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Revised Groundwater Model Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant

PREPARED FOR: Progress Energy

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DATE: November 24, 2009

1.0 Introduction

This technical memorandum (TM) documents an additional evaluation of the simulated hydrologic impacts associated with the proposed normal daily withdrawal of 1.58 million gallons per day (mgd) of groundwater from the Upper Floridan Aquifer (UFA) to provide raw water for Progress Energy Florida, Inc.'s (PEF's), Levy Nuclear Plant Units 1 and 2 (LNP).

Impacts were evaluated using a MODFLOW (Harbaugh, et al., 2000) groundwater flow model developed by CH2M HILL. The groundwater model was exported from the Southwest Florida Water Management District's (SWFWMD's) District-Wide Regulation Model, Version 2 (DWRM2) (Environmental Simulations Inc., 2004) using the telescopic mesh refinement (TMR) process, which creates a site-specific model from the regional DWRM2. Changes made to the model design and hydraulic properties are detailed in Section 3.0.

The first evaluation of simulated hydrologic impacts associated with the proposed LNP raw water wellfield was documented in a TM entitled, "Revised Conceptual Wellfield Layout and Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant" (338884-TMEM-074) (CH2M HILL, 2008). In response to the U.S. Nuclear Regulatory Commission's (NRC's) Request for Additional Information (RAI) 5.2.2-4, CH2M HILL completed a second evaluation by revising the model documented in 338884-TMEM-074. These revisions and associated simulation results are documented in this TM. This TM refers to the model documented in 338884-TMEM-074 as the "DWRM2 TMR model" and to the model documented in this TM as the "revised TMR model."

The revised TMR model is intended to better simulate the published 2007 U.S. Geological Survey (USGS) potentiometric surface maps and to better approximate the water levels measured in the field during site investigations to support the Environmental Report for the Combined License Application. The proposed raw water wellfield location has not changed from the layout proposed for the State of Florida Site Certification and is shown on Figure 1.

2.0 Model Structure and Properties

The following sections describe the layout of the finite difference grid, model layering, time discretization, recharge, boundary conditions, well withdrawals, and model modifications. Hydraulic properties are discussed in Section 3.

2.1 Finite Difference Grid

The revised TMR model grid consists of 122 rows and 131 columns, containing 47,946 cells, of which 31,963 are active. Each cell ranges in height and width from a minimum of 250 feet to a maximum of 5,000 feet. The location and configuration of the revised TMR model grid are presented on Figure 2. No changes were made to the DWRM2 TMR model grid in the revised TMR model.

2.2 Layering

The DWRM2 TMR model includes five layers representing (in descending order) the surficial aquifer system (SAS), upper intermediate aquifer system (IAS), lower IAS, UFA, and Lower Floridan Aquifer (LFA) system. Based on borings completed during field investigation activities at the LNP site during 2007, the IAS is not present at the location of the LNP site (PEF, 2008). Therefore, the IAS layers were removed in the revised TMR model.

The revised TMR model consists of the following layers (in descending order):

- Layer 1 – SAS (unconfined)
- Layer 2 – UFA system (confined)
- Layer 3 – LFA system (confined)

2.3 Time Discretization

The revised TMR model includes three stress periods. Stress Period 1 is a steady-state stress period that represents pre-development conditions; there are no well withdrawals simulated during this stress period. Stress Period 2, also steady-state, includes permitted groundwater withdrawals adjacent to the LNP, excluding withdrawals from the LNP; it is intended to provide an assessment of currently permitted impacts. Stress Period 3 is the predictive phase of the simulation and includes LNP withdrawals in addition to adjacent permitted groundwater withdrawals within the model domain. No changes were made to the DWRM2 time discretization in the revised TMR model.

2.4 Recharge

Recharge is applied to the uppermost layer (Layer 1) and is calculated as net recharge. The evapotranspiration function is not used. Figure 3 shows the range of net recharge values in the revised TMR model domain. Over most of the LNP site, net recharge ranges from 3.7 to 8.6 inches per year (in/yr). Higher recharge values occur in the southeastern corner of the property, ranging from 8.7 to 19.4 in/yr. No changes were made to the DWRM2 TMR model recharge in the revised TMR model.

2.5 Boundary Conditions

Each layer in the revised TMR model has boundary conditions that govern flow into and out of the layer. Figures 4, 5, and 6 present the boundary conditions in Layer 1 (SAS), Layer 2 (UFA), and Layer 3 (LFA), respectively. The boundary conditions for the SAS and UFA presented on Figures 4 and 5 include the boundary condition modifications discussed further in Sections 2.7 and 3.3.

Figure 4 presents the boundary conditions in Layer 1 (SAS). Layer 1 is laterally bounded by constant head cells. The vertical boundary conditions include active, drain, and river cells. Modifications were made to the Layer 1 boundary conditions and are described further in Section 3.3.

Figure 5 presents the boundary conditions in Layer 2 (UFA). Layer 2 is laterally bounded by constant head cells. The vertical boundary conditions include active and drain cells. No flow cells are present in the southwestern corner of the model domain and represent the 10,000 milligrams per liter (mg/L) salinity boundary. Modifications were made to the Layer 2 boundary conditions and are described further in Section 3.3.

Figure 6 presents the boundary conditions in Layer 3 (LFA). The majority of the LFA consists of no flow cells representing the 10,000 mg/L salinity boundary. Constant head and active cells are present in the northeastern corner of the model domain.

2.6 Well Withdrawals

Withdrawals by permitted users adjacent to the LNP site and within the modal domain are simulated in Stress Periods 2 and 3 of the revised TMR model. LNP withdrawals are simulated in Stress Period 3 of the revised TMR model. Withdrawals within the revised TMR model domain are described below in Subsections 2.6.1 and 2.6.2.

2.6.1 LNP Wellfield

The raw water wellfield layout includes four wells located in the southern portion of the LNP site. Three wells are located just north of County Road 40, and one well is located approximately 0.9 mile to the north of County Road 40, on the eastside of the heavy haul road. Figure 1 depicts the wellfield layout.

For the average day simulations, each well was simulated to pump at a constant rate of 0.395 mgd, for a total withdrawal of 1.58 mgd; for the maximum week simulations, each well was simulated to pump at a constant rate of 1.45 mgd, for a total withdrawal of 5.8 mgd.

2.6.2 Adjacent Permitted Users

Details on adjacent Individual, General, and Small General Water Use Permits included in the model domain are summarized in Table 1, and the locations of permitted wells are depicted on Figure 2. No modifications were made to the simulated withdrawal rates or locations of these permitted wells, which are from the DWRM2 TMR model. Adjacent permitted users withdraw a total of 3.51 mgd of water from the UFA (Layer 2) in the DWRM2 TMR and revised TMR models. Withdrawal rates of adjacent permitted users are based on reported 2001 withdrawal rates.

2.7 Model Modifications

Three modifications were made to the DWRM2 TMR model for the original evaluation of simulated hydrologic impacts associated with the proposed LNP wellfield as documented in 338884-TMEM-074. These modifications were retained in the Revised TMR model and are discussed in the following subsections.

2.7.1 Springs

Two springs were identified within the LNP model boundary conditions: Little King and Big King Springs (Scott, et al., 2004), which were not included in the DWRM2 TMR model. Figure 2 depicts their locations relative to the LNP site and the revised TMR model domain.

The springs were added to Layer 2 of the model, which represents the UFA. The springs were simulated using MODFLOW's drain package. The drain package allows water to be removed from a model cell based on the head differential between the model-calculated water level for that model cell and a specified elevation for the drain. The simulated flow is modulated by the conductance term, which is a product of the cell area and hydraulic conductivity.

Neither discharge nor elevation data were available for the springs. It was assumed that the pre-development (Stress Period 1) discharge from each spring was on the order of 3 mgd. This is consistent with the springs' classification as third-magnitude springs (Scott, et al., 2004). The model drain elevation and conductance values were adjusted so that the simulated flux from each spring under pre-development conditions (Stress Period 1) was on the order of 3 mgd.

2.7.2 Wetlands

Model cells that used MODFLOW's river package to represent wetlands were changed to variable-head cells (that is, the river package was not used to represent wetlands). This change was made based on SWFWMD staff concerns that MODFLOW's river package could provide an infinite source of water to the model and artificially limit simulated drawdowns. Model cells that used the river package to represent Lake Rousseau and the Withlacoochee River were not modified.

2.7.3 Time Discretization

In the DWRM2 TMR model, the length of Stress Period 3 is 1 year. For the revised TMR model, two additional periods of 7 days and 60 years were used to simulate maximum weekly withdrawals and to represent the expected life of the facility, respectively.

3.0 Model Calibration

3.1 Calibration Objectives

In response to NRC's RAI 5.2.2-4, the DWRM2 TMR model was recalibrated to accomplish the following:

1. Reproduce the USGS 2007 potentiometric surface for the UFA. For example, the USGS 2007 UFA potentiometric surface identifies an area of high groundwater elevation (approximately 70 feet) east of the LNP site; the DWRM2 TMR model documented in 338884-TMEM-074 simulates a potentiometric surface of approximately 40 feet in this area.
2. Simulate observed water level elevations at the site from SAS (Layer 1) and UFA (Layer 2) monitoring wells.

3.2 Calibration Targets

The following calibration targets were used:

- Site Water Elevation Data – The only available water level elevation data for the site were collected at SAS (Layer 1) and UFA (Layer 2) monitoring wells during 2007. It is assumed that these represent steady-state conditions and that they are roughly equivalent to 2001 water levels (see Subsection 2.6.2). Where more than one site monitoring well was located within a single model cell, only the well with the average water elevation closest to the mean value for that cell was used as a calibration target.
- USGS Water Elevation Data – Water elevation data used to compile the USGS 2007 UFA potentiometric surface were obtained or estimated for four wells from the USGS data within the revised TMR model domain. In addition, water elevation data were obtained for two additional UFA wells within the model domain used for the original DWRM2 steady-state calibration (performed by SWFWMD), but not used to compile the USGS 2007 UFA potentiometric surface.
- USGS 2007 UFA Potentiometic Surface – Additional calibration targets were synthesized from the USGS 2007 UFA potentiometric surface where no well water level data were available.

3.3 Additional Modifications

Three additional modifications were made to the revised TMR model to help meet the calibration objectives, as noted below.

1. Springs – As discussed above, Little King and Big King Springs were added to the revised TMR model. The springs are located approximately 0.5 mile apart (Figure 2). Due to the length of the cells in the area of the springs (5,000 feet), the spring discharges were combined into one model cell in the revised TMR model.
2. Lakes – Three constant head river boundary cells were added to Layer 1 (SAS) of the revised TMR model to represent lakes located east of the site. The location of these river cells are shown on Figure 4.
3. Boundary Conditions – Boundary conditions in the UFA (Layer 2) were modified in the revised TMR model to be equal to the average values of the USGS 2007 UFA May and September potentiometric surface contours, where they intersected the model boundaries. The UFA boundary conditions are shown on Figure 5.

3.4 Calibration Parameters

The following parameters were modified during the calibration of the revised TMR model:

- Hydraulic conductivity of the SAS (Layer 1)
- Transmissivity of the UFA (Layer 2)
- Inter-layer leakance between the SAS (Layer 1) and the UFA (Layer 2)
- Conductance of the new constant head (river) cells representing lakes east of the site, as detailed in Subsection 3.3

Inter-layer leakance between the UFA (Layer 2) and the LFA (Layer 3) was included in early calibration iterations, but the calibration results were found to be insensitive to changes in this parameter. Therefore, it was not included in later calibration iterations of the revised TMR model, and the values were left unchanged.

3.5 Calibration Procedure

A steady-state calibration was performed using average 2007 water elevations at calibration targets (derived from both site measurements and USGS data). The revised TMR model was recalibrated using Model-Independent Parameter Estimation (PEST) (Doherty, 2004), a model-independent parameter estimation software tool that is integrated with Groundwater Vistas. The calibration parameters discussed in Section 4.4 were adjusted to obtain the best possible match with the observed site 2007 water levels in the SAS, UFA, and USGS 2007 UFA potentiometric surface. Since the only new water level data in the SAS were from the onsite monitoring wells, the SAS was only calibrated to the site conditions. Offsite areas were not constrained in PEST; therefore, there are some areas with flooded or dry cells and unusual looking contour lines.

4.0 Calibration/Modification Results

After the PEST calibration process, the root mean square (RMS) calibration error is 1.27 feet. RMS error is a method of quantifying the difference between the observed and simulated heads at all calibration targets.

Table 2 summarizes the calibration residuals (difference between observed and simulated water elevations) at each calibration target. Calibration residuals for the revised TMR model range from -3.25 to 3.87 feet across the model grid and from -0.56 to 2.35 feet at the LNP site. Figure 7 presents scatter plots of observed and simulated water elevations (in both the SAS and UFA) after the calibration. Table 3 summarizes the pre-calibration and calibrated model parameters. Figures 8, 9, and 10 present the calibrated hydraulic conductivity values in the SAS, leakance between the SAS and UFA, and transmissivity in the UFA, respectively.

Analysis of slug test and aquifer test data collected at the site indicates that the hydraulic conductivity of the SAS at the site ranges from 0.9 to 75 feet per day (ft/day) and that the transmissivity of the UFA at the site ranges from 600 to 67,600 square feet (ft^2)/day (FSAR RAI Response 2.4.12-12). The calibrated SAS hydraulic conductivity of the revised TMR model ranges from 0.7 to 85 ft/day at the LNP site (Figure 8). The calibrated UFA transmissivity of the revised TMR model predominantly ranges from 7,920 to 250,000 ft^2/day at the LNP site (Figure 10). The calibrated revised TMR model simulates hydraulic conductivity and transmissivity values of the SAS and UFA within approximately an order of magnitude of actual site measurements. Some variation from actual site measurements is expected because slug and aquifer tests may have measured the hydraulic parameters of only a portion of the Floridan aquifer.

The phreatic and potentiometric surfaces in the SAS and UFA simulated by the revised TMR model are presented on Figures 11 through 14. Figure 11 presents the simulated UFA potentiometric surface at the end of Stress Period 2 (existing conditions) in comparison to the USGS 2007 UFA potentiometric surface. The calibrated revised TMR model simulates a UFA potentiometric surface closely matching that developed by the USGS.

Figure 12 presents the simulated SAS phreatic surface at the end of Stress Period 2 (existing conditions). It should be noted that the only SAS calibration targets were located at the LNP site; therefore, the accuracy of the simulated phreatic surface will decrease with distance from the site. Figures 13 and 14 present the simulated UFA potentiometric surface and SAS phreatic surface at the end of Stress Period 1 (pre-development conditions), respectively.

5.0 Predictive Simulation Results

Two predictive simulations were conducted: average daily and maximum weekly withdrawals.

5.1 Existing Impacts

As described in Section 2.6, the revised TMR model simulates reported 2001 withdrawals by adjacent permitted users. The simulated existing impacts from these users from pre-development conditions for the SAS and the UFA are presented on Figures 15 and 16, respectively. Simulated existing drawdown at the LNP site ranges from 0 to approximately 0.4 foot in both the SAS and the UFA.

5.2 Average Day Impacts

LNP operations will require an average of 1.58 mgd (total) from the four water supply wells. Figure 17 presents the revised TMR model water budget under these withdrawal conditions.

Figures 18 and 19 present the simulated phreatic and potentiometric surfaces after 1 year of operation in the SAS and the UFA, respectively. Simulated incremental drawdowns (resulting from LNP withdrawals only) for this period are presented on Figures 20 and 21. The simulated 0.5-foot incremental drawdown contour extends a maximum of approximately 1 mile from the supply wells in the SAS and a maximum of approximately 1.1 miles from the supply wells in the UFA. Simulated cumulative drawdowns (resulting from LNP and adjacent withdrawals) after 1 year of operation at the SAS and the UFA are presented on Figures 22 and 23, respectively.

Figures 24 and 25 present the simulated phreatic and potentiometric surfaces after 60 years of operation (the expected life of the facility) in the SAS and UFA, respectively. Simulated incremental drawdowns (resulting from LNP withdrawals only) for this period are presented on Figures 26 and 27. The simulated 0.5-foot incremental drawdown contour extends a maximum of approximately 3 miles from the supply wells in both the SAS and the UFA. Simulated cumulative drawdowns (resulting from LNP and adjacent withdrawals) after 60 years of operation at the SAS and the UFA are presented on Figures 28 and 29, respectively.

Figures 30 and 31 present the simulated incremental SAS drawdown at 1 year and 60 years of operation, respectively, with nearby wetlands.

5.3 Maximum Week Impacts

LNP operations will require a maximum of 5.8 mgd (total) for 7 consecutive days from the four water supply wells. Figures 32 and 33 present the simulated incremental drawdowns (resulting from LNP withdrawals only) for this 7-day period, for the SAS and the UFA, respectively. The simulated 0.5-foot incremental drawdown contour extends a maximum of approximately 0.2 mile from the supply wells in the SAS and a maximum of approximately 0.6 mile from the water supply wells in the UFA.

6.0 Conclusions

The revised TMR model more closely simulates the USGS published potentiometric surface map of the UFA. The simulated drawdown impacts are greater than those from the DWRM2 TMR model. The differences are a result of the revised aquifer parameter values and distribution. Actual field conditions will be confirmed by the environmental monitoring and testing discussed below.

As part of the "Conditions of Certification, adopted by the Final Order on Certification for the Progress Energy Levy Nuclear Power Plant Units 1 & 2," dated August 26, 2009, PEF will develop an Aquifer Performance Testing (APT) plan and an Environmental Monitoring Plan (EMP) for the proposed LNP raw water wellfield. The purpose of the APT plan is to measure the actual aquifer parameters in the wellfield to verify and, if necessary, revise the DWRM2 TMR model to incorporate field measured values. The EMP provides a framework for monitoring the hydrology and ecology of wetlands in the vicinity of the LNP wellfield that could potentially be affected by groundwater drawdowns resulting from operation of the LNP raw water wellfield. These required actions from the Conditions of Certification will ensure that the actual field conditions are understood at the wellfield location and that nearby wetlands are monitored to evaluate for any potential impacts from the groundwater withdrawals.

7.0 References

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Environmental Simulations Inc., 2004. Development of the District Wide Regulation Model for the Southwest Florida Water Management District. Contract 02CON000177.

Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000. MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process. U.S. Geological Survey Open-File Report 00-92.

Progress Energy Florida, Inc. (PEF), 2008. Levy Nuclear Plant Units 1 and 2 COL Application, Part 2, Final Safety Analysis Report. Rev. 0. July.

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Tables

TABLE 1
Adjacent Water Use Permits

Permit No.	Permit Holder	Expiration Date	Simulated Pumpage (gpd)
Individual Permit Holders			
207	CITY OF CRYSTAL RIVER	12/18/2011	613,139
2842	CITRUS COUNTY WATER RESOURCES DE	11/18/2007	924,260
4153	ROLLING OAKS UTILITIES INC	6/24/2018	789,520
4257	RAINBOW SPRINGS UTILITIES LC	7/27/2010	92,820
4695	FLORIDA POWER CORP DBA PROGRESS	11/26/2017	629,500
7819	CEMEX INC	3/2/2008	23,400
8785	BLACK DIAMOND PROPERTIES INC	3/30/2009	126,480
General Permit Holders			
1726	MARGARET & LONNIE KNIGHT	5/3/2011	203,600
2999	MARION UTILITIES INC	9/3/2008	123,850
6121	RANDY & SARA WIRKUS	6/16/2004	140,950
6798	EDWARD J. GERRITS, INC.	5/18/2009	264,090
7145	ROMEO RIDGE RANCH	10/9/2012	2,440
7755	TOWN OF YANKEETOWN	6/4/2014	106,380
8339	CITY OF DUNNELLON	10/8/2014	347,281
8953	TOWN OF INGLIS	2/22/2015	178,400
9964	PINE RIDGE COUNTRY CLUB & PINE RIDGE INVESTMENT GROUP LP	12/28/2010	243,060
10260	BRASSBOYS ENTERPRISES, INC DBA	4/16/2013	131,090
11281	METAL INDUSTRIES INC	9/6/2011	130,501
12144	PETER DEROSA	1/31/2011	94,500
Small General Permit Holders			
1272	LEWIS K RUNNELS	1/20/2010	60,880
3646	RAINBOW LAKES ESTATES MUNICIPAL SERVICE DISTRICT	12/3/2015	1,840
4294	CITRUS HMA INC	10/16/2010	82,730
4484	GREAT AMERICAN MANAGEMENT AND INVESTMENTS, INC.	9/30/1998	2,760
5550	DALE WRIGHT	1/20/2009	76,050
5891	AMSOUTH BANK OF FLORIDA	1/10/2006	1,730
6965	JOANE H MILLER	6/24/2015	66,170
6992	COKE E MARKHAM	6/26/2009	50,160
7296	CRYSTAL POINTE PROPERTY OWNERS ASSOCIATION INC	11/29/2010	14,890
7352	KELLY GARDINER	9/20/2014	1,120
8189	HAMIC ESTATES INC	12/27/2015	1,110
8834	RONNIE D. CANNON & EDSEL ROWAN, TRUSTEE	7/23/2014	55,060
8874	GTE FEDERAL CREDIT UNION	4/10/2013	600
8902	FLORIDA SHERIFFS YOUTH RANCHES INC	5/6/2003	5,620
9188	WEST NATURE COAST INVESTMENT INC	5/16/1998	1,470
9204	GEORGE W & SHEILA A SIKES	4/9/2018	3,960
9909	GARY A POE	3/7/2010	36,300
10192	HOLLINSWOOD TREE NURSERIES	11/28/2012	75,060
10937	GULF TO LAKES ASSOCIATES LTD	8/9/2014	61,270
11098	DONNA S COLLI	1/23/2014	55,750
11184	KINNARI, INC.	12/31/2004	15,840
11308	LEVAUGHN ROBINSON	7/8/2015	67,150
11383	INTERNAL IMPROVEMENT TRUST FUND	1/11/2016	26,700
11579	COOL SPRINGS RANCH LLC	3/14/2017	75,050
12032	LEN & NANCY ANN NOWRY	2/18/2010	23,020
12049	CITRUS CO BOCC	4/14/2014	430
12121	CRYSTAL RIVER UNITED METHODIST CHURCH	11/30/2010	43,920

Notes:
gpd = gallon per day

TABLE 2
Calibration Results

Target Name	Layer	Average Water Elevation (feet)	Revised TMR Model Simulated Water Elevation (feet)	Revised TMR Model Residual (feet)
LNP Site Targets				
MW-1S	1	37.61	37.55	0.06
MW-2S	1	38.25	38.13	0.12
MW-3S	1	42.38	42.28	0.10
MW-4S	1	42.14	41.69	0.45
MW-5S	1	39.04	38.80	0.24
MW-7S	1	39.47	39.64	-0.17
MW-9S	1	39.24	39.80	-0.56
MW-11S	1	38.97	38.76	0.21
MW-15S	1	39.3	39.42	-0.12
OW-2	1	39.22	39.16	0.06
OW-7	2	39.12	37.56	1.56
MW-6D	2	38.61	36.26	2.35
MW-8D	2	39.35	37.72	1.63
MW-10D	2	38.96	37.61	1.35
MW-12D	2	37.91	36.10	1.81
MW-16D	2	38.95	37.65	1.30
USGS 2007 Potentiometric Surface Targets				
T&J_Ranch	2	69.74	68.59	1.15
JT_Goethe[1]	2	63	59.13	3.87
Mancini_N[1]	2	49	51.17	-2.17
Geothe_Road[1]	2	26.81	30.06	-3.25
Tidewater_1[1]	2	52.38	51.06	1.32
ROMP_125[1]	2	3.21	4.14	-0.93
Syn2[1]	2	10	11.45	-1.45
Syn3[1]	2	10	10.04	-0.04
Syn4[1]	2	10	9.77	0.23
Syn9[1]	2	10	11.21	-1.21
Syn10[1]	2	10	10.24	-0.24
Syn11[1]	2	10	10.10	-0.10
Syn12[1]	2	10	9.99	0.01
Syn13[1]	2	10	9.96	0.04
Syn14[1]	2	10	10.97	-0.97
Syn15[1]	2	10	10.74	-0.74
Syn16[1]	2	20	17.69	2.31
Syn17[1]	2	20	19.74	0.26
Syn18[1]	2	20	20.15	-0.15
Syn19[1]	2	20	20.31	-0.31
Syn20[1]	2	20	19.69	0.31
Syn21[1]	2	20	20.46	-0.46

TABLE 2
Calibration Results

Target Name	Layer	Average Water Elevation (feet)	Revised TMR Model Simulated Water Elevation (feet)	Revised TMR Model Residual (feet)
Syn22[1]	2	30	31.20	-1.20
Syn23[1]	2	30	31.49	-1.49
Syn24[1]	2	30	30.02	-0.02
Syn25[1]	2	30	29.33	0.67
Root Mean Square Error				1.27

Notes:
[1] Average 2007 water elevation estimated from USGS 2007 potentiometric surface.

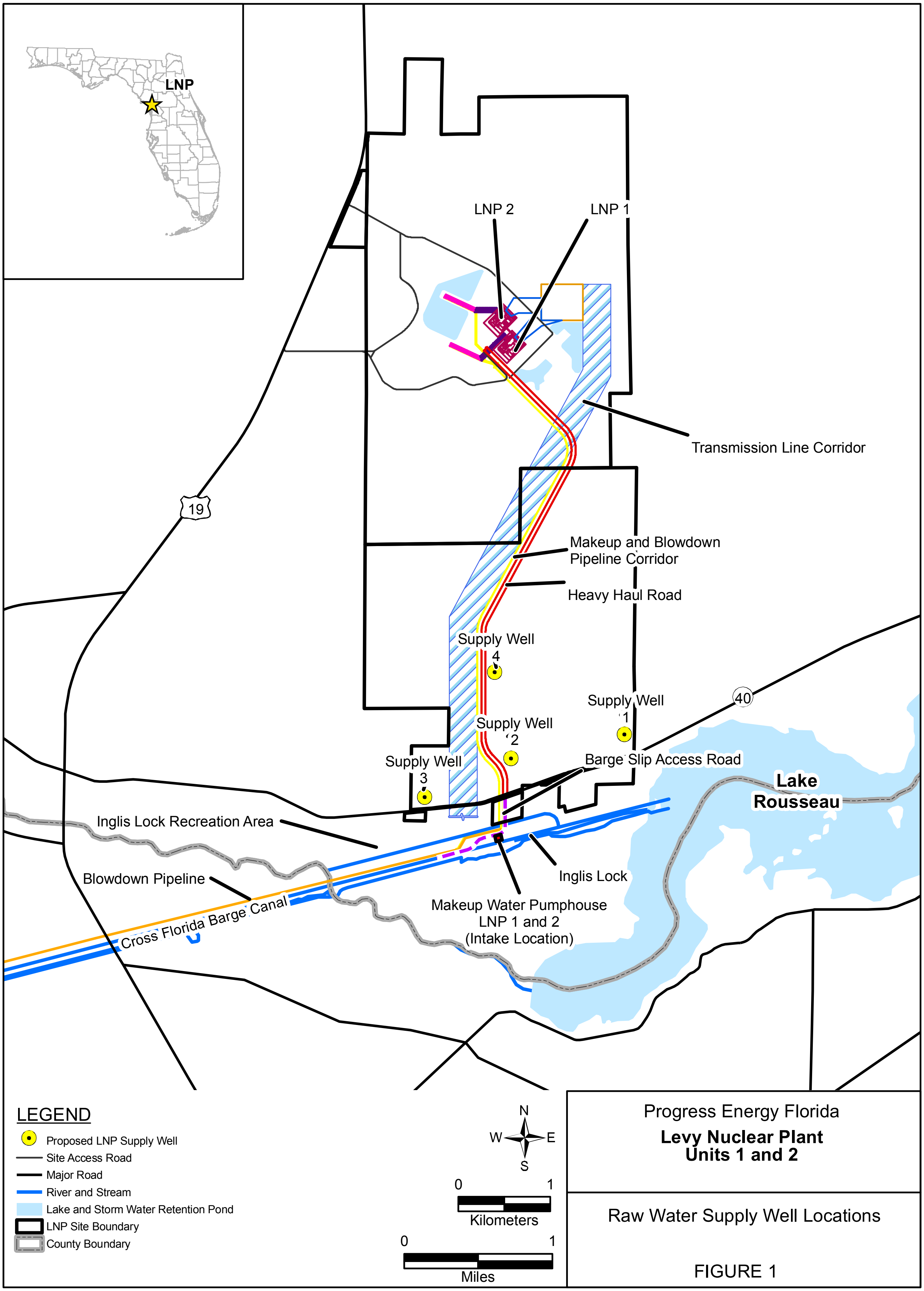
TABLE 3
Summary of Calibrated Parameters

		Hydraulic Conductivity (ft/day) / Transmissivity (ft^2/day)	
Aquifer	**Value**	**DWRM2 TMR Model**	**Revised TMR Model**
Surficial Aquifer System	Range	11.1 - 23.9	0.75 - 135
	Average	16	9.41
Upper Floridan Aquifer System	Range	20,184 - 5,383,400	7920 - 11,592,030
	Average	156,179	228,809
Lower Floridan Aquifer System[1]	Range	300,000	300,000
	Average	300,000	300,000

		Leakance (1/day)	
Aquifer	**Value**	**DWRM2 TMR Model**	**Revised TMR Model**
Surficial Aquifer System	Range	0.006 - 0.51	0.00000043 - 1.59
	Average	0.33	0.010
Upper Floridan Aquifer System[1]	Range	0.000012 - 0.001	0.000012 - 0.001
	Average	0.001	0.001
Lower Floridan Aquifer System[1]	Range	0	0
	Average	0	0

Notes:
[1] Parameter not included in calibration, provided for comparison purposes only.

Figures

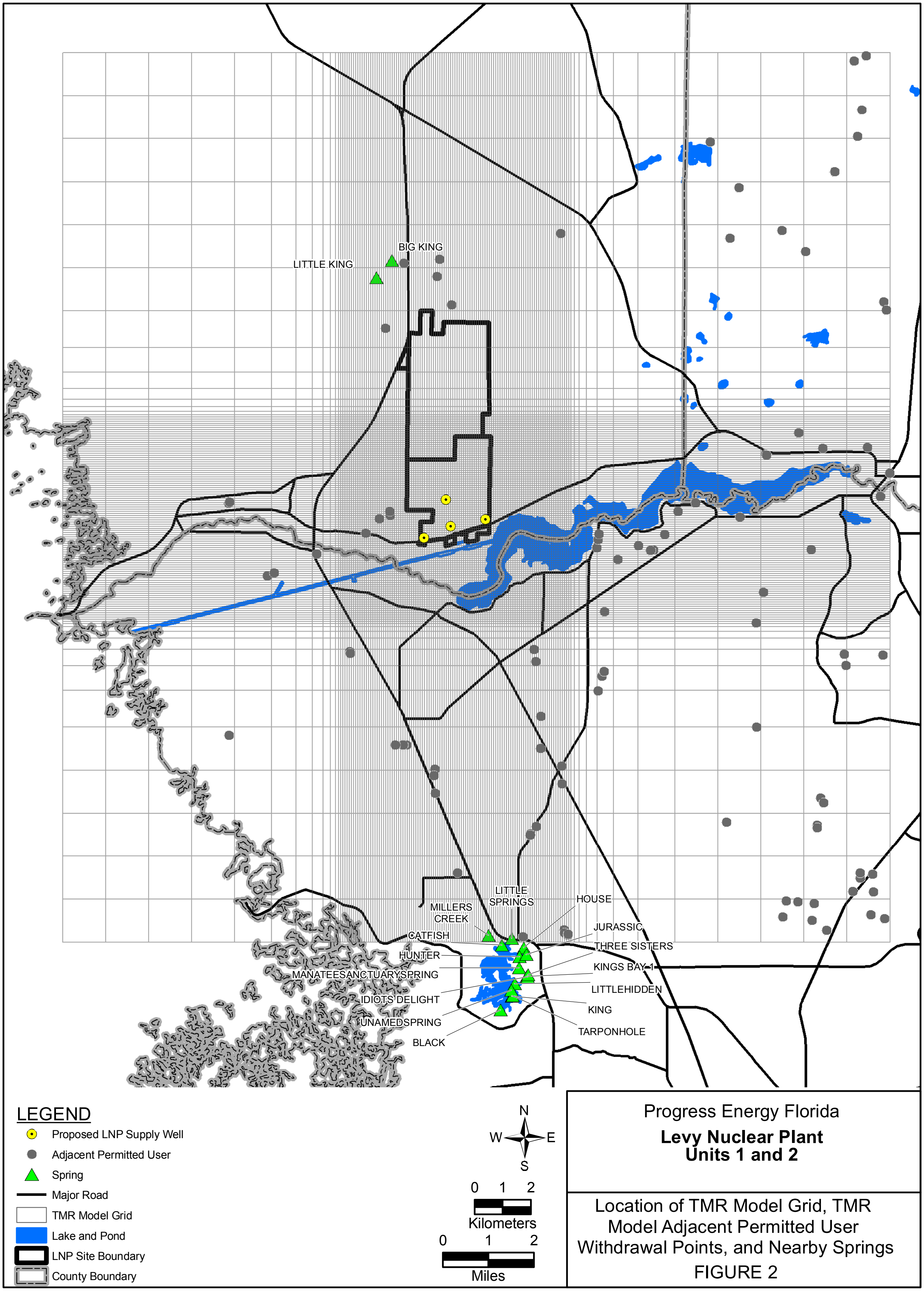


Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Raw Water Supply Well Locations

FIGURE 1

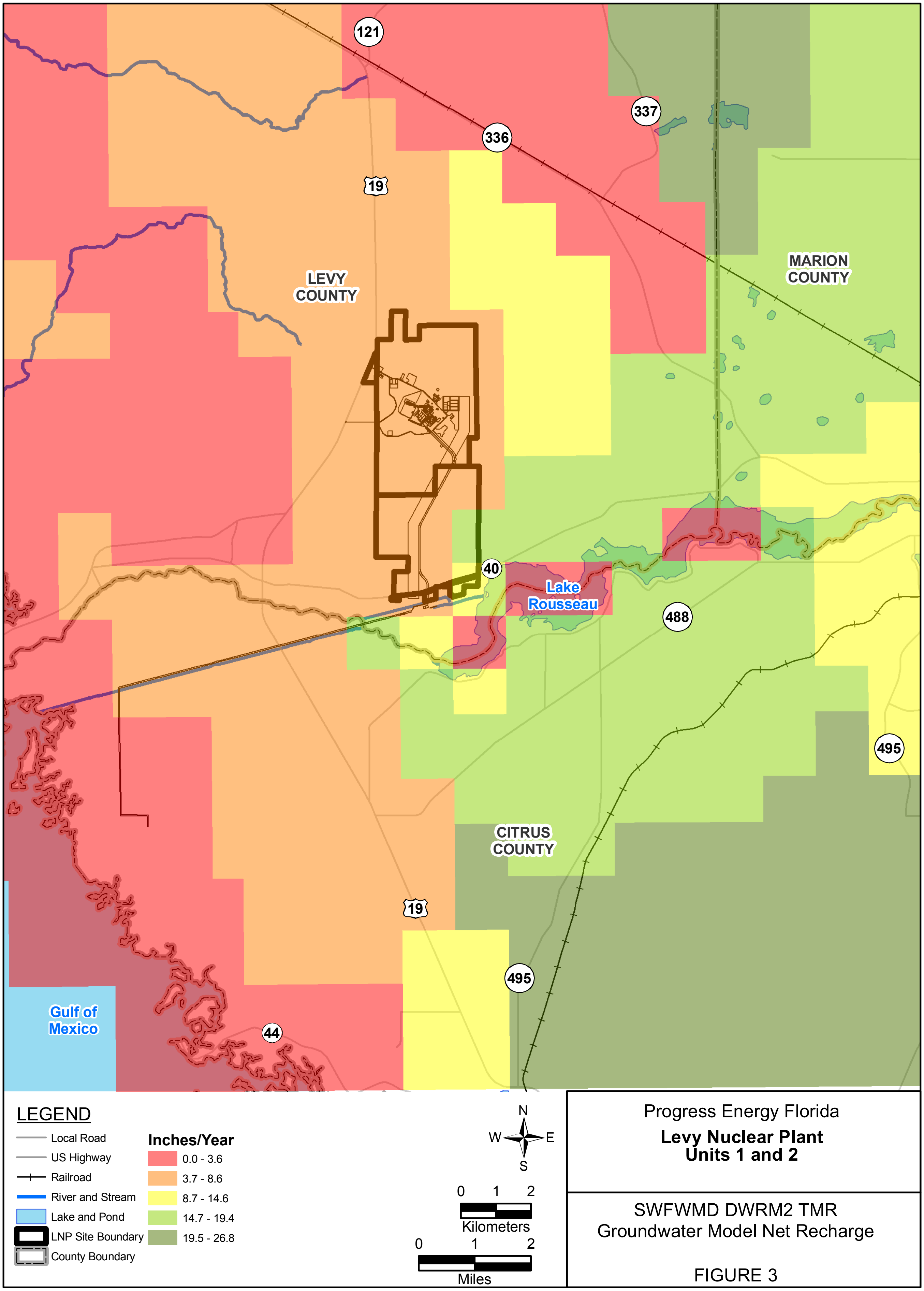


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Location of TMR Model Grid, TMR Model Adjacent Permitted User Withdrawal Points, and Nearby Springs

FIGURE 2

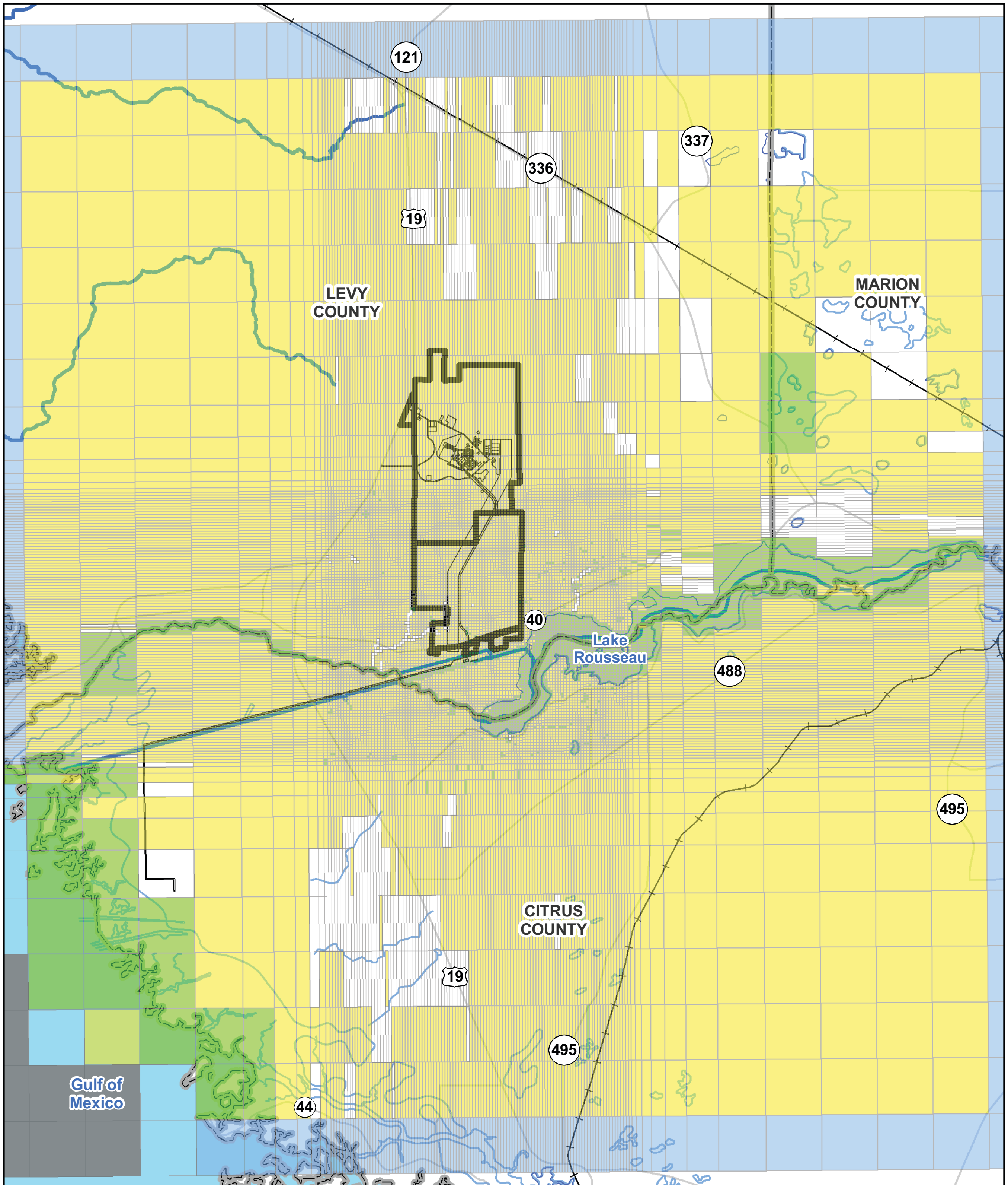


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

SWFWMD DWRM2 TMR
Groundwater Model Net Recharge

FIGURE 3



LEGEND

- Local Road
- US Highway
- Railroad
- River and Stream
- Lake and Pond
- LNP Site Boundary
- County Boundary

Boundary Conditions

- Active
- Constant Head
- Drain
- River
- No Flow

N W E S

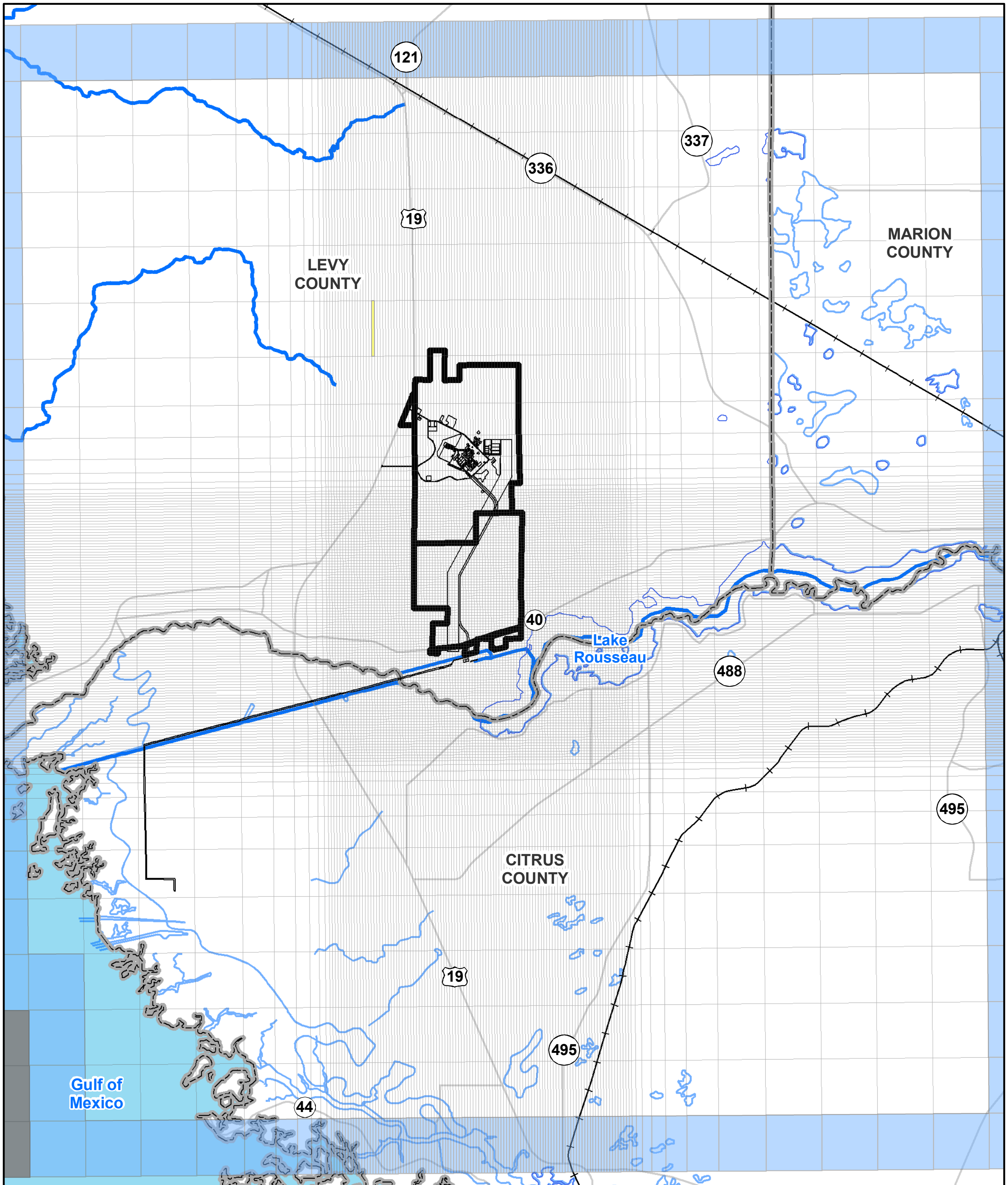
0 1 2 Kilometers

0 1 2 Miles

Progress Energy Florida
Levy Nuclear Plant Units 1 and 2

Revised TMR Model Layer 1 Boundary Conditions

FIGURE 4



LEGEND

- Local Road
- US Highway
- Railroad
- River and Stream
- Lake and Pond
- LNP Site Boundary
- County Boundary

Boundary Conditions

- Active
- Constant Head
- Drain
- No Flow

N W E S

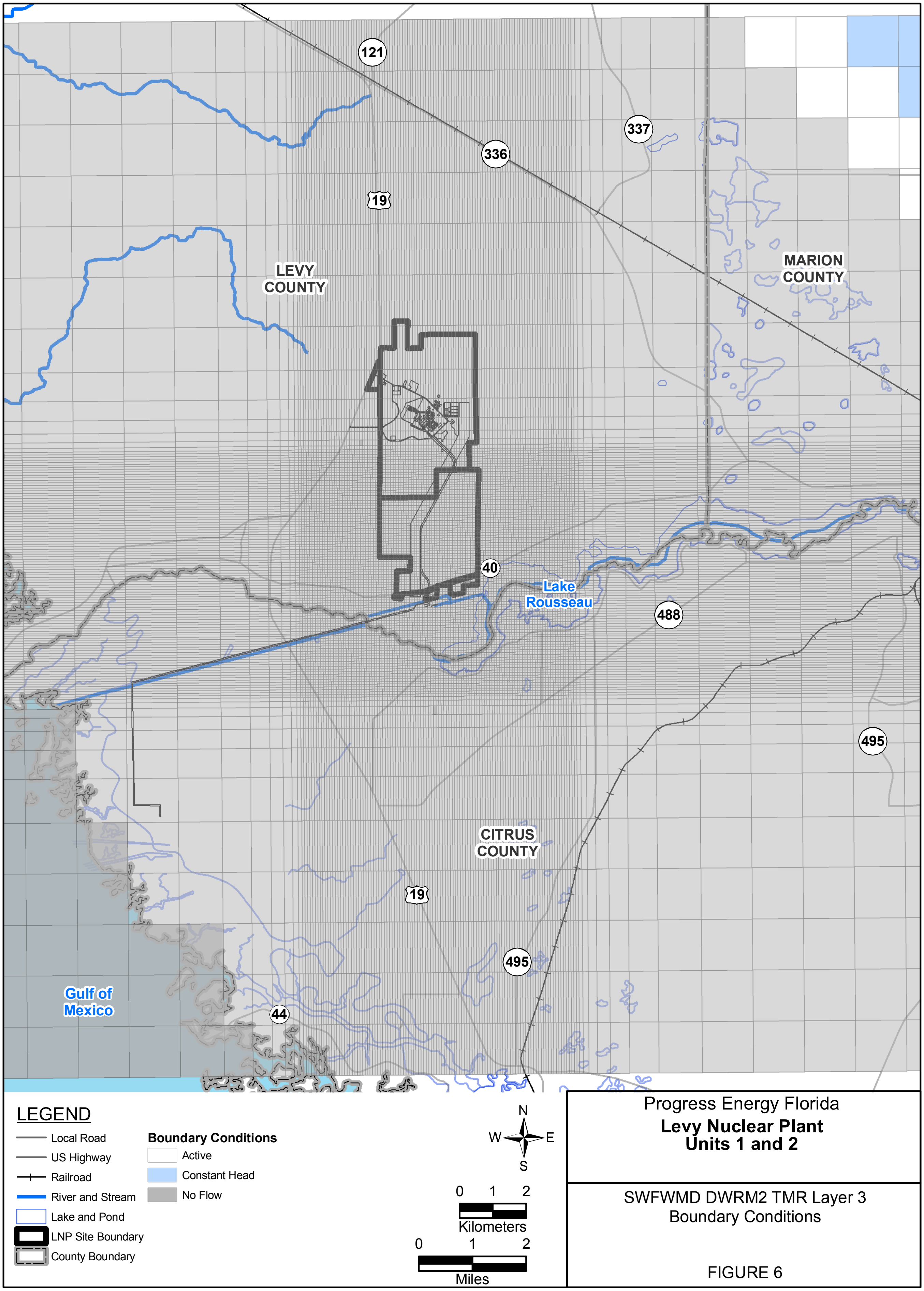
0 1 2 Kilometers

0 1 2 Miles

Progress Energy Florida
Levy Nuclear Plant Units 1 and 2

Revised TMR Model Layer 2 Boundary Conditions

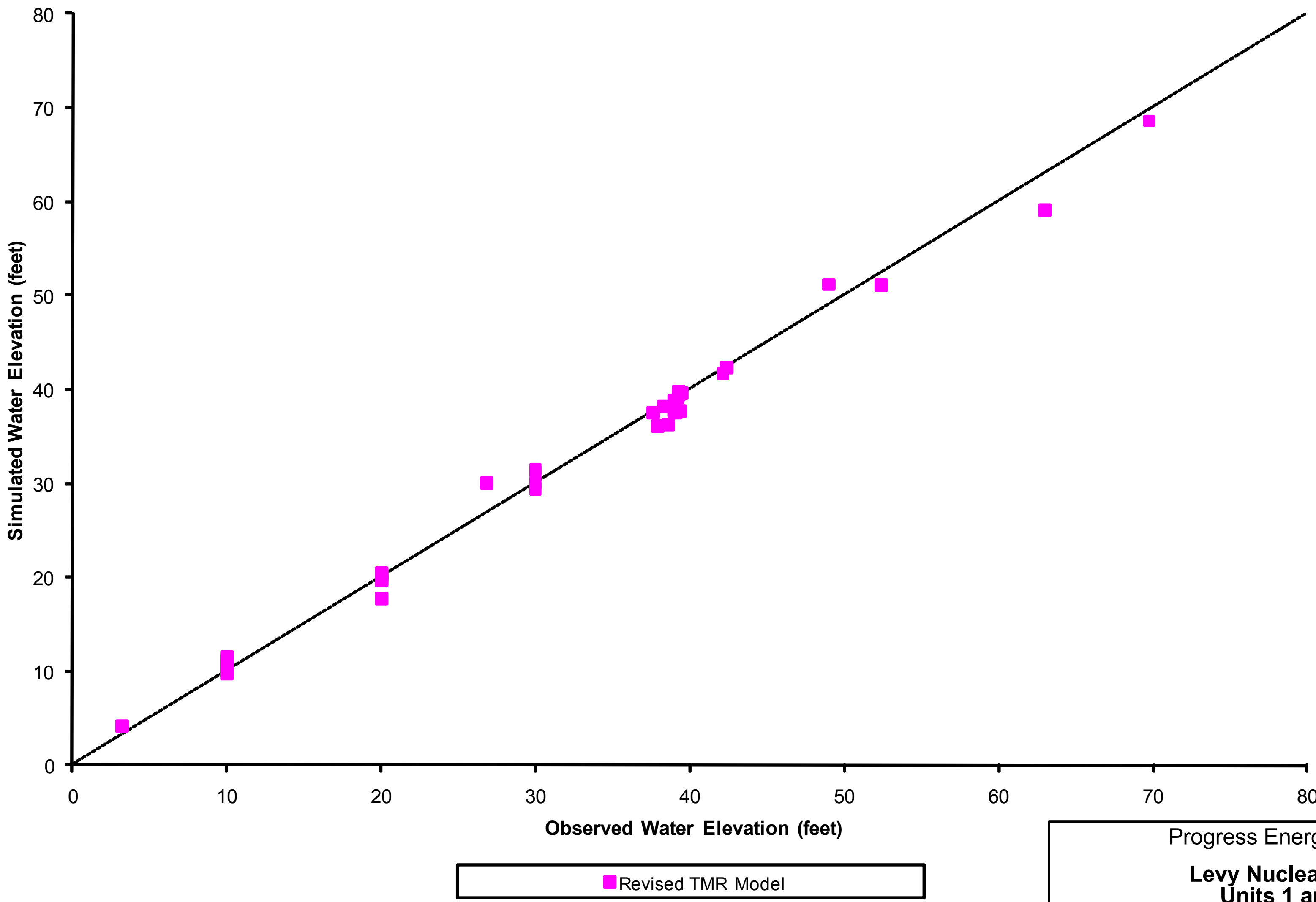
FIGURE 5



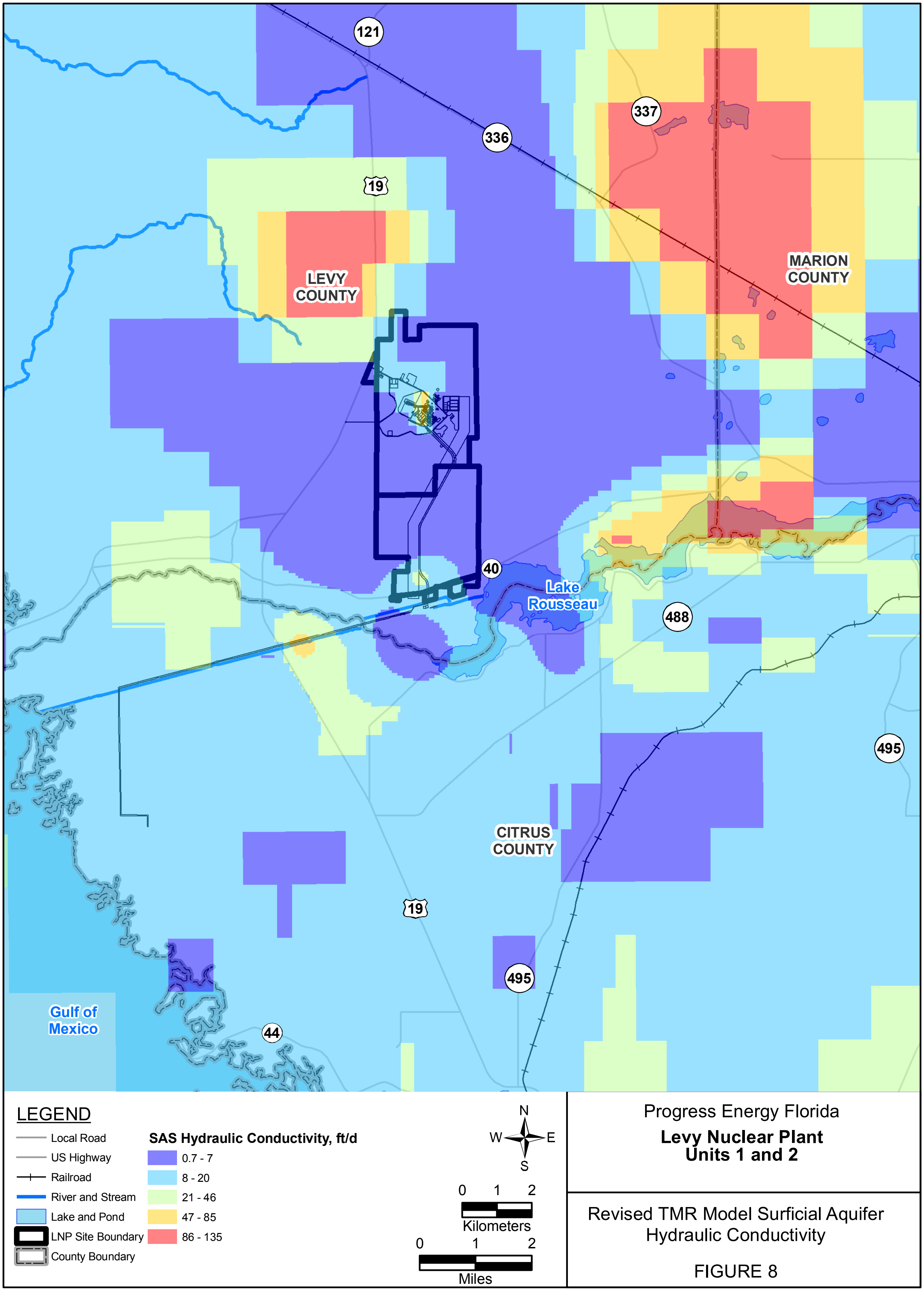
Progress Energy Florida
Levy Nuclear Plant Units 1 and 2

SWFWMD DWRM2 TMR Layer 3 Boundary Conditions

FIGURE 6



Progress Energy Florida
Levy Nuclear Plant Units 1 and 2
Calibration Results
FIGURE 7

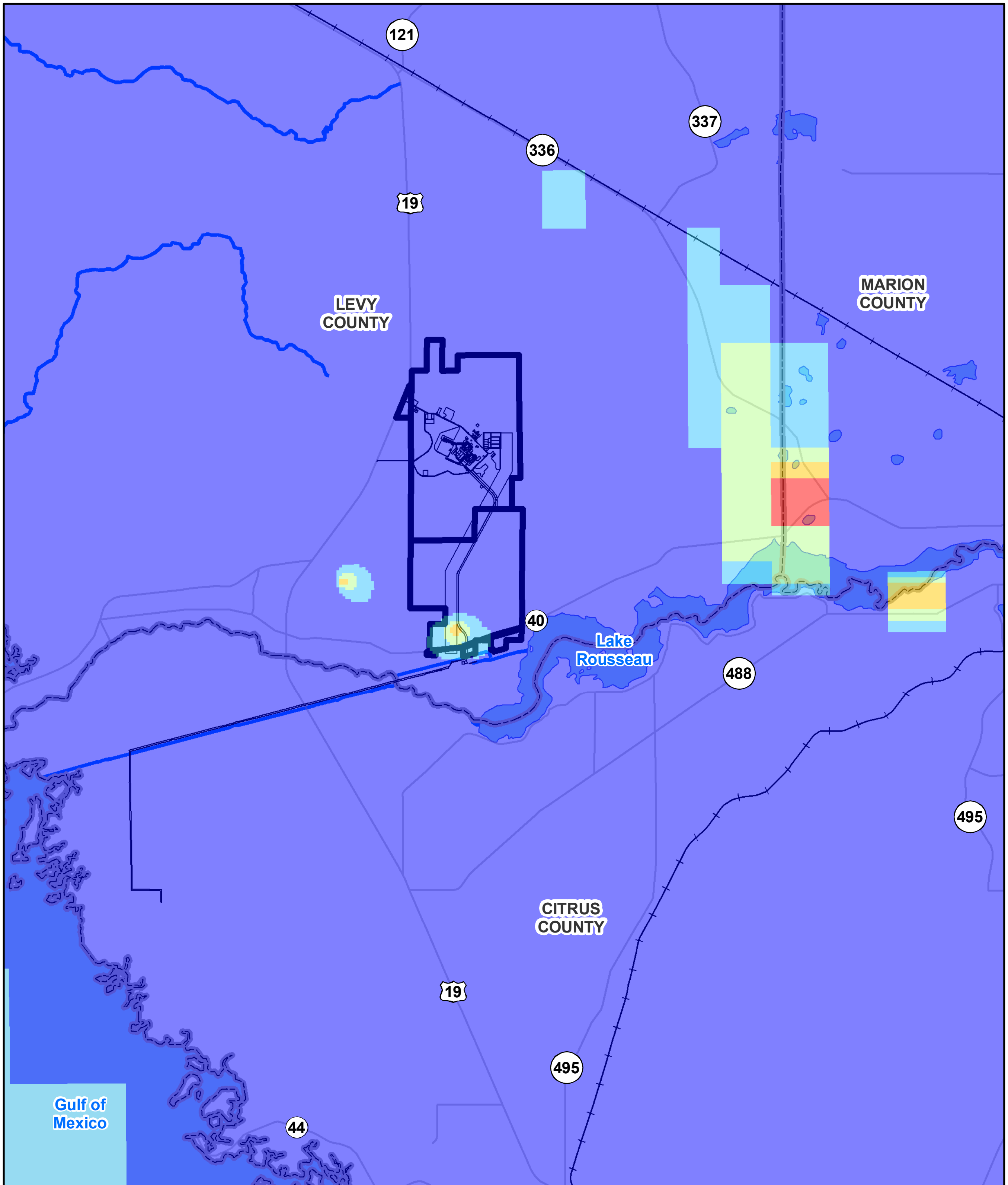


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Revised TMR Model Surficial Aquifer Hydraulic Conductivity

FIGURE 8



LEGEND

- Local Road
- US Highway
- Railroad
- River and Stream
- Lake and Pond
- LNP Site Boundary
- County Boundary

SAS Leakance, 1/d

- 0.0 - 0.05
- 0.06 - 0.19
- 0.21 - 0.46
- 0.47 - 0.85
- 0.86 - 1.6

N W E S

0 1 2 Kilometers

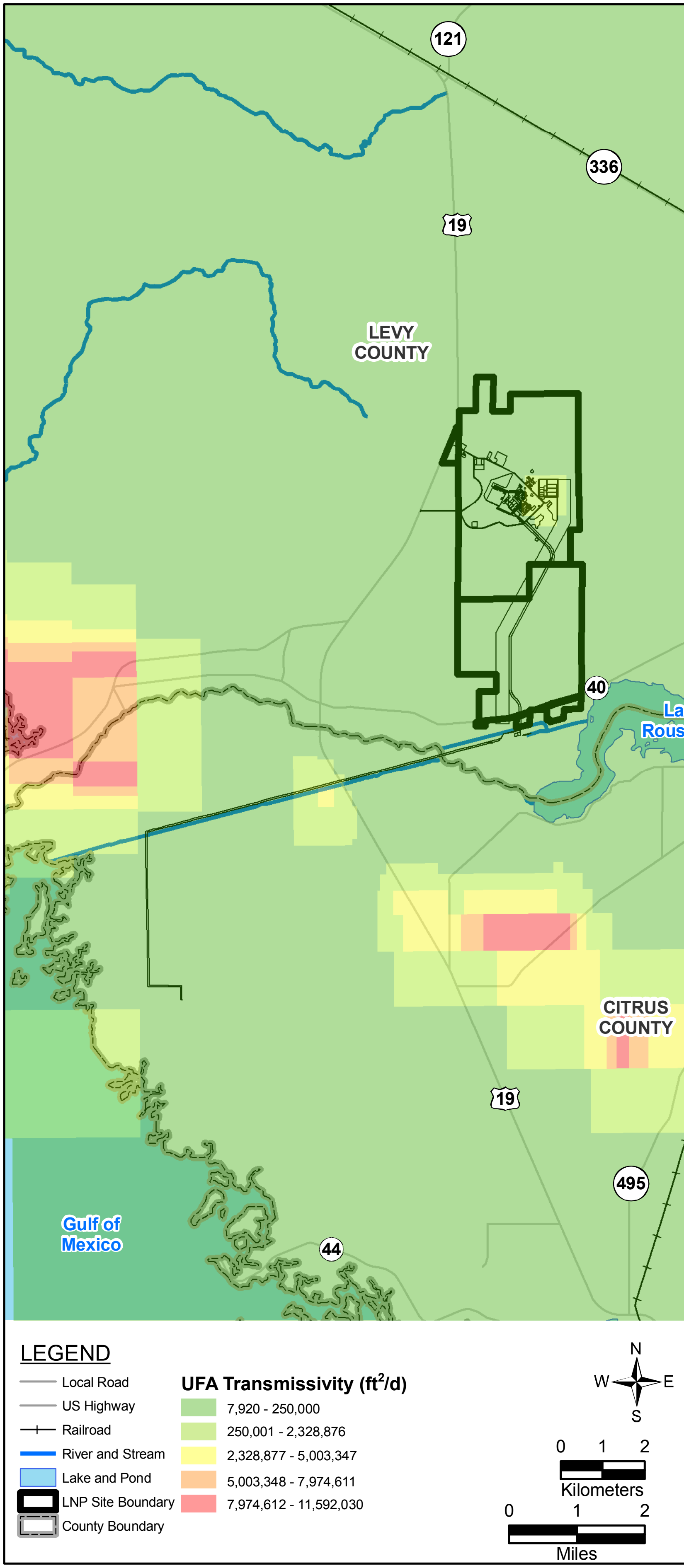
0 1 2 Miles

Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Revised TMR Model Surficial Aquifer Leakance

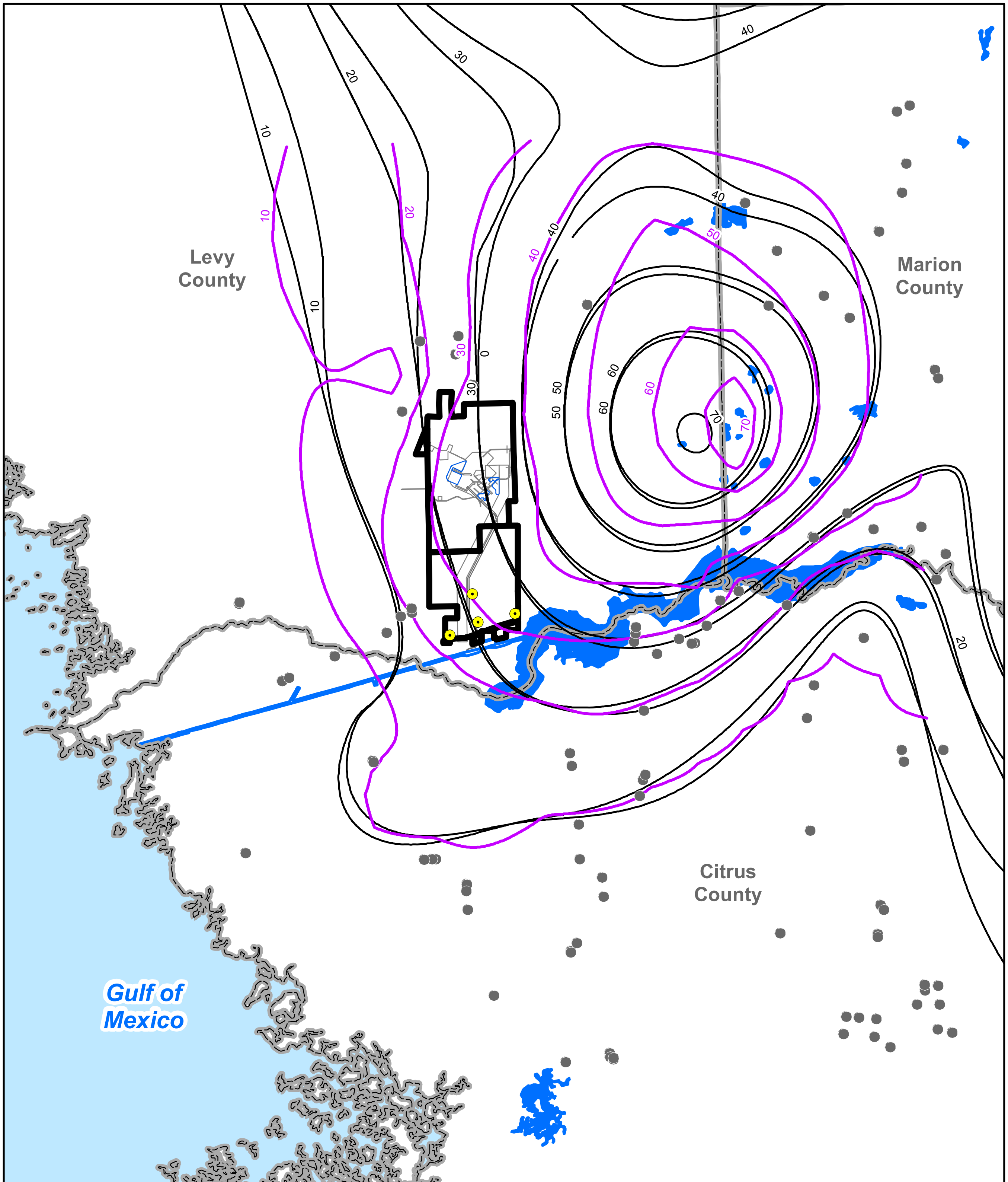
FIGURE 9



Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2

Revised TMR Model Upper Floridan Aquifer Transmissivity

FIGURE 10



LEGEND

- Adjacent Permitted User
- Proposed LNP Supply Well
- 2007 May and September USGS UFA Potentiometric Contour Lines
- Simulated UFA (Stress Period 2) Potentiometric Contour Lines
- Lake and Pond
- LNP Site Boundary
- County Boundary

N W E S

0 1 2 3
Kilometers

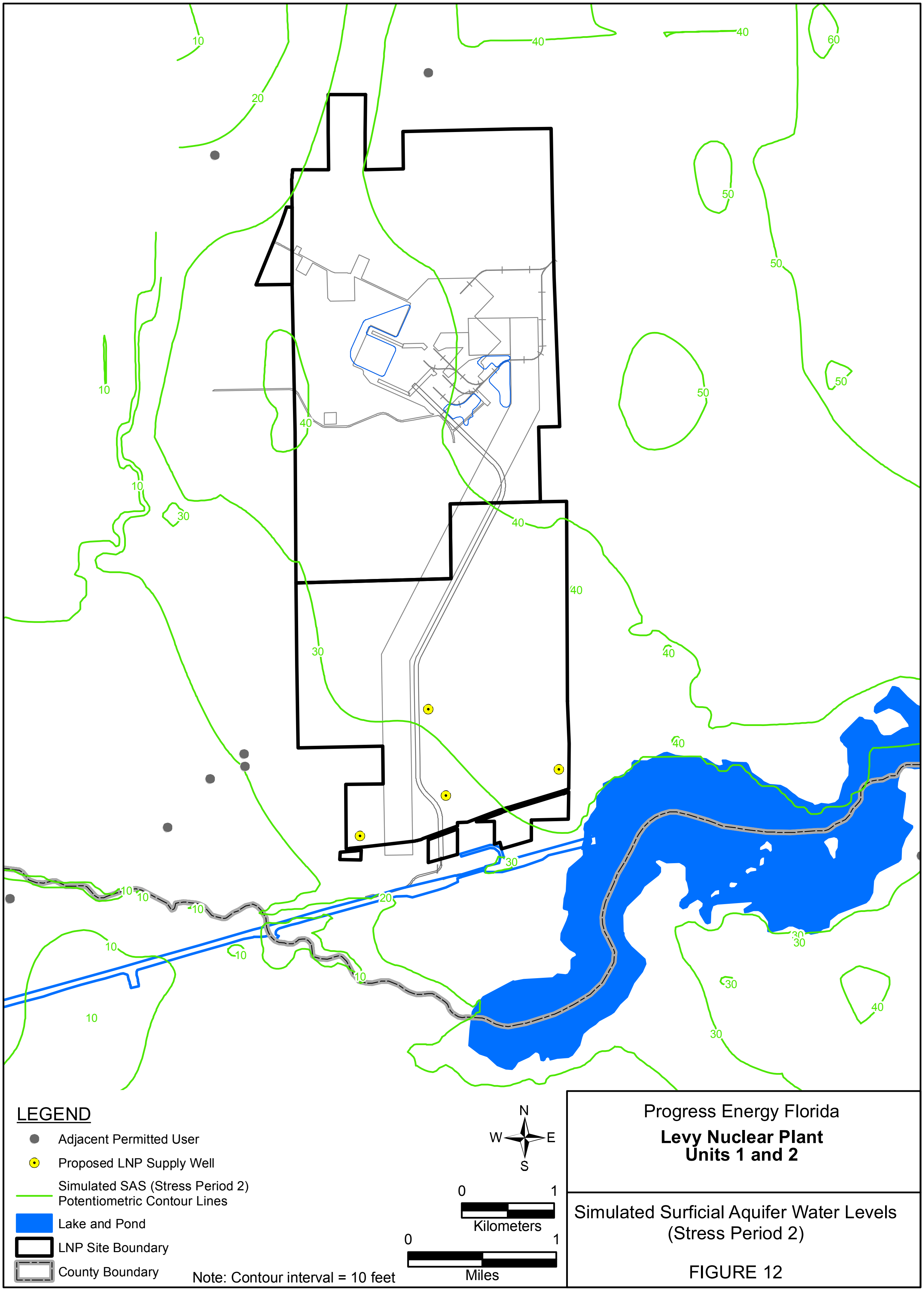
0 1 2 3
Miles

Note: Contour interval = 10 feet

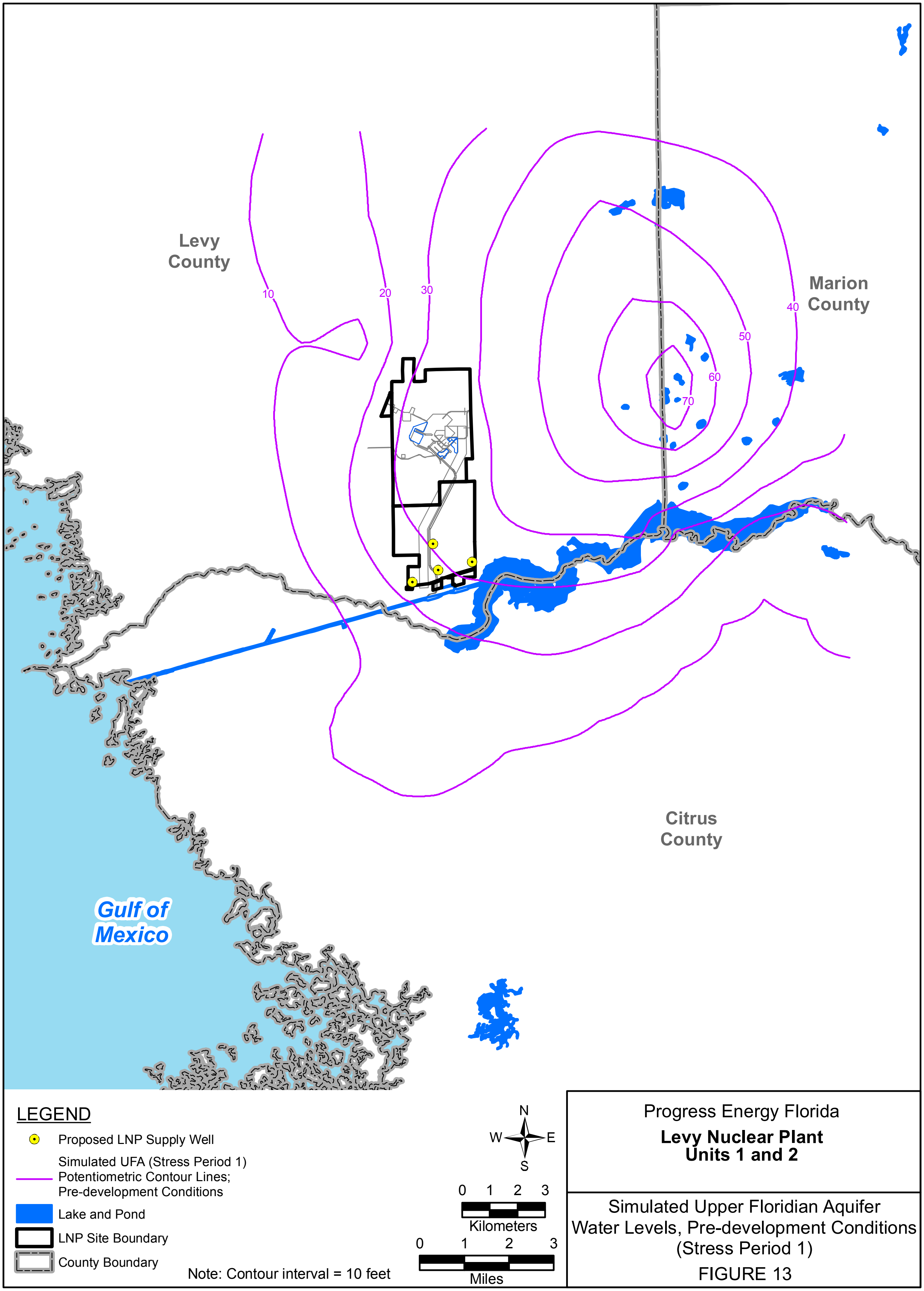
Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Upper Floridan Aquifer Water Levels (Stress Period 2) Compared to 2007 USGS Upper Floridan Aquifer Potentiometric Surface
FIGURE 11



10
20
40
40
60
50
50
50
50
10
40
10
30
40
40
30
40
40
10
10
10
20
30
10
10
10
10
30
30
30
40
LEGEND
Adjacent Permitted User
Proposed LNP Supply Well
Simulated SAS (Stress Period 2) Potentiometric Contour Lines
Lake and Pond
LNP Site Boundary
County Boundary
Note: Contour interval = 10 feet
N
W
E
S
0
1
Kilometers
0
1
Miles
Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2
Simulated Surficial Aquifer Water Levels
(Stress Period 2)
FIGURE 12

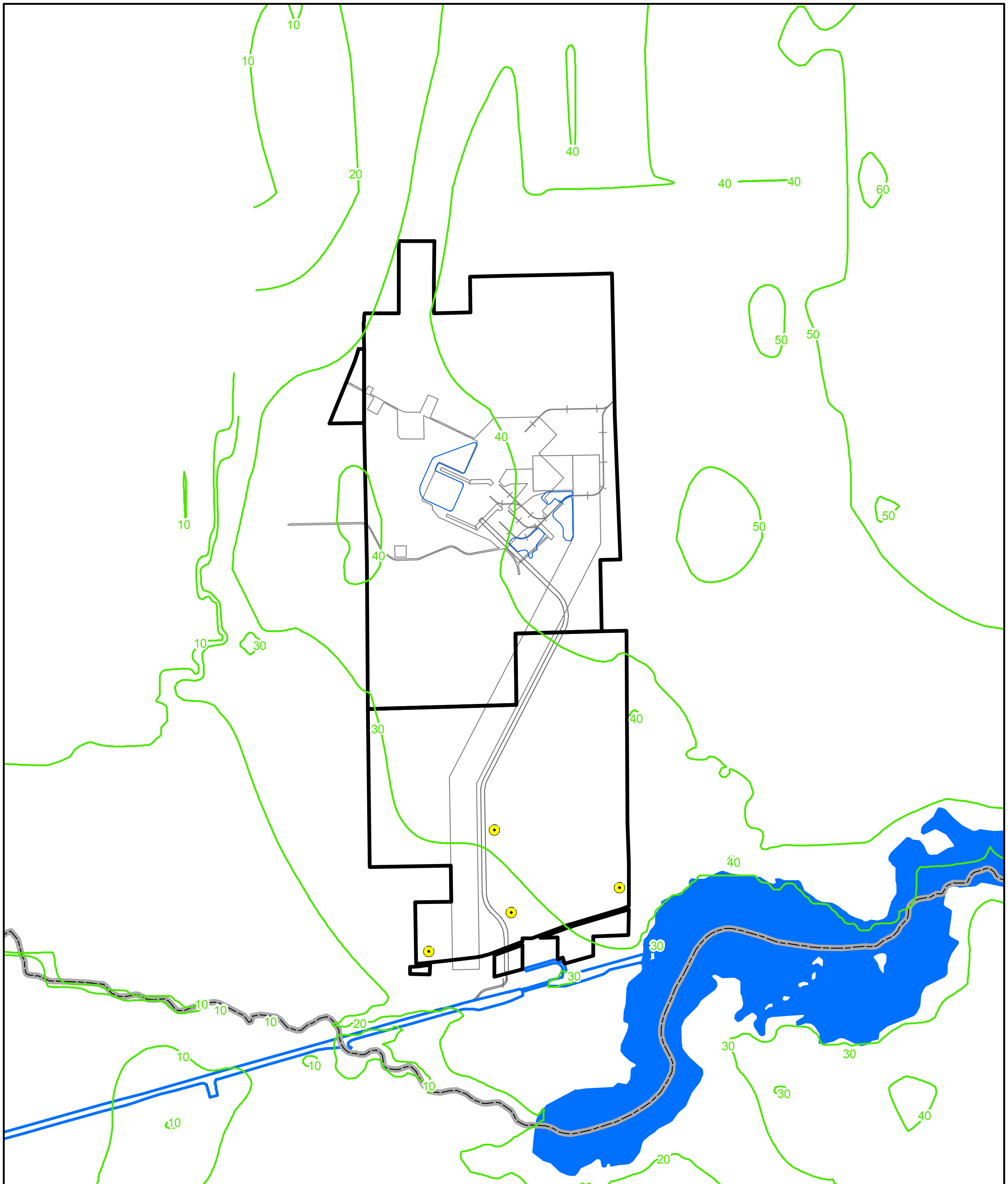


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Upper Floridian Aquifer Water Levels, Pre-development Conditions (Stress Period 1)

FIGURE 13



LEGEND

- Proposed LNP Supply Well
- Simulated SAS (Stress Period 1) Potentiometric Contour Lines; Pre-development Conditions
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 10 feet

N
W E
S

0 1
Kilometers

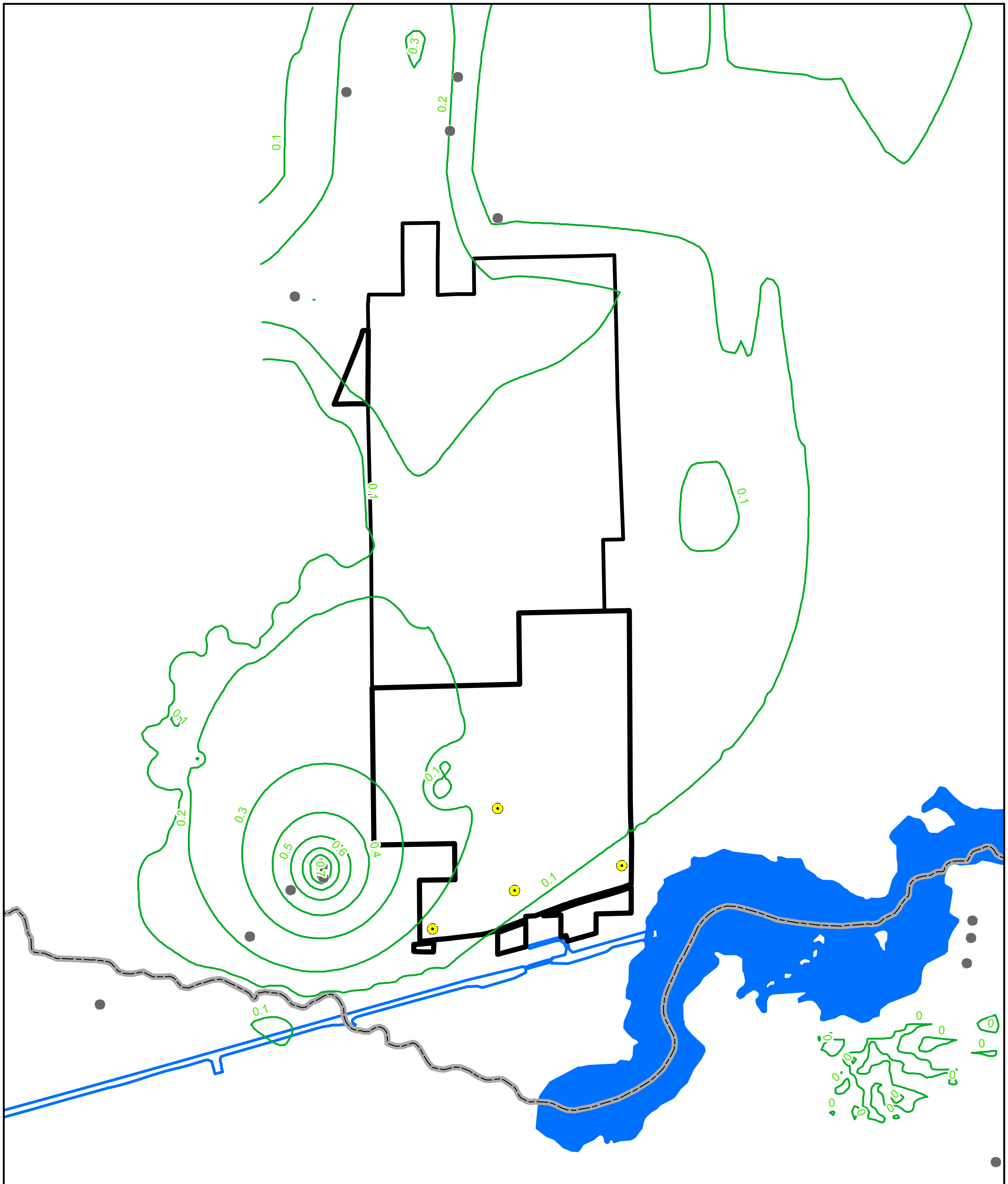
0 1
Miles

Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Surficial Aquifer Water Levels;
Pre-development Conditions
(Stress Period 1)

FIGURE 14



LEGEND

- Adjacent Permitted User
- Proposed LNP Supply Well
- Simulated drawdown, SAS (ft) Other Users from Pre-Development
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 0.1 feet

N
W E
S

0 1
Kilometers

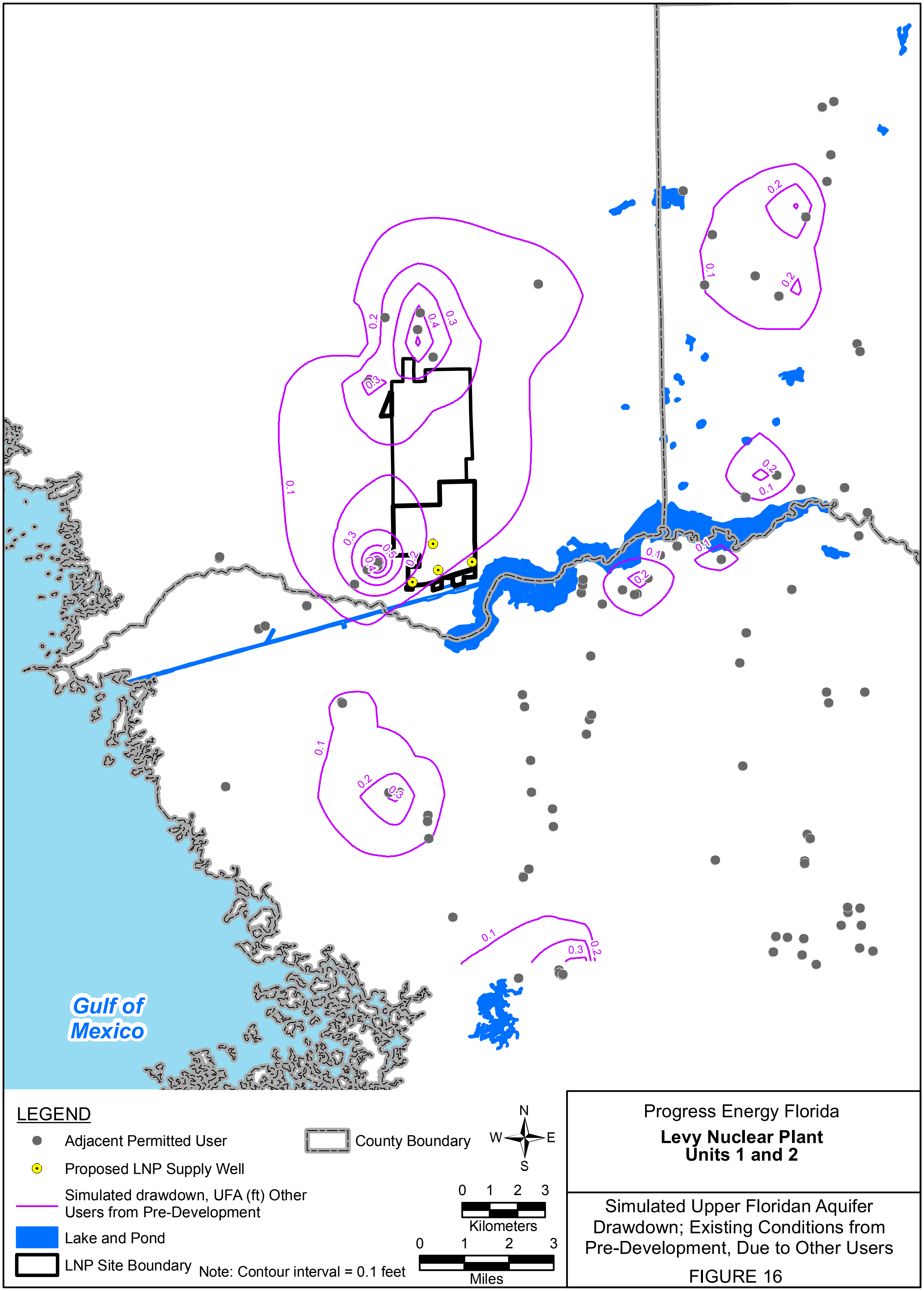
0 1
Miles

Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Surficial Aquifer Drawdown; Existing Conditions from Pre-Development, Due to Other Users

FIGURE 15

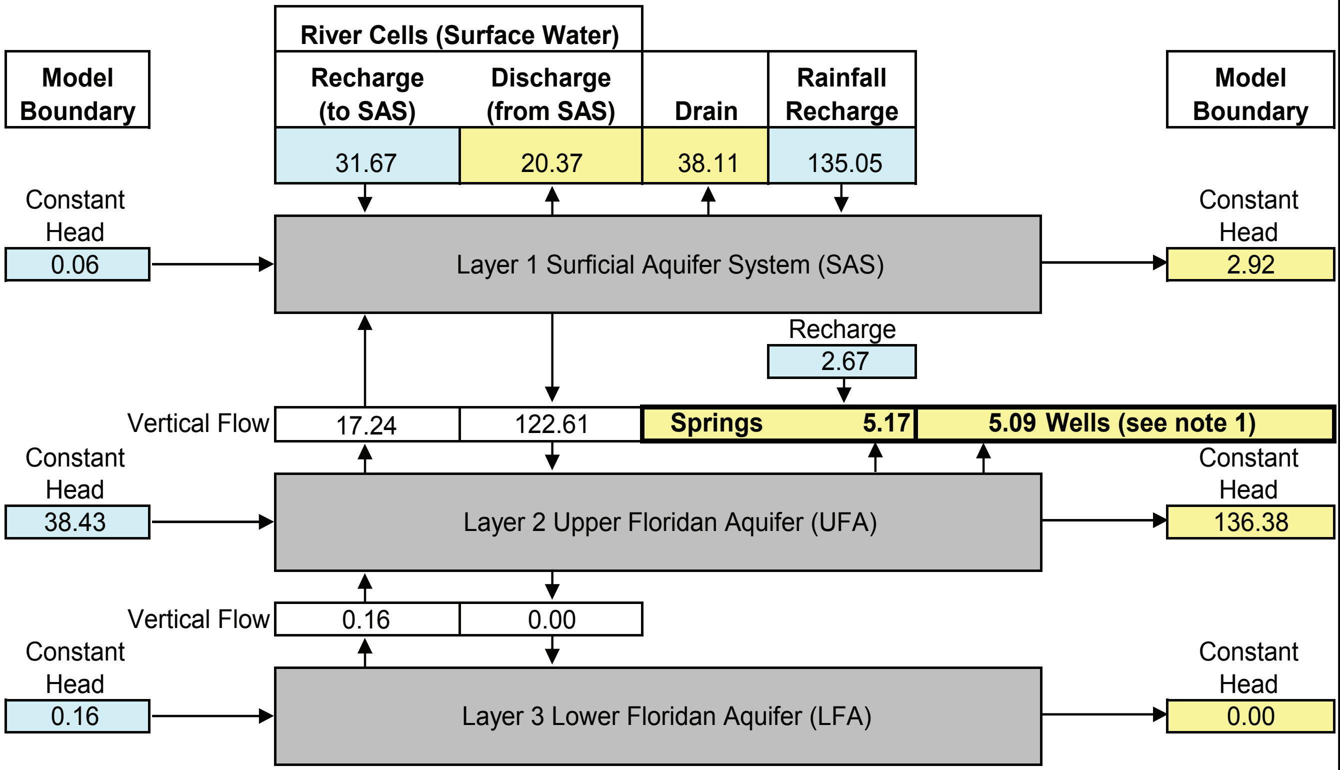


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Upper Floridan Aquifer Drawdown; Existing Conditions from Pre-Development, Due to Other Users

FIGURE 16



Note 1: Well withdrawal comprised of 3.51 mgd from other users (model calibration year 2001) + 1.58 mgd for LNP

Inflow	Outflow	Difference	% Difference
208.04	208.04	0.00	0.00%

LEGEND

INFLOW

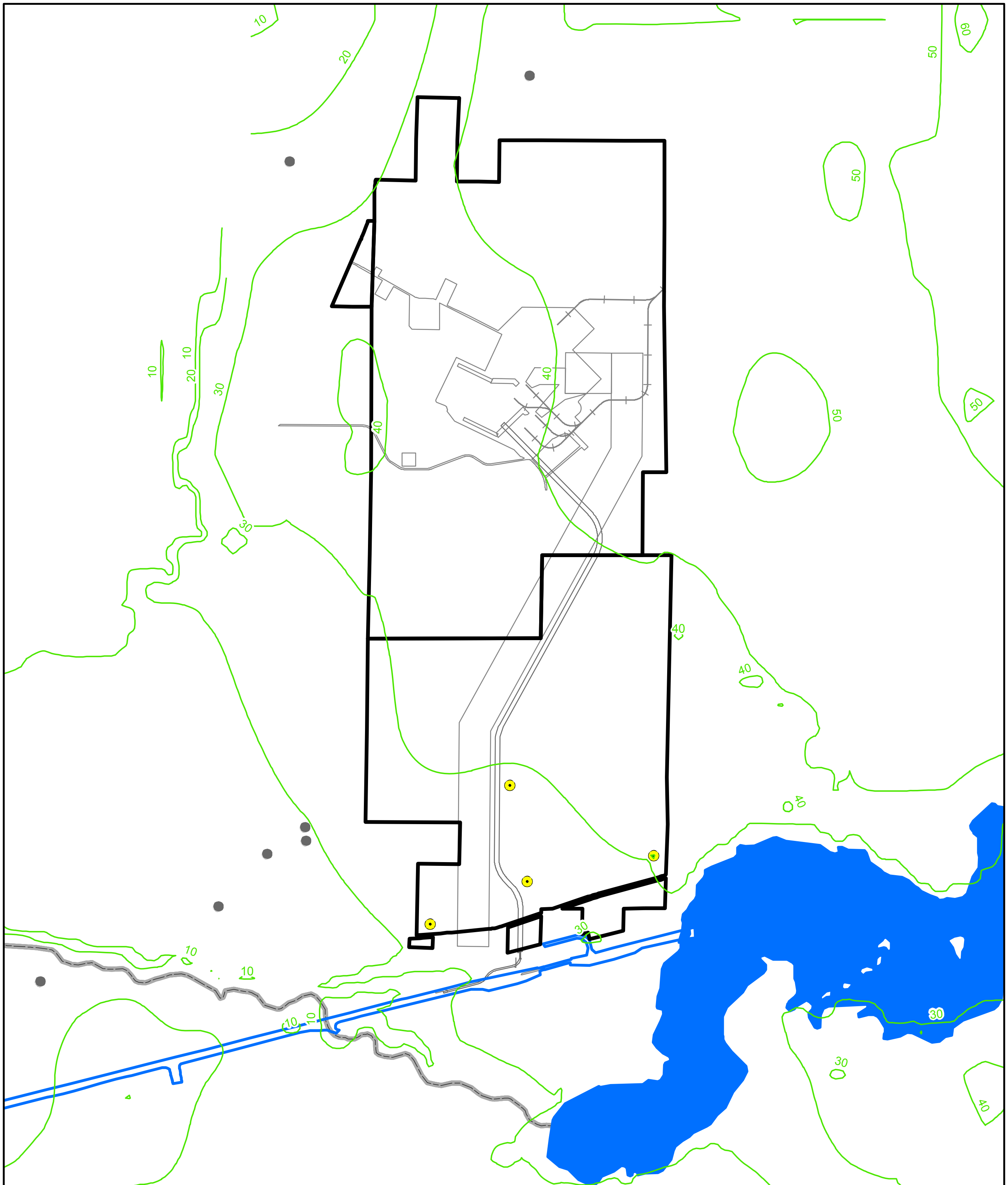
OUTFLOWS

ALL VALUES ARE IN UNITS OF MGD.

Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2

Revised TMR Model Water Budget
with LNP Withdrawing 1.58 mgd

FIGURE 17



LEGEND

- Adjacent Permitted User
- Proposed LNP Supply Well
- Simulated SAS Water Levels (ft)
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 10 feet

N
W E
S

0 1
Kilometers

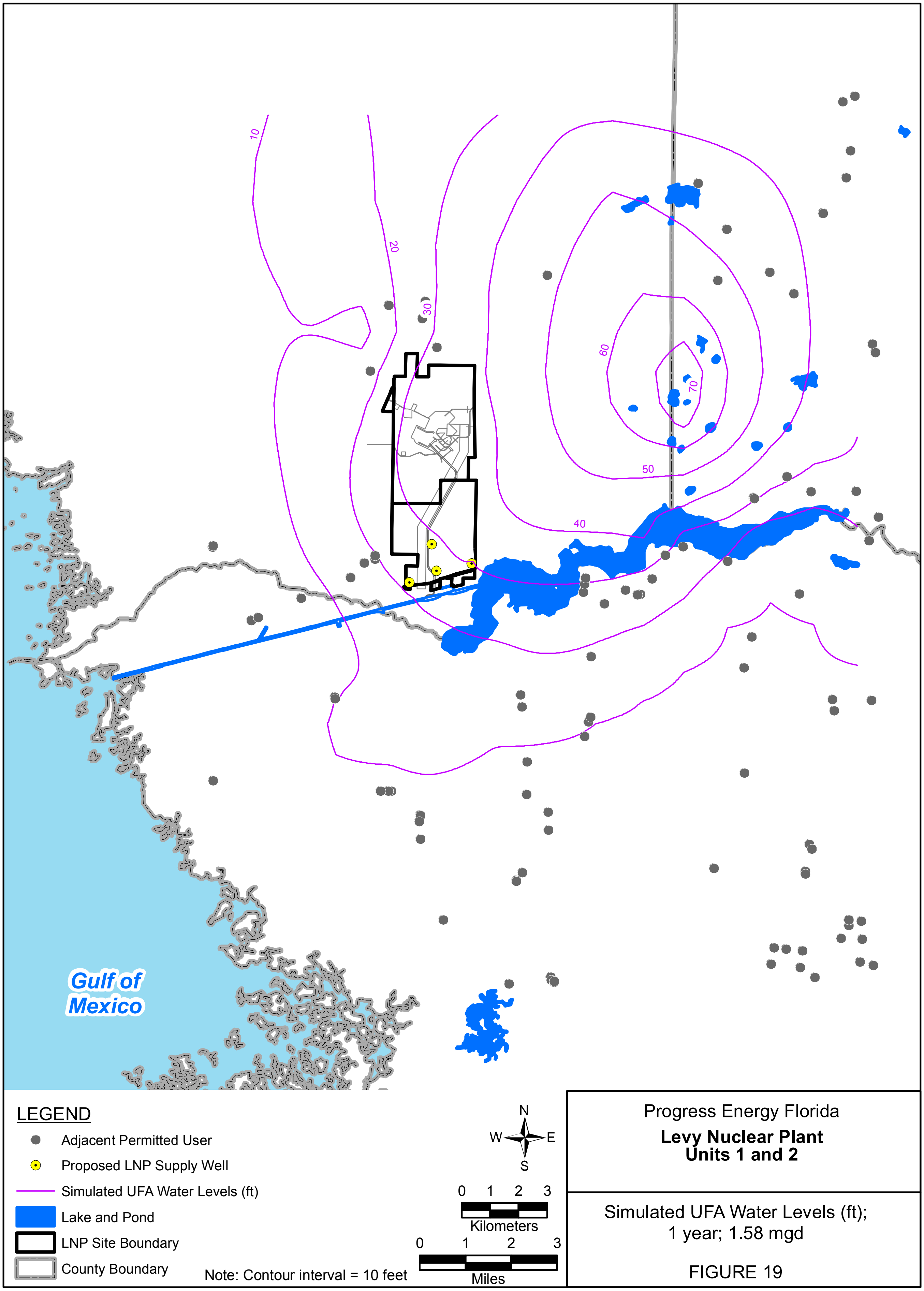
0 1
Miles

Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated SAS Water Levels (ft);
1 year; 1.58 mgd

FIGURE 18

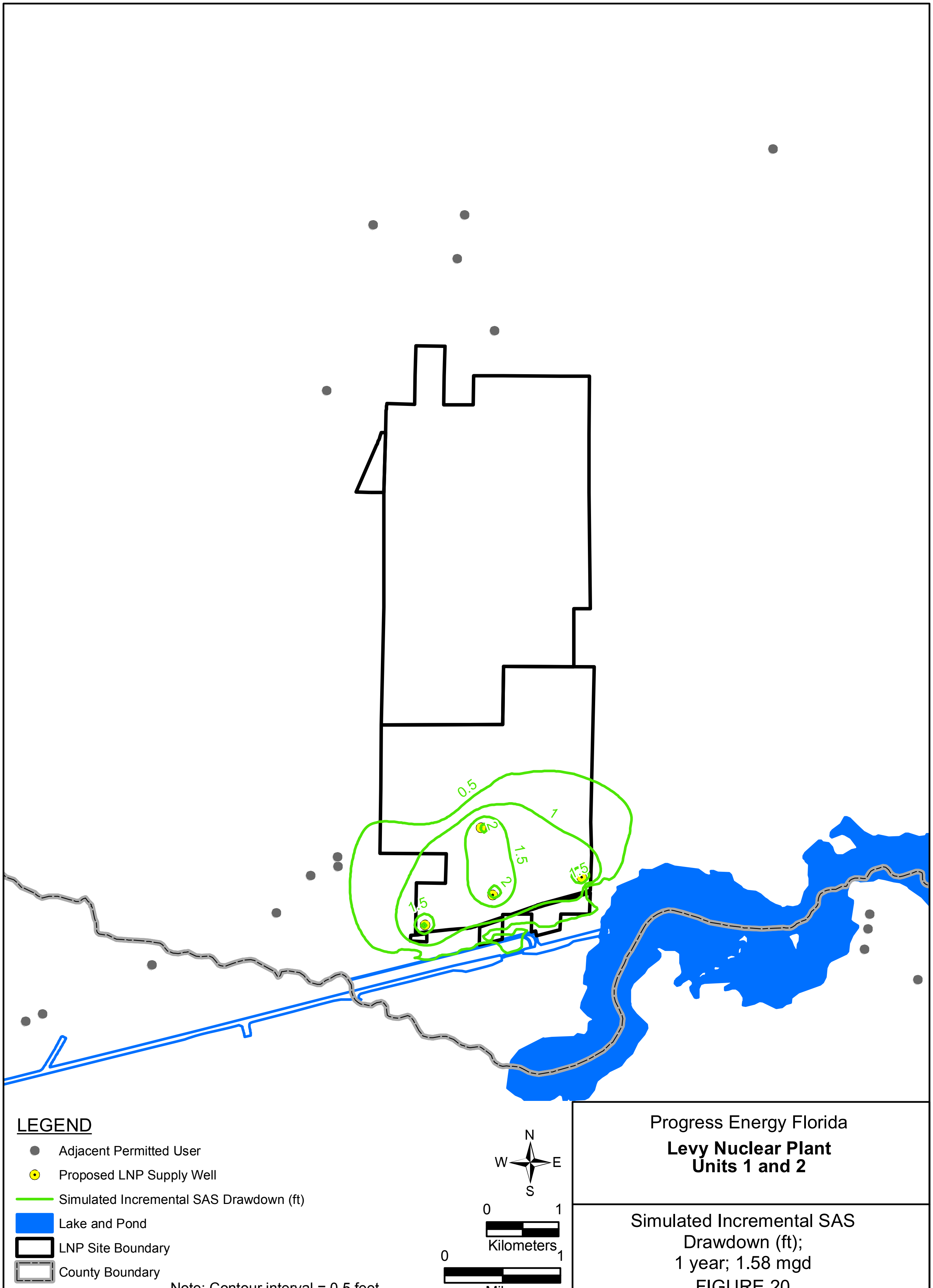


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated UFA Water Levels (ft); 1 year; 1.58 mgd

FIGURE 19

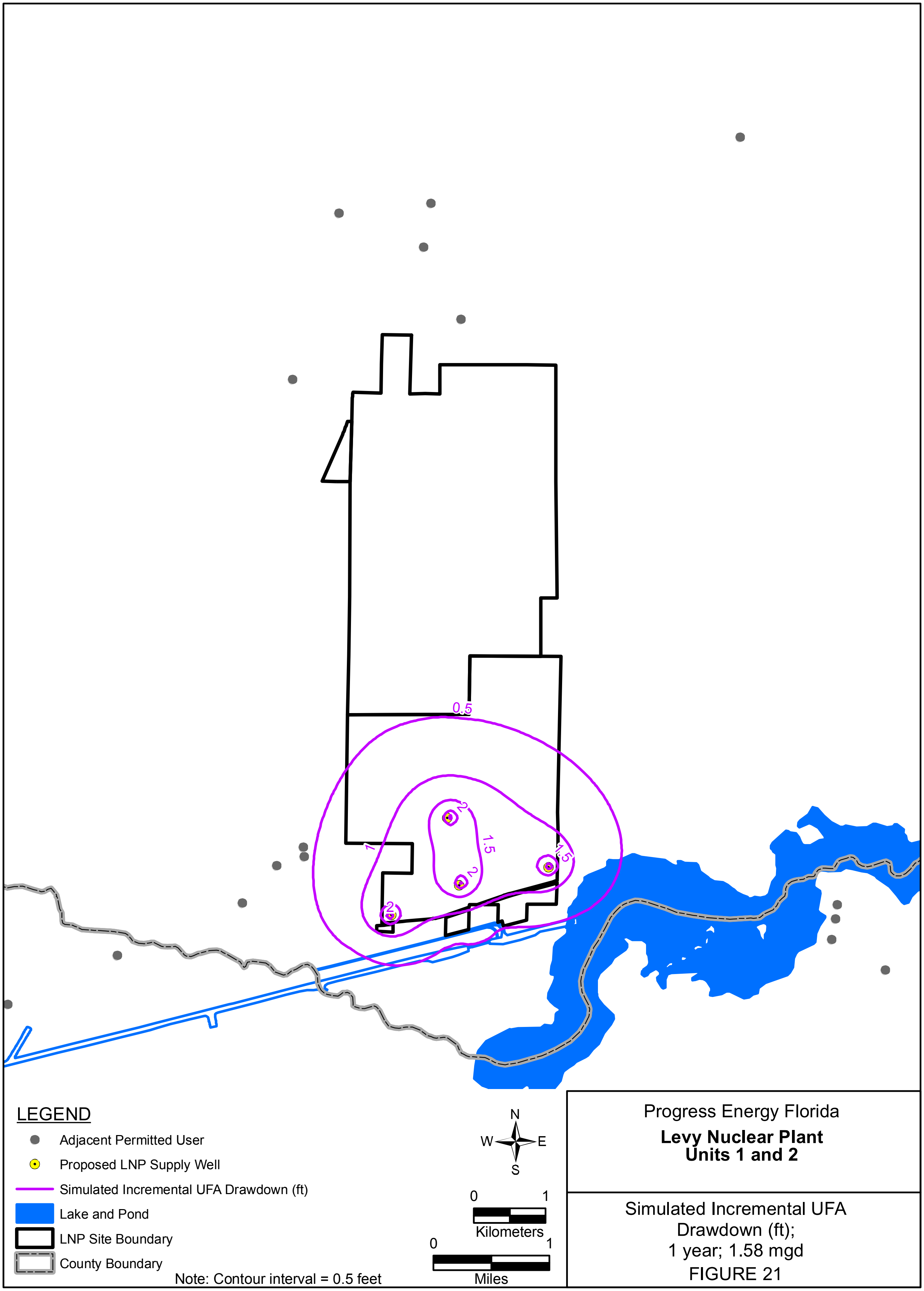


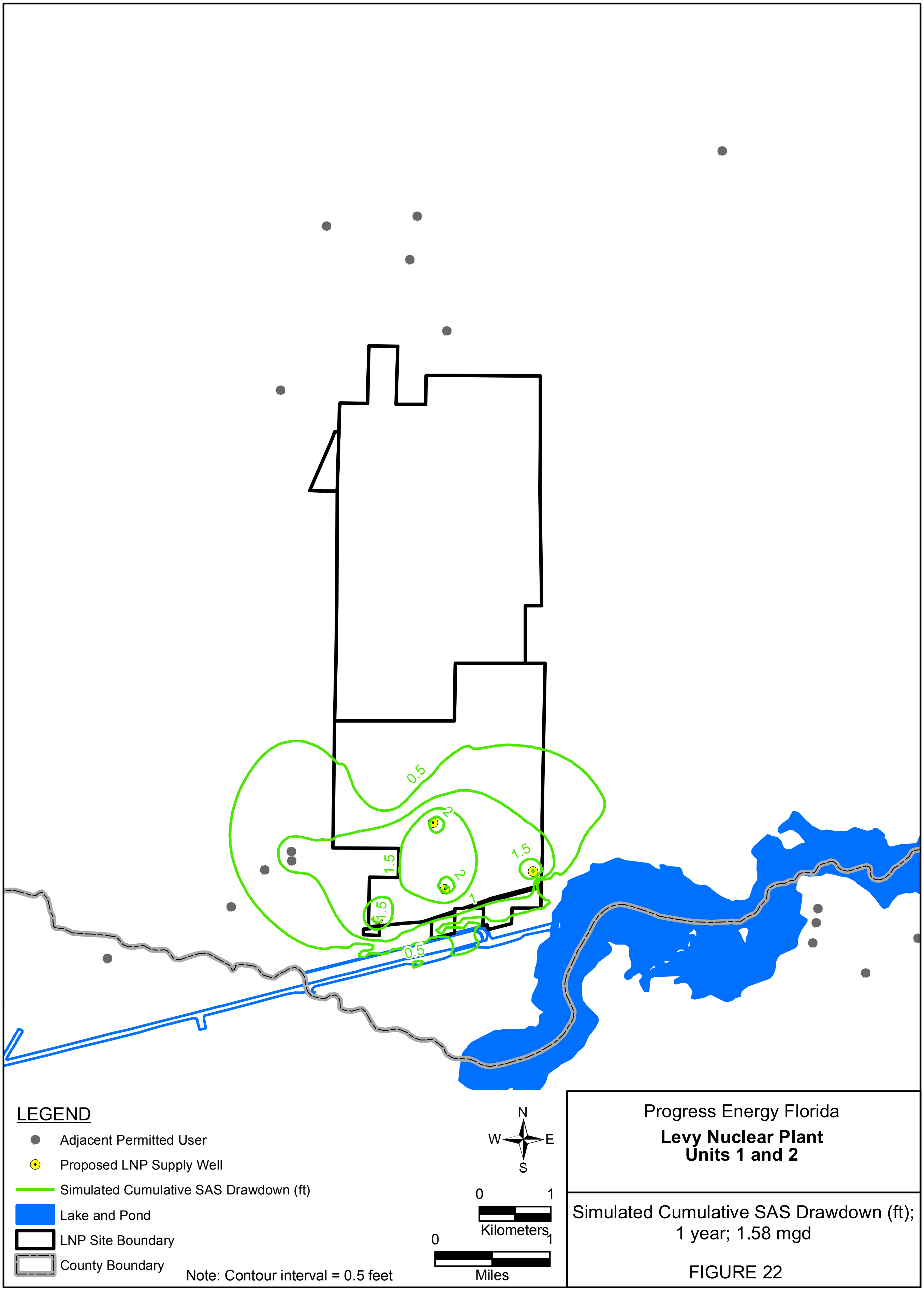
Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental SAS Drawdown (ft); 1 year; 1.58 mgd

FIGURE 20


0.5
1
1.5
2
LEGEND
Adjacent Permitted User
Proposed LNP Supply Well
Simulated Incremental UFA Drawdown (ft)
Lake and Pond
LNP Site Boundary
County Boundary
Note: Contour interval = 0.5 feet
N
W
E
S
0
1
Kilometers
0
1
Miles
Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2
Simulated Incremental UFA
Drawdown (ft);
1 year; 1.58 mgd
FIGURE 21

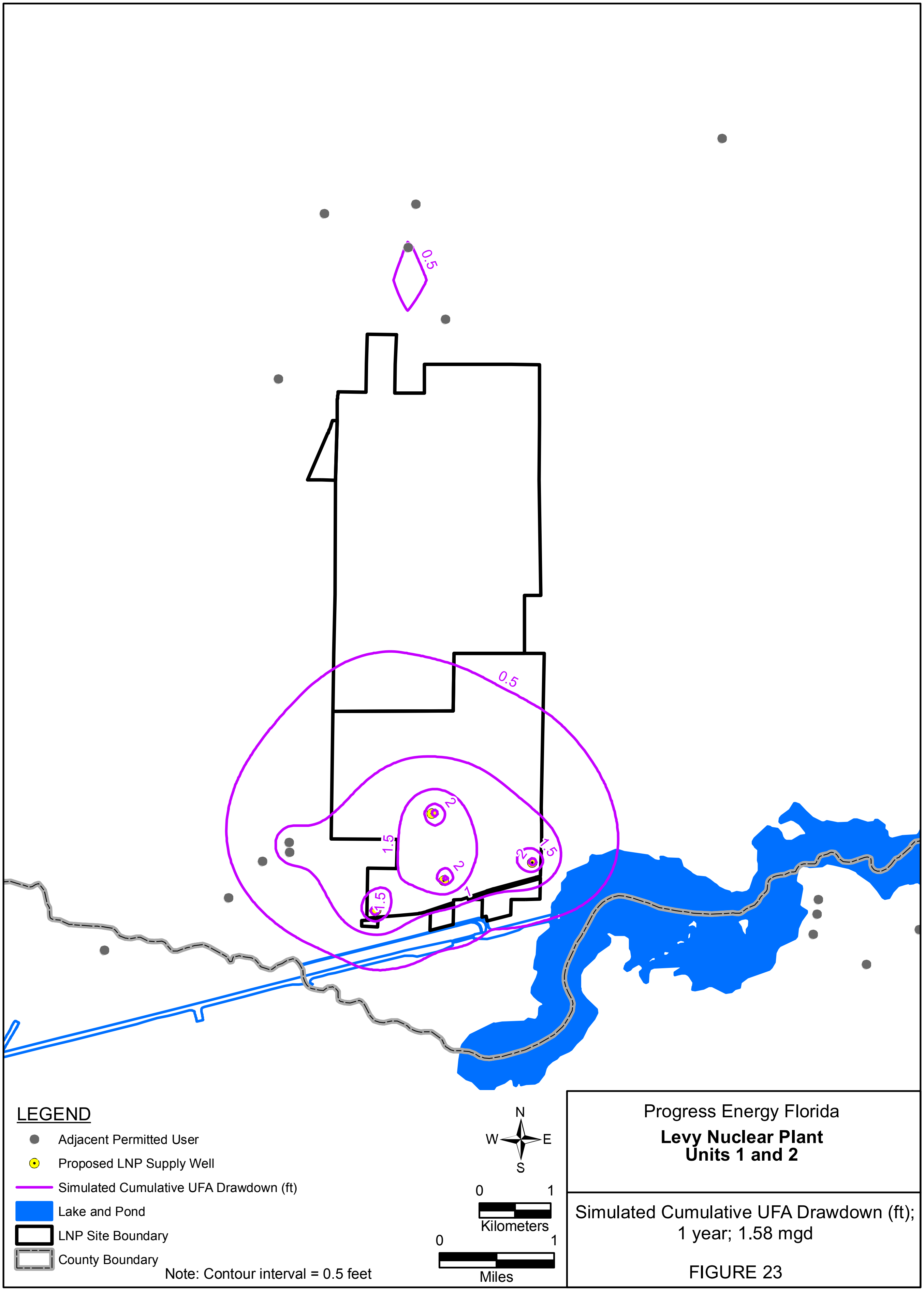


Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Cumulative SAS Drawdown (ft);
1 year; 1.58 mgd

FIGURE 22

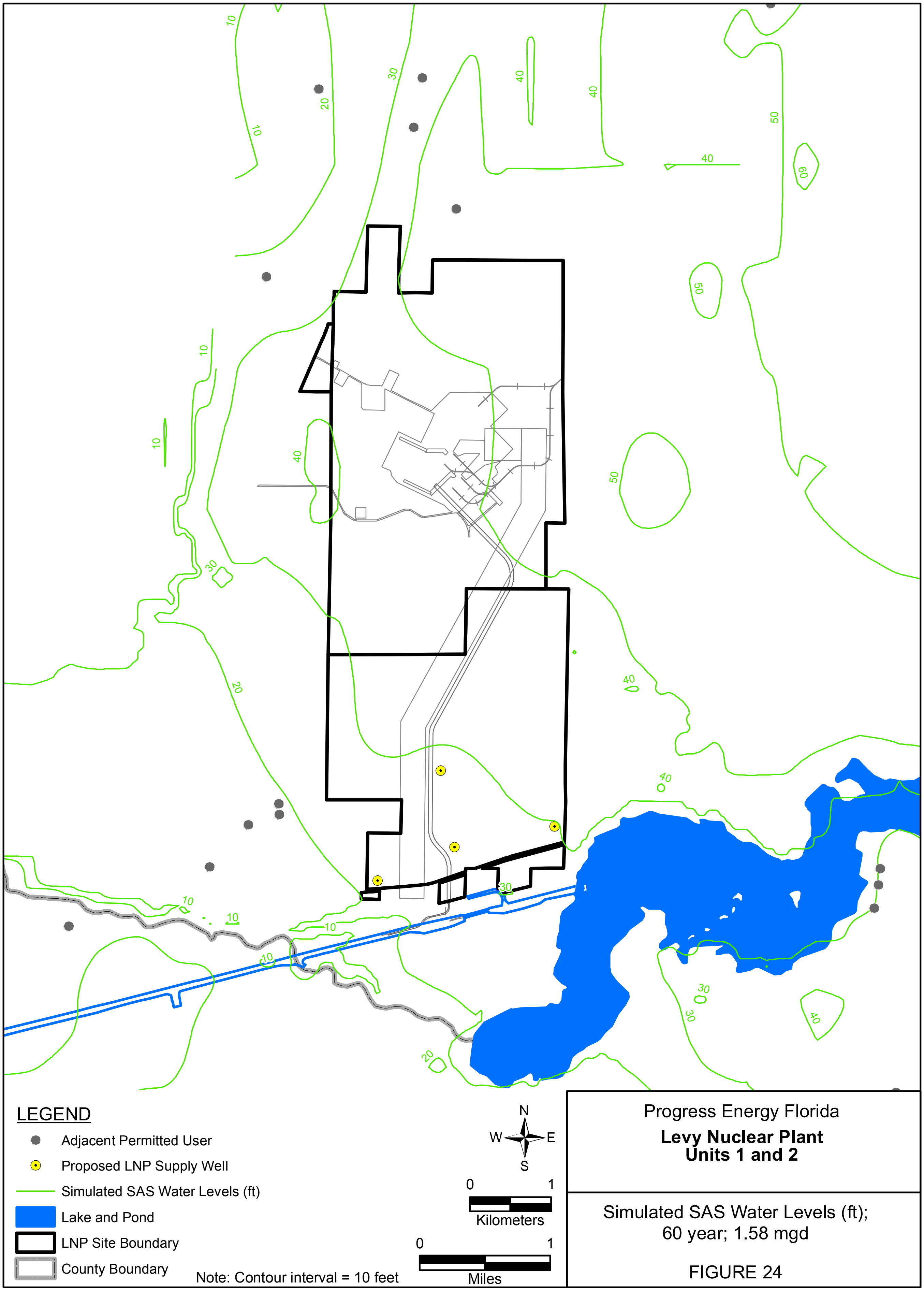


Progress Energy Florida

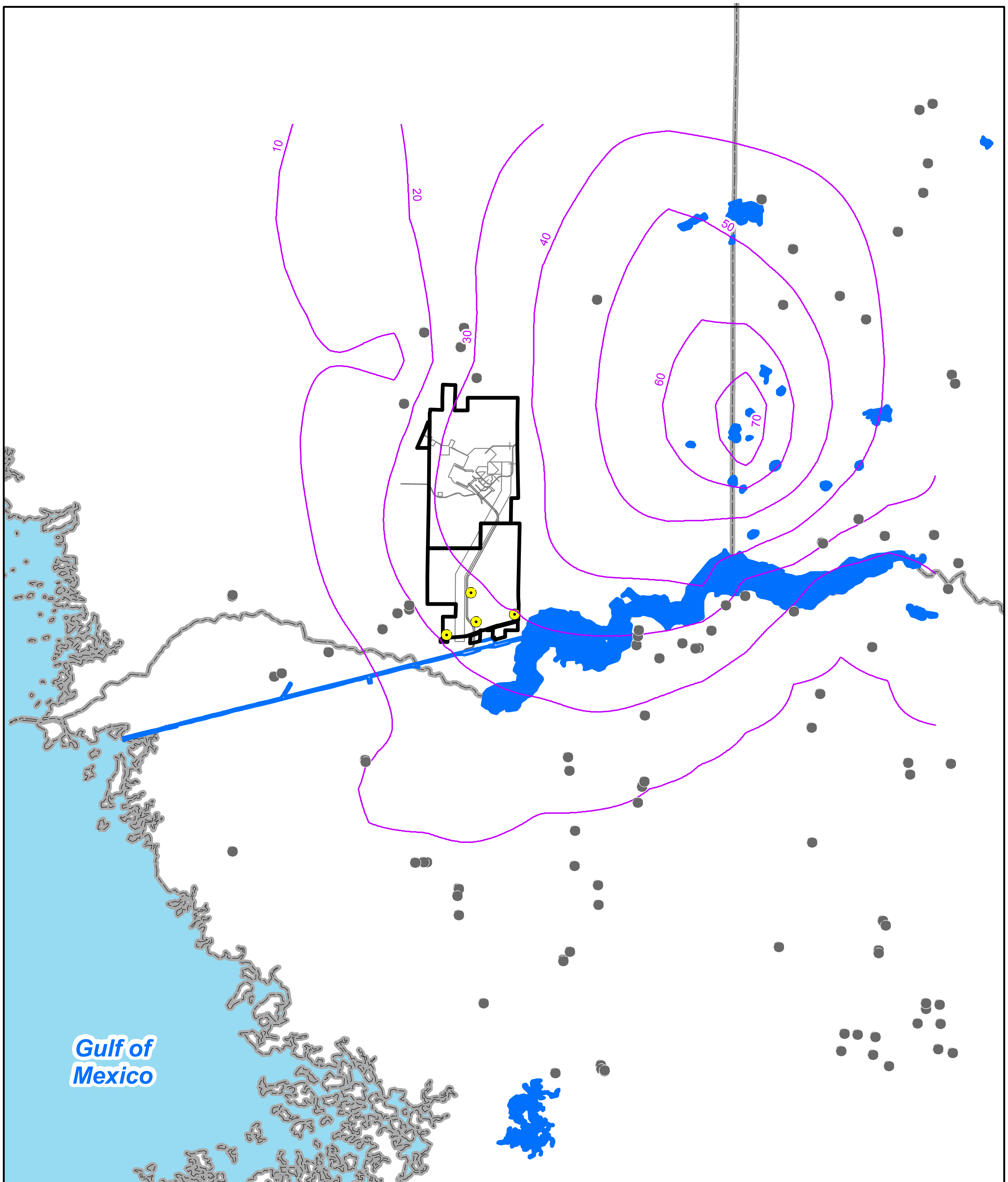
Levy Nuclear Plant Units 1 and 2

Simulated Cumulative UFA Drawdown (ft); 1 year; 1.58 mgd

FIGURE 23



10
20
30
40
50
60
LEGEND
Adjacent Permitted User
Proposed LNP Supply Well
Simulated SAS Water Levels (ft)
Lake and Pond
LNP Site Boundary
County Boundary
Note: Contour interval = 10 feet
N
W
E
S
0
1
Kilometers
0
1
Miles
Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2
Simulated SAS Water Levels (ft);
60 year; 1.58 mgd
FIGURE 24



LEGEND

- Adjacent Permitted User
- Proposed LNP Supply Well
- Simulated UFA Water Levels (ft)
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 10 feet

N W E S

0 1 2 3 Kilometers

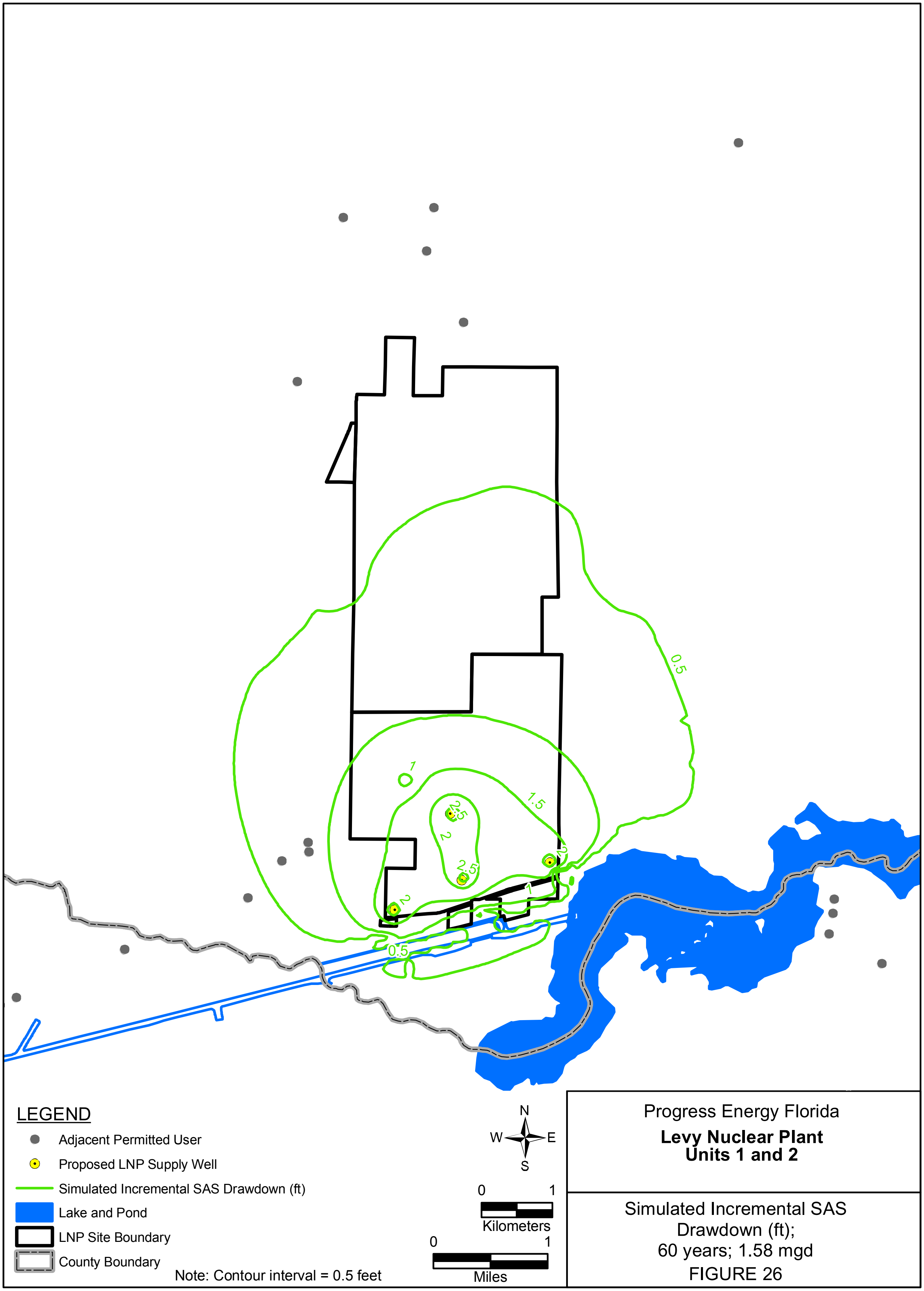
0 1 2 3 Miles

Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated UFA Water Levels (ft); 60 year; 1.58 mgd

FIGURE 25

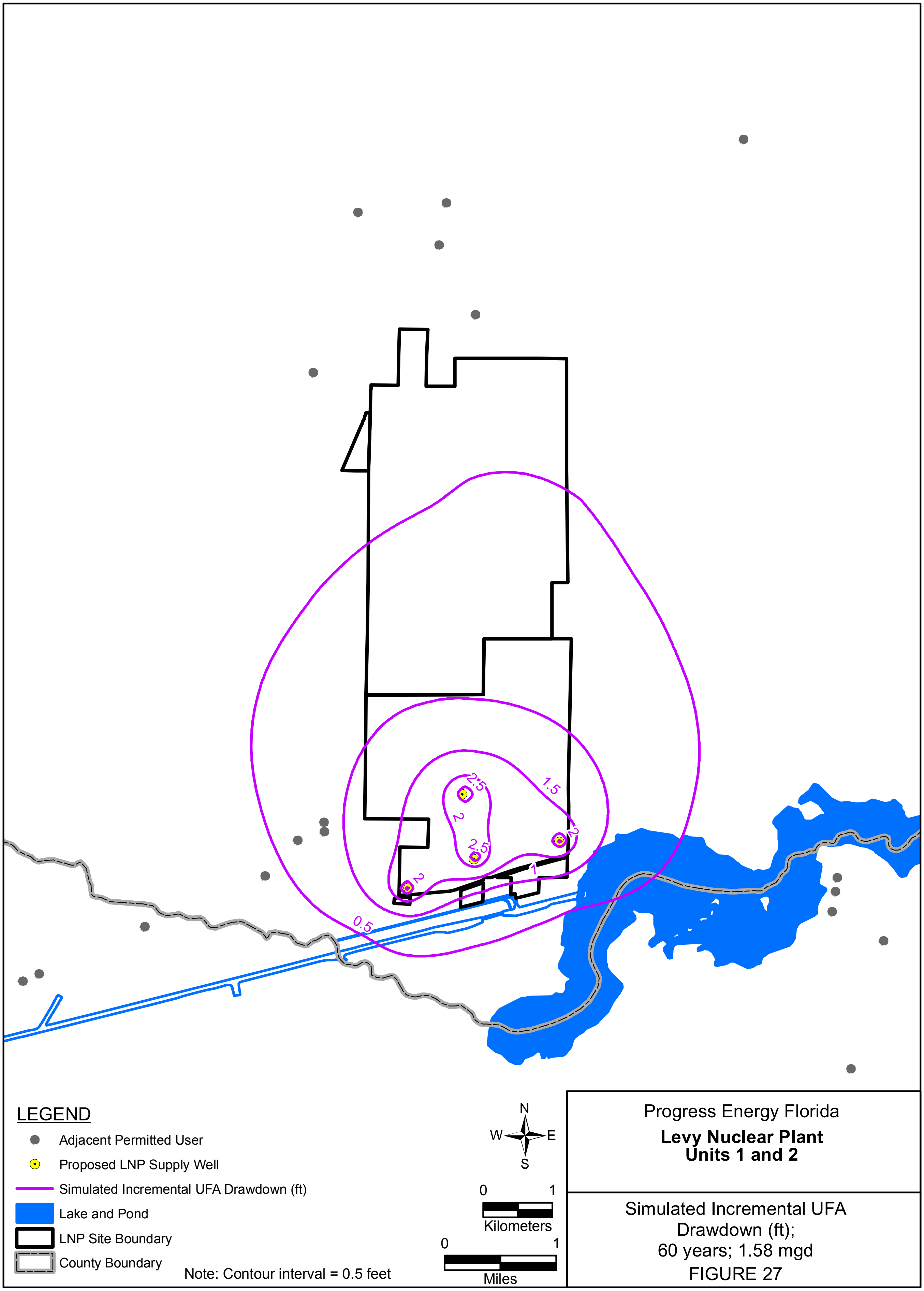


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental SAS Drawdown (ft); 60 years; 1.58 mgd

FIGURE 26

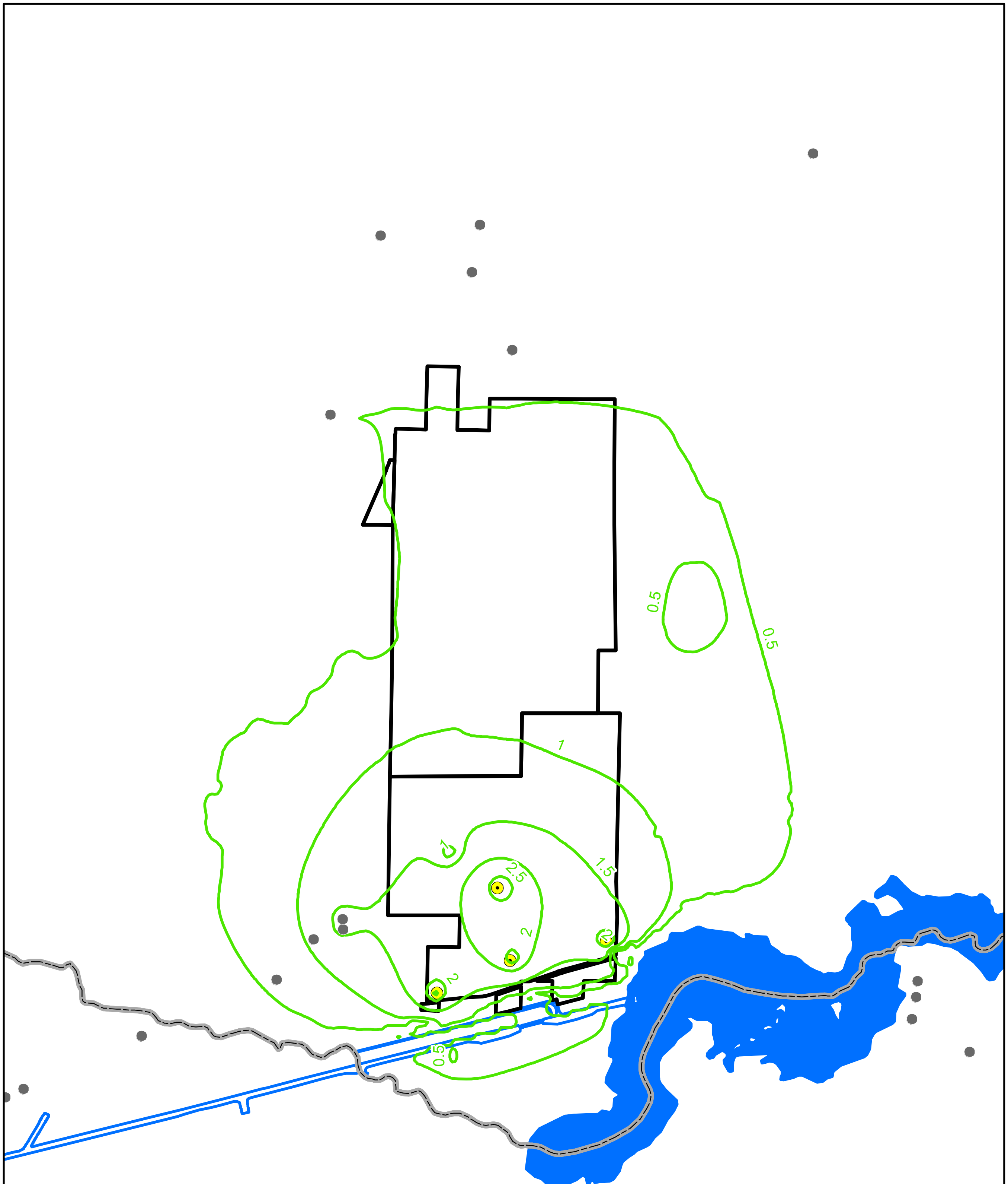


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental UFA Drawdown (ft); 60 years; 1.58 mgd

FIGURE 27



LEGEND

- Adjacent Permitted User
- Proposed LNP Supply Well
- Simulated Cumulative SAS Drawdown (ft)
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 0.5 feet

N
W E
S

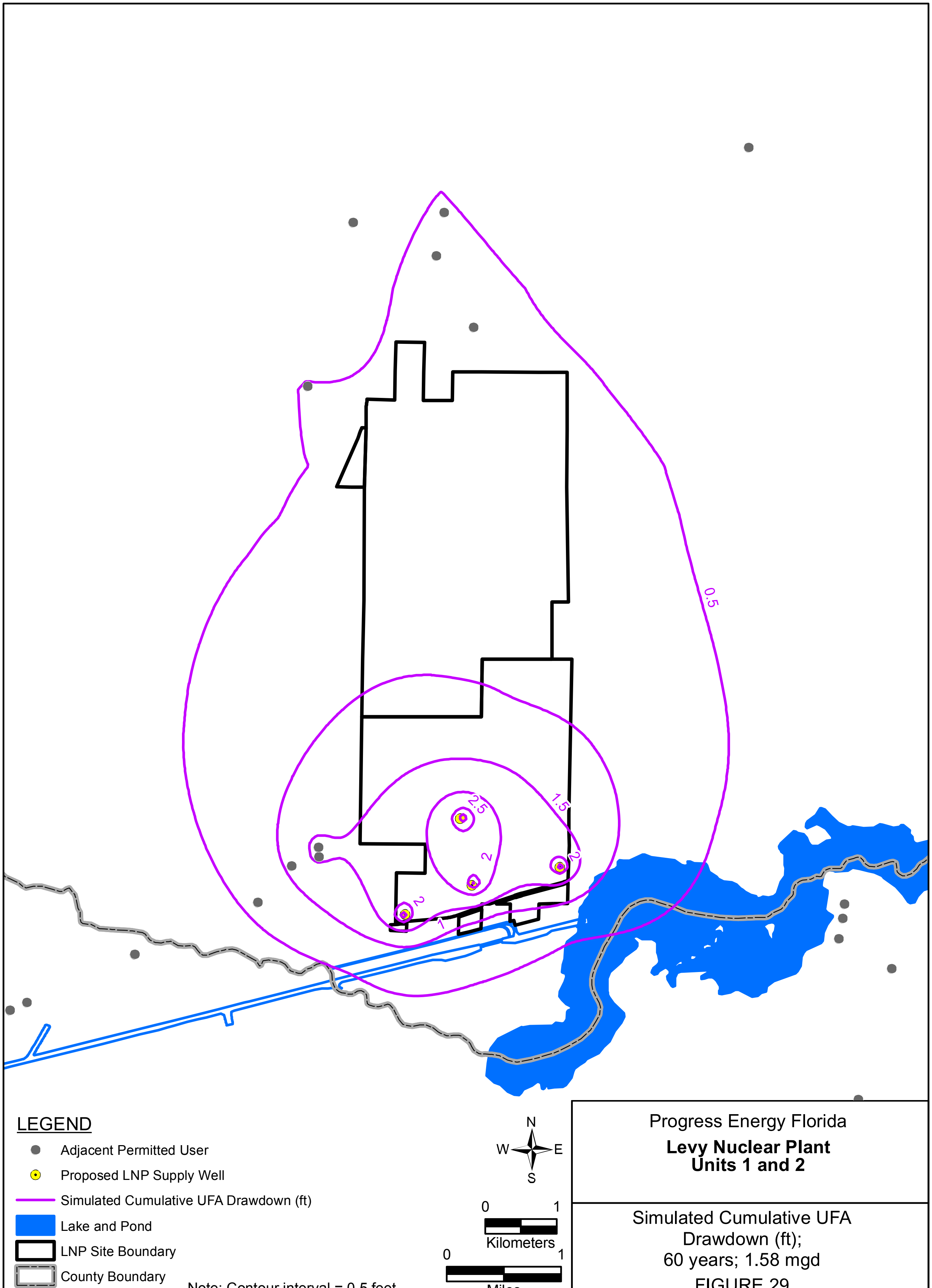
0 1
Kilometers

0 1
Miles

Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Cumulative SAS
Drawdown (ft);
60 years; 1.58 mgd
FIGURE 28

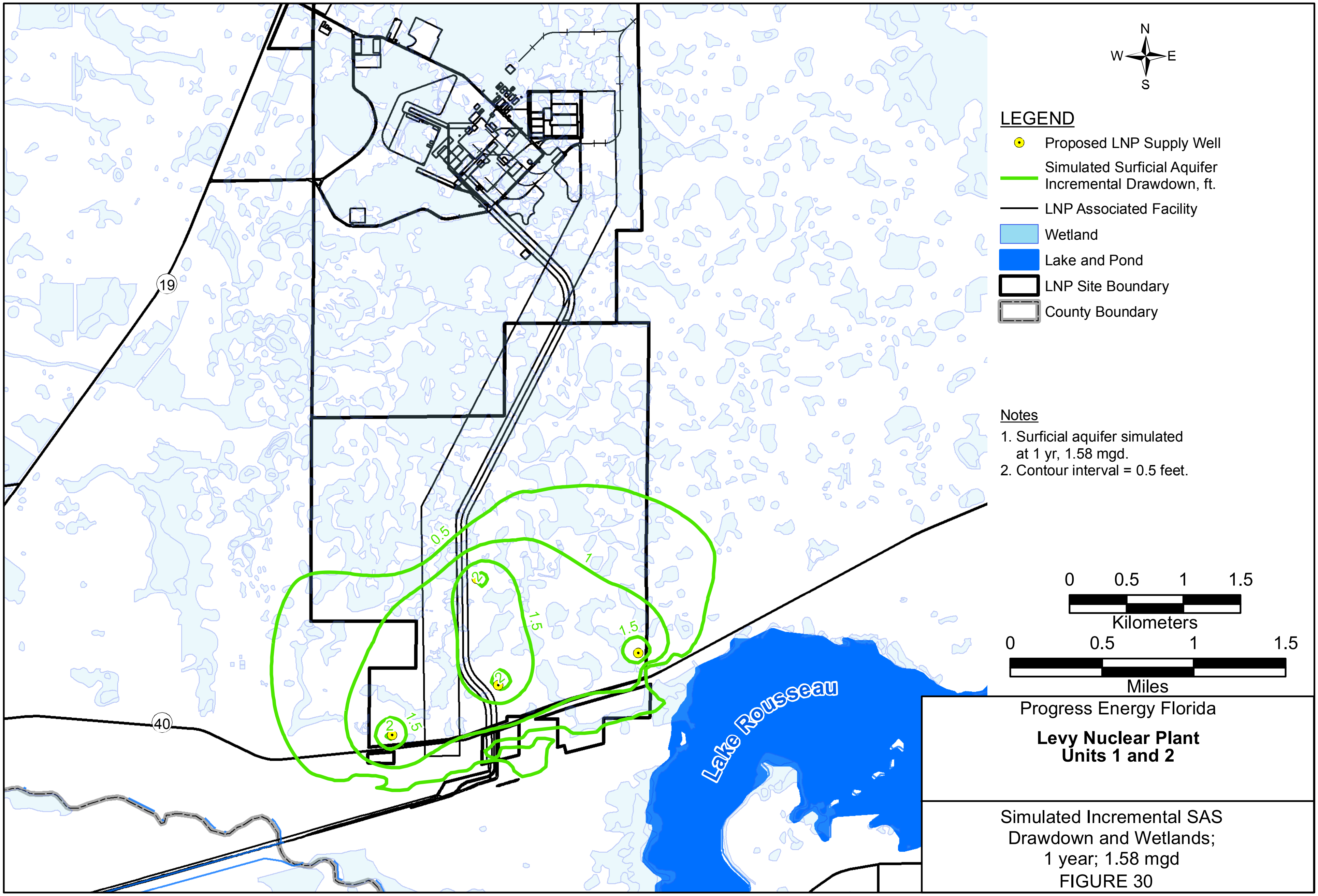


Progress Energy Florida

Levy Nuclear Plant
Units 1 and 2

Simulated Cumulative UFA Drawdown (ft);
60 years; 1.58 mgd

FIGURE 29

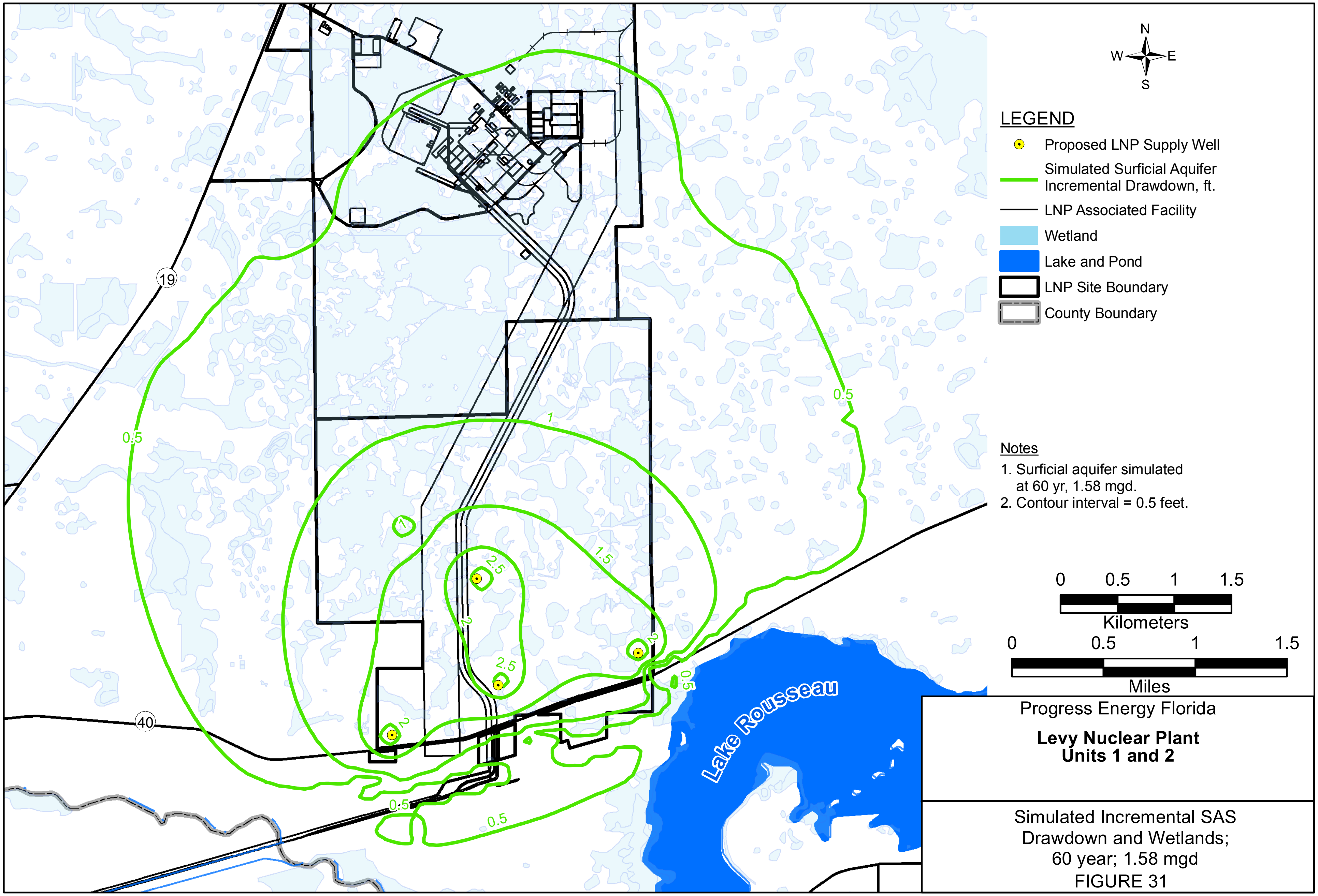


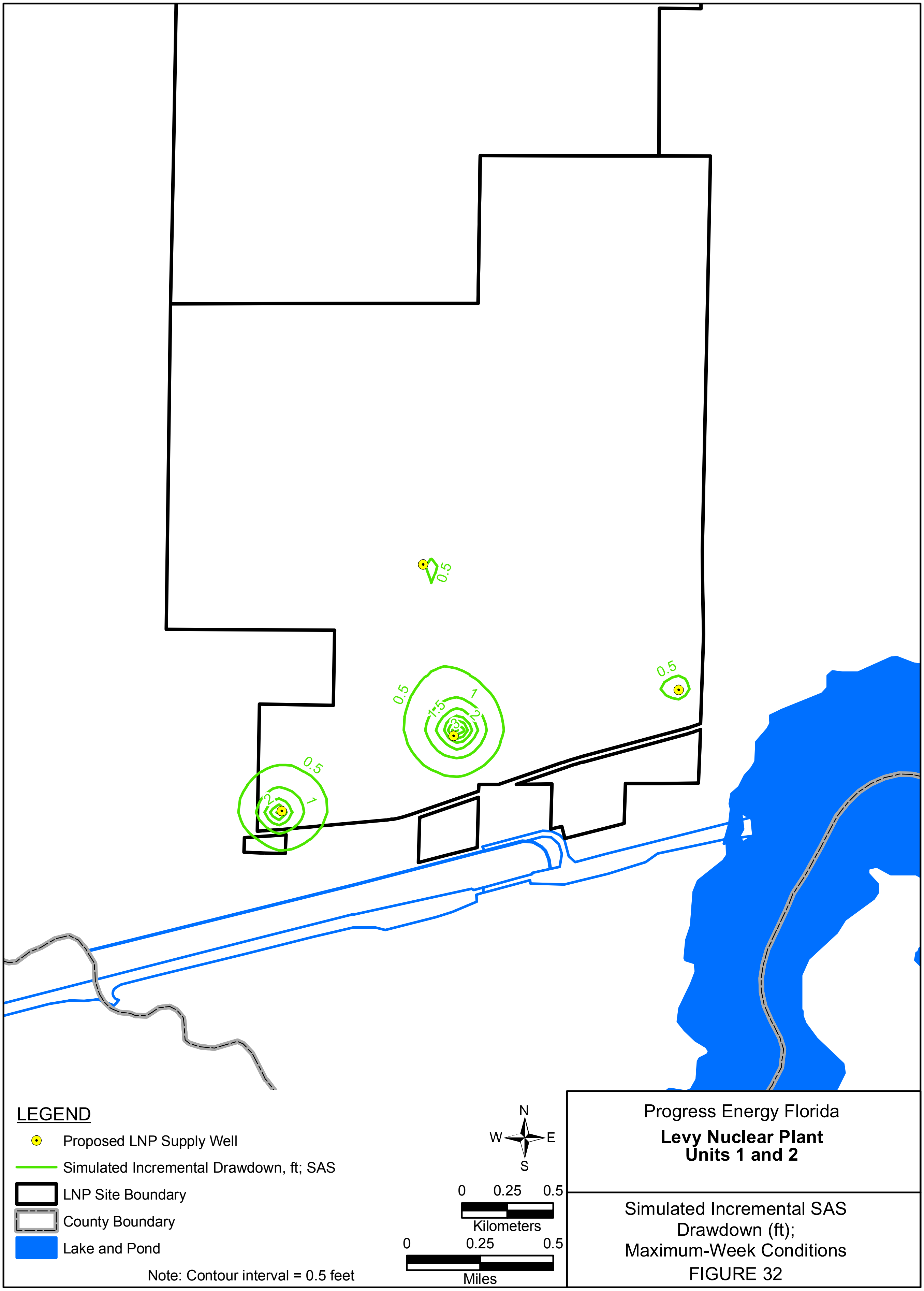
Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental SAS Drawdown and Wetlands; 1 year; 1.58 mgd

FIGURE 30


N
W
E
S
LEGEND
Proposed LNP Supply Well
Simulated Surficial Aquifer Incremental Drawdown, ft.
LNP Associated Facility
Wetland
Lake and Pond
LNP Site Boundary
County Boundary
Notes
1. Surficial aquifer simulated at 60 yr, 1.58 mgd.
2. Contour interval = 0.5 feet.
0 0.5 1 1.5
Kilometers
0 0.5 1 1.5
Miles
19
40
0.5
1
1.5
2
2.5
Lake Rousseau
Progress Energy Florida
Levy Nuclear Plant
Units 1 and 2
Simulated Incremental SAS Drawdown and Wetlands; 60 year; 1.58 mgd
FIGURE 31

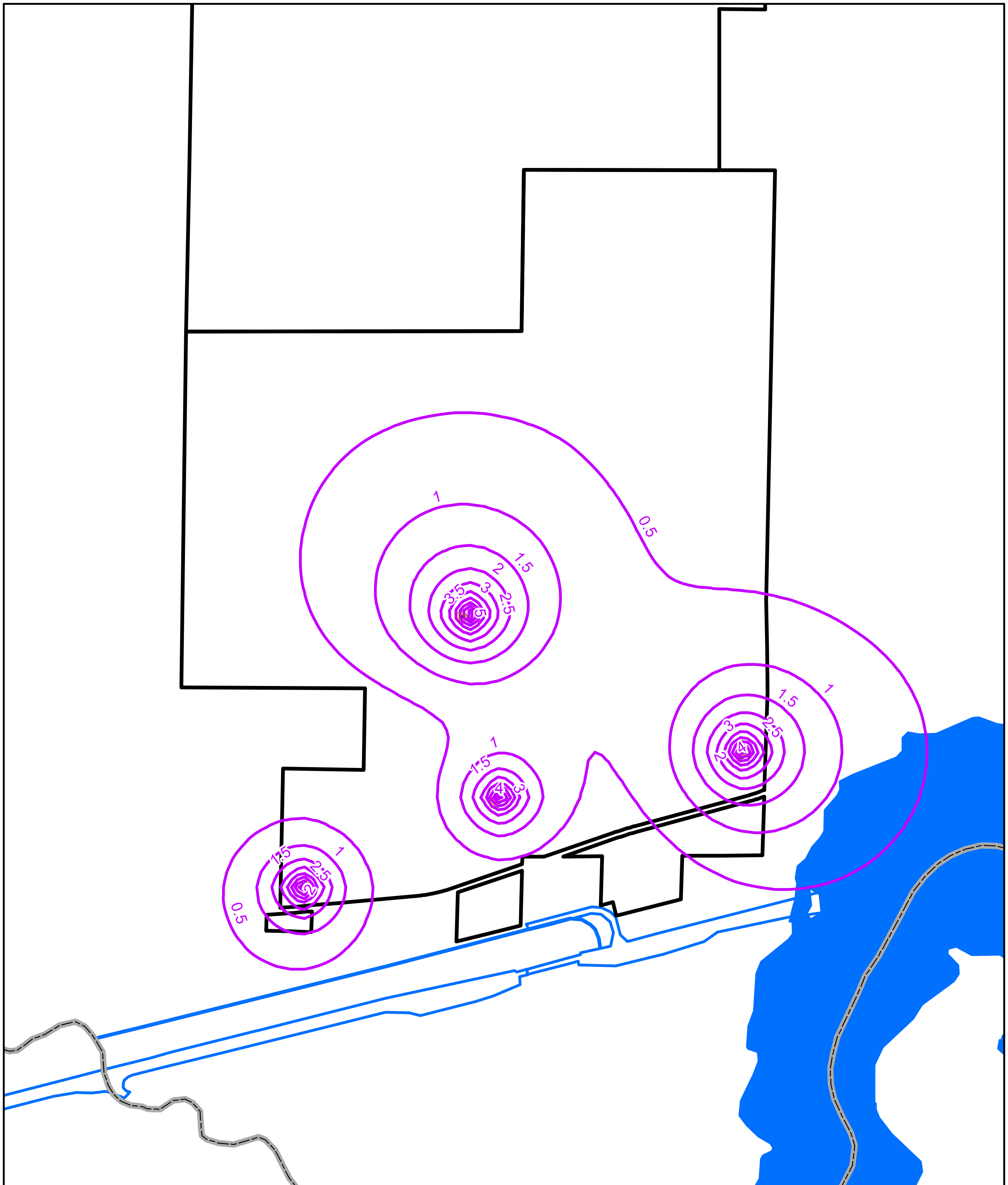


Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental SAS Drawdown (ft); Maximum-Week Conditions

FIGURE 32



LEGEND

- Proposed LNP Supply Well
- Simulated Incremental Drawdown, ft; UFA
- Lake and Pond
- LNP Site Boundary
- County Boundary

Note: Contour interval = 0.5 feet

Progress Energy Florida

Levy Nuclear Plant Units 1 and 2

Simulated Incremental UFA Drawdown (ft); Maximum-Week Conditions

FIGURE 33