ASSOCIATED COLA REVISIONS:

Replace the entire FSAR Subsection 11.2.3.5 with the following text.

Replace the information in DCD Subsection 11.2.3.5 with the following paragraphs and subsections (LMA 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 prior to 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 coupled 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 Regulatory Guide (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 would require 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 has been 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, has identified 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 have been 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 has been 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 has first been 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 upon 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 Section 11.2.3.5.2.5.1 below, the injectate plume is not projected to reach the receptor location until about 10 years after initiation of injection (for the base case simulation). These four radionuclides are, therefore, retained for further fate and 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

<u>Numerical Model Description</u>

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.

<u>Modeling Approach</u>

The DIS injection field is simulated utilizing 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.

<u>Model Domain, Parameters and Boundary Conditions</u>

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 upon 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 one-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 was 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 was 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 upon 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 members-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.

In order 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 11.2-11.2-201,11.2- 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 timeframe 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 depicted in Figure 11.2-211, are defined as follows:

<u>Plant Area</u> – 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.

<u>Property Area</u> – 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.

<u>Beyond Property Area</u> – This area includes the area beyond the Turkey Point Property Boundary. Members of the public and populations which 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 the a scenario will be retained for detailed liquid effluent pathway analysis or, alternatively, will be eliminated from further consideration. This screening analysis is described in the paragraphs below. Those scenarios which 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 Section 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

<u>Middle Confining Unit Failure.</u> 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 (bpl) to 3230 feet bpl of EW-1 was reviewed for evidence of a fracture(s) within the logged interval. Based on this data (Reference 214), no features were 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 will be 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 earth moving 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 have been 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 that no such failures system failures as injection well failure or subsurface loss of confinement occur 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 as 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 ground water 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 ground water 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 non-residential 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 utilized 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 meet the county's existing and future water supply needs. After 2013, Miami-Dade County will 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 impact the selection of members of the public/populations which 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 utilize 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; 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 proximate 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, in order 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:

- **<u>Credible</u> – Such a scenario may be expected to occur during the operational lifetime of the plant (or beyond).**
- **<u>Non-Credible</u> – 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 in the near proximity of 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, accessing 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 11.2-215), 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 of 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 then unknowing use of 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 11.2-215, 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 upon 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 required 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 above, these are the radionuclides which 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 at 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 upon 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, 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 1.0E-07 Ci/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:

$$C_{rec} = C_{inj}\, e^{-\lambda t}$$

$$t = [\ln(C_{inj}/C_{rec})][t_{1/2}/\ln(2)]$$

$$t = [\ln(1.0E05\ pCi/L/3.1E04\ pCi/L)][12.33/0.693]$$

$$t = 21\ \text{years}$$

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 which 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 which 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 and consumption 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).

In order 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. As 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 prior to 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)

Revise FSAR Subsection 11.2.6 as follows:

~~201. U.S. Environmental Protection Agency (EPA) 2003. *Relative RiskAssessment of Management Options for Treated Wastewater in SouthFlorida*. Office of Water, EPA 816-R-03-010, pp. 4-9. April 2003.~~

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224. U.S. Environmental Protection Agency, *External Exposure to Radionuclides in Air, Water and Soil*, Federal Guidance Report No. 12, EPA-402-R-93-081, September 1993.

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Add new tables to FSAR Section 11.2 as follows:

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

Notes:
(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)
Initial head in Boulder Zone	1.9 m (6.2 ft) NAVD 88

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%)

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

(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

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

Table 11.2-204 Cumulative Isotopic Inventory at the End of Plant Operations (Sheet 1 of 2)

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

Table 11.2-204 Cumulative Isotopic Inventory at the End of Plant Operations (Sheet 2 of 2)

Isotope	Release per Unit (Ci/yr)[a]	Subsurface Activity at 61 years (Ci)
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]

Notes:
(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 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
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 User	Water Source							
	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 usage (Florida Keys Aqueduct Authority) and irrigation usage (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

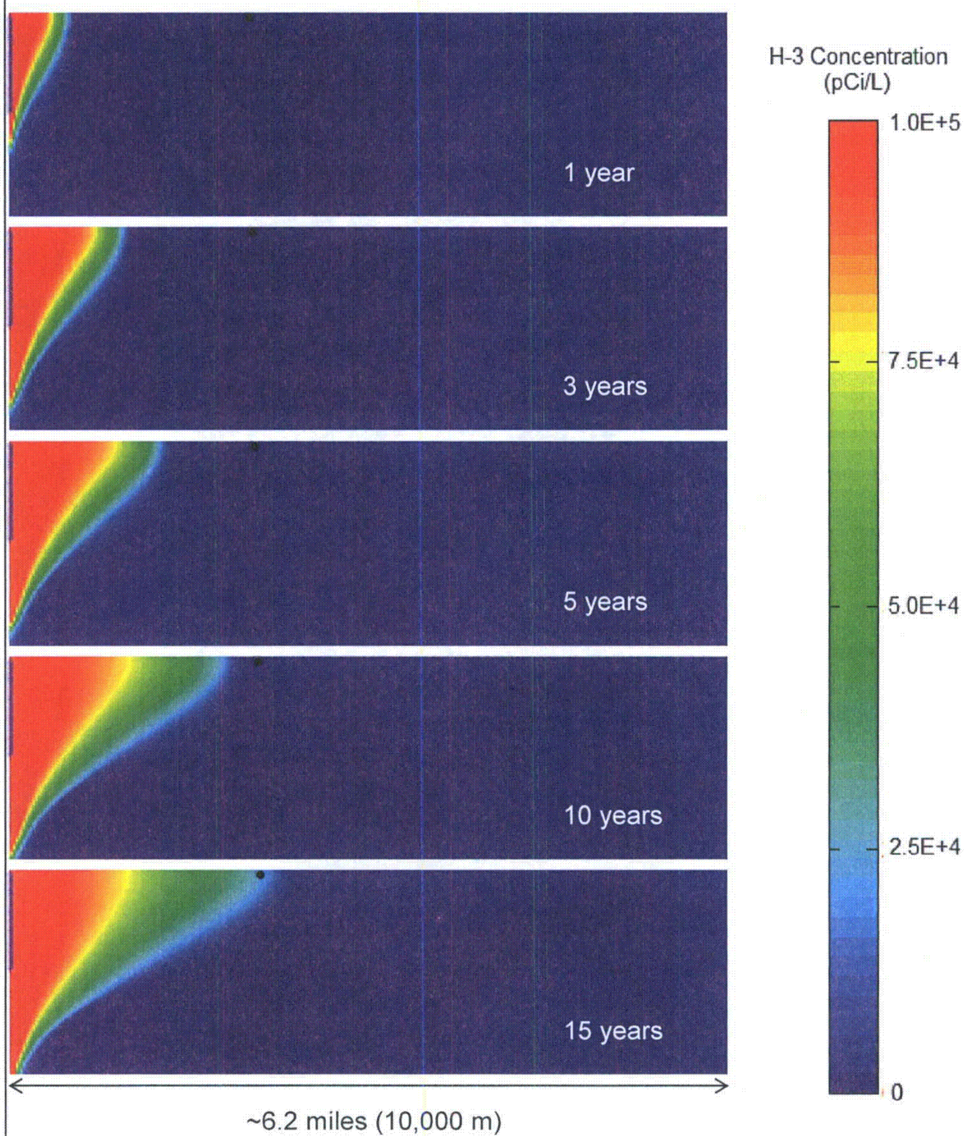
Pathway	Dose (mrem) per Unit	
	Total Body	Liver[(a)]
Annual Ingestion of Water and Irrigated Foods	2.7	3.8
Inhalation During Drilling	8.2E-02	8.3E-02
Air Immersion During Drilling	2.6E-06	2.6E-06
Deposition During Drilling	1.8E-05	0
Total	2.8	3.9
10 CFR Part 50, Appendix I Design Objectives	3	10

(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

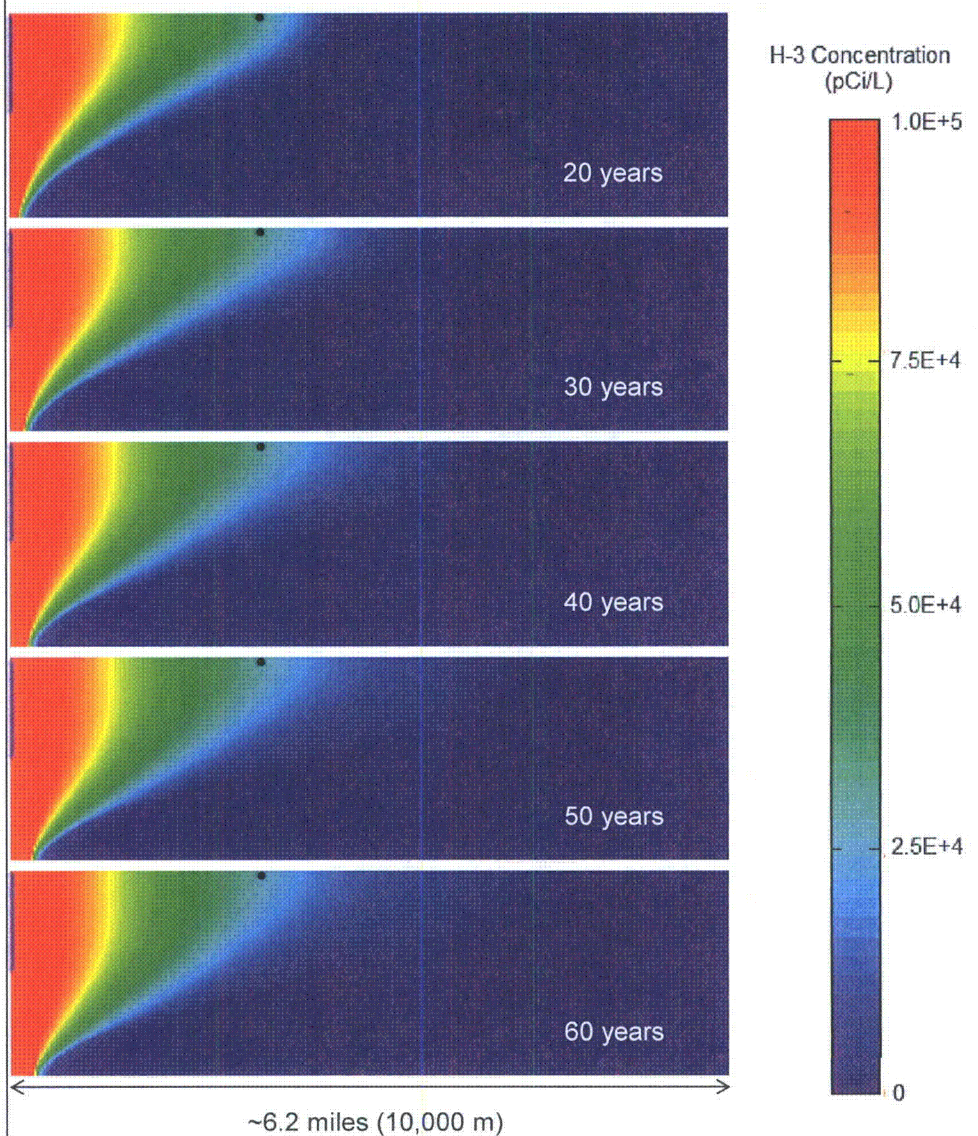
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 1 of 4)



● 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.

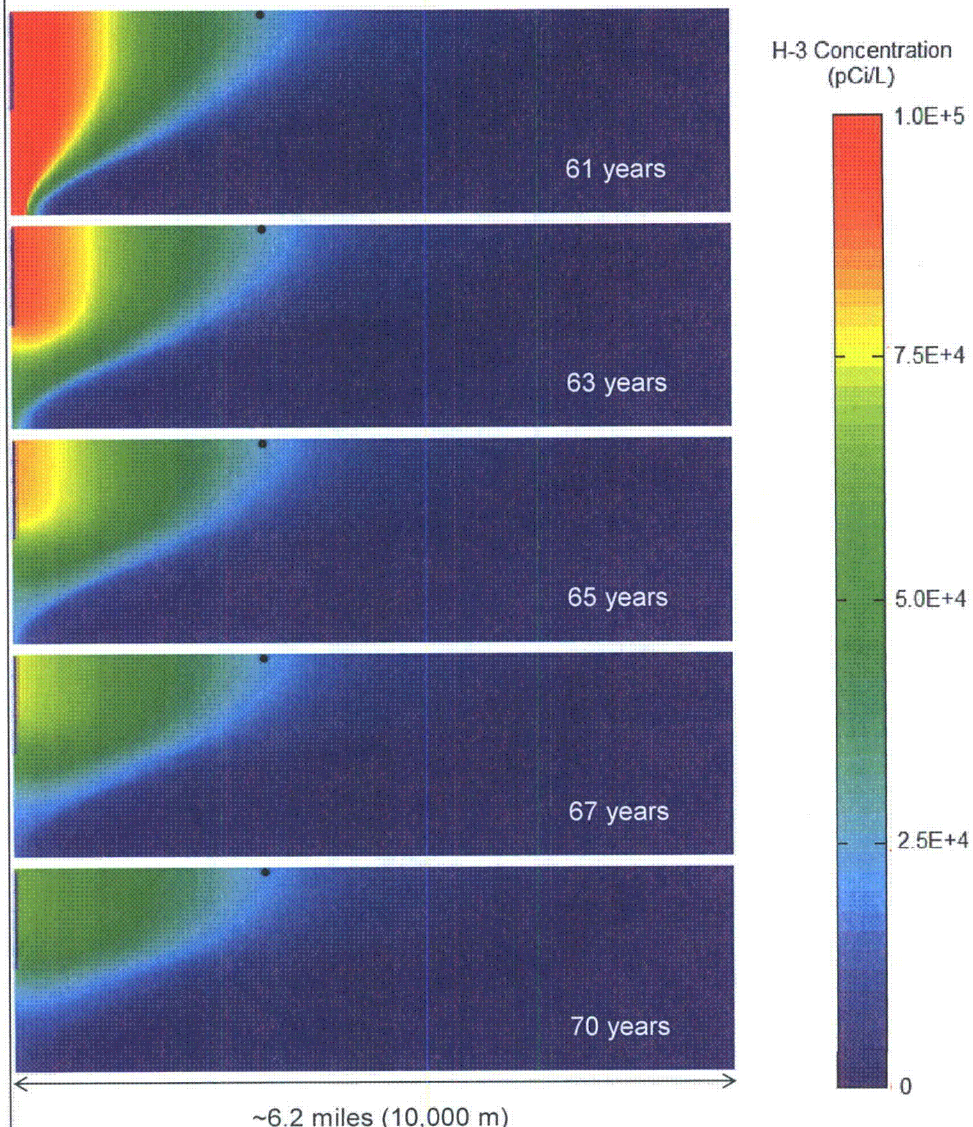
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 2 of 4)



● 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.

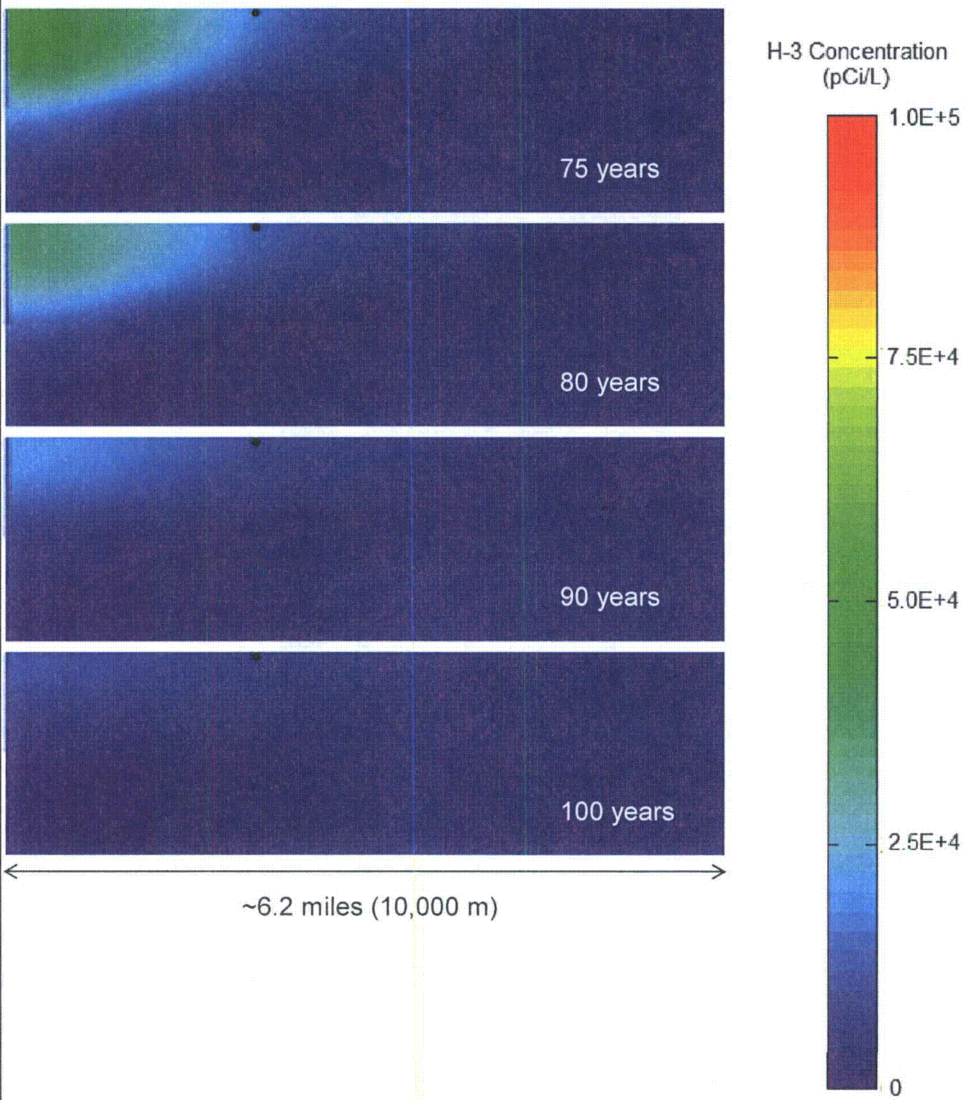
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 3 of 4)



- 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.

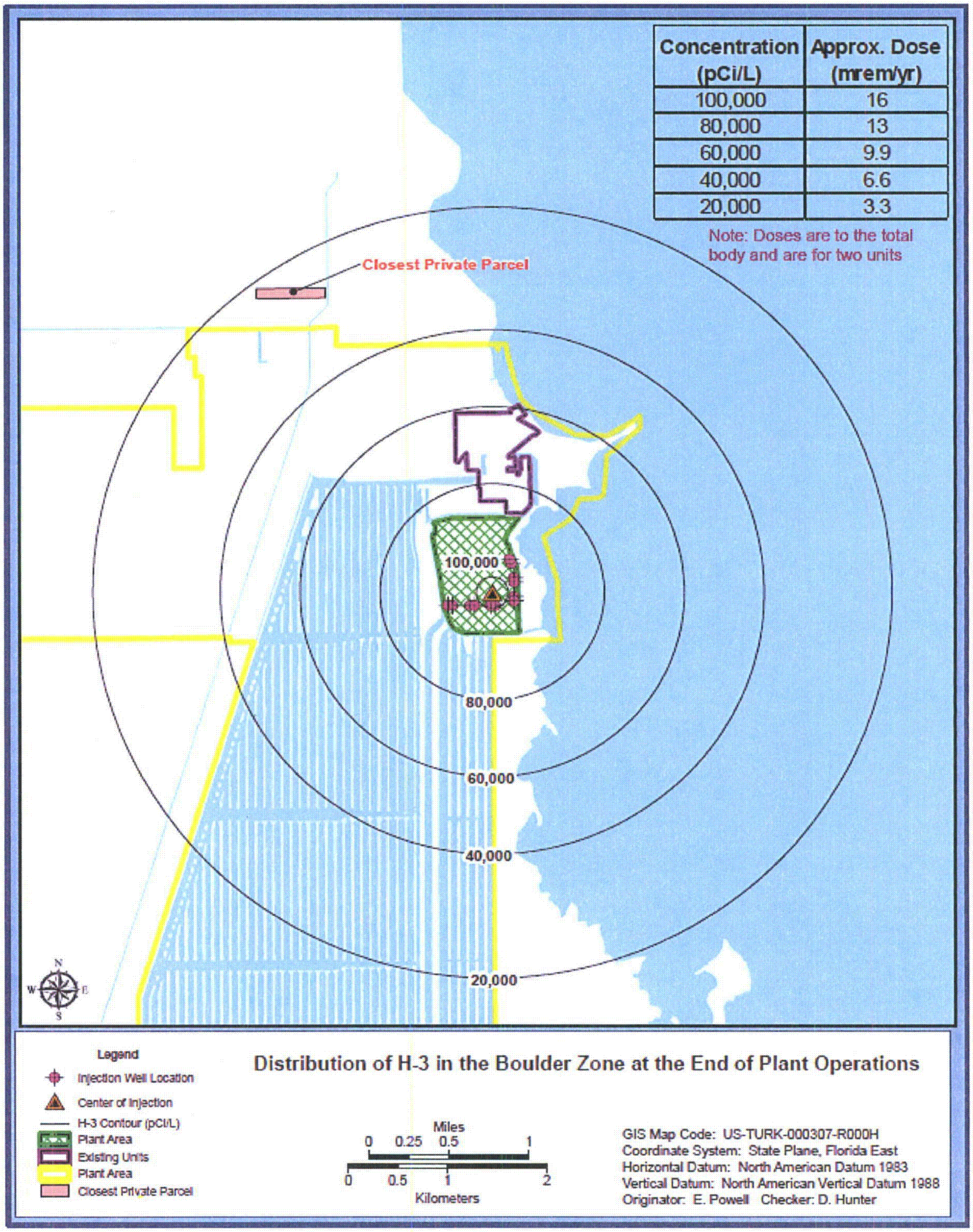
Figure 11.2-201 Base Case Boulder Zone Tritium Concentrations (Sheet 4 of 4)



● 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

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

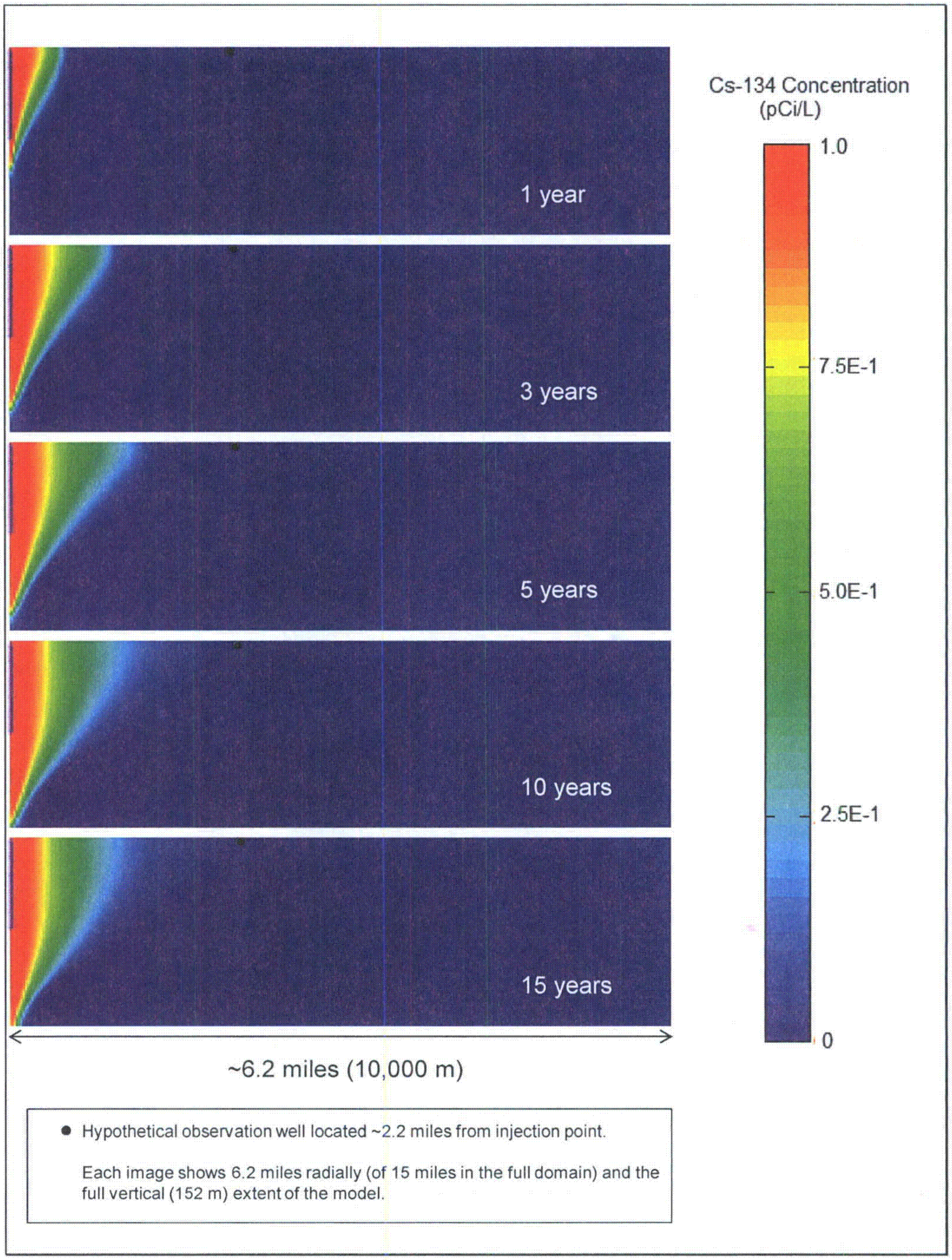


Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 2 of 4)

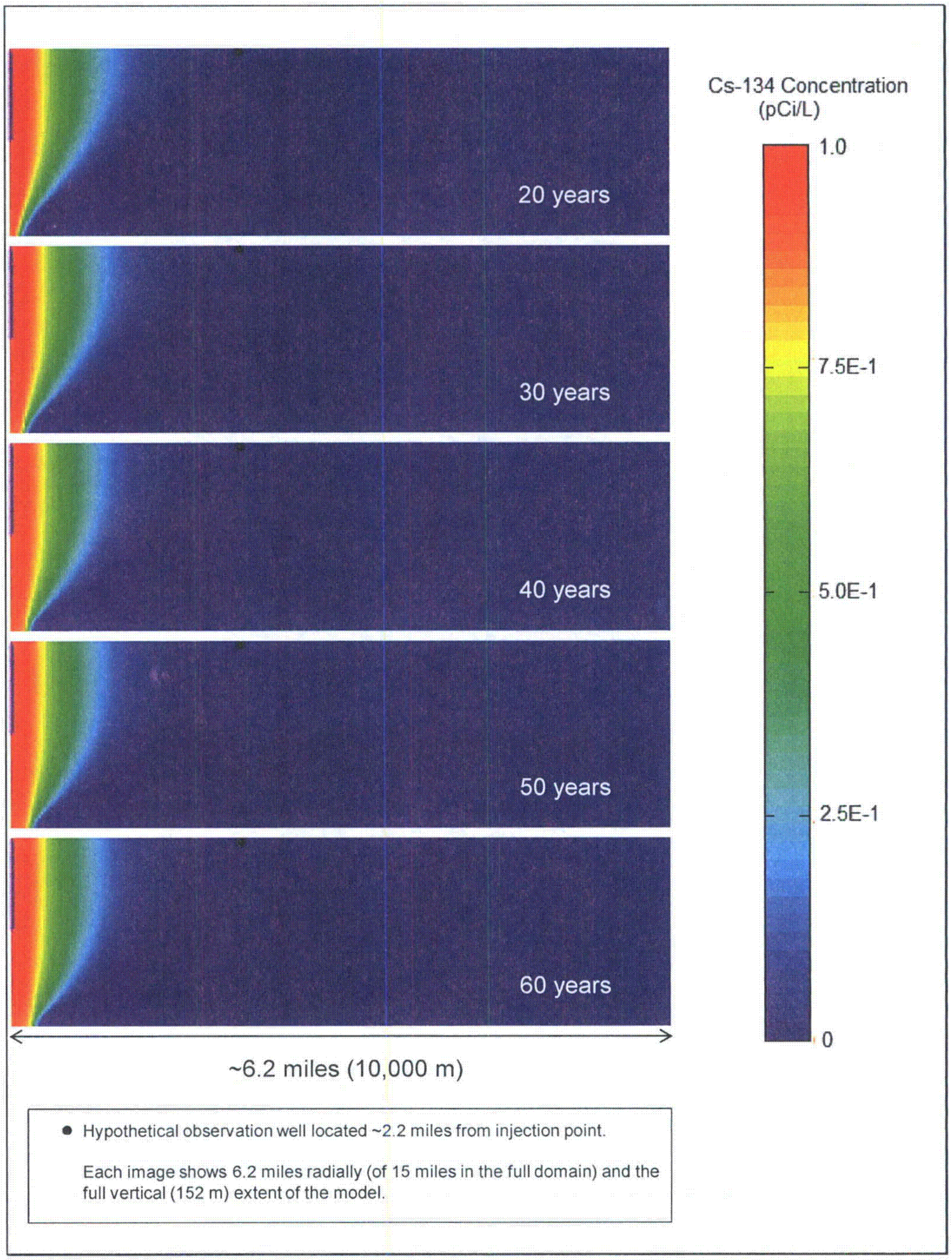
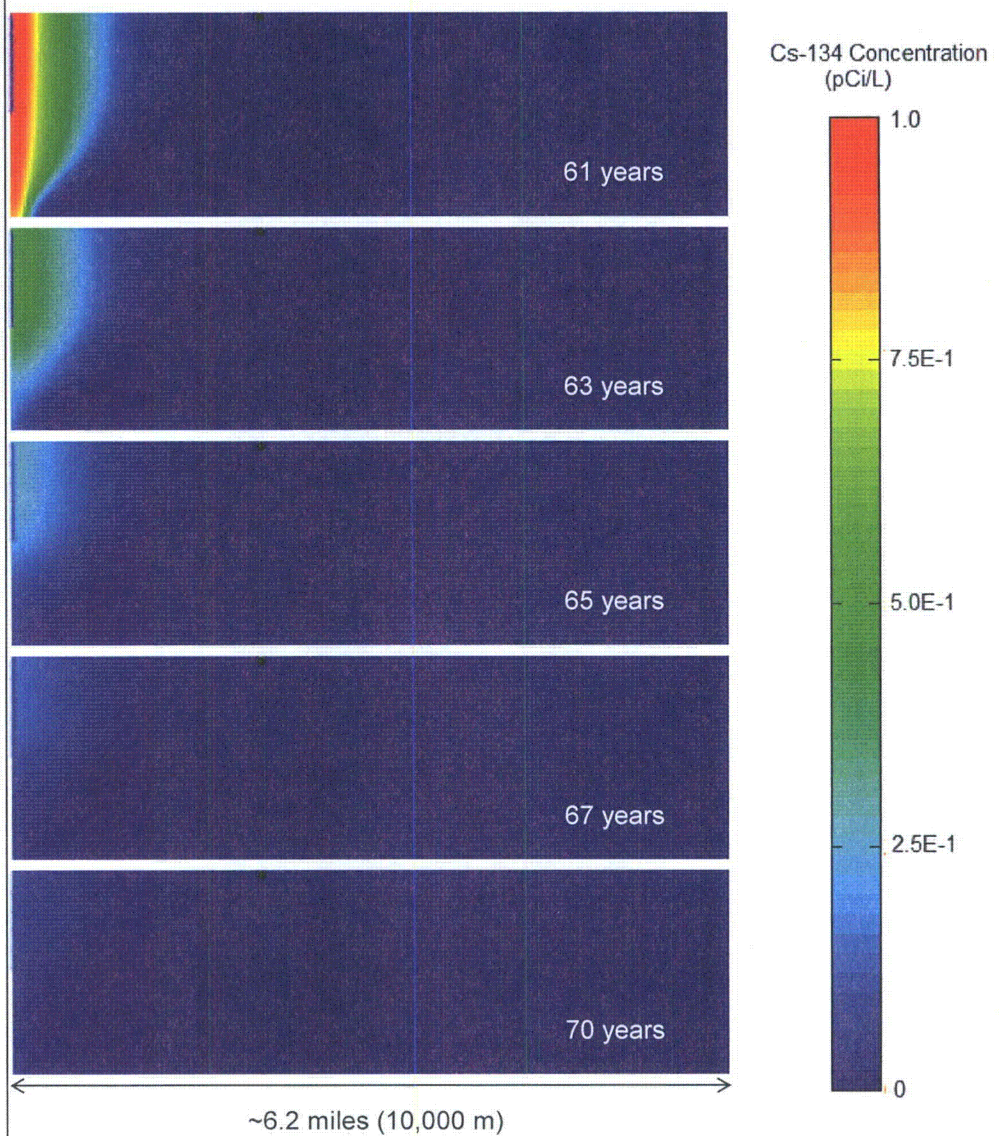


Figure 11.2-203 Base Case Boulder Zone Cesium-134 Concentrations (Sheet 3 of 4)



- 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)

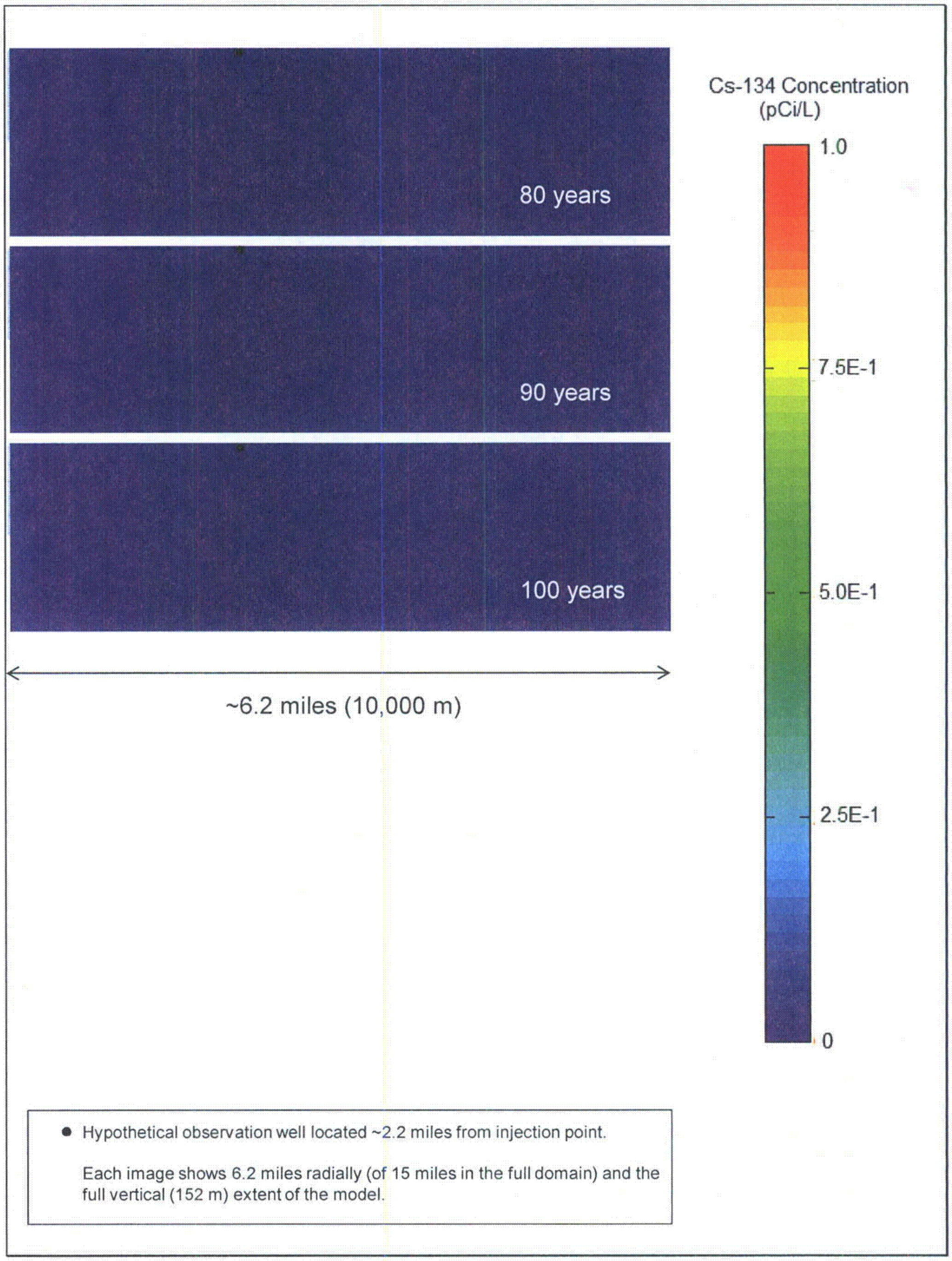


Figure 11.2-204 Model Layer 1 Distribution of Cesium-134 in the Boulder Zone for the Base Case Simulation at the End of Plant Operations

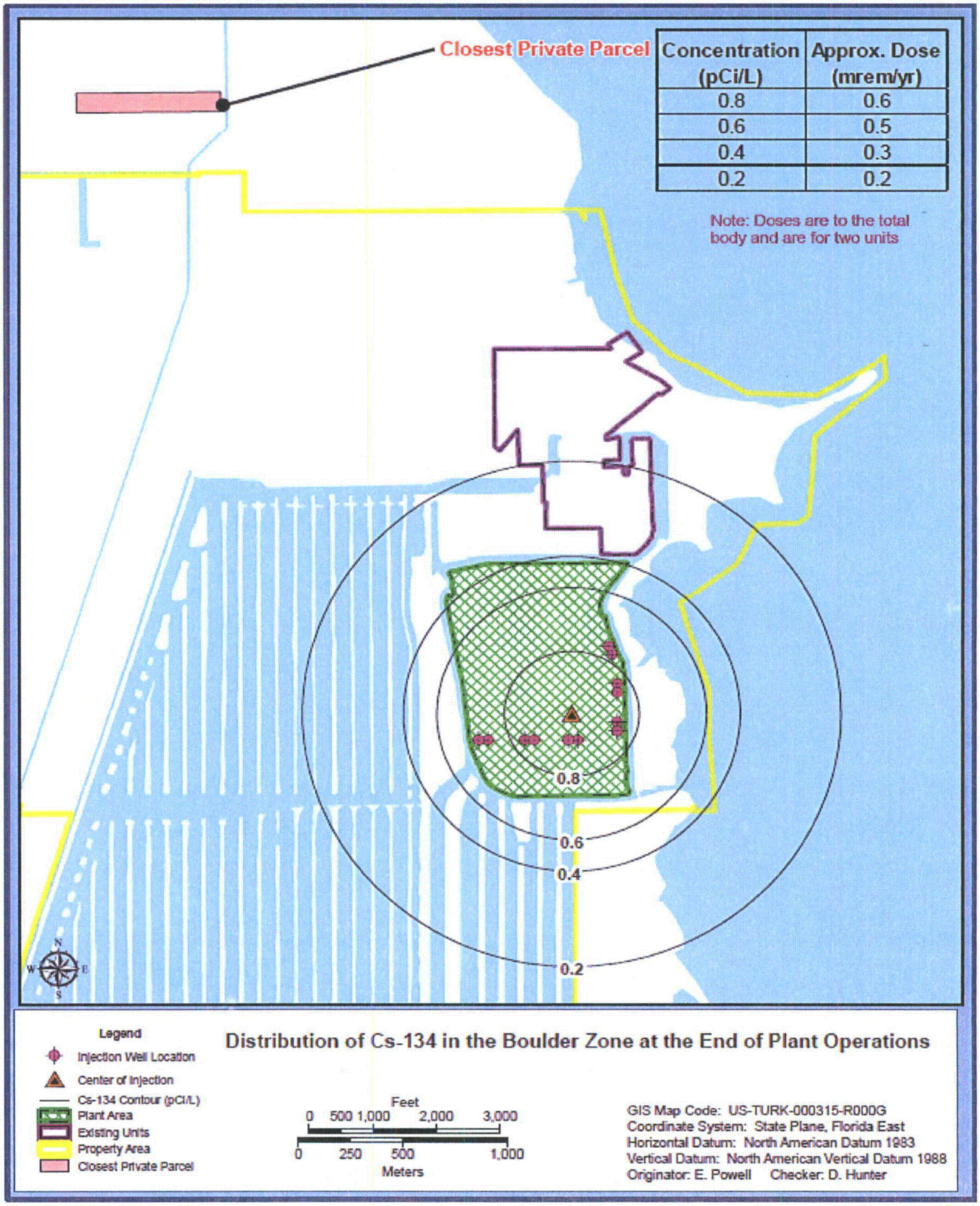


Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 1 of 4)

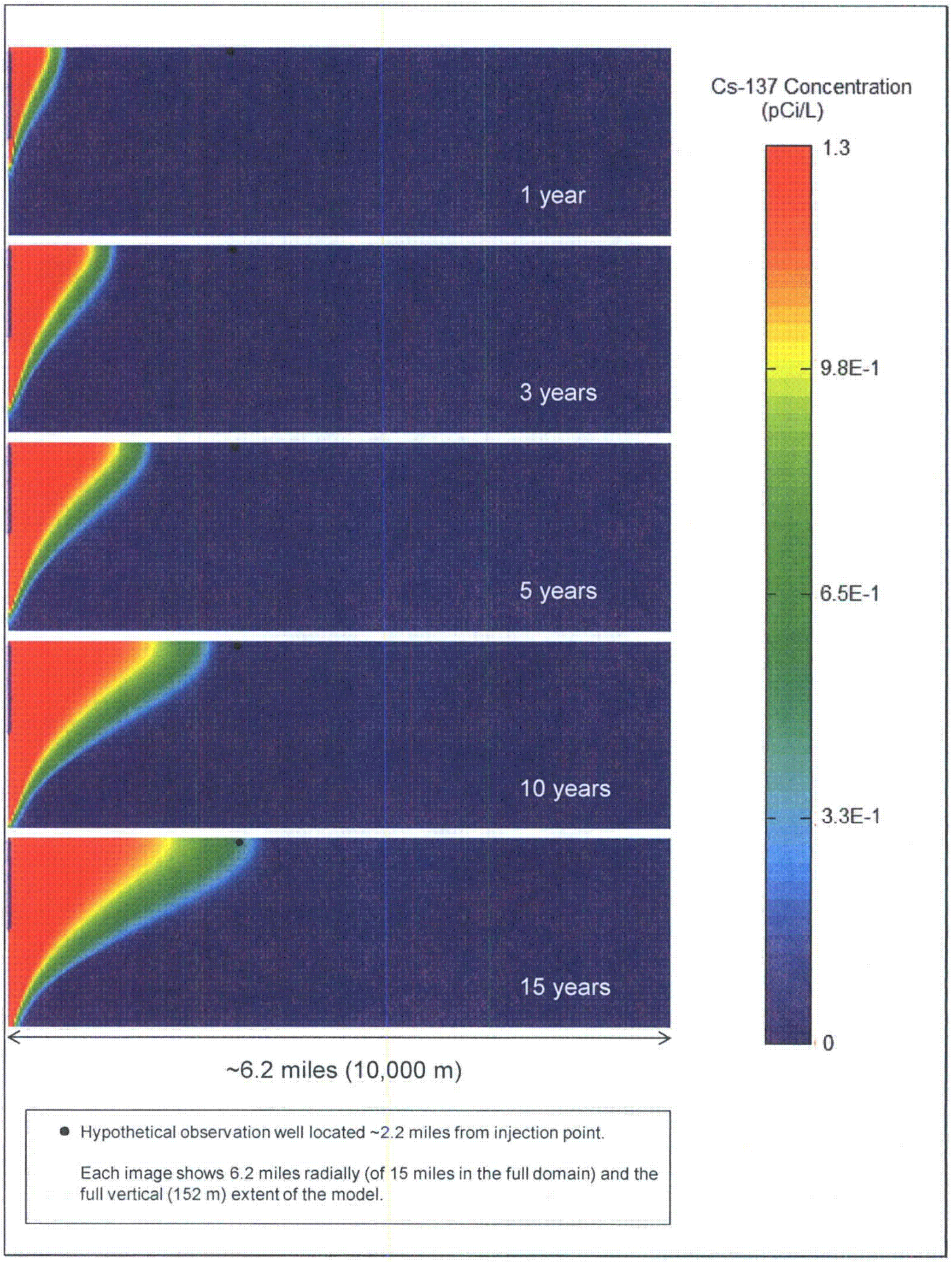


Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 2 of 4)

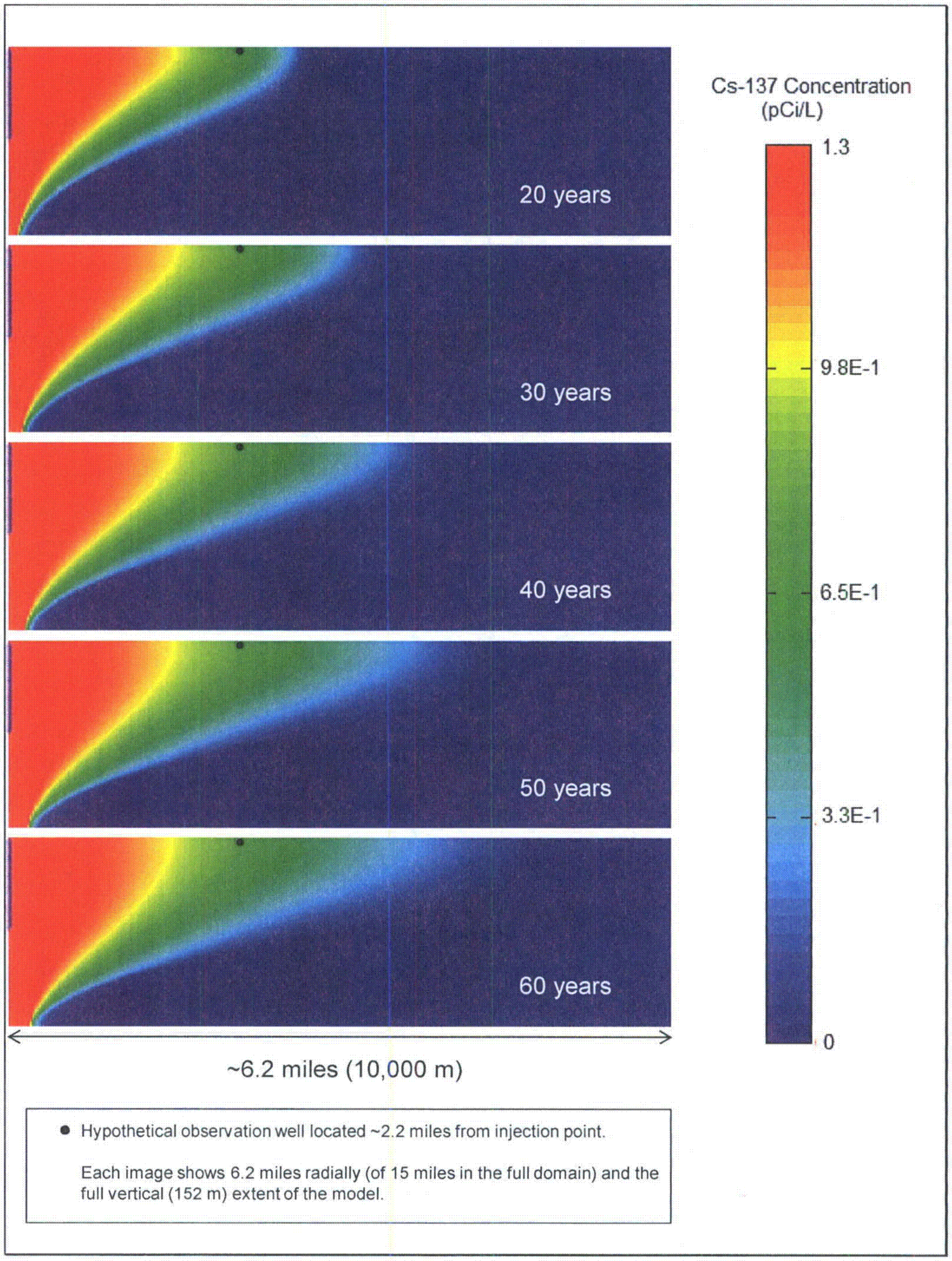
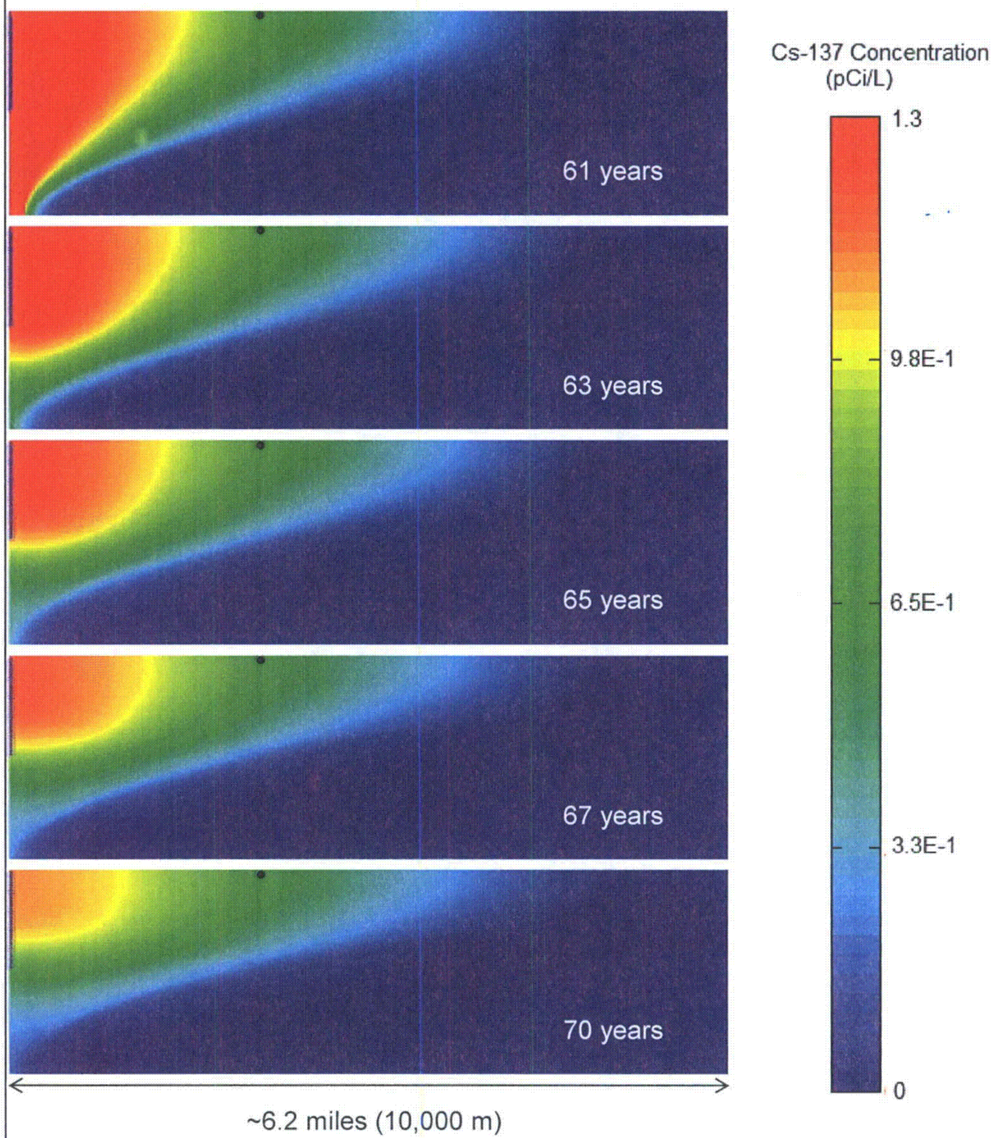


Figure 11.2-205 Base Case Boulder Zone Cesium-137 Concentrations (Sheet 3 of 4)



- 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)

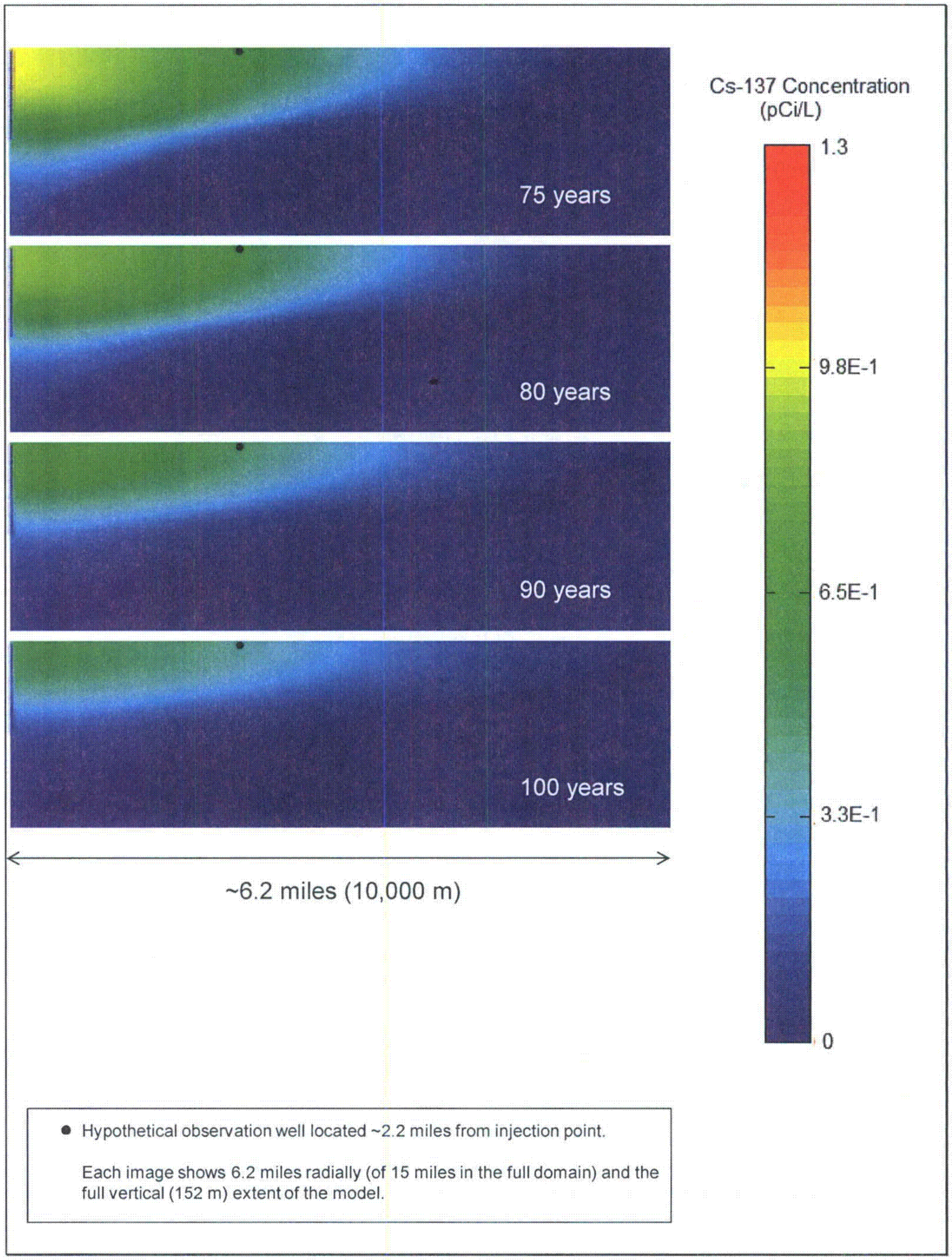


Figure 11.2-206 Model Layer 1 Distribution of Cesium-137 in the Boulder Zone for the Base Case Simulation at the End of Plant Operations

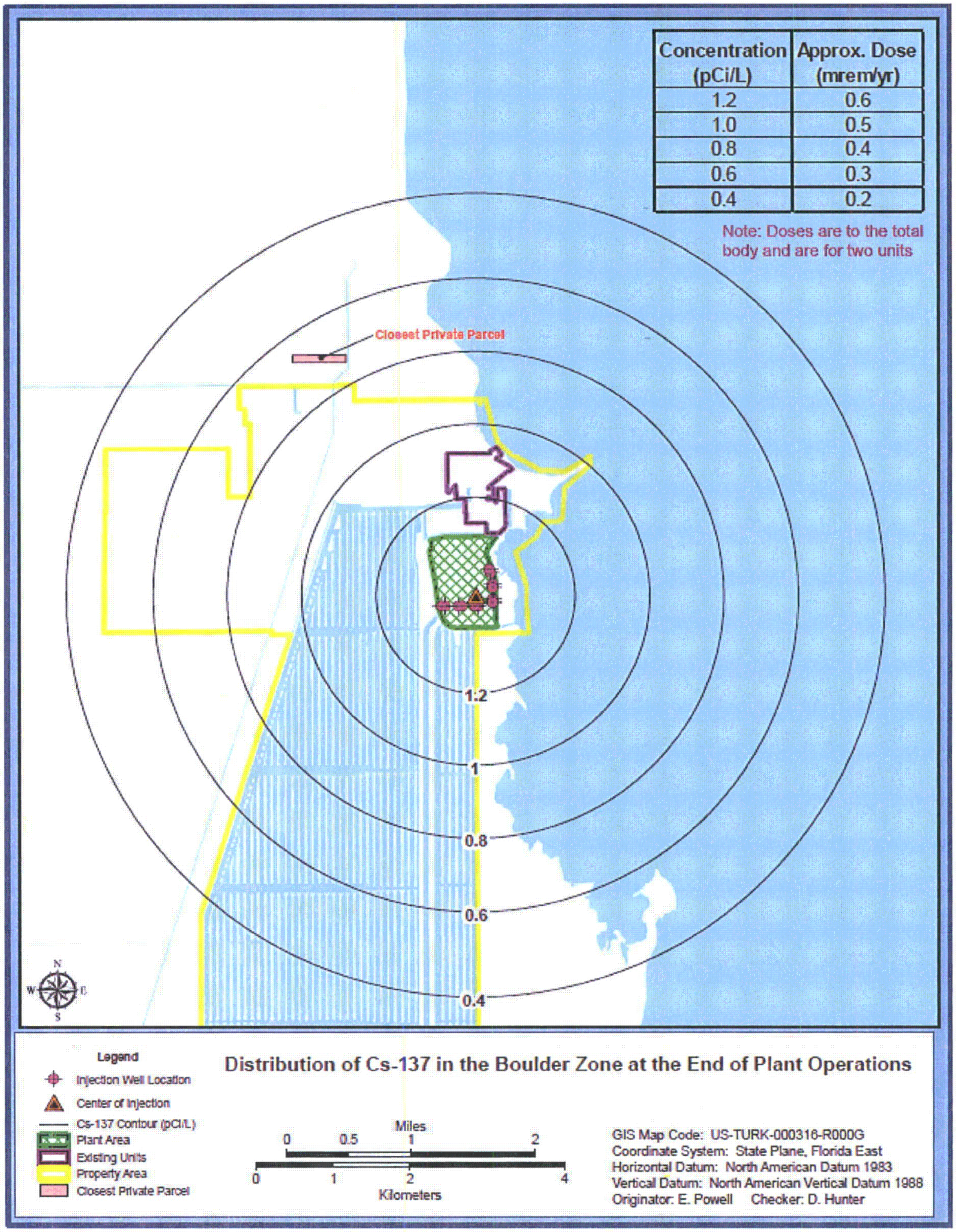
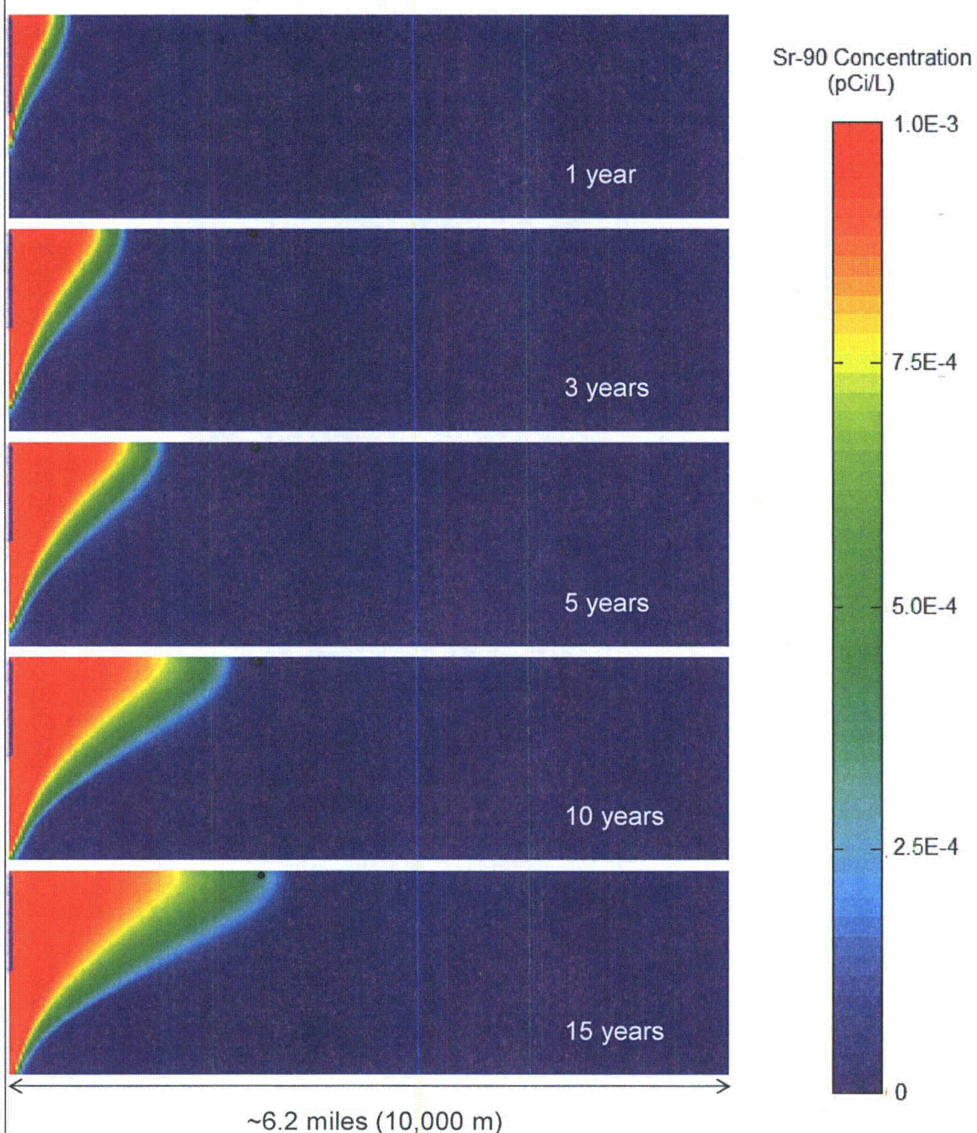


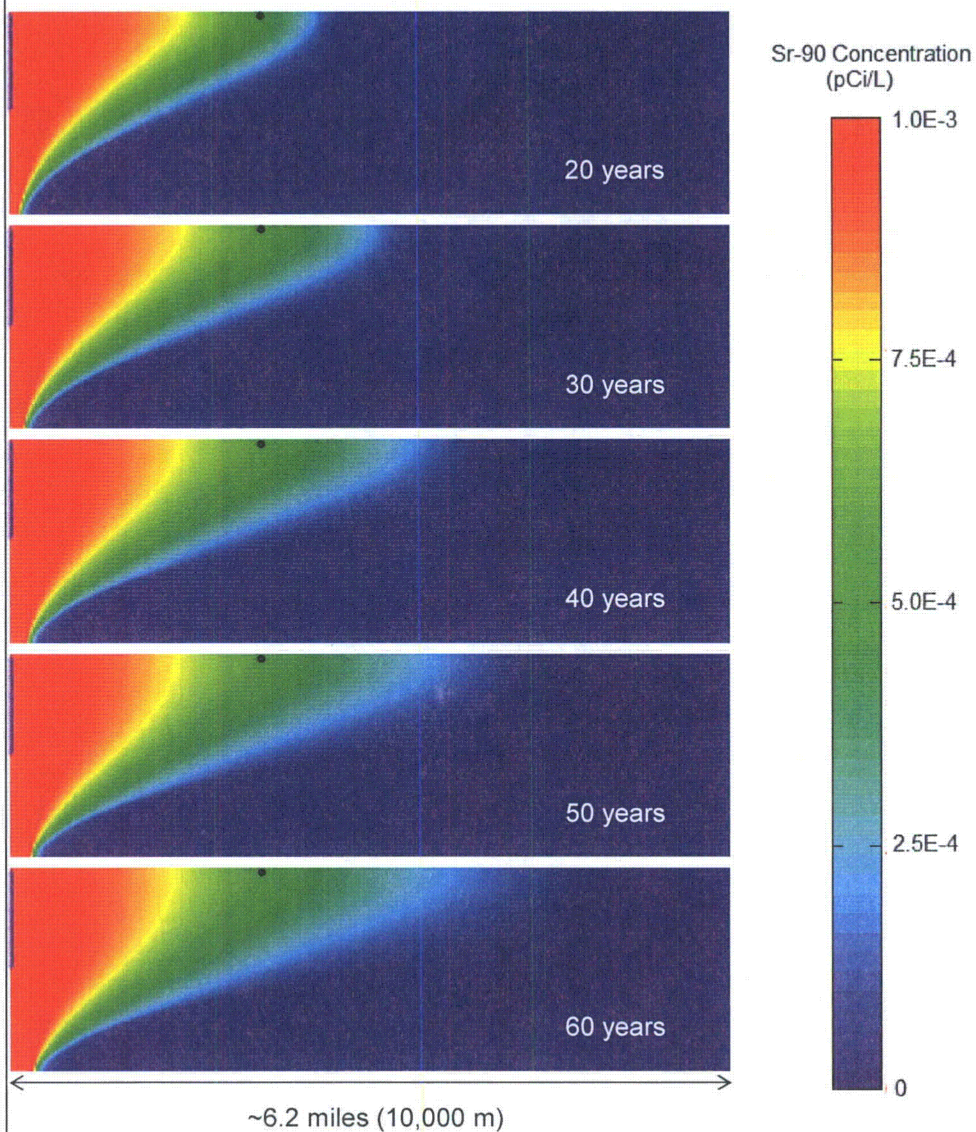
Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 1 of 4)



- 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)

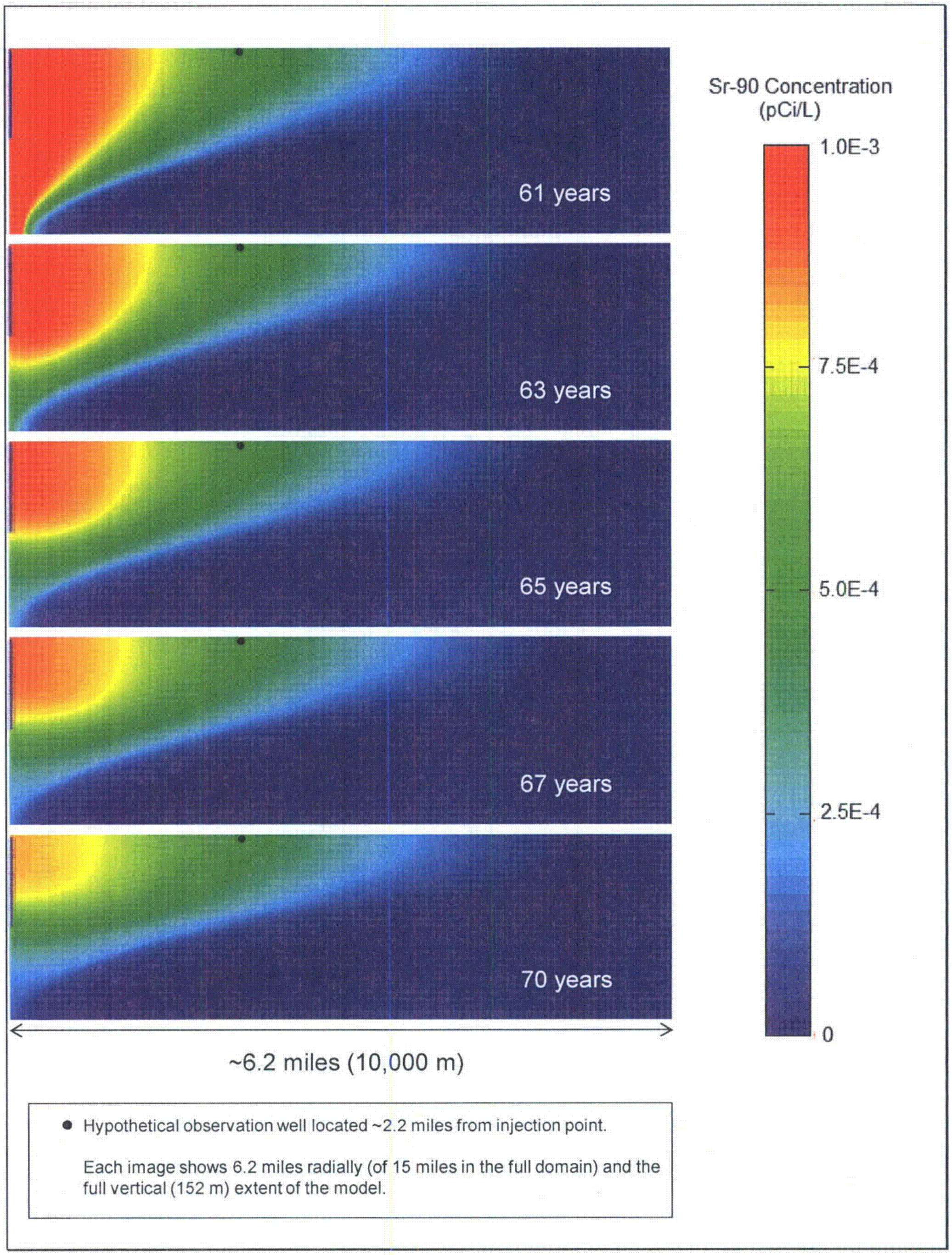


Figure 11.2-207 Base Case Boulder Zone Strontium-90 Concentrations (Sheet 4 of 4)

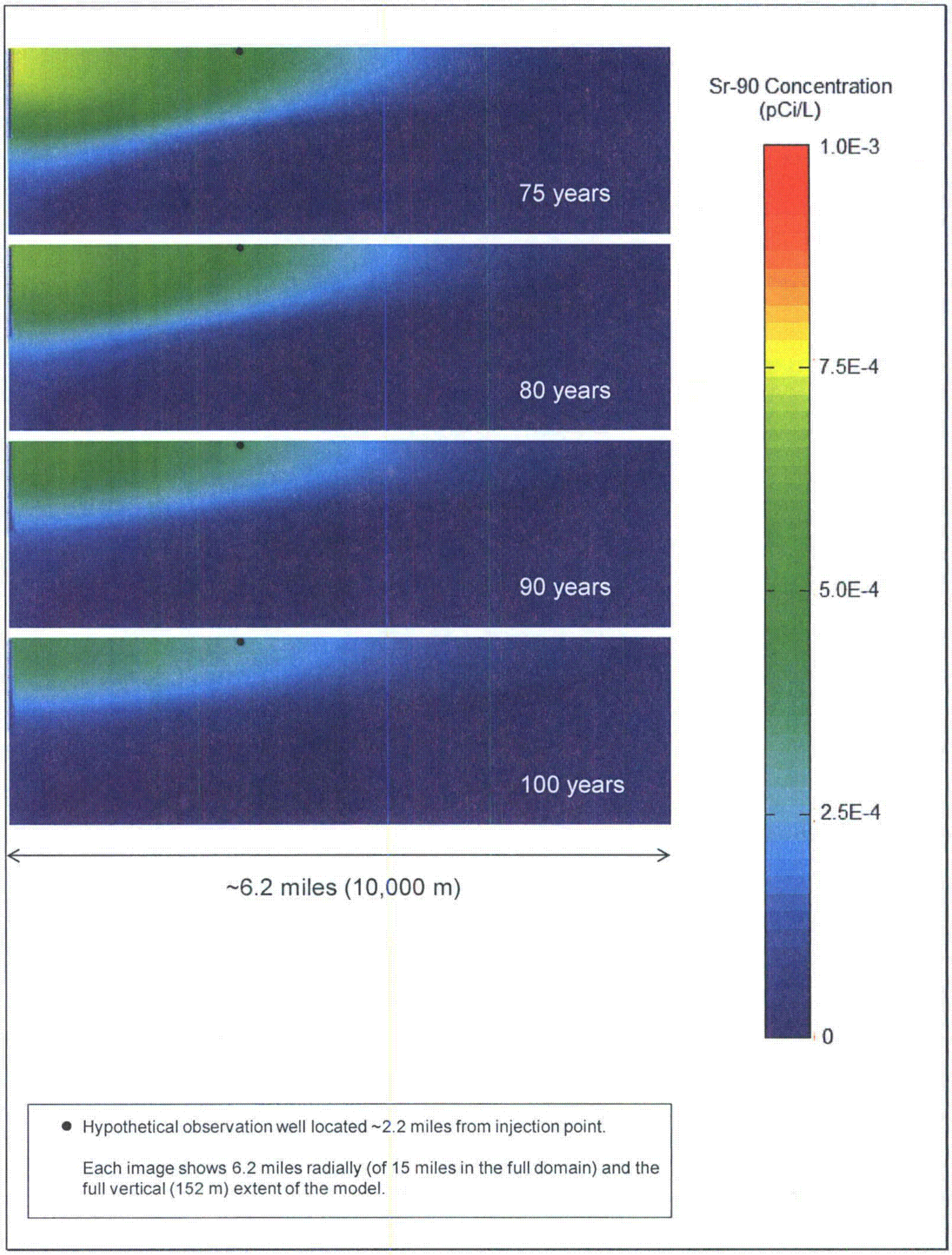


Figure 11.2-208 Model Layer 1 Distribution of Strontium-90 in the Boulder Zone for the Base Case Simulation at the End of Plant Operations

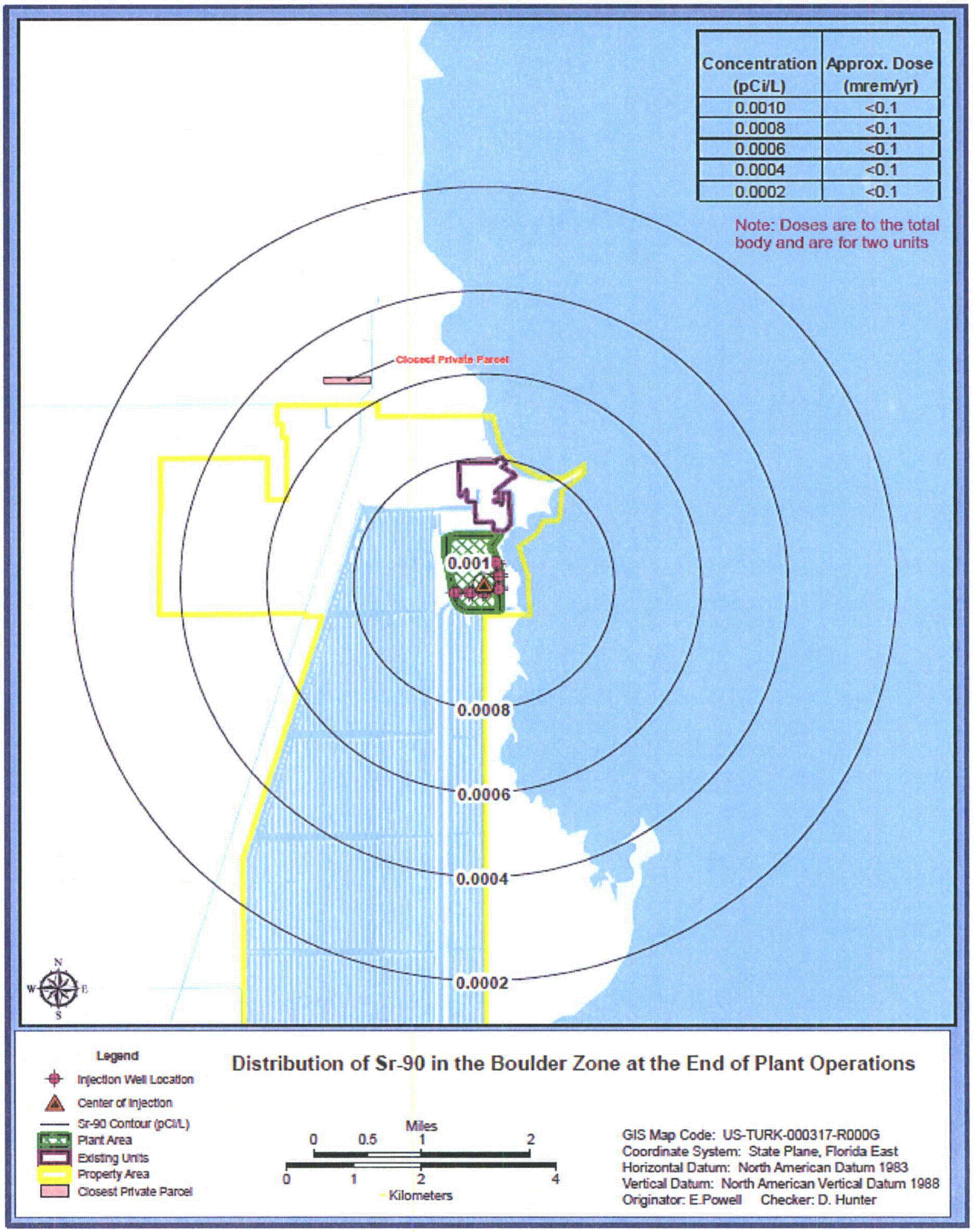


Figure 11.2-209 Model Layer 1 Base Case Relative Concentration Breakthrough Curves at 2.2 mile Receptor Location

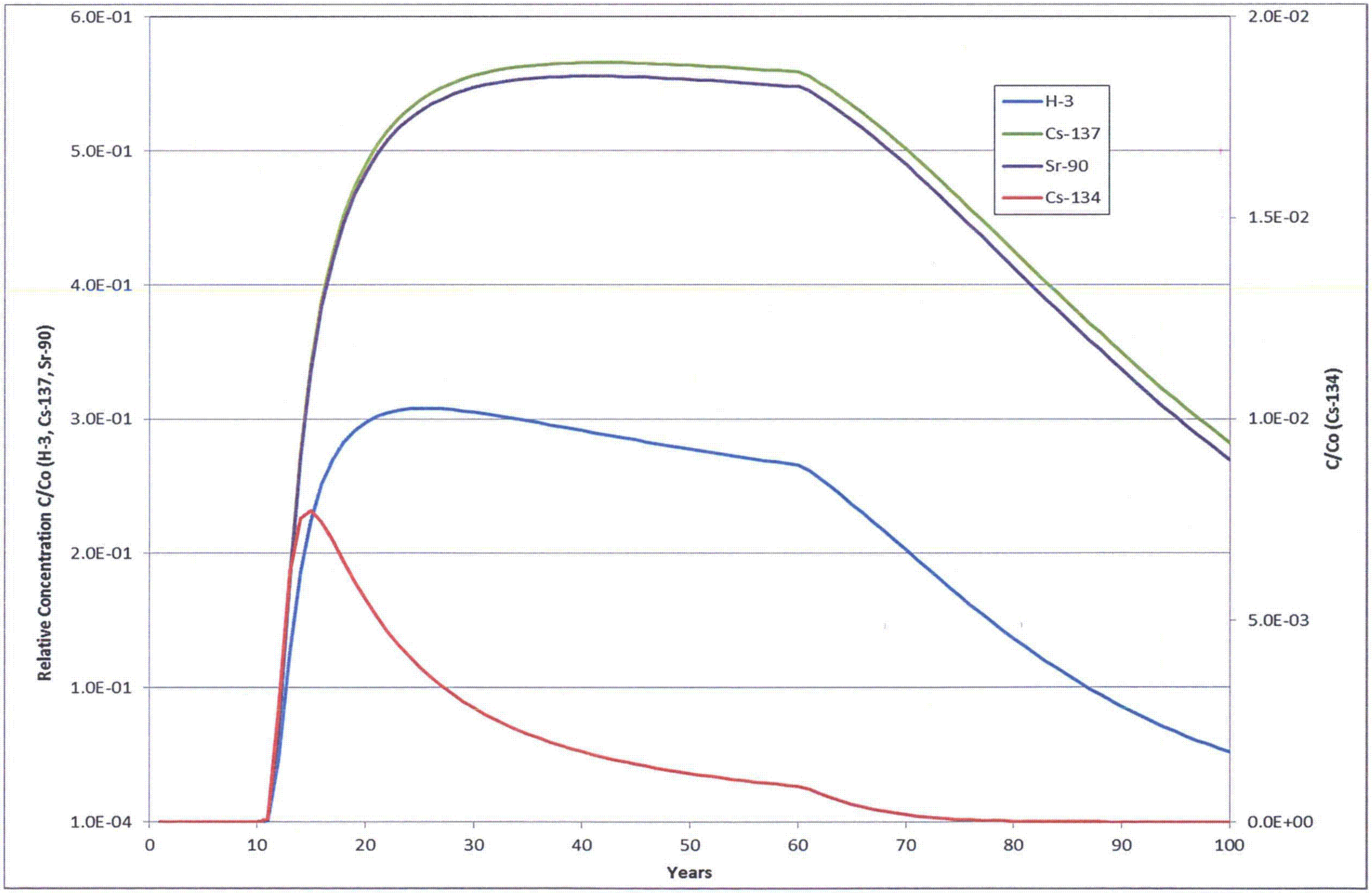


Figure 11.2-210 Six mrem Derived Tritium Activity Concentration Profiles in the Boulder Zone – Base Case Simulation

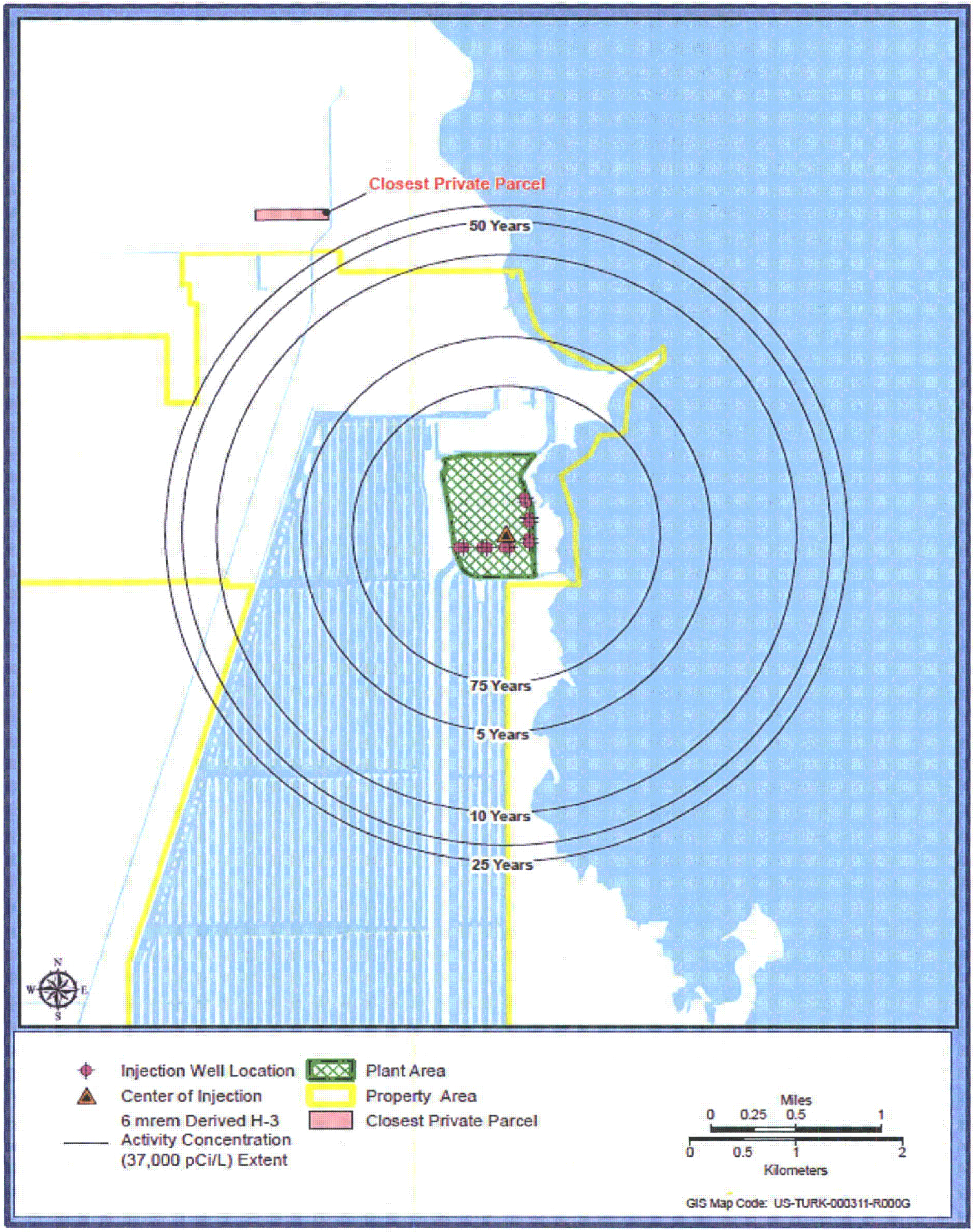


Figure 11.2-211 Potential Exposure Location Areas

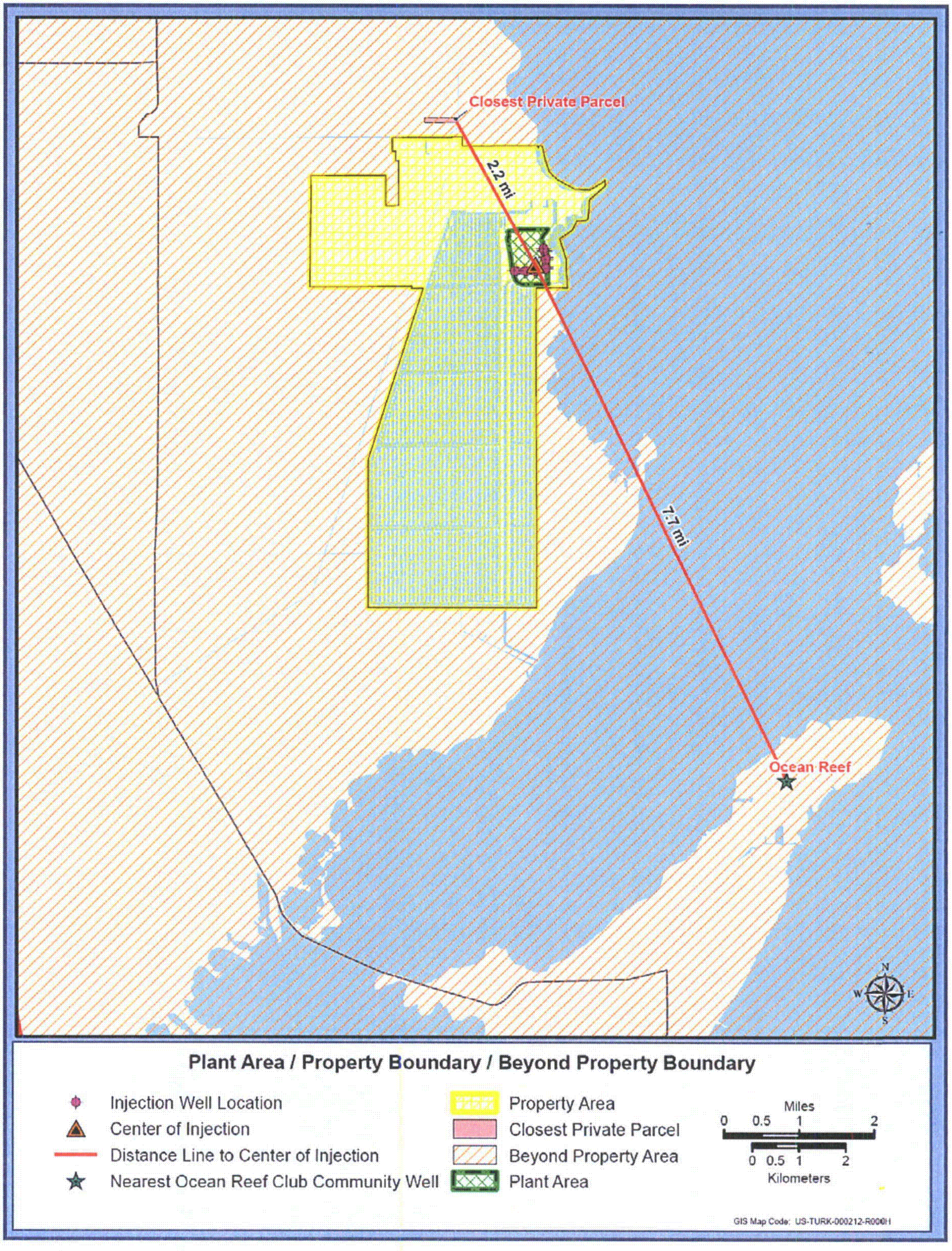
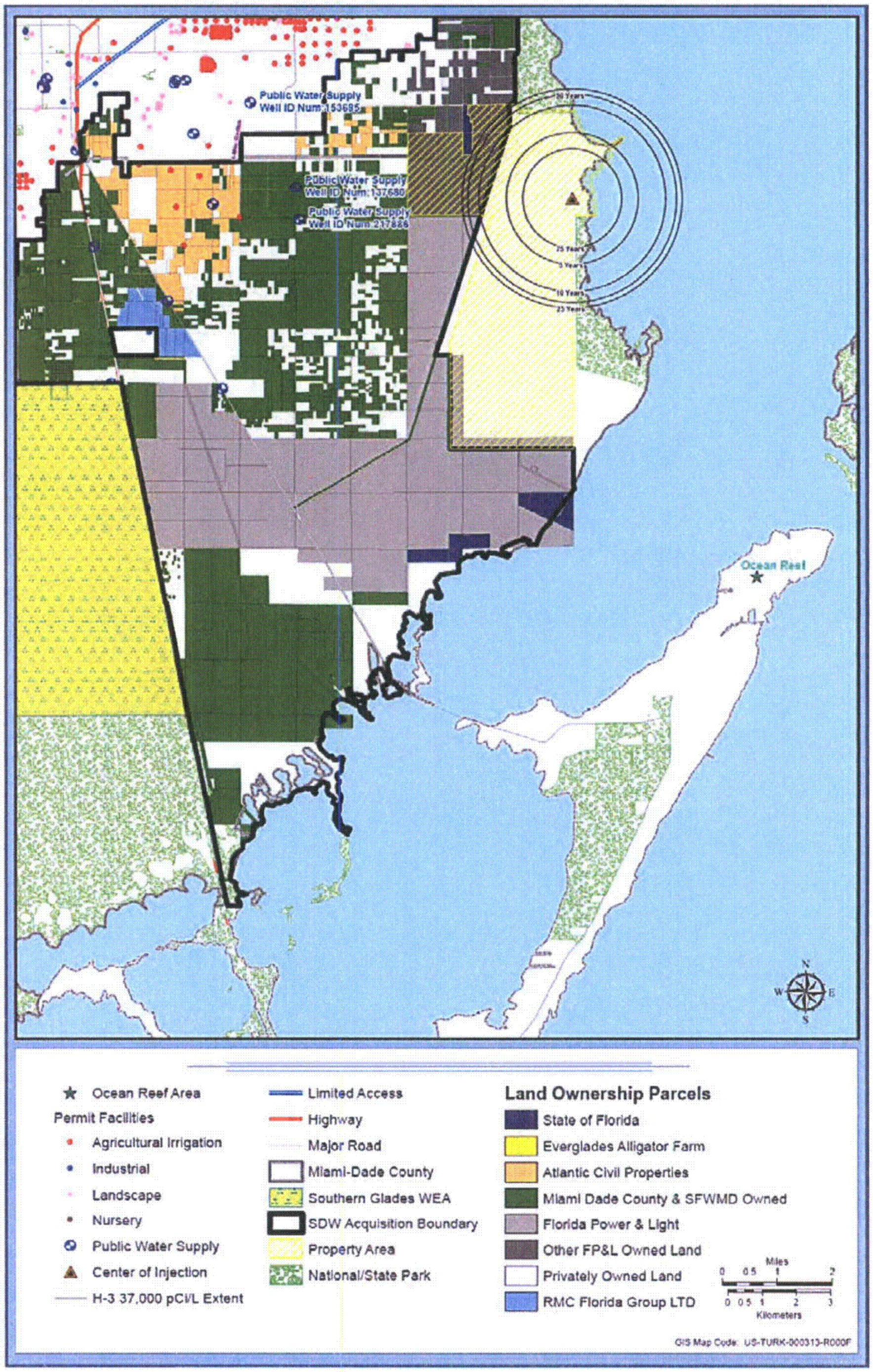
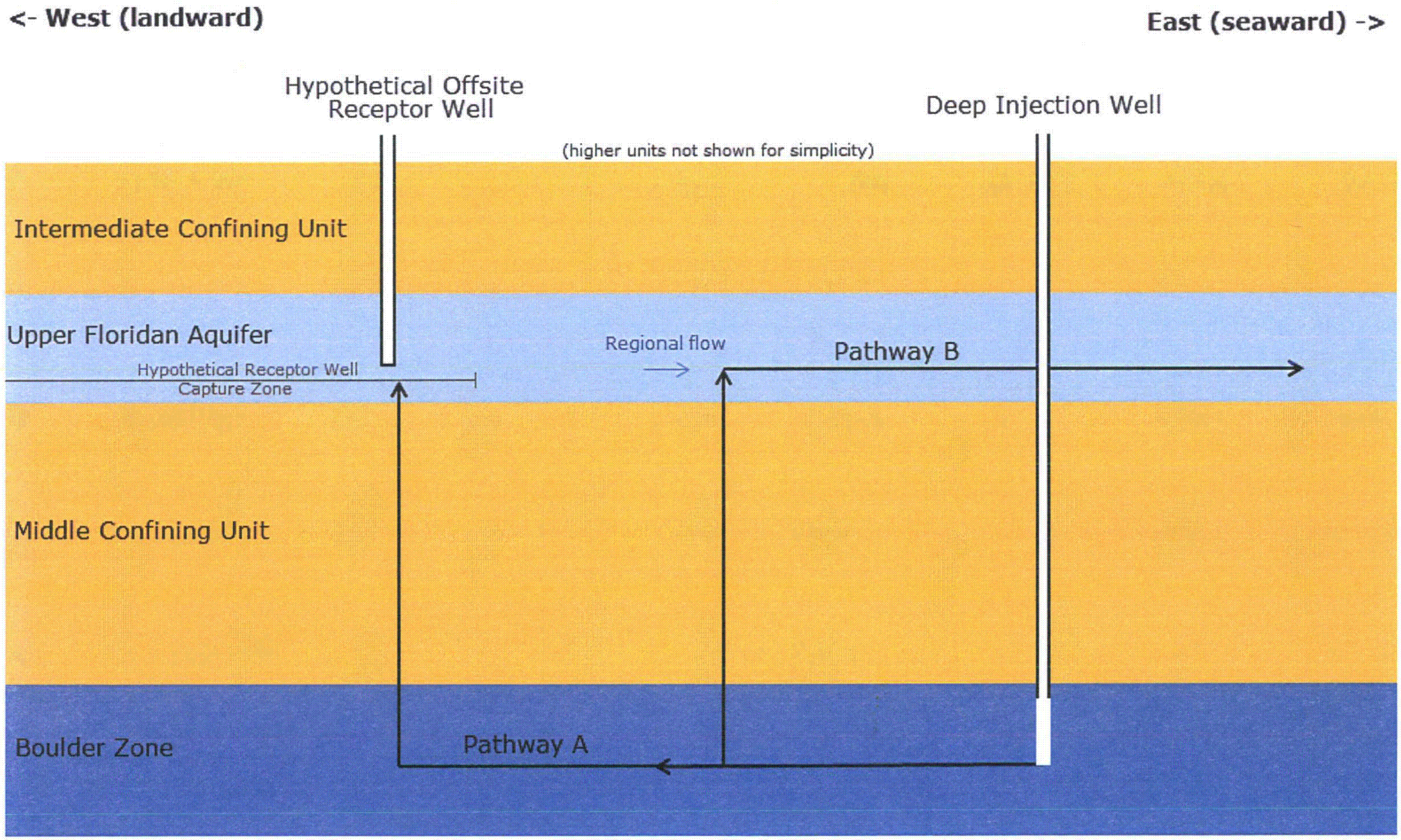


Figure 11.2-212 Land Ownership and Water Supply Well Locations in the Area of Turkey Point



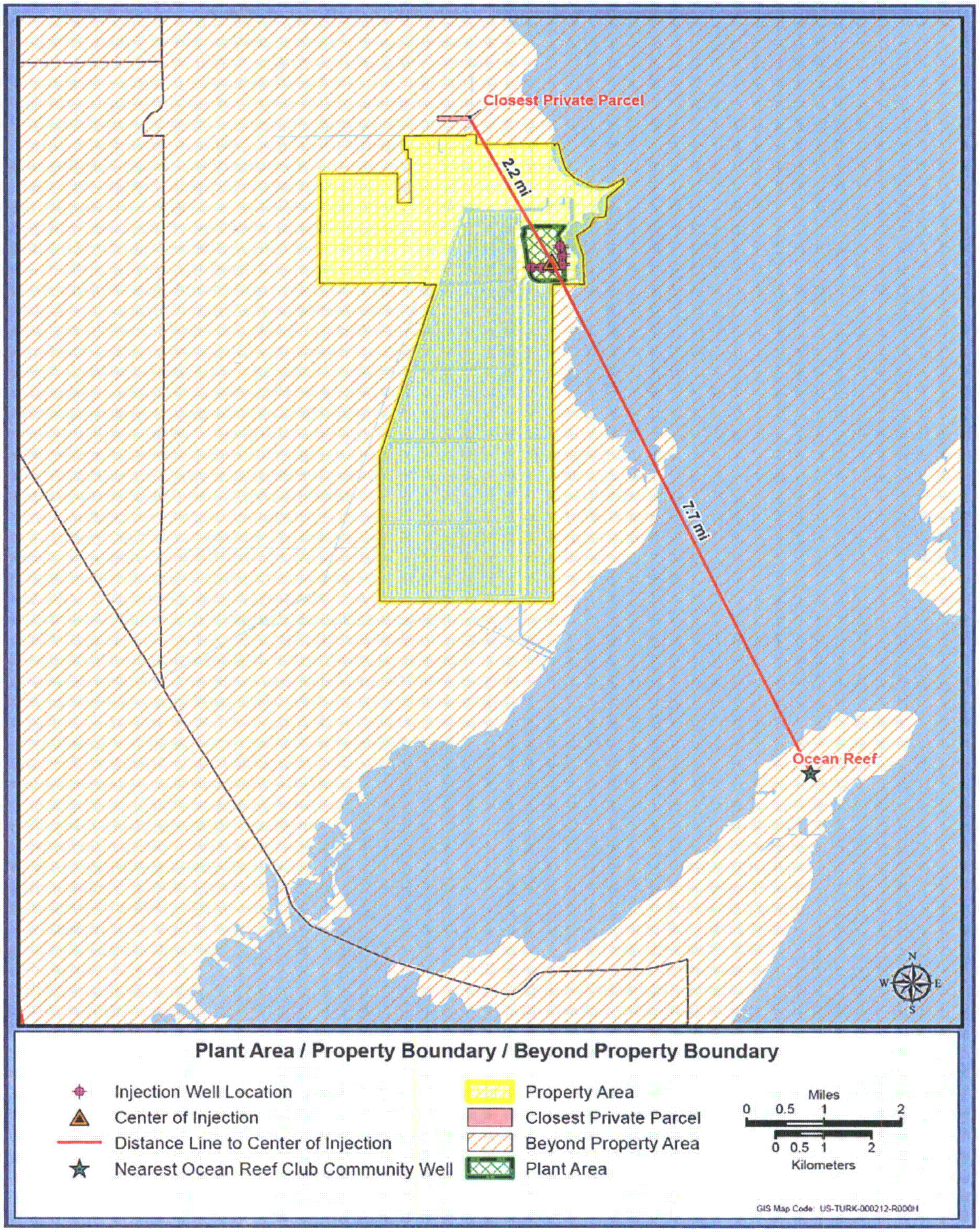
Note: Water supply wells depicted with a specified well ID number are monitoring wells placed along the 2008 USGS salt front line to monitor the Biscayne aquifer for saltwater intrusion

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



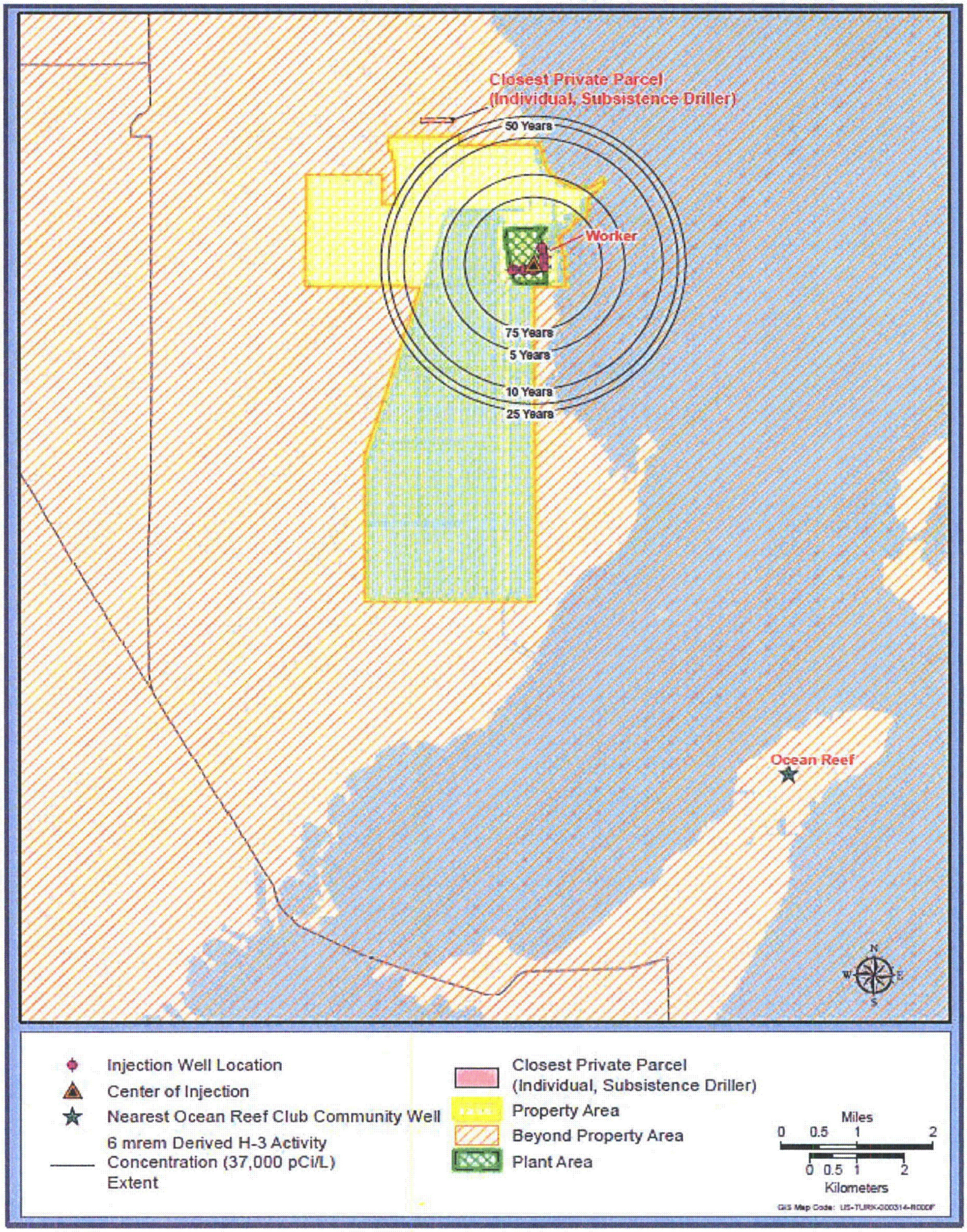
Schematic illustration of potential pathways. Not to scale.

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



Replace the entire ER Subsection 5.4.1.1 as follows:

5.4.1.1 Liquid Pathways

Treated liquid radioactive waste from the operation of Turkey Point Units 6 & 7 would be diluted with the blowdown sump discharge flow prior to injection into the Boulder Zone via the deep well injection system (DIS) (Section 3.5). As described in Subsection 2.3.2, the highly saline Boulder Zone of the Lower Floridan aquifer is used for deep well injection of treated municipal wastewater and reverse osmosis concentrate in Miami-Dade County. Injection occurs below the middle confining layer at depths of approximately 2700 feet or greater.

An analysis of potential liquid effluent pathways was performed to determine the affected member of the public and the doses that may result from the injection of treated liquid radioactive waste into the Boulder Zone and subsequent member-of-the-public exposure. This analysis is summarized below. FSAR Subsection 11.2.3.5 contains a more detailed presentation of this analysis.

Three exposure pathway modes – normal operation, off-normal operation, and inadvertent intrusion – are considered for the member-of-the-public screening analysis. These modes are defined as follows:

> **<u>Normal Operation</u> – Operation within specified operational limits and conditions. This mode assumes that the DIS and subsurface hydrogeological units operate as designed or expected with no system failures, such as deep injection well seal failure or subsurface confining unit fracture/failure.**
>
> **<u>Off-Normal Operation</u> – 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.**
>
> **<u>Inadvertent Intrusion</u> – 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.**

The locations for the potential receptors have been assigned to three areas based on their placement locations relative to Turkey Point Units 6 & 7 site. They are described as follows:

> **<u>Plant Area</u> – 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 be exposed to effluent.**
>
> **<u>Property Area</u> – 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 be exposed to effluent.

Beyond Property Area – This area includes the area beyond the Turkey Point Property Boundary. Members of the public and populations which 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.

Based upon both a preliminary and detailed screening analysis, several liquid effluent pathway scenarios were retained for detailed dose analysis (FSAR Subsection 11.2.3.5.2). An additional category was created to distinguish between a "credible" and a "non-credible" member of the public located beyond the Property Boundary. These categories are based on actual/predicted potential dose pathways. They are defined as follows:

- **Credible – Such a scenario may be expected to occur during the operational lifetime of the plant (or beyond) based on current and projected water/land usage local to Turkey Point.**
- **Non-Credible – Such a scenario is not likely to occur during the operational lifetime of the plant or beyond based on current and projected water/land usage local to Turkey Point; however, it is included to provide a bounding dose for the Off-Normal event category.**

The retained scenarios are summarized in Table 5.4-1. A detailed description of the dose analyses for the retained members of the public is summarized in the following paragraphs.

Beyond Property Area – Off-Normal Operation

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

The Ocean Reef Club community is approximately 7.7-miles from the effluent injection point. This community represents the only member of the public in the near vicinity of Turkey Points Units 6 & 7 to currently utilize 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 than is observed in the Boulder Zone. Based on groundwater modeling (FSAR Subsection 11.2.3.5.1), 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. The local source term is required at this location. Groundwater modeling was performed to determine the radionuclide concentrations in groundwater at this point (FSAR Subsection 11.2.3.5.1). The maximum tritium, cesium-134, cesium-137, and strontium-90 concentrations occur at 25, 15, 42 and 41 years, respectively. Tritium, cesiuim-134, cesium-137, and strontium-90 concentrations at these times were 3.1E04, 7.7E-03, 7.6E-01, and 5.6E-04 pCi/L, respectively. These maximum concentrations are conservatively assumed to occur concurrently and, therefore, will be used collectively for the source term for the dose analyses conducted at this location.

The member of the public is assumed to use the Upper Floridan aquifer water for drinking water ingestion only via a water supply well. This water supply well is assumed to be directly over a conduit in the middle confining unit which allows injectate from the Boulder Zone to travel vertically to the Upper Floridan aquifer. The tritium, cesium-134, cesium-137 and strontium-90 concentrations in the Upper Floridan aquifer are assumed to instantaneously equal the maximum tritium, cesium-134, cesium-137 and strontium-90 concentrations in the Boulder Zone as described above. No additional consideration is given to upward migration time or retardation.

The NRC-endorsed LADTAP II computer program (NUREG/CR-4013) is used to calculate doses to the member of the public from drinking water ingestion of Upper Floridan groundwater. A separate LADTAP II run is made for each isotope (tritium, cesium-134, cesium-137, strontium-90). Table 5.4-2 summarizes the 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, limit for a member of the public (annual limit of 3 mrem per Unit). The organ dose (dose to child's liver as maximum organ) is lower than the 10 CFR Part 50, Appendix I, limit for a member of the public (annual limit of 10 mrem per Unit). As can be seen, tritium is the dominant dose contributor.

<u>Beyond Property Area – Inadvertent Intrusion</u>

The doses associated with the inadvertent intrusion scenario represent a non-credible worst case, bounding estimate for dose. 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 which 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 incurred 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 and consumption 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 (US EPA 1993).

In order 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. As 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 (US EPA 2009). 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 prior to 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 5.4-3 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 5.4-4 summarizes the doses for all retained scenarios.

Revise the last paragraph of ER Subsection 5.4.1.2 as follows:

The input parameters for the gaseous effluent exposure pathway are presented in Table ~~5.4-1~~**5.4-5** and the receptor locations are shown in Table ~~5.4-2~~**5.4-6**. The receptor locations are those at which the maximum atmospheric dispersion and deposition factors occur for each exposure pathway.

Revise ER Subsection 5.4.2 as follows:

Based on the parameters in Tables ~~5.4-1~~**5.4-5** and ~~5.4-2~~**5.4-6**, the GASPAR II computer program was used to calculate annual doses from gaseous effluents from one new unit to the MEI, the population, and biota. As stated above, there is no dose due to liquid effluents during normal operations. The MEI doses were determined by considering the maximally exposed adult, teenager, child, and infant at the following locations:

- Nearest site boundary (nearest boundary of the Turkey Point plant property)
- Nearest residence (2.7 miles)
- Nearest vegetable garden
- Nearest meat cow pasture

There are no milk animals within five miles of Turkey Point Units 6 & 7. The maximum total body and organ doses are presented in Table ~~5.4-3~~**5.4-7**. In this table, the contributions from viable pathways are summed to obtain a total dose for each organ and age group. Although Table ~~5.4-2~~**5.4-6** shows the vegetable garden is farther away than the residence and the meat animal, the garden doses were added to the doses from the other two pathways. For comparison, Table ~~5.4-2~~**5.4-6** includes dose estimates at the limiting Turkey Point plant property boundary location, where no established human exposure pathways have been identified. In effect, doses were calculated at two locations: Turkey Point plant property boundary and the merged residence/garden/meat animal location. The latter location represents the MEI. Table ~~5.4-3~~**5.4-7** shows that the maximum doses from each unit occur at the Turkey Point plant property boundary and that most of the dose is a result of the external exposure pathways. The maximum total body dose is 3.9 mrem/year to the adult, the teen, and the child while the maximum organ doses are 14 mrem/year to the skin and 7.5 mrem/year to the thyroid of the child. These are theoretical doses based on conservative assumptions. Table ~~5.4-5~~**5.4-9** shows comparable doses from the operation of Units 3 and 4 are negligible.

Revise ER Subsection 5.4.3 as follows:

Table ~~5.4-4~~**5.4-8** shows that even the site boundary doses, which bound the MEI, are within the design objectives of 10 CFR Part 50, Appendix I. Table ~~5.4-5~~**5.4-9** shows that the total site

doses from the two new units as well as the two existing units are within the regulatory limits of 40 CFR Part 190. Since the dose limits for members of the public in 40 CFR Part 190 are more restrictive than those in 10 CFR 20.1301(a)(1), demonstration of compliance with the limits of 40 CFR Part 190 is also a demonstration of compliance with the 0.1 rem total effective dose equivalent (TEDE) limit of 10 CFR 20.1301(a)(1). Table ~~5.4-6~~**5.4-10** shows that collective doses from the new units to the population within 50 miles of the plant are extremely low compared to collective doses from natural background radiation. Based on the estimated doses from the new units, impacts to members of the public would be SMALL and would not warrant additional mitigation.

Revise ER Subsection 5.4.4 as follows:

Radiation exposure pathways to biota other than members of the public were examined to determine if these pathways could result in doses to biota greater than those predicted for humans. Immersion and ground deposition doses are largely independent of organism size, and the doses to humans, calculated as described in Subsection 5.4.2, can be applied to biota except that the location of the biota is as shown in Table ~~5.4-2~~**5.4-6**. The maximum total body dose to a human from inhalation, vegetable, plume, and ground deposition pathways, as calculated by GASPAR II, was applied to biota except that the ground deposition dose was increased by a factor of two to account for the proximity of terrestrial organisms to the ground. The resulting dose to biota species represented by muskrat, raccoon, heron, and duck is 26 mrad/year or 0.07 mrad/day per unit. The International Council on Radiation Protection states that "if man is adequately protected, then other living things are also likely to be sufficiently protected," (ICRP 1977), and the National Council on Radiation Protection concurs with this conclusion (NCRP 1991). Furthermore, the International Atomic Energy Agency (IAEA) concludes that there is no scientific evidence that chronic dose rates below 100 mrad per day are harmful to plants and animals (IAEA 1992). It is seen that the biota dose is well within the IAEA guideline. Therefore, impacts to biota other than members of the public would be SMALL and would not warrant additional mitigation.

Insert new reference to Section 5.4 References as follows:

US EPA 1993. U.S. Environmental Protection Agency, *External Exposure to Radionuclides in Air, Water and Soil,* Federal Guidance Report No. 12, EPA-402-R-93-081, September 1993.

US EPA 2009. U.S. Environmental Protection Agency, *Risk Management Program Guidance for Offsite Consequence Analysis,* EPA 550-B-99-009, April 2009.

Revise the second paragraph of ER Subsection 5.11.6 as follows:

Units 6 & 7 would release small quantities of radioactivity to the environment through both permissible liquid and gaseous releases. The permissible liquid releases would be released

into deep injection wells approximately 2900 feet underground. Based on a receptor analysis and liquid exposure dose modeling, the predicted doses from radioactive liquid effluent disposal would be negligible. The existing nuclear units, Units 3 & 4, release small quantities of radioactivity. A small radiological dose would be attributable to the Units 3 & 4 ISFSI. Table ~~5.4-4~~**5.4-8** shows that the maximum exposed individual doses are within the design objectives of 10 CFR Part 50, Appendix I. Table ~~5.4-5~~**5.4-9** shows that the total site doses from the two new units as well as the two existing nuclear units are within the regulatory limits of 40 CFR Part 190. Table ~~5.4-6~~**5.4-10** shows that collective doses from the new units to the population within 50 miles of the plant are extremely low compared to collective doses from natural background radiation.

Insert new tables as follows:

Table 5.4-1 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 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 5.4-2 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 5.4-3 Inadvertent Intrusion Subsistence Driller Dose Summary

	Dose (mrem) per Unit	
Pathway	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 5.4-4 Dose Summary

Location	Exposure Pathway Mode	Description	Location	Dose
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

Renumber ER Section 5.4 tables as follows:

Table ~~5.4-1~~ **5.4-5**

Table ~~5.4-2~~ **5.4-6**

Table ~~5.4-3~~ **5.4-7**

Table ~~5.4-4~~ **5.4-8**

Table ~~5.4-5~~ **5.4-9**

Table ~~5.4-6~~ **5.4-10**

ASSOCIATED ENCLOSURES:

None