ECFTX TRANSIENT MODEL CALIBRATION SUMMARY

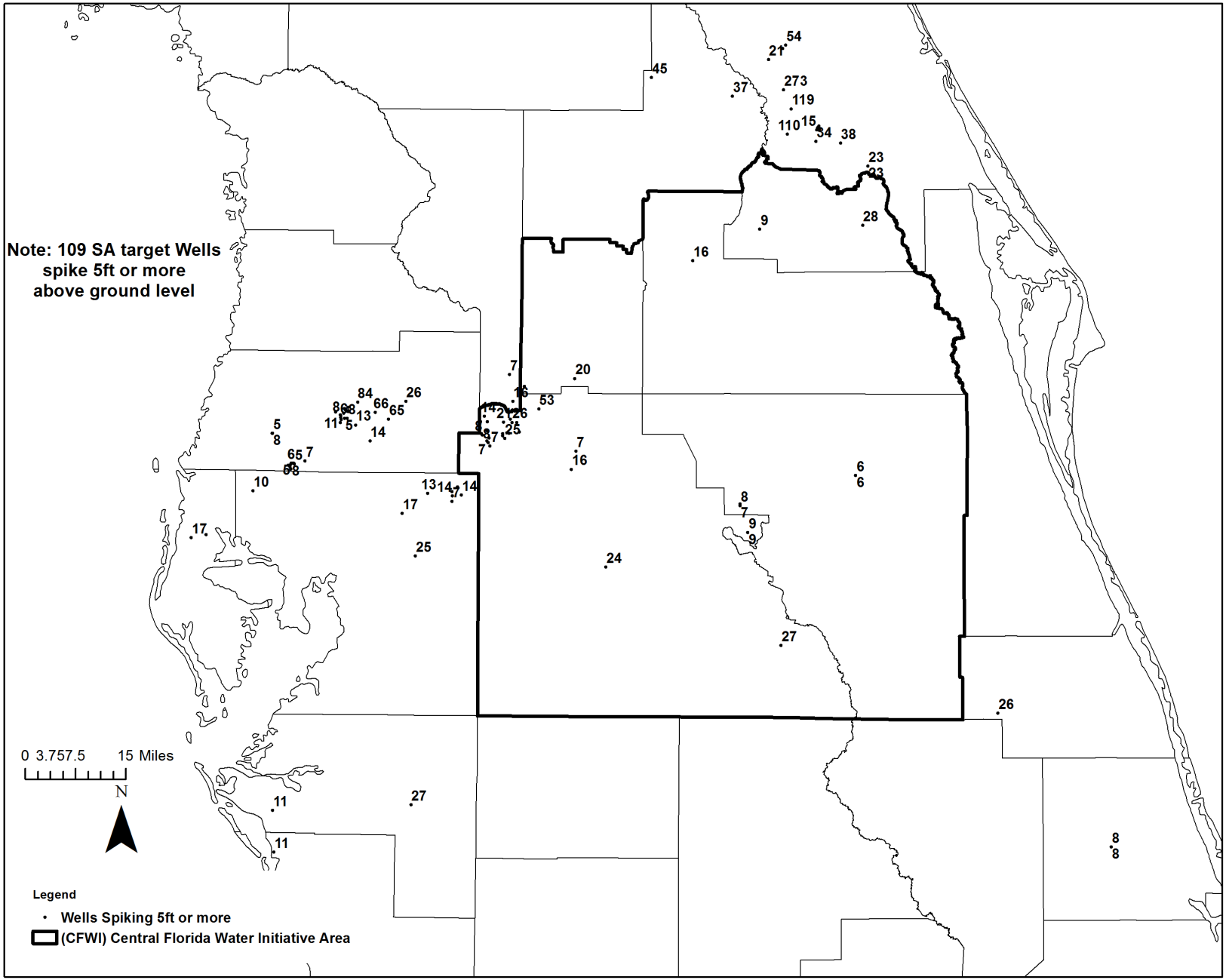
Wednesday, December 12, 2018 1-4 PM

PEER REVIEW PANEL TELECONFERENCE

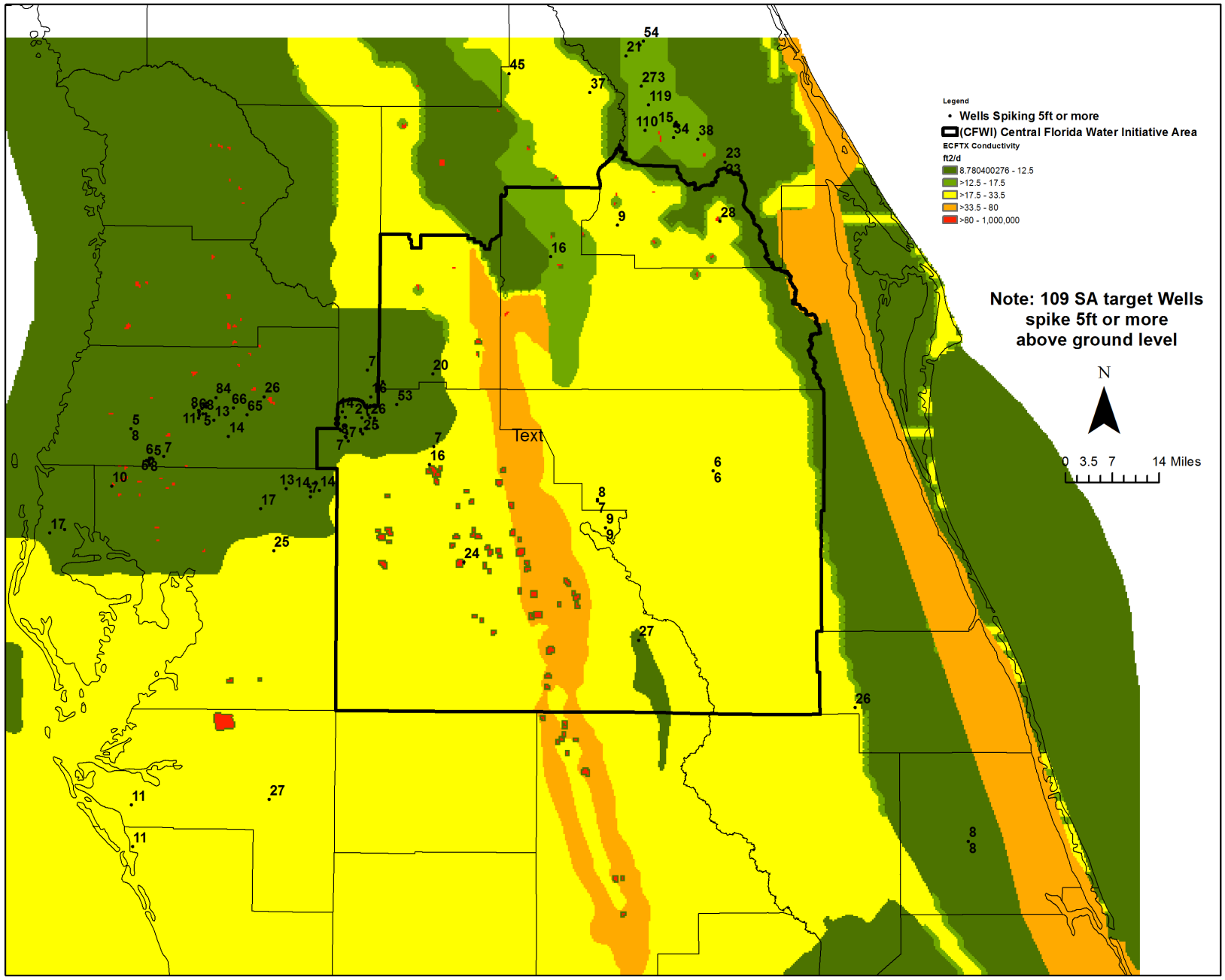
Agenda

1. Introduction
2. Summary of work performed since last meeting
3. Transient Model Calibration summary
4. Panel Discussion
5. Schedule
6. Public Comment

SA Target Well Spiking Above 5ft (Sept 2004)

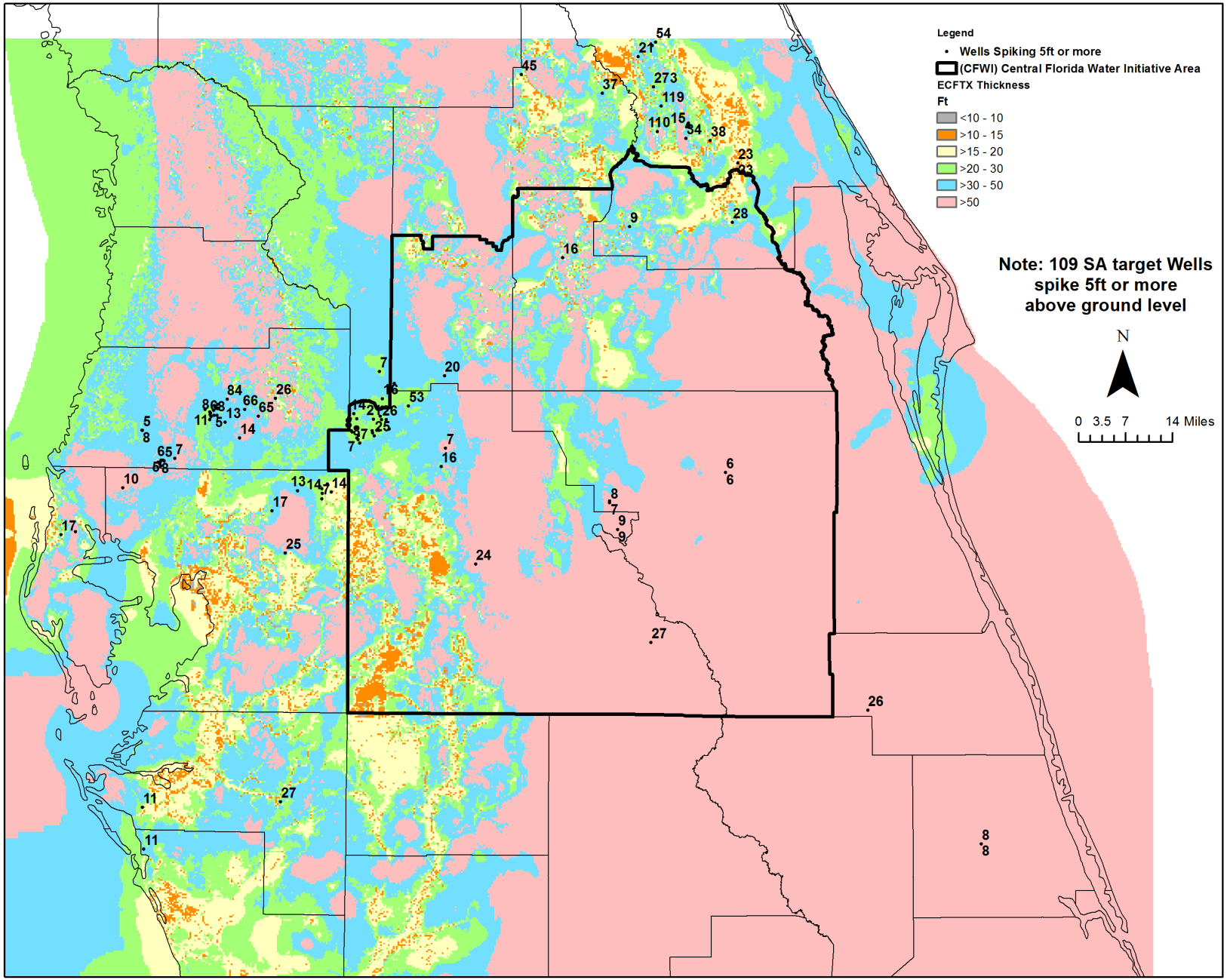


Map Showing Hydraulic Conductivity & SA Target Wells That Spike Above 5ft (Sept 2004)

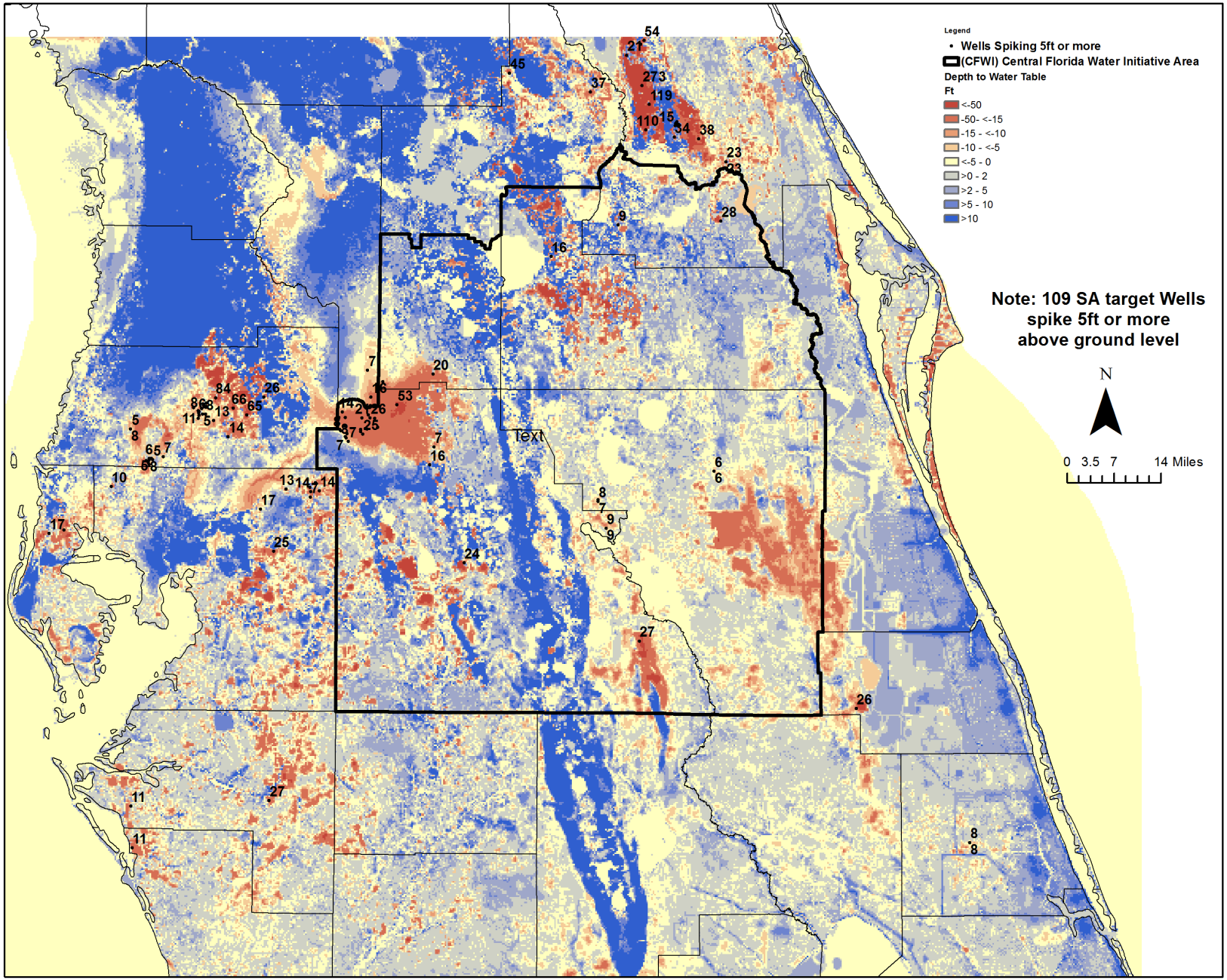


Note: Negative numbers represent that the water table is above ground level, while positive numbers represent that the water table is below ground level

Layer One Thickness With Spikes Above 5ft (Sept 2004)

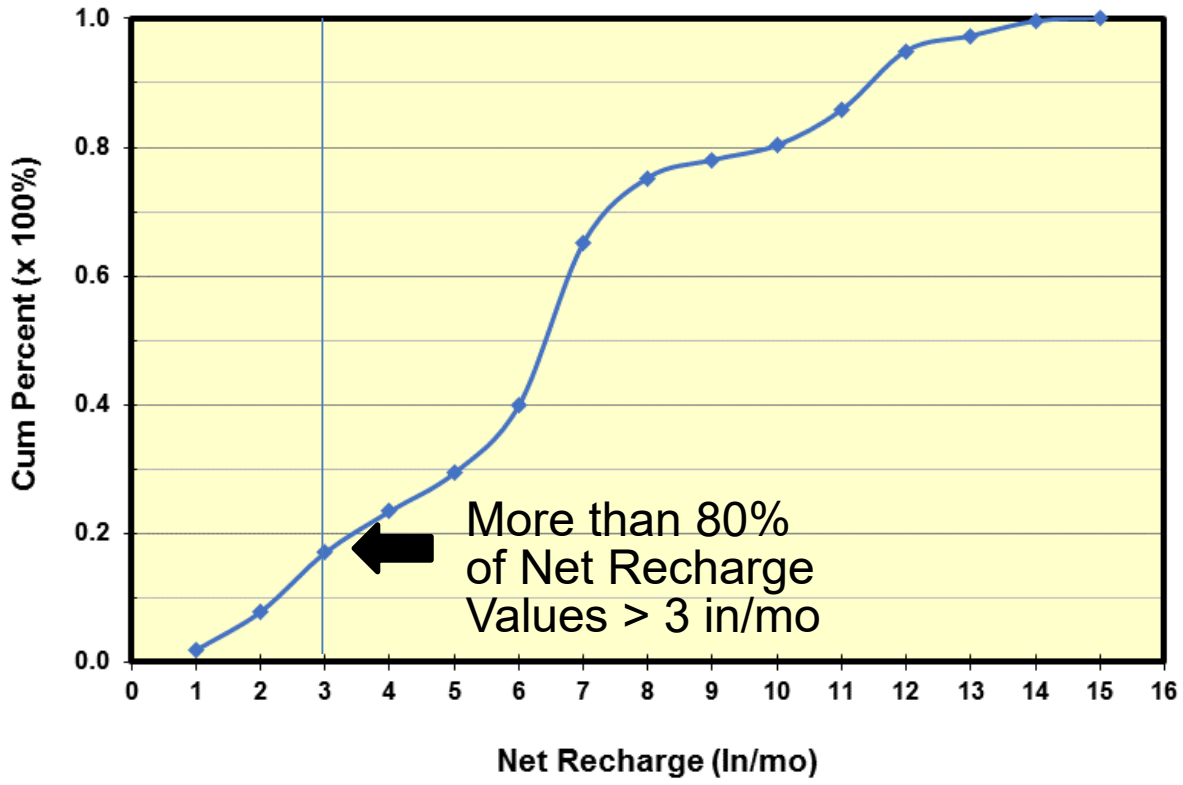


Map Showing Depth to Water Table & SA Target Wells That Spike Above 5ft (Sept 2004)



Note: Negative numbers represent that the water table is above ground level, while positive numbers represent that the water table is below ground level

Cumulative frequency of Net Recharge for 109 model cells with peaking water levels



INTB Model (1989-98)

Month	Rainfall_INTB (inches)	Ratio Recharge To Rainfall
Jan	3.45	0.31
Feb	2.86	0.28
Mar	3.56	0.25
Apr	2.99	0.19
May	2.50	0.11
Jun	6.85	0.17
Jul	7.62	0.22
Aug	7.15	0.21
Sep	6.40	0.22
Oct	3.58	0.25
Nov	1.69	0.23
Dec	2.87	0.26
Avg	4.29	0.22

Assuming 15 in/mo of rainfall = 3 in/mo recharge with a rainfall/recharge ratio of 0.2

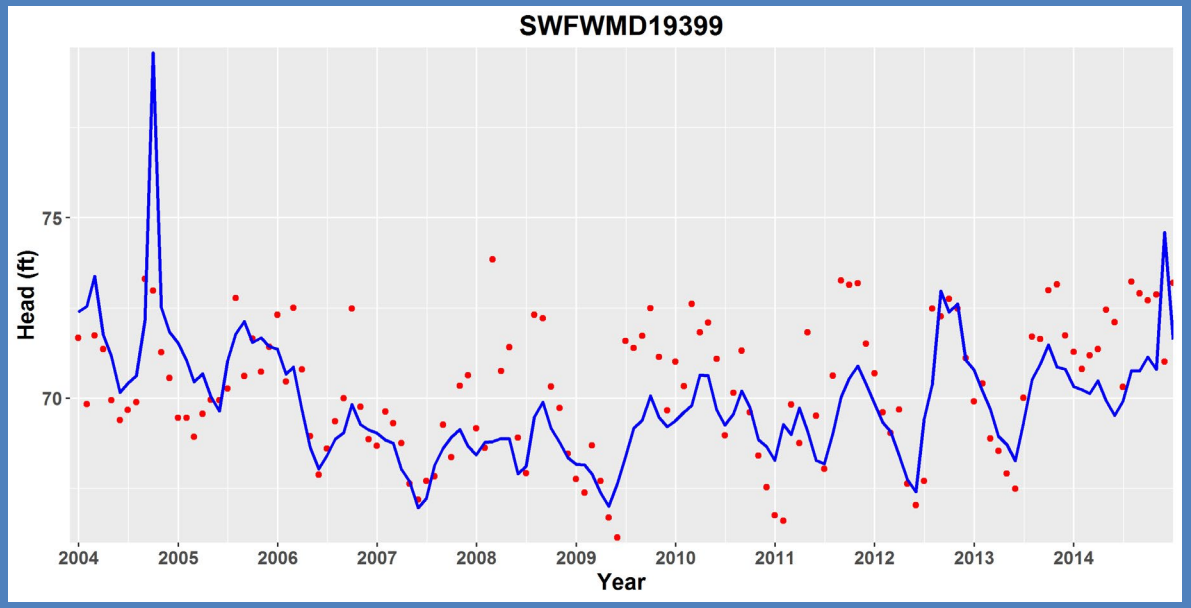
Issue with using static depth to water table (DWT)

- ET-RCH-ROFF program uses depth to water table (DWT) to calculate ET and recharge input
  - For unsaturated conditions (urban, agricultural, forest)
    - ET=UZET+GWET=PET
    - RCH=using unsaturated zone water balance model AFSIRS: uses DWT
  - For saturated conditions (open water, rivers, lakes)
    - ET=PET ; UZET=0
    - RCH=Rainfall
- 2003 average conditions are used for DWT during the transient period
- Spikes occur in situations where MODFLOW simulated DWT becomes significantly shallower than 2003 average conditions
- ET-RCH-ROFF program did not take this DWT variation into account (not coupled to MODFLOW)

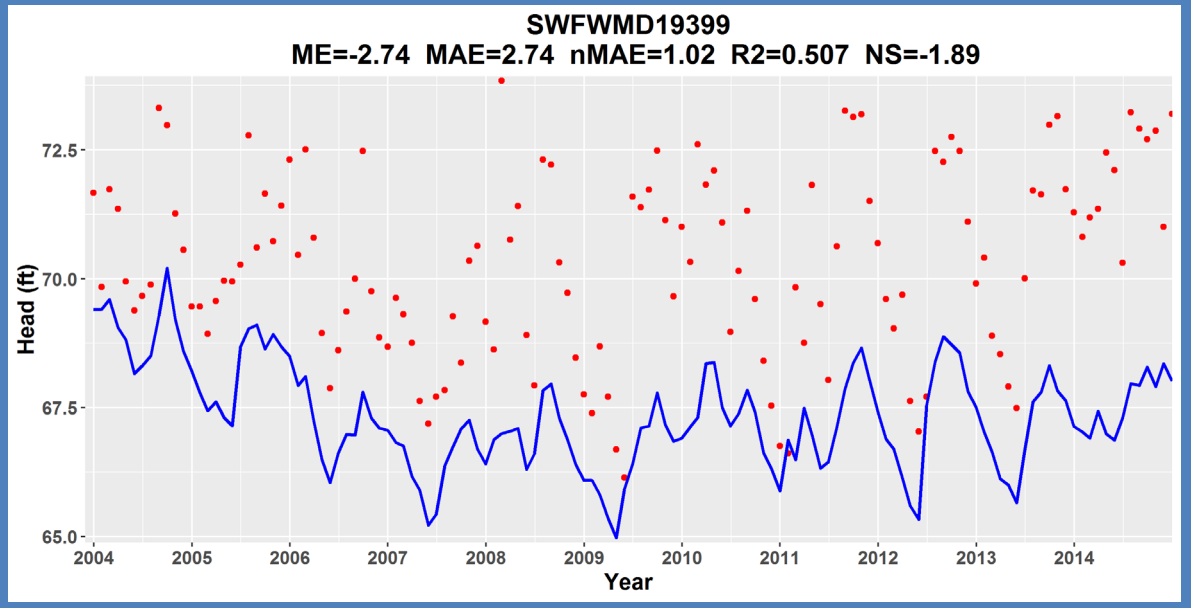
Run ET-RCH-ROFF program with MODFLOW simulated DWT

- Iter1: Use MODFLOW simulated heads in SAS to calculate DWT -> use this DWT to calculate new ET-RCH input
- Following additional condition is included for unsaturated conditions
  - **If (DWT<0.5 ft)**
    - **ET=PET; UZET=0.0 -> increased ET**
    - **RCH=0 ; Runoff=Rainfall -> reduced recharge**
- This method reduces the recharge as well as increases GWET in flooded situations
- Iter2: Use updated ET and RCH input to run MODFLOW

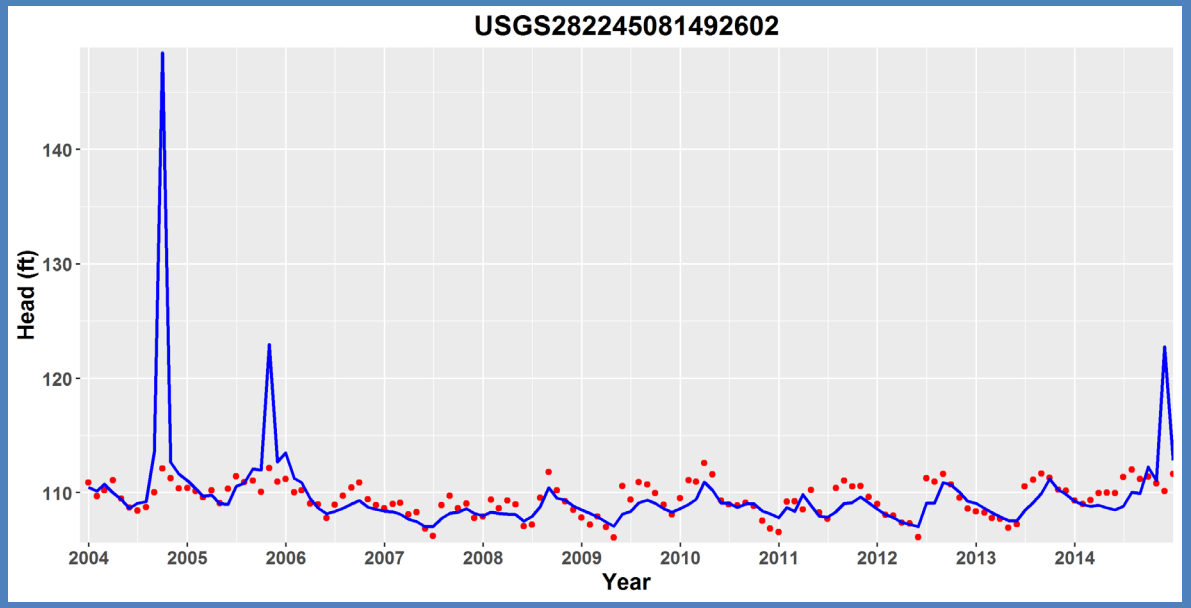
Before



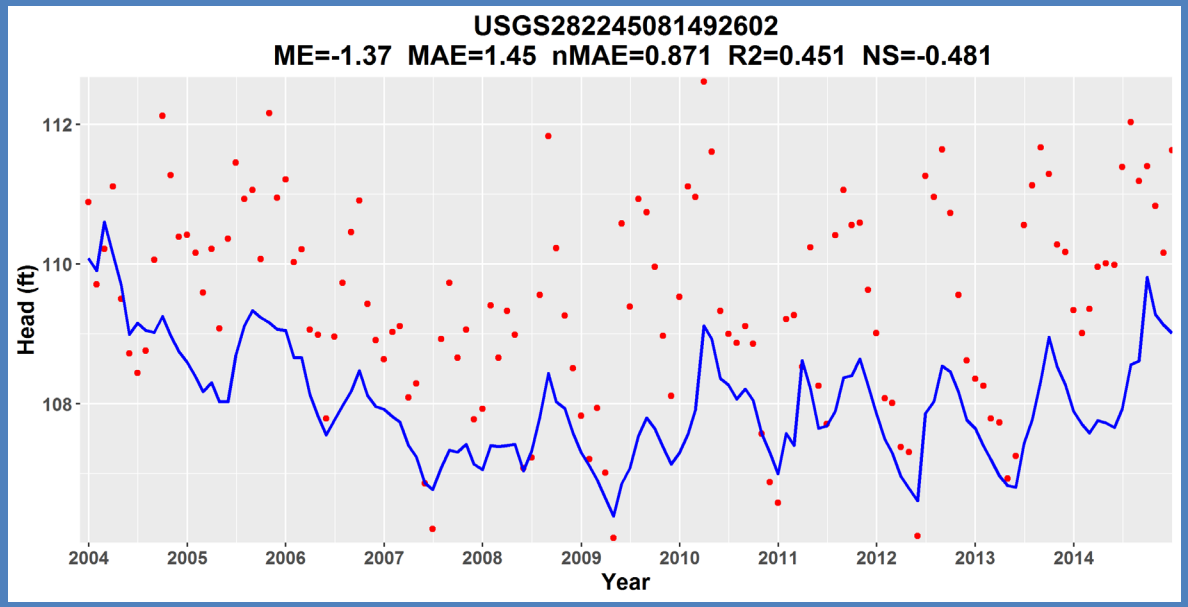
After



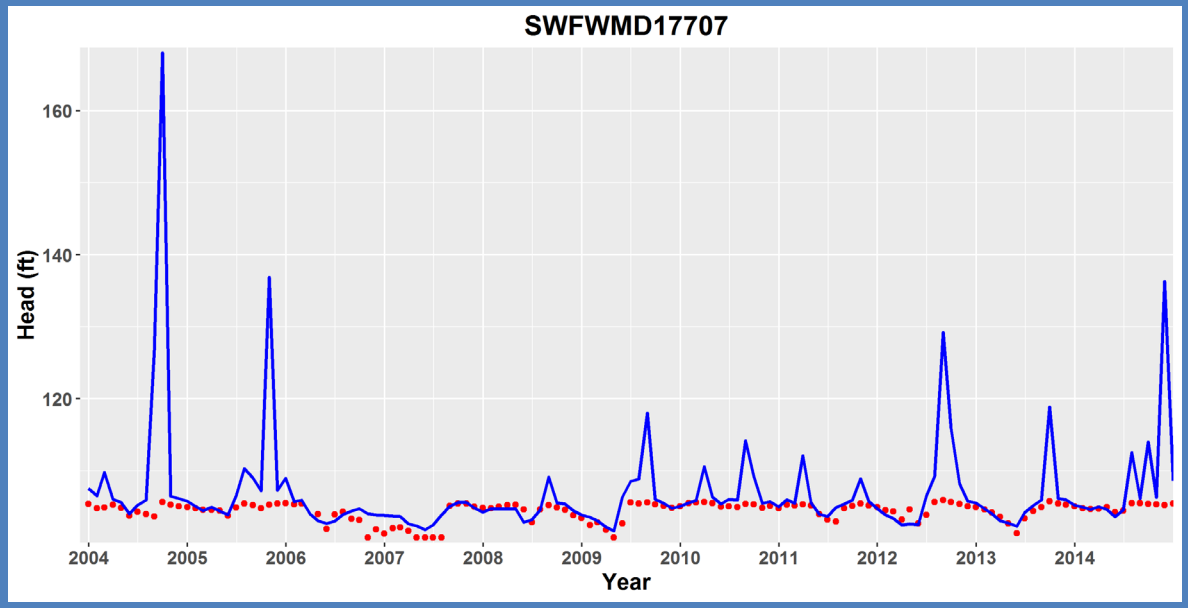
Before



After



Before



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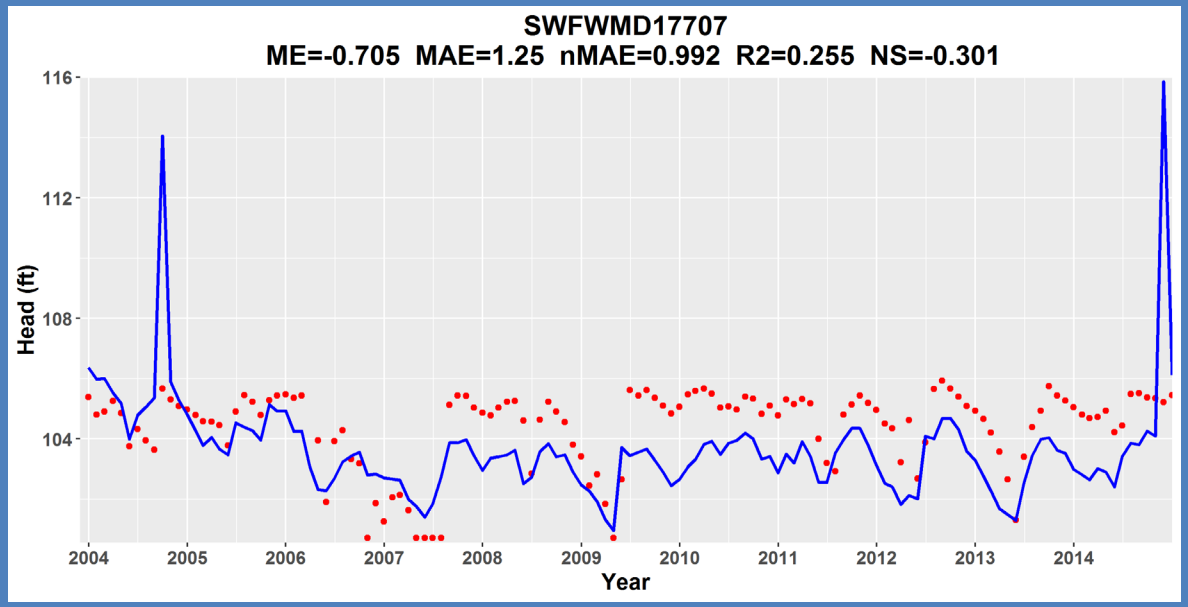

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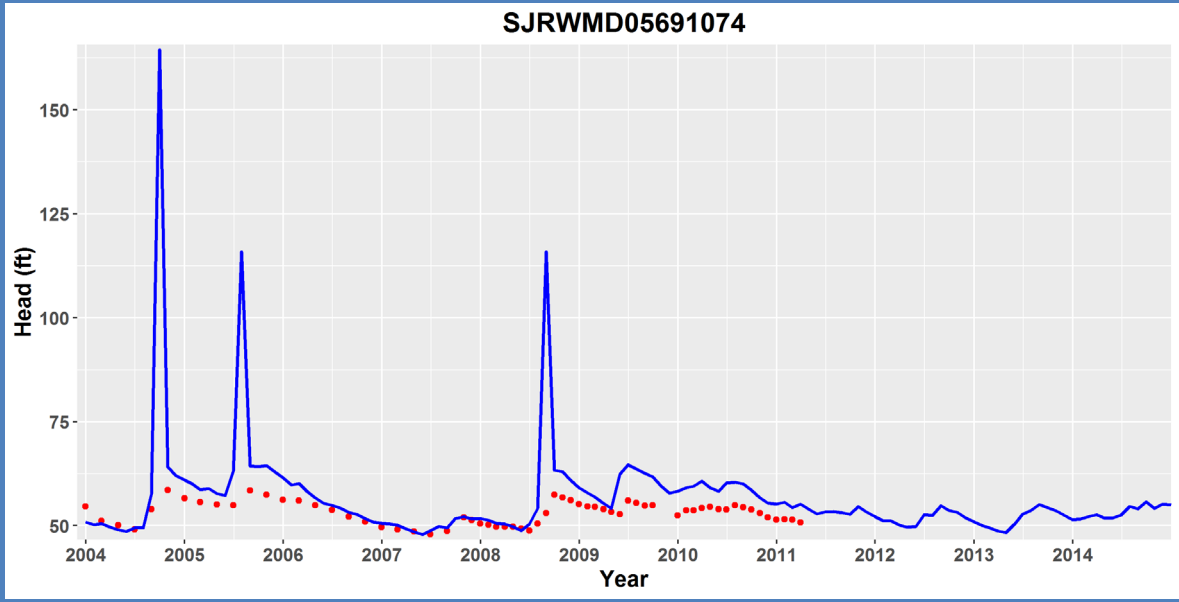

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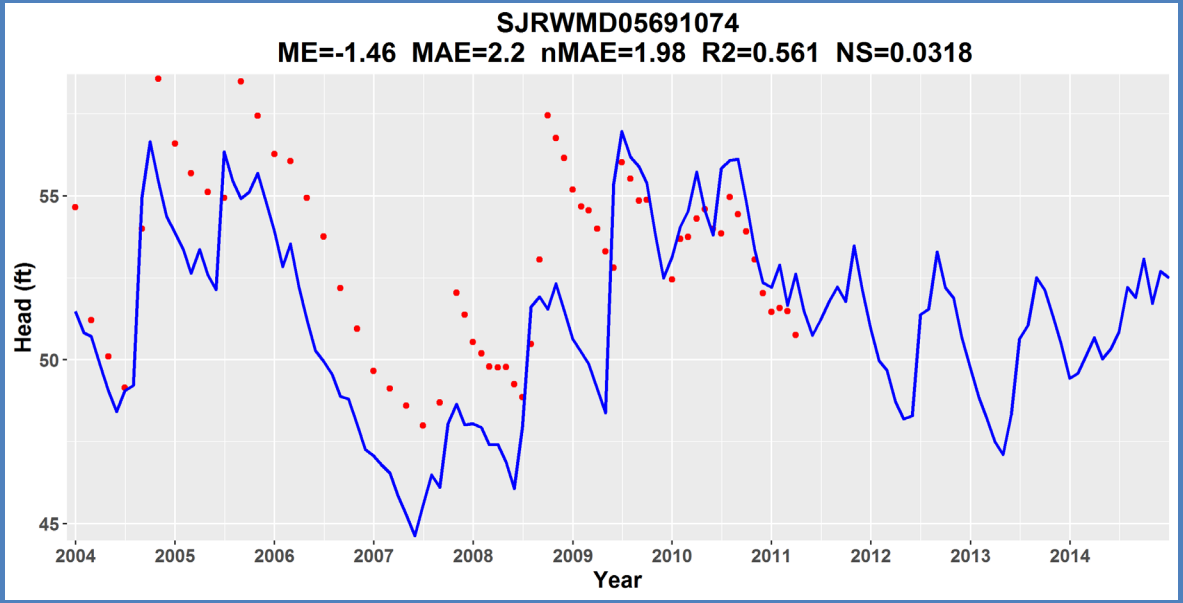
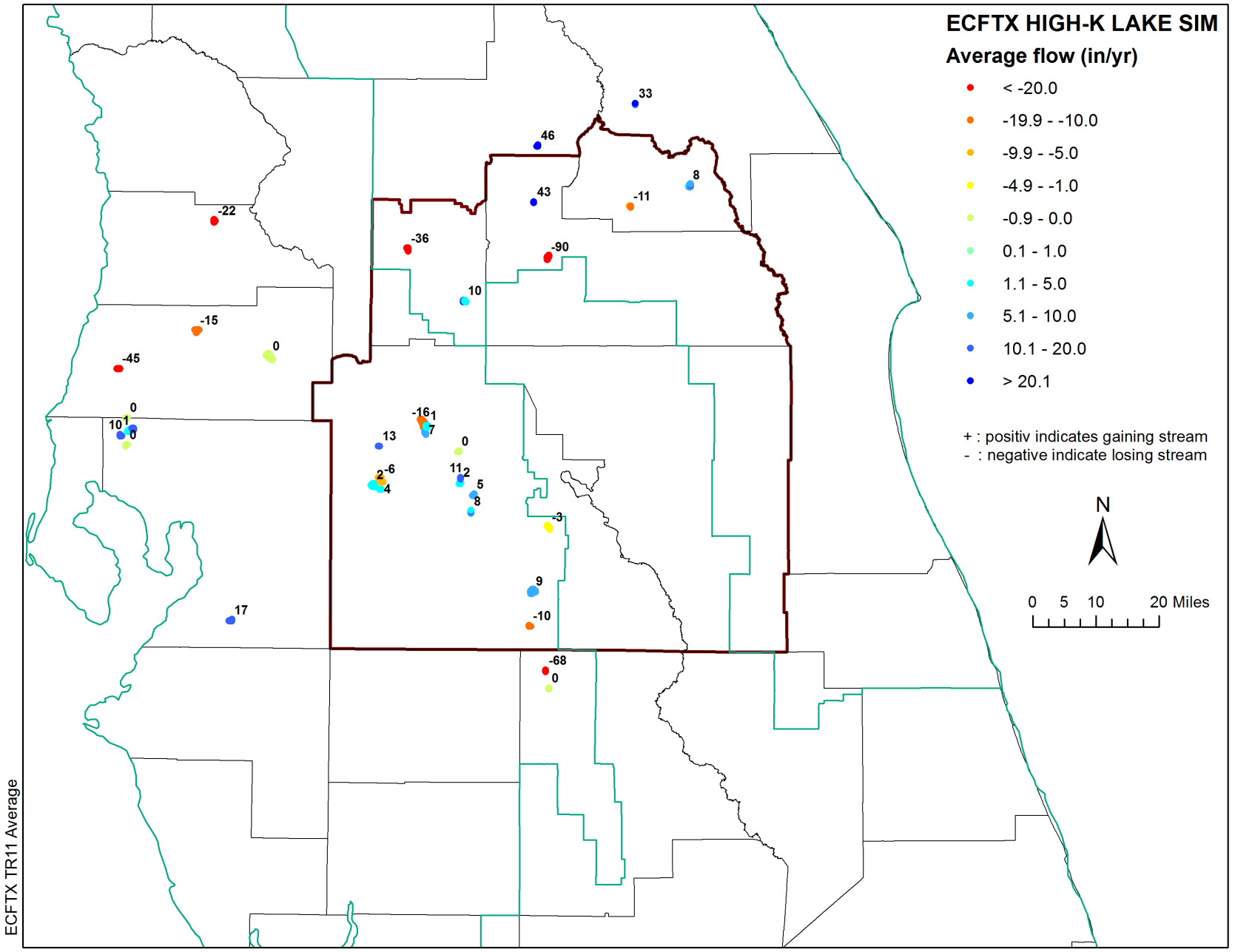


High K lakes converted to river cells due to peaking water levels (avg flux rate over model period)



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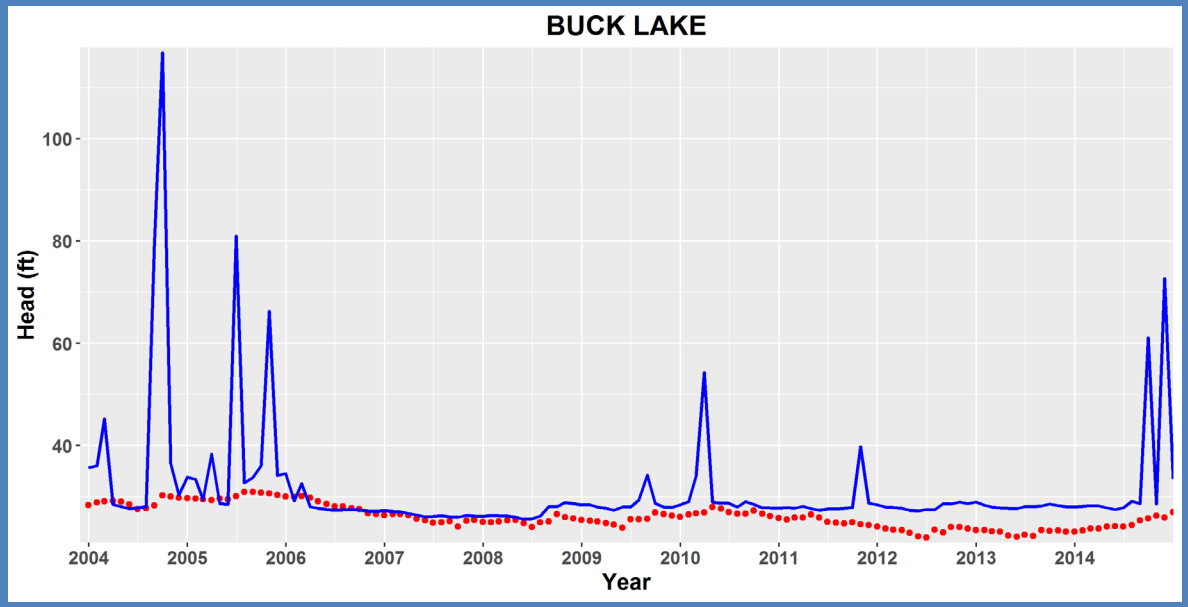
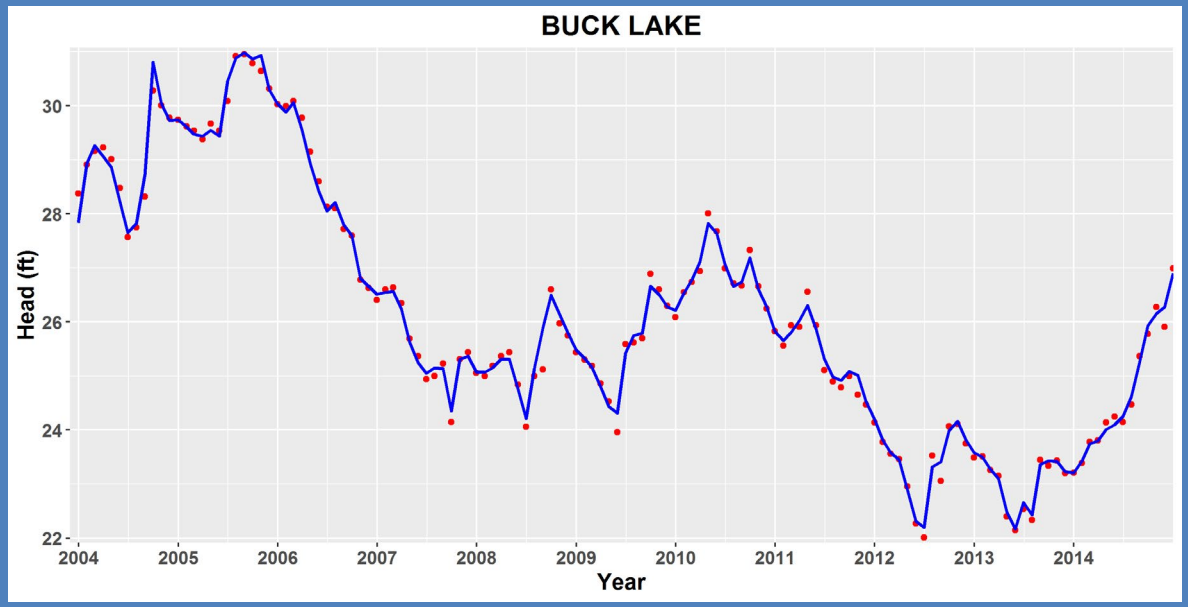
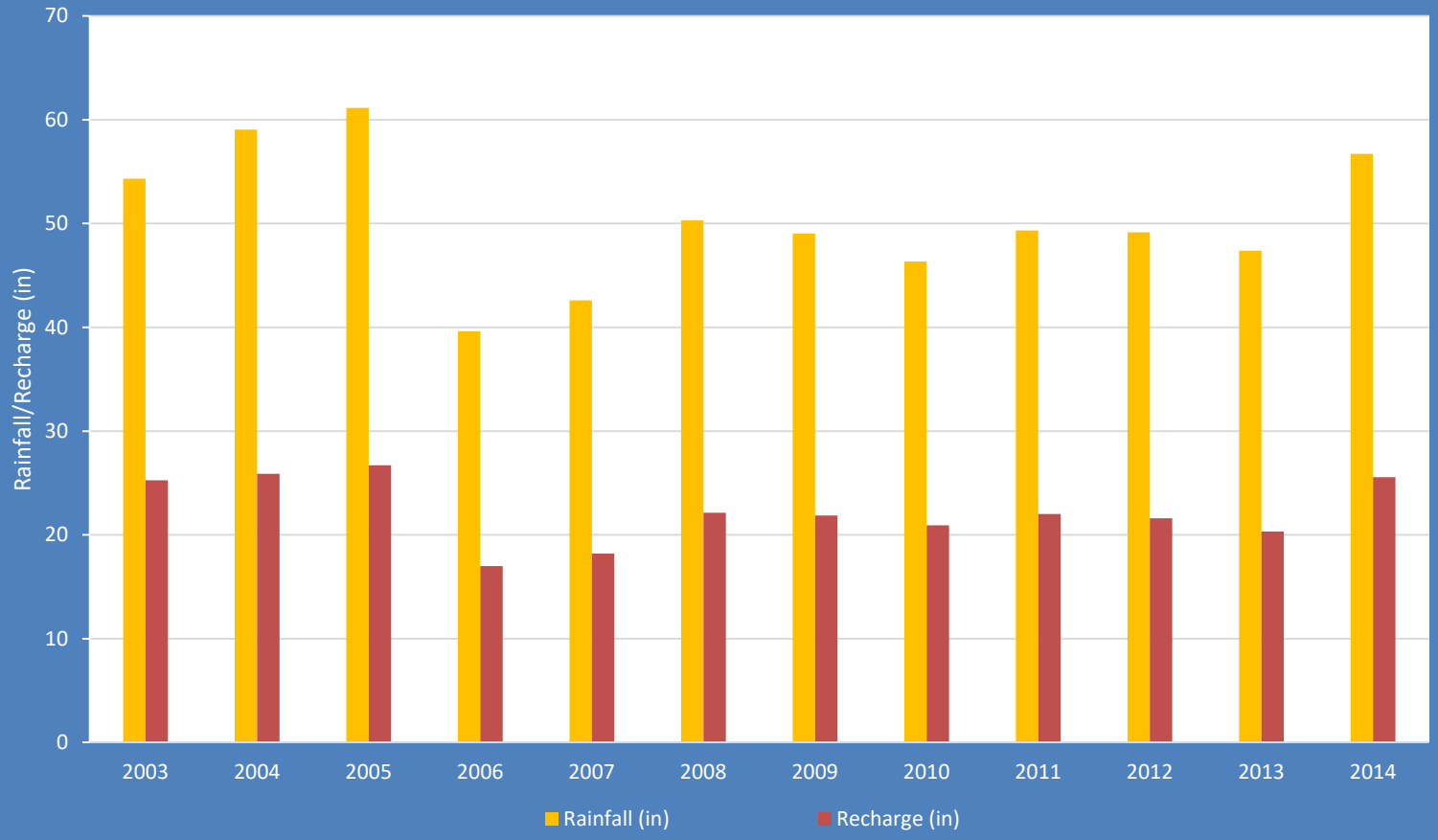


After

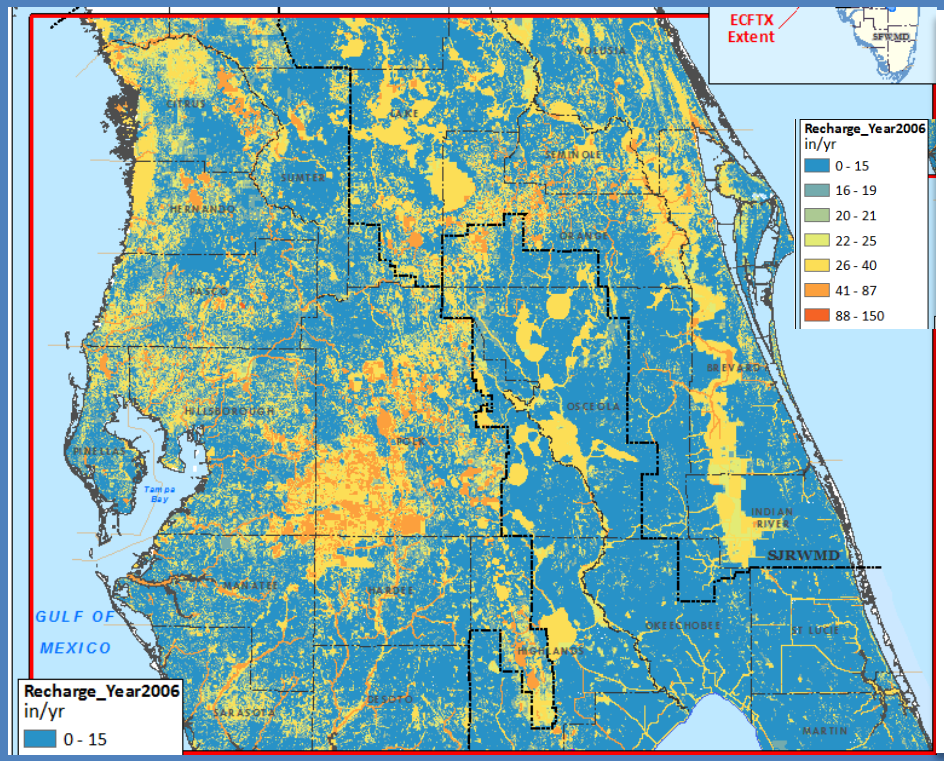


Annual Rainfall-Recharge in the ECFTX Model

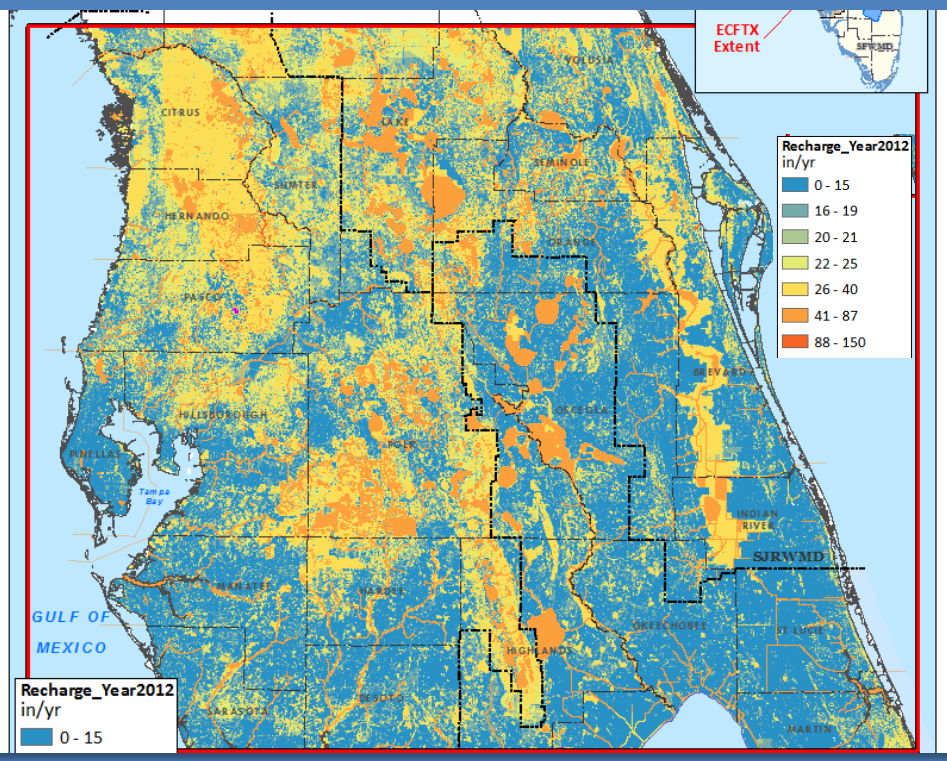


Applied Recharge

2006 Dry (Average RCH=17 in/yr)



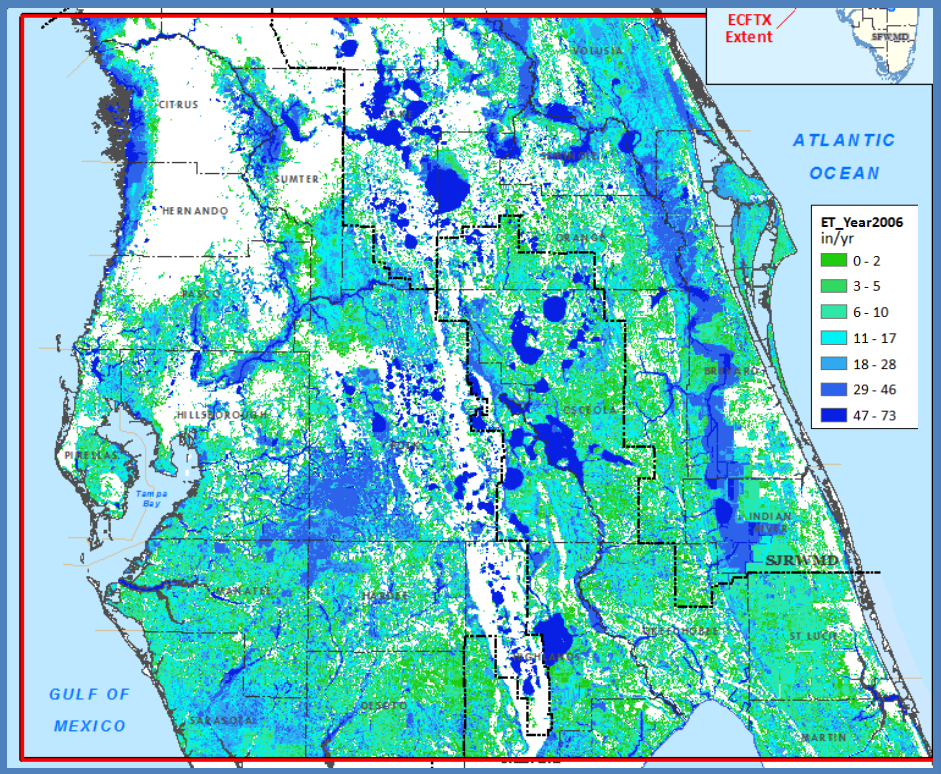
2012 Wet (Average RCH=21.6 in/yr)



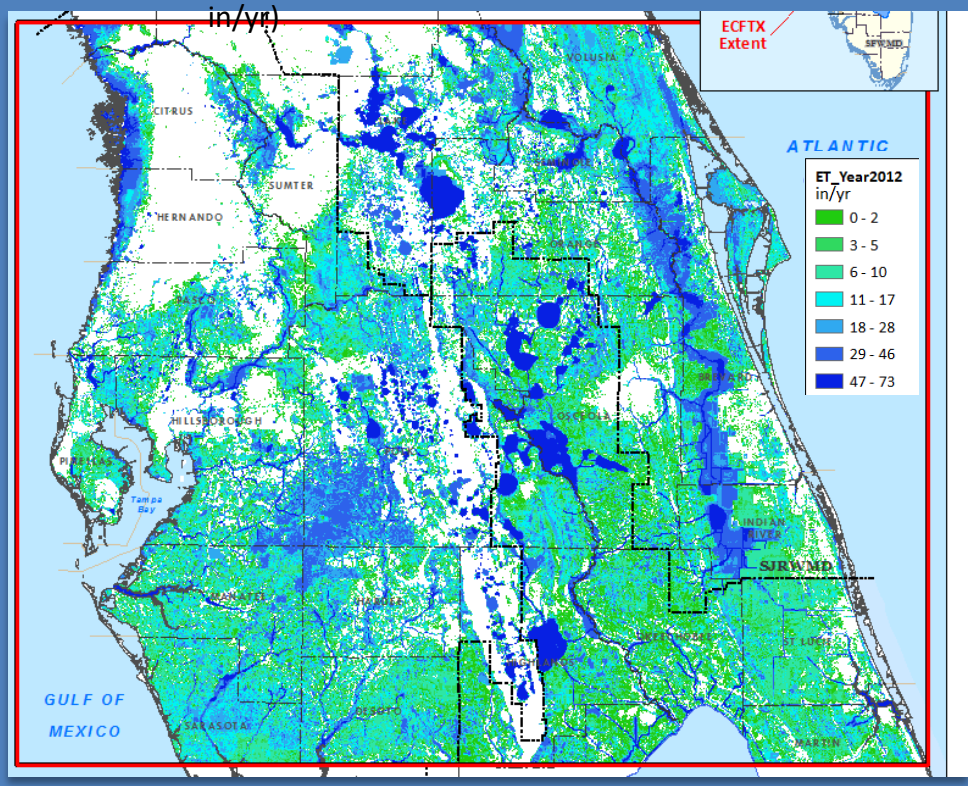
Average for 2003-2014= 18 in/yr

Groundwater ET

2006 Dry (Average ET= 14 in/yr)



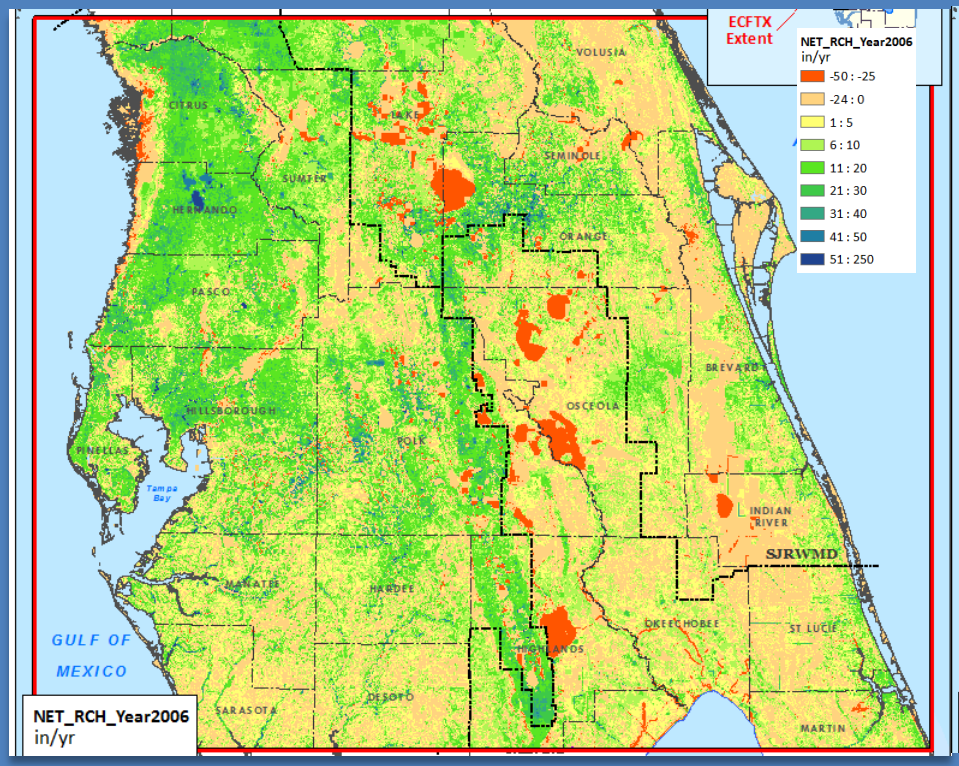
2012 Wet (Average ET=12.7 in/yr)



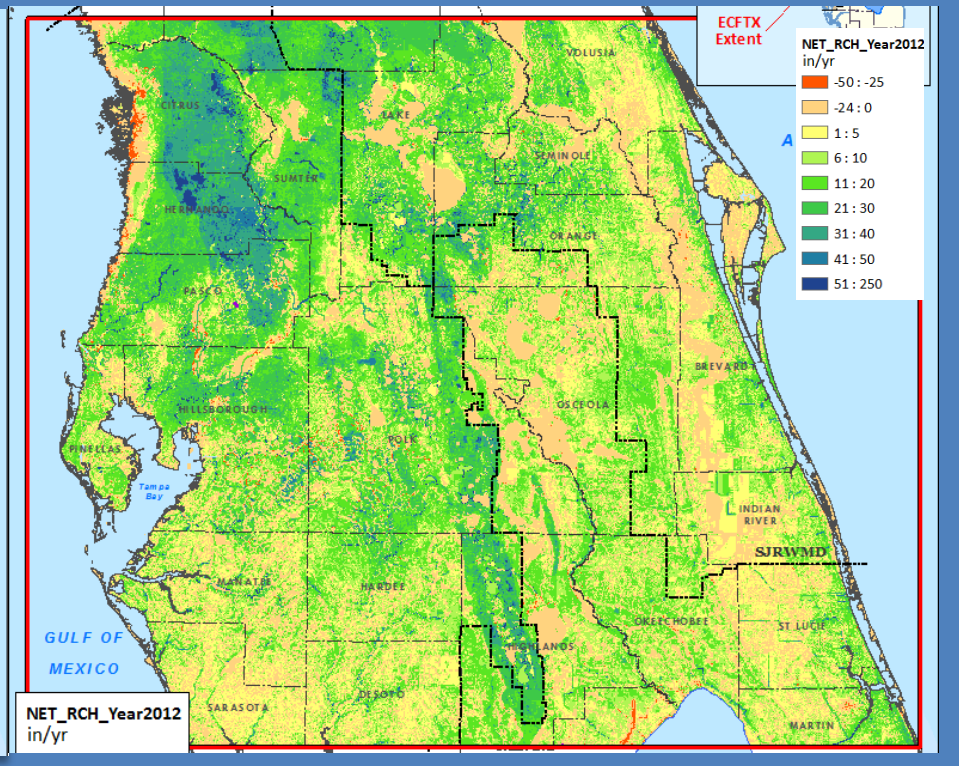
Average for 2003-2014= 10.7 in/yr

Net Recharge (Recharge-GW ET)

2006 Dry (Average Net RCH= 3 in/yr)



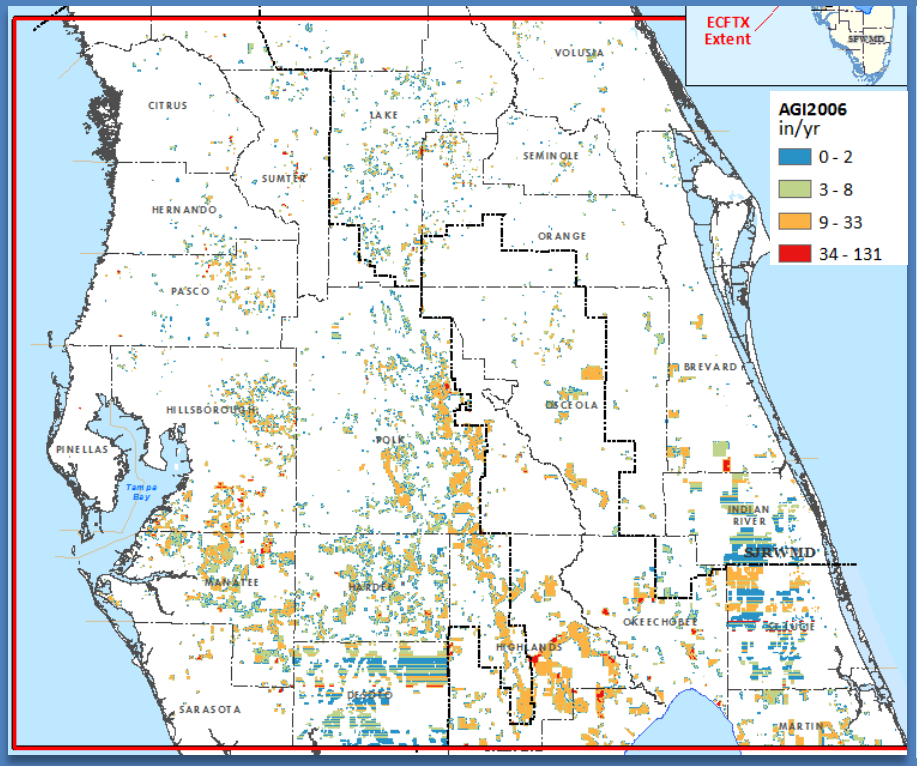
2012 Wet (Average Net RCH=8.9 in/yr)



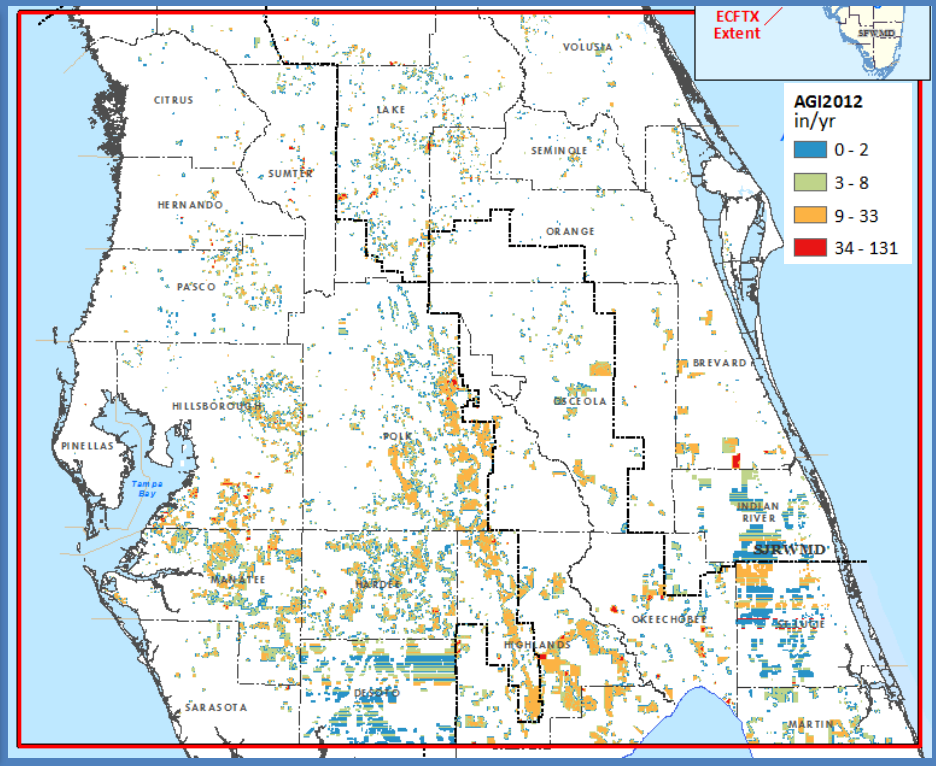
Average for 2003-2014= 7.3 in/yr

Agricultural Irrigation Return-AGI

2006 Dry (849 mgd)



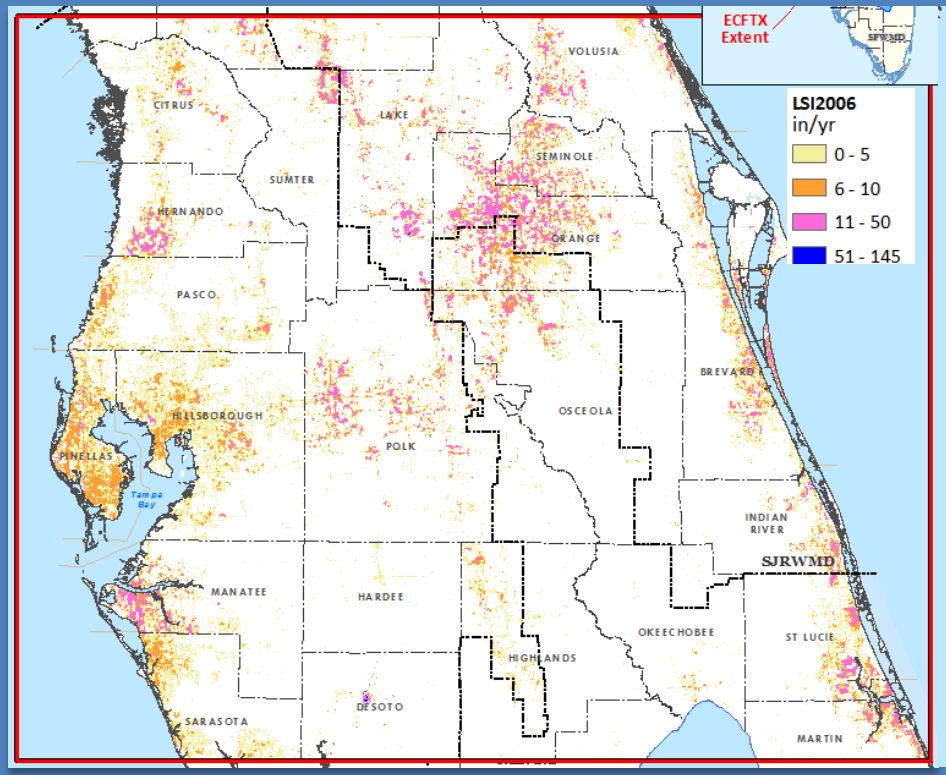
2012 Wet (Average = 742 mgd)



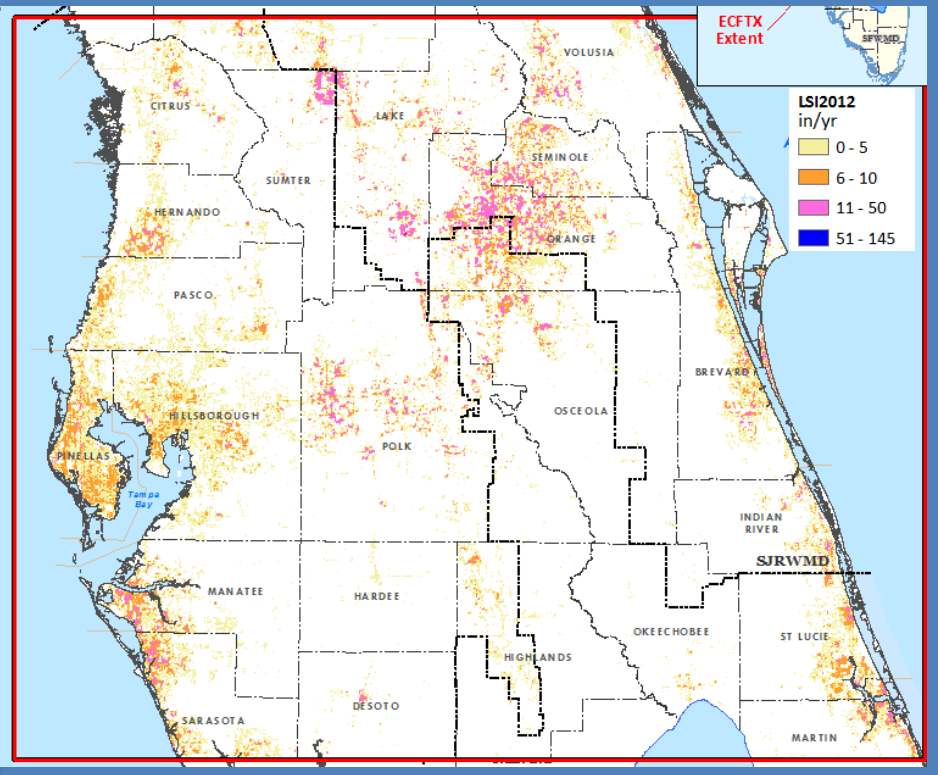
Average for 2003-2014= 679 mgd

Landscape Irrigation Return-LSI

2006 Dry (626 mgd)



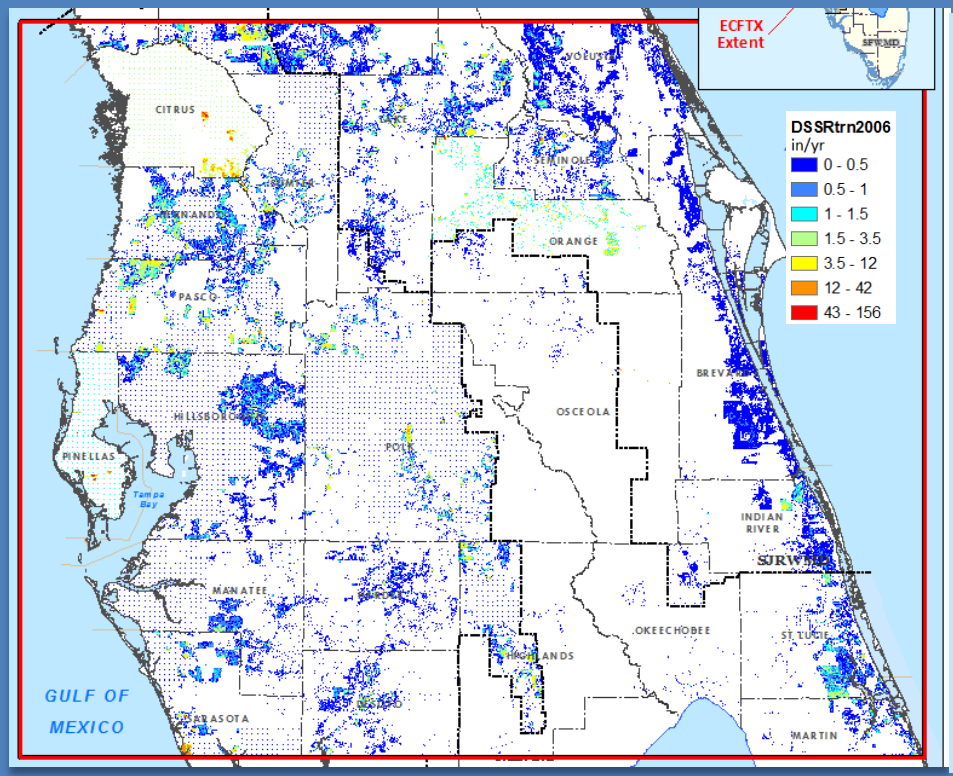
2012 Wet (507 mgd)



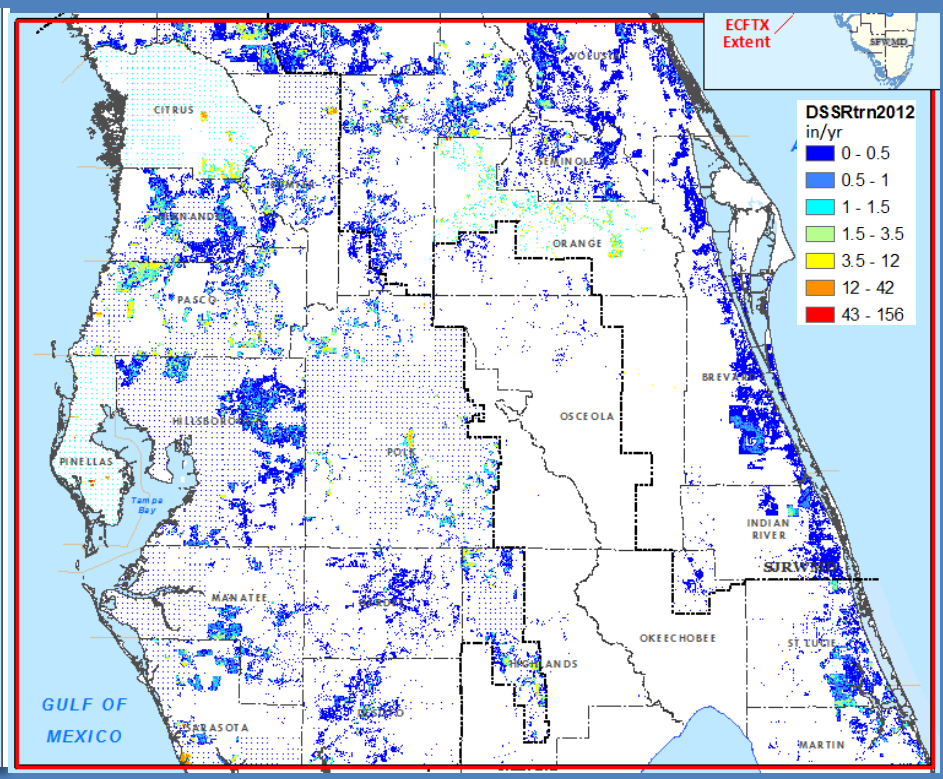
Average for 2003-2014= 533 mgd

Domestic Self-Supplied Septic Tank & Irrigation Return-DSSI

2006 Dry (109 mgd)



2012 Wet (94 mgd)

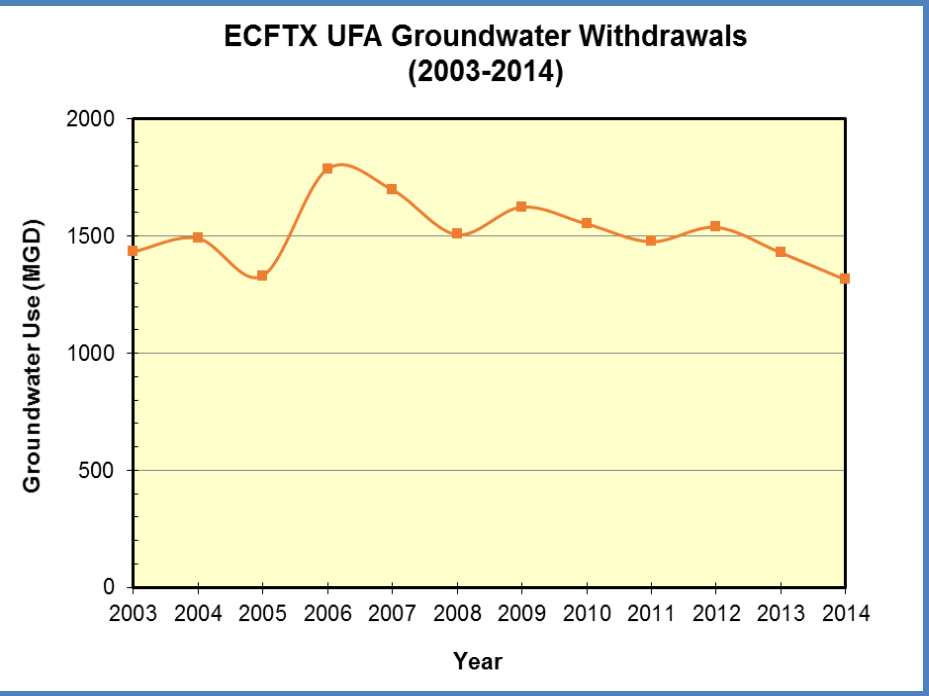


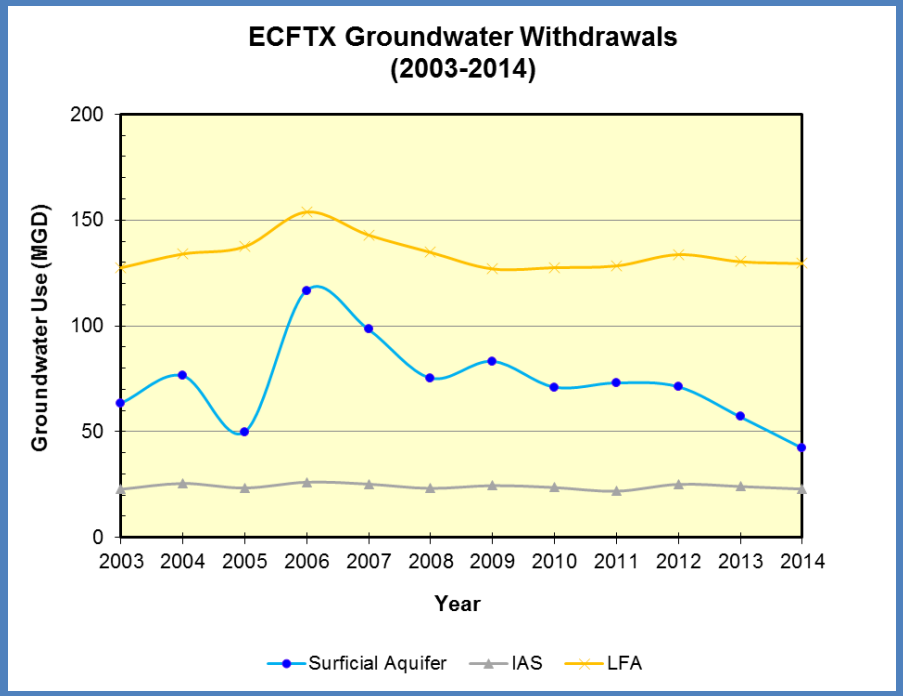
Average for 2003-2014= 97 mgd

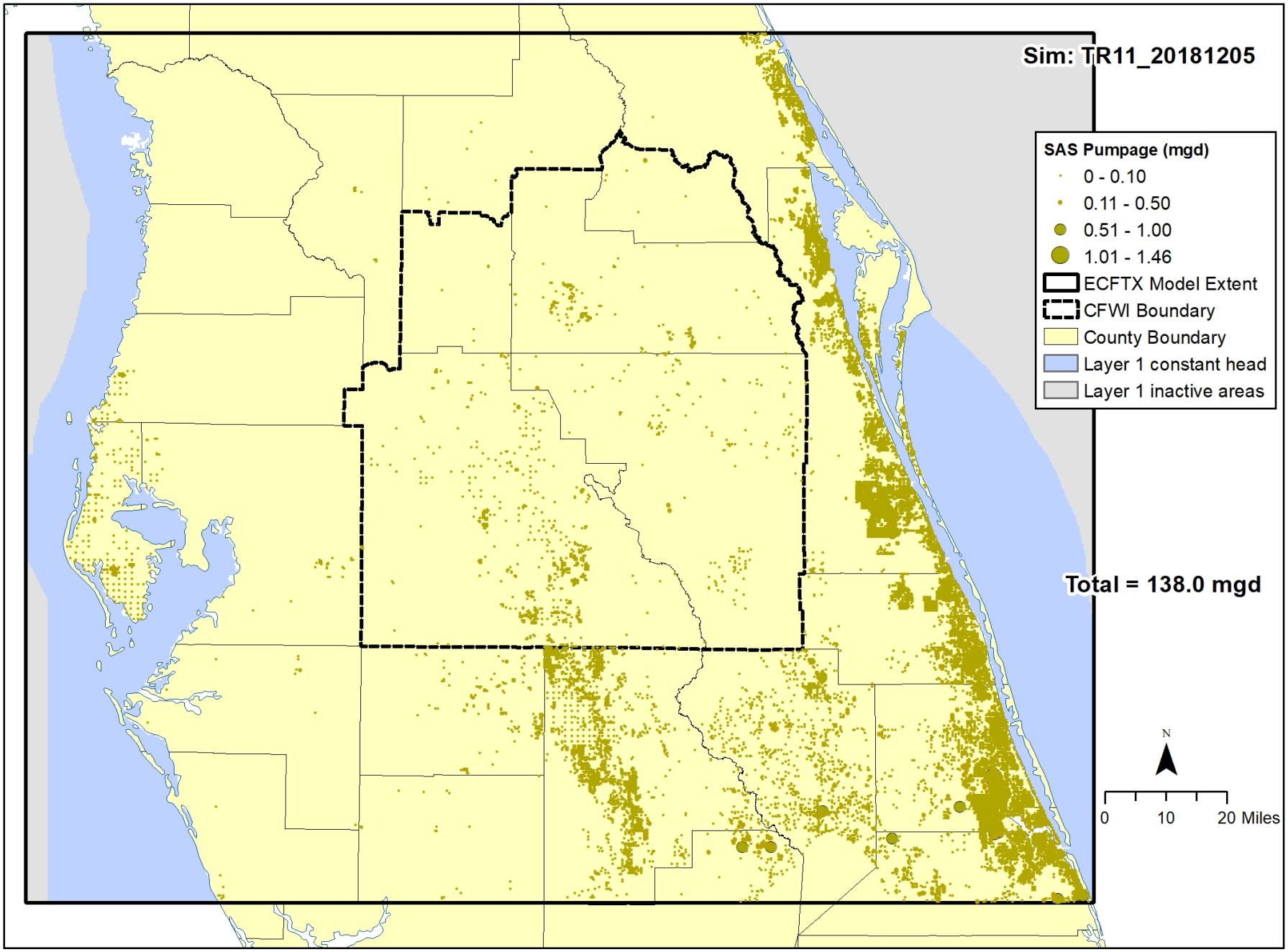
Structure Flow (runoff + baseflow) Calibration Status-ECFTX

ECFTX BasinID	Basin	District	CFWI (Y/N)	Total Flow-12yrAvg (cfs)		Total Flow Statistics			Calib (Y/N)
				Observed	Simulated	%DV	NS	Rsq.	
31	Alligator Lake-Lake Gentry-Lonesome Camp Swamp	SFWMD	Y	114	119	-5	0.56	0.60	Y
62	Boggy Creek	SFWMD	Y	85	93	-11	0.76	0.79	Y
80	C-24	SFWMD	N	166	188	-10	0.76	0.77	Y
81	C-25	SFWMD	N	198	195	-3	0.76	0.77	Y
55	Cypress Creek-C23	SFWMD	N	158	169	-9	0.77	0.79	Y
33	Lake Arbuckle	SFWMD	Y	254	261	-8	0.50	0.68	Y
29	Lake Toho	SFWMD	Y	146	87	46	0.14	0.21	N
50	Lower Canal C-41A	SFWMD	N	41	44	-4	0.63	0.76	Y
5	Reedy Creek	SFWMD	Y	52	65	-4	0.33	0.56	Y
28	Shingle Creek	SFWMD	Y	211	145	32	0.47	0.59	N
48	Upper Bay Swamp-Upper Harney Pond Canal	SFWMD	N	197	220	-1	0.50	0.50	Y
27	Bear Gully Lake+Howell Creek	SJRWMD	Y	64	99	-59	0.41	0.82	N
11	Bird Lake+Halfway Lake etc. SJRiver	SJRWMD	N	208	209	-12	0.31	0.33	N
21	Econ River	SJRWMD	Y	564	531	-1	0.63	0.68	Y
24	Lake Dorr+Lake Norris	SJRWMD	N	53	104	-90	-1.46	0.60	N
9	North Branch of Crab Grass Creek	SJRWMD	N	24	28	-18	0.56	0.58	N
20	Sixmile Creek	SJRWMD	N	25	24	0	0.47	0.51	N
25	Soldier Creek	SJRWMD	N	12	17	-46	0.42	0.79	N
12	South Fork of Taylor Creek+Taylor Creek-SJRiver	SJRWMD	N	44	49	-15	0.68	0.70	Y
3	Triplet Lake	SJRWMD	N	16	20	-36	0.28	0.65	N
58	Turbull Creek	SJRWMD	N	18	22	2	0.54	0.53	Y
7	Wekiva River	SJRWMD	N	265	158	-23	-2.11	0.52	N
10	Wolf Creek	SJRWMD	Y	30	34	-16	0.71	0.72	N
71	Cypress Creek	SWFWMD	N	45	40	9	0.72	0.77	Y
75	3100206-Brooker sub watershed	SWFWMD	N	15	10	34	0.55	0.60	N
36	Alderman Creek	SWFWMD	N	26	45	-66	0.24	0.73	N
70	Baker Creek-Flint Creek-Hillsborough River	SWFWMD	N	48	63	-35	0.68	0.72	N
16	Bear Branch+Thompson Branch etc-Peac River	SWFWMD	N	134	352	-159	-4.37	0.30	N
40	BlackwaterCreek-BranchBoroughChannel-HillsboroughRiverDrain	SWFWMD	N	178	245	-62	0.39	0.64	N
46	Brooker Creek	SWFWMD	N	22	34	-62	0.38	0.76	N
41	Carlton Branch-Dug Creek-South Fork of the Little Manatee River etc	SWFWMD	N	112	168	-49	0.49	0.82	N
49	Charlie Creek	SWFWMD	N	221	371	-75	0.57	0.73	N
34	Hawthorn Creek+Lower Joshua Creek etc	SWFWMD	N	70	146	-121	0.29	0.75	Y
38	Horse Creek	SWFWMD	N	117	125	-4	0.79	0.81	N
14	Lake Ariana+Lake Hancock+Lake Parker	SWFWMD	N	149	213	-42	0.73	0.78	N
35	Maple Creek+Owen Creek+Wingate Creek+Oglegy Creek	SWFWMD	N	45	102	-132	0.15	0.62	Y
17	Payne Creek	SWFWMD	Y	127	136	-8	0.74	0.74	Y
47	Sweetwater Creek	SWFWMD	N	108	121	-10	0.67	0.68	N
67	TurkeyCreek+LittleFishawkCreek etc	SWFWMD	N	21	18	17	0.52	0.69	N

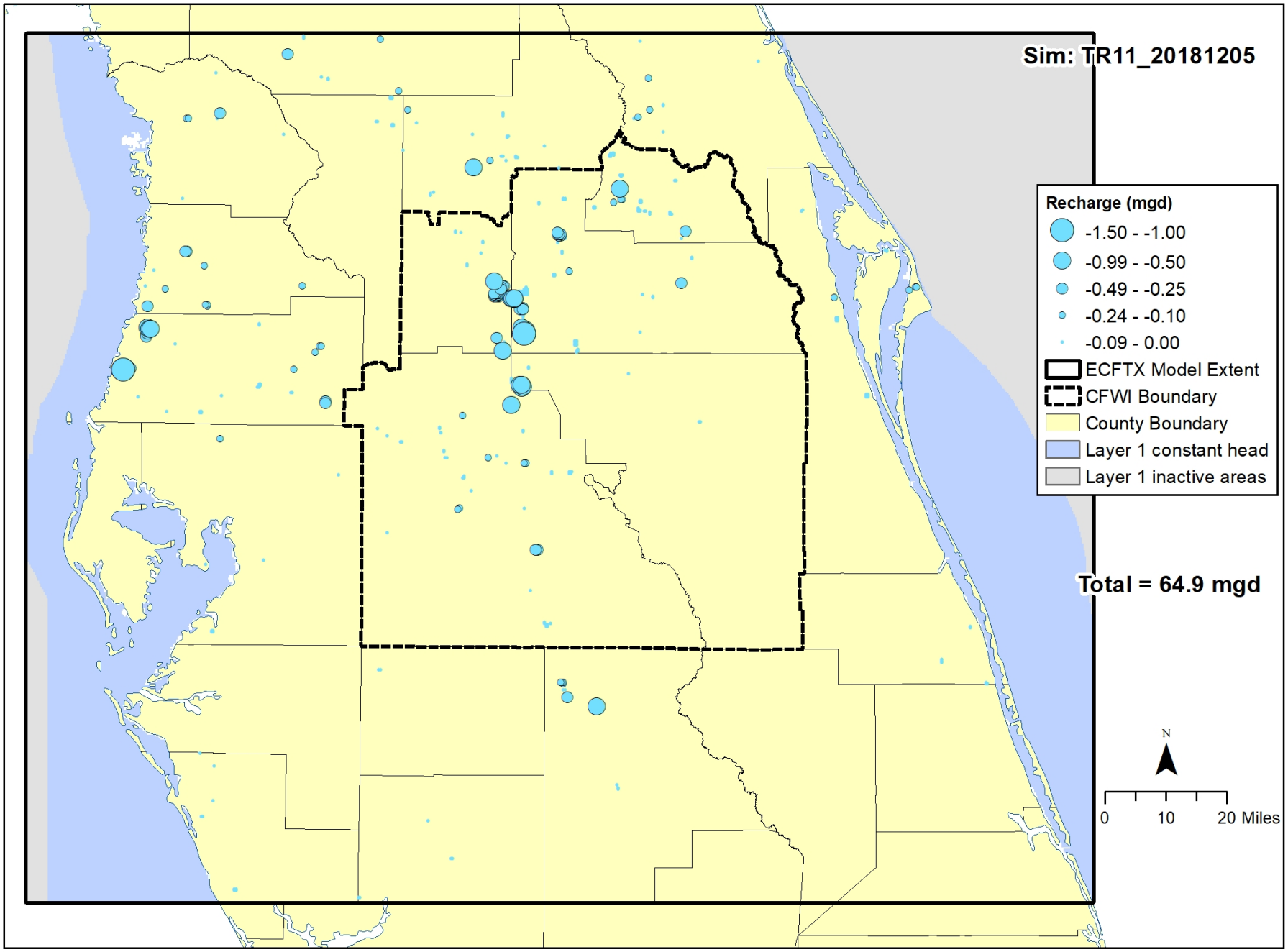
Groundwater withdrawal rates by aquifer in the ECFTX transient simulation



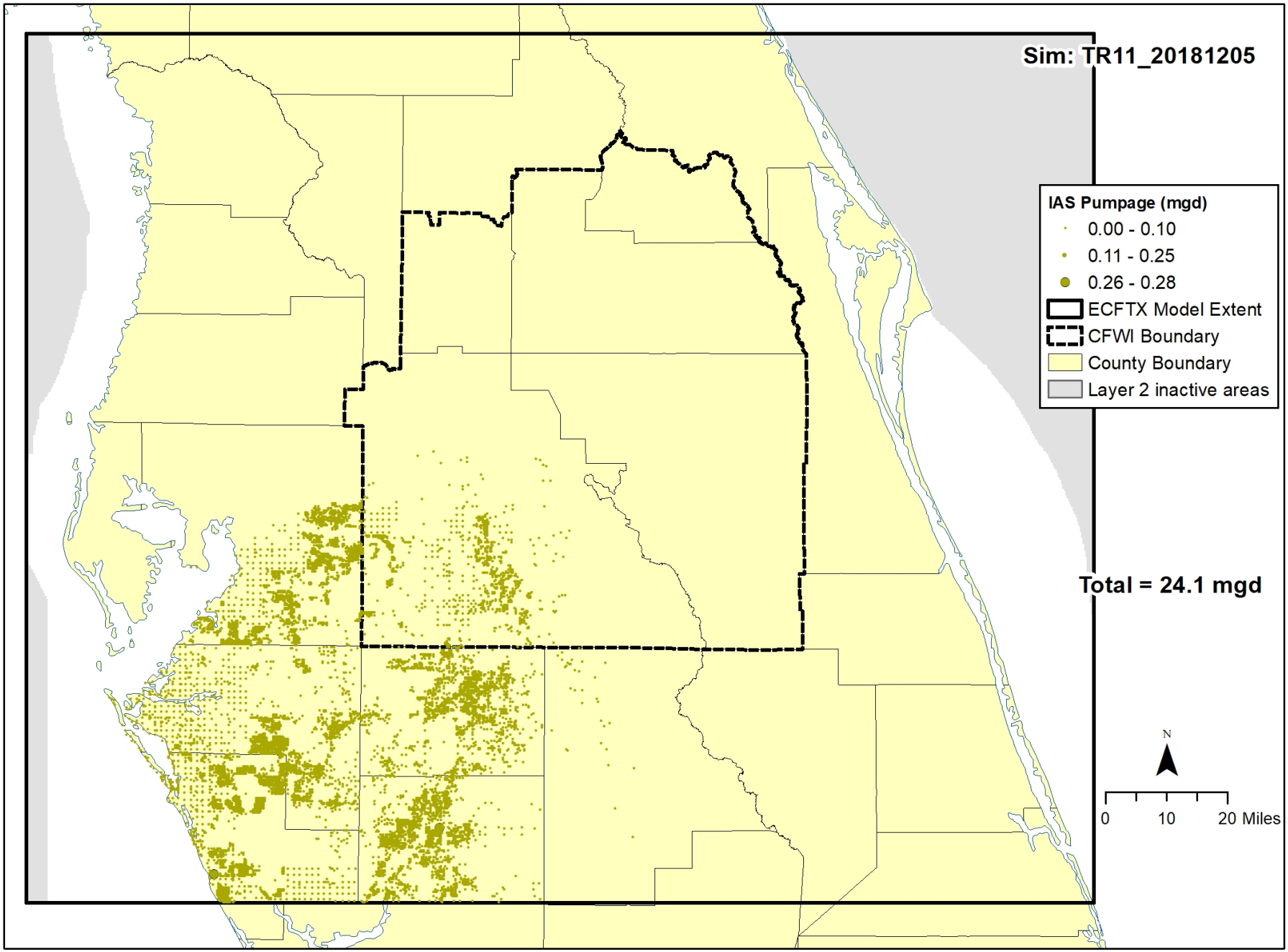




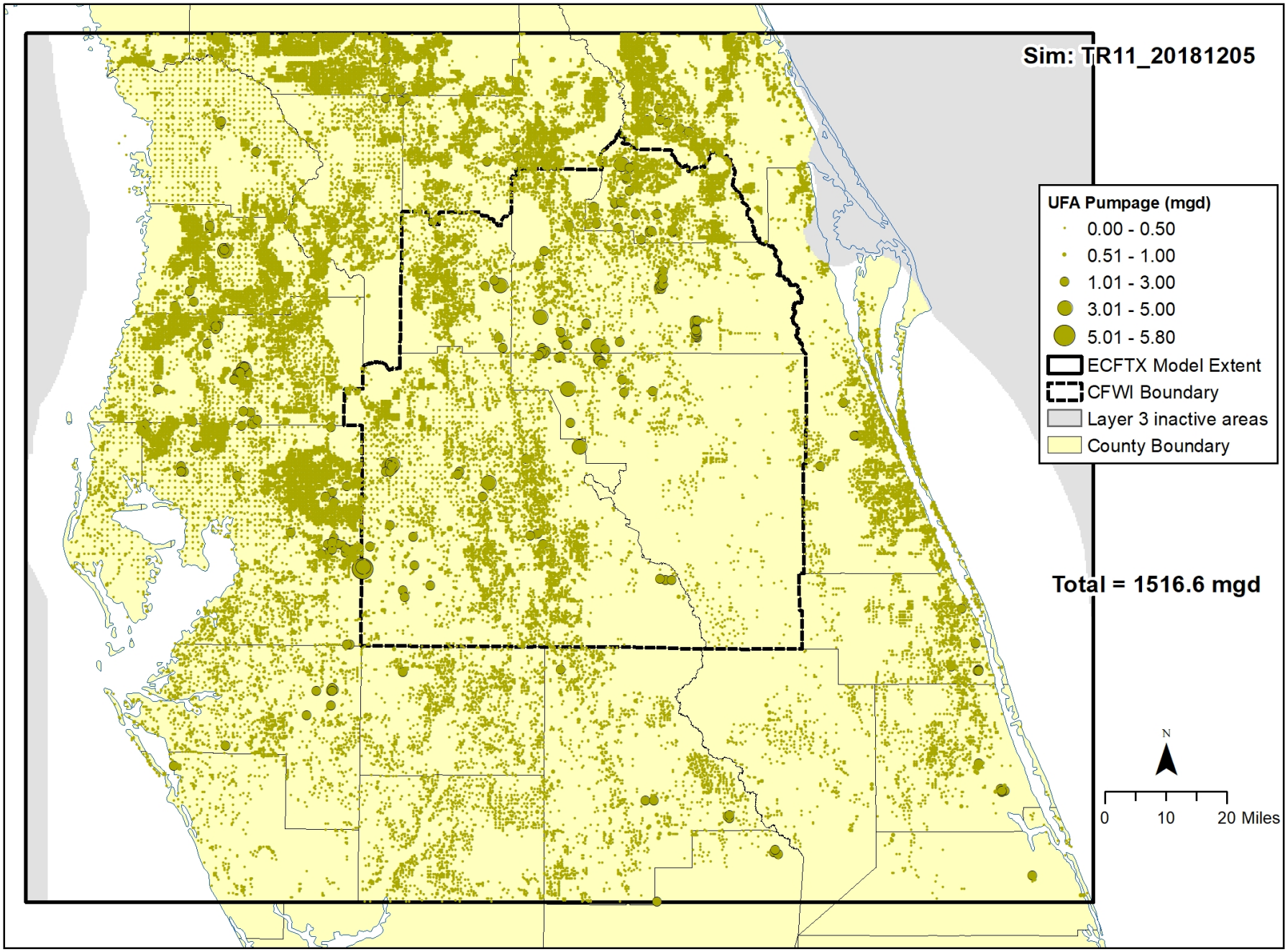
Surficial Aquifer Withdrawals (Layer 1) - 2003-2014 Ave



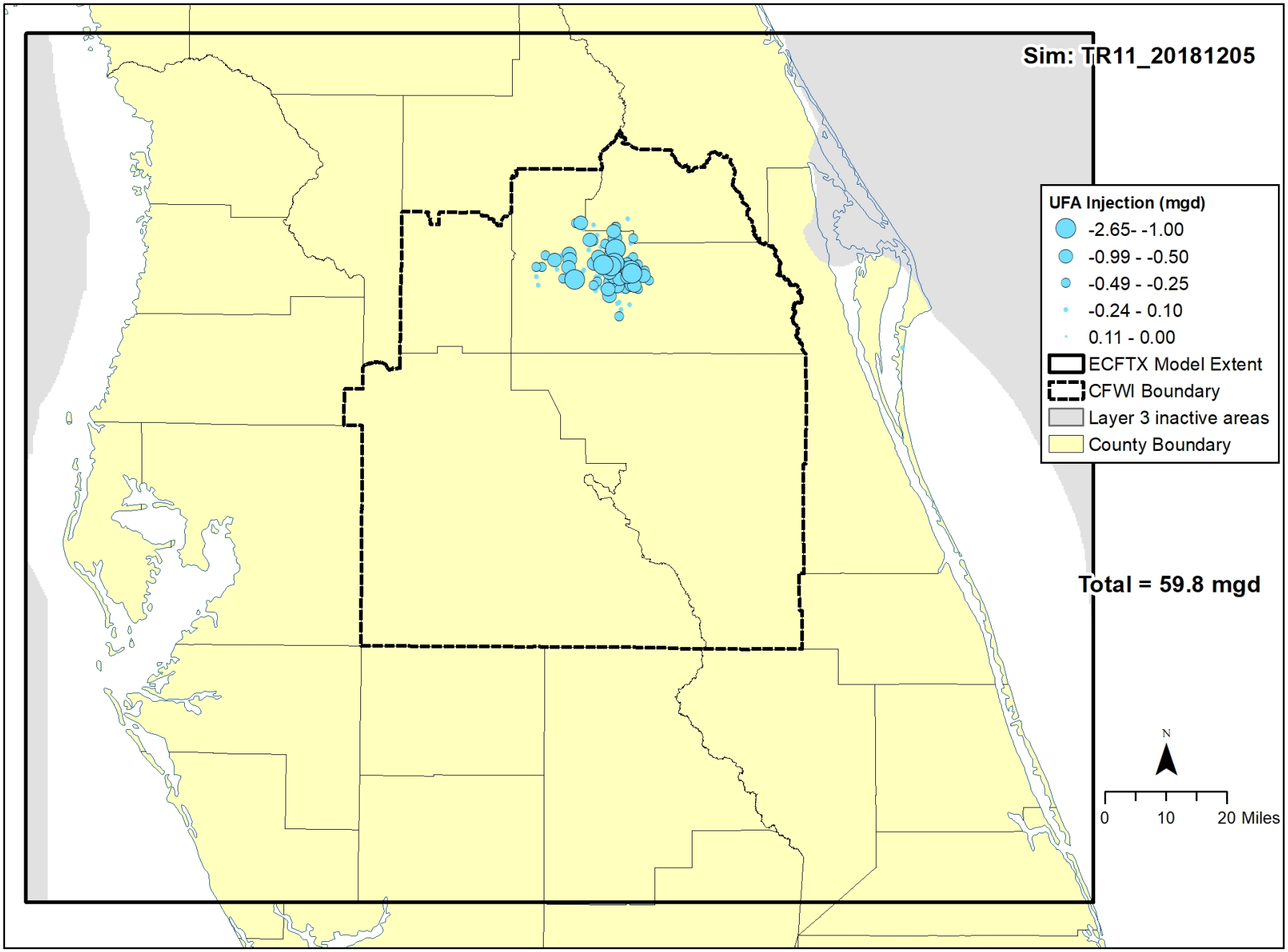
Surficial Aquifer Return Recharge (Layer 1) - 2003-2014



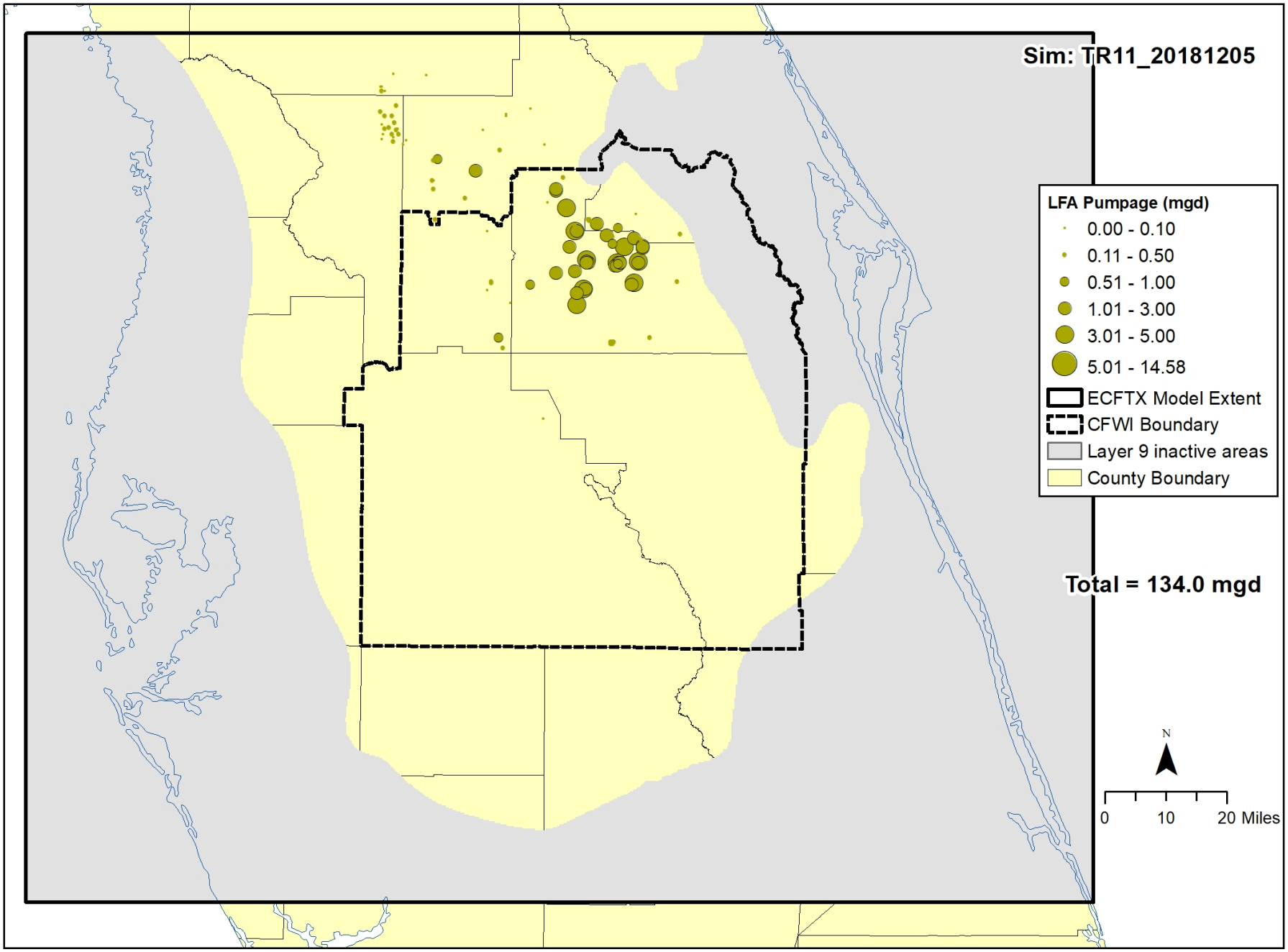
Intermediate Aquifer Withdrawals (Layer 2) - 2003-2014



Upper Floridan Aquifer Withdrawals (Layers 3-7) - 2003-2014

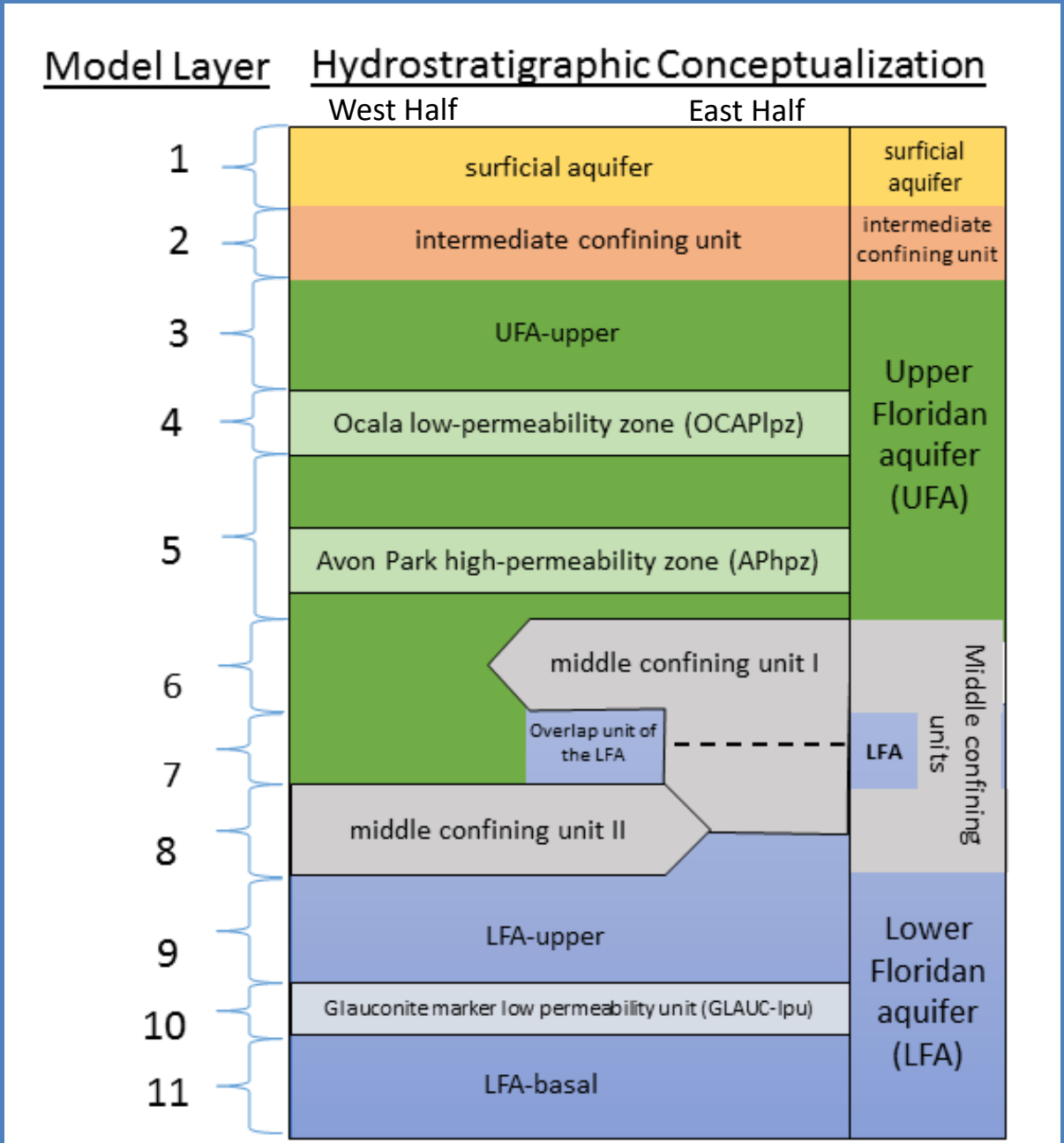


Upper Floridan Aquifer Injection (Layers 3-7) - 2003-2014

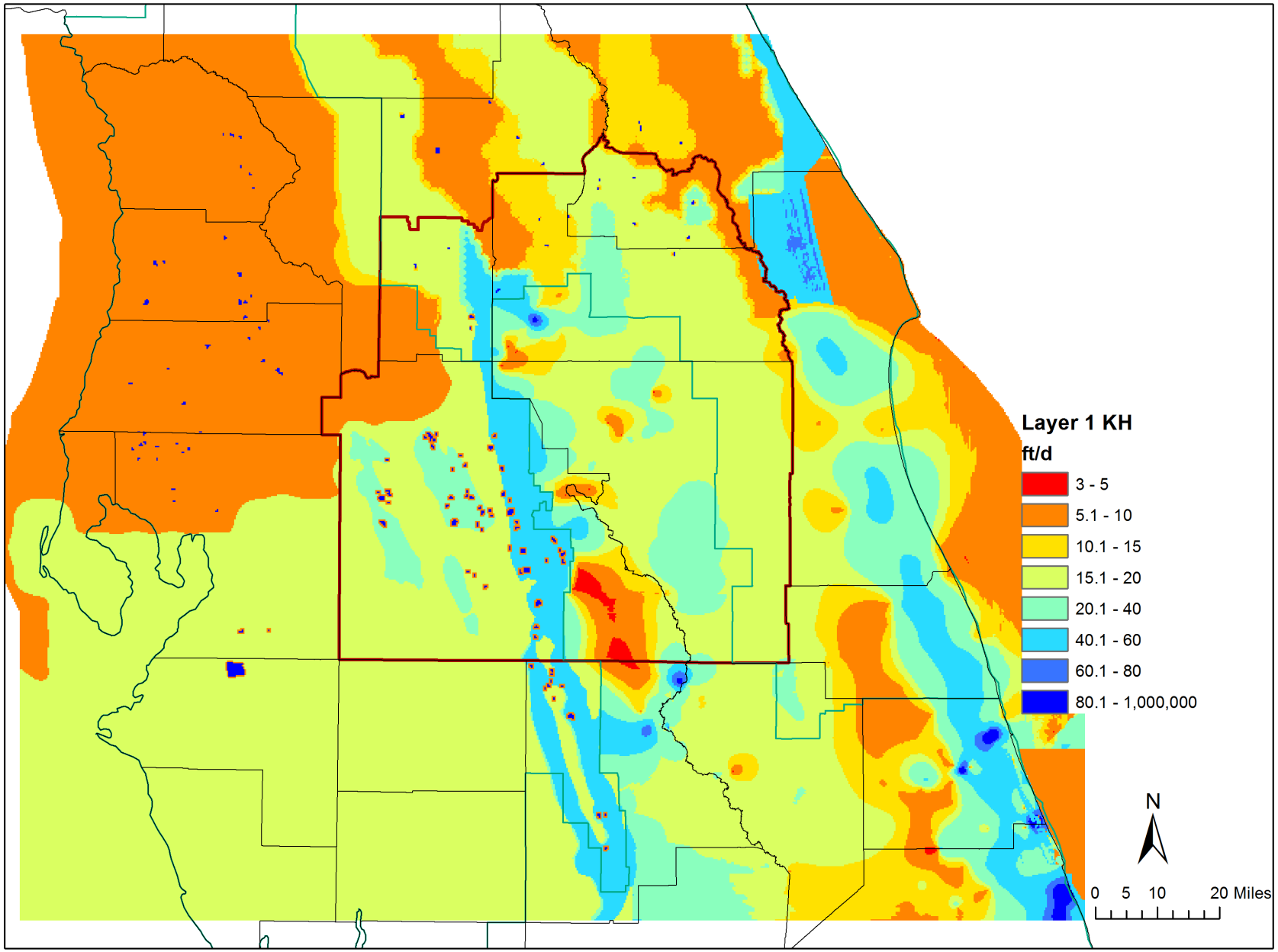


Lower Floridan Aquifer Withdrawals (Layers 9-11) - 2003-2014

ECFTX Model Conceptualization

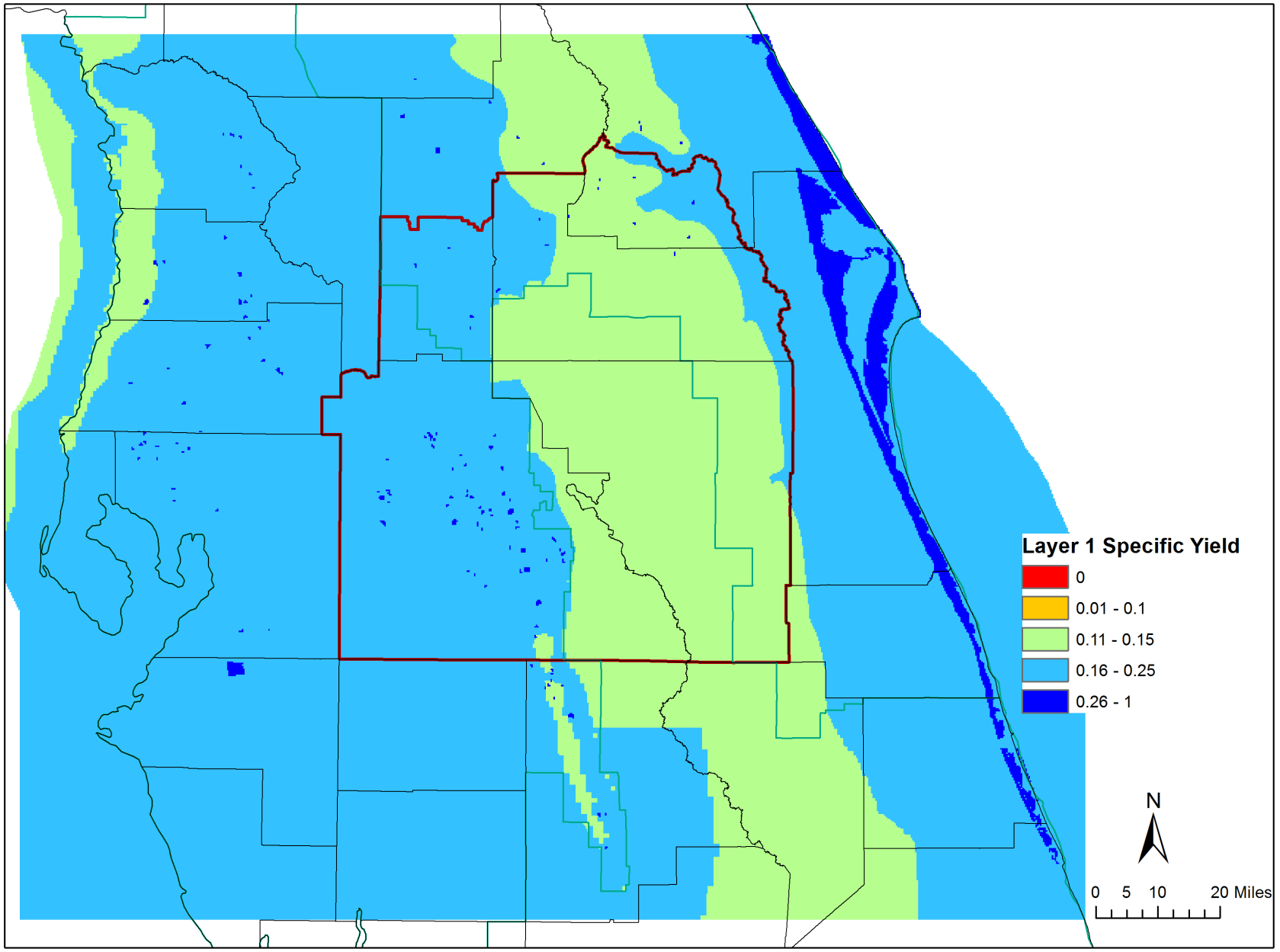


Layer 1 (Surficial Aquifer) - Hydraulic Conductivity



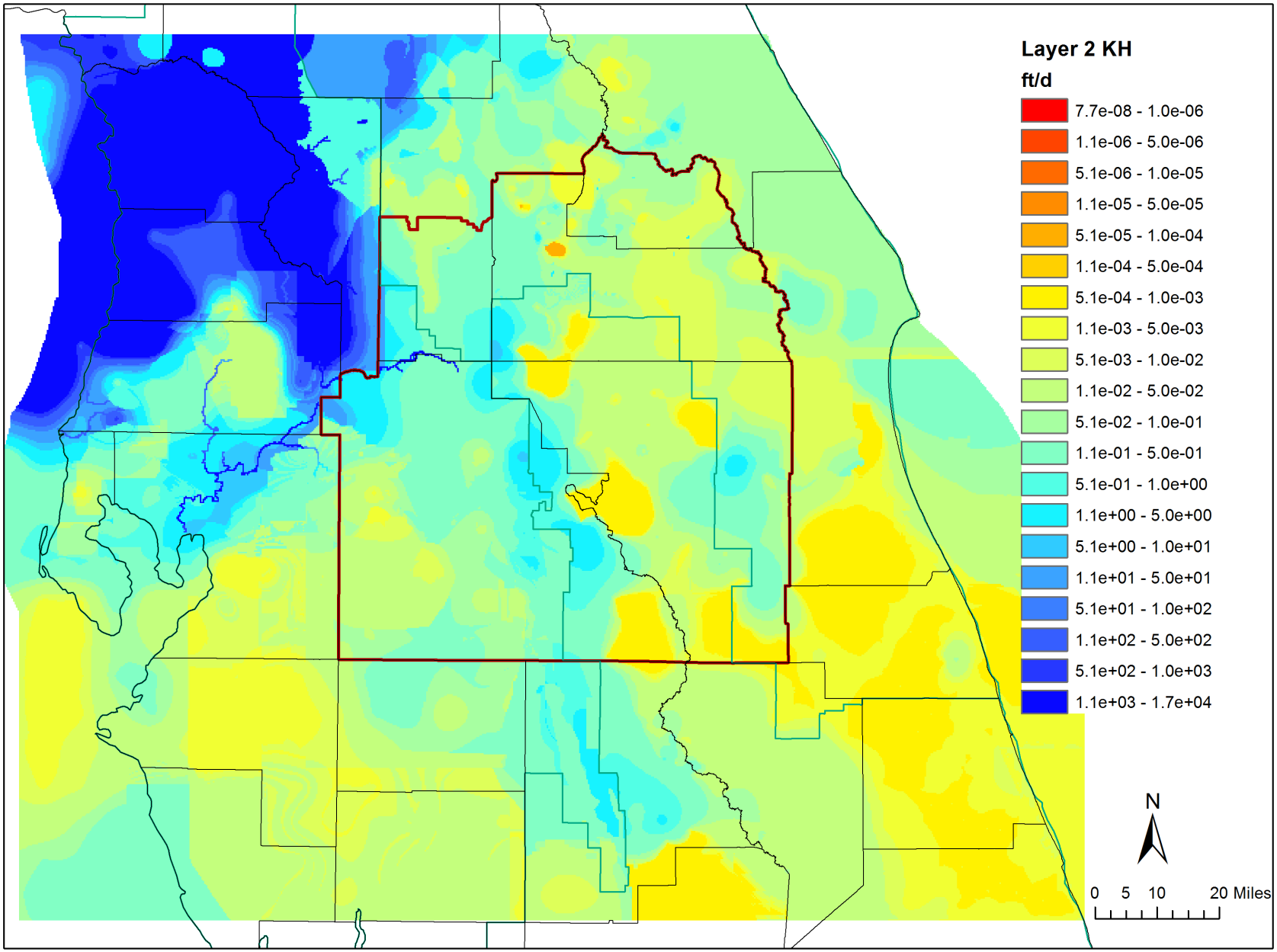
ECFTX TR11 20181205

Layer 1 (Surficial Aquifer) – Specific Yield



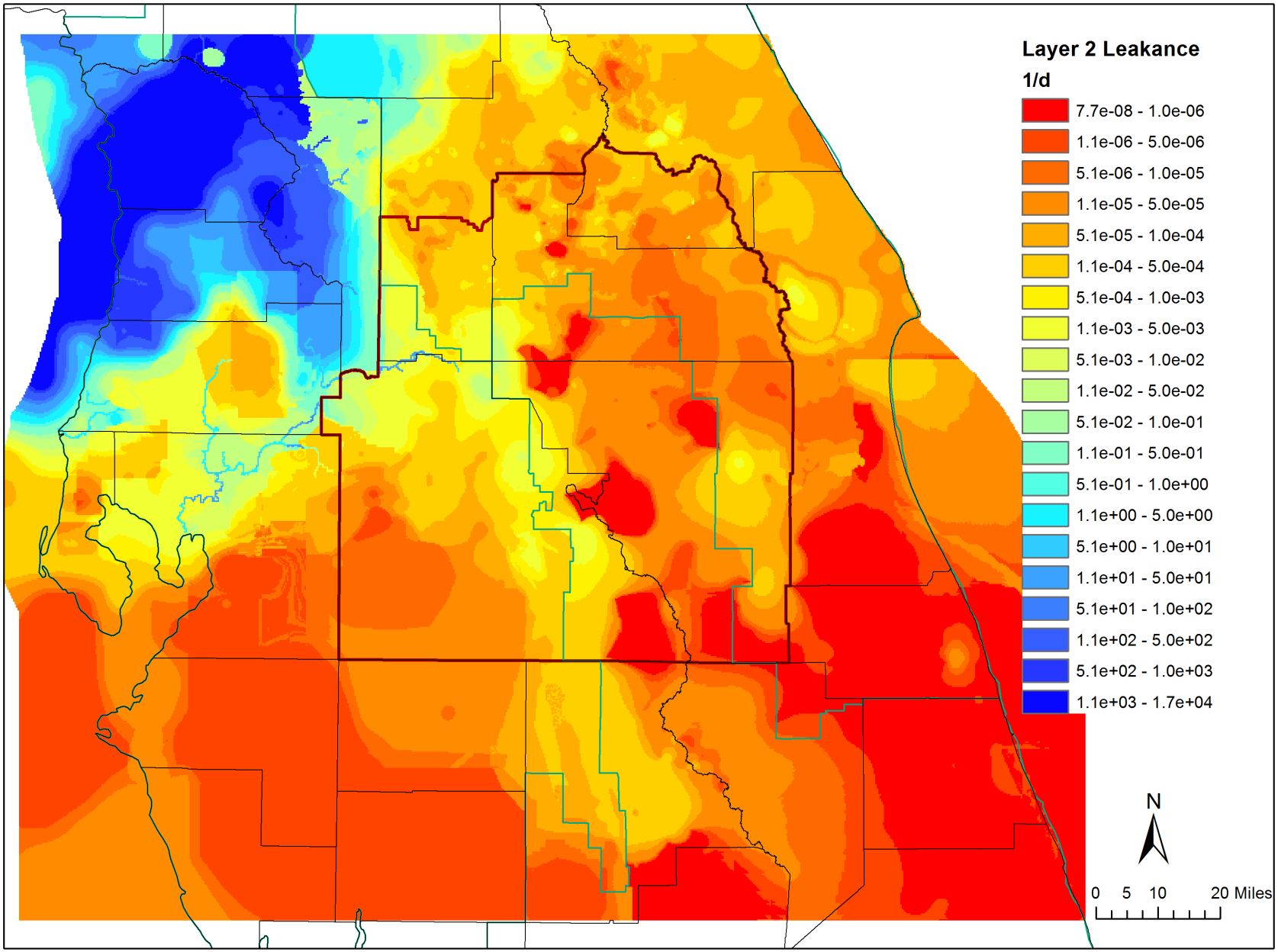
ECFTX TR11 20181205

Layer 2 (ICU except far NW where unconfined) – Hydraulic Conductivity



ECFTX TR11 20181205

Layer 2 (ICU except far NW where unconfined) – Leakance Coefficient



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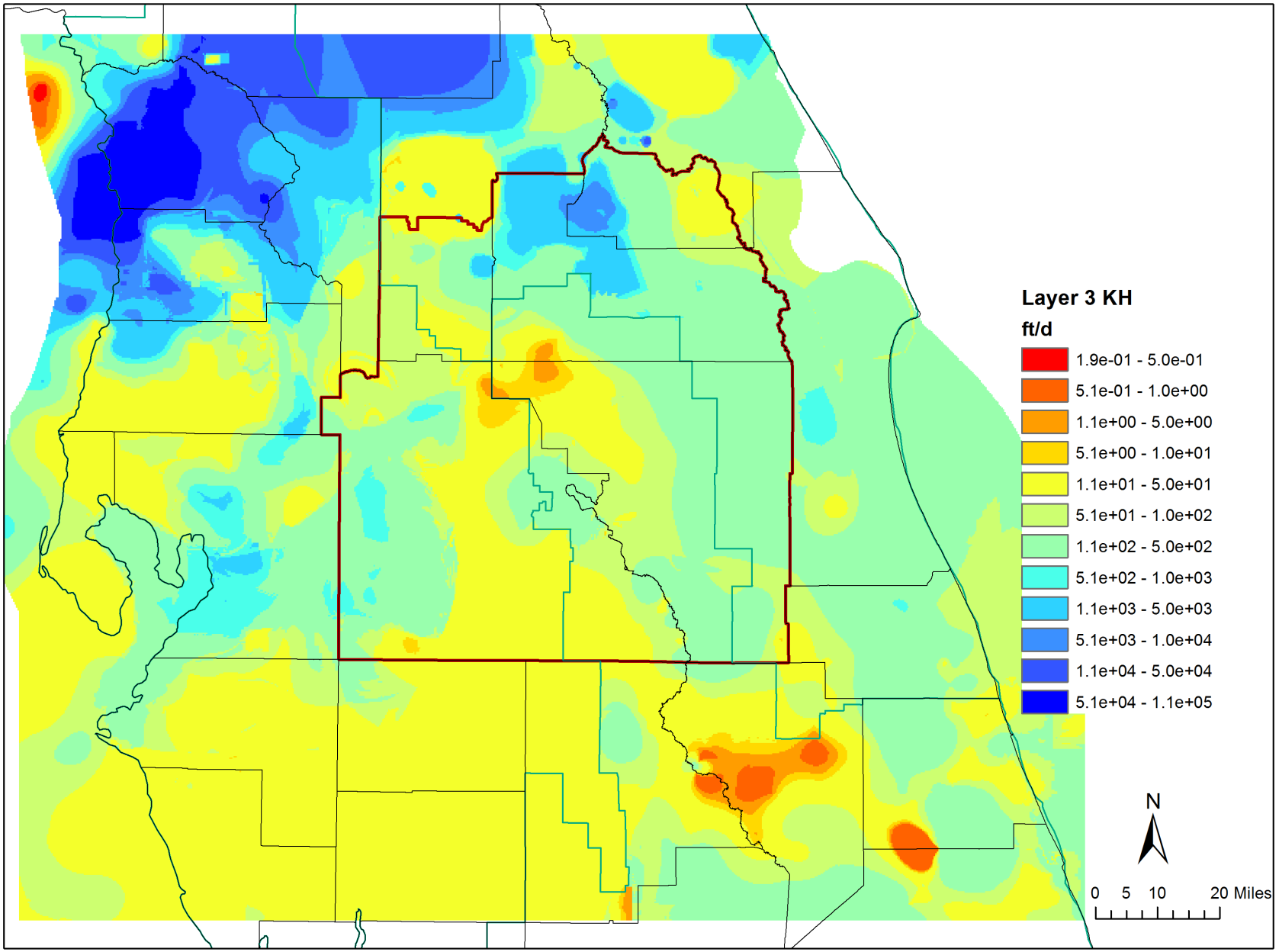
Layer 3 (Tampa-Suwannee Limestone) – Hydraulic Conductivity



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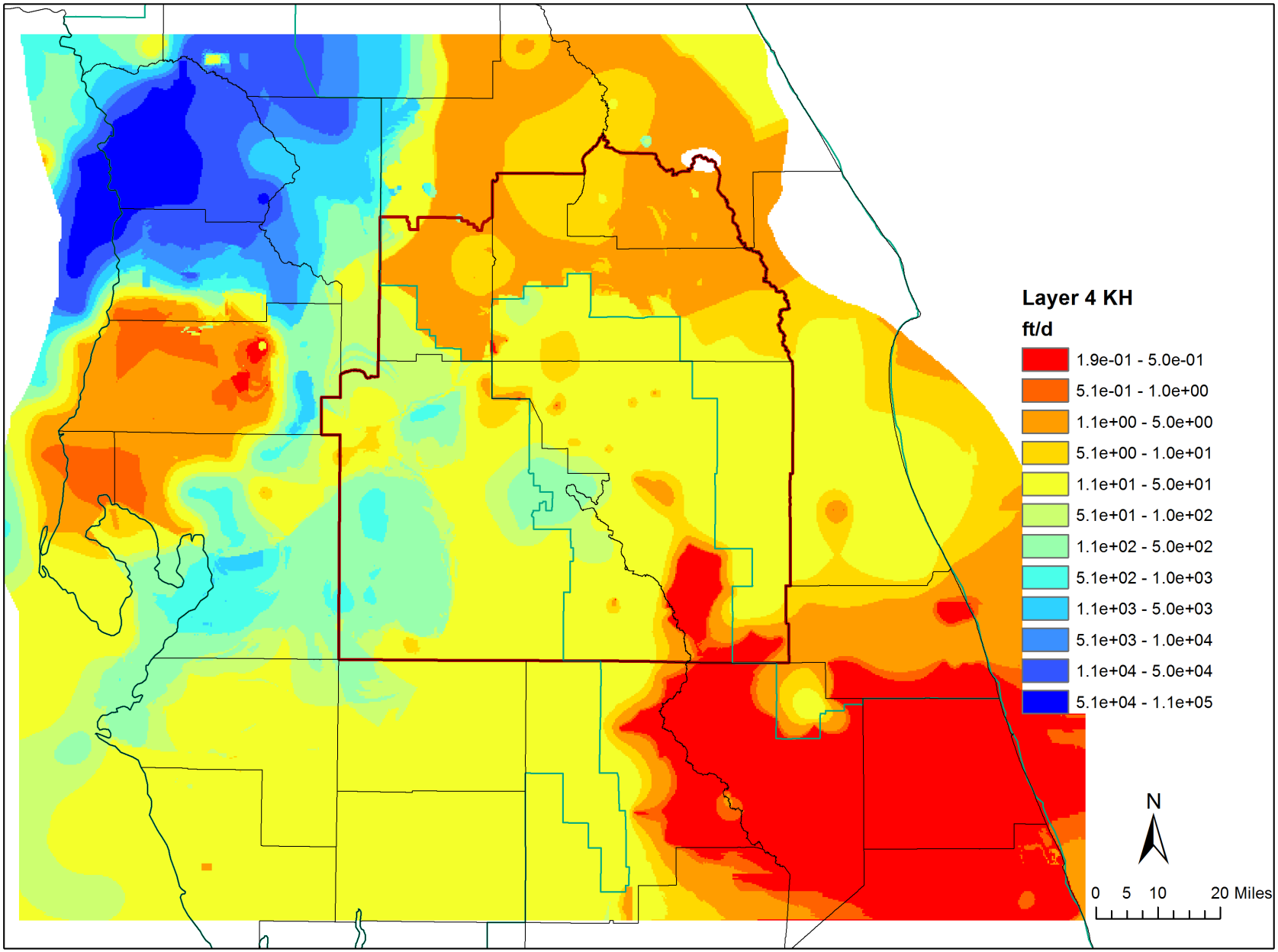
Layer 4 (Ocala Limestone - confining in SE part) – Hydraulic Conductivity



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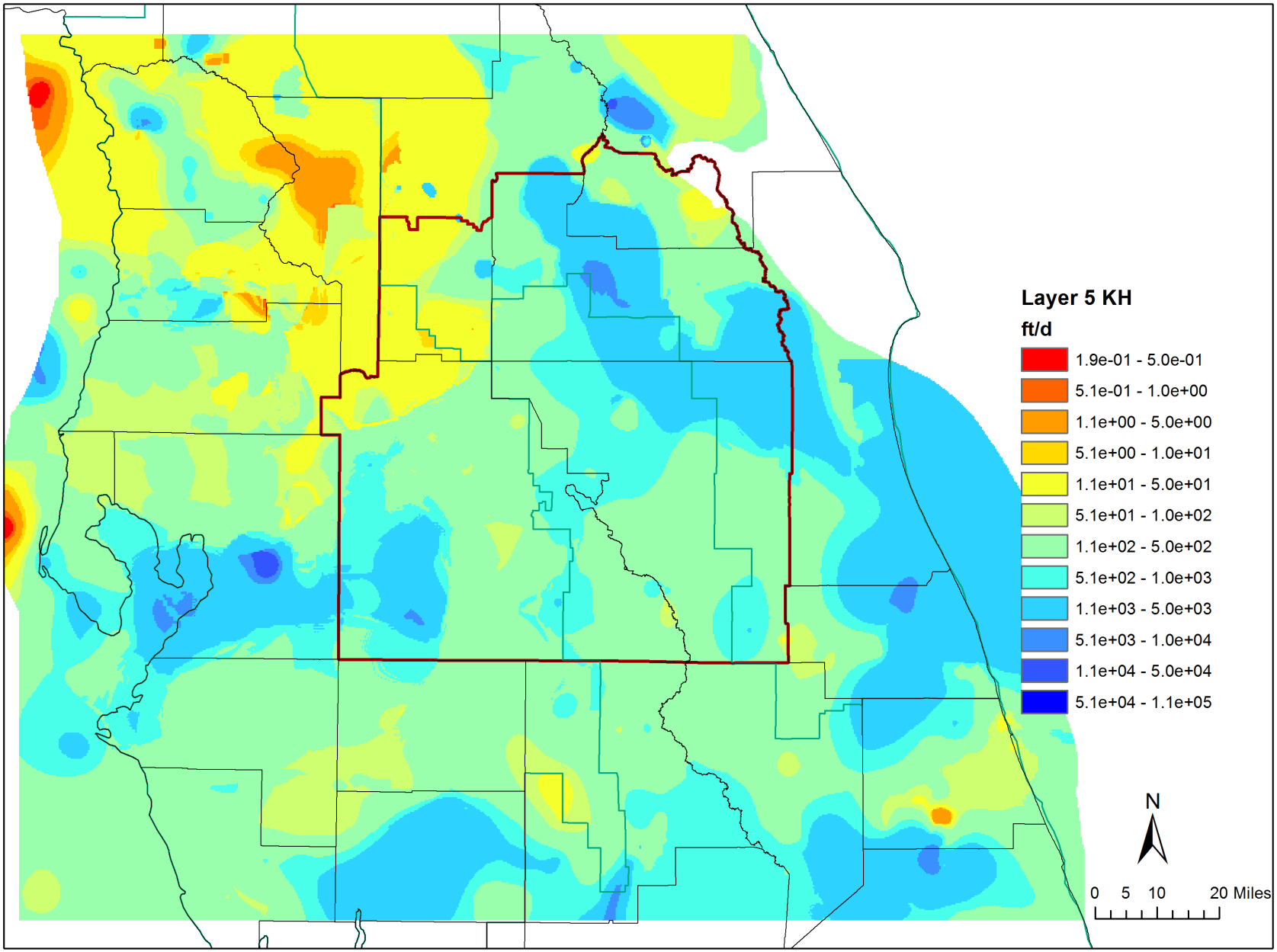
Layer 5 (Avon Park) - Hydraulic Conductivity



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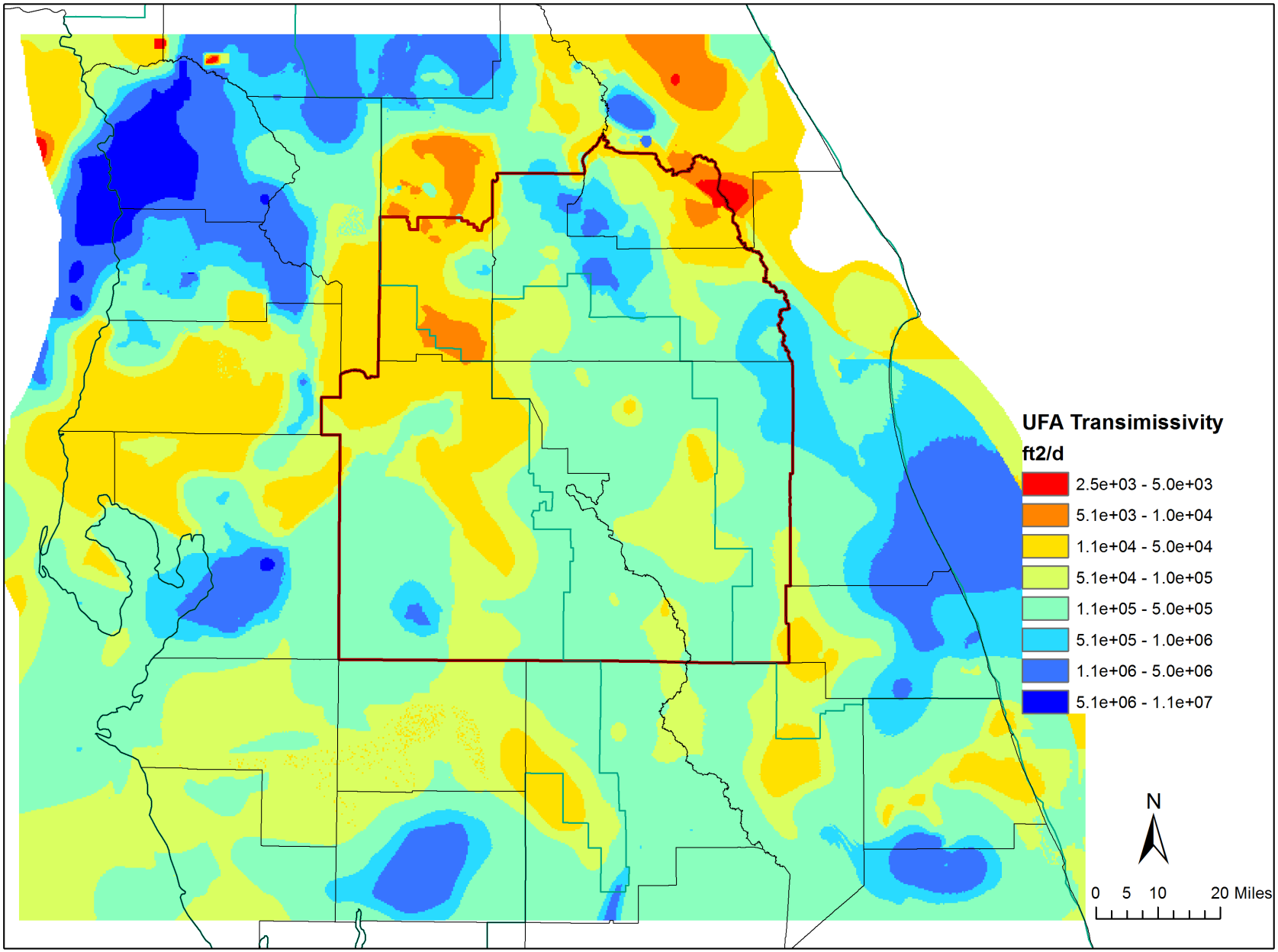
UFA Transmissivity



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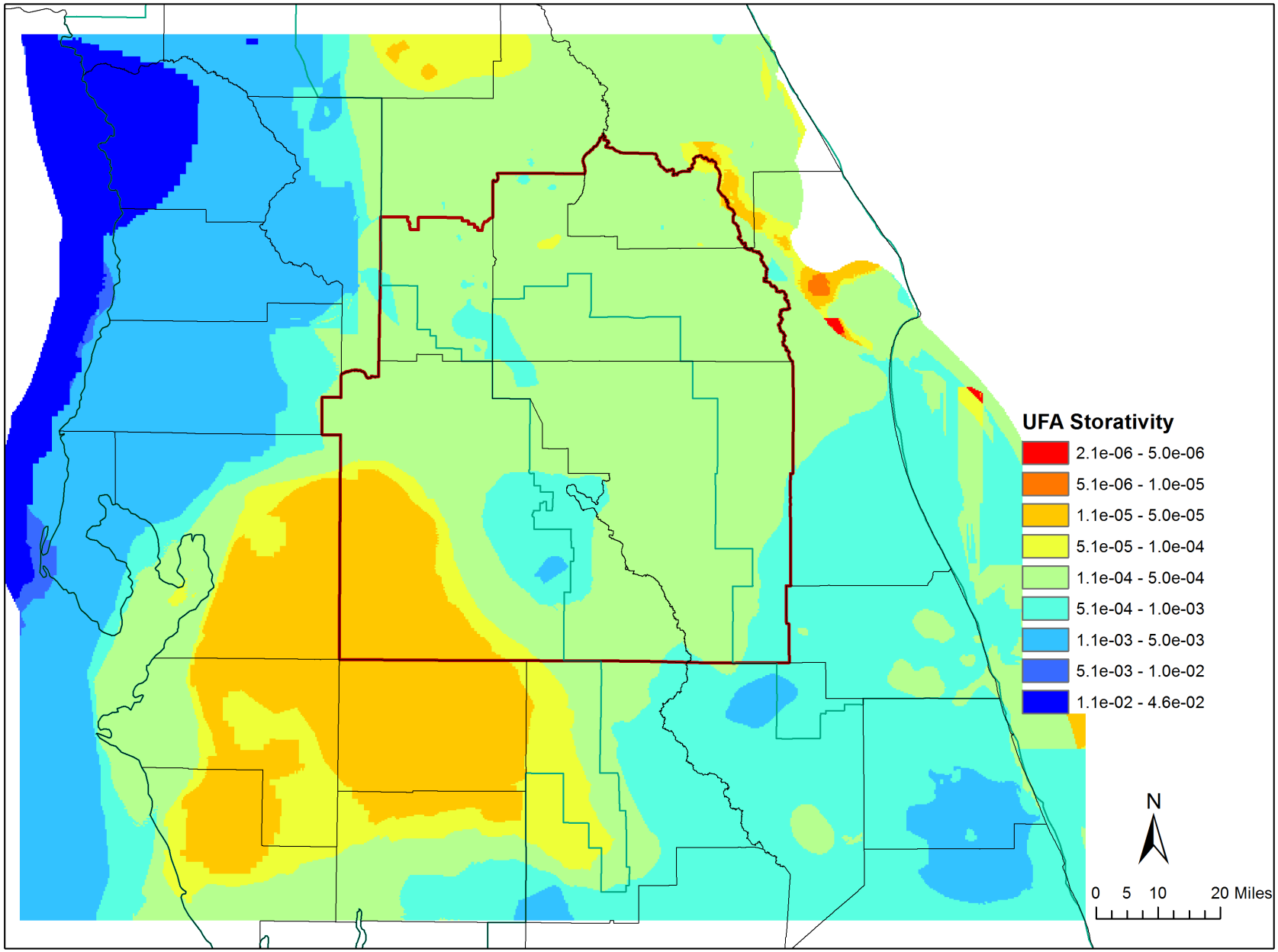
UFA Storage Coefficients



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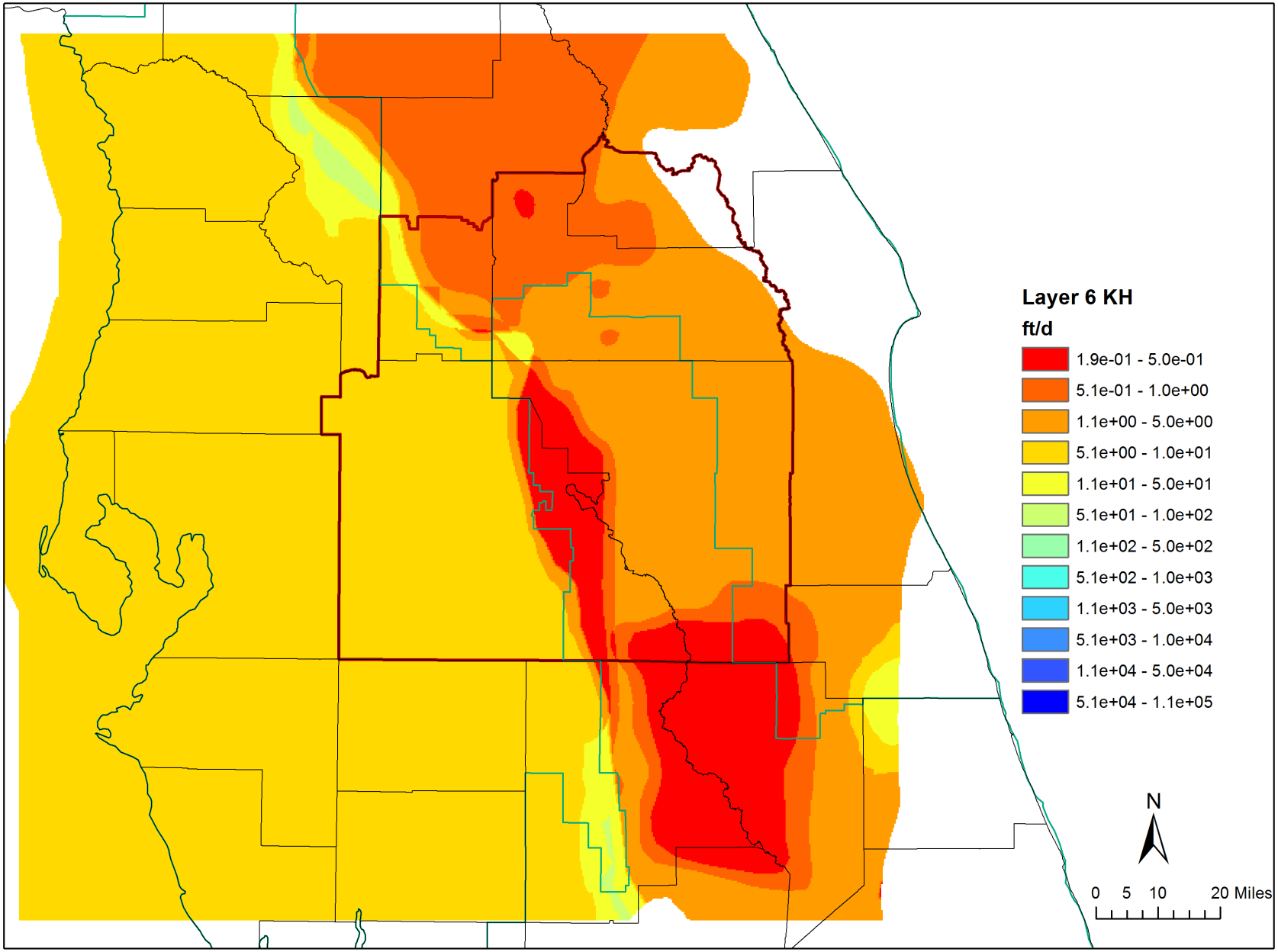
Layer 6 (Part of UFA in west half – MCU in eastern half) – Hydraulic Conductivity



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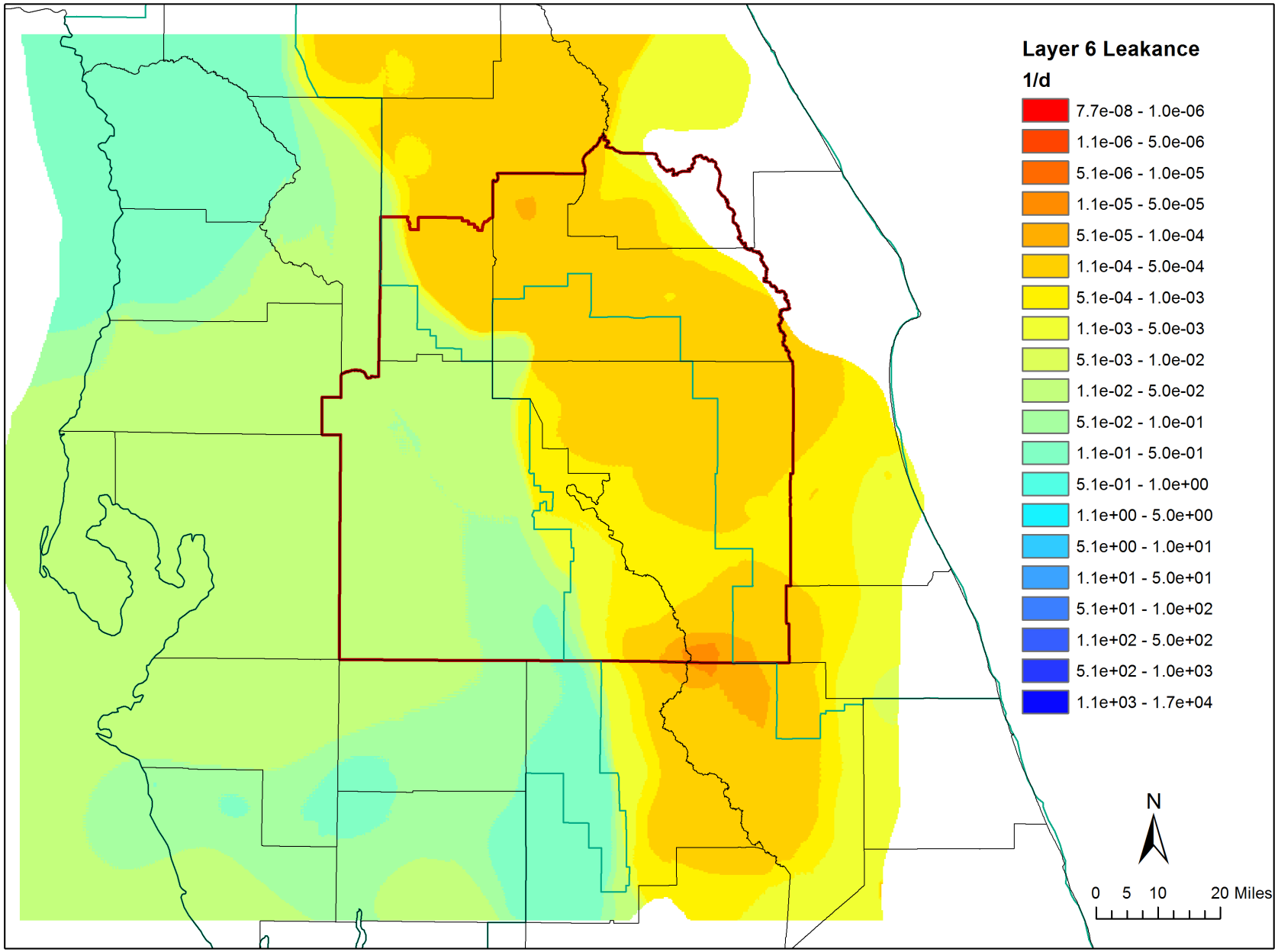
Layer 6 (Part of UFA in west half – part of MCU in eastern half) – Leakance Coefficient



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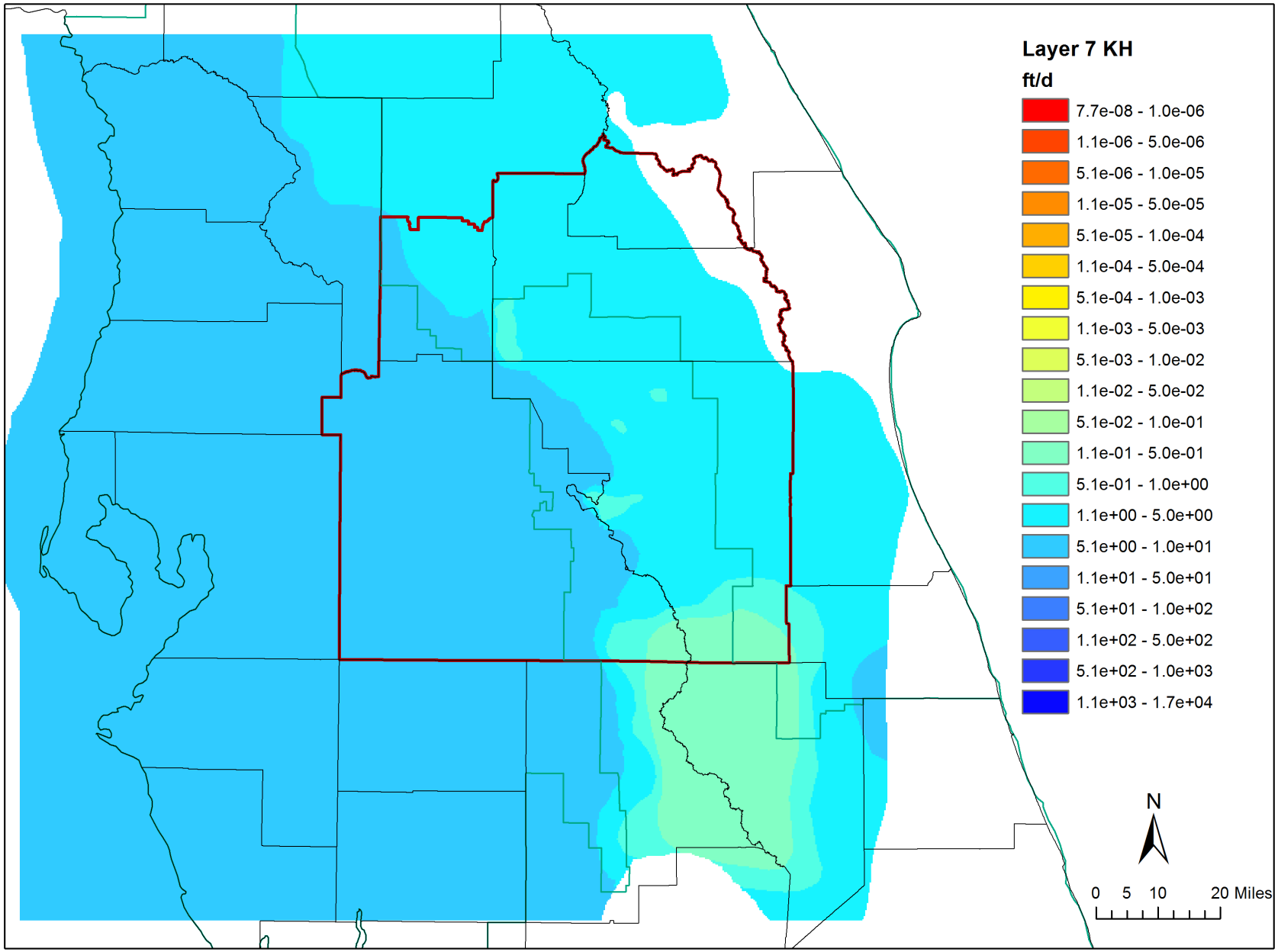
Layer 7 (Part of UFA in west half – part of MCU in eastern half) – Hydraulic Conductivity



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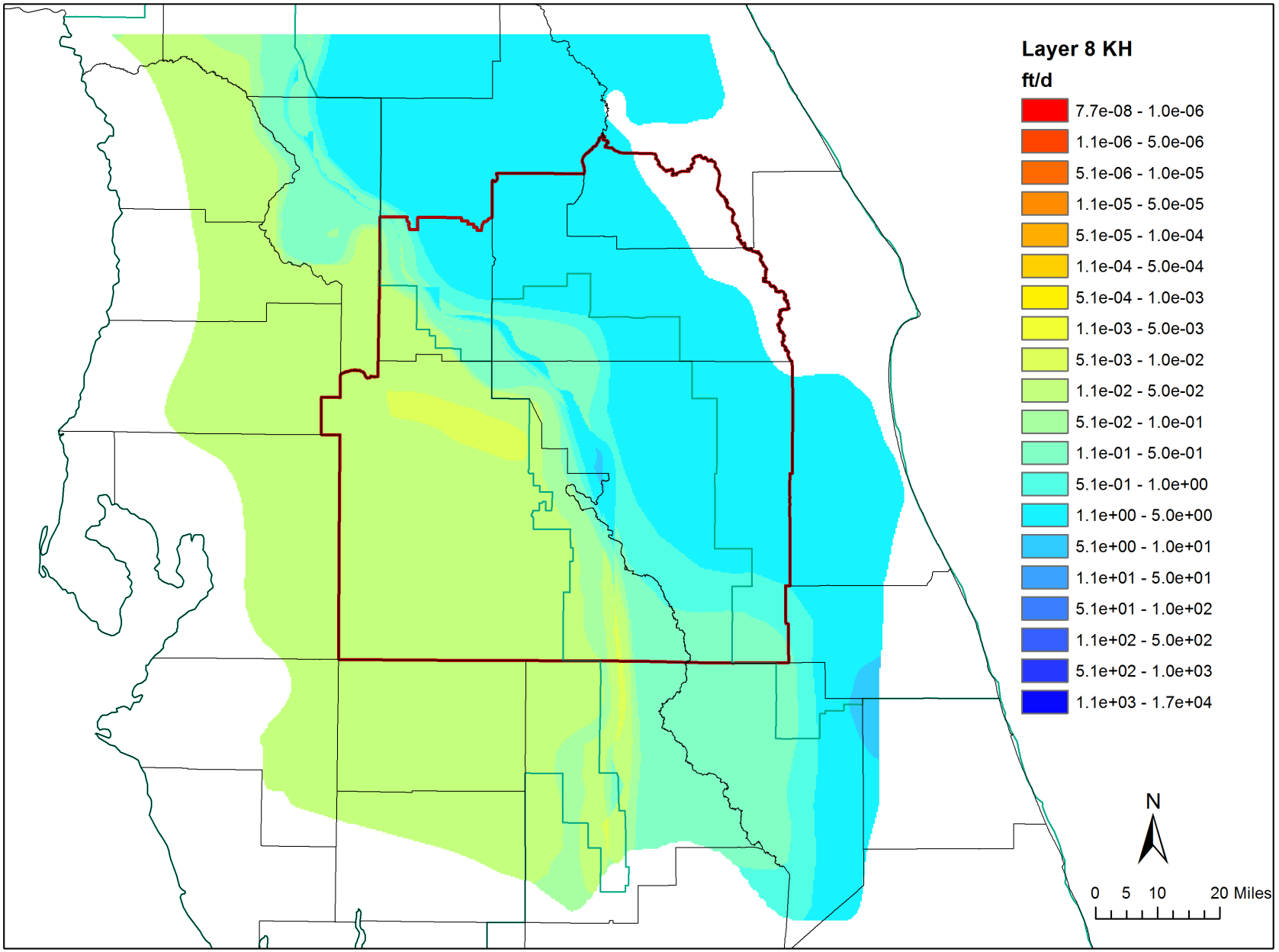
Layer 8 (MCU in west half – part of MCU eastern half) – Hydraulic Conductivity



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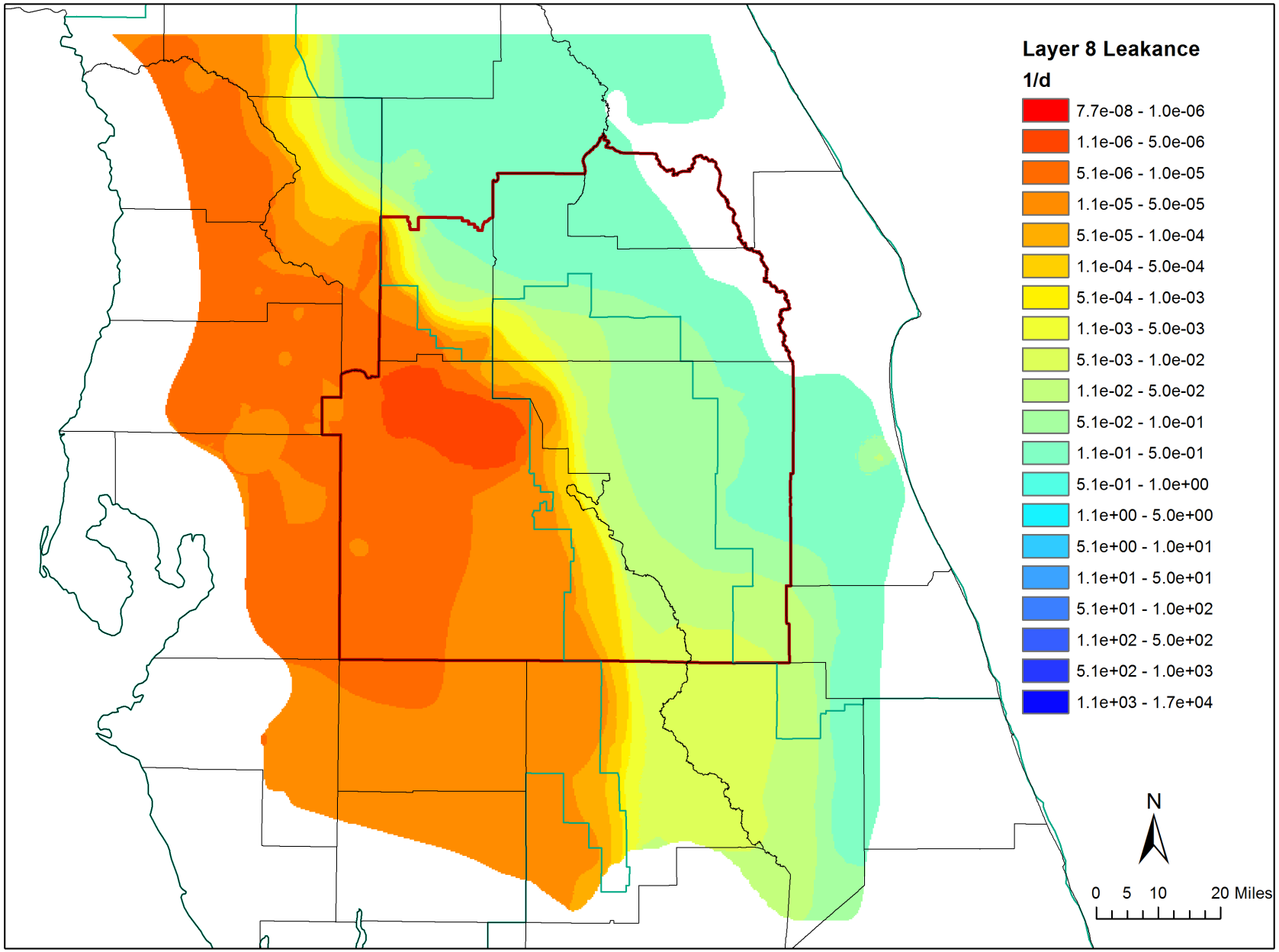
Layer 8 (MCU in west half – part of MCU in eastern half) – Leakance Coefficient



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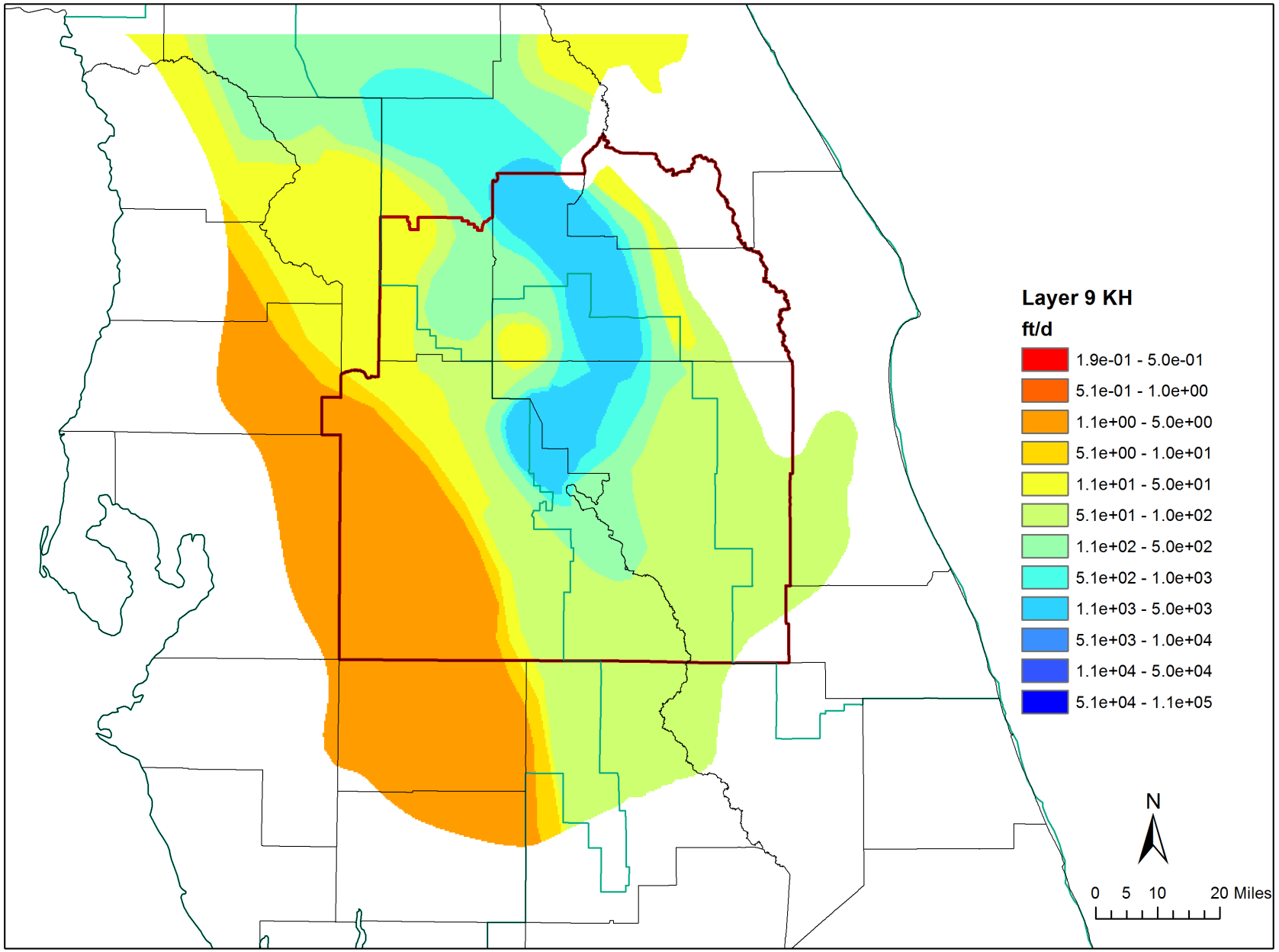
Layer 9 (LFA) – Hydraulic Conductivity



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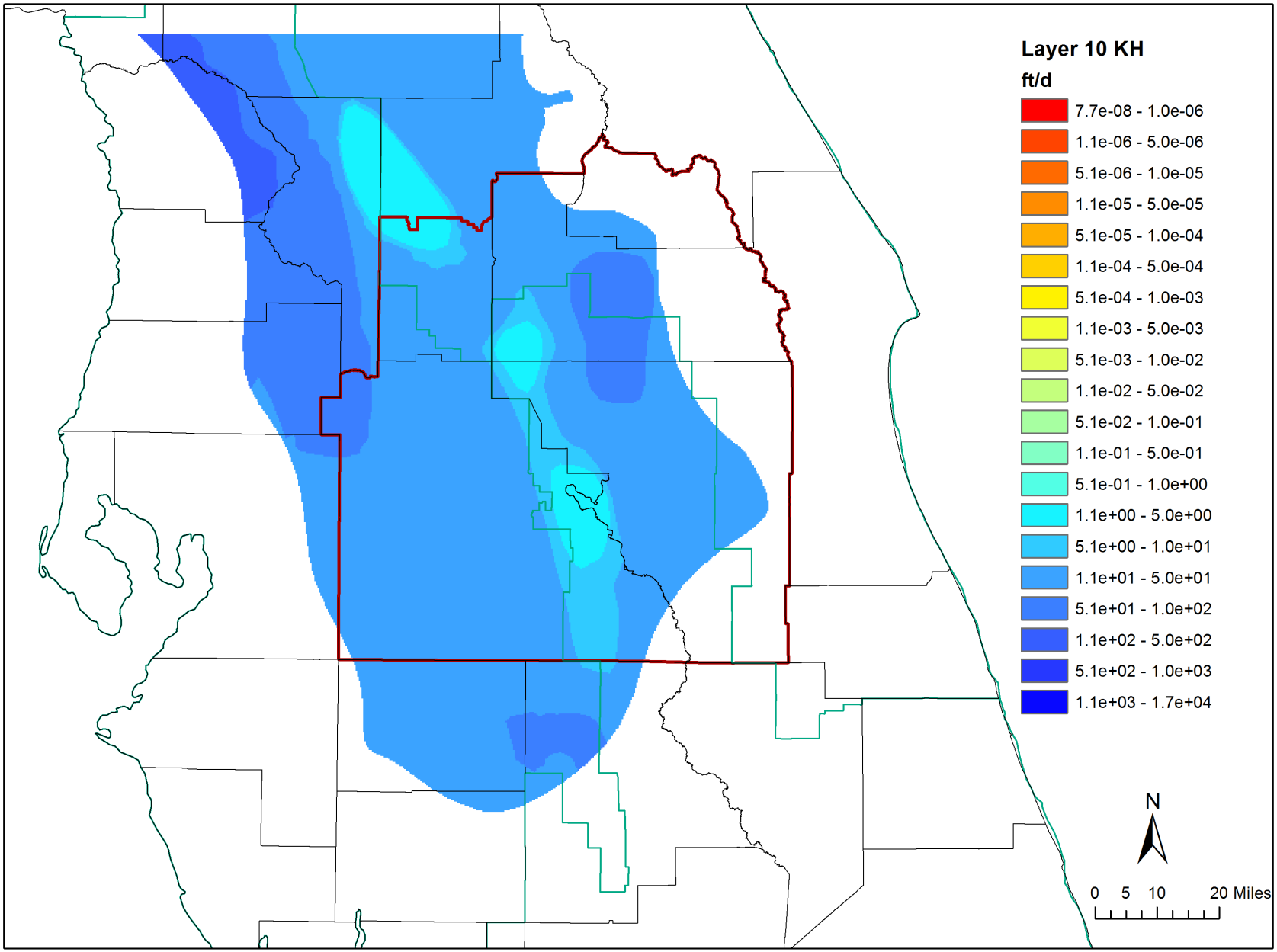
Layer 10 (LFA semi-confining unit) – Hydraulic Conductivity



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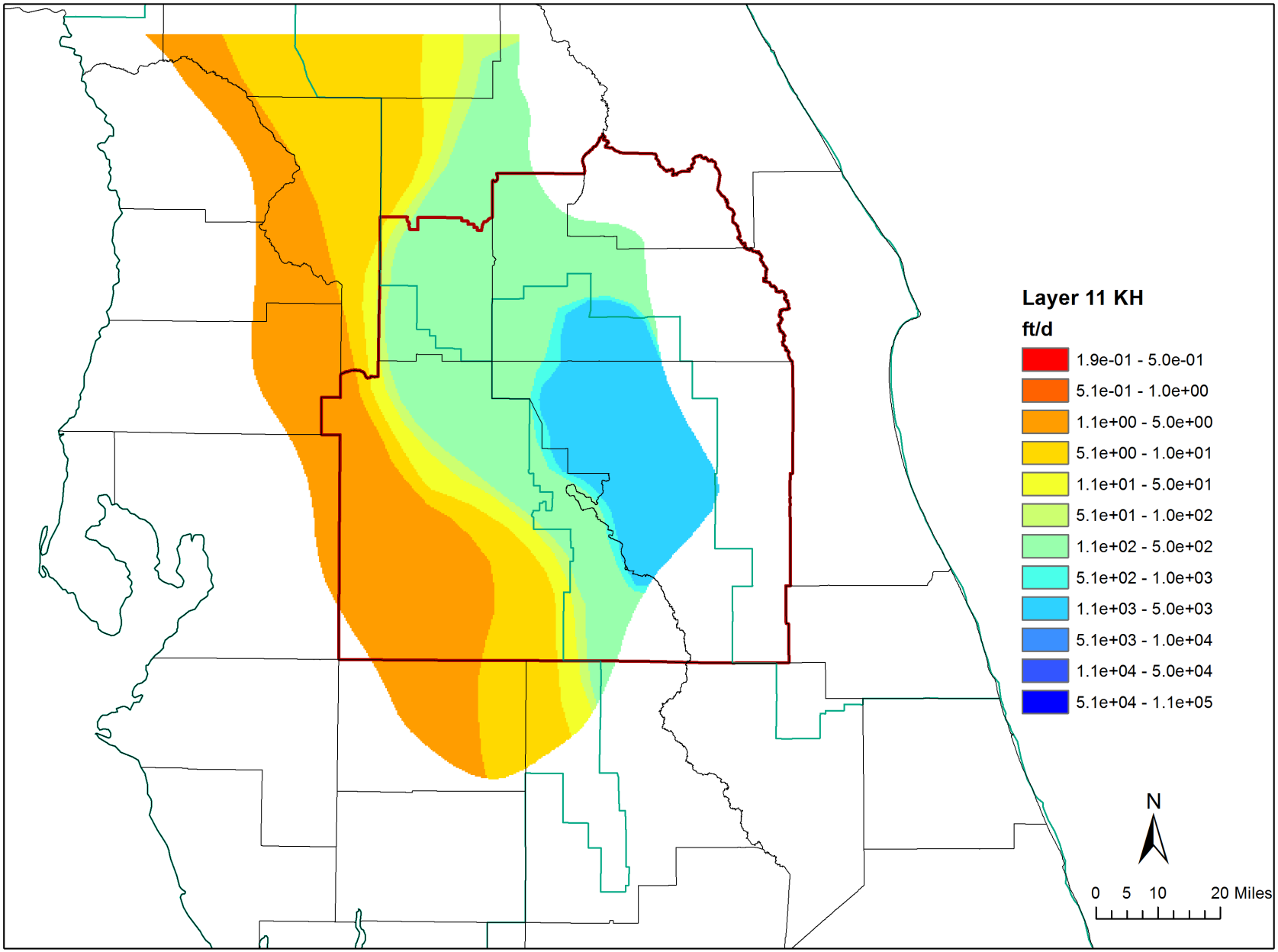
Layer 11 (LFA) – Hydraulic Conductivity



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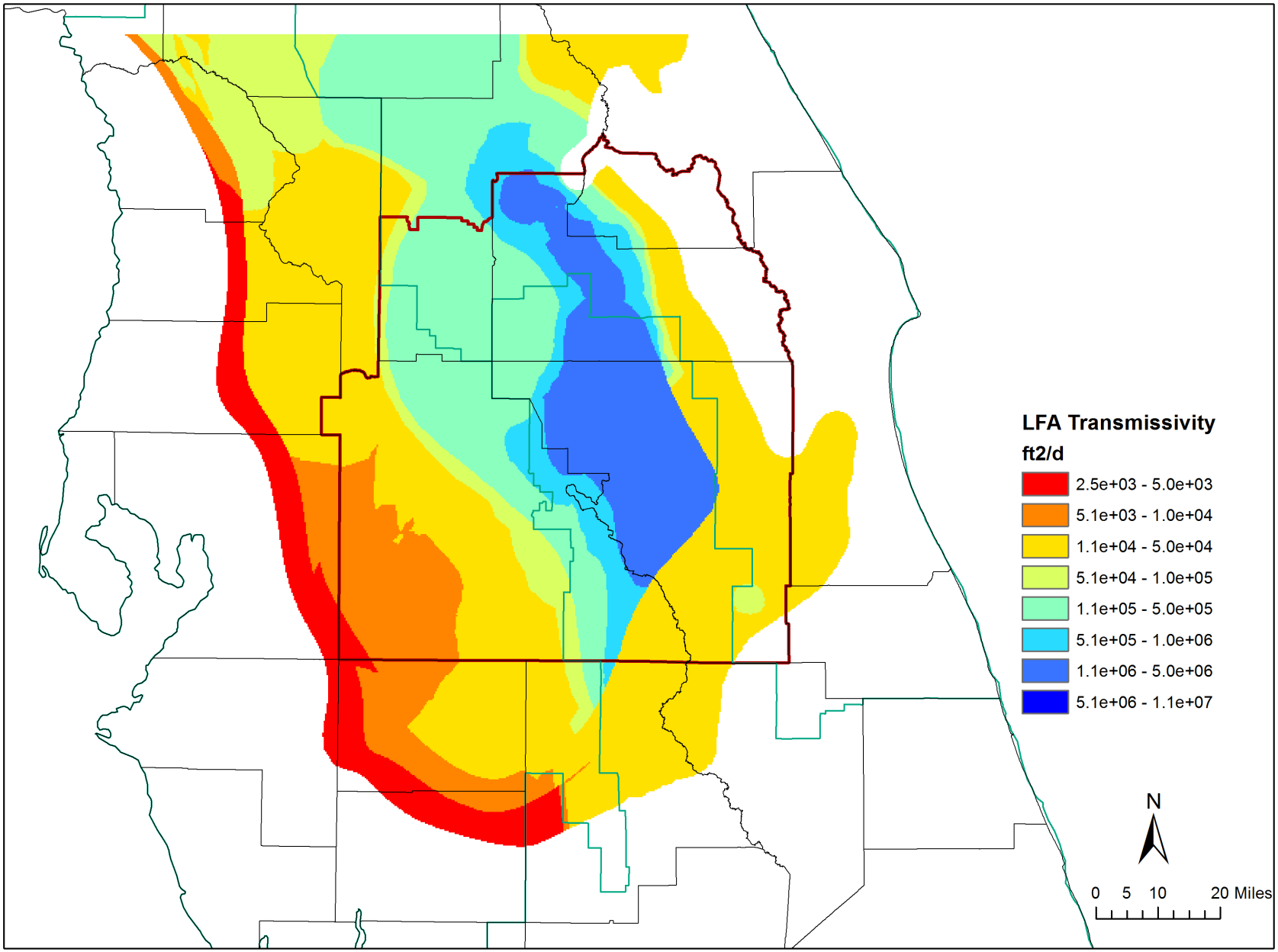
LFA – Transmissivity



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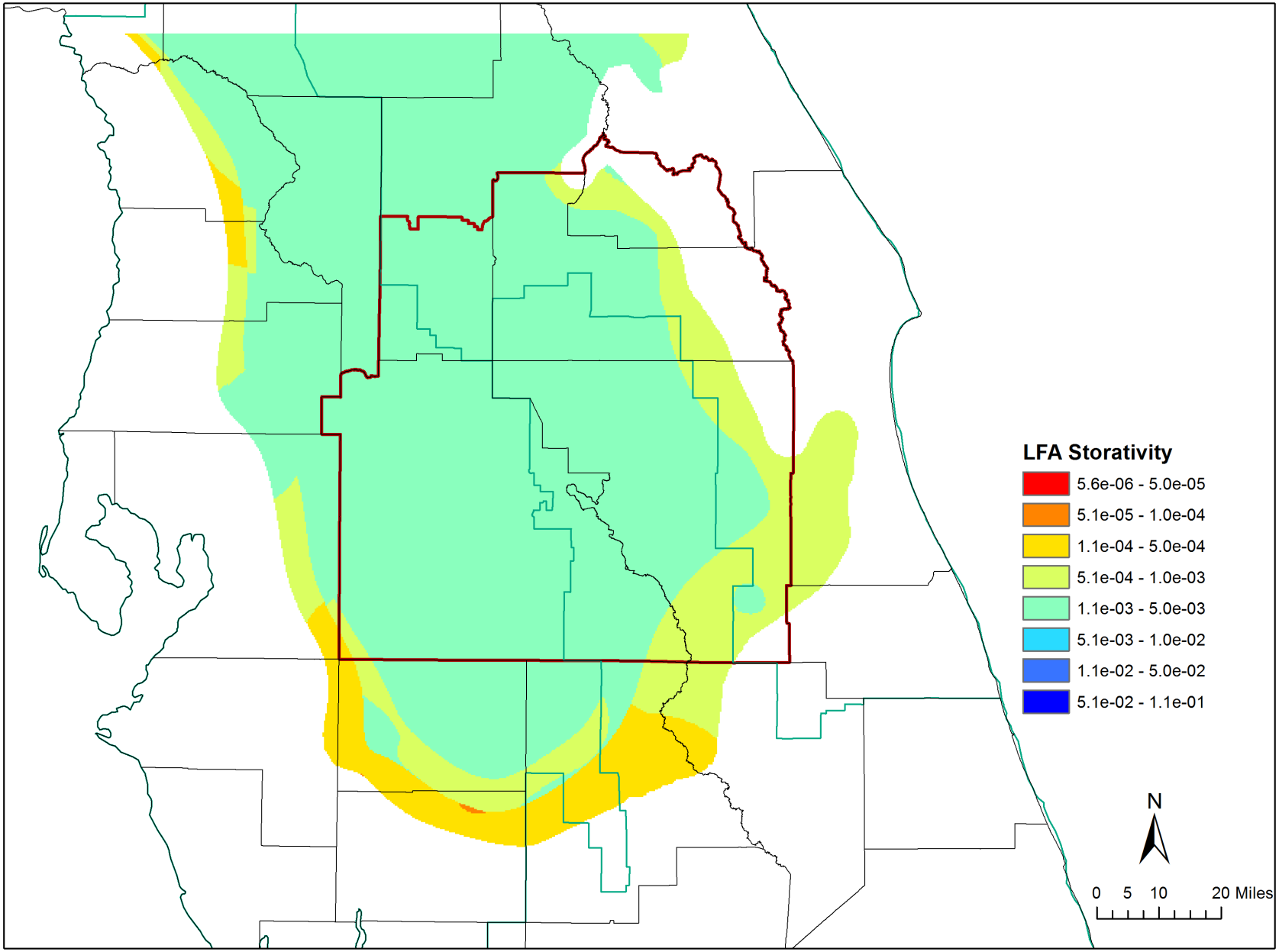
LFA – Storage Coefficients



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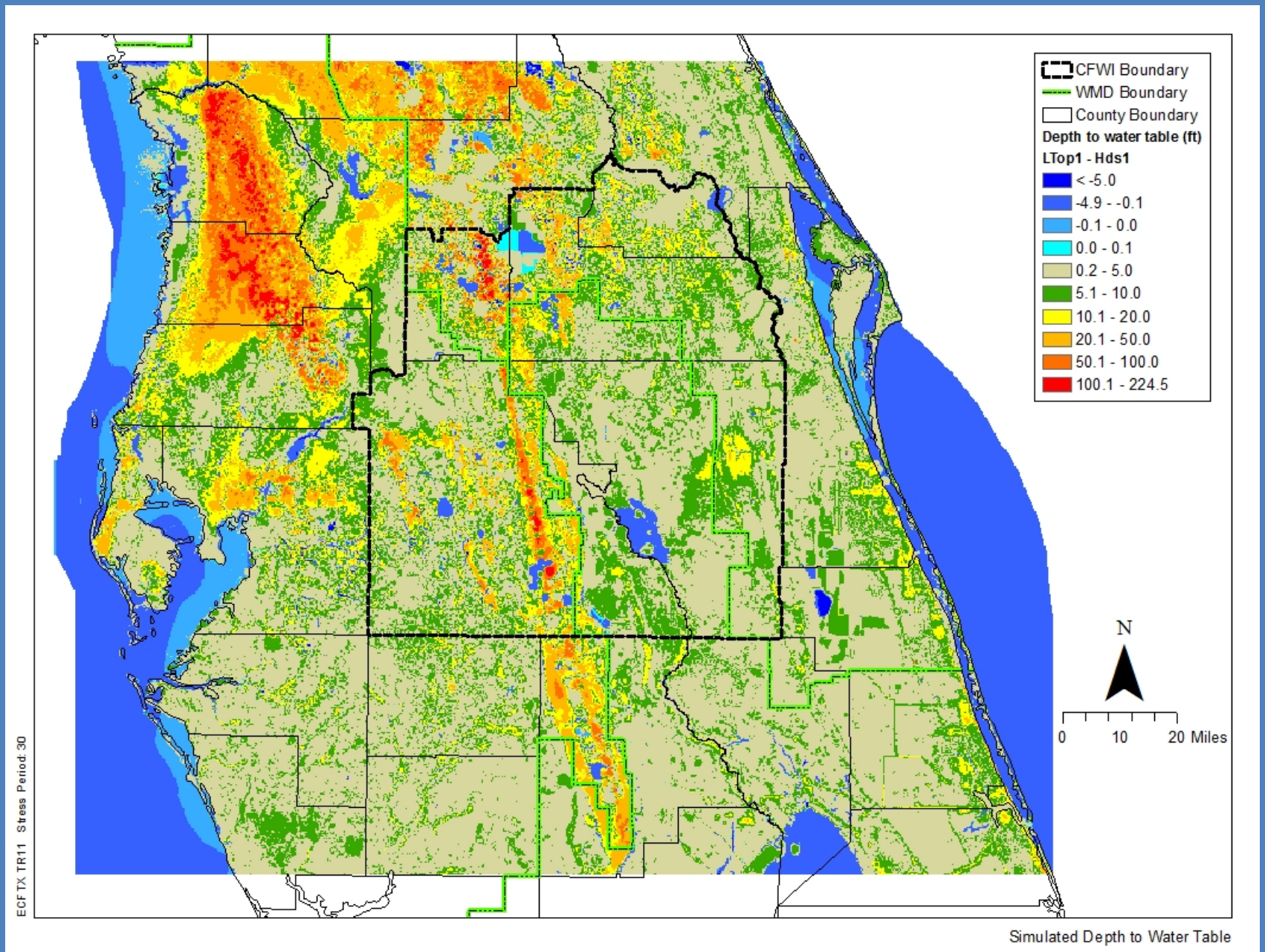
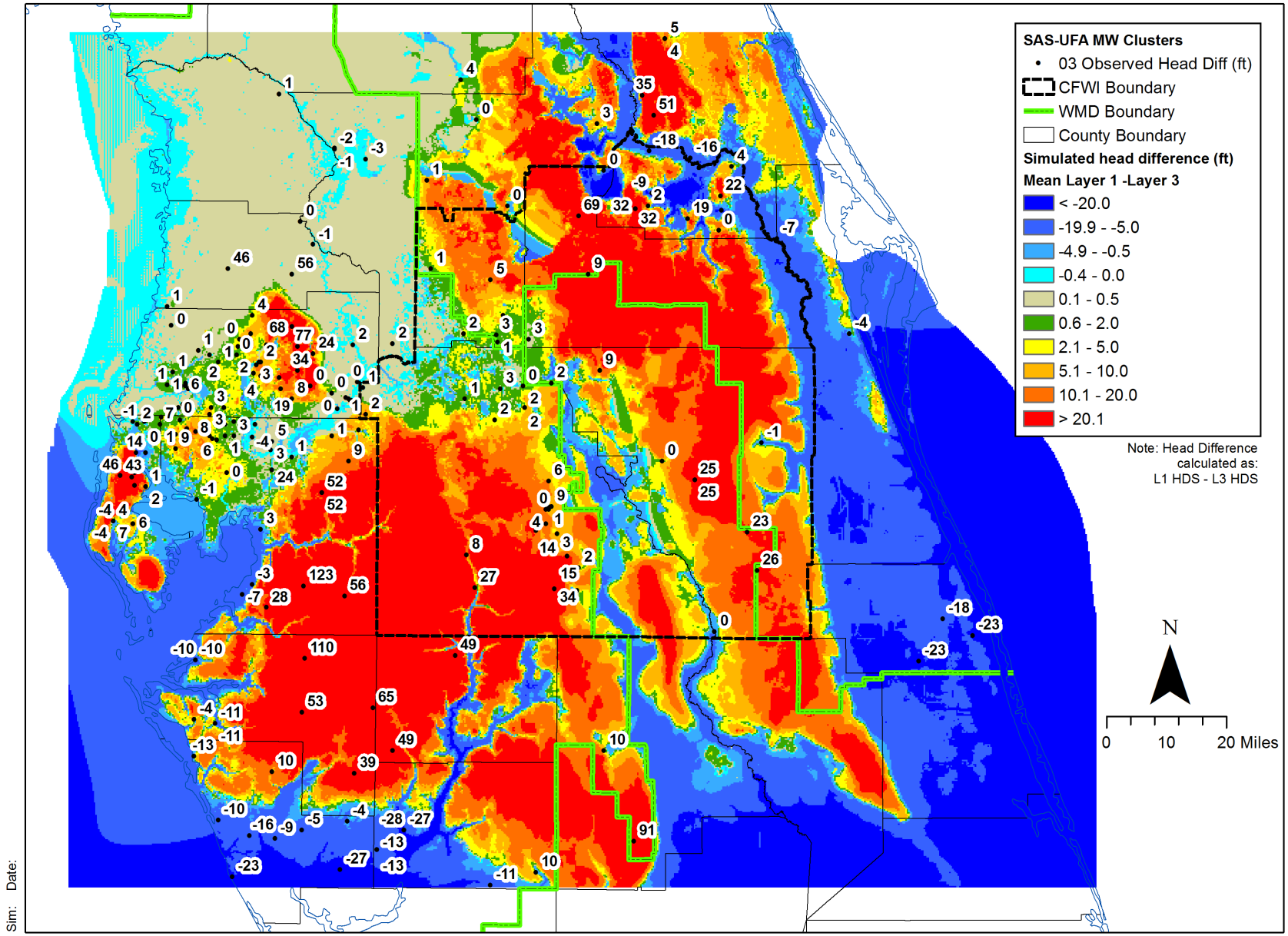
Average Simulated Depth to Water Table

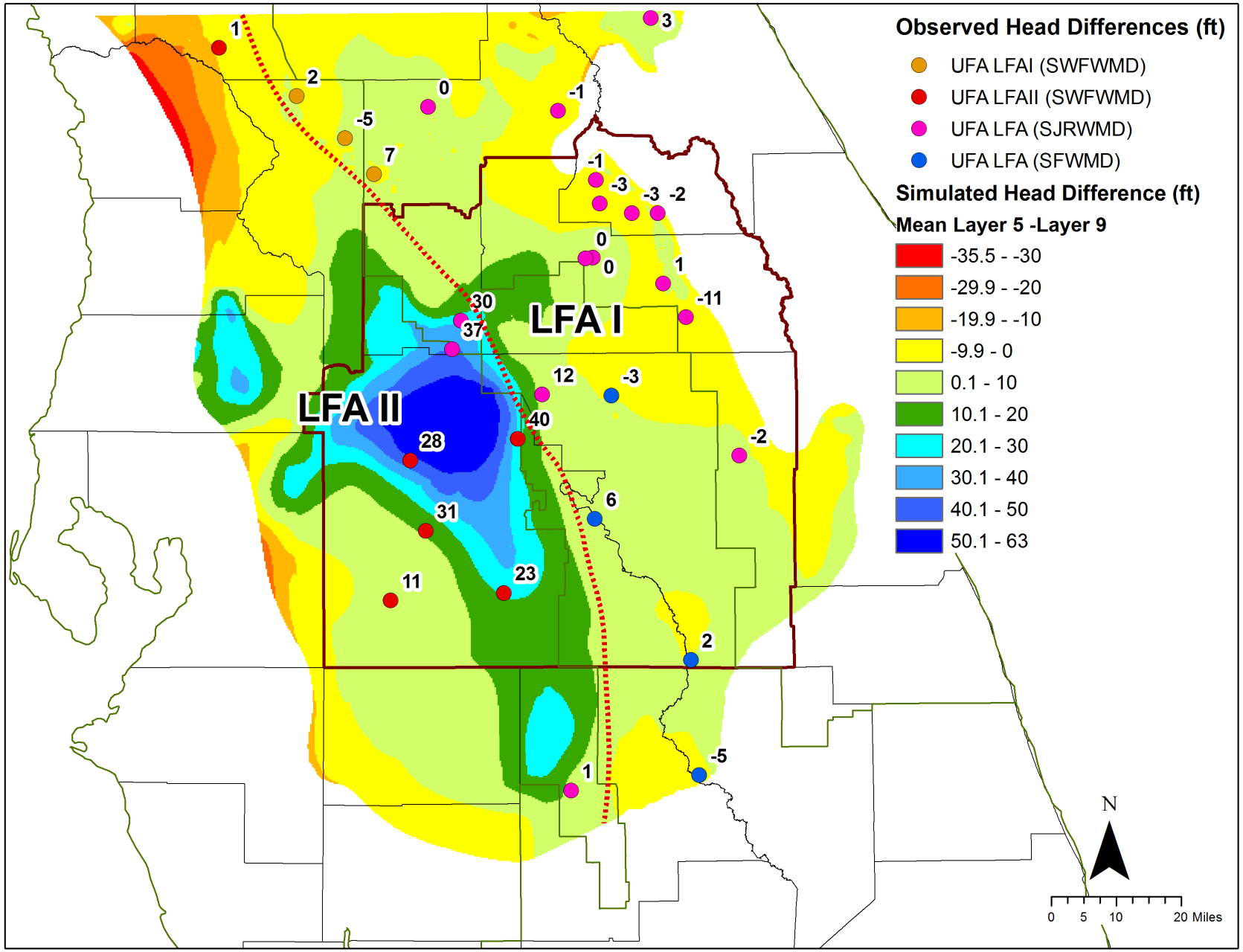


Average Simulated vs Observed Head Difference between Surficial Aquifer-UFA

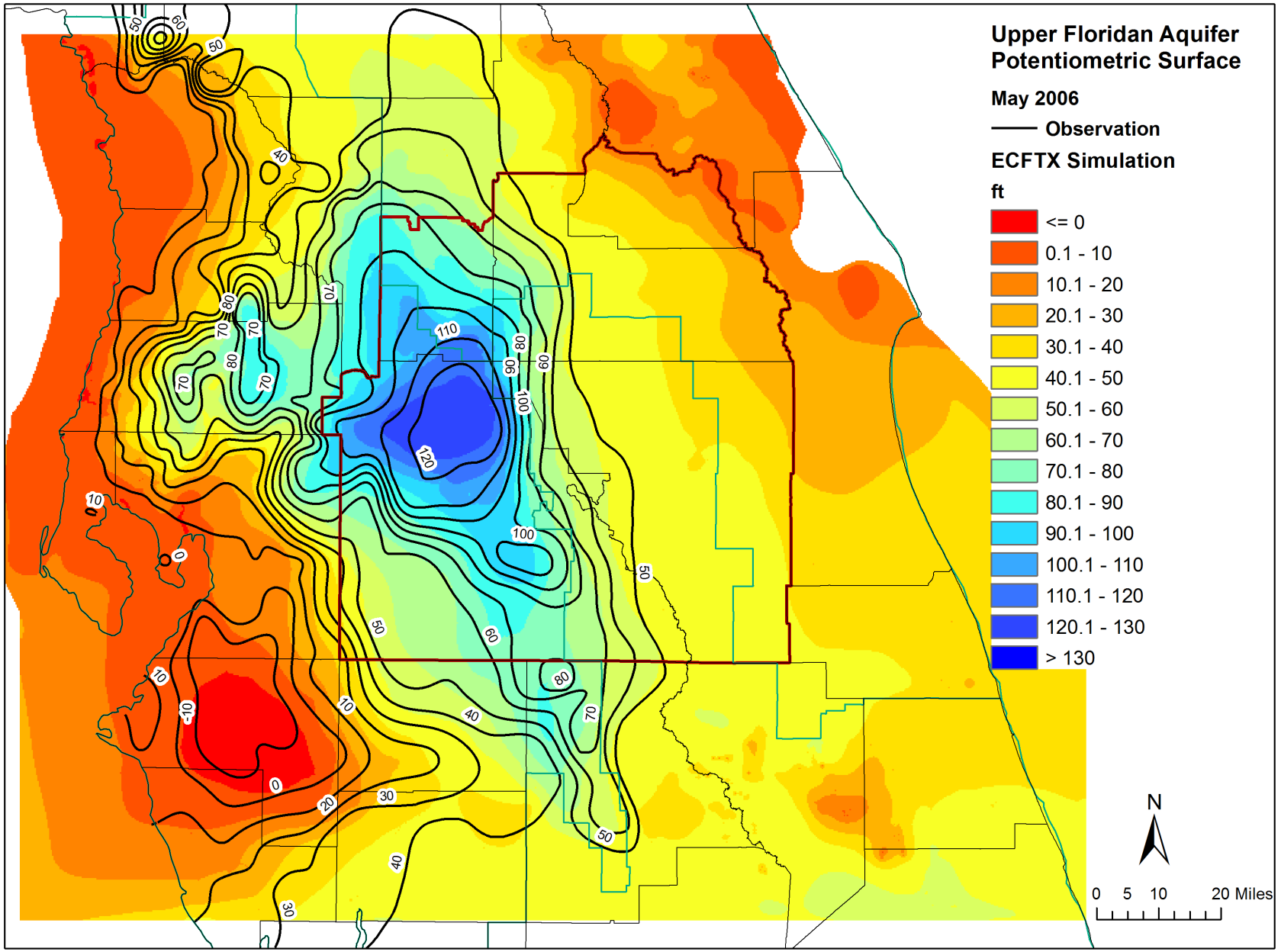


Simulated SAS-UFA Head Difference

Average Simulated vs Observed Head Difference between UFA-LFA



Simulated UFA Head compared to May 2006 USGS potentiometric surface



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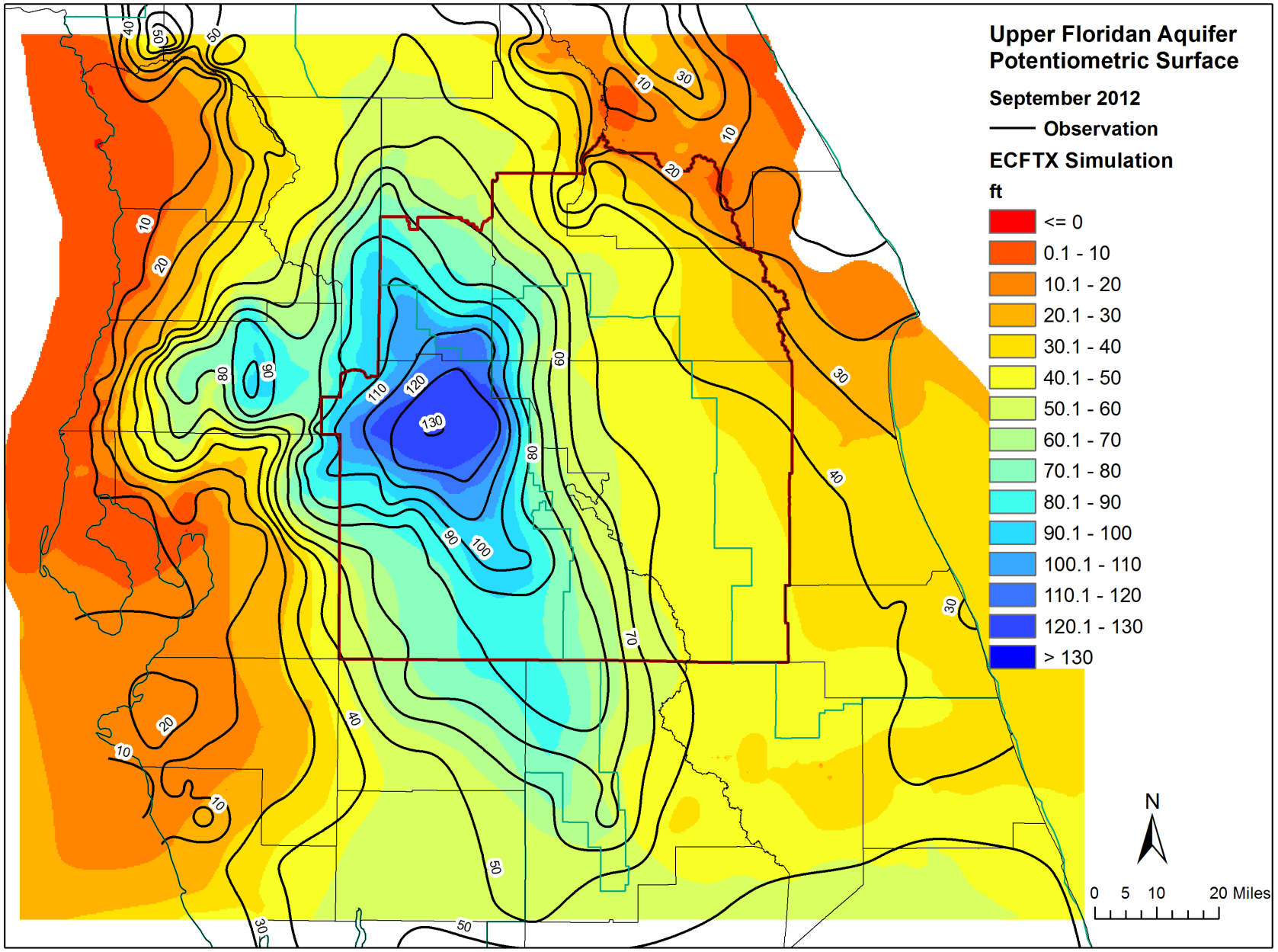
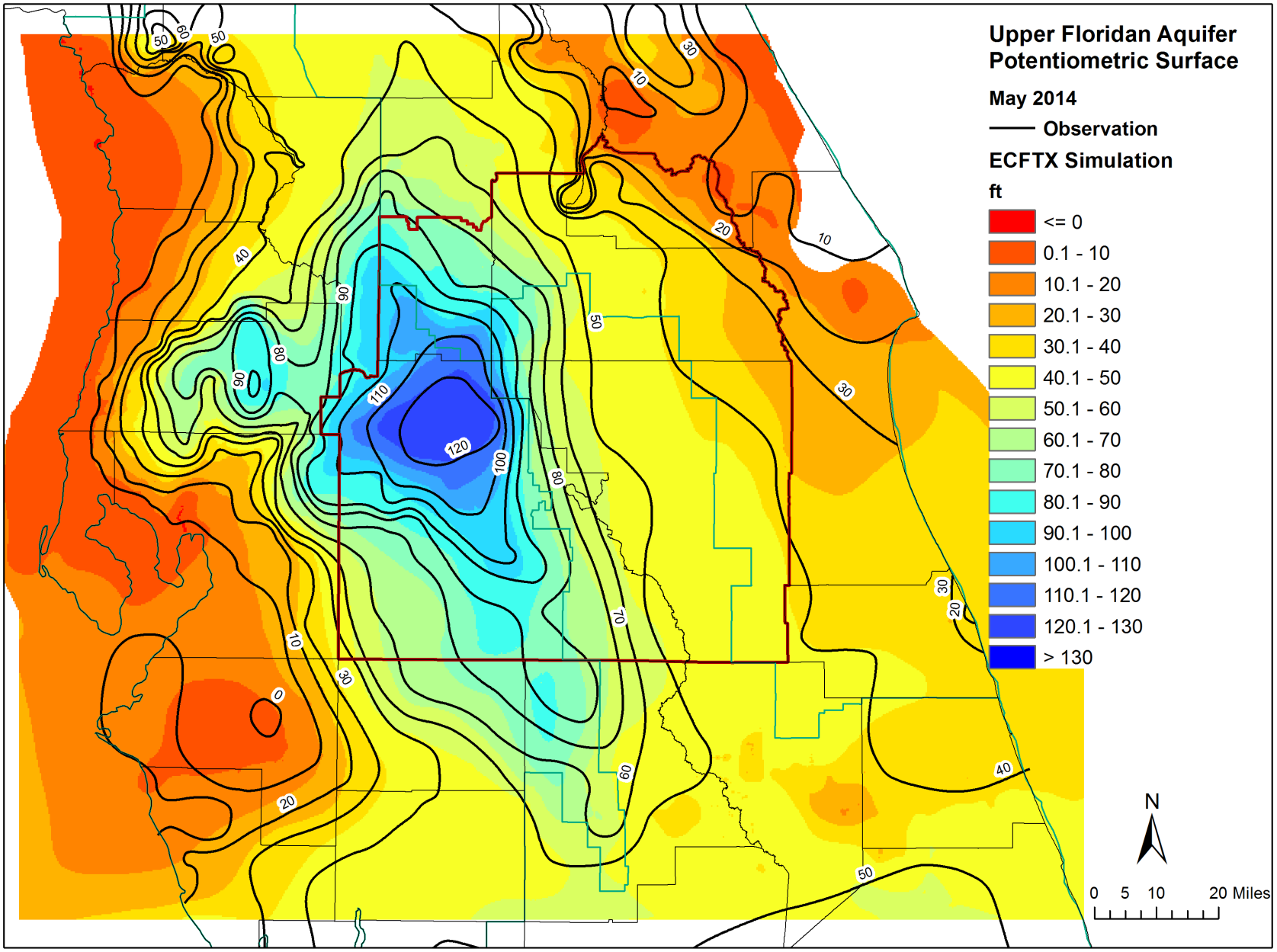
Simulated UFA Head compared to Sept 2012 USGS potentiometric surface



ECFTX TR11 20181205

Simulated UFA Head compared to May 2014 USGS potentiometric surface



ECFTX TR11 20181205

Calibration Criteria

- Structure Flow Criteria:
  - Deviation of Volume (DV) < 15%
  - Nash-Sutcliffe Efficiency (NS) > 0.5
  - Coefficient of Determination (R^2) > 0.5
- Springflow Criteria:
  - ME within +/- 10% for Mag 1 and Mag 2 springs with continuous measurements
  - ME of within +/- 10% for total springflow
- Baseflow Criteria:
  - ME within an order of magnitude for the sum of all simulated baseflow
- Water Level Criteria:
  - Within CFWI, by Aquifer (SAS, UFA, and LFA):
    - 50% of the wells with MAE < 2.5 ft and 80% of the wells with MAE < 5 ft
  - Model Wide, by Aquifer (SAS, UFA, and LFA):
    - Average RMSE < 5 ft
    - Average Overall ME < 1 ft
    - Average MAE < 5% of the range of all observed heads within that aquifer

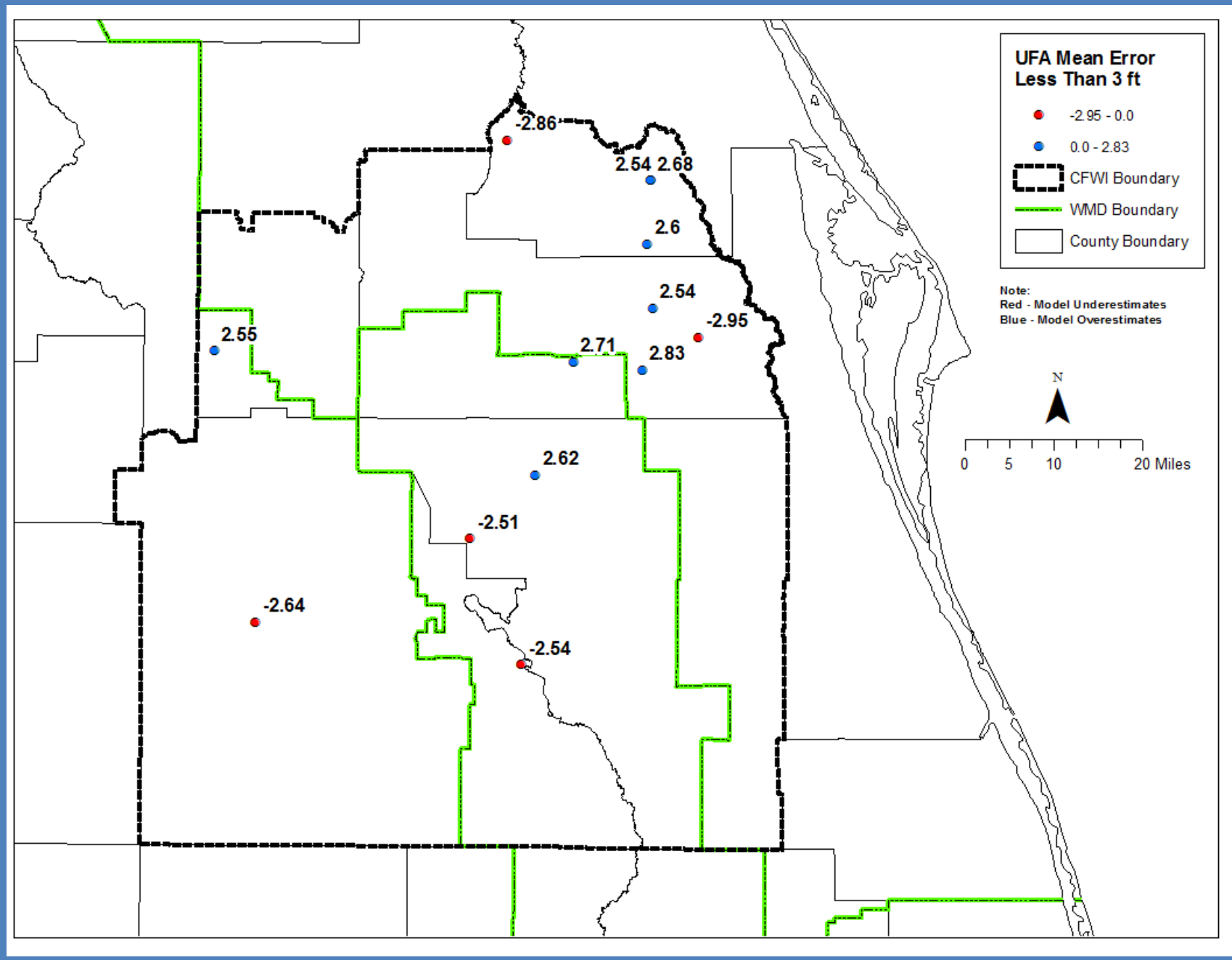
2004-2012 Calibration Period; 2013-14 Verification Period

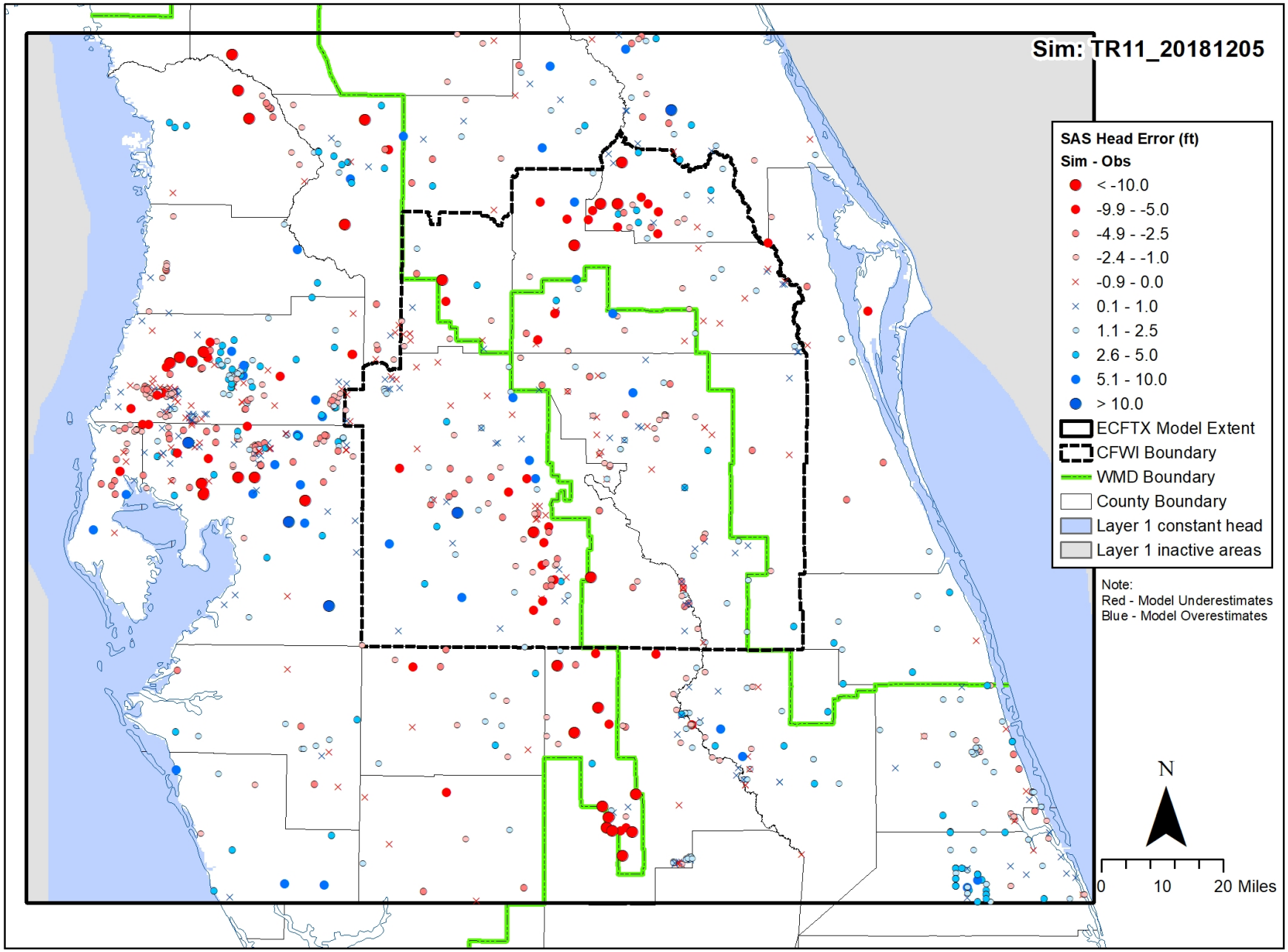
ECFTX	Calibration			Verification		
	SA	UFA	LFA	SA	UFA	LFA
Residual Mean	-0.56	0.63	0.13	-1.1	0.07	0.2
Error Standard Dev	4.28	4.76	3.55	4.42	4.66	3.33
5% of Observation Range	8.97	7.59	2.79	8.66	6.95	2.52
Absolute Residual Mean	2.86	3.84	2.57	2.9	3.62	2.4
Error Sum of Squares	18530	21344	367	16506	15384	334
RMS Error	4.31	4.8	3.5	4.55	4.66	3.28
Minimum Residual	-32.28	-22.26	-10.19	-32.6	-21.96	-10.84
Maximum Residual	20.72	19.06	6.61	20.78	18.68	6.28
Numer of Observations	997	928	30	796	709	31
Percentage with MAE < 2.5 ft	67%	47%	67%	64%	47%	68%
Percentage with MAE < 5.0 ft	88%	75%	80%	87%	78%	84%
Percentage with R2 > 0.4	78%	94%	97%	80%	87%	94%

2004-2012 Calibration Period; 2013-14 Verification Period

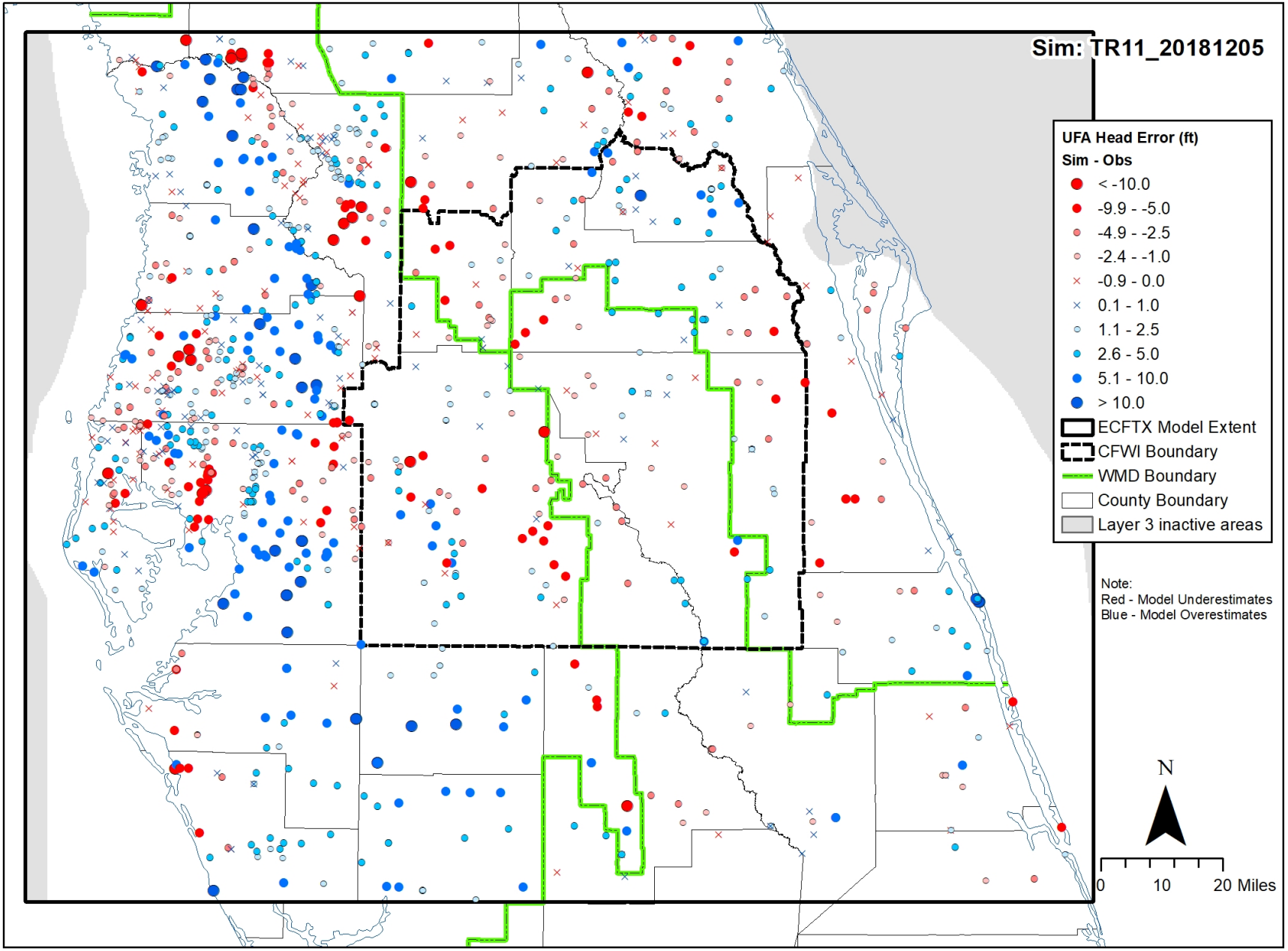
CFWI	Calibration			Verification		
	SA	UFA	LFA	SA	UFA	LFA
Residual Mean	-0.89	-0.02	0.91	-0.91	-0.46	1.08
Error Standard Dev	3.56	3.93	3.12	3.68	3.97	2.52
5% of Observation Range	8.6	6.2	2.62	8.56	6.02	2.38
Absolute Residual Mean	2.7	3.42	2.42	2.69	3.38	2.09
Error Sum of Squares	3718	2983	244	3150	2559	182
RMS Error	3.66	3.92	3.19	3.78	3.99	2.7
Minimum Residual	-16.75	-12.19	-6.75	-16.59	-12.37	-5.67
Maximum Residual	12.97	10.27	6.61	11.32	10.26	6.28
Numer of Observations	277	194	24	220	161	25
Percentage with MAE < 2.5 ft	68%	46%	67%	65%	47%	72%
Percentage with MAE < 5.0 ft	86%	81%	79%	85%	84%	84%
Percentage with R2 > 0.4	81%	97%	96%	78%	93%	100%

UFA Target Wells close to 2.5 ft MAE

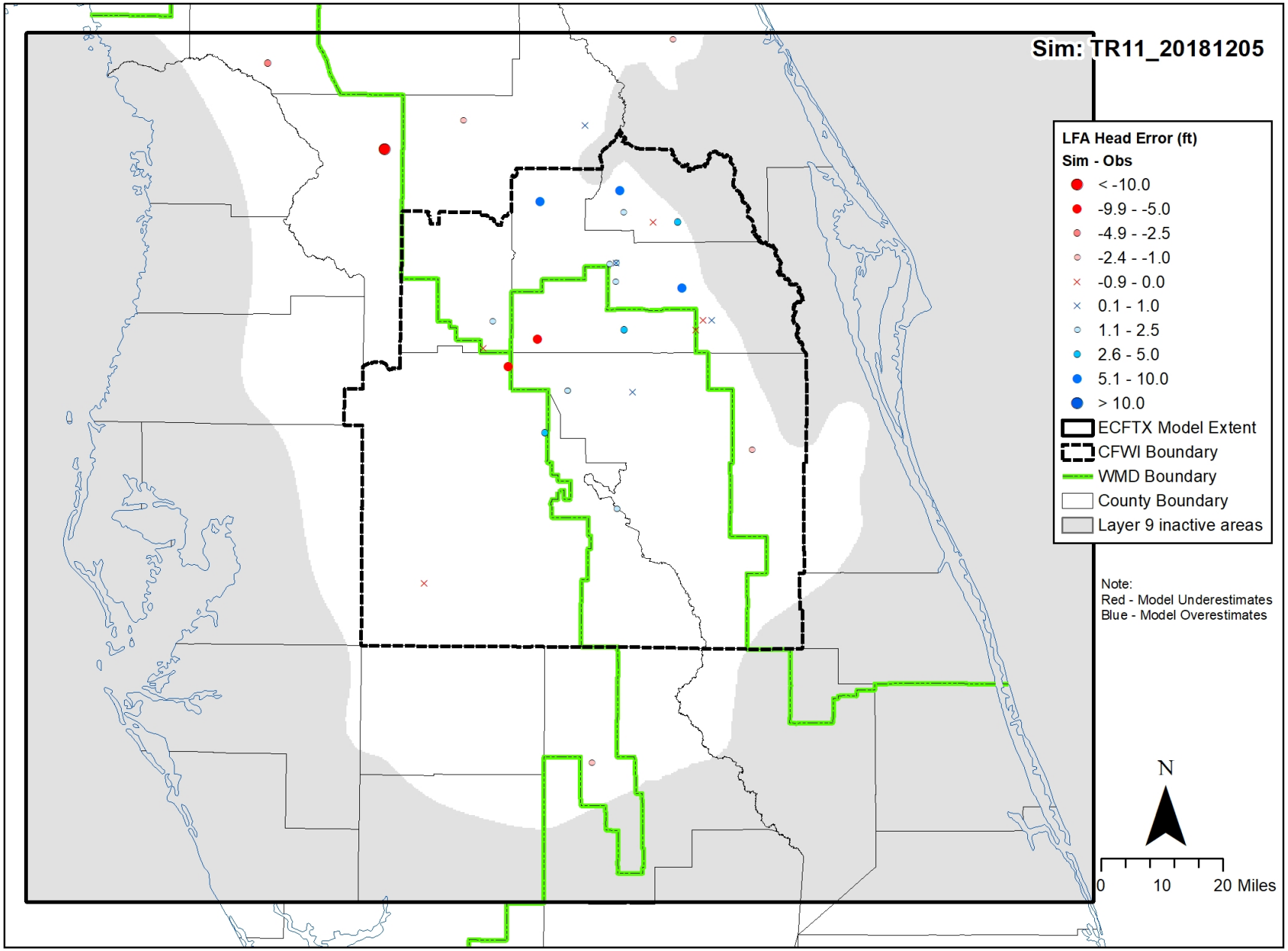




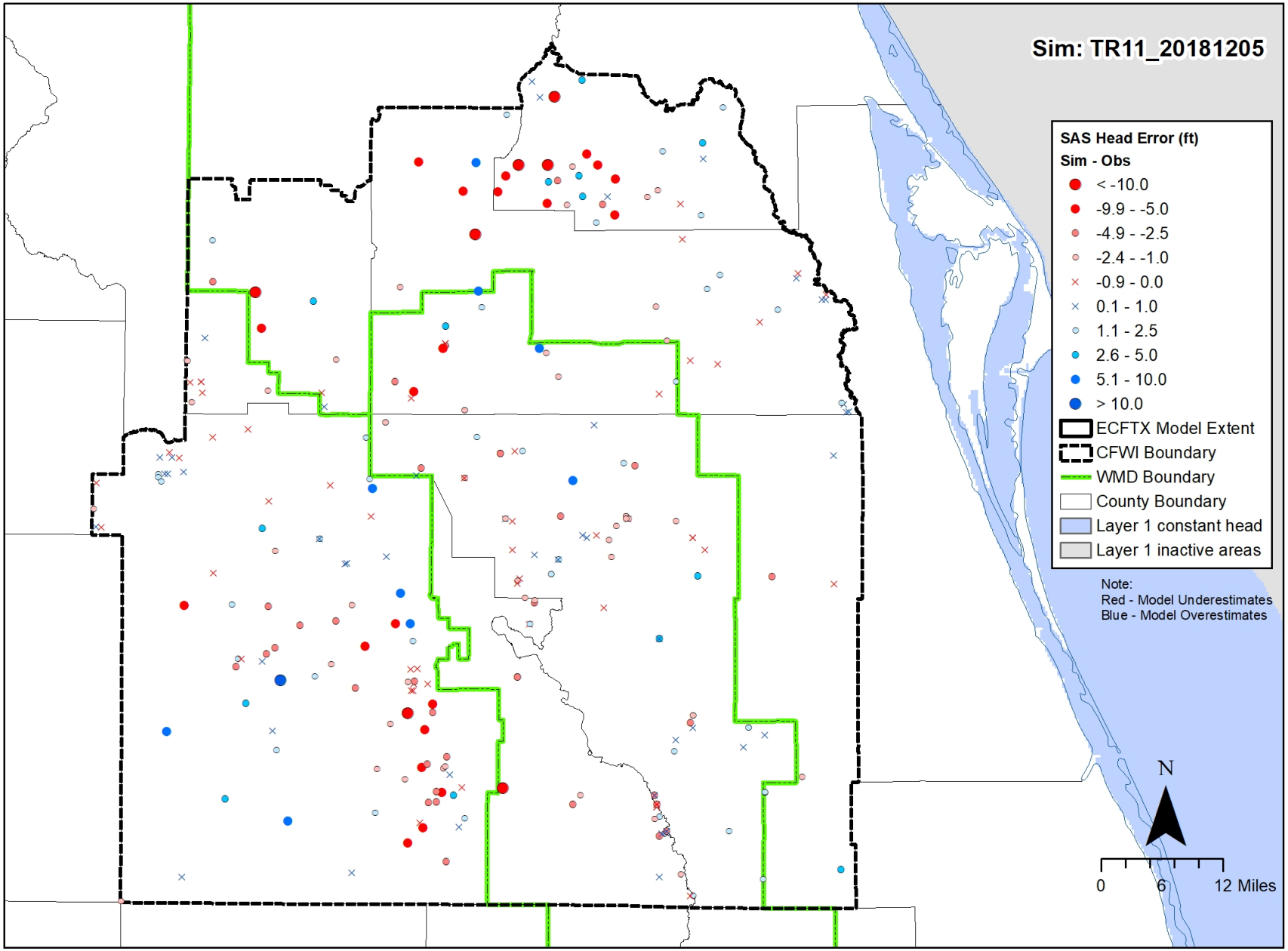
Simulated SAS Head Target (L1) Residuals - Modelwide
Mean Error - Calibration Period (2004-2012)



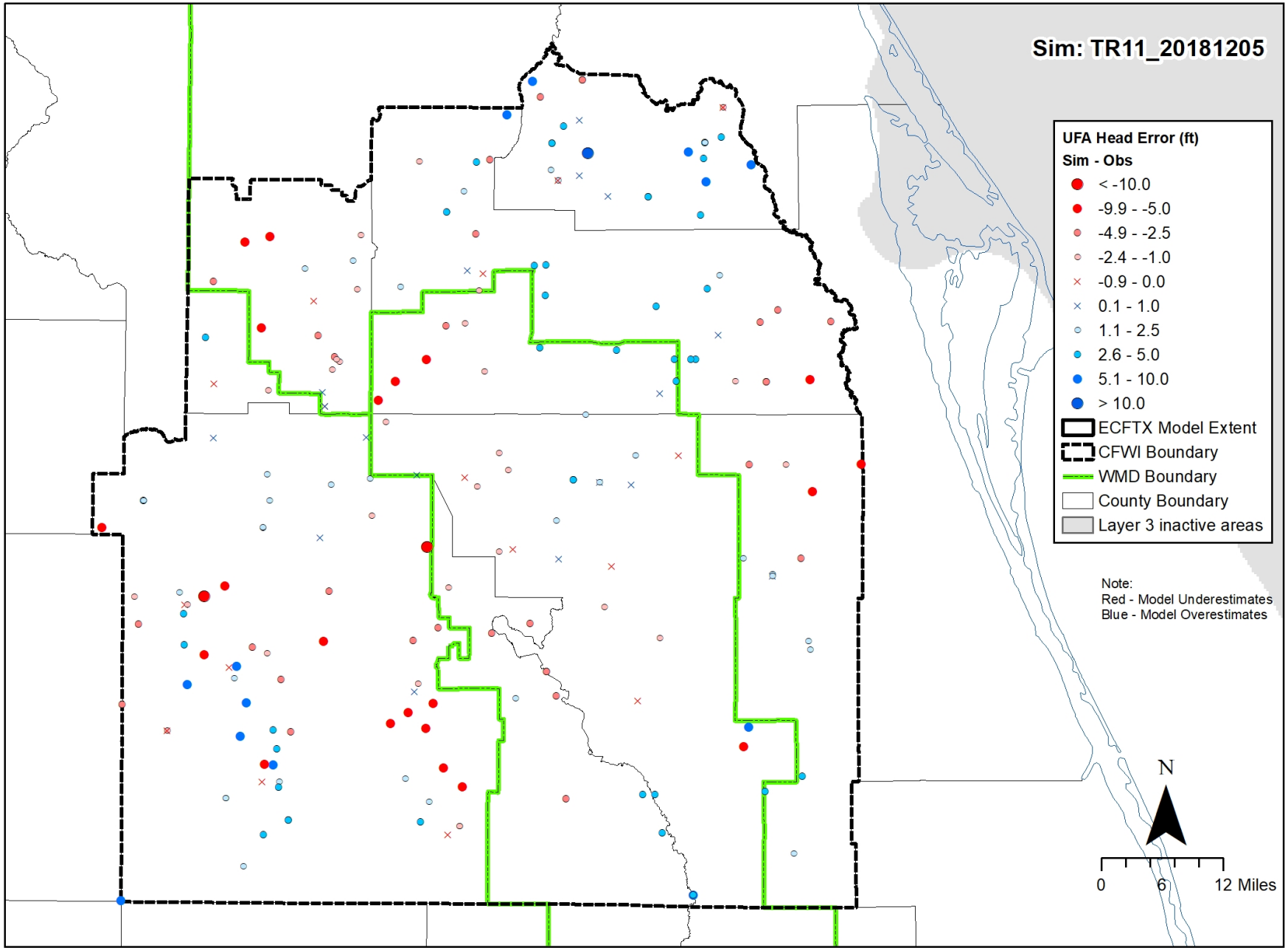
Simulated UFA Head Target (L3-5) Residuals - Modelwide
Mean Error - Calibration Period (2004-2012)



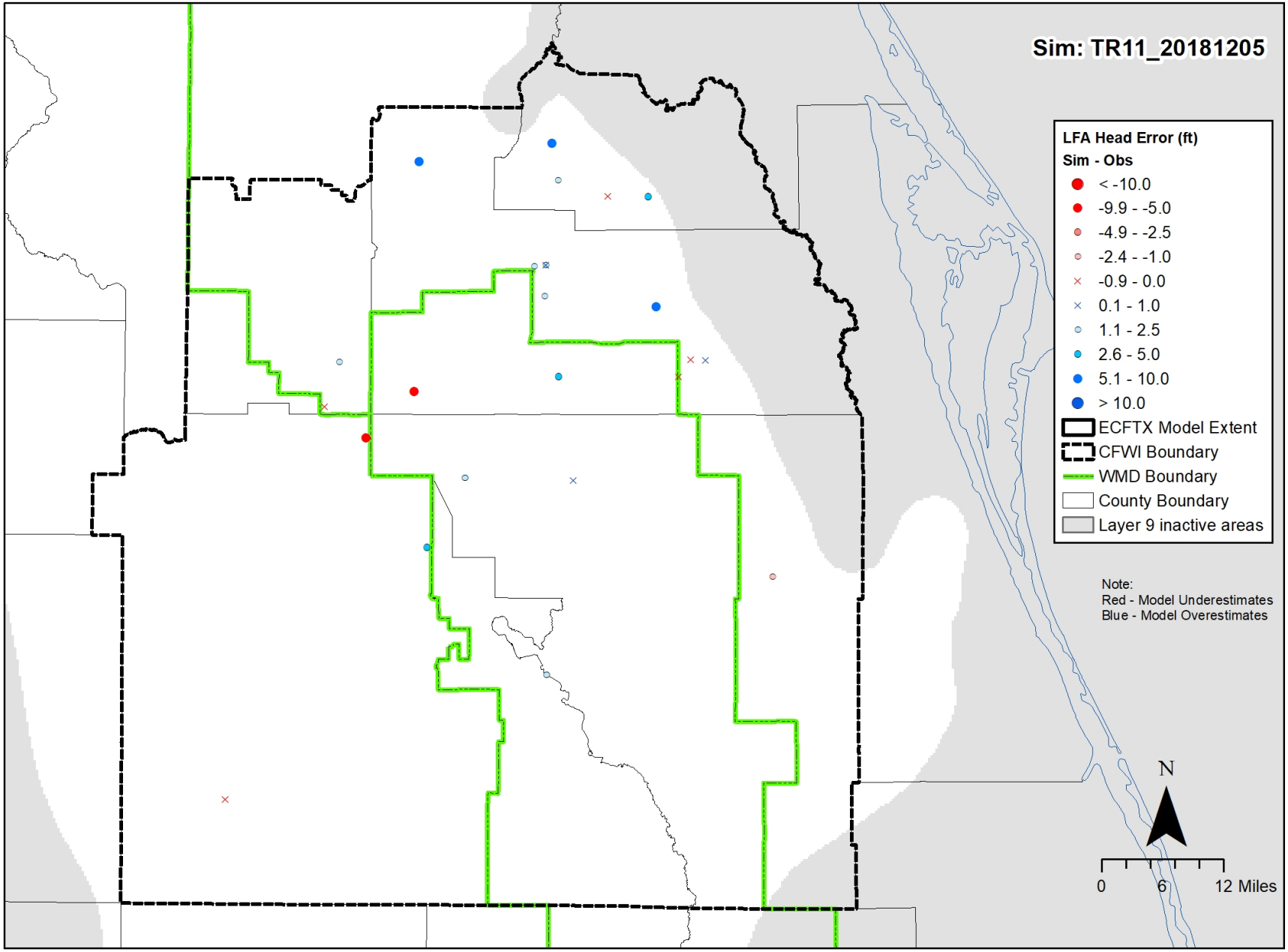
Simulated LFA Head Target (L9-11) Residuals - Modelwide
Mean Error - Calibration Period (2004-2012)



Simulated SAS Head Target (L1) Residuals - CFWI
Mean Error - Calibration Period (2004-2012)

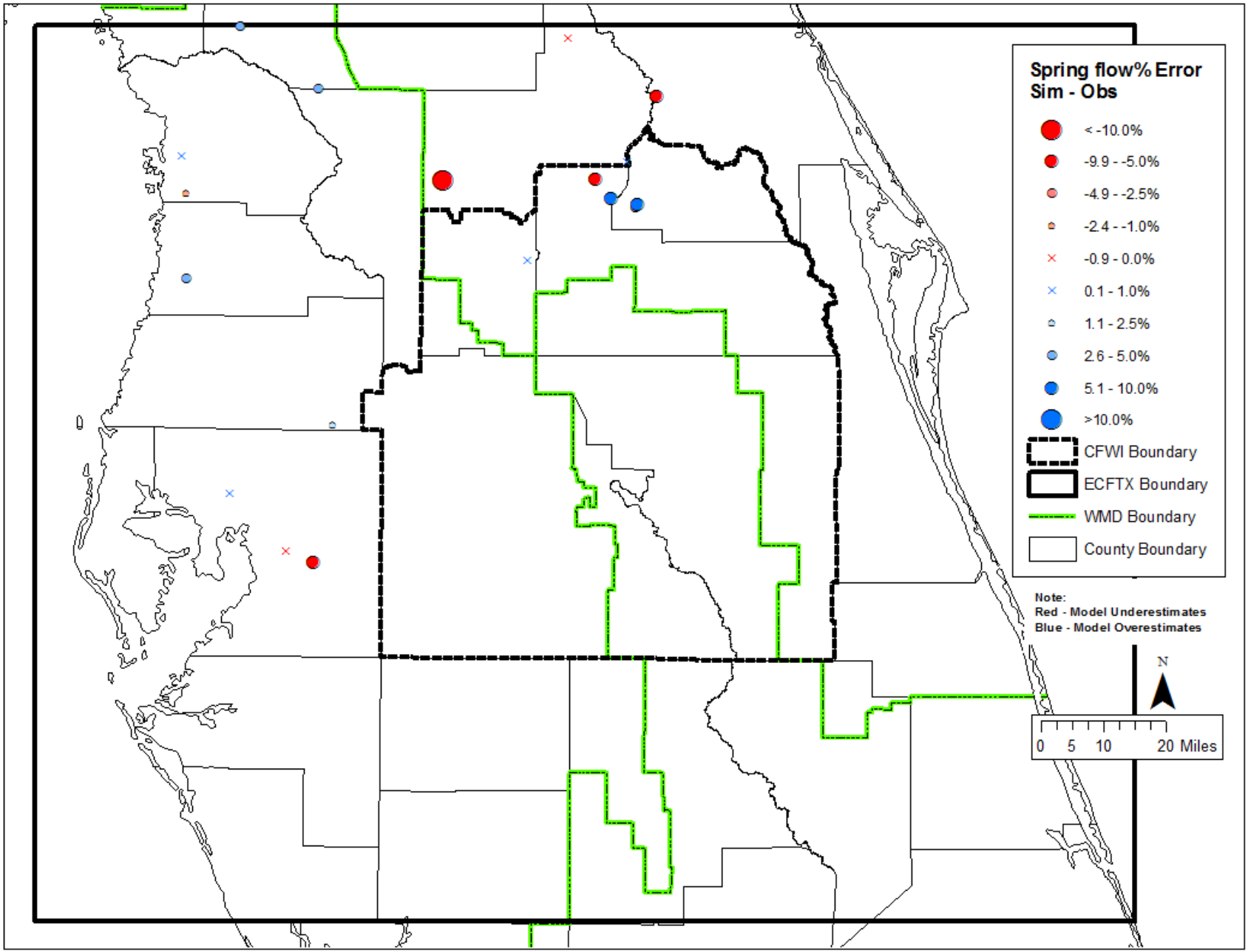


Simulated UFA Head Target (L3-5) Residuals - CFWI
Mean Error - Calibration Period (2004-2012)



Simulated LFA Head Target (L9-11) Residuals - CFWI
Mean Error - Calibration Period (2004-2012)

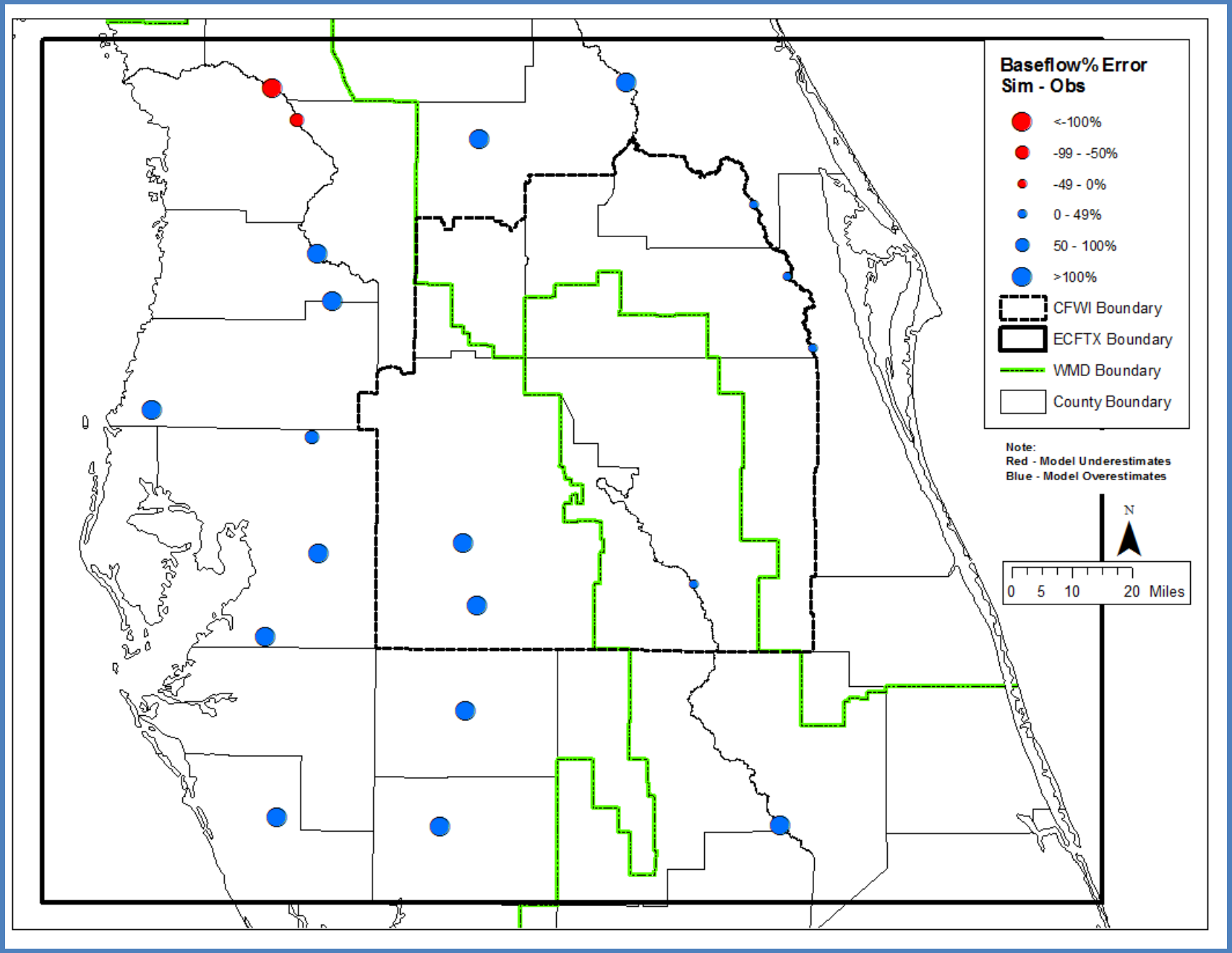
Springflow mean error (sim vs obs) for mag 1 and 2 measured sites



Magnitude 1 and 2 Springflow (sim vs obs)

Spring Name	County	Observed Flow (cfs)	Simulated Flow (cfs)	Residual (cfs) Sim - Obs	Residual (pct) Sim - Obs
ALEXANDER SPRING	Lake	100.1	99.1	-1.1	1%
APOPKA SPRING	Lake	24.9	25.47	0.6	2%
BUCKHORN MAIN SPRING	Hillsborough	12.2	12.1	-0.1	0%
BUGG SPRING (LAKE)	Lake	10.6	9	-1.6	15%
CHASSAHOWITZKA SPRING MAIN	Citrus	59.6	59.1	-0.6	-1%
CRYSTAL MAIN SPRING (PASCO)	Pasco	45.5	46.3	0.8	2%
GUM SPRING MAIN	Sumter	63.8	66	2.2	3%
HOMOSASSA SPRING #1	Citrus	83.5	84.3	0.8	1%
LITHIA SPRING MAJOR	Hillsborough	34.7	33.2	-1.5	-4%
RAINBOW SPRING #1	Marion	71.9	73.9	2	4%
ROCK SPRINGS (ORANGE)	Orange	54.9	52	-2.9	-5%
SANLANDO SPRINGS	Seminole	18.9	20	1.1	6%
STARBUCK SPRING	Seminole	12.1	12.6	0.5	4%
SULPHUR SPRING (HILLSBOROUGH)	Hillsborough	34.7	35.3	0.5	1%
VOLUSIA BLUE SPRING	Volusia	143.6	130	-13.6	9%
WEEKI WACHEE SPRING	Hernando	160.4	166.8	6.4	4%
WEKIVA FALLS RESORT (FLOWING 14" BOREHOLE)	Seminole	12	12.4	0.4	3%
WEKIWA SPRING (ORANGE)	Orange	61	64.7	3.7	6%
Total		**1004.4**	**1002.3**		

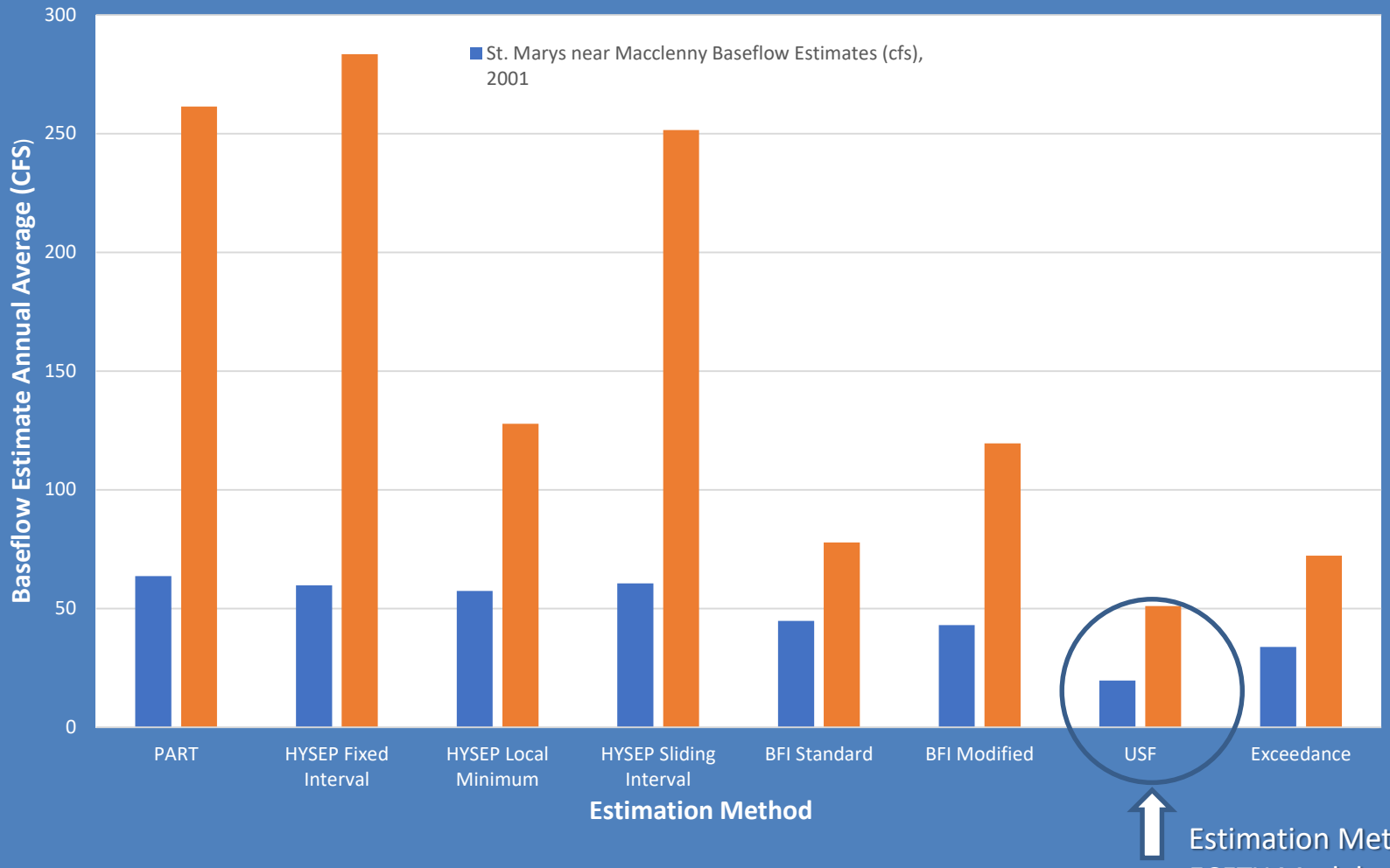
Baseflow mean error (sim vs estimated)



Non-structured Baseflow (sim vs est)

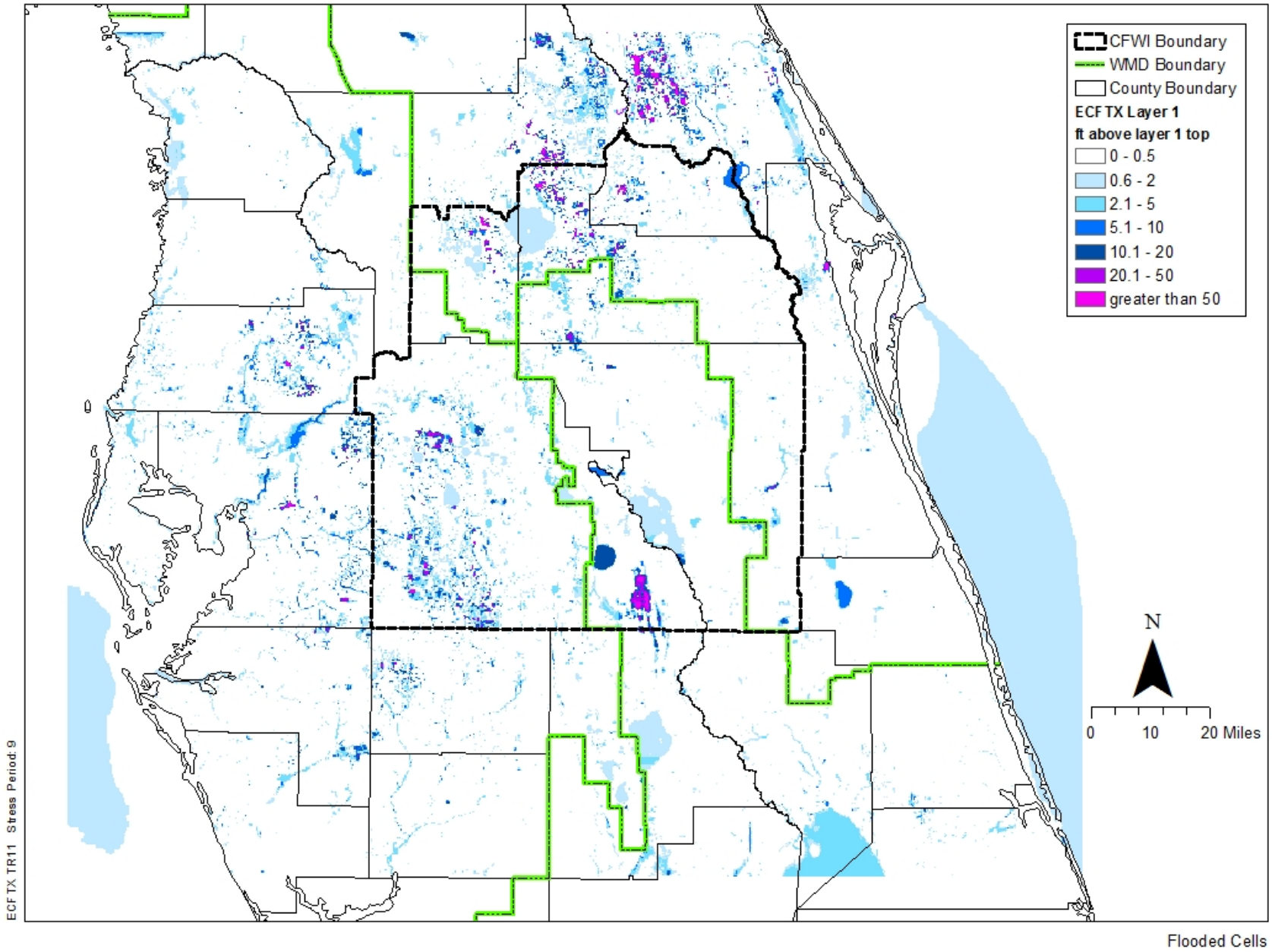
Group	Gage	Station Name	Area (sq miles)	Spring (cfs)	River (cfs)	DRN (cfs)	Total (cfs)	Obs (cfs)	Residual (cfs)	Residual (pct)
UpperSJR	52	ST_JOHNS_RIVER_NEAR_COCOA_FL	1331.7	-	89.9	191.4	281.3	225.0	56.3	25%
UpperSJR	16	ST_JOHNS_RIVER_NEAR_CHRISTMAS_FL	1540.9	-	111.9	262.4	374.3	313.9	60.4	19%
MiddleSJR	31	ST_JOHNS_RIVER_ABOVE_LAKE_HARNEY_NEAR_GENEVA_FL	2027.7	-	221.4	517.4	738.8	496.6	242.2	49%
MiddleSJR	2	ST_JOHNS_RIVER_NEAR_DE_LAND_FL	2908.7	387.2	432.5	803.8	1,623.4	466.7	1,156.7	248%
KISS	117	S65_FLOW	1555	-	51.6	232.5	284.1	248.9	35.2	14%
KISS	97	S65E_FLOW	2916.2	-	183.7	548.5	732.3	131.7	600.6	456%
OCK	119	HAYNES CREEK AT LISBON	496	35.6	(22.4)	64.2	77.5	15.9	61.6	388%
WITH	259	WITHLACOOCHEE RIVER AT TRILBY	568.7	-	140.8	25.5	166.3	32.0	134.2	419%
WITH	258	WITHLACOOCHEE RIVER AT CROOM	798	-	154.6	35.9	190.5	61.0	129.5	212%
WITH	264	WITHLACOOCHEE RIVER NR INVERNESS	1649.2	38.0	(100.4)	92.0	29.7	168.7	(139.1)	-82%
WITH	263	WITHLACOOCHEE RIVER NR HOLDER	1813.5	114.6	(228.8)	96.1	(18.2)	256.7	(274.9)	-107%
HILLS	222	HILLSBOROUGH RIVER NR ZEPHYRHILLS	225.1	46.3	36.1	19.8	102.2	66.8	35.4	53%
ALA	201	ALAFIA RIVER AT LITHIA	343.7	-	29.7	80.4	110.1	53.5	56.6	106%
MYA	235	MYAKKA RIVER NR SARASOTA	224.8	-	16.8	35.4	52.1	16.8	35.3	210%
PEACE	241	PEACE RIVER AT BARTOW	377.2	-	9.6	56.0	65.5	20.1	45.4	225%
PEACE	242	PEACE RIVER AT FORT MEADE	451.9	-	28.5	88.7	117.2	18.8	98.4	522%
PEACE	243	PEACE RIVER AT ZOLFO SPRINGS	811.1	-	113.7	186.0	299.7	79.2	220.5	278%
PEACE	240	PEACE RIVER AT ARCADIA	1344.1	-	205.5	295.8	501.3	120.3	381.0	317%
NW	203	ANCLOTE RIVER NR ELFERS	68.4	1.8	9.2	0.5	11.5	4.4	7.1	162%
LMAN	230	LITTLE MANATEE RIVER NR WIMAUMA	143.4	-	23.5	50.2	73.6	23.6	50.0	212%
		Total					**5,813.1**	**2,820.7**		

Summary of Estimated Baseflows by Method for St. Marys near Macclenny (0223100)

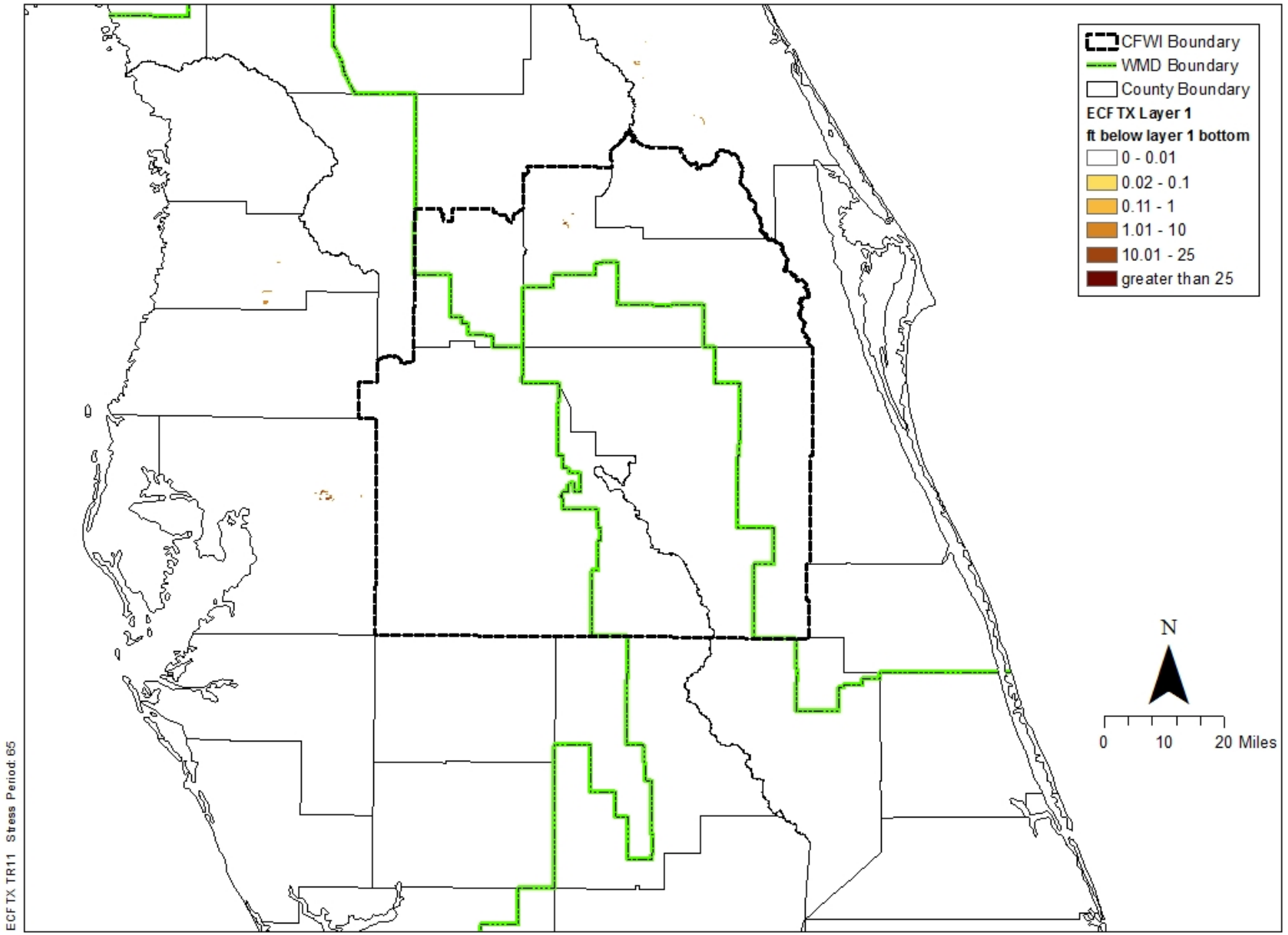


Shiny App

Sept 2004 flooded cells (worst month)



April 2009 Dry cells (worst month)



2003-2014 Flux over ECFTX Model Domain (unit: in/yr)

Aquifer	Layer	Well		Recharge	ET	River		Drain	Spring	GHB		CHD	Net Vertical	Storage	TOTAL
		In	Out			In	Out			In	Out				
SA	1	0.06	-0.13	17.98	-10.68	2.52	-3.16	-2.77	-	0.03	-0.02	-2.22	-1.75	0.14	-
ICU/IAS	2	-	-0.02	-	-	-	-	-	-	0.66	-0.59	-	-0.06	-	-0.01
UFA - Upper	3	0.06	-0.60	-	-	-	-	-	-1.27	0.81	-0.63	-	1.64	-	0.01
OCAPlpz	4	-	-0.29	-	-	-	-	-	-	0.37	-0.33	-	0.25	-	-
Aphpz	5	-	-0.55	-	-	-	-	-	-0.01	0.82	-0.18	-	-0.08	-	-
UFA/MCU I	6	-	-	-	-	-	-	-	-	0.18	-	-	-0.18	-	-
UFA/Overlap/LFA	7	-	-	-	-	-	-	-	-	0.15	-	-	-0.15	-	-
MCU II/LFA	8	-	-	-	-	-	-	-	-	0.11	-	-	-0.11	-	-
LFA - Upper	9	-	-0.13	-	-	-	-	-	-	0.09	-0.08	-	0.12	-	-
GLAUC-lpz	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LFA - Basal	11	-	-	-	-	-	-	-	-	0.04	-0.36	-	0.32	-	-
UFA		0.06	-1.44	-	-	-	-	-	-1.28	2.00	-1.14	-	1.81	-	0.01
LFA		-	-0.13	-	-	-	-	-	-	0.13	-0.44	-	0.44	-	-
Overall		0.12	-1.72	17.98	-10.68	2.52	-3.16	-2.77	-1.28	3.26	-2.19	-2.22	-	0.14	-

Note 1: Positive values indicate the layer is gaining water, negative values indicate the layer is losing water.
Note 2: UFA = Layers 3, 4, and 5; LFA = Layers 9, 10, and 11; Overall = Layers 1 through 11.

Agenda

1. Introduction
2. Summary of work performed since last meeting
3. Transient Model Calibration summary
4. Panel Discussion
5. Schedule
6. Public Comment