μCi/cm^3)	MPC[e] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	5.70E-02	1.00E-03	5696%
Co-60		1.93E+03				3.59E-04	2.22E-04	4.40	292.56	0.00E+00	3.00E-06	0%
Sr-90		1.06E+04				6.54E-05	2.38E-05	0.70	47.38	1.59E-30	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	1.61E-30	7.00E-06	0%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-134		7.53E+02				9.21E-04	3.35E-01	1.00	67.26	0.00E+00	9.00E-07	0%
Cs-137		1.10E+04				6.30E-05	2.42E-01	1.00	67.26	8.85E-36	1.00E-06	0%

Travel time = 51.2 years
Effective porosity = 0.04
Bulk density = 2.65 g/cm^3

Notes (a) to (f): See notes below Table 2.4-230.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-254 Calculation of Dilution Factor by Mayo Creek for Unit 2– Bedrock Pathway

Tank volume	28,000	gallons
Spill volume (80% tank volume)	22,400	gallons
	2994	cf
Contaminated Aquifer Volume	74861	cf
Contaminated Aquifer Area	7486.1	ft^2
Effective Porosity	0.04	
Darcy velocity	0.006350	ft/day
Unit thickness (i.e. saprolite layer)	10	ft
Contaminanted Aquifer Width	86.5	ft
Contaminated cross-sectional area	865	ft^2
Flow Rate	5.49	cf/day
	6.36E-05	cfs
	2.85E-02	gpm
Minimium River flow[1]	0.39	cfs
Dilution Factor	**1.63E-04**	

Notes:
1. 100-year low annual mean flow of Mayo Creek at Parr Road.

Table 2.4-255 Transport Analysis Considering Radioactive Decay, Adsorption, and Dilution – Bedrock Pathway to Mayo Creek

Unit 2				
Radionuclide	MPC[1] (μCi/cm^3)	Ground Water Concentration[2] (μCi/cm^3)	Surface Water Concentration[3] (μCi/cm^3)	Surface Water Concentration / MPC
H-3	1.00E-03	5.70E-02	9.29E-06	9.29E-03
I-129	2.00E-07	7.28E-09	1.19E-12	5.93E-06

1. 10 CFR Part 20, Appendix B, Table 2, Column 2
2. Table 2.4-253
3. Surface water concentration = groundwater concentration*dilution factor.

Table 2.4-256 Compliance with 10 CFR Part 20 for Unit 2 for the Bedrock Pathway to Mayo Creek

Parent Radionuclide	Progeny in Chain	Radioactive Decay	Radioactive Decay + Retardation	Radioactive Decay + Retardation + Dilution	Minimum C/MPC
H-3		5.70E+01	5.70E+01	9.29E-03	9.29E-03
Cr-51		1.28E-203			1.28E-203
Mn-54		2.29E-17			2.29E-17
Mn-56		0.00E+00			0.00E+00
Fe-55		9.81E-06			9.81E-06
Fe-59		3.65E-126			3.65E-126
Co-58		2.74E-78			2.74E-78
Co-60		8.94E-02	0.00E+00		0.00E+00
Br-83		0.00E+00			0.00E+00
	Kr-83m				0.00E+00
Br-84		0.00E+00			0.00E+00
Br-85					0.00E+00
Rb-88		0.00E+00			0.00E+00
Rb-89		0.00E+00			0.00E+00
	Sr-89	2.04E-110			2.04E-110
Sr-90		1.40E+01	3.18E-24		3.18E-24
	Y-90	1.00E+00	2.30E-25		2.30E-25
Sr-91		0.00E+00			0.00E+00
	Y-91m	0.00E+00			0.00E+00
	Y-91	4.97E-96			4.97E-96
Sr-92		0.00E+00			0.00E+00
	Y-92	0.00E+00			0.00E+00
Y-93		0.00E+00			0.00E+00
Zr-95		3.92E-88			3.92E-88
	Nb-95m	1.94E-90			1.94E-90
	Nb-95	5.81E-88			5.81E-88
Mo-99		0.00E+00			0.00E+00
	Tc-99m	0.00E+00			0.00E+00
Ru-103		1.13E-143			1.13E-143
	Rh-103m	5.65E-146			5.65E-146
Rh-106					0.00E+00
Ag-110m		9.61E-22			9.61E-22
	Ag-110				0.00E+00
Te-127m		8.80E-51			8.80E-51
	Te-127	7.76E-52			7.76E-52
Te-129m		4.41E-166			4.41E-166
	Te-129	5.03E-168			5.03E-168
	I-129	3.64E-02	3.64E-02	5.93E-06	5.93E-06
Te-131m		0.00E+00			0.00E+00
	Te-131	0.00E+00			0.00E+00
	I-131	0.00E+00			0.00E+00
Te-132		0.00E+00			0.00E+00
	I-132	0.00E+00			0.00E+00
Te-134		0.00E+00			0.00E+00
	I-134	0.00E+00			0.00E+00
I-130		0.00E+00			0.00E+00
I-133		0.00E+00			0.00E+00
	Xe-133m				0.00E+00
	Xe-133				0.00E+00
I-135		0.00E+00			0.00E+00
	Xe-135m				0.00E+00
	Xe-135				0.00E+00
Cs-134		1.24E-02	0.00E+00		0.00E+00
Cs-136		0.00E+00			0.00E+00
Cs-137		7.44E+04	8.85E-30		8.85E-30
	Ba-137m				0.00E+00
Cs-138		0.00E+00			0.00E+00
Ba-140		0.00E+00			0.00E+00
	La-140	0.00E+00			0.00E+00
Ce-141		1.35E-173			1.35E-173
Ce-143		0.00E+00			0.00E+00
	Pr-143	0.00E+00			0.00E+00
Ce-144		2.87E-19			2.87E-19
	Pr-144m				0.00E+00
	Pr-144	1.43E-21			1.43E-21
				Sum =	9.30E-03

Yellow-highlighted cells indicate nuclides whose C/MPC ratios exceed 1% at the specified level of analysis.

Table 2.4-257 Results of Transport Analysis with Radioactive Decay Only – Bedrock Discharge to Private Well from Unit 2 (travel time of 93.1 years)

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics							Radioactive Decay				
		$t_{1/2}$[a] (days)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	MPC[c] (μCi/cm^3)	C_o[c] (μCi/cm^3)	K1	K2	K3	C[d] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.00E-03	1.01E+00				5.42E-03	5.42E+00
Cr-51		2.77E+01				2.50E-02	5.00E-04	1.31E-03				0.00E+00	0.00E+00
Mn-54		3.13E+02				2.21E-03	3.00E-05	6.77E-04				1.31E-36	4.36E-32
Mn-56		1.07E-01				6.48E+00	7.00E-05	1.72E-01				0.00E+00	0.00E+00
Fe-55		9.86E+02				7.03E-04	1.00E-04	5.05E-04				2.08E-14	2.08E-10
Fe-59		4.45E+01				1.56E-02	1.00E-05	1.31E-04				1.04E-234	1.04E-229
Co-58		7.08E+01				9.79E-03	2.00E-05	1.92E-03				4.55E-148	2.27E-143
Co-60		1.93E+03				3.59E-04	3.00E-06	2.22E-04				1.10E-09	3.66E-04
Br-83		9.96E-02				6.96E+00	9.00E-04	1.55E-02				0.00E+00	0.00E+00
	Kr-83m	7.63E-02	0.9998			9.09E+00	NA[f]					0.00E+00	
Br-84		2.21E-02				3.14E+01	4.00E-04	8.24E-03				0.00E+00	0.00E+00
Br-85		2.01E-03				3.44E+02	NA[f]	9.70E-04				0.00E+00	
Rb-88		1.24E-02				5.61E+01	4.00E-04	7.27E-01				0.00E+00	0.00E+00
Rb-89		1.06E-02				6.54E+01	9.00E-04	3.35E-02				0.00E+00	0.00E+00
	Sr-89	5.05E+01	1.0000			1.37E-02	8.00E-06	5.33E-04	-7.03E-06	5.40E-04		9.34E-207	1.17E-201
Sr-90		1.06E+04				6.54E-05	5.00E-07	2.38E-05				2.57E-06	5.15E+00
	Y-90	2.67E+00	1.0000			2.60E-01	7.00E-06	6.30E-06	2.38E-05	-1.75E-05		2.57E-06	3.68E-01
Sr-91		3.96E-01				1.75E+00	2.00E-05	8.24E-04				0.00E+00	0.00E+00
	Y-91m	3.45E-02	0.5780			2.01E+01	2.00E-03	4.46E-04	5.22E-04	-7.57E-05		0.00E+00	0.00E+00
	Y-91	5.85E+01		0.4220	1.0000	1.18E-02	8.00E-06	6.79E-05	-5.93E-06	4.47E-08	7.38E-05	6.82E-180	8.53E-175
Sr-92		1.13E-01				6.14E+00	4.00E-05	1.99E-04				0.00E+00	0.00E+00
0	Y-92	1.48E-01	1.0000			4.68E+00	4.00E-05	1.65E-04	-6.40E-04	8.05E-04		0.00E+00	0.00E+00
Y-93		4.21E-01				1.65E+00	2.00E-05	5.33E-05				0.00E+00	0.00E+00
Zr-95		6.40E+01				1.08E-02	2.00E-05	7.76E-05				7.90E-165	3.95E-160
	Nb-95m	3.61E+00	0.0070			1.92E-01	3.00E-05		5.76E-07	-5.76E-07		5.86E-167	1.95E-162
	Nb-95	3.52E+01		0.9930	1.0000	1.97E-02	3.00E-05	7.76E-05	1.73E-04	6.58E-08	-9.50E-05	1.76E-164	5.86E-160
Mo-99		2.75E+00				2.52E-01	2.00E-05	1.02E-01				0.00E+00	0.00E+00
	Tc-99m	2.51E-01	0.8760			2.76E+00	1.00E-03	9.70E-02	9.83E-02	-1.33E-03		0.00E+00	0.00E+00
Ru-103		3.93E+01				1.76E-02	3.00E-05	6.79E-05				1.93E-265	6.43E-261
	Rh-103m	3.90E-02	0.9970			1.78E+01	6.00E-03	6.79E-05	6.78E-05	1.36E-07		1.92E-265	3.21E-263
Rh-106		3.45E-04				2.01E+03	NA[f]	2.18E-05				0.00E+00	
Ag-110m		2.50E+02				2.77E-03	6.00E-06	1.94E-04				2.14E-45	3.56E-40
	Ag-110	2.85E-04	0.0133			2.43E+03	NA[f]		2.58E-06	-2.58E-06		2.84E-47	
Te-127m		1.09E+02				6.36E-03	9.00E-06	3.68E-04				4.22E-98	4.69E-93
	Te-127	3.90E-01	0.9760			1.78E+00	1.00E-04		3.60E-04	-3.60E-04		4.14E-98	4.14E-94
Te-129m		3.36E+01				2.06E-02	7.00E-06	1.26E-03				2.26E-308	3.23E-303
	Te-129	4.83E-02	0.6500			1.44E+01	4.00E-04	1.84E-03	8.20E-04	1.02E-03		0.00E+00	0.00E+00
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	2.00E-07	7.27E-09	-7.39E-12	-8.59E-15	7.28E-09	7.28E-09	3.64E-02
Te-131m		1.25E+00				5.55E-01	8.00E-06	3.25E-03				0.00E+00	0.00E+00
	Te-131	1.74E-02	0.2220			3.98E+01	8.00E-05	2.08E-03	7.32E-04	1.35E-03		0.00E+00	0.00E+00
	I-131	8.04E+00		0.7780	1.0000	8.62E-02	1.00E-06	3.44E-01	-6.00E-04	-2.92E-06	3.45E-01	0.00E+00	0.00E+00
Te-132		3.26E+00				2.13E-01	9.00E-06	3.83E-02				0.00E+00	0.00E+00
	I-132	9.58E-02	1.0000			7.24E+00	1.00E-04	4.56E-01	3.95E-02	4.17E-01		0.00E+00	0.00E+00
Te-134		2.90E-02				2.39E+01	3.00E-04	5.33E-03				0.00E+00	0.00E+00
	I-134	3.65E-02	1.0000			1.90E+01	4.00E-04	1.07E-01	-2.07E-02	1.28E-01		0.00E+00	0.00E+00
I-130		5.15E-01				1.35E+00	2.00E-05	5.33E-03				0.00E+00	0.00E+00
I-133		8.67E-01				7.99E-01	7.00E-06	6.30E-01				0.00E+00	0.00E+00
	Xe-133m	2.19E+00	0.0290			3.17E-01	NA[f]		-1.20E-02	1.20E-02		0.00E+00	
	Xe-133	5.25E+00		0.9710	1.0000	1.32E-01	NA[f]		-1.19E-01	-8.58E-03	1.27E-01	0.00E+00	
I-135		2.75E-01				2.52E+00	3.00E-05	3.78E-01				0.00E+00	0.00E+00
	Xe-135m	1.06E-02	0.1540			6.53E+01	NA[f]		6.05E-02	-6.05E-02		0.00E+00	
	Xe-135	3.79E-01		0.8460	1.0000	1.83E+00	NA[f]		-1.01E+00	1.75E-03	1.00E+00	0.00E+00	
Cs-134		7.53E+02				9.21E-04	9.00E-07	3.35E-01				8.45E-15	9.39E-09
Cs-136		1.31E+01				5.29E-02	6.00E-06	4.85E-01				0.00E+00	0.00E+00
Cs-137		1.10E+04				6.30E-05	1.00E-06	2.42E-01				2.84E-02	2.84E+04
	Ba-137m	1.77E-03	0.9460			3.91E+02	NA[f]	2.28E-01	2.29E-01	-9.32E-04		2.68E-02	
Cs-138		2.24E-02				3.09E+01	4.00E-04	1.79E-01				0.00E+00	0.00E+00
Ba-140		1.27E+01				5.46E-02	8.00E-06	4.85E-04				0.00E+00	0.00E+00
	La-140	1.68E+00	1.0000			4.13E-01	9.00E-06	1.50E-04	5.59E-04	-4.09E-04		0.00E+00	0.00E+00
Ce-141		3.25E+01				2.13E-02	3.00E-05	7.76E-05				0.00E+00	0.00E+00
Ce-143		1.38E+00				5.04E-01	2.00E-05	6.79E-05				0.00E+00	0.00E+00
	Pr-143	1.36E+01	1.0000			5.11E-02	2.00E-05	7.27E-05	-7.66E-06	8.04E-05		0.00E+00	0.00E+00
Ce-144		2.84E+02				2.44E-03	3.00E-06	5.82E-05				5.13E-41	1.71E-35
	Pr-144m	5.07E-03	0.0178			1.37E+02	NA[f]		1.04E-06	-1.04E-06		9.14E-43	
	Pr-144	1.20E-02		0.9822	0.9990	5.78E+01	6.00E-04	5.82E-05	5.82E-05	7.57E-07	-7.58E-07	5.13E-41	8.56E-38

Notes (a) to (f): See notes below Table 2.4-227.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for only radioactive decay.

Table 2.4-258 Transport Analysis Considering Radioactive Decay and Adsorption for Unit 2 through Bedrock to the Private Well

Parent Radionuclide	Progeny in Chain	Radionuclide Characteristics										
		$t_{1/2}$[a] (years)	d_{12}	d_{13}	d_{23}	λ[b] (days^{-1})	C_0[c] (μCi/cm^3)	K_d (cm^3/g)	R[f]	C[d] (μCi/cm^3)	MPC[e] (μCi/cm^3)	C/MPC
H-3		4.51E+03				1.54E-04	1.01E+00	0.00	1.00	3.57E-03	1.00E-03	357%
Sr-90		1.06E+04				6.54E-05	2.38E-05	0.70	47.38	9.09E-55	5.00E-07	0%
	Y-90	2.67E+00	1.0000			2.60E-01	6.30E-06	0.00	1.00	9.20E-55	7.00E-06	0%
Te-129m		3.36E+01				2.06E-02	1.26E-03	0.00	1.00		7.00E-06	
	Te-129	4.83E-02	0.6500			1.44E+01	1.84E-03	0.00	1.00		4.00E-04	
	I-129	5.73E+09		0.3500	1.0000	1.21E-10	7.27E-09	0.00	1.00	7.28E-09	2.00E-07	4%
Cs-137		1.10E+04				6.30E-05	2.42E-01	1.00	67.26	6.09E-69	1.00E-06	0%

Travel time = 93.1 years
Effective porosity = 0.04
Bulk density = 2.65 g/cm^3

Notes (a) to (f): See notes below Table 2.4-230.

Yellow-highlighted rows indicate nuclides whose C/MPC ratios exceed 1% after accounting for radioactive decay and adsorption.

Table 2.4-259 Summary of Results for H-3 and I-129 Accounting for Decay, Retardation, and Dilution, but Not Dispersion

Source	Unit 2	Unit 3	Unit 2	Unit 3	Unit 2	Unit 2
Transport Zone	**Saprolite**			**Bedrock**		
Discharges to	**Unnamed Creeks**		**Mayo Creek**	**Broad River**	**Mayo Creek**	**Private Well (East)**
Groundwater concentration (□Ci/cm³):						
H-3	6.55E-01	4.78E-01	4.81E-02	1.09E-01	5.70E-02	5.42E-03
I-129	7.28E-09	7.28E-09	7.28E-09	7.28E-09	7.28E-09	7.28E-09
100-year low annual mean flow (cfs)	1,543	1,543	0.39	1,543	0.39	N/A
Dilution factor, d_f	1.66E-07	1.95E-07	3.27E-04	6.90E-08	1.63E-04	N/A
Surface water concentration (□Ci/cm³, equal to groundwater concentration×d_f***):***						
H-3	1.09E-07	9.33E-08	1.57E-05	7.53E-09	9.29E-06	5.42E-03
I-129	1.21E-15	1.42E-15	2.38E-12	5.02E-16	1.19E-12	7.28E-09
Ratios of concentrations to maximum permissible concentrations (MPCs)*:						
H-3 concentration / MPC*	1.09E-04	9.33E-05	1.57E-02	7.53E-06	9.29E-03	5.42E+00
I-129 concentration / MPC*	6.04E-09	7.10E-09	1.19E-05	2.51E-09	5.93E-06	3.64E-02

The MPCs for H-3 and I-129 are 0.001 □Ci/cm³ and 2E-07 □Ci/cm³, respectively.

Table 2.4-260 Summary of the Groundwater Pathline Analyses

Source	Half-	Unit 2	Unit 3	Unit 2	Unit 3	Unit 2	Unit 2	Unit 2	Unit 2
Transport Zone	Life	Saprolite			Bedrock				
Discharges to	(years)	Unnamed Creeks		Mayo Creek	Broad River	Mayo Creek	Private Well (East)		
L (feet)		850	1,727	2,970	3,850	2,970	5,400	5,400	5,400
K (ft/day)		1.7	1.7	1.7	0.40	0.40	0.40	0.40	0.40
n_e		0.18	0.18	0.18	0.04	0.04	0.04	0.04	0.04
h_0 (feet)		367.15	368.35	367.15	368.35	367.15	367.15	367.15	367.15
h_1 (feet)		340	303.55	320	266	320	---	---	---
dh/dx		-0.0319	-0.0375	-0.0159	-0.0266	-0.0159	-0.0159	-0.0159	-0.0159
Velocity, *U* (ft/year)		110.2	129.5	54.8	97.1	58.0	58.0	58.0	58.0
t (years)		7.71	13.3	54.2	39.7	51.2	93.1	93.1	93.1
100-year low annual mean flow (cfs)		1,543	1,543	0.39	1,543	0.39	N/A	N/A	N/A
Dilution factor, d_f		1.66E-07	1.95E-07	3.27E-04	6.90E-08	1.63E-04	N/A	N/A	N/A
Inverse: $1 / d_f$		6019467	5122992	3,062	1.45E+07	6,134	N/A	N/A	N/A
Dispersion considered:		No	No	No	No	No	No	**Yes**	**Yes**
Dispersivity		N/A	N/A	N/A	N/A	N/A	N/A	540	45.7
H-3 concentration	12.3477	1.09E-07	3.21E-12	1.57E-05	7.53E-09	9.29E-06	5.42E-03	2.74E-05	5.55E-05
I-129 concentration	2E+07	1.21E-15	0.00E+00	2.38E-12	5.02E-16	1.19E-12	7.28E-09	5.18E-12	5.53E-11
H-3 conc. / MPC		1.09E-04	3.21E-09	1.57E-02	7.53E-06	9.29E-03	5.42E+00	2.74E-02	5.55E-02
I-129 conc. / MPC		6.04E-09	0.00E+00	1.19E-05	2.51E-09	5.93E-06	3.64E-02	2.59E-05	2.77E-04
Sum of all concs. / MPC		2.10E-04	7.38E-04	2.02E-02	1.99E-04	9.30E-03	5.46E+00	2.77E-02	5.62E-02

Modify the title on the existing Figure 2.4-251 in the FSAR to read as follows:

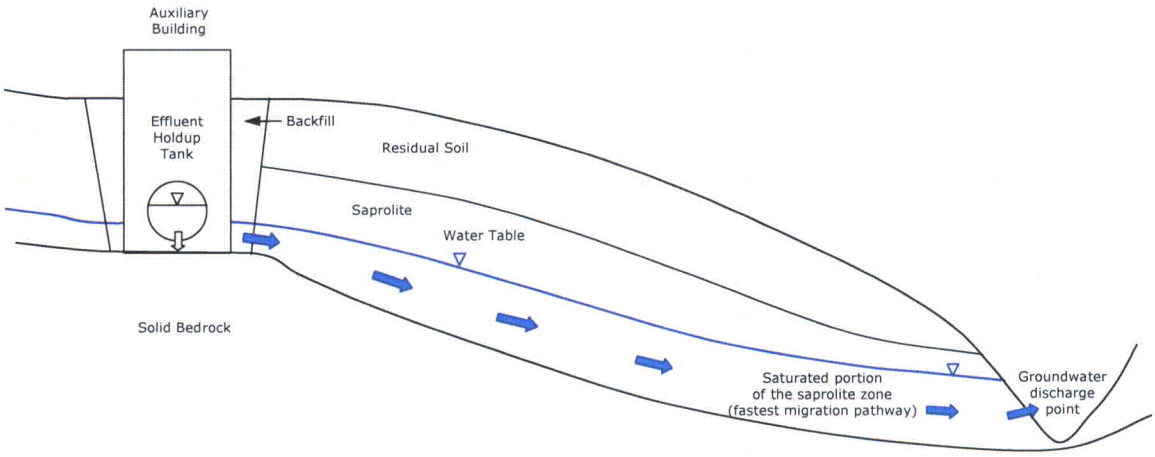

Figure 2.4-251 Conceptual Model for Evaluating Radionuclide Transport in Groundwater through the Saprolite Material to the Unnamed Creeks or to Mayo Creek.

Replace Figure 2.4-252 in the FSAR with the following new figure:

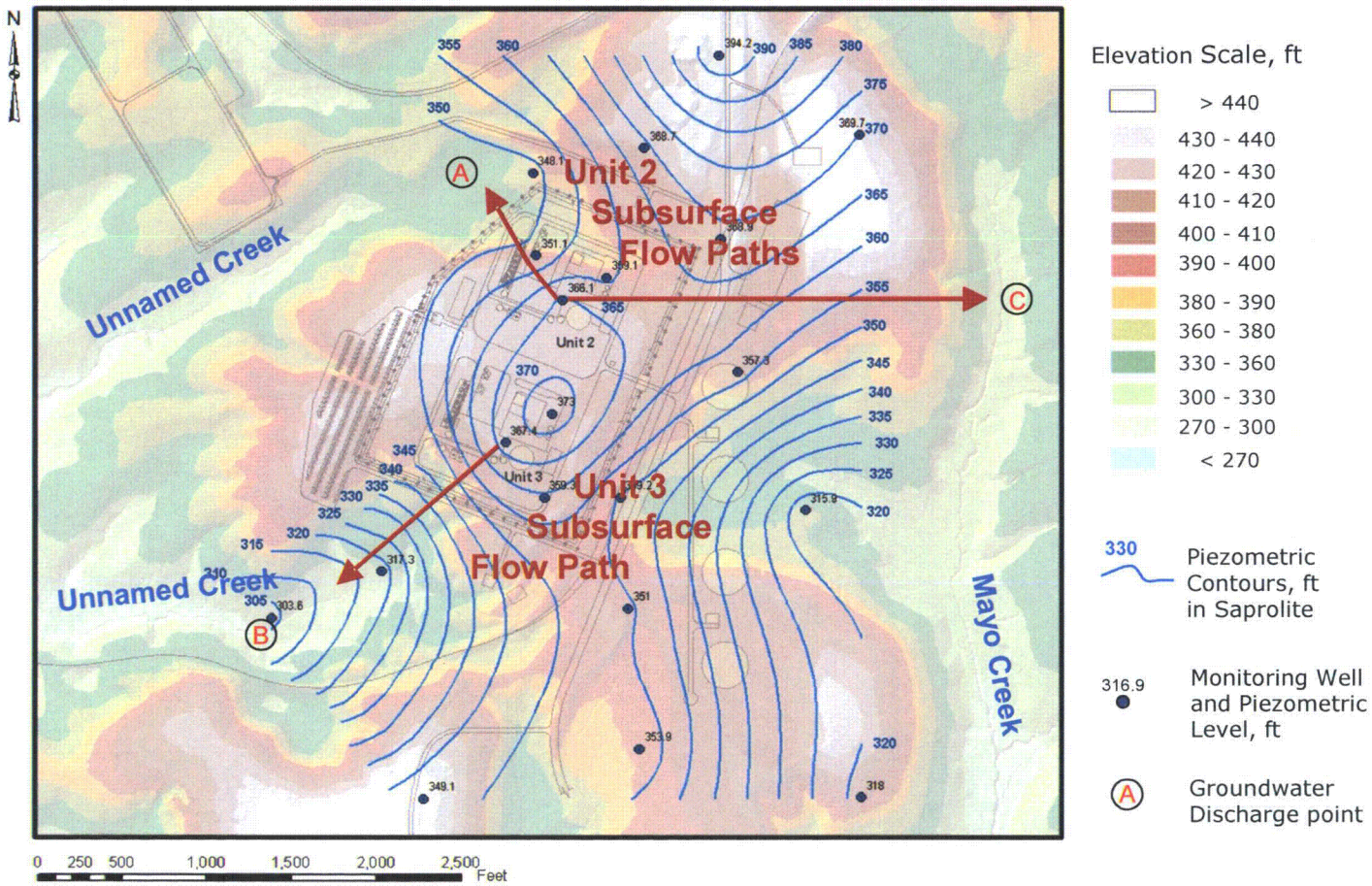

Figure 2.4-252 Plan View of Subsurface Contaminant Pathways for Units 2 and 3 to the Unnamed Creeks and from Unit 2 to Mayo Creek (All elevations are with reference to the NAVD88 datum)

The following three figures from the FSAR, numbers 2.4-253 to 2.4-255, are unchanged.

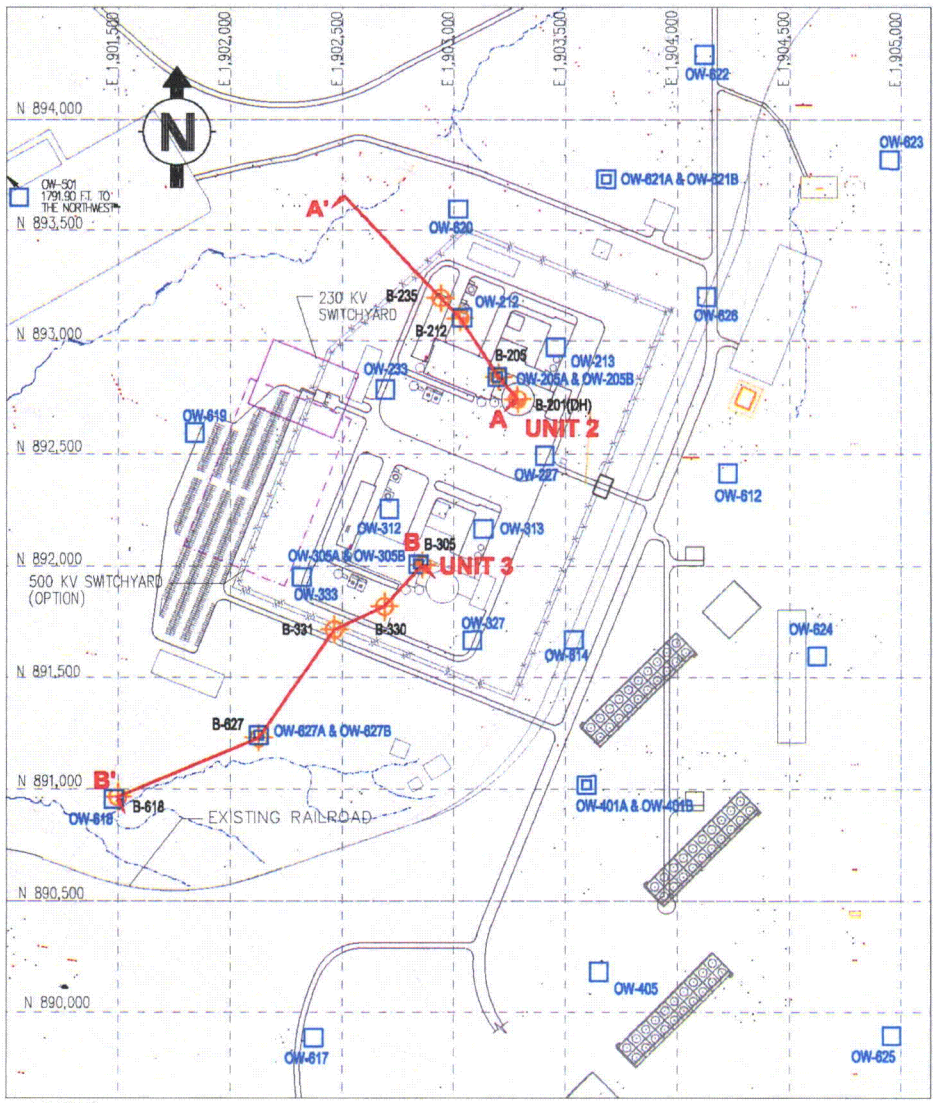

Figure 2.4-253 Plan View Showing Locations of ~~Cross Sections for~~ Cross-Sections of the Western Pathways from Units 2 and 3 ~~Pathways~~ to the Unnamed Creeks (All elevations are with reference to the NAVD88 datum)

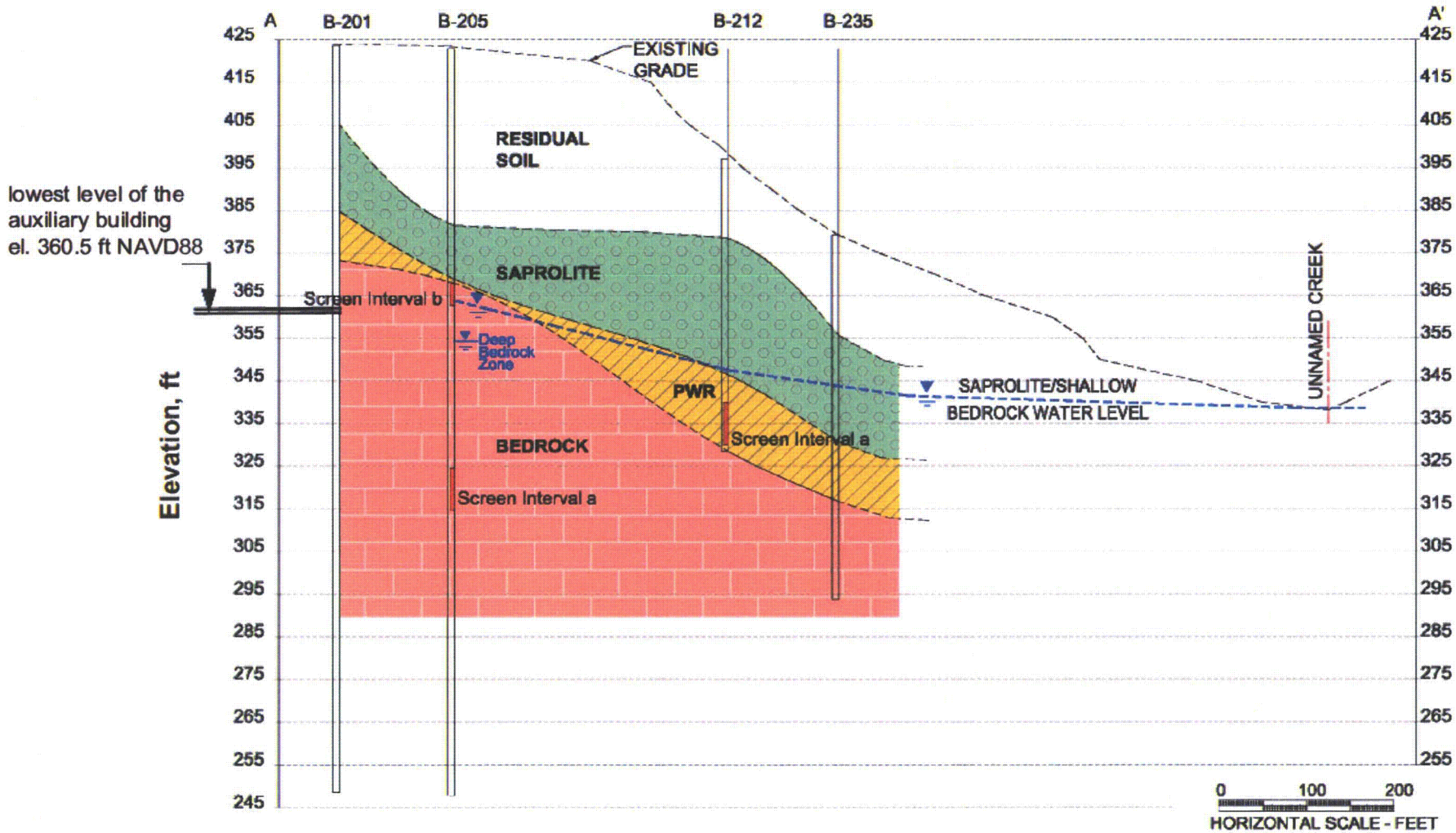

Figure 2.4-254 Cross Section along the Subsurface Contaminant Pathway from Unit 2 to the nearest unnamed creek (All elevations are with reference to the NAVD88 datum)

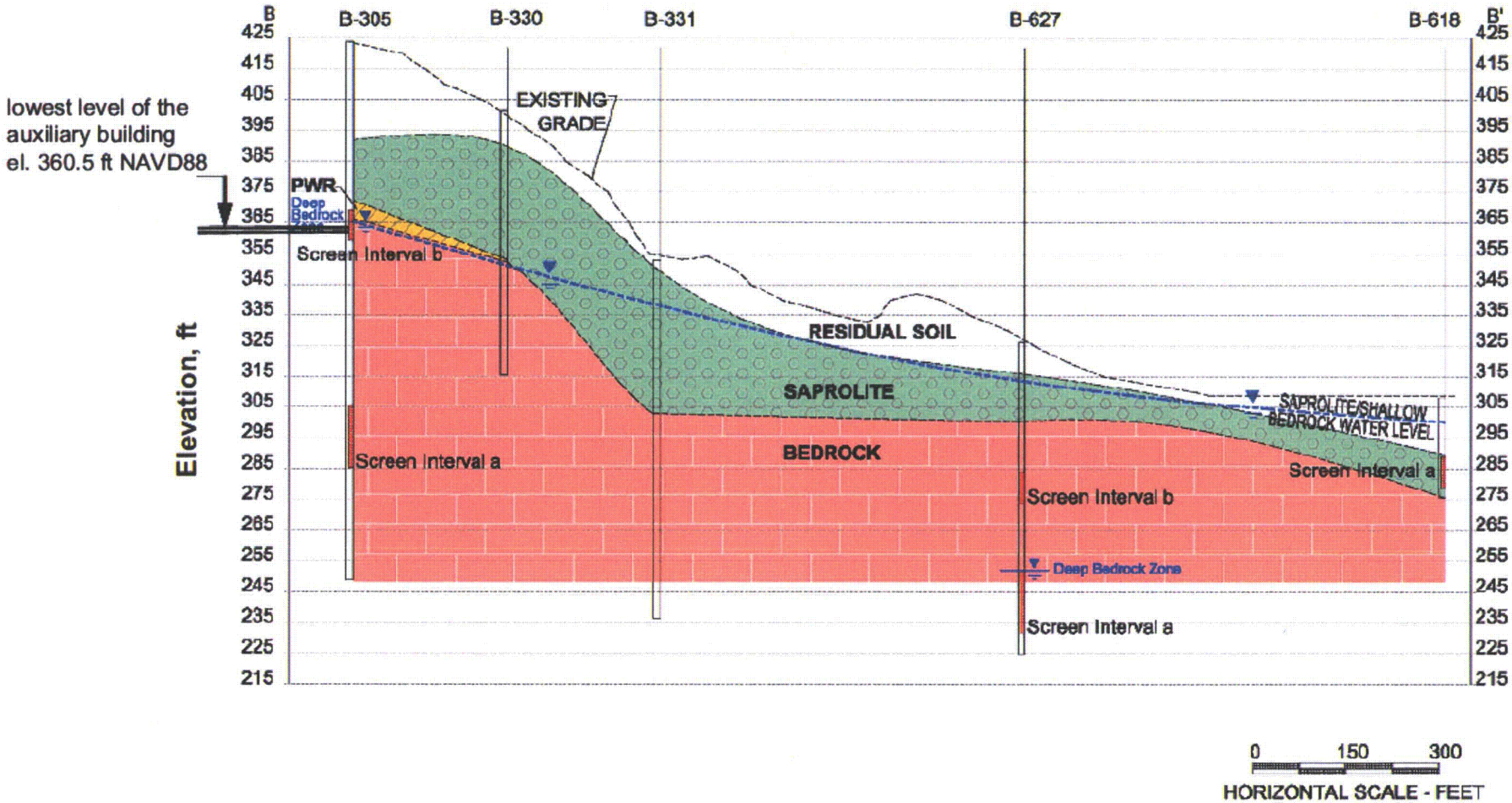

Figure 2.4-255 Cross Section along the Subsurface Contaminant Pathway from Unit 3 to the nearest unnamed creek (All elevations are with reference to the NAVD88 datum)

Insert the following new figures after Figure 2.4-255 in the FSAR:

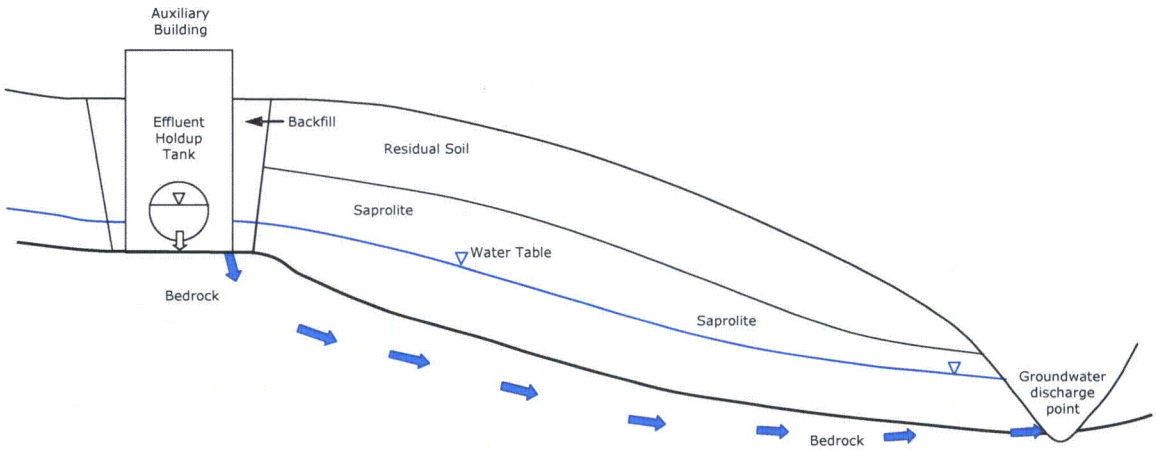

Figure 2.4-256 Conceptual Model for Evaluating Radionuclide Transport in Groundwater through the Bedrock Material to the Broad River or to Mayo Creek

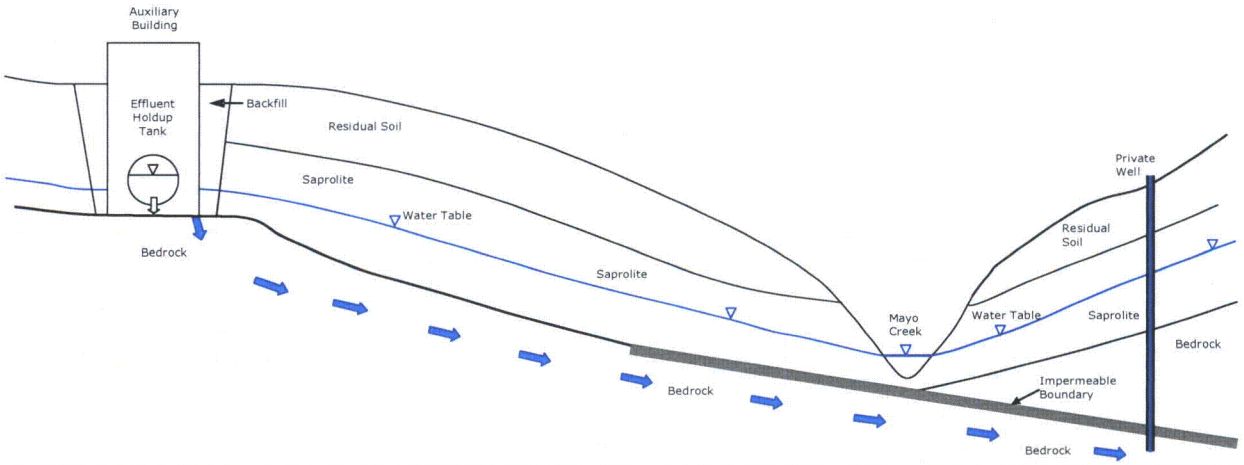

Figure 2.4-257 Conceptual Model for Evaluating Radionuclide Transport in Groundwater through the Bedrock Material to a Private Well on the SCE&G Property Line to the East of Mayo Creek

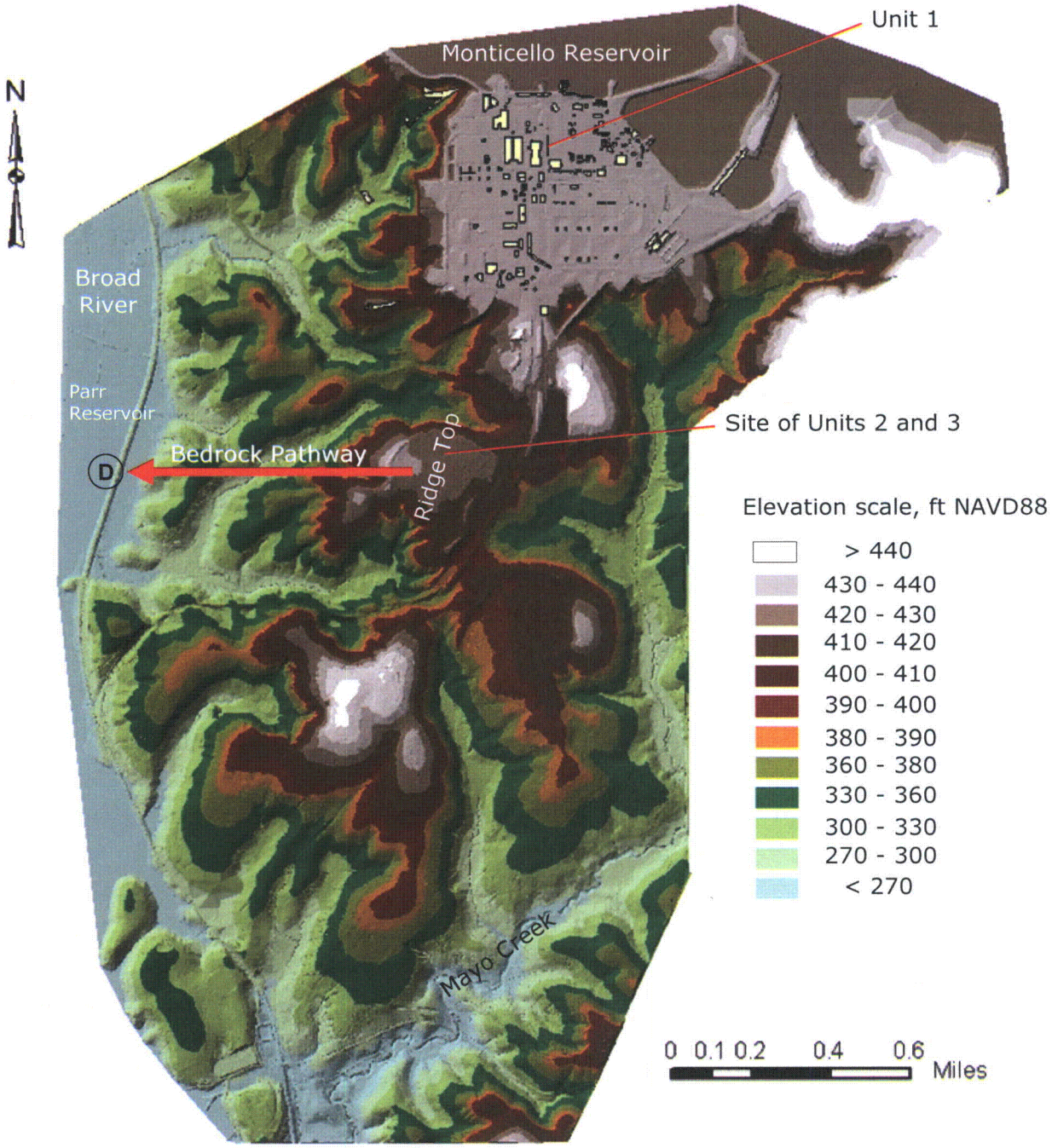

Figure 2.4-258 Plan View of the Western Contaminant Pathway through Bedrock to the Broad River (All elevations are with reference to the NAVD88 datum)

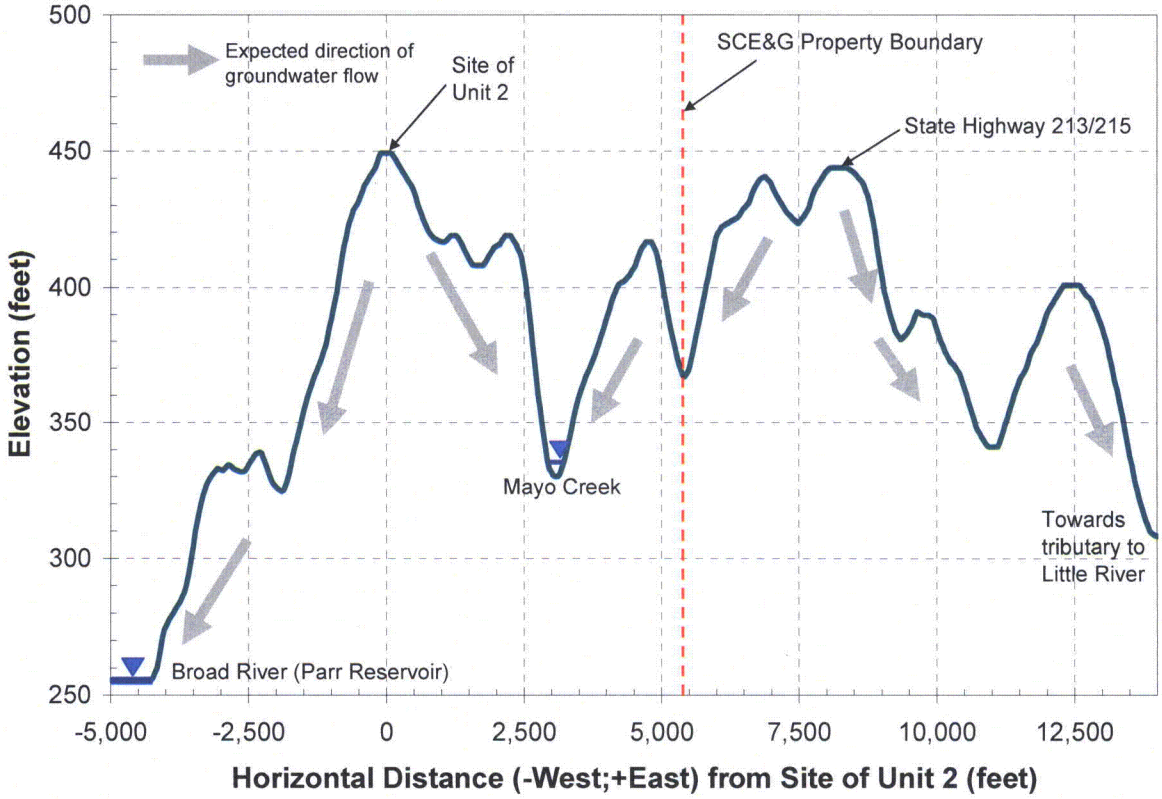

Figure 2.4-259 Elevation Transect along the Alternative Eastern Path from Unit 2 to the SCE&G Property Boundary

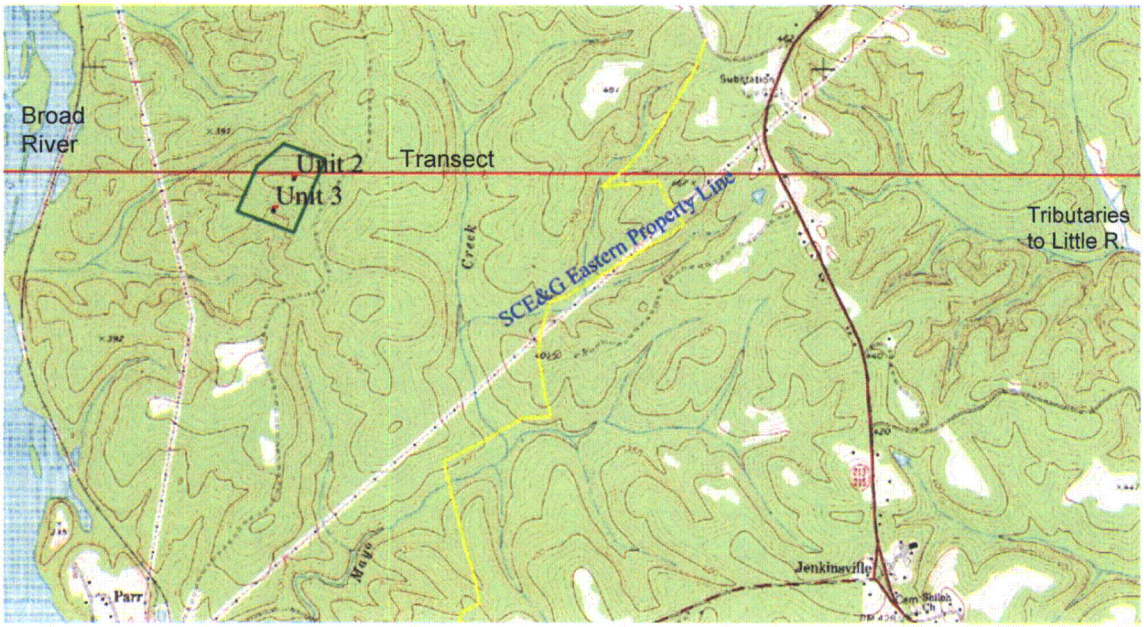

Figure 2.4-260 Plan View of the Elevation Transect along the Alternative Eastern Path from Unit 2 to the SCE&G Property Boundary

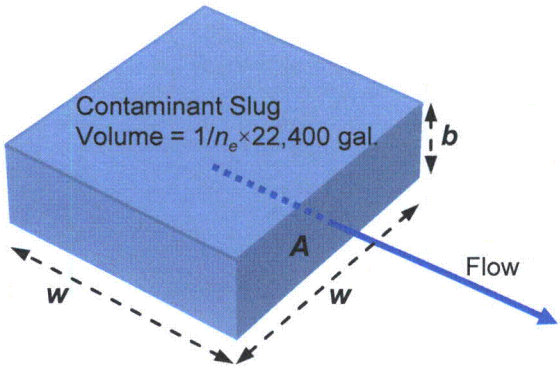

Figure 2.4-261 Conceptual Model of the Contaminant Slug Dimensions in the Aquifer

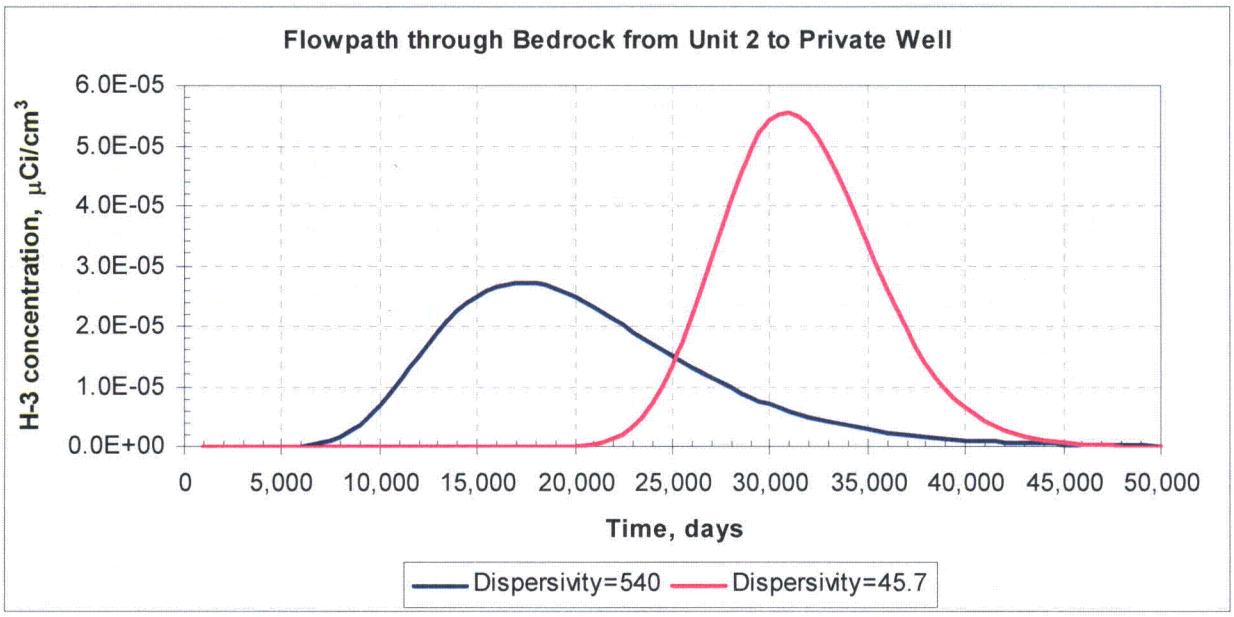

Figure 2.4-262 Predicted H-3 Concentrations at the Eastern SCE&G Property Boundary

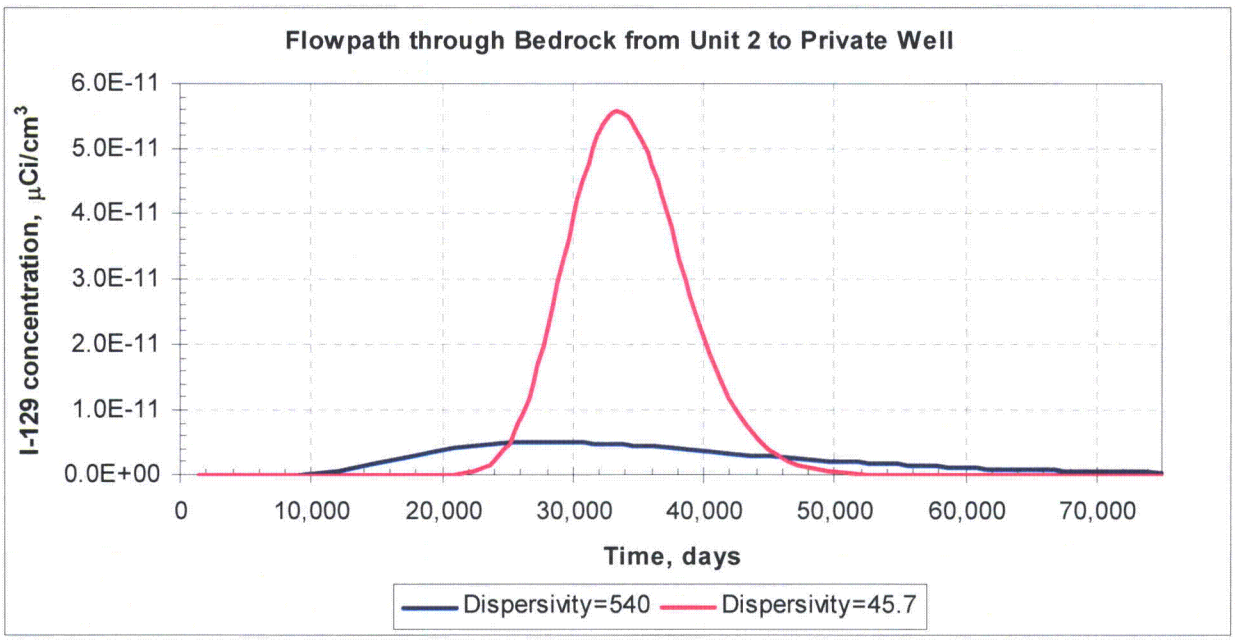

Figure 2.4-263 Predicted I-129 Concentrations at the Eastern SCE&G Property Boundary