Lake Pickett Hydrologic/Nutrient Budgets and Water Quality Management Plan

Lake Pickett Community Meeting
September 10, 2018

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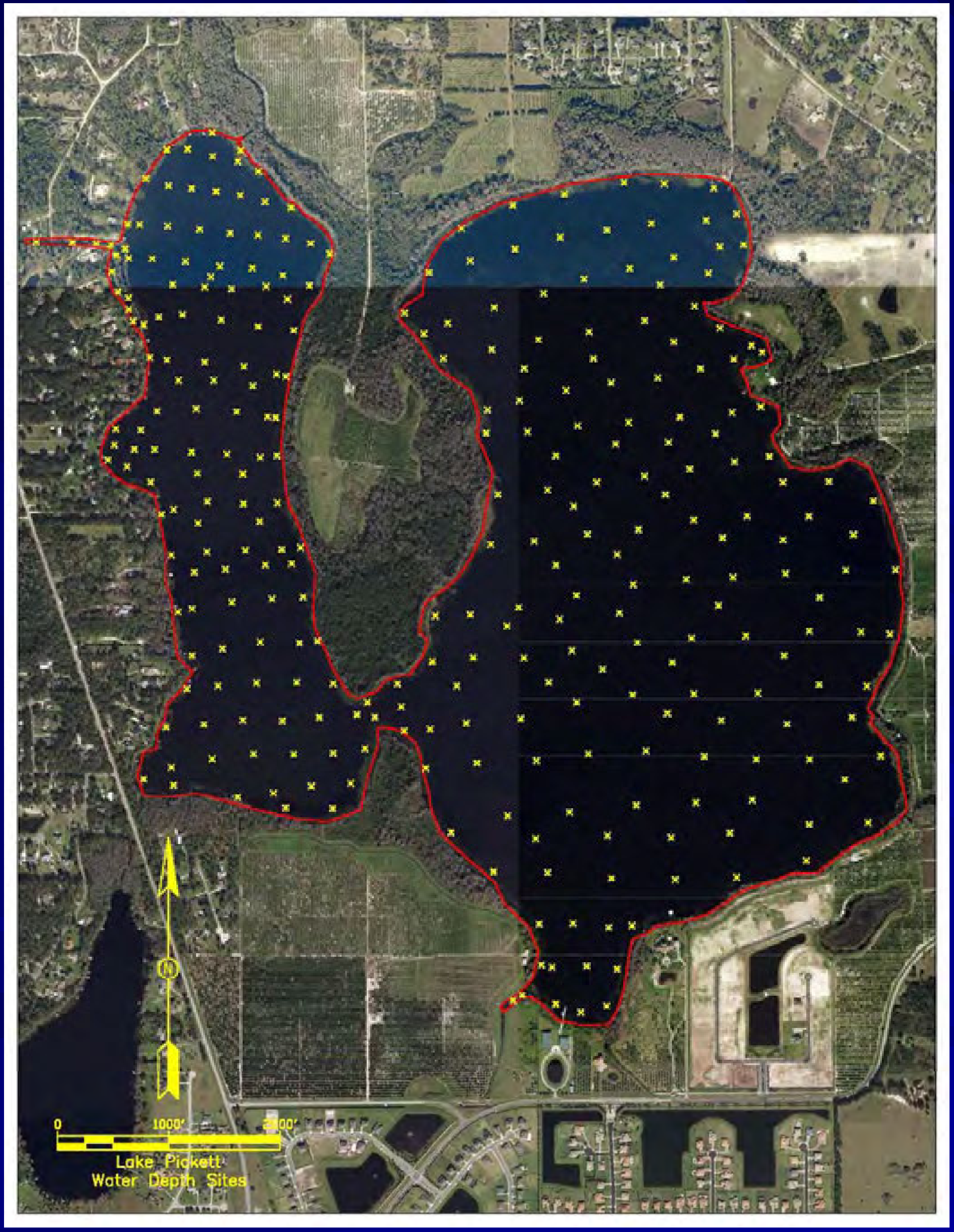
Scope of Work

Objectives

- Develop hydrologic and nutrient budgets for Lake Pickett
- Prioritize pollutant inputs, develop lake management plans and conceptual retrofit projects

Work Efforts

1. Review available historical data
2. Field reconnaissance of watershed
3. Routine surface water monitoring
4. Inflow monitoring
5. Groundwater seepage
6. Bathymetric surveys
7. Sediment characteristics
8. Hydrologic modeling
9. Develop hydrologic budgets
10. Develop nutrient budgets
11. Develop lake management plans
12. Draft and Final Reports

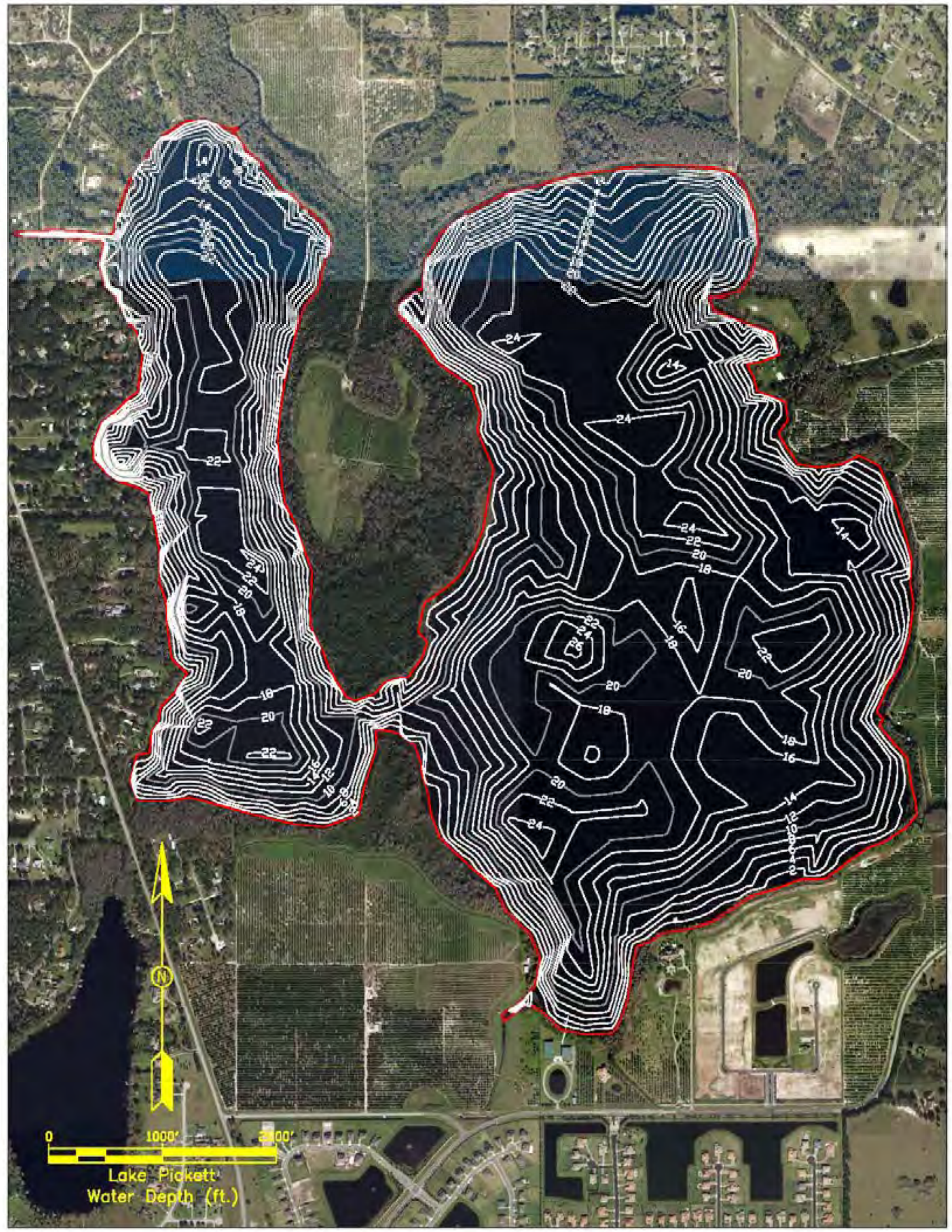


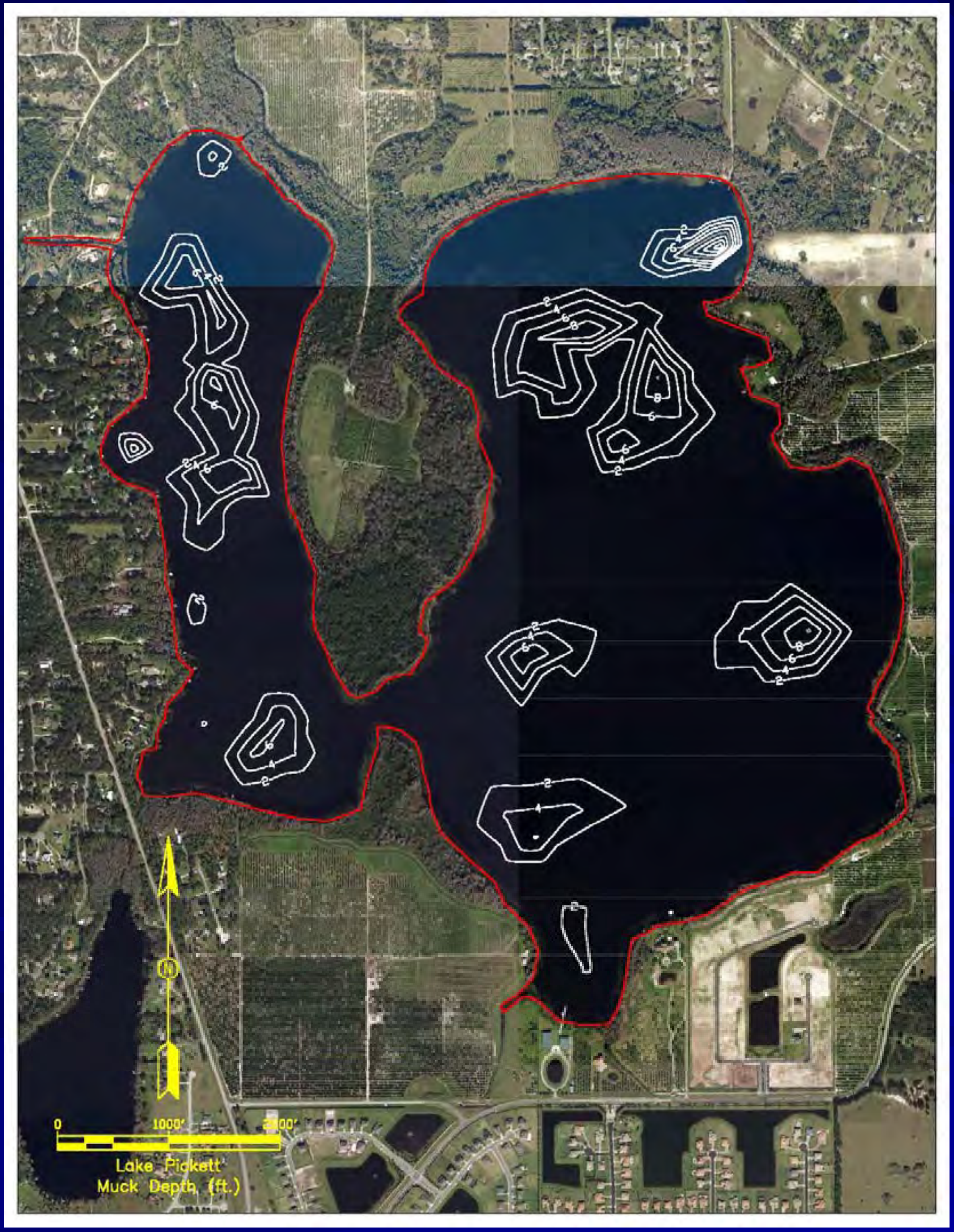
Probing Locations for Water and Muck Depth in Lake Pickett (November 11, 2015)

Water Depth Contours for Lake Pickett on November 11, 2015

(Water Elev. = 54.03 ft.)

Parameter	Value
Surface Area	745 acres
Total Volume	10,609 ac-ft
Mean Depth	14.2 ft
Maximum Depth	29 ft
Shoreline Length	41,272 ft (7.82 miles)





Muck Depth Contours for Lake Pickett on November 11, 2015

Muck Volume = 958 ac-ft

Mean Depth = 1.3 ft

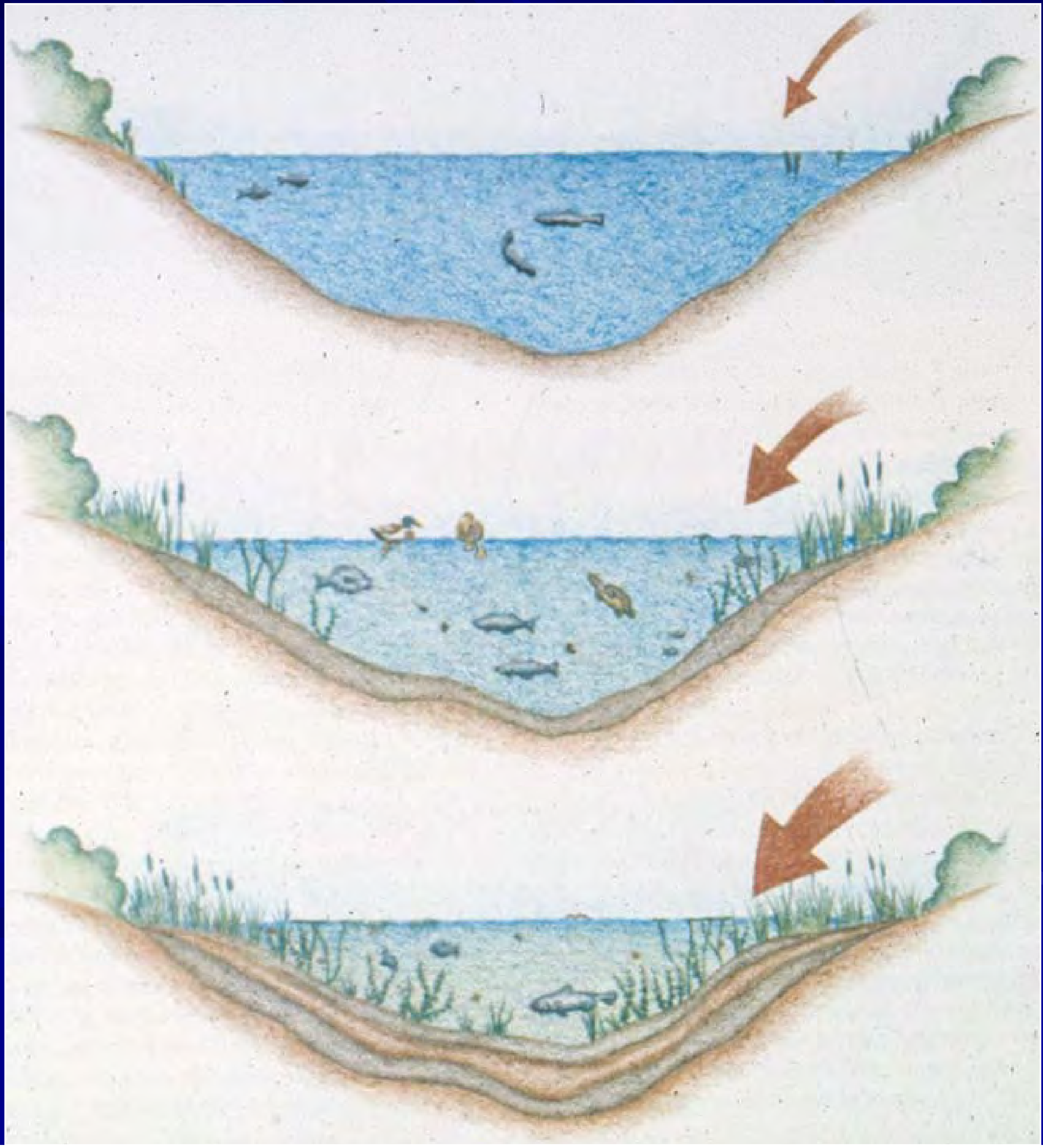
8% of original lake volume filled

Excessive Nutrient Additions Can Accelerate Lake Aging

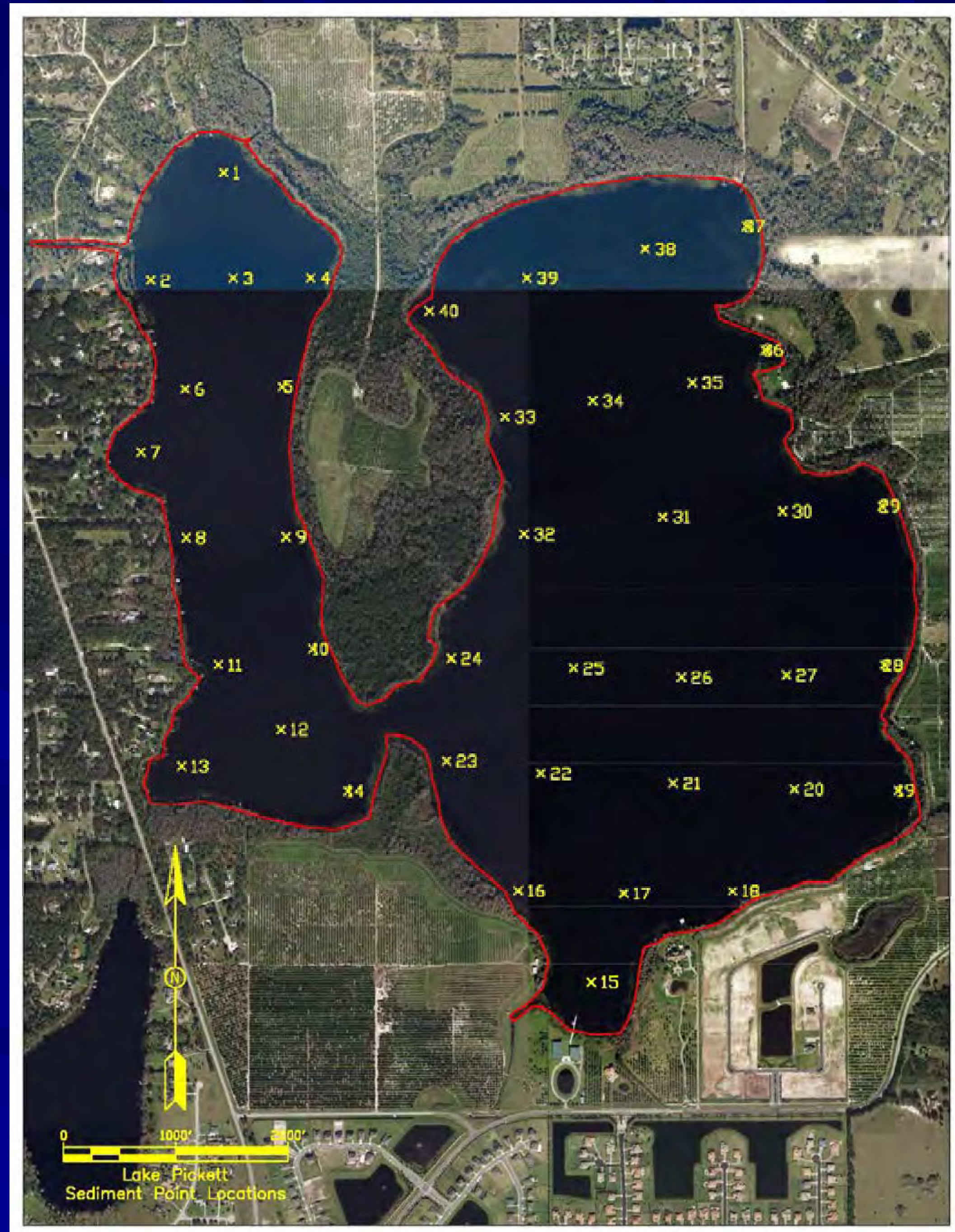
Newly formed lake
- few nutrients
- low productivity
- little sediment

Middle aged lake
- increasing nutrients
- moderate prod.
- increasing sediment
- decreasing depth

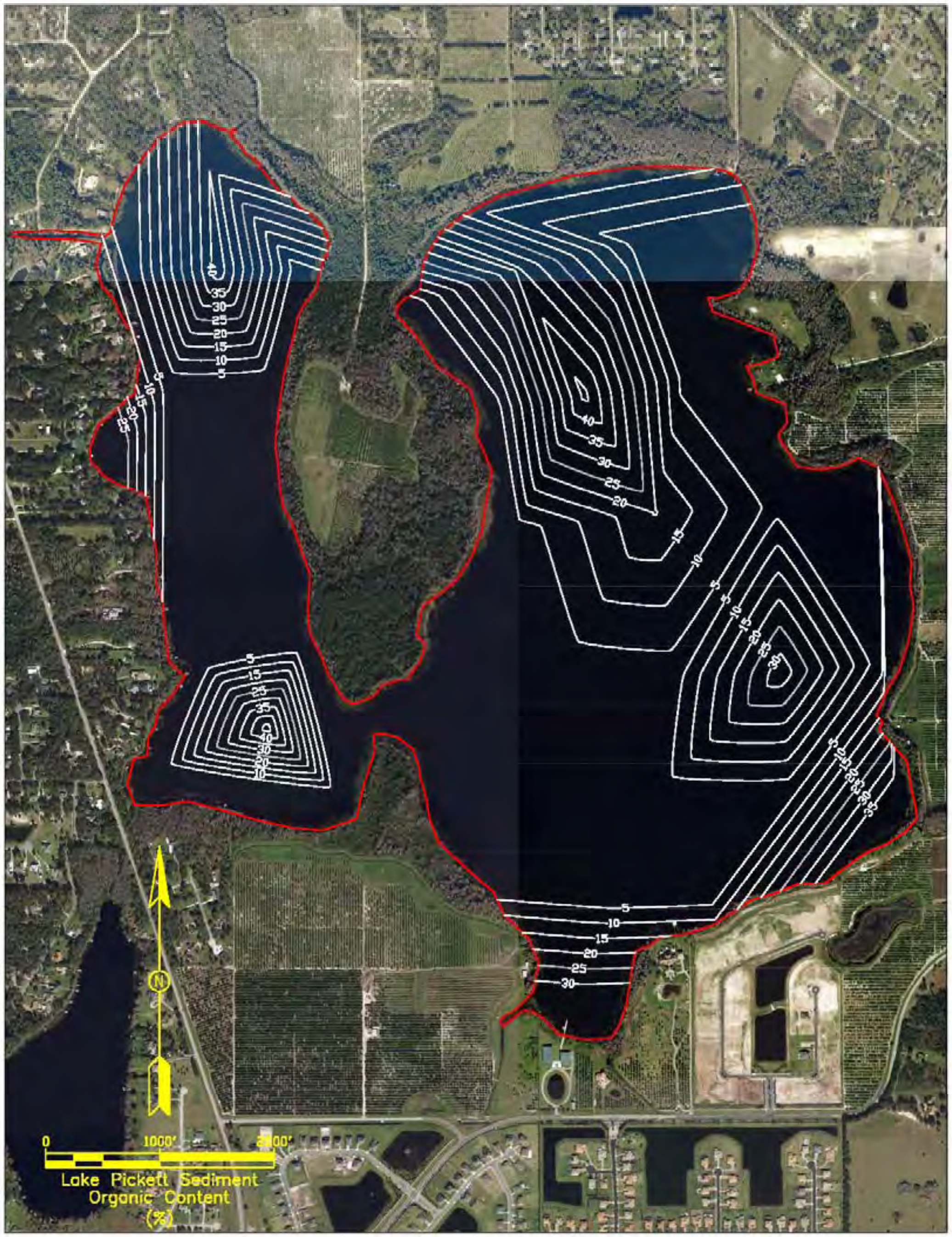
Aging lake
- high nutrients
- high productivity
- deep sediments
- plant invasions



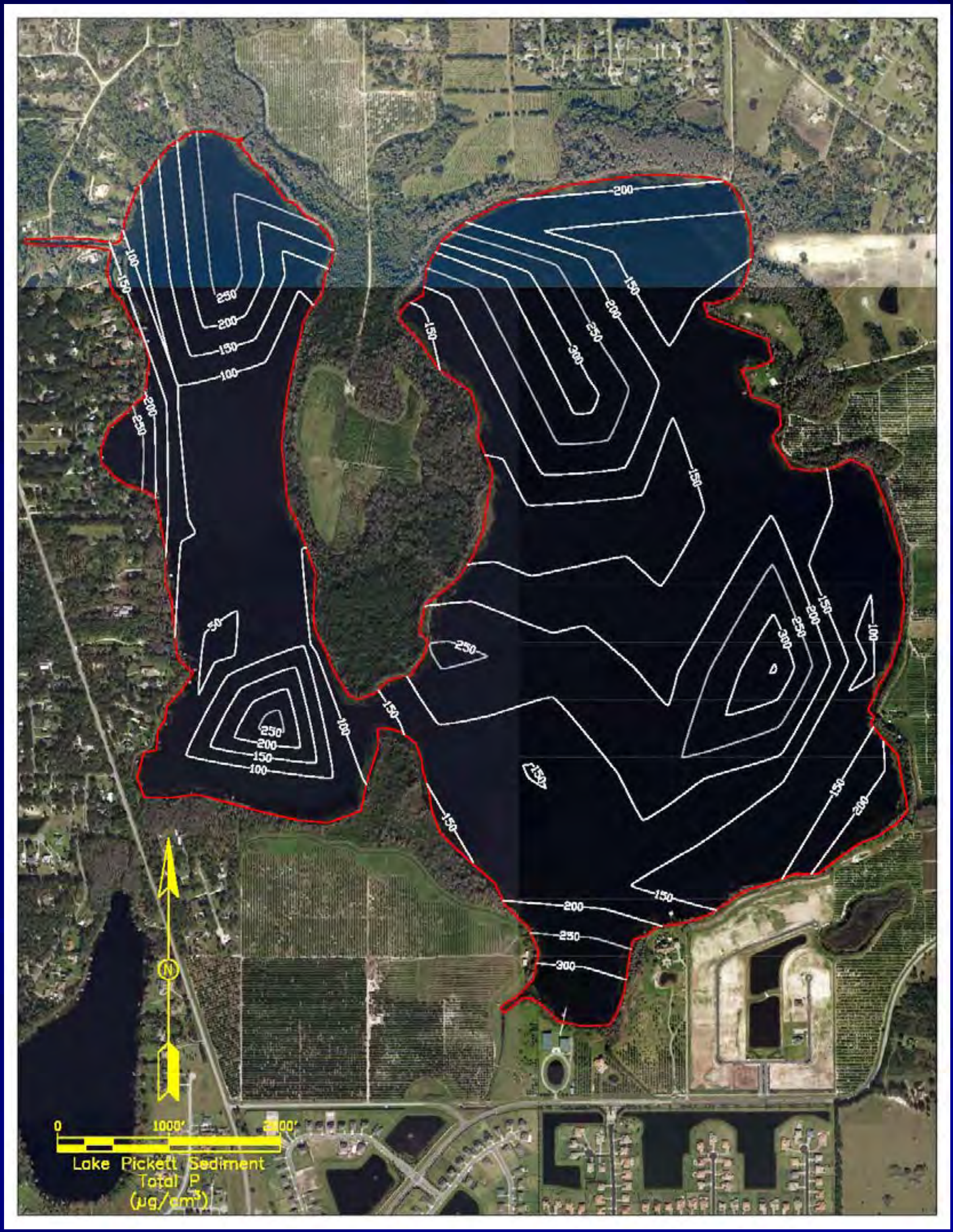
Sediment Core Sample Collection Sites in Lake Pickett on November 11, 2015



Isopleths of Organic Content (%) in the Top 10 cm of Sediments in Lake Pickett During November 2015

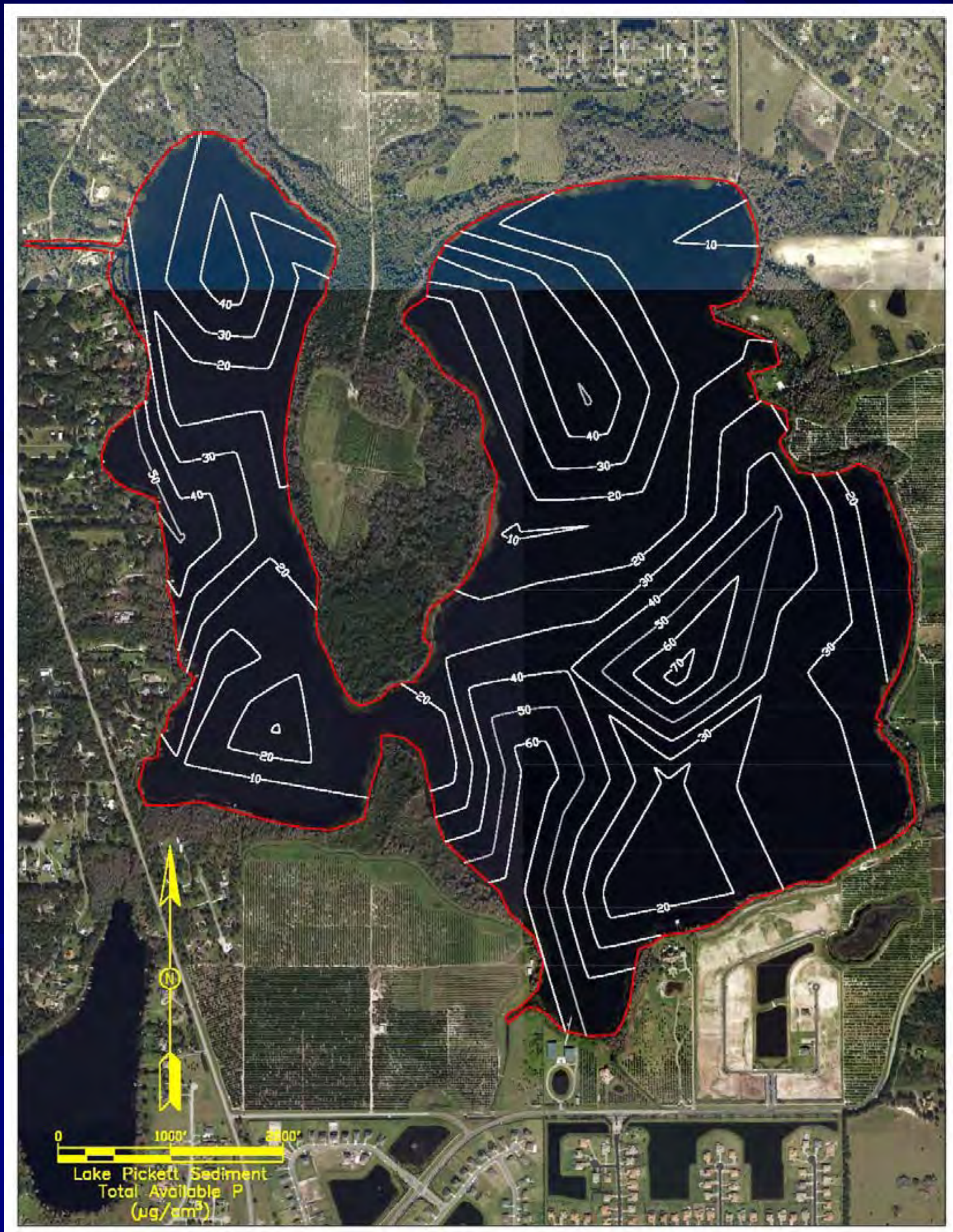


- Elevated organic content corresponds with areas of organic muck



Isopleths of Total Phosphorus (µg/cm^3) in the Top 10 cm of Sediments in Lake Pickett During November 2015

- Sediment phosphorus concentrations are low to moderate in value



Isopleths of Total Available Phosphorus (µg/cm^3) in the Top 10 cm of Sediments in Lake Pickett During November 2015

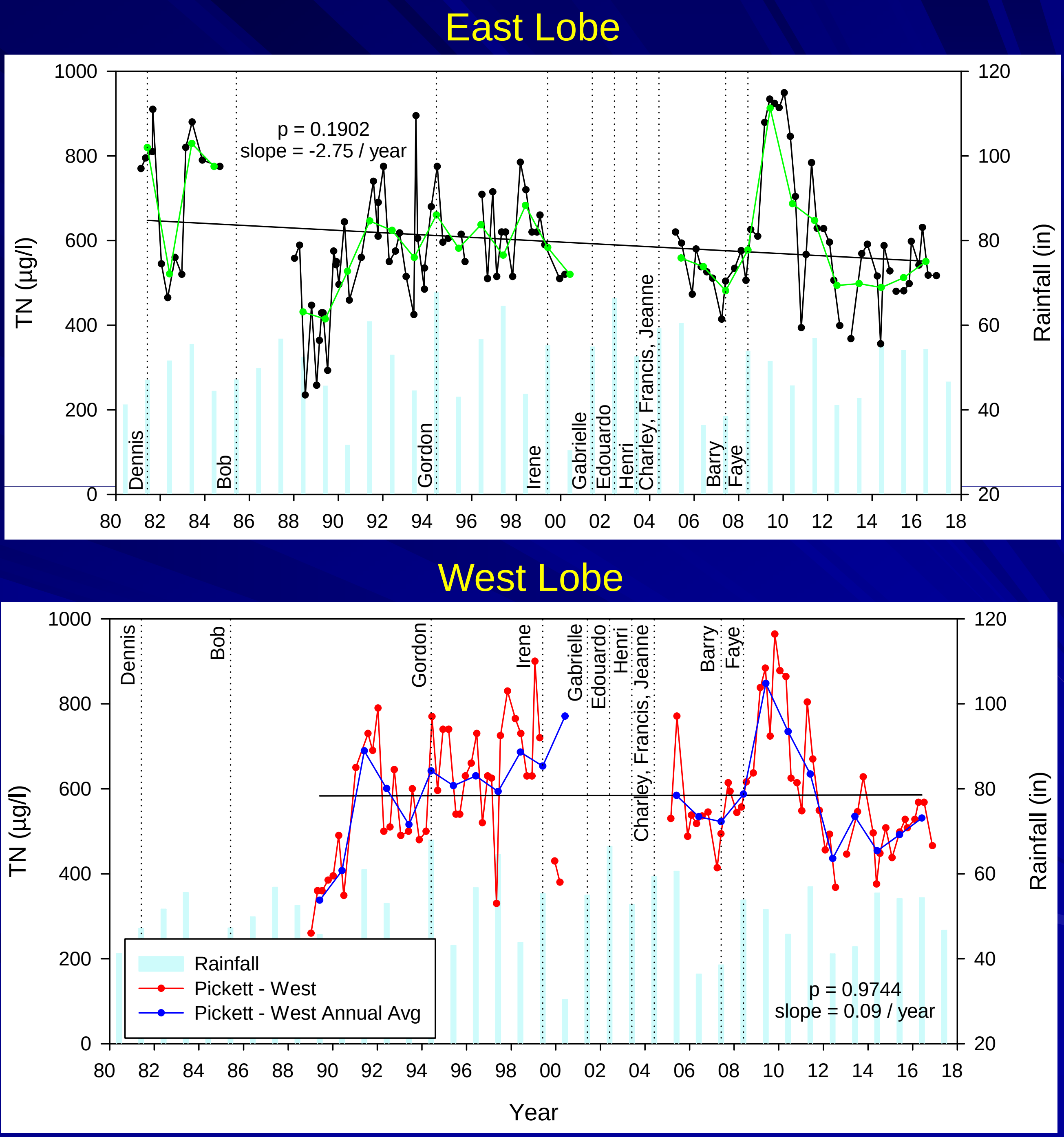
- Measure of the amount of phosphorus that can be potentially released from the sediments through internal recycling

Historical Water Quality Monitoring Sites in Lake Pickett

Historical Water Quality Data for Lake Pickett

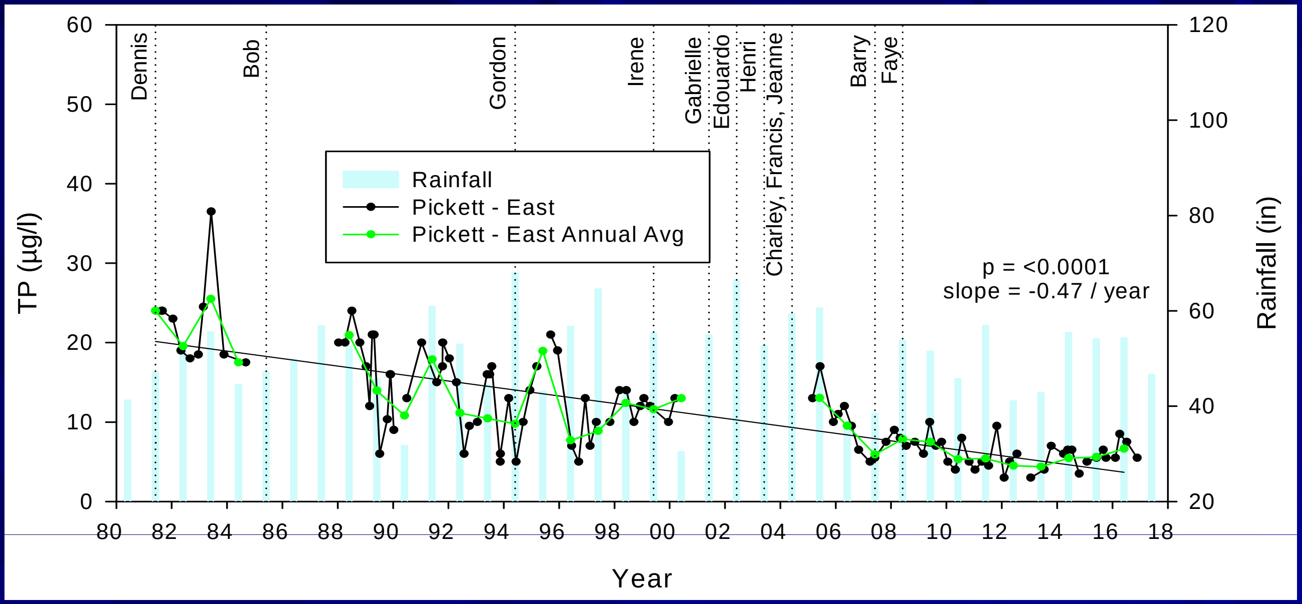
Agency	Station I.D.	Collection Dates	Monitoring Frequency		No. of Events	Type Of Data Collected
OCEPD	BE9E	2/81-Present	1981-83	Quarterly	110	Field parameters, general parameters, nutrients, microbiological parameters, Secchi disk depth
			1984	1 event		
			1985-99	Quarterly		
			2000	1 event		
			2005-16	Quarterly		
	BE9W	1/89-Present	1989-99	Quarterly	89	
			2000	1 event		
			2005-16	Quarterly		
FDEP	20010791 (north side of west lobe)	2/07-11/07	Bi-monthly		5	Field parameters, general parameters, nutrients, chlorophyll-a, Secchi disk depth
	20010792 (center of west lobe)	2/07-11/07	Bi-monthly		5	
LAKEWATCH	PIC	9/15-Present	Variable		7	Total nitrogen, total phosphorus, chlorophyll, Secchi disk depth

Trends in Total Nitrogen in Lake Pickett from 1981-2017

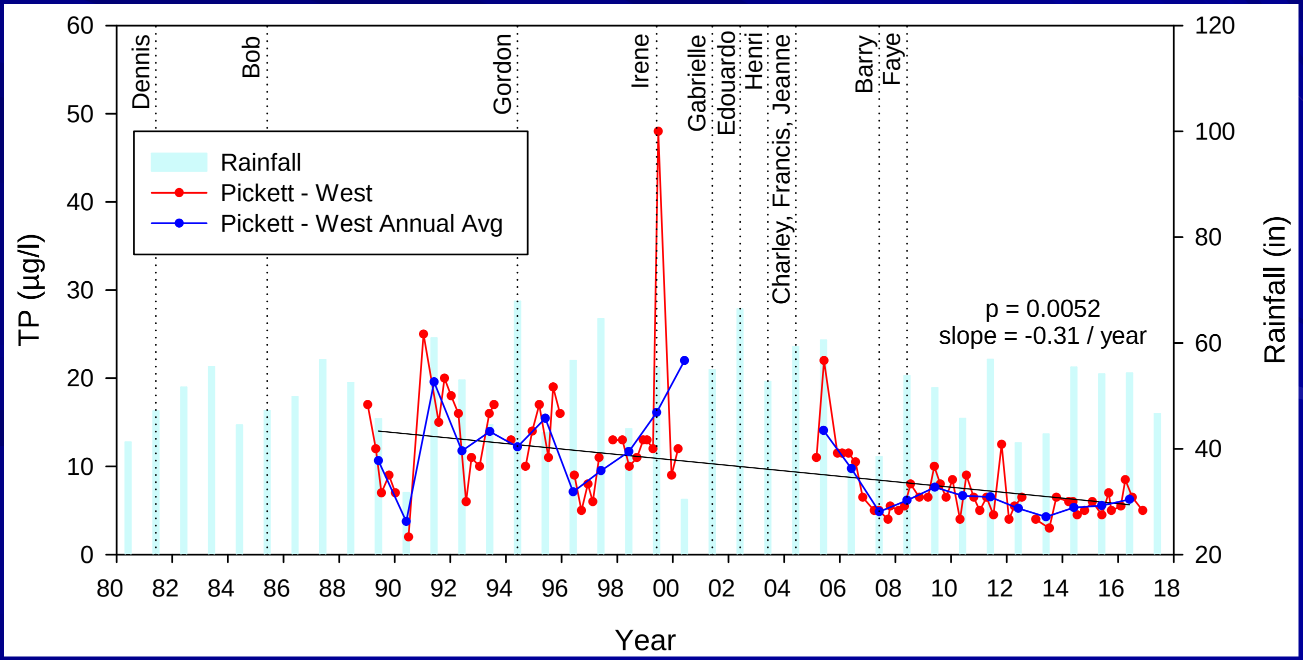


Trends in Total Phosphorus in Lake Pickett from 1981-2017

East Lobe

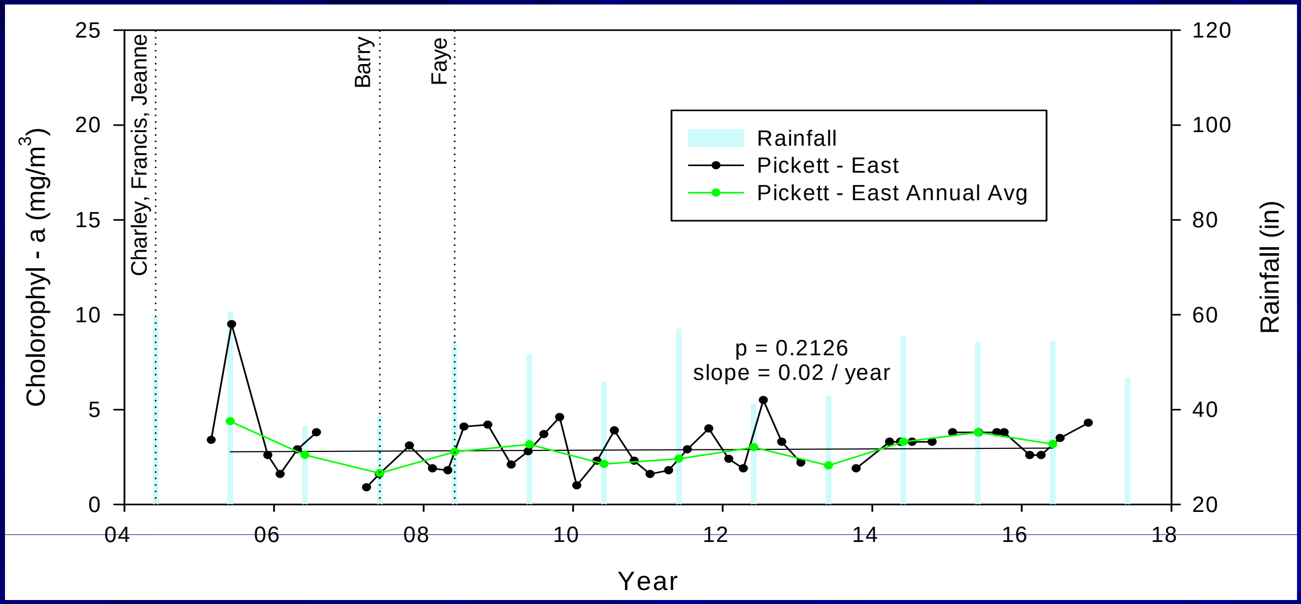


West Lobe

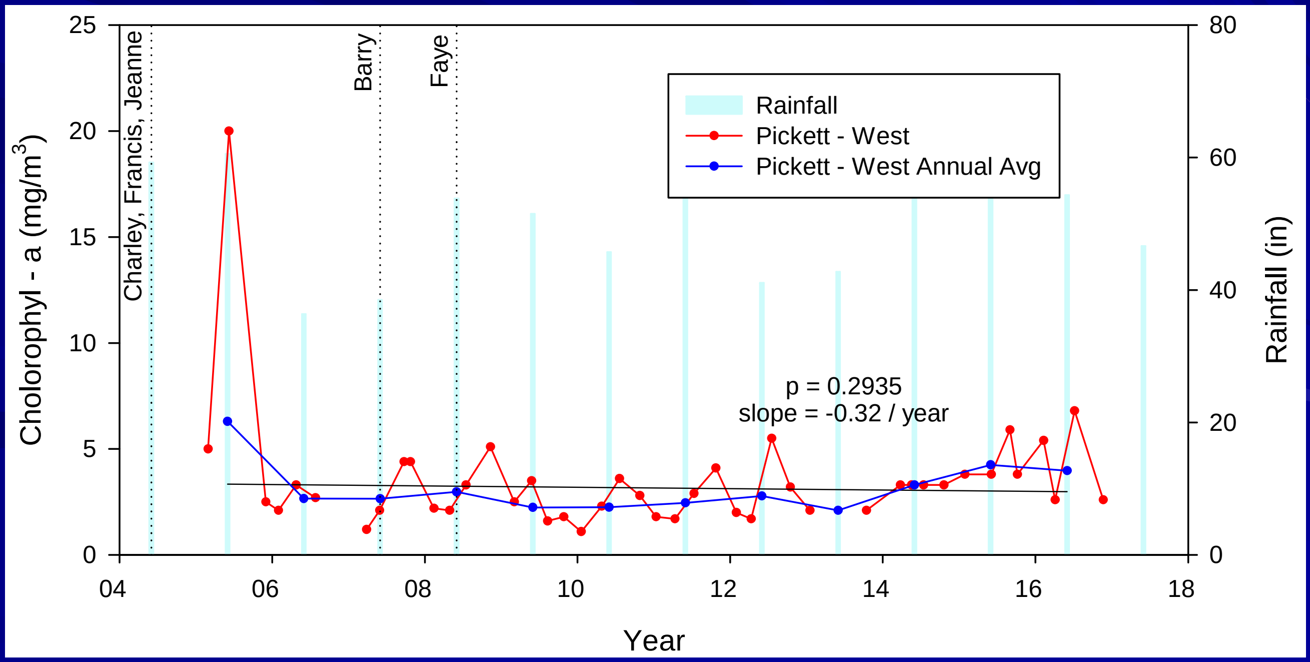


Trends in Total Chlorophyll-a in Lake Pickett from 2005-2017

East Lobe

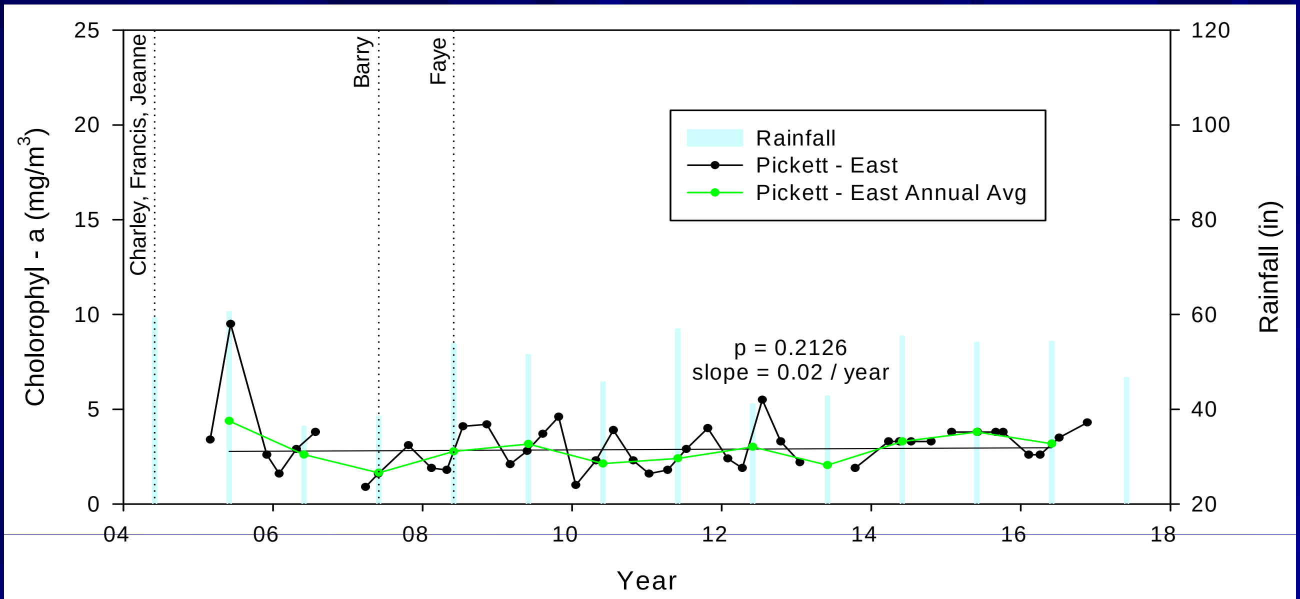


West Lobe

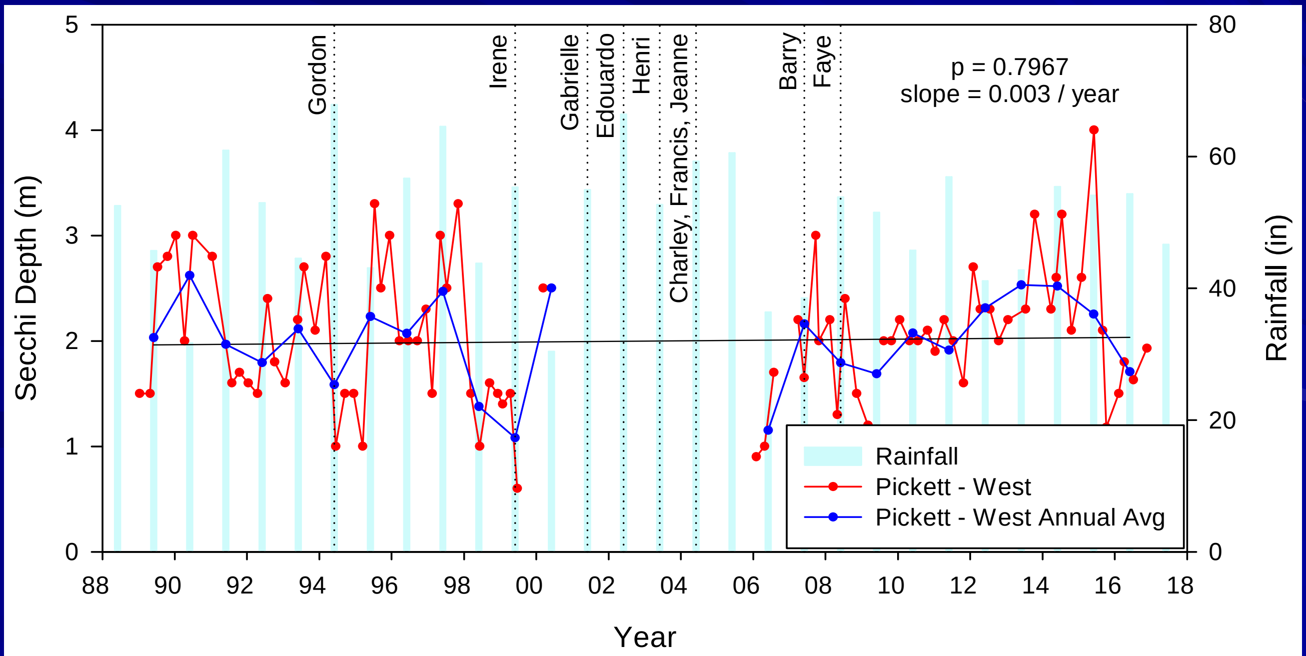


Trends in Total Secchi Disk Depth in Lake Pickett from 1989-2017

East Lobe



West Lobe

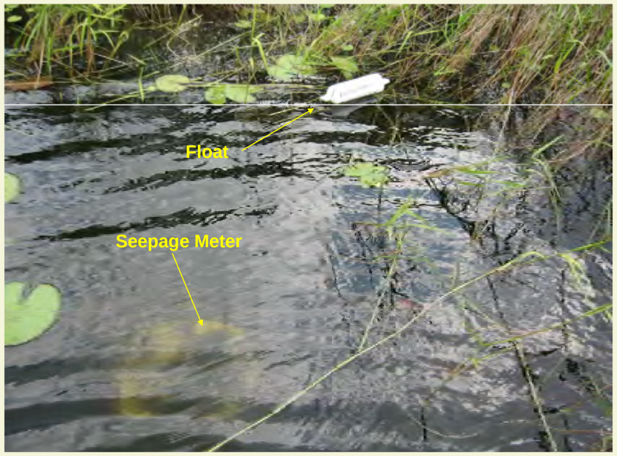


Lake Trophic State Classifications

Oligotrophic Lakes

- Low in nutrients
- Few algae grow
- No algal blooms
- Water is very clear
- Support very few plants and fish
- About 12% of Florida lakes
- Water clarity > 12 feet
- Chlorophyll < 3 micrograms/liter
- Total P < 15 micrograms/liter

Mesotrophic Lakes



- Moderate in nutrients
- Moderate algal production
- Periodic algal blooms
- Slightly green water
- Support moderate amounts of plants and fish
- About 31% of Florida lakes
- Water clarity 8 – 12 feet
- Chlorophyll 3 - 7 micrograms/liter
- Total P 15 to 25 micrograms/liter

Lake Trophic State Classifications

Eutrophic Lakes

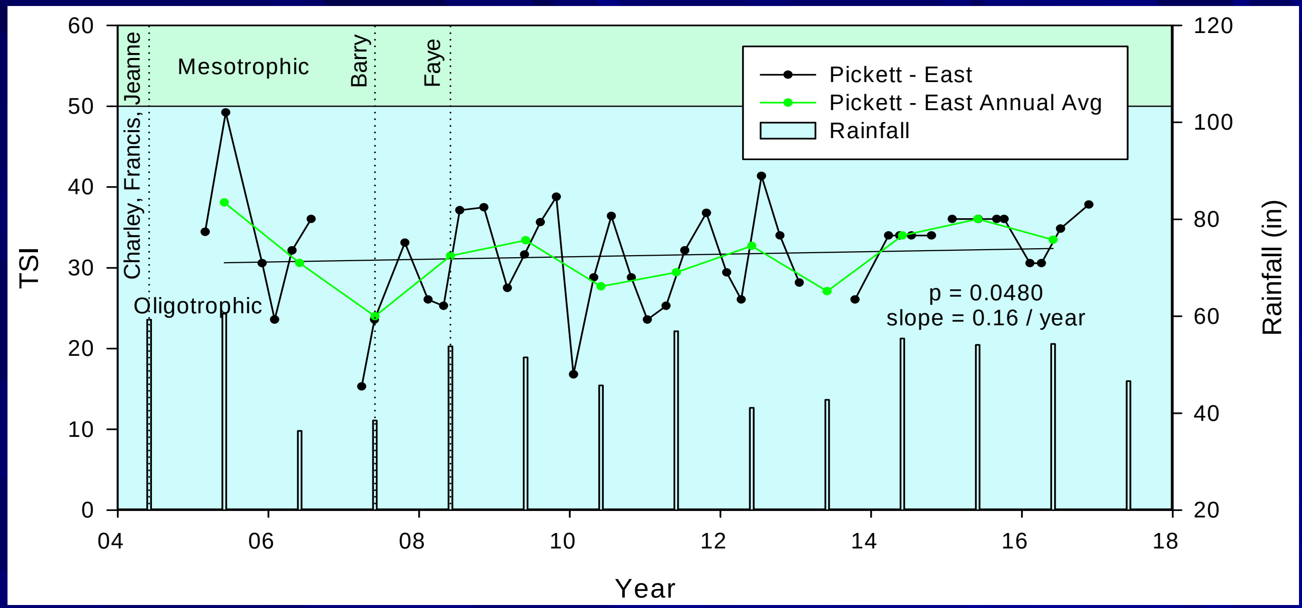
- High in nutrients
- High level of algal production
- Frequent algal blooms
- Green water with poor visibility
- May have large amount of plants
- About 41% of Florida lakes
- Water clarity 3 - 8 feet
- Chlorophyll 7 to 40 micrograms/liter
- Total P 25 to 100 micrograms/liter

Hyper-Eutrophic Lakes

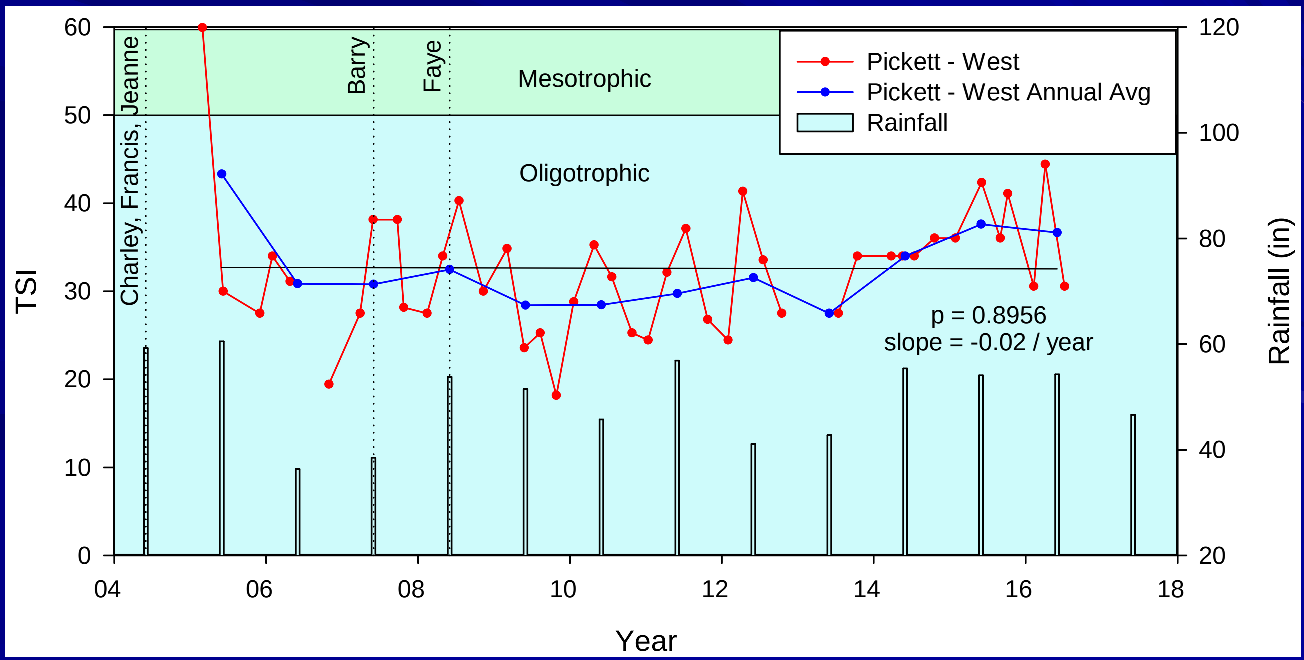
- Very high in nutrients
- Extremely high algal production
- Virtually constant algal blooms
- Most biologically productive lakes
- Support large amounts of plants and fish
- About 16% of Florida lakes
- Water clarity < 3 feet
- Chlorophyll > 40 micrograms/liter
- Total P > 100 micrograms/liter

Trends in Trophic Status in Lake Pickett from 2005-2017

East Lobe



West Lobe

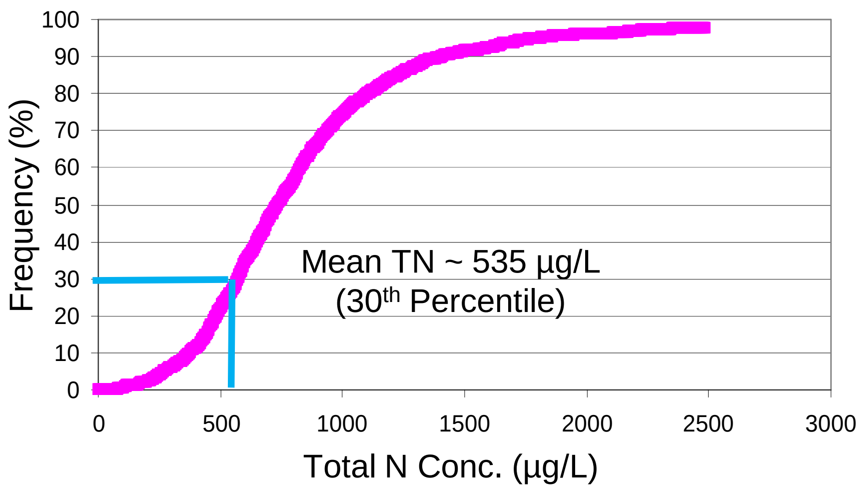


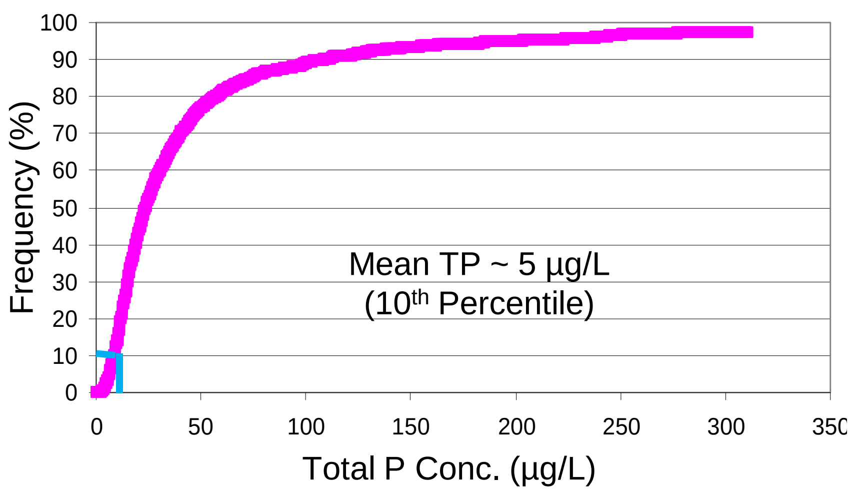
Summary of Water Quality Trends in Lake Pickett from 1981-2016

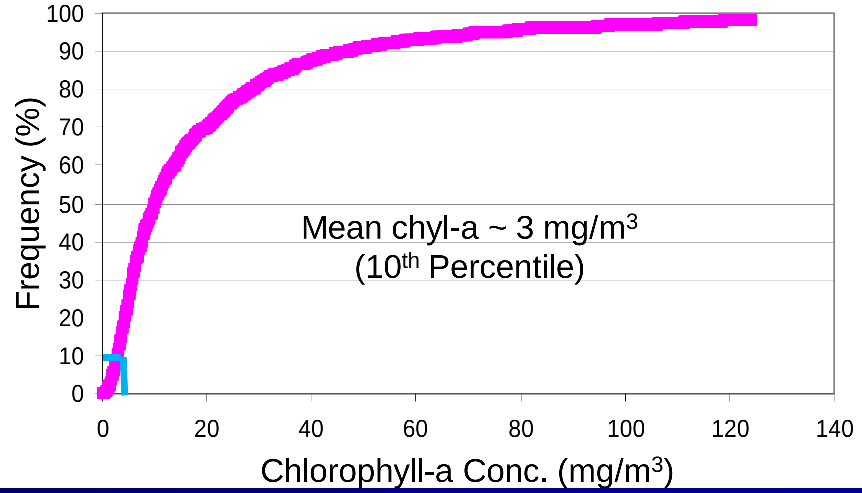
Parameter	West Lobe	East Lobe
Total N	No Significant Trend	No Significant Trend
Total P	↓	↓
Chlorophyll-a	No Significant Trend	No Significant Trend
Secchi Disk	No Significant Trend	↑
Trophic State	No Significant Trend	↑ (Vegetation Impacted)

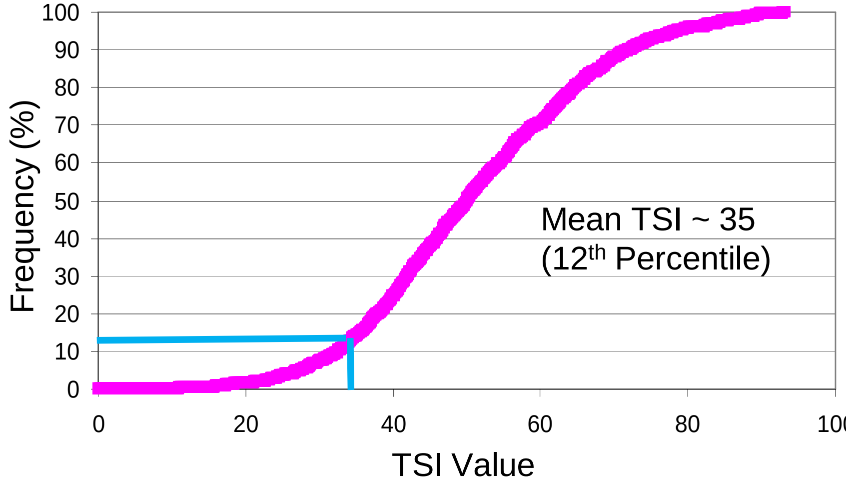
- All trends show that water quality is stable
- No apparent water quality issues at this time

Comparison of Significant Water Quality Variables in Lake Pickett with Florida LAKEWATCH Data

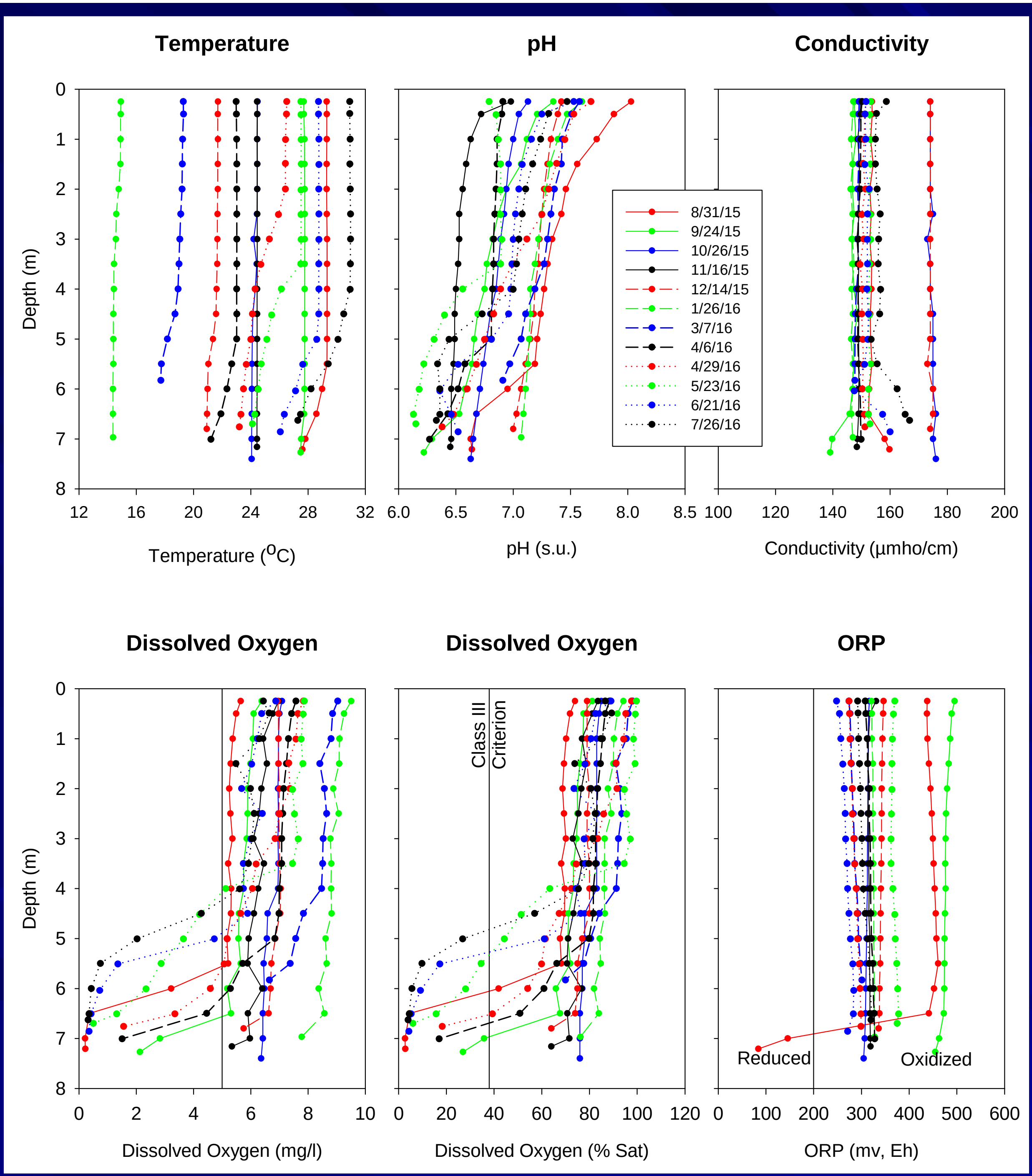








Surface Water Monitoring Sites in Lake Pickett Used by ERD



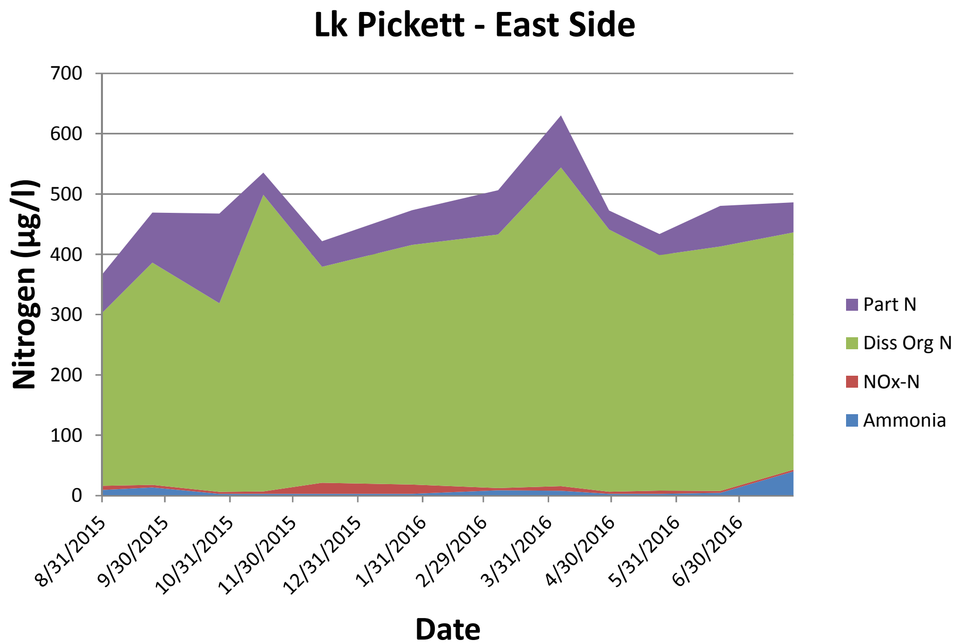
Vertical Field Profiles Collected in Lake Pickett at Site 1

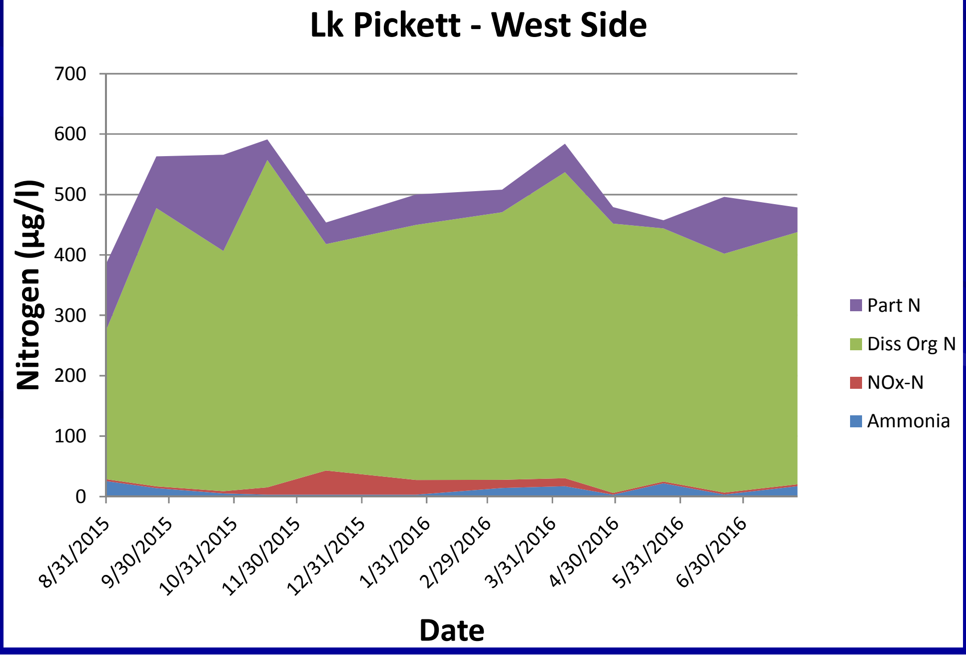
- Similar profiles at the other monitoring sites

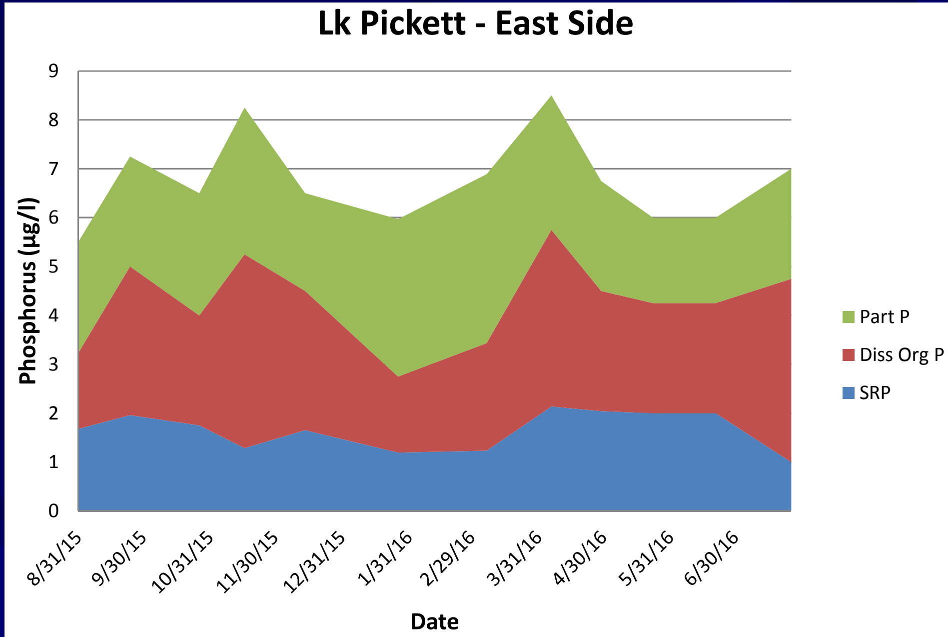
Variability in Measured Concentrations of Nitrogen Species in the East and West Lobes of Lake Pickett from August 2015-July 2016

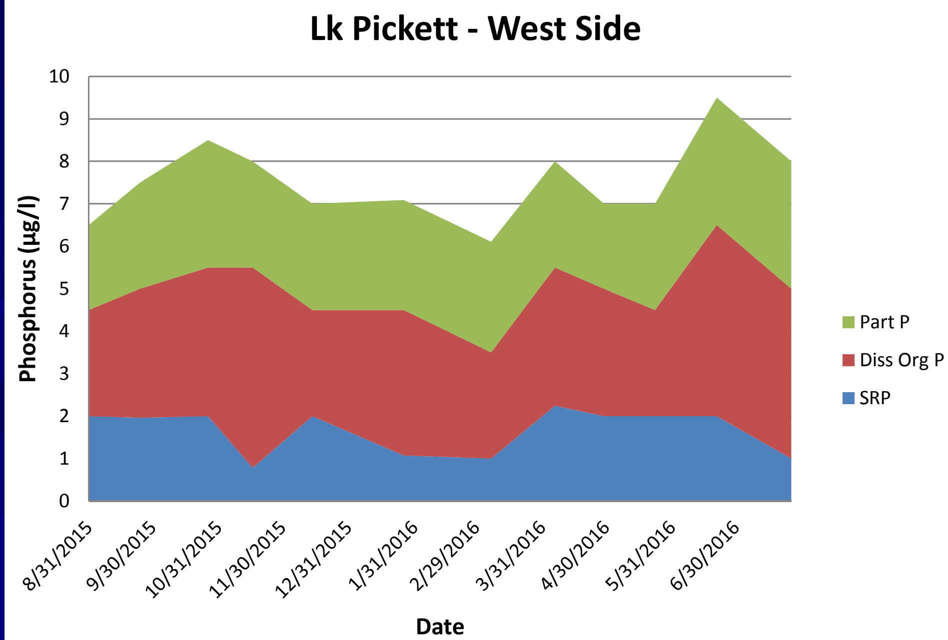
- Virtually all nitrogen combined with organic matter

- Very little nitrogen is available for algal uptake





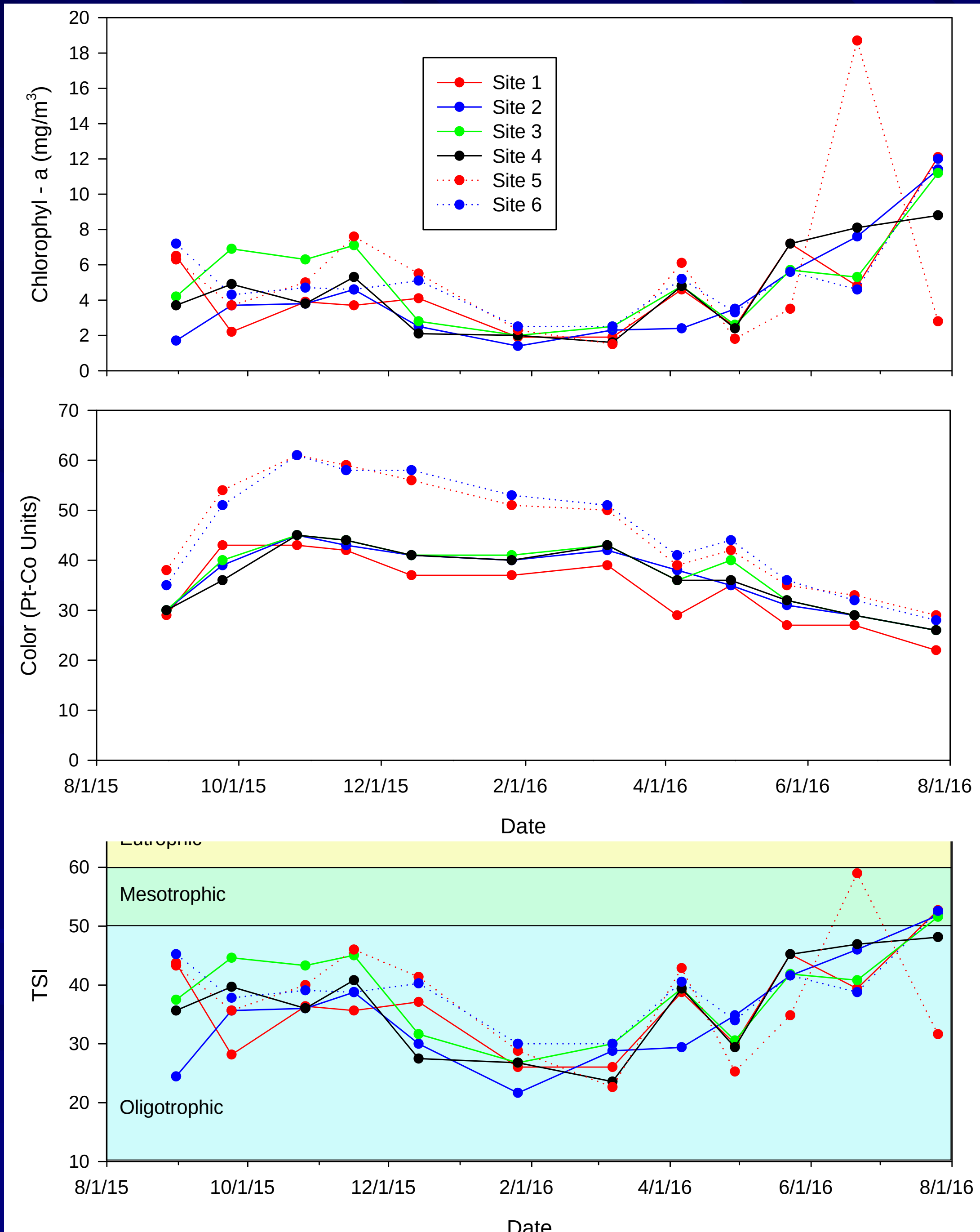




Variability in Measured Concentrations of Phosphorus Species in the East and West Lobes of Lake Pickett from August 2015-July 2016

- Most phosphorus is combined with organic matter

- Little phosphorus is available for algal uptake



Variability in Measured Concentrations of Chlorophyll-a, Color, and TSI Values at the 6 Surface Water Monitoring Sites in Lake Pickett from August 2015-July 2016

- Chlorophyll peaks during summer conditions

- Color is higher in west lobe

- TSI indicates primarily oligotrophic conditions

- TSI greater during summer conditions

Numeric Nutrient Criteria (NNC) for Florida Lakes

Category	Long-Term Geometric Mean Lake Color And Alkalinity	Annual Geometric Mean Chlorophyll-a (mg/m^3)	Minimum Calculated Numeric Interpretation		Maximum Calculated Numeric Interpretation	
			Annual Geometric Mean TP (µg/L)	Annual Geometric Mean TN (µg/L)	Annual Geometric Mean TP (µg/L)	Annual Geometric Mean TN (µg/L)
I	> 40 Pt-Co units	20	50	1,270	160	2,230
II	$\leq$ 40 Pt-Co units and > 20 mg/l $CaCO_3$	20	30	1,050	90	1,910
III	$\leq$ 40 Pt-Co units and $\leq$ 20 mg/l $CaCO_3$	6	10	510	30	930

Summary of Geometric Mean Water Quality Data for Lake Pickett During 2016

(Combined data collected by OCEPD and ERD)

Parameter	Units	Geometric Mean Value During 2016			NNC Criteria (Cat. III)
		East Lobe	West Lobe	Overall	
Alkalinity	mg/l	12.3	11.8	12.1	-
Color	Pt-Co	33	36	35	-
Chlorophyll-a	mg/m^3	3.6	4.0	3.8	6
Total Nitrogen	mg/l	521	513	517	510
Total Phosphorus	mg/l	7	7	7	10

- Low color, low alkalinity lake (Category III)
- Lake currently meets NNC criteria
- Lake TP concentrations regulated by plant biomass

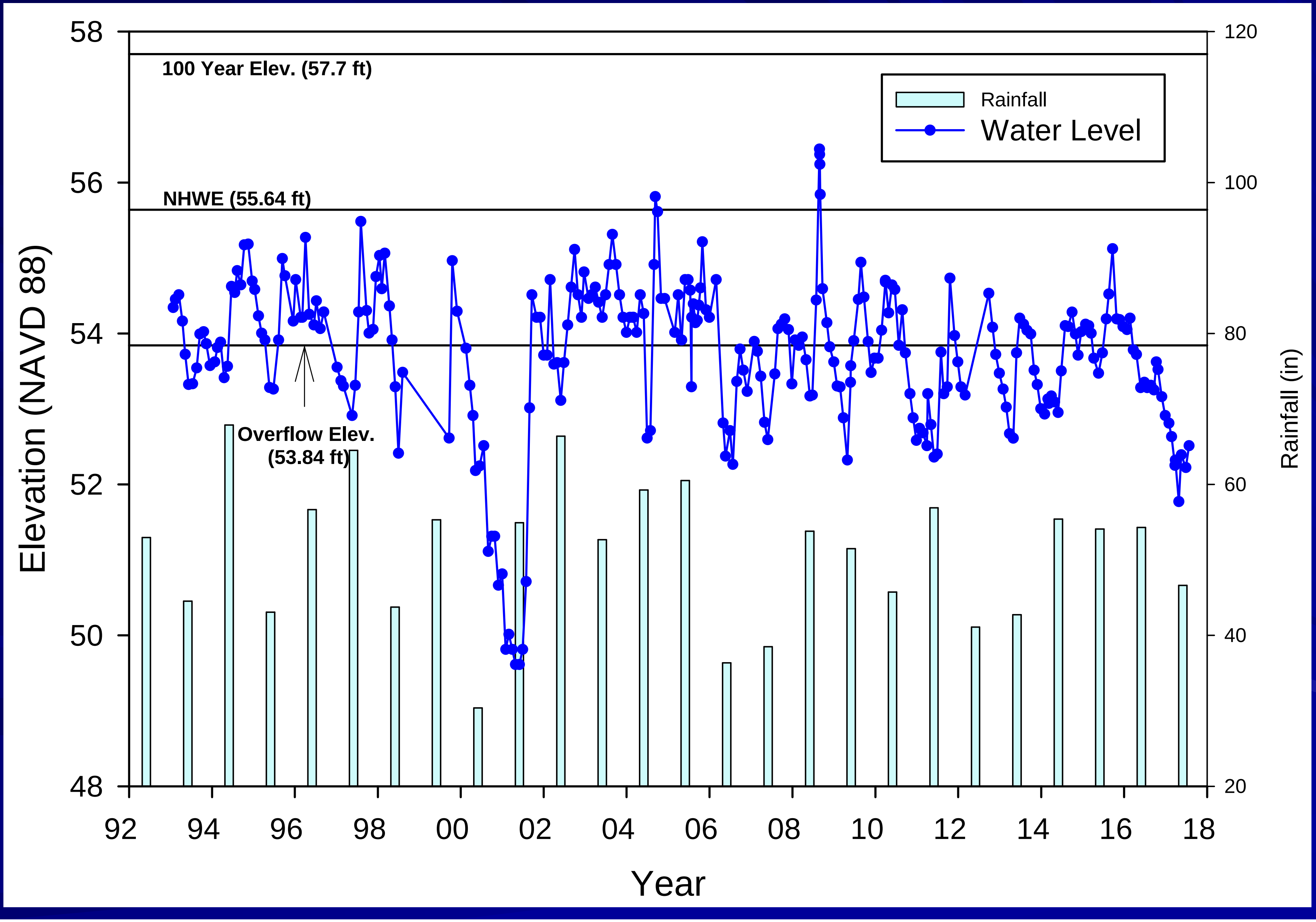
Outfall Drainage Patterns and Lake Pickett Water Level Control Structure

Lake Pickett Water Control Structure

a. Upstream and downstream areas under moderate flow conditions

b. Upstream and downstream areas under low/no flow conditions

Monitored Water Level Elevations in Lake Pickett from 1992-2016



Current Shoreline Conditions in Lake Pickett






- Extensive high quality shoreline vegetation in virtually all areas
- Most areas are still in undeveloped state and reflect semi-natural conditions
- A few cleared shorelines on residential lots

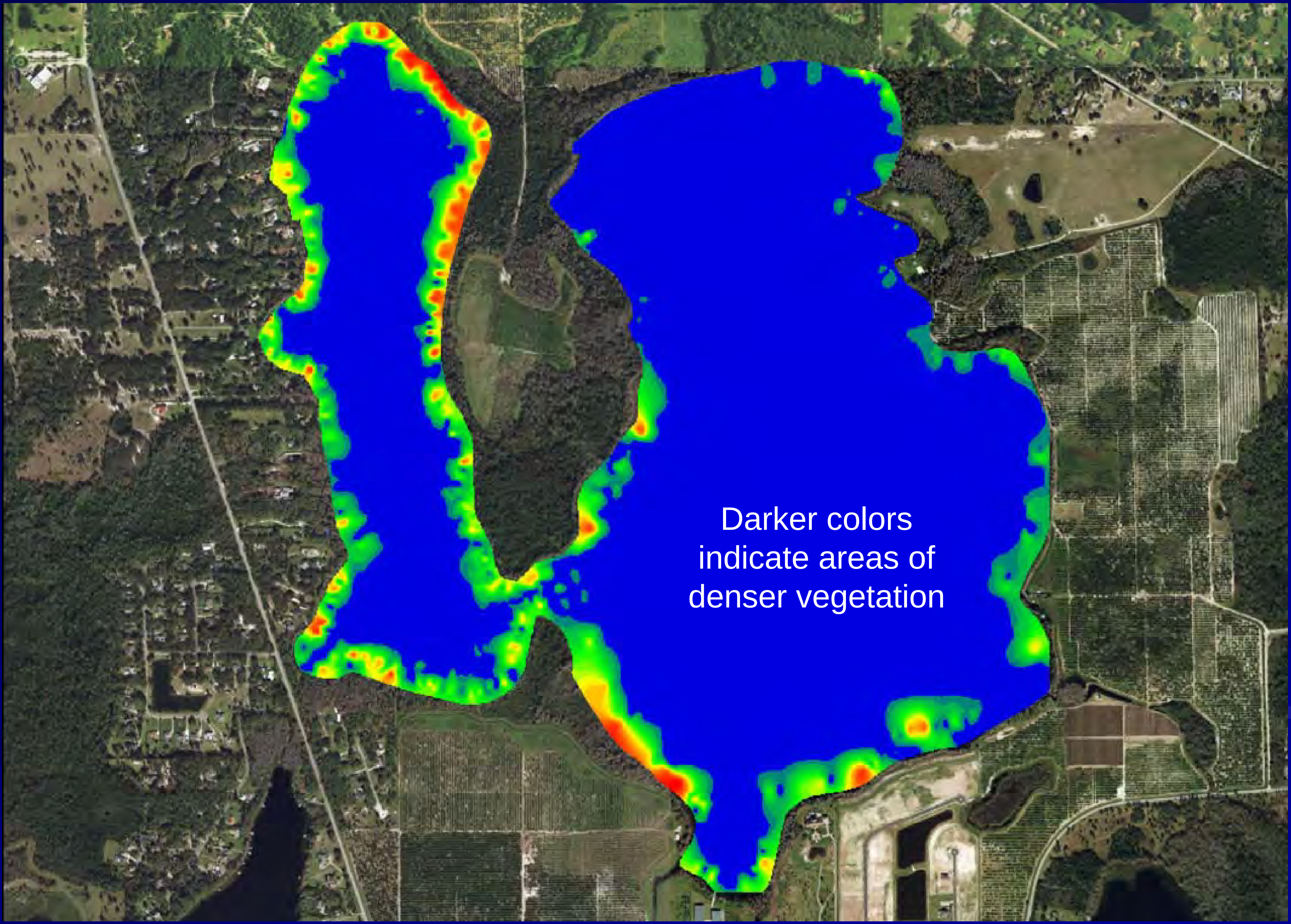
Submerged Vegetation

- Present in virtually all areas in photic zone
  - Dominant species are hydrilla and bog moss
  - Both have created nuisance conditions since early 2000s
  - Asian marshweed has also been observed

Hydrilla

Bog Moss

Vegetation Biovolume Heat Map for Lake Pickett

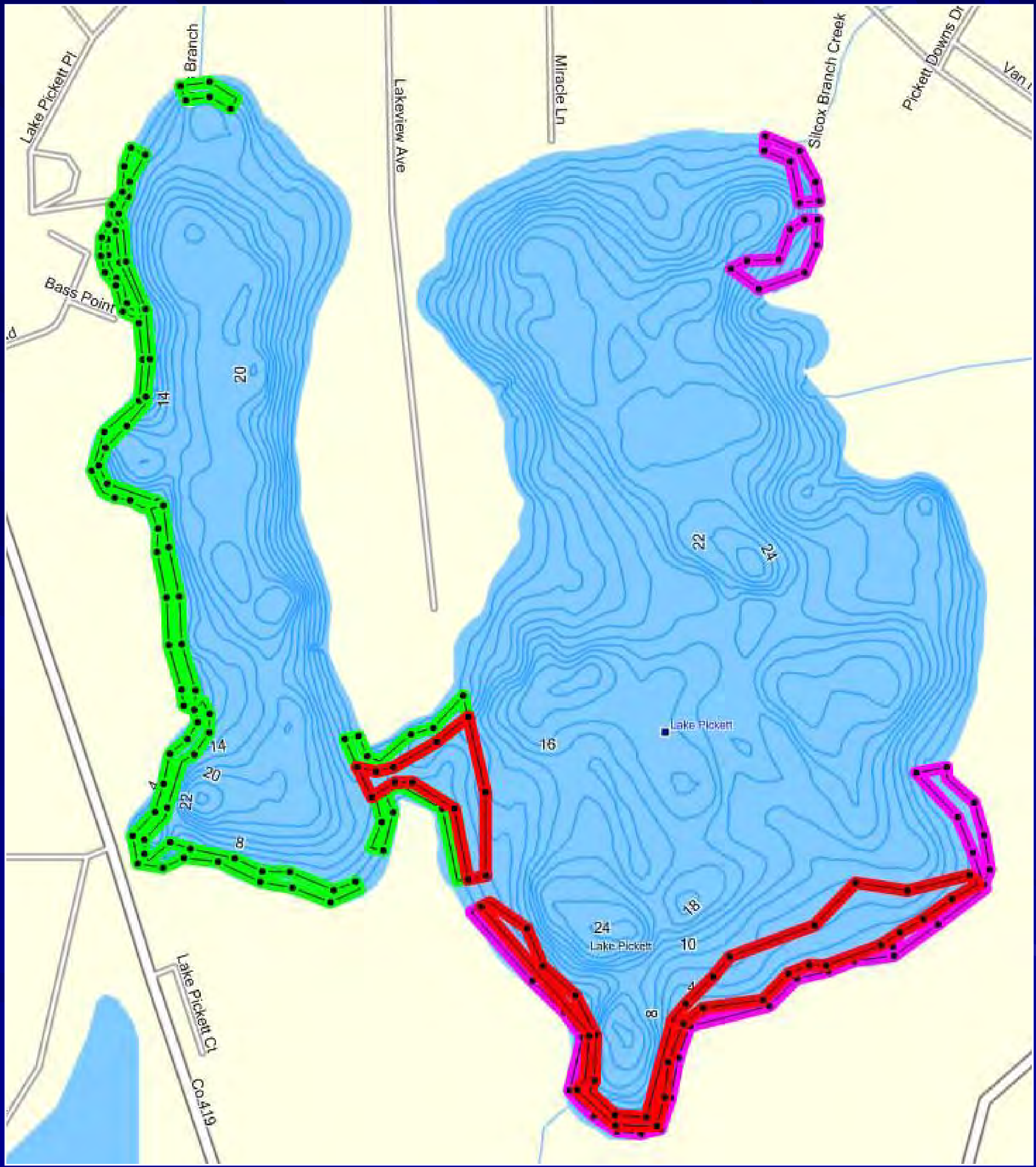


Vegetation Control

- Complaints of excessive Hydrilla growth date to the early 1990s
- Municipal Service Benefit Unit (MSBU) was established in 1996 to fund aquatic weed control
- Weed control initiated by the County during 2008 to control hydrilla, Salvinia, cattails, and shoreline grasses
- From 2008-2017, the County has conducted more than 40 spraying events
  - Areas ranging from 0.3 – 73 acres
  - Aquathol, Diquat, glyphosphate, and Flumioxazin

Vegetation Control Areas

(August 8, 2012)



- Total area = 73 ac.

- Coloring indicates vegetation type and method of treatment

Grass Carp

- On October 30, 2015, FGFFC added 1,524 triploid grass carp to Lake Pickett
  - Stocking rate of 2 fish/acre
  - Live for at least 10 years
  - Grow to more than 40 pounds
  - Consume plants from top down, minimizes broken vegetation
  - Prefer hydrilla, chara, southern niad, elodea, watermeal, and duckweed
  - As fish grow larger, reliance on chemicals goes down

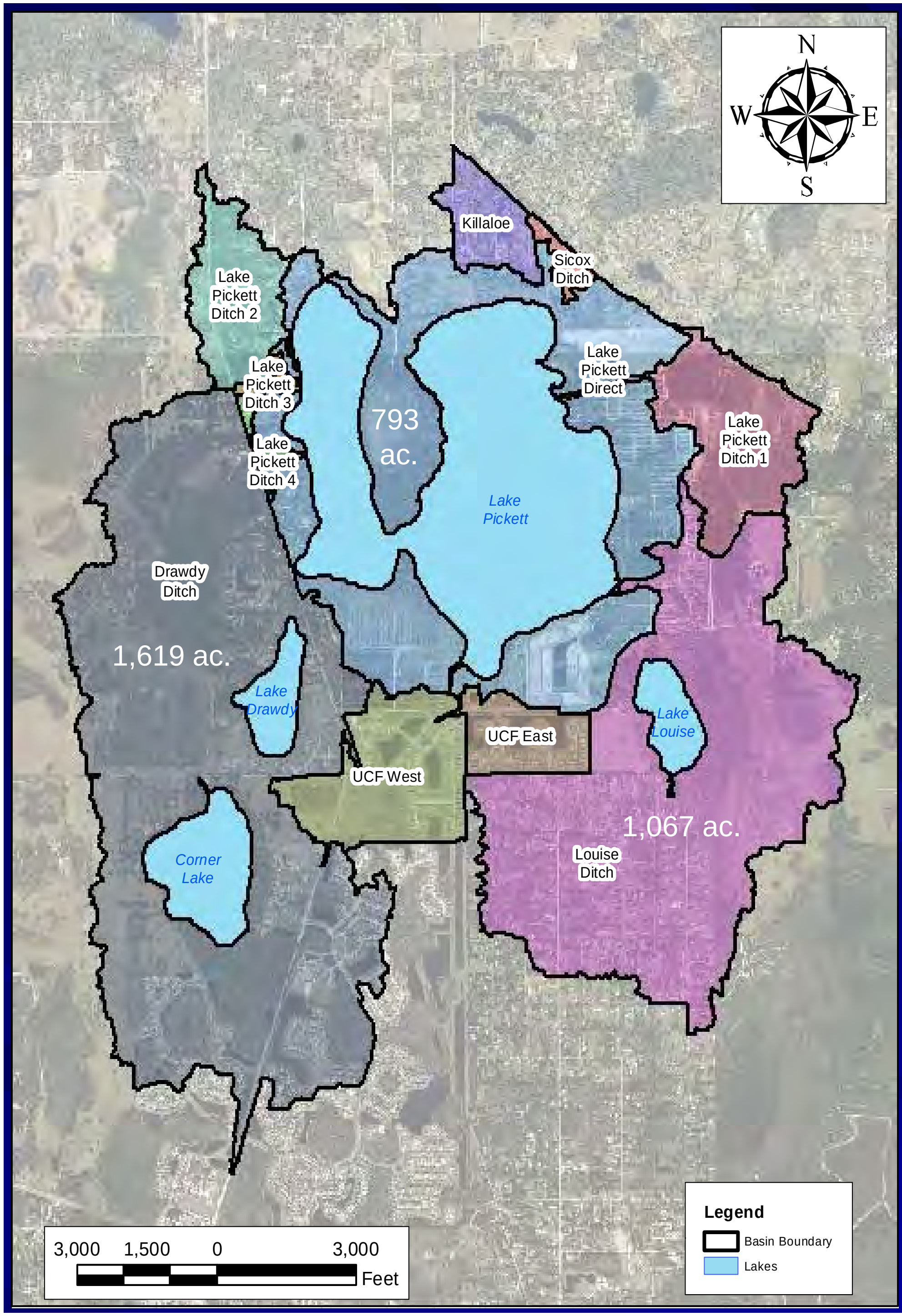
- However, too many fish will remove all vegetation which will cause changes in lake clarity and chemistry
- Lakes will convert from a macrophyte dominated system to an algae dominated system
  - Chlorophyll-a will increase, clarity will decrease, and muck accumulation will increase

Importance of Submerged Vegetation in Lake Pickett

- Existing phosphorus (P) loadings are sufficient to create mesotrophic/eutrophic conditions
  - Supplemental P uptake from vegetation allows lake to be oligotrophic
  - Delicate equilibrium between plants and water quality
- Reduction in plant biomass could result in rapid changes in water quality
  - In-lake P concentrations would increase
  - Algal growth would increase
  - Light penetration decreases
  - Areas available for plant growth decrease, further reducing P uptake
  - Lake would be converted to an algae dominated system
  - Increases sediment deposition and internal recycling

Drainage Basin Evaluations

- Current conditions
  - Assumed to be conditions that existed in January 2016, approximately halfway through the field monitoring program
- Pre-Development conditions
  - Assumed to be conditions prior to watershed development
  - Earliest available aerial photography is 1940
  - Watershed contained agricultural activities, but no development
  - No septic tanks in watershed
- Future conditions
  - Assumes that all currently undeveloped land, excluding wetlands, is developed into single family residential homes similar to the existing development on the south side of the lake
  - Also includes some “fill-in” in existing low density residential areas
  - All future development will have stormwater management systems designed according to current SJRWMD design criteria
  - Sanitary sewage systems available for additional development in areas along CR 419 (Corner Lake Basin) which have existing sewer system
  - All other areas will have on-site septic tank systems



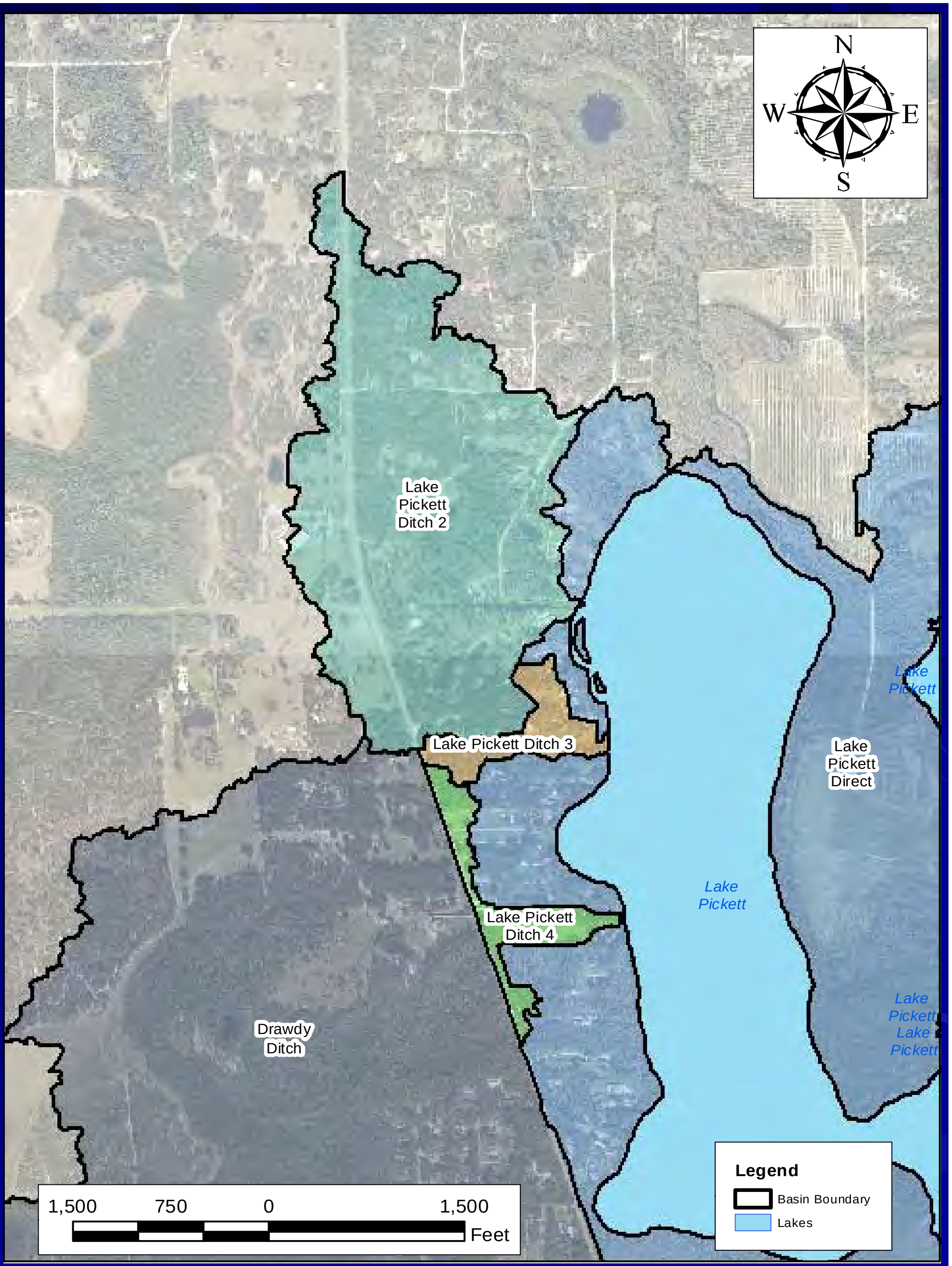
Overview of the Current Lake Pickett Drainage Basin

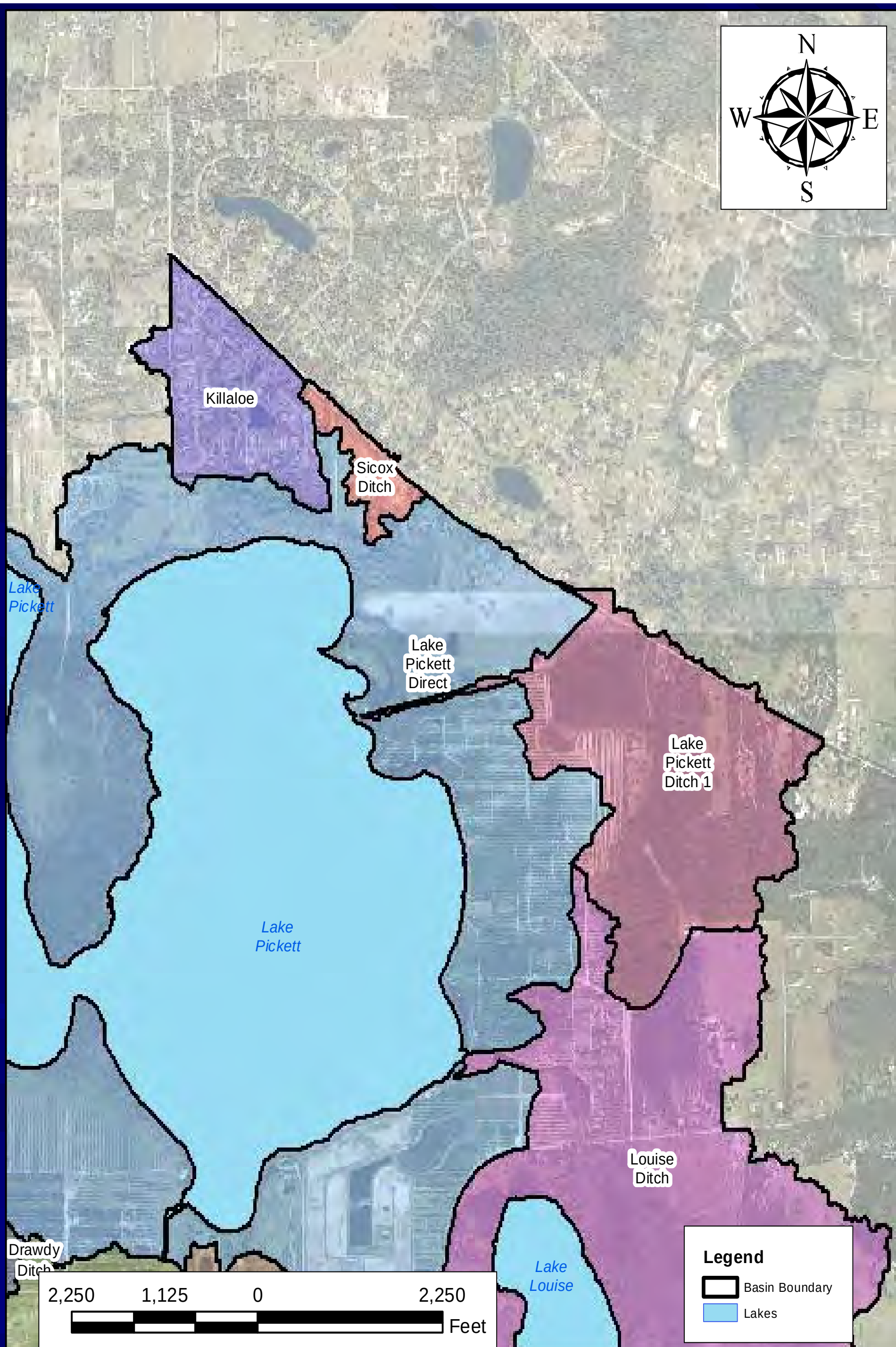
Each sub-basin represents an area that discharges to the lake through the same pipe, ditch, canal, or tributary

- 11 sub-basins

- Total area = 4,264 ac.

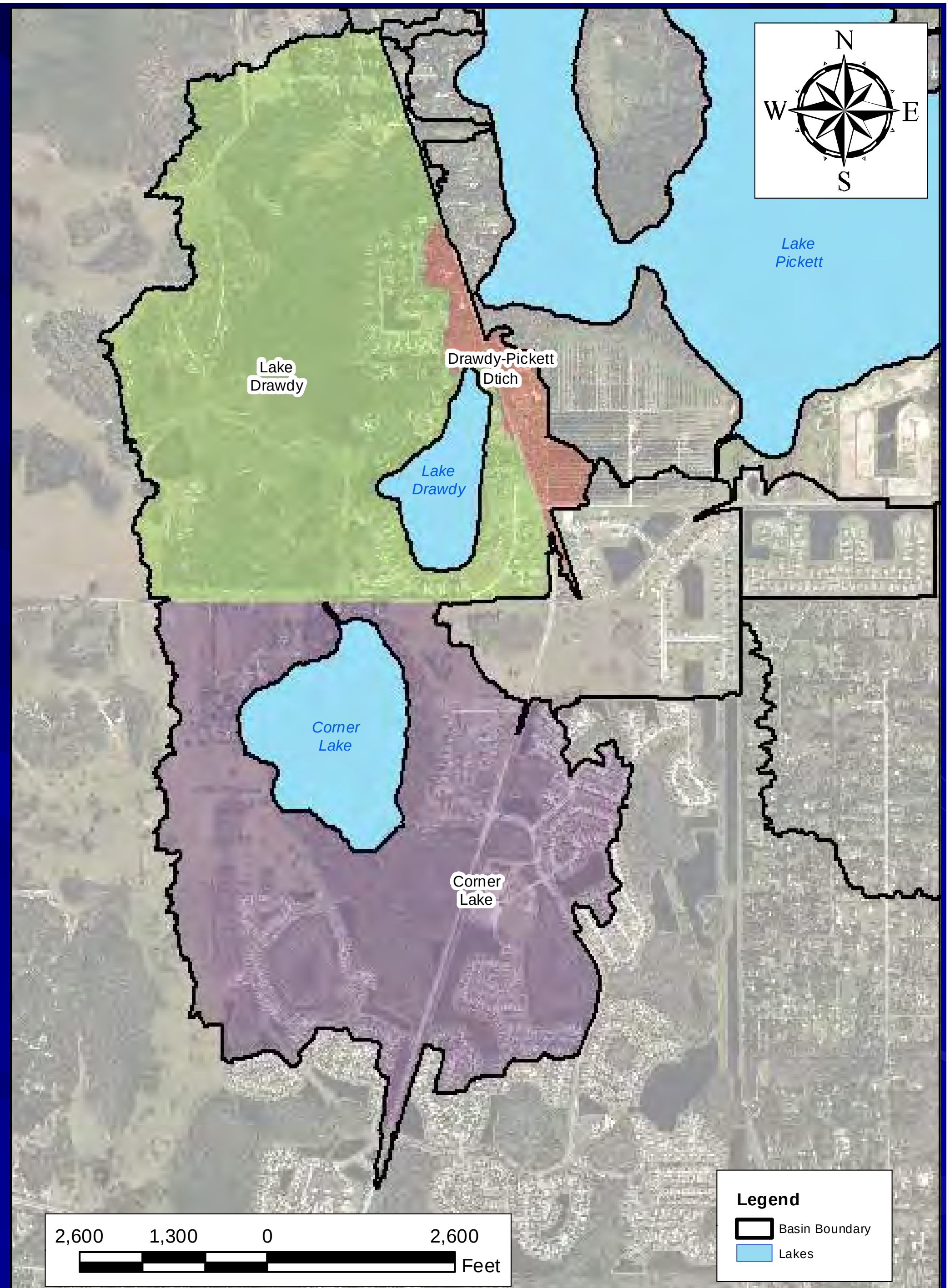
Expanded View of Northwest Portions of the Current Lake Pickett Drainage Basin

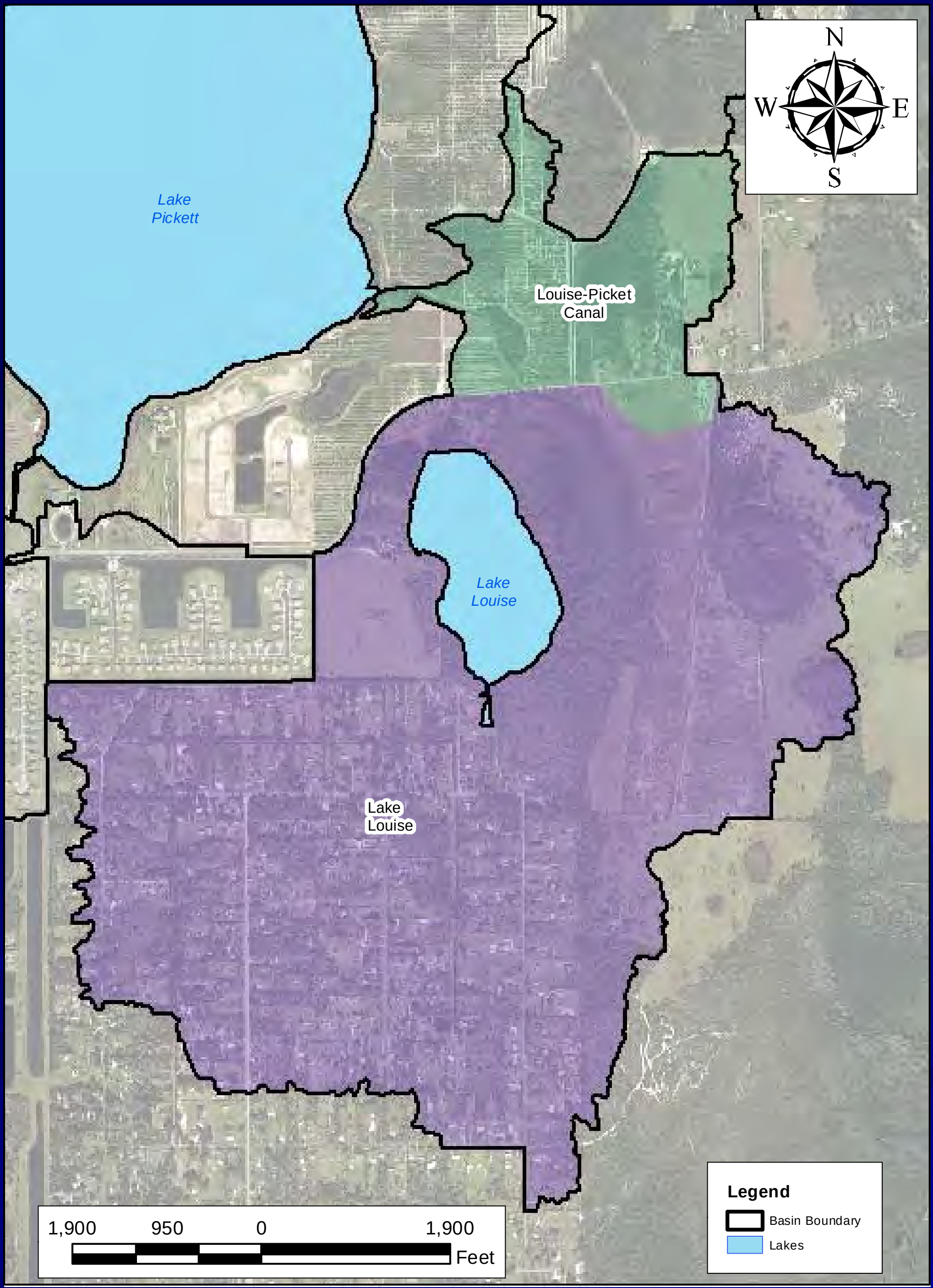




Expanded View of the Northeast Portion of the Current Lake Pickett Drainage Basin

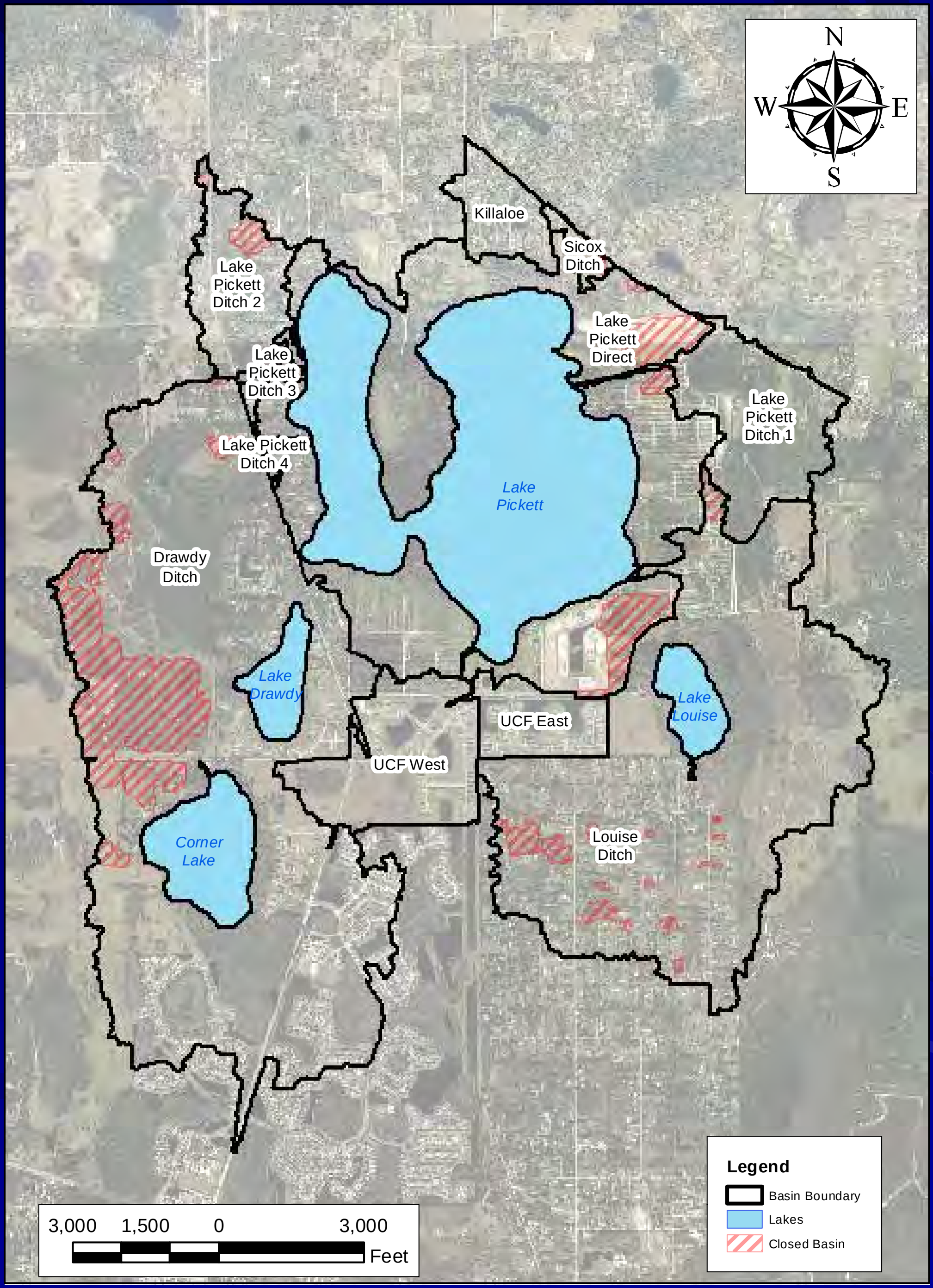
Expanded View of Drawdy Ditch Basin Under Current Conditions

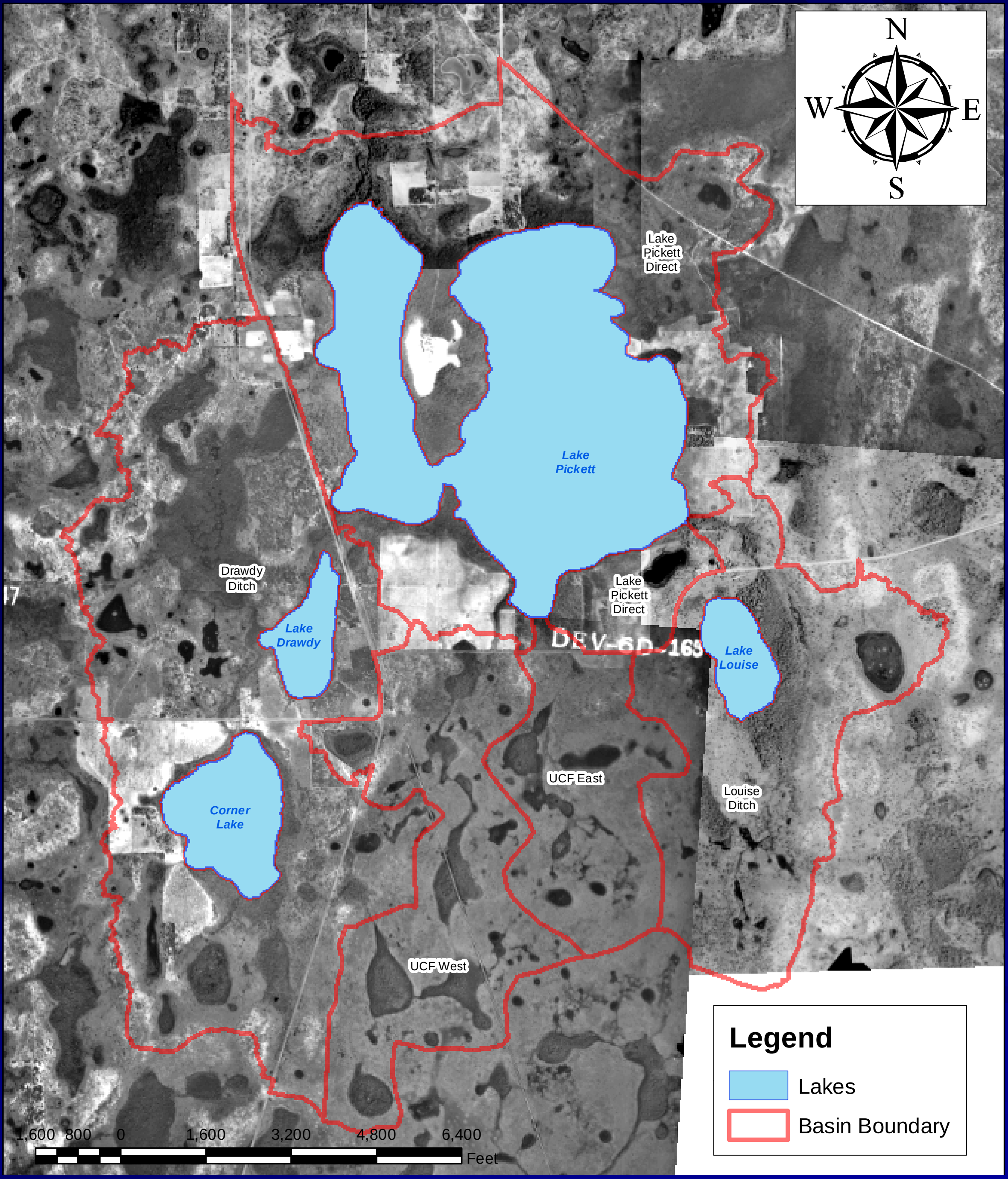




Expanded View of Louise Ditch Basin Under Current Conditions

Hydrologically Closed Portions of the Lake Pickett Drainage Basin Under Current Conditions



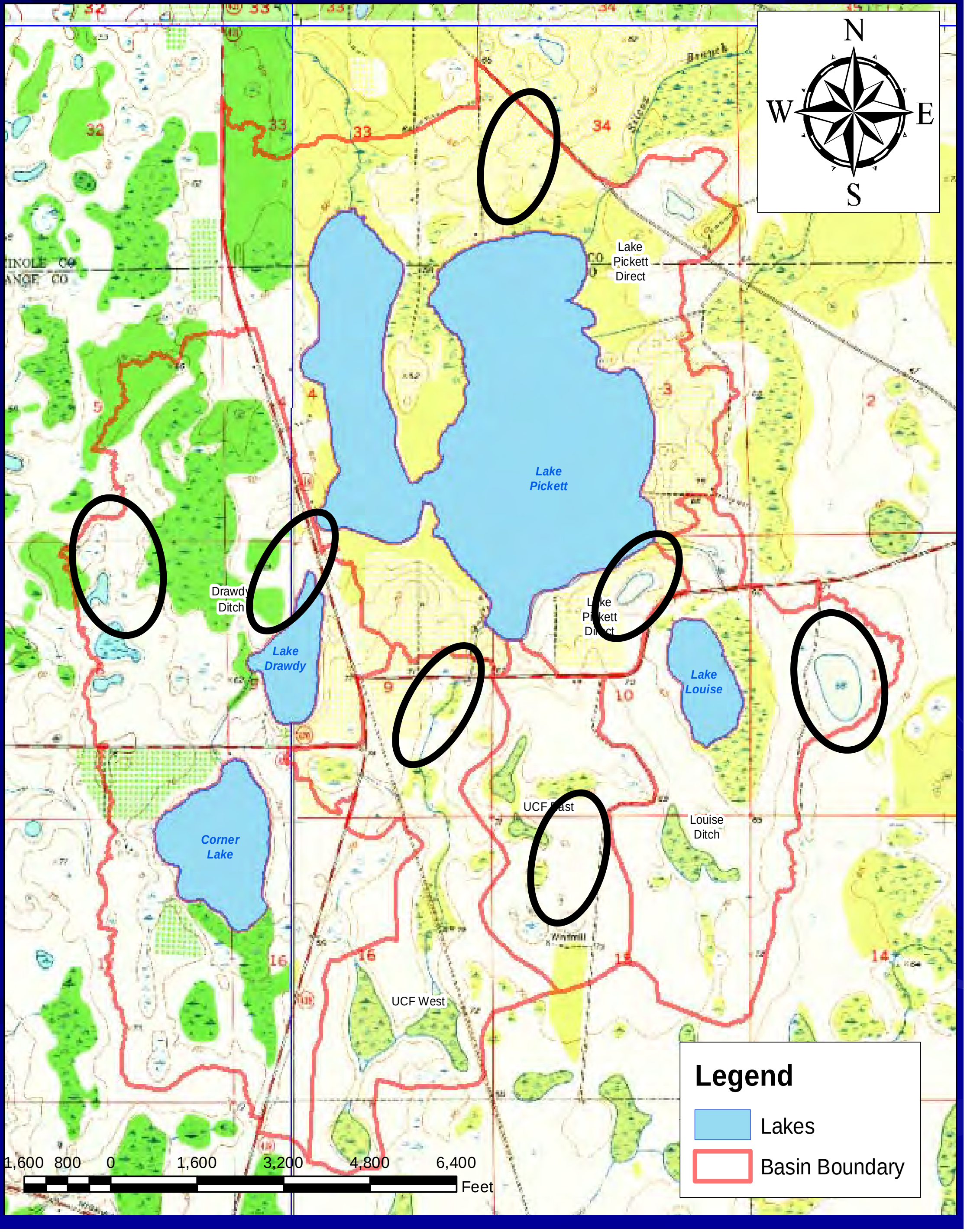


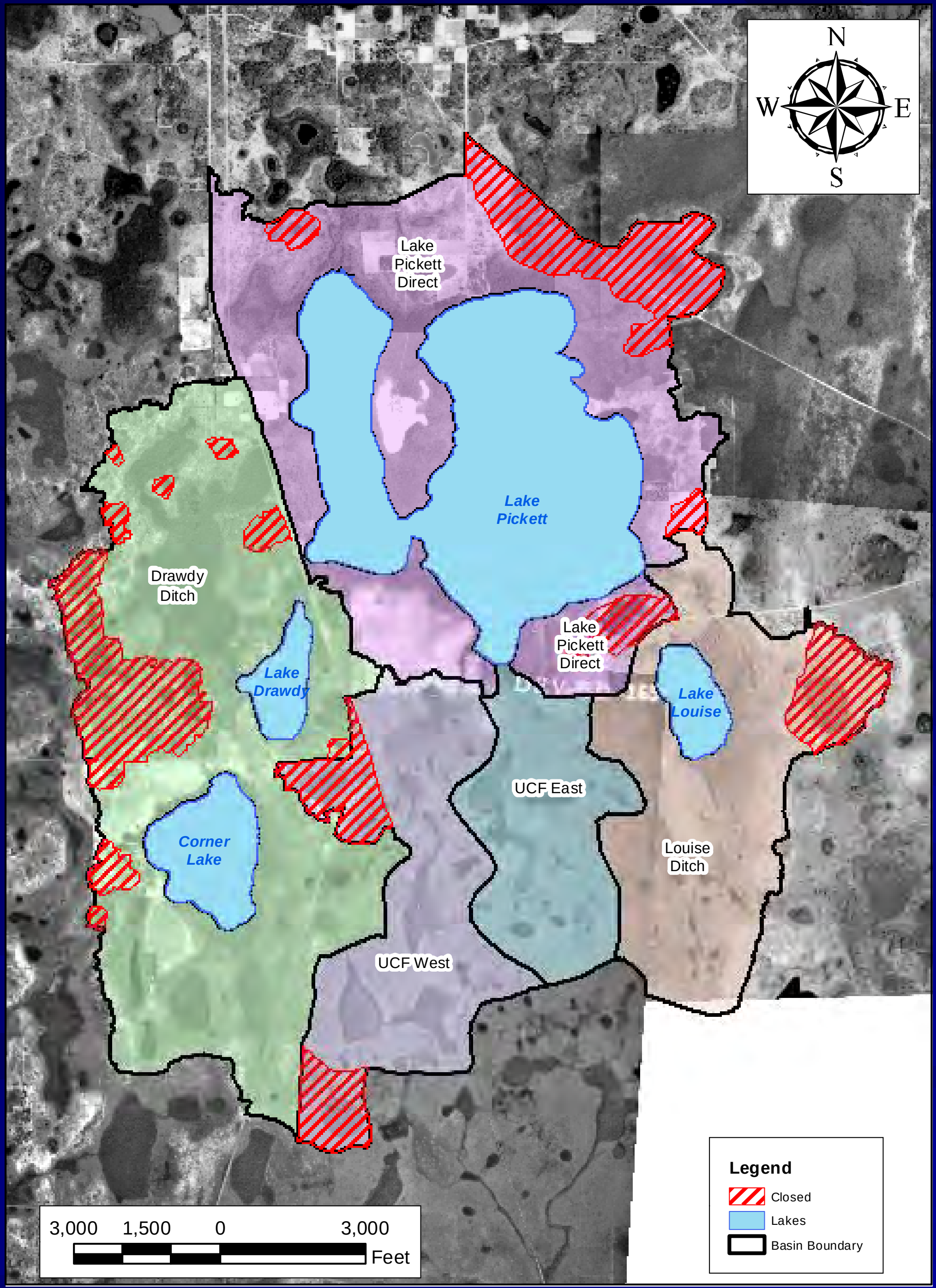
Lake Pickett Pre-Development Drainage Basin Shown on 1940 Aerial

- Total area = 4,434 ac.
- 170 ac. larger than existing

Lake Pickett Pre-Development Watershed Shown on 1953 USGS Quad Map

- Evidence of wetland loss



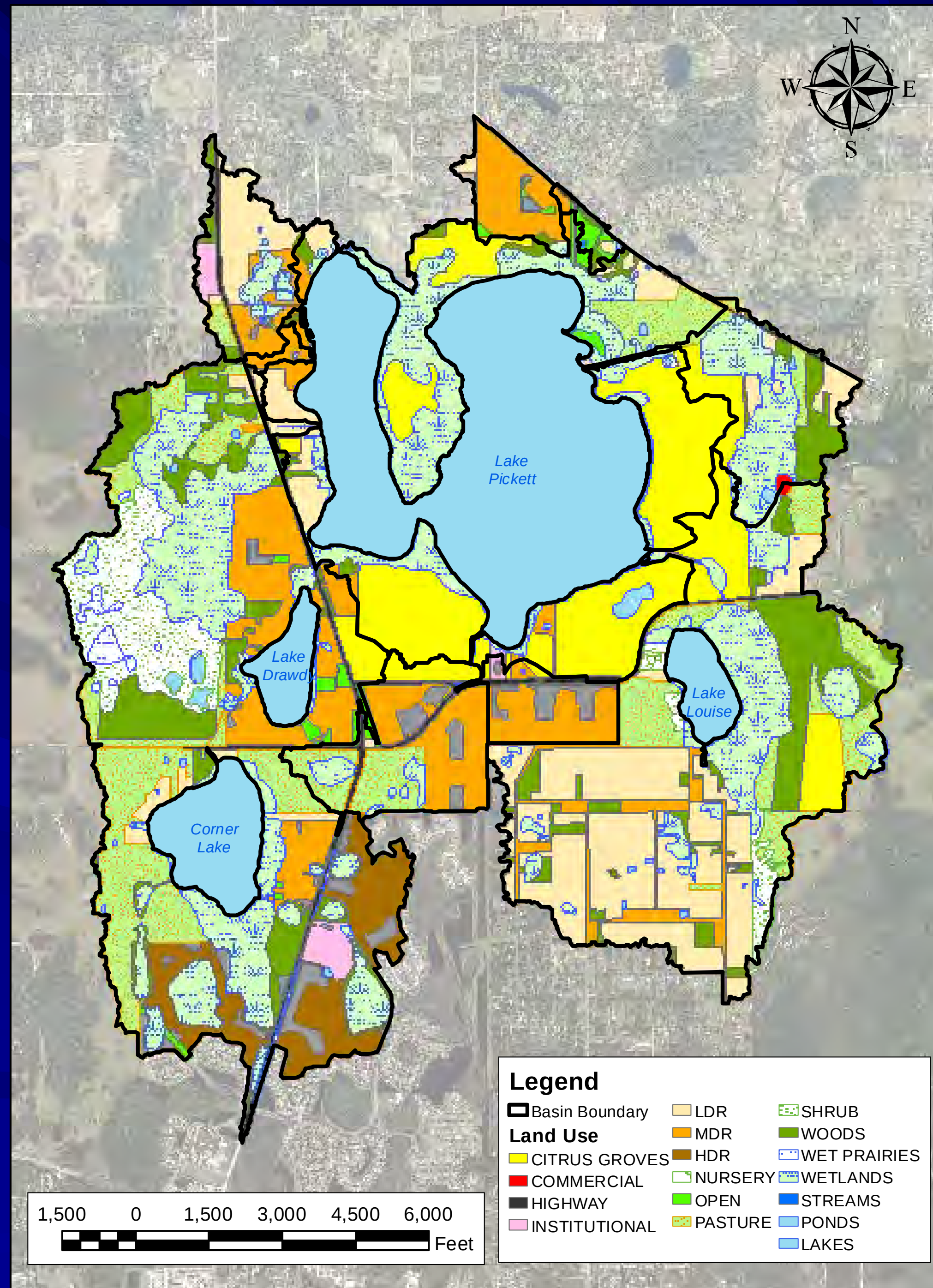


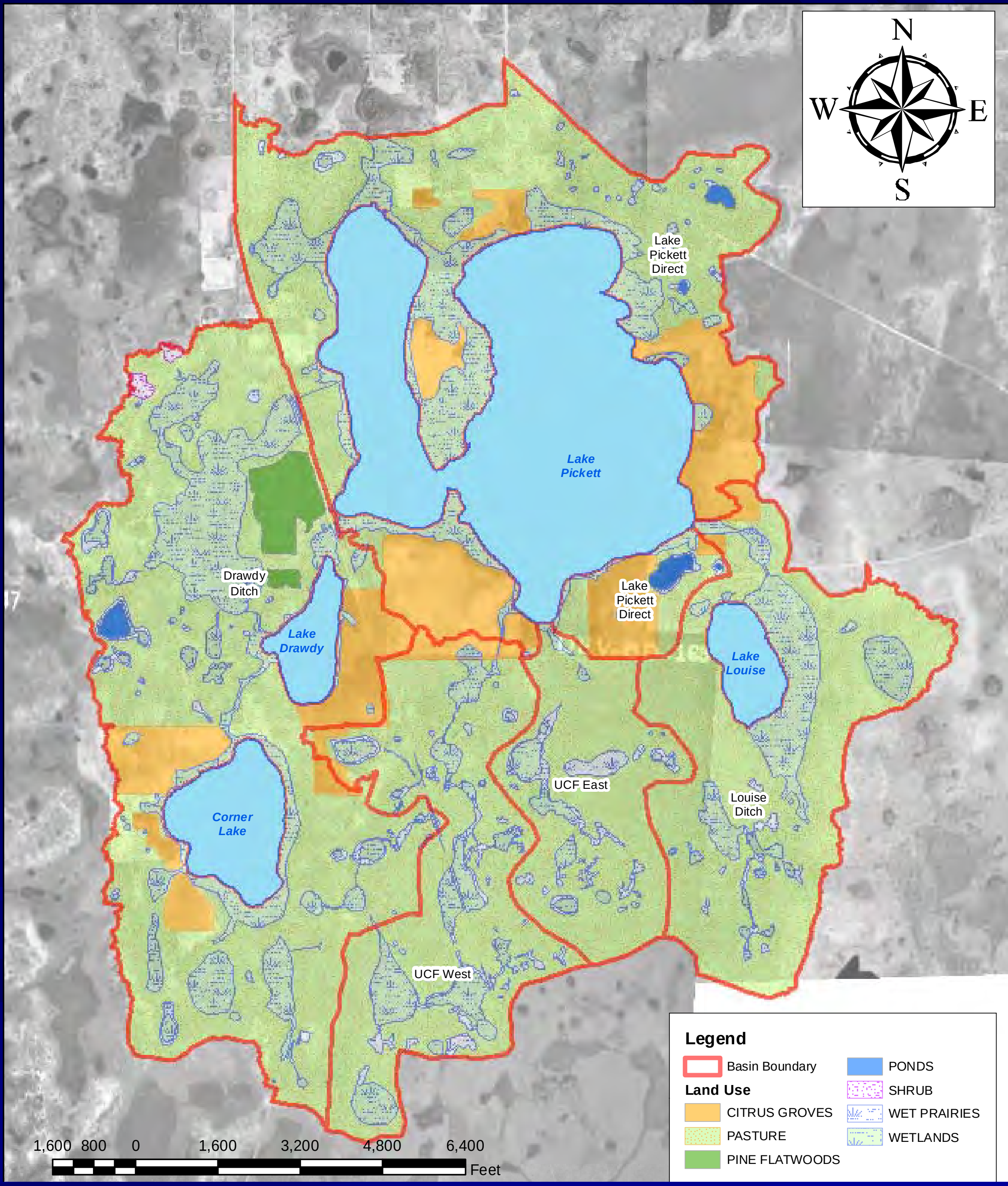
Depressional Areas in the Lake Pickett Pre-Development Drainage Basin

Current Land Use in the Lake Pickett Drainage Basin

- Total area = 4,264 ac.

Land Use	% of Basin
Wetlands	20.8
Medium Density Resid. (MDR)	13.7
Low Density Resid. (LDR)	12.4
Pasture	11.9
Citrus Groves	11.5
Woods	9.1
Lakes	5.1
Shrub	4.3
High Density Resid. (HDR)	3.8
Highway	2.0
Wet Stormwater Ponds	1.9
Open Space	1.2
Institutional	0.8
Water	0.7
Wet Prairies	0.4
Nursery	0.1
Commercial	0.1
Totals	100.0





Estimated Pre-Development Land Use in the Lake Pickett Drainage Basin

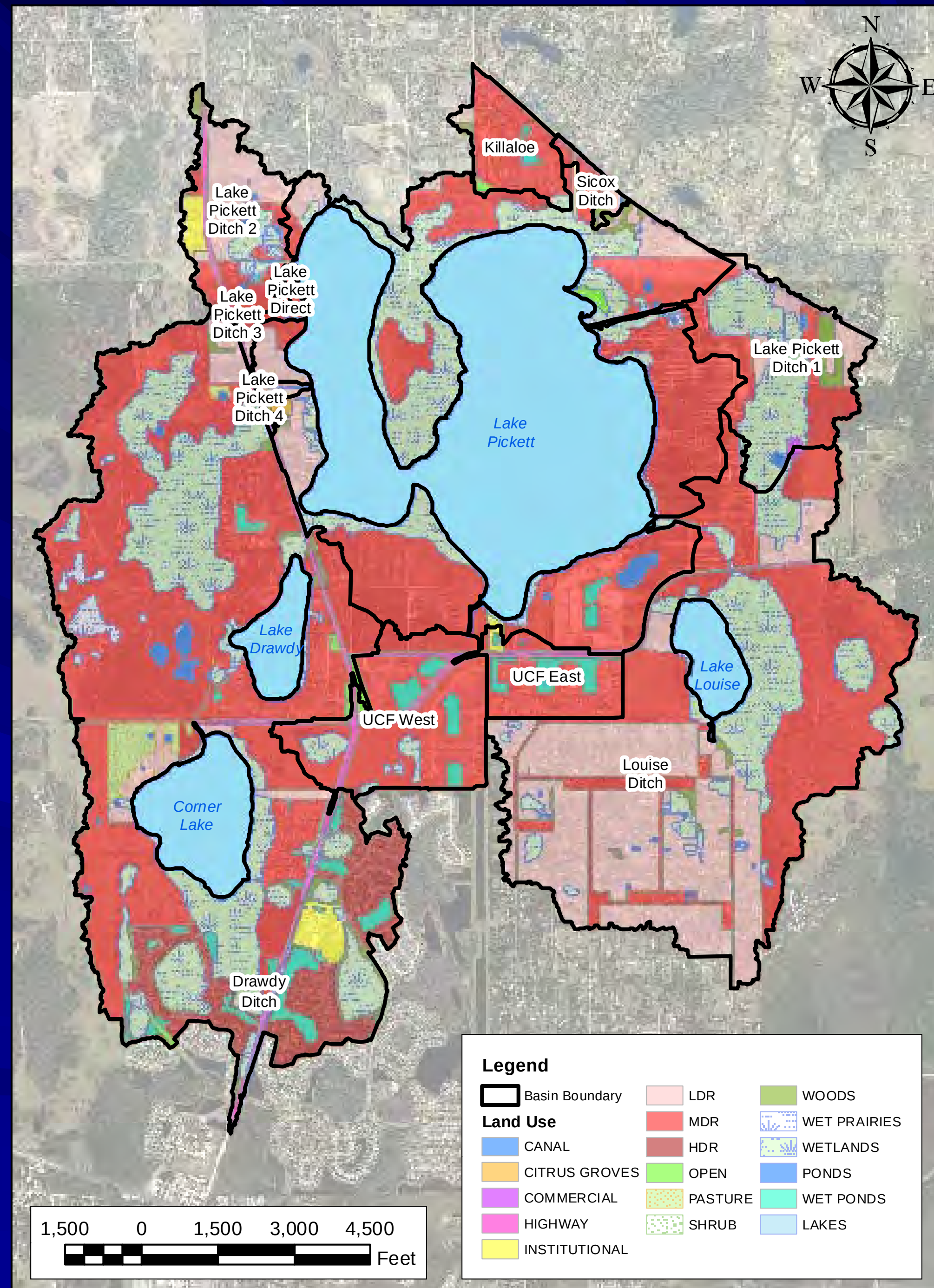
- Total area = 4,434 ac.

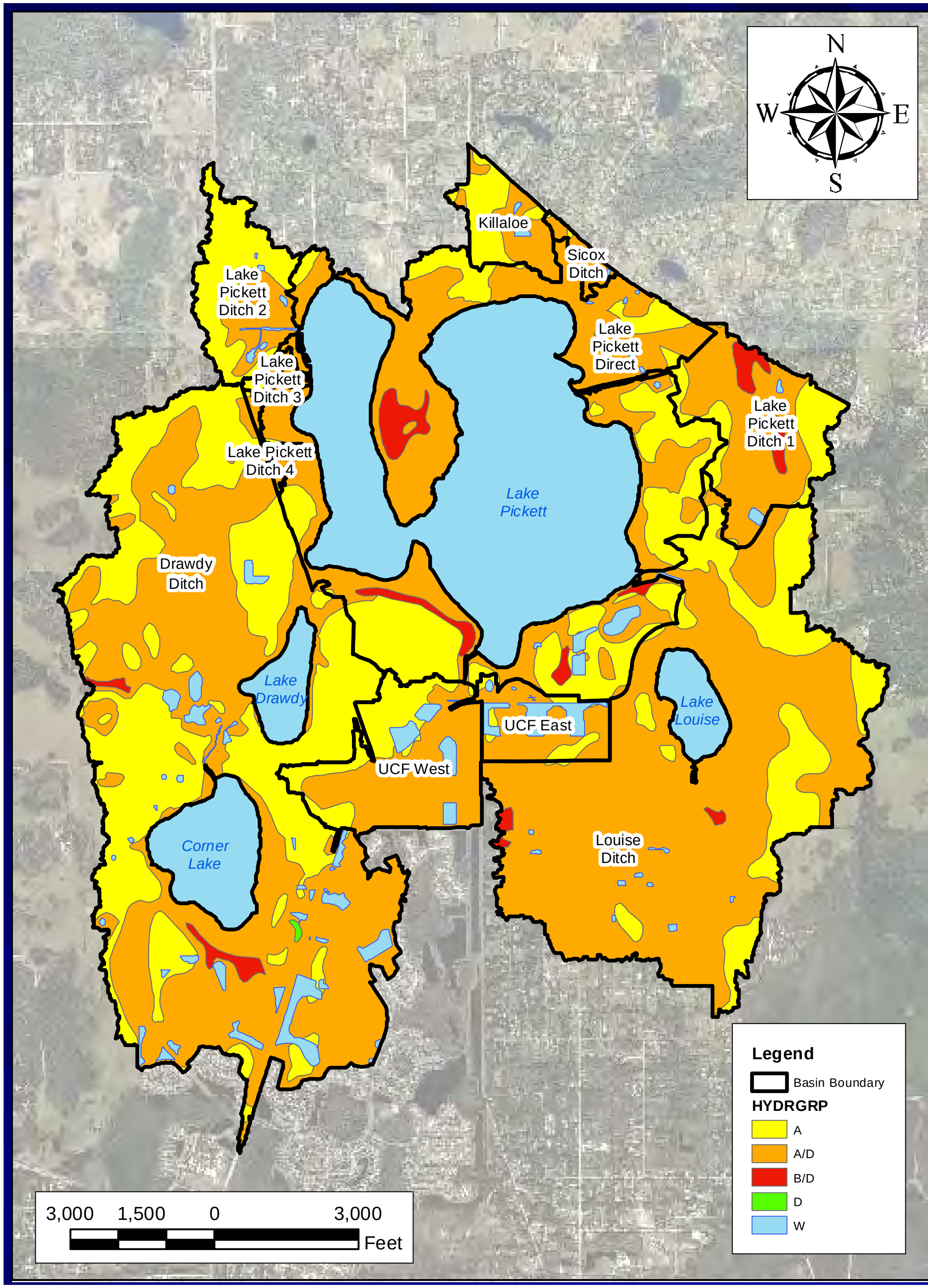
Land Use	% of Basin
Pasture	60.5
Wetlands	19.0
Citrus Groves	11.5
Lakes	4.9
Wet Prairies	2.4
Pine Flatwoods	1.1
Ponds	0.4
Shrub	0.1
Totals	100.0

Estimated Future Land Use in the Lake Pickett Drainage Basin

- Assumes that existing undeveloped land is converted to single family residential

Land Use	% Basin
Medium Density Resid. (MDR)	46.9
Wetlands	20.8
Low Density Resid. (LDR)	14.8
Lakes	5.1
High Density Resid. (HDR)	3.8
Highway	2.0
Wet Stormwater Ponds	1.9
Woods	1.2
Institutional	0.8
Water	0.7
Open Space	0.7
Pasture	0.6
Wet Prairies	0.4
Citrus Groves	0.1
Commercial	0.1
Totals	100





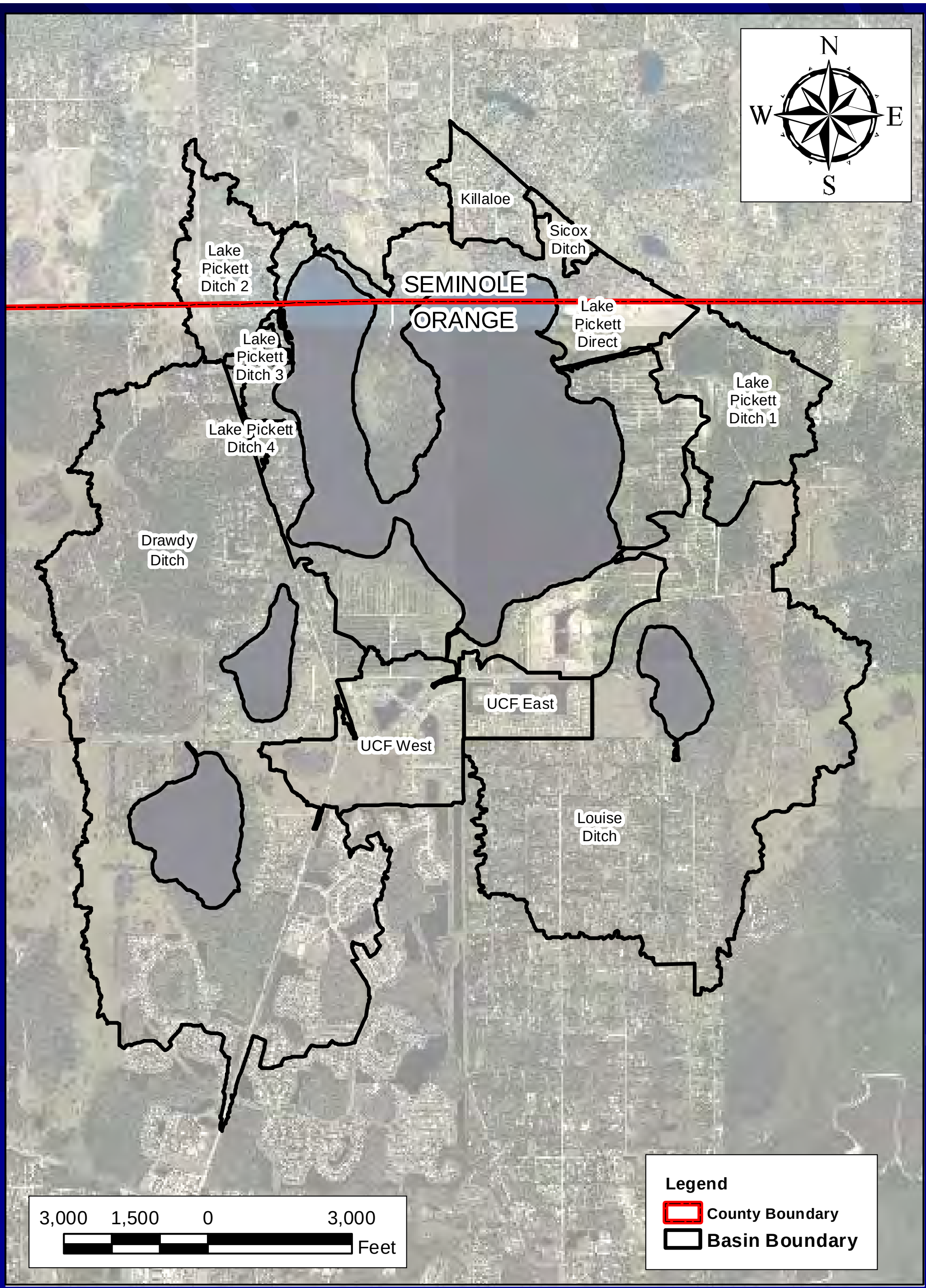
Hydrologic Soil Groups in the Lake Pickett Drainage Basin Under Current Conditions

- Soils are sandy and well-drained

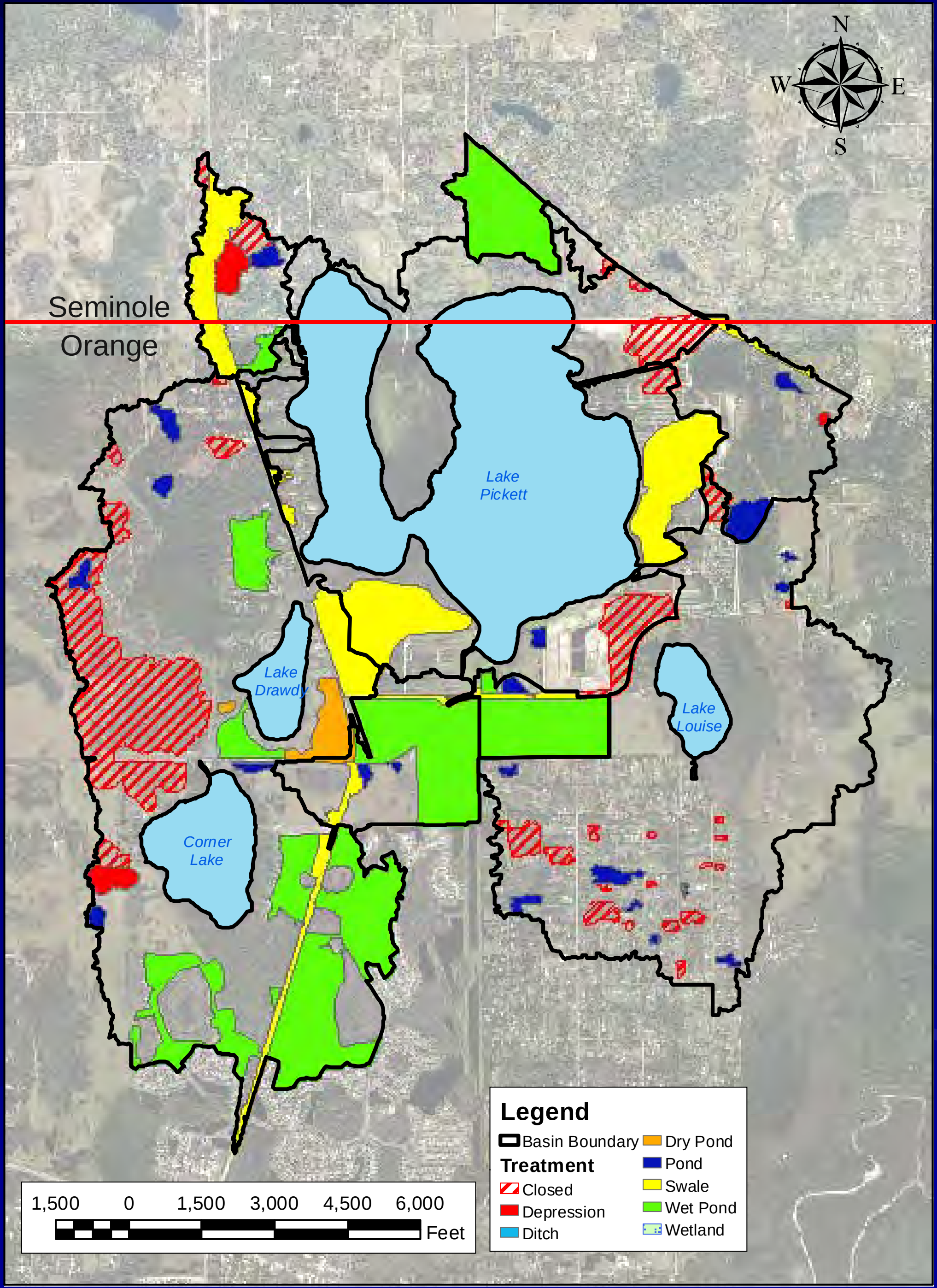
- Most rainfall enters the soil and migrates to the lake through groundwater

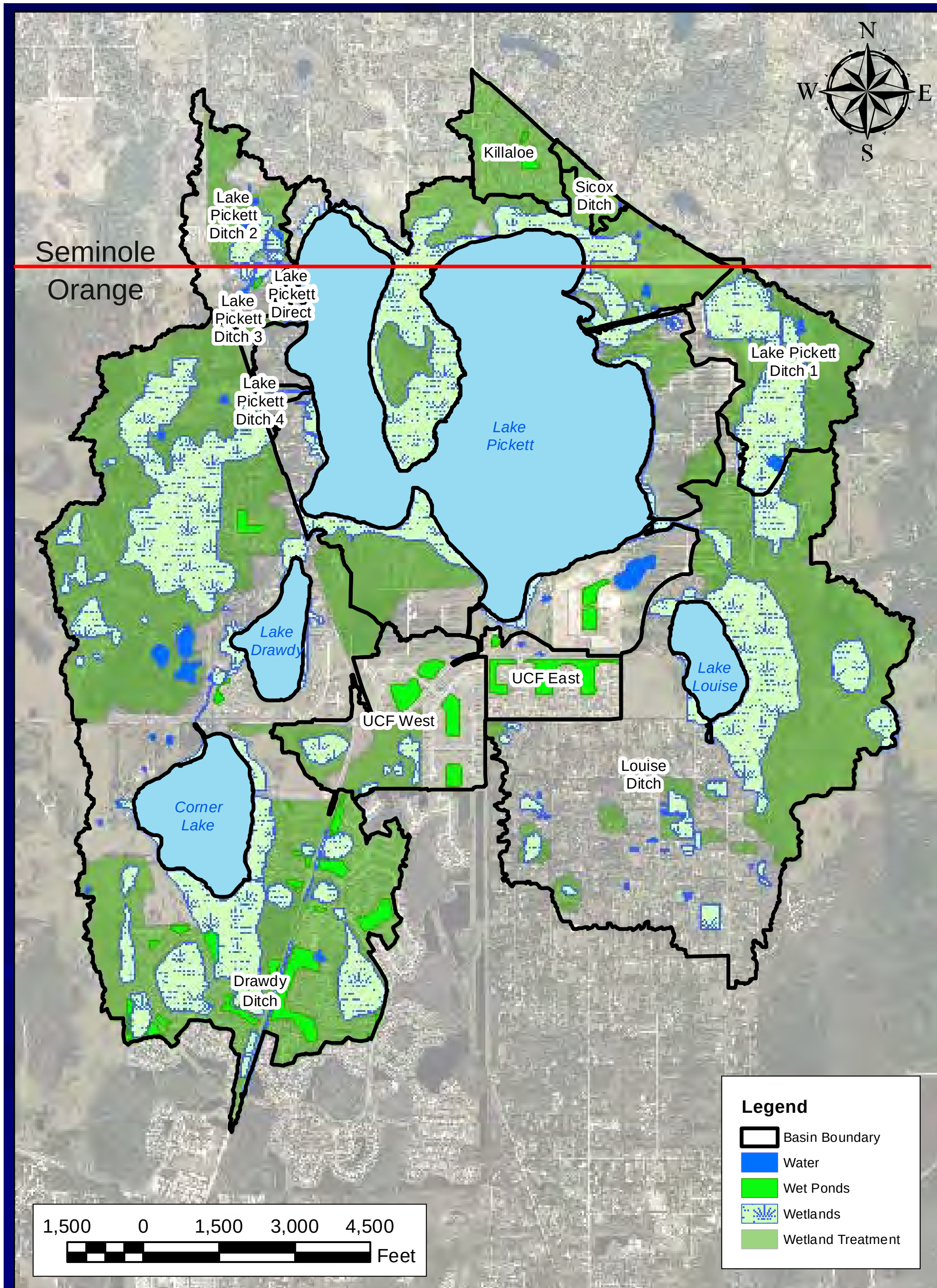
Governmental Jurisdictions in the Lake Pickett Drainage Basin Under Current Conditions

Jurisdiction	Percent of Basin Area	
	Current	Pre-Dev.
Orange County	91.7	88.2
Seminole County	8.3	11.2

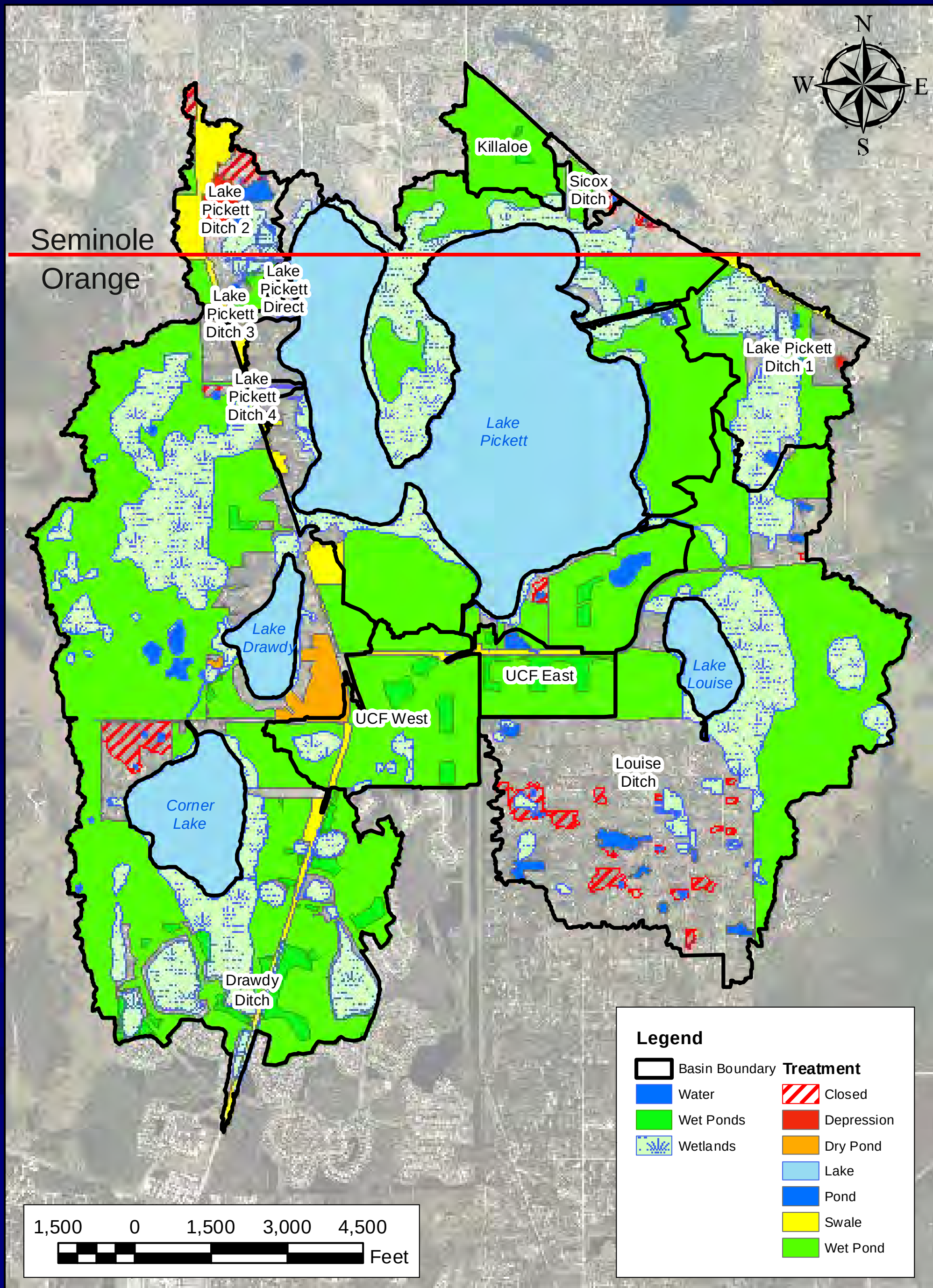


Stormwater Treatment in the Lake Pickett Drainage Basin Under Current Conditions

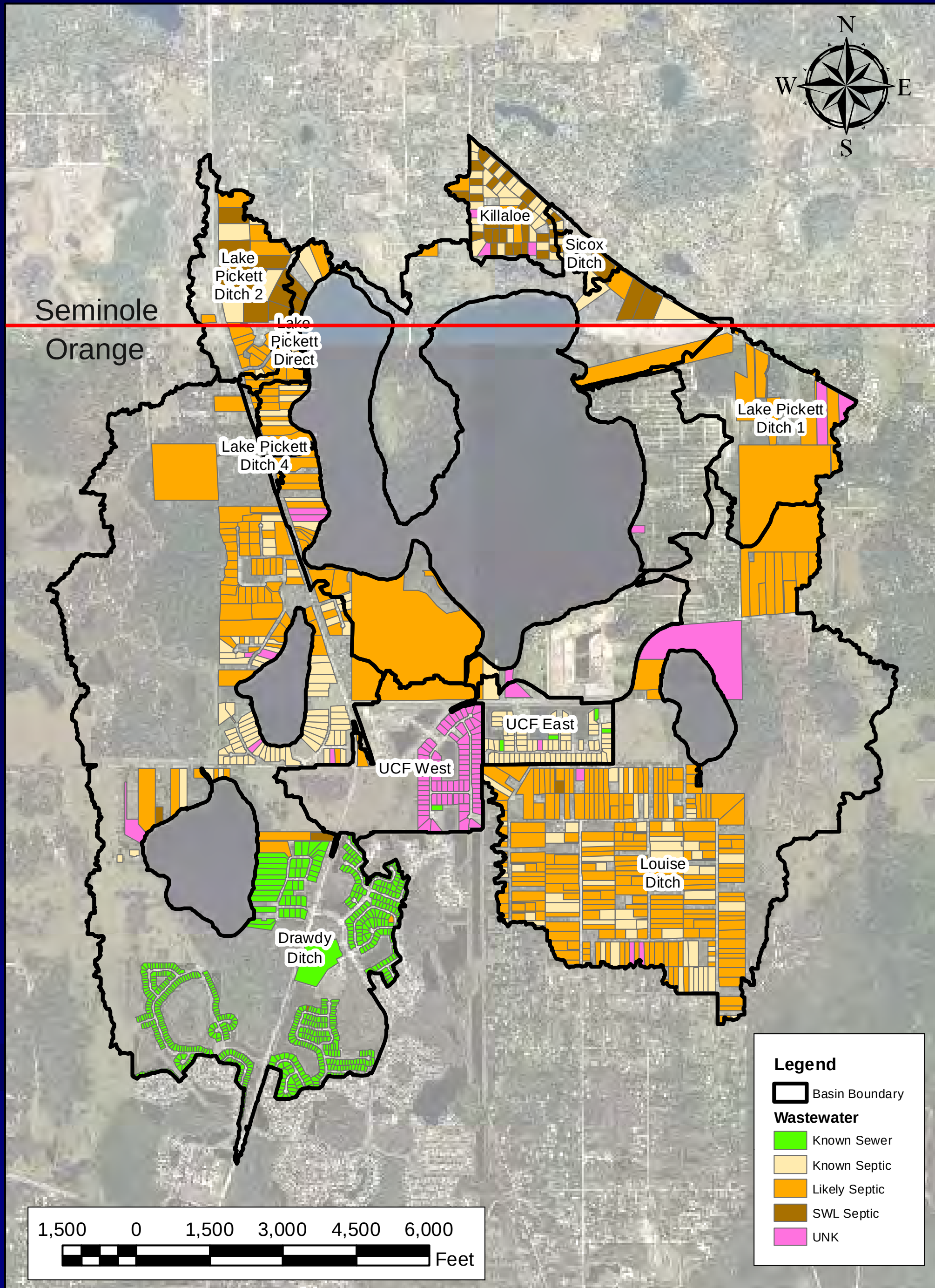




Areas Receiving Wetland Treatment in the Lake Pickett Drainage Basin Under Current Conditions



Overview of Stormwater Treatment in the Lake Pickett Drainage Basin Under Future Conditions



Current Methods of Sewage Disposal in the Lake Pickett Drainage Basin

Summary of Septic Tanks in the Lake Pickett Drainage Basin for Residential Land Uses Under Current Conditions

(Information provided by Orange and Seminole County)

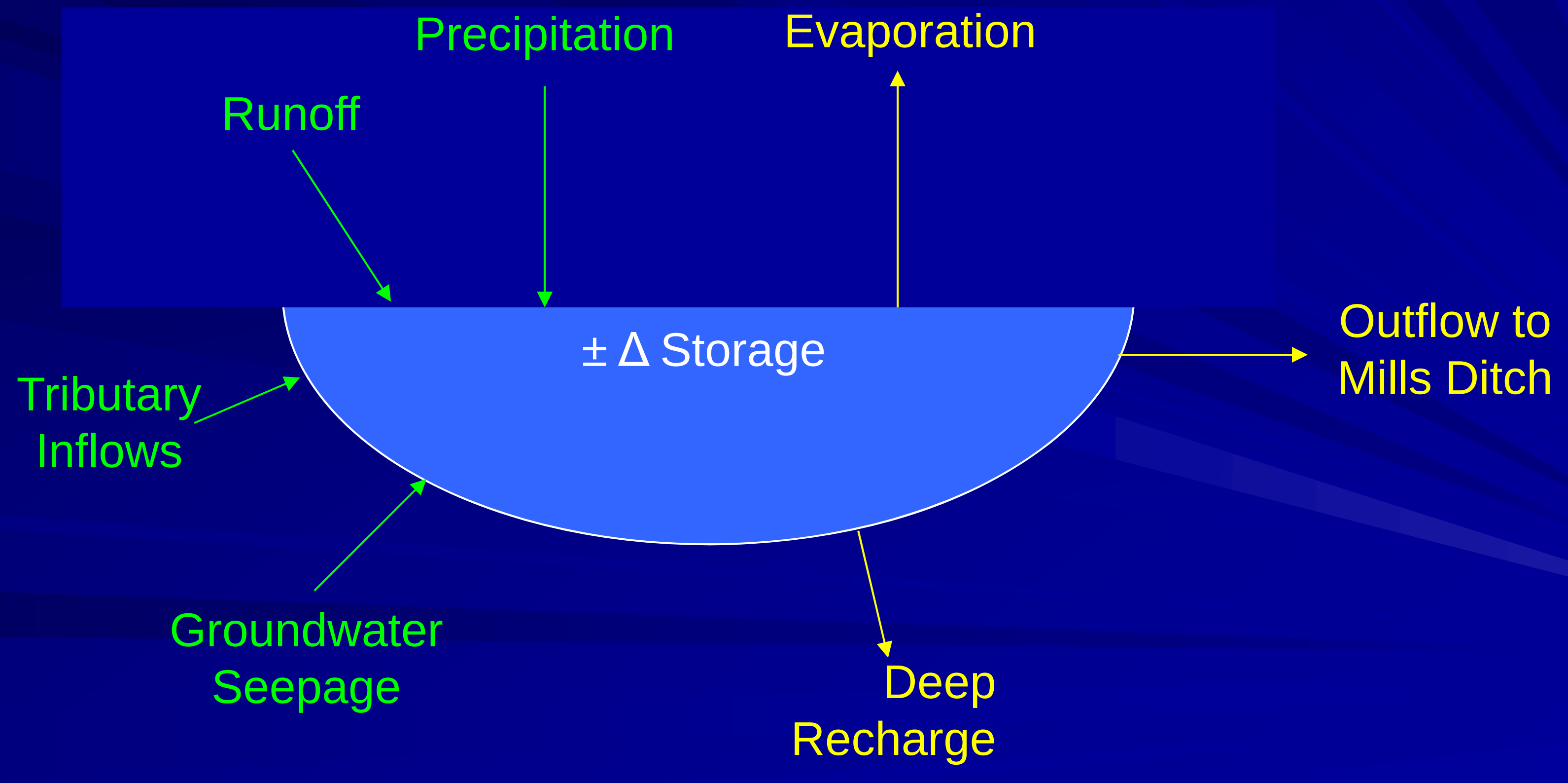
Land Use	Number of Septic Tanks	Land Use Area (acres)	Septic Tank Density (acres/unit)
Medium-Density Residential	313	308.44	0.99
Low-Density Residential	290	471.50	1.63
Total:	603	779.94	

Projected Future Septic Tanks in the Lake Pickett Drainage Basin

(Assumes development occurs with septic tank density same as current)

Land Use	Current Conditions		Future Conditions		
	Area (acres)	Number of Septic Tanks	Area Increase (acres)	Number of New Septic Tanks	Total Number of Septic Tanks
Medium-Density Residential	308.44	313	1,213.01	1,225	1,538
Low-Density Residential	471.50	290	104.24	64	354
Total:		603			1,892

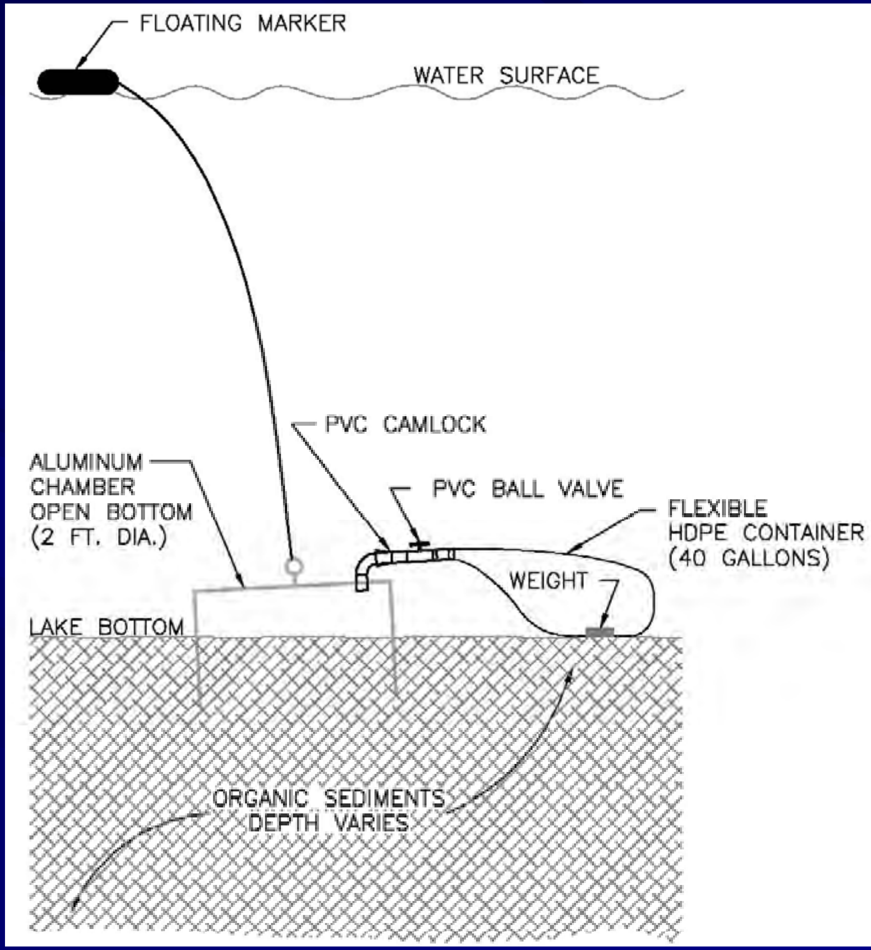
Lake Pickett
Hydrologic Budget Components



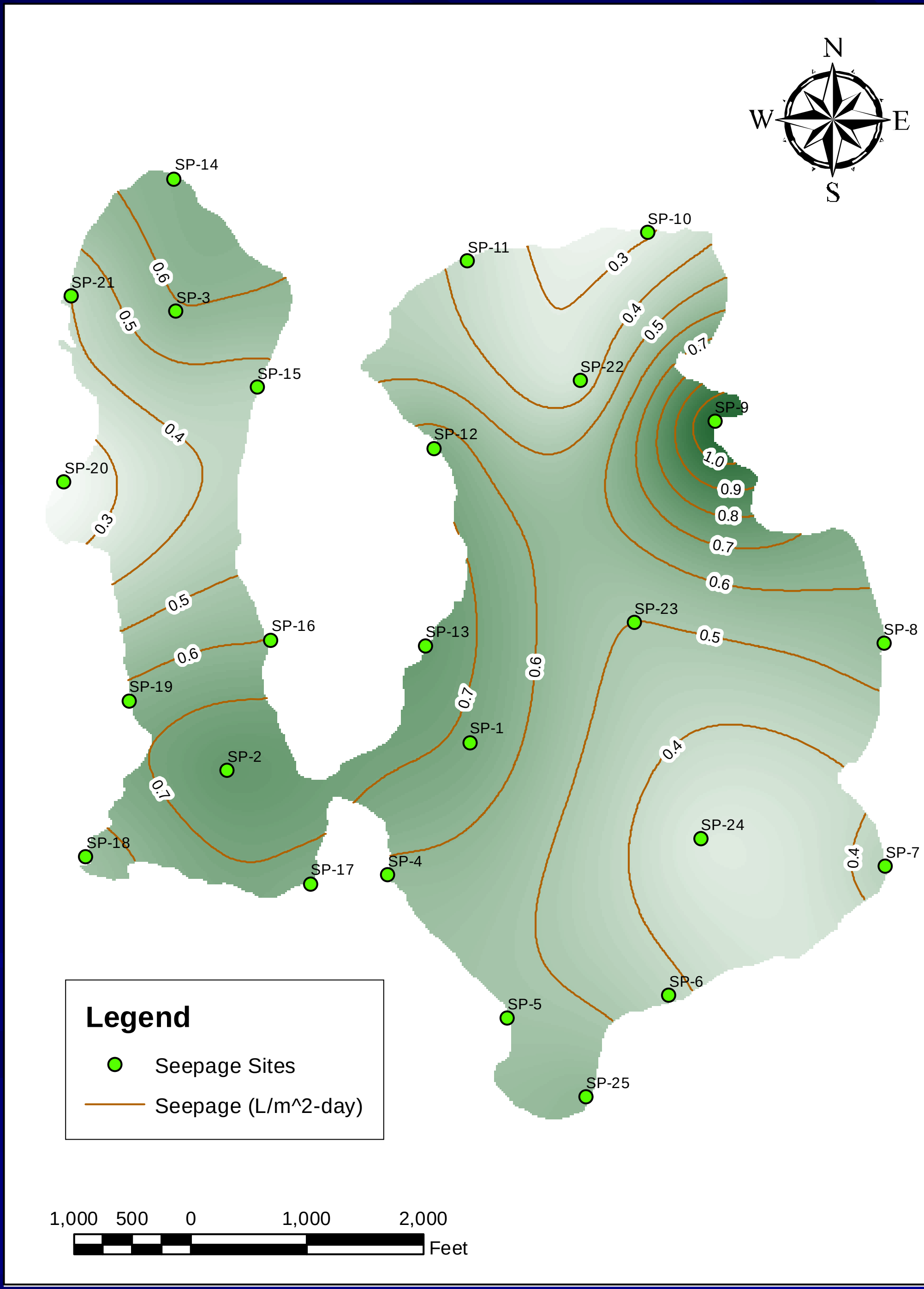
Estimation of Hydrologic Inputs/Losses to Lake Pickett

- Precipitation
  - Based on average monthly rainfall
- Runoff
  - Runoff inputs based on continuous modeling for each sub-basin area
  - Generated runoff adjusted for losses in ponds, stormwater systems, wetlands, and depressional areas
- Groundwater seepage
  - Based on direct field measurements
- Inter-connected lake inflows
  - Based on hydrologic budgets for each lake
- Evaporation
  - Based on average monthly evaporation
- Deep recharge to aquifer
  - Based on recharge maps produced by St. Johns River Water Management District

Typical Seepage Meter Installation



Seepage Monitoring Sites in Lake Pickett



Mean Seepage Inflow Isopleths for Lake Pickett from August 2015-August 2016

Parameter	Units	Value
Lake Area	acres	745
Mean Seepage Inflow	liters/m^2-day	0.52
	ac-ft/year	465
	ft/yr	0.62

Tributary Inflow and Outflow Monitoring Sites

Overview of the Drawdy Ditch Monitoring Site

Drawdy Ditch
upstream of Chuluota Road

Drawdy Ditch
downstream of Chuluota Road

Overview of the UCF West Monitoring Site

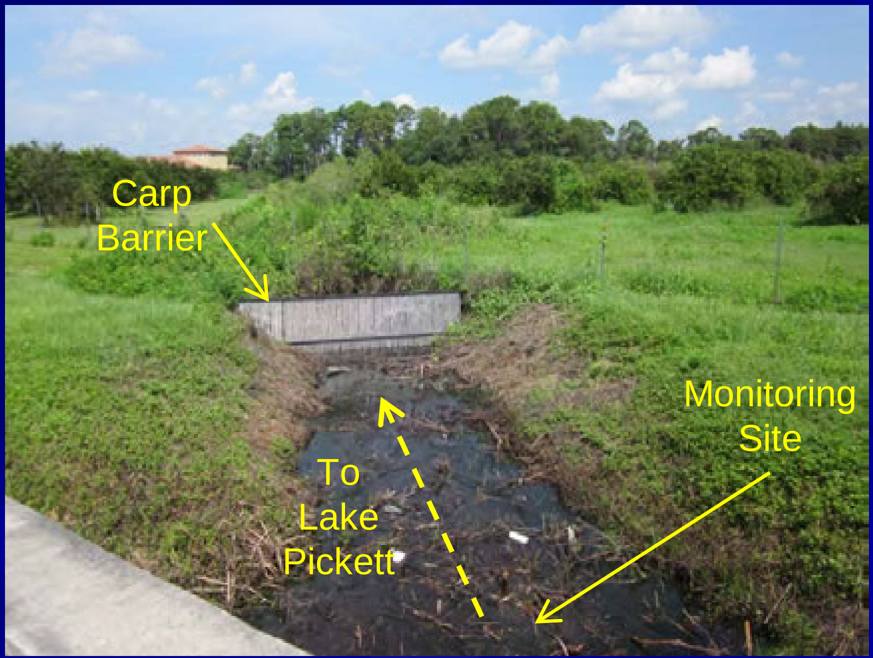
Ditch upstream of Old Lake Pickett Road

Ditch at Lake Pickett Road Crossing

Culvert beneath Lake Pickett Road

Overview of the UCF East Monitoring Site

Ditch upstream of Lake Pickett Road



Ditch downstream of Lake Pickett Road

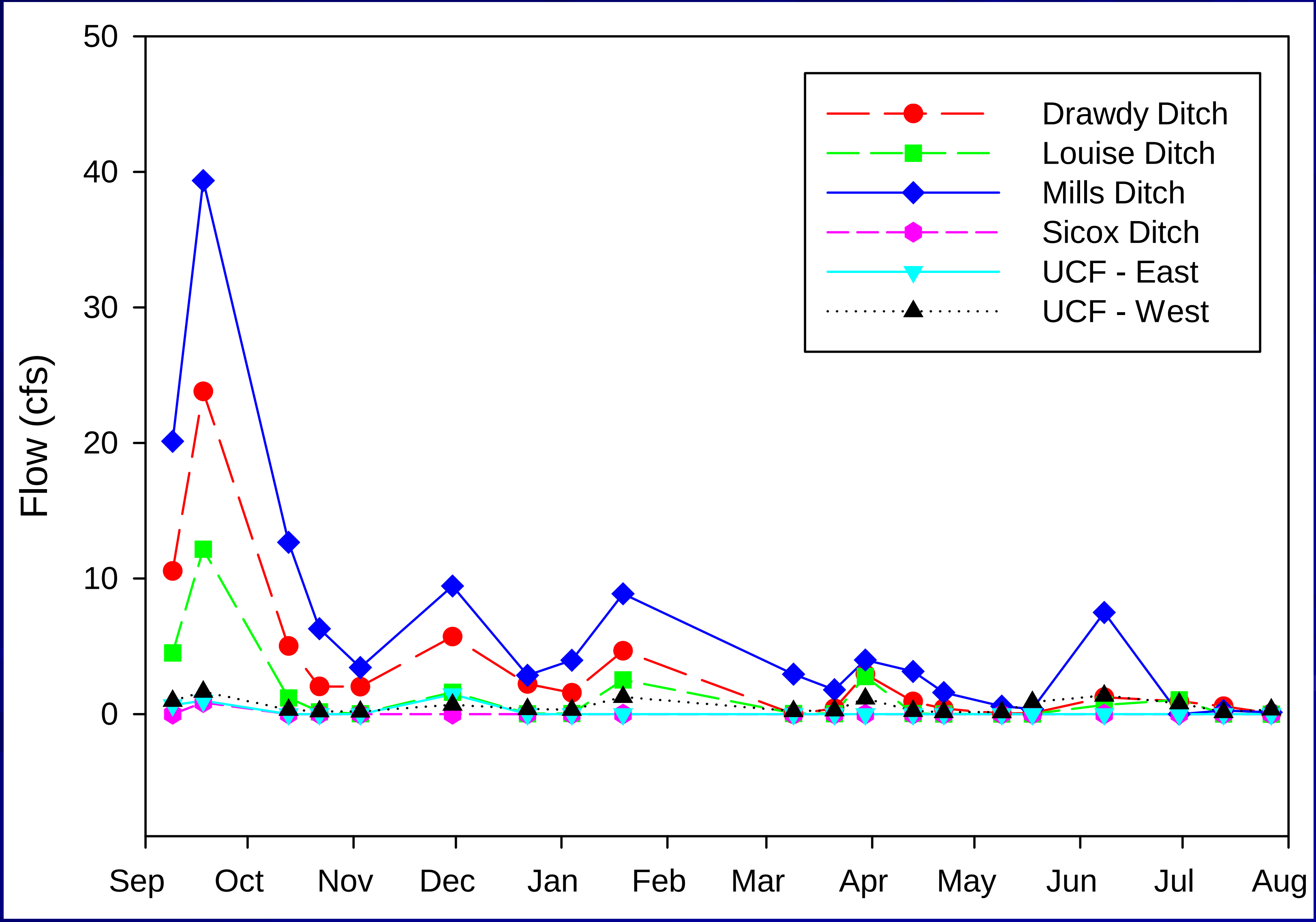
Overview of the Louise Ditch Monitoring Site

Arch culvert beneath Lake Pickett Rd.

Ditch downstream of Lake Pickett Rd.

Overview of the Silcox Ditch Monitoring Site

Comparison of Measured Discharge Rates at the Tributary Monitoring Sites



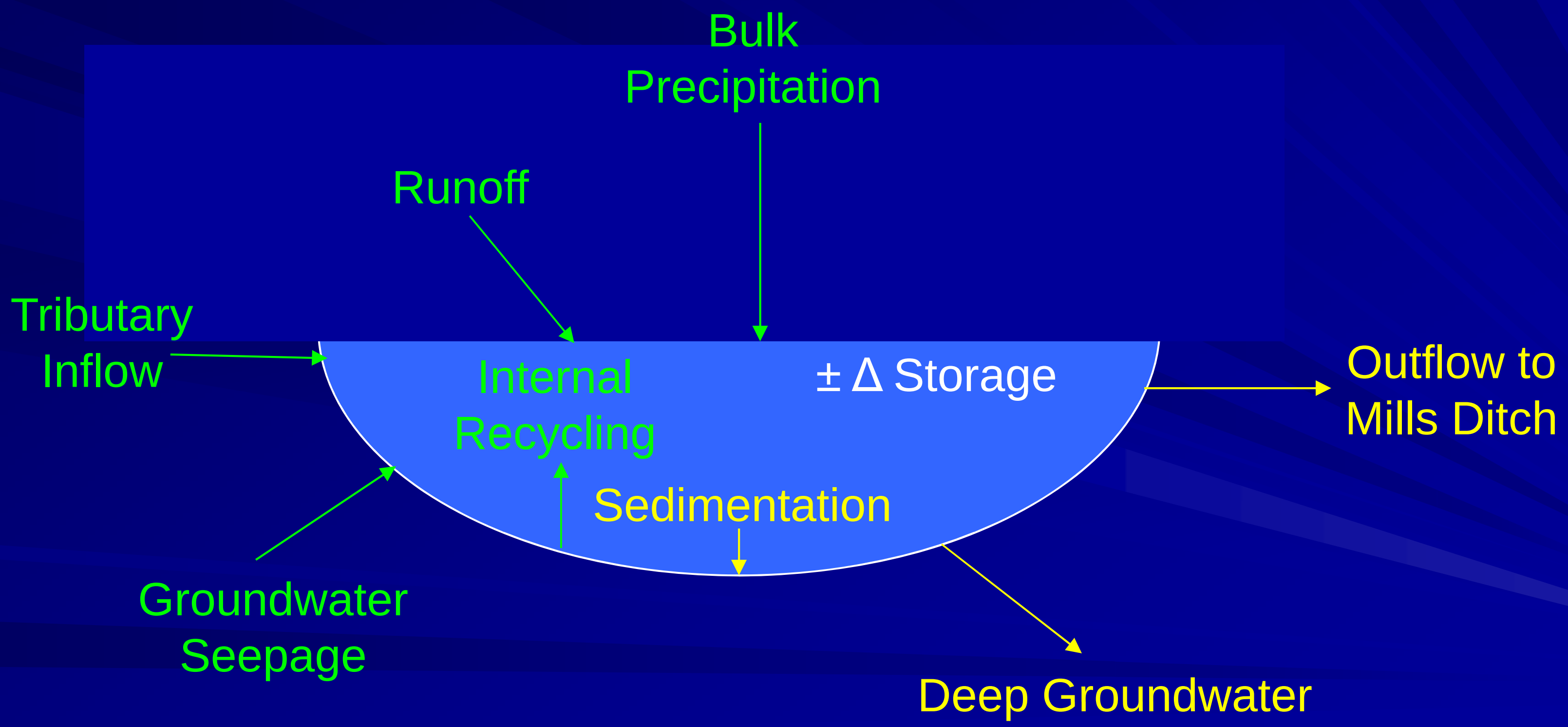
Comparison of Annual Hydrologic Inputs to Lake Pickett

Parameter	Annual Inputs (ac-ft/yr)		
	Pre (1940)	Current	Future
Precipitation	3,106 (40%)	3,106 (39%)	3,106 (30%)
Runoff	778 (10%)	1,152 (15%)	1,421 (18%)
Tributary Inflows	3,165 (41%)	3,165 (41%)	2,695 (34%)
Overland Flow	198 (3%)	206 (3%)	327 (4%)
Groundwater Seepage	496 (6%)	465 (6%)	422 (5%)
Totals	7,742	7,877	7,971

Calculated Mean Annual Residence Times in Lake Pickett Under Current, Pre-Development, and Future Development Conditions

Condition	Lake Volume (ac-ft)	Annual Inflow (ac-ft/yr)	Mean Residence Time (days)
Current	10,609	7,877	492
Pre-Development	10,609	7,742	500
Future Development	10,609	7,971	486

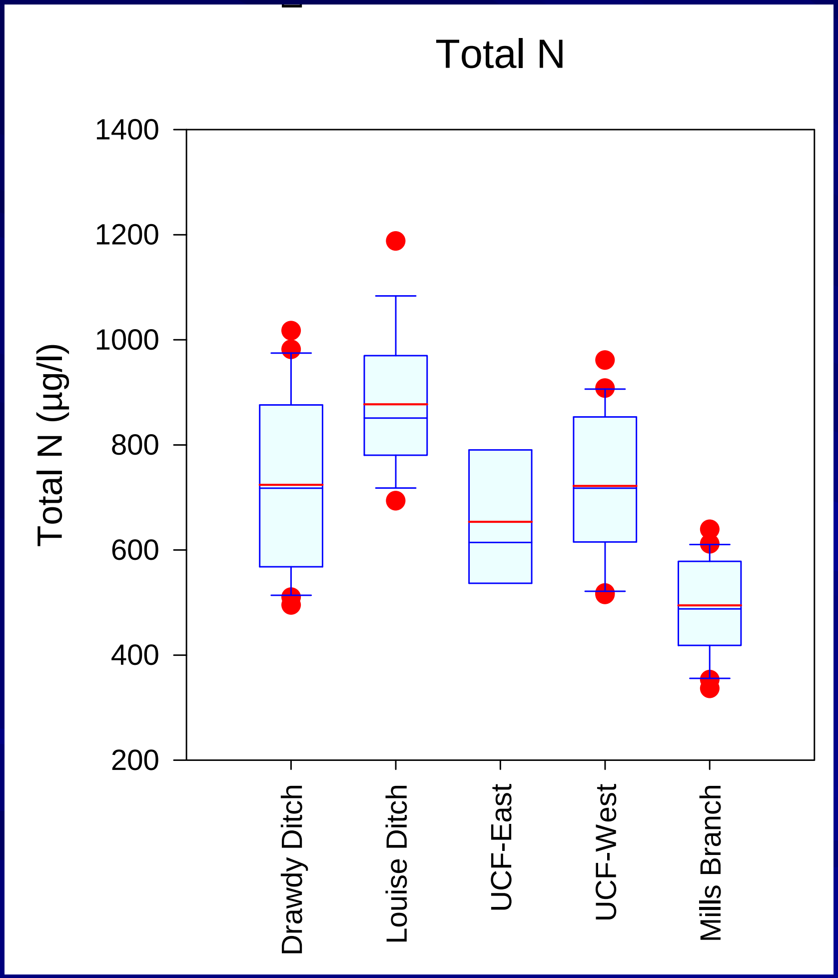
Lake Pickett
Nutrient Budget Components

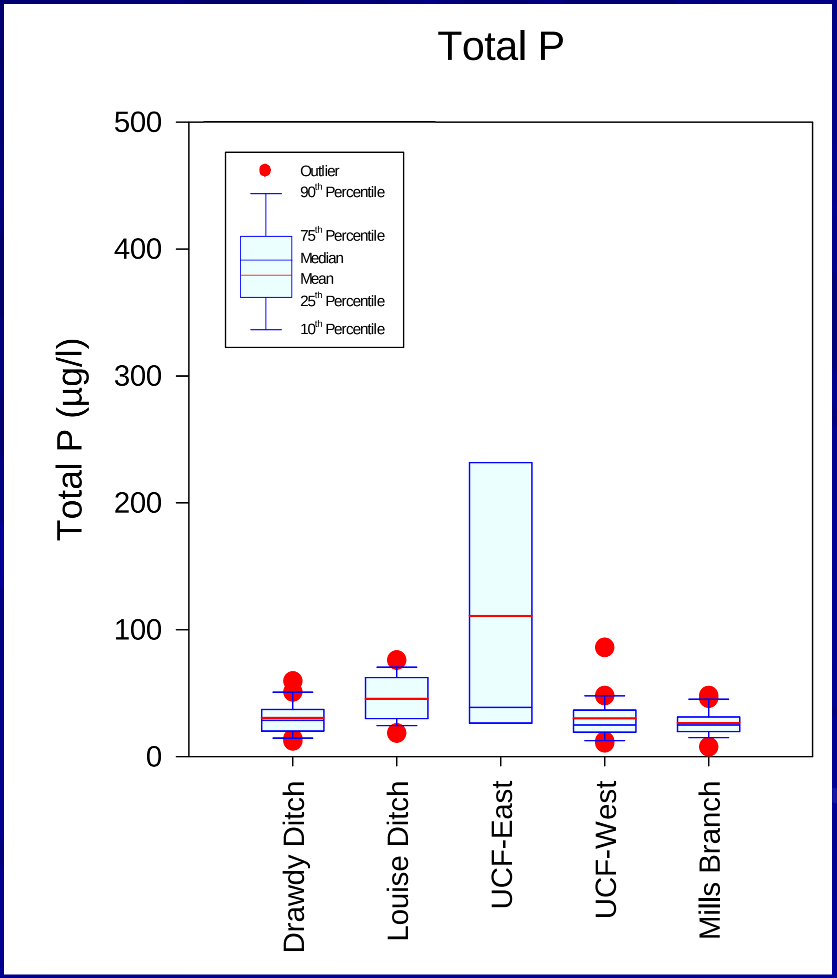


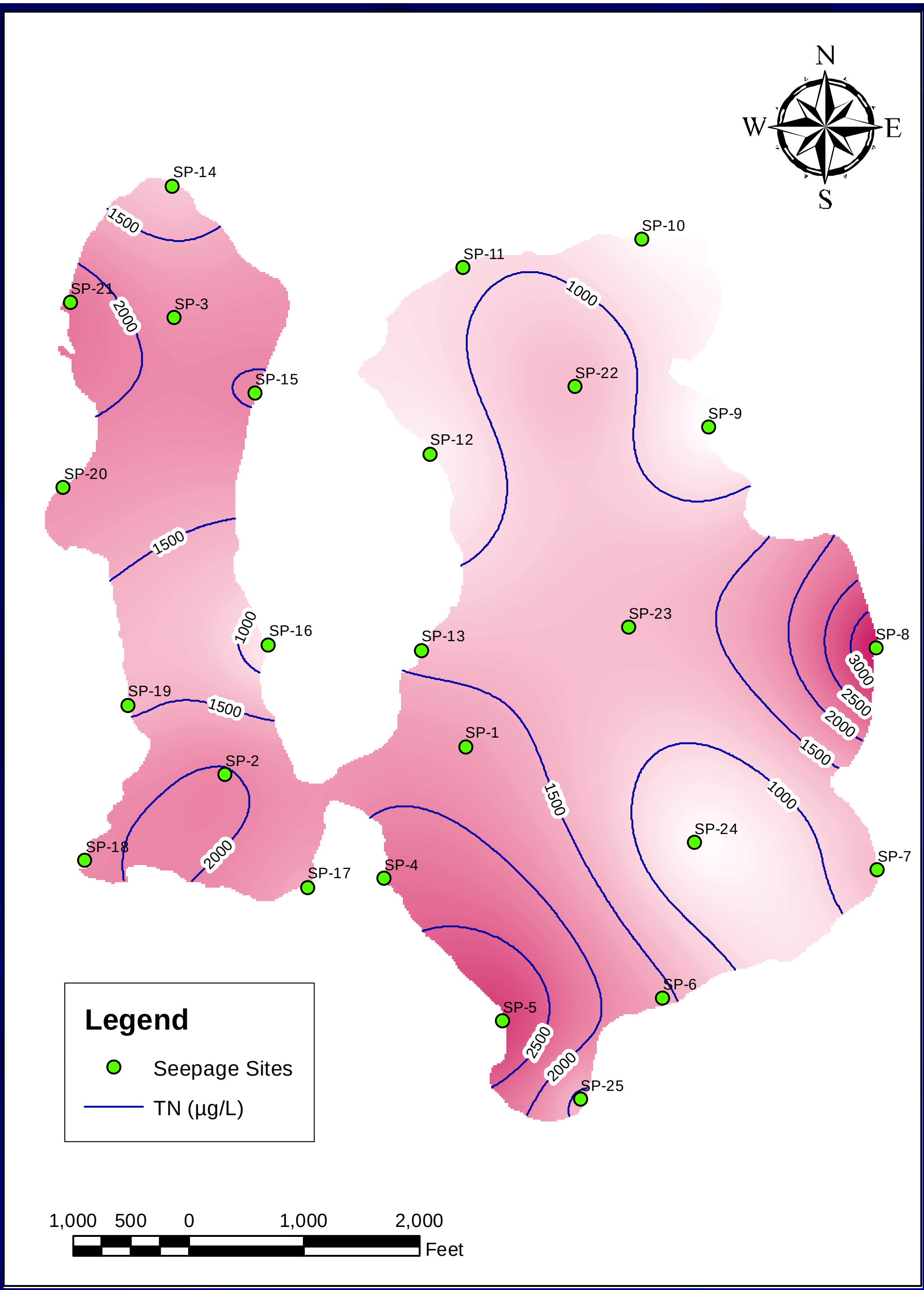
Estimation of Nutrient Inputs/Losses to Lake Pickett

- Precipitation
  - Based on measurements conducted by ERD in Central Florida
- Runoff
  - Field monitoring of runoff characteristics conducted at 8 locations surrounding Spring Lake
  - Flow-weighted runoff samples collected during 3-6 storm events at each site
- Groundwater seepage
  - Based on direct field measurements
- Internal recycling
  - Based on direct measurements
- Inter-connected lake inflows
  - Based on water quality characteristics of upstream lakes and calculated hydrologic inputs
- Deep recharge to aquifer
  - Assumed similar to in-lake water quality
- Outfall losses
  - Based on measured outflow characteristics and calculated discharges

Measured Nutrient Concentrations in Tributary Inflows / Outflows to Lake Pickett

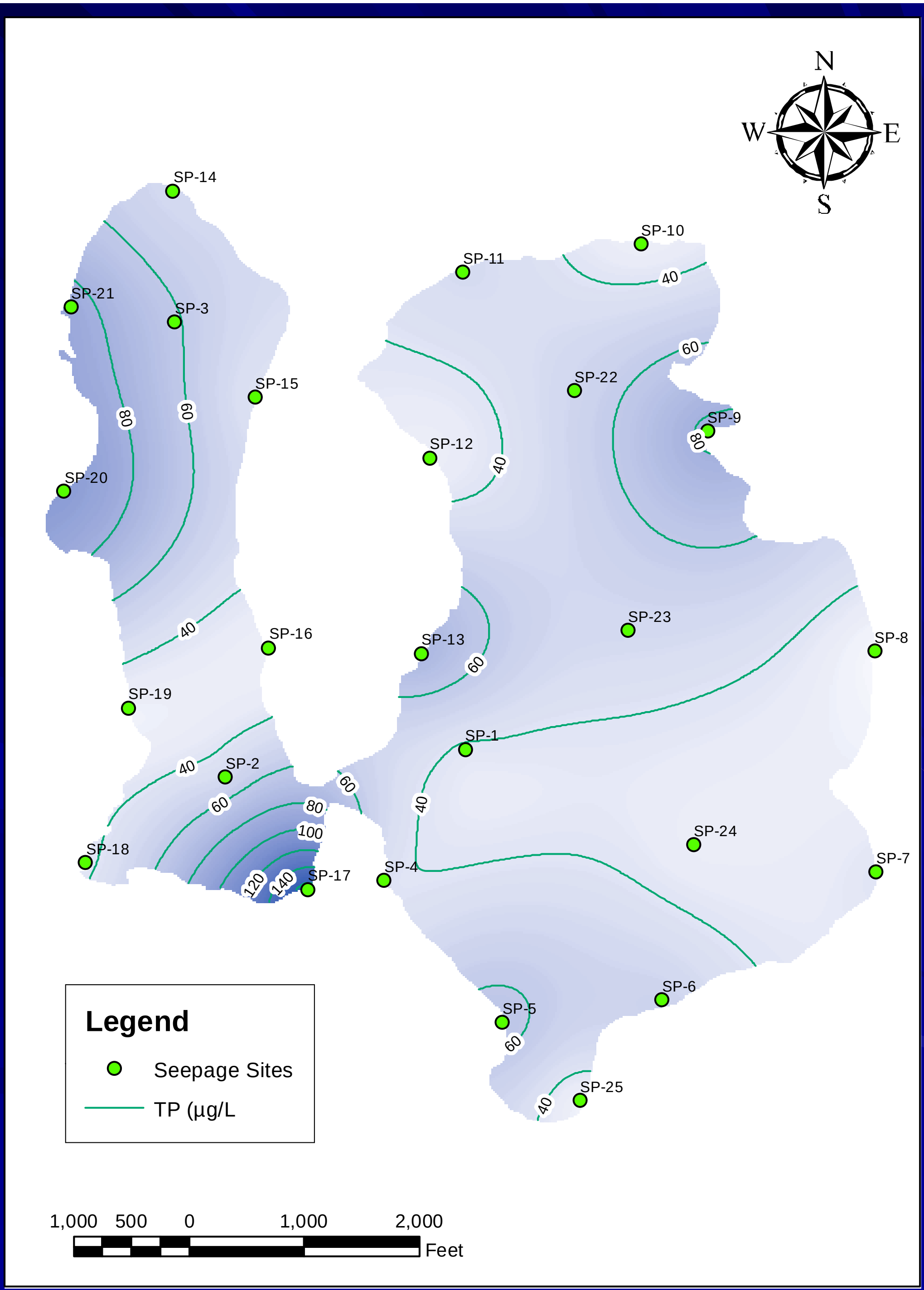




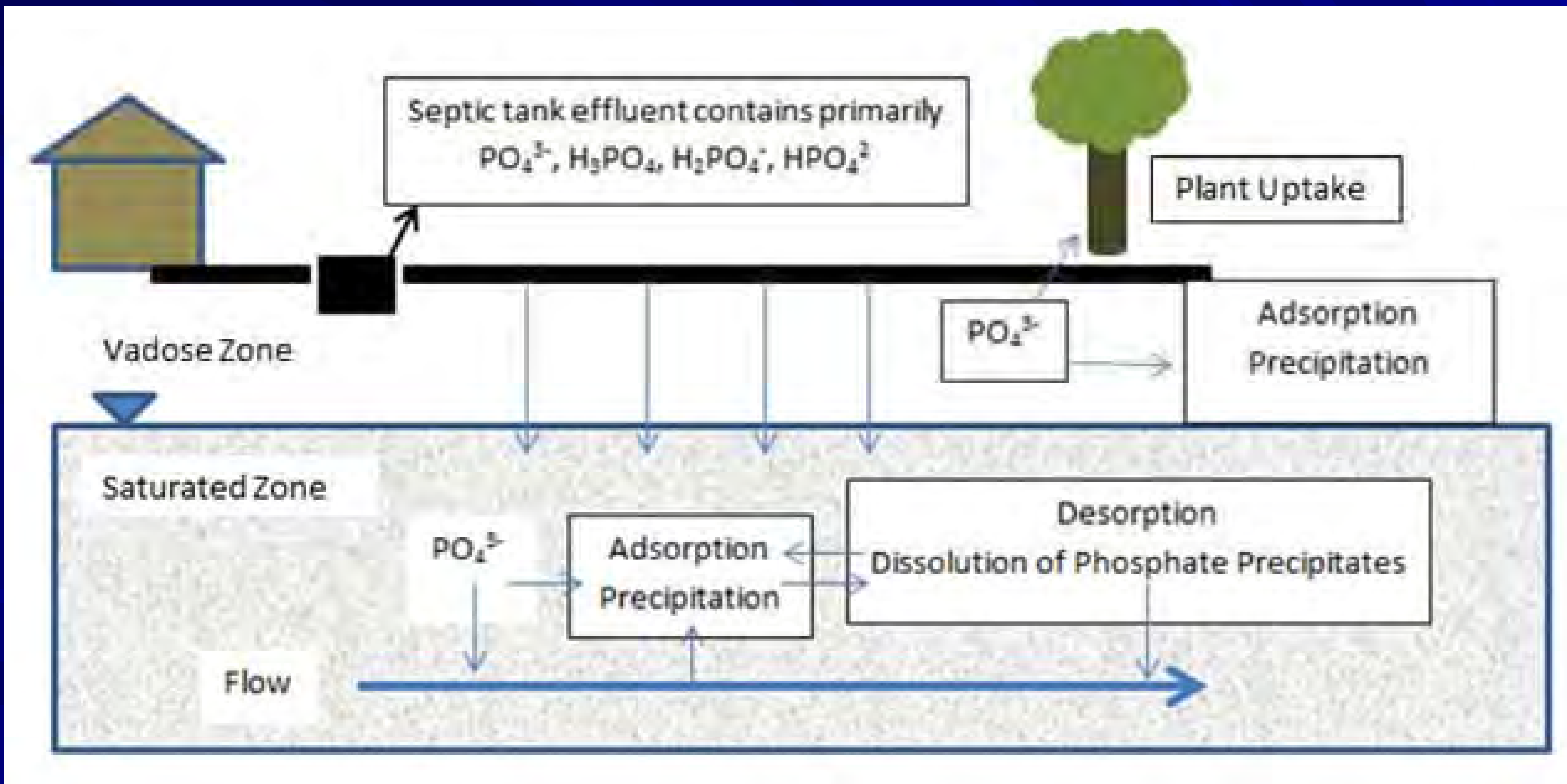


Isopleths of Mean Total Nitrogen Concentrations (µg/l) in Seepage Samples Collected from Lake Pickett from August 2015-August 2016

Isopleths of Mean Total Phosphorus Concentrations (µg/l) in Seepage Samples Collected from Lake Pickett from August 2015-August 2016



Overview of Phosphorus Movement and Uptake Mechanisms for Septic Tank Effluent



Estimated Loadings to Lake Pickett from Septic Tanks Under Future Development Conditions

Parameter	Units	Value	Reference
Number of Septic Tanks	--	1,366	Table 3-11
Total Nitrogen Loading	g/capita-day	11.2	UF/IFAS Pub. SL348
Total Phosphorus Loading	g/capita-day	2.7	UF/IFAS Pub. SL349
Number of Persons/Household	--	2.5	Assumption
Generated Total N Load	kg/yr	13,961	Calculation
Generated Total P	kg/yr	3,365	Calculation
Total Nitrogen Attenuation	%	50	UF/IFAS Pub. SL348
Total Phosphorus Attenuation	%	95	UF/IFAS Pub. SL349
Total N Loading to Lake Pickett	kg/yr	6,981	Calculation
Total P Loading to Lake Pickett	kg/yr	168	Calculation

Internal P Recycling

- Large diameter core samples collected at 4 sites in Spring Lake
- Core samples incubated under aerobic and anoxic conditions
  - Samples collected periodically and analyzed for P

Locations for Collection of Large Diameter Core Samples in Lake Pickett

Nutrient Budgets for Pre-, Current and Future Conditions

Total P

Source	Pre		Current		Future	
	kg/yr	% of Total	kg/yr	% of Total	kg/yr	% of Total
Precipitation	115	12	234	30	291	25
Runoff	137	14	69	9	123	10
Overland Flow	55.1	6	31.0	4	34.6	3
Tributary Inflows	361	36	119	16	228	19
GW Seepage	31.2	3	29.1	4	53.1	5
Septic Tanks	0	0	Included in seepage		168	14
Internal Recy.	280	29	280	37	280	24
Totals:	979	100	762	100	1,178	100

Total N

Source	Pre		Current		Future	
	kg/yr	% of Total	kg/yr	% of Total	kg/yr	% of Total
Precipitation	1,475	11	2,950	27	3,689	19
Runoff	1,524	12	998	9	1,462	7
Overland Flow	449	3	338	3	404	2
Tributary Inflows	5,458	42	2,483	23	2,729	14
GW Seepage	924	7	864	8	1,572	8
Septic Tanks	0	0	Included in seepage		6,981	34
Internal Recy.	3,247	25	3,247	30	3,247	16
Totals:	13,077	100	10,880	100	20,084	100

Comparison of Annual Areal Loadings of Nitrogen and Phosphorus to Lake Pickett

Condition	Area (acres)	Phosphorus Loading		Nitrogen Loading	
		kg/yr	g/m^2-yr	kg/yr	g/m^2-yr
Current	745	762	0.25	10,880	3.59
Pre-Development	745	979	0.32	13,077	4.34
Future	745	1,178	0.39	20,084	6.53

Permissible Loading Levels (Vollenweider, 1968) for Lakes up to 15 m Deep:

1. Phosphorus:
   a. Permissible: < 0.1 g/m^2-yr
   b. Dangerous: > 0.2 g/m^2-yr
2. Nitrogen:
   a. Permissible: < 1.5 g/m^2-yr
   b. Dangerous: > 3 g/m^2-yr

Management Philosophy

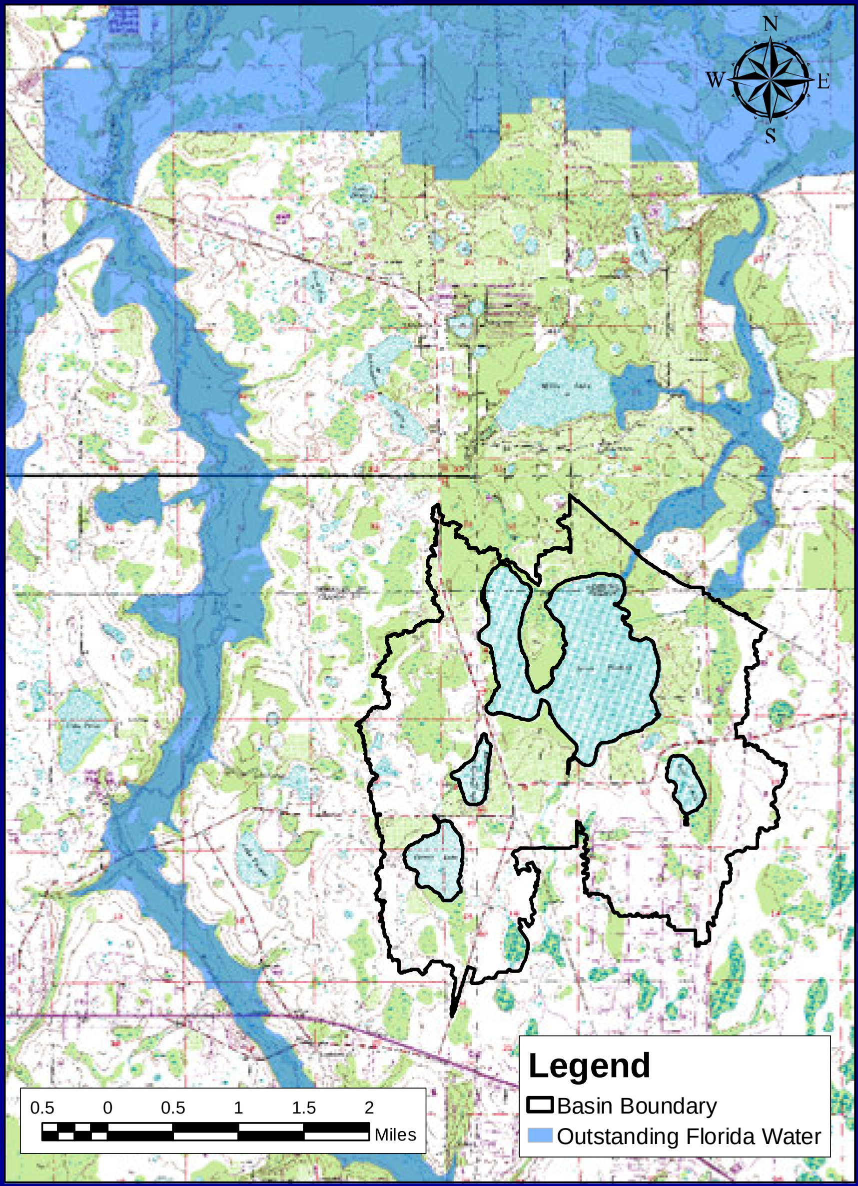
- Lake Pickett is a P limited oligotrophic lake and P loadings must be controlled to maintain or improve water quality
- Lake currently appears to be in a steady-state between P loading and plant uptake
- Water quality will begin to degrade when the equilibrium is broken with future development
- Management of P loadings should occur as necessary and emphasize significant inputs
- Smaller inputs should be managed as opportunities arise

1. OFW Designation

- Outstanding Florida Water (OFW)
  - Waters which are worthy of protection because of natural and unique attributes
  - Designation must be approved by FDEP and the Environmental Regulation Commission (ERC)
- Protections
  - Water quality standard becomes the water quality during the 12 month period prior to designation
  - A permit cannot be issued for a project that degrades water quality
    - Stormwater systems must be designed for post < pre loadings
    - All development must be “clearly in the public interest”
  - Lengthy process
    - Public notices and workshop required
    - Economic analysis required
    - Last designation was in 2003
  - Only option available to protect existing water quality

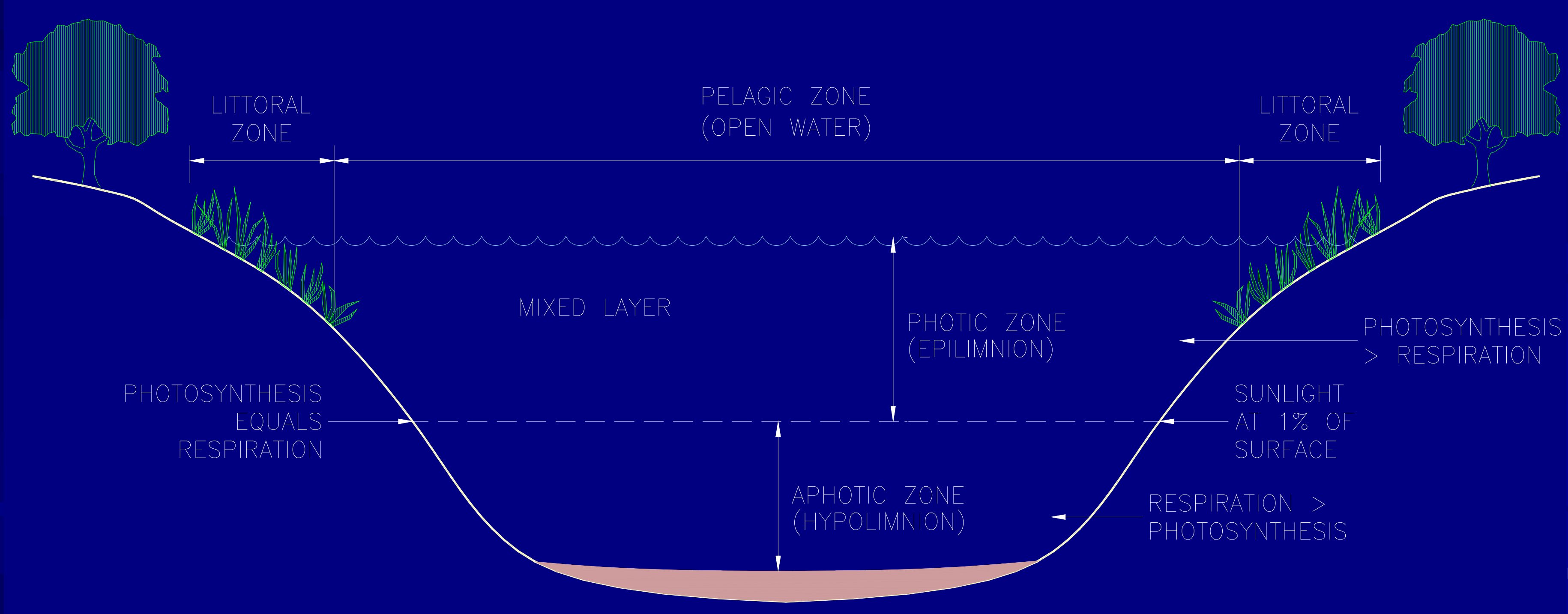
1. OFW Designation – cont.

- Econon River is an OFW
  - Current OFW designations extend from the River upstream into Mills Creek to Mills Lake
  - Silcox Branch to Lake Pickett
  - Southern portion of Mills Creek to Ft. Christmas Rd.



2. Sediment Inactivation

Vertical Zonation in a Lake



Internal Recycling

- Internal recycling contributes significant TP loadings to Lake Pickett

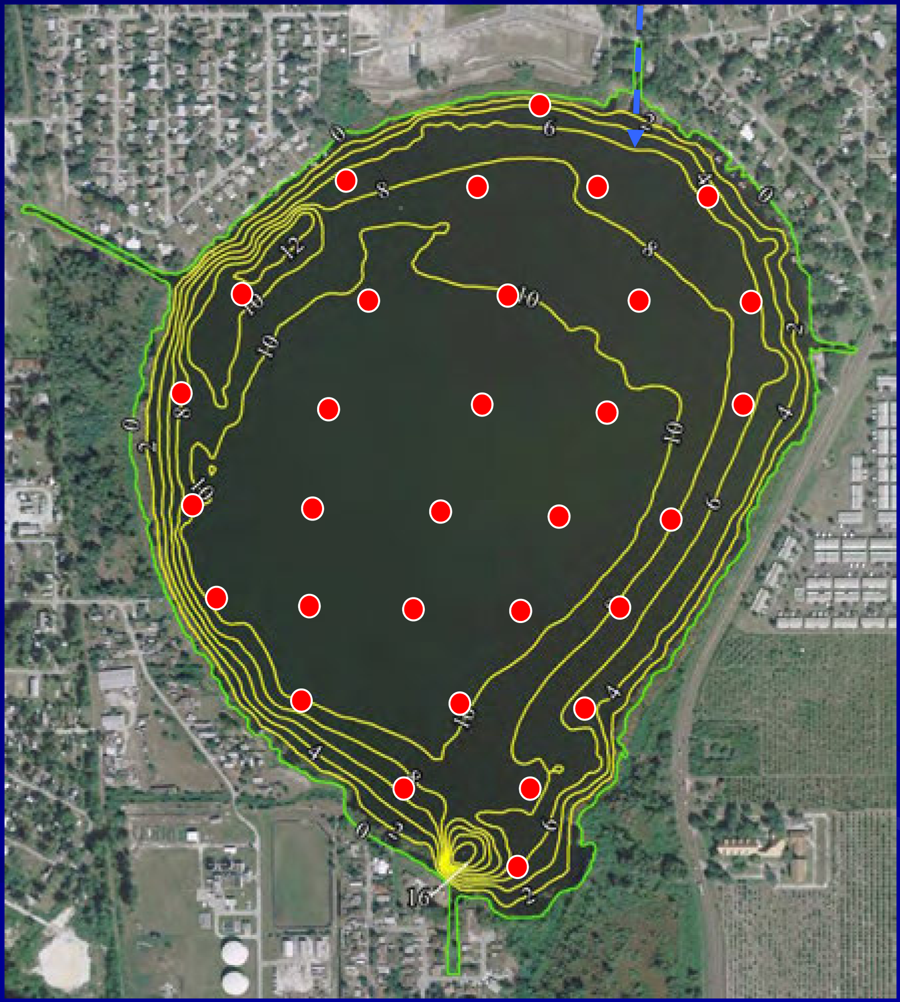
Source	Total P Load (kg/yr)	Percent of Total Loading (%)
Internal Recycling	280	37
Groundwater Seepage	29.1	4

- Control of internal recycling can be achieved by dredging or chemical inactivation using alum
- Dredging is generally prohibitively expensive
- Alum sediment inactivation can also treat inputs of TP from groundwater seepage
  - Equivalent to 41% of current TP loading to lake

Sediment Inactivation Dose Determination

- Sediment core samples collected throughout lake
- Top 10 cm sediment layer is collected and speciated for available sediment P
- Sediment P isopleth map developed and used as application guide

Typical sediment characteristics

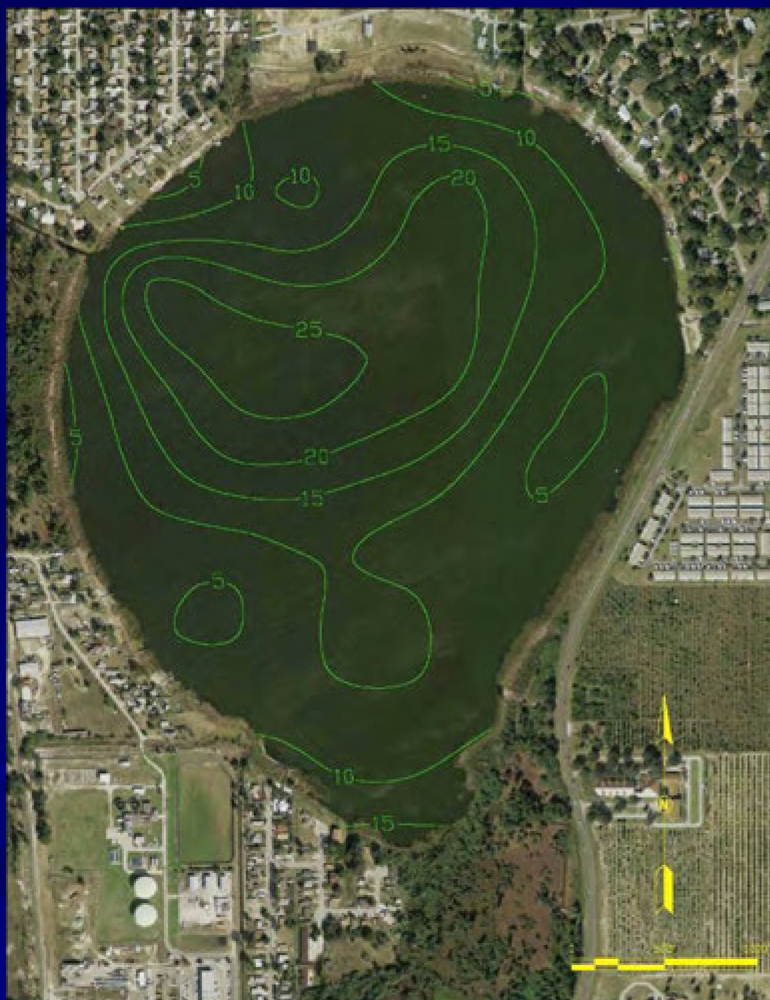


Water Depth Contours (ft)

Sediment Inactivation Dose Determination

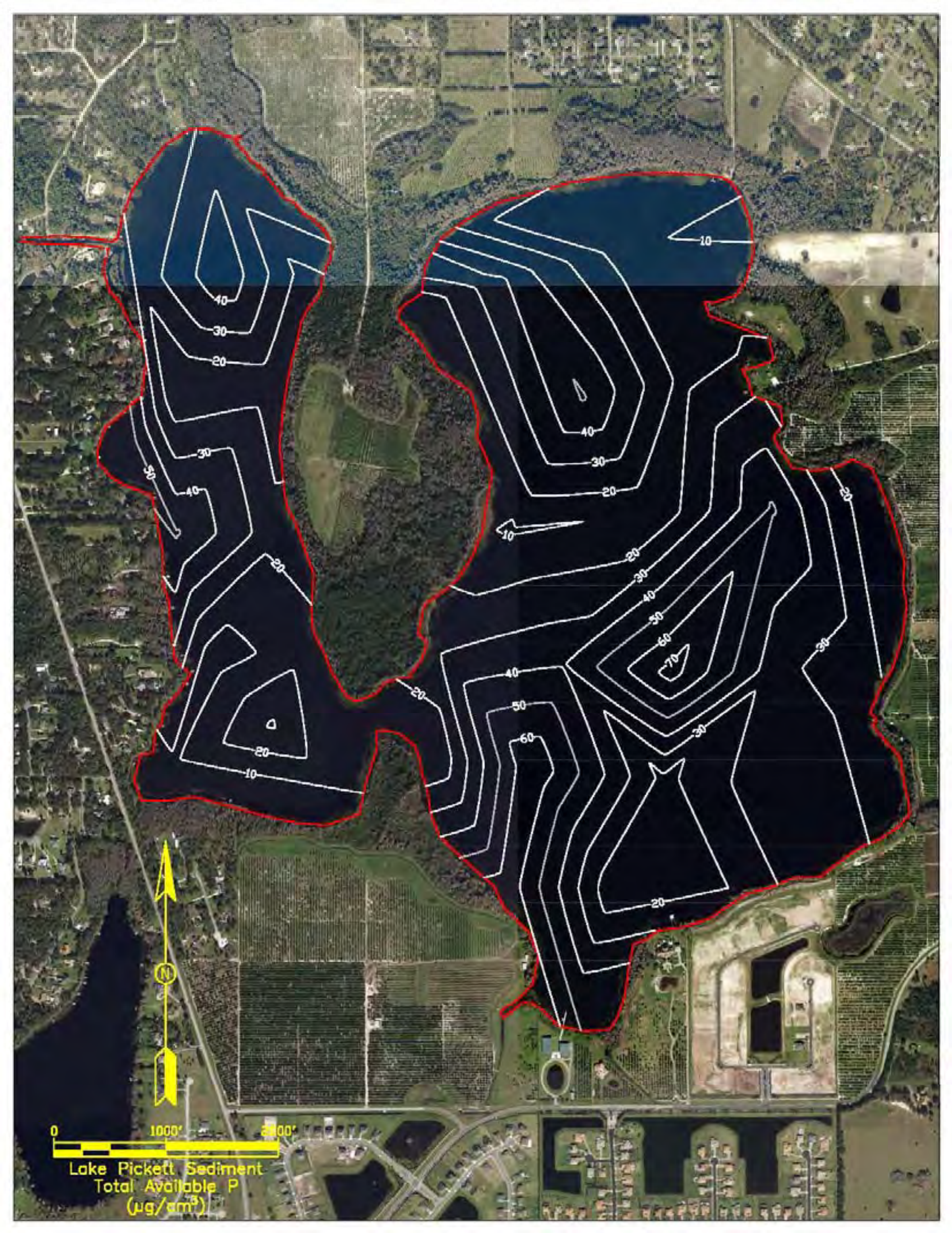
Available P Contours

(µg P/cm^3)



Application Map

- Each area contains the same amount of available P and receives equal amounts of alum



Isopleths of Total Available Phosphorus (µg/cm^3) in the Top 10 cm of Sediments in Lake Pickett During November 2015

Alum Application

- Alum dose calculated using a 15:1 Al:P ratio
- Alum applied in multiple applications spaced 6 months apart
- Alum applied based on available sediment P
- Isopleth map used as application guide
- Buoys set up on lake to mark areas receiving specific alum volumes
- Daily pre/post treatment vertical profiles and water samples collected

Estimated Application Costs for Sediment Inactivation and Control of Groundwater Seepage in Lake Pickett

(Based on 4 separate treatments)

Parameter		Quantity/ Treatment	Units	Unit Cost ($)	Cost Per Treatment ($)	Total Cost ($)
Chemical Costs	Alum	135,000	gallons	0.45[1]	60,750	243,000
	Lime	12,000	gallons	5.00	60,000	240,000
Labor Costs	Planning/Mobilization	1	each	5,000	5,000	20,000
	Chemical Application	30	tankers	1,500[2]	45,000	180,000
Monitoring/ Lab Testing	Field Monitoring	1	each	1,000	1,000	4,000
	Lab Analyses (pre/post)	16	samples	200	3,200	12,800
				Total:	$ 174,950	$ 699,800

1. Assumed contract cost
2. Includes raw labor, monitoring, insurance, expenses, application equipment, mileage, and rentals

3. Stormwater Management

- Significant runoff contributions of total P to Lake Pickett:

Sub-Basin	Total P Load (kg/yr)	Percent of Total Loading (%)
Louise Ditch	25.3	3.3
Drawdy Ditch	15.5	2.0
Pickett Ditch 1	11.2	1.5
Totals	52.0	6.8

- Stormwater contributes a small portion of the annual TP loading to Lake Pickett
- Runoff inflows are spread out over the 4,000+ acre watershed
- Any individual stormwater project would have negligible impact on water quality
- Stormwater projects should be undertaken as part of larger projects, as opportunities arise

4. Vegetated Shorelines

- A wide range of shoreline characteristics are present in Lake Pickett:
  - Natural vegetated shoreline
  - Planted vegetation
  - Cleared and bare shorelines

- Monitoring conducted by ERD has indicated that non-vegetated shorelines are susceptible to erosion and re-suspension of sediments, contributing to water quality degradation

- Shoreline vegetation provides many important functions, including:
  - Erosion control
  - Diverse habitats which can improve water quality

- Overland flow from rear yards contributes 4% of the annual TP loadings to the lake

5. Fertilizer and Landscape Activities

- Improper landscape maintenance activities have a potential for significant impacts to adjacent waterbodies:
  - Blowing grass clippings, leaves and other vegetation onto roadways
  - Improper application of fertilizers/pesticides

- Instances of improper landscaping activities were observed by ERD during this project

- Discharge of grass clippings and other landscaping wastes onto roadway surfaces or into stormsewers is a senseless and irresponsible practice

Landscape Activities Recommendations

- Improper applications of dry and wet fertilizers onto impervious surfaces occurs from both ignorance and carelessness
  - Many homeowners are not aware of impacts of improper practices on water quality
  - Educational programs can be used to inform citizens and businesses of impacts of improper practices
- Phosphorus containing fertilizers should be prohibited
  - Most soils do not need supplemental additions of P for plants
  - Restrict use of P fertilizers unless a soil test confirms actual need
  - Soil testing is available at agricultural extension offices

Landscape Activities

- Both Orange and Seminole Counties have adopted Fertilizer Ordinances that restrict the amount and timing of fertilizer applications
  - Both Orange and Seminole Counties prohibit application of P unless a soil test identifies a deficiency
  - Orange County – summer season ban (June-Sept), except for commercial applicators
  - Seminole – summer season ban (June-Sept)

- Both Counties have prohibitions on discharge of grass clippings and fertilizers onto impervious surfaces

- Both Counties have provisions for enforcement
  - Orange – written citations then fines ($50 and $100)
  - Seminole – “subject to any applicable civil enforcement mechanisms”

6. Source Control

- Source reduction programs have the potential to provide effective reductions in runoff concentrations

- The two most common source reduction methods are street sweeping and public educations

a. Street Sweeping

- Most applicable for paved streets having curbs and gutters, but can be used on any impervious surface
- Particularly applicable to urban built-out areas where space for conventional stormwater treatment is unavailable or too expensive
- Types of street sweepers:
  - Vacuum (plus mechanical)
    - Provides air vacuum over entire path with mechanical broom assist
    - Some particles do not receive sufficient agitation to become air-entrained
  - Regenerative Air
    - Air is forced down onto the pavement, suspending particles, which are then picked up by the vacuum

Estimated TSS Reduction from Street Sweeping (%)
(Residential Area)

Sweeper Type	Frequency of Sweeping			
	Monthly	Twice Monthly	Weekly	Twice Weekly
New Type Vacuum	51	63	79	87
Air Regenerative	43	53	65	71
Mechanical Brush Type	17	23	29	33

- More frequent street sweeping during periods of leaf fall
- ERD recommends that street sweeping be implemented with the residential areas surrounding Lake Pickett on a bi-weekly to monthly basis

b. Public Education

- Many homeowners are unaware of the relationship between their day to day activities and water pollution
- Educational programs can be effective in reducing Pointless Personal Pollution
  1. Relationship between land use, runoff, and pollutants
  2. Typical stormwater treatment systems
  3. How to reduce stormwater runoff volume
  4. Impacts of waterfowl and pets on runoff and surface water quality
  5. Stormwater program goals and regulations
  6. Responsible use of fertilizer, pesticides, and herbicides
  7. Elimination of illicit connections to stormwater system
  8. Controlling erosion and turbidity
  9. Proper operation and maintenance of stormwater systems
- Educational materials can be distributed in utility bills or mass mailouts
- Conduct educational seminars around the community

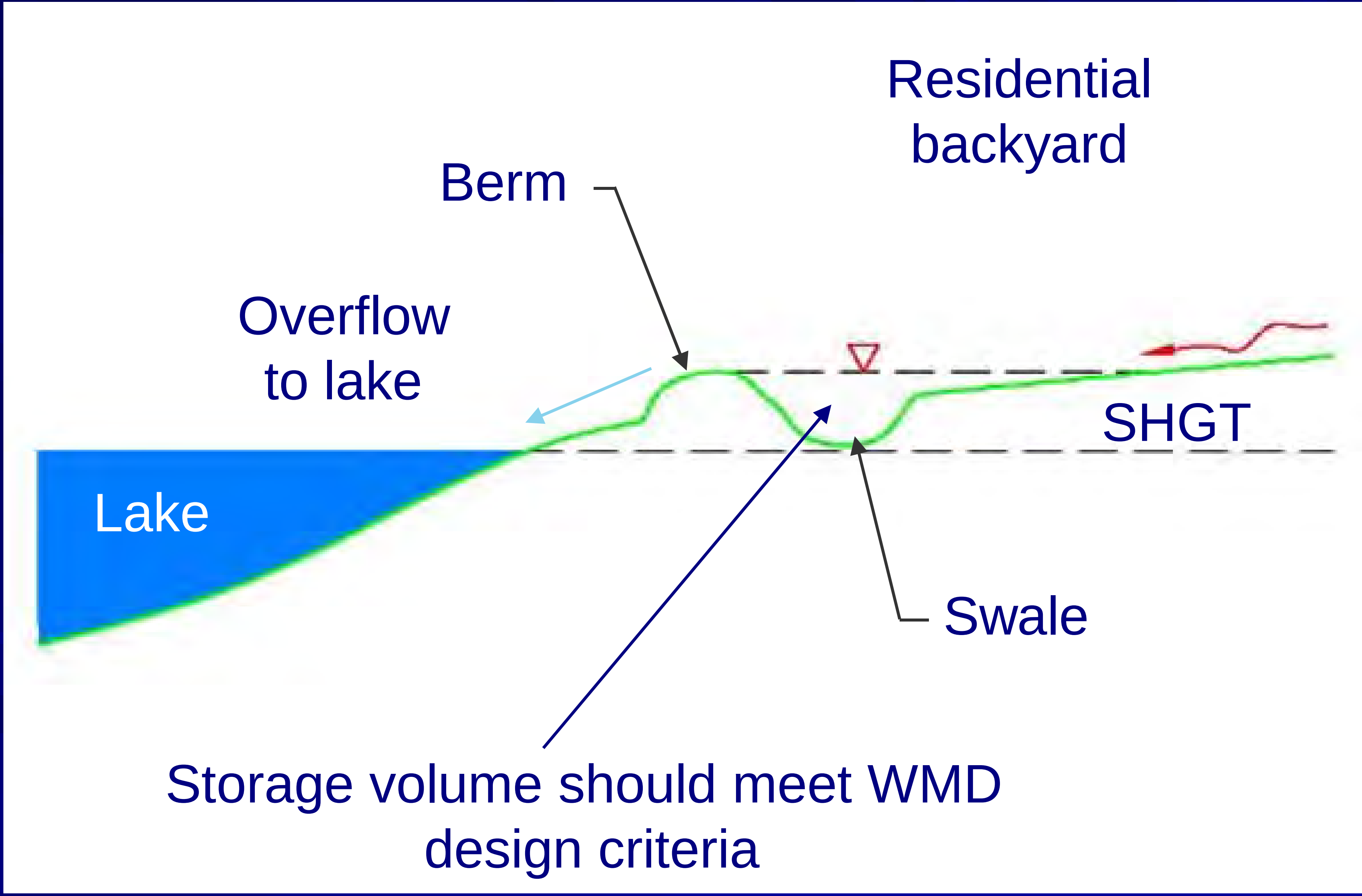
7. Direct Overland Flow

- Direct overland flow originates from the year yards of homes directly on Lake Pickett
  - In addition to nutrients, direct overland flow contributes pesticides and pet wastes to the lake
  - The number of lakefront homes is currently limited but is likely to increase over time

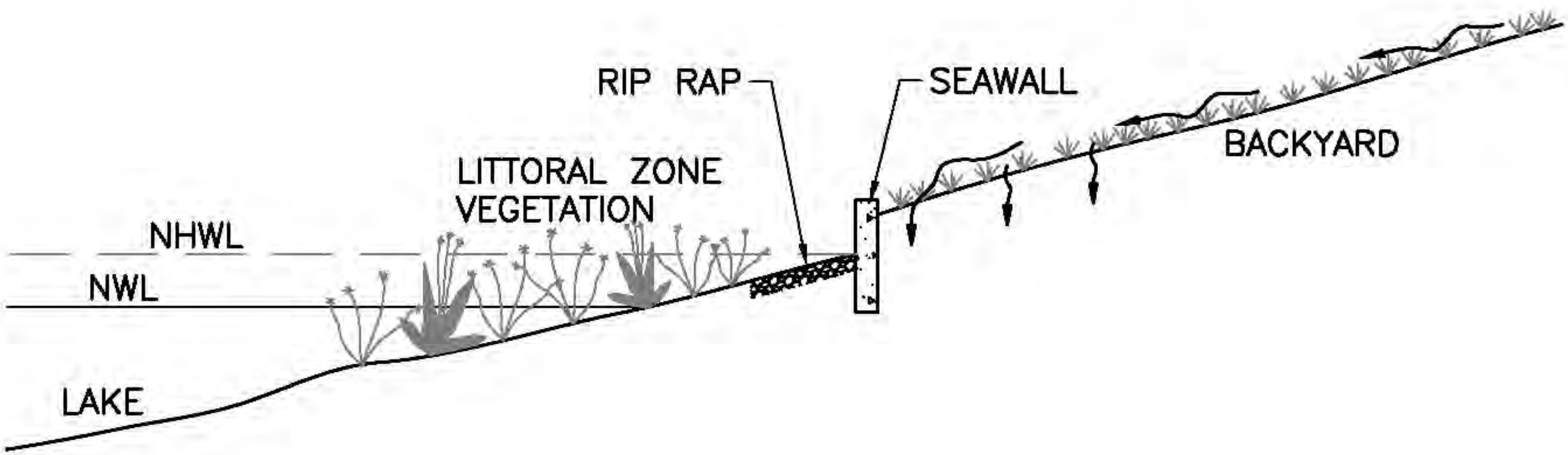
- Direct overland flow contributes 4% of annual phosphorus loadings to the lake
  - Exceeds phosphorus loadings from groundwater

- Best option for these areas is a rear yard berm and swale system

Schematic of Recommended Rear Yard Swale and Berm Design



Alternative Seawall Design Used as Rear Yard Berm



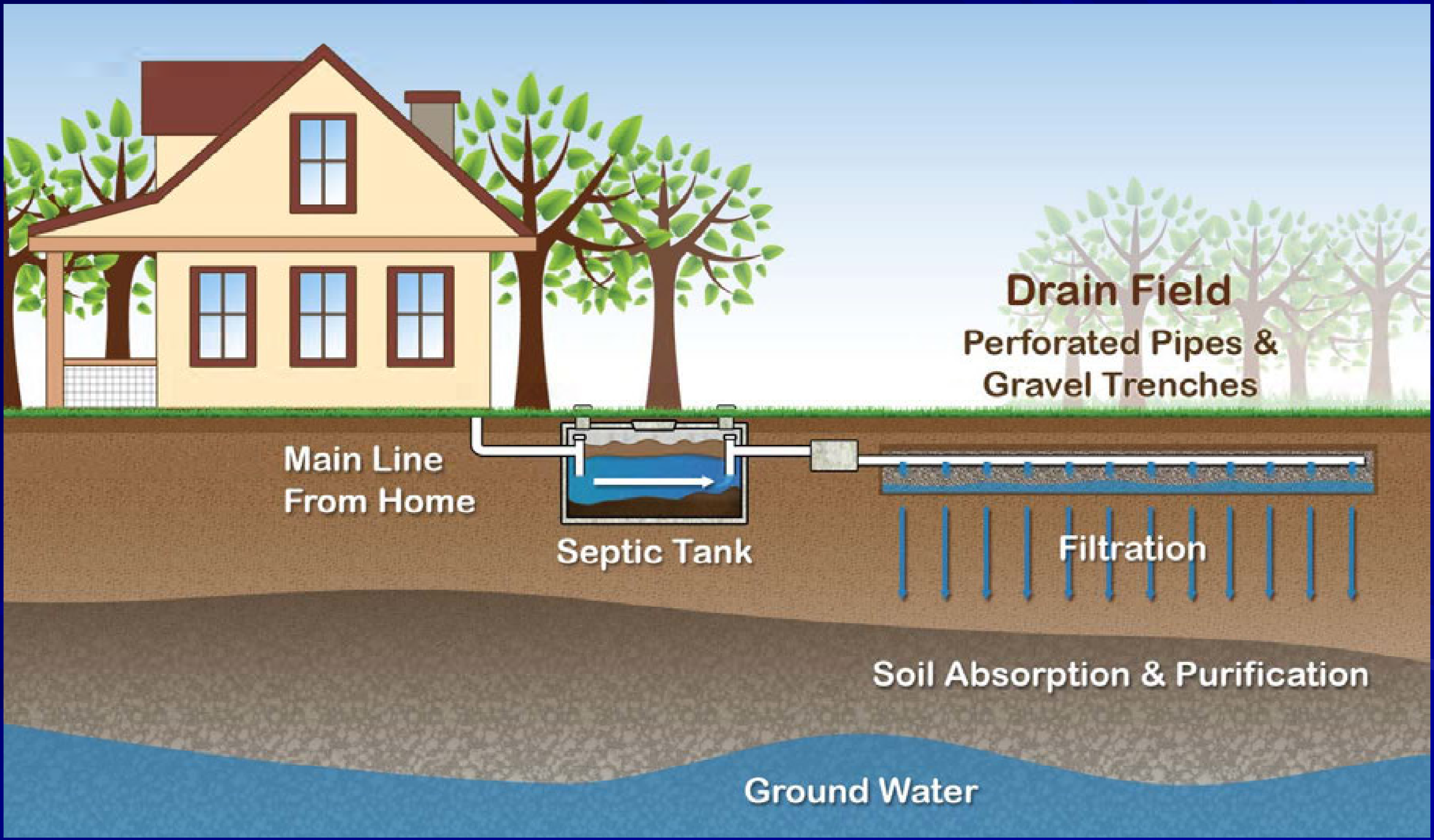
PROPOSED ALTERNATIVE SEAWALL DESIGN

8. Septic Tanks

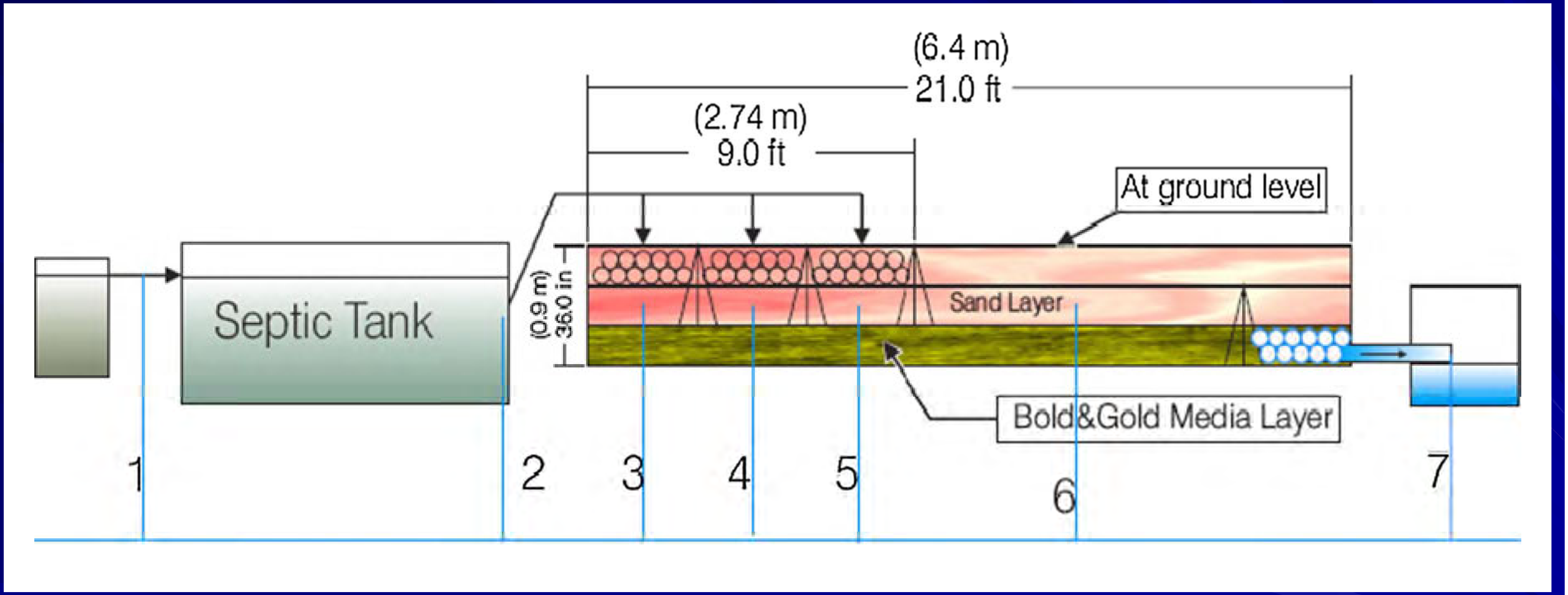
- Future development will add a minimum of hundreds of new septic tanks to the Lake Pickett basin

- Depending on the pattern of development, septic tanks may add an additional 100-150 kg TP/yr to Lake Pickett
  - 10-14% of annual TP load to the lake

Overview of a Conventional Septic Tank System



Septic Tank Modification with Bold and Gold Media



Comparison of Untreated and Treated (B&G) Leachate Effluent Concentrations

Parameter	Units	Conventional Drain Field Control	Conventional Drain Field With Recirculation	Bold And Gold Media Filter
Nitrate-N	µg/l	42,000	14,900	3,150 (-93%)
Total Nitrogen	µg/l	48,100	18,200	12,900 (-73%)
SRP	µg/l	4,580	3,070	1,000 (-80%)
Total Phosphorus	µg/l	4,920	3,880	1,380 (-70)

- Addition of B&G media to future septic tanks would reduce additional septic tank loadings to Lake Pickett by 70%
- For assumed built-out conditions
  - Reduce TP load from 168 kg/yr to 50 kg/yr

Cost Comparison of Conventional Septic Tank Systems with a Bold and Gold Media Modified System Based on a 500-gpd Flow

System Technology	Construction Cost In 2009 ($)	Annualized Construction Cost At 6% Interest Rate and 20 Years ($)	Annual Operating Cost ($)	Unit Cost ($/1000 Gallons)
Conventional OSTDS	5,770	500	200	3.84
Bold and Gold Filter Media and Drain Field	8,370	725	200	5.07

9. Boating Impacts

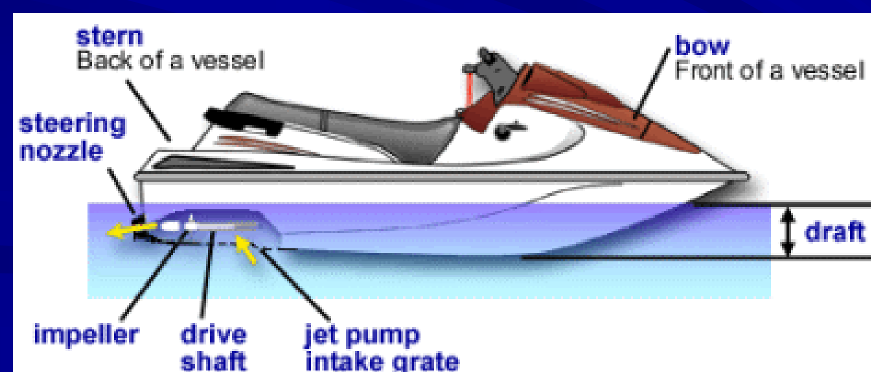
Lake Pickett is used for recreational boating activities such as wake boarding and skiing

Personal Watercraft

- Propulsion jet exits close to the water surface in focused stream

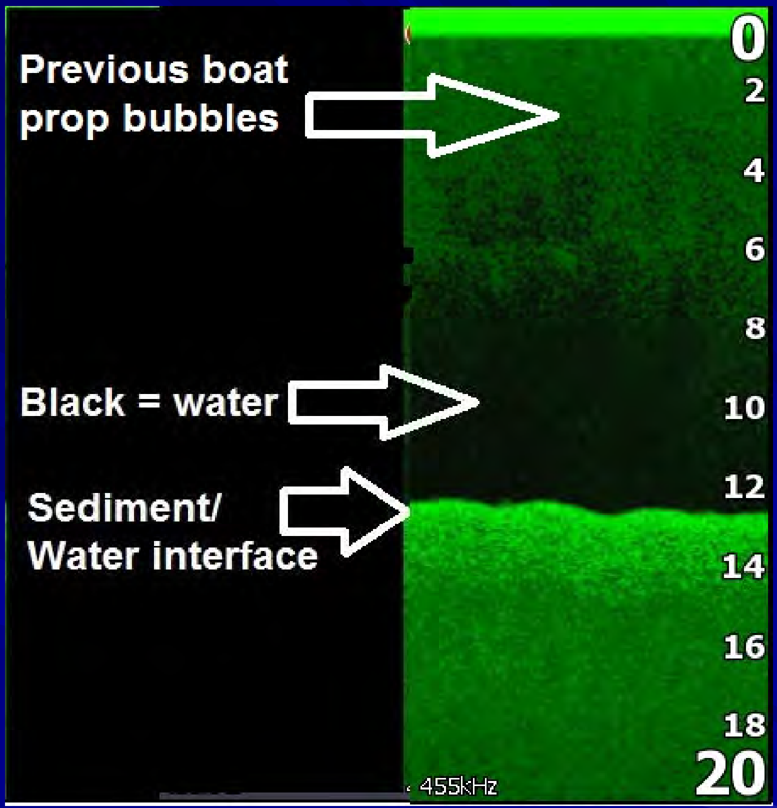
- Maximum energy input occurs within top 1-2 ft of water column

- Generates minimum wake



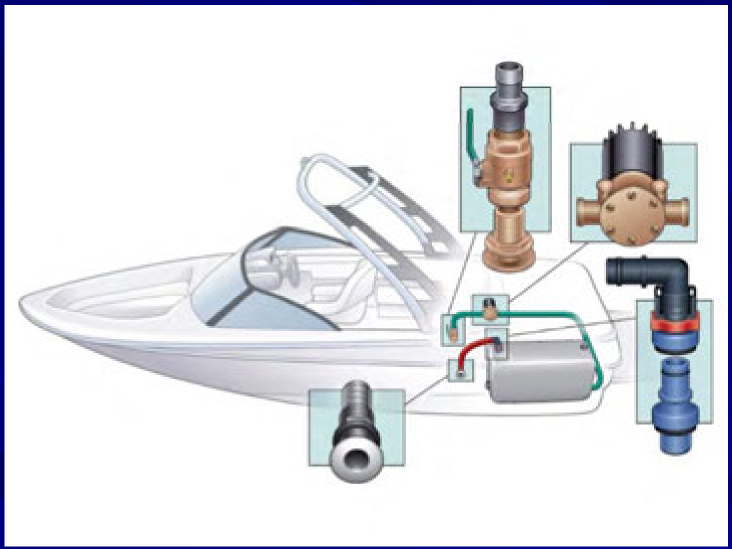
Traditional Watercraft

- When on plane, the boat rises up, lifting the motor and reducing prop depth
- Generates moderate wake



- Water disturbance limited to top 10 ft.

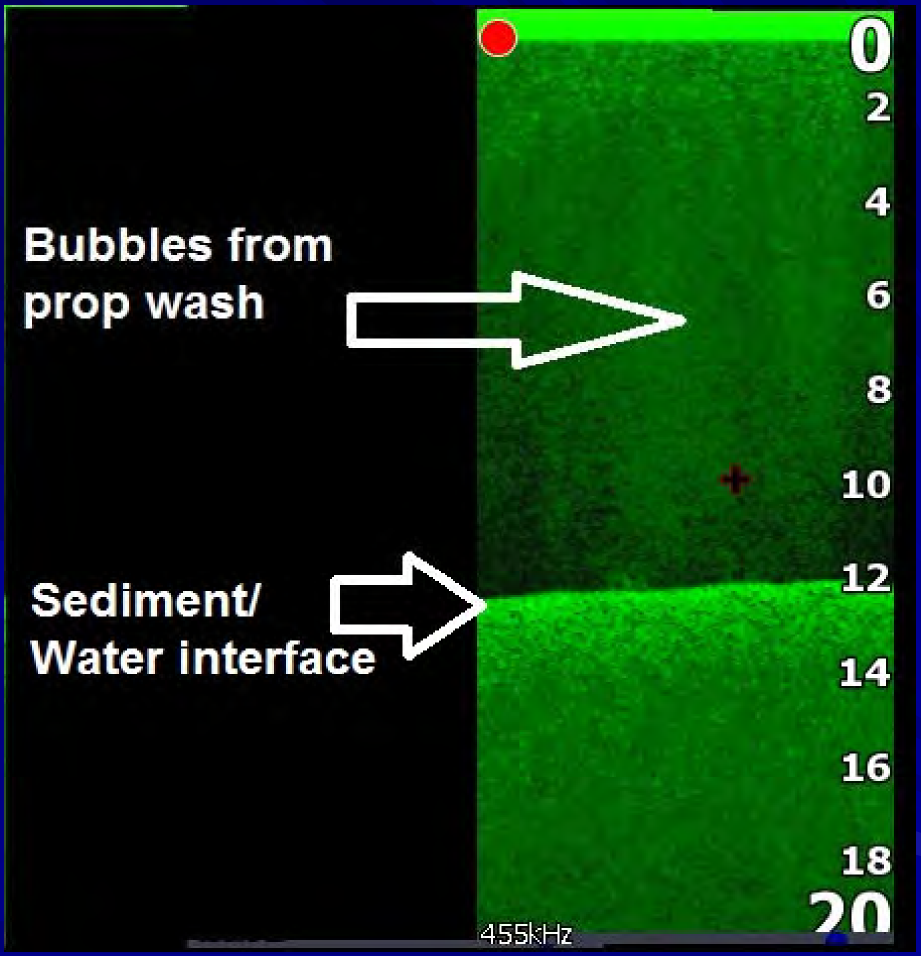
Enhanced Wake Watercraft



- Use water ballast to push rear of boat into the water which lowers the prop
  - Propulsion drives rear of boat farther into the water
    - Generates extreme wake

Enhanced Wake Watercraft – cont.

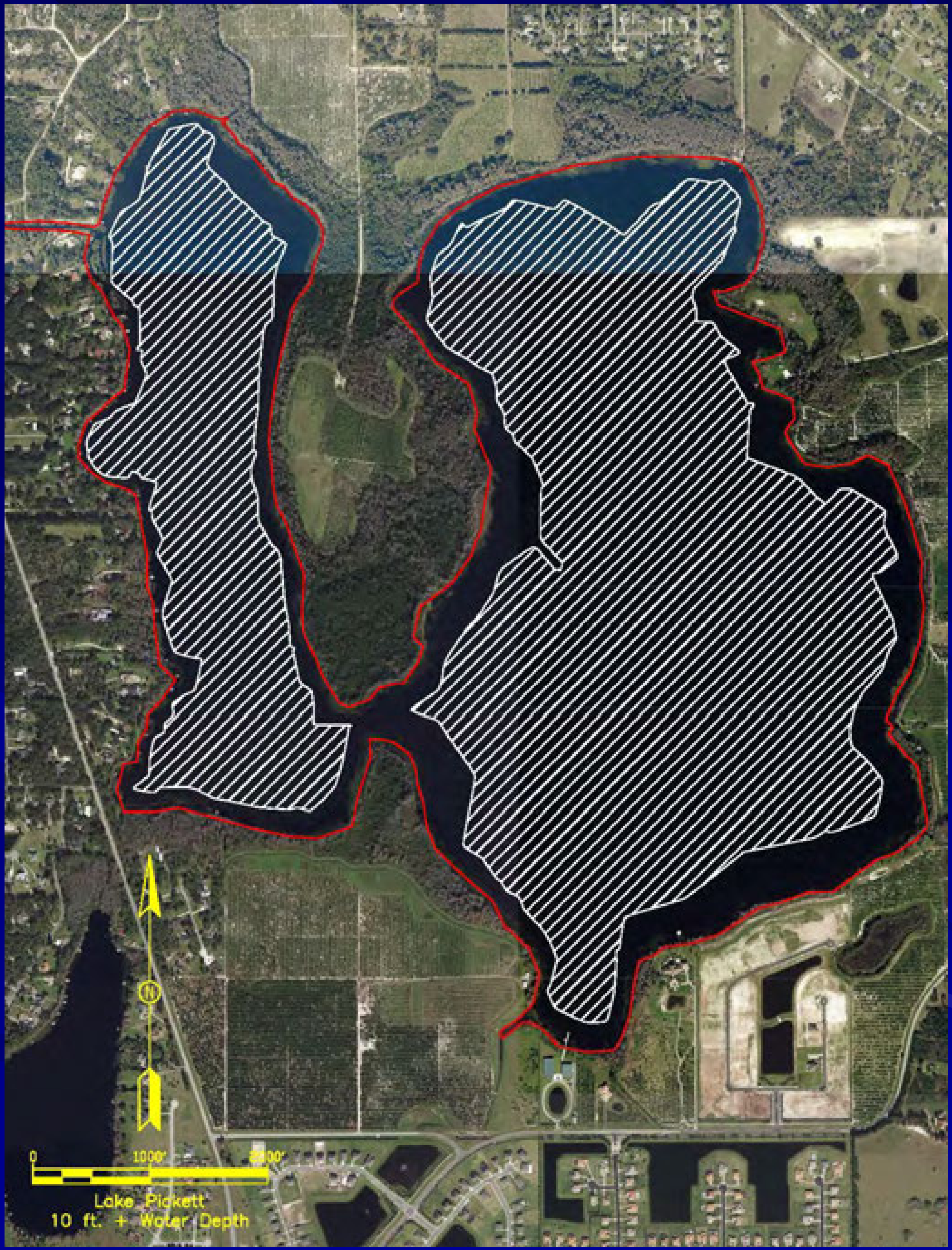
- Water disturbance extends well into the water column
- Energy waves extend to 10 – 15 ft. or more
- Capable of disturbing sediments and releasing pore water

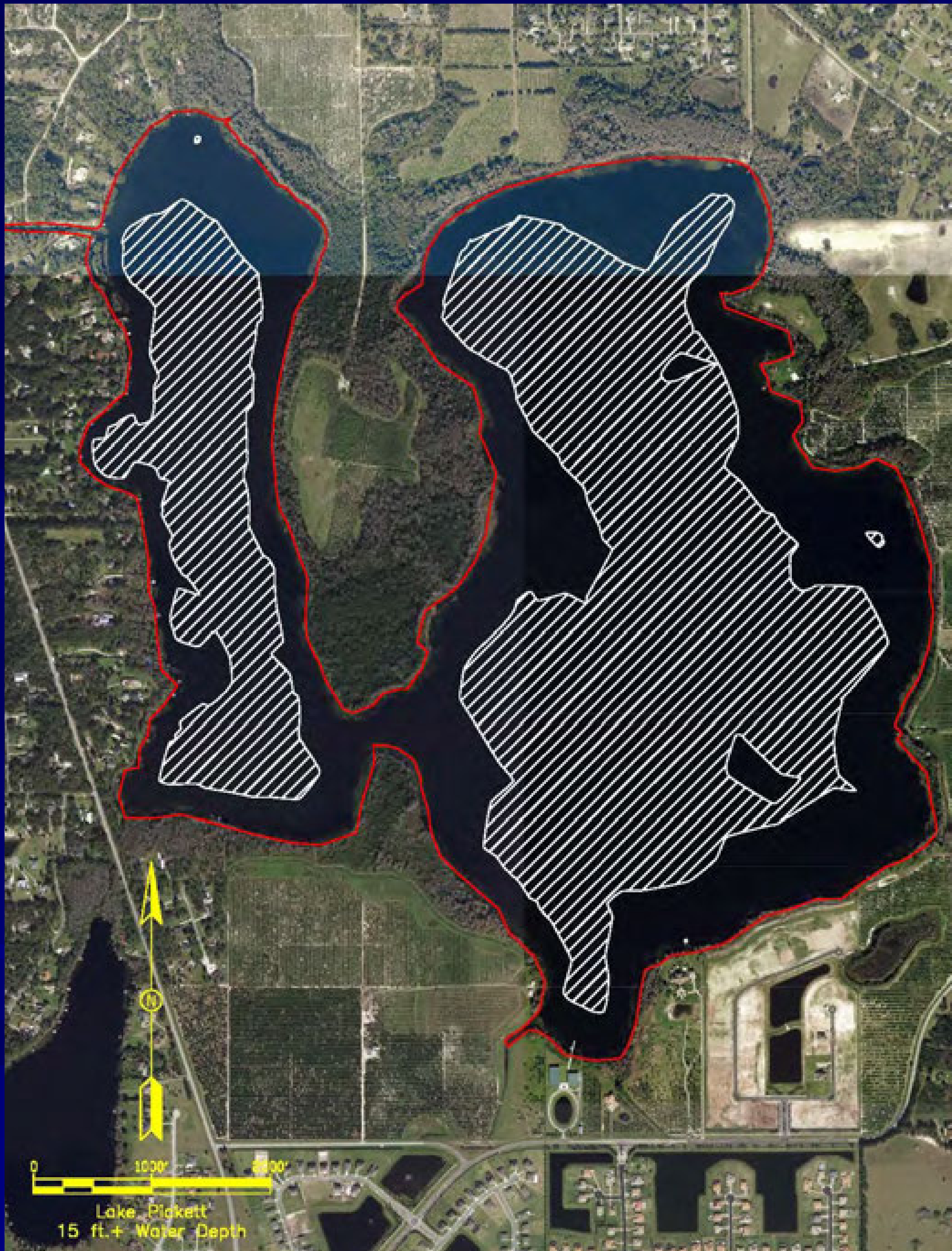


Boating Recommendations

- Studies have indicated that boating activities can disturb bottom sediments to a water depth of 10-15 feet
- Normal boating activities should be restricted to water depths of 10 feet or more
  - Idle speed zones should be established in areas > 10 feet
  - deep
- Normal operation for boats designed for enhanced wake should be restricted to water depths of 15 feet or more

Areas of Lake Pickett with Water Depths > 10 ft





Areas of Lake Pickett with Water Depths > 15 ft

10. Tributary Inflows

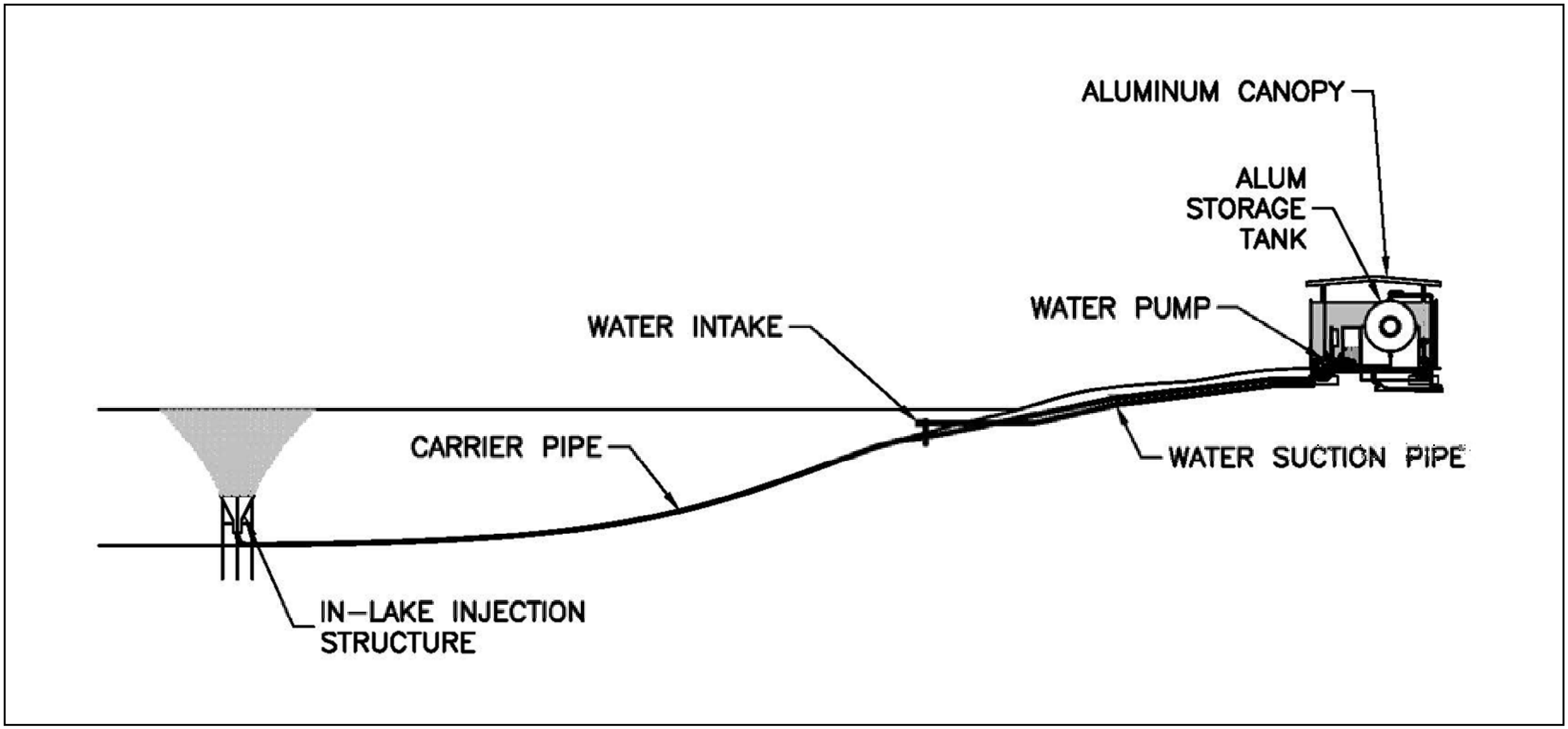
- Tributary inflow contributions of total P Lake Pickett (current conditions):

Tributary	Total P Load (kg/yr)			Percent of total load[1] (%)
	Runoff	Baseflow	Total	
Drawdy Ditch	15.5	58	73.5	10
Louise Ditch	25.3	43	68.3	9
Totals:	40.8	101	142	19

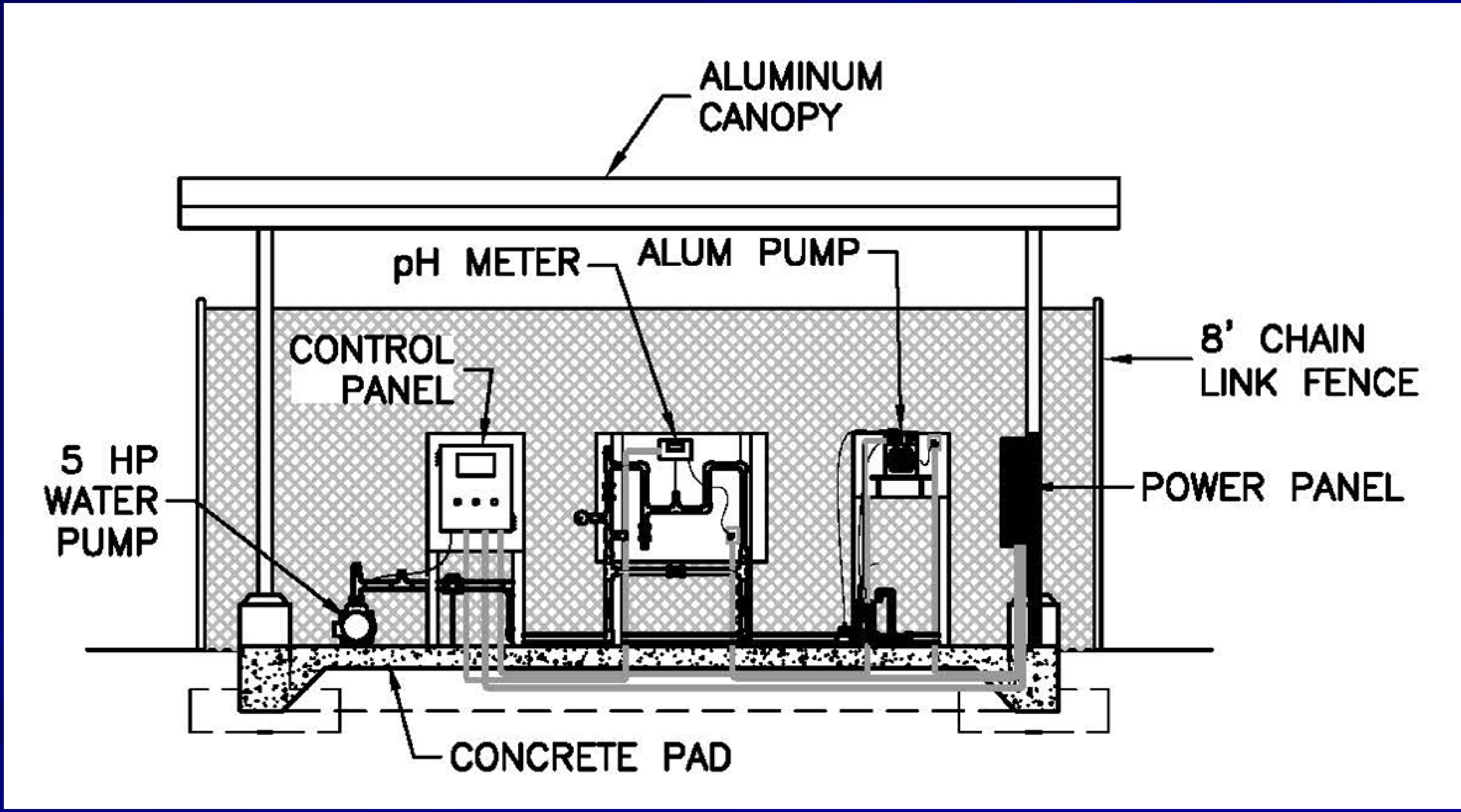
1. Total annual TP load = 762 kg/yr

- Tributary loadings equal to about 50% of internal recycling load
- Inflows are colored and contain moderate TP concentrations

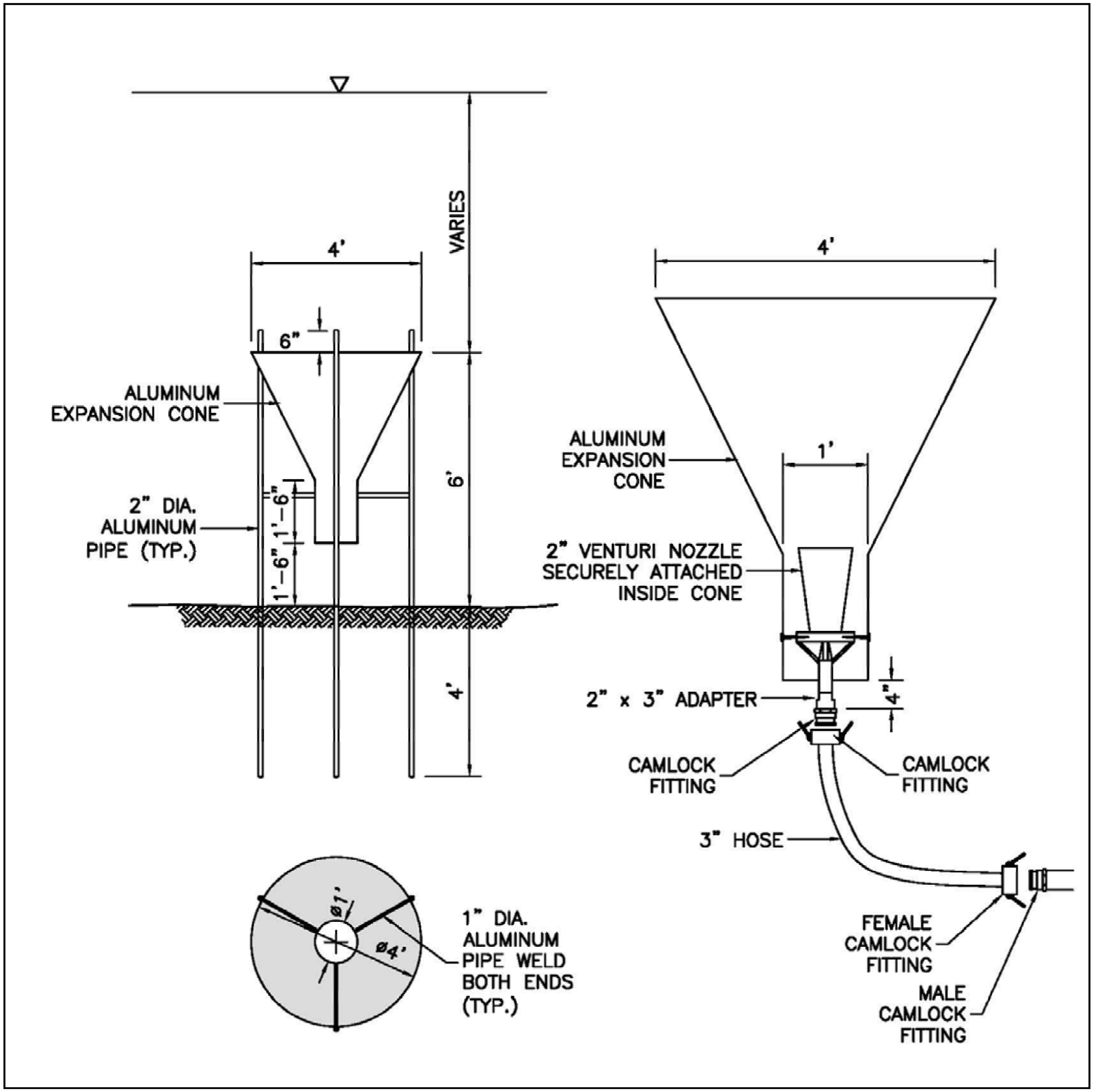
Overall Schematic of the In-Lake Alum Addition System



System Components and Controls for the In-Lake Alum Addition System



Schematic of the In-Lake Alum Injection Structure



Estimated Design and Construction Costs for the In-Lake Alum Addition System

Parameter	Estimated Cost Per System[1]
Engineering Design	$ 65,000
Construction Cost	$ 275,000
Total:	$ 340,000

1. Assumes that land purchase is not necessary

Estimated Alum Use and Costs for the Lake Drawdy In-Lake Treatment System

Parameter		Units	Value	Reference
Lake Area		acres	52.1	Orange County Water Atlas
Lake Volume		ac-ft	729	Orange County Water Atlas
Assumed Alum Addition Dose		mg Al/liter	5.0	Estimate
Assumed Volume Treated		ac-ft	502	Annual lake inflow
Alum Addition per Year		gallons	12,794	Calculation
Alum Cost:	Unit Cost	$/gallon	0.55	Current contract price
	Annual Cost	$	7,037	
Floc Generation Rate		%	0.1	Percent of treated water volume
Floc Volume		ac-ft/yr	0.50	Calculation
Assumed Settling Area		acres	26	50% of lake area
Floc Accumulation Rate		inches/year	0.23	Calculation

Estimated Alum Use and Costs for the Lake Louise In-Lake Treatment System

Parameter		Units	Value	Reference
Lake Area		acres	54.5	Orange County Water Atlas
Lake Volume		ac-ft	764	Orange County Water Atlas
Assumed Alum Addition Dose		mg Al/liter	5.0	Estimate
Assumed Volume Treated		ac-ft	366	Annual lake inflow
Alum Addition per Year		gallons	9,345	Calculation
Alum Cost:	Unit Cost	$/gallon	0.55	Current contract price
	Annual Cost	$	5,140	
Floc Generation Rate		%	0.1	Percent of treated water volume
Floc Volume		ac-ft/yr	0.37	Calculation
Assumed Settling Area		acres	27	50% of lake area
Floc Accumulation Rate		inches/year	0.16	Calculation

Recommended Management Options
(in order of recommended implementation)

Implementation Order	Management Option	Implementation Time	Relative Cost
1	Designation of Lake Pickett as an OFW a. Submit application to FDEP	ASAP	Low
2	Vegetated Shorelines a. Maintain existing clearing restrictions b. Monitor shorelines for compliance c. Maintain existing management program	ASAP	Low
3	Landscape/Fertilizer Activities a. Attempt to restrict phosphorus application in Orange County b. Enhance enforcement of current Fertilizer Ordinance	ASAP	Low
4	Public Education a. Public education programs should be initiated for residents in Lake Pickett watershed	ASAP	Low
5	Berms and Swales a. Construct berms and swales for existing lakefront lots b. Ensure that new development incorporates berms and swales	Within 12 Months	$500 – 3,000 per lot
6	Septic Tanks a. Require that future septic tanks include adsorption media b. Retrofit existing septic tanks with media when replaced	Within 12 Months	$3,000 – 5,000 per lot
7	Boating Activities a. Restrict motor boating to water depths of 10 ft b. Restrict wake boats to water depths of 15 ft	Within 12 Months	None
8	Tributary Inflow Treatment a. Construct alum addition systems in Lake Drawdy and Lake Louise	As Needed	$335,000-670,000
9	Sediment Inactivation	As Needed	$700,000

Questions?