PMTurkeyCOLPEm Resource

From: Franzone, Steve <Steve.Franzone@fpl.com>
Sent: Wednesday, August 10, 2016 3:02 PM
To: Comar, Manny
Cc: TurkeyCOL Resource; Maher, William; Orthen, Richard
Subject: [External_Sender] RE: PTN 6&7 ACRS Subcommittee Slides - Day 1
Attachments: FPL_ACRS_Presentation_Day_1_Combined_20160810_(FINAL).pdf

The attached version has the "Final Draft" words removed from each slide.

Thanks
Steve Franzone
NNP Licensing Manager - COLA
"The road to success is dotted with many tempting parking places." –Unknown
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754.204.5996 (cell)
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From: Franzone, Steve
Sent: Tuesday, August 09, 2016 4:11 PM
To: Mr. Manny Comar (manny.comar@nrc.gov)
Cc: TurkeyCOL Resource; Maher, William; Orthen, Richard
Subject: PTN 6&7 ACRS Subcommittee Slides - Day 1

I have attached the final version of our slides for ACRS Day 1. We plan no further changes.
Any questions, please call.
Thanks
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NNP Licensing Manager - COLA
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Turkey Point Nuclear Power Plant

Units 6 & 7

Combined License Application

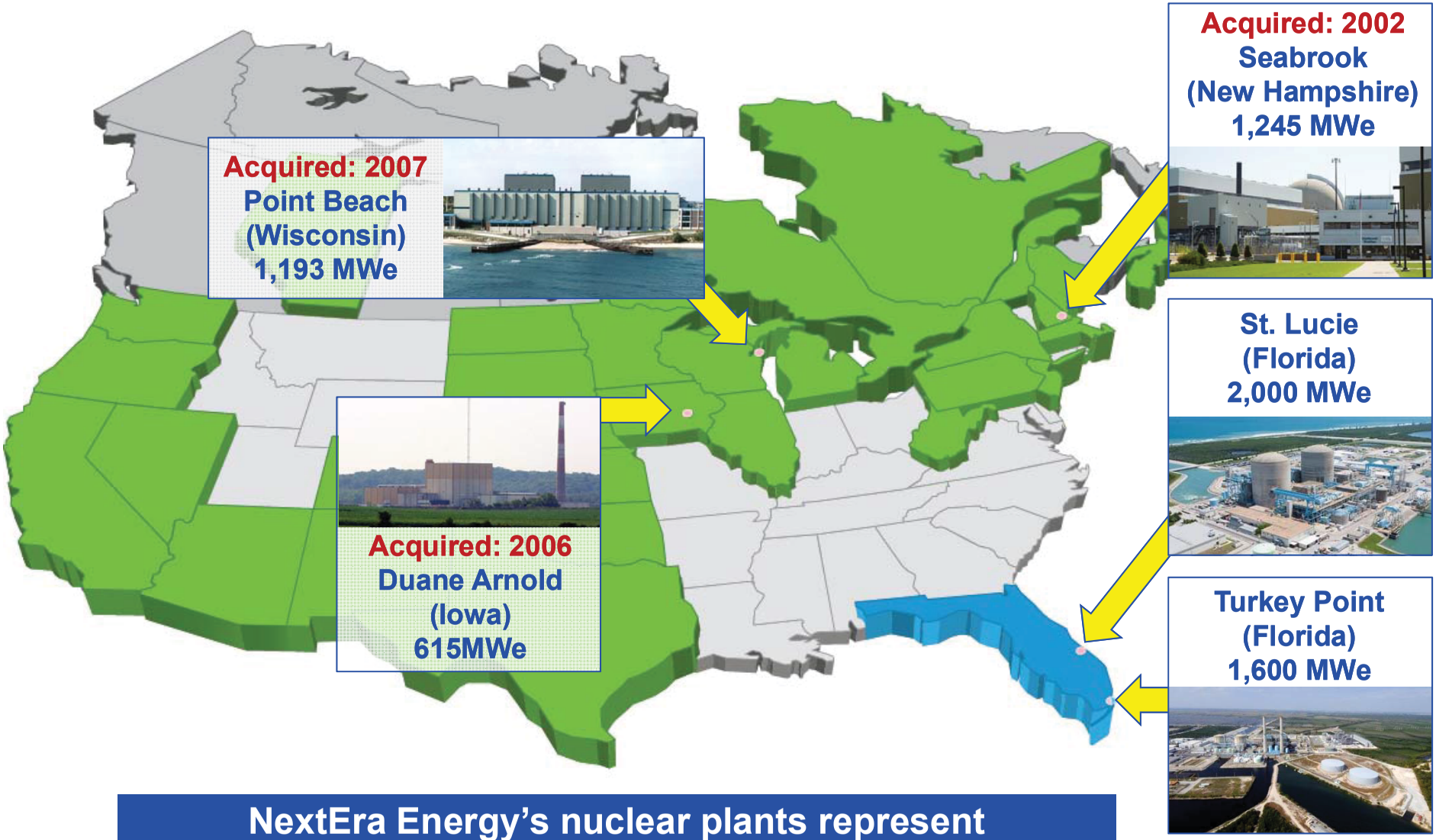
August 18, 2016

Turkey Point Nuclear Plant Units 6 & 7

Introduction

William Maher
Senior Licensing Director
New Nuclear Projects

NextEra Energy's nuclear fleet is 4th largest in MW capacity and number of reactors in the United States



NextEra Energy's nuclear plants represent approximately 24 percent of the company's generation

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Turkey Point Nuclear Plant Units 6 & 7
Day 1

- Introduction
- Chap. 1 General Description of the Plant
- Chap. 2 Site Characteristics
- Section 2.1 Geography and Demography
- Section 2.2 Nearby Industrial, Transportation, & Military Facilities
- Section 2.3 Meteorology
- Section 2.4 Hydrologic Engineering
- Section 11.2 Liquid Waste Management System

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Turkey Point Nuclear Plant Units 6 & 7
Day 2

- Section 2.5 Geology, Seismology, and Geotechnical Engineering
- Chap. 3 Design Of Structures, Components, Equipment and Systems
- Section 13.3 Emergency Planning
- Chap. 19 Probabilistic Risk Assessment
- Chap. 20 Requirements Resulting from Fukushima Near-Term Task Force Recommendations
- Chap. 21 Design Changes Proposed in Accordance with ISG-11

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Turkey Point Nuclear Plant Units 6 & 7
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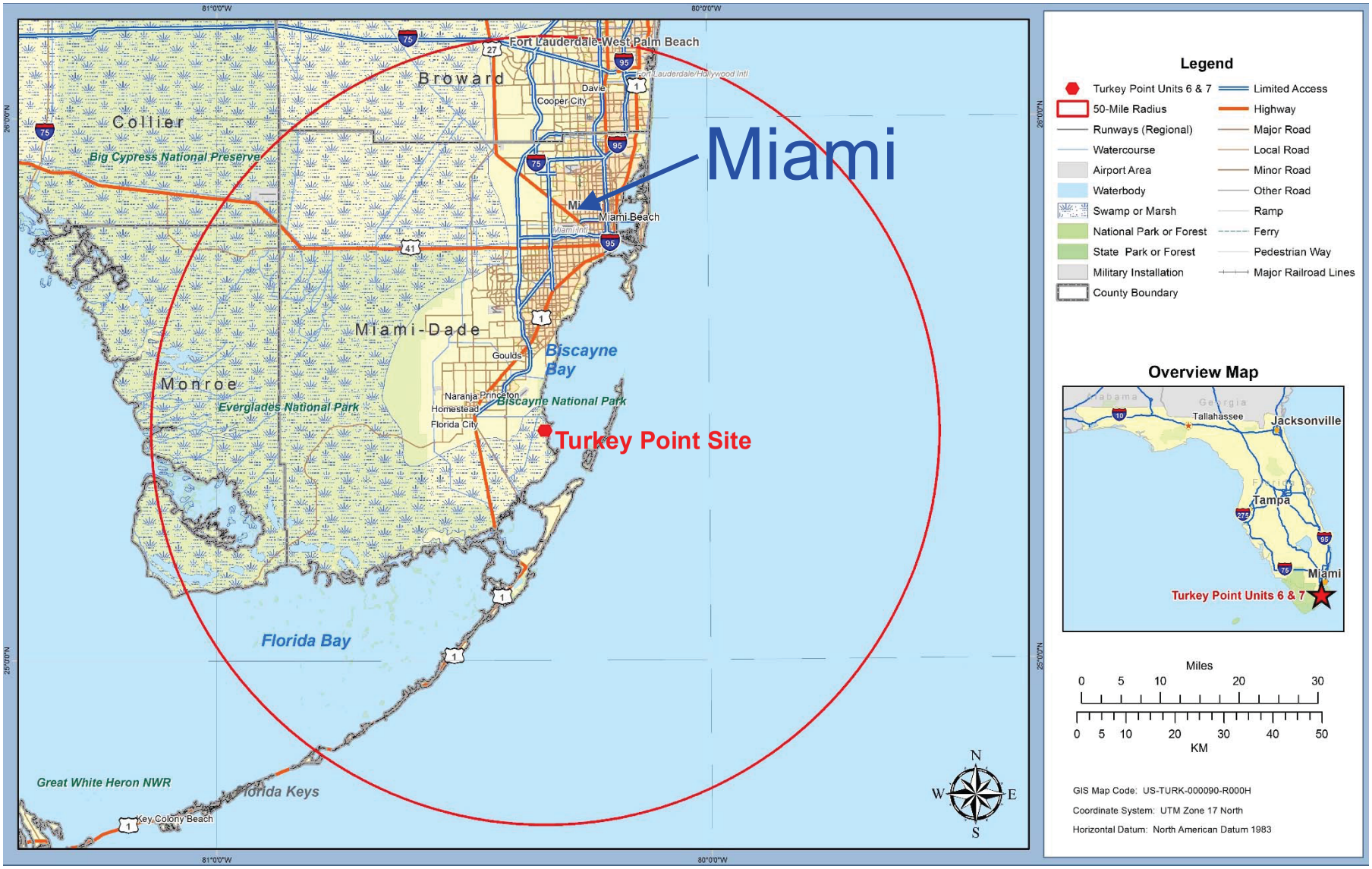
Turkey Point Nuclear Plant Units 6 & 7

Chap. 1 General Description of the Plant

Steve Franzone
Licensing Manager
New Nuclear Projects

Turkey Point Nuclear Plant Units 6 & 7



Source: FSAR Figure 2.1-201

Turkey Point Nuclear Plant Units 6 & 7

Turkey Point Site Background

- 1965 – The site construction started with 2-400 MWe oil plants
- 1967 – Construction permit granted on April 27 for Turkey Point Nuclear (PTN) Units 3 & 4
- 1972 (Unit 3) – Commercial operation
- 1973 (Unit 4) – Commercial operation
- 2007 – Turkey Point Unit 5, a 1150 MWe combined-cycle gas-fired plant, goes into commercial operation
- 2009 – Submitted application for proposed PTN Units 6 & 7
- 2010 – Unit 2 retired
- 2013 – Completed power uprates to existing nuclear units
- 2016 – Unit 1 in process of being retired

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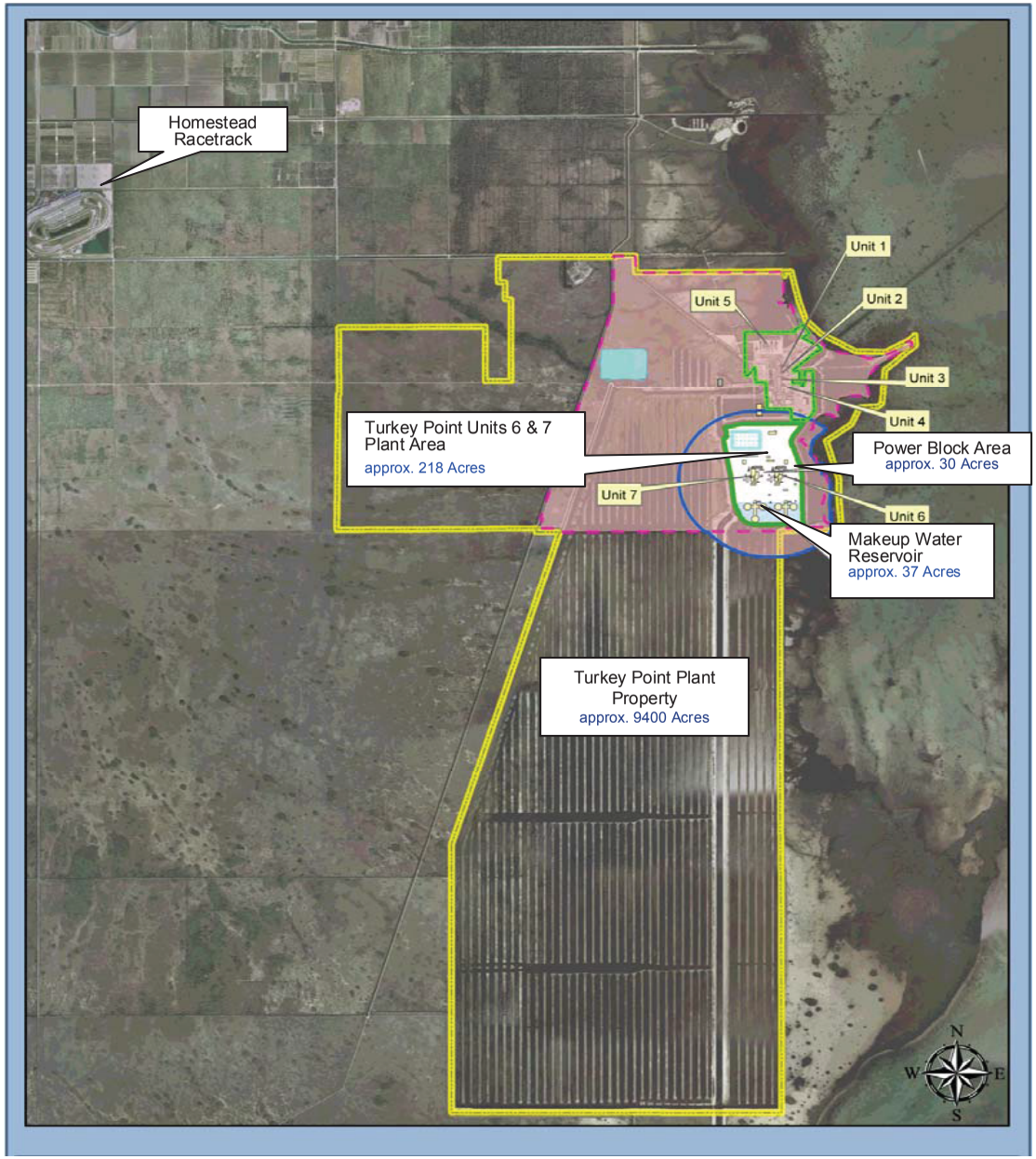
Turkey Point Site Area



Turkey Point Nuclear Plant Units 6 & 7

Turkey Point Site Area

Source: FSAR Figure 2.2-201

Chapter 1 General Description of the Plant

- **AP1000 DCD incorporated by reference**
- **Standard material incorporated (including supplements, departures and exemptions)**
- **Site-specific information**
  - Section 1.2: Units 6 & 7 Plant Layout
  - Section 1.4: Identification of Agents and Contractors
  - Section 1.8: Interfaces for Standard Design

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Turkey Point Nuclear Plant Units 6 & 7

Turkey Point Units 6 & 7 Site

Turkey Point Nuclear Plant Units 6 & 7

Site Plot Plan

Turkey Point COLA Changes Since R-COL

- **Fukushima event**
- **Central & Eastern US Seismic Source Characterization sensitivity assessments**
- **Electrical Bulletin 2012-01 response**
- **AP1000 Generic Design Changes (reviewed on Levy docket)**
  - Condensate Return & Passive RHR Cooling
  - Main Control Room Operator Dose
  - Main Control Room Heat Load
  - Hydrogen Venting in Containment
  - Plant Monitoring System (PMS) Flux Doubling to comply with IEEE 603

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Turkey Point Project - Challenges

- Postulated karst-related deformations
- Cuban seismic sources
- Address Regulatory Guide (RG) 1.221 (i.e., hurricane missiles)
- Use of Deep Well Injection System

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Section 1.4 – Identification of Agents and Contractors

- **COLA Development**
  - Bechtel Power Corporation
- **AP1000 Standard Plant**
  - Westinghouse Electric Company LLC
- **Technical Services Supporting COLA Development**
  - Paul C. Rizzo Associates, Inc.
  - MACTEC Engineering and Consulting, Inc.
  - McNabb Hydrogeologic Consulting, Inc.
  - Fugro Consultants Inc.
  - AMEC Foster Wheeler (Environmental & Infrastructure, Inc.)
  - Golder Associates, Inc.
  - Risk Engineering, Inc.
  - William Lettis & Associates, Inc.
  - Tetra Tech NUS, Inc.
  - KLD Engineering, P.C.
  - ABS Consulting

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Turkey Point Nuclear Plant Units 6 & 7
Day 1

- Introduction
- Chap. 1 General Description of the Plant
- **Chap. 2 Site Characteristics**
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- Section 2.3 Meteorology
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- Section 11.2 Liquid Waste Management System

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Turkey Point Nuclear Plant Units 6 & 7

Chap. 2 Site Characteristics

Paul Jacobs
Engineering Supervisor
New Nuclear Projects

Section 2.0 – Site Characteristics

- **FSAR Table 2.0-201 provides comparison of the site-specific characteristics with the AP1000 site parameters in DCD Tier 2 Table 2-1**
- **All site-specific characteristics are bounded by the AP1000 site parameters, with the following exceptions:**
  - Air temperatures
  - Wind speed
  - Population distribution exclusion area

Turkey Point Nuclear Plant Units 6 & 7
Day 1

- Introduction
- Chap. 1 General Description of the Plant
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- Section 2.2 Nearby Industrial, Transportation, & Military Facilities
- Section 2.3 Meteorology
- Section 2.4 Hydrologic Engineering
- Section 11.2 Liquid Waste Management System

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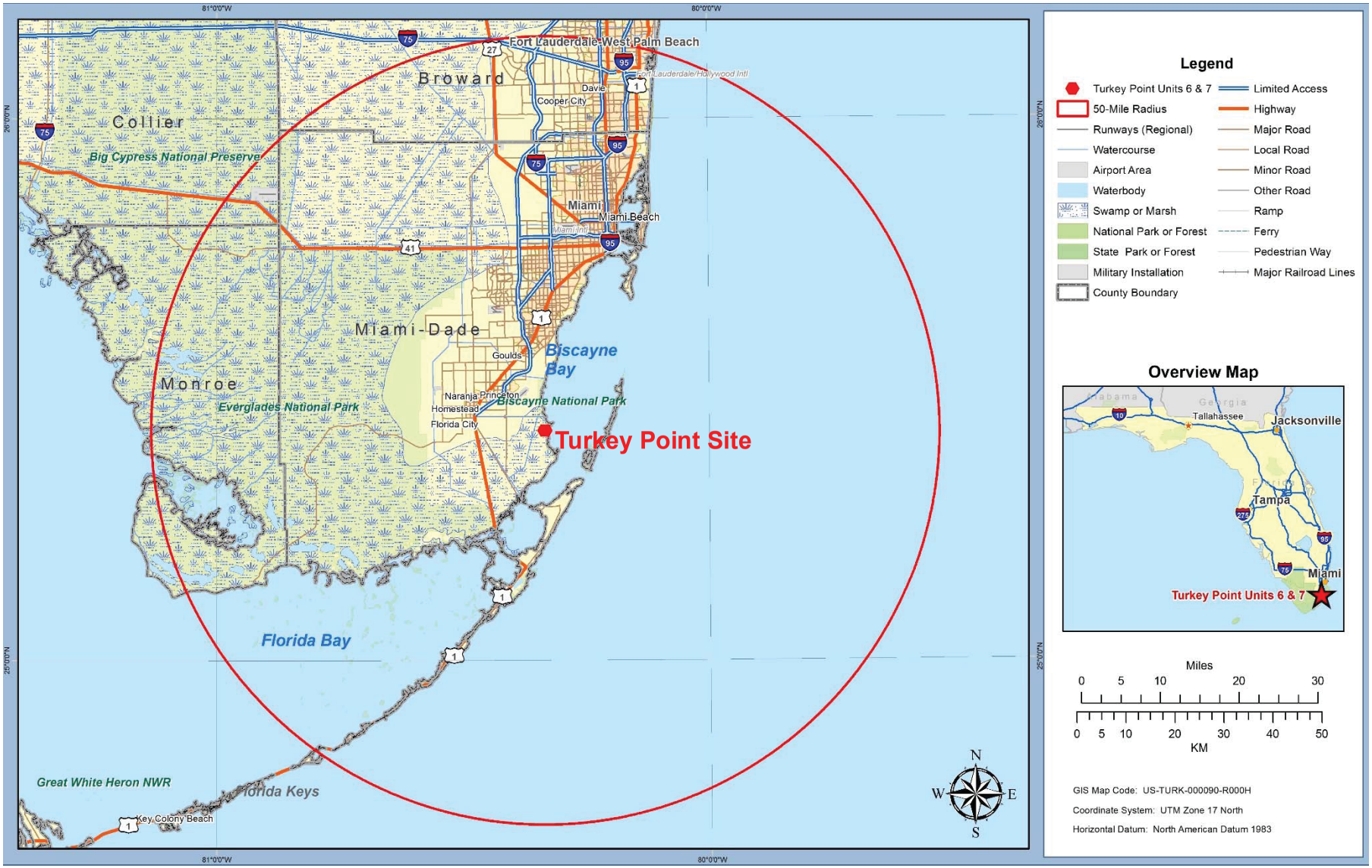
Section 2.1 – Geography and Demography

COL Information Item, PTN COL 2.1-1:

- **Site Information-Location and Description**
  - Miami Dade County, Florida
    - -- 25 miles south of Miami
  - Prominent natural features
    - -- Biscayne Bay
    - -- Everglades National Park
  - Closest municipalities
    - -- Homestead
    - -- Islandia
    - -- Florida City

Turkey Point Nuclear Plant Units 6 & 7



Source: FSAR Figure 2.1-201

Section 2.1 – Geography and Demography

COL Information Item, PTN COL 2.1-1:

- **Population**
  - Closest population center (10 CFR 100.3)
    - -- Homestead – population 60,512
  - Meets requirement of 10 CFR 100.21(b)
    - -- Distance between municipal limits of Homestead and site boundary is approximately 4.5 miles
    - -- Distance to boundary of population center is 1.6 times radius of the 5-mile LPZ centered on Units 3 & 4
    - -- Requirement that population center distance is at least one and one-third times distance from Units 6 & 7 reactors to outer boundary of LPZ is met

Population center distance criterion (10 CFR 100.21(b)) met.

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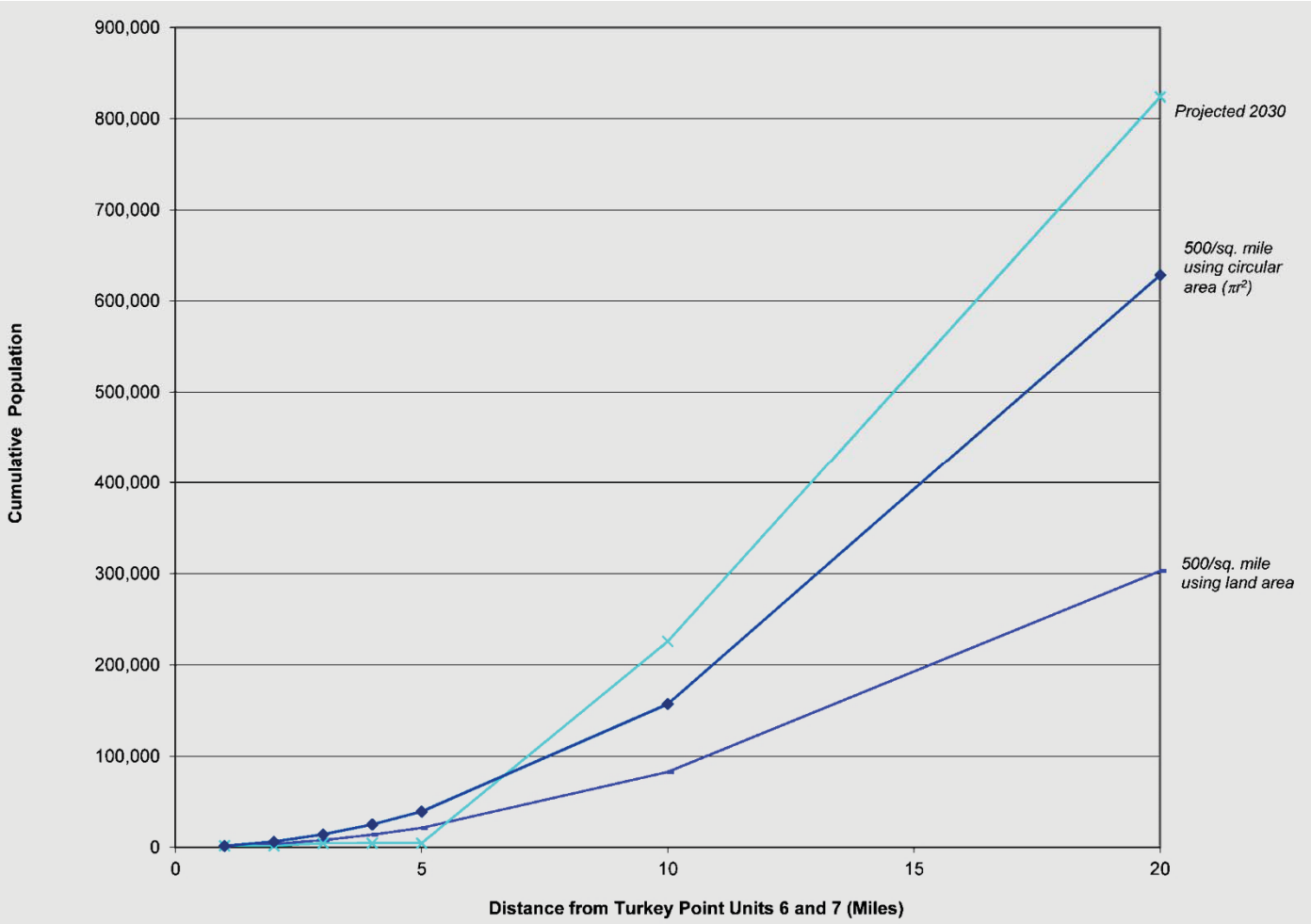
Turkey Point Nuclear Plant Units 6 & 7

Section 2.1 – Geography and Demography

Population Compared to NRC Siting Criteria



Source: FSAR Figure 2.1-227

Section 2.1 – Geography and Demography

- **Population (continued)**
  - Population density per Regulatory Guide 4.7
    - -- 2030 population, based on 2010 census block date, is greater than 500 person-per-square-mile density criterion using both land area and circular area calculation methods
    - -- Projected 2030 population at 10- and 20-mile radii also exceed criterion calculated for both land area and circular area
  - While Regulatory Guide 4.7 population density criterion is not met, related safety factors were considered:
    - -- Radiation dose requirements in 10 CFR 52.79(a)(1)(vi) to public are met
    - -- Emergency Plan and associated Evacuation Time Estimate account for consequences of radiological emergencies required by 10 CFR 50.47 and 10 CFR 50, Appendix E
  - As stated in Regulatory Guide 4.7 and 10 CFR 100.21(h), in determining acceptability of a site located away from a very densely populated center but not in an area of low density, consideration should be given to safety, environmental, economic, or other factors
    - -- Alternative site analysis presented unique safety, economic, reliability, and environmental attributes that would not be realized if the plant were developed elsewhere
    - -- Analysis concluded no alternative site was environmentally preferable

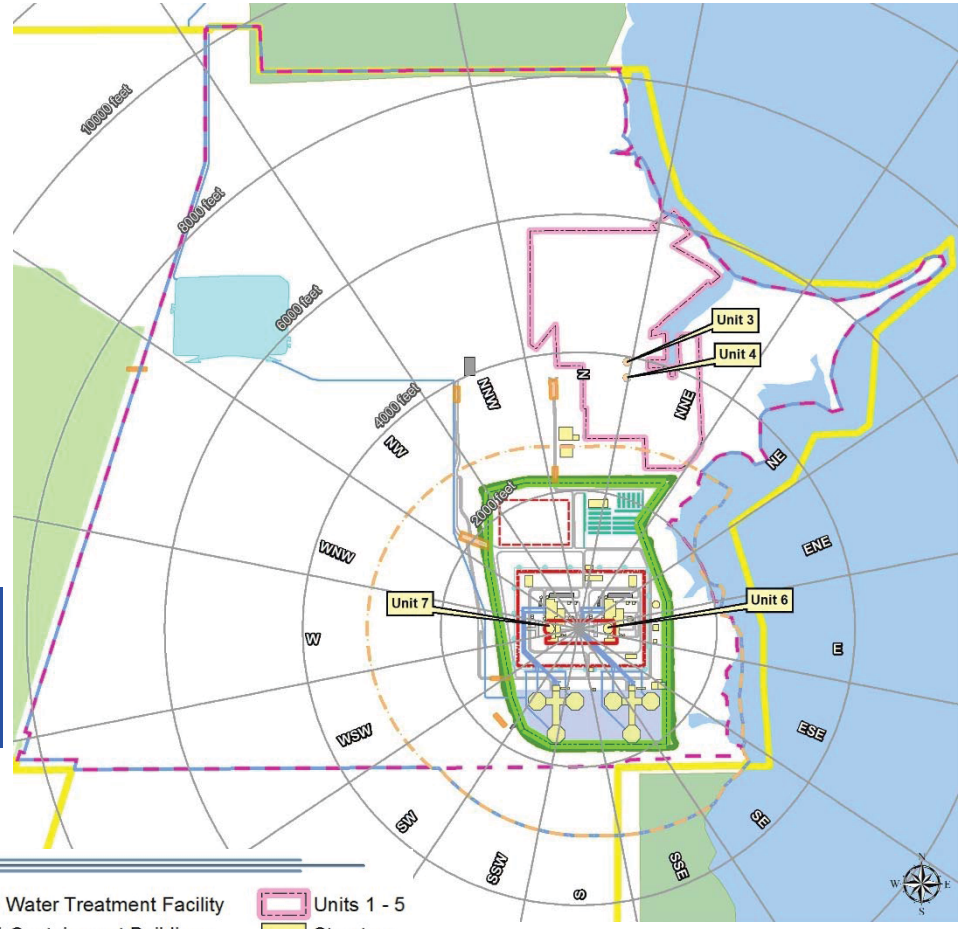
Turkey Point Nuclear Plant Units 6 & 7

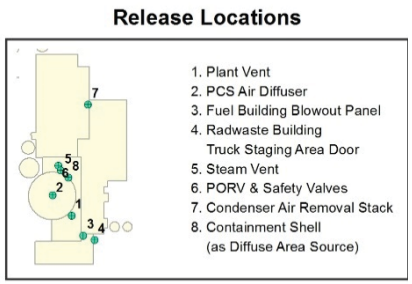
Section 2.1 – Geography and Demography

COL Information Item, PTN COL 2.1-1:

- **Exclusion Area Boundary**
  - EAB for Units 6 & 7 primarily lies within EAB for Units 3 & 4 with exception of eastern and southern portions
  - Combined EAB provides a minimum distance of 1427 feet from Units 6 & 7 source boundary (PTN DEP 2.0-4)

PTN DEP 2.0-4 Evaluation: Site characteristic X/Qs at EAB meet DCD parameter value.





Plant Wall Line
Water Line
Fence Line
Combined EAB
Turkey Point Plant Property
Reclaimed Water Treatment Facility
Units 3 & 4 Containment Buildings
Units 6 & 7 EAB
Units 3 & 4 EAB
Source Boundary
Substation Transformer
Units 1 - 5
Structure
Bridge
Slab

Source: FSAR Figure 2.1-204

Turkey Point Nuclear Plant Units 6 & 7
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- **Section 2.2 Nearby Industrial, Transportation, & Military Facilities**
- Section 2.3 Meteorology
- Section 2.4 Hydrologic Engineering
- Section 11.2 Liquid Waste Management System

Section 2.2 – Nearby Industrial, Transportation, & Military Facilities

COL Information Item, PTN COL 2.2-1:

- **Evaluation of Potential Accidents**
  - Nearby Industrial, Transportation and Military Facilities
    - -- Industrial/Military
      - – Turkey Point Units 1 through 5
      - – Homestead Air Reserve Base
    - -- Transportation
      - – Onsite Transportation Routes
      - – Miami to Key West Florida Intracoastal Waterway
      - – Florida Gas Transmission Company's Turkey Point Lateral Pipeline and Homestead Lateral Pipeline
      - – Airport and Airway Routes
        - » Homestead Air Reserve Base
        - » Airway V-3

Turkey Point Nuclear Plant Units 6 & 7

Section 2.2 – Nearby Industrial, Transportation, & Military Facilities

Source: FSAR Figure 2.2-201

Section 2.2 – Nearby Industrial, Transportation, & Military Facilities

- **Evaluation of Potential Accidents (continued)**
  - Hazard Evaluations (Site-Specific Chemicals)
    - -- Explosions/Boiling Liquid Expanding Vapor Explosion (BLEVE)
      - – Analyses demonstrated a peak positive overpressure of 1 psi, or a thermal heat flux of 5KW/m^2 from a BLEVE, will not be exceeded at any safety-related structure
    - -- Flammable/Explosive Vapor Cloud (Delayed Ignition)/Jet Fire/Heat Flux
      - – Analyses demonstrate that ignition of a flammable/explosive vapor cloud involving the identified chemicals, or a jet fire from the pipeline, would not affect safe operation of Turkey Point Units 6 & 7
    - -- Toxic Chemicals
      - – Each toxic chemical evaluated was below the Immediately Dangerous to Life or Health (IDLH) limit prior to reaching the control room air intake with the exception of chlorine and sodium hypochlorite
        - » The concentration of both chlorine and sodium hypochlorite were below the IDLH limit inside the control room
      - – Analyses demonstrate that a toxic vapor cloud involving the identified chemicals would not affect safe operation of Turkey Point Units 6 & 7

Section 2.2 – Nearby Industrial, Transportation, & Military Facilities

- **Evaluation of Potential Accidents (continued)**
  - Hazard Evaluations (AP1000 Standard Chemicals)
    - -- Hazards associated with AP1000 standard chemicals are addressed in DCD Table 2.2-1 (explosion and flammable vapor cloud safe distances) and FSAR Table 6.4-201 (toxicity)
    - -- Storage of identified AP1000 standard chemicals meet safe distance requirements
- **Review of Aircraft/Airway Hazards**
  - Evaluation performed using guidance and methodology specified in SRP 3.5.1.6 and DOE-STD-3014-96
    - -- Total impact frequency from airport operations: 2.56E-07/year
    - -- Total impact frequency from non-airport operations: 3.61E-06/year
    - -- Total impact frequency: 3.86E-06/year
      - – Dominated by general aviation operations
      - – Greater than an order of magnitude of 1E-07/year (SRP 3.5.1.6 criteria)
      - – Evaluation against second criterion (core damage frequency, CDF, less than 1E-08/year) was performed
        - » Evaluation presented in FSAR Section 19.58

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Turkey Point Nuclear Plant Units 6 & 7
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Section 2.3 – Meteorology

COL Information Item, PTN COL 2.3-1 Regional Climatology:

- Units 6 & 7 site is a relatively flat site located on the lower east coast of Florida within the Atlantic Coastal Ridge
- General climate is classified as subtropical maritime (humid subtropical)
- Region is subject to sea/land breeze circulations

Turkey Point Nuclear Plant Units 6 & 7

Section 2.3 – Meteorology

AP1000 Site Parameters Related to Regional Climatology

Design Parameter		Tier 1	Tier 2	Site-Specific Characteristic
Air Temperature				
Maximum Safety	115°F dry bulb/86.1°F coincident wet bulb	√	√	103.0°F/75.2°F (100-year return period)
	86.1°F wet bulb (noncoincident)	√	√	87.4°F
Minimum Safety	-40°F	√	√	17.9°F
Maximum Normal	101°F dry bulb/80.1°F coincident wet bulb		√	91.3°F/79.3°F
	80.1°F wet bulb (noncoincident)		√	81.5°F
Minimum Normal	-10°F		√	46.9°F
Wind Speed/Tornado				
Operating Basis	145 mph (3 second gust); importance factor 1.15 (safety), 1.0 (nonsafety); exposure C; topographic factor 1.0		√	150 mph
Tornado	Maximum wind speed of 300 mph	√	√	200 mph
	Maximum pressure differential of 2.0 lb/in^2	√		0.9 lb/in^2

Section 2.3 – Meteorology

Regional Climatology (continued)

Site-specific characteristics are bounded by AP1000 site parameters except for maximum safety and normal wet-bulb (noncoincident) air temperature and basic wind speed

- **Maximum Safety Wet Bulb (noncoincident) is approximately 87.4°F (PTN DEP 2.0-3)**
  - Exceeds the AP1000 DCD Tier 1 and 2 design value of 86.1°F
  - Effect of site-specific maximum safety wet bulb (noncoincident) air temperature of 87.4°F evaluated
- **Maximum Normal Wet Bulb (noncoincident) is approximately 81.5°F (PTN DEP 2.0-2)**
  - Exceeds the AP1000 DCD Tier 2 design value of 80.1°F
  - Effect of site-specific maximum normal wet bulb temperature of 81.5°F (noncoincident) evaluated

PTN DEP 2.0-2 and 2.0-3 temperature evaluations: Site-specific values do not affect any SSC design function or analysis methods as presented in DCD.

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Section 2.3 – Meteorology

Regional Climatology (continued)

- **"Basic" wind speed is approximately 150 mph (PTN DEP 2.0-1)**
  - 150 mph 3-second gust is associated with a 50-year recurrence interval
  - Estimated from plot of basic wind speeds in Figure 6-1B of ASCE 7-05
  - Exceeds the AP1000 DCD Tier 2 design value of 145 mph (3 second gust)
  - Wind load does not control design for Nuclear Island structures
    - -- Auxiliary Building wall and roof structure design is controlled by tornado, seismic, and accident pressure/temperature
    - -- Shield Building design is controlled by seismic loads

PTN DEP 2.0-1 wind speed evaluation: Increase in wind design speed will not impact AP1000 design.

- **Other SRP considerations:**
  - 3-second gust wind speed for 100-year return interval is 161 mph (150 mph times scaling factor, 1.07)
  - Nominal 3-second gust that can be expected to occur with a return period of 1E07 years is 260 mph (Figure 1 of Regulatory Guide 1.221)

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Section 2.3 – Meteorology

COL Information Item, PTN COL 2.3-2 Local Meteorology:

- **The annual wind direction distribution at the 10-meter level generally follows an easterly orientation on an annual basis**
  - Winds from east direction predominate during spring, summer and autumn months
  - During winter, relative frequency of north-northwest winds is greater
- **On annual basis, mean wind speeds at 10- and 60-meter levels are 3.8 and 5.6 meters/second, respectively**
  - Only few calm winds recorded by meteorological monitoring system at 10- and 60-meter levels
- **Data indicates:**
  - Predominance of neutral stability (Class D) and slightly stable (Class E) conditions throughout the year, 28.5 percent and 36.5 percent, respectively
  - Extremely stable conditions (Class G) most frequent during winter (approximately 10.3 percent) and less frequent during summer (approximately 1.7 percent)

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Section 2.3 – Meteorology

COL Information Item, PTN COL 2.3-3 Onsite Meteorological Measurements Program:

- **Meteorological monitoring program is comprised of a set of towers and associated systems and consists of two phases:**
  - Preoperational monitoring—Data from existing Units 3 & 4 meteorological stations during 2002, 2005, and 2006 establish baseline. Period of data is:
    - -- Best available (using validated data with least data substitution)
    - -- Representative (tower and sensor siting in accordance with RG 1.23, Revision 1)
    - -- Complete (with annualized composite data recovery of 90 percent), without being older than 10 years
  - Operational monitoring—same preoperational set of existing meteorological stations is used for operational phase for Units 6 & 7

Section 2.3 – Meteorology

COL Information Item, PTN COL 2.3-4 Short-Term Diffusion Estimates:

- **NRC-sponsored PAVAN computer code used to estimate relative ground-level atmospheric concentrations (X/Q) at EAB and LPZ for potential accidental releases of radioactive material**
  - Effects of airflow recirculation from Biscayne Bay on dispersion environment were accounted for in annual average calculations as indicated in RG 1.111
  - Results demonstrate X/Q values determined by PAVAN modeling analyses at EAB and LPZ do not exceed corresponding AP1000 DCD Tier 1 and 2 site parameter design values
- **NRC-sponsored ARCON96 model used to estimate control room X/Qs for potential accidental releases of radioactive material**
  - Estimated at control room HVAC intake and annex building access door receptors from eight release sources
  - Results demonstrate the X/Qs determined by ARCON96 modeling analyses at control room air intake and annex building access door for reactor building plant stack releases are bounded by corresponding AP1000 DCD Tier 1 and Tier 2 site parameter design values

Site specific short-term X/Qs meet AP1000 site parameter design values.

Section 2.3 – Meteorology

COL Information Item, PTN COL 2.3-5 Long-Term Diffusion Estimates:

- **NRC-sponsored XOQDOQ computer code used to estimate X/Q and D/Q values for continuous releases of gaseous effluents to the atmosphere**
  - X/Q and D/Q values calculated at receptors of interest—EAB, nearest resident, nearest vegetable garden, nearest milk animal, and nearest meat animal
  - To account for possible land-water recirculation effects from Biscayne Bay on the local meteorological conditions, default correction factors implemented

Calculated doses at receptors of interest are below 10 CFR 50, Appendix I design objectives.

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Turkey Point Nuclear Plant Units 6 & 7
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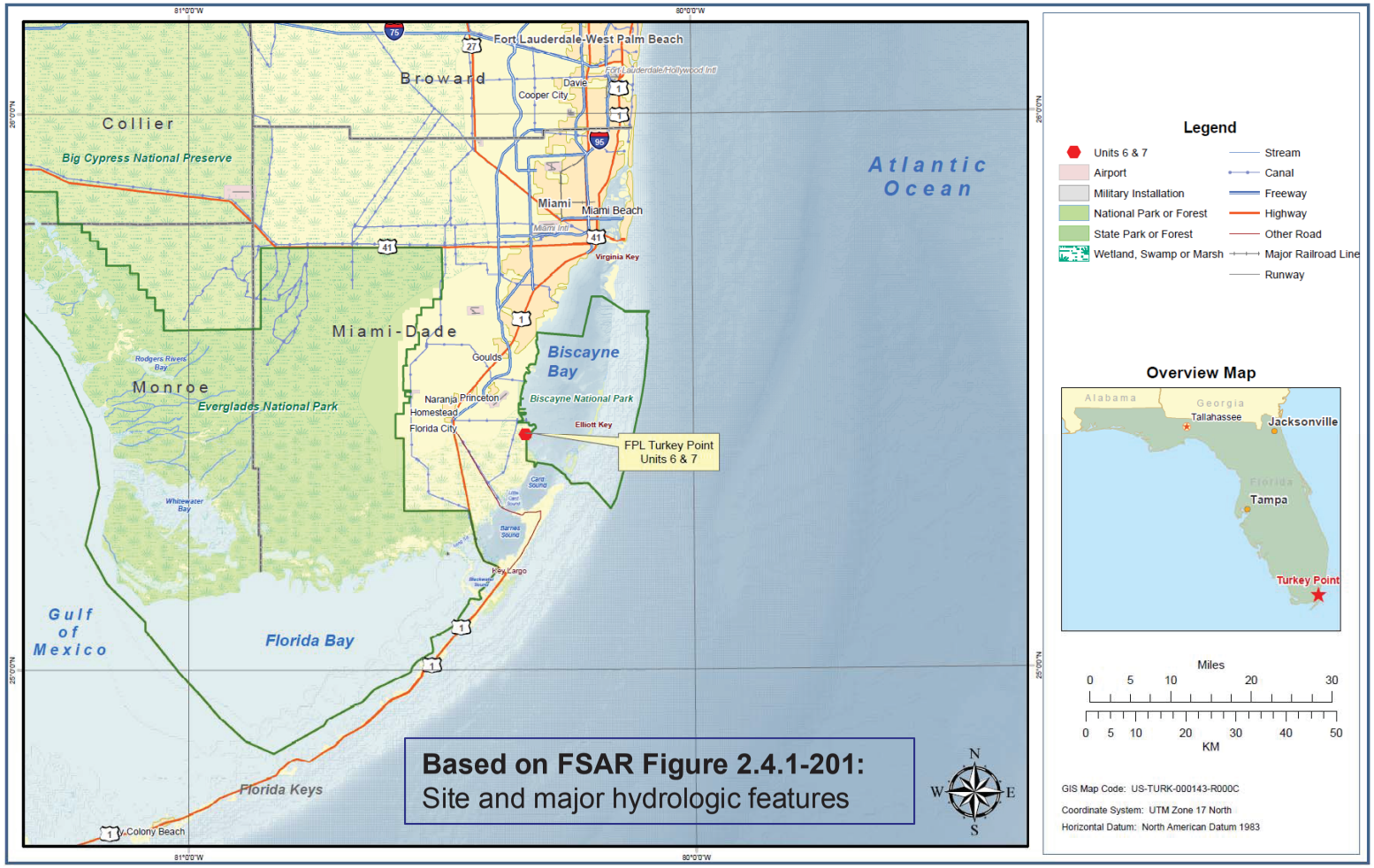
Section 2.4 – Hydrologic Engineering

- **Review of each Sub-section:**
  - 2.4.1 Hydrologic Description
  - 2.4.2 Floods
  - 2.4.3 Probable Maximum Flood on Streams and Rivers
  - 2.4.4 Potential Dam Failures
  - 2.4.5 Probable Maximum Surge and Seiche Flooding
  - 2.4.6 Probable Maximum Tsunami Hazards
  - 2.4.7 Ice Effects
  - 2.4.8 Cooling Water Canals and Reservoirs
  - 2.4.9 Channel Diversions
  - 2.4.10 Flooding Protection Requirements
  - 2.4.11 Low Water Considerations
  - 2.4.12 Groundwater
  - 2.4.13 Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.1: Hydrologic Description

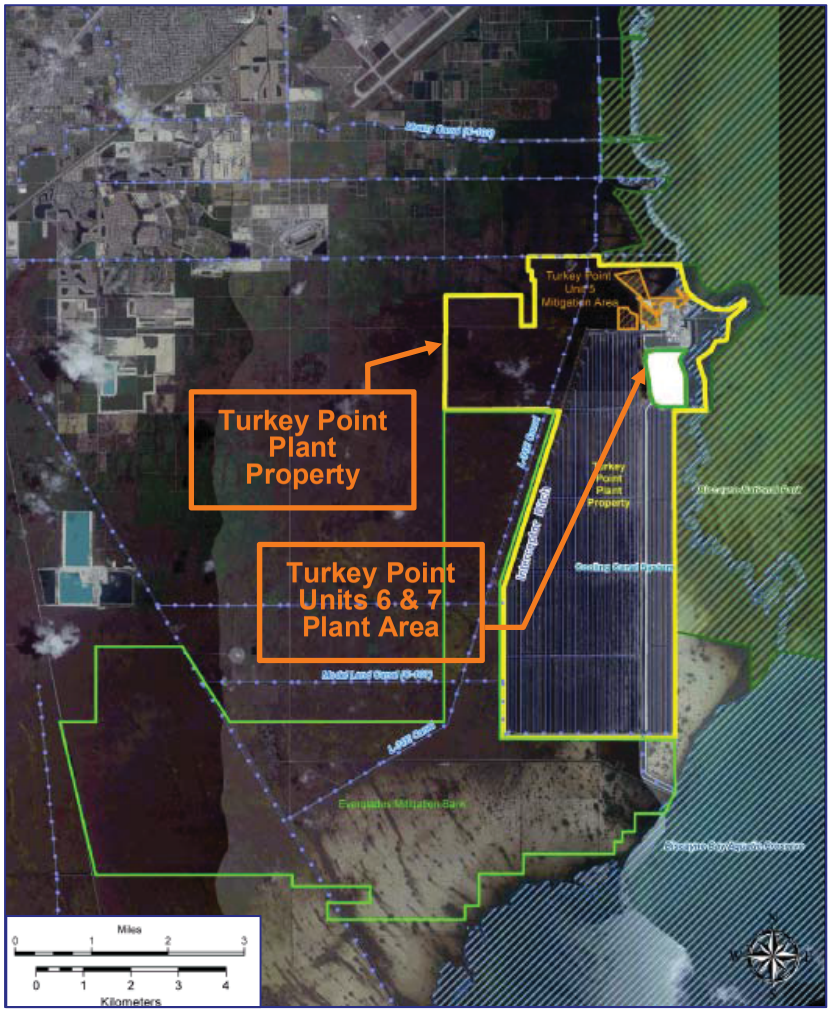


Units 6 & 7 to be located on the Biscayne Bay shore about 8 miles west of the Elliott Key barrier island that separates the bay from the Atlantic Ocean

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.1: Hydrologic Description

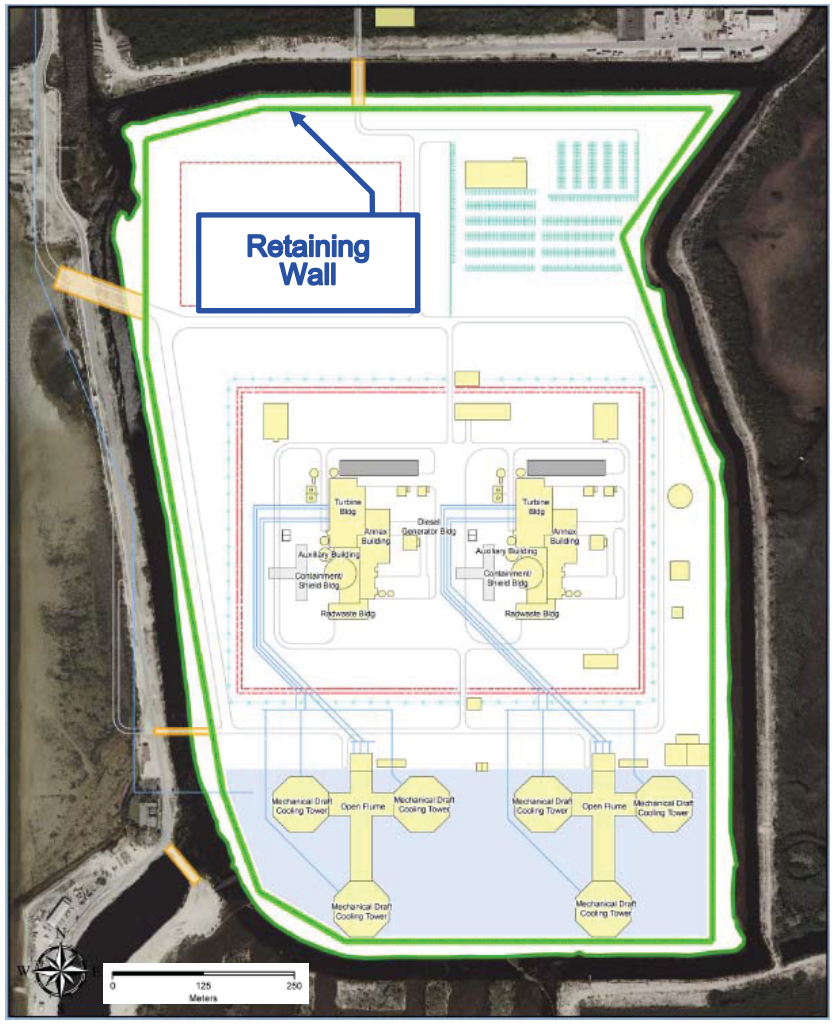
- No surface water bodies are to be used as a water supply source, effluent discharge point, or heat sink



Based on FSAR Figure 2.4.1-203:
Site and cooling canal system

Subsection 2.4.1: Hydrologic Description

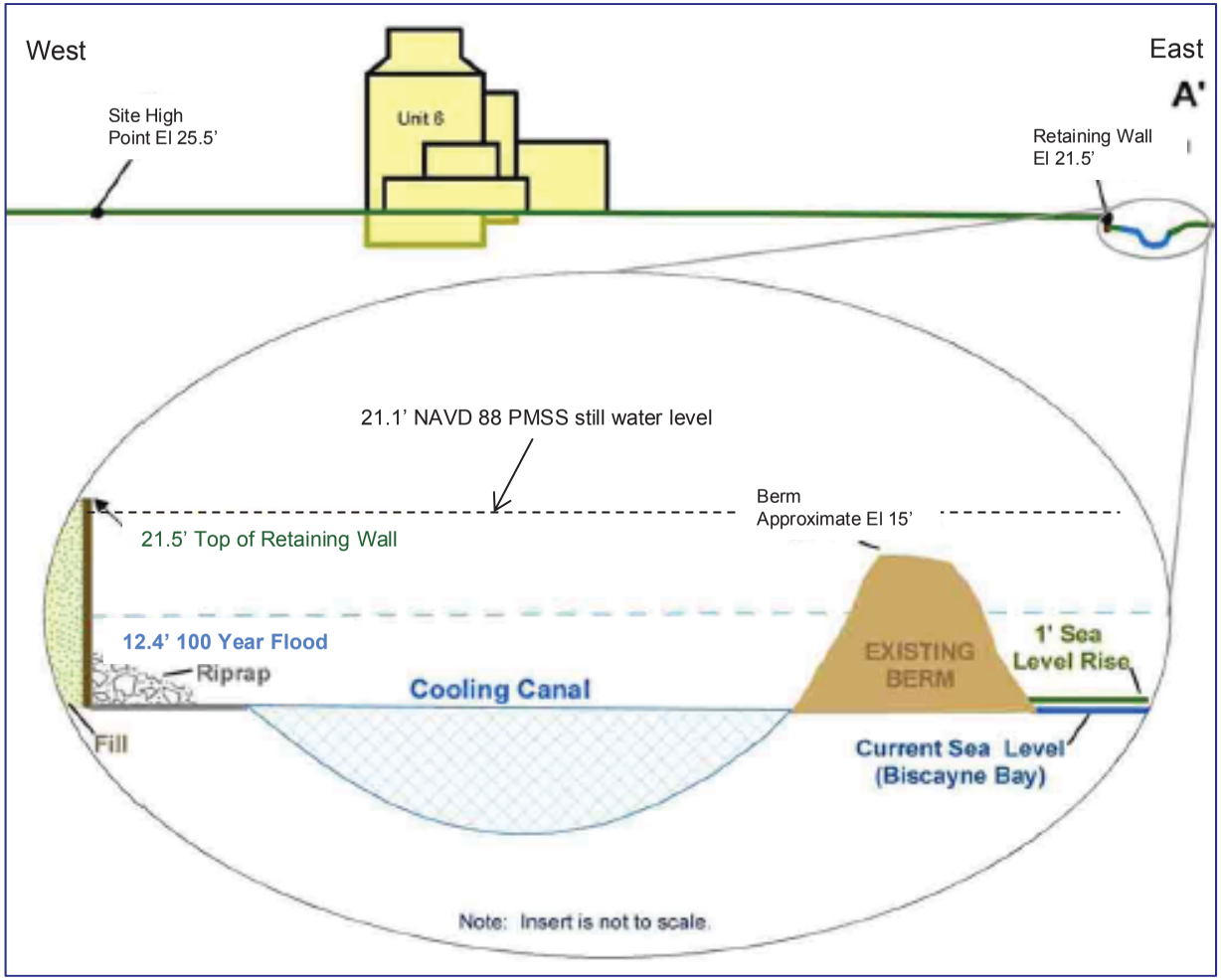
- Site elevation to be raised, protected by a retaining wall
- Site grade ranges between El. 19.0 feet NAVD 88 at the retaining wall and 25.5 feet NAVD 88 at the highest elevation
- DCD Plant elevation El. 100 feet corresponds to the plant design grade elevation at 26.0 feet NAVD 88



Based on FSAR Figure 2.4.1-204:
Site general arrangement

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.1: Hydrologic Description



Based on FSAR Figure 2.5.4-221: Profile of site grading

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.2: Floods

Design Grade and Flood Events	Elevation (feet NAVD 88)
Plant Design Grade Elevation	26.0
Local Intense Precipitation Flooding	24.5
Probable Maximum Storm Surge Flooding (Design Basis Flood elevation)	**24.8**
Probable Maximum Tsunami Flooding	14.0
Maximum Observed Water Level in Biscayne Bay (from Hurricane Andrew, 1992)	15.37

AP1000 DCD criterion met for design basis flood elevation.

Subsection 2.4.2.3: Effects of Local Intense Precipitation

- Local probable maximum precipitation (local PMP) depths are obtained from National Oceanic and Atmospheric Administration Hydrometeorological Reports 51 and 52
- 1-hour point (1-mi^2) rainfall depth is obtained as 19.4 inches

AP1000 DCD criterion met for one-hour one-mi^2 rainfall intensity.

- During local PMP, site grade would allow runoff to drain away from safety-related structures as sheet flows and overland flows
- Assumed all underground normal stormwater drainage features completely blocked
- The maximum local PMP flood elevation obtained is 24.5 feet NAVD 88, which is below the plant design grade elevation of 26.0 feet NAVD 88

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Subsection 2.4.5: Probable Maximum Surge and Seiche Flooding

- **The Atlantic Ocean is the source of hurricane storm surges near the site where the storm surge generated by the probable maximum hurricane (PMH) would propagate through the bay to affect the site**
- **PMH parameters obtained from the National Oceanic and Atmospheric Administration (NOAA) are applied to compute storm surge elevation at the site**
- **Antecedent water level, which is used as the initial water level in the computation, is 3.6 feet NAVD 88 including:**
  - 10% exceedance high spring tide and initial rise (from RG 1.59): 2.6 feet NAVD 88
  - Long-term sea level rise (60 years): 1.0 foot
- **The computed 10-minute average PMH maximum wind speed is 159 miles/hour, coincidental wave height is 15.4 feet and period is 5.1sec.**
- **The Probable Maximum Storm Surge is obtained as 24.8 feet NAVD 88 including:**
  - Probable maximum surge: 21.1 feet NAVD 88
  - Wave runup: 3.7 feet
- **No seiche impacts from Biscayne Bay or makeup water reservoir**

Subsection 2.4.6: Probable Maximum Tsunami Hazards

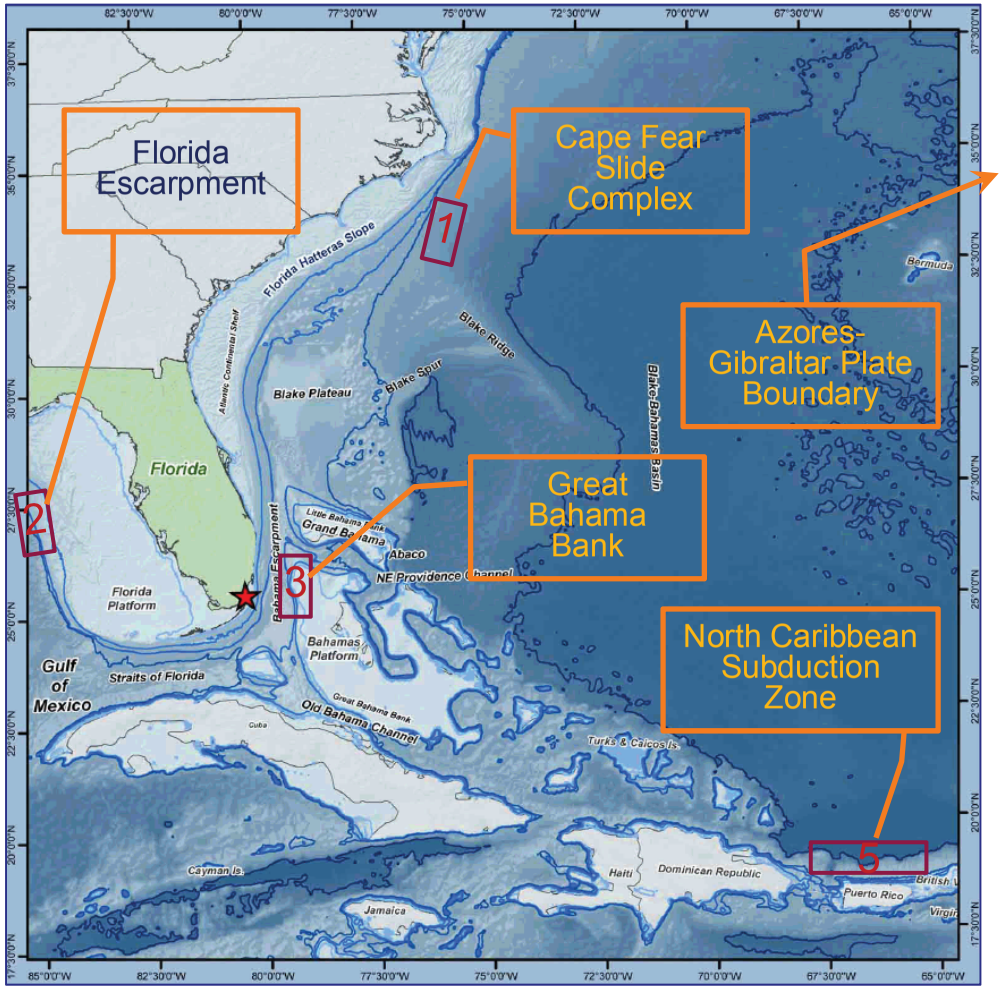
Potential PMT Sources

- **Submarine Landslide Sources**
  1. Cape Fear Slide Complex
  2. Florida Escarpment
  3. Great Bahama Bank

  – Tsunami elevation of 13.5 feet NAVD 88 from the Great Bahama Bank

- **Earthquake Sources**
  4. Azores-Gibraltar Plate Boundary
  5. North Caribbean Subduction Zone

  – Probable maximum tsunami elevation of 14.0 feet NAVD 88 from the Azores-Gibraltar earthquake source



Based on FSAR Figure 2.4.6-209:
Geophysical setting and seafloor topography

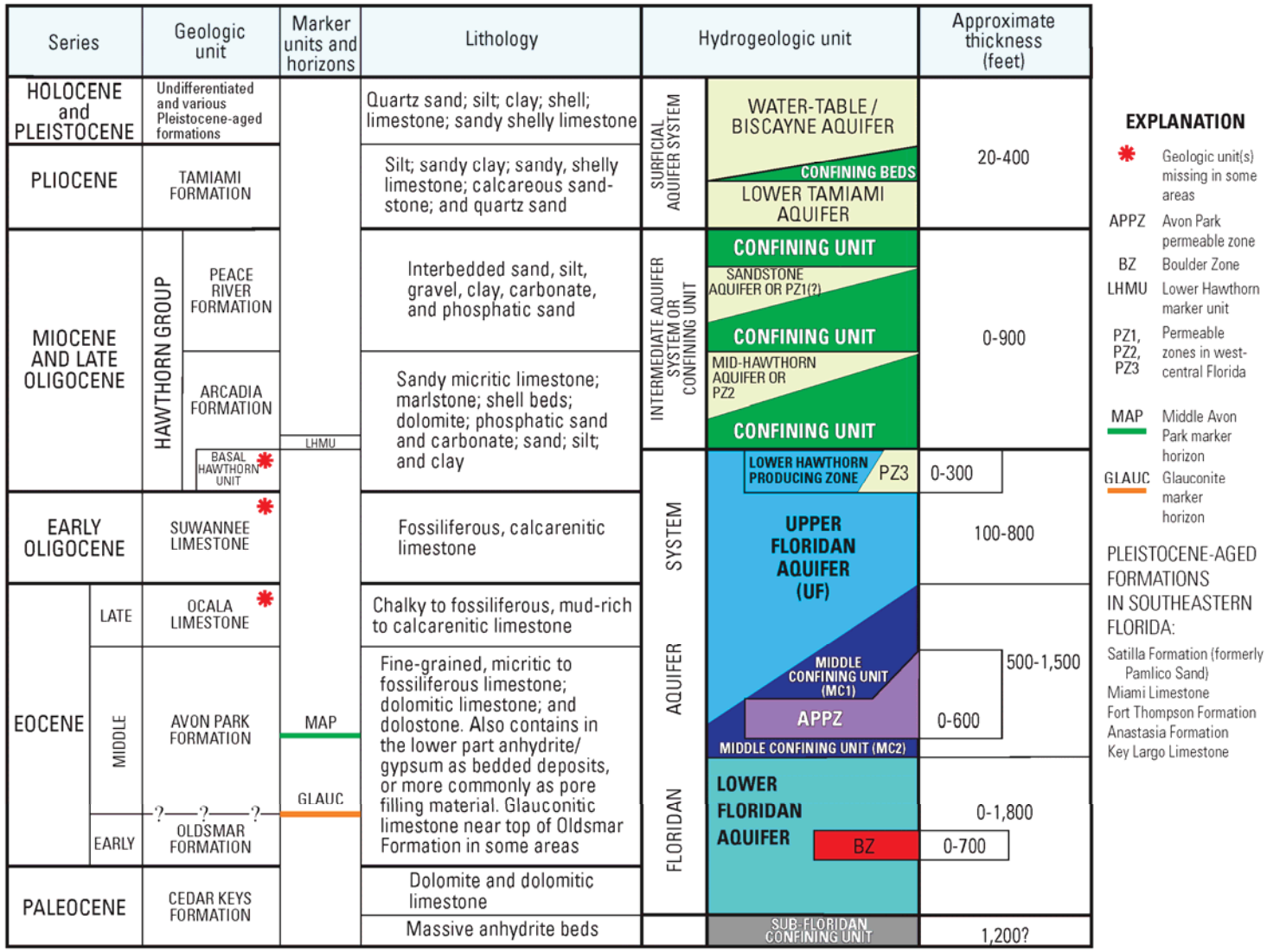
Subsection 2.4.12: Groundwater

Topics

- Hydrostratigraphic framework
- Maximum groundwater level
- Radial collector well operation
- Wastewater disposal (discussed in Section 11.2)

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.12: Groundwater



Regional Generalized Hydrostratigraphic Column

(FSAR Figure 2.4.12-202 [Source Reference 206])

Subsection 2.4.12: Groundwater

Surficial Aquifer System

- Biscayne aquifer and Tamiami formation
- Undifferentiated sand, silt and clay, shell, and shelly limestone (220 ft thick at site)
- Saline water quality in vicinity of site (unsuitable for potable water supply)

Intermediate Confining Unit

- Hawthorn group
- Relatively impermeable clayey deposits (700-1,000 ft thick at site)

Floridan Aquifer System (interbedded carbonate rocks)

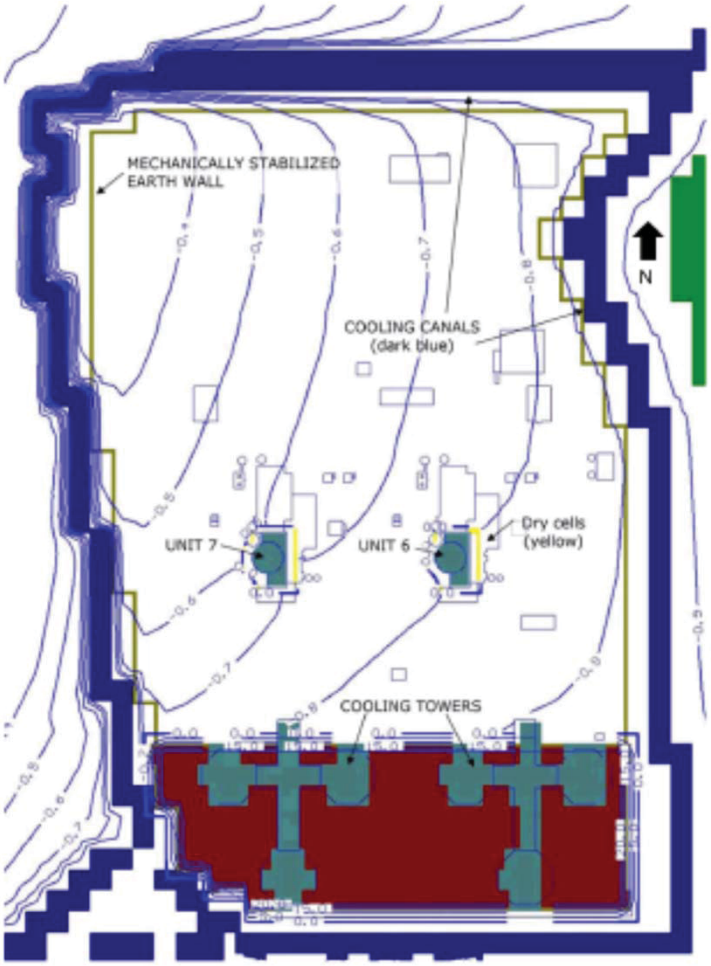
- Upper Floridan aquifer
  - Brackish water quality
- Middle confining unit
  - 1,000 ft thick at site
- Lower Floridan aquifer
  - Saline water quality
  - Includes highly transmissive interval called the Boulder Zone

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.12: Groundwater

Maximum Groundwater Level

- DCD site parameter requires maximum groundwater elevation ≥ 2 ft below plant grade
- Pre-existing site grade ≈ sea level
- Maximum site grade elevation = 25.5 ft NAVD 88 (plant grade = 26 ft NAVD 88)
- Maximum post-construction groundwater elevation ≈ 3 ft NAVD 88 (23 ft below plant grade)
- DCD requirements met
- Evaluation considered:
  - Sea level rise
  - Makeup water reservoir failure



Note: Groundwater level contours in ft NAVD 88.

Phase 2 Case 1 Simulated Groundwater Contours – Model Layer 1 Under Base-Case MWR Conditions
(FSAR Figure 2.4.12, 2CC-262)

Turkey Point Nuclear Plant Units 6 & 7

Subsection 2.4.12: Groundwater

Radial Collector Well (RCW) System

- Backup supply for cooling tower makeup water (86,400 gpm)
- 4 wells
- Each consists of central caisson on peninsula with radial, horizontal laterals extending under Biscayne Bay
  - Laterals up to 900 ft in length
  - Laterals 25-40 ft below bay bottom
- Operation limited to 60 days/12 months by permit
- Model results (continuous operation)
  - Drawdown limited to Units 1-5 plant site and peninsula
  - Water origins
    - -- Biscayne Bay: 97.8%
    - -- Inland sources: 2.2%

Radial Collector Well Drawdown within the Top Layer

(Based on FSAR Figure 2.4.12, 2CC-246)

Subsection 2.4.13: Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

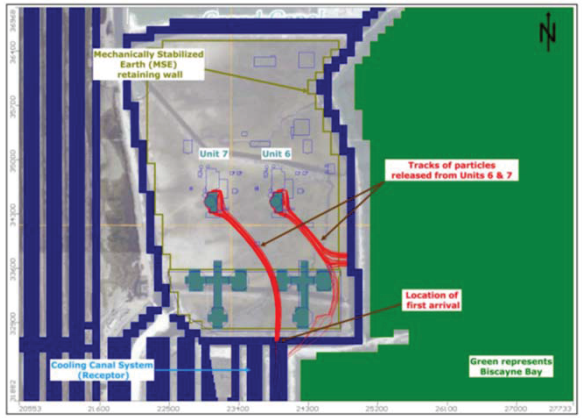
Approach

- Branch Technical Position 11-6

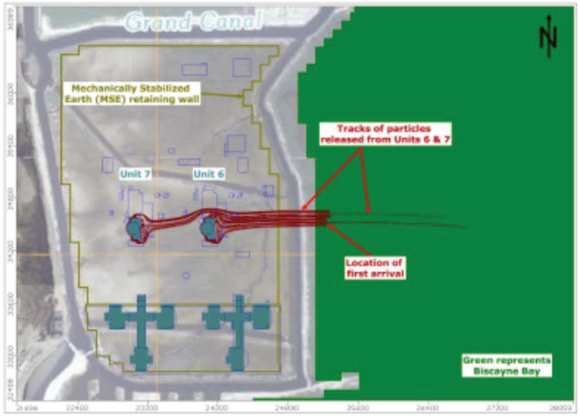
Groundwater

- Source
  - Postulated failure of effluent holdup tank located in auxiliary building
- Primary conceptual model (Case 1)
  - Release to groundwater, groundwater transport, discharge to Industrial Wastewater Facility (IWF), and migration from IWF to Biscayne Bay
  - IWF operational, RCW off
- Alternate conceptual model (Case 3)
  - Release to groundwater, groundwater transport, and discharge to Biscayne Bay
  - IWF not operational, RCW off

All Criteria related to accidental releases of radioactive liquid effluents have been met.



MODPATH Particle Tracking Case 1
Plan View (IWF-On, RCW-Off)
(FSAR Figure 2.4.13-202)



MODPATH Particle Tracking Case 3
Plan View (IWF-Off, RCW-Off)
(FSAR Figure 2.4.13-205)

Subsection 2.4.13: Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters

Groundwater (cont.)

- Exposure scenario
  - Consumption of fish and mollusk/crustaceans harvested from Biscayne Bay
- Exposure concentrations
  - Travel times and concentrations determined from surficial aquifer model
- Dose calculation
  - Bioaccumulation factors from RG 1.109
  - Fish and mollusk/crustacean dietary factors from ANL/EAD-4
  - Dose conversion factors from EPA-520/1-88-020
- Results
  - Bounding dose below regulatory limit (10 CFR Part 20.1301)

Surface Water

- AP1000 outdoor tanks do not contain radioactive material
- Accidental release directly to surface water is not plausible

Turkey Point Nuclear Plant Units 6 & 7
Day 1

- Introduction
- Chap. 1 General Description of the Plant
- Chap. 2 Site Characteristics
- Section 2.1 Geography and Demography
- Section 2.2 Nearby Industrial, Transportation, & Military Facilities
- Section 2.3 Meteorology
- Section 2.4 Hydrologic Engineering
- **Section 11.2 Liquid Waste Management System**

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Turkey Point Nuclear Plant Units 6 & 7

FSAR CHAPTER 11

Paul Jacobs
Engineering Supervisor
New Nuclear Projects

Chapter 11 – Radioactive Waste Management

- **AP1000 DCD incorporated by reference**
  - Site-specific information
    - -- Liquid Waste Management System, PTN SUP 11.2-1
      - – Liquid Waste Management System/Liquid waste piping integrity
      - – Deep Well Injection System
      - – Liquid effluent pathway analysis
        - » Groundwater modeling-Boulder Zone vertical and horizontal modeling
        - » Dose consequence

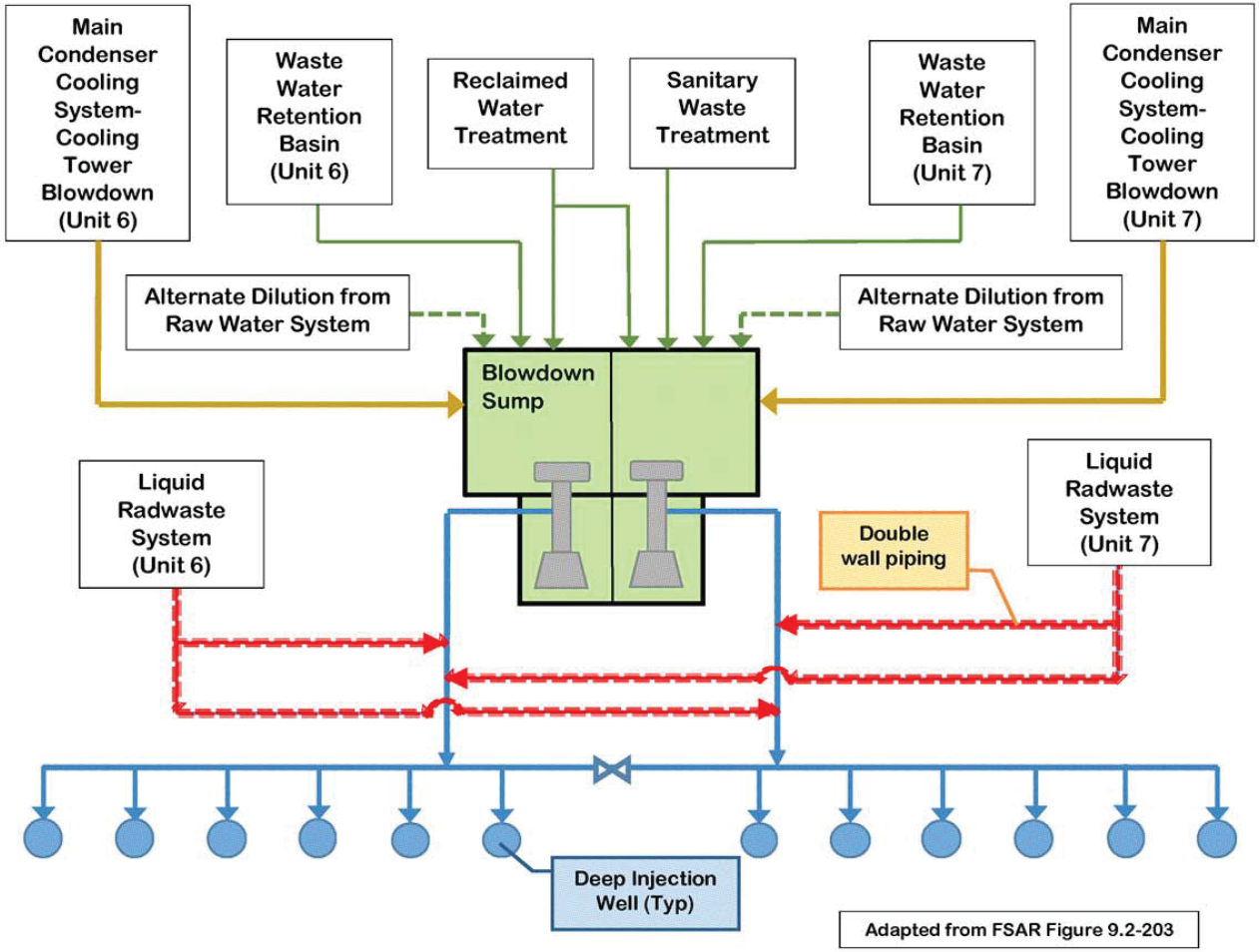
Liquid Waste Management System

Collection of liquid waste and liquid radioactive waste:

- **Liquid waste, wastewater from main condenser cooling system (blowdown), retention basin, and sanitary waste treatment system, collected in blowdown sump**
- **Processed liquid radioactive waste discharged to plant blowdown sump discharge line prior to release (injection)**
  - Required minimum dilution factor to control concentrations of liquid radioactive waste discharges to 10 CFR Part 20, Appendix B, effluent concentration limits met by specifying flow rates at blowdown sump discharge and liquid radwaste discharge lines
    - -- The required minimum dilution factor is calculated and applied prior to release of liquid radioactive waste
    - -- 6000 gpm typical dilution flow per unit (DCD Table 11.2-8)
  - Implementation of the liquid radioactive waste effluent control program in accordance with Units 6 & 7 Offsite Dose Calculation Manual

Turkey Point Nuclear Plant Units 6 & 7

Liquid Waste Management System Design



Liquid Waste Management System Design

Liquid Radwaste Piping Integrity/Monitoring

- **Liquid radwaste piping:**
  - The first section of piping (liquid radwaste system discharge pipeline) connects a combination of waste streams to the blowdown sump discharge piping downstream of the blowdown sump (red portion)
    - -- Guard-pipe enclosed
    - -- Leakage monitoring of pipe and underground pit where pipe ties into blowdown sump discharge implemented as part of Radiation Protection Program
  - The second section of piping (injectate piping) from the blowdown sump discharge connection point to deep injection wells
    - -- Single-walled, partially buried, constructed of steel
    - -- Piping, manifolds, valves, controls, and appurtenances designed to minimize inadvertent releases
    - -- Leakage monitoring consists of periodic visual inspection (accessible portions) as part of routine operation and maintenance activities or remote surveillance as part of Groundwater Monitoring Program

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Section 11.2 – Liquid Waste Management System

Discharge of Blowdown Water Site Dependent

- **Cooling water study performed to select discharge alternative**
  - Scope of study included analyzing alternatives for discharging blowdown from circulating water system (CWS)
  - Nine potential alternatives were identified within reasonable proximity
    - -- Biscayne Bay
    - -- Card Sound
    - -- Atlantic Ocean
    - -- Card Sound Canal
    - -- Turning Basin
    - -- Lower Floridan Aquifer (Boulder Zone)
    - -- Wastewater Treatment Plant
    - -- Existing Cooling Canal System
    - -- Wetlands Rehydration
  - The potential alternatives went through a screening process which considered:
    - -- Statutory or legal restriction prohibiting discharge
    - -- Capacity of water body/treatment system to treat or accommodate discharge
    - -- Technical feasibility of construction/operation of discharge alternative
  - Only one alternative determined to be feasible, deep well injection of blowdown discharge to the Boulder Zone

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Section 11.2 – Liquid Waste Management System

Lower Floridan Aquifer (Boulder Zone) Alternative for CWS Blowdown Discharge:

- **Consists of blowdown discharge via deep well injection system (DIS) to the Lower Floridan aquifer (Boulder Zone), approximately 3000 feet below ground surface (bgs)**

Boulder Zone - highly permeable zone containing saltwater:

- **Permitted by Florida Department of Environmental Protection for injection of sewage, industrial, and domestic wastes in South Florida**
  - Used in Florida for underground disposal of liquid waste since 1943
  - 180 active Class I injection wells permitted
    - -- Class I injection wells- industrial and municipal disposal wells which inject fluids beneath the lowermost unit containing an underground source of drinking water (USDW)
      - – Most municipal Class I wells dispose of treated municipal effluent
      - – Power plant industrial Class I wells primarily dispose of cooling tower blowdown

Liquid Waste Management System Design

DIS Design

- **12 Class I deep injection wells (10 primary/2 backup wells), 6 dual-zone monitoring wells, pipes, valves, pumps, and monitoring instrumentation**
- **Operation of DIS is identical for both reclaimed and saltwater—only number of deep injection wells used differs**
  - Reclaimed Water (4 cycles of concentration in cooling towers)
    - -- Deep well injection flow rate -12,500 gpm (normal) and 13,000 gpm (maximum) for two units
    - -- Liquid radwaste component - 3 gpm (normal) and 150 gpm (maximum) for two units
    - -- 3 deep injection wells sufficient (2 active/1 backup)
  - Saltwater (1.5 cycles of concentration in cooling towers)
    - -- Deep well injection flow rate - 58,000 gpm (normal) and 59,000 gpm (maximum) for two units
    - -- Liquid radwaste component is 3 gpm (normal) and 150 gpm (maximum) for two units
    - -- 11 deep injection wells sufficient (9 active/2 backup)

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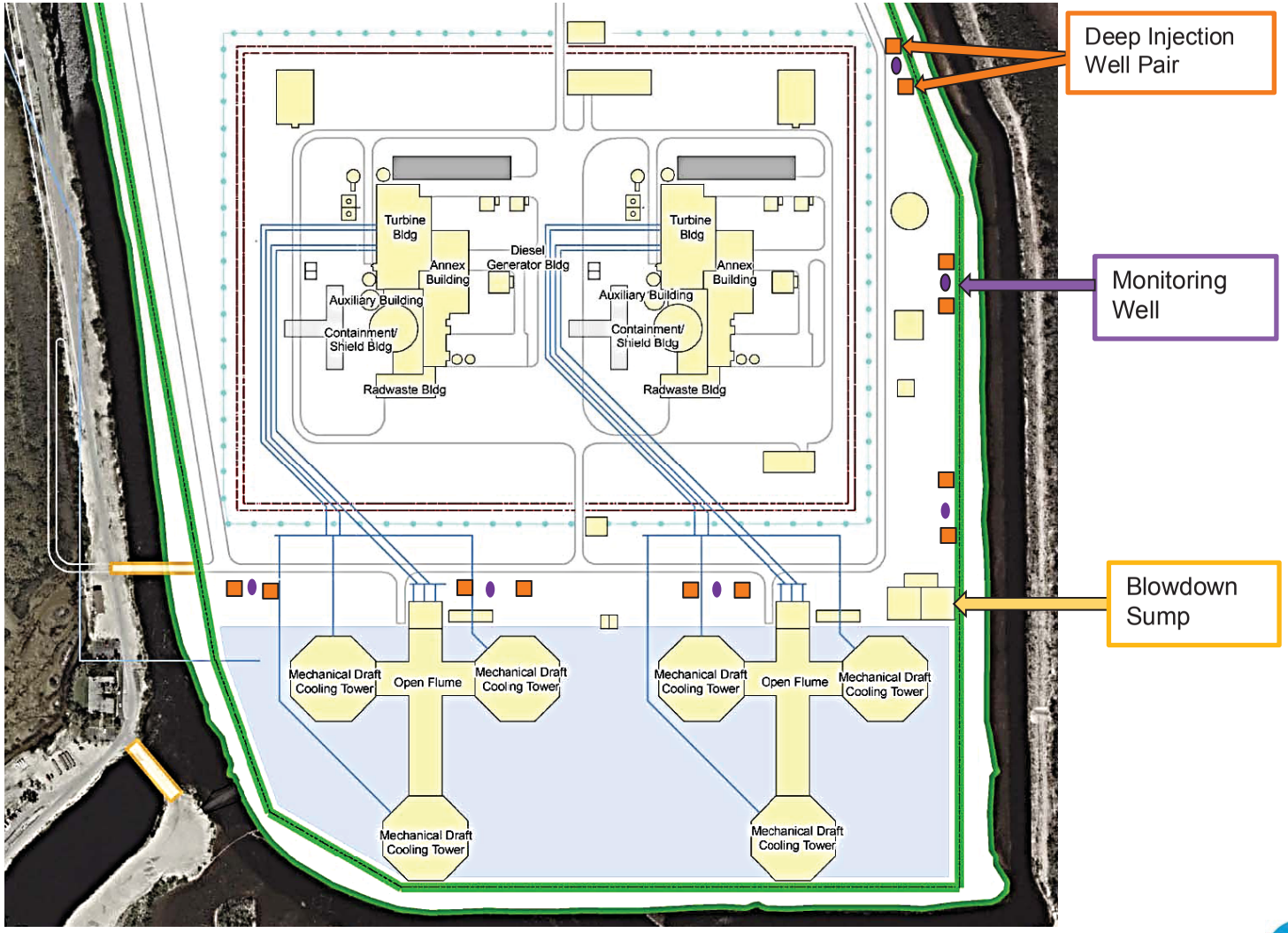
Turkey Point Nuclear Plant Units 6 & 7

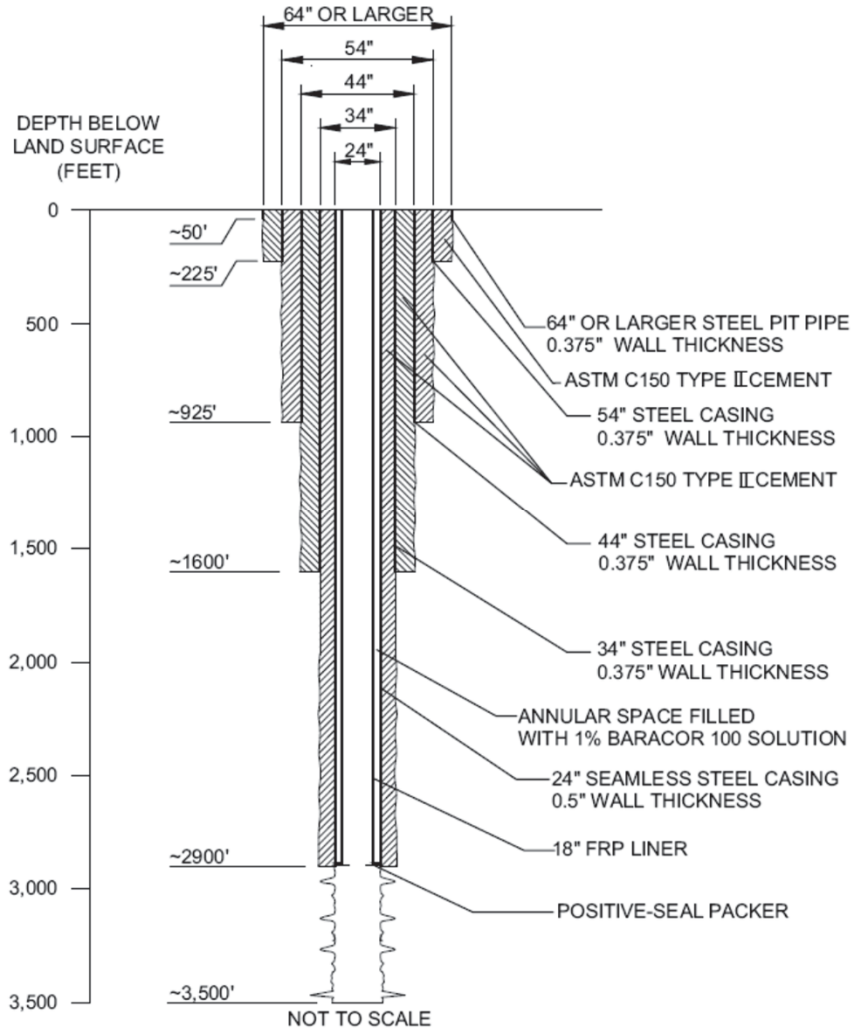
Liquid Waste Management System



Source: FSAR Figure 1.1-201 and ER Figure 2.3-4

Turkey Point Nuclear Plant Units 6 & 7

Liquid Waste Management System Design



Source: FSAR Figure 9.2-204

Liquid Waste Management System Design

DIS – Injection Well Design

- **Multiple concentric casings**
  - 54-, 44-, 34-, and 24-inch diameter steel fully cemented casings
  - 0.375-inch wall thickness except final casing is 0.5-inch
  - 34-inch and 24-inch diameter casings set below base of USDW
- **Fiberglass Reinforced Pipe (FRP) injection tubing**
  - 18-inch FRP injection tube installed within the final casing
  - Protects final casing from corrosion

DIS – Monitoring Well Design

- **Multiple concentric casings**
  - 34-, 24-, 16-, and 6.625-inch diameter casings
  - 34- and 24- inch diameter casings are 0.375-inch wall thickness steel; 16-inch diameter casing is 0.5-inch wall thickness steel; and 6.625-inch diameter casing is FRP to provide corrosion protection
- **Monitors two separate zones**
  - Upper Zone monitors just above or at the base of the USDW
  - Lower Zone monitors below the base of the USDW just above confining unit

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Testing During/At Completion of Construction

- **Injection Wells**
  - Cement bond log, temperature log, video survey and pressure test performed on 24-inch casing prior to installation of FRP liner to identify leaks on the 24-inch casing
  - Pressure test of annular space between 24-inch and FRP liner to identify leaks in 24-inch casing, FRP liner, seal at top and bottom of annulus
  - Video survey and temperature log of FRP liner to identify leaks in FRP liner
- **Monitor Wells**
  - Cement bond log, video survey and pressure test performed on 6.625-inch casing to identify leaks in 6.625-inch casing
  - Pressure test and video survey of 6.625-inch casing

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Testing During Operational Testing and Operation

- **Injection Wells**
  - Continuous pressure monitoring of annular space between 24-inch and FRP liner to identify leaks in 24-inch casing, FRP liner, or seal at top and bottom of annulus
  - Continuous flowrate monitoring to ensure maximum permitted flowrate is not exceeded
  - Continuous injection pressure monitoring to ensure maximum permitted injection pressure is not exceeded
  - Weekly sampling of waste stream
    - -- Chloride, total dissolved solids, sulfate, temperature, pH
    - -- Additional parameters likely to be added upon starting operational testing
    - -- Frequency to be reduced to monthly after 6 months and FDEP concurrence

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Testing During Operational Testing and Operation

- **Monitoring Wells**
  - Continuous water level monitoring of both monitoring intervals of each dual-zone monitor well
  - Water level monitoring detects development of holes in casings
  - Water level monitoring used to assist in identification of impacts to monitored intervals by injected fluids
  - Weekly sampling of both monitoring zones
    - -- Chloride, total dissolved solids, sulfate, temperature, pH
    - -- Additional parameters likely to be added upon starting operational testing
    - -- Frequency to be reduced to monthly after 6 months and FDEP concurrence

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Testing During Operational Testing and Operation

- **Injection Wells**
  - Mechanical Integrity Testing required every 5 years
    - -- Video survey – visual inspection of injection tubing, packer and open hole interval
    - -- High-resolution temperature logging – leak detection
    - -- Annular pressure test – test for leaks in tubing, final casing and packer
    - -- Radioactive tracer survey – test the integrity of the cement seal at the base of the final casing
    - -- Interpretation of previous five years of monitoring and operating data
    - -- Results summarized in report submitted to FDEP for review and approval

FPL

Section 11.2 – Liquid Waste Management System

DIS Design

- **Traditional disposal (discharge) method for liquid radioactive effluent**
  - Direct discharge to surface water where radioactive effluent is diluted and dispersed in receiving waters and immediately available for member-of-the-public exposure
- **Turkey Point Units 6 & 7 DIS**
  - Non-traditional disposal (discharge) method
  - Due to depth (approximately 3000 ft bgs) and presence of confining units, it is not expected, under normal operating conditions, that radioactivity injected into Boulder Zone would reach either an USDW or surface environment
- **FPL performed and provided an analysis under provisions of 10 CFR 20.2002 to demonstrate compliance with 10 CFR Part 50, Appendix I**
  - Radiological assessment methods used to quantify radiological impacts and demonstrate compliance with NRC regulations for effluents discharged in surface water bodies are not directly applicable

Section 11.2 – Liquid Waste Management System

Performance Assessment

- **Performed to assess the environmental fate and transport of liquid effluent discharged via DIS to the Boulder Zone**
  - Liquid Effluent Pathway Analysis
    - -- Designed to identify any appropriate member-of-the-public receptors and ultimately determine the Maximally Exposed Individual (MEI) through a process in which postulated exposure scenarios were screened for feasibility/credibility
    - -- In determining exposure scenarios extraordinary events/assumptions had to be postulated in order for the scenario to result in a member of the public being exposed to radioactive effluents
    - -- Culminated in an assessment of doses potentially delivered to the MEI as a result of the injection of radioactive effluent to the Boulder Zone
    - -- MEI dose assigned using Regulatory Guide 1.109

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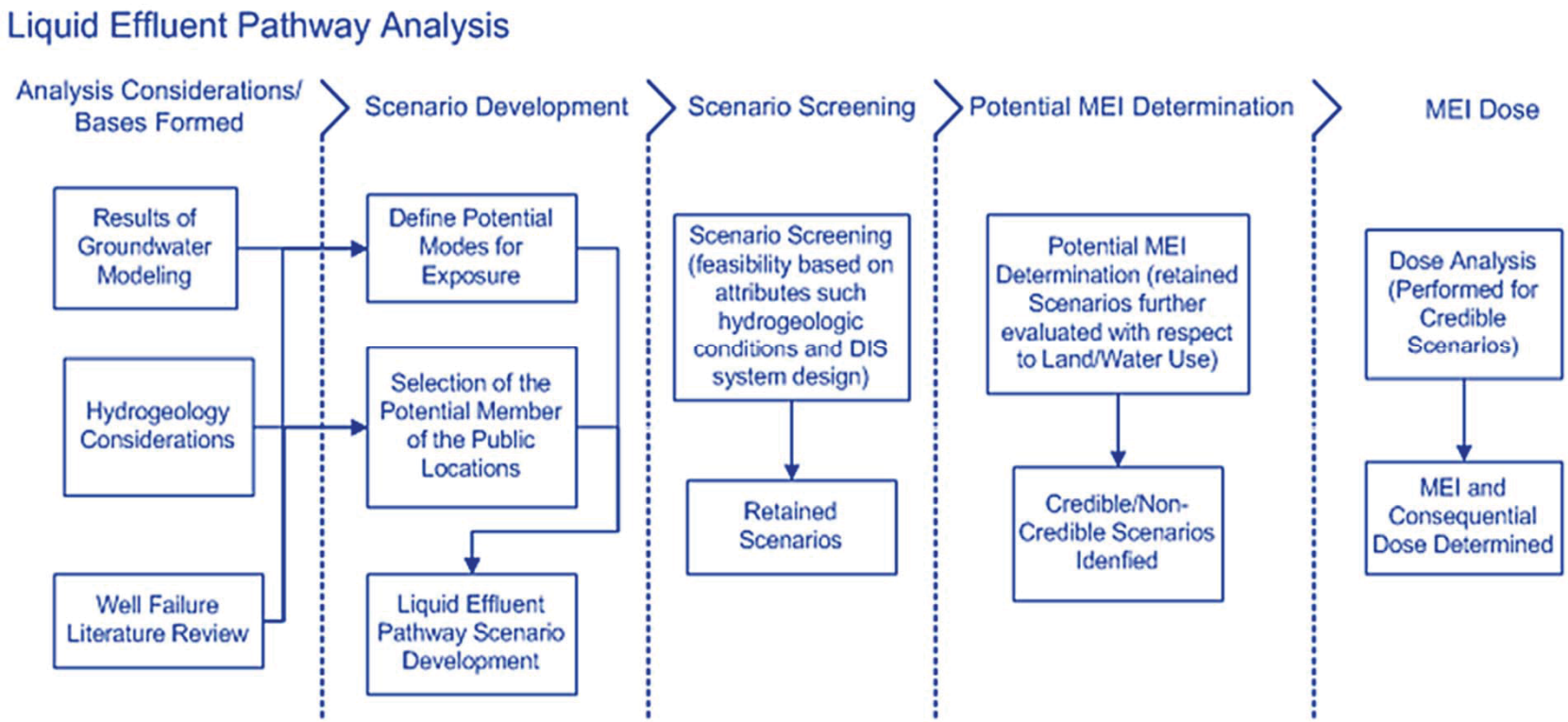
Turkey Point Nuclear Plant Units 6 & 7

Section 11.2 – Liquid Waste Management System

Process:



Section 11.2 – Liquid Waste Management System

Liquid effluent pathway analysis considerations/bases

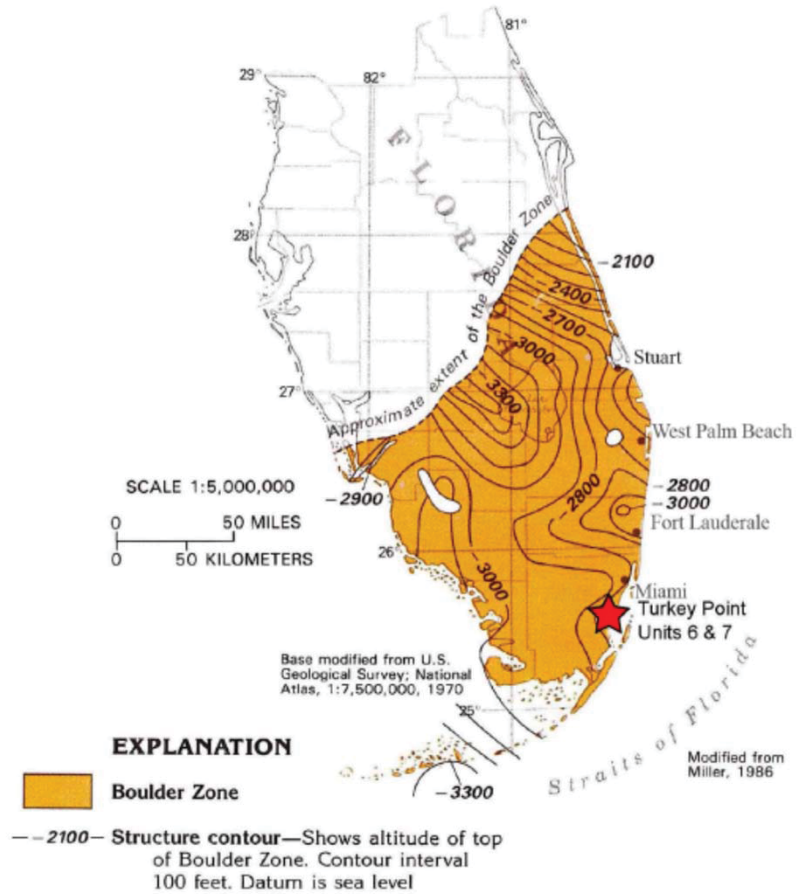
- **Because liquid effluent is released via deep well injection, there is no surface release; groundwater transport is the only exposure pathway**
  - Groundwater Modeling
    - -- Radial Transport
    - -- Vertical Transport
  - Hydrogeology
  - Well Failure
  - Land Use

Turkey Point Nuclear Plant Units 6 & 7

Groundwater Modeling Deep Well Injection

Boulder Zone Characteristics

- **Areally extensive**
- **3,000 ft below ground surface at site**
- **500 ft thick**
- **Highly transmissive**
  - 250,000 ft^2/d at site
- **Relatively stagnant**
- **Used for municipal and industrial wastewater disposal**
  - Located below underground sources of drinking water (USDW)
  - 180 Class I injection wells permitted



The Boulder Zone in Southern Florida
Source: FSAR Figure 2.4.12-241

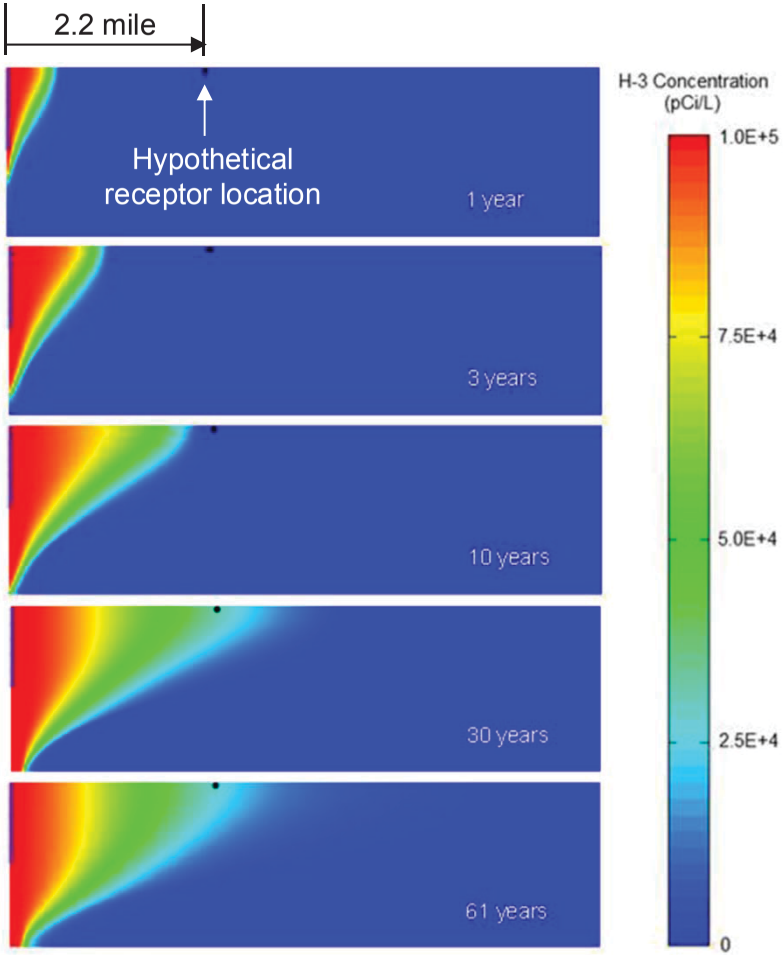
Groundwater Modeling Deep Well Injection

Radial Transport Model in the Boulder Zone (BZ)

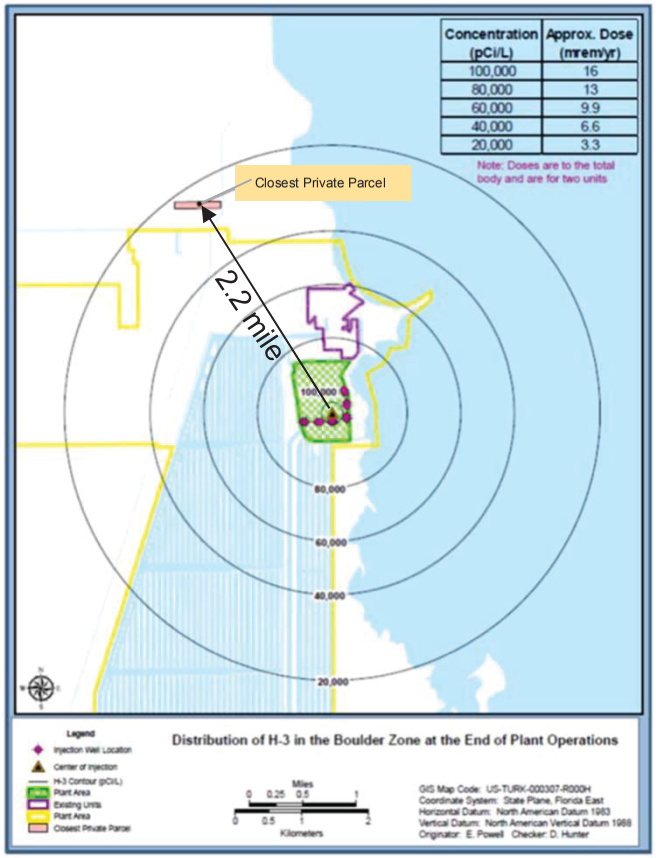
- **Objective**
  - Determine radionuclide concentrations and spatial distributions in BZ
  - Provide input to MEI dose calculation
- **Variable density groundwater flow and transport model (SEAWAT)**
  - Injectate density differs from BZ water (36.2 kg/m^3 TDS)
    - -- Cycled reclaimed water (2.7 kg/m^3 TDS) => “floats”
    - -- Cycled saltwater from radial collector well (57.0 kg/m^3 TDS) => “sinks”
- **Conceptual model**
  - Two-dimensional, radially symmetric flow
  - BZ confined
  - Continuous injection
- **Radionuclides of interest**
  - H-3, Sr-90, Cs-134 and Cs-137 => 99% of dose
  - No adsorption

Turkey Point Nuclear Plant Units 6 & 7

Groundwater Modeling Deep Well Injection



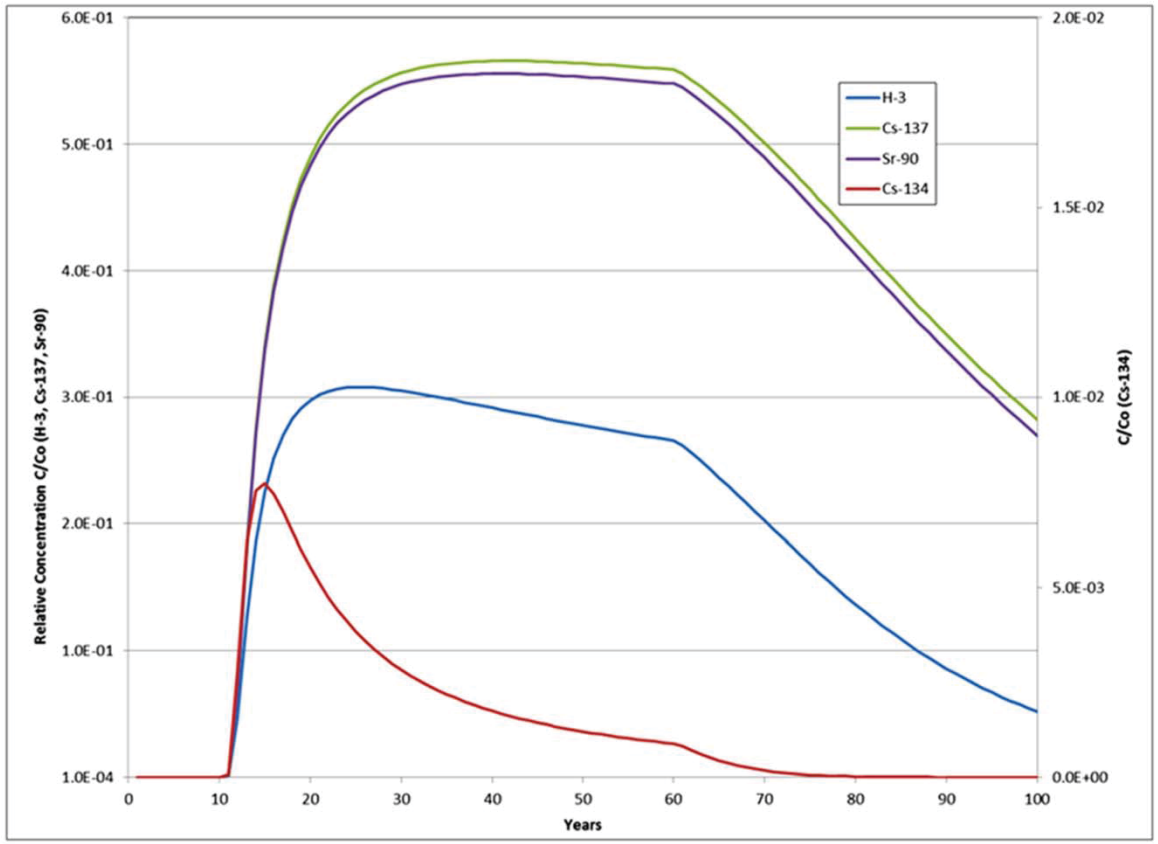
Base Case Boulder Zone Tritium Concentrations
Source: FSAR Figure 11.2-201



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

Turkey Point Nuclear Plant Units 6 & 7

Groundwater Modeling Deep Well Injection

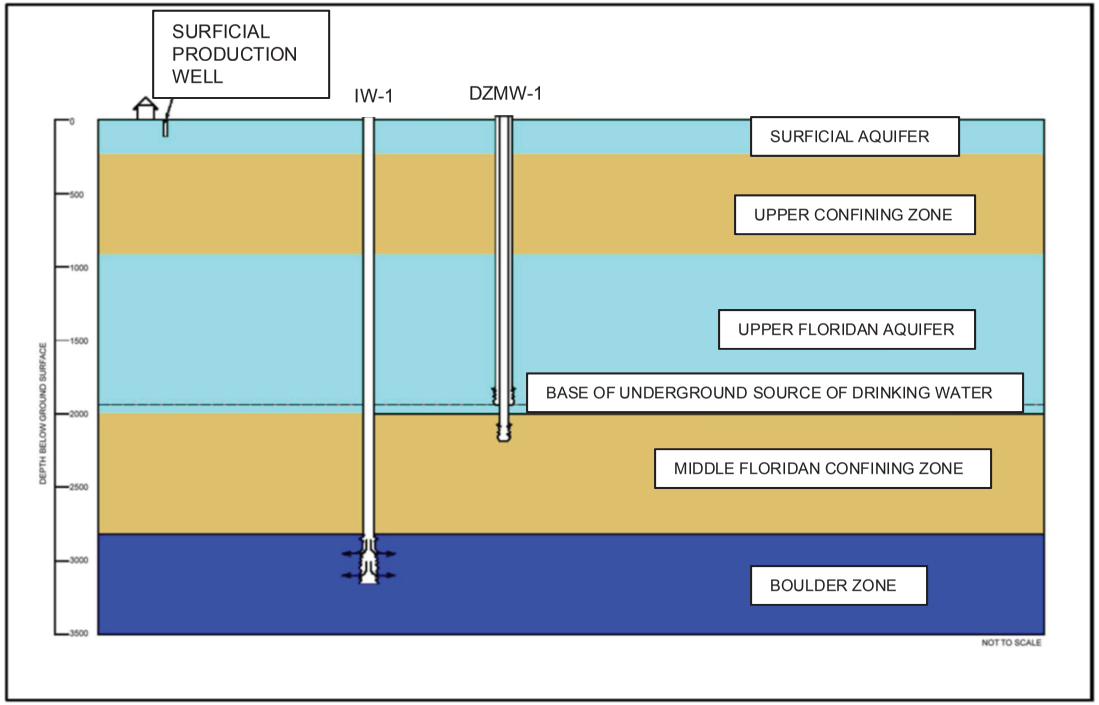


Model Layer 1 Base Case Relative Breakthrough Curves at 2.2-mile Hypothetical Receptor Location
Source: FSAR Figure 11.2-209

Groundwater Modeling Deep Well Injection

Vertical Transport Model

- **Objective**
  - Evaluate upward migration of injectate from BZ through the Middle Confining Unit to the Upper Floridan aquifer
- **Model attributes**
  - Variable density groundwater flow and transport model (SEAWAT)
  - 3D model simulating injection of cycled reclaimed water into BZ
- **Model results**
  - 300 ft vertical migration into Middle Confining Unit after 100 years
  - Migration of radionuclides out of the BZ not significant

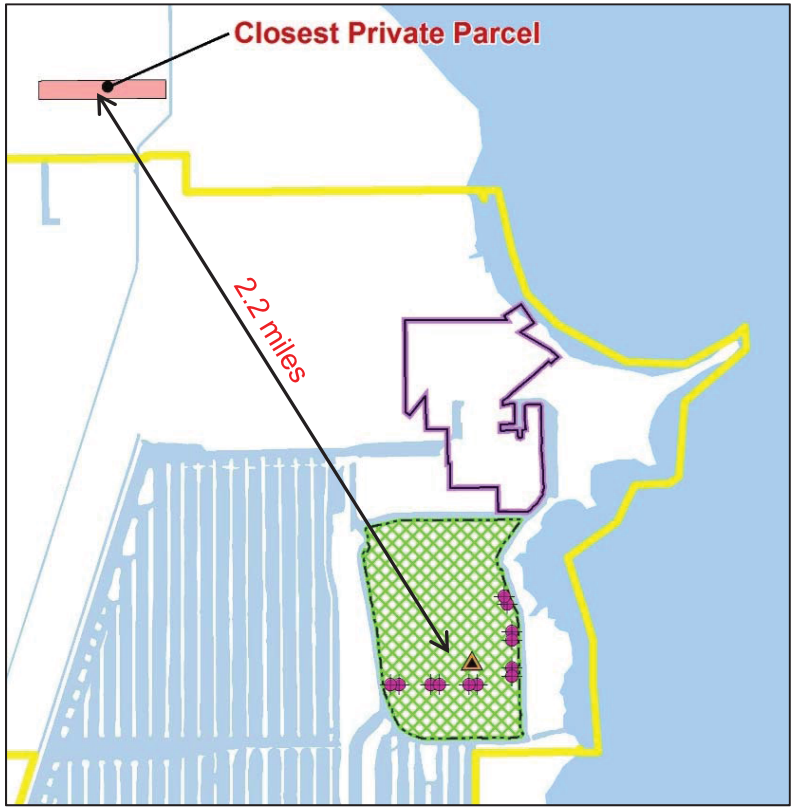


Typical Injection Well System
Source: FSAR Figure 2.4.12-244

Turkey Point Nuclear Plant Units 6 & 7

Section 11.2 – Liquid Waste Management System

- **Scenario Development/Screening**
  - Under normal operation, radiological exposure of any consequence to the public is incredible. However, to meet the requirements of Regulatory Guides 1.109 and 1.113, developed for surface water discharge systems, the following process was used:
    - -- Potential exposure modes identified
    - -- Selection of the potential member-of-the-public locations
    - -- Liquid effluent pathway scenario development
- **MEI Determination**
  - Two scenarios ultimately evaluated at MEI location 2.2 miles away:
    - -- Off-normal operation
    - -- Inadvertent intrusion (bounding)



Location of Closest Private Parcel
Source: FSAR Figure 11.2-211

Section 11.2 – Liquid Waste Management System

MEI Dose Analysis

- **Inadvertent Intrusion –Member of the public drills well into the Upper Floridan aquifer immediately above a failure in the middle confining unit, resulting in following exposure pathways:**
  - Ingestion of water and irrigated vegetables, milk and meat
  - Inhalation of airborne contaminants in vapor cloud formed from evaporation of a postulated liquid puddle formed during drilling of well
  - Immersion in vapor cloud from evaporation of a postulated liquid puddle formed during drilling of well
  - Exposure to direct radiation from contamination in puddle formed on the ground during drilling of well
  - Applies to MEI only, as the well is assumed to be on private property

Section 11.2 – Liquid Waste Management System

MEI Dose Analysis—Liquid Effluent

- **Ingestion doses are calculated using the LADTAP II computer program**
  - Effective decay time during transit determined for each radionuclide, based on concentrations at injection point (calculated using DCD Table 11.2-7 release rate and site-specific dilution flow rate of 6230 gpm per unit) and the MEI location (calculated using SEAWAT)
  - A separate LADTAP II run is made for each radionuclide, with the release rate being the DCD Table 11.2-7 value multiplied by 365/292 (scaling the assumed days of operation in DCD to full calendar year) and transit time being the calculated decay time
  - LADTAP II runs are for two units, consistent with the SEAWAT model for peak concentrations
  - Doses during drilling via inhalation, immersion, and deposition pathways are calculated using Environmental Protection Agency guidance and Regulatory Guide 1.109

Section 11.2 – Liquid Waste Management System

MEI Dose Analysis-Liquid Effluent

Inadvertent Intrusion Subsidence Driller Dose Summary

Pathway	Dose (mrem/year) per Unit[b]	
	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.

(b) Doses are calculated based on the operation of two units, as this maximizes the doses at offsite receptors. The calculated two-unit dose is then divided by two to obtain the dose per unit.

Source: FSAR Table 11.2-209

Calculated doses meet 10 CFR 50 Appendix I

Section 11.2 – Liquid Waste Management System

Bounding MEI Dose Analysis

- **In assigning a 10 CFR 50 Appendix I compliance dose, extremely conservative assumptions were invoked:**
  - Radionuclide Transport in Groundwater
    - -- Radionuclide concentrations are not depleted by sorption to the subsurface matrix
    - -- Boulder Zone is a confined, non-leaky aquifer (minimizing decay time)
    - -- Injection occurs continuously (minimizing decay time)
  - MEI Exposure Scenario
    - -- Subsistence driller
      - – Ignores all notification and permitting requirements for a large drilling operation
      - – Has the financial ability to plan and undertake a large drilling operation
      - – Effectively drills into the Boulder Zone (confinement and Upper Floridan dispersion ignored)
      - – Is unprotected while continually exposed to affected water, mist, and drill cuttings
      - – Uses affected water to maintain livestock and food crops
      - – Harvests and consumes affected livestock and food crops
      - – Dose due to inhalation, immersion, and deposition is doubled
      - – Is always in the age group receiving the maximum dose (‘omnireceptor’)
    - -- Peak isotopic concentrations are concurrent

Boulder Zone salinity is similar to seawater.

QUESTIONS?