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2.4.12 GROUNDWATER

This subsection contains a description of the hydrogeologic conditions present at and in the area around Units 6 & 7. Regional and site-specific data on the physical and hydrogeologic characteristics of the groundwater system and existing and potential use of groundwater is summarized.

2.4.12.1 Description and Onsite Use

This subsection contains a description of the regional and local physiography and geomorphology, groundwater aquifers, geologic formations, and groundwater sources and sinks. Onsite uses of groundwater are also described, including groundwater production wells and groundwater flow requirements for Units 6 & 7.

2.4.12.1.1 Physiography and Geomorphology

Units 6 & 7 are located in Miami-Dade County, Florida, approximately 25 miles south of Miami and approximately 9 miles southeast of Homestead. Units 6 & 7 are located in the Southern Slope sub-province of the Southern Zone of the Florida Platform (a partly submerged peninsula of the continental shelf) in the Atlantic Coastal Plain physiographic province as shown in Figure 2.4.12-201. The plant property is bordered on the east by Biscayne Bay, on the west by the FPL Everglades Mitigation Bank, and on the northeast by Biscayne National Park. The Florida Platform is underlain by approximately 4000 to 15,000 feet of clastic deposits (quartz sands, silt, marl, and clay) and nonclastic deposits of carbonate sediments (shell beds, calcareous sandstone, limestone, dolostone, dolomite, and anhydrite). The sediments range in age from Paleozoic to Recent. A detailed description of the regional and site-specific geology, physiography, and geomorphology is provided in Subsections 2.5.1.1 and 2.5.1.2.

The physiographic features near Units 6 & 7 are the Atlantic Coastal Ridge, the Everglades, and the Florida Keys. The geomorphology of Florida has been described in the literature (References 201 and 202) as having three zones: Northern, Central, and Southern. The Units 6 & 7 plant area is in the Southern Zone (Figure 2.4.12-201). The Units 6 & 7 plant area spans former coastal mangrove swamps and tidal flats along the west margin of Biscayne Bay that were altered to develop the existing units and cooling canals.

The 5900-acre industrial wastewater facility (approximately 2 miles wide and 5 miles long), of which 4370 acres is water (approximately 75 percent), is a predominant feature at the plant property (Subsection 2.4.12.1.5.3).

The surficial geology of the Units 6 & 7 plant area consisted primarily of organic muck. The organic muck is described as either light gray-dark gray to pale brown with trace amounts of shell fragments and little to no reaction to hydrochloric acid and/or black to brown with organic fibers and strong reaction to hydrochloric acid. The thickness of the muck across the plant area typically varied from 2 to 7 feet, with an average of 3.4 feet (Reference 248). The underlying Miami Limestone is a marine carbonate consisting predominately of oolitic facies of white to gray limestone with fossils (mollusks, bryozoans, and corals).

2.4.12.1.2 Regional Groundwater Aquifers

The hydrostratigraphic framework of Florida consists of a thick sequence of Cenozoic sediments that comprise three major aquifers: (1) the surficial aquifer system, (2) intermediate aquifer system/confining unit, and (3) the Floridan aquifer system (Reference 204). The hydrologic parameters and lithologies of each aquifer system vary widely across the state. A generalized hydrostratigraphic column is presented in Figure 2.4.12-202.

2.4.12.1.2.1 Surficial Aquifer System

The surficial aquifer system is defined by the Southeastern Geological Society Ad Hoc Committee (Reference 204) as the permeable hydrologic unit contiguous with the land surface that is comprised principally of unconsolidated to poorly indurated, siliciclastic deposits. Rocks making up the surficial aquifer system belong to all or part of the Upper Miocene to Holocene Series, consisting mainly of quartz sands, shell beds, and carbonates. In southern Florida, the surficial aquifer system consists of the Tamiami, Caloosahatchee, Fort Thompson, and Anastasia Formations, the Key Largo and Miami Limestones, and the undifferentiated sediments (Reference 204).

The surficial aquifer is under primarily unconfined conditions, although beds of low permeability may cause semi-confined or locally confined conditions to prevail in its deeper parts. The lower limit of the surficial aquifer system coincides with the top of the laterally extensive and vertically persistent beds of much lower permeability. The primary aquifer in the surficial aquifer system in southeastern Florida to which a name has been applied is the Biscayne aquifer, which immediately underlies the plant area. The thickness of the surficial aquifer ranges from approximately 20 to 400 feet (Figure 2.4.12-202).

The Biscayne aquifer has been declared a sole-source aquifer by the EPA. The EPA defines a sole-source aquifer as “an underground water source that supplies at least 50 percent of the drinking water in the area overlying the aquifer. These areas have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend on the aquifer for drinking water." Figure 2.4.12-203 (Reference 205) shows the locations of sole-source aquifers in EPA Region 4, which encompasses the Units 6 & 7 plant area. The figure also contains a description of the Biscayne sole-source aquifer. The Biscayne aquifer in the area of Units 6 & 7 contains saline to saltwater and is not useable as a potable water supply.

2.4.12.1.2.2 Intermediate Aquifer System/Confining Unit

Regionally, a sequence of relatively low-permeability, largely clayey deposits up to 900 feet thick form a confining unit that separates the Biscayne aquifer from the underlying, fresh to saline water Floridan aquifer system. The confining unit also contains transmissive units that can locally act as an aquifer.

The Southeastern Geological Society (Reference 204) defines the intermediate aquifer system/confining unit as all rocks that lie between and collectively retard the exchange of water between the overlying surficial aquifer system and the underlying Floridan aquifer system. In general, the rocks of this system consist of fine-grained siliciclastic deposits interlayered with carbonate strata of Miocene or younger age. In areas where poorly yielding to non-water yielding units occur, the term intermediate confining unit is used. In areas where low to moderate yielding units are interlayered with relatively impermeable confining beds, the term intermediate aquifer system applies. The aquifer's units in this system contain water under confined conditions. The top of the intermediate aquifer system/confining unit coincides with the base of the surficial aquifer system. The base of the intermediate aquifer, or confining unit, is at the top of the vertically persistent, permeable, carbonate section that comprises the Floridan aquifer system. The sediments comprising the intermediate aquifer system/confining unit are widely variable across the state. In the southern part of the state, the Hawthorn Group sediments form both an intermediate confining unit and an intermediate aquifer system. The Hawthorn Group sediments are up to approximately 900 feet thick in southern Florida (Figure 2.4.12-202) (Reference 206). In many areas of the state, permeable carbonates occurring at the base of the Hawthorn Group may be hydraulically connected to the Floridan aquifer system and locally form the top of the Upper Floridan aquifer. The intermediate confining unit provides an effective aquiclude for the Floridan aquifer system throughout the state.

2.4.12.1.2.3 Floridan Aquifer System

The Floridan aquifer system underlies approximately 100,000 square miles in southern Alabama, southeastern Georgia, southern South Carolina, and all of Florida. Potable water is not present everywhere in the aquifer. As defined by Miller (Reference 207), the Floridan aquifer system is a vertically continuous sequence of interbedded carbonate rocks of Tertiary age that are hydraulically interconnected by varying degrees and with permeabilities several orders of magnitude greater than the hydrogeologic systems above and below. The system may occur as a continuous series of vertically connected carbonate sediments or may be separated by subregional to regional confining beds (Reference 207). The Floridan aquifer formally consists of three primary hydrogeologic units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer (Figure 2.4.12-202). Porosity and permeability in the aquifer units vary widely depending on location and formation.

In southern Florida, the Floridan aquifer system is composed of all or parts of the Cedar Keys Formation, Oldsmar Formation, Avon Park Formation, Ocala Limestone, Suwannee Limestone and, possibly, the basal carbonates of the Hawthorn Group in limited areas.

In peninsular Florida, the top of the Floridan aquifer system ranges in elevation from approximately 0 feet National Geodetic Vertical Datum of 1929 (NGVD 29) to more than –1100 feet NGVD 29 with thicknesses ranging from approximately 2300 feet to more than 3400 feet in southern Florida (Reference 207). Throughout most of southern Florida, the Floridan aquifer system occurs under confined conditions.

2.4.12.1.3 Local Hydrogeology

Two major regional aquifers underlie the area, including all of Miami-Dade County and the Units 6 & 7 plant area: (1) the surficial aquifer system, including the Biscayne aquifer, and (2) the Floridan aquifer system consisting of the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer. A generalized regional hydrostratigraphic column is presented in Figure 2.4.12-202. A site-specific hydrostratigraphic column, developed from hydrogeologic data obtained from borings drilled up to a maximum depth of approximately 615 feet bgs as part of the Units 6 & 7 geotechnical investigation, (Reference 248) is presented in Figure 2.4.12-204.

The Biscayne aquifer, as shown in Figure 2.4.12-205, extends from near surface to a depth of approximately 240 feet near Fort Lauderdale and approximately 80 to 115 feet locally (Figure 2.4.12-206). The Upper Floridan aquifer extends from approximately 1000 to 1200 feet bgs. The middle confining unit extends from approximately 1200 to 2400 feet bgs. The Lower Floridan aquifer extends from approximately 2400 feet bgs to an undetermined depth thought to be greater than 4000 feet bgs in the Miami-Dade County area (Reference 206). The Boulder Zone in the Lower Floridan aquifer extends from approximately 2800 to greater than 3000 feet bgs at the MDWASD South District Wastewater Treatment Plant (Reference 208), which is located approximately 9 miles north of Units 6 & 7.

2.4.12.1.3.1 Surficial (Biscayne) Aquifer

The surficial aquifer system comprises all the rocks and sediments from the land surface downward to the top of the intermediate confining unit. These lithologic materials consist primarily of limestones and sandstones with sands, shells, and clayey sand with minor clays and silts. The base of the system is defined by a significant change in hydraulic conductivity. Sedimentary bedrock and unconsolidated sediments in the surficial aquifer system have a wide range of hydraulic properties and locally may be divided into one or more aquifers separated by less permeable or semi-confining units. Within the surficial aquifer system, the major water producing unit is the unconfined Biscayne aquifer that underlies the Units 6 & 7 plant area and most of Miami-Dade County and parts of Broward, Monroe, and Palm Beach counties, as shown in Figure 2.4.12-205. The aquifer contains carbonate rocks, sandstones, and sands extending from an elevation –10 feet NGVD 29 in southern Miami-Dade County and deepening northward to more than –240 feet NGVD 29 in southeastern Palm Beach County and eastern Broward County (Figure 2.4.12-206). The surfical aquifer system formations include, from oldest to youngest (bottom to top): the Tamiami Formation, Caloosahatchee Formation, Fort Thompson Formation, Anastasia Formation, Key Largo Limestone, Miami Limestone, and Pamlico Sand (Reference 209). However, the entire sequence of units is not present in any one place. At Units 6 & 7, the formations in the Biscayne aquifer include the limestones of the Miami Limestone, Key Largo Limestone, and Fort Thompson Formation (Figure 2.4.12-204). The Fort Thompson Formation and Key Largo Limestone (interpreted as the Upper Fort Thompson Formation elsewhere) are the major water producing formations in the Biscayne aquifer (Reference 210). Site-specific boring data indicate that the maximum thickness of the Biscayne aquifer is approximately 115 feet at Units 6 & 7 (Reference 248).

The water table occurs primarily within the organic soils (muck) or the Miami Limestone and fluctuates in response to variations in tide levels, water levels in the adjacent canals, recharge, natural discharge, and well withdrawal/injection. The aquifer extends beneath Biscayne Bay and the Atlantic Ocean, and because of the aquifer's high permeability and in response to the lowering of inland groundwater levels as a result of pumpage, saltwater has migrated inland along the base of the aquifer and affects the entire coastal zone. Saltwater moves inland and upward in response to low groundwater levels and moves seaward and downward in response to high groundwater levels (Reference 211).

Biscayne aquifer groundwater use in the immediate vicinity of Units 6 & 7 has been limited as a result of its saline to saltwater composition. Figure 2.4.12-207 (Reference 212) shows the approximate location of the freshwater-saltwater interface in the area. The figure indicates that the saltwater interface at the base of the aquifer is approximately 6 to 8 miles inland of Units 6 & 7. Provisional data from the USGS (Reference 203) showing the 2008 freshwater-saltwater in southeast Florida indicates a similar pattern to that shown in Figure 2.4.12-207.

2.4.12.1.3.2 Intermediate Confining Unit

The intermediate confining unit (upper confining unit for the Upper Floridan aquifer) extends from the base of the surficial aquifer system to the top of the Floridan aquifer system and is characterized by the complex interbedded lithologies of the Hawthorn Group. These lithologies consist primarily of silty clay, calcareous sands, silts, calcareous wackestones, limestones, sandstones, and sands, and obtain a thickness of approximately 600 to 1050 feet at Turkey Point (Reference 217). The top of the Hawthorn Group occurs at approximately –100 to –200 feet MSL in the vicinity of the site. The unit is not exposed at the land surface and is recharged primarily by downward leakage from the overlying surficial aquifer or upward leakage from the Upper Floridan aquifer. Sand beds and limestone lenses comprise the permeable parts of the system, however, the overall hydraulic conductivity of the group is very low and provides good confinement for the underlying Floridan aquifer system.

2.4.12.1.3.3 Floridan Aquifer System

The Floridan aquifer system underlies Units 6 & 7 and all of Florida. The system formally consists of three primary hydrogeologic units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer (Figure 2.4.12-202). In the Miami-Dade County area, the top of the Floridan aquifer system is found at a depth of approximately 900 feet bgs, is approximately 3000 feet thick, and is directly overlain by the intermediate confining unit. The Floridan aquifer system forms the deepest part of the active groundwater flow system in southeastern Florida (References 204 and 217).

Floridan Aquifer System: Upper Floridan Aquifer

The topmost hydrogeologic unit of the Floridan aquifer system is the Upper Floridan aquifer. This unit is overlain by the surficial aquifer system and the intermediate confining unit, of which the latter acts as a confining layer to the Upper Floridan aquifer (Reference 213). The Upper Floridan aquifer consists of several thin water-bearing zones of high permeability interlayered with thick zones of low permeability. The hydrogeology of the Upper Floridan aquifer varies throughout Florida. In southeastern Florida, the aquifer has been interpreted to include a thinner Suwannee Limestone and extends down into the Avon Park Formation. Confinement is typically better between flow zones in southwestern Florida than in southeastern Florida (Reference 206). In southeastern Florida, the Upper Floridan aquifer ranges from 100 to greater than 400 feet in thickness as shown in Figure 2.4.12-208. In the vicinity of the Turkey Point plant property area, the Upper Floridan aquifer is approximately 200 feet thick.

Although the Upper Floridan aquifer is a major source of potable groundwater in much of Florida, water withdrawn from the unit in southeastern Florida, including Miami-Dade County, is brackish and variable in quality.

Floridan Aquifer System: Middle Confining Unit

The middle confining unit of the Floridan aquifer system underlies the Upper Floridan aquifer, separating it from the Lower Floridan aquifer. In many places, the middle confining unit is divided into upper and lower units separated by the Avon Park permeable zone. The middle confining unit contains beds of micritic limestone (wackestone to mudstone), dolomitic limestone, and dolomite (dolostone) that are distinctly less permeable that the strata of the Upper Floridan aquifer and Lower Floridan aquifer. The elevation of the top of the middle confining unit is approximately –1200 feet NGVD 29 and the thickness is greater than 1000 feet in the vicinity of the Turkey Point plant property (Reference 206).

Floridan Aquifer System: Lower Floridan Aquifer

The Lower Floridan aquifer in southern Florida consists of a thick sequence of low permeability rocks separated by relatively thin permeable zones (Reference 207). The aquifer underlies the middle confining unit and extends from a depth of approximately 2400 feet bgs to a depth that is undetermined, but thought to be greater than 4000 feet bgs in the Miami-Dade County area. The Lower Floridan aquifer includes the lower part of the Avon Park Formation, the Oldsmar Limestone, and the upper part of the Cedar Keys Formation. The base of the Lower Floridan aquifer (or the base of the Floridan aquifer system) is marked by impermeable, massive anhydrite beds of the Cedar Keys Formation (Reference 207).

A highly permeable zone in the Lower Floridan aquifer (known as the Boulder Zone) occurs in southern Florida. The Boulder Zone contains saltwater and has been permitted by FDEP as a discharge zone for treated sewage and other wastes disposed of through injection wells in South Florida.

In southern Florida, the Lower Floridan aquifer contains thick confining units above the Boulder Zone. These confining units are similar in lithology to the middle confining unit of the Floridan aquifer system (Reference 217). The base of the Lower Floridan aquifer is below the base of the Boulder Zone, with the lower section consisting of permeable dolomites or dolomitic limestones of the Cedar Keys Formation (References 215 and 217).

2.4.12.1.4 Site-Specific Hydrogeology

A subsurface investigation was conducted in the Units 6 & 7 plant area between February and June 2008 to evaluate soil, bedrock, and groundwater conditions at depths of up to a maximum of approximately 615 feet bgs. Subsurface data were collected from 94 geotechnical borings, 4 cone penetrometer tests, 2 test pits, 22 groundwater observation wells, and 2 surface water stations. A detailed description of the geotechnical investigation, including the locations of the borings, test pits, and cone penetrometer tests, and the resulting boring logs, laboratory test results, etc. is provided in Reference 248.

Twenty groundwater observation wells, two deep geotechnical piezometers, and the two surface water monitoring stations were installed in the Units 6 & 7 plant area as follows:

- Ten observation well pairs (or 20 individual observation wells) installed across the Units 6 & 7 plant area. These wells were completed to depths ranging from 24 to 110 feet bgs and were installed in the Miami Limestone/Key Largo Limestone and the Fort Thompson Formation.

- Two deep geotechnical piezometers, one at each reactor site, installed to a depth of approximately 135 feet bgs. These two piezometers were installed to measure pore pressure in the Tamiami Formation and were not part of the groundwater level monitoring network.

- Two surface water monitoring stations (SW-1 and SW-2) installed in the cooling canals surrounding the Units 6 & 7 plant area. The pressure transducers were set several feet below the water level in the cooling canals to allow monitoring of surface water level variations.

Groundwater levels have been collected hourly since the transducers were installed in June 2008.

Figure 2.4.12-209 shows the locations of the 20 observation wells, 2 geotechnical piezometers, and 2 surface water stations in the Units 6 & 7 plant area. Table 2.4.12-201 presents construction information for the wells. The observation wells are named in three series that represent the location and screened intervals of the wells:

- OW-600 series wells and geotechnical piezometer are located in the Unit 6 power block area and include “U,” “L,” and “D” suffix wells monitoring the Key Largo Limestone, the Fort Thompson Formation, and the upper Tamiami Formation, respectively.

- OW-700 series wells and geotechnical piezometer are located in the Unit 7 power block area and include “U,” “L,” and “D” suffix wells monitoring the Key Largo Limestone, the Fort Thompson Formation, and the upper Tamiami Formation, respectively.

- OW-800 series wells are located outside the power block areas and include “U” and “L” suffix wells that monitor the Key Largo Limestone and the Fort Thompson Formation, respectively.

The boring logs, core photographs, and soil testing data are included in Reference 248, and addressed in Subsection 2.5.4.

A supplemental investigation program was conducted between January and March 2009 to perform aquifer pumping tests at the Units 6 & 7 plant area. This supplemental investigation was performed to determine aquifer properties for construction dewatering evaluation, groundwater modeling, analyses of postulated accidental releases of radioactive liquids, and to support simulation of radial collector well operation. The program consisted of four test wells and fifty temporary pumping test observation wells installed for the purpose of conducting aquifer pumping tests. Two test wells were located at each reactor site, with one well completed as an open-hole to test the upper Biscayne aquifer (Key Largo Limestone) and one well completed as an open-hole to test the lower Biscayne aquifer (Fort Thompson Formation). The observation wells at each reactor site consisted of five well clusters containing five temporary wells each, installed in the following test zones:

- Upper aquitard (Miami Limestone)
- Upper Biscayne aquifer test zone (Key Largo Limestone)
- Middle aquitard (freshwater limestone unit)
- Lower Biscayne aquifer test zone (Fort Thompson Formation)
- Lower aquitard (Upper Tamiami Formation)

Descriptions and locations of the aquifer pumping test wells and temporary observation wells are presented in Subsection 2.4.12.2.4.1. Explanation as to the classification of aquitards and aquifers is also provided in this subsection.

Groundwater level and surface water level measurements commenced in the 20 observation wells and 2 surface water stations in June 2008. Groundwater level measurements were made using In-Situ Incorporated Level Troll® model 500 and Aqua Troll® model 200 recording pressure transducers. The model 500 Level Troll measured groundwater level and temperature and the model 200 Aqua Troll measured groundwater level, temperature, and specific conductance. The pressure transducers were networked together for remote reading using a Troll Link telemetry system (Reference 218).

The results of the geotechnical investigation pertaining to the hydrogeology of the Units 6 & 7 plant area and the supplemental groundwater investigation are described in detail in Subsections 2.4.12.2.2 through 2.4.12.2.5.

2.4.12.1.5 Groundwater Sources and Sinks

This subsection describes the regional, local, and site-specific discharge and recharge areas, mechanisms, and characteristics of the different aquifer units.

2.4.12.1.5.1 Groundwater Discharge

Natural discharge of groundwater in the Biscayne aquifer is by seepage into streams, canals, or the ocean, by evaporation, and by transpiration by plants.

Induced discharge is through wells pumped for municipal, industrial, domestic, and agricultural supplies. Evapotranspiration, transpiration, and groundwater discharge are greatest during the wet season when water levels, temperature, and plant growth rates are high. Pumpage of groundwater constitutes a part of the total discharge from the aquifer. The effect of pumpage is amplified because it is greatest during the dry season when recharge and aquifer storage are least. Most of the water that circulates in the surficial aquifer system is discharged by canals (Reference 209). There is very little direct run-off of precipitation; however, regional discharge of the surficial aquifer into drainage canals and directly into Biscayne Bay is estimated to be approximately 15 to 25 inches per year (Reference 219). It is estimated that 20 inches of the approximately 60 inches of annual rainfall in Miami-Dade County are lost directly by evaporation, approximately 20 inches are lost by evapotranspiration after infiltration, 16 to 18 inches are discharged by canals and by coastal seepage, and the remainder are used by humans (References 215 and 219). Nearly 50 percent of the rainfall that infiltrates the Biscayne aquifer is discharged to the ocean, a reflection of the high degree of connection between the aquifer and the canals (Reference 211).

2.4.12.1.5.2 Groundwater Recharge

There are several mechanisms affecting recharge of the surficial/Biscayne aquifer in Miami-Dade County including: (1) infiltration of rainfall or irrigation water through surface materials to the water table; (2) infiltration of surface water imported by run-off from the north in the water conservation areas or by canals; (3) infiltration of urban run-off by way of drains, wells, or ponds; and (4) groundwater inflow from southwestern Broward County (Reference 209).

Recharge by rainfall is greatest during the wet season, from June to November, and recharge by canal seepage is greatest during the dry season, from December to May. The average annual rainfall in Miami-Dade County is approximately 60 inches, of which approximately 38 inches are recharge to the aquifer and 22 inches are lost to evapotranspiration (Reference 219). Recharge occurs over most of Miami-Dade County during rainstorms. The low coastal groundwater levels and the low, but continuous, seaward gradient indicate a very high transmissivity in the aquifer, a high degree of interconnection between the aquifer and the drainage canals, and the effectiveness of the present drainage canals in rapidly dispersing floodwaters (Reference 209).

Recharge to the Floridan aquifer system is directly related to the confinement of the system. The highest recharge rates occur where the Floridan aquifer is unconfined or poorly confined, which occurs in areas where the system is at or near land surface or where the confining layers are breached by karst or other structural features. The Floridan aquifer system is confined, with upward vertical gradients in the vicinity of the Turkey Point plant property.

2.4.12.1.5.3 Interaction of Cooling Canals With Groundwater

Units 1-4 use the 5900-acre industrial wastewater facility for condenser cooling (Figure 2.4.12-210). The canals are shallow, approximately 3 feet deep, with the exception of the grand canal (main return canal), north discharge canal, south collector canal, and the east return canal, all of which are approximately 18 feet deep. The canals convey warm water south from Units 1 through 5 and return cooled water for Units 1 through 4. The canals do not directly discharge to fresh or marine surface waters; however, because the canals are not lined, water in the canals does interact with groundwater in the unconfined Biscayne aquifer, which immediately underlies the bottom of the cooling canals. Makeup water to replace evaporative and seepage losses from the canals comes from plant process water, rainfall, stormwater run-off, and groundwater infiltration. There is a net inflow to the cooling canals from the saline Biscayne aquifer beneath the canals. The water in the canals has a salinity greater than that of seawater due to the effects of evaporation, with salinity concentrations approximately twice that of Biscayne Bay.

An interceptor ditch adjacent to the west side of the cooling canals and east of the L-31E Canal and levee was constructed at the same time as the cooling canals (Figure 2.4.12-210). The purpose of the interceptor ditch is to keep cooling canal water from influencing groundwater quality west of the canals in the upper portion of the aquifer. This is accomplished by the existence of a natural freshwater hydraulic gradient during the wet season and by pumping water as necessary from the interceptor ditch into the westernmost cooling canal (Canal 32) during the dry season when natural freshwater hydraulic gradients are low. Operation of the interceptor ditch prevents seepage from the cooling canals from moving landward toward the L-31E Canal and thereby helps to maintain existing groundwater quality in the Biscayne aquifer west of the interceptor ditch.

2.4.12.1.6 Onsite Use of Groundwater

Units 1-4 use cooling water from a closed loop system that includes the canal network adjacent to Units 6 & 7. Cooling water for Unit 5 and process water for Units 1, 2, and 5 are obtained from Upper Floridan aquifer production wells. The water is obtained from the three production wells (PW-1, PW-3, and PW-4) shown in Figure 2.4.12-211. A description of these wells is presented in

Subsection 2.4.12.2. The Biscayne aquifer at Units 3 & 4 is used for the disposal of domestic wastewater. A single Class V, Group 3 gravity injection well is used to dispose of up to 35,000 gallons per day of domestic reclaimed water at the Units 3 & 4 sewage treatment plant. The well, designated IW-1, is open from 42 to 62 feet bgs and is 8 inches in diameter.

The primary source of makeup water for the circulating water cooling towers is reclaimed water supplied by the MDWASD South District Wastewater Treatment Plant as discussed in Subsection 2.4.11.1.1. When reclaimed water cannot supply the quantity and/or quality of water needed for the circulating water system, radial collector wells supplying saltwater are used to supplement the supply. The raw water system is designed to supply 100 percent of the makeup water from either reclaimed water or saltwater, or any combination of both. The ratio of water supplied by the two makeup water sources varies depending on the availability of reclaimed water from the MDWASD South District Wastewater Treatment Plant. The circulating water system is designed to accommodate the differing water quality of the two sources. Additional description of the radial collector wells is presented in Subsection 2.4.12.2.

2.4.12.2 Groundwater Sources

This subsection contains a description of the present and projected regional groundwater use at and in the vicinity of Units 6 & 7. Specifically, the description contains information pertaining to existing users, historical groundwater levels, groundwater flow directions and hydraulic gradients, seasonal and long-term variations of groundwater levels, horizontal and vertical hydraulic conductivity and total and effective porosity of the geologic formations, reversibility of groundwater flow, the effects of water use on hydraulic gradients and groundwater levels beneath the site, and groundwater recharge areas. This information has been organized into five subcategories: (1) historical and projected groundwater use, (2) groundwater flow directions, (3) temporal groundwater trends, (4) aquifer properties, and (5) hydrogeochemical characteristics.

2.4.12.2.1 Historical and Projected Groundwater Use

Historical, current, and projected groundwater use in the vicinity of Units 6 & 7 is evaluated in the following subsections using information from the USGS and the SFWMD.

2.4.12.2.1.1 Historical Groundwater Use

Historical freshwater withdrawal of groundwater has been monitored for Miami-Dade County by the USGS (References 221 and 222). In the Miami-Dade County area, freshwater is restricted to the Biscayne aquifer. Groundwater use has shown a steady increase between the 1960s and the present as shown in Figure 2.4.12-212. The primary groundwater use in the county is for public water supply, followed by agricultural irrigation. Beginning in approximately 1985, a new category of use was introduced—recreational irrigation. This category includes golf course irrigation and other types of turf grass irrigation. Table 2.4.12-202 presents the groundwater use for each category.

The underlying Floridan aquifer typically contains saline water (greater than 250 milligrams per liter of chloride) or saltwater (greater than 19,000 milligrams per liter of chloride) as defined by the SFWMD (Reference 223). As a result, groundwater use from the Floridan aquifer is limited. In 1990 and 1995, no groundwater use was reported from the Floridan aquifer for Miami-Dade County (References 224 and 225). In 2000, a water use of 3.68 million gallons per day was reported for the county with a use category of industrial, which includes mining and power generation (Reference 226).

2.4.12.2.1.2 Current Groundwater Use

Figure 2.4.12-213 shows the current groundwater users in Miami-Dade County based on water use permits filed with the SFWMD (Reference 227). The figure does not show wells that do not require a water use permit, such as domestic wells, wells used exclusively for fire fighting, or those wells withdrawing saline or saltwater. Table 2.4.12-203 lists the public water supply systems in Miami-Dade County along with the population served (Reference 228).

In addition to the traditional uses of groundwater, other uses of groundwater are present in South Florida. These include disposal of municipal and industrial wastewater in Class I injection wells and the use of aquifer storage and recovery wells. The aquifer storage and recovery wells are used to inject raw or partially treated water into the aquifer for later extraction and use. The water must meet drinking water standards before injection. Figure 2.4.12-214 shows the typical configuration of Class I injection wells and aquifer storage and recovery wells in South Florida. Aquifer storage and recovery wells are typically completed as open-hole wells in the Upper Floridan aquifer. Class I injection wells are typically completed as open-hole wells in the Boulder Zone portion of the Lower Floridan aquifer, which is below the lowermost underground source of drinking water

(USDW). Figure 2.4.12-215 and 2.4.12-216 show the locations of these wells in Florida (Reference 229).

Units 1-4 use cooling water from a closed loop system that includes the canal network adjacent to Units 6 & 7. Cooling water for Unit 5 and process water for Units 1, 2, and 5 are obtained from Upper Floridan aquifer production wells. Figure 2.4.12-211 shows the locations of the Upper Floridan production wells. These wells (PW-1, PW-3, and PW-4) were commissioned in February 2007. Figure 2.4.12-217 shows the monthly production from each of the wells. The average production of the wells is approximately 180 million gallons per month.Water supply for non-cooling water use at Units 3 & 4 comes from the potable water system of the MDWASD.

The Units 3 & 4 sewage treatment plant has a Biscayne aquifer injection well as described in Subsection 2.4.12.1.6.

2.4.12.2.1.3 Projected Groundwater Use

Projected groundwater use in Miami-Dade County was obtained from the *Lower East Coast Water Supply Plan*, 2005–2006 update (Reference 230). Figure 2.4.12-212 contains projections of groundwater use through 2025. The projections combine domestic and public water supply categories into one total value. The water use demand for power generation is expected to grow with the addition of seven planned power plants in the Lower East Coast Planning area.

The Unit 5 cooling water supply is from Upper Floridan aquifer production wells. The maximum pumping rate from the Upper Floridan aquifer is limited to a 90-day average of 14.06 million gallons per day and an annual average supply of 4599 million gallons per year.

Reclaimed water from the MDWASD or saltwater from radial collector wells are the cooling water sources for Units 6 & 7. The total makeup flow required from radial collector wells is estimated to be 86,400 gallons per minute; however, the actual amount of saltwater used will depend on the quality and quantity of reclaimed water available from the MDWASD. The source of saltwater from the radial collector wells will be the offshore portions of the Biscayne aquifer, which underlies Biscayne Bay. Water supply for potable water, service water system makeup, fire protection, and miscellaneous raw water use is from the MDWASD.

The radial collector wells consist of a central concrete caisson excavated to an optimal target depth. The caisson diameter is based on the size of the pumps and number of laterals required. The optimal target depth of the caisson is based on the available drawdown and the desired elevation of the laterals. Screened sections are incorporated along the laterals based on site conditions. Once the caisson and laterals are installed, groundwater infiltrates into the laterals and flows back to the caisson. The water is then pumped from the caisson.

Four radial collector wells, each capable of producing approximately 45 million gallons per day, are installed. Figure 2.4.12-218 shows the location of the radial collector wells. At any time, one collector well is in standby mode as a reserve well in the event of an unplanned well outage or scheduled maintenance event. Each radial collector well consists of a central reinforced concrete caisson extending below the ground surface with laterals projecting horizontally from the caisson at depths of approximately 40 feet bgs. The laterals are advanced a distance of up to 900 feet from the caisson. The wells are designed and located to induce infiltration from Biscayne Bay.

The Boulder Zone is permitted by the FDEP as a zone for the discharge of treated sewage and other wastes disposed of through injection wells. The Boulder Zone meets the Florida Department of Environmental Regulations criteria for Class I injection. The Boulder Zone has the following characteristics throughout its extent:

- Deep. The top of the Boulder Zone is 2000 to 3400 feet in depth.
- Confined. There are approximately 800 to 1000 feet of confining limestone and dolomite beds between the Boulder Zone and the base of the USDW.
- Thick. The Boulder Zone is up to 700 feet thick.
- Porous. The Boulder Zone has well developed secondary permeability.
- Highly transmissive. The transmissivity of the Boulder Zone is up to 24.6E06 square feet per day.
- Contains groundwater with total dissolved solids concentration >10,000 milligrams per liter. The average dissolved solids concentration of Boulder Zone groundwater is approximately 37,000 milligrams per liter.

Over 90 Class I injection wells are used to dispose of over 200 million gallons per day of secondary treated wastewater in southeast Florida (Reference 216).

FPL has applied to the FDEP for a Class V Exploratory Well Construction Permit for construction of an exploratory well (EW-1) and dual-zone monitor well (DZMW-1) for Units 6 & 7 pursuant to the provisions of rule 62-528.603, FAC

(Reference 229). The purpose of this exploratory well (EW-1) is to investigate the geologic and hydrogeologic feasibility of disposal of non-hazardous cooling water blowdown and other plant wastewater via deep well injection into the Boulder Zone at the site. EW-1 has been designed, and will be constructed, to Class I Industrial deep injection well standards. The conceptual design for EW-1 and DZMW-1 are presented on Figures 2.4.12-245 and 2.4.12-246, respectively.

The injection zone is in the Boulder Zone of the lower Floridan aquifer, which is anticipated to be present at a depth of approximately 2900 feet bgs in the plant area. Approximately 800 to 1000 feet of confining limestone and dolomite beds are anticipated to be present between the injection zone and the base of the USDW.

The design components of the injection wells include determining the allowable injection rate and the area of review. Section 62-528.415 (1)(f)2, FAC (Reference 229) states that the hourly peak injection flow should not exceed a velocity of 10 feet per second. Based on a review of data from other deep injection well systems in southeast Florida, it is anticipated that each injection well will have a permitted injection capacity of up to 18.6 mgd at a peak hourly flow, corresponding to an injection velocity of 10 feet per second (Reference 229). However, it is anticipated that the wells will be operated at an injection rate of approximately 10 mgd.

The wastewater disposal requirements for Units 6 & 7 are a combined total of approximately 20 million gallons per day when using only reclaimed water from the MDWASD as a cooling water source, and as high as 90 million gallons per day when using only saltwater from radial collector wells as a cooling water source. Therefore, the combined disposal volumes are between 20 and 90 million gallons per day when using a combination of reclaimed and saltwater for cooling. For purposes of providing upper bounds for the project, a disposal capacity of 90 million gallons per day is assumed. Based on this disposal capacity, the deep injection wells consist of ten primary wells and two backup wells for use during routine maintenance or in the event of unscheduled shutdowns. Exploratory well EW-1 will be converted to one of the Class I Industrial deep injection wells if the geology and hydrogeology of the site is determined to be appropriate for deep well injection. As part of the injection permit, a dual-zone monitoring well will also be installed. The deep injection wells will be regulated by and fully comply with the requirements of Chapter 62-528 of the FAC (Reference 229) and applicable FDEP rules.

For the purpose of evaluating the injected fluid buoyancy, the most important characteristics of the injected effluent are temperature and total dissolved solids (TDS), because these parameters determine fluid density. The injected effluent temperature will vary seasonally. The maximum and minimum expected temperatures are 91° F and 65° F, respectively. The expected wastewater TDS when using reclaimed water is 2721 milligrams per liter and when using saltwater from the radial collector wells is 57,030 milligrams per liter. Based on the temperature and TDS values, the density of the injected fluid is estimated to range from 996.8 kilograms per cubic meter (100-percent reclaimed water in the summer) to 1042.2 kilograms per cubic meter (100-percent saltwater in the winter). The temperature and TDS concentration in the Boulder Zone are about 50° F and 37,000 milligrams per liter, respectively (Subsection 2.4.12.2.4.3). The density of the Boulder Zone fluid is estimated to be 1028.5 kilograms per cubic meter.

2.4.12.2.2 Groundwater Flow Directions

2.4.12.2.2.1 Biscayne Aquifer

Regional groundwater flow in the Biscayne aquifer is generally toward the east-southeast. Figures 2.4.12-219 and 2.4.12-220 (Reference 212) show potentiometric surface maps of the Biscayne aquifer for May and November of 1993. The potentiometric maps show localized effects from surface water canals and cones of depression associated with groundwater well fields. Based on the regional data, the hydraulic gradient in the vicinity of the Turkey Point plant property is approximately 0.00002 foot per foot. The elevations in NGVD 29 used by the USGS are approximately 1.53 feet higher than the North American Vertical Datum of 1988 (NAVD 88) elevations used for the plant area data (Reference 231).

Potentiometric surface maps for the upper and lower monitoring zones of the Biscayne aquifer in the immediate vicinity of the Units 6 & 7 plant area are shown in Figures 2.4.12-221 through 2.4.12-228. A separate map was prepared for each high- and low-tide time sequence for the upper (Miami and Key Largo Limestones) and lower (Fort Thompson Formation) monitoring zones. The water levels were corrected to equivalent saltwater heads. Also shown on these figures is the flow direction. Appendix 2AA describes the data evaluation process for the transducer generated water level data. The results of this evaluation indicate that the presented data is sufficient.

These maps indicate that the highest portion of the potentiometric surface in the lower monitoring zone runs from the southwestern portion of the island near OW-735L to the central portion of the island near OW-706L. Flow patterns extend radially in multiple directions from this high spot, but flow patterns are not symmetrically arrayed. The lower monitoring zone potentiometric surfaces and resulting flow patterns are similar for all high and low tide conditions examined.

In the upper monitoring zone, a relative high spot in the potentiometric surface runs from the northwest near OW-812U to the center of the island near OW-706U. A second high spot in the potentiometric surface is evident in the southeast corner of the island near OW-636U. A relatively low region in the potentiometric surface extends from the southwest near OW-735U to east-central portion of the island near OW-805U and OW-606U.

Flow patterns in both monitoring zones are complex. In both zones, the center of the island near OW-706 provides a relative high spot in the potentiometric surface and flow lines extend in multiple directions away from this high spot.

Because of the complexity of the observed flow patterns in the upper and lower monitoring zones, one to three flow path lines were used to calculate horizontal gradients for each potentiometric surface shown in Figures 2.4.12-221 through 2.4.12-228. The average gradient for the two or three flow path lines is shown on each potentiometric surface map for each tidal condition examined. The average horizontal gradient in the upper monitoring zone across all examined tidal conditions is 0.0004 ft/ft, and the average horizontal gradient in the lower monitoring zone is 0.001 ft/ft.

Vertical hydraulic gradients were computed for selected observation well pairs on the site. Table 2.4.12-204 presents the vertical hydraulic gradients determined from these well pairs. The overall vertical hydraulic gradient is generally upward across the plant area. The vertical hydraulic gradients do not vary significantly between high and low tidal cycles.

In general the groundwater flow conditions in the Biscayne aquifer at the Units 6 & 7 plant area can be summarized as follows:

- Flow conditions in the upper monitoring zone indicate a consistent flow direction from the high spots in the potentiometric surface in the northwest and southeast towards the relative low region in the potentiometric surface that runs from the southwest to the east-central of the island. Flow in the low region is generally towards the southwest.

- Flow conditions in the lower monitoring zone indicate a high spot in the potentiometric surface that extends from the southwestern portion of the island to the center of the island. Flow patterns extend in multiple directions from this high spot but the patterns are not symmetrical.
- Vertical hydraulic gradients indicate upward flow potential.
- The vertical (upward) gradient is approximately an order of magnitude larger than the horizontal gradient in the lower monitoring zone. The average horizontal gradient in the lower monitoring zone is, in turn, approximately an order of magnitude larger than the average horizontal gradient in the upper monitoring zone.

2.4.12.2.2.2 Floridan Aquifer

Regional groundwater flow in the Upper Floridan aquifer is generally toward the east. Figure 2.4.12-229 shows a potentiometric surface map of the Upper Floridan aquifer for May 1980 (Reference 215). The apparent hydraulic gradient in the vicinity of the Turkey Point plant property is approximately 0.00006 foot per foot. As indicated in Figure 2.4.12-229, South Florida is in the brackish to saline portion of the aquifer, and groundwater development has generally been restricted to industrial water supplies.

Determination of groundwater flow directions and hydraulic heads in the Boulder Zone has been unreliable due to the lack of good head data and the transitory effects of ocean tides, Earth tides, and atmospheric tides (Reference 215). Regional groundwater movement in the Lower Floridan aquifer in southern Florida is estimated to follow the circulation pattern described as follows: 1) cold seawater moves inland through the Lower Floridan aquifer, 2) heating of the seawater in the Lower Floridan aquifer during inland movement results in lower fluid density, 3) upwelling of this seawater from the Lower Floridan aquifer occurs through the middle confining unit, and 4) dilution of the seawater (further reducing fluid density) results in its transport back to the ocean by seaward flowing groundwater in the Upper Floridan aquifer. Figure 2.4.12-243 illustrates this circulation pattern (Reference 215). This circulation is generally very slow due to the low permeability of the middle confining unit.

2.4.12.2.3 Temporal Groundwater Trends

Regional temporal trends in the Biscayne aquifer groundwater levels are monitored by the USGS (Reference 232) and the SFWMD (Reference 233). Figure 2.4.12-230 presents a map of wells and surface water control structures in the vicinity of the Turkey Point plant property used for long-term monitoring of groundwater and surface water levels. Figures 2.4.12-231 and 2.4.12-232 show the hydrographs for these locations. The hydrographs show varying degrees of short-term tidal influence and fluctuations associated with precipitation events. The long-term trends in the wells and surface water indicate a generally steady water level over the period examined. Well G-1183 shows the largest magnitude of fluctuation with water level elevations ranging from –0.59 to 6.38 feet NGVD 29. The remaining wells show a range of fluctuation of less than 3.5 feet.

Figure 2.4.12-233 shows hydrographs of the Biscayne aquifer monitoring wells at Units 6 & 7. Over the period of record, the maximum groundwater elevation in the upper monitoring zone was 0.62 feet NAVD 88 (OW-636U) and the minimum was –3.42 feet NAVD 88 (OW-809U). The maximum groundwater elevation in the lower monitoring zone was 2.15 feet NAVD 88 (OW-735L) and the minimum was –2.45 feet NAVD 88 (OW-805L). A partial listing of water level data from the transducers is presented in Appendix 2AA.

The water level record contains data gaps, which were a result of loss of transducer data due to storm preparation activities, or equipment malfunction. Data telemetry and measurement issues were identified with the In-Situ transducers. The data were reviewed for consistency and accuracy of the water level and specific conductance readings. At the conclusion of this evaluation, a portion of the data were rejected. The causes for data rejection include erratic behavior indicative of a transducer malfunction, and poor agreement between manual and transducer measurements. The portions of the data rejected are identified on the hydrographs in Figure 2.4.12-233.

Regional temporal trends in the Floridan aquifer have been monitored by the USGS (Reference 234). A hydrograph of a well completed in the Upper Floridan aquifer is shown in Figure 2.4.12-234. The wellhead elevation is 4.50 feet NGVD 29 and the head inside the well ranges from 30 to 42.6 feet MSL (NGVD 29), indicating that the potentiometric surface in this area is above the ground surface.

2.4.12.2.4 Aquifer Properties

This subsection provides a summary of the regional, local, and site-specific hydrogeologic parameters for the different aquifer units. These parameters include transmissivity, storativity (storage coefficient), specific yield, hydraulic conductivity (permeability), and leakage coefficient (leakance). The following are definitions of these properties:

- Transmissivity — The rate at which a fluid of a specified density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient and is a function of the properties of the fluid, the porous medium, and the thickness of the porous medium (Reference 235).

- Storativity (Storage Coefficient) — The volume of water released from or taken into storage per unit surface area of the aquifer per unit change in head (Reference 235).

- Specific Yield — The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil (Reference 235).

- Hydraulic Conductivity (permeability) — A coefficient of proportionality describing flow per unit time under a unit hydraulic gradient through a unit area of a porous medium and is a function of the properties of the fluid and the porous medium (Reference 235).

- Leakage Coefficient (Leakance) — The quantity of water that flows across a unit area of the boundary between the main aquifer and its semi-confining bed, typically expressed as seconds^{-1}or days^{-1}, derived from the relationship K'/b' where K' is the hydraulic conductivity of the semi-confining unit and b' is its thickness (Reference 236).

Typical values of hydraulic conductivity, porosity, and thickness for different formations in Miami-Dade County are shown on Table 2.4.12-205 (Reference 237). The values are based on weighted averages for management of treated waste water and may not be representative of actual conditions.

Table 2.4.12-206 presents aquifer test results for tests performed within 15 miles of Units 6 & 7. Figure 2.4.12-235 shows the locations of these tests. The data were obtained from the SFWMD DBHYDRO database and the Dames & Moore site investigation report (References 233 and 238). The tests were performed in the Biscayne aquifer, the Floridan aquifer, and confining layers. The tests include standard aquifer performance tests and packer tests used for assessment of the injection and confining layers for deep injection well permitting. The Boulder Zone packer tests listed in Table 2.4.12-206 show transmissivities lower than those reported for other regional testing of the Boulder Zone (Subsection 2.4.12.2.4.3). The depths given on the table suggest that the tests were performed in the interval between the top of the Lower Floridan aquifer and the top of the Boulder Zone as determined from cross section Y-Y' in Reference 206.

2.4.12.2.4.1 Surficial/Biscayne Aquifer

Hydrogeologic properties in the Biscayne aquifer vary due to lithology. Along the coast, where the Biscayne aquifer is the thickest, transmissivities are lower because of the silty sand/sandy lithology. In central and south Miami-Dade County, the aquifer is thinner with higher hydraulic conductivity due to the occurrence of cavernous limestone (Reference 211). The permeable limestone content in the aquifer decreases northward and the overall transmissivity of the aquifer decreases with increased sand content.

Transmissivities for the highly permeable limestones and less permeable sandstones and sands of the aquifer in the vicinity of Units 6 & 7 have been estimated to range from less than 1.0E06 gallons per day per foot to 3.0E06 gallons per day per foot (Reference 238). Along the coast, where the Biscayne aquifer is the thickest, transmissivities are lower due to the presence of sandy material. In central and south Miami-Dade County, the aquifer is thinner with higher hydraulic conductivity due to the occurrence of vuggy and highly porous limestone (Reference 211).

According to Parker et al. (Reference 219), the Biscayne aquifer is the most productive of the shallow non-artesian aquifers in the area and is one of the most permeable with transmissivity values (hydraulic conductivity x saturated thickness) for the highly permeable limestones ranging from 4.0E06 to 15.0E06 gallons per day per foot (5.4E05 to 2.0E06 square feet per day) with a median value of 5.0E06 gallons per day per foot (6.7E05 square feet per day) and storage coefficients ranging from 0.047 to 0.247. In Broward County, transmissivities are reported to range from approximately 4.0E05 gallons per day per foot (5.4E04 square feet per day) to 4.0E06 gallons per day per foot (5.4E05 square feet per day) with storage coefficients as high as 0.34 (Reference 239). A generalized distribution of the transmissivities in the Biscayne aquifer is presented in Figure 2.4.12-236 (Reference 240).

Large-capacity municipal wells are commonly completed as open holes and yield from 500 to more than 7000 gpm with only small drawdowns. Specific capacities obtained from pumping tests are on the order of 1000 gpm per foot of draw-down in Miami-Dade County (Reference 211).

A study performed by the USGS (Reference 240) included estimates of specific yield in the Biscayne aquifer based on water level responses to individual rainfall events between the years 1933 and 1966. The results of this study suggested that a range between 20 and 25 percent specific yield may be representative of the

Biscayne aquifer. The main focus of this study was the development of a groundwater flow model of the Biscayne aquifer. The results of the model calibration suggested that a specific yield of 20 percent provided the best match between observed and modeled groundwater levels.

Two studies performed northwest of Turkey Point by the USGS (References 241 and 242) examined the vertical variations in aquifer properties of the Biscayne aquifer. Table 2.4.12-207 presents the results of testing core samples. The locations of the core samples are shown in Figure 2.4.12-235. Figure 2.4.12-237 is a plot of the core properties versus elevation. The core samples were tested for horizontal air permeability, vertical air permeability, porosity, and grain density. The horizontal air permeability test included a maximum permeability and a permeability at 90 degrees to the maximum permeability direction to assess horizontal anisotropy. The studies included a detailed examination of the core samples to determine lithology and fossil assemblages. As a result of this examination, the USGS subdivided the Biscayne aquifer into a series of high frequency depositional cycles that ranged from a freshwater to a marine depositional environment. These depositional cycles control the permeability and porosity of the aquifer. The freshwater and transitional portions of the depositional cycles are characterized by lower permeability (<1000 milliDarcies) and porosity (<20 percent), while the marine portions of the depositional cycles exhibit higher permeability (>1000 milliDarcies) and porosity (20–40 percent). This general observation appears to support the site-specific findings regarding the freshwater limestone layer and the other marine and transitional units identified at the Units 6 & 7 plant area.

The vertical changes in properties as a result of these depositional cycles can be seen on the figure. Figure 2.4.12-238 presents a plot of the vertical anisotropy ratio ($K_{vertical}$:$K_{horizontal}$) versus elevation using the vertical permeability and maximum horizontal permeability determined from the USGS laboratory core testing. The graph indicates that the central tendency of the anisotropy measurements is approximately 1. This value was used as a starting point for groundwater model calibration.

As part of the Units 6 & 7 investigation, ten observation wells were installed in the upper part of the Biscayne aquifer in the Miami Limestone/Key Largo Limestone ("U" suffix wells) and ten observation wells were installed in the lower part of the Biscayne aquifer in the Fort Thompson Formation ("L" suffix wells). The screen depths for the upper (U) wells range from 15 to 28 feet bgs and for the lower ("L") wells range from 98 to 110 feet bgs. The location and installation details of the wells are provided in Figure 2.4.12-209 and Table 2.4.12-201, respectively.

Thirty-one in situ hydraulic conductivity tests (slug tests) were conducted in these wells. These data were imported into AQTESOLV™ for Windows version 4.5 (Reference 243) and evaluated using either the Butler, KGS (Kansas Geologic Survey), McElwee-Zenner, or Springer-Gelhar solution methods. Hydraulic conductivity values obtained for wells screened in the upper part ("U" wells) of the Biscayne aquifer range from 3 feet per day to 319 feet per day with a geometric mean of 61.3 feet per day.

For the wells screened in the lower part ("L" wells) of the aquifer, hydraulic conductivity values range from 1.0 feet per day to 120 feet per day with a geometric mean of 20.1 feet per day. The results of the tests are summarized in Table 2.4.12-208. The results suggest that the rate-limiting recharge of the well filter pack may be influencing the results of the tests. The rate-limiting recharge effect is caused by the formation having a higher hydraulic conductivity than the filter pack material; this results in the filter pack controlling the slug test response rather than the formation. This interpretation is supported by the Units 6 & 7 aquifer pumping tests described below, site vicinity aquifer tests (Reference 238), and other regional studies (Table 2.4.12-206) that suggest much higher hydraulic conductivity values for the aquifer.

Four aquifer pumping tests were conducted in 2009 at Units 6 & 7. These tests were performed to determine the hydrogeologic properties of the Biscayne aquifer units and the overlying or underlying aquitards for use in the design and implementation of the construction dewatering system, development of the site groundwater flow model, and simulation of radial collector well operation in the groundwater model. Two test zones were identified within the Biscayne aquifer: the upper zone, which is located in the Key Largo Limestone; and the lower zone, which is located in the Fort Thompson Formation. The muck and Miami Limestone units are interpreted to have a lower hydraulic conductivity than the underlying Key Largo Limestone. The freshwater limestone layer is interpreted to have a lower hydraulic conductivity than either the overlying Key Largo Limestone or the underlying Fort Thompson Formation. The Tamiami Formation is also interpreted to have a lower hydraulic conductivity than the overlying Fort Thompson Formation. Thus, the Miami Limestone, the freshwater limestone unit, and the Tamiami Formation were treated as aquitards in the subsurface profile. For the conditions at Units 6 & 7, the term aquitard is amended from its usual definition as a low permeability unit to a unit that has a much lower permeability than the aquifer units.

A total of four pumping wells and fifty temporary observation wells were installed for aquifer characterization. Two pumping wells and twenty-five observation wells were installed at each reactor site. The pumping wells at Unit 6 were designated PW-6U and PW-6L and at Unit 7 were designated PW-7U and PW-7L with the U/L suffix indicating completion in either the upper (U) or lower (L) Biscayne aquifer test zone. The pumping wells were nominally 30-inches in diameter and were completed as open holes in the test intervals. The upper test zone wells (PW-6U and PW-7U) were both completed to a total depth of 45 feet. The lower test zone wells (PW-6L and PW-7L) were completed to a total depth of 105 feet and 87 feet, respectively. Each aquifer test location had two observation well clusters of five wells each installed at right angles to and approximately 10 feet from the pumping well. Additionally, a shared well cluster of five wells was installed between the two pumping wells at each reactor site at a distance of approximately 25 feet. The observation well clusters at Unit 6 (C6-1 through C6-5) and Unit 7 (C7-1 through C7-5) each included wells designated as A through E that were completed in the following zones:

- Miami Limestone/upper aquitard (A)
- Key Largo Limestone/upper test zone (D)
- Freshwater limestone/middle aquitard (B)
- Fort Thompson Formation/lower test zone (E)
- Tamiami Formation/lower aquitard (C)

Figure 2.4.12-239 presents the configuration of the pumping and observation wells for Units 6 & 7.

Each pumping test was conducted at a constant discharge rate and drawdown data was collected for a period of eight hours, followed immediately by the recovery period during which water level data were collected for an additional eight hours. The discharge rate for each test was selected based on data collected during a step-drawdown test conducted on each pumping well prior to initiation of the 8-hour drawdown test. Discharge rates for the tests ranged from approximately 3300 gpm to 5100 gpm.

The pumping test results were interpreted using the AQTESOLV™ (Reference 243) computer program. This program contains solution options for different hydrogeologic conditions such as unconfined, confined, and leaky conditions. Two interpretation methods were used: the Theis method and the Hantush leaky aquifer with aquitard storage method. The Theis method was applied to the time-drawdown data, to provide an upper bound on transmissivity, because the Theis method assumes no leakage. The Hantush leaky method with aquitard storage was used to evaluate the distance-drawdown and time-drawdown relationships in the pumping zone observation wells ("D" or "E" series wells). Table 2.4.12-209 presents a summary of the averages of the aquifer test results. Based on these analyses, the average transmissivity for the upper Biscayne aquifer is approximately 2.3E06 gallons per day per foot and for the lower Biscayne aquifer it is approximately 1.3E05 gallons per day per foot. Details of the pumping tests and the analytical methods are provided in Appendix 2BB.

2.4.12.2.4.2 Intermediate Aquifer System/Confining Unit

The overall hydraulic conductivity of the intermediate confining group (upper confining unit of the Floridan aquifer) is very low and provides good confinement for the underlying Floridan aquifer system. The leakage coefficient of this confining unit is highly variable, especially in the semi-confined areas where the confining beds may be either sandy or clayey. Leakage coefficient values of the upper confining unit, derived from computer model simulations, range from less than 0.01 inches per year per foot in tightly confined areas to more than 1.0 inches per year per foot in semi-confined areas (Reference 220). According to Bush and Johnston (Reference 220), leakage coefficients calculated from aquifer test data, in general, are much larger than those obtained from simulation, ranging from 0.44 to 88 inches per year per foot. Their analyses indicate that in the majority of locations, leakage coefficients from aquifer test data are too large to realistically represent the exchange of water between the surficial aquifer and the Upper Floridan aquifer. The values obtained from aquifer test data can reflect not only downward leakage from the surficial aquifer, but upward leakage from permeable rocks beneath the pumped interval, as well as leakage from beds of relatively low permeability that might exist in the pumped interval. These upper confining unit leakage coefficients derived from Floridan aquifer test data are a composite of leakage from all of these sources.

2.4.12.2.4.3 Floridan Aquifer System

The Floridan aquifer system is a confined series of aquifer zones, separated by aquicludes, that is approximately 3000 feet thick in southeastern Florida. Porosity and permeability in the aquifer vary widely depending on location and formation. High permeability values are the result of both fractured limestone and extensive secondary porosity derived from dissolution of carbonates. At the base of the Floridan aquifer system is the Boulder Zone, a highly permeable zone containing saline water used for underground injection of industrial and domestic wastes in South Florida.

Floridan Aquifer System: Upper Floridan Aquifer

Hydraulic parameters of the Upper Floridan aquifer vary considerably as a result of the wide variation in hydrogeologic conditions encountered at different locations. According to Johnson and Bush (Reference 244), conditions that most affect transmissivity are the degree of solution development in the aquifer and, to a lesser extent, aquifer thickness. High transmissivities are usually found in the areas having less confinement because circulation of flow helps to develop solution openings in the aquifer.

Transmissivities are lowest (less than 50,000 square feet per day) in the Florida panhandle and southernmost Florida (where the aquifer is confined by thick clay sections and contains thick sections of low-permeability limestone) and are highest (greater than 1 million square feet per day) in the karst areas of central and northern Florida where the aquifer is generally unconfined or semi-confined (Reference 244). Based on data obtained from 114 aquifer tests, computer simulation, and geologic conditions, Johnson and Bush (Reference 244) developed the areal distribution of the probable ranges of transmissivity in the Upper Floridan aquifer shown in Figure 2.4.12-240.

Regional storage coefficients calculated from aquifer tests conducted in the Upper Floridan aquifer range from a low of 1.0E-05 to a high of 2.0E-02 with most values in the 1.0E-03 to 1.0E-04 range (Reference 244).

Dames & Moore (Reference 214) installed a test production well, designated W-12295 as shown in Figure 2.4.12-235, and four observation wells southwest of the Units 6 & 7 plant area. They conducted a 90-day continuous pumping test of the principal artesian water-bearing zone (Upper Floridan aquifer). The test production well was completed as an open hole between approximately 1130 feet and 1400 feet bgs. Calculated average values for transmissivity, storage coefficient, and leakance obtained from graphical solutions of the test data were 400,000 gallons per day per foot (53,600 square feet per day), 6.0E-04, and 0.002 gallons per day per cubic foot, respectively. Bush and Johnston (Reference 220) report a transmissivity of approximately 232,000 gallons per day per foot (31,000 square feet per day) for the Upper Floridan aquifer near Units 6 & 7.

The most transmissive zone is generally found at the top of the unit and is estimated to range between 10,000 to 60,000 square feet per day. According to

Bush and Johnston (Reference 220), wells S-1532 and S-1533 have a calculated transmissivity of 31,000 square feet per day (Reference 217). Transmissivity of the Upper Floridan aquifer is highest in west central Florida (greater than 100,000 square feet per day) with lower transmissivities (less than 10,000 square feet per day) in central Florida (Reference 206).

The Upper Floridan aquifer water supply wells used for Unit 5 cooling water and Units 1 & 2 process water included the performance of an aquifer pumping test as part of the well installation process. The results of this test indicate a transmissivity of 244,000 gallons per day per foot, a storage coefficient of 2.0E-04, and a leakance of 5.0E-03 gallons per day per cubic foot (6.7E-04 day^{-1}). These values are consistent with the values reported from other nearby tests in the Upper Floridan aquifer.

Floridan Aquifer System: Middle Confining Unit

The middle confining unit of the Floridan aquifer system includes most of the Avon Park Formation (Reference 206). The zones that contain highly transmissive dolomite with cavernous porosity are found in the upper to middle part of the Oldsmar Formation in southeastern Florida. Reese (Reference 217) places the base of the middle confining unit at the top of the first such zone. The base of the middle confining unit is encountered at a depth of approximately 2460 feet in a well (MDS-I12) drilled in southeastern Miami-Dade County, 230 feet below the top of the Oldsmar Formation (Reference 206). Based on core sample analysis, packer tests, and aquifer tests conducted at the MDWASD South District Wastewater Treatment Plant site, the hydraulic conductivity of the middle to lower part of the confining unit ranges from 3.0E-03 to 3.0 feet per day (Reference 217). Vertical hydraulic conductivity measured in eight core samples from a well drilled in eastern Broward County, reported in Reese (Reference 217), ranged from 1.3E-04 to 0.24 feet per day. Core analyses of the low porosity (<15%) dolostones from the Floridan aquifer middle confining unit in Palm Beach County gave vertical hydraulic conductivities of less than or equal to 1.7E-08 centimeters per second. The lowest recorded value was 2.7E-09 centimeters per second (Reference 247).

Floridan Aquifer System: Lower Floridan Aquifer

The Lower Floridan aquifer underlies the middle confining unit and extends from a depth of approximately 2400 feet bgs to a depth that is undetermined, but thought to be greater than 4000 feet bgs in the Miami-Dade County area. This thick sequence of carbonate rocks contains several permeable zones separated by thick confining units (Reference 207). These confining units are similar in lithology to the middle confining unit of the Floridan aquifer system (Reference 217). Underlying the confining beds in the lower part of the Lower Floridan aquifer is the highly transmissive Boulder Zone, which is of varying thickness. The base of the Lower Floridan aquifer extends below the base of the Boulder Zone with the lower section consisting of permeable dolomites or dolomitic limestones of the Cedar Keys Formation (References 207, 215, and 217). Because the Lower Floridan aquifer is deeply buried in southern Florida and contains saltwater, the unit has not been intensively drilled or tested; therefore, the hydraulic characteristics are not well known (Reference 207).

Boulder Zone

The Boulder Zone is a highly transmissive zone of limestones and dolomites found in the lower Oldsmar Limestone in the Lower Floridan aquifer in southeastern Florida. However, locally the Boulder Zone may range upward to the middle of the Oldsmar Limestone or downward to the top of the Cedar Keys Formation (Reference 207). It consists mostly of massively bedded dolostones within which secondary permeability has been extensively developed. The term "Boulder Zone" is a misnomer because no boulders are present other than large chunks occasionally broken off during drilling. The difficult slow drilling and rough bit behavior, similar to that observed drilling in boulders, encountered while drilling the dolostone, gave rise to the term "Boulder Zone" (Reference 207). The Boulder Zone can be up to 700 feet in thickness (Reference 206). Based on previous studies in the region (References 206, 207, 208, and 214), the Boulder Zone underlies a 13-county area in southern Florida with the elevation of the top of the zone ranging from about –2000 feet NGVD 29 to about –3400 feet NGVD 29, Figure 2.4.12-241 (Reference 210). The Boulder Zone is found at a depth of approximately 2800 feet at Turkey Point.

Transmissivities ranging from 3.2E06 to 24.6E06 square feet per day have been reported for the Boulder Zone (Reference 215). A measured hydraulic conductivity value of approximately 4250 feet per day was obtained from an injection well at the SDWTP, operated by the MDWASD in Miami-Dade County. This value is approximately two orders of magnitude larger than measured values in the overlying portion of the Lower Floridan aquifer and the middle confining unit (Reference 208).

2.4.12.2.5 Hydrogeochemical Characteristics

The state of Florida has conducted an extensive characterization of the background water quality in the major aquifer systems (Reference 245). These data have been subdivided into properties for each of the water management districts. Tables 2.4.12-210 and 2.4.12-211 present typical geochemical parameters for the surfical aquifer, the Floridan aquifer, and precipitation at the Everglades National Park.

Groundwater in the vicinity of the Turkey Point property is not used as a potable water source because of its salinity. The state of Florida has classified these as Class G-III waters to identify groundwater that has no reasonable potential as a future source of drinking water due to high total dissolved solids content (Reference 240). Field-measured groundwater quality indicator parameters (temperature, pH, dissolved oxygen, specific conductance, turbidity, and oxidation-reduction potential) obtained during the collection of water samples from observation wells (installed in the Biscayne aquifer as part of the site characterization investigation) are summarized in Table 2.4.12-210. The results of laboratory analyses of the water samples are presented in Table 2.4.12-211.

Although the Upper Floridan aquifer is a major source of potable groundwater in much of Florida, water withdrawn from the unit in southeastern Florida, including Miami-Dade County, is brackish and variable with chloride and dissolved solid concentrations greater than 1000 milligrams per liter. Groundwater samples from the Upper Floridan aquifer production wells at Unit 5 (Table 2.4.12-211) show an average chloride concentration of 2900 milligrams per liter. Chemically, the water in the middle confining unit is similar to seawater, but salinity varies greatly at the top of the unit as the upward moving saline water from the Lower Floridan is blended with the seaward flowing freshwater in the Upper Floridan aquifer (Reference 215).

Average dissolved solids concentration of Boulder Zone groundwater is approximately 37,000 milligrams per liter total dissolved solids (Reference 215). There is also a pronounced temperature anomaly present in the Boulder Zone with the lowest observed temperature (approximately 50°F) occurring along the southeastern coast. The temperature increases from the Straits of Florida toward the center of the Florida Plateau, suggesting recharge from cold seawater through the lower part of the Floridan aquifer system. The groundwater circulation pattern is shown on Figure 2.4.12-243 (Reference 215).

Figure 2.4.12-242 presents a Piper trilinear diagram of the site and regional geochemical data. Examination of the diamond field on the diagram indicates that the site groundwater, Biscayne Bay, and the cooling canals data all plot together on the diagram indicating similar geochemical compositions. These waters are classified as a sodium-chloride type.

PTN COL 2.4-5

2.4.12.3 Subsurface Pathways

Subsurface pathways are described below for the two major aquifers beneath the Units 6 & 7 plant area: the Biscayne aquifer and the Floridan aquifer system.

2.4.12.3.1 Biscayne Aquifer

Regional groundwater flow in the Biscayne aquifer is generally toward the east-southeast in Miami-Dade County (Reference 209). The Biscayne aquifer groundwater flow direction in the Units 6 & 7 plant area is described in Subsection 2.4.12.2.2.1.

The hydrogeologic conditions at Units 6 & 7 indicate two potential pathways for offsite migration of a postulated accidental release of radionuclides. The most likely pathway is through the Key Largo Limestone, with discharge to the cooling canals and then migration from the cooling canals to Biscayne Bay. An alternate pathway would be through the Fort Thompson Formation with discharge into Biscayne Bay. Neither of these release scenarios would threaten groundwater or surface water supplies. Further description of these pathways, source radionuclides, analytical methods, and subsurface properties is provided in Subsection 2.4.13.

The ground surface at Units 6 & 7 was at approximately sea level. The Biscayne aquifer is generally present within 5 feet of the ground surface, with up to 7 feet of muck deposits covering the aquifer. As part of plant construction, the muck deposits were removed and engineered fill was placed to raise the finish grade to El. 25.5 feet NAVD 88. Additionally, as part of the construction process, a reinforced concrete diaphragm wall and grouting program was used to control groundwater inflow into the excavation (Subsection 2.5.4.5.4 and 2.5.4.6.2).

In order to account for the changes to the pre-construction groundwater flow system, a three-dimensional numerical groundwater flow model was used. The model code used was MODFLOW-2000 (Reference 246) as implemented in the Visual MODFLOW modeling software. The MODFLOW model is a constant-density, three-dimensional finite-difference model, with modular capability to add various equation solvers and boundary conditions to the basic model. The model developed for Units 6 & 7 used a geometric multigrid (GMG) solver.

The Biscayne aquifer is represented in the model by six layers: 1) muck, 2) Miami Limestone, 3) Key Largo Limestone, 4) freshwater limestone, 5) Fort Thompson Formation, and 6) Tamiami Formation. The horizontal discretization for most simulations in the model is represented by a telescopic grid that ranges from a coarse grid (200 by 450 feet) at the model perimeter to a fine grid (20 by 20 feet) in the immediate area of Units 6 & 7.

Hydrological features are represented in the model as boundary conditions. The river boundary condition is used to represent the cooling canals and the regional water management canals. Recharge and evapotranspiration boundaries are assigned to the top layer of the model, with properties varying depending on the surface conditions. These conditions include open water (canals), wetlands, and impervious surfaces (Units 1-5). The perimeter of the model is represented by a general head boundary, except in portions of the top layer at Biscayne Bay. The general head boundary represents the influence of conditions beyond the model area, primarily recharge from the Everglades. The top layer in Biscayne Bay is represented in the model as a constant head boundary condition using an average head based on tidal monitoring at Virginia Key. The remaining layers beneath Biscayne Bay are represented as general head boundaries at the perimeter of the model. The bottom layer of the model (Tamiami Formation) is represented as a no flow boundary condition. The vertical seepage upwards or downwards through the Tamiami Formation and the Hawthorn Group is assumed to be negligible relative to the horizontal flow in the Biscayne aquifer.

Calibration of the model was performed by adjusting the river boundary condition conductance and riverbed thickness values in the industrial wastewater facility and regional water management canals and by adjusting hydraulic conductivities. The calibration targets for the model were the average measured groundwater levels in the upper and lower monitoring zones at Units 6 & 7 and two SFWMD wells adjacent to the plant area. The average inflow/outflow between the industrial wastewater facility and Biscayne Bay was also used as a calibration target.

The calibrated model was used to simulate the impacts of construction dewatering, construction of Units 6 & 7 (site grade increase and use of diaphragm walls for groundwater control), and operation of the radial collector wells. The results of these model simulations are presented in Appendix 2CC.

2.4.12.3.2 Floridan Aquifer System

Regional groundwater movement in the Floridan aquifer system in southern Florida is estimated to occur in the following circulation pattern: 1) inland movement of cold seawater through the Lower Floridan aquifer, 2) heating of the seawater in the Lower Floridan aquifer during inland movement, which results in lower fluid density, 3) upwelling of seawater from the Lower Floridan aquifer through the middle confining unit, and 4) dilution of seawater (further reducing fluid density) and transport of the seawater back to the ocean by seaward flowing groundwater in the Upper Floridan aquifer. Figure 2.4.12-243 illustrates this circulation pattern (Reference 215). This is generally a very slow circulation pattern due to the low permeability of the middle confining unit.

Over the past 30 years, deep well injection has become an accepted technology for the disposal of liquid wastes in Florida, and currently there are approximately 127 active Class I injection wells in the state. In south Florida, the primary injection unit is the Boulder Zone, which is part of the Lower Floridan aquifer. In 2006, there were 32 active Class I injection wells in southeast Florida (Miami-Dade, Broward, and Palm Beach counties). All Class I injection wells are required to have a dual-zone monitoring system that consists of a zone below the deepest USDW and a zone in the USDW (USDW is defined as an aquifer that contains water with a total dissolved solids concentration of less than 10,000 milligrams/liter). Of the 32 injection systems, 3 systems have documented upward migration (Seacoast Utilities, and Miami-Dade North and South District Regional Wastewater Treatment Plants) into the USDW and 7 other injection systems have upward migration that has remained below the USDW. This upward migration is considered to potentially indicate failure of the well construction methods and not geologically related. The remaining injection wells have no detected vertical migration of injection fluids (Reference 247). A typical injection well system is shown on Figure 2.4.12-244.

PTN COL 2.4-4

2.4.12.4 Monitoring or Safeguard Requirements

Groundwater levels at Units 6 & 7 were determined through the use of groundwater observation wells installed in 2008 as part of the site subsurface investigation, and through periodic review of USGS and SFWMD monitoring stations to evaluate changes in groundwater or canal conditions in the general vicinity of the Units 6 & 7.

Consistent with RG 4.21 and the Nuclear Energy Institute (NEI) groundwater initiatives, the groundwater observation well network will be evaluated and an environmental monitoring program developed as part of detailed design activities for Units 6 & 7. The groundwater monitoring program will consider the following components:

- Biscayne aquifer — Periodic water level measurements in observation wells and geochemical sampling and analysis of the radial collector wells will detect changes in the Biscayne aquifer that may impact groundwater supply or the accidental release analysis.

- Floridan aquifer — Geochemical and pressure monitoring will be conducted in the Floridan aquifer as mandated by underground injection control regulations Chapter 62-528 FAC (Reference 229). The underground injection control permit requirements are expected to include monthly reporting of the average, minimum, and maximum injection pressure; flow rate; volume; and annular pressure. The requirement for mechanical integrity tests in the injection well to be performed every five years would also be expected in the permit. The monitoring program will include dual-zone monitor wells located less than 150 feet from the injection wells. The upper zone monitors just above or at the base of the USDW and the lower zone monitors below the base of the USDW and just above the primary confining unit in order to detect any vertical migration of injected fluids into the overlying Upper Floridan and Biscayne aquifers.

- Operational accident monitoring — The effluent and process monitoring program is addressed in Subsections 11.5.3 and 11.5.4 and will be implemented in accordance with the schedule in Subsection 13.3.

Groundwater level measurements in Biscayne aquifer observation wells (existing or future) are made during construction and after plant startup. Selection of observation wells included in the program is made before the start of operation based on well condition, position relative to plant site and other observation wells (provide optimal spatial distribution for potentiometric map preparation and vertical hydraulic gradient assessment), and long-term viability of the observation well (likelihood that the well will not be damaged or destroyed).

Geochemical sampling and analysis of the Biscayne and Floridan aquifers are performed during construction and after startup. Analysis includes field parameters (pH, temperature, specific conductance, oxidation-reduction potential, and dissolved oxygen), major cations, major anions, total dissolved solids, silica, and any additional water use or injection well permit-required parameters. Sampling is performed in site water supply wells, selected observation wells, and dual-zone monitoring wells as part of the UIC program.

Operational accident monitoring will be initiated in the unlikely event of a release of liquid effluent from the plant. Quarterly groundwater samples will be collected from downgradient Biscayne aquifer observation wells as needed to identify impact. Selection of downgradient observation wells will be based on flow directions determined from the most recent groundwater level measurements and post-construction groundwater modeling.

Safeguards will be used to minimize the potential for adverse impacts to the groundwater caused by construction and operation of the new units. These safeguards include the use of emergency cleanup procedures to capture and remove surface contaminants, and other measures deemed necessary to prevent or minimize adverse impacts to the groundwater beneath the site.

2.4.12.5 Site Characteristics for Subsurface Hydrostatic Loading

Subsurface hydrostatic loading estimates for Units 6 & 7 structures were evaluated using two approaches. First, a conservative maximum groundwater level of 0.6 meters (2 feet) below grade was evaluated as specified in DCD Table 2-1. The finish grade in the power block area at Units 6 & 7 is El. 25.5 feet NAVD 88. The maximum acceptable groundwater elevation at the site is El. 23.5 feet NAVD 88, which is over 20 feet higher than the current or predicted groundwater levels. The second approach uses the simulated post-construction groundwater level elevation from the numerical groundwater flow model (Appendix 2CC). The model results for post-construction groundwater conditions indicate an average elevation of approximately –0.5 to –0.6 feet NAVD 88 in the power block area. The maximum hydrostatic loading was estimated using the following formula:

$$\rho_w = z_w \times \gamma_w$$

Where,

ρ_w = hydrostatic pressure (pounds per square foot)

z_w = depth below groundwater level (feet)

γ_w = unit weight of water (64.4 pounds per cubic foot for site groundwater in the upper monitoring zone)

Figure 2.4.12-247 presents a graph of subsurface hydrostatic loading. Two lines are provided on the graph: the first represents the upper boundary condition using the DCD maximum groundwater level, and the second represents the predicted water level in the power block area from the calibrated groundwater flow model.

Subsurface hydrostatic loading on safety-related structures during construction is anticipated to be less than that predicted above as a result of the implementation of construction groundwater control measures.

Construction-related excavation dewatering or groundwater control is required to a depth of approximately 35 feet below pre-construction grade for the reactor building. A discussion of this dewatering is provided in Subsections 2.5.4.5.4 and 2.5.4.6.2.

Groundwater level recovery following backfilling around the plant structures is conducted in a controlled manner to prevent rapid hydrostatic pressure buildup or damage to the backfill materials. Before the start of excavation, a groundwater control and recovery plan will be prepared to describe the system design, installation, and removal.

In summary, based on the groundwater level elevations and the groundwater computer modeling activities, the groundwater depth in both power block areas is below the maximum groundwater level of 2 feet below design grade as specified in DCD Table 2-1. Based on this observation, a permanent dewatering system is not a design feature for Units 6 & 7.

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PTN COL 2.4-4

Table 2.4.12-201
Summary of Observation Well Construction Data

Well Number	Borehole Depth (feet bgs)	Well Depth (feet bgs)	Coordinates (Florida East State Plane) in feet		Screened Interval (feet bgs)	Top of Casing Elevation (feet NAVD 88)	Height of casing (feet ags)	Pad Elevation (feet NAVD 88)
			Northing	Easting				
OW-606D	137.0	136.0	396962.8	876712.9	125–135	1.70	3.2	–1.6
OW-606L	110.0	108.0	396979.9	876732.6	97–107	1.31	2.8	–1.5
OW-606U	30.2	29.0	396938.0	876734.8	18–28	1.37	3.2	–1.8
OW-621L	110.0	109.6	97364.5	876970.0	98.6–108.6	3.07	3.0	0.1
OW-621U	30.0	28.4	397375.8	876930.0	17.4–27.4	3.88	3.3	0.6
OW-636L	111.0	108.1	395290.8	877257.2	97.1–107.1	2.89	3.4	–0.4
OW-636U	29.8	28.0	396960.1	875864.4	17–27	2.82	3.4	–0.6
OW-706D	138.4	135.1	396960.1	875864.4	123.8–133.8	2.22	3.3	–1.1
OW-706L	112.0	111.0	396978.2	875904.6	100–110	2.26	3.2	–1.0
OW-706U	29.0	28.0	396940.1	875895.7	17–27	1.70	3.2	–1.5
OW-721L	109.0	107.0	397321.5	876120.3	96–106	2.06	3.2	–1.2
OW-721U	26.0	25.0	397361.2	876121.4	14–24	2.07	3.1	–1.1
OW-735L	110.0	107.9	395824.3	875669.5	96.9–106.9	2.70	3.4	–0.7
OW-735U	28.0	27.0	395823.3	875709.2	16–26	2.82	3.3	–0.5
OW-802L	110.0	109.0	398817.1	876255.7	98–108	2.16	3.3	–1.2
OW-802U	27.0	26.0	398820.2	876243.7	15–25	2.23	3.4	–1.2
OW-805L	97.0	96.0	396883.0	877239.5	85–95	2.25	3.7	–1.5
OW-805U	30.0	29.0	396842.8	877240.9	18–28	1.28	2.8	–1.6
OW-809L	110.0	106.5	397007.9	875152.3	95.5–105.5	2.38	3.3	–0.9
OW-809U	27.0	26.0	397045.8	875152.4	15–25	2.55	3.2	–0.7
OW-812L	109.0	108.0	368892.8	875045.5	97–107	2.15	3.3	–1.2
OW-812U	27.0	26.0	398933.9	875043.5	15–25	2.22	3.0	–0.8

bgs = Below ground surface
ags = Above ground surface

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Table 2.4.12-202
Historical and Projected Groundwater Use in Miami-Dade County

Year	Groundwater Use/Projected Use in million gallons per day					
	Public Supply	Domestic	Commercial	Agricultural	Recreational	Power Generation
1965	202.3	9.6	5	67.9	—	0.3
1970	212.1	9.13	7.7	44.8	—	0.04
1975	270.5	9.5	3.38	87.66	—	0.04
1977	280.15	3.98	6.73	101.06	—	0
1980	314.29	18.38	19.73	86.98	—	0
1985	339.77	13.32	15.78	103.68	13.5	0
1990	337.69	10.75	40.34	115.01	20.55	2.26
1995	386.6	12.71	38.82	95.95	14.24	2.1
2000	394.29	4.85	41.65	86.55	8.51	2.08
2005	400.01	2.78	40.08	58.06	13.4	0.42
2010	407.8[(a)]		41.7	92.1	10.4	14.2
2015	435.2[(a)]		41.7	91.5	12	14.2
2020	459.6[(a)]		41.7	90.8	13.6	14.2
2025	483.1[(a)]		41.7	90.2	15.1	69.8

(a) Projected use includes Public Supply and Domestic as a single value.
Sources:
1965–2000 Reference 221
2005 Reference 222
2010–2025 Reference 230

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Table 2.4.12-203 (Sheet 1 of 5)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4130077	Community	Bal Harbour Village	Bal Harbour	Municipality	3,309	0	3,672,000
4130089	Community	Bay Harbor Islands Town of	Bay Harbor Islands	Municipality	5,146	0	1,500,000
4130255	Community	Florida City	Florida City	Municipality	9,445	0	4,000,000
4130588	Community	Redlands Mobile Home Park	Miami	Investor	160	0	100,000
4130604	Community	Hialeah City of	Hialeah	Municipality	110,000	0	40,000,000
4130645	Community	Homestead City of	Homestead	Municipality	39,000	385	16,900,000
4130662	Community	Indian Creek Village	Miami Beach	Authority/Commission/District	103	0	1,080,000
4130833	Community	Jones' Trailer Park	Miami	Investor	120	0	50,000
4130871	Community	Mdwasa - Main System	Miami	Municipality	2,100,000	322,608	442,740,000
4130901	Community	Miami Beach City of	Miami Beach	Municipality	87,933	3309	65,000,000
4130904	Community	Miami Springs City of	Miami Springs	Municipality	14,000	0	5,472,000
4130970	Community	North Bay Village City of	North Bay Village	Municipality	6,733	0	6,480,000
4130977	Community	North Miami City of	North Miami	Municipality	80,000	4,809	9,300,000
4131001	Community	Opa Locka City of	Opa Locka	Municipality	15,250	0	6,900,000
4131202	Community	Mdwasa/Rex Utilities	Miami	Investor	41,500	0	12,030,000
4131206	Community	Rex Utilities Inc/Redavo	Homestead	Municipality	385	0	570,000
4131312	Community	Silver Palm Mobile Homes	Miami	Investor	250	0	122,000
4131403	Community	Americana Village	Miami	Investor	2,100	0	500,000
4131424	Community	Surfside Town of	Surfside	Municipality	5,600	103	1,512,000
4131474	Community	Medley Water Department	Miami	Municipality	1,098	0	1,800,000
4131531	Community	Virginia Gardens Village of	Virginia Gardens	Municipality	2,212	0	5,000,000
4131558	Community	West Miami City of	West Miami	Municipality	5,863	0	1,000,000
4131618	Community	North Miami Beach	North Miami Beach	Municipality	160,000	13,146	32,000,000
4134357	Community	Fkaa J. Robert Dean W.T.P.	Florida City	State	80,500	0	22,000,000
4134358	Community	Dade Juvenile Residential Facility	Florida City	Investor	290	0	35,000
4134365	Community	Hialeah Gardens	Hialeah Gardens	Municipality	19,297	0	1
4130048	Noncommunity	Anderson's Corner Grocery	Miami	Investor	35	0	8,000
4130053	Noncommunity	Hightailin' It	Miami	Investor	205	0	28,000
4130112	Noncommunity	Benson Lighting	Miami	Investor	25	0	36,000
4130159	Noncommunity	Brooks (J R) & Son	Homestead	Investor	100	0	28,000
4130320	Noncommunity	Camp Owaissa Bauer	Miami	Municipality	146	0	183,000
4130496	Noncommunity	Franksher Building	Miami	Investor	25	0	64,000

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Table 2.4.12-203 (Sheet 2 of 5)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4130721	Noncommunity	Miami Everglades Campground	Miami	Unknown	562	0	122,000
4130736	Noncommunity	Villa De Don Pollo	Miami	Investor	599	0	36,000
4130793	Noncommunity	Deluxe Motel	Leisure City	Investor	50	0	46,000
4130811	Noncommunity	De Leon Harvesting	Homestead	Investor	25	0	36,000
4130823	Noncommunity	Dan Lewis Properties	Miami	Investor	25	0	15,000
4130891	Noncommunity	Roberts Air	Homestead	Municipality	25	0	28,000
4130893	Noncommunity	Dade Homestead Gaa - Admin.	Homestead	Municipality	25	0	28,000
4130894	Noncommunity	Dade Homestead Gaa Skydive	Homestead	Municipality	30	0	28,000
4130897	Noncommunity	Dade Landscape Nursery	Miami	Municipality	40	0	86,000
4130933	Noncommunity	Monkey Jungle	Miami	Investor	300	0	122,000
4130951	Noncommunity	Last Chance Lounge	Florida City	Investor	100	0	5,000
4131080	Noncommunity	Pedersen Building	Miami	Investor	25	0	17,000
4131185	Noncommunity	Grove Inn	Miami	Investor	25	0	36,000
4131192	Noncommunity	Redland Golf & Country Club	Homestead	Investor	380	0	57,000
4131217	Noncommunity	Rinker Cement Mill	Miami	Investor	130	0	720,000
4131250	Noncommunity	America’s Best Inn	Homestead	Investor	50	0	61,000
4131313	Noncommunity	Silver Palms Methodist Church	Homestead	Other	200	0	36,000
4131454	Noncommunity	R & R Cafe	Homestead	Investor	100	0	36,000
4131961	Noncommunity	Redland Fruit and Spice Park	Miami	County	55	0	46,000
4131962	Noncommunity	Castellow Hammock Park	Miami	County	68	0	1,700
4134228	Noncommunity	Chevron Krome	Homestead	Investor	25	0	1,000
4134234	Noncommunity	Cemex Materials - Sweetwater	Miami	Investor	50	0	5,000
4134237	Noncommunity	Jack’s Bait & Tackle	Florida City	Investor	200	0	3,200
4134239	Noncommunity	Liberty (Formerly Shell Gas Station)	Miami	Investor	25	0	9,600
4134301	Noncommunity	Iglesia Buen Samaritano	Miami	Investor	100	0	12,000
4134328	Noncommunity	Atlantic Fertilizer	Homestead	Investor	40	0	1,000
4134334	Noncommunity	Costa Nursery II	Miami	Investor	25	0	1,000
4134338	Noncommunity	Benito Juarez Park	Homestead	County	100	0	1,700
4134363	Noncommunity	Homestead Jehovah’s Witness	Homestead	Other	100	0	1
4134364	Noncommunity	Dade Corners	Miami	Investor	25	0	10,000
4134379	Noncommunity	Bernecker’s Nursery	Miami	Investor	25	0	5,000
4134422	Noncommunity	South Florida Testing Service	Hialeah	Investor	50	0	5,000
4134430	Noncommunity	Tom Thumb #122	Miami 33170	Investor	25	0	5,000
4134431	Noncommunity	Redland Exxon	Miami	Investor	25	0	5,000

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Table 2.4.12-203 (Sheet 3 of 5)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4134434	Noncommunity	Community Asphalt	Hialeah	Investor	25	0	5,000
4134439	Noncommunity	Cemex-F.E.C. Office	Hialeah	Investor	160	0	3,000
4134442	Noncommunity	Redland Community Church	Miami	Investor	500	0	3,000
4134382	Noncommunity	Butler's Nursery	Miami	Investor	25	0	5,000
4134384	Noncommunity	Cauley Square Tea Room	Miami	Investor	40	0	10,000
4134387	Noncommunity	Coconut Palm Trading Post	Homestead	Investor	300	0	5,000
4134388	Noncommunity	Coffey's Market	Miami	Investor	35	0	5,000
4134393	Noncommunity	Coopertown	Miami	Investor	100	0	5,000
4134394	Noncommunity	Costa Nursery	Miami	Investor	150	0	5,000
4134400	Noncommunity	El Nopal	Miami	Investor	25	0	5,000
4134402	Noncommunity	Greenleaf Nursery	Homestead	Investor	25	0	5,000
4134404	Noncommunity	Gulfstream Tomato Growers	Miami	Investor	100	0	5,000
4134414	Noncommunity	Playpen South (Gator Kicks)	Miami	Investor	50	0	5,000
4134417	Noncommunity	Redland Tavern	Goulds	Investor	40	0	5,000
4134420	Noncommunity	Safari Restaurant	Miami	Investor	25	0	5,000
4134443	Noncommunity	Comcast Cable	Miami	Other	225	0	3,000
4134445	Noncommunity	First Grace Faith Pentecost	Princeton	Investor	25	0	3,000
4134446	Noncommunity	Kent Motel	Goulds	Investor	50	0	3,000
4134448	Noncommunity	Palms Professional Center	Miami	Investor	25	0	3,000
4134451	Noncommunity	Farm Credit Service	Homestead Fl 33090	Investor	25	0	2,720
4134453	Noncommunity	Cemex-F.E.C. Shop	Hialeah	Investor	35	0	16,000
4134454	Noncommunity	Rancho Okeechobee	Hialeah Gardens	Investor	200	0	3,000
4134459	Noncommunity	Circle D Farms	Homestead	Investor	25	0	3,000
4134462	Noncommunity	Redlands Grocery	Homestead	Investor	200	0	3,000
4134464	Noncommunity	Sunrise Adult Group Home (15190)	Naranja	Investor	25	0	3,000
4134465	Noncommunity	Sunrise Adult Services (29800)	Homestead	Investor	80	0	3,000
4134468	Noncommunity	U-Haul Rental & Services	Miami	Investor	25	0	3,000
4134471	Noncommunity	Certified Auto	Miami	Investor	25	0	3,000
4134494	Noncommunity	Dinas Quick Mart	Miami	Investor	25	0	3,000
4134499	Noncommunity	Our Lady of Mercy Cemetery	Doral	Investor	50	0	2,000
4134506	Noncommunity	First Baptist Church Redland	Homestead	Other	120	0	2,000
4134508	Noncommunity	Aviary Bird Shop	Goulds	Investor	25	0	2,000
4134512	Noncommunity	De Leon Bromeliads	Miami	Investor	54	0	5,000
4134516	Noncommunity	Tom Thumb #127	Hialeah	Investor	25	0	2,400

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Table 2.4.12-203 (Sheet 4 of 5)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4134518	Noncommunity	Christ Life Center	Miami	Other	485	0	500
4134519	Noncommunity	Okeechobee Barrier	Miami	State	39	0	9,600
4134522	Noncommunity	1st Baptist Church of Homestead	Homestead	Other	300	0	5,000
4134523	Noncommunity	Women's Club of Homestead	Homestead	Other	25	0	3,300
4134524	Noncommunity	Redland Church of the Nazarene	Miami	Other	150	0	7,200
4134525	Noncommunity	Cemex Hydro-Conduit	Miami	Investor	28	0	1,400
4134527	Noncommunity	Cemex Employees	Miami	Investor	50	0	0
4134528	Noncommunity	Fruitcuba	Miami	Investor	50	0	0
4134529	Noncommunity	Us 1 Motors	Miami	Unknown	25	0	2,000
4134531	Noncommunity	Tom Thumb 131	Homestead	Investor	25	0	1,000
4134532	Noncommunity	Sunoco Krome Ave	Miami	Investor	25	0	50
4134533	Noncommunity	Gator Park	Miami	Investor	25	0	3,000
4134535	Noncommunity	Vila & Sons	Medley	Investor	25	0	50
4134536	Noncommunity	Everglades Store	Florida City	Investor	25	0	15
4134537	Noncommunity	Mannheime Foundation	Homestead	Investor	50	0	0
4134538	Noncommunity	Bt South Dba Boody Trap	Homestead	Investor	30	0	120
4134540	Noncommunity	Chevron Gas Station	Miami	Investor	80	0	320
4134542	Noncommunity	Las Margaritas Shopping Center	Miami	Investor	50	0	3,200
4134543	Noncommunity	Schnebly Winery	Homestead	Investor	25	0	4,800
4134544	Noncommunity	Fruteria Cachita	Miami	Investor	25	0	2,000
4134545	Noncommunity	Cope Produce	Homestead	Investor	50	0	0
4130322	Nontransient Noncommunity	Redland Jr. High School	Homestead	Municipality	1,496	0	144,000
4130445	Nontransient Noncommunity	Tropical Research & Education Center	Homestead	State	75	0	36,000
4130934	Nontransient Noncommunity	Montessori Country School	Homestead	Investor	120	0	38,000
4131958	Nontransient Noncommunity	Sunrise Community	Miami	Investor	120	0	150,000
4134300	Nontransient Noncommunity	Redland Christian Academy	Homestead	Other	300	0	10,000
4134385	Nontransient Noncommunity	Unitarian Universal Congr'n of Miami	Miami	Investor	75	0	5,000

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Table 2.4.12-203 (Sheet 5 of 5)
Public Water Supply Systems in Miami-Dade County

Pws Id	Type	Mailing Name	City	Owner Type	Pop Served	Sells to Pop	Design Cap
4134498	Nontransient Noncommunity	Creative Years	Miami	Investor	100	0	2,000
4134502	Nontransient Noncommunity	Christian Family Worship Center	Homestead	Investor	400	0	9,600
4134513	Nontransient Noncommunity	Miami Intl Airport	Miami	County	26,800	0	1

Pop = Population note
Cap = Capacity
Source: Reference 228

Table 2.4.12-204 (Sheet 1 of 2)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet bgs)	Lower Screened Interval Midpoint (feet bgs)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	Δh (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-621U/L	6/29/2008 14:00	Low	22.4	103.6	81.2	-1.30	0.45	1.75	0.022
OW-621U/L	6/29/2008 7:00	High	22.4	103.6	81.2	-0.98	0.77	1.75	0.022
OW-621U/L	8/15/2008 17:00	Low	22.4	103.6	81.2	-1.09	0.64	1.73	0.021
OW-621U/L	8/15/2008 10:00	High	22.4	103.6	81.2	-0.64	1.08	1.72	0.021
OW-621U/L	10/5/2008 8:00	Low	22.4	103.6	81.2	0.16	1.82	1.66	0.020
OW-621U/L	10/5/2008 1:00	High	22.4	103.6	81.2	0.63	2.30	1.67	0.021
OW-621U/L	1/21/2009 2:00	Low	22.4	103.6	81.2	-2.82	-0.97	1.85	0.023
OW-621U/L	1/20/2009 19:00	High	22.4	103.6	81.2	-2.18	-0.34	1.84	0.023
OW-636U/L	6/29/2008 14:00	Low	22	102.1	80.1	-1.02	-0.24	0.78	0.010
OW-636U/L	6/29/2008 7:00	High	22	102.1	80.1	-0.69	0.06	0.75	0.009
OW-636U/L	8/15/2008 17:00	Low	22	102.1	80.1	-0.80	-0.01	0.78	0.010
OW-636U/L	8/15/2008 10:00	High	22	102.1	80.1	-0.35	0.39	0.75	0.009
OW-636U/L	10/5/2008 8:00	Low	22	102.1	80.1	0.35	1.05	0.70	0.009
OW-636U/L	10/5/2008 1:00	High	22	102.1	80.1	0.83	1.52	0.69	0.009
OW-735U/L	6/29/2008 14:00	Low	21	101.9	80.9	-1.32	2.08	3.41	0.042
OW-735U/L	6/29/2008 7:00	High	21	101.9	80.9	-1.21	2.20	3.40	0.042
OW-735U/L	8/15/2008 17:00	Low	21	101.9	80.9	-1.20	2.19	3.40	0.042
OW-735U/L	8/15/2008 10:00	High	21	101.9	80.9	-0.93	2.46	3.38	0.042
OW-735U/L	10/5/2008 8:00	Low	21	101.9	80.9	0.18	3.35	3.17	0.039
OW-735U/L	10/5/2008 1:00	High	21	101.9	80.9	0.40	3.56	3.16	0.039
OW-805U/L	6/29/2008 14:00	Low	23	90	67.0	-1.32	0.09	1.40	0.021
OW-805U/L	6/29/2008 7:00	High	23	90	67.0	-0.97	0.44	1.41	0.021
OW-805U/L	8/15/2008 17:00	Low	23	90	67.0	-1.11	0.28	1.40	0.021
OW-805U/L	8/15/2008 10:00	High	23	90	67.0	-0.63	0.71	1.34	0.020
OW-805U/L	10/5/2008 8:00	Low	23	90	67.0	0.06	1.44	1.37	0.021
OW-805U/L	1/21/2009 2:00	Low	23	90	67.0	-2.77	-1.42	1.35	0.020
OW-805U/L	1/20/2009 19:00	High	23	90	67.0	-2.14	-0.80	1.35	0.020

Table 2.4.12-204 (Sheet 2 of 2)
Vertical Hydraulic Gradients

Well Pair	Date/Time	Tide Condition	Upper Screened Interval Midpoint (feet bgs)	Lower Screened Interval Midpoint (feet bgs)	ΔL (feet)	Upper Reference Head (feet NAVD 88)	Lower Reference Head (feet NAVD 88)	Δh (feet)	Vertical Hydraulic Gradient i (feet/feet)
OW-809U/L	6/29/2008 14:00	Low	20	100.5	80.5	-1.22	0.47	1.69	0.021
OW-809U/L	6/29/2008 7:00	High	20	100.5	80.5	-1.14	0.54	1.69	0.021
OW-809U/L	8/15/2008 17:00	Low	20	100.5	80.5	-1.12	0.46	1.58	0.020
OW-809U/L	8/15/2008 10:00	High	20	100.5	80.5	-0.90	0.68	1.58	0.020
OW-809U/L	10/5/2008 8:00	Low	20	100.5	80.5	0.39	1.88	1.49	0.019
OW-809U/L	10/5/2008 1:00	High	20	100.5	80.5	0.54	2.04	1.50	0.019
OW-809U/L	1/21/2009 2:00	Low	20	100.5	80.5	-3.01	-1.53	1.47	0.018
OW-809U/L	1/20/2009 19:00	High	20	100.5	80.5	-2.39	-0.91	1.48	0.018
OW-812U/L	6/29/2008 14:00	Low	20	102	82.0	-0.99	0.61	1.60	0.019
OW-812U/L	6/29/2008 7:00	High	20	102	82.0	-0.89	0.73	1.62	0.020
OW-812U/L	8/15/2008 17:00	Low	20	102	82.0	-0.88	0.73	1.61	0.020
OW-812U/L	8/15/2008 10:00	High	20	102	82.0	-0.65	0.97	1.62	0.020

bgs = Below ground surface
Δh = Lower Reference Head – Upper Reference Head
ΔL = Lower Screened Interval Midpoint – Upper Screened Interval Midpoint
i = Δh/ΔL (negative value indicates downward flow potential and positive value indicates upward flow potential)
Reference Head values are estimated using the density of water in the well and correcting the water level to the average density of seawater in Biscayne Bay.

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Table 2.4.12-205
Representative Hydrogeologic Properties in Miami-Dade County[a]

Hydrogeologic Unit or Subunit	Hydraulic Conductivity (feet per day)		Porosity	Approximate Depth (feet bgs)	Unit Thickness (feet)
	Horizontal	Vertical			
Biscayne aquifer	1524	15	0.31	0–230	230
Intermediate confining unit	90	0.1–2.38	0.1–0.31	230–840	610
Upper Floridan aquifer	42	0.42–2.38	0.1–0.32	840–2060	1220
Middle confining unit	4.7	0.04–1.50[b]	0.1–0.43	2060–2550	490
Lower Floridan aquifer	0.01	0.1	0.1–0.4	2550–2750	200[c]
Boulder Zone	6540	65	0.2	2750–>3250	500

(a) Values in this table represent weighted averages for risk assessment for management of treated wastewater and thus may not be representative of actual conditions.
(b) The vertical hydraulic conductivity included here may be two to three orders of magnitude higher than other measurements in South Florida. Reference 247 indicates a vertical hydraulic conductivity range of 3E-04 to 3E-05 feet per day based on core measurements.
(c) The Lower Floridan aquifer extends below the Boulder Zone; the thickness presented is only for the portion above the Boulder Zone.

Adapted from Reference 237

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Table 2.4.12-206 (Sheet 1 of 8) Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	APT	10/08/2003 0000	FKAAFCEW1	818,318	403,673	280	10,790	72	—	880	1,353	—	—	—	Upper Floridan Aquifer	Specific capacity: 15 gpm/ft **Water was blended with raw water from Biscayne aquifer well field and apt initiated as step test to accommodate discharge to sewer system. Initial pump rate of 280 gpm; increased to 500 gpm and 750 gpm for first 24 hours. Rate decreased to 600 gpm for remainder of test as TDS concentration rose at 750 gpm.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City [(b)]	Packer	07/02/2003 0000	FKAAFCEW1	818,318	403,673	25	29	—	—	1,050	1,150	—	—	—	Upper Floridan Aquifer	Packer test #1 Specific capacity: 0.3 gpm/ft Salt plug in well was not completely purged prior to start of test- the initial static water level assumed to be the level to which the water level in the drill stem recovered at conclusion of test.

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Table 2.4.12-206 (Sheet 2 of 8) Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/09/2003 0000	FKAAFCEW1	818,318	403,673	85	—	—	—	1,220	1,283	—	—	—	Upper Floridan Aquifer	Packer test #2 Specific capacity: 12 gpm/ft Parameters not analyzed- no typical pump or recovery curves-water level responded so quickly to the start and stop of test.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/10/2003 0000	FKAAFCEW1	818,318	403,673	82	2,200	—	—	1,150	1,213	—	—	—	Upper Floridan Aquifer	Packer test #3 Specific capacity: 3 gpm/ft.
Florida Keys Aqueduct Auth Jr Dean WTP-Florida City[(b)]	Packer	07/22/2003 0000	FKAAFCEW1	818,318	403,673	60	492	—	—	880	1,040	—	—	—	Upper Floridan Aquifer	Packer test #4 Specific capacity: 2 gpm/ft.
Homestead Airforce Base[(b)]	Step-Draw-down	12/25/1991 0000	G-3314	801,450	426,168	—	1,000,000	—	—	21	48	37,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 3 of 8) Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Camp Owaissa-Bauer[b]	Step-Draw-down	12/25/1991 0000	G-3315	833,217	432,443	—	1,000,000	—	—	32	69	27,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.
Camp Owaissa-Bauer[b]	Other	12/25/1991 0000	G-3315	833,217	432,443	—	65	—	—	94	111.5	3.7	—	—	Surficial Aquifer System	Specific capacity test.
Levee 31w (At Structure 175)[b]	Other	12/25/1991 0000	G-3319	796,786	394,757	—	1,000,000	—	—	21	39.3	55,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.
Naval Station[b]	Other	12/25/1991 0000	G-3320	831,332	399,726	—	1,000,000	—	—	32	80	21,000	—	—	Surficial Aquifer System	Step drawdown test. Limits of the aquifer testing resulted in the transmissivity and conductivity values being greater than the values listed. For example the transmissivity may say 1,000,000 but it was actually 1,000,000+.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 4 of 8) Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Homestead Airforce Base Well Field 2[(b)]	Specific Capacity	01/01/200 0 0000	HAFB-1	852,589	423,035	900	60,000	—	—	—	30	—	—	—	Surficial Aquifer System	Transmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Miami-Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/25/197 7 0812	MDWSA_I5	876,304	442,461	50	8.54	0.7	—	2,737	2,759	—	1	—	Boulder Zone	Packer test 1 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional [(b)]	Packer	08/25/197 7 1225	MDWSA_I5	876,304	442,461	4	12.47	3.2	—	2,697	2,727	—	—	—	Boulder Zone	Packer test 2 of 10 Pump adjusted to 7.9 gpm at time 1310 and to 23 gpm at time 1424 leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[(b)]	Packer	08/25/197 7 2317	MDWSA_I5	876,304	442,461	24.5	18.97	3.31	—	2,367	2,397	—	—	—	Boulder Zone	Packer test 3 of 10 (parts 1 & 2)--pumped was stopped at 42 min into pumping at rate of 12.8 gpm (part 1); began pumping again at rate of 24.5 gpm for 2.6 hours--transmissivity is average of the two tests. Leakance was not determined due to very small drawdown in Boulder Zone.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 5 of 8)
Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/26/1977 0747	MDWSA_I5	876,304	442,461	61	47.43	1.55	—	2,407	2,759	—	—	—	Boulder Zone	Packer test 4 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/26/1977 1558	MDWSA_I5	876,304	442,461	42.5	23.98	1.28	—	1,968	1,998	—	—	—	Boulder Zone	Packer test 5 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/26/1977 1814	MDWSA_I5	876,304	442,461	61	88.48	0.5	—	2,008	2,759	—	—	—	Boulder Zone	Packer test 6 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/27/1977 1150	MDWSA_I5	876,304	442,461	55	19.38	1.88	—	2,543	2,573	—	—	—	Boulder Zone	Packer test 7 of 10Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WTPP[b]	Packer	08/27/1977 1628	MDWSA_I5	876,304	442,461	33	44.17	1.78	—	2,583	2,759	—	—	—	Boulder Zone	Packer test 8 of 10 pumping rate was increased to 60 gpm at time 1733 Leakance was not determined due to very small drawdown in Boulder Zone.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 6 of 8)
Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/28/1977 0130	MDWSA_I5	876,304	442,461	12	35.77	2.8	—	2,692	2,759	—	—	—	Boulder Zone	Packer test 9 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Miami Dade Water and Sewer Auth. So. District Regional WWTP[b]	Packer	08/28/1977 0554	MDWSA_I5	876,304	442,461	20	13.01	2.4	—	2,652	2,682	—	—	—	Boulder Zone	Packer test 10 of 10 Leakance was not determined due to very small drawdown in Boulder Zone.
Florida City[b]	Specific Capacity	01/01/2000 0000	S-3051	826,078	407,075	900	220,000	—	—	—	47.5	—	—	—	Surficial Aquifer System	Transmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Florida City[b]	Specific Capacity	01/01/2000 0000	S-3052	825,987	406,974	590	160,000	—	—	40	60	—	—	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 7 of 8) Regional Aquifer Properties

Site	Test Type[(a)]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Harris Park Power Plant[(b)]	Specific Capacity	01/01/200 0 0000	S-3060	833,747	414,778	3,000	240,000	4	—	40	60	—	—	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Harris Park Power Plant[(b)]	Specific Capacity	01/01/200 0 0000	S-3061	833,105	41,4775	3,000	110,000	9	—	40	60	—	–	—	Surficial Aquifer System	Trasmissivity value was estimated from specific capacity value. Prepared in cooperation with the SFWMD, this data was compiled from Metro-Dade Water and Sewer Authority or from SFWMD files.
Turkey Point Area – FAS[(b)]	APT	04/24/200 6 0000	TKPT-PW1	874,572	402,532	4,500	33,062	72	0.0002	1003	1242	—	3	0.005	Upper Floridan Aquifer	Average of results from Hantush-Jacob, leaky confined aquifer solution. Tidal effects negligible.

PTN COL 2.4-4

Table 2.4.12-206 (Sheet 8 of 8)
Regional Aquifer Properties

Site	Test Type[a]	Start Test Date Time	Pumped Well	Pumped Well X-Coord. (feet)	Pumped Well Y-Coord. (feet)	Discharge Rate (g/min)	Transmissivity (ft^2/day)	Hours Pumped	Storativity	Tested Interval Min. (ft)	Tested Interval Max. (ft)	Horizontal K (feet/day)	No. Monitored Wells	Leakance (1/day)	Aquifer	Comments
Turkey Point Area - FAS[b]	APT	10/16/1974 1000	W-12295	851,079	370,735	5,000	67,750.68	2,160	0.005	1126	1,400	—	5	6.68 E-06	Floridan Aquifer System	Very long-term (90 day) test. Barometric eff. Est. = 100%. Graphical plots of drawdown vs time indicated that despite the very long duration of the test full equilibrium had not been reached. Recommended values based on drawdowns from the furthest observation wells (r=2000' & r=45,000'). Leakance values are based on drawdown in lower monitor zone (so leakance for middle confining unit). Estimated effective porosity = 0.30.
Turkey Point Area[c]	APT	06/1971	GH-11 (GH-11B)	864,80	384,465	13,80	401,070	4	0.35	15	50	—	5		Biscayne Aquifer	No apparent tidal influence during the test.
Turkey Point Area [c]	APT	06/1971	GH-14 (GH-14A)	873,673	400,465	1,380	133,690	4	0.35	15	40	—	6		Biscayne Aquifer	Tidal fluctuations observed during the test.
Turkey Point Area[c]	APT	06/1971	GH-14 (GH-14B)	873,673	400,465	1,380	200,535	2	0.2	15	50	—	6	—	Biscayne Aquifer	Tidal fluctuations observed during the test.

(a) APT = Aquifer pumping test
(b) Reference 233
(c) Reference 238
FAS = Floridan aquifer system

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 1 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3672	16	20	4	HFC5	0.69	NM	NM	NM	27.4	2.68	core plug	1
G-3672	17	20	3	HFC5	96.3	NM	NM	NM	33.9	2.68	core plug	1
G-3672	18.25–18.75	20	1.5	HFC5	175	NM	NM	NM	37.0	2.66	core plug	1
G-3673	17–17.5	20	2.75	HFC5	654	NM	NM	NM	37.1	2.66	core plug	1
G-3674	4.25–5	10	5.63	HFC5	515	NM	NM	NM	37.5	2.67	core plug	1
G-3675	4.25–4.5	8	3.62	HFC5	98.1	NM	NM	NM	22.0	2.69	core plug	1
G-3675	4.5–5	8	3.25	HFC5	599	NM	NM	NM	29.5	2.67	core plug	1
G-3711	4	10	6	HFC5	NM	25,764	12,875	13,372	46.7	2.69	whole core	1
G-3712	6.21	10	3.79	HFC5	NM	NM	NM	14,159	47.8	2.70	whole core	1
G-3714	9.46	13	3.54	HFC5	NM	NM	NM	9,494	49.3	2.67	whole core	1
G-3770	4.05–4.22	6.7	2.61	HFC5	NM	4,564	1,531	7,099	41.6	2.66	whole core	2
G-3778	8.46–8.73	16.4	7.76	HFC5	NM	1,684	79	220	40.4	2.70	whole core	2
G-3778	9.4–9.67	16.4	6.82	HFC5	NM	11,659	10,201	1,990	45.4	2.70	whole core	2
G-3778	9.92–10.11	16.4	6.39	HFC5	NM	1,116	966	14,750	46.1	2.70	whole core	2
G-3778	11.03–11.24	16.4	5.27	HFC5	NM	19,355	19,355	2,291	41.6	2.67	whole core	2
G-3778	13.08–13.48	16.4	3.12	HFC5	NM	10,178	9,159	3,605	43.2	2.69	whole core	2
G-3778	13.48–13.90	16.4	2.71	HFC5	NM	8,638	5,757	6,157	43.2	2.69	whole core	2
G-3778	13.90–14.28	16.4	2.31	HFC5	NM	10,356	10,356	3,727	44.7	2.69	whole core	2
G-3778	14.28–14.70	16.4	1.91	HFC5	NM	8,357	7,312	2,687	44.7	2.68	whole core	2
G-3778	15.03–15.36	16.4	1.21	HFC5	NM	10,155	8,884	6,520	45.9	2.71	whole core	2
G-3779	14.93–15.26	16.2	1.07	HFC5	NM	2,703	2,101	2,121	47.0	2.72	whole core	2
G-3779	15.26–15.55	16.2	0.8	HFC5	NM	4,178	4,178	2,107	46.7	2.72	whole core	2
G-3779	15.75–15.96	16.2	0.35	HFC5	NM	17,818	9,646	1,347	44.2	2.70	whole core	2
G-3779	16.25–16.63	16.2	–0.23	HFC5	NM	7,566	3,360	3,195	45.5	2.72	whole core	2
G-3779	16.63–17.09	16.2	–0.66	HFC5	NM	7,805	6,829	2,973	47.6	2.72	whole core	2

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Table 2.4.12-207 (Sheet 2 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3779	17.51–17.93	16.2	–1.52	HFC5	NM	6,717	4,797	3,023	44.3	2.71	whole core	2
G-3779	17.93–18.39	16.2	–1.96	HFC5	NM	7,101	4,436	2,239	44.4	2.71	whole core	2
G-3779	18.39–18.77	16.2	–2.38	HFC5	NM	8,022	5,728	2,168	44.5	2.70	whole core	2
G-3791	6.42–6.8	8	1.39	HFC5	NM	10,733	10,733	4,357	44.5	2.71	whole core	2
G-3791	7.05–7.38	8	0.78	HFC5	NM	12,695	12,695	4,423	49.4	2.69	whole core	2
G-3794	6.68–7.10	9	2.11	HFC5	NM	2,257	1544	2,044	42.6	2.70	whole core	2
G-3675	6.0	8	2.00	HFC4	NM	9,080	2054	NM	34.7	2.70	whole core	1
G-3683	12.5	12	–0.5	HFC4	NM	13.8	2.56	11.3	16.7	2.72	whole core	1
G-3689	15.3	9	–6.3	HFC4	NM	950	337	0.03	18.6	2.72	whole core	1
G-3692	10.8	9	–1.8	HFC4	221.32	NM	NM	NM	23.3	2.71	core plug	1
G-3694	16	10	–6	HFC4	NM	83.2	42.5	11.8	17.3	2.71	whole core	1
G-3696	19	10	–9	HFC4	NM	1,035	680	5,624	12.5	2.71	whole core	1
G-3697	12.9	9	–3.9	HFC4	NM	0.67	0.5	0.18	18.9	2.72	whole core	1
G-3697	13	9	–4	HFC4	NM	18.2	0.05	0.02	8.3	2.72	whole core	1
G-3713	9.28	10	0.72	HFC4	NM	2,204	1835	922	27.3	2.70	whole core	1
G-3717	11.75	9	–2.75	HFC4	NM	7,017	4302	248	11.0	2.69	whole core	1
G-3721	9.75	10	0.25	HFC4	NM	82.5	21.1	10.6	16.4	2.70	whole core	1
G-3725	9.92	6	–3.92	HFC4	NM	6,964	3731	758	14.8	2.69	whole core	1
G-3730	9	6	–3	HFC4	NM	1,319	47.3	262	13.7	2.68	whole core	1
G-3731	9.67	6.7	–2.97	HFC4	NM	144	0.03	201	5.9	2.69	whole core	1
G-3770	4.38-4.59	6.7	2.22	HFC4	NM	2	0.3	0.02	10.1	2.70	whole core	2
G-3770	4.76-5.01	6.7	1.82	HFC4	NM	1,067	949	1090	27.3	2.69	whole core	2
G-3771	6.85-7.1	6	–0.98	HFC4	NM	0.04	0.04	13,108	15.0	2.68	whole core	2
G-3771	7.1–7.4	6	–1.25	HFC4	NM	831	215	2,463	10.1	2.68	whole core	2
G-3771	7.4–7.7	6	–1.55	HFC4	NM	0.02	0.02	0.01	7.8	2.68	whole core	2
G-3771	7.8–8.1	6	–1.95	HFC4	NM	694	600	1	16.9	2.68	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 3 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3789	10.29–10.46	8	–2.38	HFC4	NM	10,040	7529	2,118	37.2	2.73	whole core	2
G-3790	11.6-11.85	8	–3.72	HFC4	NM	11,017	9,442	1,727	16.8	2.70	whole core	2
G-3790	17.43–17.72	8	–9.58	HFC4	NM	43	28	31	11.2	2.69	whole core	2
G-3790	18.17–18.42	8	–10.3	HFC4	NM	708	567	359	15.0	2.70	whole core	2
G-3790	18.55–18.71	8	–10.63	HFC4	NM	3,813	1,670	997	26.0	2.72	whole core	2
G-3791	14.11-14.36	8	–6.24	HFC4	NM	734	291	1,750	21.6	2.68	whole core	2
G-3791	15.45–15.68	8	–7.56	HFC4	NM	560	453	255	24.6	2.69	whole core	2
G-3792	13.15–13.35	8	–5.25	HFC4	NM	1	0.05	0.01	6.9	2.69	whole core	2
G-3794	6.82–7.09	9	2.04	HFC4	NM	31	19	16	16.1	2.71	whole core	2
G-3794	7.42–7.67	9	1.46	HFC4	NM	799	671	348	21.4	2.71	whole core	2
G-3794	8.65–8.92	9	0.22	HFC4/3	NM	366	40	19	13.1	2.70	whole core	2
G-3794	9.38–9.63	9	–0.5	HFC4	NM	869	810	391	16.2	2.72	whole core	2
G-3672	20.5	20	–0.5	HFC3	NM	750	280	0.2	13.5	2.75	whole core	1
G-3672	24	20	-4	HFC3	3098	NM	NM	NM	32.1	2.71	core plug	1
G-3673	20-20.75	20	-0.38	HFC3	1,699	NM	NM	NM	19.1	2.70	core plug	1
G-3673	23.5-24	20	-3.75	HFC3	3,704	NM	NM	NM	30.9	2.68	core plug	1
G-3673	24.5-25	20	-4.75	HFC3	80.6	NM	NM	NM	14.6	2.71	core plug	1
G-3673	27.25-27.75	20	-7.5	HFC3	4,657	NM	NM	NM	28.8	2.70	core plug	1
G-3673	30.75-31.25	20	-11	HFC3	9,443	NM	NM	NM	20.6	2.69	core plug	1
G-3673	32–32.3	20	–12.15	HFC3	10.1	NM	NM	NM	19.3	2.68	core plug	1
G-3674	15.5–6	10	–5.75	HFC3	5,222	NM	NM	NM	27.4	2.69	core plug	1
G-3674	18	10	-8	HFC3	NM	2,428	1,582	0.05	21.0	2.70	whole core	1
G-3674	18.5–19	10	–8.75	HFC3	0.01	NM	NM	NM	20.8	2.70	core plug	1
G-3675	8	8	0	HFC3	NM	856	847	0.52	21.3	2.70	whole core	1
G-3675	9–9.5	8	–1.25	HFC3	112	NM	NM	NM	21.4	2.70	core plug	1
G-3678	23.3	9	–14.3	HFC3	NM	3,758	1,754	8,662	19.7	2.71	whole core	1

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 4 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-m um Hori-zo ntal	Hori-zo ntal 90°	Vertical				
G-3679	14.6	9	–5.6	HFC3	8,818	NM	NM	NM	46.6	2.71	core plug	1
G-3679	15.6	9	–6.6	HFC3	NM	3,410	1,101	14000	20.9	2.71	whole core	1
G-3681	15.6	9	–6.6	HFC3	NM	20.1	2.56	0.72	12.8	2.72	whole core	1
G-3688	13.3	9.5	–3.8	HFC3	NM	0.15	0.07	<0.01	6.5	2.71	whole core	1
G-3689	28.5	9	-19.5	HFC3	NM	19,323	19,323	15,112	25.8	2.72	whole core	1
G-3690	11.7	9	-2.7	HFC3	NM	202	20.8	235	10.2	2.73	whole core	1
G-3691	22.3	8	–14.3	HFC3	NM	6,501	4,332	7,474	32.4	2.71	whole core	1
G-3695	15.5	9.5	–6	HFC3	NM	0.14	0.11	0.02	10.6	2.70	whole core	1
G-3695	20	9.5	–10.5	HFC3	NM	58.5	13.7	532	16.7	2.72	whole core	1
G-3696	19.5	10	–9.5	HFC3	NM	355	291	0.12	13.9	2.71	whole core	1
G-3710	19.25	10	–9.25	HFC3	NM	11,227	11,227	12,900	22.6	2.72	whole core	1
G-3710	24.33	10	–14.33	HFC3	NM	1,315	998	9,754	14.7	2.71	whole core	1
G-3710	26.3	10	–16.3	HFC3	34400	NM	NM	NM	35.2	2.72	core plug	1
G-3711	27.33	10	–17.33	HFC3	NM	1,031	1,007	6.18	25.9	2.71	whole core	1
G-3713	22.5	10	–9.83	HFC3	NM	27.5	0.18	840	16.0	2.71	whole core	1
G-3713	23.75	10	–13.75	HFC3	NM	31,148	29,419	8,171	32.3	2.72	whole core	1
G-3714	18.83	9	–9.83	HFC3	NM	13,356	11,685	11,642	36.6	2.71	whole core	1
G-3715	16.88	9	–7.88	HFC3	NM	2,606	1,968	2,226	31.1	2.71	whole core	1
G-3717	20.29	9	–11.29	HFC3	NM	20,592	18,303	13,217	23.4	2.71	whole core	1
G-3717	21.25	9	–12.25	HFC3	NM	16.3	10.5	92.3	20.3	2.70	whole core	1
G-3717	23.58	9	–14.58	HFC3	NM	8,458	4,229	12,213	21.8	2.70	whole core	1
G-3719	8.75	9	0.25	HFC3	NM	4.1	0.12	4.13	10.4	2.71	whole core	1
G-3719	14.57	9	–5.57	HFC3	NM	8,067	6,054	8,532	34.8	2.72	whole core	1
G-3720	18.71	9	–9.71	HFC3	NM	16,478	16,478	11,878	38.0	2.73	whole core	1
G-3722	15.62	10	–5.62	HFC3	NM	1,867	1,787	2,273	37.1	2.65	whole core	1
G-3722	17.33	10	–7.33	HFC3	NM	5,263	4,426	7,190	41.7	2.72	whole core	1

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 5 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3724	9.67	9	–0.67	HFC3	NM	673	597	404	12.6	2.69	whole core	1
G-3724	14.08	9	–5.08	HFC3	NM	18,308	7,891	5,100	44.6	2.72	whole core	1
G-3725	18.83	6	–12.83	HFC3	NM	12,191	8,125	6,354	41.1	2.72	whole core	1
G-3728	9	7	–2	HFC3	NM	1,200	1,200	607	20.5	2.70	whole core	1
G-3730	21.58	6	–15.58	HFC3	NM	8,452	6,500	15,894	15.5	2.70	whole core	1
G-3731	11.75	10	–1.75	HFC3	NM	2,595	1,842	1,839	31.0	2.71	whole core	1
G-3734	9.13	8	–1.13	HFC3	NM	15.5	10.9	20.2	13.1	2.70	whole core	1
G-3770	9–9.29	6.7	–2.45	HFC3	NM	0.2	0.03	0.02	12.5	2.70	whole core	2
G-3770	9.46–9.67	6.7	–2.86	HFC3	NM	20	11	167	14.9	2.69	whole core	2
G-3770	9.94–10.23	6.7	–3.39	HFC3	NM	1,345	1,125	1142	22.7	2.69	whole core	2
G-3770	10.86–11.19	6.7	–4.32	HFC3	NM	1,637	1,059	648	26.4	2.70	whole core	2
G-3770	13.9–14.34	6.7	–7.42	HFC3	NM	2,389	2,296	20,140	46.8	2.70	whole core	2
G-3770	14.34–14.74	6.7	–7.84	HFC3	NM	3,471	2,726	18,802	45.8	2.70	whole core	2
G-3770	14.74-15.07	6.7	–8.2	HFC3	NM	3,389	3,389	17,827	48.3	2.70	whole core	2
G-3770	18.49—8.78	6.7	–11.94	HFC3	NM	3,278	3,278	13,992	26.6	2.69	whole core	2
G-3771	8.60–8.85	6	–2.72	HFC3	NM	5	0.2	258	12.2	2.69	whole core	2
G-3771	8.85–9.1	6	–2.98	HFC3	NM	1,511	1151	3,152	15.7	2.68	whole core	2
G-3771	9.5–9.77	6	–3.64	HFC3	NM	263	188	194	14.5	2.69	whole core	2
G-3771	9.89–10.1	6	–4	HFC3	NM	1,717	1,552	1,277	19.7	2.69	whole core	2
G-3771	10.23–10.56	6	–4.4	HFC3	NM	667	601	370	19.7	2.69	whole core	2
G-3771	10.56–10.85	6	–4.7	HFC3	NM	2,350	2,268	13,272	29.7	2.68	whole core	2
G-3771	11.15–11.4	6	–5.28	HFC3	NM	329	270	317	24.1	2.70	whole core	2
G-3771	11.65–11.94	6	–5.8	HFC3	NM	1,427	1,366	363	25.9	2.70	whole core	2
G-3771	12.52–12.71	6	–6.62	HFC3	NM	2,459	2,346	8,483	25.2	2.70	whole core	2
G-3771	12.98–13.19	6	–7.08	HFC3	NM	1,528	1,251	4,877	26.9	2.71	whole core	2
G-3771	13.60–13.89	6	–7.74	HFC3	NM	3,391	3,391	14,564	40.3	2.73	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 6 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3771	14.06–14.4	6	–8.23	HFC3	NM	2,731	1,306	16,468	42.1	2.72	whole core	2
G-3771	16.5-16.85	6	–10.68	HFC3	NM	2,783	2,783	15,965	17.6	2.69	whole core	2
G-3771	16.88–17.09	6	–10.98	HFC3	NM	3,427	3,182	9,885	17.6	2.69	whole core	2
G-3778	15.86–16.15	16.4	0.4	HFC3	NM	0.02	0.001	0.001	7.2	2.70	whole core	2
G-3778	16.15–16.44	16.4	0.1	HFC3	NM	0.02	0.02	0.3	6.1	2.71	whole core	2
G-3778	16.69–16.82	16.4	–0.36	HFC3	NM	19	0.3	8	7.2	2.73	whole core	2
G-3778	17.24–17.59	16.4	–1.02	HFC3	NM	2,713	2,469	301	19.3	2.70	whole core	2
G-3778	26.01–26.18	16.4	–9.7	HFC3	NM	NM	NM	1,569	48.4	2.75	whole core	2
G-3778	31.06–31.16	16.4	–14.71	HFC3	NM	11,797	5,363	951	39.7	2.75	whole core	2
G-3778	31.75–31.65	16.4	–15.3	HFC3	NM	22,704	22,704	2,213	40.8	2.73	whole core	2
G-3778	35-35.17	16.4	–18.68	HFC3	NM	3,993	2,966	2,253	41.5	2.71	whole core	2
G-3778	35.54-35.87	16.4	–19.3	HFC3	NM	217	4	602	24.3	2.70	whole core	2
G-3779	21.6-21.85	16.2	–5.52	HFC3	NM	0.001	0.001	0.001	5.5	2.71	whole core	2
G-3779	21.95-22.25	16.2	5.9	HFC3	NM	0.2	0.02	0.3	7.1	2.71	whole core	2
G-3779	24.38-24.57	16.2	–8.28	HFC3	NM	5,268	4,811	1,652	46.9	2.79	whole core	2
G-3779	25.53-26.03	16.2	–9.58	HFC3	NM	7,228	6,424	4,169	50.2	2.81	whole core	2
G-3779	26.95-27.18	16.2	–10.86	HFC3	NM	14,754	NM	2,103	45.5	2.76	whole core	2
G-3779	35.06-35.37	16.2	–19.02	HFC3	NM	9,319	6,211	3,806	28.1	2.72	whole core	2
G-3789	13.68-13.93	8	–5.8	HFC3	NM	2,470	1,082	159	8.6	2.70	whole core	2
G-3789	14.59-14.76	8	–6.68	HFC3	NM	7,529	6,694	1,333	31.4	2.72	whole core	2
G-3789	15.85-16.08	8	–7.96	HFC3	NM	1,249	1,067	512	26.0	2.71	whole core	2
G-3789	19.63-19.94	8	–11.78	HFC3	NM	12,974	12,974	3,645	31.1	2.74	whole core	2
G-3789	20.15-20.44	8	–12.3	HFC3	NM	12,213	10,855	2,566	21.5	2.72	whole core	2
G-3789	20.86-21.24	8	–13.05	HFC3	NM	5,315	4,961	3,274	32.6	2.74	whole core	2
G-3789	21.49-21.93	8	–13.71	HFC3	NM	4,336	3,716	4,770	29.3	2.74	whole core	2
G-3789	22.06-22.56	8	–14.31	HFC3	NM	7,484	6,235	4,189	33.5	2.75	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 7 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[a]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3789	25.32-25.47	8	–17.4	HFC3	NM	54	1	1,578	17.9	2.71	whole core	2
G-3790	22.79-23	8	–14.9	HFC3	NM	4,478	4,277	507	27.0	2.73	whole core	2
G-3790	24-24.33	8	–16.16	HFC3	NM	10,076	7,195	2,084	27.7	2.73	whole core	2
G-3790	31.5-31.88	8	––3.69	HFC3	NM	2,566	1,970	2,765	30.2	2.72	whole core	2
G-3790	31.88–32.25	8	–24.19	HFC3/2	NM	3,335	3,160	3,661	32.6	2.72	whole core	2
G-3791	16.06–16.28	8	–8.17	HFC3	NM	0.02	0.02	0.02	12.7	2.69	whole core	2
G-3791	16.47–16.80	8	–8.64	HFC3	NM	476	0.2	7	14.7	2.70	whole core	2
G-3791	19.3–19.59	8	–11.74	HFC3	NM	5,258	4,343	2,439	29.7	2.71	whole core	2
G-3791	23.28–23.74	8	–15.51	HFC3	NM	4,338	4,049	3,037	30.0	2.72	whole core	2
G-3791	24.41–24.66	8	–16.54	HFC3	NM	15,535	13,980	2,858	30.0	2.72	whole core	2
G-3791	24.91–25.24	8	–17.08	HFC3	NM	8,994	8,994	3,097	32.7	2.72	whole core	2
G-3791	27.93–28.30	8	–20.1	HFC3	NM	10,831	10,831	4,639	29.6	2.72	whole core	2
G-3791	29.25–29.67	8	–21.46	HFC3	NM	6,663	3,805	4,054	19.7	2.70	whole core	2
G-3792	14.41–14.58	8	–6.5	HFC3	NM	4,247	4,106	769	17.4	2.70	whole core	2
G-3793	6.98–7.27	10	2.88	HFC3	NM	283	271	463	13.6	2.71	whole core	2
G-3794	12.7–12.89	9	–3.8	HFC3	NM	5,268	2,401	533	20.2	2.71	whole core	2
G-3794	17.63–18.01	9	–8.82	HFC3	NM	10,356	692	1,032	12.8	2.71	whole core	2
G-3794	20.18–20.60	9	–11.39	HFC3	NM	4,333	3,999	1,930	23.2	2.70	whole core	2
G-3673	46.5–47.25	20	–26.88	HFC2	<0.01	NM	NM	NM	12.8	2.69	core plug	1
G-3674	26.5–27	10	–16.75	HFC2	5,011	NM	NM	NM	19.6	2.70	core plug	1
G-3675	20.4	20	–0.4	HFC2	<0.01	NM	NM	NM	6.6	2.68	core plug	1
G-3675	23.5	8	–15.5	HFC2	NM	0.12	0.06	<0.01	11.3	2.69	whole core	1
G-3675	24.5–25	8	–16.75	HFC2	5027	NM	NM	NM	22.9	2.68	core plug	1
G-3675	31.75–32	8	–23.88	HFC2	<0.01	NM	NM	NM	12.5	2.70	core plug	1
G-3675	50.75–51	8	–42.88	HFC2	1688	NM	NM	NM	27.8	2.68	core plug	1
G-3679	28.3	9	–19.3	HFC2	0.3	NM	NM	NM	25.7	2.72	core plug	1

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 8 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3681	43.3	9	–34.3	HFC2	NM	0.08	0.05	0.02	11.6	2.72	whole core	1
G-3685	28.5	9	–19.5	HFC2	NM	10.6	0.71	1,949	13.9	2.71	whole core	1
G-3690	22	9	–13	HFC2	NM	670	638	711	13.8	2.71	whole core	1
G-3697	27.5	9	–18.5	HFC2	NM	0.45	0.4	0.16	23.2	2.72	whole core	1
G-3710	30.33	10	–20.33	HFC2	NM	4,754	1,357	92.5	33.7	2.72	whole core	1
G-3718	24.4	9	–15.4	HFC2	9.49	NM	NM	NM	24.1	2.72	core plug	1
G-3718	24.38	9	–15.38	HFC2	NM	47	11.3	179	24.3	2.70	whole core	1
G-3720	22	9	–13	HFC2	NM	7.33	0.61	10,875	17.0	2.71	whole core	1
G-3721	20.5	10	–10.5	HFC2	NM	0.14	0.04	0.62	20.5	2.81	whole core	1
G-3722	29.42	10	–19.42	HFC2	NM	9,580	6,385	9,704	25.2	2.70	whole core	1
G-3727	23.29	8	–14.29	HFC2	NM	0.19	0.14	0.01	15.2	2.71	whole core	1
G-3729	24.12	6	–18.12	HFC2	NM	4.51	1.03	570	21.8	2.71	whole core	1
G-3731	30.71	10	-20.71	HFC2	NM	7.23	0.53	10,038	18.2	2.72	whole core	1
G-3732	25.5	6	–19.5	HFC2	NM	28.7	22.9	206	11.5	2.71	whole core	1
G-3734	24	8	–16	HFC2	NM	667	332	17,567	23.4	2.72	whole core	1
G-3733	46.25-46.44	6	–40.34	HFC2	NM	138	94	66	17.4	2.70	whole core	2
G-3733	48.63-48.79	6	–42.71	HFC2	NM	101	18	202	23.6	2.71	whole core	2
G-3733	49.04-49.42	6	–43.23	HFC2	NM	3,932	2,449	59	26.1	2.70	whole core	2
G-3733	49.67-49.92	6	–43.8	HFC2	NM	1,432	249	112	21.7	2.70	whole core	2
G-3770	20.5-20.79	6.7	–13.94	HFC2	NM	3,830	3,458	13,701	34.2	2.70	whole core	2
G-3770	24.26-24.47	6.7	–17.66	HFC2	NM	11,232	11,232	10,294	47.7	2.70	whole core	2
G-3770	25.03-25.34	6.7	–18.48	HFC2	NM	5,616	5,616	14,886	32.6	2.70	whole core	2
G-3770	25.63-25.92	6.7	–19.08	HFC2	NM	1,742	1,421	12,891	24.9	2.71	whole core	2
G-3770	29.47-29.87	6.7	–22.97	HFC2	NM	361	2	18,551	22.2	2.71	whole core	2
G-3770	30.04-30.27	6.7	-23.46	HFC2	NM	3,073	1,634	10,694	28.9	2.70	whole core	2
G-3770	37.69-38.02	6.7	-31.16	HFC2	NM	4,917	4,917	7,419	35.1	2.70	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 9 of 15) Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-m um Hori-zo ntal	Hori-zo ntal 90°	Vertical				
G-3770	40.93-41.28	6.7	-34.4	HFC2	NM	4,470	2,037	5,524	30.8	2.68	whole core	2
G-3770	44.88–45.21	6.7	–38.34	HFC2	NM	NM	0.6	NM	30.7	2.69	whole core	2
G-3770	45.4–45.63	6.7	–38.82	HFC2	NM	7,375	3,361	2,481	27.8	2.70	whole core	2
G-3770	50.9–51.13	6.7	–44.32	HFC2	NM	0.2	0.2	3	17.0	2.70	whole core	2
G-3770	51.3–51.72	6.7	–44.81	HFC2	NM	14	0.2	0.1	17.7	2.71	whole core	2
G-3770	51.72–52.14	6.7	–45.23	HFC2	NM	0.2	0.1	0.1	16.6	2.69	whole core	2
G-3770	52.29–52.62	6.7	–45.76	HFC2	NM	20	0.3	0.1	21.1	2.70	whole core	2
G-3771	18.0–18.38	6	–12.19	HFC2	NM	983	248	5	19.2	2.71	whole core	2
G-3771	18.38–18.67	6	–12.52	HFC2	NM	18	0.07	1	18.6	2.71	whole core	2
G-3771	18.67–19.02	6	–12.84	HFC2	NM	10	0.5	1,925	23.3	2.71	whole core	2
G-3771	19.29–19.64	6	–13.46	HFC2	NM	2,135	813	16,070	24.6	2.70	whole core	2
G-3771	19.64–20.02	6	–13.83	HFC2	NM	11,534	11,534	15,745	24.9	2.70	whole core	2
G-3771	20.15–20.48	6	–14.32	HFC2	NM	11,316	11,316	16,068	31.7	2.71	whole core	2
G-3771	20.61–20.98	6	–14.8	HFC2	NM	10,615	10,615	17,158	30.3	2.71	whole core	2
G-3771	25.77–26.14	6	–19.96	HFC2	NM	10,341	5,168	17,428	15.9	2.70	whole core	2
G-3771	27.94–28.27	6	–22.1	HFC2	NM	11,646	11,646	15,674	25.9	2.70	whole core	2
G-3771	29.57–29.84	6	–23.7	HFC2	NM	1	0.04	1	13.1	2.71	whole core	2
G-3771	29.84–30.07	6	–23.96	HFC2	NM	0.04	0.04	0.5	13.2	2.71	whole core	2
G-3771	30.42–30.57	6	–24.5	HFC2	NM	0.2	0.1	634	13.8	2.69	whole core	2
G-3771	30.61–30.76	6	–24.68	HFC2	NM	7	0.3	2,057	17.5	2.70	whole core	2
G-3771	31.58–31.91	6	–25.74	HFC2	NM	527	41	787	20.1	2.69	whole core	2
G-3771	32.16–32.41	6	–26.28	HFC2	NM	7,887	7,887	5,732	22.7	2.70	whole core	2
G-3771	32.7–32.95	6	–26.82	HFC2	NM	215	37	456	17.3	2.70	whole core	2
G-3771	32.95–33.24	6	–27.1	HFC2	NM	314	70	492	18.5	2.71	whole core	2
G-3771	33.24–33.53	6	–27.38	HFC2	NM	6,446	6,446	7,001	17.7	2.71	whole core	2
G-3771	34.18–34.47	6	–28.32	HFC2	NM	14,112	14,112	6,410	34.9	2.71	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 10 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-m um Hori-zo ntal	Hori-zo ntal 90°	Vertical				
G-3771	40.49–40.72	6	–34.6	HFC2	NM	922	665	749	25.1	2.71	whole core	2
G-3771	40.91-41.12	6	–35.02	HFC2	NM	NM	76	NM	30.2	2.72	whole core	2
G-3771	47.93–48.03	6	–41.98	HFC2	NM	4	1	81	22.2	2.70	whole core	2
G-3771	48.23–48.52	6	–42.38	HFC2	NM	315	70	394	27.6	2.72	whole core	2
G-3771	49.06–49.27	6	–43.16	HFC2	NM	109	49	38	29.2	2.71	whole core	2
G-3771	49.27–49.5	6	–43.38	HFC2	NM	4,106	2,878	803	31.0	2.71	whole core	2
G-3771	49.65–49.88	6	–43.76	HFC2	NM	5,789	5,789	5,235	34.3	2.71	whole core	2
G-3771	50.09–50.15	6	–44.12	HFC2	NM	4,550	3,327	136	25.7	2.71	whole core	2
G-3778	38.6–38.88	16.4	–22.34	HFC2	NM	109	80	100	38.5	2.71	whole core	2
G-3778	39.2–39.37	16.4	–22.88	HFC2	NM	87	81	273	35.6	2.72	whole core	2
G-3778	40.96–41.25	16.4	–24.7	HFC2	NM	5,985	5,129	4,145	42.6	2.73	whole core	2
G-3778	52.27–52.52	16.4	–36	HFC2	NM	2,726	1,890	2,321	21.3	2.71	whole core	2
G-3778	54.16–54.43	16.4	–37.9	HFC2	NM	28	4	588	22.2	2.71	whole core	2
G-3778	55.13–55.23	16.4	–38.78	HFC2	NM	77	42	310	20.0	2.72	whole core	2
G-3778	59.2–59.47	16.4	–42.94	HFC2	NM	20,467	20,467	2,452	23.5	2.70	whole core	2
G-3778	59.8–60.05	16.4	–43.52	HFC2	NM	18,720	18,720	3,490	21.5	2.70	whole core	2
G-3779	46.8–46.97	16.2	–30.68	HFC2	NM	114	91	574	37.1	2.73	whole core	2
G-3779	47.39–47.6	16.2	–31.3	HFC2	NM	358	26	801	35.4	2.75	whole core	2
G-3779	47.6–47.81	16.2	–31.5	HFC2	NM	873	680	57	36.0	2.73	whole core	2
G-3779	49.18–49.31	16.2	–33.04	HFC2	NM	4,595	3,201	1,682	29.6	2.72	whole core	2
G-3779	49.5–49.63	16.2	–33.36	HFC2	NM	10,813	7,053	893	25.6	2.73	whole core	2
G-3779	49.88–50.07	16.2	–33.78	HFC2	NM	2,137	2,137	1,647	32.2	2.73	whole core	2
G-3779	52.19–52.57	16.2	–36.18	HFC2	NM	2,165	1,866	4,821	16.8	2.71	whole core	2
G-3779	54.3–54.68	16.2	–38.26	HFC2	NM	49	33	365	24.1	2.72	whole core	2
G-3779	54.94–55.06	16.2	–38.8	HFC2	NM	16	16	926	18.4	2.69	whole core	2
G-3779	58.21–58.42	16.2	–42.12	HFC2	NM	17,621	17,621	4,697	26.7	2.71	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 11 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zo ntal	Hori-zo ntal 90°	Vertical				
G-3779	58.75–58.92	16.2	–42.64	HFC2	NM	26,236	26,236	2,252	23.5	2.70	whole core	2
G-3779	59.09–59.26	16.2	–42.98	HFC2	NM	25,120	268	2,588	12.0	2.69	whole core	2
G-3779	59.59–60.01	16.2	–43.6	HFC2	NM	9,599	8,638	5,542	29.4	2.72	whole core	2
G-3789	27.67–28	8	–19.84	HFC2	NM	1,529	782	2,465	23.1	2.72	whole core	2
G-3789	28-28.27	8	–20.14	HFC2	NM	2,784	2,784	1,966	23.1	2.71	whole core	2
G-3789	28.27–28.58	8	–20.42	HFC2	NM	5,618	5,185	2,975	22.8	2.72	whole core	2
G-3789	28.88-29.07	8	–20.98	HFC2	NM	5,784	3,439	2,170	20.8	2.72	whole core	2
G-3789	29.24-29.39	8	–21.32	HFC2	NM	9,142	8,230	1,615	22.9	2.72	whole core	2
G-3789	29.68-30.03	8	–21.86	HFC2	NM	506	250	495	22.6	2.73	whole core	2
G-3789	31.61-32.15	8	–23.88	HFC2	NM	77	46	4	29.4	2.73	whole core	2
G-3789	32.23-32.56	8	–24.4	HFC2	NM	214	184	255	32.0	2.73	whole core	2
G-3789	33.86-34.19	8	–26.08	HFC2	NM	41	0.4	0.1	22.1	2.73	whole core	2
G-3789	34.4-34.73	8	–26.56	HFC2	NM	696	365	184	25.1	2.72	whole core	2
G-3789	34.9-35.15	8	–27.02	HFC2	NM	1,096	888	1,232	30.0	2.73	whole core	2
G-3789	37.33-37.54	8	–29.44	HFC2	NM	0.4	0.2	0.05	18.4	2.71	whole core	2
G-3789	40.66-40.87	8	–32.76	HFC2	NM	38	0.4	61	18.1	2.73	whole core	2
G-3789	42.57-42.92	8	–34.74	HFC2	NM	0.02	0.001	2,840	13.5	2.71	whole core	2
G-3789	52-52.17	8	–44.08	HFC2	NM	28	23	89	17.9	2.69	whole core	2
G-3789	53.10-53.56	8	–45.33	HFC2	NM	1,874	1,055	238	25.8	2.69	whole core	2
G-3790	32.25-32.54	8	–24.4	HFC2	NM	2,016	1,328	3,268	28.2	2.72	whole core	2
G-3790	34.2-34.45	8	–26.32	HFC2	NM	952	713	299	37.4	2.72	whole core	2
G-3790	39.31-39.69	8	–31.5	HFC2	NM	0.2	0.2	0.2	26.7	2.72	whole core	2
G-3790	40.54-40.96	8	–32.75	HFC2	NM	0.08	0.08	4,391	19.4	2.71	whole core	2
G-3790	41.21-41.5	8	–33.36	HFC2	NM	0.02	0.02	4	13.0	2.72	whole core	2
G-3790	41.68-41.95	8	–33.82	HFC2	NM	9	9	12	19.3	2.72	whole core	2
G-3790	42.38-42.71	8	–34.54	HFC2	NM	3,539	0.05	1,796	22.5	2.72	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 12 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3790	44.63-44.8	8	–36.72	HFC2	NM	24	7	273	14.5	2.71	whole core	2
G-3790	49.76-50.01	8	–41.88	HFC2	NM	9,569	7,973	2,300	21.1	2.71	whole core	2
G-3790	50.18-50.42	8	–42.3	HFC2	NM	9,077	7,260	8	21.5	2.69	whole core	2
G-3790	52.98-53.23	8	–45.1	HFC2	NM	297	282	75	26.8	2.70	whole core	2
G-3790	56.17-56.5	8	–48.25	HFC2	NM	309	2	2	19.2	2.70	whole core	2
G-3790	57.83-57.71	8	–50.27	HFC2	NM	380	6	0.5	22.1	2.70	whole core	2
G-3791	30.63-30.88	8	–22.76	HFC2	NM	2,101	1,641	1,047	37.8	2.70	whole core	2
G-3791	32-32.29	8	–24.14	HFC2	NM	1,084	658	1,016	29.5	2.71	whole core	2
G-3791	32.83-33.25	8	–25.04	HFC2	NM	8,854	6,885	4,117	45.4	2.73	whole core	2
G-3791	33.75-34.21	8	–25.98	HFC2	NM	8,555	8,555	4,957	30.4	2.72	whole core	2
G-3791	34.38-34.8	8	–26.59	HFC2	NM	8,854	6,885	3,050	22.2	2.71	whole core	2
G-3791	38.13-38.42	8	–30.3	HFC2	NM	6,413	5,557	1,936	31.6	2.72	whole core	2
G-3791	38.63-38.96	8	–30.8	HFC2	NM	8,100	6,942	3,334	31.0	2.71	whole core	2
G-3791	41.21-41.59	8	–33.4	HFC2	NM	1,762	1,560	2,110	32.0	2.70	whole core	2
G-3791	41.96-42.38	8	–34.17	HFC2	NM	2,634	2,406	3,304	36.0	2.71	whole core	2
G-3791	42.38-42.59	8	–34.48	HFC2	NM	4,338	3,407	2,223	32.0	2.70	whole core	2
G-3791	43.42-43.65	8	–35.54	HFC2	NM	16,346	14,529	2,125	25.5	2.71	whole core	2
G-3791	51.35-51.68	8	–43.52	HFC2	NM	2,612	1,729	1,589	15.4	2.70	whole core	2
G-3791	51.68-52.06	8	–43.87	HFC2	NM	2,472	1,831	6	17.7	2.70	whole core	2
G-3792	26.06-26.39	8	–18.22	HFC2	NM	10,954	0.2	764	24.2	2.70	whole core	2
G-3792	26.39-26.72	8	–18.56	HFC2	NM	2,082	2,005	1,405	30.1	2.71	whole core	2
G-3792	27.14-27.45	8	–19.3	HFC2	NM	812	462	1,337	18.3	2.71	whole core	2
G-3792	27.83-28.25	8	–20.04	HFC2	NM	4,123	4,123	3,265	16.9	2.71	whole core	2
G-3792	28.25-28.58	8	–20.42	HFC2	NM	7,454	6,211	2,502	20.1	2.72	whole core	2
G-3792	32.82-33.24	8	–25.03	HFC2	NM	3,836	564	296	18.4	2.71	whole core	2
G-3792	34.17-34.50	8	–26.34	HFC2	NM	40	39	1	13.4	2.68	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 13 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-m um Hori-zo ntal	Hori-zo ntal 90°	Vertical				
G-3792	34.50-34.88	8	–26.69	HFC2	NM	589	346	0.02	15.5	2.69	whole core	2
G-3792	34.88-35.09	8	–26.98	HFC2	NM	0.1	0.1	0.2	10.8	2.69	whole core	2
G-3792	38.63-38.96	8	–30.8	HFC2	NM	404	265	6	19.9	2.70	whole core	2
G-3792	43.15-43.53	8	–35.34	HFC2	NM	2	0.04	0.02	13.3	2.70	whole core	2
G-3792	45.27-45.5	8	–37.38	HFC2	NM	1,736	53	1,517	9.9	2.70	whole core	2
G-3792	45.6-45.98	8	–37.79	HFC2	NM	699	470	3,333	8.3	2.69	whole core	2
G-3792	50.05-50.3	8	–42.18	HFC2	NM	15	0.4	591	19.7	2.70	whole core	2
G-3792	51.69-51.98	8	–43.84	HFC2	NM	13,265	11,938	4,010	23.4	2.71	whole core	2
G-3792	62.71-63.04	8	–54.88	HFC2	NM	533	495	155	21.5	2.72	whole core	2
G-3792	66.81-67.06	8	–58.94	HFC2	NM	0.3	0.02	0.2	13.8	2.71	whole core	2
G-3792	67.39-67.72	8	–59.56	HFC2	NM	7,869	5,619	0.02	18.3	2.71	whole core	2
G-3792	67.72—68.05	8	–59.88	HFC2	NM	8,022	4,199	1	17.5	2.71	whole core	2
G-3792	69.47-69.89	8	–61.68	HFC2	NM	273	12	0.03	13.8	2.71	whole core	2
G-3792	76-76.25	8	–68.12	HFC2	NM	23,984	4,012	1,387	30.8	2.72	whole core	2
G-3793	13.88-14.21	10	–4.04	HFC2	NM	9,081	3,403	3,906	22.8	2.70	whole core	2
G-3793	17.21-17.63	10	–7.42	HFC2	NM	4,268	3,047	3,067	17.9	2.71	whole core	2
G-3793	27-27.21	10	–17.1	HFC2	NM	962	3	5	22.8	2.71	whole core	2
G-3793	28.68-29.01	10	–18.84	HFC2	NM	12,480	9,599	3,023	31.2	2.72	whole core	2
G-3793	29.18-29.6	10	–19.39	HFC2	NM	19,318	15,000	1,502	23.4	2.73	whole core	2
G-3793	31.75-31.94	10	–21.84	HFC2	NM	27,411	21,083	1,290	27.0	2.72	whole core	2
G-3793	32.11-32.36	10	–22.24	HFC2	NM	15,136	13,622	1,742	29.3	2.71	whole core	2
G-3793	39.52-39.9	10	–29.71	HFC2	NM	929	678	940	22.0	2.71	whole core	2
G-3793	39.9-40.28	10	–30.09	HFC2	NM	1,865	1,678	1,626	22.8	2.71	whole core	2
G-3793	40.44—40.73	10	–30.58	HFC2	NM	571	28	1,657	20.1	2.72	whole core	2
G-3793	41.15-41.42	10	–31.34	HFC2	NM	52	41	1,853	17.9	2.71	whole core	2
G-3793	52.98-53.25	10	–43.12	HFC2	NM	3,616	2,218	357	27.1	2.70	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 14 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3793	53.79-53.98	10	–43.88	HFC2	NM	327	13	189	22.7	2.70	whole core	2
G-3794	19.4-19.73	9	–10.56	HFC2	NM	439	316	2,251	15.0	2.77	whole core	2
G-3794	24.18-24.51	9	–15.34	HFC2	NM	2,317	1,958	3,592	22.0	2.71	whole core	2
G-3794	30.72-30.97	9	–21.84	HFC2	NM	5,055	226	233	29.6	2.72	whole core	2
G-3673	51-51.5	20	–31.25	HFC1	34.3	NM	NM	NM	37.3	2.68	core plug	1
G-3674	39.25-40	10	–29.62	HFC1	77.6	NM	NM	NM	12.3	2.70	core plug	1
G-3674	49-49.75	10	–39.38	HFC1	<0.01	NM	NM	NM	21.2	2.68	core plug	1
G-3674	52.1	10	–42.1	HFC1	2.19	NM	NM	NM	18.1	2.69	core plug	1
G-3675	64.5-65	8	–56.75	HFC1	<0.01	NM	NM	NM	17.7	2.69	core plug	1
G-3678	33.3	9	–24.3	HFC1	NM	2,244	997	18,223	16.1	2.71	whole core	1
G-3679	36.7	9	–27.7	HFC1	NM	1,870	0.54	13,498	20.7	2.71	whole core	1
G-3731	39.08	10	–29.08	HFC1	NM	3,530	1,463	13,050	20.4	2.71	whole core	1
G-3732	39.5	6	–33.5	HFC1	194.3	NM	NM	NM	10.8	2.71	core plug	1
G-3732	42.4-42.7	6	–36.55	HFC1	NM	NM	NM	13,362	34.8	2.68	whole core	1
G-3732	44	6	–38	HFC1	165.3	NM	NM	NM	16.2	2.71	core plug	1
G-3674	83.5-84	10	–73.75	Tamiami	16584	NM	NM	NM	42.6	2.68	core plug	1
G-3770	64.59-64.8	6.7	–58	Tamiami	NM	1,956	1,831	1,236	28.2	2.74	whole core	2
G-3770	64.92-65.38	6.7	–58.45	Tamiami	NM	1,996	1,996	2,862	29.0	2.72	whole core	2
G-3770	69.88-70.17	6.7	–63.35	Tamiami	NM	1,983	63	296	19.7	2.72	whole core	2
G-3770	70.17-70.42	6.7	–63.6	Tamiami	NM	1,402	1,329	343	22.6	2.72	whole core	2
G-3770	70.42-70.67	6.7	–63.85	Tamiami	NM	2,186	1,994	1,878	26.1	2.72	whole core	2
G-3771	54.21-54.46	6	–48.35	Tamiami	NM	13	13	32	23.3	2.74	whole core	2
G-3771	55.47-55.7	6	–49.58	Tamiami	NM	36	12	116	19.0	2.74	whole core	2
G-3771	55.89-56.08	6	–49.98	Tamiami	NM	39	2	37	18.4	2.74	whole core	2
G-3771	58.93-59.18	6	–53.06	Tamiami	NM	2,650	2,467	2,490	26.3	2.77	whole core	2
G-3771	59.93-60.1	6	–54.02	Tamiami	NM	4,825	4,669	2,077	38.2	2.79	whole core	2

PTN COL 2.4-4

Table 2.4.12-207 (Sheet 15 of 15)
Regional Hydrogeologic Properties from Rock Core Samples

Boring	Depth (feet)	Surface Elevation (ft MSL)	Midpoint Elevation (ft MSL)	High Frequency Cycle or Formation	Permeability (K_{air}) (millidarcies)				Porosity (percent)	Grain Density (grams per cubic centimeter)[(a)]	Sample Type	Source
					Steady State	Maxi-mum Hori-zontal	Hori-zontal 90°	Vertical				
G-3771	74.27-74.44	6	–68.36	Tamiami	NM	4,302	3,625	4,127	40.6	2.74	whole core	2
G-3771	74.57-74.78	6	–68.68	Tamiami	NM	7,091	7,091	5,116	40.3	2.72	whole core	2
G-3793	63.95-64.12	10	–54.04	Tamiami	NM	20,433	15,889	735	11.5	2.69	whole core	2
G-3793	64.29-64.62	10	–54.46	Tamiami	NM	12,171	10,954	2,042	14.5	2.69	whole core	2
G-3793	64.92-64.96	10	–54.94	Tamiami	NM	4,964	4,964	465	11.2	2.69	whole core	2
G-3794	59.23-59.65	9	–49.44	Tamiami	NM	4,690	3,607	2,006	15.7	2.72	whole core	2
G-3794	61.02-61.52	9	–52.27	Tamiami	NM	100	17	11	15.8	2.69	whole core	2
G-3794	61.94-62.27	9	–53.1	Tamiami	NM	2,807	2,010	638	26.4	2.74	whole core	2
G-3794	63.13-63.38	9	–54.26	Tamiami	NM	61	0.1	204	10.0	2.72	whole core	2
G-3794	64.07-64.57	9	–55.32	Tamiami	NM	1,952	837	0.03	21.0	2.76	whole core	2

(a) Reported as grams per centimeter in the references.
Sources: References 241 and 242
MSL = Mean sea level
NM = Not measured

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 1 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-me tic Mean
OW-606U Test #1	5/20/2008	–1.4	18–28	Miami Limestone	29.9	KGS	NC	97.98	97.98
OW-606U Test #1						Springer-Gelhar	NC	134.80	134.80
OW-606U Test #2						KGS	NC	92.02	92.02
OW-606U Test #2						Springer-Gelhar	NC	123.10	123.10
OW-606U Average							N/A	111.98	111.98
OW-606L Test #1	5/18/2008	–1.4	97–107	Lower Fort Thompson Formation	92.0	Butler	119.90	30.16	75.03
OW-606L Test #1						McElwee-Zenner	117.80	NC	117.80
OW-606L Test #1						KGS	NC	35.04	35.04
OW-606L Test #2						Butler	NC	67.40	67.40
OW-606L Test #2						McElwee-Zenner	NC	66.13	66.13
OW-606L Average							118.85	49.68	72.74
OW-621U	5/20/2008	0.2	17.4–27.4	Miami Limestone	27.6	KGS	NC	94.35	94.35
OW-621U						Springer-Gelhar	NC	68.89	68.89
OW-621U Average							N/A	81.62	81.62
OW-621L Test #1	5/17/2008	0.2	98.6–108.6	Lower Fort Thompson Formation	88.5	Butler	91.59	31.07	61.33
OW-621L Test #1						KGS	71.28	33.31	52.30
OW-621L Test #2						Butler	NC	35.72	35.72
OW-621L Test #2						KGS	NC	30.40	30.40
OW-621L Test #3						Butler	NC	16.65	16.65
OW-621L Test #3						KGS	NC	16.66	16.66
OW-621L Average							81.44	27.30	40.84
OW-636U Test #1	5/21/2008	-1.1	17–27	Miami Limestone	28.9	KGS	NC	57.27	57.27
OW-636U Test #1						Springer-Gelhar	NC	50.64	50.64
OW-636U Test #2						KGS	NC	79.27	79.27
OW-636U Test #2						Springer-Gelhar	NC	64.33	64.33
OW-636U Average							N/A	62.88	62.88

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 2 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-me tic Mean
OW-636L	5/21/2008	–1.1	97–107.1	Lower Fort Thompson Formation	88.0	Butler	NC	10.08	10.08
OW-636L						KGS	NC	10.58	10.58
OW-636L						Butler	NC	9.425	9.43
OW-636L						KGS	NC	10.01	10.01
OW-636L Average							N/A	10.02	10.02
OW-706U Test #1	5/16/2008	–1.2	17–27	Miami Limestone	30.7	KGS	6.423	31.19	18.81
OW-706U Test #1						Springer-Gelhar	83.78	30.27	57.03
OW-706U Test #1						Hvorslev	0.7146	NC	0.71
OW-706U Test #1						Bouwer-Rice	0.5455	NC	0.55
OW-706U Test #2						Springer-Gelhar	NC	70.18	70.18
OW-706U Test #2						KGS	NC	76.09	76.09
OW-706U Average							22.87	51.93	37.40
OW-706L	5/16/2008	–1.2	100–110	Lower Fort Thompson Fm	82.8	Butler	21.20	25.09	23.15
OW-706L						KGS	21.97	26.07	24.02
OW-706L Average							21.59	25.58	23.58
OW-721U Test #1	5/15/2008	–1.5	14–24	Miami Limestone	24.8	Springer-Gelhar	45.50	27.03	36.27
OW-721U Test #1						KGS	45.50	32.46	38.98
OW-721U Test #2						Springer-Gelhar	NC	24.39	24.39
OW-721U Test #2						KGS	NC	32.47	32.47
OW-721U Average							45.50	29.09	37.29
OW-721L Test #1	5/15/2008	–1.5	96–106	Lower Fort Thompson Formation	90.0	Butler	2.726	11.59	7.16
OW-721L Test #1						KGS	1.13	2.91	1.13
OW-721L Test #2						Butler	NC	2.839	2.84
OW-721L Test #2						KGS	NC	1.325	1.33
OW-721L Average							1.93	4.67	3.30

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 3 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-me tic Mean
OW-735 U Test #1	5/15/2008	–0.8	16–26	Miami Limestone	26.5	Springer-Gelhar	319.20	58.21	188.70
OW-735 U Test #1						KGS	109.50	84.68	97.09
OW-735 U Test #2						Springer-Gelhar	NC	80.18	80.18
OW-735 U Test #2						KGS	NC	70.70	70.70
OW-735U Average							214.35	73.44	143.90
OW-735L Test #1	5/13/2008	–0.8	96.9–106.9	Lower Fort Thompson Fm	87.0	Butler	49.09	42.01	45.55
OW-735L Test #1						KGS	20.57	32.05	26.31
OW-735L Average							34.83	37.03	35.93
OW-802U	5/20/2008	–1.5	15–27	Miami Limestone	25.8	KGS	NC	41.06	41.06
OW-802U						Springer-Gelhar	NC	31.90	31.90
OW-802U Average							N/A	36.48	36.48
OW-802L	5/20/2008	–1.5	98–08	Lower Fort Thompson Fm	88.0	Butler	NC	23.28	23.28
OW-802L						KGS	NC	30.99	30.99
OW-802L Average							N/A	27.14	27.14
OW-805U	6/6/2008	–1.6	18–28	Miami Limestone	32.3	KGS	NC	101.7	101.70
OW-805U						Butler	NC	136.4	136.40
OW-805U						Springer-Gelhar	NC	107.1	107.10
OW-805U Average							N/A	115.07	115.07
OW-805L	6/6/2008	–1.6	85–95	Lower Fort Thompson Fm	67.5	Butler	NC	5.269	5.27
OW-805L						KGS	NC	5.936	5.94
OW-805L Average							N/A	5.60	5.60
OW-809U Test #1	5/15/2008	–1.3	15–25	Miami Limestone	25.5	Spriniger-Gelhar	91.20	60.67	75.90
OW-809U Test #1						KGS	102.90	82.32	92.60
OW-809U Test #2						Springer-Gelhar	NC	26.86	26.86
OW-809U Test #2						KGS	NC	35.94	35.94

PTN COL 2.4-4

Table 2.4.12-208 (Sheet 4 of 4)
Slug Test Hydraulic Conductivity Summary

Observation Well	Test Date	Surface Elevation (NAVD 88)	Screened Interval (feet bgs)	Geologic Unit	Saturated Thickness (feet)	Solution	Hydraulic Conductivity in feet per day		
							Falling	Rising	Arith-me tic Mean
OW-809U Average							97.05	51.45	74.25
OW-809L	5/15/2008	–1.3	95.5–105.5	Lower Fort Thompson Fm	88.0	KGS	108.60	36.57	72.60
OW-809L						Butler	103.70	33.43	68.57
OW-809L Average							106.15	35.00	70.58
OW-812U	5/20/2008	–1.4	15–25	Miami Limestone	25.5	KGS	NC	31.24	31.24
OW-812U						Springer-Gelhar	NC	24.49	24.49
OW-812U Average							N/A	27.87	27.87
OW-812L	5/20/2008	–1.4	97–107	Lower Fort Thompson Fm	86.0	Butler	NC	21.01	21.01
OW-812L						KGS	NC	21.20	21.20
OW-812L Average							N/A	21.11	21.11

Source: Reference 248
bgs = Below ground surface
NAVD 88 = North American Vertical Datum of 1988
N/A = Not Applicable
NC = Not Conducted
KGS = Kansas Geological Survey
For wells with multiple tests, test results were averaged and used to calculate the geometric mean.
Data from these tests are considered not valid due to rate-limiting recharge effects from the filter pack.

Geometric Mean: Upper: 61.3 feet per day
Lower: 20.1 feet per day

PTN COL 2.4-4

Table 2.4.12-209
Summary of Aquifer Pumping Test Results

Geologic Unit	Thickness (ft)	Test Well	Aquifer Transmissivity (gpd/ft)[a]	Aquifer Storativity (dimensionless)[a]	Hydraulic Conductivity (K_h or K_v)		
					gpd/ft^{2}[a]	ft/d[a]	cm/s[a]
Miami Limestone (K_v)	8	PW-6U	—	—	103	14	0.005
	13	PW-7U	—	—	173	23	0.008
Key Largo Limestone (K_h)	33	PW-6U	2,331,000	0.00015	71,000	9,400	3.3
	24	PW-7U	2,200,000	0.0022	92,000	12,000	4.3
freshwater limestone (K_v)	11	PW-6U	—	—	46	6	0.002
	19	PW-7U	—	—	54	7	0.003
	11	PW-6L	—	—	2	0.2	7E-05
	19	PW-7L	—	—	3	0.4	1E-04
Fort Thompson Formation (K_h)	57	PW-6L	122,000	0.00016	2,140	286	0.1
	36	PW-7L	131,200	0.0003	3,600	490	0.2
Tamiami Formation (K_v)	18	PW-6L	—	—	7,940	1,061	0.4
	18	PW-7L	—	—	740	100	0.04

(a) All values are averages.

PTN COL 2.4-4

Table 2.4.12-210
Summary of Groundwater Field Measurements

Well ID	Sample Date	Temperature (°Celsius)	pH (standard units)	Dissolved Oxygen (milligrams per liter)	Specific Conductance (milliSiemens per centimeter)	Turbidity (Nephelometric Turbidity Units)	Oxidation-Reduction Potential (millivolts)
OW-606L[a]	5/28/2008	28.29	7.08	9.92	52.8, 72.4[c]	0.77	–370
OW-606U[a]	5/28/2008	28.71	6.84	1.66	66.9, 62.8[c]	0.34	–344
OW-621L[a]	6/4/2008	27.80	7.06	1.66	>99.9, 73.9[c]	0.21	–349
OW-621U[a]	5/29/2008	27.82	7.08	0.05	91.0, 58.3[c]	2.91	–351
OW-706L[a]	5/29/2008	29.61	6.83	1.49	46.4, 48.6[c]	0.20	–351
OW-706U[a]	5/29/2008	30.85	6.65	1.13	76.6, 77.3[c]	0.83	–392
OW-721L[a]	5/28/2008	28.56	6.76	1.18	74.3, 73.7[c]	7.55	–370
OW-721U[a]	5/28/2008	28.92	7.10	10.6	53.1, 63.8[c]	0.36	–364
OW-735U[a]	5/27/2008	29.47	7.00	0.02	86.6, 77.5[c]	0.92	–360
OW-802U[a]	6/5/2008	28.27	6.80	1.90	82.8, 70.8[c]	0.48	–322
OW-805U[a]	6/5/2008	28.26	7.10	1.19	60.9, 59.8[c]	0.32	–346
OW-809U[a]	5/27/2008	30.82	6.98	0.01	83.9, 79.0[c]	0.97	–371
ENP Precipitation[b]	mean	NM	4.98	NM	0.016	NM	NM
Surficial Aquifer SFWMD[b]	median	24.8	6.9	NM	0.619	NM	NM
Floridan Aquifer SFWMD[b]	median	26.3	7.4	NM	1.787	NM	NM
Cooling Canal	average	30.05	8.02	8.70	NM	1.92	NM
L-31N	average	NM	NM	NM	NM	NM	NM
Biscayne Bay	average	NM	NM	NM	NM	NM	NM
Upper Floridan Production well	mean	NM	7.70	NM	NM	1.1	NM

ENP = Everglades National Park NM = Not Measured

(a) Reference 248
(b) Reference 245
(c) Samples collected February 3–5, 2009

Table 2.4.12-211 (Sheet 1 of 3)
Hydrogeochemical Data

Constituent		TDS	Calcium	Iron	Magnesium	Manganese	Potassium	Silica	Silicon	Sodium
Location ID	Date Collected	mg/L	mg/L							
OW-606L[a]	5/28/2008	34,320[i], 47,047[i][j]	632[b]	<0.050U[c]	1,880[b]	0.0391	549[b]	3	<250[b][c]	15,100[b]
OW-606U[a]	5/28/2008	43,485[i], 40,804[i][j]	535[b]	0.318[b][d]	1,730[b]	0.0354	525[b]	0.729	<250[b][c]	14,400[b]
OW-621L[a]	6/4/2008	64,935[i][k], 48, 045[i][j]	574[b]	<50[b][c]	1,960[b]	<2[b][c]	586[b]	133[d][e]	62.1[b][d][e]	16,300[b]
OW-621U[a]	5/29/2008	59,150[i], 37,901[i][j]	492[b]	0.453[b][d]	1,600[b]	0.0368	476[b]	0.637	<250[b][c]	13,100[b]
OW-706L[a]	5/29/2008	30,160[i], 31,610[i][j]	413[b]	0.531[b][d]	1,170[b]	0.0083	327[b]	8	<250[b][c]	9,440[b]
OW-706U[a]	5/29/2008	49,790[i], 50,229[i][j]	725[b]	0.178[b][d]	2,150[b]	0.0435	658[b]	2	<250[b][c]	17,500[b]
OW-721L[a]	5/28/2008	48,295[i], 47,912[i][j]	667[b]	0.362[b][d]	2,020[b]	0.0462	587[b]	3	<250[b][c]	16,300[b]
OW-721U[a]	5/28/2008	34,515[i], 41,472[i][j]	603[b]	0.329[b][d]	1,890[b]	0.0581	569[b]	0.848	<250[b][c]	15,400[b]
OW-735U[a]	5/27/2008	56,290[i], 50,351[i][j]	749[b]	0.133[b][d]	2,140[b]	0.0327	655[b]	<0.250[c]	<250[b][c]	17,700[b]
OW-802U[a]	6/5/2008	53,820[i], 46,022[i][j]	579[b]	<50[b][c]	1,980[b]	<2[b][c]	586[b]	143[e]	66.7[b][e]	16,400[b]
OW-805U[a]	6/5/2008	39,585[i], 38,853[i][j]	447[b]	<50[b][c]	1,570[b]	<2[b][c]	493[b]	107[e]	49.9[b][e]	13,200[b]
OW-809U[a]	5/27/2008	54,535[i], 51,356[i][j]	704[b]	0.158[b][d]	2,040[b]	0.0281	607[b]	<0.250[c]	<250[b][c]	16,700[b]
ENP Precipitation[f][g]	mean		0.36		0.2		0.2			1.32
Surficial Aquifer SFWMD[g]	median	388	98	0.88	3.9		1.3			21.1
Floridan Aquifer SFWMD[g]	median	1,138	67.2	<0.05[c]	46.4		9.5			220.5
Cooling Canal	average	54,500	720		2,050		680	0.52		

Table 2.4.12-211 (Sheet 2 of 3)
Hydrogeochemical Data

Constituent		TDS	Calcium	Iron	Magnesium	Manganese	Potassium	Silica	Silicon	Sodium
Location ID	Date Collected	mg/L	mg/L							
L-31N	average	370	70		5.35		6.3			
Biscayne Bay	average	33,757	446		1,270		421	0.32		
Upper Floridan Production well	average	5,451	149	0.28	177	<0.07	77	12		

Table 2.4.12-211 (Sheet 3 of 3)
Hydrogeochemical Data

Constituent		Bromide	Chloride	Fluoride	Sulfate	Nitrate	Nitrite	Bicarbonate	Carbonate	Total Alkalinity	Ammonia[h]
Location ID	Date Collected	mg/L						mg/L		mg/L	mg/L
OW-606L[a]	5/28/2008	62.5	29,600	<20.0[c]	3,860	<0.20[c]	<200[c]	165	<5.0[c]	165	1.58
OW-606U[a]	5/28/2008	56.6	27,900	<20.0[c]	3,470	<0.20[c]	<200[c]	155	<5.0[c]	155	0.844
OW-621L[a]	6/4/2008	65.9	31,300[d]	<20.0[c]	3,610	<0.20[c]	<200[c]	181	<5.0[c]	181	1.30
OW-621U[a]	5/29/2008	50.6	25,500	<1.0[c]	3,210	<4.0[c]	<200[c]	189	<5.0[c]	189	0.588
OW-706L[a]	5/29/2008	37.7[e]	19,100	<1.0[c]	2,280	<4.0[c]	<200[c]	191	<5.0[c]	191	0.61
OW-706U[a]	5/29/2008	70.5	33,300	<1.0[c]	3,850	<4.0[c]	<200[c]	204	<5.0[c]	204	2.09
OW-721L[a]	5/28/2008	64.9	31,100	<20.0[c]	3,990	<0.20[c]	<200[c]	180	<5.0[c]	180	1.82
OW-721U[a]	5/28/2008	60.1	29,900	<20.0[c]	3,860	<0.20[c]	<200[c]	164	<5.0[c]	164	1.68
OW-735U[a]	5/27/2008	262	37,500	<20.0[c]	4,090	<4.0[c]	<200[c]	179	<5.0[c]	179	2.15
OW-802U[a]	6/5/2008	65.1	31,600[d]	<20.0[c]	3,720	<0.20[c]	<200[c]	178	<5.0[c]	178	1.40
OW-805U[a]	6/5/2008	53.6	27,600[d]	<20.0[c]	3,070	<0.20[c]	<200[c]	177	<5.0[c]	177	0.548
OW-809U[a]	5/27/2008	241[e]	35,900	<1.0[c]	4,050	<4.0[c]	<200[c]	177	<5.0[c]	177	2.21
ENP Precipitation[f][g]	mean		2		1.14	0.73					0.22
Surficial Aquifer SFWMD[g]	median		48	0.2	12	<0.01[c]		263		251	
Floridan Aquifer SFWMD[g]	median		420	0.81	176	<0.01[c]				130	
Cooling Canal	average		30,000		3,950			165		165	0.16
L-31N	average		59		26	1.05		200		200	
Biscayne Bay	average		18,582		2,447			102		102	0.1
Upper Floridan Production well	average		2,909	1.6	661	<0.01[c]		196			

(shaded) Not analyzed

(a) Reference 248.
(b) Spiked analyte recovery is outside stated control limits. Method performance confirmed using Laboratory Control Spike sample results.
(c) Analyte not detected at or above the method detection limit.
(d) Method blank contamination. The associated method blank contains the target analyte at a reportable level. These data should be used with caution.
(e) Estimated result. Result is less than the reporting limit.
(f) Everglades National Park.
(g) Reference 245.
(h) Test conducted on Nitrogen, as Ammonia.
(i) TDS is estimated as specific conductance in milliSiemens per centimeter x 1000 x 0.65, specific conductance values are listed in Table 2.4.12-210.
(j) Based on specific conductance measurements collected February 3-5, 2009.
(k) Assumes specific conductance equals 99 milliSiemens per centimeter.