CHAPTER 11: RADIOACTIVE WASTE MANAGEMENT
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CHAPTER 11 RADIOACTIVE WASTE MANAGEMENT

11.1 SOURCE TERMS

This section of the referenced DCD is incorporated by reference with no departures or supplements.

11.2 LIQUID WASTE MANAGEMENT SYSTEMS

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

11.2.1.2.4 Controlled Release of Radioactivity

Add the following to the end of DCD Subsection 11.2.1.2.4:

PTN SUP 11.2-1 The guard pipe-enclosed radwaste discharge piping connects to the blowdown sump discharge piping downstream of the blowdown sump pumps. Dilution of the liquid radwaste is initiated as the radwaste enters the blowdown sump discharge stream. The content of the blowdown sump is a combination of waste streams largely comprised of reclaimed water or seawater from circulating water system blowdown during plant operation or from the alternate dilution flow paths when CWS blowdown is not sufficient or available for dilution.

Piping from the blowdown sump dilution connection point is routed to the deep injection wells, distributed in two branches; one branch is oriented in a north-south direction and located to the east of Unit 6. The second branch is oriented in the east-west direction and located to the south of Units 6 & 7, as shown on Figure 1.1-201.

This injectate piping to each deep injection well isolation valve is single-walled, partially buried, and constructed of material suitable for the range of injectate composition, flow rates, and pressures, as well as environmental factors. The injectate piping contains manifolds, valves, and controls necessary to supply any appropriate combination of the deep injection wells. The injectate piping also includes appurtenances, such as vacuum breakers, vent lines, and access ways, as necessary, for proper operation and maintenance of the piping.

The piping, manifolds, valves, controls, and appurtenances are designed to minimize inadvertent or unidentified releases to the environment. Integrity of the injectate piping will be monitored for leakage or will be accessible for visual inspection or remote surveillance in conjunction with groundwater monitoring, as necessary, as part of the Units 6 & 7 Groundwater Monitoring Program.

As stated in Appendix 12AA, NEI 08-08A is adopted for Turkey Point Units 6 & 7. The NEI 08-08A template guidance provides a description of the operational and programmatic elements and controls that minimize contamination of the facility, site, and the environment, to meet the requirements of 10 CFR 20.1406.

The activity concentration of the radwaste portion of the effluent is controlled to 10 CFR Part 20, Appendix B, Effluent Concentration Limits (ECLs), by specifying and maintaining flow rates at the blowdown sump discharge corresponding to at least the minimum dilution factor (DF). The required minimum DF is calculated and applied before the release of liquid radwaste (batch is the only release mode anticipated) to ensure the activity concentration of the mixture complies with 10 CFR Part 20, Appendix B, ECLs. Implementation of the liquid radwaste effluent control program is in accordance with the Turkey Point Units 6 & 7 Offsite Dose Calculation Manual (ODCM), an operational program identified in Table 13.4-201.

11.2.1.2.5.2 Use of Mobile and Temporary Equipment

Add the following information at the end of DCD Subsection 11.2.1.2.5.2:

STD COL 11.2-1 When mobile or temporary equipment is selected to process liquid effluents, the equipment design and testing meets the applicable requirements of Regulatory Guide 1.143. When confirmed through sampling that the radioactive waste contents do not exceed the A_2 quantities for radionuclides specified in Appendix A to 10 CFR Part 71, liquid effluent may be processed with mobile or temporary equipment in the Radwaste Building. When the A_2 quantities are exceeded, liquid effluent is processed in the Seismic Category I auxiliary building.

Mobile and temporary equipment are designed in accordance with the applicable mobile and temporary radwaste treatment systems guidance provided in Regulatory Guide 1.143, including the codes and standards listed in Table 1 of the Regulatory Guide.

Mobile or temporary equipment has the following features:

- Level indication and alarms (high-level) on tanks.
- Screwed connections are permitted only for instrument connections beyond the first isolation valve.
- Remote operated valves are used where operations personnel would be required to frequently manipulate a valve.
- Local control panels are located away from the equipment, in low dose areas.

- Instrumentation readings are accessible from the local control panels (i.e., temperature, flow, pressure, liquid level, etc.).
- Wetted parts are 300 series stainless steel, except flexible hose and gaskets.
- Flexible hose is used only for mobile equipment within the designated “black box” locations between mobile components and at the interface with the permanent plant piping.
- The contents of tanks are capable of being mixed, either through recirculation or with a mixer.
- Grab sample points are located in tanks and upstream and downstream of the process equipment.

Inspection and testing of mobile or temporary equipment is in accordance with the codes and standards listed in Table 1 of Regulatory Guide 1.143 with the following additions:

- After placement in the station, the mobile or temporary equipment is hydrostatically, or pneumatically, tested prior to tie-in to permanent plant piping.
- A functional test, using demineralized water, is performed. Remote operated valves are stroked (open-closed-open or closed-open-closed) under full flow conditions. The proper function of the instrumentation, including alarms, is verified. The operating procedures are verified correct during the functional test.
- Tank overflows are routed to floor drains.
- Floor drains are confirmed to be functional prior to placing mobile or temporary equipment into operation.

11.2.3.5 Estimated Doses

Replace the information in DCD Subsection 11.2.3.5 with the following paragraphs and subsections.

PTN COL 11.2-2
PTN COL 11.5-3

Processed liquid radioactive waste from Turkey Point Units 6 & 7 operation is discharged to the plant blowdown sump pump discharge line before release to the Lower Floridan aquifer (Boulder Zone) by the deep well injection system (DIS) (Subsection 9.2.12). The performance assessment (PA) discussed in the following subsections is performed to assess the environmental fate and transport of Turkey Point Units 6 & 7 liquid effluent releases by deep well injection. The PA couples numerical groundwater modeling techniques with a liquid pathway analysis to identify the maximum exposed member of the public in unrestricted areas (maximally exposed individual, MEI) as a result of the Turkey Point Units 6 & 7 liquid effluent releases. The MEI is a hypothetical individual who—because of proximity, activities, or living habits—could potentially receive the maximum possible radiological dose attributed to each of three postulated deep well injection exposure pathway modes (i.e., normal operation, off-normal operation, and Inadvertent Intrusion). MEI dose is assigned using RG 1.109 dose contribution calculations for the radionuclides retained in the PA; where necessary, independent recognized technical approaches are used to validate RG 1.109 results. The groundwater modeling portion of the PA is conducted independent of RG 1.109 since that NRC guidance solely addresses surface water transport. The regulatory criteria applied in interpreting the MEI dose assignments are the single reactor 10 CFR Part 50, Appendix I, calendar year design objectives: less than or equal to 3 mrem to the total body and less than or equal to 10 mrem to the critical organ. MEI dose assignments attributable to the operational flexibility allowed by the calendar quarter Appendix I numerical guidance on technical specifications defining limiting conditions for operation are not explored in the PA because this guidance is specifically intended to allow operational flexibility in response to actual, as opposed to estimated, releases from the plant under unusual conditions. Doing so requires unreasonable speculation about in-plant liquid effluent generation or processing upsets.

11.2.3.5.1 Fate and Transport of Injected Radionuclides in the Subsurface

Turkey Point Units 6 & 7 disposes of liquid wastewater effluent via deep well injection into the Boulder Zone. To evaluate the fate and transport of radionuclides injected into the Boulder Zone, a variable-density numerical groundwater flow model is developed. A variable-density model is selected because density differentials between the injectate and the in situ groundwater are expected to have a significant impact on the flow and transport regimes, as described below.

The source term used in this model is based on a screening analysis of the entire DCD Table 11.2-7 inventory. This screening analysis, as described in the *Radioactive Source Term Selection* section, identifies four radionuclides (tritium, cesium-134, cesium-137 and strontium-90) that are the most significant potential dose contributors. These four radionuclides are retained throughout the variable-density flow and transport modeling calculations.

11.2.3.5.1.1 Groundwater Modeling

To support the evaluation of potential impacts to members of the public and doses to the MEI due to operation of the Turkey Point Units 6 & 7 DIS, the following models are developed:

Radial Transport Model In the Boulder Zone: models the fate and radial transport of radionuclides injected into the Boulder Zone.

Vertical Transport Model: models the upward transport of injectate out of the Boulder Zone.

Each analysis/model is described in detail below.

11.2.3.5.1.1.1 Radial Transport Model In the Boulder Zone

To evaluate the fate and transport of radionuclides injected into the Boulder Zone, a variable-density numerical groundwater flow model is developed. A variable-density model is selected because density differentials between the injectate (cycled reclaimed water or saltwater) and the in situ groundwater are expected to have an impact on the flow and transport regimes in the Boulder Zone.

This model considers the Boulder Zone (i.e., injection zone) only; other aquifer and/or confining units are not taken into account. The Boulder Zone is modeled as a confined (non-leaky) aquifer, neglecting other aquifer and/or confining units, which is conservative with respect to modeling radial transport because solutes (radionuclides) cannot leave the system by vertical leakance.

The elements of the numerical model for the base case, including the development of the input parameters and predicted radionuclide activity concentrations at potential receptor locations are described in the following paragraphs. A base case scenario is first developed, followed by a series of sensitivity analyses.

Radioactive Source Term Selection

Development of injectate activity concentrations takes into consideration the entire DCD Table 11.2-7 inventory. Radionuclide-specific activity concentrations are then determined on a basis consistent with that upon which DCD Table 11.2-8 has been developed.

A screening analysis is performed using the LADTAP II computer code (NUREG/CR-4013) to identify the DCD Table 11.2-7 radionuclides that are the most significant potential dose contributors considering the ingestion pathways of drinking water and irrigated milk, meats, and vegetables for effluent decay times ranging from 5 to 100 years. Based on this analysis, tritium, strontium-90, cesium-134, and cesium-137 are determined to contribute over 99 percent of the dose to the total body and the organs of a child (the most conservative receptor) after a decay time of 10 years or more. As discussed in greater detail in Subsection 11.2.3.5.2.5.1, the injectate plume is not projected to reach the receptor location until approximately 10 years after initiation of injection (for the base case simulation). These four radionuclides are, therefore, retained for further fate, transport modeling, and subsequent dose analysis. The injectate activity concentrations of these four radionuclides are presented in Table 11.2-201.

Numerical Model Description and Development of Model Input Parameters

Numerical Model Description

Depending on the source of cooling water makeup (reclaimed water or saltwater), the deep well injectate blowdown may be less or more dense than the in situ Boulder Zone groundwater. The injectate is less dense than the in situ groundwater when reclaimed water is used for cooling water makeup and more dense when saltwater is used.

To account for these density differences and their impact on radionuclide transport, SEAWAT, a finite-difference, variable-density groundwater code (Reference 202) is used to model the fate and transport of radionuclides injected into the Boulder Zone. SEAWAT solves the three-dimensional (3D), variable-density groundwater flow and multi-species transport equations by coupling MODFLOW (Reference 203) and MT3DMS (References 204 and 205). SEAWAT is widely used to simulate variable-density groundwater flow and is maintained by the U.S. Geological Survey. Groundwater Vistas (Reference 206) is used as a preprocessor and postprocessor to facilitate development of the model and interpretation of model results.

Modeling Approach

The DIS injection field is simulated using an axisymmetric approach, which represents a radially symmetric 3D system as a two-dimensional model

(Reference 207). With this approach, the DIS injection field is represented as a single well and provides a computationally efficient alternative to a full 3D model (Reference 207). This approach is appropriate given the absence of a strong regional hydraulic gradient in the Boulder Zone (Reference 208) relative to that likely to be induced by the injection.

Model Domain, Parameters, and Boundary Conditions

The model domain extends approximately 15 miles radially from the point of injection. This distance is selected to fully encompass the anticipated radial extent of the injectate plume over the life of the facility. The Boulder Zone is assumed to be homogeneous for the purpose of assigning groundwater flow and transport parameters. These parameters include transmissivity, storativity, effective porosity, and longitudinal and vertical dispersivity (Table 11.2-202).

The principal injectate component is wastewater from the main condenser cooling system (blowdown). Therefore, the main condenser cooling system makeup water source determines the fundamental hydrological characteristics of the injectate. The base case modeling scenario is predicated on the use of reclaimed water as the makeup water source. The intermittent use of saltwater as a makeup water source and its effect on radionuclide transport is also assessed, as are variations in the other operational parameters upon which the groundwater model is predicated (Table 11.2-203).

With a projected 60-year operational life (40-year license and 20-year renewal) per unit and a 1-year interval between the startup of Unit 6 and Unit 7, the total time period spanned by the operation of both units is 61 years. The groundwater model simulation duration is 100 years, which includes 61 years of DIS operation followed by 39 years without injection. This 39-year period is simulated to evaluate radionuclide migration after injection ceases.

In the event that reclaimed water is not available in sufficient quality or quantity, Turkey Point Units 6 & 7 uses saltwater provided by radial collector wells as a backup water source. The use of saltwater is limited to a maximum of 60 days in any consecutive 12-month period (References 215 and 216). While using saltwater as the source of cooling water, the injection flow rate (58,175 gpm) is approximately five times greater than that when using reclaimed water and the resulting radionuclide concentrations are approximately five times lower.

11.2.3.5.1.1.2 Vertical Transport Model

Given the depth of the Boulder Zone and the high salinity of the groundwater it contains, it is considered unlikely that the Boulder Zone will be accessed directly as a source of supply for either irrigation or ingestion purposes. However, the Upper Floridan aquifer is already being used as a source of supply for irrigation purposes in the vicinity of the Turkey Point Units 6 & 7 site. Therefore, the potential scenarios under which a member-of-the-public exposure to effluent injected into the Boulder Zone may occur are, in part, a function of the expected ability of the overlying middle confining unit to preclude upward migration of injectate out of the Boulder Zone and into the Upper Floridan aquifer.

The primary mechanism for migration of injectate out of the Boulder Zone is upward flow due to the injection pressure and the density differential between the injected fluid and the in situ groundwater. Cooling water sourced from reclaimed water has the potential for upward migration due to its relatively low total dissolved solids (TDS) concentration and correspondingly low density compared to groundwater in the Boulder Zone, while cooling water derived from saltwater (radial collector wells) will tend to sink due to a high TDS concentration and, therefore, does not pose a risk of upward vertical migration. While TDS concentration is the primary determinant of fluid density for the expected range of conditions, temperature can also contribute to density differentials.

To evaluate the potential for upward migration from the Boulder Zone through the middle confining unit to the Upper Floridan aquifer absent some failure such as an improperly abandoned well, naturally formed conduit, etc., a 3D groundwater model is developed to simulate injection of reclaimed water into the Boulder Zone. The modeling is also performed using SEAWAT (Reference 202) and included consideration of fluid density variations due to both TDS concentration and temperature. Solute transport modeling is performed for TDS concentration, which serves as a non-decaying radionuclide surrogate.

Based on the modeling results, the migration of radioactive species out of the Boulder Zone by density-driven vertical migration is not expected to be significant.

11.2.3.5.1.2 Cumulative Radionuclide Inventory at the End of Plant Operations

The cumulative radionuclide inventory present in the Boulder Zone at the end of Turkey Point Units 6 & 7 plant operations is presented in Table 11.2-204. This table represents the DCD Table 11.2-7 inventory continually injected into the Boulder Zone for 61 years, with radioactive decay being the only removal mechanism. Note that the estimate of the cumulative inventory of radionuclides in the Boulder Zone is not performed using results of the radial transport model. While injectate radionuclide activity concentrations are determined on a basis essentially consistent with that used to develop DCD Table 11.2-8 (i.e., based on the release of the average daily discharge for only 292 days per year), it is otherwise conservatively assumed for purposes of the PA that both units operate continuously (i.e., for 365 days per year) throughout the life of the plant and, therefore, continuously release their average daily discharge. This assumption of continuous operation and release is conservative because it increases the radioactive source term, resulting in a higher estimate for the cumulative inventory than would otherwise be obtained.

11.2.3.5.2 Receptor Determination and Dose Analysis

The determination of appropriate members-of-the-public receptors and assessment of the consequential doses which they could potentially receive as a result of the injection of radwaste to the Boulder Zone are described in the paragraphs below. The use of both preliminary and detailed liquid effluent pathway scenario identification and screening analyses in the selection of the members of the public to be considered and retained for dose analysis purposes is discussed, to include their consideration of the local hydrogeology and consequential potential for vertical effluent migration out of the Boulder Zone as well as current and projected land and water use. The identification and screening process includes a definition of Turkey Point Units 6 & 7 specific liquid effluent exposure pathway modes and associated event scenarios, development of a conceptual model for each such scenario, an assessment of whether a liquid effluent pathway scenario is to be retained for further analysis, and the determination of the consequential doses to the associated member-of-the-public receptors.

11.2.3.5.2.1 Exposure Pathway Modes for Liquid Effluent Pathway Analysis

Two operating modes—normal operation and off-normal operation—and a special case (inadvertent intrusion) are considered for purposes of the member-of-the-public screening analysis.

Normal Operation – Operation within specified operational limits and conditions. This mode assumes that the DIS and subsurface hydrogeological units operate as designed or expected, i.e., with no system failures such as deep injection well seal failure or subsurface confining unit fracture/failure.

Off-Normal Operation – An operational process beyond specified operational limits or conditions that, while not expected, may occur during the operating lifetime of a facility, e.g., a deep injection well seal failure or subsurface confining unit fracture/failure.

Inadvertent Intrusion – This is a special case mode whereby, while highly unexpected, a member of the public is unknowingly exposed to injectate while otherwise engaging in normal activities.

11.2.3.5.2.2 Member-of-the-Public Location Selection Process and Bases

RG 1.109 provides guidance regarding the determination of doses to members of the public as a result of routine releases of reactor effluents. Specifically, RG 1.109 provides guidance related to the selection of member-of-the-public locations. Per RG 1.109, the point of dose evaluation for the liquid effluent pathway analysis is to be the location of the highest offsite dose. It is evaluated:

- *“At a location that is anticipated to be occupied during the operating lifetime of the plant, or*
- *With respect to such potential land and water usage and food pathways as could actually exist during the term of plant operation.”*

With regard to the latter evaluation consideration, RG 1.109 states:

…the applicant may take into account any real phenomena or actual exposure conditions. Such conditions could include actual values for agricultural productivity, dietary habits, residence times, dose attenuation by structures, measured environmental transport factors (such as bioaccumulation factors), or similar values actually determined for a specific site.

The above guidance is applied first to identify locations in unrestricted areas beyond the Turkey Point Units 6 & 7 site where liquid effluent pathway exposure to a member of the public might occur. The dose delivered to each identified member of the public is then estimated through the application of the maximum-exposed-individual approach regarding lifestyle and dietary habits as implemented in the NRC-endorsed computer program LADTAP II.

To determine the greatest relevant extent of radionuclide propagation within which potential liquid effluent pathway exposure to a member of the public must be assessed, an initial dose analysis is performed using the LADTAP II computer program to identify the DCD Table 11.2-7 radionuclides that are the most significant potential dose contributors considering the assumed ingestion pathways of drinking water and irrigated milk, meats, and vegetables for effluent decay times ranging from 5 to 100 years. This analysis determined that, while the percentage of each of the radionuclide's contribution to the total dose varies over time due to each of their respective half-lives, tritium, strontium-90, cesium-134, and cesium-137 contribute over 99 percent of the dose to the total body and the organs of a child (the most conservative receptor) after a decay time of 10 years or more. The time-dependent radial extents of tritium, cesium-134, cesium-137, and strontium-90 along with the corresponding concentration in the respective plumes as determined using the radial transport model are illustrated in Figures 11.2-201,11.2-203, 11.2-205, and 11.2-207, respectively. As these figures indicate, the injectate plume is not expected to reach the nearest potential receptor location until more than 10 years after the inception of injection. The distributions of tritium, cesium-134, cesium-137, and strontium-90 in the Boulder Zone at the end of plant operations are depicted in Figures 11.2-202, 11.2-204, 11.2-206, and 11.2-208, respectively, while Figure 11.2-209 provides the time-dependent relative concentration (i.e., simulated concentration, C, divided by the as-injected concentration, C_0) breakthrough curves for all four radionuclides.

To give some context to the actual dose contribution from each radionuclide during the modeled time period, there is a limited duration, i.e., over a decay period of about 30 years or less, in which the sum of the per-unit radionuclide doses is expected to be at least 1 mrem. During this period, tritium contributes more than 90 percent of the total dose (i.e., the contribution to the total body dose for a child from radionuclides other than tritium is a small fraction of a mrem for any period greater than 5 years). Based on the most limiting 10 CFR Part 50, Appendix I, design objective of 3 mrem per year for the total body per unit, or 6 mrem for both units, the tritium concentration yielding this dose to the child (i.e., the 6 mrem derived activity concentration) is determined to be 37,000 pCi/L (two-unit source term and two-unit deep well injection rate; the two-unit case is more limiting as it results in a greater extent of plume expansion at any given point in time as well as a higher cumulative radionuclide inventory).

As an indicative determinant of the area of consequence to this analysis, this 37,000 pCi/L derived tritium activity concentration is then used as a basis for ascertaining the farthest radial extent of a tritium concentration capable of producing doses at the level of the 10 CFR Part 50, Appendix I, design objectives during the modeled timeframe. Figure 11.2-210 depicts the extent of the 37,000 pCi/L tritium activity concentration profile at 5, 10, 25, 50, and 75 years. Tritium concentrations are below the 37,000 pCi/L derived activity concentration at all locations at 100 years and, therefore, no contour is shown in Figure 11.2-210 for this simulation time. As Figure 11.2-210 indicates, the farthest radial extent of the 37,000 pCi/L-derived tritium activity concentration during the modeled time frame is between approximately 1.9 and 2.0 miles from the injection zone. The radial extent of the 37,000 pCi/L tritium activity concentration profile begins to retract after year 25 due to the increasing thickness of the low salinity injectate plume and the resultant increase in the travel time to any given radial distance from the injection point. After injection ceases at year 61, the tritium plume diminishes due to radioactive decay and the lack of continued injection, and as a result, the 37,000 pCi/L tritium activity concentration contour retracts more rapidly toward the injection location.

The locations at which exposure to treated liquid radioactive waste disposed of through deep well injection may potentially occur are assigned to three areas based on their placement relative to Turkey Point Units 6 & 7. These areas, which are illustrated in Figure 11.2-211, are defined as follows:

Plant Area – This area includes the location of Turkey Point Units 6 & 7 and includes the DIS. No current or future member of the public or populations has access to effluent at this location. Plant workers, however, may have exposure to effluent.

Property Area – This area includes all FPL-owned property between the plant area and the Turkey Point property boundary. No current or future member of the public or populations has access to effluent at this location. Plant workers, however, may have exposure to effluent.

Beyond Property Area – This area includes the area beyond the Turkey Point property boundary. Members of the public and populations who are part of the general public may access effluent at these locations. The land ownership in this area includes private, government, and significant FPL ownership (Figure 11.2-212).

11.2.3.5.2.3 Liquid Effluent Pathway Screening Analysis

11.2.3.5.2.3.1 Scenario Identification

An initial liquid effluent pathway screening analysis is conducted to identify potential scenarios under which members of the public could possibly be exposed to the liquid effluent and to then categorize them by location (plant area, property area, beyond property area) and mode (normal, off-normal, inadvertent intrusion). An analysis is then performed to determine if a scenario is retained for detailed liquid effluent pathway analysis or, alternatively, eliminated from further consideration. This screening analysis is described in the paragraphs below. Those scenarios that are retained for further analysis along with the determination of the resultant doses are described in greater detail in the subsequent sections.

11.2.3.5.2.3.1.1 Plant Area

Normal Operation

The normal operation mode for purposes of potential member-of-the-public exposure scenario determination assumes that no such system failures as injection well failure or subsurface loss of confinement occur within the bounds of the plant area or elsewhere. As part of the normal operation of the DIS, it is anticipated that some vertical migration of the effluent will occur from the Boulder Zone into the middle confining unit, primarily as a result of injection pressure and buoyancy. Based on the vertical transport modeling results discussed in Subsection 11.2.3.5.1.1.2, this upward migration of effluent is expected to be contained below a depth of 2600 feet, or approximately 300 feet into the middle confining unit, at the end of the 100-year simulation duration. Given that the top of the middle confining unit is at approximately 1200 feet below ground surface (bgs) (References 214 and 217), the plume would have to vertically migrate an additional 1000 feet or more to reach the Upper Floridan aquifer. The time to transit this additional distance and reach the Upper Floridan aquifer is expected to be greater than 100 years under this Normal Operation scenario (i.e., no unanticipated vertical flow conduit is encountered in the middle confining unit), by which time radionuclide concentrations are expected to have fallen to non-consequential levels even if only radioactive decay is taken into consideration. Because the Upper Floridan aquifer is, therefore, not anticipated to be impacted, no member-of-the-public exposure pathway is possible, and this scenario is not retained for further liquid effluent pathway analysis.

Off-Normal Operation

Middle Confining Unit Failure

Geological, seismological, and geophysical investigations performed for the site (Subsection 2.5.3) as well as geologic results from EW-1 (Reference 214) indicate there are no known or suspected faults or other geological features at the Turkey Point Units 6 & 7 site that would allow vertical fluid movement through the middle confining layer. The borehole compensated sonic geophysical log performed on the interval from 1475 feet below pad level to 3230 feet below pad level of EW-1 was reviewed for evidence of a fracture(s) within the logged interval. Based on this data (Reference 214), no features are observed in EW-1 suggesting that the confining strata above the Boulder Zone has been compromised by vertical fractures or other features. However, a failure in the lower confining unit above the Boulder Zone within the bounds of the plant area, should one occur, could cause a “U-Tube” type scenario where Boulder Zone water containing effluent travels vertically through an improperly abandoned well, naturally formed conduit, etc. This effluent could conceivably travel laterally through the Upper Floridan aquifer to beyond property area locations to potentially be accessed by members of the public/populations for use (e.g., in plant nurseries). However, the potential radiological impacts of this scenario are bounded by those of the beyond property area—off-normal operation middle confining unit failure—related scenario described below. Specifically, in being transported to a potential beyond property area member-of-the-public receptor location, the effluent would undergo dilution and dispersion in the Upper Floridan aquifer and the eastward gradient in the Upper Floridan aquifer (Reference 208) would tend to impede the flow of the effluent plume inland toward the beyond property area location (illustrated as Pathway B in Figure 11.2-213). Further, as part of the prompt detection and mitigative strategies program prepared for DIS off-normal operations, monitoring of the Upper Floridan aquifer and dual-zone monitoring well conditions is to be conducted to alert plant operators of possible effluent incursions into the Upper Floridan aquifer. Response actions are to include, as appropriate, confirmatory Upper Floridan aquifer/dual-zone well monitoring, removal of affected DIS components from service, and other actions protective of members of the public and plant workers. The DIS off-normal operations prompt detection and mitigative strategies program will be part of the Turkey Point Units 6 & 7 Offsite Dose Calculation Manual (ODCM)/Radiological Environmental Monitoring Program (REMP) to be made available for inspection prior to fuel load (Table 13.4-201). This scenario is, therefore, not considered a feasible Off-Normal Operation scenario and is not retained for further liquid effluent pathway analysis.

Worker Exposure at Leaking Pipe

A section of the deep injection well piping is anticipated to be located above grade. There is a possibility that a temporary leak could occur in this piping, resulting in a localized release of effluent. However, any consequential plant worker exposure is suitably controlled through the appropriate implementation of the plant’s occupational radiation control program as described in Appendix 12AA in applying engineering controls, ALARA practices, and other exposure avoidance/reduction measures to maintain each radiation worker’s resultant dose below the applicable annual occupational limit of 5 rem. Additionally, since positive access control of the plant area is maintained, there is no potential for member-of-the-public exposure. Therefore, this scenario is not retained for further liquid effluent pathway analysis.

Worker Exposure to Biscayne Aquifer

The exposure pathway is a worker at the site who may be exposed to effluent from the Biscayne aquifer during any type of earthmoving work (e.g., trenching) that may be conducted over the operational lifetime of Turkey Point Units 6 & 7. Normal operation assumes some limited vertical migration of effluent into the middle confining unit above the Boulder Zone, but as described above, it is expected to be contained well below the top of the middle confining unit over the plant's operational lifetime and beyond. This scenario, however, assumes vertical migration of effluent through both the middle and the intermediate confining units into the Biscayne aquifer and discounts the dispersion and dilution that will occur in the intervening Upper Floridan aquifer. Therefore, this scenario is not considered feasible and is not retained for further liquid effluent pathway analysis.

Deep Injection Well Failure at Site

This scenario involves a subsurface mechanical failure of one or more deep injection wells that is undetected by plant operators, resulting in the injection of effluent into the Upper Floridan or Biscayne aquifers. This scenario is not considered feasible for the following reasons:

- The construction materials, installation, and testing for the deep injection wells are both rigorous and thorough (Subsection 9.2.12)
- Pressure and flow into the deep injection wells are continuously monitored for fluctuations, which could indicate a well failure

Middle Confining Unit Failure and Injectate Travel to the Unit 5 Upper Floridan Water Supply Wells

This scenario assumes travel of injectate through a fracture in the middle confining unit and travel to one or more of the Unit 5 water supply wells, which are screened in the Upper Floridan aquifer. As discussed above, geological, seismological, and geophysical investigations performed for the site (Subsection 2.5.3) as well as geologic results from EW-1 (Reference 214) indicate there are no known or suspected faults or other geological features at the Turkey Point Units 6 & 7 site that would allow vertical fluid movement through the middle confining layer. As also discussed above, monitoring of Upper Floridan aquifer and dual-zone monitoring well conditions is to be conducted to alert plant operators of possible injectate incursions to the Upper Floridan aquifer. Response actions are to include, as appropriate, confirmatory Upper Floridan aquifer/dual-zone well monitoring, removal of affected DIS components from service, and other actions protective of members of the public and plant workers. The DIS off-normal operations prompt detection and mitigative strategies program will be part of the Turkey Point Units 6 & 7 ODCM/REMP to be made available for inspection prior to fuel load (Table 13.4-201).

This scenario, therefore, is not considered feasible and is not retained for further liquid effluent pathway analysis.

Inadvertent Intrusion

No inadvertent intrusion scenarios relating to exposure and subsequent dose from the operation of the DIS are identified at the plant area since positive access control is maintained.

11.2.3.5.2.3.1.2 Property Area

Normal Operation

As described in the *Plant Area — Normal Operation* discussion above, the normal operation mode for purposes of potential member-of-the-public exposure scenario determination assumes no system failures, e.g., injection well failure or subsurface loss of confinement, within the bounds of the property area. As part of the normal operation of the DIS, there is expected to be some limited vertical migration of the effluent from the Boulder Zone into the middle confining unit. However, as further described in the *Plant Area — Normal Operation* scenario above, because the Upper Floridan aquifer is not anticipated to be impacted, no member-of-the-public exposure pathway is expected, and this scenario is not retained for further liquid effluent pathway analysis.

Off-Normal Operation

Middle Confining Unit Failure

As previously discussed, a failure in the middle confining unit above the Boulder Zone within the bounds of the property area, should one occur, could create a "U-Tube"-type scenario where Boulder Zone water could be introduced into the Upper Floridan aquifer to potentially be accessed by beyond property area members of the public/populations for use. However, as also discussed above, such a failure within the property area is unlikely, the effluent would undergo dilution and dispersion in the Upper Floridan aquifer in being transported to a potential beyond property area member-of-the-public receptor location, and the eastward gradient in the Upper Floridan aquifer (Reference 208) would tend to impede the flow of the effluent plume inland toward the beyond property area location (illustrated as Pathway B in Figure 11.2-213). Therefore, this scenario is not considered a feasible off-normal operation scenario and is not retained for further liquid effluent pathway analysis.

Migration of Effluent Through the Middle and Intermediate Confining Units

The potential exposure pathway is a member of the public who may be exposed to surface water that is in connection with the Biscayne aquifer. This scenario is similar to the worker exposure to Biscayne aquifer scenario discussed above as it also assumes the vertical migration of effluent through both the middle and the intermediate confining units into the Biscayne aquifer. However, as further described in the previously discussed *Plant Area — Normal Operation* scenario, any upward migration of effluent is expected to be contained well below the top of the middle confining unit over the plant's operational lifetime and beyond, and thus, it is not anticipated that any radionuclides will travel through the middle confining unit absent some failure in that stratum. This scenario, however, requires the postulation of a failure in the intermediate confining unit as well as the middle confining unit in order for the effluent to enter into the Biscayne aquifer and discounts the dilution and dispersion that will occur in the intervening Upper Floridan aquifer. Therefore, this scenario is not considered feasible and is not retained for further liquid effluent pathway analysis.

Inadvertent Intrusion

No inadvertent intrusion scenarios relating to exposure and subsequent dose from the operation of the DIS have been identified at the property area since positive access control is maintained.

11.2.3.5.2.3.1.3 Beyond Property Area

Normal Operation

As described in the *Plant Area — Normal Operation* discussion above, the normal operation mode for purposes of potential member-of-the-public exposure scenario determination assumes that no systems failures, e.g., injection well failure or subsurface loss of confinement, occur beyond the property area. As part of the normal operation of the DIS, there is expected to be some limited vertical migration of the effluent from the Boulder Zone into the middle confining unit. However, as further described in the *Plant Area — Normal Operation* scenario above, because the Upper Floridan aquifer is not anticipated to be impacted, no member-of-the-public exposure pathway is expected, and this scenario is not retained for further liquid effluent pathway analysis.

Off-Normal Operation

Migration of Effluent Through the Middle and Intermediate Confining Units

The potential exposure pathway is a member of the public who may become exposed to effluent that is in connection with the Biscayne aquifer. This scenario is similar to the *Plant Area — Worker Exposure* to Biscayne aquifer scenario discussed above because it also assumes the vertical migration of effluent through both the middle and the intermediate confining units into the Biscayne aquifer. This aquifer could then potentially be accessed by a member of the public or population for potable water use, farming, etc. However, as further described in the *Plant Area — Normal Operation* scenario above, any upward migration of effluent is expected to be contained well below the top of the middle confining unit over the plant's operational lifetime and beyond, and thus, it is not anticipated that any radionuclides will travel through the middle confining unit absent some failure in that stratum. This scenario, however, requires the postulation of a failure in the intermediate confining unit as well as the middle confining unit in order for the effluent to enter the Biscayne aquifer and discounts the dilution and dispersion that will occur in the intervening Upper Floridan aquifer. Therefore, this scenario is not considered feasible and is not retained for further liquid effluent pathway analysis.

Middle Confining Unit Failure

A failure in the middle confining unit above the Boulder Zone could create a "U-Tube"-type scenario where Boulder Zone injectate containing effluent travels vertically up into the Upper Floridan aquifer through an improperly abandoned well, naturally formed conduit, etc., at a location where it could potentially be accessed by a member of the public/populations for use (e.g., in plant nurseries). This scenario is considered feasible and is retained for further liquid effluent pathway analysis.

Inadvertent Intrusion

A member of the public located at or near the property boundary could drill a water supply well directly into the Boulder Zone and use its groundwater for ingestion, irrigation, and livestock. While possible, this scenario is highly improbable given the Boulder Zone's extreme depth, high TDS concentration, and classification by the Florida Department of Environmental Protection (FDEP) as a Class G-IV aquifer not suitable for potable use and not subject to the minimum groundwater criteria. (See rules 62-520.410 and 62-520.440, Florida Administrative Code.) A more plausible scenario is for a member of the public to drill a well into the Upper Floridan aquifer immediately above a failure in the middle confining unit (illustrated as Pathway A in Figure 11.2-213) and to then unknowingly use the contaminated Upper Floridan groundwater for both drinking water ingestion and subsistence irrigation. This hypothetical scenario is, therefore, retained for further dose consideration to represent the maximum exposed member of the public.

11.2.3.5.2.3.2 Summary of Scenarios Retained for Further Liquid Effluent Pathway Analysis

Table 11.2-205 summarizes the scenarios retained for further detailed consideration (as indicated by shading). The members of the public are listed where they have been identified.

11.2.3.5.2.4 Detailed Liquid Effluent Pathway Analysis and Member-of-the-Public Determination

A more detailed analysis of the liquid effluent pathway scenarios considered feasible following completion of the initial screening analysis is performed to determine which liquid pathway effluent scenarios (location and mode) potentially constituting exposure to the MEI are to be used for detailed dose analysis purposes. As part of this analysis, current and projected land and water usage in the vicinity of Turkey Point are taken into consideration in selecting member-of-the-public location(s) at and beyond the property boundary and the associated members of the public/populations that may potentially be impacted. A description of this current and projected land and water usage is provided below followed by a discussion of the detailed liquid effluent pathway analysis and its results.

11.2.3.5.2.4.1 Land Ownership/Water Use in Areas Beyond the Property Boundary

To identify opportunities where members of the public could potentially be exposed to injectate at points beyond the property boundary (Figure 11.2-211), an examination of current and projected land use/ownership and groundwater use in the vicinity of Turkey Point is conducted. This examination provides the rationale both for eliminating, if possible, previously retained off-normal scenarios from further consideration and for selecting the associated member-of-the-public locations and exposure pathways (e.g., ingestion, irrigation) for those scenarios that are retained. (Note: all normal operation scenarios have already been eliminated from further consideration.)

Figure 11.2-212 depicts the available information related to current land ownership and water supply well location and type. For reference, the maximum areal extent in which a tritium activity concentration at or above the 37,000 pCi/L derived activity concentration might exist is also depicted. The following paragraphs summarize current and projected land/water use in the area of Turkey Point based on data obtained from several sources, including South Florida Water Management District (SFWMD), county, and local municipal planning documents (References 218 through 223) and discuss the consequential implications with regard to the identification of the beyond property area members of the public. This information will be verified during the annual land use census required by the Turkey Point Units 6 & 7 ODCM. Changes to the liquid effluent pathway analysis as a result of the land use census will be incorporated in an ODCM and/or ODCM-implementing procedure revision.

The land parcels immediately adjacent to the west of the property area consist of agriculture land that is owned predominantly by FPL, Miami-Dade County, SFWMD, as well as other private entities or individuals (Figure 11.2-212). Land parcels owned by private entities or individuals are within an area of agricultural use, and based on aerial photography, only a few houses are located on these parcels to the west. The land parcels immediately adjacent to the north of the property area are categorized as parks and recreation land use, environmental protected parks land use, undeveloped land, or agriculture use. FPL, SFWMD, and Miami-Dade County are the predominant land owners in this area. There are land parcels owned by private entities and individuals, with the nearest privately owned parcel to the property boundary being located 2.2 miles from the effluent injection point (Figure 11.2-214), but these parcels are also designated for nonresidential use. Based on current land use records and aerial photography, no large scale or individual subsistence farming is currently occurring near Turkey Point. Current land use near Turkey Point does not include large-scale farming or livestock raising that could potentially impact the population through the ingestion of food products.

Future land use near Turkey Point will be influenced by planning and policies enacted by Miami-Dade County as well as state and federal agencies. Areas designated as resources of regional significance and wetlands on federal, state, or county land acquisition lists have been given a high priority for public acquisition. Additionally, lands may be acquired as part of the Comprehensive Everglades Restoration Plan projects in the area. Urban sprawl is to be discouraged by not providing new water supply or wastewater collection service to land within areas designated agriculture, open land, or environmental protection. Potentially, all land near Turkey Point is to be removed from private ownership and designated as public protected land during the operational lifetime of Turkey Point Units 6 & 7. More importantly, the projected future land use in the beyond property area will not be enabling of large-scale farming or livestock raising that could potentially impact the population through the ingestion of food products.

Current water use indicates that there are no current public users of any groundwater in the immediate vicinity of the property area (Figure 11.2-212). There are only three current users of the Upper Floridan aquifer within Miami-Dade County (Table 11.2-206), all of whom are located significantly beyond the maximum extent of the 37,000 pCi/L derived tritium activity concentration contours. Future water use policy mandates that individual potable water supplies, including private wells, are to be considered interim facilities to be used only where no alternative public water supply is available and land use and water resources are suitable for an interim water supply. Such interim water supply systems are to be phased out as service becomes available from municipal or county supply.

Miami-Dade County future water use planning includes development of new potable water well fields and alternative water supplies to plan for the county's existing and future water supply needs. After 2013, Miami-Dade County plans to meet all water supply demands associated with new growth from alternative water supply sources, which may include withdrawals from the Floridan aquifer. However, the planned points of withdrawal for these potential additional sources of water are located 10 miles or more from the Turkey Point Units 6 & 7 site.

Current and future land and water use in the beyond property area impacts the selection of members of the public/populations who could be exposed to the DIS effluent. These populations could be impacted through the use of groundwater and through the ingestion of animals and crops exposed to this same groundwater. Current and future land use in the area would indicate that large scale farming or livestock production is not expected. Although several municipalities may in the future use such additional groundwater resources as water from the Upper Floridan aquifer, these potential well fields would be located significantly beyond the maximum extent of the 37,000 pCi/L derived tritium activity concentration contours. Based on current and projected future land and water use policy and trends as described above, population exposure to effluent is not anticipated.

11.2.3.5.2.4.2 Retained Liquid Effluent Pathway Scenarios, Member-of-the-Public Identification, and Selection of Locations for Dose Analyses

As noted above, potential member-of-the-public exposure is influenced by current land/water use and future land and water use policy and trends (References 218 through 223). Individual ownership of beyond property area land in the vicinity of Turkey Point is limited and future land use planning would indicate that individual ownership in this area will only decrease. Additionally, there is no current subsistence farming or the raising of livestock in the area; based on future planning and trends, this is expected to remain the case throughout the operational life of Turkey Point Units 6 & 7. There are no current individual users of groundwater from any aquifer either within or in the vicinity of the maximum extent of the 37,000 pCi/L derived tritium activity concentration contours. Future water use planning would discourage long-term groundwater use in favor of water provided by municipalities drawing on water sources at points significantly beyond the maximum extent of the 37,000 pCi/L derived tritium activity concentration contours.

Although the likelihood of individual land ownership and groundwater use in the vicinity of the Turkey Point Units 6 &7 site is low, radiological exposure to members of the public as a consequence of underground injection of effluent is a possibility, albeit remote, particularly within an extended timeframe (e.g., 100 years) as influenced by such factors as changes in public policy, climate, or population trends. Therefore, to bound this uncertainty, member-of-the-public locations have been selected based on their placement relative to the property area. Specific event scenarios potentially involving members of the public sited at these locations have been categorized as follows:

- Credible – Such a scenario may be expected to occur during the operational lifetime of the plant (or beyond).
- Non-Credible – Such a scenario is not likely to occur during the operational lifetime of the plant or beyond; however, it is included to provide a bounding dose for the off-normal event category.

The only current users of water from the Upper Floridan aquifer in the vicinity of Turkey Point are located at the Ocean Reef Club community, approximately 7.7 miles southeast of the Turkey Point Units 6 & 7 site (Figure 11.2-214). Although the current use of this water is for landscape irrigation, potable water use could occur at this location. Therefore, such use by the Ocean Reef Club community is retained as a credible beyond property boundary member-of-the-public exposure scenario.

As described previously, there are no members of the public currently resident within or near the maximum extent of the 37,000 pCi/L derived tritium activity concentration contours. Although sustained individual production of livestock and garden products through subsistence farming and associated groundwater ingestion in the beyond property area is not anticipated during the operational life of Turkey Point Units 6 & 7, short-term groundwater use and ingestion of groundwater potentially containing effluent is a possibility. Therefore, access and use of such groundwater in the beyond property area by a member of the public, while classified as non-credible, is retained for further liquid effluent pathway analysis.

All potentially exposed individuals other than those in the Ocean Reef Club community are placed at the location of the nearest privately owned land parcel to the property boundary, located 2.2 miles from the effluent injection point (Figure 11.2-214), as this constitutes the nearest beyond property area location that could potentially serve as an exposure point for a member of the public. The “U-tube” or conduit constituting failure of the middle confining unit is assumed to occur beneath this land parcel, since as discussed above, the eastward gradient in the Upper Floridan aquifer would cause the effluent introduced by a failure occurring closer to the effluent injection point to flow away from the member of the public’s location (Figure 11.2-213). The effluent-containing water is then assumed to instantaneously travel to the Upper Floridan aquifer, where it is then available for access by a member of the public. It is assumed that a production well is placed exactly over the middle confining unit failure; dilution in the Upper Floridan aquifer is, therefore, not considered. Furthermore, no credit is taken for travel time from the Boulder Zone through the middle confining unit to the Upper Floridan aquifer.

The consequential scenarios retained for dose analysis purposes are summarized below.

Plant Area

Normal Operation – None retained

Off-Normal Operation – None retained

Inadvertent Intrusion – Not applicable

Property Area

Normal Operation – None retained

Off-Normal Operation – None retained

Inadvertent Intrusion – Not applicable

Beyond Property Area

Normal Operation – None retained

Off-Normal Operation

- Middle confining unit failure located 2.2 miles from the modeled effluent injection point and member-of-the-public Upper Floridan aquifer use resulting in exposure through drinking water ingestion (non-credible)
- Middle confining unit failure and individual member-of-the-public Upper Floridan aquifer use at Ocean Reef community for drinking water only (credible)

Inadvertent Intrusion

- Member-of-the-public drilling a well into the Upper Floridan aquifer immediately above a failure in the middle confining unit located 2.2 miles from the effluent injection point and then unknowingly using the contaminated Upper Floridan groundwater thereby made available for drinking water ingestion, irrigation, milk animals, and livestock (subsistence driller)

Table 11.2-207 provides a summary of the scenarios retained for detailed dose analysis purposes, including the location of the members of the public. Figure 11.2-214 depicts the location of the members of the public. Specific source terms, methods/pathways of exposure, etc., are summarized in the next section.

11.2.3.5.2.5 Dose Analyses

The doses allocated to the retained members of the public are based on the source term, exposure duration, exposure pathways, etc. established by the associated scenarios. The dose analyses are summarized in the following paragraphs.

11.2.3.5.2.5.1 Beyond Property Area – Off-Normal Operation

Middle Confining Unit Failure and Member-of–the-Public Exposure (Credible)

The Ocean Reef Club community, as depicted on Figure 11.2-214, is approximately 7.7 miles from the effluent injection point. As summarized in Table 11.2-206, this community represents the nearest members of the public in the near vicinity of the Turkey Point Units 6 & 7 site to currently use Upper Floridan aquifer water for any application. While Upper Floridan aquifer water is currently only being used by Ocean Reef Club for irrigation purposes, the most credible off-normal receptor was identified as a member of the public in the Ocean Reef Club community. This scenario assumes the water supply well is directly over the middle confining unit failure and takes no credit for further dilution, resulting in the same radionuclide concentrations in the Upper Floridan aquifer as are observed in the Boulder Zone. Based on the radial transport model's simulation results, the Boulder Zone groundwater radionuclide concentration at this location for all radionuclides of interest is expected to remain at non-consequential levels for the full 100-year simulation duration. Therefore, no dose has been calculated.

Middle Confining Unit Failure and Member-of-the Public-Exposure (Non-Credible)

The nearest privately owned land parcel to the property boundary, which is located 2.2 miles from the centroid of the DIS, has been selected as the location for the non-credible member of the public (Figure 11.2-215). It is assumed that a production well is directly connected to a conduit or other failure in the middle confining unit occurring at this location such that no mixing occurs in the Upper Floridan aquifer. The member of the public is assumed to use the Upper Floridan aquifer water for drinking water ingestion only.

The expected radionuclide concentrations are evaluated at this location. Figure 11.2-209 presents the tritium, cesium-134, cesium-137, and strontium-90 relative concentration profiles at this location over the 100-year simulation duration, as calculated by the radial transport model. As discussed under *Radioactive Source Term Selection* in Subsection 11.2.3.5.1.1.1, these are the radionuclides that have been retained for fate and transport modeling and subsequent dose analysis. The maximum radionuclide concentrations and corresponding times of occurrence following start of plant operation are as follows:

tritium: 3.1E04 pCi/L (25 years)
cesium-134: 7.7E-03 pCi/L (15 years)
cesium-137: 7.6E-01 pCi/L (42 years)
strontium-90: 5.6E-04 pCi/L (41 years)

These maximum concentrations are conservatively assumed to occur concurrently and, therefore, are used collectively as the source term for the dose analyses conducted for this location. For these further analyses, a separate LADTAP II run is made for each radionuclide (tritium, strontium-90, cesium-134, and cesium-137) to calculate the dose to an offsite receptor 2.2 miles from the modeled effluent injection point.

For tritium, as an example, the LADTAP II input parameters are as follows:

- Discharge to impoundment per unit = 6230 gpm = 3.40E07 L/day
- Annual release per unit = 1.3E03 Ci/yr
- LADTAP II transit (decay) time = 21 years

The annual release per unit is calculated as follows:

- Injectate concentration = 1.0E05 pCi/L as given on Table 11.2-201

- Annual release per unit = (1.0E05 pCi/L)(3.40E07 L/day)(365 day/yr) (Ci/1E12 pCi) = 1.3E03 Ci/yr

Note that this annual release value exceeds the corresponding DCD Table 11.2-7 value by a factor of 1.25. This reflects the impact of having determined the plant-specific injectate concentrations on a basis consistent with that used to develop DCD Table 11.2-8, i.e., based on the release of the average daily discharge for only 292 days per year, while otherwise conservatively assuming that both units operate continuously (i.e., for 365 days per year throughout the life of the plant) and, therefore, continuously release their average daily discharge. It must be emphasized that these are simplifying assumptions made solely for the purposes of performing a conservatively bounding analysis and that, in making these assumptions, there is no intent to convey that the plant is expected to actually be operated in a way that is different from the certified design.

LADTAP II uses the transit time parameter to calculate the effective decayed radionuclide activity concentration at the receptor location. To assign transit time values, a two-step approach is necessary. First, as further described above, a radial transport model is used to determine activity concentrations at the receptor location that account for advection, dispersion, buoyancy effects, and chemical processes that include first-order radioactive decay. For tritium, the calculated peak concentration at the offsite receptor is 3.1E04 pCi/L based on the injection concentration of 1.0E05 pCi/L and the dilution flow of 6230 gpm per unit.

Second, the LADTAP II transit time input parameter value is determined by calculating the duration that would be required for the as-injected tritium activity concentration of 1.0E05 pCi/L to decay to this peak concentration at the receptor location of 3.1E04 pCi/L as predicted by radial transport model. This duration, i.e., the transit time value, is solved for using a variation of the general equation for radioactive decay:

$$C_{rec} = C_{inj}\, e^{-\lambda t}$$
$$t = [\ln(C_{inj}/C_{rec})][t_{1/2}/\ln(2)]$$
$$t = [\ln(1.0E05/3.1E04)][12.33/0.693]$$
$$t = 21 \text{ years}$$

In this tritium example, C_{inj} and C_{rec} are the tritium activity concentrations at the injection and receptor locations, respectively; λ is the tritium decay constant, defined as ln(2) divided by the tritium half-life, $t_{1/2}$, of 12.33 yr; and t is the decay time, i.e., the value of the LADTAP II transit time input parameter to be solved for.

Based on this and the other required inputs as noted above, LADTAP II calculates the doses to the offsite receptor corresponding to a peak tritium activity concentration of 3.1E04 pCi/L. Source terms, peak activity concentrations, and receptor doses for the other three radionuclides retained for further analysis are similarly calculated.

Table 11.2-208 summarizes the resultant doses (for conservatism, a child was considered as the member of the public). The total body dose is lower than the 10 CFR Part 50, Appendix I, annual design objective of 6 mrem for two units. The organ dose (dose to child's liver as maximum organ) is lower than the 10 CFR Part 50, Appendix I, annual design objective of 20 mrem for two units. As can be seen, tritium is the dominant dose contributor.

11.2.3.5.2.5.2 Beyond Property Area – Inadvertent Intrusion

The doses associated with the inadvertent intrusion scenario represent a non-credible worst-case bounding estimate for annual dose. As previously described, farming and the raising of milk animals and livestock are not currently performed and are not anticipated to be performed in the region adjacent to Turkey Point. However, to present this worst-case dose, a subsistence driller is assumed exposed through these pathways as well as through effluent ingestion subsequent to the inhalation, immersion, and deposition exposure that occurs during the actual drilling operations. This scenario assumes that a water supply well is installed in the Upper Floridan aquifer directly above the conduit in the middle confining unit at the 2.2-mile location that allows deep well injectate to instantaneously travel to the Upper Floridan aquifer from the Boulder Zone. Therefore, the location as well as the radionuclide concentrations for this member of the public are the same as those for the beyond property area – off-normal operation non-credible member of the public, as previously described.

Doses to the total body and maximum organ (liver) due to inhalation, immersion, and deposition acquired during the drilling activity by the member-of-the-public age group receiving the maximum doses are first calculated. For purposes of this calculation, the total duration of exposure during drilling operations is determined as follows:

- A water supply well in the Upper Floridan aquifer typically requires 75 days to complete. The Upper Floridan aquifer, which is assumed to contain the radionuclides, is not encountered until 1000 feet have been completed (or 66 percent of the 75 days). Therefore, exposure due to drilling is assumed to be for 25 days.

- The time to complete and develop a water supply well in the Upper Floridan aquifer is 20 days. Exposure is assumed to occur during this entire time period.

Therefore, the exposure time for the driller is 45 days total. A 12-hour shift is assumed for each day.

These doses are then conservatively combined with the annual doses to the maximum dose age group from ingestion of drinking water and irrigated foods to arrive at the total annual doses for the subsistence driller. The LADTAP II computer program is used to calculate doses to the member of the public from ingestion of drinking water, milk, meats, and vegetables irrigated with Upper

Floridan groundwater. Drilling-related doses to the total body and maximum organ (liver) due to inhalation, immersion, and deposition are determined using the appropriate RG 1.109 methodology, with the exception that immersion-related dose conversion factors are obtained from Federal Guidance Report No. 12 (Reference 224).

To determine the inhalation and immersion pathway doses resulting from a driller standing in an evaporating puddle of liquid effluent brought to the surface by the drilling operations, the resultant concentration of radionuclides in the air must first be determined. Because RG 1.109 does not provide guidance on establishing airborne activity concentrations due to puddle evaporation, an empirical relationship for determining puddle evaporation rates developed by the EPA is used (Reference 225). In all cases, values for the various parameters used in determining the doses due to inhalation, immersion, and deposition are conservatively selected. For further conservatism, the as-calculated doses due to these exposure pathways are then doubled before being combined with the annual doses from ingestion of drinking water and irrigated foods to arrive at the total annual doses for the subsistence driller.

Table 11.2-209 summarizes the resultant doses to the subsistence driller (the maximum dose age group for drilling-related doses is the teen, while for conservatism, a child was considered as the member of the public for purposes of determining the ingestion-related doses). The member of the public’s total body and total organ doses are both determined to be lower than the associated 10 CFR Part 50, Appendix I, annual design objectives of 3 mrem and 10 mrem, respectively, for a single unit. Table 11.2-210 summarizes the doses for all retained scenarios.

11.2.3.5.3 DIS Performance Monitoring

The dual-zone monitoring wells serve as the primary points for system performance monitoring. Based on the member-of-the-public PA described above, additional offsite monitoring is not proposed. Baseline and operational groundwater radiochemical monitoring is performed at these sampling points. This monitoring includes gross beta, gamma isotopic, and tritium, which will be initially sampled monthly. This frequency will be reduced to quarterly once the underground injection system operational testing phase is complete.

Continuous injection rate and injection pressure monitoring is performed at each deep injection well. Continuous monitoring of water level in each dual-zone monitoring well is also performed. The data is transmitted to each control room where it is continuously monitored.

The proposed monitoring described is applicable to the plant site. Additional offsite sampling, based on exposure pathways and annual land use census results, is performed as necessary during plant operation. This groundwater sampling is taken where Upper Floridan water is used for ingestion or irrigation purposes within the region of Turkey Point. In addition to the land use census, local well permits, as issued by FDEP, are monitored to ensure that the exposure pathways are current. The Turkey Point Units 6 & 7 ODCM documents the exposure pathways, land and water use census, and exposure pathway updates, if necessary. The results of the sampling are reported in the annual radiological operating report. As part of the prompt detection and mitigative strategies program prepared for DIS off-normal operations, monitoring of the Upper Floridan aquifer and dual-zone monitoring well conditions are conducted to alert plant operators of possible injectate incursions to the Upper Floridan aquifer. Response actions include, as appropriate, confirmatory Upper Floridan aquifer/dual-zone monitoring well monitoring, removal of affected DIS components from service, and other actions protective of members of the public and plant workers. The DIS off-normal operations prompt detection and mitigative strategies program are part of the Turkey Point Units 6 & 7 ODCM/REMP to be made available for inspection prior to fuel load. (Table 13.4-201)

11.2.3.6 Quality Assurance

Add the following to the end of DCD Subsection 11.2.3.6:

STD SUP 11.2-1 Since the impact of radwaste systems on safety is limited, the extent of control required by Appendix B to 10 CFR Part 50 is similarly limited. Thus, a supplemental quality assurance program applicable to design, construction, installation and testing provisions of the liquid radwaste system is established by procedures that complies with the guidance presented in RG 1.143.

PTN SUP 11.2-2 The quality assurance program for design, construction, procurement, materials, welding, fabrication, inspection and testing activities conforms to the quality control provisions of the codes and standards recommended in Table 1 of RG 1.143.

11.2.5 Combined License Information

11.2.5.1 Liquid Radwaste Processing by Mobile Equipment

STD COL 11.2-1 This COL Item is addressed in Subsection 11.2.1.2.5.2.

11.2.5.2 Cost Benefit Analysis of Population Doses

PTN COL 11.2-2 This COL item is addressed in Subsection 11.2.3.5.

11.2.6 REFERENCES

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Table 11.2-201
Injectate Concentrations

Component	Half-life (yrs)[a]	Annual Releases (Ci/year)[b]	Injectate Water Concentration (reclaimed water source)	Injectate Water Concentration (saltwater source)
TDS	Not applicable	Not applicable	2.7 kg/m^3	57.0 kg/m^3
H-3	12.4	1.01E3	1.0E5 pCi/L	2.2E4 pCi/L
Cs-134	2.1	9.93E-3	1.0E0 pCi/L	2.1E-1 pCi/L
Cs-137	30.1	1.332E-2	1.3E0 pCi/L	2.9E-1 pCi/L
Sr-90	29.0	1.0E-5	1.0E-3 pCi/L	2.2E-4 pCi/L

(a) Reference 201
(b) Source: DCD Table 11.2-7 (based on 292 days per year operation)

Table 11.2-202
Model Parameter Summary

Parameter	Value
Transmissivity	23,223 m^2/day (250,000 ft^2/day)
Anisotropy ratio (K_z/K_x)	1/3
Effective Porosity (ϕ_e)	0.2
Storativity (S)	3.6E-04
Longitudinal Dispersivity (α_L)	15 m (49 ft)
Vertical Dispersivity (α_V)	0.3 m (1 ft)
Injection well length	74m (243 ft)
Boulder Zone TDS concentration	36.2 kg/m^3
Boulder Zone aquifer thickness	152 m (500 ft)
Horizontal grid spacing	45 m (uniform) (148 ft)
Vertical grid spacing	2 m (uniform) (6.5 ft)
Distribution Coefficient (K_d)	0 ml/g (all species)[a]
Initial head in Boulder Zone	1.9 m (6.2 ft) NAVD 88

(a) With consideration of non-zero K_d values for the evaluated partitioning radionuclides, the total dose from the partitioning radionuclides would be reduced.

Source: References 209, 210, 211, 212, 213, 214

Table 11.2-203
Peak Activity Concentrations at the 2.2-Mile Location

Case	Peak Activity Concentrations at 2.2 mi from Injection Point (pCi/L)[a]			
	H-3[b]	Cs-134	Cs-137	Sr-90
Base case	3.1E04	7.7E-03	7.6E-01	5.6E-04
Sensitivity Cases				
Φ_e = 15% (decreased Φ_e)	4.0E04 (+29%)	2.1E-02 (+173%)	8.6E-01 (+13%)	6.4E-04 (+14%)
α_V =0.1 m (decreased α_V)	3.9E04 (+26%)	1.2E-02 (+56%)	8.6E-01 (+13%)	6.3E-04 (+13%)
T = 55,736 m^2/day (increased T)	3.7E04 (+19%)	2.2E-02 (+186%)	8.1E-01 (+7%)	6.0E-04 (+7%)
b = 92 m (decreased b)	3.6E04 (+16%)	1.5E-02 (+95%)	8.2E-01 (+8%)	6.0E-04 (+7%)
K_z=0.1K_x (decreased K_z/K_x)	3.1E04 (0%)	7.8E-03 (+1%)	7.6E-01 (0%)	5.6E-04 (0%)
α_L= 5 m (decreased α_L)	3.1E04 (0%)	7.5E-03 (–3%)	7.6E-01 (0%)	5.6E-04 (0%)
α_L= 30 m (increased α_L)	3.1E04 (0%)	8.1E-03 (+5%)	7.6E-01 (0%)	5.6E-04 (0%)
S = 1E-3 (increased S)	3.1E04 (0%)	7.7E-03 (0%)	7.6E-01 (0%)	5.6E-04 (0%)
S = 1E-4 (decreased S)	3.1E04 (0%)	7.7E-03 (0%)	7.6E-01 (0%)	5.6E-04 (0%)
Saltwater injection 60 days per year	2.4E04 (–23%)	3.5E-03 (–55%)	6.5E-01 (–14%)	4.8E-04 (–14%)
α_V= 1.0 m (increased α_V)	2.3E04 (–26%)	4.0E-03 (–48%)	6.3E-01 (–17%)	4.6E-04 (–18%)
T = 5573 m^2/day (decreased T)	2.0E04 (–35%)	5.6E-04 (–93%)	6.4E-01 (–16%)	4.7E-04 (–16%)

(a) Values in parentheses represent changes in peak concentration relative to the base case on a percentage basis.

(b) Tritium contributes more than 90 percent of the member-of-the-public dose over the period in which these peak concentrations are seen.

Notes:
T = transmissivity
b = aquifer thickness (note that in this simulation the transmissivity value is the same as that of the base case and therefore hydraulic conductivity increases)
Φ_e = effective porosity
α_V = vertical dispersivity
α_L = longitudinal dispersivity
K_z = vertical hydraulic conductivity
K_x =horizontal hydraulic conductivity
S = storativity

Concentrations are from a simulated observation well in model layer 1.

Table 11.2-204
Cumulative Isotopic Inventory at End of Plant Operations

Isotope	Release per Unit (Ci/yr)(a)	Subsurface Activity at 61 years (Ci)
H-3	1.26E03	2.17E04
Na-24	2.04E-03	5.02E-06
Cr-51	2.31E-03	2.53E-04
Mn-54	1.63E-03	2.01E-03
Fe-55	1.25E-03	4.93E-03
Fe-59	2.50E-04	4.40E-05
Co-58	4.20E-03	1.18E-03
Co-60	5.50E-04	4.18E-03
Zn-65	5.13E-04	4.95E-04
Br-84	2.50E-05	2.18E-09
Rb-88	3.38E-04	1.65E-08
Sr-89	1.25E-04	2.50E-05
Sr-90	1.25E-05	4.00E-04
Sr-91	2.50E-05	3.97E-08
Y-91m	1.25E-05	1.71E-09
Y-93	1.13E-04	1.89E-07
Zr-95	2.88E-04	7.28E-05
Nb-95	2.63E-04	3.63E-05
Mo-99	7.13E-04	7.74E-06
Tc-99m	6.88E-04	6.81E-07
Ru-103	6.17E-03	9.57E-04
Ru-106	9.20E-02	1.36E-01
Rh-103m	6.17E-03	9.50E-07
Rh-106	9.20E-02	1.25E-07
Ag-110m	1.31E-03	1.30E-03
Ag-110	1.75E-04	1.97E-10
Te-129m	1.50E-04	1.99E-05
Te-129	1.88E-04	3.58E-08
Te-131m	1.13E-04	5.56E-07
Te-131	3.75E-05	2.58E-09
Te-132	3.00E-04	3.80E-06
I-131	1.77E-02	5.59E-04
I-132	2.05E-03	7.75E-07
I-133	8.38E-03	2.87E-05
I-134	1.01E-03	1.46E-07
I-135	6.22E-03	6.73E-06
Cs-134	1.24E-02	3.70E-02
Cs-136	7.88E-04	4.10E-05
Cs-137	1.67E-02	5.45E-01
Ba-137m	1.56E-02	1.10E-07
Ba-140	6.90E-03	3.48E-04
La-140	9.29E-03	6.16E-05
Ce-141	1.13E-04	1.45E-05
Ce-143	2.38E-04	1.29E-06
Ce-144	3.95E-03	4.45E-03
Pr-143	1.63E-04	8.72E-06
Pr-144	3.95E-03	1.87E-07
W-187	1.63E-04	6.35E-07
Np-239	3.00E-04	2.80E-06
Total		**4.35E04(b)**

(a) Release per unit values are based on the AP1000 DCD values (as described in the Radioactive Source Term section above).

(b) The “Total” value represents the sum of all isotopes, multiplied by 2 to account for multiple units.

Table 11.2-205 (Sheet 1 of 2)
Results of Initial Exposure Pathway Scenario Screening

Location	DIS Operation Mode	Description	Retained for Further Analysis	Member-of-the-public Type/Location
Plant Area	Normal Operation	Migration through the middle confining unit	No – injectate contained in middle confining unit	Not Applicable
	Off-Normal Operation	Worker exposure at leaking pipe	No –controlled by occupational radiation control program	Not Applicable
		Worker exposure to Biscayne aquifer	No – not considered feasible	Not Applicable
		Middle confining unit failure	No – not considered feasible	Not Applicable
		Migration through the middle and intermediate confining units	No – not considered feasible	Not Applicable
		Catastrophic failure of deep injection well	No – not considered feasible	Not Applicable
		Middle confining unit failure and injectate travel to Unit 5 Upper Floridan wells	No – not considered feasible	Not Applicable
	Inadvertent Intrusion	Not Applicable	Not Applicable	Not Applicable
Property Area	Normal Operation	Migration through the middle confining unit	No – Injectate contained in middle confining unit	Not Applicable
	Off-Normal Operation	Middle confining unit failure	No – not considered feasible	Not Applicable
		Migration through the middle and intermediate confining units	No – not considered feasible	Not Applicable
	Inadvertent Intrusion	Not Applicable	Not Applicable	Not Applicable

Table 11.2-205 (Sheet 2 of 2)
Results of Initial Exposure Pathway Scenario Screening

Location	DIS Operation Mode	Description	Retained for Further Analysis	Member-of-the-public Type/Location
Beyond Property Area	Normal Operation	Migration through the middle confining unit	No – injectate contained in middle confining unit	Not Applicable
	Off-Normal Operation	Middle confining unit failure	Yes	Refer to Table 11.2-207
		Migration through the middle and intermediate confining units	No – not considered feasible	Not Applicable
	Inadvertent Intrusion	Middle confining unit failure and member-of-the-public drilling and ingestion exposure	Yes (worst case)	Refer to Table 11.2-207

Table 11.2-206
Summary of Water Use in Miami-Dade County

	Water Source							
Water User	Biscayne Aquifer	Floridan Aquifer	Surficial Aquifer	Onsite Lake	Tamiami Aquifer	County Water	Canals	Borrow Pits
FPL (Unit 5)	—	3	—	—	—	—	—	—
Public[(a)]	173	1	8	1	—	—	—	—
Agricultural [(a)]	723	2	15	2	1	20	—	—
Aquaculture	20	—	—	—	—	—	—	—
Golf Course	60	—	—	30	—	22	—	—
Industrial	284	—	16	3	—	2	7	8
Landscape	762	—	19	93	—	9	33	—
Livestock	5	—	—	—	—	—	—	—
Nursery	673	—	6	2	—	16	1	—

(a) Floridan Aquifer use includes public use (Florida Keys Aqueduct Authority) and irrigation use (Card Sound Golf Club and Ocean Reef Club).

Table 11.2-207
Retained Dose Scenarios

Location	Exposure Pathway Mode	Description	Member-of-the-Public Type/ Location
Plant Area	None Retained		
Property Area	None Retained		
Beyond Property Area	Off-Normal Operation	Middle confining unit failure and member-of-the-public ingestion exposure (Non-Credible)	Beyond property boundary at closest private parcel
		Middle confining unit failure and member-of-the-public ingestion exposure (Credible)	Beyond property boundary at Ocean Reef Club Community
	Inadvertent Intrusion	Middle confining unit failure and member-of-the-public drilling and ingestion exposure (Worst Case)	Beyond property boundary at closest private parcel

Table 11.2-208
Member-of-the-Public Injectate Ingestion Dose Summary

Radionuclide	Total Body Dose for 2 Units (mrem/year)	Liver[(a)] Dose for 2 Units (mrem/year)
Tritium	1.8E00	1.8E00
Cesium-134	3.1E-04	1.5E-03
Cesium-137	1.8E-02	1.2E-01
Strontium-90	1.5E-04	0
Total	1.8	1.9

(a) Liver is the organ receiving the maximum dose.

Table 11.2-209
Inadvertent Intrusion Subsistence Driller Dose Summary

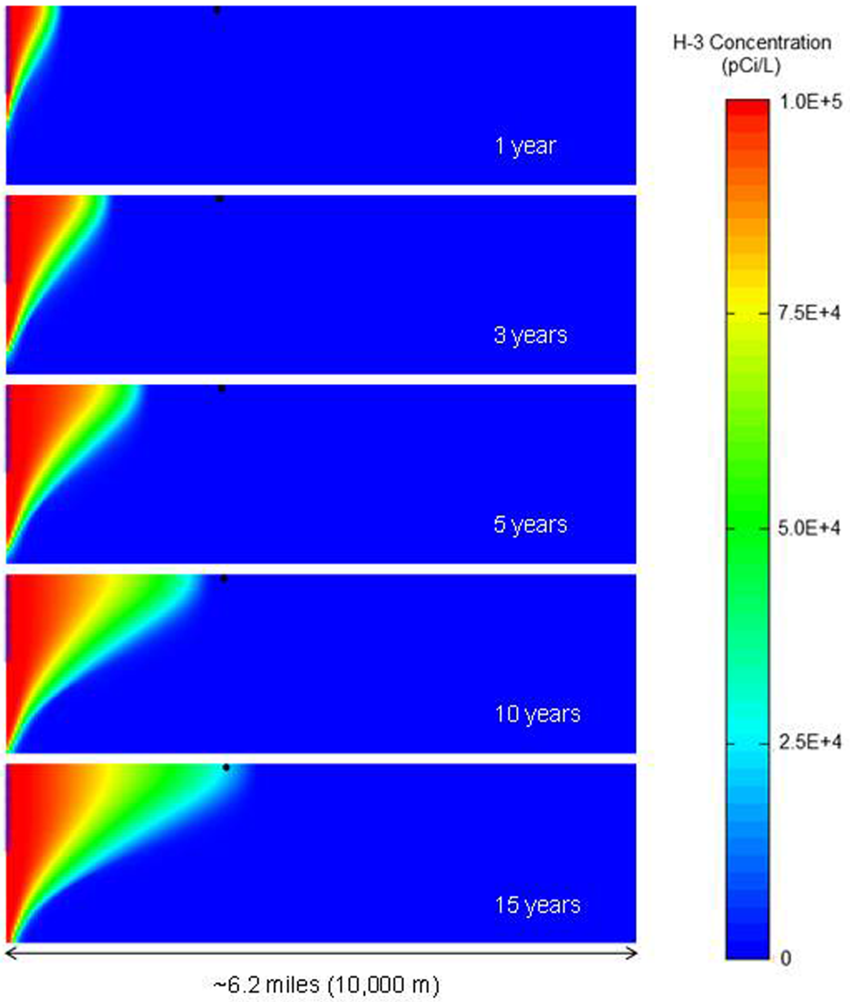
Pathway	Dose (mrem) per Unit	
	Total Body	Liver[(a)]
Annual Ingestion of Water and Irrigated Foods	2.7	3.8
Inhalation During Drilling	8.2E-02	8.3E-02
Air Immersion During Drilling	2.6E-06	2.6E-06
Deposition During Drilling	1.8E-05	0
Total	2.8	3.9
10 CFR Part 50, Appendix I Design Objectives	3	10

(a) Liver is the organ receiving the maximum dose.

Table 11.2-210
Dose Summary

Location	Exposure Pathway Mode	Description	Location	Dose (peak airborne concentration)
Beyond Property Area	Off-Normal Operation	Middle confining unit failure and member-of-the-public ingestion exposure (Non-Credible)	Beyond Property Boundary at closest private parcel	1.8 mrem/year total body dose for 2 units
		Middle confining unit failure and member-of-the-public exposure – Ocean Reef Club Community (Credible)	Ocean Reef Club Community	0 mrem/year total body dose
	Inadvertent Intrusion	Middle confining unit failure and member-of-the-public drilling and ingestion exposure (Worst Case)	Beyond Property Boundary at closest private parcel	5.6 mrem/year total body dose for 2 units

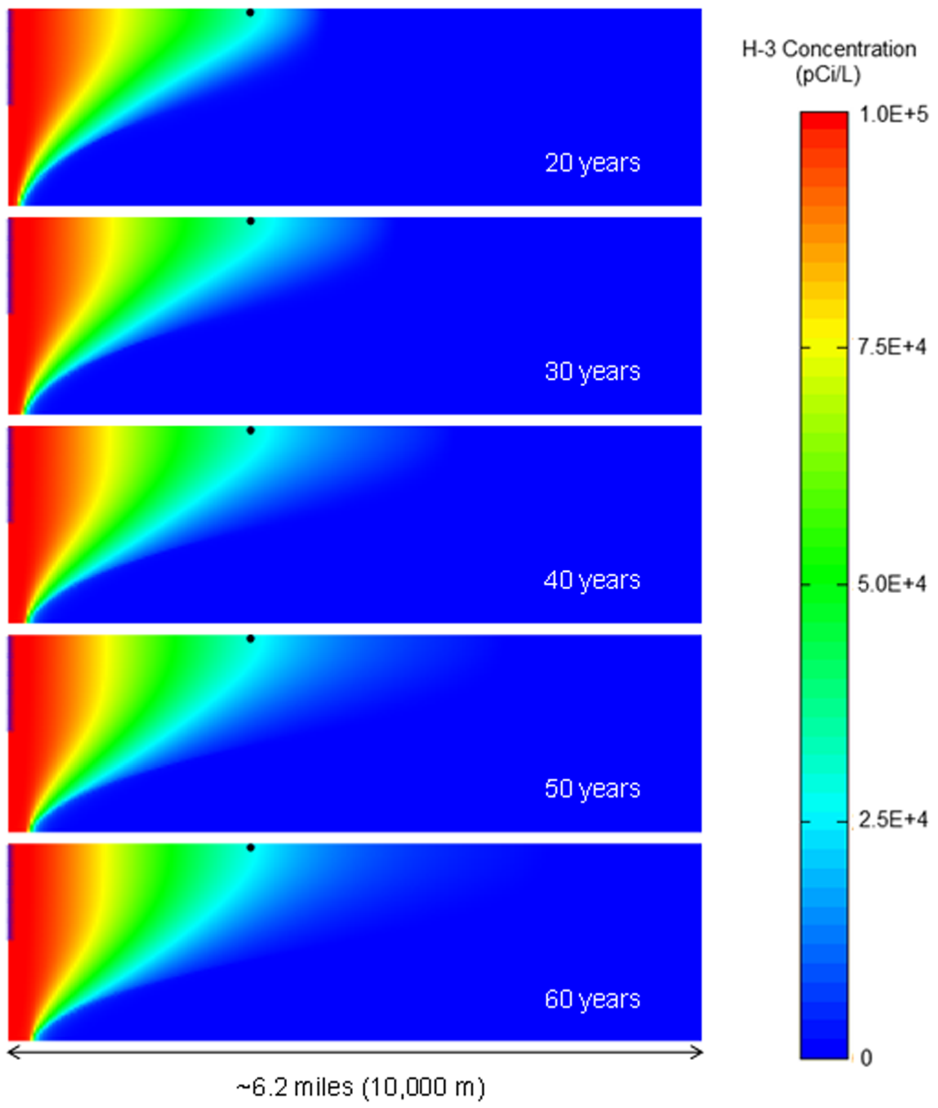
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 1 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

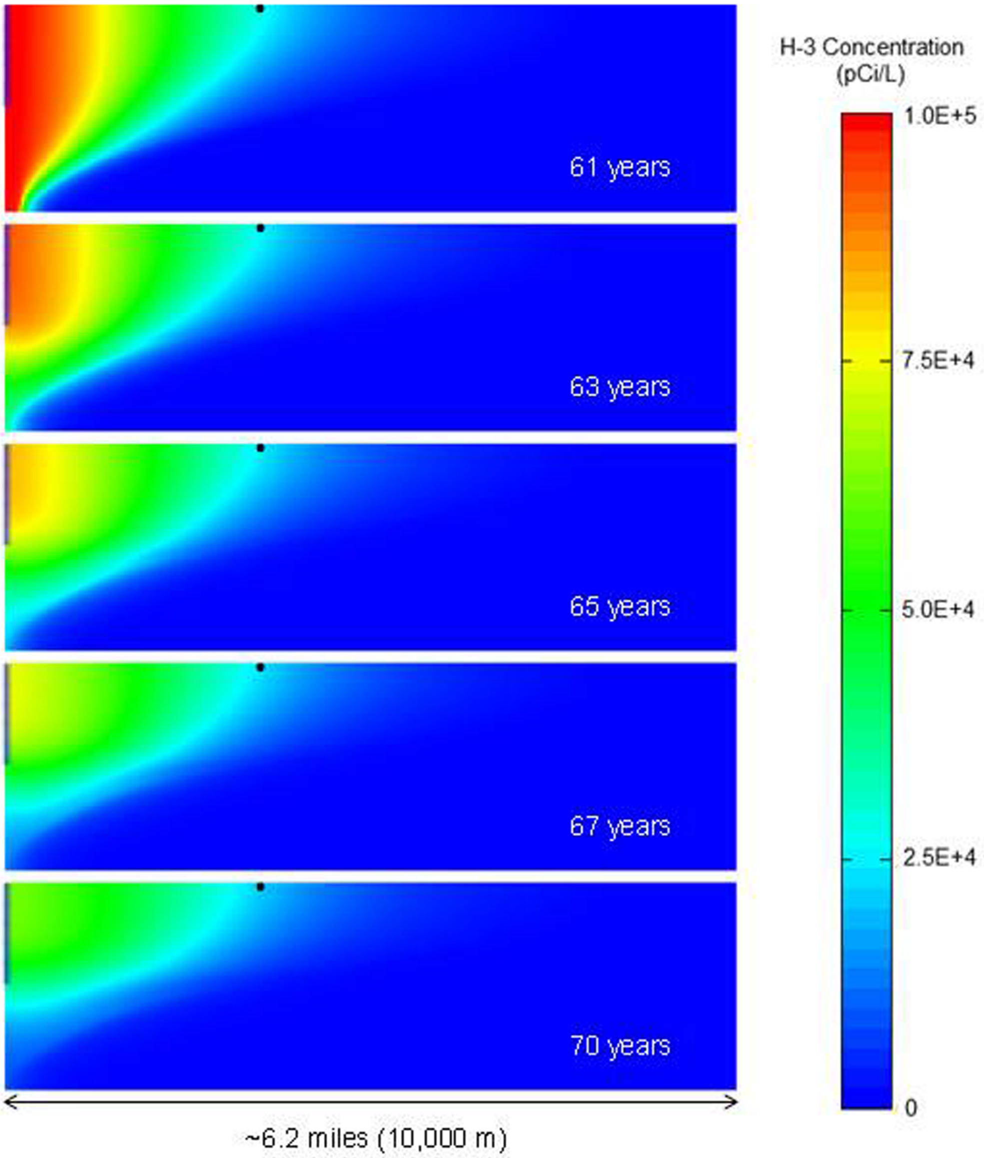
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 2 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

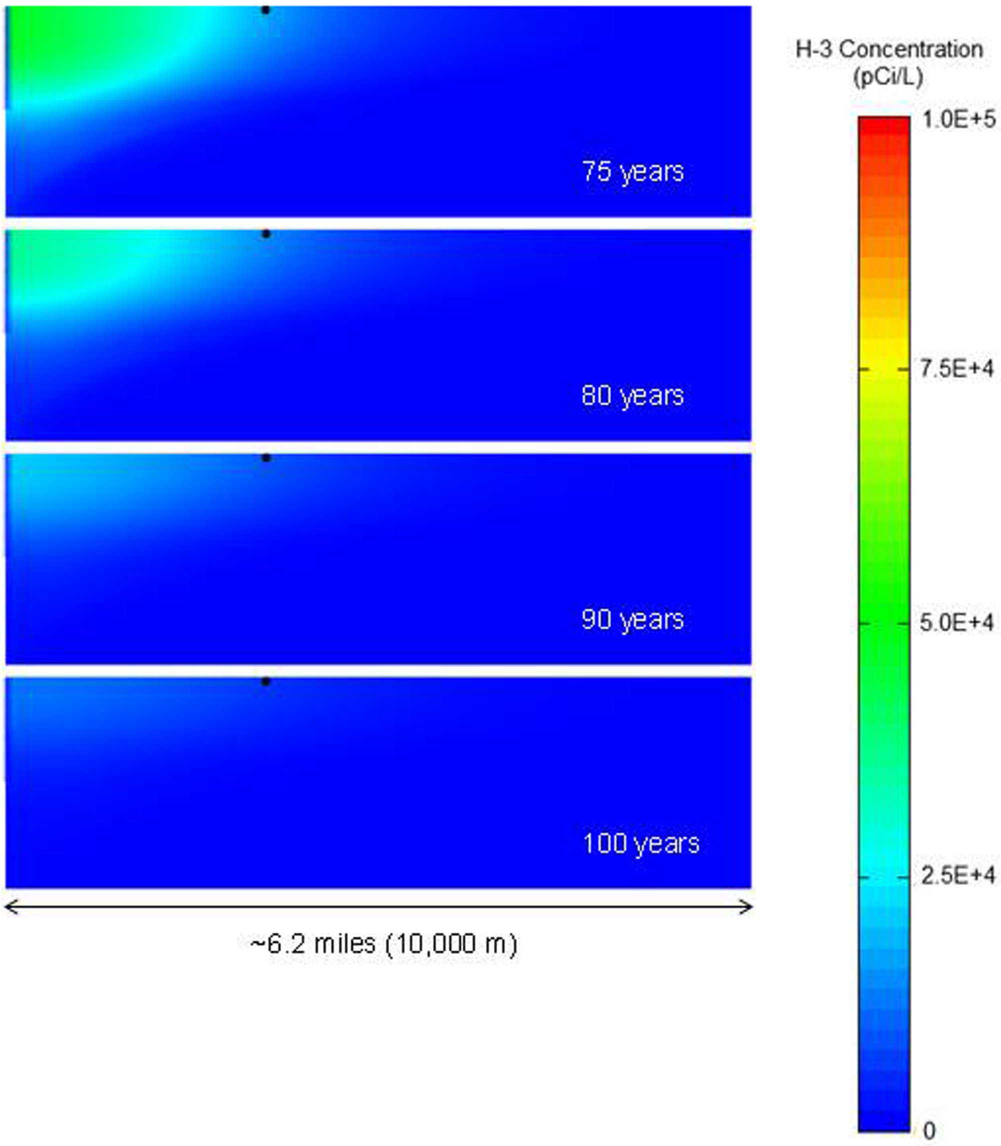
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 3 of 4)



- Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

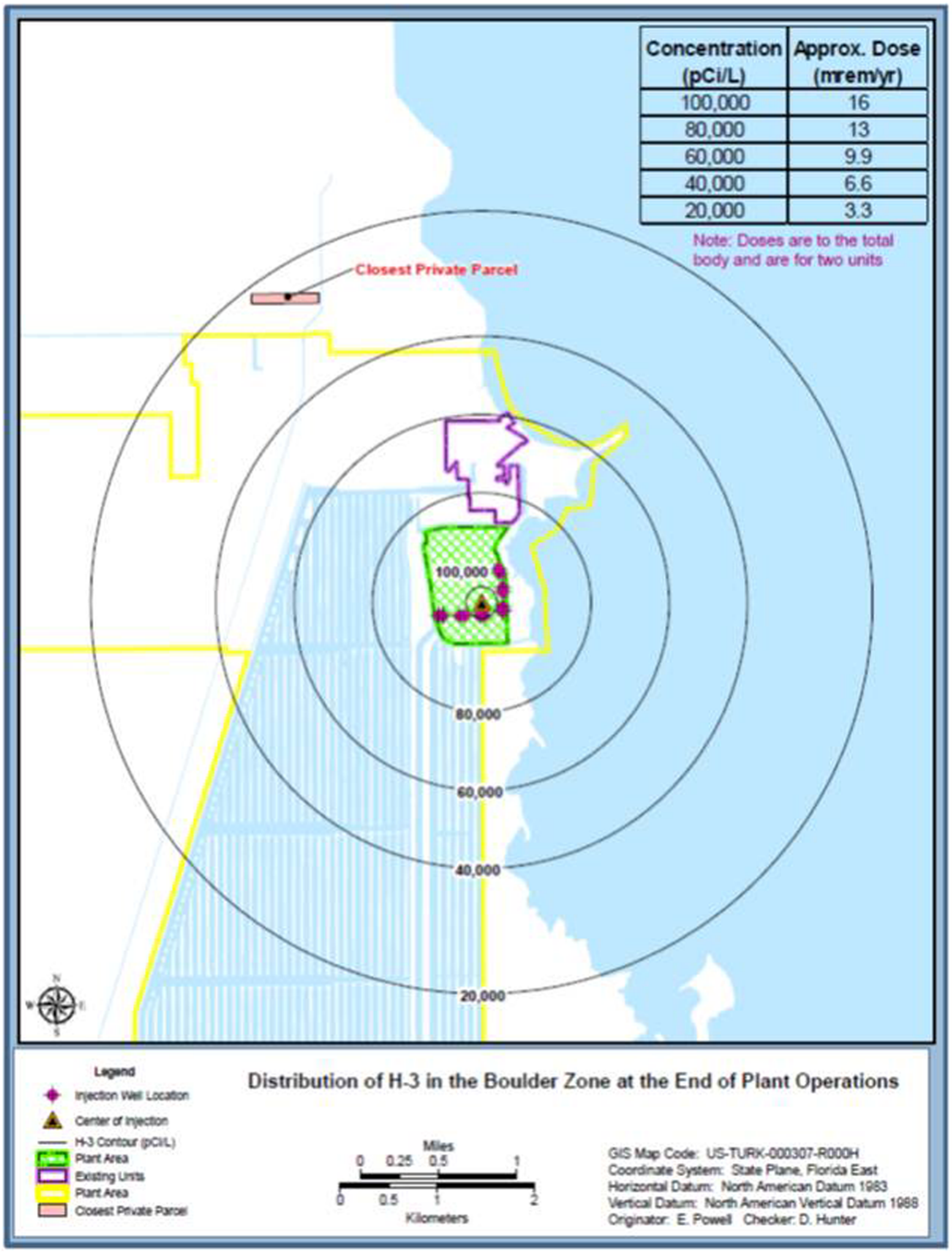
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 4 of 4)



- Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

Figure 11.2-202 Model Layer 1 Distribution of Tritium in the Boulder Zone for the Base Case Simulation at the End of Plant Operations



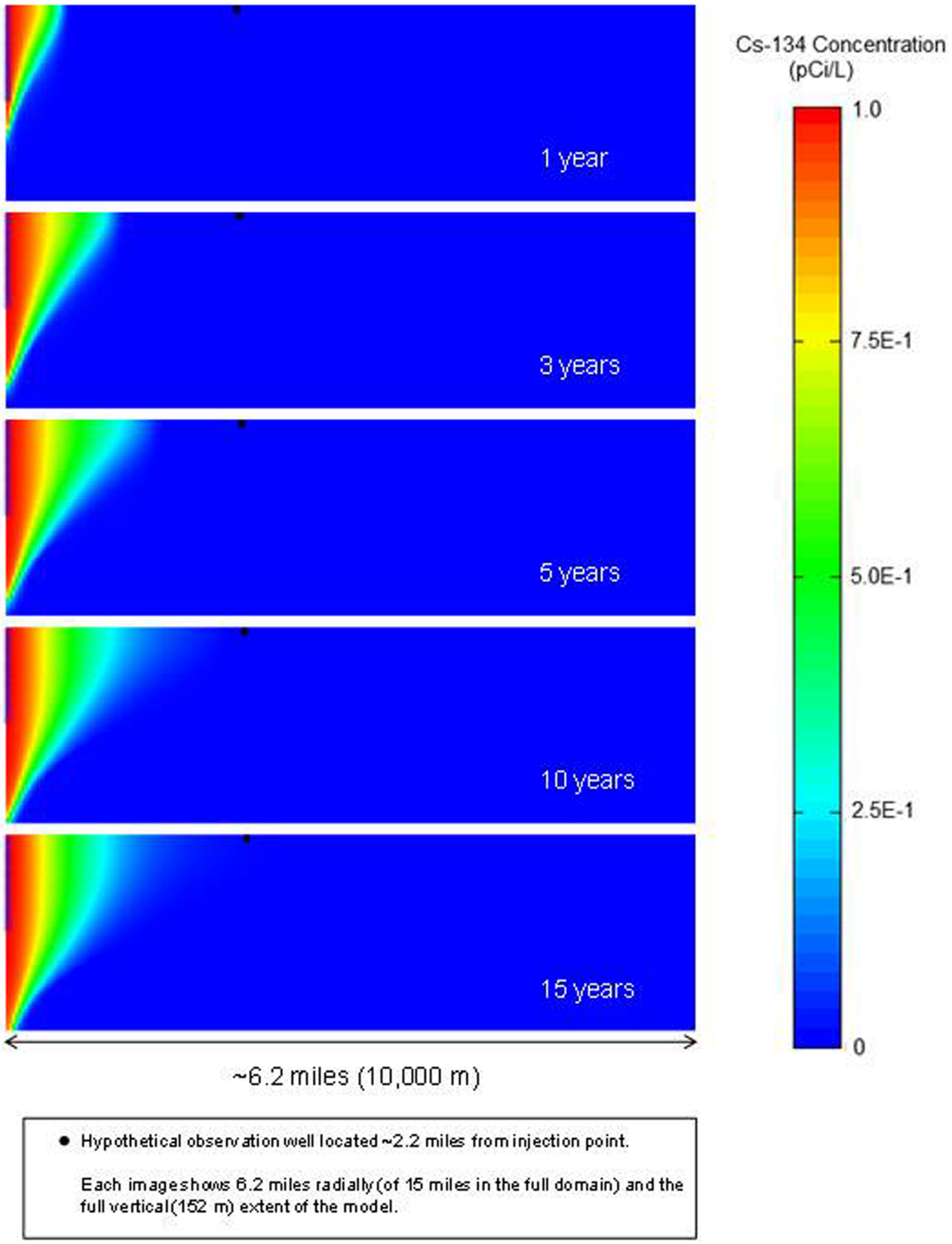
Concentration (pCi/L)	Approx. Dose (mrem/yr)
100,000	16
80,000	13
60,000	9.9
40,000	6.6
20,000	3.3

Note: Doses are to the total body and are for two units

Distribution of H-3 in the Boulder Zone at the End of Plant Operations

GIS Map Code: US-TURK-000307-R000H
Coordinate System: State Plane, Florida East
Horizontal Datum: North American Datum 1983
Vertical Datum: North American Vertical Datum 1988
Originator: E. Powell Checker: D. Hunter

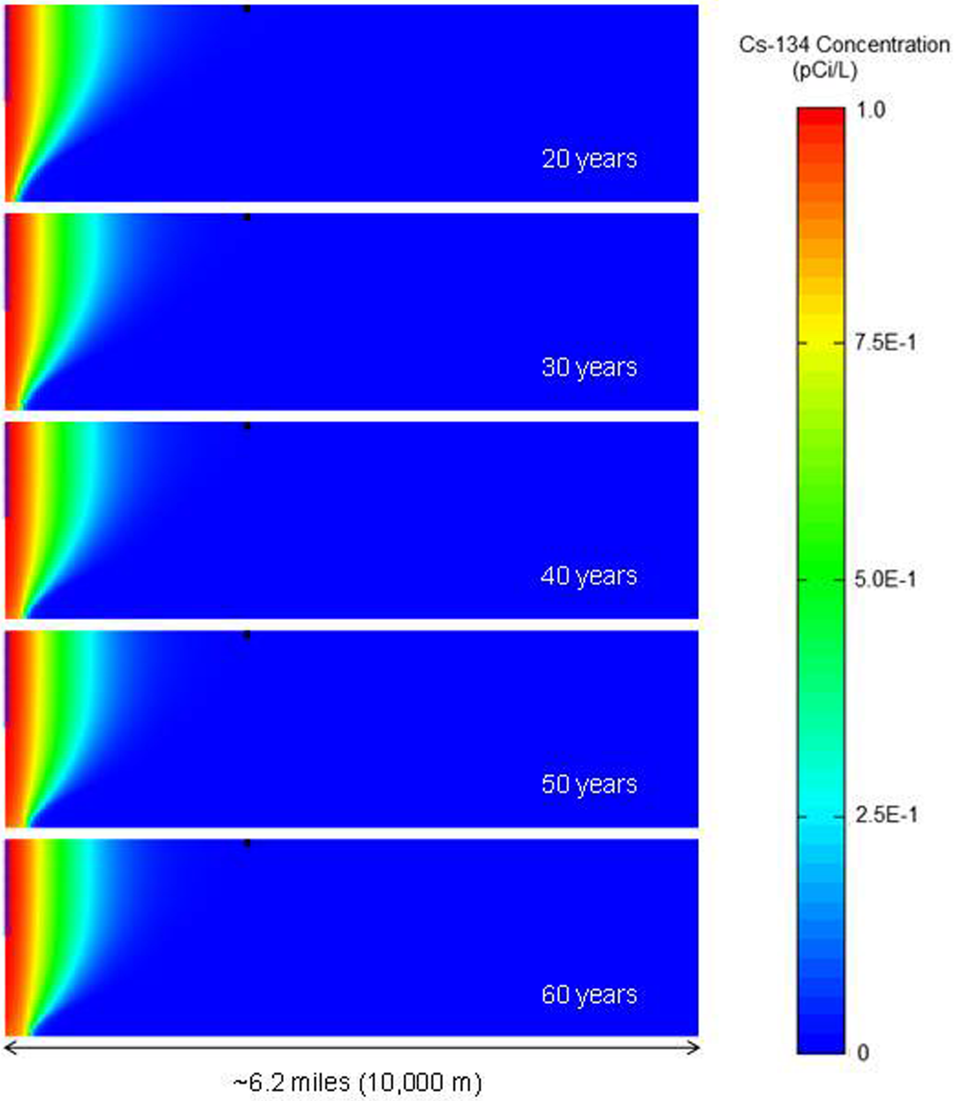
Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 1 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

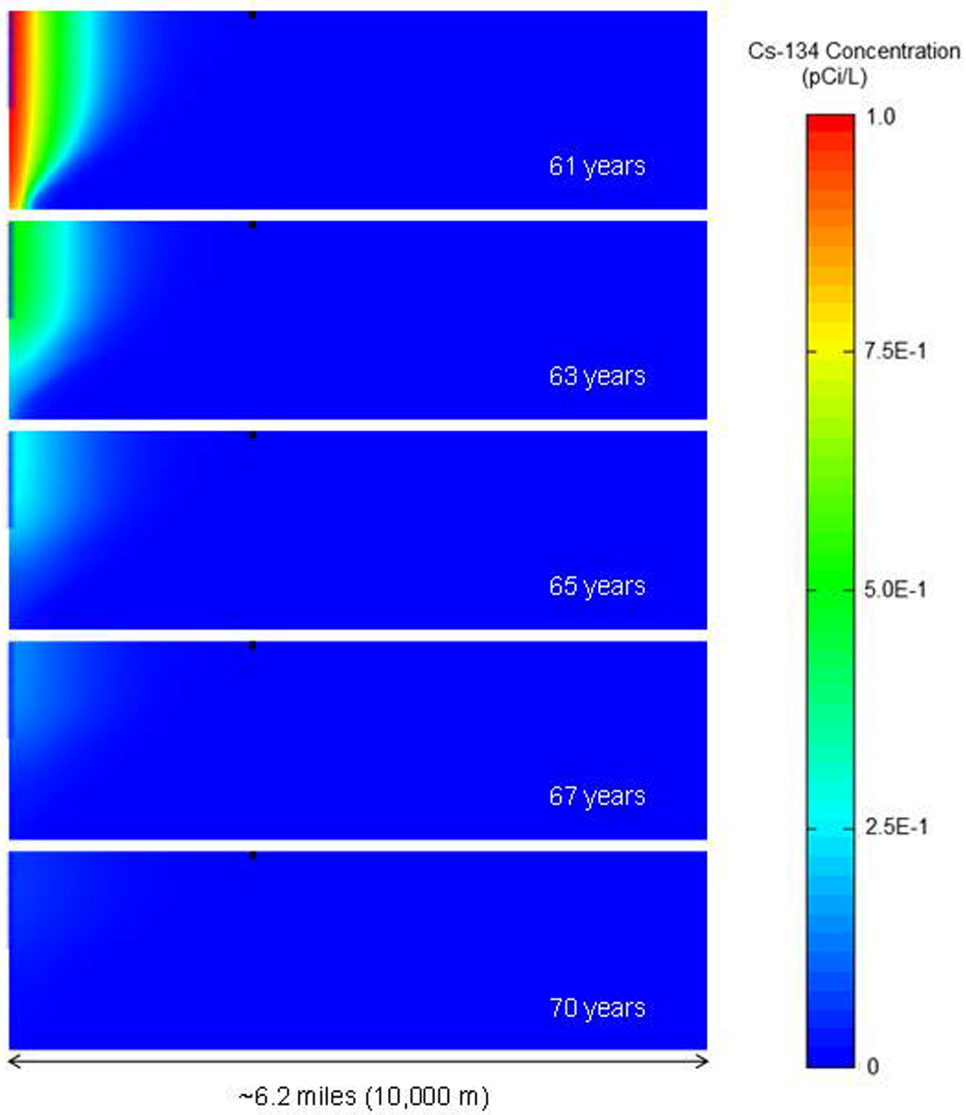
Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 2 of 4)



- Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

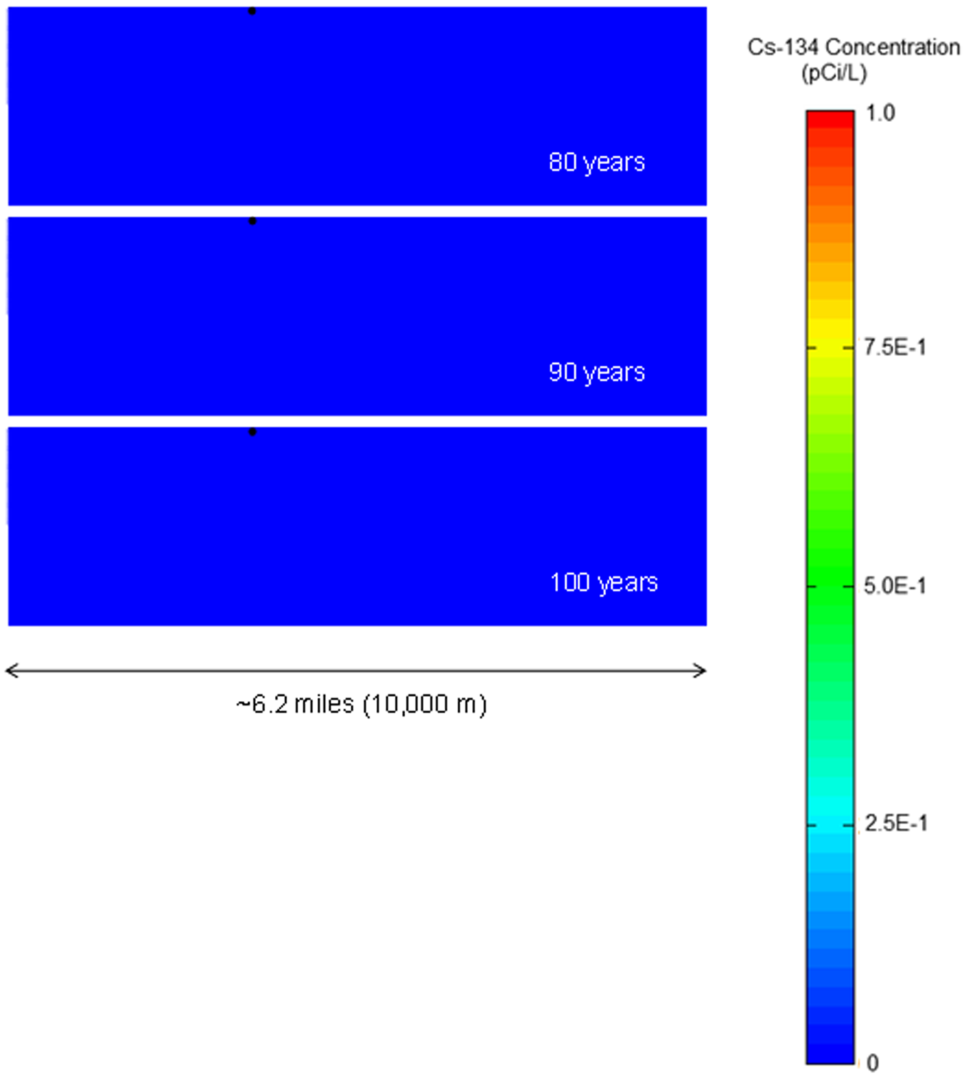
Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 3 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

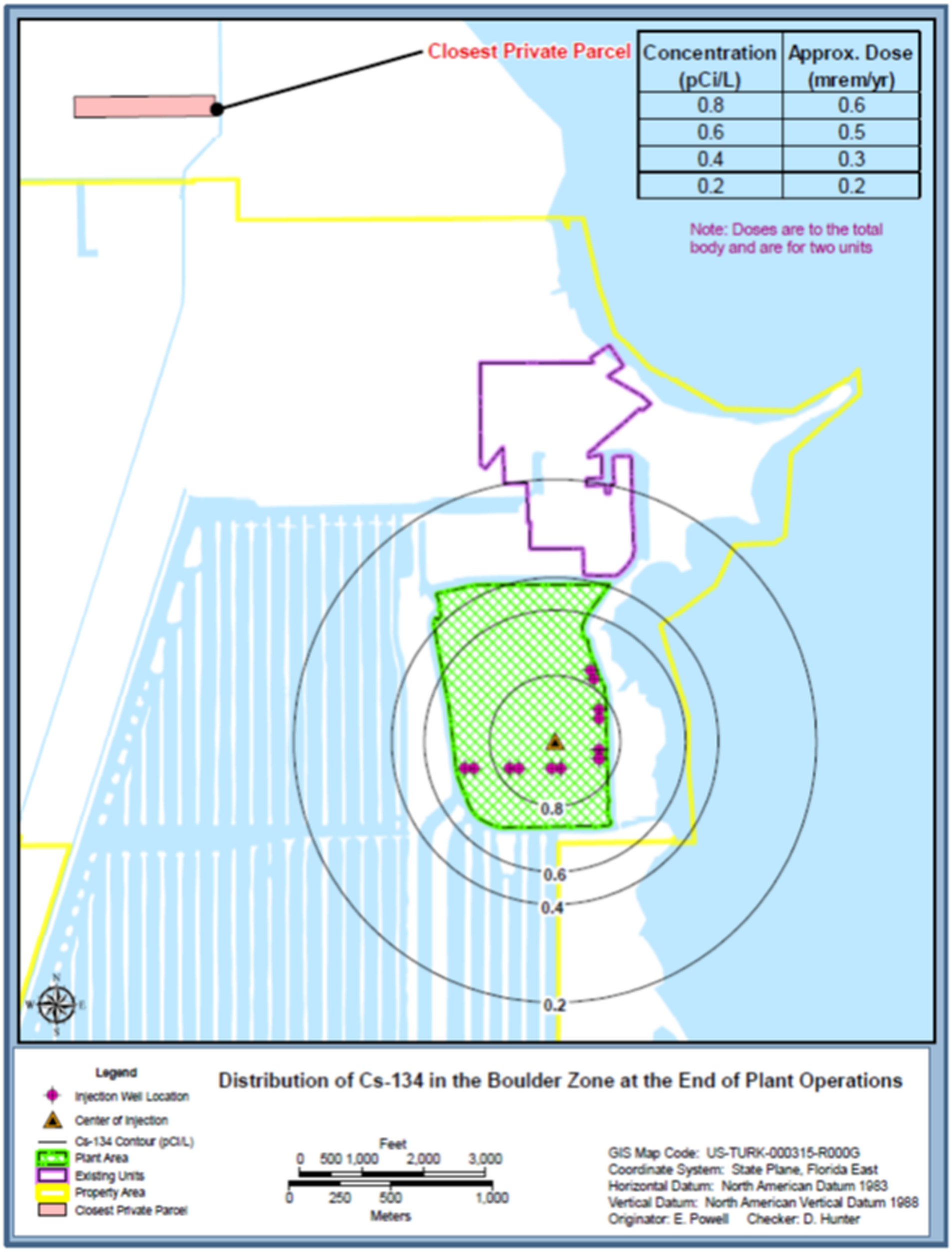
Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 4 of 4)



- ● Hypothetical observation well located ~2.2 miles from injection point.

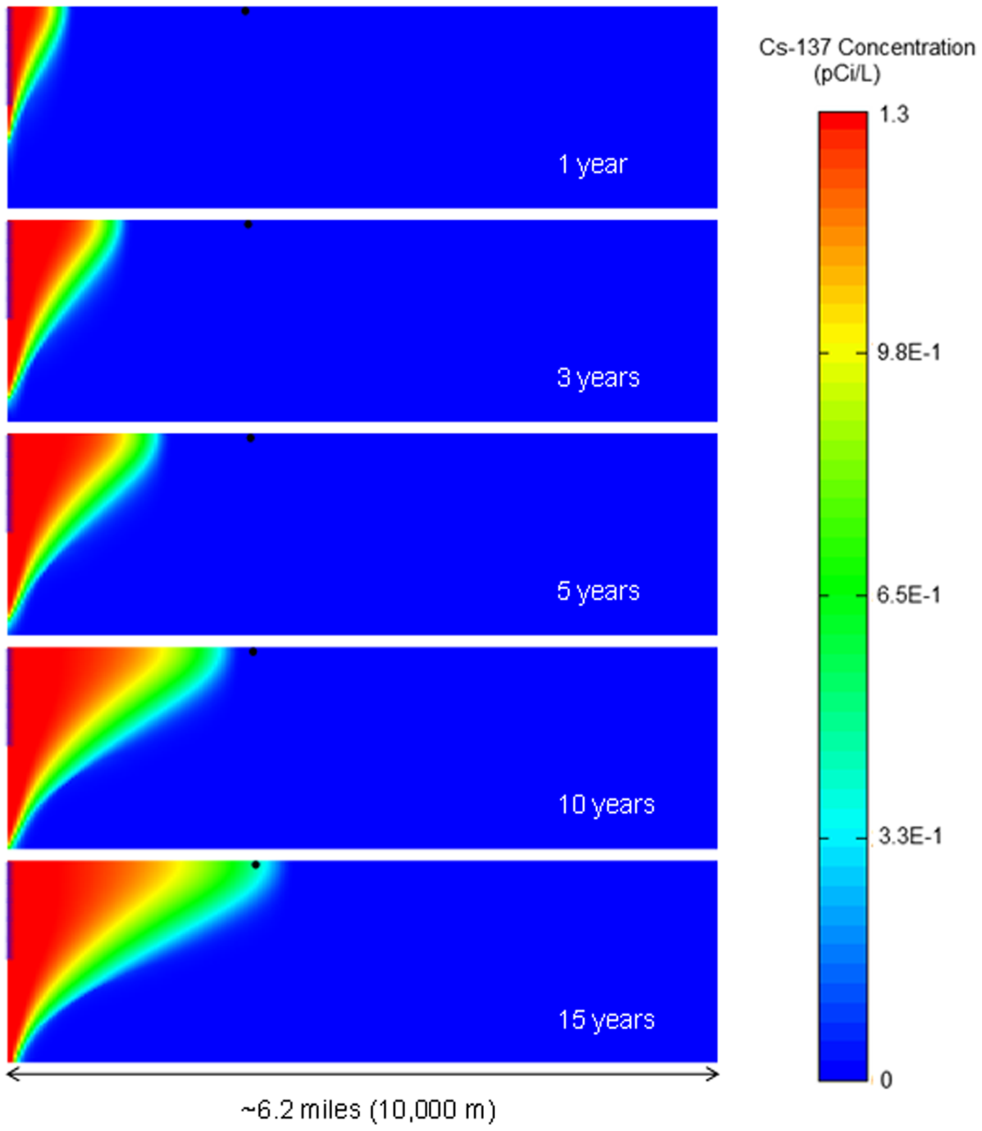
Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

Figure 11.2-204 Model Layer 1 Distribution of Cesium-134 in the Boulder Zone for the Base Case Simulation at the End of Plant Operations



Concentration (pCi/L)	Approx. Dose (mrem/yr)
0.8	0.6
0.6	0.5
0.4	0.3
0.2	0.2

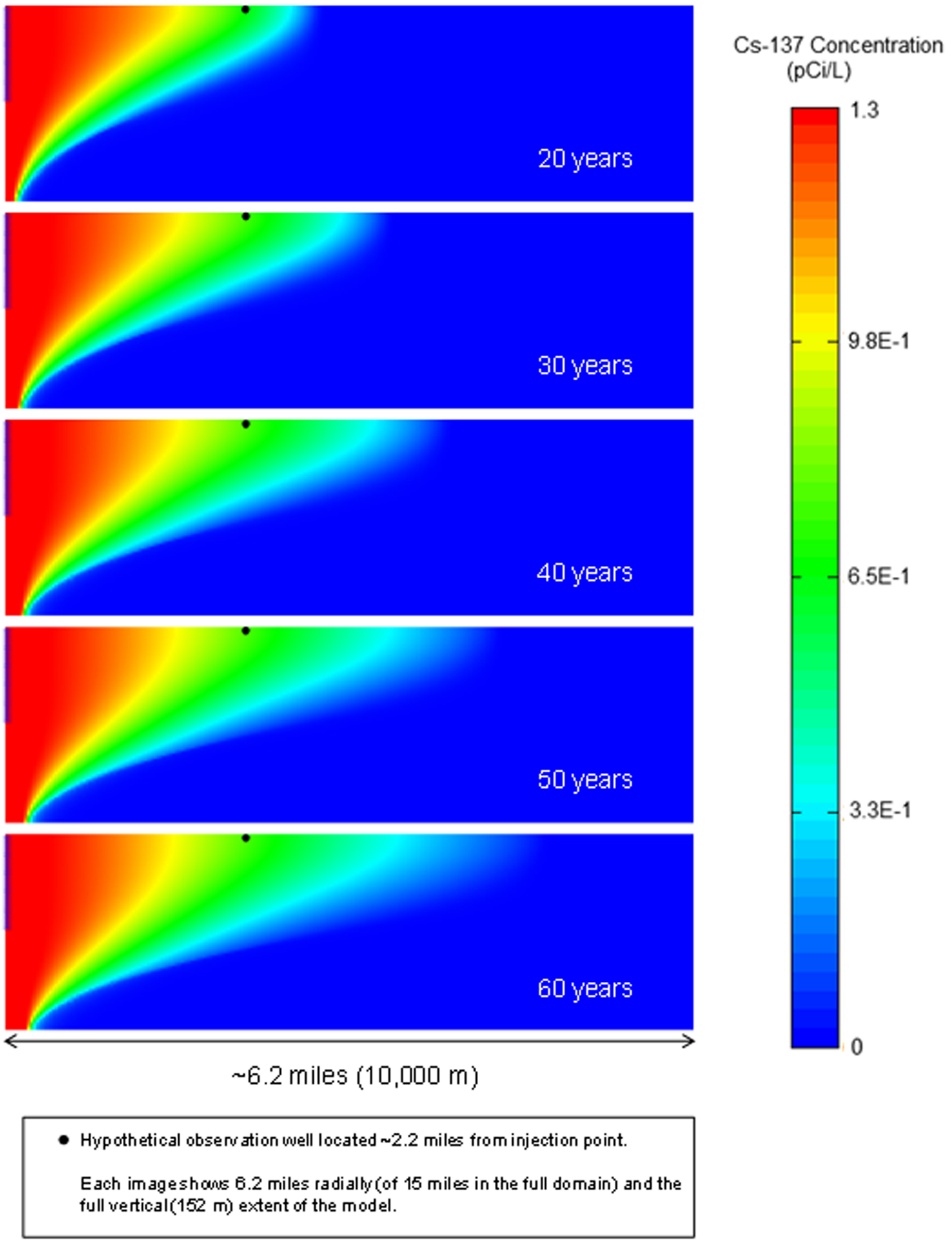
Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 1 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

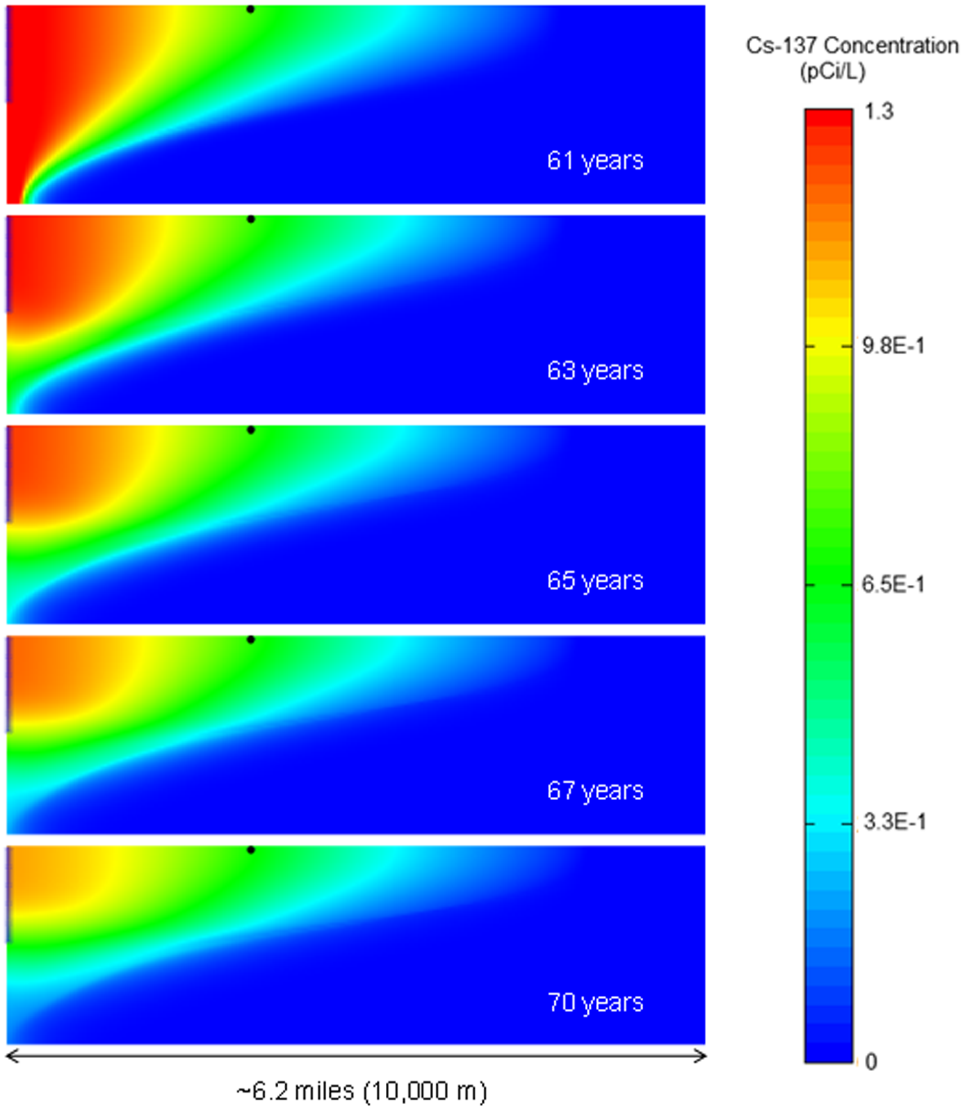
Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 2 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

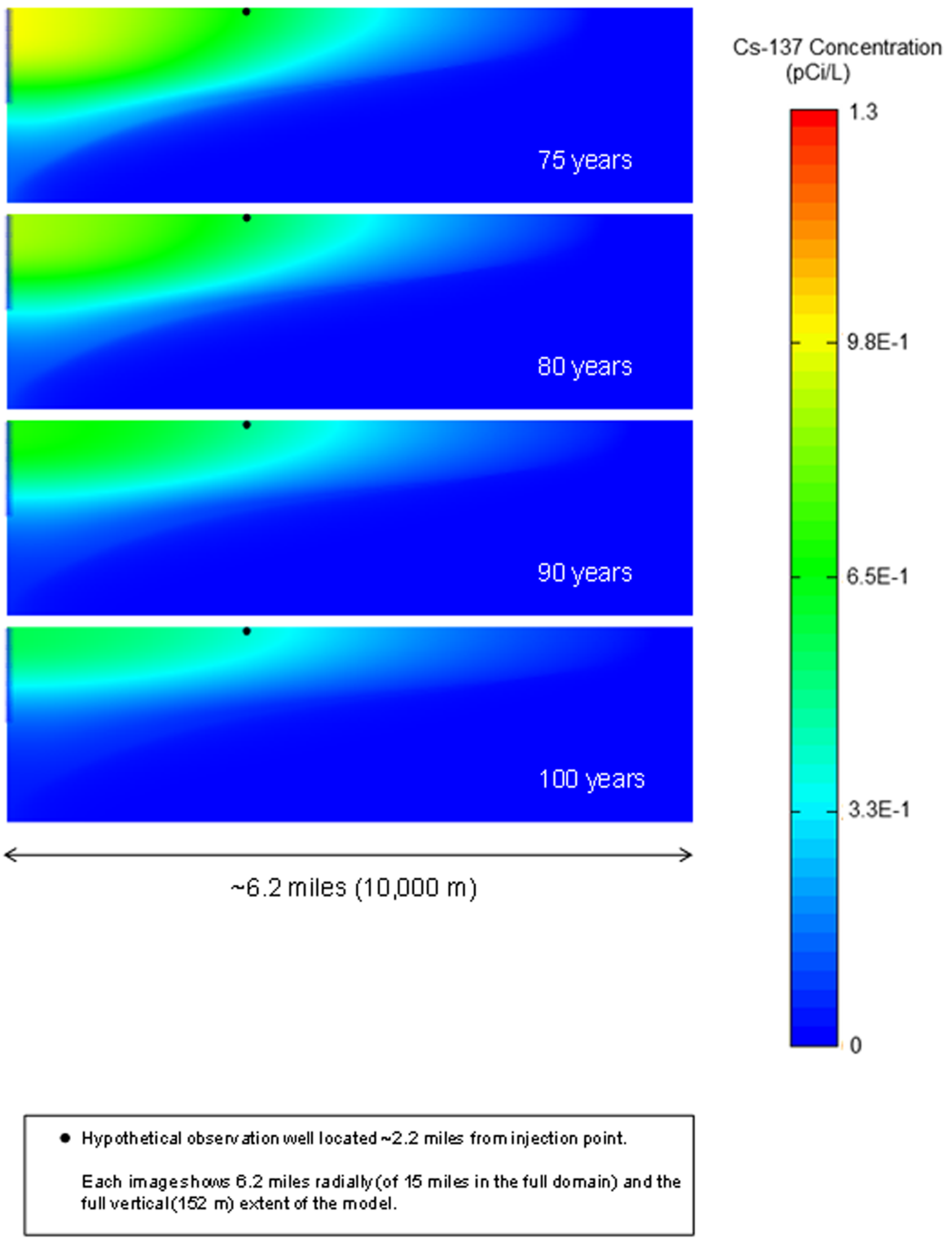
Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 3 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

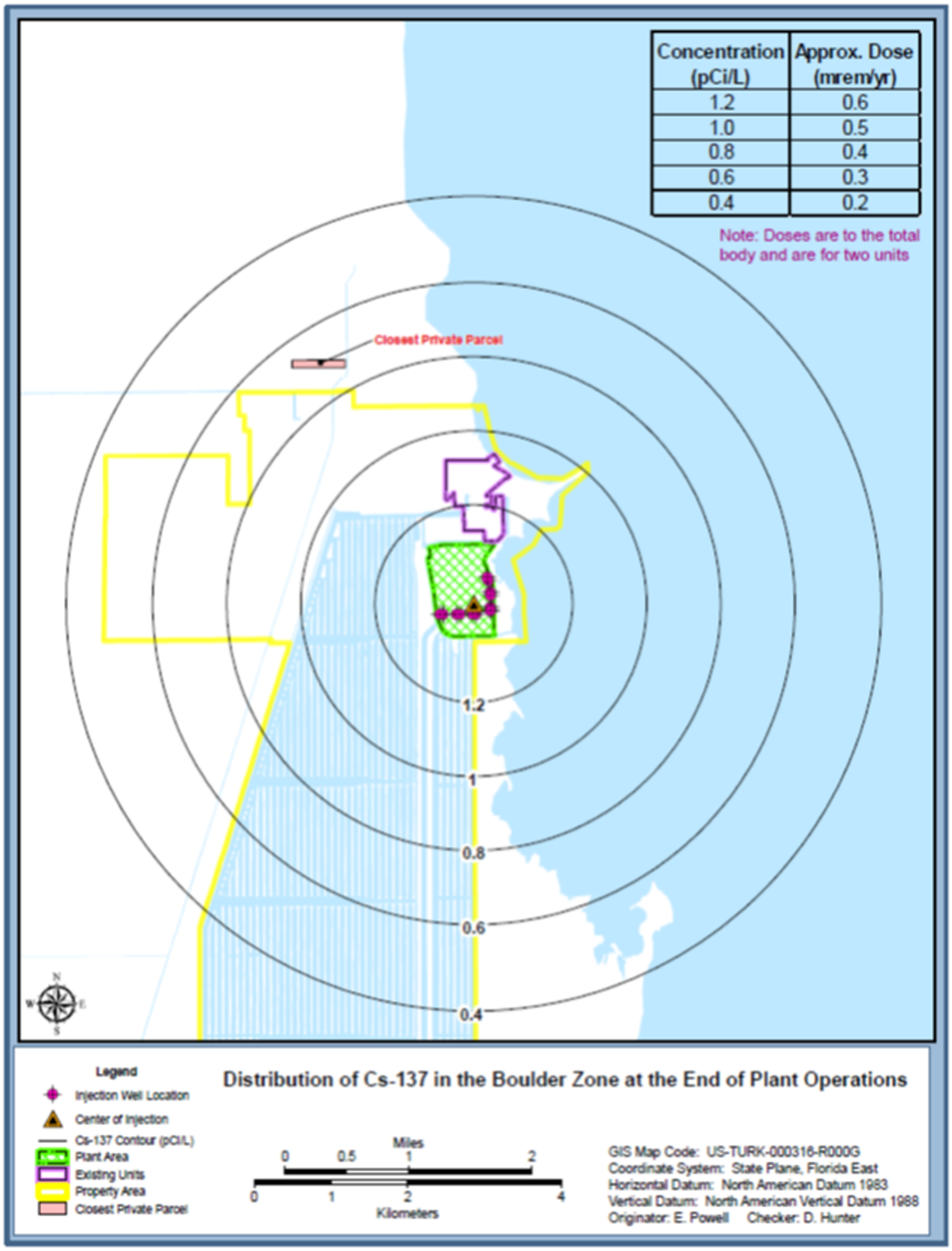
Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 4 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

Figure 11.2-206 Model Layer 1 Distribution of Cesium-137 in the Boulder Zone for the Base Case Simulation the End of Plant Operations



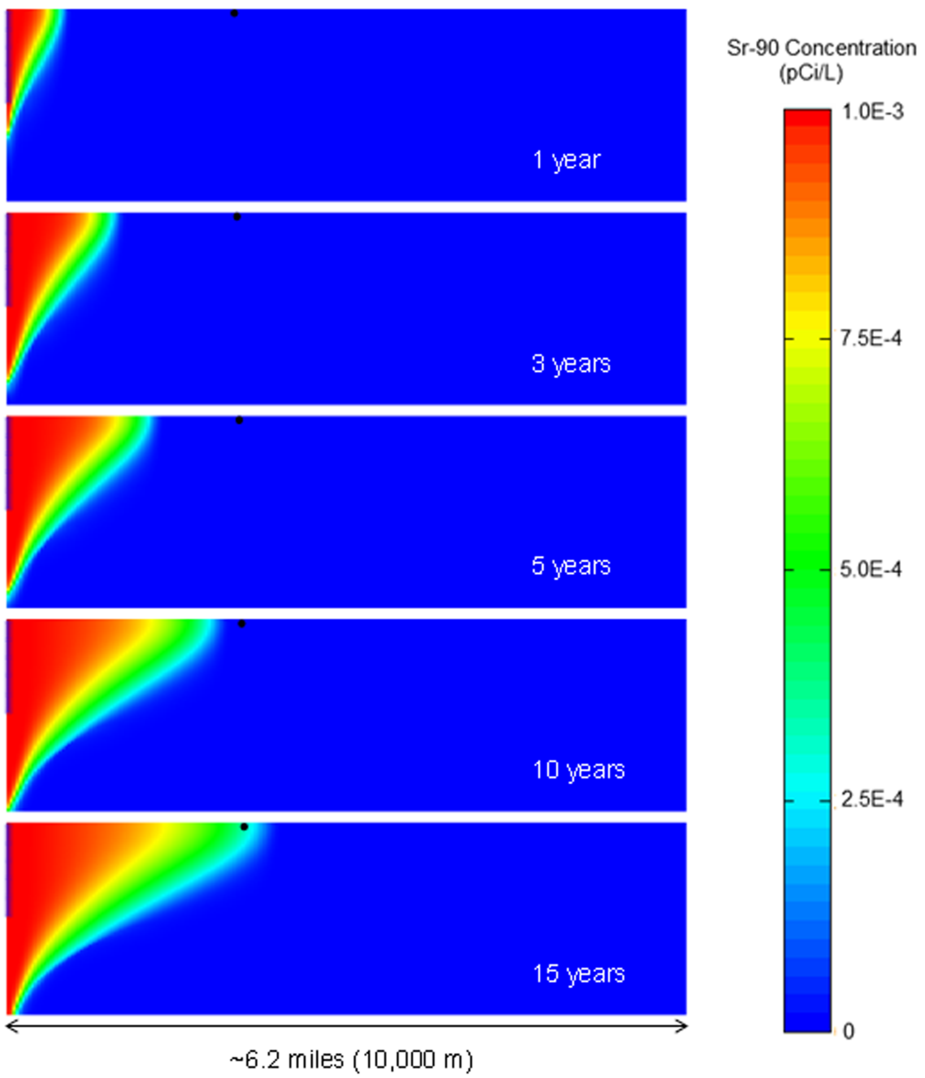
Concentration (pCi/L)	Approx. Dose (mrem/yr)
1.2	0.6
1.0	0.5
0.8	0.4
0.6	0.3
0.4	0.2

Note: Doses are to the total body and are for two units

Distribution of Cs-137 in the Boulder Zone at the End of Plant Operations

GIS Map Code: US-TURK-000316-R000G
Coordinate System: State Plane, Florida East
Horizontal Datum: North American Datum 1983
Vertical Datum: North American Vertical Datum 1988
Originator: E. Powell Checker: D. Hunter

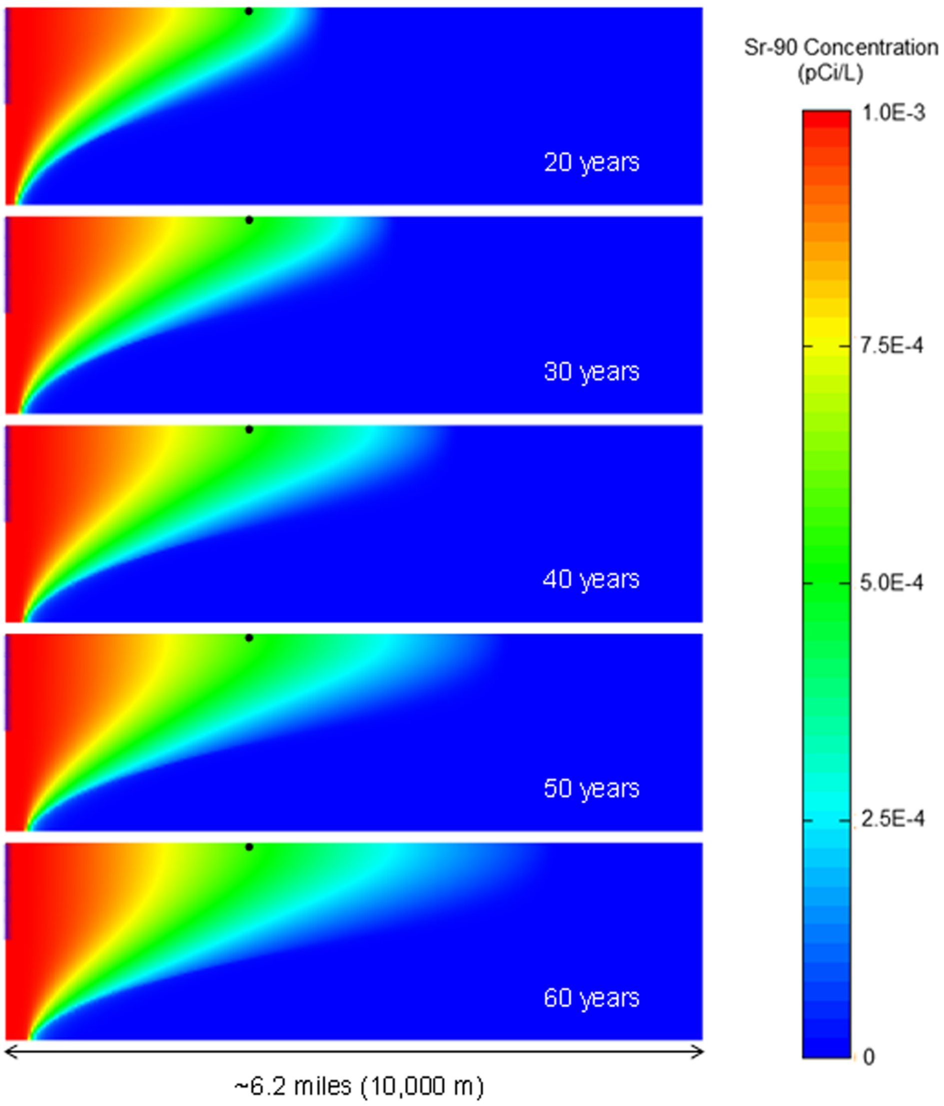
Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 1 of 4)



- ● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

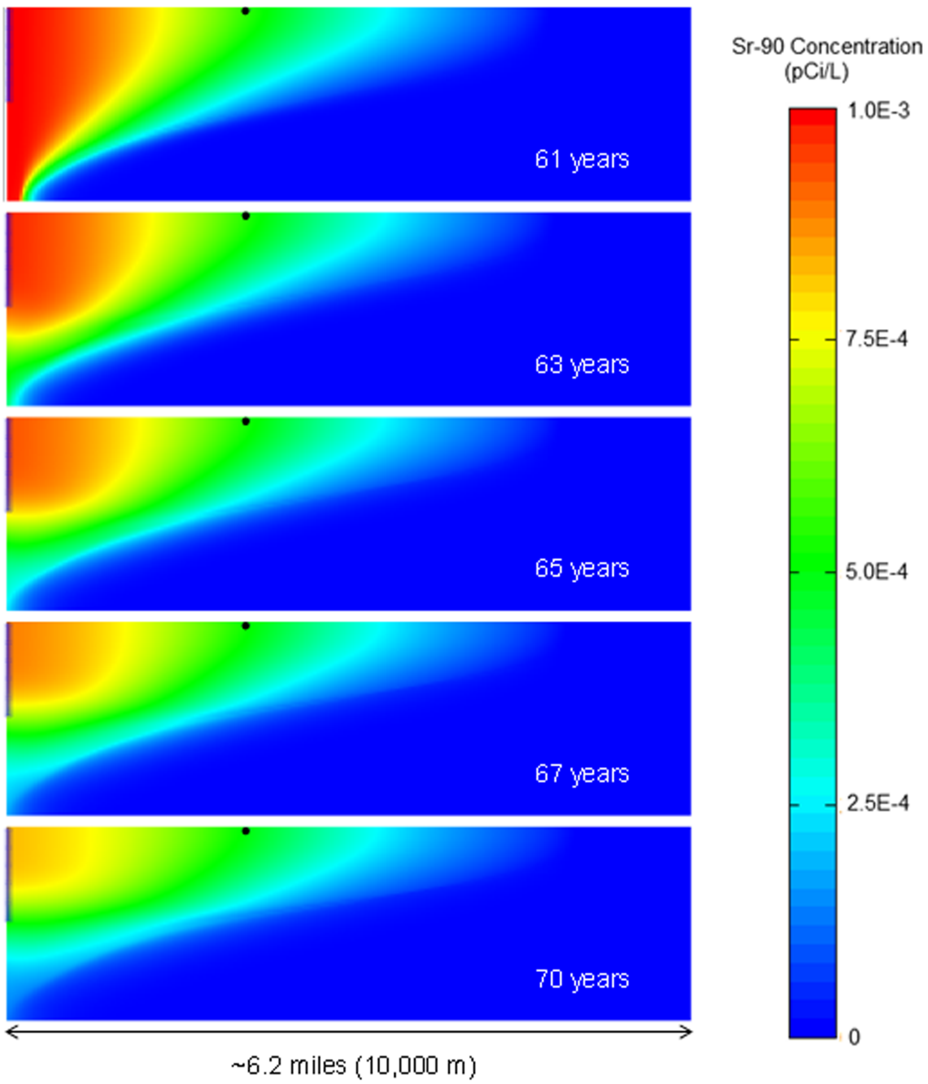
Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 2 of 4)



● Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

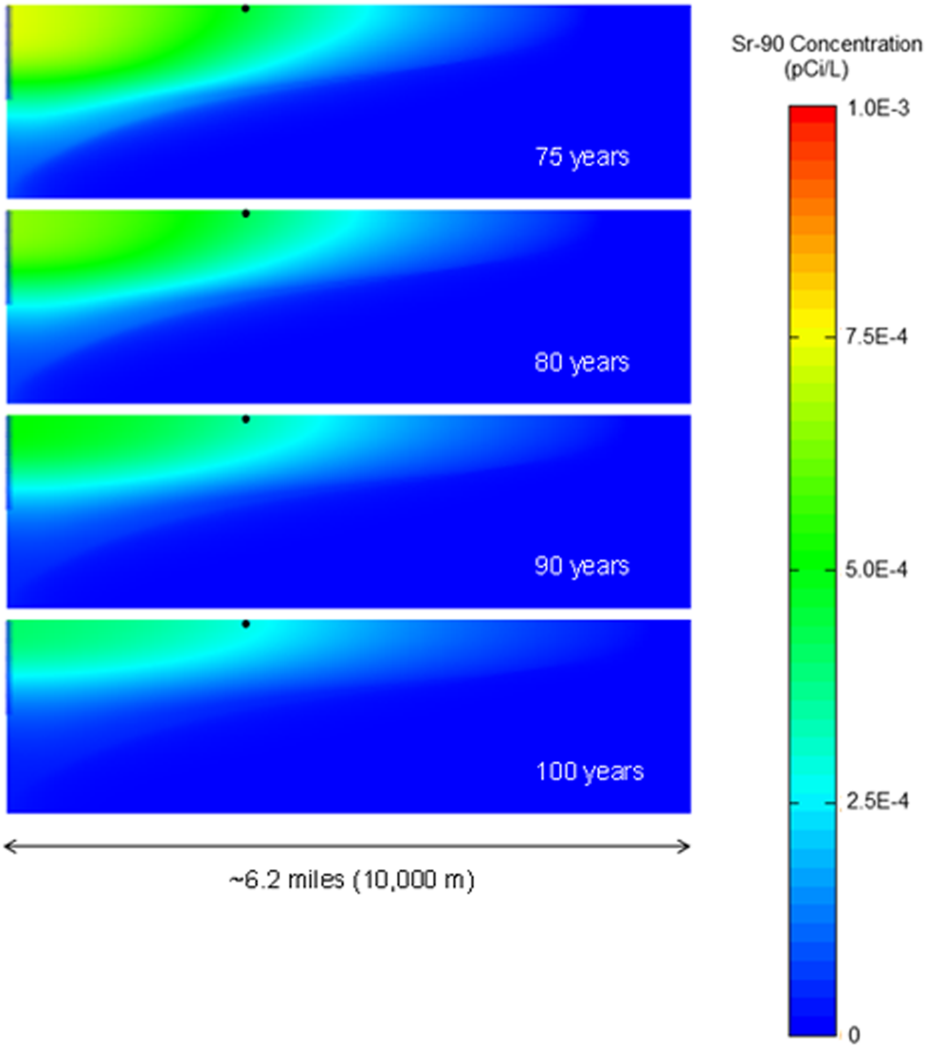
Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 3 of 4)



- Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

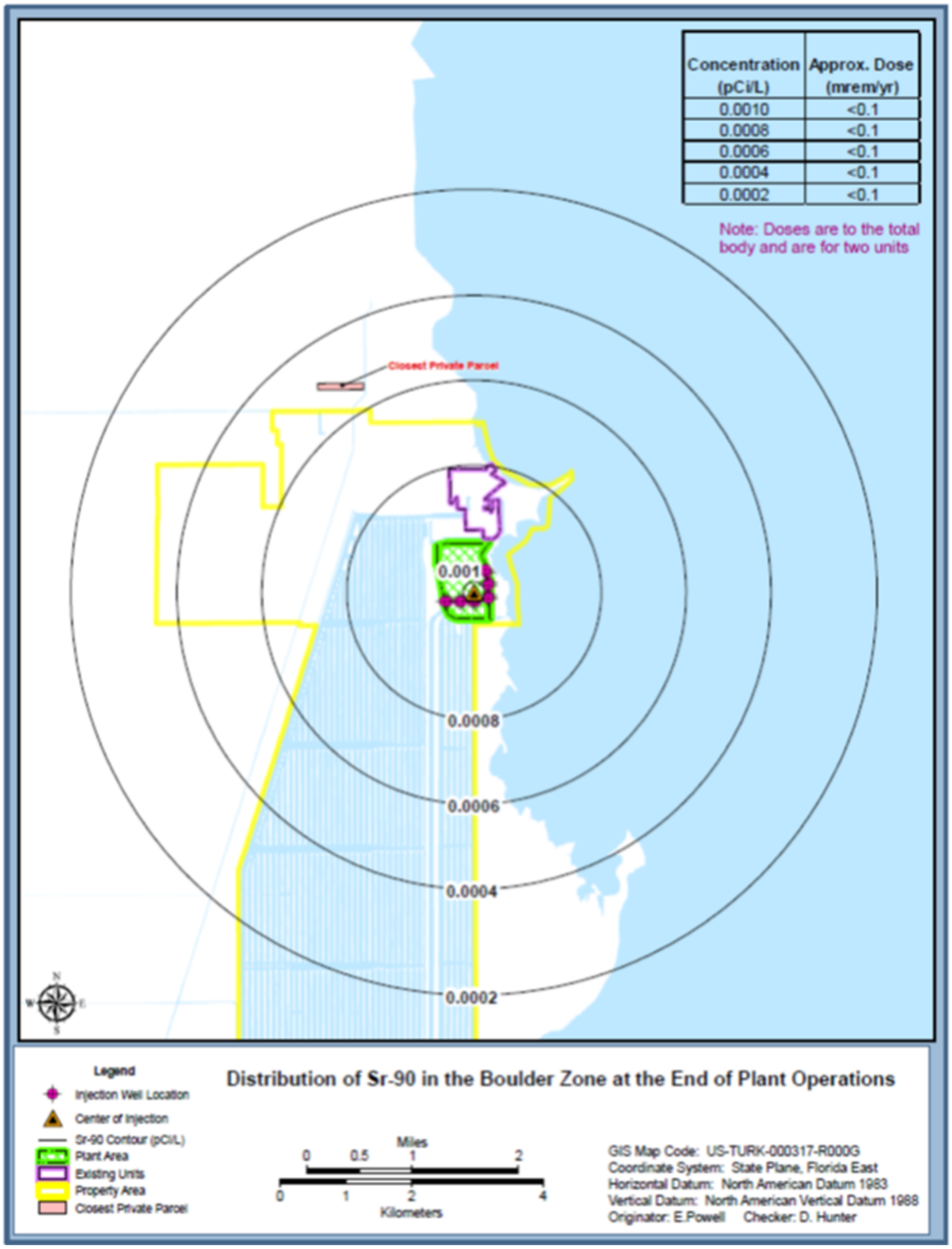
Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 4 of 4)



- Hypothetical observation well located ~2.2 miles from injection point.

Each image shows 6.2 miles radially (of 15 miles in the full domain) and the full vertical (152 m) extent of the model.

Figure 11.2-208 Model Layer 1 Distribution of Strontium-90 in the Boulder Zone for the Base Case Simulation at the End of Plant Operations



Concentration (pCi/L)	Approx. Dose (mrem/yr)
0.0010	<0.1
0.0008	<0.1
0.0006	<0.1
0.0004	<0.1
0.0002	<0.1

Note: Doses are to the total body and are for two units

Distribution of Sr-90 in the Boulder Zone at the End of Plant Operations

GIS Map Code: US-TURK-000317-R000G
Coordinate System: State Plane, Florida East
Horizontal Datum: North American Datum 1983
Vertical Datum: North American Vertical Datum 1988
Originator: E.Powell Checker: D. Hunter

Figure 11.2-209 Model Layer 1 Base Case Relative Concentration Breakthrough Curves at 2.2-Mile Receptor Location

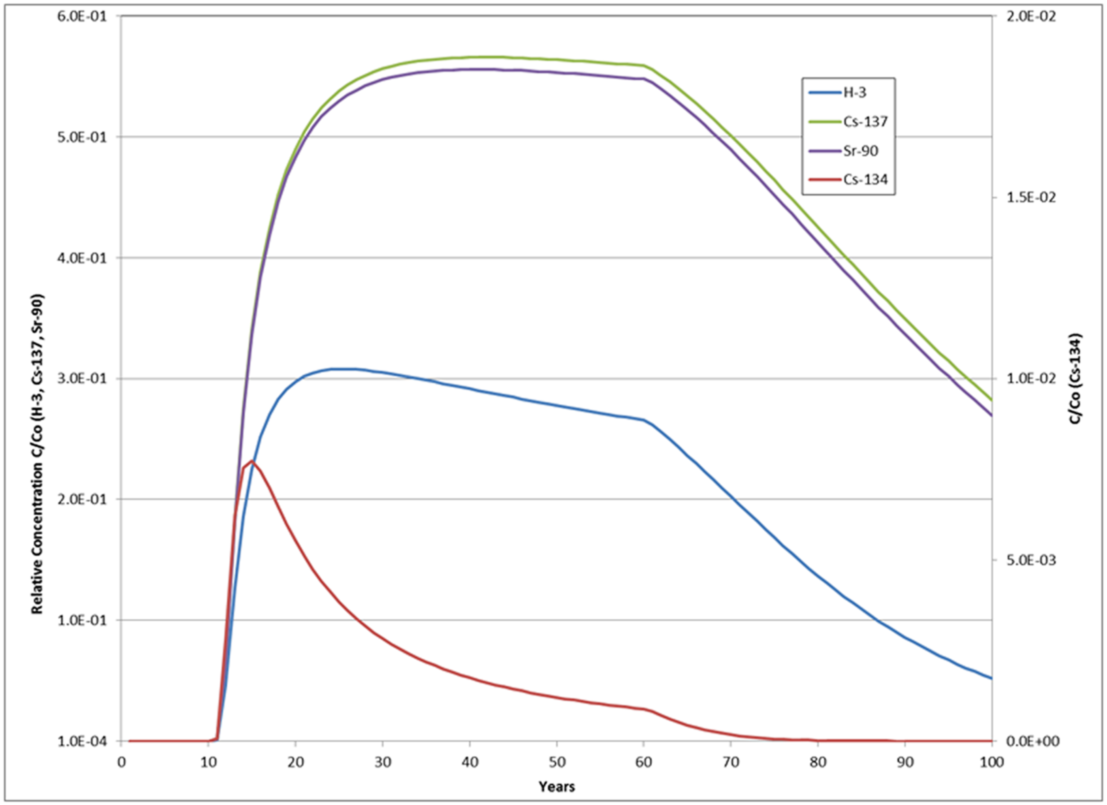


Figure 11.2-210 Six mrem Derived Tritium Activity Concentration Profiles in the Boulder Zone - Base Case Simulation

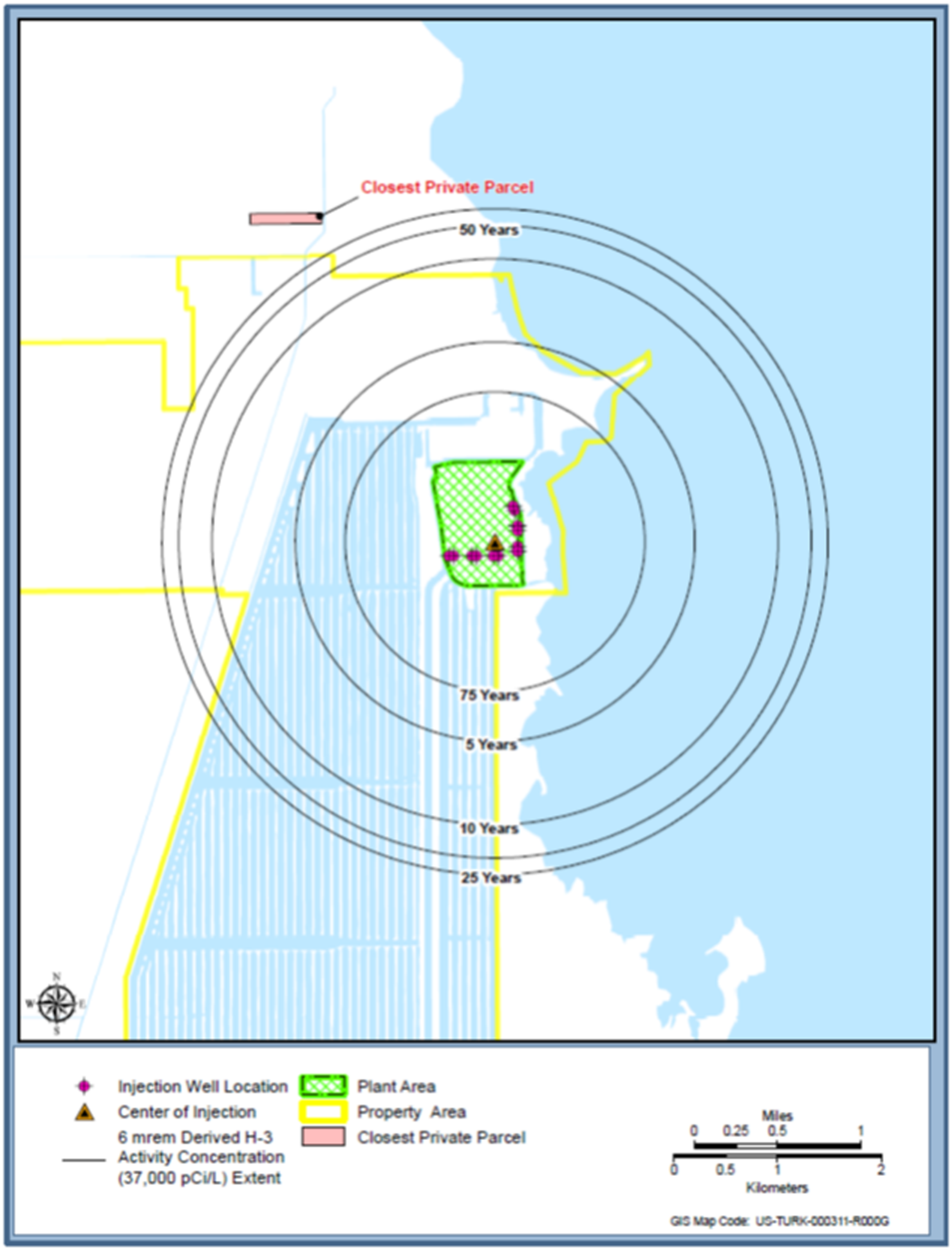


Figure 11.2-211 Potential Exposure Location Areas

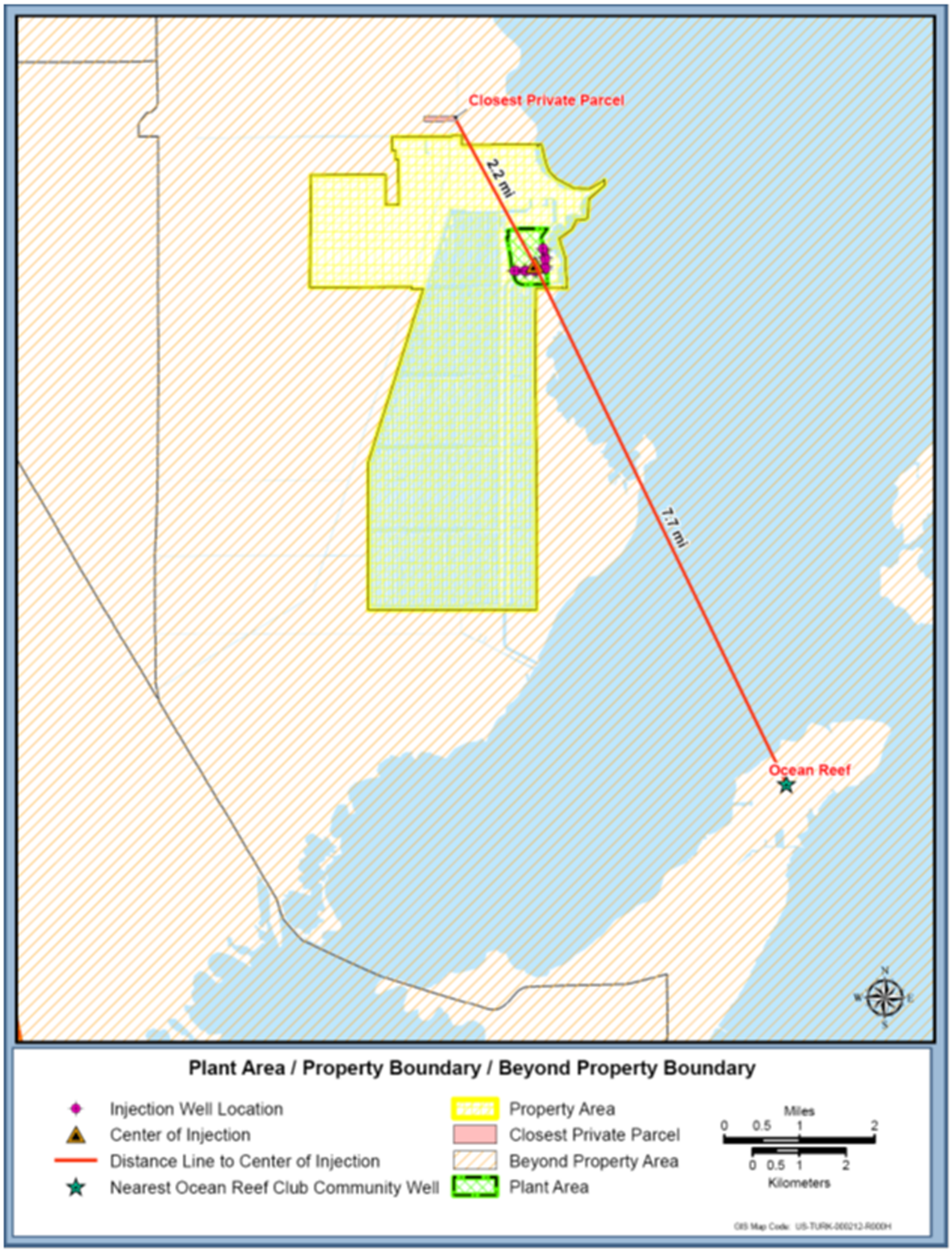
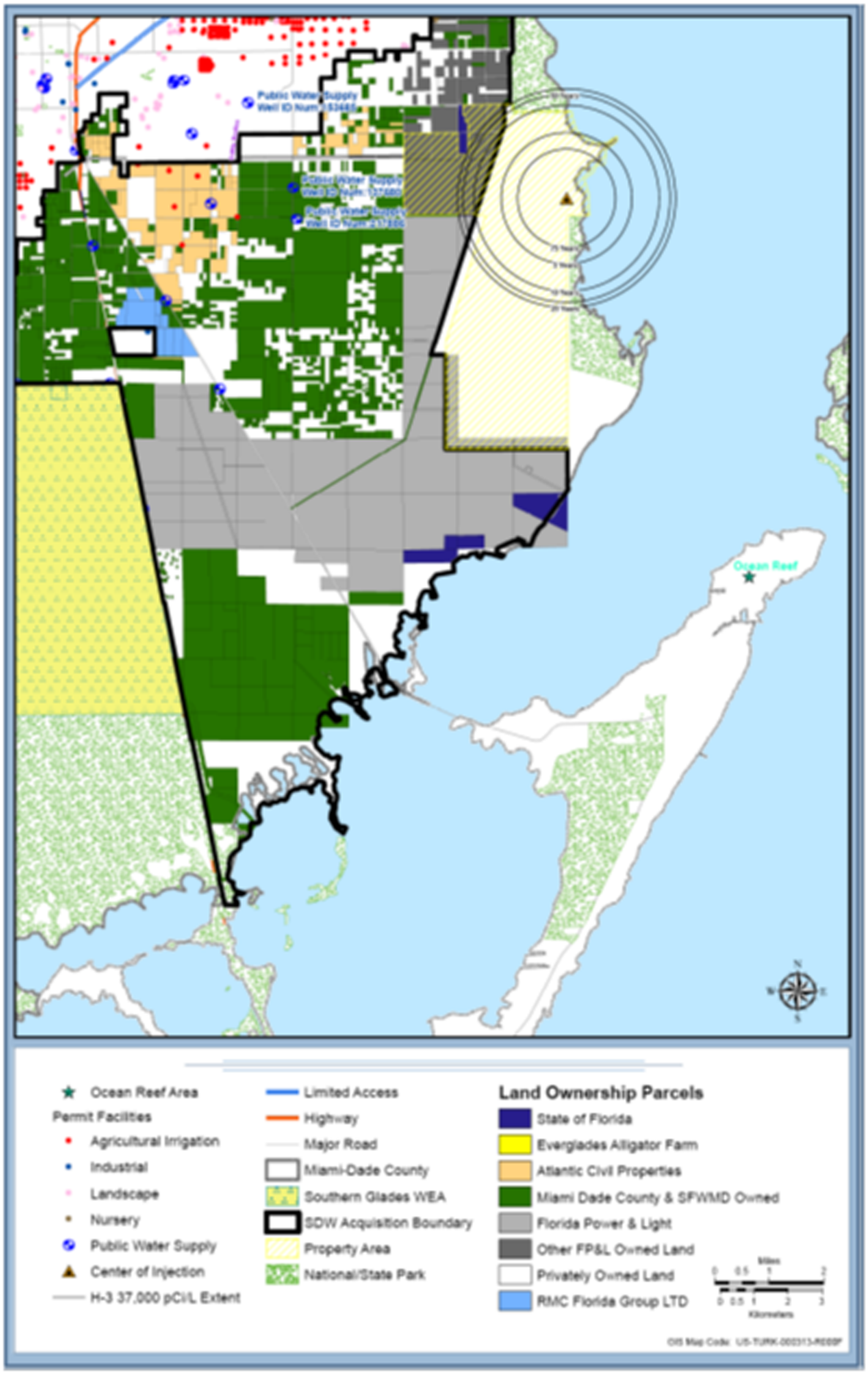
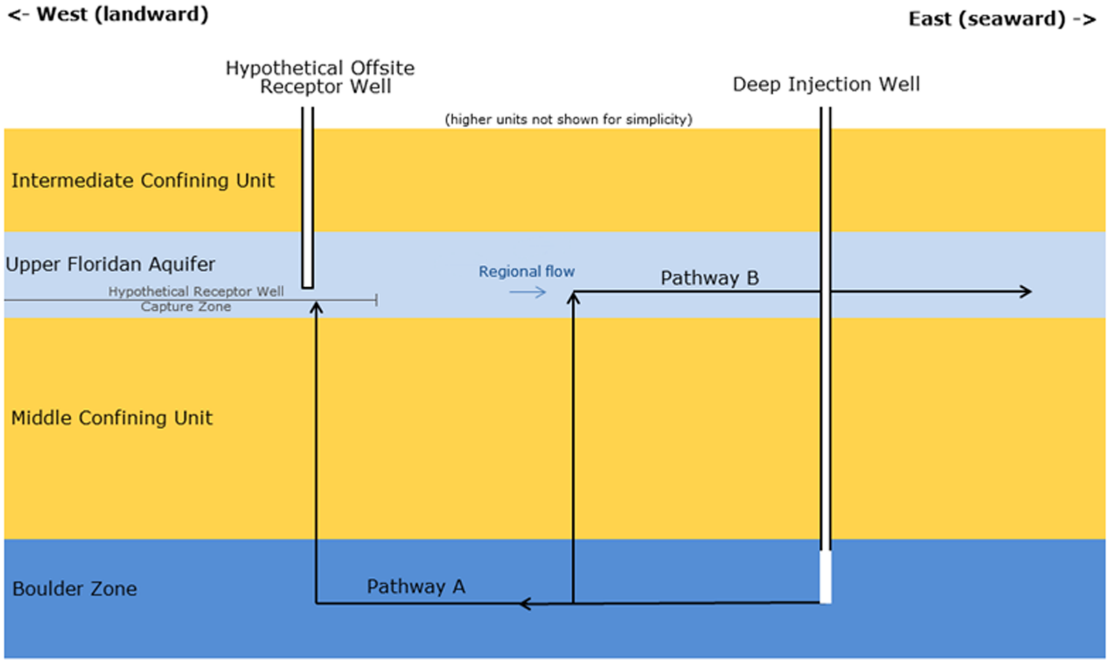


Figure 11.2-212 Land Ownership and Water Supply Well Locations in the Area of Turkey Point



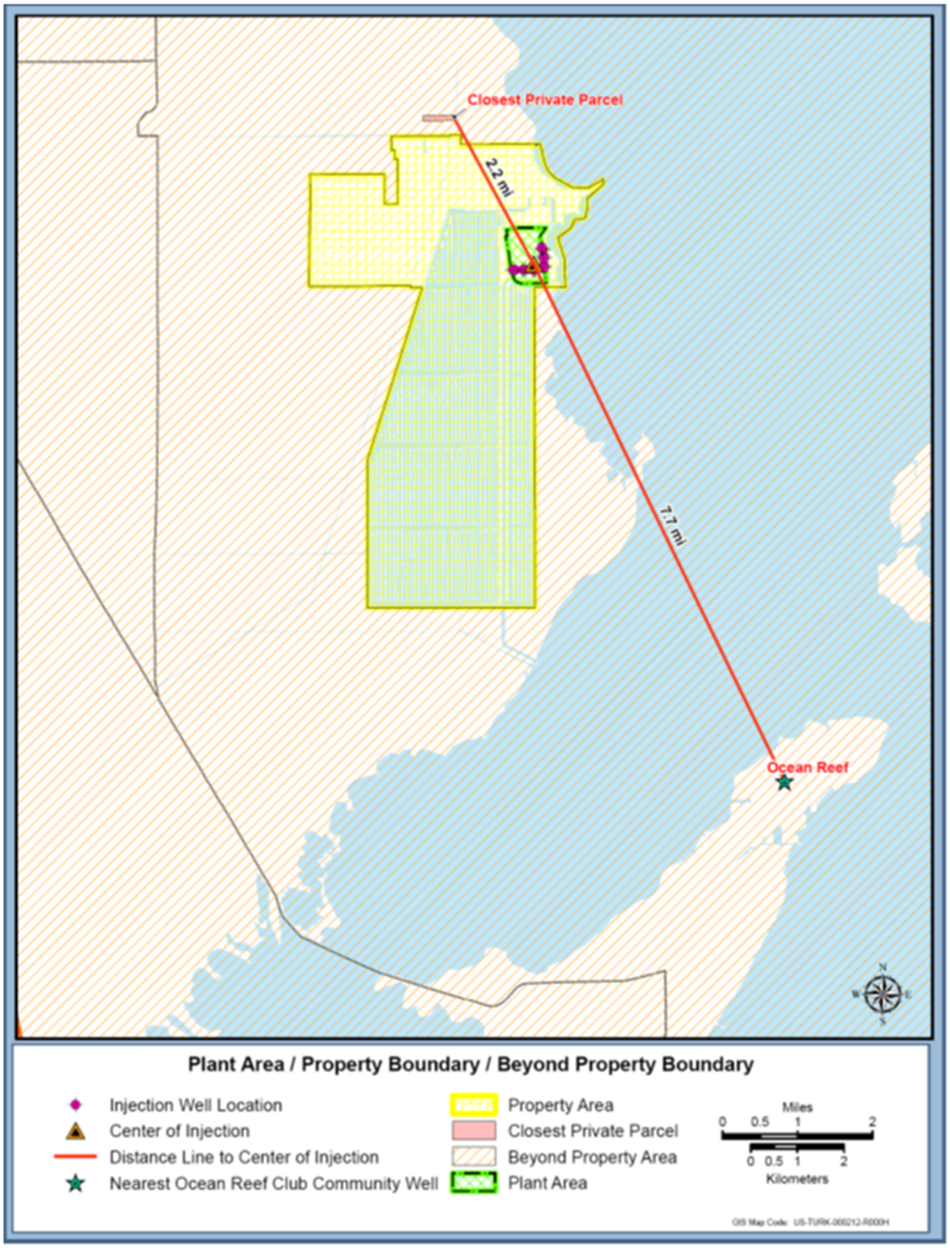
Note: Water supply wells depicted with a specified well ID number are monitoring wells placed along the 2008 USGS salt front line to monitor the Biscayne aquifer for saltwater intrusion.

Figure 11.2-213 Conceptual Schematic of Pathways to Hypothetical Offsite Receptor Accessing the Upper Floridan Aquifer



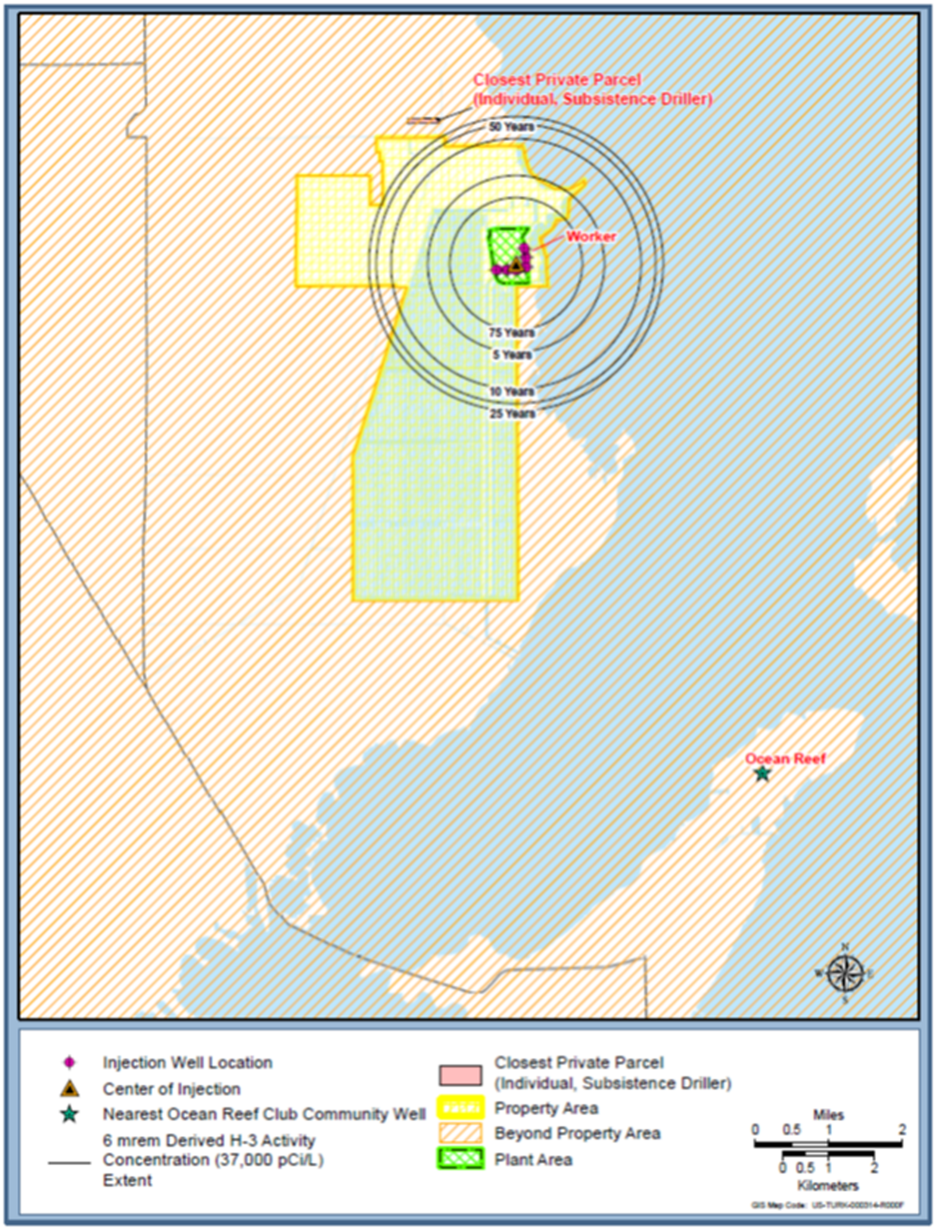
Schematic illustration of potential pathways. Not to scale.

Figure 11.2-214 Proposed Injection Well Field and Hypothesized Receptor Locations



Note: See Figure 11.2-204 for a more detailed view of the injection field.

Figure 11.2-215 Retained Member-of-the-Public Locations



11.3 GASEOUS WASTE MANAGEMENT SYSTEM

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

11.3.3 RADIOACTIVE RELEASES

Add the following new paragraph at the end of DCD Subsection 11.3.3:

STD SUP 11.3-2 There are no gaseous effluent site interface parameters outside of the Westinghouse scope.

11.3.3.2 Estimated Annual Releases

Add the following new paragraph at the end of DCD Subsection 11.3.3.2:

PTN SUP 11.3-1 The effluent concentrations in DCD Table 11.3-4 are based on an atmospheric dispersion factor of 2.0E-05 seconds per cubic meter, as indicated in the table footnotes. The site-specific atmospheric dispersion factor at the site boundary is 3.4E-05 seconds per cubic meter, as shown in Table 2.3.5-202. As concentration is directly proportional to dispersion factor, the concentrations in DCD Table 11.3-4 are multiplied by the ratio of 3.4E-05 to 2.0E-05, a factor of 1.7. The overall fraction of effluent concentration limit for the expected releases increases from the DCD value of 0.030 to the site-specific value of 0.051. This is within the allowable value of 1.0.

11.3.3.4 Estimated Doses

Add the following information at the end of DCD Subsection 11.3.3.4.

PTN COL 11.5-3 The site-specific atmospheric dispersion factor for the site boundary provided in Subsection 2.3.4.2 is bounded by the value given in DCD Table 2-1. Hence, the single failure of an active component in the gaseous radwaste system yields a whole body dose less than 0.1 rem.

With the annual airborne releases listed in DCD Table 11.3-3, the Units 6 & 7 site specific air doses at ground level at the site boundary are 4.2 mrad for gamma radiation and 18 mrad for beta radiation. These doses are based on the annual average atmospheric dispersion factor from Section 2.3. These doses are below the 10 CFR Part 50, Appendix I design objectives of 10 mrad per year for gamma radiation or 20 mrad per year for beta radiation.

Doses and dose rates to people were calculated using the GASPAR II computer code. This code is based on the methodology presented in the RG 1.109. Factors common to both estimated individual dose rates and estimated population dose are addressed in this subsection. Unique data is addressed in the respective subsections.

Exposure pathways considered for the individual are plume, ground deposition, inhalation, and ingestion of vegetables and meat. Exposure pathways considered for the population are plume, ground deposition, inhalation, and ingestion of vegetables, meat, and milk (both cow and goat).

Based on site meteorological conditions, the highest rate of plume exposure and ground deposition occurs at the site boundary 0.56 kilometers (0.35 miles) south-southeast of the plant (Figure 2.1-204).

The projected population distribution within 81 kilometers (50 miles) of the site in the year 2090 is in Figure 2.1-225.

Agricultural products are estimated from U. S. Department of Agriculture National Agricultural Statistics Service. Vegetable, milk, and meat production data is in Table 11.3-203.

11.3.3.4.1 Estimated Individual Doses

Dose rates to individuals are calculated for airborne decay and deposition, inhalation, and ingestion of meat and vegetables. Because there are no milk animals identified within 5 miles of Units 6 & 7, no dose from ingestion of milk is calculated. Dose from plume and ground deposition are calculated as affecting all age groups equally.

Plume exposure at the site boundary, 0.56 kilometers (0.35 miles) south-southeast of Units 6 & 7, produces a maximum dose rate to a single organ of

13 mrem/year to skin. The maximum total body dose rate was calculated to be 2.6 mrem/year.

Ground deposition at the site boundary, 0.56 kilometers (0.35 miles) south-southeast of Units 6 & 7, produces a maximum dose rate to a single organ of 1.2 mrem/year to skin. The maximum total body dose rate was calculated to be 1.1 mrem/year.

Inhalation dose at the nearest residence, 4.3 kilometers (2.7 miles) north of Units 6 & 7, results in a maximum dose rate to a single organ of 0.014 mrem/year to a child's thyroid. The maximum total body dose rate is calculated to be 0.0012 mrem/year to a teenager.

Vegetable consumption assumes that the dose is received from the nearest garden, 7.7 kilometers (4.8 miles) northwest of the plant. The GASPAR II default vegetable consumption values are used in lieu of site-specific vegetable consumption data as permitted by RG 1.109. The maximum dose rate to a single organ is 0.21 mrem/year to a child's thyroid. The maximum total body dose rate is calculated to be 0.020 mrem/year to a child.

Meat consumption assumes that the dose is received from the nearest meat animal, 4.3 kilometers (2.7 miles) north of Units 6 & 7. The GASPAR II default meat consumption values are used in lieu of site-specific meat consumption data as permitted by RG 1.109. The maximum dose rate to a single organ is 0.018 mrem/year to a child's bone. The maximum total body dose rate is calculated to be 0.0038 mrem/year to a child.

The milk pathway to the individual is not considered because there are no milk animals within 5 miles of Units 6 & 7.

The maximum dose rate to any organ considering every pathway is calculated to be 0.24 mrem/year to a child's thyroid. The maximum total body dose rate is calculated to be 0.038 mrem/year to a child, which includes the pathway doses (meat, vegetable, and inhalation) plus the plume and ground deposition doses (Table 11.3-204). These are below the 10 CFR Part 50, Appendix I design objectives of 5 mrem/year to total body, and 15 mrem/year to any organ, including skin.

Table 11.3-201 contains GASPAR II input data for dose rate calculations. Information regarding the locations for the nearest residence, meat animal, garden, and the site boundary is located in Section 2.3. Table 11.3-204 contains total organ dose rates based on age group. Table 11.3-205 contains total air doses at each special location. Table 11.3-206 shows the total site doses from Units 6 & 7 as well as the two existing Units 3 & 4 are within the regulatory limits of 40 CFR Part 190.

11.3.3.4.2 Estimated Population Dose

The estimated population dose within 81 kilometers (50 miles) is calculated as 4.0 person-rem total body and 7.5 person-rem thyroid per unit. Table 11.3-207 contains the estimated population doses by nuclide group (noble gases, iodines, particulates, C-14, and H-3).

PTN COL 11.3-1

11.3.3.4.3 Gaseous Radwaste Cost Benefit Analysis Methodology

The methodology of Regulatory Guide 1.110 was used to satisfy the cost benefit analysis requirements of 10 CFR Part 50, Appendix I, Section II.D. The parameters used in calculating the Total Annual Cost (TAC) are fixed and are given for each radwaste treatment system augment listed in Regulatory Guide 1.110, including the Annual Operating Cost (AOC) (Table A-2), Annual Maintenance Cost (AMC) (Table A-3), Direct Cost of Equipment and Materials (DCEM) (Table A-1), and Direct Labor Cost (DLC) (Table A-1). The following variable parameters were used:

- Capital Recovery Factor (CRF) — This factor is taken from Table A-6 of Regulatory Guide 1.110 and reflects the cost of money for capital expenditures. A cost-of-money value of 7 percent per year is assumed in this analysis, consistent with the "Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission" (NUREG/BR-0058). A CRF of 0.0806 was obtained from Table A-6.

- Indirect Cost Factor (ICF) — This factor takes into account whether the radwaste system is unitized or shared (in the case of a multi-unit site) and is taken from Table A-5 of RG 1.110. It is assumed that the radwaste system for this analysis is a unitized system at a 2-unit site, which equals an Indirect Cost Factor of 1.625.

- Labor Cost Correction Factor (LCCF) — This factor takes into account the differences in relative labor costs between geographical regions and is taken from Table A-4 of Regulatory Guide 1.110. A factor of 1 (the lowest value) is assumed in this analysis.

The value of $1000 per person-rem is prescribed in Appendix I to 10 CFR Part 50.

The analysis used a conservative assumption that the respective radwaste treatment system augment is a "perfect" system that reduces the effluent and dose by 100 percent. The gaseous radwaste treatment system augment's annual costs were determined and the lowest annual cost considered a threshold value. The lowest-cost option for gaseous radwaste treatment system augments is the Steam Generator Flash Tank Vent to Main Condenser at $6320 per year, which yields a threshold value of 6.32 person-rem total body or thyroid from gaseous effluents.

For AP1000 sites with population dose estimates less than 6.32 person-rem total body or thyroid dose from gaseous effluents, no further cost-benefit analysis is needed to demonstrate compliance with 10 CFR Part 50, Appendix I Section II.D.

11.3.3.4.4 Gaseous Radwaste Cost Benefit Analysis

The Units 6 & 7 population doses are given in Subsection 11.3.3.4.2. The augments provided in RG 1.110 were reviewed and were found not to be cost beneficial in reducing the population dose of 4.0 person-rem total body and 7.5 person-rem thyroid. The lowest cost gaseous radwaste system augment is $6320, which would be $6320/4.0 person-rem total body or $1580 per person-rem total body, and $6320/7.5 person-rem thyroid or $843 per person-rem thyroid. The total body cost per person-rem reduction exceeds the $1000 per person-rem criterion provided in RG 1.110 and is therefore not cost beneficial. Although the cost of thyroid dose reduction is below the threshold, this is assuming the augment completely eliminates the dose. As shown in Table 11.3-207, 2.1 of the 7.5 person-rem thyroid dose is due to noble gases, which will not be mitigated by the Steam Generator Flash Tank Vent to Main Condenser. With the noble gas contribution unaffected by the augment, the cost of thyroid dose reduction is $1170 per person-rem thyroid. Although the cost of $1170 only slightly exceeds the benefit of $1000, this augment is for the addition of a vent to a flash tank that is presumed to exist. Since the AP1000 design does not include a flash tank, the cost of the tank would have to be added to the cost of this augment, further increasing the cost relative to the benefit.

11.3.3.5 Maximum Release Concentrations

Add the following new paragraph at the end of DCD Subsection 11.3.3.5:

PTN SUP 11.3-1 The effluent concentrations in DCD Table 11.3-4 are based on an atmospheric dispersion factor of 2.0E-05 seconds per cubic meter, as indicated in the table footnotes. The site-specific atmospheric dispersion factor at the site boundary is 3.4E-05 seconds per cubic meter, as shown in Table 2.3.5-202. As concentration is directly proportional to dispersion factor, the concentrations in DCD Table 11.3-4 are multiplied by the ratio of 3.4E-05 to 2.0E-05, a factor of 1.7. The overall fraction of effluent concentration limit for the maximum releases increases from the DCD value of 0.33 to the site-specific value of 0.56. This is within the allowable value of 1.0.

11.3.3.6 Quality Assurance

Add the following to the end of DCD Subsection 11.3.3.6:

STD SUP 11.3-1 Since the impact of radwaste systems on safety is limited, the extent of control required by Appendix B to 10 CFR Part 50 is similarly limited. Thus, a supplemental quality assurance program applicable to design, construction, installation, and testing provisions of the gaseous radwaste system is established by procedures that complies with the guidance presented in Regulatory Guide 1.143.

PTN SUP 11.3-1 The quality assurance program for design, construction, procurement, materials, welding, fabrication, inspection and testing activities conforms to the quality control provisions of the codes and standards recommended in Table 1 of Regulatory Guide 1.143.

11.3.5 COMBINED LICENSE INFORMATION

11.3.5.1 Cost Benefit Analysis of Population Doses

PTN COL 11.3-1 This COL Item is addressed in Subsections 11.3.3.4.3 and 11.3.3.4.4.

PTN COL 11.5-3 This COL Item is addressed in Subsection 11.3.3.2.

11.3.6 REFERENCES

201. Florida Power & Light Company, *2010 Annual Radiological Environmental Operating Report,* Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML11140A084, April 2011.

202. National Agricultural Statistics Service, *Florida Annual Statistical Bulletin* 2008. Available at http://www.nass.usda.gov/Statistics_by _State/Florida/Publications/ AnnuaL Statistical_Bulletin/fasb08p.htm, accessed August 27, 2013.

203. U.S. Department of Agriculture, *Commercial Red Meat: Production, by State and U.S.*, National Agricultural Statistics Bulletin. Available at http://www.nass.usda.gov/Statistics_by Statellowa/Publicationsl Annual_ Statistical_ Bulletin/2007107 1 02.pdf, accessed August 27, 2013.

204. U.S. Department of Agriculture, *2002 Census of Agriculture*, Florida State and County Data, Vol. 1, June 2004. Available at www.nass.usda.gov/Publications/2002/index.php, accessed August 27, 2013.

205. Florida Power & Light Company, *Annual Radioactive Effluent Release Report*, *January 2004 through December 2004,* Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML050960370, March 2005.

206. Florida Power & Light Company, *Annual Radioactive Effluent Release Report*, *January 2005 through December 2005,* Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML060940646, March 2006.

207. Florida Power & Light Company, *Annual Radioactive Effluent Release Report*, January *2006 through December 2006,* Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML070920509, March 2007.

208. Florida Power & Light Company, *Annual Radioactive Effluent Release Report, January 2007 through December 2007*, Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML080940605, March 2008.

209. Florida Power & Light Company, *Annual Radioactive Effluent Release Report, January 2008 through December 2008*, Turkey Point Units 3 & 4, U.S. NRC ADAMS Accession No. ML090760628, February 2009.

PTN COL 11.3-1

PTN COL 11.5-3

Table 11.3-201
GASPAR II Input

Input Parameter	Value
Number of Source Terms	1
Source Term	DCD Table 11.3-3
Population Data	Table 11.3-202
Fraction of the year leafy vegetables are grown	1.0
Fraction of the year milk cows are on pasture	1.0[(a)]
Fraction of max individual’s vegetable intake from own garden	0.76
Fraction of the year goats are on pasture	1.0
Fraction of goat feed intake from pasture while on pasture	1.0
Fraction of the year beef cattle are on pasture	1.0
Fraction of beef-cattle feed intake from pasture while on pasture	1.0
Total Production Rate for the 50-mile area	
– Vegetables (kg/yr)	Table 11.3-203
– Milk (l/yr)	Table 11.3-203
– Meat (kg/yr)	Table 11.3-203
Special Location Data	FSAR Section 2.3.5

(a) There are no milk animals identified within 5 miles of Units 6 & 7 (Reference 201).

PTN COL 11.3-1

PTN COL 11.5-3

Table 11.3-202
Population Distribution in 2090

Direction	Distance (miles)									
	0–1	1–2	2–3	3–4	4–5	5–10	10–20	20–30	30–40	40–50
S	—	—	—	—	—	76	1,749	19	—	—
SSW	—	—	—	—	—	12	361	7,598	4,811	893
SW	—	—	—	—	—	—	—	—	—	12
WSW	—	—	—	—	—	207	450	41	—	2
W	—	—	—	—	—	38,378	12,086	—	—	—
WNW	—	—	—	—	—	121,964	40,618	—	9	5
NW	—	—	—	8	8	86,987	21,406	78	797	26
NNW	—	—	12	—	—	60,646	480,443	248,964	153	30
N	2,872	—	4,698	—	—	44,579	419,603	957,596	1,048,495	717,732
NNE	—	—	—	—	—	—	11,133	828,933	809,459	302,611
NE	—	—	—	—	—	—	30	—	—	—
ENE	—	—	—	—	—	6	—	—	—	—
E	—	—	—	—	—	—	—	—	—	—
ESE	—	—	—	—	—	—	—	—	—	—
SE	—	—	—	—	—	84	—	—	—	—
SSE	—	—	—	—	—	6,748	—	—	—	—
Total	2,872	0	4,710	8	8	359,687	987,879	2,043,229	1,863,724	1,021,311
									Grand Total	6,283,428

Note: Based on Figures 2.1-215 and 2.1-225.

PTN COL 11.3-1

PTN COL 11.5-3

Table 11.3-203
Vegetable, Milk, and Meat Production Data

Food(a)	State Production(b)				Production Basis(c)			50-Mile Fraction(d)	50-Mile Production(e)			
					Measure	**State**	**50-mile**		**Current**		**2090**	
Red Meat	6.67E+07	lbm	3.03E+07	kg	No. of beef cows	9.82E+05	2.01E+03	2.05E–03	6.19E+04	kg	1.12E+05	kg
Broilers	4.25E+08	lbm	1.93E+08	kg	No. of broilers	1.97E+07	3.44E+02	1.74E–05	3.36E+03	kg	6.09E+03	kg
Milk	2.11E+08	lbm	9.57E+07	L	No. of milk cows	1.45E+05	6.60E+01	4.56E–04	4.36E+04	L	7.89E+04	L
Vegetables	5.18E+07	cwt	2.35E+09	kg	Harvested acres	2.31E+06	5.95E+04	2.57E–02	6.04E+07	kg	1.09E+08	kg

(a) Meat Production — in calculating population doses, the red meat and broiler values are added to conservatively estimate the total meat production.

(b) State Production — The production rates are converted into units of kilograms (1 cwt = 100 lbm = 45.36 kg); milk density is assumed to be 1 kilogram/liter. State production values are from U.S. Department of Agriculture:
Broilers, milk and vegetables — *Florida Annual Statistical Bulletin 2008*, National Agricultural Statistics Service, http://www.nass.usda.gov/Statistics_by_State/Florida/Publications/Annual_Statistical_Bulletin/fasd08p.htm. (Reference 202)
Red meat — *Commercial Red Meat: Production, by State and U.S.*, U.S. Department of Agriculture, National Agricultural Statistics Bulletin, p. 102, http://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/Annual_Statistical_Bulletin/2007/07_102.pdf. (Reference 203)

(c) Production Basis — The production bases for the state and the four counties (Broward, Collier, Dade, and Monroe) within 50 miles of the plant. The production values are from U.S. Department of Agriculture:
2002 Census of Agriculture, Florida State and County Data, Volume 1, U.S. Department of Agriculture, June 2004, www.nass.usda.gov/census/census02/volume1/fl/FLVolume104.pdf. (Reference 204)

(d) 50-Mile Fraction — The fraction of production within 50 miles is obtained by dividing the 50-mile value by the state value.

(e) 50-Mile Production — The current 50-mile production is obtained by multiplying the state production by the 50-mile fraction. The 2090 production is obtained by multiplying the current production by 1.81, representing the population increase from 3,464,756 in 2010 to 6,283,428 in 2090.

PTN COL 11.5-3

Table 11.3-204
Individual Dose Rates

Location[a]	Pathway		Dose Rate per Unit (mrem/yr)[b]							
			Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
Residence 2.7 mi N	External	Plume	0.0067	0.0067	0.0067	0.0067	0.0067	0.0067	0.0074	0.046
		Ground	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0066	0.0077
		Total	0.013	0.013	0.013	0.013	0.013	0.013	0.014	0.053
	Inhalation	Adult	0.0012	0.0012	0.00016	0.0012	0.0012	0.0096	0.0015	0
		Teen	0.0012	0.0012	0.00019	0.0012	0.0012	0.012	0.0016	0
		Child	0.0010	0.0010	0.00023	0.0011	0.0011	0.014	0.0014	0
		Infant	0.00059	0.00058	0.00012	0.00063	0.00063	0.012	0.00087	0
Garden 4.8 miles NW	Vegetable	Adult	0.0064	0.0065	0.033	0.0064	0.0061	0.086	0.0055	0
		Teen	0.0092	0.0093	0.050	0.0096	0.0091	0.11	0.0083	0
		Child	0.020	0.019	0.11	0.021	0.020	0.21	0.018	0
Meat Animal 2.7 miles N	Meat	Adult	0.0026	0.0036	0.011	0.0027	0.0026	0.0094	0.0025	0
		Teen	0.0021	0.0027	0.0095	0.0022	0.0021	0.0070	0.0020	0
		Child	0.0038	0.0040	0.018	0.0039	0.0038	0.011	0.0037	0
MEI[c] — Sum of Residence, Garden, Meat Animal	All	Adult	0.023	0.025	0.058	0.023	0.023	0.12	0.023	0.053
		Teen	0.026	0.026	0.073	0.026	0.026	0.14	0.026	0.053
		Child	0.038	0.037	0.15	0.039	0.038	0.24	0.037	0.053
		Infant	0.014	0.014	0.013	0.014	0.014	0.025	0.015	0.053

(a) Locations are from Table 2.3.5-202.

(b) 10 CFR 50 Appendix I: Total body dose limit = 5 mrem/year, skin dose = 15 mrem/year, and dose to any organ = 15 mrem/year.

(c) MEI dose rates represent the summation of dose rates from each pathway (plume, ground, inhalation, vegetable, and meat). There are no milk animals identified within 5 miles of Units 6 & 7 (Reference 201).

PTN COL 11.5-3

Table 11.3-205
Doses in Millirads at Special Locations per Unit

Special Location	Beta Air Dose	Gamma Air Dose
Site Boundary[(a)]	18	4.2
Nearest Residence/Meat Animal	0.068	0.012
Nearest Vegetable Garden	0.048	0.0099

(a) 10 CFR 50 Appendix I Design Objective: Gamma Air Dose = 10 mrad and Beta Air Dose = 20 mrad.

PTN COL 11.5-3

Table 11.3-206
Comparison of Individual Doses with 40 CFR 190 Criteria

	Dose (mrem/yr)			
	Units 6 & 7[(a)]	Units 3 & 4[(b)]	Site Total	Limit
Total Body	7.8	0.0029	7.8	25
Thyroid	15	0.0059	15	75
Other Organ - Lung	8.4	0.0059	8.4	25

(a) Site boundary doses from a single new unit are doubled.

(b) Doses are due to liquid and gaseous effluents. The dose due to direct radiation is negligible, as exposure rates from the plant are consistent with those observed during the preoperational surveillance program (Reference 201). Effluent doses are taken as the maximum over a 5-year period, as reported in the annual effluent reports (References 205 to 209). Since the annual reports do not include plume contribution, the maximum gamma air dose is added to the total body and thyroid doses and the maximum beta air dose is added to the skin dose. Lung dose is assumed to be the same as thyroid dose.

PTN COL 11.5-3

Table 11.3-207
Estimated Population Doses per Unit

	Dose (person-rem/yr)	
	Total Body	Thyroid
Noble Gases	2.1	2.1
Iodines	0.013	3.5
Particulates	1.2	1.2
C-14	0.21	0.21
H-3	0.48	0.48
Total	4.0	7.5

11.4 SOLID WASTE MANAGEMENT

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

11.4.2 SYSTEM DESCRIPTION

Add the following information after DCD Subsection 11.4.2.4.2:

11.4.2.4.3 Contingency Plans for Temporary Storage of Low-Level Radioactive Waste (LLW)

PTN SUP 11.4-2 In the event that offsite shipping of radwaste is not available when Units 6 & 7 become operational, temporary storage capability is available on site for greater than two years at the expected rate of radwaste generation and greater than one year at the maximum rate of radwaste generation, as described in DCD Subsection 11.4.2.1 paragraph ten. Implementation of waste minimization strategies could extend the duration of temporary radwaste storage capability.

If additional onsite radwaste storage capability were required, then onsite facilities would be designed, constructed, and operated in accordance with the design guidance provided in NUREG-0800, Standard Review Plan Chapter 11 Radioactive Waste Management Appendix 11.4-A, Design Guidance for Temporary Storage of Low-Level Radioactive Waste.

11.4.5 QUALITY ASSURANCE

Add the following information to the end of DCD Subsection 11.4.5:

STD SUP 11.4-1 Since the impact of radwaste systems on safety is limited, the extent of control required by Appendix B to 10 CFR Part 50 is similarly limited. Thus, a supplemental quality assurance program applicable to design, construction, installation and testing provisions of the solid radwaste system is established by procedures that complies with the guidance presented in Regulatory Guide 1.143.

PTN SUP 11.4-2 The quality assurance program for design, construction, procurement, materials, welding, fabrication, inspection and testing activities conforms to the quality control provisions of the codes and standards recommended in Table 1 of Regulatory Guide 1.143.

11.4.6 COMBINED LICENSE INFORMATION FOR SOLID WASTE MANAGEMENT SYSTEM PROCESS CONTROL PROGRAM

Add the following information to the end of DCD Subsection 11.4.6.

This COL Item is addressed below.

STD COL 11.4-1 A Process Control Program (PCP) is developed and implemented in accordance with the recommendations and guidance of NEI 07-10A (Reference 201). The PCP describes the administrative and operational controls used for the solidification of liquid or wet solid waste and the dewatering of wet solid waste. Its purpose is to provide the necessary controls such that the final disposal waste product meets applicable federal regulations (10 CFR Parts 20, 50, 61, 71, and 49 CFR Part 173), state regulations, and disposal site waste form requirements for burial at a low level waste (LLW) disposal site that is licensed in accordance with 10 CFR Part 61.

Waste processing (solidification or dewatering) equipment and services may be provided by the plant or by third-party vendors. Each process used meets the applicable requirements of the PCP.

No additional onsite radwaste storage is required beyond that described in the DCD.

Table 13.4-201 provides milestones for PCP implementation.

PTN SUP 11.4-1 Low-level radioactive waste is packaged to meet transportation and disposal site acceptance requirements. Packaging of waste for offsite shipment complies with applicable DOT (49 CFR Parts 173 and 178) and NRC regulations (10 CFR Part 71) for transportation of radioactive material. The packaged waste is stored on site on an interim basis before being shipped offsite to a licensed processing, storage, or disposal facility. Onsite storage for more than a year at the maximum rate of generation is provided in the waste accumulation room of the radwaste building. Radioactive waste is shipped offsite by truck.

Consistent with current commercial agreements, a third-party contractor processes, stores, owns, and ultimately disposes of low-level waste generated as a result of operations. Activities associated with the transportation, processing, and ultimate disposal of low-level waste comply with applicable laws and regulations in order to ensure the public's health and safety. In particular, the third-party contractor conducts its operations consistent with NRC regulations (e.g., 10 CFR Part 20).

All packaged and stored radwaste is shipped to offsite disposal/storage facilities and temporary storage of radwaste is only provided until routine offsite shipping can be performed. Accordingly, there is no expected need for permanent onsite storage facilities at Units 6 & 7.

If additional storage capacity for Class B and C waste were required, further temporary storage would be designed, constructed, and operated in accordance with the design guidance provided in NUREG-0800, Standard Review Plan 11.4, Appendix 11.4-A. The change to the facility to provide additional onsite storage would be evaluated by performing written safety analyses in accordance with 10 CFR 50.59. If the acceptability of the proposed additional storage could not be demonstrated by 10 CFR 50.59 analyses, a license amendment would be sought to approve the proposed storage.

11.4.6.1 Procedures

STD SUP 11.4-1 Operating procedures specify the processes to be followed to ship waste that complies with the waste acceptance criteria (WAC) of the disposal site, 10 CFR 61.55 and 61.56, and the requirements of third party waste processors.

Each waste stream process is controlled by procedures that specify the process for packaging, shipment, material properties, destination (for disposal or further processing), testing to verify compliance, the process to address non-conforming materials, and required documentation.

Where materials are to be disposed of as non-radioactive waste (as described in DCD Subsection 11.4.2.3.3), final measurements of each package are performed to verify there has not been an accumulation of licensed material resulting from a buildup of multiple, non-detectable quantities. These measurements are obtained using sensitive scintillation detectors, or instruments of equal sensitivity, in a low-background area.

Procedures document maintenance activities, spill abatement, upset condition recovery, and training.

Procedures document the periodic review and revision, as necessary, of the PCP based on changes to the disposal site, WAC regulations, and third party PCPs.

11.4.6.2 Third Party Vendors

Third party equipment suppliers and/or waste processors are required to supply approved PCPs. Third party vendor PCPs describe compliance with Regulatory Guide 1.143, Generic Letter 80-09, and Generic Letter 81-39. Third party vendor PCPs are referenced appropriately in the plant PCP before commencement of waste processing.

11.4.7 REFERENCES

201. Nuclear Energy Institute, *Generic FSAR Template Guidance for Process Control Program (PCP)*, NEI 07-10A, Rev. 0, NRC ADAMS Accession No. ML091460627, March 2009.

202. Not Used.

203. Not Used.

204. Not Used.

205. Not Used.

11.5 RADIATION MONITORING

This section of the referenced DCD is incorporated by reference with the following departures and/or supplements.

11.5.1.2 Power Generation Design Basis

Revise the fourth bullet in DCD Subsection 11.5.1.2 as follows:

PTN COL 11.5-2

- Data collection and data storage to support compliance reporting for the applicable NRC requirements and guidelines, such as General Design Criterion 64 and Regulatory Guide 1.21 and Regulatory Guide 4.15, Revision 2.

11.5.2.4 Inservice Inspection, Calibration, and Maintenance

Add the following information at the end of DCD Subsection 11.5.2.4:

STD COL 11.5-2 Daily checks of effluent monitoring system operability are made by observing channel behavior. Detector response is routinely observed with a remotely-positioned check source in accordance with plant procedures. Instrument background count rate is also observed to determine proper functioning of the monitors. Any detector whose response cannot be verified by observation during normal operation or by using the remotely-positioned check source can have its response checked with a portable check source. A record is maintained showing the background radiation level and the detector response.

Calibration of the continuous radiation monitors is done with commercial radionuclide standards that have been standardized using a measurement system traceable to the National Institute of Standards and Technology.

11.5.3 EFFLUENT MONITORING AND SAMPLING

Add the following information at the end of DCD Subsection 11.5.3.

PTN COL 11.5-2 Units 6 & 7 use the existing fleet program for quality assurance of radiological effluent and environmental monitoring that is based on RG 4.15, Revision 2.

PTN SUP 11.5-1 The effluent from the reclaimed water treatment facility (RWTF) is monitored for measurable quantities of unregulated radioactive material. If present, a fraction of this radioactive material would be adsorbed in RWTF treatment sludge and another fraction would remain in the treated RWTF effluent as circulating water supply. The RWTF sludge fraction is characterized as required to demonstrate compliance with the waste acceptance criteria established by the commercial sludge disposal facility, as well as applicable transportation regulations. The RWTF effluent fraction, including some end products of processing that may be bypassed to the plant blowdown sump (as warranted by operational conditions), is characterized to enable its differentiation from radioactive material attributed to Units 6 & 7 operations (to ensure the reporting of deep well injection system discharge quantities and dose solely reflects Units 6 & 7 radioactive material).

The Units 6 & 7 ODCM developed and made available for NRC inspection prior to fuel load describes the sampling, monitoring, analysis, and assessment of the RWTF effluent as it relates to reporting deep well injection system discharge quantities and doses.

The activity concentration of the radwaste portion of the effluent is controlled to 10 CFR Part 20, Appendix B, Effluent Concentration Limits, by specifying and maintaining flow rates at the blowdown sump discharge corresponding to at least the minimum DF. The required minimum DF is calculated and applied before the release of liquid radwaste (batch is the only release mode anticipated) to ensure the activity concentration of the mixture complies with 10 CFR Part 20, Appendix B, ECLs. Implementation of the liquid radwaste effluent control program is in accordance with the Turkey Point Units 6 & 7 ODCM, an operational program identified in Table 13.4-201.

11.5.4 PROCESS AND AIRBORNE MONITORING AND SAMPLING

Add the following information at the end of the first paragraph in DCD Subsection 11.5.4.

PTN COL 11.5-2 The sampling program for liquid and gaseous effluents will conform to RG 4.15, Revision 2 (see Appendix 1AA).

Add the following information at the end of DCD Subsection 11.5.4.

11.5.4.1 Effluent Sampling

STD COL 11.5-2 Effluent sampling of potential radioactive liquid and gaseous effluent paths is conducted on a periodic basis to verify effluent processing meets the discharge limits to offsite areas. The effluent sampling program provides the information for the effluent measuring and reporting required by 10 CFR 50.36a and 10 CFR Part 20 and implemented through the Offsite Dose Calculation Manual (ODCM) and plant procedures. The frequency of the periodic sampling and analyses described herein are nominal and may be increased as permitted by procedure. Tables 11.5-201 and 11.5-202 summarize the sample and analysis schedules and sensitivities, respectively. The information contained in Tables 11.5-201 and 11.5-202 are derived from Regulatory Guide 1.21.

Laboratory isotopic analyses are performed on continuous and batch effluent releases in accordance with the ODCM. Results of these analyses are compiled and appropriate portions are utilized to produce the Radioactive Effluent Release Report.

11.5.4.2 Representative Sampling

Representative samples are obtained from well-mixed stream of volumes of effluent liquid through the use of proper sampling equipment, proper location of sampling points, and the development and use of sampling procedures. The recommendations of ANSI N 42.18 (Reference 203) are considered for the selection of instrumentation specific to the continuous monitoring of radioactivity in liquid effluents.

Sampling of effluent liquids is consistent with guidance in Regulatory Guide 1.21. When practical, effluent releases are batch-controlled, and prior to sampling, large volumes of liquid waste are mixed, in as short a time span as practicable, so that solid particulates are uniformly distributed in the liquid volume. Sampling and analysis is performed, and release conditions set, before release. Sample points are located to minimize flow disturbance due to fittings and other characteristics of equipment and components. Sample lines are flushed consistent with plant procedures to remove sediment deposits.

Representative sampling of process effluents is attained through sample and monitor locations and methods and criteria detailed in plant procedures.

Composite sampling is employed to analyze for hard to measure radionuclides and to monitor effluent streams that normally are not expected to contain significant amounts of radioactive contamination. Composite liquid samples are collected in proportion to the volume of each batch of effluent release. The composite is thoroughly mixed prior to analysis. Collection periods for composites are as short as practicable and periodic checks are performed to identify changes in composite samples. When grab samples are collected instead of composite samples, the time of the sample, location, and frequency are considered to provide a representative sample of the radioactive materials.

The pressure head of the fluid, if available, is used for taking samples. If sufficient pressure head is not available to take samples, then sample pumps are used to draw the sample from the process fluid to the detector panels and back to the process.

Testing and obtaining representative samples using the radiation monitors described in DCD Subsection 11.5 will be performed in accordance with ANSI N13.1 (Reference 201).

For obtaining representative samples in unfiltered ducts, isokinetic probes are tested and used as recommended by ANSI N13.1 (Reference 201).

Analytical Procedures

Typically, samples of process and effluent gases and liquids are analyzed in the station laboratory or by an outside laboratory via the following techniques:

- Gross alpha/beta counting
- Gamma spectrometry
- Liquid scintillation counting

"Available" instrumentation and counting techniques change as other instruments and techniques become available. For this reason, the frequency of sampling and the analysis of samples are generalized in this subsection.

Gross alpha/beta analysis may be performed directly on unprocessed samples (e.g., air filters) or on processed samples (e.g., evaporated liquid samples).

Sample volume, counting geometry, and counting time are chosen to match measurement capability with sample activity. Correction factors for sample detector geometry, self-absorption and counter resolving time are applied to provide the required accuracy.

Liquid effluent samples are prepared for alpha/beta counting by evaporation onto steel planchets. Gamma analysis may be done on any type of sample (gas, solid or liquid) in a gamma spectrometer.

Tritiated water vapor samples are collected by condensation or adsorption, and the resultant liquid is analyzed by liquid scintillation counting techniques.

Radiochemical separations are used for the routine analysis of Sr-89 and Sr-90.

Liquid samples are collected in polyethylene bottles to minimize absorption of nuclides onto container walls.

11.5.6.5 Quality Assurance

Add the following information at the end of DCD Subsection 11.5.6.5.

PTN COL 11.5-2 The sampling program and the associated monitors conform to RG 4.15, Revision 2 (see Appendix 1AA).

11.5.8 COMBINED LICENSE INFORMATION

STD COL 11.5-1 An Offsite Dose Calculation Manual (ODCM) is developed and implemented in accordance with the recommendations and guidance of NEI 07-09A (Reference 202). The ODCM contains the methodology and parameters used for calculating doses resulting from liquid and gaseous effluents. The ODCM addresses operational setpoints, including planned discharge rates, for radiation monitors and monitoring programs (process and effluent monitoring and environmental monitoring) for the control and assessment of the release of radioactive material to the environment. The ODCM provides the limitations on operation of the radwaste systems, including functional capability of monitoring instruments, concentrations of effluents, sampling, analysis, 10 CFR Part 50, Appendix I dose and dose commitments, and reporting. The ODCM will be finalized prior to fuel load with site-specific information.

PTN SUP 11.5-2 The site-specific conditions addressed in the ODCM include information addressing the deep injection wells, describe methods that are used in controlling and monitoring discharges of liquid effluents via deep injection wells, and describe how water samples are collected and sampled from each dual zone monitoring well. Also addressed are well development and purging, containment and processing of purged well water, and sample processing including sample collection, sample preservation, and quality control.

STD COL 11.5-1 Table 13.4-201 provides milestones for ODCM implementation.

PTN COL 11.5-1 Formal administrative controls will be implemented by the licensees of Turkey Point Units 6 & 7 and Turkey Point Units 3 & 4 coordinating their direct radiation contributions and liquid and gaseous effluent release concentrations so that applicable site-allocated dose and dose rate limits (10 CFR 20 and 40 CFR 190) are not exceeded. These administrative controls will be incorporated into each licensee's procedures controlling direct radiation and effluent releases for normal operations and anticipated operational occurrences. The administrative controls and coordination process will be described in the ODCM.

STD COL 11.5-2 This COL Item is addressed in Subsections 11.5.2.4, 11.5.4.1, 11.5.4.2.

PTN COL 11.5-2 This COL Item is addressed in Subsections 11.5.1.2, 11.5.3, 11.5.4, and 11.5.6.5.

PTN COL 11.5-3 This COL Item is addressed in Subsection 11.2.3.5 and 11.3.3.2 for liquid and gaseous effluents, respectively.

Add the following subsection after DCD Subsection 11.5.8.

11.5.9 REFERENCES

201. American National Standards Institute, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, ANSI N13.1-1969.

202. Nuclear Energy Institute, *Generic FSAR Template Guidance for Offsite Dose Calculation Manual (ODCM) Program Description*, NEI 07-09A, Rev. 0, NRC ADAMS Accession No. ML091050234, March 2009.

203. American National Standards Institute, *Specification and Performance of On-Site Instrumentation for Continuous Monitoring Radioactivity in Effluents*, ANSI N42.18-2004.

STD COL 11.5-2

Table 11.5-201
Minimum Sampling Frequency

Stream	Sampled Medium	Frequency
Gaseous	Continuous Release	A sample is taken within one month of initial criticality, and at least weekly thereafter to determine the identity and quantity for principal nuclides being released. A similar analysis of samples is performed following each refueling, process change, or other occurrence that could alter the mixture of radionuclides.
		When continuous monitoring shows an unexplained variance from an established norm.
		Monthly for tritium.
	Batch Release	Prior to release to determine the identity and quantity of the principal radionuclides (including tritium).
	Filters (particulates)	Weekly.
		Quarterly for Sr-89 and Sr-90.
		Monthly for gross alpha.
Liquid	Continuous Releases	Weekly for principal gamma-emitting radionuclides.
		Monthly, a composite sample for tritium and gross alpha.
		Monthly, a representative sample for dissolved and entrained fission and activation gases.
		Quarterly, a composite sample for Sr-89, Sr-90, and Fe-55.
	Batch Releases	Prior to release for principal gamma-emitting radionuclides.
		Monthly, a composite sample for tritium and gross alpha.
		Monthly, a representative sample from at least one representative batch for dissolved and entrained fission and activation gases.
		Quarterly, a composite sample for Sr-89, Sr-90 and Fe-55.

STD COL 11.5-2

Table 11.5-202
Minimum Sensitivities

Stream	Nuclide	Sensitivity
Gaseous	Fission & Activation Gases	1.0E-04 μCi/cc
	Tritium	1.0E-06 μCi/cc
	Iodines & Particulates	Sufficient to permit measurement of a small fraction of the activity that would result in annual exposures of 15 mrem to thyroid for iodines, and 15 mrem to any organ for particulates, to an individual in an unrestricted area.
	Gross Radioactivity	Sufficient to permit measurement of a small fraction of the activity that would result in annual air dose of 1) 10 mrad due to gamma, and 2) 20 mrad of beta at any location near ground level at or beyond the site boundary.
Liquid	Gross Radioactivity	1.0E-07 μCi/ml
	Gamma-emitters	5.0E-07 μCi/ml
	Dissolved & Entrained Gases	1.0E-05 μCi/ml
	Gross Alpha	1.0E-07 μCi/ml
	Tritium	1.0E-05 μCi/ml
	Sr-89 & Sr-90	5.0E-08 μCi/ml
	Fe-55	1.0E-06 μCi/ml