

APPENDIX 10.4
ENVIRONMENTAL RESOURCE PERMIT
ATTACHMENT A.8
WATER TABLE

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Station ID: 8727386

Name: FLORIDA POWER, CRYSTAL RIVER
FLORIDA

NOAA Chart: 11409

USGS Quad: RED LEVEL

PUBLICATION DATE: 11/04/1995

SUPERCEDED DATE: 04/21/2003

Latitude: 28° 57.6' N

Longitude: 82° 43.5' W

To reach the tidal bench marks proceed along U.S. Highway 19 to the access road of the Crystal River Power Plant, then west on the access road to a dirt road just before the fenced area starts, then follow the dirt road to the boat ramp area. The bench marks are located in the area between the dirt road and the marsh and the tide gage and staff were located on the power company wharf.

T I D A L B E N C H M A R K S

PRIMARY BENCH MARK STAMPING: 7386 B 1978

MONUMENTATION: Survey Disk

AGENCY:

SETTING CLASSIFICATION: Rock Outcropping

VM#: 8180

[PID#: AL7699](#)

The bench mark is set in an outcropping rock 3x2 feet (1x1 m), 246.0 feet (75.0 m) NNW of Bench Mark 7386 A 1978, 44 feet (13 m) east of the shore of the Gulf of Mexico, 13.0 feet (4.0 m) west of a dirt road, 2.0 feet (0.6 m) south of a metal witness post, and at ground level.

BENCH MARK STAMPING: 7386 A 1978

MONUMENTATION: Survey Disk

AGENCY:

SETTING CLASSIFICATION: Concrete Foundation

VM#: 8179

[PID#: AL7698](#)

The bench mark is set in the base of the the old boat ramp, 87.0 feet (26.5 m) east of the Gulf of Mexico waters edge, 59.0 feet (18.0 m) north of the north bank of canal, and 45.0 feet (13.7 m) west of the NW corner of the boat ramp.

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T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 7386 C 1978

MONUMENTATION: Survey Disk

AGENCY:

SETTING CLASSIFICATION: Concrete

VM#: 8181

[PID#: AL7700](#)

The bench mark is set in a 20x2 foot (6x1 m) mass of concrete at the end of a dirt road, 39.0 feet (11.9 m) south of the end of the road, and 9.0 feet (2.7 m) north of a witness post.

BENCH MARK STAMPING: 7386 D 1978

MONUMENTATION: Survey Disk

AGENCY:

SETTING CLASSIFICATION: Rock Outcropping

VM#: 8182

[PID#: AL7697](#)

The bench mark is set in a outcropping rock 2x3 feet (1x1 m), 345 feet (105 m) SE of Bench Mark 7386 C 1978, 165.0 feet (50.3 m) NNE of the boat ramp, 106.0 feet (32.3 m) west of the marsh line and 2.9 feet (0.9 m) north of a metal witness post, and level with the ground.

BENCH MARK STAMPING: 7386 E 1978

MONUMENTATION: Survey Disk

AGENCY:

SETTING CLASSIFICATION: Rock Outcropping

VM#: 8183

[PID#: AL7696](#)

The bench mark is set in an outcropping rock 2x2 feet (1x1 m), 330 feet (101 m) east of Bench Mark 7386 A 1978, 270.0 feet (82.3 m) east of the NE corner of the boat ramp, 22.0 feet (6.7 m) NW of a cedar tree, 1.0 foot (0.3 m) west of a metal witness post, and level with the ground.

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Station ID: 8727386

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USGS Quad: RED LEVEL

PUBLICATION DATE: 11/04/1995

SUPERCEDED DATE: 04/21/2003

Latitude: 28° 57.6' N

Longitude: 82° 43.5' W

T I D A L D A T U M S

Tidal datums at FLORIDA POWER, CRYSTAL RIVER based on:

LENGTH OF SERIES: 1 MONTH
TIME PERIOD: SEPTEMBER 1978
TIDAL EPOCH: 1960-1978
CONTROL TIDE STATION: 8727520 CEDAR KEY

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in FEET:

HIGHEST OBSERVED WATER LEVEL (12/05/1978)	=	5.90
MEAN HIGHER HIGH WATER (MHHW)	=	3.90
MEAN HIGH WATER (MHW)	=	3.56
MEAN TIDE LEVEL (MTL)	=	2.06
MEAN LOW WATER (MLW)	=	0.56
MEAN LOWER LOW WATER (MLLW)	=	0.00

[National Geodetic Vertical Datum \(NGVD 29\)](#)

Bench Mark Elevation Information

In FEET above:

Stamping or Designation	MLLW	MHW
7386 B 1978	6.83	3.27
7386 A 1978	6.61	3.05
7386 C 1978	4.56	1.00
7386 D 1978	6.45	2.89
7386 E 1978	5.55	1.99

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Station ID: 8727520

PUBLICATION DATE: 05/27/2003

**Name: CEDAR KEY, GULF OF MEXICO
FLORIDA**

NOAA Chart: 11408

Latitude: 29° 8.1' N

USGS Quad: CEDAR KEY

Longitude: 83° 1.9' W

To reach the tidal bench marks from the Post Office at Second Avenue and C Street in Cedar Key, proceed SE on C Street for 0.03 km (0.2 mi) to Levy County Pier. The bench marks are in the area between the Fish House and G Street going east/west and between Whiddon Street and the county pier going north/south. The tide gauge and staff are at the NW end of the restroom building near the foot of the pier.

T I D A L B E N C H M A R K S

PRIMARY BENCH MARK STAMPING: 8

DESIGNATION: TIDAL STA 3-60 TIDAL 8

ALIAS: 8 1910

MONUMENTATION: Triangulation Station disk

VM#: 751

AGENCY: US Coast and Geodetic Survey (USC&GS)

[PID#: AR1204](#)

SETTING CLASSIFICATION: Concrete post

The primary bench mark is a disk set in the top of a concrete-filled terra cotta pipe, about one-half block NW along C Street from its intersection with Second Street, 16.31 m (53.5 ft) NE of the center line of C Street, 6.83 m (22.4 ft) NW of the north corner of the SW portion of a large apartment building, 1.07 m (3.5 ft) SW of the SW edge of a concrete wall which is 0.61 m (2.0 ft) high, 0.3 m (1 ft) below the level of the street, and 0.06 m (0.2 ft) below ground level.

BENCH MARK STAMPING: 17 1923

DESIGNATION: 872 7520 TIDAL 17

MONUMENTATION: Tidal Station disk

VM#: 753

AGENCY: US Coast and Geodetic Survey (USC&GS)

[PID#: AR1203](#)

SETTING CLASSIFICATION: Foundation

The bench mark is a disk set set vertically in the SW face of the south corner of Island Hotel (a two-storied pink stucco building) at the north corner of B and Second Streets, 5 m (16 ft) NW of the NW curb of Second Street, 0.76 m (2.5 ft) NW of the south corner of the building, and 1.22 m (4.0 ft) above the level of the street.

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USGS Quad: CEDAR KEY

Longitude: 83° 1.9' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 18 1923

DESIGNATION: 872 7520 TIDAL 18

MONUMENTATION: Tidal Station disk

VM#: 754

AGENCY: US Coast and Geodetic Survey (USC&GS)

PID#: AR1211

SETTING CLASSIFICATION: Sidewalk

The bench mark is a disk set on top of an old sidewalk which is partly covered with dirt, in the south corner of the intersection of C and Second Streets, 9.30 m (30.5 ft) SW of the centerline of C Street, 3.02 m (9.9 ft) SE of the SE curb of Second Street, 4 m (12 ft) north of the north corner of a small white house, about level with the street and 0.06 m (0.2 ft) underground.

BENCH MARK STAMPING: D 280

DESIGNATION: D 280

MONUMENTATION: Survey disk

VM#: 756

AGENCY: Florida State Road Department (FLSRD)

PID#: AR1210

SETTING CLASSIFICATION: Bridge curb

The bench mark is a disk set on the top of the concrete guard rail base along the SW side of the C Street bridge near the city pier, directly over the SW end of the NW one of two piers, 30.54 m (100.2 ft) SE of the NW end of the bridge, 0.18 m (0.6 ft) SW of the SW bridge curb, and 0.3 m (1 ft) above the bridge floor.

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FLORIDA

NOAA Chart: 11408

Latitude: 29° 8.1' N

USGS Quad: CEDAR KEY

Longitude: 83° 1.9' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: D 290

DESIGNATION: D 290

MONUMENTATION: Survey disk

VM#: 757

AGENCY: Florida State Road Department (FLSRD)

[PID#: AR1665](#)

SETTING CLASSIFICATION: Concrete sea wall

The bench mark is a disk located along First Street between B Street and C Street, 27 m (89 ft) south of the centerline of First Street, and 0.15 m (0.5 ft) east of the west end of the seawall along the north side of a tidal basin.

BENCH MARK STAMPING: 7520 K 1978

DESIGNATION: 872 7520 K TIDAL

MONUMENTATION: Tidal Station disk

VM#: 760

AGENCY: National Ocean Survey (NOS)

[PID#: AR1666](#)

SETTING CLASSIFICATION: Stainless steel rod

The bench mark is a disk near the interseciton of Third and E Streets, 40 m (131 ft) west of the centerline of E Street, 5.76 m (18.9 ft) NNW of the NW corner of the Southern Bell Telephone Company Building, 5.03 m (16.5 ft) SW of a manhole cover, and 1.49 m (4.9 ft) south of the north end of a retaining wall. The bench mark is 5 cm (0.2 ft) above ground level, crimped to a stainless steel rod driven 11.0 m (36 ft) to refusal (no PVC kickblock).

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NOAA Chart: 11408

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USGS Quad: CEDAR KEY

Longitude: 83° 1.9' W

T I D A L B E N C H M A R K S

BENCH MARK STAMPING: 7520 A 1983

DESIGNATION: 872 7520 A TIDAL

MONUMENTATION: Tidal Station disk

VM#: 761

AGENCY: National Ocean Service (NOS)

PID#: AR1667

SETTING CLASSIFICATION: Sidewalk

The bench mark is a disk set in the concrete sidewalk atop a seawall, near the intersection of C and Dock Streets at the foot of the city pier, 5.10 (16.7 ft) SE from the junction of where the centerlines meet at the end of the two streets, 0.60 m (2.0 ft) west of the NW corner of the city pier, 0.50 m (1.6 ft) NW of the SE end of the guardrail. NOTE: Difficult tripod set-up, not much room, lots of people traffic and parking is a premium.

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FLORIDA

NOAA Chart: 11408

Latitude: 29° 8.1' N

USGS Quad: CEDAR KEY

Longitude: 83° 1.9' W

T I D A L D A T U M S

Tidal datums at CEDAR KEY, GULF OF MEXICO based on:

LENGTH OF SERIES: 16 YEARS
TIME PERIOD: 1/1983-12/1987 ; 1/1989-12/1994 ; 1/1997-12/2001
TIDAL EPOCH: 1983-2001
CONTROL TIDE STATION: 8726520 ST. PETERSBURG, TAMPA BAY

Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

HIGHEST OBSERVED WATER LEVEL (10/07/1996)	=	2.727
MEAN HIGHER HIGH WATER (MHHW)	=	1.158
MEAN HIGH WATER (MHW)	=	1.055
NORTH AMERICAN VERTICAL DATUM-1988 (NAVD)	=	0.687
MEAN TIDE LEVEL (MTL)	=	0.624
MEAN SEA LEVEL (MSL)	=	0.621
MEAN LOW WATER (MLW)	=	0.193
MEAN LOWER LOW WATER (MLLW)	=	0.000
LOWEST OBSERVED WATER LEVEL (09/18/1947)	=	-1.282

[National Geodetic Vertical Datum \(NGVD 29\)](#)

Bench Mark Elevation Information In METERS above:

Stamping or Designation	MLLW	MHW
8	1.797	0.742
17 1923	4.998	3.943
18 1923	2.208	1.153
D 280	4.108	3.053
D 290	2.059	1.005
7520 K 1978	7.032	5.976
7520 A 1983	3.098	2.042

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Water table elevations (normal and seasonal high) including aerial extent and magnitude of any proposed water table draw down

Water table

Groundwater elevations have been monitored by CH2M Hill in support of the COLA since March, 2007, as shown on the table. The locations of the monitoring wells are shown as Attachment A.

Summary of Groundwater Levels Within the Plant Area

Well ID	Ground Elevation	Top of Casing (TOC) Elevation	Groundwater Surface Elevation			
	(ft NAVD88)	(ft NAVD88)	March 6, 2007	June 14, 2007	Sept 13, 2007	Dec 4, 2007
MW-1S	41.95	45.09	40.50	37.40	36.21	36.31
MW-2S	43.34	45.84	41.93	37.98	36.87	36.21
MW-3S	48.41	51.55	45.82	41.93	41.12	40.66
MW-4S	46.38	48.83	45.09	41.78	40.77	40.93
MW-5S	42.80	45.52	41.74	39.14	37.68	37.59
MW-6D	42.66	45.59	41.40	38.59	37.18	37.27
MW-7S	44.22	46.91	42.54	39.30	38.03	37.99
MW-8D	44.00	46.83	42.21	39.28	37.95	37.97
MW-9S	43.45	46.08	41.75	39.22	37.94	38.05
MW-10D	43.51	46.00	41.72	38.95	37.47	37.71
MW-11S	42.06	44.70	41.30	39.28	37.64	37.66
MW-12D	41.89	44.54	40.73	37.83	36.49	36.58
MW-13S	42.58	45.78	41.94	39.17	37.66	37.70
MW-14D	42.56	45.72	41.83	38.91	37.39	37.56
MW-15S	43.35	46.24	42.05	39.25	38.01	37.88
MW-16D	43.34	46.01	41.73	38.93	37.46	37.68
OW-1	43.21	45.89	41.96	39.17	37.64	37.71
OW-2	42.56	45.62	42.09	39.25	37.73	37.80
OW-3	42.39	45.48	42.12	39.20	37.68	37.75
OW-4	42.41	45.48	41.97	39.13	37.61	37.69
OW-5	43.15	45.53	41.75	38.87	37.38	37.54

OW-6	42.46	45.57	41.89	39.08	37.55	37.64
OW-7	42.59	45.61	41.98	39.14	37.63	37.73
PW-1	41.99	45.82	42.00	39.17	37.65	37.72

In the table the OW wells and the wells with the S ending are representative of water table wells. Wells with the D endings are in the Avon Park limestone with depths over 100 ft. The following wells were located adjacent to each other (well pairs) to measure vertical gradients between deep and shallow groundwater; MW-5S and MW-6D, MW-7S and MW-8D, MW-9S and MW-10D, MW-11S and MW-12D, MW-13S and MW-14D, and MW-15S and MW-16D.

Groundwater elevation measurements show that, during seasonally wet seasons such as that represented by March, 2007, the water table is very close to the ground surface, ranging from 0.47 ft to 2.59 ft below grade. During the wet season much of the site area is flooded.

The measurements also show that after extended periods of little precipitation, such as that represented by readings taken in December 2007, the water table was 4.39 to 7.75 ft below grade.

Comparison of readings of each well pairs shows that the vertical hydraulic gradients are small which indicates that the deeper limestone is part of the water table aquifer.

Thirty-one test pits were performed in November and December, 2007 for roads and laydown areas. Groundwater in the test pits was estimated to occur between 4 ft and 9.5 ft below grade. The test pits were performed after an extended period of little precipitation at the site. The table below indicates the depth of groundwater occurrence.

Test Pit No.	Easting (ft)	Northing (ft)	Facility	Groundwater Depth (ft)
1	453500	1728180	N. Substation	>7
4	455490	1727211	Motor Pool	8
5	454437	1726728	Warehouse 1	5.5
6	454987	1726728	Warehouse 2	6.25
7	454713	1726302	Warehouse laydown	8
8	456467	1726331	N. Road	8
10	456770	1725132	Material Laydown Area	8
11	455967	1724875	Cooling Towers Unit 2	8
12	455395	1723729	Module Laydown Area	4
15	456257	1723105	Cooling Towers Unit 1	6

16	457097	1722713	Cooling Towers Unit 1	8
18	456906	1724437	Cooling Towers Unit 2	4
20	457767	1724645	Turbine Module Assembly Area Unit 2	9.5
21	457368	1725350	Material Laydown Area	5.5
22	457979	1725605	Parking Lot	5.5
27	459561	1726632	Batch plant	6
29	459533	1725787	Batch plant	>8
31	458326	1724985	N. Road	8
32	458619	1724502	Power Block Parking	>7
33	458089	1724049	Power Block Unit2	4.5
34	458611	1723940	Maint Support Bldg	6.75
35	459159	1723944	Power Block Parking	7.5
37	458897	1723147	Permanent Warehouse	>7
38	459019	1722818	Plant Road	8
39	458293	1723834	Turbine Module Assembly Area Unit 1	8
40	457924	1723310	Module Assembly Area	8
41	457752	1723570	Warehouse	7
42	457421	1723283	Module Fab Area	8
43	458129	1721967	S. Road	6
44	455668	1721790	S. Road	5.5
45	453232	1722721	S. Road	7

The site soils were identified by the National Resource Conservation Service in the Levy County Soil Survey. Attachment B shows the distribution of the soil types. The predominant soil types (in order of percent of land area within the site) found in the proposed reactor area are listed and described below:

1. Smyrna fine sand – Poorly drained soils formed in thick deposits of sandy marine materials. Land surface slopes range from 0 to 2 percent. The water table is at depths less than 18 inches for 1 to 4 months of the year and 12 to 40 inches for more than 6 months. In rainy seasons the water table rises above the surface briefly. In depression areas water stands above the surface for 6 to 9 months. Smyrna fine sand is listed as NRCS hydrologic soil group B/D.

2. Placid and Samsula soils, depressional – Poorly drained soils formed in sandy marine sediments. Land surface slopes range from 0 to 2 percent. These soils are in swamps, poorly defined drainageways and flood plains. The water table ranges from 0 to 6 inches for more than 2 months in most years. In depressed areas, the water table is above the soils surface for more than 6 months annually. Placida and Samsula soils are listed as NRCS hydrologic soil group B/D.
3. Chobee-Gator complex, frequently flooded – Poorly drained soils formed in thick deposits of loamy marine sediments. Land surfaces range from 0 to 2 percent. The surface is commonly an organic silty loam. The water table is within 6 inches of the ground surface from 1 to 4 months of the year and is flooded for long durations in depressional areas. The Chobee-Gator complex soils is listed as NRCS hydrologic soil group B/D.
4. Wauchula fine sand – The Wauchula series consists of very deep, very poorly or poorly drained, moderately slow or slowly permeable soils on flatwoods on the lower coastal plains. They formed in sandy and loamy marine sediments. Slopes range from 0 to 5 percent. Water table is at depths of 6 to 18 inches for 1 to 4 months during most years. It is at depths of about 10 to 40 inches for periods as long as about 6 months, but during the driest season it recedes to depths of more than 40 inches. Depressional areas are covered with standing water for periods of 6 to 9 months or more in most years. Wauchula fine sand is listed as NRCS hydrologic soil group B/D.

As can be seen from the soil descriptions, groundwater is located within 18 inches of the ground surface for the site soils for much of the year.

Proposed water table draw down

Water table drawdown will occur due to water withdrawal for groundwater control during excavation and construction and well water usage (construction and post-construction).

Five major areas will require groundwater level control for excavation and construction:

- The Nuclear Island (NI)
- Turbine building
- Circulating water system
- Blowdown and make-up lines from the plant to the barge canal area
- The pump house

Due to the high level of groundwater at the site an extensive groundwater management program will be required to excavate for the foundation construction of the Nuclear Island.

A likely scenario for groundwater management for site excavation consists of a combination of impermeable flow barriers (e.g. diaphragm wall), grouting, and dewatering by means of wellpoints, deep wells, and/or sumps. Similar groundwater management has been applied at the Crystal River site during its construction.

The current design for the NI excavation consists of an impermeable diaphragm wall surrounding the excavation and extending to a depth of 100 feet for the 75 ft deep excavation. The diaphragm wall will prohibit horizontal groundwater flow into the excavation and provide shoring of the excavation face.

To reduce the upward flow of groundwater through the bottom of the excavation, a plug will be created by grouting the limestone beneath the excavation. This involves drilling a grid of grout intake holes within the limits of the curtain wall and into the rock layer beneath the bottom of the proposed excavation depth. Grout is then injected into this rock layer at pressure to form a horizontal layer of grouted rock beneath the excavation that will resist the upward flow of groundwater. The grouted layer must be thick enough to maintain stability when subjected to the unbalanced hydrostatic forces that will exist after completion of the excavation.

An ideal outcome would result in the excavation becoming a “bathtub”, water withdrawal would consist of only that water which was within the “tub”. However, it is expected that the tub will leak and some continuous pumping of the excavation will be required. The quantity of pumping is expected to be less than 1000 gpm. A flow of 1000 gpm would potentially cause approximately a foot of drawdown 4000 feet from the NI excavation, 0.5 ft 6000 feet from the NI excavation, and 0.05 ft approximately 12,000 ft from the NI excavation. The magnitude of drawdown would be approximately proportional to the quantity of discharge, hence a flow of 2000 gpm would double the drawdown.

The turbine building is proposed to be supported on deep foundations. Excavation for the turbine building should not extend to the water table except for the circulation water pipes beneath the building. The circulating water pipe excavations will extend to a depth of 36 ft below the proposed site grade. Ground water control will be provided by a combination of grouting the limestone beneath the excavations, well points, and sumps. Sheetpile walls, slurry walls, or diaphragm walls may be used to reduce horizontal flow into the excavation. Drawdown resulting from dewatering of the turbine building excavation

The blowdown and makeup water lines will require excavation approximately 7 feet below the water table for most of its route from the plant area to the pumphouse. It is assumed that the groundwater control for excavation and construction will be performed by well points. It is estimated that dewatering for the trench will require 1 to 5 gpm per foot of open trench. Groundwater

drawdown will be controlled by limiting the amount of open trench. Drawdown of the water table will be minimal (<0.1 ft) more than 200 ft. from the open trench.

The pumphouse is located at the barge canal. Groundwater will be controlled by sheetpiling, coffer dams, and wells; possibly grouting of the excavation subgrade will be required. Due to the close proximity of the barge canal and bypass canal, groundwater withdrawal rates may be substantial. However, due to the location of the pumphouse between the two canals, the drawdown on the water table north of the pumphouse will be minimal.

