ATTACHMENT A
Tech Memo Approval Form

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Revised Conceptual Wellfield Layout and Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant

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0	Initial Submittal	08/11/2008	All
1	SWFWMD staff requested further analysis	11/14/2008	All

Document Review and Approval

Originator:	Christopher Peters/Geologist Name/Position Signature	Date 11/11/08
Reviewer	Mitch Griffin/Engineer Name/Position Signature	11/11/08 Date
Project Manager:	Lorin Young/Deputy PM Name/Position Signature	11/14/2008 Approval Date

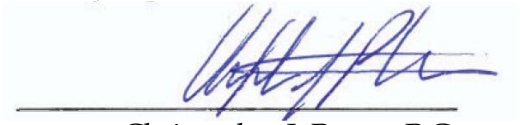
Revised Conceptual Wellfield Layout and Evaluation of Simulated Drawdown Impacts, Levy Nuclear Plant

PREPARED FOR: Progress Energy

PREPARED BY: CH2M HILL

DATE: October 27, 2008

I certify that this report was prepared under my supervision and direction.



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10/27/08

1.0 Introduction

This technical memorandum (TM) documents 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 fresh water for Progress Energy Florida's (PEF's) proposed Levy Nuclear Plant (LNP). The impacts were evaluated using a MODFLOW (Harbaugh, Banta, Hill, and McDonald, 2000) groundwater flow model developed by CH2M HILL. A new model was prepared by CH2M HILL in response to questions raised by Southwest Florida Water Management District (SWFWMD) staff in their review of the SCA Volume 5, Section D 10.09, Water Use Permit, Attachment B, Groundwater Modeling (Progress Energy, 2008).

The revised groundwater model was exported from the 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 DWRM model. Since the location of the wellfield and number of wells had changed significantly from the previous submittal, it was judged more appropriate to start with a new TMR extraction to better reflect the revised wellfield scenario. No changes, other than those documented herein, were made to the model design or hydraulic properties.

The wellfield configuration for LNP has been refined to avoid and minimize potential impacts to surface waters, wetlands, and adjacent users. The analysis presented in this memorandum is based on the revised conceptual wellfield layout and the well locations may be further refined as the design of LNP proceeds.

2.0 Model Revision Objectives

After their initial review, the SWFWMD staff requested further analysis of the following:

- Extent of water-level drawdown in the surficial and Floridan aquifers resulting from withdrawals of LNP and existing permitted users.
- Lake level and spring flow impacts (where applicable).
- Impact of simulated drawdown on wetlands.

3.0 Model Modifications

Three modifications were made to the TMR model created from the DWRM2 model:

- Two springs (Little King and Big King) were added to the model.
- Model cells that used MODFLOW's River (RIV) package to represent wetlands were changed to variable-head cells (i.e., 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 RIV package to represent Lake Rousseau and the Withlacoochee River were not modified.
- The length of model stress period 3 was increased to 60 years to represent the expected operating life of the facility.

3.1 Springs

Two springs were identified within the LNP model domain: Little King and Big King Springs, which were not included in the SWFWMD's DWRM2 model (Environmental Simulations Inc., 2004). Exhibit 1 depicts their locations relative to the LNP site and the model domain. Brief descriptions of these springs can be found in Appendix C of Scott et al. (2004).

The springs were added to Layer 4 of the model, which represents the Upper Floridan aquifer. The springs were simulated using MODFLOW's drain (DRN) package. The DRN 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 elevations 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. Exhibit 2 summarizes the details on each spring added to the model.

3.2 Wellfield

The layout and operation of the proposed wellfield were modified. The original wellfield layout included four wells on 1,000-foot (ft) spacing located northeast of the plant. The revised conceptual layout, documented in this memorandum, includes four wells located in the southern portion of the LNP site. Two wells are located along County Road 40 with two

wells located to the north, on the eastside of the heavy haul road. Exhibit 3 depicts the original and revised wellfield layouts.

Each well was simulated to pump at a constant rate of 0.395 mgd, for a total withdrawal of 1.58 mgd. The previous simulation incorporated a daily rotation; however, after discussion with SWFWMD staff, it was determined that an equal allocation of pumpage among all four wells would be more representative of the long-term impacts associated with the proposed 60-year operating life of the facility.

3.3 Time Discretization

The 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 from the model. Stress Period 2, also steady-state, includes all other users except LNP. It is intended to provide an assessment of currently-permitted impacts. Stress Period 3 is the predictive phase of the simulation. In the SWFWMD's DWRM2 model, its length is 1 year. For this simulation, its length was increased to 60 years to represent the expected life of the facility.

3.4 Summary of Modifications

A new groundwater flow model was exported from the SWFWMD's DWRM2 model using the TMR procedure. The model was modified to include Little King and Big King springs, which were added to the model as MODFLOW drain cells. MODFLOW river cells used to represent wetlands were removed from the model. The duration of Stress Period 3 was increased to 60 years to represent the expected operating life of the facility. No other changes were made to the model.

4.0 Results

4.1 Existing Impacts

Details on adjacent Individual and General Water Use Permits (WUPs) included in the model domain are summarized in Exhibit 4 and the locations of wells in all categories of WUPs (including smaller general permits) are depicted in Exhibit 5. No modifications were made to their simulated withdrawal rates or locations, which are from the DWRM2 model.

Exhibit 6 depicts the simulated drawdown impacts (relative to pre-development conditions) on the SAS and UFA, without LNP's proposed pumping.

Immediately north of the proposed LNP site, there is approximately 0.4 ft of drawdown associated with WUP 001726001. South of the site, there is approximately 0.1 ft of drawdown resulting from the Town of Inglis' pumpage (WUP 008953003). The simulated drawdowns in the SAS and UFA are virtually identical, which is attributed to the DWRM2 model's designation of Stress Period 2 as steady-state.

4.2 Average-Day Impacts

The following sections discuss *incremental* and *cumulative* simulated drawdown impacts. Incremental drawdown impacts are those additional simulated drawdown impacts relative to 2001 water levels. Cumulative drawdown impacts are those of LNP's proposed wellfield,

as well as the impact of adjacent permitted users. The cumulative drawdown is referenced to assumed pre-development water levels. Both cumulative and incremental impacts include the pumping from adjacent permitted users.

4.3.1 Drawdown

Incremental impacts (relative to 2001 conditions) for the SAS and UFA after 1 year and 60 years are depicted in Exhibits 7 and 8, respectively. Exhibit 7 depicts approximately 0.3 ft of simulated drawdown in the SAS and UFA in the central portion of the LNP wellfield after 1 year. The simulated drawdown increases slightly to 0.4 ft in the UFA in the central portion of the wellfield after 60 years of operation (Exhibit 8). Simulated drawdowns at individual wells are approximately 0.5 ft in the immediate vicinity of each well. Simulated incremental impacts to wetlands are discussed in Section 5.

Exhibits 9 and 10 depict the simulated average-day cumulative drawdown impacts in the SAS and UFA after 1 year and 60 years, respectively. Exhibit 9 depicts approximately 0.5 ft of simulated drawdown in the SAS and UFA in the central portion of the LNP wellfield after 1 year of operation. The simulated drawdown increases slightly to 0.6 ft in the UFA in the immediate vicinity of one of the wells after 60 years of operation (Exhibit 10).

The simulated 0.1-ft drawdown contour extends approximately 2.25 miles away from the proposed wellfield and encompasses several adjacent permitted users. The greatest impact on an adjacent user is approximately 0.2 ft to several users located approximately 1.25 miles west of the proposed wellfield. An additional 0.2 ft of drawdown on another user's pumped well is not expected to cause any adverse impacts to their ability to pump water.

4.3.2 Lakes and Springs

The simulated average-day impacts to lakes and springs were quantified by calculating the difference in net flux through the model cells representing those features for model runs with and without LNP's withdrawals. Lakes and rivers are simulated in the model by MODFLOW's River (RIV) package and springs are simulated using MODFLOW's Drain (DRN) package. Since the only change made to the model in this case was the addition of LNP's pumpage, any difference in model-simulated flux (flow into or out of river or drain cells) can be attributed to LNP's simulated withdrawals.

Exhibit 11 summarizes the simulated impacts on lakes and springs. As a groundwater flow model, MODFLOW cannot directly simulate water levels in rivers and lakes, since these features are represented as specified-head boundary conditions so only the aquifer/river flux (flow) is variable in those modeled cells. With no LNP withdrawals, there is a total flux of 98.3 mgd from river cells into the SAS and UFA, and 216.3 mgd from the SAS and UFA into river cells, for a net flux of 118.0 mgd from the SAS and UFA into river cells. With the simulated withdrawals from LNP, there is a change of net flux of 1.1 mgd less discharge from the SAS and UFA to the river cells. This 1.1 mgd reduction equates to approximately 0.9 percent of the model-simulated discharge to the rivers.

The model-simulated change in discharge from the drain cells representing Big King and Little King Springs decreases by 0.01 mgd (7 gpm). This change is approximately one third of one percent of the flow from these springs.

4.4 Maximum Week Impacts

The most conservative maximum pumping rate for the LNP facility is 5.8 mgd. This projection is the summary of the four main processes that utilize the freshwater supply. Those include potable, service water, demineralized water, and fire protection systems. The facility design capacities for each water system were used to calculate the maximum pumping rate capacity for the wellfield. While it is highly unlikely that all four processes would be pumping at their maximum design capacity at the same time, the wellfield must be designed to meet this improbable scenario.

The most likely scenario that could result in the maximum pumping rate would be during facility maintenance that occurs annually for one week. A second model simulation was conducted to evaluate incremental drawdown impacts associated with 1 week of pumpage at a rate of 5.8 mgd. It was assumed that all four wells would be operating simultaneously, each at a rate of 1.45 mgd.

Exhibit 12 depicts the simulated maximum week incremental drawdown impact in the SAS and UFA at the end of the simulation. The simulated 0.1-ft drawdown contour extends one mile or less from the central portion of the proposed wellfield. Adjacent users may experience drawdown impacts of 0.1 to 0.2 ft of drawdown under maximum-week conditions.

5.0 Wetlands

In accordance with the SWFWMD Basis of Review for Water Use Permits, withdrawal of water must not cause unacceptable adverse impacts to environmental features, such as surface water bodies, protected species habitat, and wetlands (Section 4.2). Lacking permanent surface water bodies or significant protected species habitat, the predominant environmental features of concern on the LNP property are wetlands.

Wetlands within the project area were delineated and the lines were subsequently field-verified by the Wetland Evaluation and Delineation Section (WEDS) of the FDEP. A wetland map was compiled using the field delineated wetland boundaries in areas to be impacted by construction, and photo-interpreted wetland boundaries in on-site areas that will be undisturbed. Offsite wetlands were mapped using data from the Florida Land Use and Cover Classification System (FLUCCSIII) database.

Cypress swamp (FLUCCS Code 621) is the predominant wetland type in the vicinity of the LNP site, followed by bottomland (FLUCCS Code 615), wetland forested mixed (FLUCCS Code 630), and wet prairies (FLUCCS Code 643). The LNP site is characterized by stands of planted slash pine interspersed with isolated pond cypress swamps. The cypress swamps have been logged and exhibit varying successional stages, from relatively intact systems to remnant cypress savannah with largely herbaceous vegetation. Historic aerial photographs suggest that most of the wetlands classified as wet prairies by FLUCCS were previously cypress systems that were clear cut. While ditching is limited on-site, water table dynamics in the wetlands have been modified through silvicultural activities such as clear-cutting, bedding, and access road construction.

The SCA submittal contained an evaluation of the predicted drawdown in the surficial aquifer as a result of pumping the Floridan aquifer at the site. The original simulated drawdown in the SAS as a result of pumping the UFA at the average-day rate of 1.58 mgd from four wells separated by 1,000 ft estimated that the wetland area with 1.0 ft or greater predicted drawdown was approximately 138 acres. In response to comments from the FDEP, SWFWMD, Levy County, and other agencies, several alternative wellfield layouts were evaluated in an effort to reduce the potential impact of the drawdown on wetlands.

Exhibit 13 shows the incremental SAS drawdown effects from the revised wellfield layout overlaid on the wetland map of the site for 1 year of withdrawals. Exhibit 14 shows the incremental SAS drawdown after 60 years of withdrawals. Drawdowns are below 0.3 ft throughout most of the wellfield and site, and are less than 0.5 ft in the immediate vicinity of all of the wells but one after 1 and 60 years. There are no wetlands located within the 0.5 ft or greater simulated drawdown contours of the SAS. With the reduced SAS drawdown predicted from the model, the wet season water level of the on-site wetlands is expected to remain within the normal range of water levels, and the hydroperiods of these wetlands are expected to remain within a normal range and duration.

6.0 Conclusions

An evaluation of simulated withdrawal of 1.58 mgd of UFA groundwater for the proposed LNP project indicates that:

- Simulated *incremental* and *cumulative* SAS and UFA drawdown in the wellfield after 60 years of operation do not exceed 0.5 ft anywhere in the wellfield except in the immediate vicinity of some wells.
- There are no wetlands with either an incremental or cumulative drawdown of 0.5 foot or greater within the proposed wellfield's area of influence.
- Under Average Day conditions, the operation of the LNP wellfield decreased the model-simulated surficial and Floridan aquifer discharge into river cells used to represent rivers and lakes by approximately 1.1 mgd, or about 0.9 percent of the simulated total flux between the Floridan aquifer and river cells in the model.
- The simulated impacts to Lake Rousseau and the lower Withlacoochee River (measured at the bypass canal) of 1.1 mgd are insignificant compared to the 37 year recorded average daily discharge of 687 mgd through the Bypass Canal.
- Under Average Day conditions, the operation of the LNP wellfield decreased the model-simulated discharge from the drain cells representing Big King and Little King springs by approximately 0.01 mgd, or about 0.3 percent of their total simulated flux.

The operation of LNP's proposed wellfield is not expected to adversely impact adjacent permitted users of the Floridan aquifer. The model predicts less than 0.2 ft of additional drawdown on the nearest other UFA user under Average Day conditions. The model simulation for Maximum Week withdrawals estimates an additional 0.1 to 0.2 ft of drawdown at the nearest Floridan aquifer well. Wetland impacts are not expected to occur during the short duration (1 week) of the maximum week withdrawal.

7.0 References

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, 2008. Site Certification Application.

Scott, T.M., G.H. Means, R.P. Meegan, R.C. Means, S.B. Upchurch, R.E. Copeland, J. Jones, T. Roberts, and A. Willet, 2004. Springs of Florida, Version 1.1. Florida Geological Survey Bulletin 66.

Exhibits

EXHIBIT 1
Springs near LNP Site

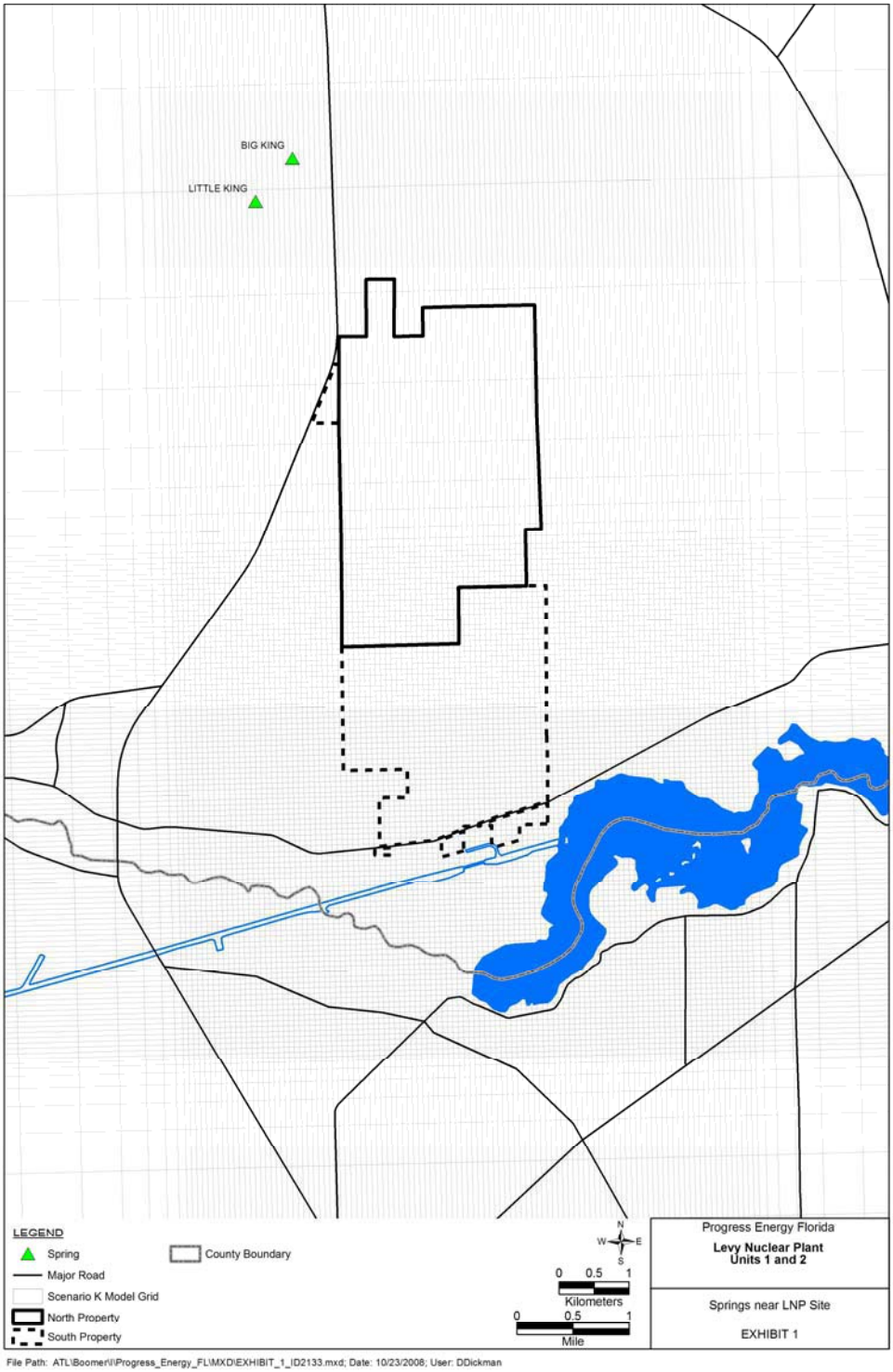


EXHIBIT 2
MODFLOW Drain Cell Parameters Used to Simulate Springs

Spring	Model Layer	Model Row	Model Column	Drain Elevation, ft	Conductance, ft^2/d	Stress Period 1 Flow, mgd
Big King	4	5	36	5.5	$1x10^6$	3.07 mgd
Little King	4	6	29	4.7	$1x10^6$	2.92 mgd

EXHIBIT 3
Original and Revised Wellfield Layouts

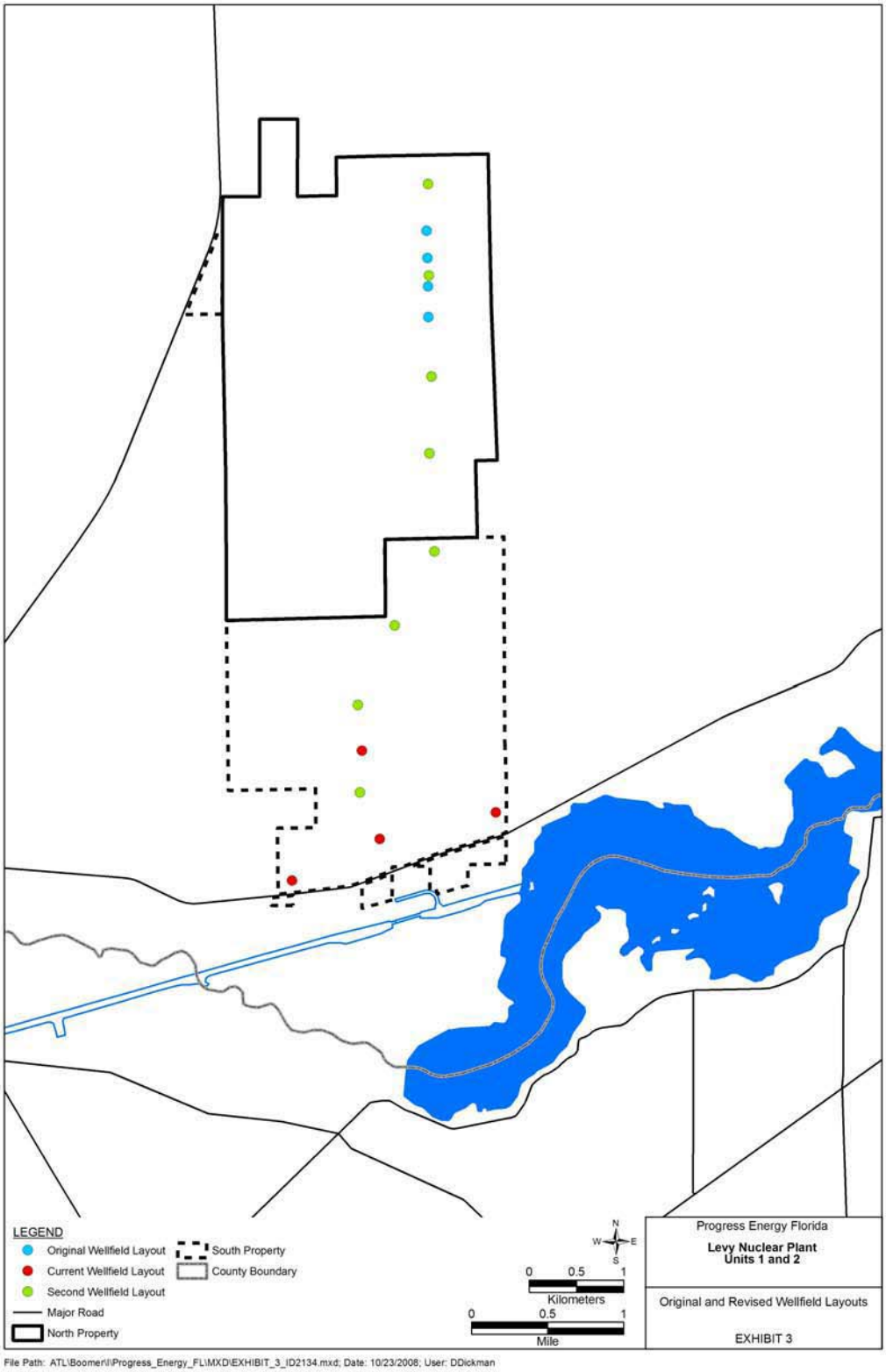


Exhibit 4
Adjacent Water Use Permits

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
Small General Permit Holders, continued			
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

EXHIBIT 5
Locations of Withdrawal Points (wells) for Adjacent Permitted Users

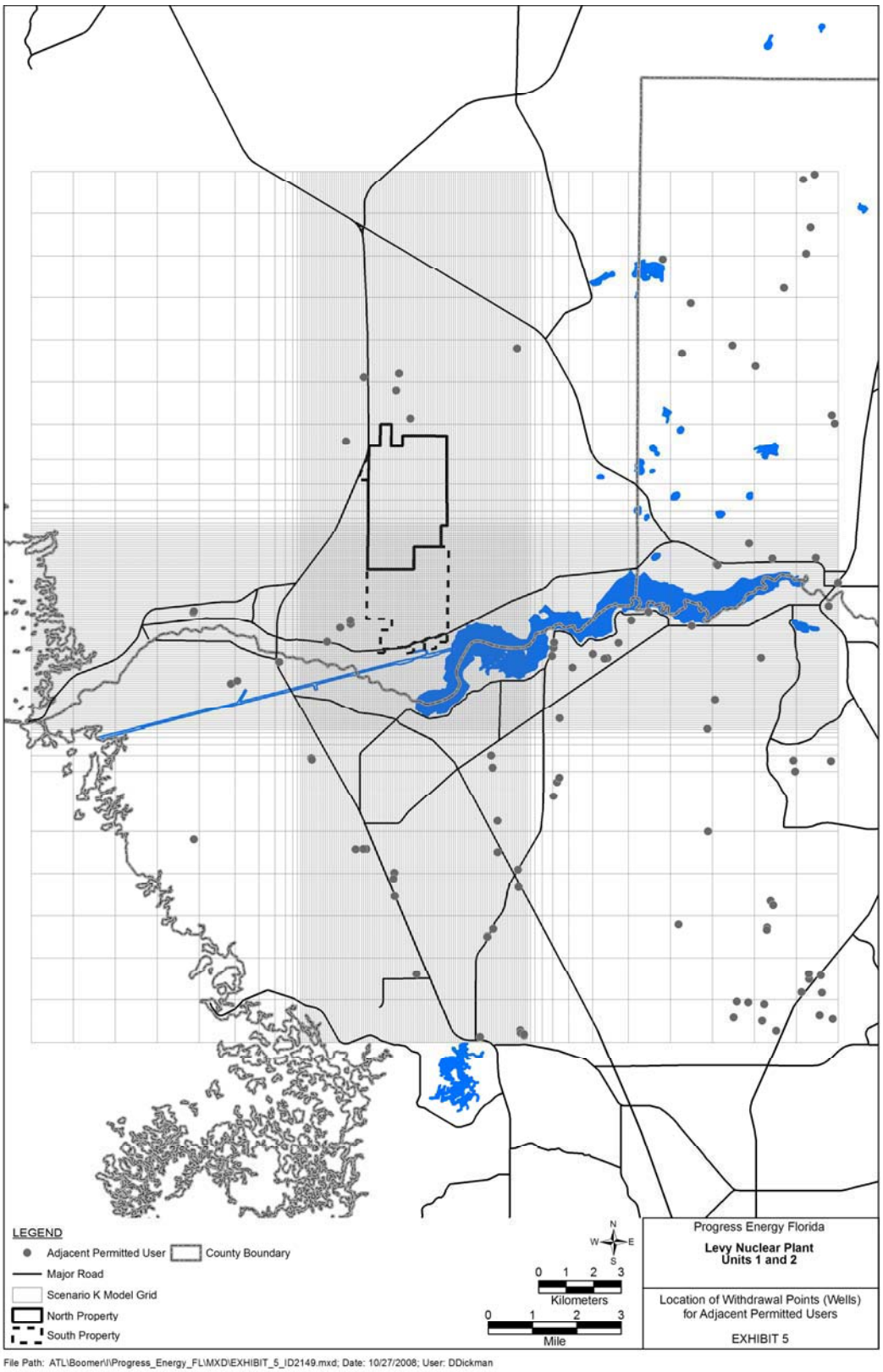


EXHIBIT 6
Simulated Impact due to Other Users, Surficial and Upper Floridan Aquifers, from pre-Development Conditions

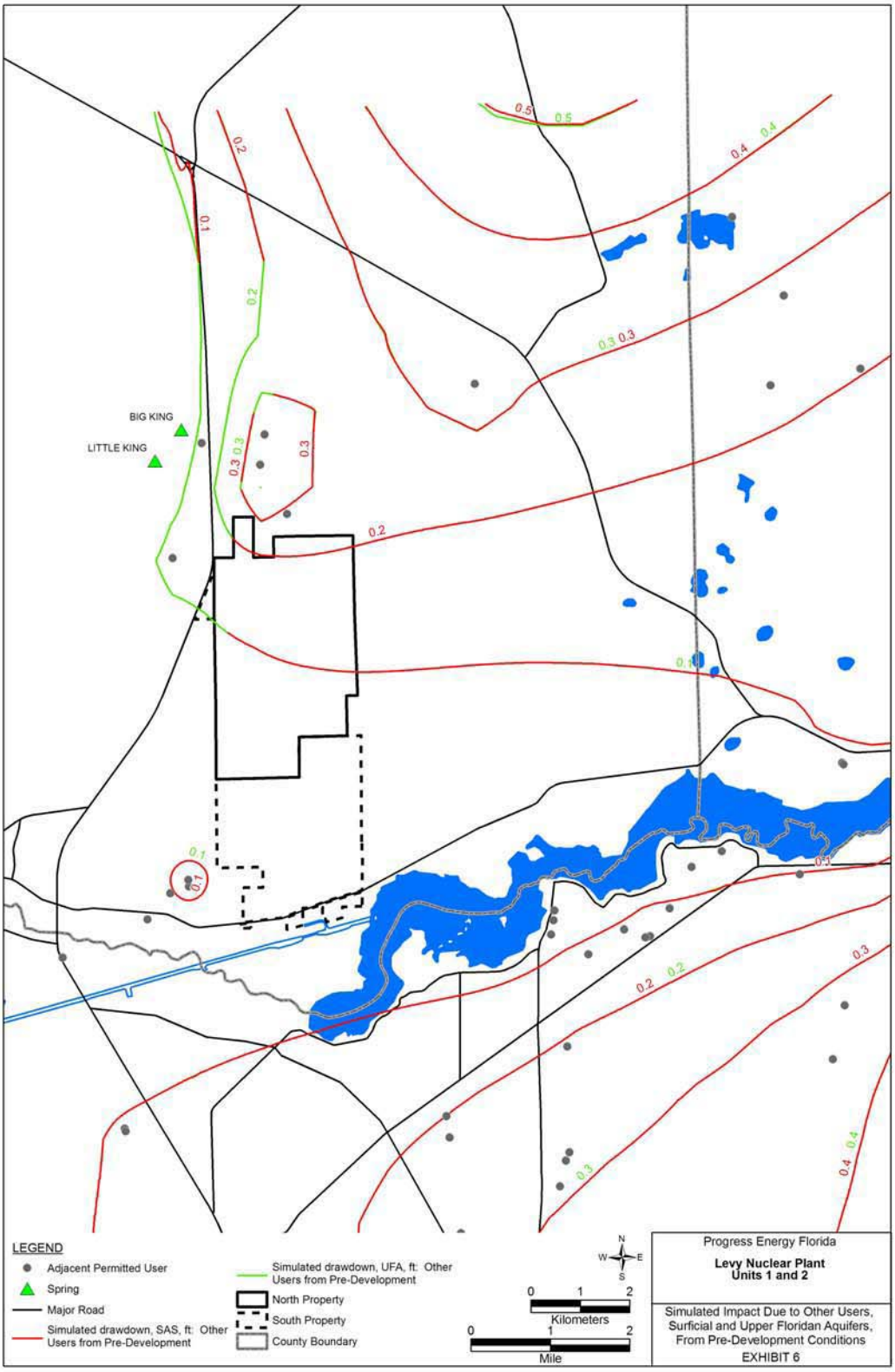


EXHIBIT 7
Simulated Incremental SAS and UFA Drawdown, ft; 1 year; 1.58 mgd

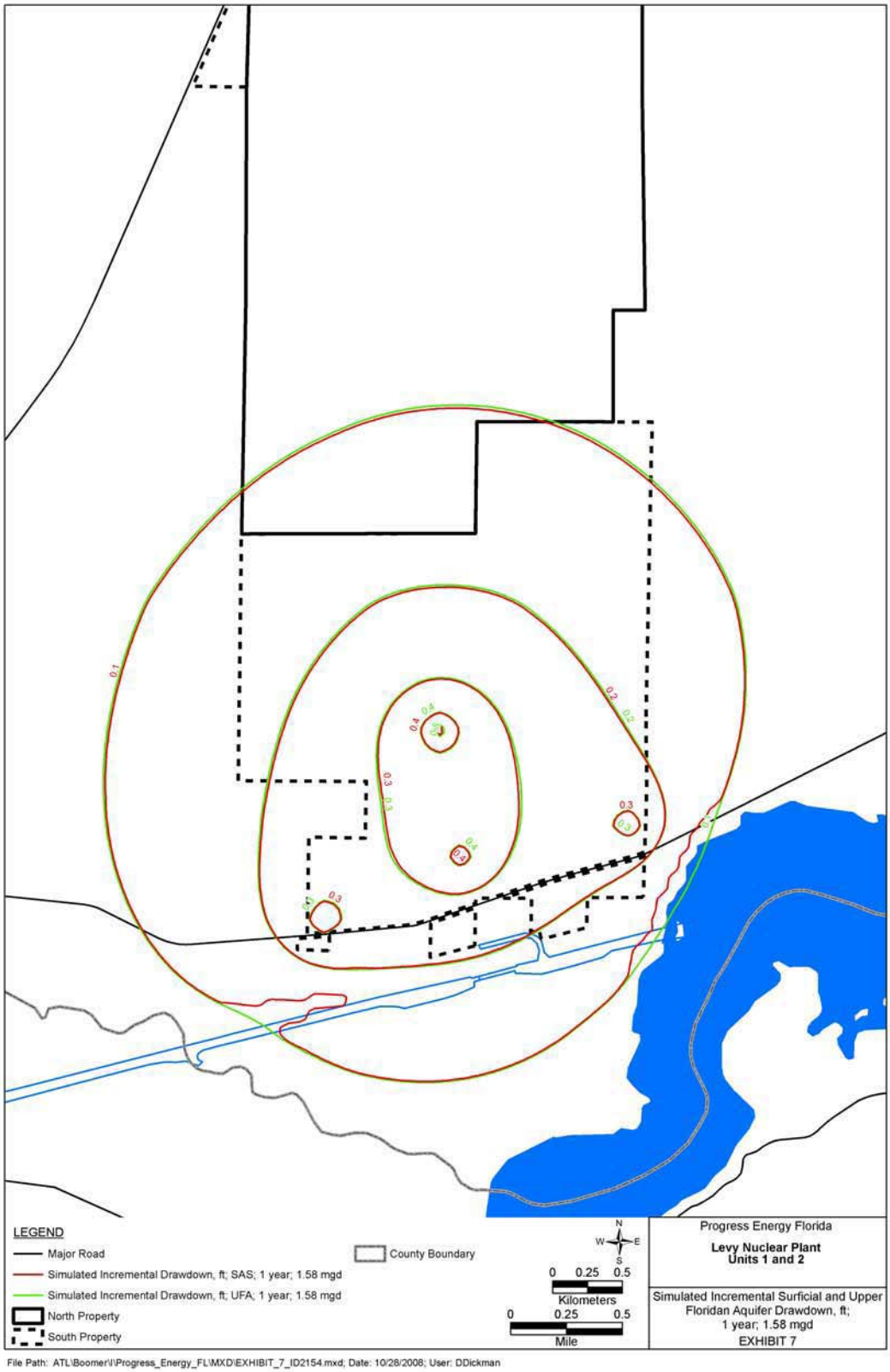


EXHIBIT 8
Simulated Incremental SAS and UFA Drawdown, ft; 60 years; 1.58 mgd

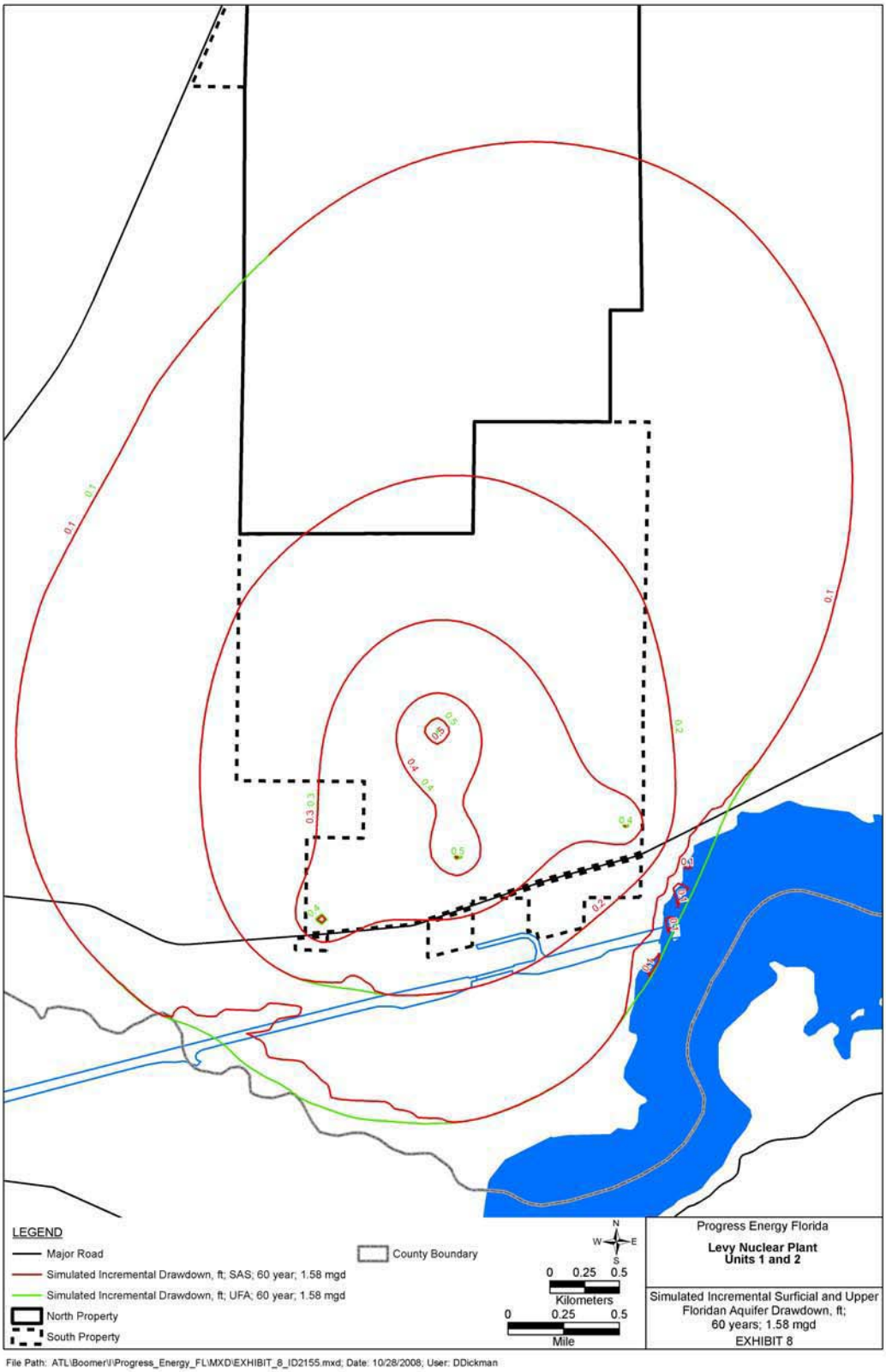


EXHIBIT 9
Simulated Cumulative SAS and UFA Drawdown, ft; 1 year; 1.58 mgd

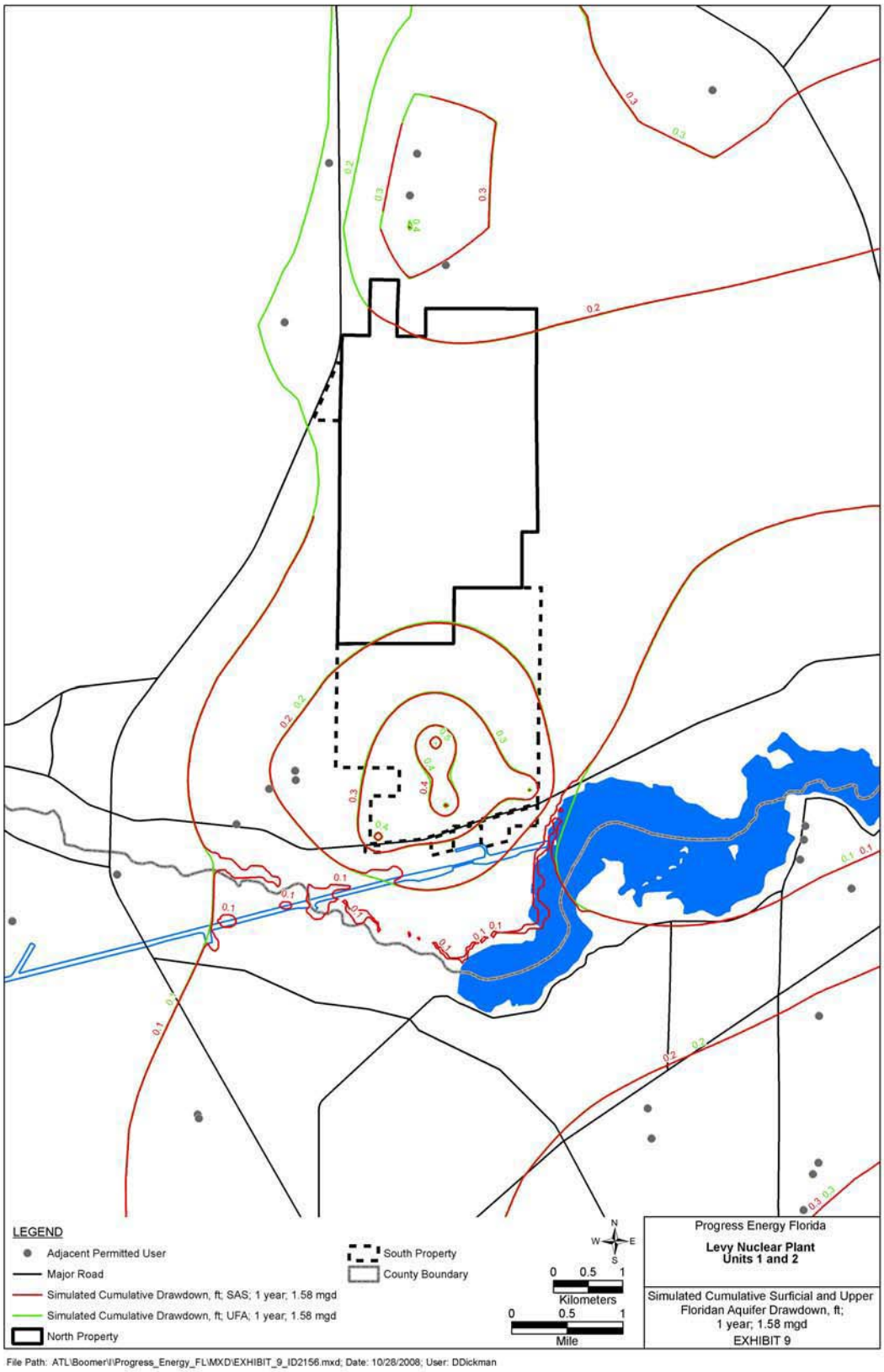


EXHIBIT 10
Simulated Cumulative SAS and UFA Drawdown, ft; 60 years; 1.58 mgd

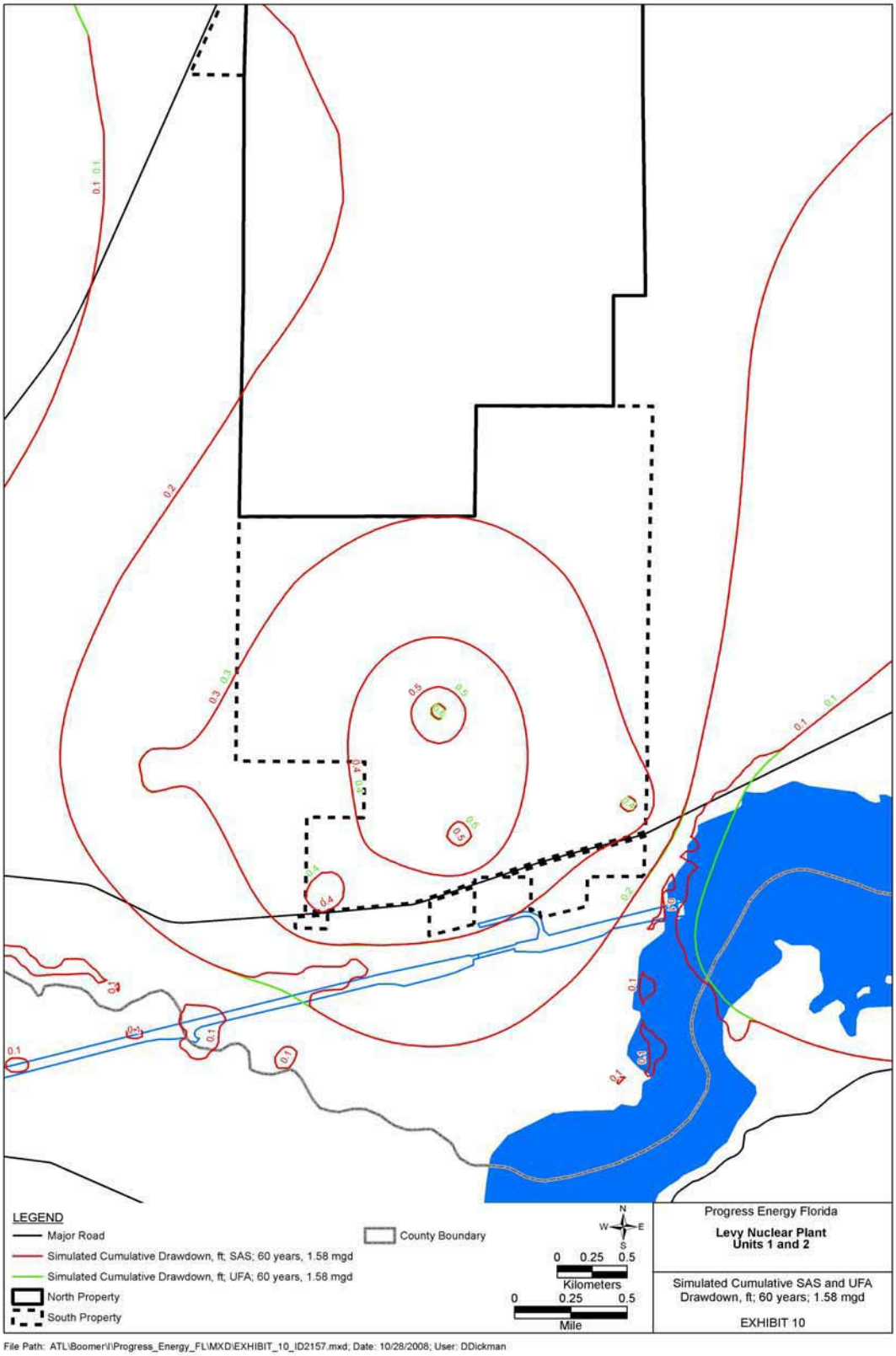


EXHIBIT 11

Simulated Impacts (mgd) to Lakes and Springs, Average-Day Conditions

	No LNP Withdrawals		With LNP Withdrawals		Difference	
	River	**Springs**	**River**	**Springs**	**River**	**Springs**
Into Aquifer from:	98.3		99.0		-0.7	N/A
Out from Aquifer to:	216.3	5.87	215.9	5.86	0.4	0.01
Net	-118.0	-5.87	-116.8	-5.86	-1.1	-0.01

All units are million gallons per day (mgd)

EXHIBIT 12
Simulated Incremental Drawdown, Maximum-Week Conditions

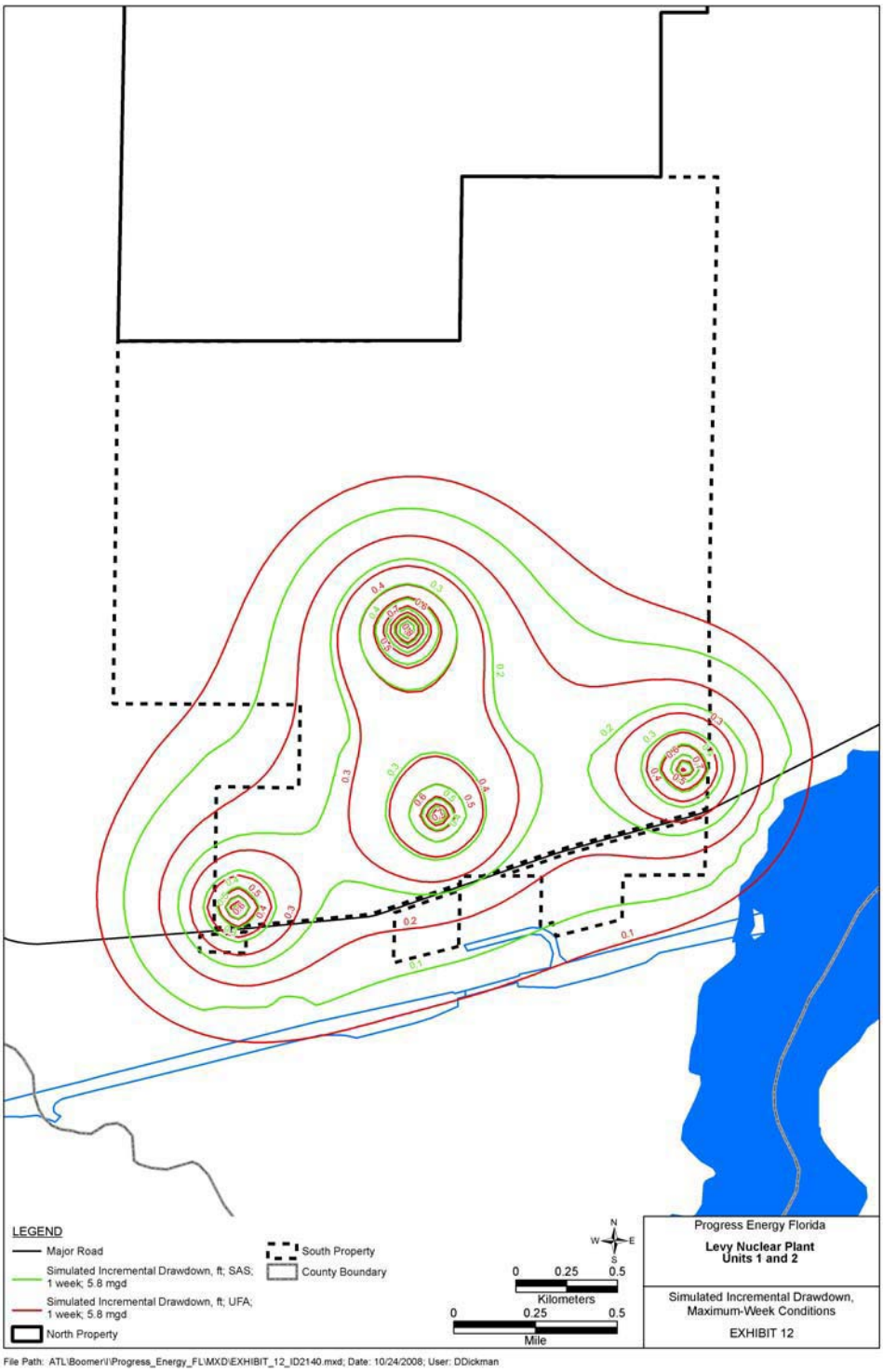


EXHIBIT 13
Simulated Incremental SAS Drawdown and Wetlands, 1 yr, 1.58 mgd

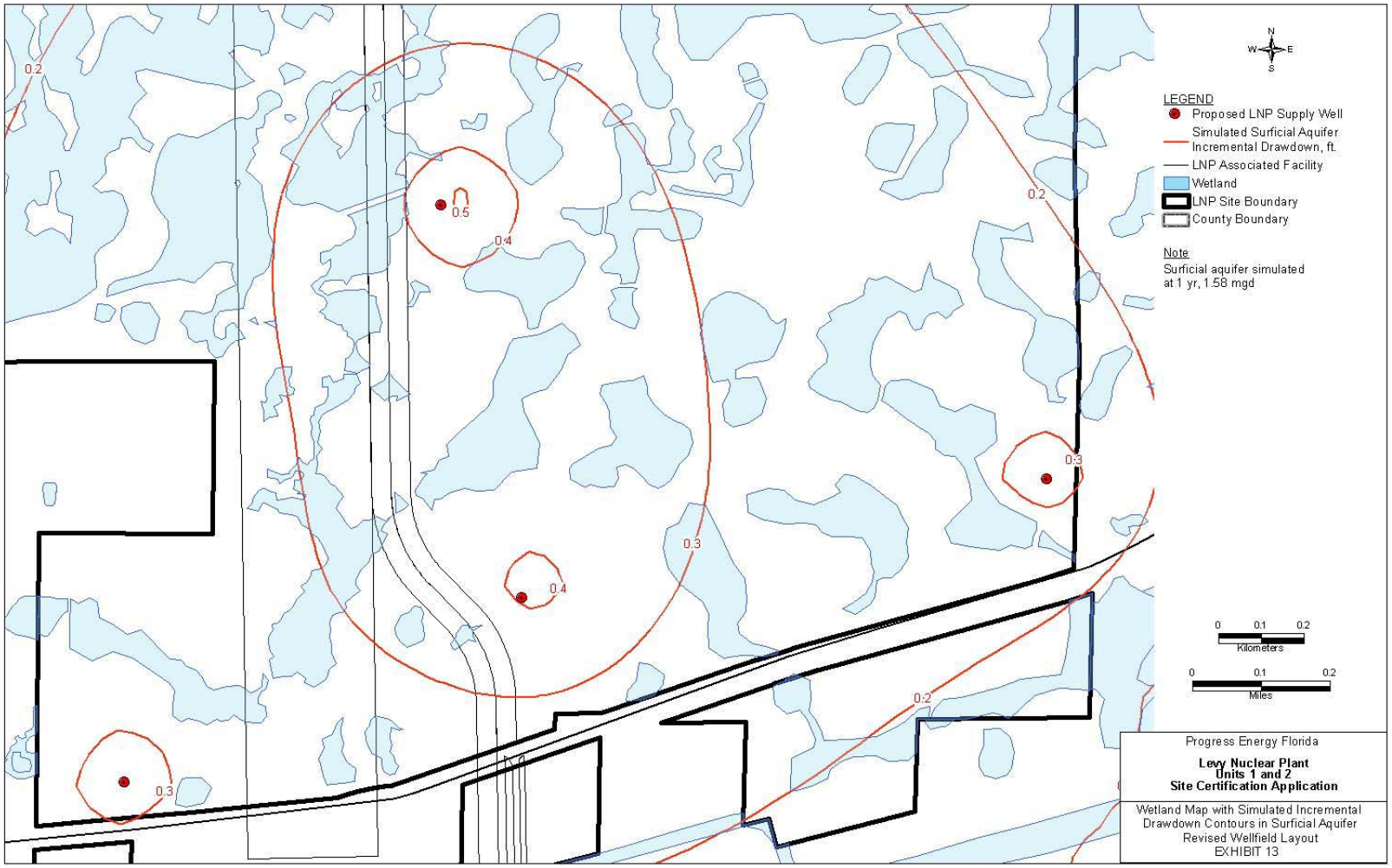
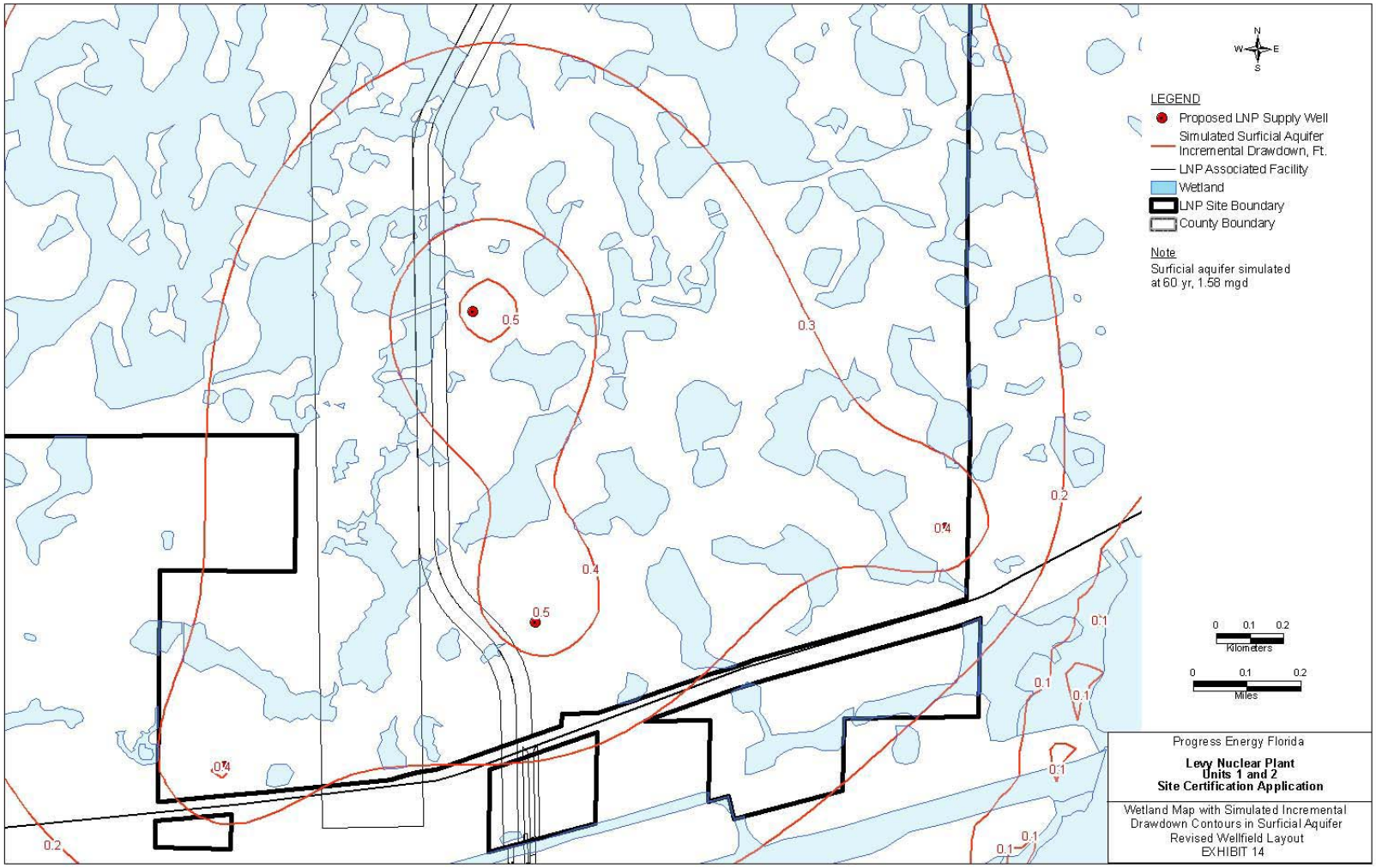


EXHIBIT 14
Simulated Incremental SAS Drawdown and Wetlands, 60 yrs, 1.58 mgd



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