

## **Enhanced Water Quality Monitoring and Modeling Program for the A.R.M. Loxahatchee National Wildlife Refuge Quarterly Update Report – January 2007**

Prepared by:

Matt Harwell, A.R.M. Loxahatchee National Wildlife Refuge

With contributions from Leslie MacGregor (NPS), Donatto Surratt,  
and Mike Waldon

### Overview

This update is a summary of activities since the previous status report of October 2006 on the implementation of the Refuge's Enhanced Water Quality Monitoring and Modeling Program. A project overview, and other detailed information about the program can be found at: [http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/). The primary objective of this overall program focuses on providing information for use in ecological management of the Refuge (Brandt et al. 2004; Harwell et al. 2005).

The Refuge's monitoring component of this program also addresses one of the Consent Decree Principals recommendations (17 December 2003):

#### ***B. Enhancing Monitoring of the Refuge***

*Design and implement an enhanced monitoring program to improve spatial and temporal understanding of factors related to phosphorus dynamics.*

The Refuge's modeling component of this program also addresses several of the Consent Decree Principals recommendations (17 December 2003):

#### ***C. Modeling of the Refuge***

- 1. Develop a water quality/hydraulic model for the Refuge with a phosphorus cycling component.*
- 2. Evaluate issues associated with phosphorus loads and transports within the L-40 and L-7 canals.*
- 3. Develop and track a simple phosphorus mass-balance model for the Refuge.*

### Information Availability

Through collaboration with USGS, information from the Refuge's Enhanced Water Quality Monitoring and Modeling Program has been made available on the USGS' SOFIA web site at: [http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/).

Final data for monthly samples through May 2006 are publicly posted on DBHYDRO by the SFWMD at <http://www.sfwmd.gov/org/ema/dbhydro/index.html>. Data for June 2006-January 2007 are posted on the Technical Oversight Committee's web site at <http://www.sfwmd.gov/org/ema/toc/index.html>. This report includes information from samples collected through December 2006.

### Water Quality Data Analyses Update

Primary efforts from this quarter focused on finalizing the peer-review process for the Second Annual Report. This report, presently scheduled to be finalized and available by February 2007, is composed of three sections. The first section of the Annual Report provides a general introductory overview of the Refuge and the Enhanced Water Quality Monitoring and Modeling Program. The second section is comprised of three technical chapters that present extensive analyses of water quality data generally covering the period from June 2004 (the initiation of this program) through December 2005. The second section also contains a chapter on the status of the model efforts through April 2006, and presents a list of the types of management questions/scenarios that are anticipated for modeling tools application. Finally, the report contains a synthesis of the information presented in report in the context of the support for management decisions. In addition, the report discusses what additional information is necessary to continue to improve our scientific understanding of water quality issues in the Refuge.

### Monitoring Update (October 2006 – December 2006)

Sampling of the enhanced water quality monitoring network (**Figure 1**) occurred at 35 stations in October 2006, 36 stations in November 2006, and 25 stations in December 2006 (**Table 1**). In November 2006 station LOXA123 was replaced by a new station, LOXA141, and LOXA121 was dropped from the sampling collection network as it was overrun by cattail. The total number of sampling sites as of November 2006 is 38.

Total phosphorus data available to date for 2006 are presented in **Table 1**. Maps of stations where samples were collected for October 2006 through December 2006 are presented in **Figures 2-4**.

Conductivity sonde deployment information for 2006 is presented in **Table 2**.

### Modeling Update

Model development continues with intensive effort by the modeling team. The modeling “Technical Advisory Panel” met on October 27, 2006 in Lafayette, Louisiana. This panel had previously met in a public session in West Palm Beach in late 2005. This expert panel is chaired by Dr. Vincent S. Neary (Tennessee Tech Univ.). Members of the panel, Drs. Malcolm L. Spaulding (Univ. of Rhode Island) and J. Alex McCorquodale (Univ. of New Orleans), were selected by Dr. Neary. Presentations were made to the panel on all aspects of modeling completed to-date, and planned. The panel provided valuable questions and comments following the presentations, and will submit a written report in early 2007.

Beyond the technical review, notable accomplishments of the modeling team during this quarter include:

- Completion of a version of the simplified water model to be publicly released
- Completion of a version of the simplified chloride model
- Continued development of the simplified total phosphorus model
- Development and testing of modeling of outflow gate operations under the regulation schedule

- Completion of calibration of the MIKE-FLOOD complex model for Refuge water stage
- Continued efforts toward creation of a post-doctoral fellow position through the University of Florida to aid in future Refuge model maintenance and scenario analyses

#### Next Steps

The next steps for this program include finalizing the Annual Report, exploring mechanisms to present information from the Annual Report – in particular the modeling efforts – to a larger audience, continuation of data collection and analysis, additional model development and implementation. Presentations are planned to contribute to a special session on water quality issues in the Everglades for the 2007 annual meeting of the North American Benthological Society being held in June 2007 in Columbia, SC (see: <http://www.benthos.org/Meeting/>). Finally, as funding for this program ends in September 2007 (end of FY07), efforts are underway to examine potential mechanisms to continue program funding.

#### References

[http://sofia.usgs.gov/lox\\_monitor\\_model/](http://sofia.usgs.gov/lox_monitor_model/)

Brandt, L.A., Harwell, M., Waldon, M. (2004) Work Plan: Water Quality Monitoring and Modeling for the A.R.M. Loxahatchee National Wildlife Refuge: 2004-2006. Prepared for the A.R.M. Loxahatchee National Wildlife Refuge. April, 2004. 33 pp.

Harwell, M. Surratt, D., Waldon, M., Walker, B., Brandt, L. (2005) A.R.M. Loxahatchee National Wildlife Refuge Enhanced Water Quality Monitoring and Modeling Interim Report. April, 2005. 106 pp.

**Table 1.** 2006 Total phosphorus data (ppb) available for January – December 2006 from the Enhanced Water Quality Monitoring Program for: (a) marsh, and (b) canal stations for the A.R.M. Loxahatchee National Wildlife Refuge. Graphical representation of station locations are shown in Figures 1-3.

a) Marsh stations

Marsh Station	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06
LOXA101	10	8	11	-	-	-	23	U	36	9	13	5
LOXA102	7	7	-	-	-	-	17	-	11	6	6	U
LOXA103	7	6	7	-	-	-	17	-	13	8	-	2
LOXA105	10	10	12	-	-	-	48	-	12	-	14	-
LOXA106	8	6	-	-	-	-	17	3	8	8	7	-
LOXA107	-	6	-	-	-	-	-	-	7	7	5	-
LOXA108	-	6	-	7	-	-	-	-	10	5	3	-
LOXA109	7	7	7	-	-	-	8	5	4	8	5	U
LOXA110	6	7	-	-	-	-	U	-	3	11	4	-
LOXA111	7	8	-	-	-	-	21	-	5	4	6	-
LOXA112	8	8	9	-	-	-	4	U	5	6	8	-
LOXA113	5	6	8	9	-	-	14	-	6	4	6	-
LOXA114	6	5	-	-	-	-	4	U	6	6	4	-
LOXA116	14	13	18	18	-	-	90	24	25	86	-	8
LOXA117	10	9	10	-	-	-	20	8	9	19	11	13
LOXA118	7	7	7	7	-	-	5	U	6	8	4	6
LOXA119	6	5	6	6	-	-	20	U	3	U	4	U
LOXA120	7	5	10	8	20	8	10	U	3	6	5	6
LOXA121	-	36	-	-	-	-	-	-	-	-	X	X
LOXA122	11	5	11	-	-	-	10	16	8	7	7	9
LOXA123	-	-	-	-	-	-	-	-	-	-	X	X
LOXA124	9	7	9	10	-	-	5	U	47	3	14	8
LOXA126	6	10	9	10	-	-	5	U	9	U	5	8
LOXA127	7	6	9	9	-	-	U	U	9	U	13	7
LOXA128	7	6	-	-	-	-	3	U	5	5	3	2
LOXA130	8	9	10	14	-	9	23	U	12	U	18	6
LOXA131	8	5	8	13	-	8	10	U	7	U	3	9
LOXA133	-	15	16	-	-	-	-	28	-	-	20	-
LOXA134	12	12	12	19	-	-	7	36	13	12	9	11
LOXA136	27	12	-	-	-	-	-	28	28	18	15	13
LOXA137	10	7	11	13	-	11	10	27	10	5	9	6
LOXA138	8	7	11	-	-	-	8	U	9	4	4	-
LOXA139	8	7	-	-	-	-	5	-	6	4	4	-
LOXA140	7	6	11	-	-	-	15	-	13	6	9	-
LOXA141											8	3
MAX	27	36	18	19	20	11	90	36	47	86	20	13
MIN	5	5	6	6	20	8	4	3	3	3	3	3

U indicates that compound was analyzed but not detected.  
X indicates station no longer sampled.

**Table 1 cont.**

b) Canal stations

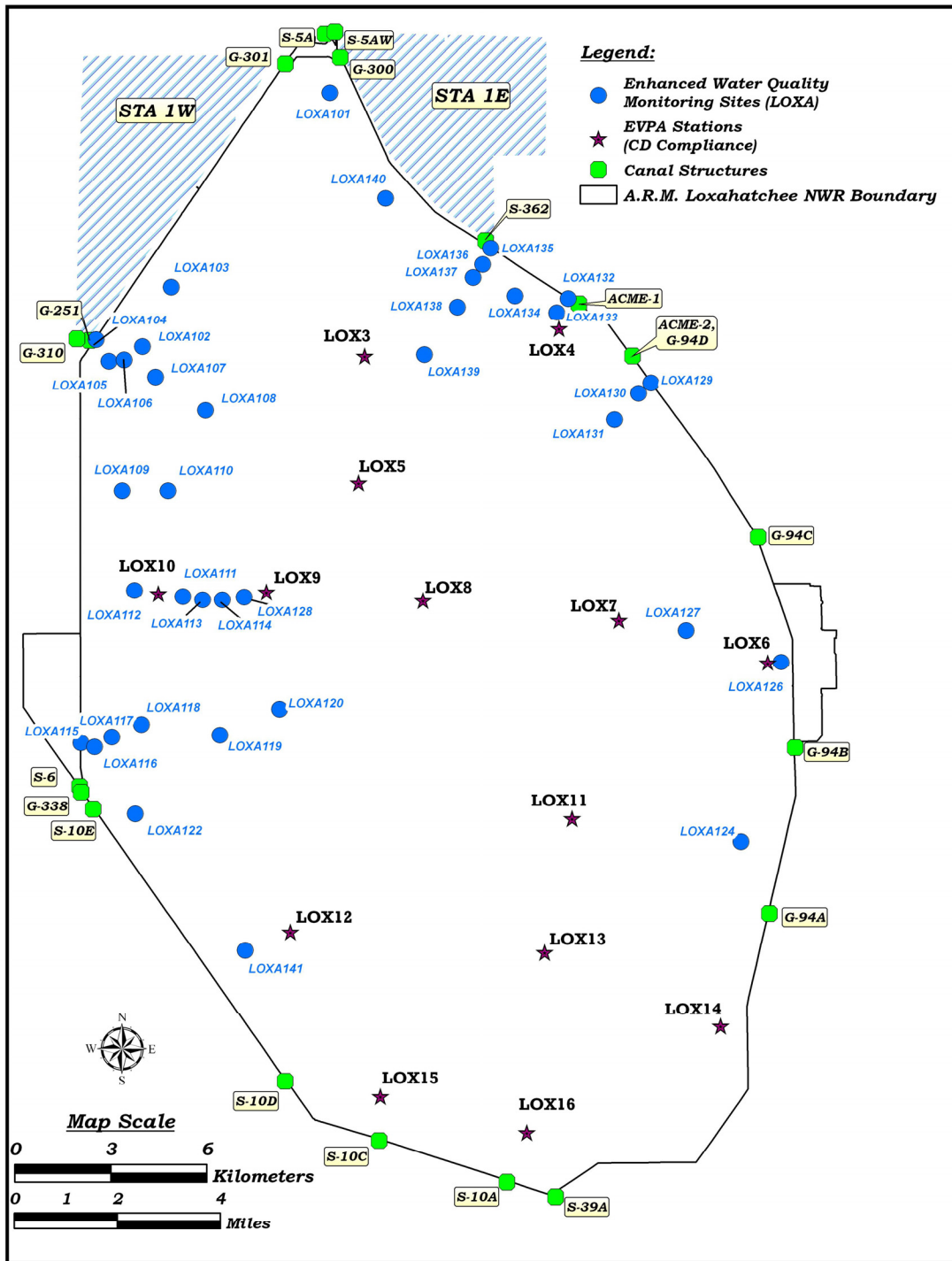
Canal Station	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06
LOXA104	51	122	73	60	43	68	110	75	150	43	60	37
LOXA115	35	143	50	39	41	36	120	71	120	60	34	25
LOXA129	77	88	80	78	88	71	68	34	110	19	51	35
LOXA132	62	89	99	78	78	64	80	41	93	43	43	41
LOXA135	64	86	109	74	74	43	100	42	150	46	48	34
MAX	77	143	109	78	88	71	120	75	150	60	60	41
MIN	35	86	50	39	41	36	68	34	93	19	34	25

U indicates that compound was analyzed but not detected.

**Table 2.** January 2006 - December 2006 Conductivity sonde deployment information, separated by transect, for the A.R.M. Loxahatchee National Wildlife Refuge. X = data collected from sonde deployment during that month. Graphical representation of station locations are shown in Figures 1-3.

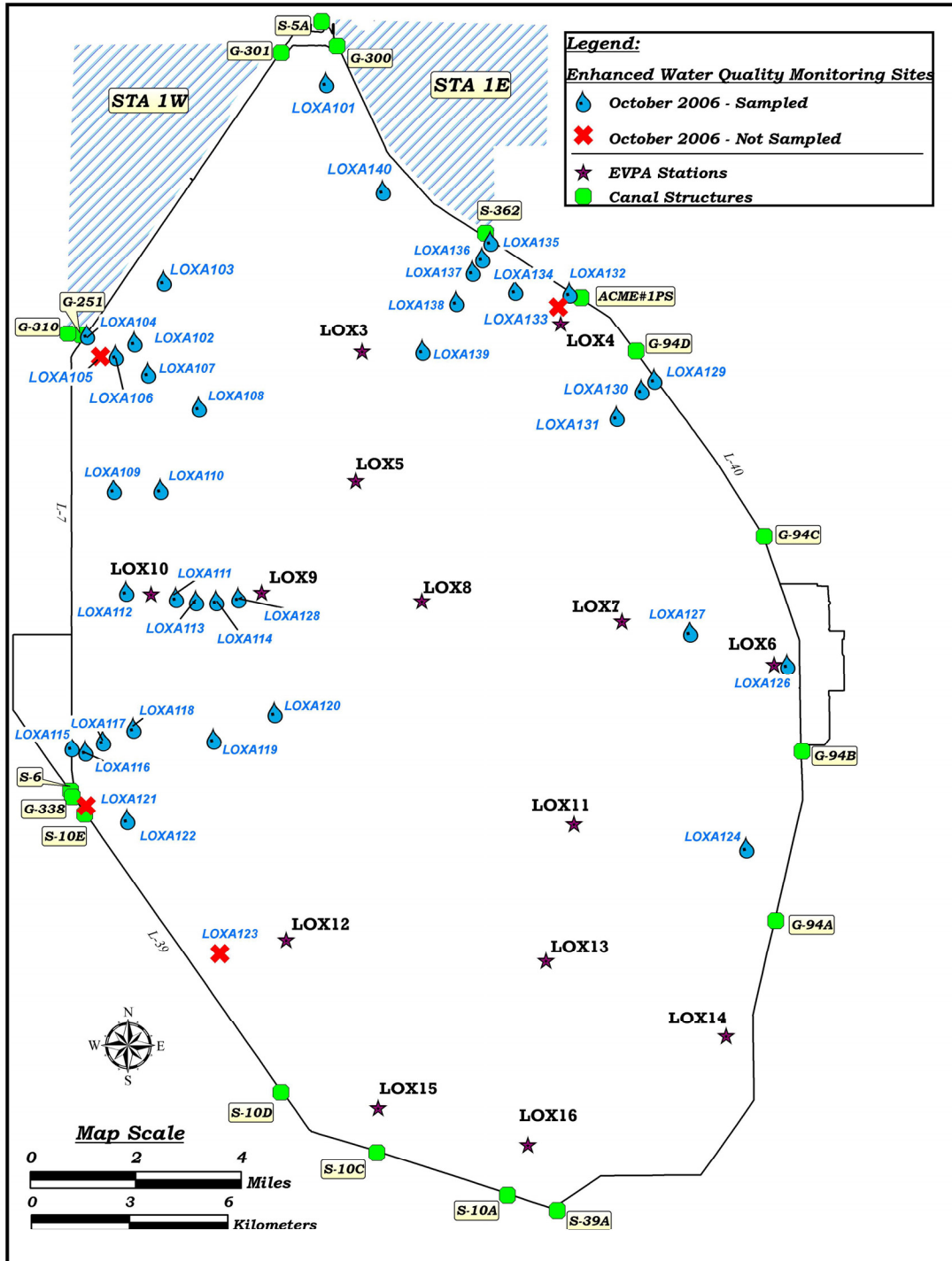
**Table 2**

Site ID	Description	2006											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
LOXA104	NW Transect 0 (canal)	X		X		X			X		X		X
LOXA105	NW Transect 0.5	X		X		X		X		X		X	
LOXA106	NW Transect 1	X		X		X		X		X		X	
LOXA107	NW Transect 2	X		X		X		X		X		X	
LOXA108	NW Transect 4	X		X		X		X		X		X	
LOXA111		X	X		X		X		X		X		X
LOXA112		X	X		X		X		X		X		X
LOXA113		X	X		X		X		X		X		X
LOXA114		X	X		X		X		X		X		X
LOXA115	SW Transect 0 (canal)	X		X		X			X		X		X
LOXA116	SW Transect 0.5		X			X		X		X		X	
LOXA117	SW Transect 1		X			X		X		X		X	
LOXA118	SW Transect 2		X			X		X		X		X	
LOXA119	SW Transect 4		X			X		X		X		X	
LOXA120	SW Transect- X5		X			X		X		X		X	
LOXA126		X			X				X		X	X	X
LOXA127		X			X		X		X	X	X	X	X
LOXA128					X	X			X		X	X	
LOXA129	NE Transect S 0 (canal)	X		X		X	X	X	X	X		X	
LOXA130	NE Transect S	X		X		X		X		X		X	
LOXA131	NE Transect S	X		X		X		X		X		X	
LOXA132	NE Transect N 0 (canal)	X	X	X	X	X	X	X	X	X		X	
LOXA133	NE Transect N	X		X		X			X	X		X	
LOXA135	NE Transect STA1E 0 (canal)	X		X		X	X	X	X	X		X	
LOXA136	NE Transect STA1E 0.5	X		X		X			X	X		X	
LOXA137	NE Transect STA1E 1	X		X		X		X		X		X	
LOXA138	NE Transect STA1E 2	X		X		X		X		X		X	
LOXA139	NE Transect STA1E 4	X		X		X		X		X		X	
LOX6	EVPA site	X	X		X		X		X		X	X	X
LOX7	EVPA site	X	X		X		X		X			X	X
LOX8	EVPA site	X	X		X		X		X		X	X	X
LOX9	EVPA site	X	X		X		X		X		X	X	X
LOX10	EVPA site	X	X		X		X		X		X		X

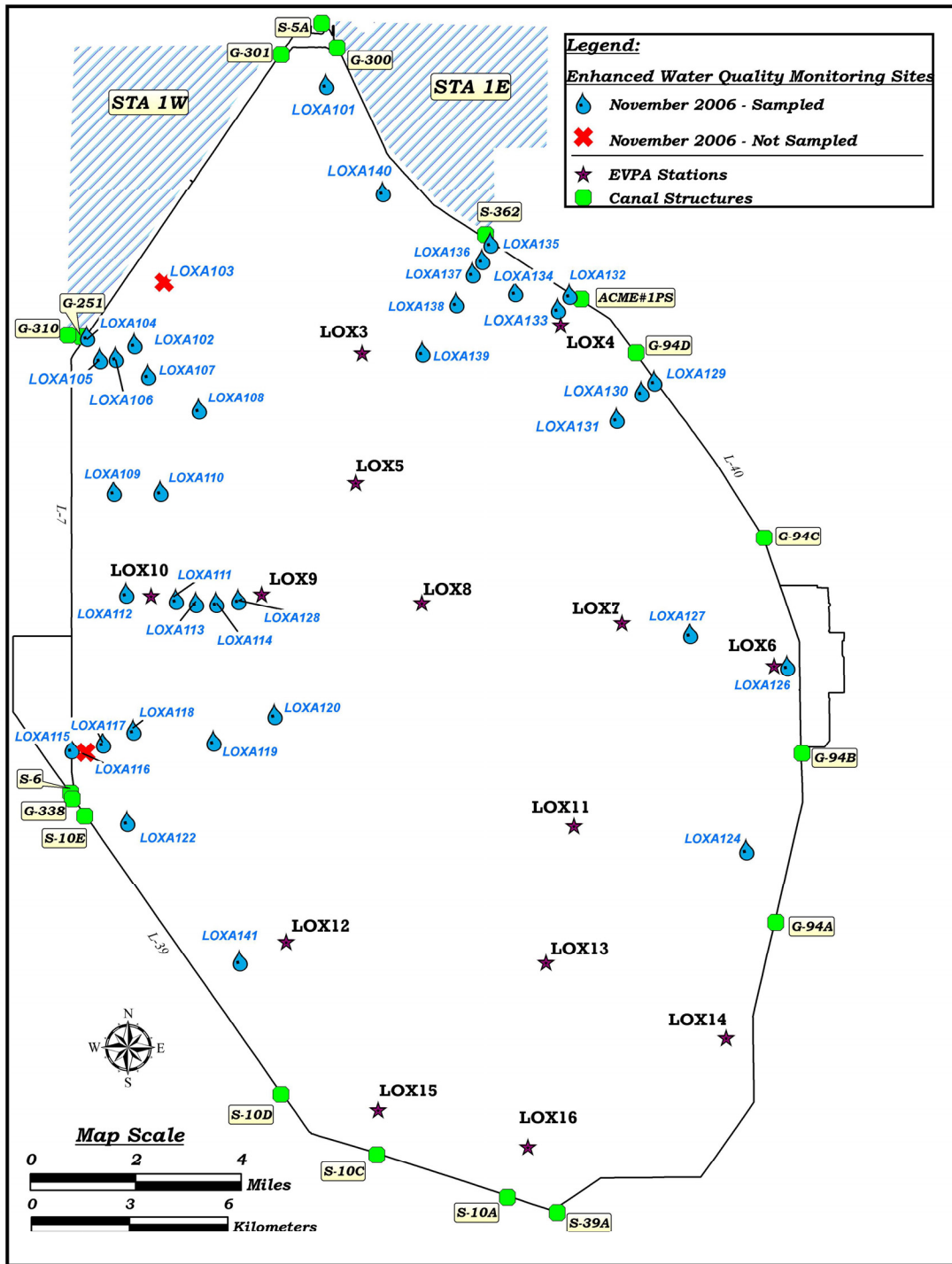


**Figure 1.** Location of Enhanced Water Quality Monitoring network stations (LOXA###), in relation to Consent Decree compliance stations (LOX##), for the A.R.M. Loxahatchee National Wildlife Refuge. Note: former stations LOXA121 and LOXA123 were no longer sampled after October 2006, and are not shown in this map.

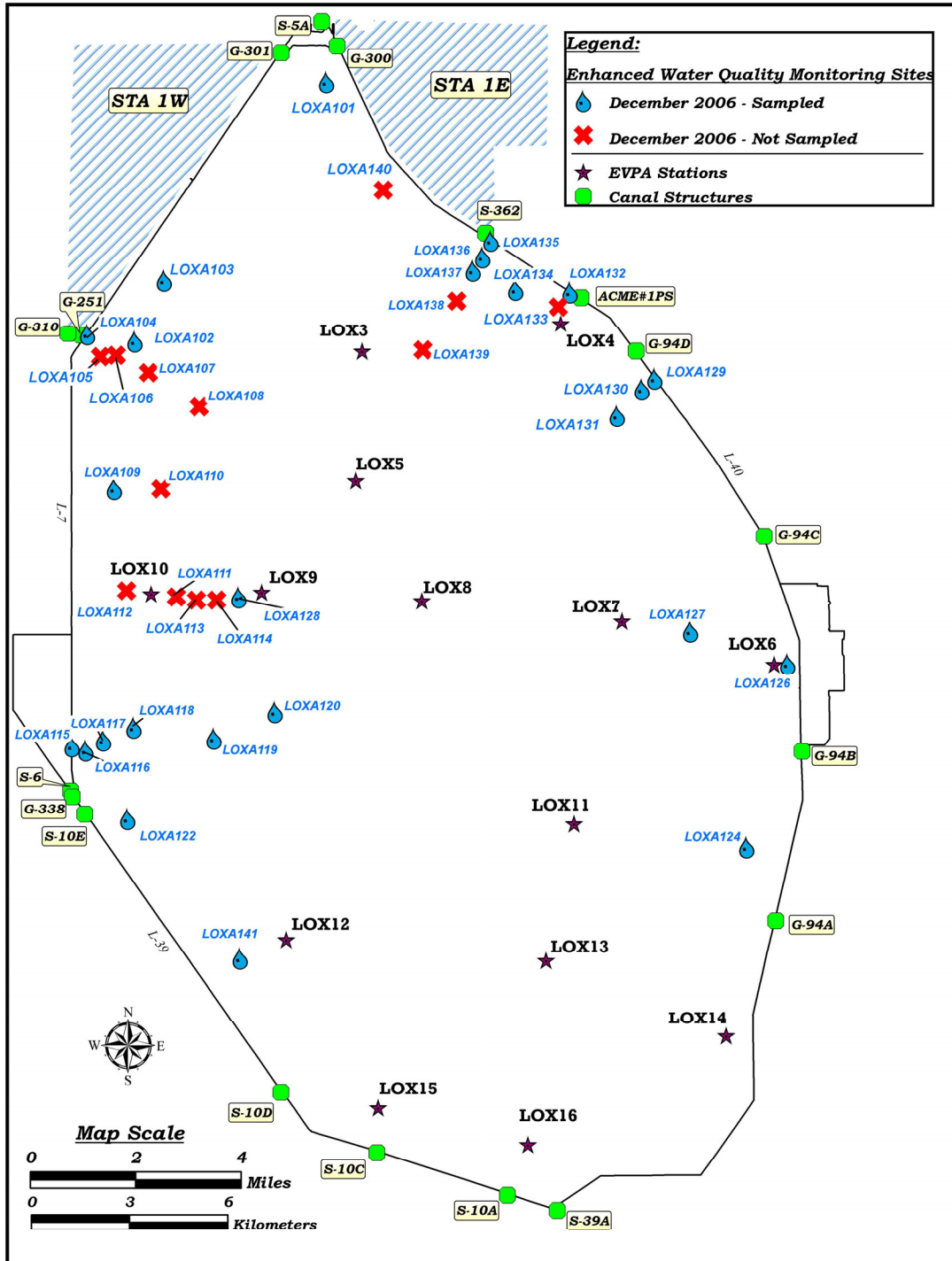




**Figure 2.** October 2006 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.



**Figure 3.** November 2006 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.



**Figure 4.** December 2006 map of total phosphorus sample collections from the Enhanced Water Quality Monitoring and the EVPA stations in the A.R.M. Loxahatchee National Wildlife Refuge. A primary reason that a station is not sampled is that it has less than 10 cm of clear water column representative of that area.