Preliminary Nitrogen Source Inventory and Loading to Ground Water, Silver Springs BMAP Area

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Sources of Nitrogen in BMAP area

- **Atmospheric Deposition**

- **Fertilizers (cropland, pasture, turfgrass)**



- **Land application of treated wastewater/ biosolids**

- **Septic Tanks**

- **Animal wastes**


- **Stormwater runoff**

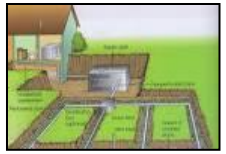
Estimating Nitrogen Loads to Ground Water

Process:

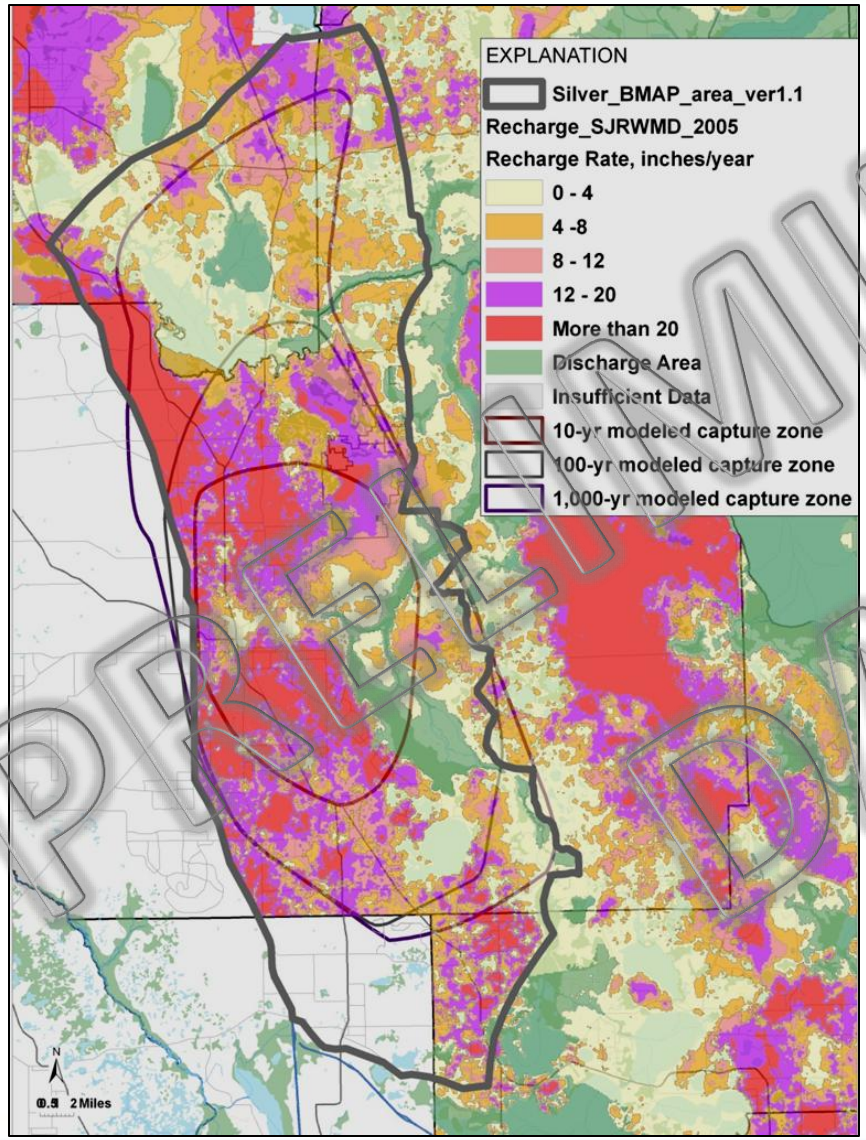
1. Estimate the inputs of nitrogen to the land surface from the source inventory information (a work in progress).
2. Apply attenuation factors based on the various environmental processes that could transform the various forms of nitrogen in the subsurface (such as denitrification, nitrification of ammonia, uptake by vegetation, mineralization of organic nitrogen).
3. Apply an areal weighting factor that is based on the rate of recharge to ground water to get nitrogen loads to ground water.
4. Account for proximity of N source to spring. Fine-tune estimates after getting feedback from stakeholders.








UFA Recharge Rates in Silver Springs BMAP Area



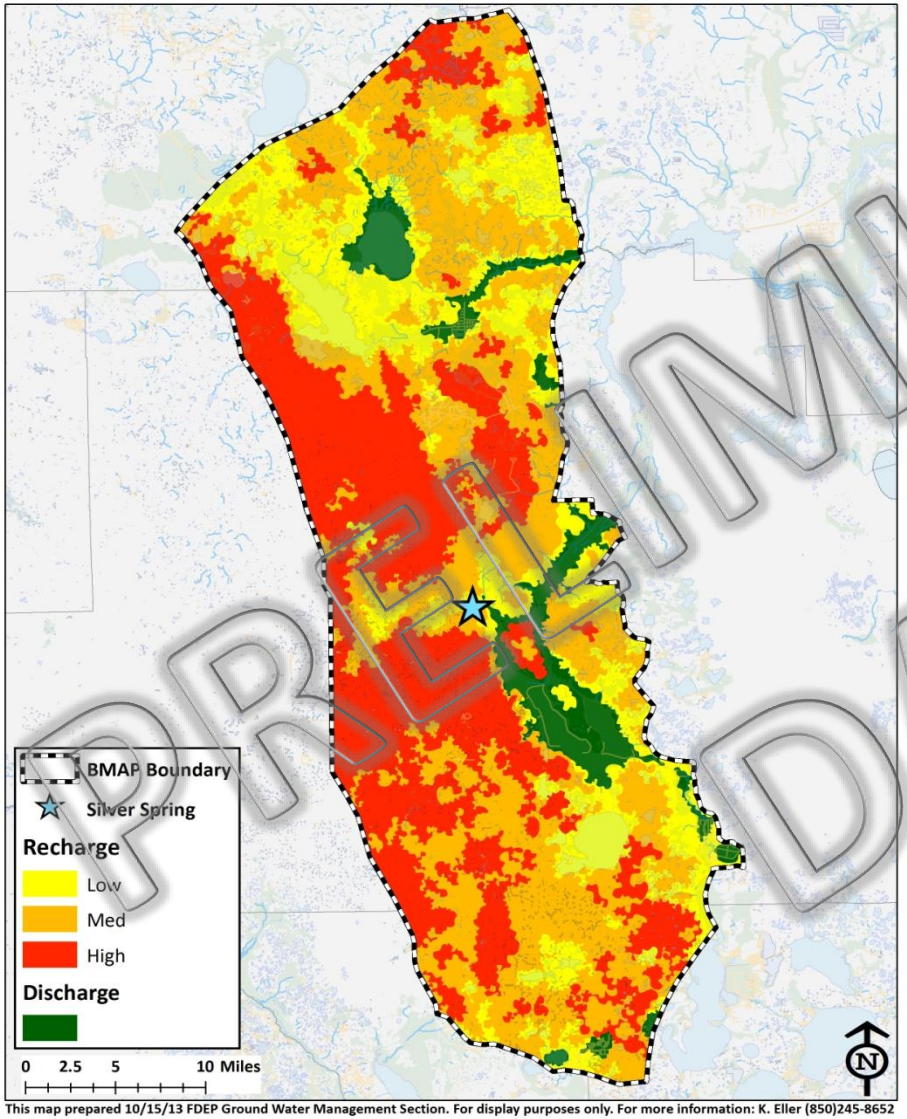
Recharge rates to the Floridan aquifer (SJRWMD)

Rates are based on rainfall, evapotranspiration, the hydraulic pressure difference between the surficial aquifer and the Floridan aquifer, and the leakance properties of the confining unit separating the surficial and Floridan aquifers.

Note the high recharge values surrounding Silver Springs Group on the north, northeast, and southwest of the springs.

Most of the highest recharge values occur in the 10-year capture zone for Silver Springs that delineates an area of high aquifer vulnerability .

Recharge Weighting Factors



Recharge weighting factors for estimating N inputs to the subsurface for three recharge categories:

- 0.1---Low (<= 4 in/yr)
- 0.5---Medium (4-12 in/yr)
- 0.9---High (>12 in/yr)

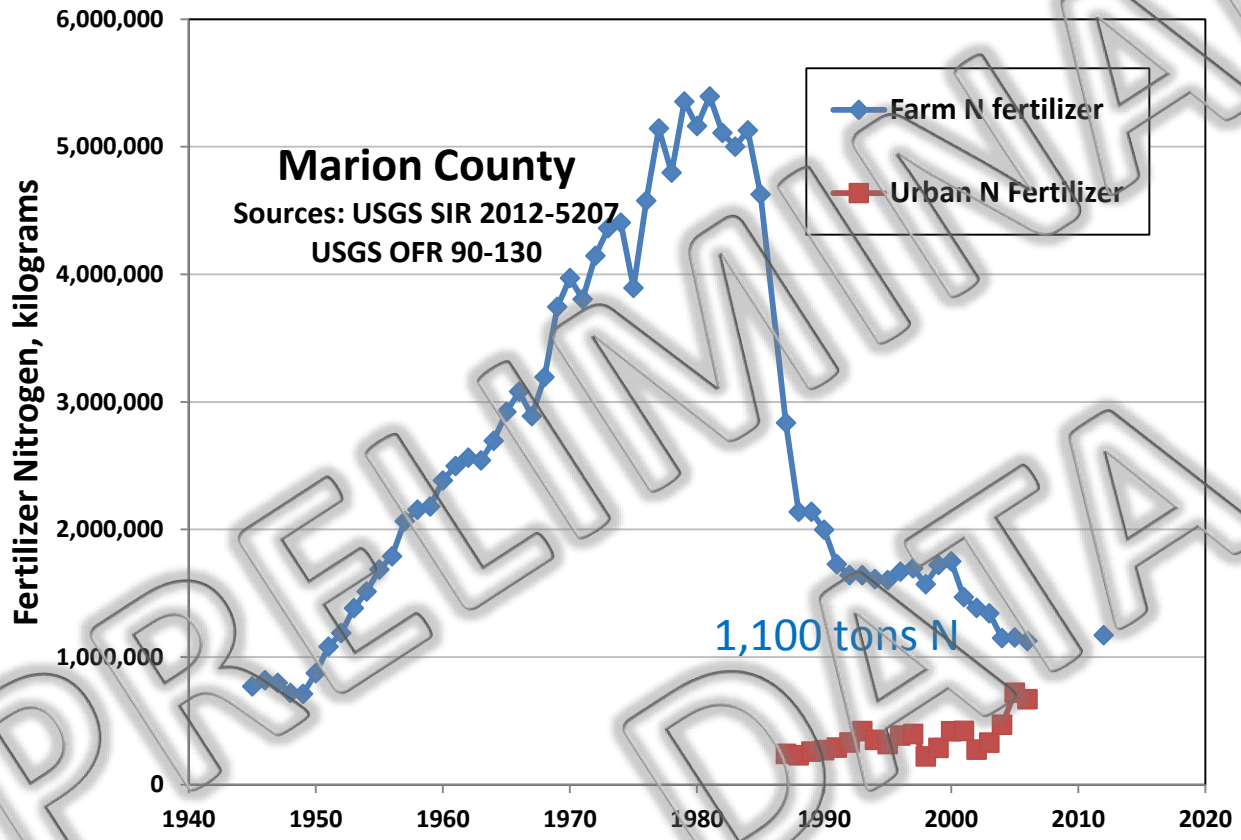
Nitrogen Attenuation Factors

Nitrogen attenuation factors used to estimate loads to ground water.

These factors represent the percentage of nitrogen removed by various environmental processes.

Nitrogen Source Category	Attenuation Factor	References
Atmospheric Deposition	90%	Katz et al 2009; HT Odum Florida Springs Institute 2011; Lombardo Associates, 2011
WWTF	60%	Katz et al 2009; HT Odum Florida Springs Institute 2011; Lombardo Associates, 2011
Septic Tanks	45%	Otis 2007; Katz et al . 2010; Lombardo Associates, 2011
Farm Fertilizers	70%	Goolsby et al 1999; Katz et al 2009; HT Odum Florida Springs Institute 2011
Urban Fertilizers	80%	Goolsby et al 1999; Katz et al 2009; HT Odum Florida Springs Institute 2011
Livestock Waste	80%	Oenema 2006; Goolsby et al 1999; Katz et al 1999, 2009; Baton et al 2005;
Stormwater	20 %	Estimated in this study

Fertilizers



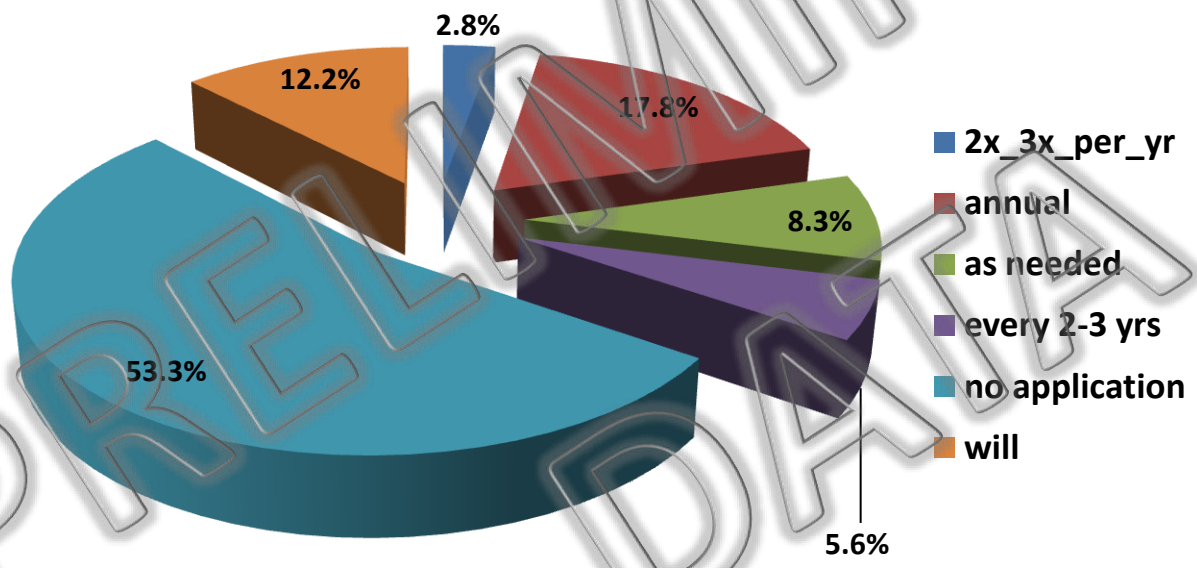
County Fertilizer sales data

- Need to estimate the quantity of fertilizer N applied relative to the amount sold.
- We are tracking down historical information about a fertilizer plant in Ocala

**** Important to estimate historical nitrogen loading to ground water system because some of this legacy nitrate from several decades ago still could be in the subsurface and moving toward Silver Springs**.

Fertilizer Applications -- Horse Farms

Fertilizer application at horse farms (2011-2013; 180 farms; Jamie Cohen*, IFAS)



* Jamie has visited 786 horse farms since 2007.

18% apply fertilizer annually; 27% every third year.

Animal Wastes

2007 Agricultural Census for Marion County, Florida

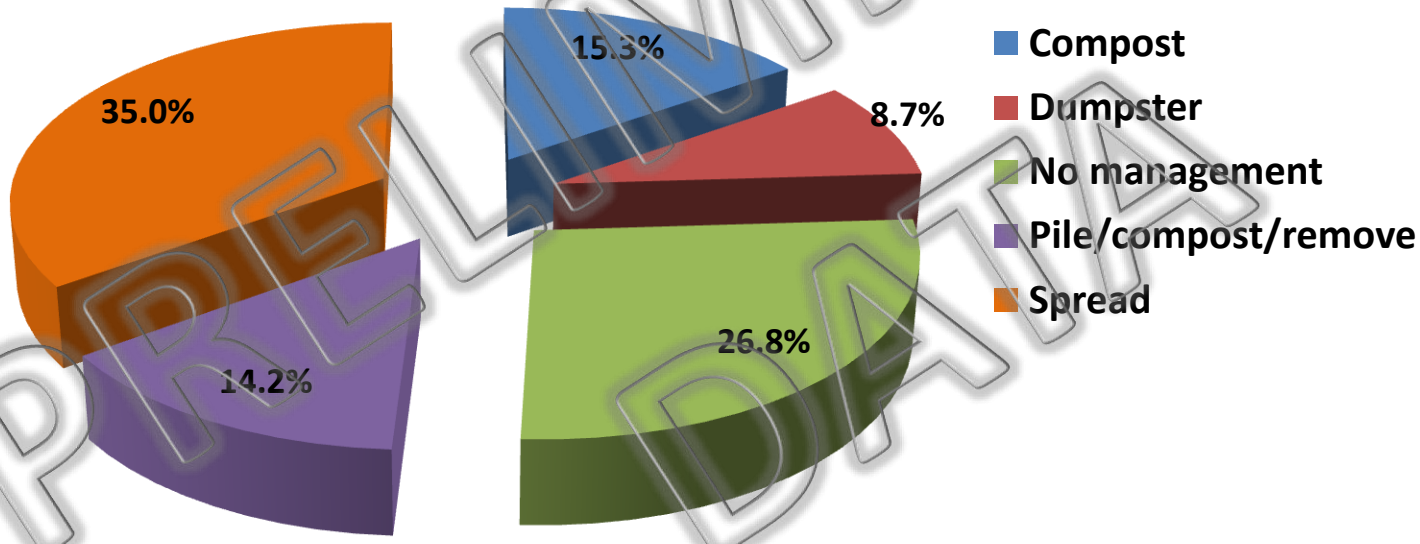
Livestock Type Inventory	Quantity	U.S. Rank (~3,100 counties)	Manure N content (kg-N/animal/year)
Cattle and Calves	47,403*	624	80.0
Horses and ponies	31,128**	1	45.3
Chicken, Layers	5,316		0.44
Chicken, Broilers	623		26.0
Hogs	1,220	--	31.4
Sheep and lambs	1,176	--	32.9
Goats	3,448	--	5.84

* 1,401 farms
**2,161 farms

These numbers will be apportioned to the Silver Springs and Rainbow Springs BMAP areas based on the percentage of agricultural pasture land in each area.

Animal Wastes– Horse Farms

Horse farm manure management (2011-2013)
180 farms, J. Cohen, IFAS



Manure on land at 62% of farms

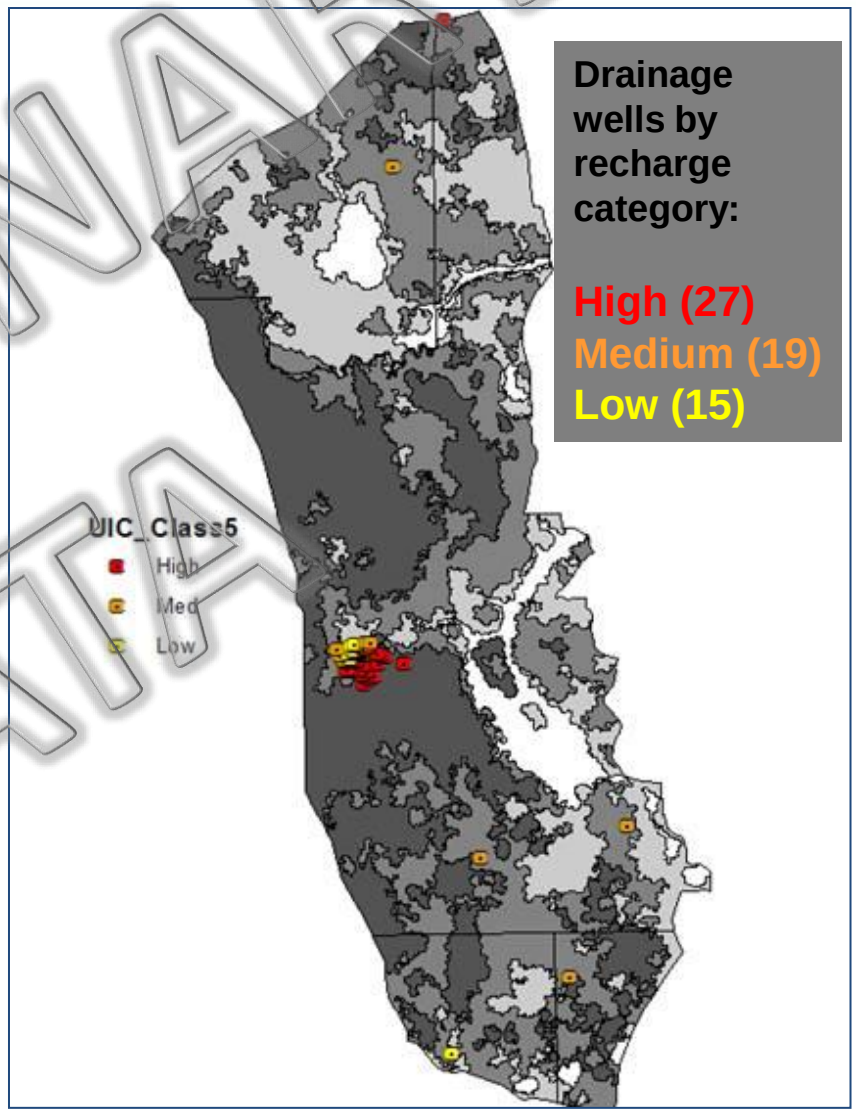
Stormwater runoff

Marion County and City of Ocala NPDES Phase II MS4 Permits for addressing stormwater runoff from small municipal separate storm sewer systems.

Some drainage retention areas provide treatment of stormwater before discharging into drainage wells that are open to the Floridan aquifer.

Based on measurements by the City of Ocala DPW, TN levels ranged from 0.3 to 1.8 mg/L; most of N is TKN (ammonium plus organic N).

Need volume estimates to be able to estimate N loading to ground water, particularly in low-rate and medium-rate recharge areas.



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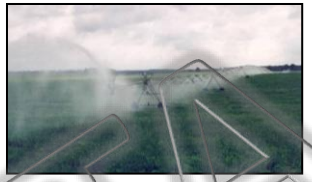
- **Land application of treated wastewater/ biosolids**



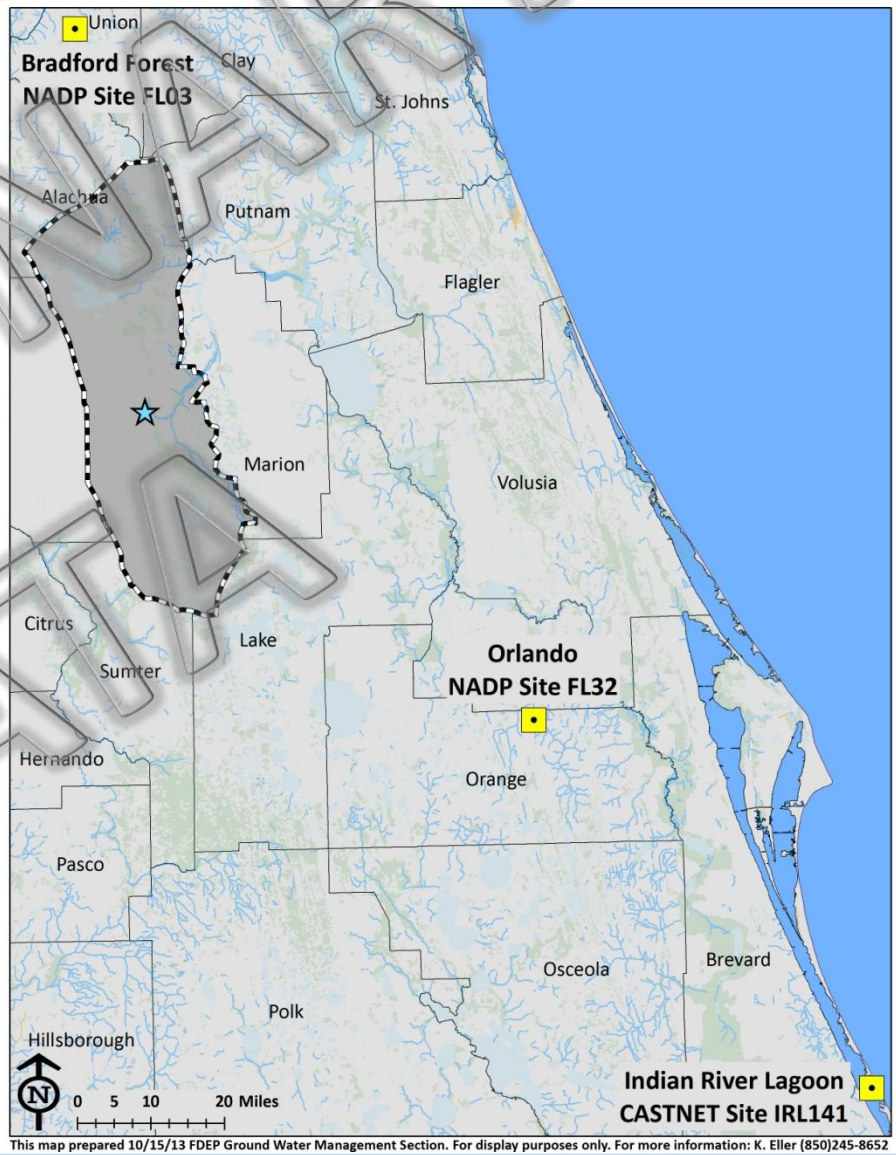
- **Septic Tanks**

- **Animal wastes**


- **Stormwater runoff**

Atmospheric Deposition

- National Atmospheric Deposition Program (NADP)
  - Wet deposition
  - Bradford Forest (FL03)
  - Orlando (FL32)
- Clean Air Status and Trend Network (CASTNET)
  - Dry deposition
  - Indian River Lagoon (IRL141)
- Annual Average TN deposition
  - 2007-2012
  - 3.06 kg-N/ha



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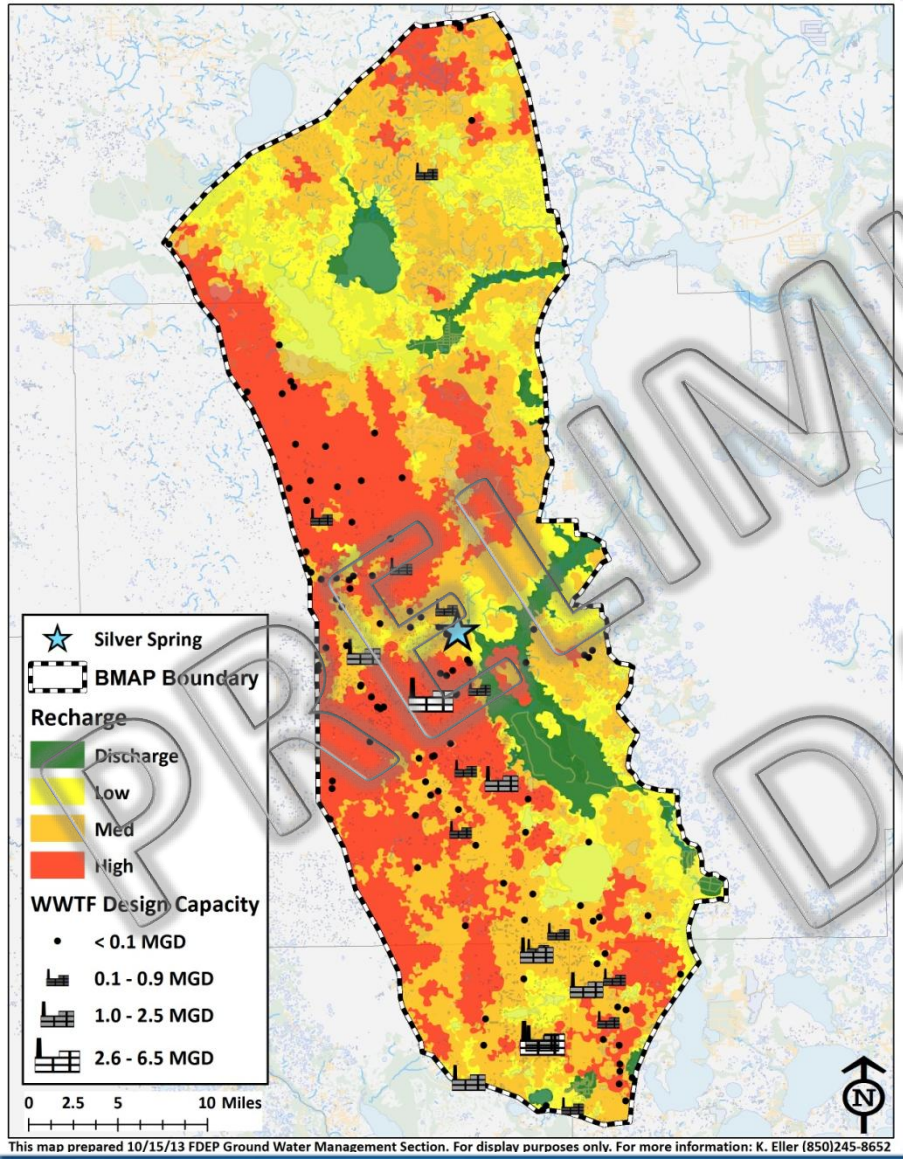
Wastewater Treatment Facilities



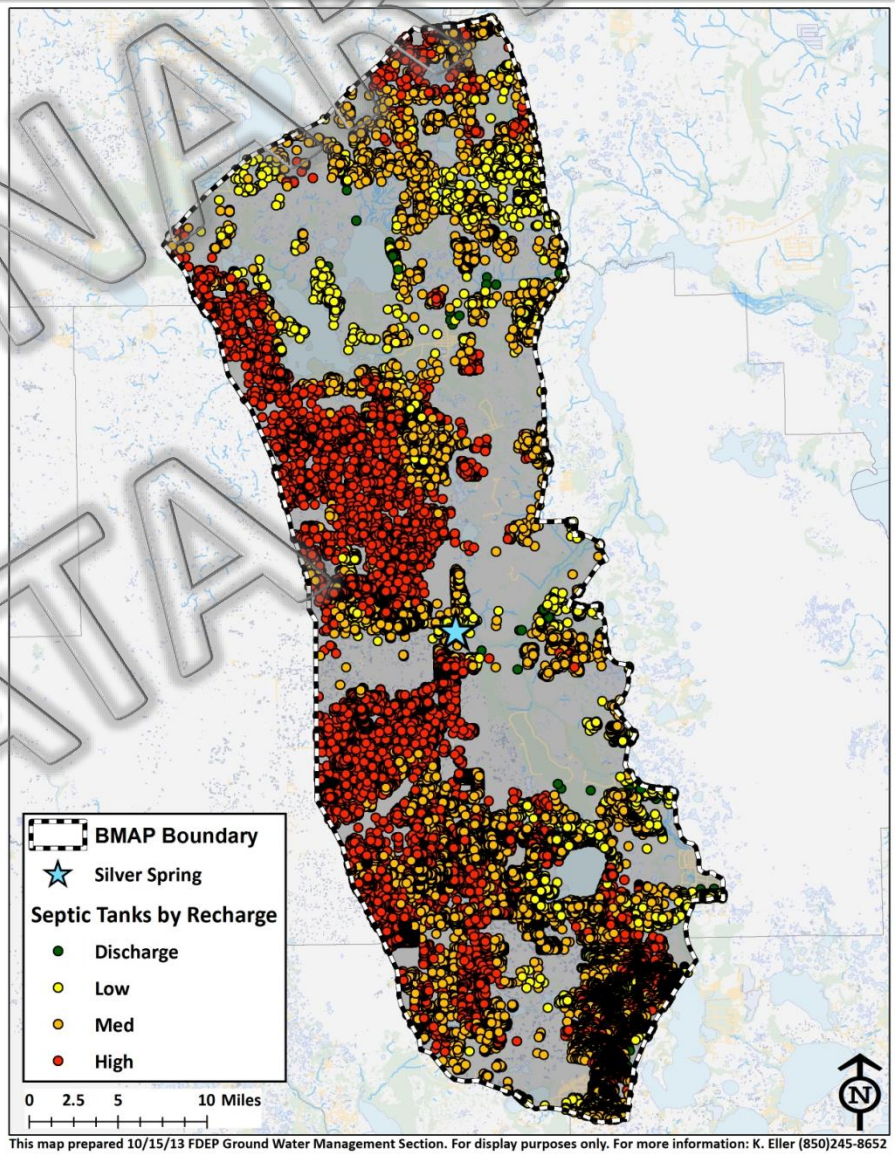
- 21 facilities with permitted discharge ≥ 0.1 MGD
  - High Recharge: 6
  - Medium Recharge: 12
  - Low Recharge: 2
- TN effluent concentrations as reported in DMR
- N inputs calculated using 50% design capacity
- Input to land surface
  - High: 51,477 kg-N
  - Medium: 68,328 kg-N
  - Low: 50,280 kg-N

Septic Tanks

- Marion County provided best available septic tank data
- DOH model relying on tax parcel data and sewer service areas
- Average annual input to septic tank = 4.1 kg-N/person (US EPA, 2002)

County	People per household (2010 Census)	Recharge Area	# of septic tanks
Alachua	2.46	Low	587
		Medium	1,299
		High	818
Lake	2.45	Low	532
		Medium	3,818
		High	3,341
Marion	2.41	Low	3,710
		Medium	16,825
		High	22,070
Sumter	2.26	Low	184
		Medium	1,803
		High	748
Putnam	2.53	Low	1,715
		Medium	1,551
		High	372

Recharge Area	Input to Land Surface (kg-N)
Low	67,338
Medium	250,156
High	270,250



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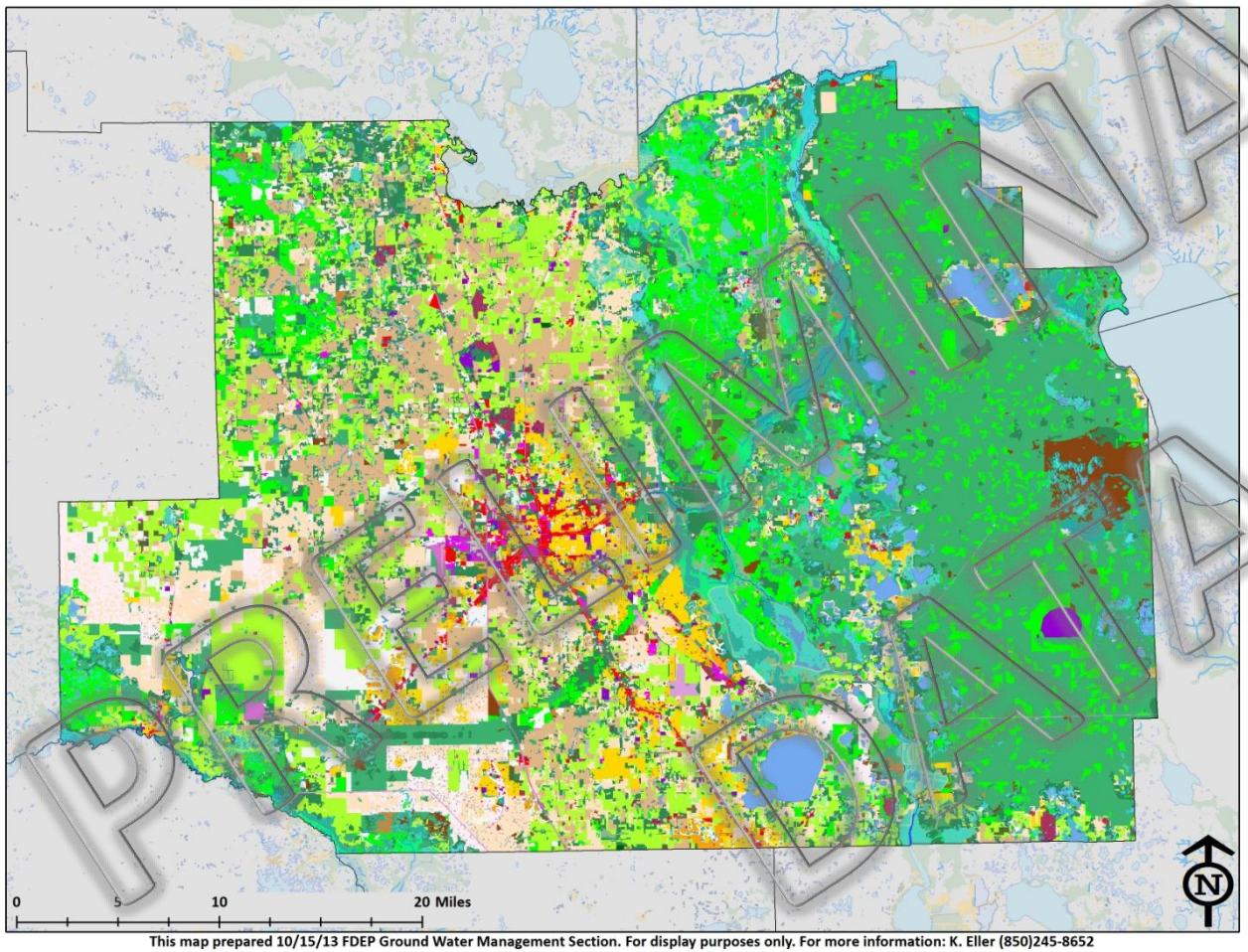
Livestock

- Census of Agriculture
  - Dept of Agriculture
  - Every 5 years
  - # of livestock (categorized by animal)
  - Full county data ONLY
- Livestock loading factors (kg-N/animal/day)
  - Horses: 0.124
  - Cattle: 0.219
  - Goats: 0.016
  - Hogs: 0.086
  - Sheep: 0.09
  - Turkey: 0.0025
  - Broiler Chickens: 0.072
  - Layer Chickens: 0.0012

Livestock: Land use Percentages



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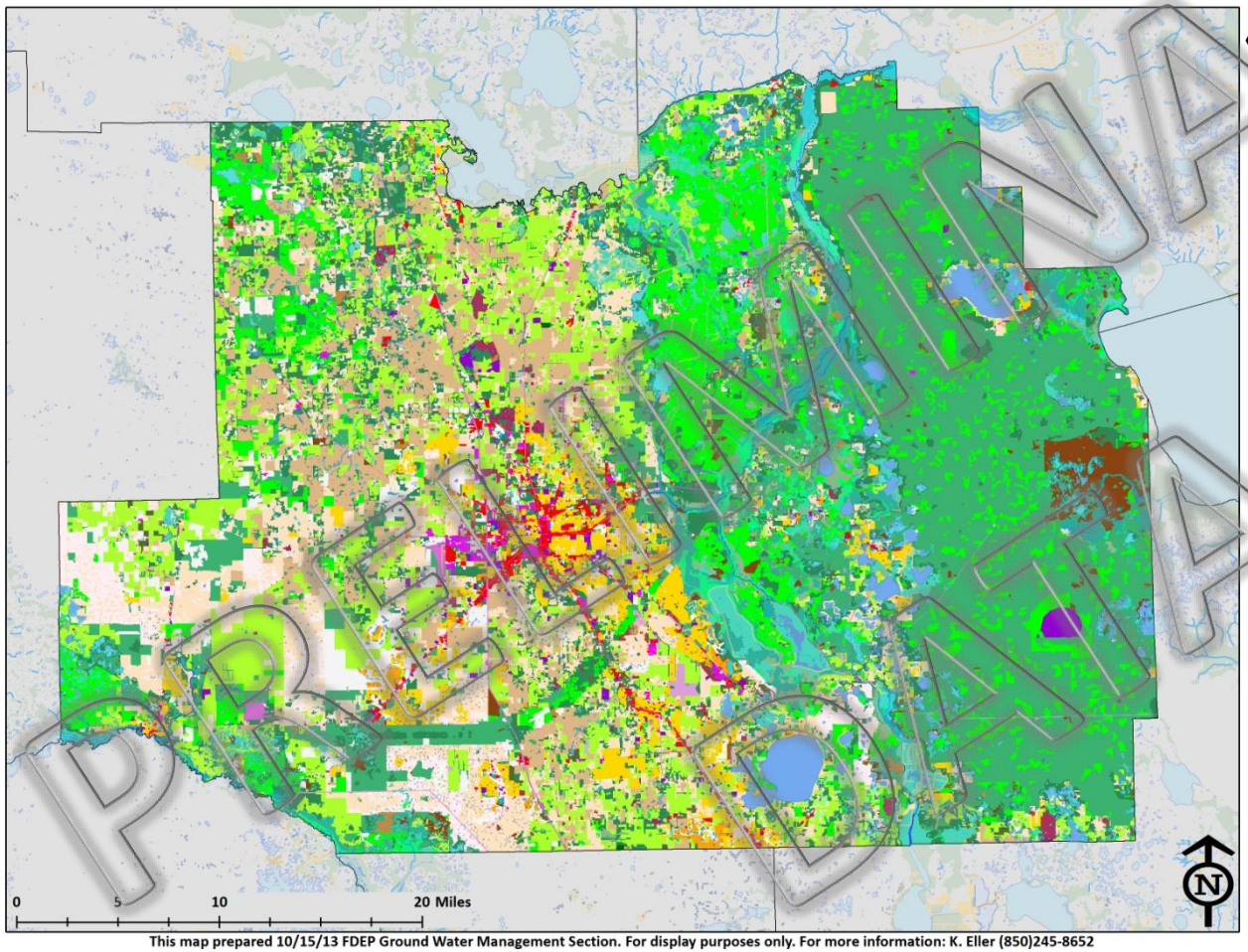
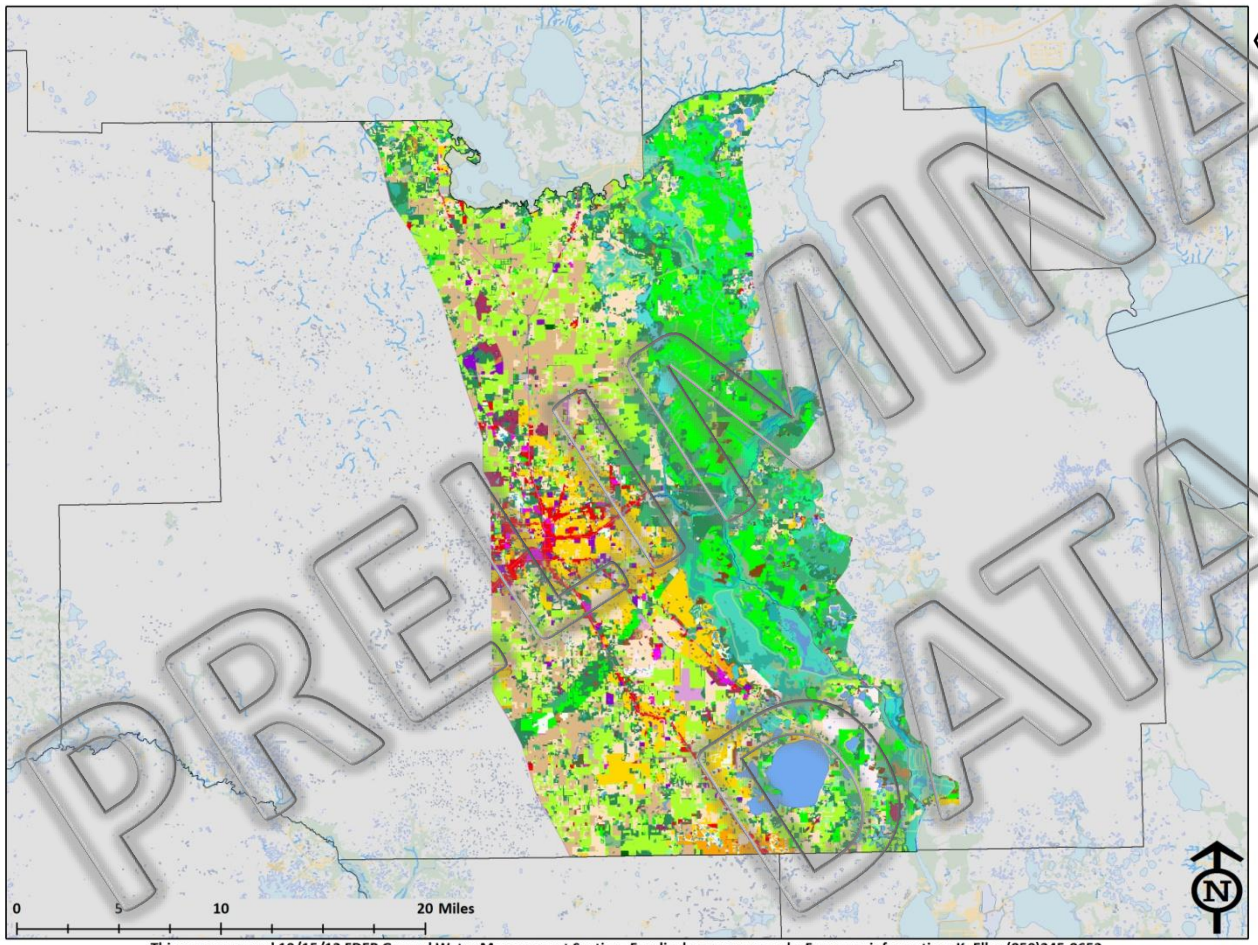
- Pastures
  - Improved
  - Unimproved
  - Woodland
- Feeding Operations
  - Cattle
  - Poultry
- Specialty Farms
  - Horse farms
  - Dairies
  - Aquaculture

Livestock: Land use Percentages



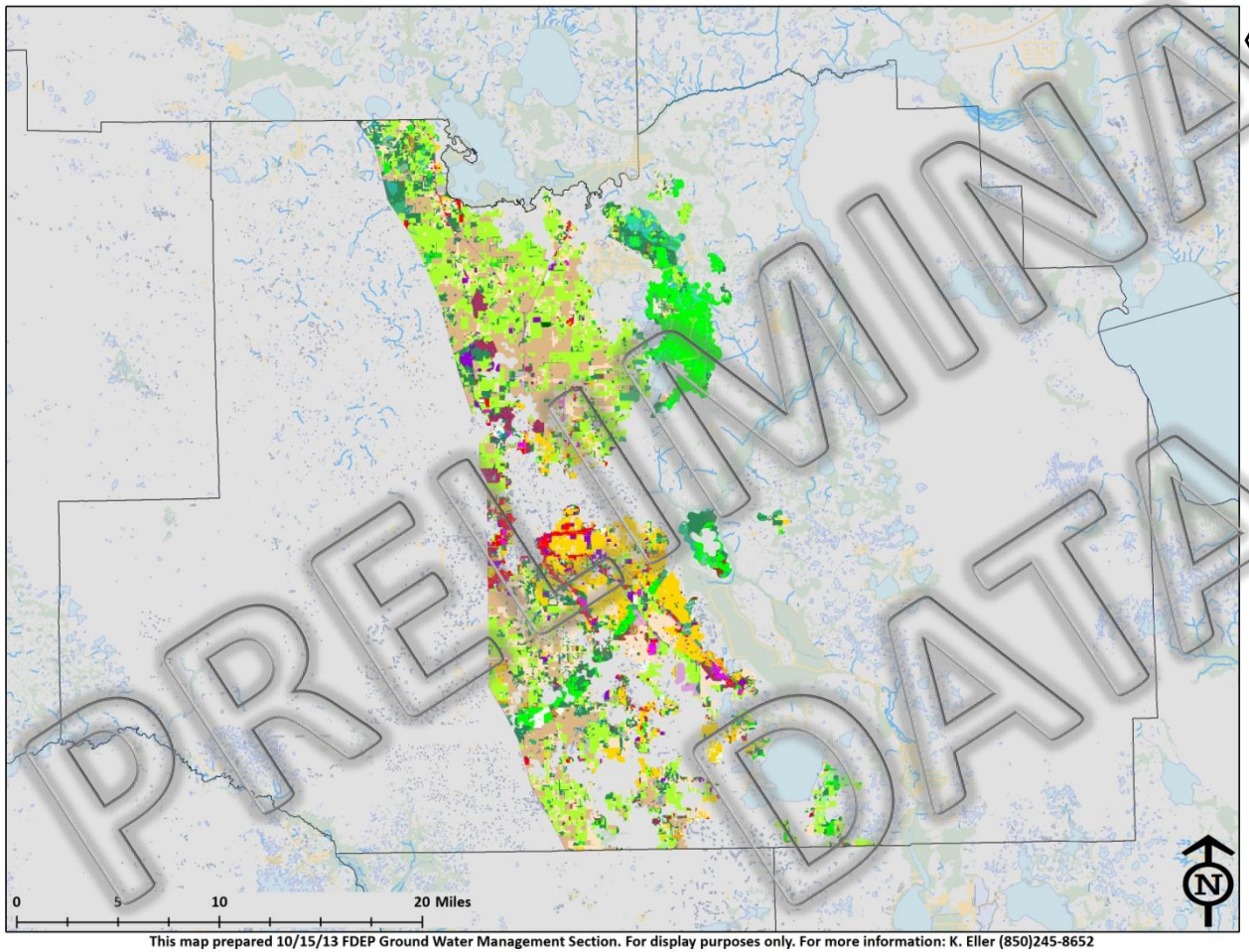
- EXAMPLE:
  - Marion County livestock lands
    - Marion County- 78,891 ha

Livestock: Land use Percentages



- EXAMPLE:
  - Marion County livestock lands
    - Marion County- 78,891 ha
    - BMAP Area- 31,739 ha, 40%

Livestock: Land use Percentages



- EXAMPLE:
  - Marion County livestock lands
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    - BMAP Area- 31,739 ha, 40%
    - **High Recharge- 22,834 ha, 28.9%**

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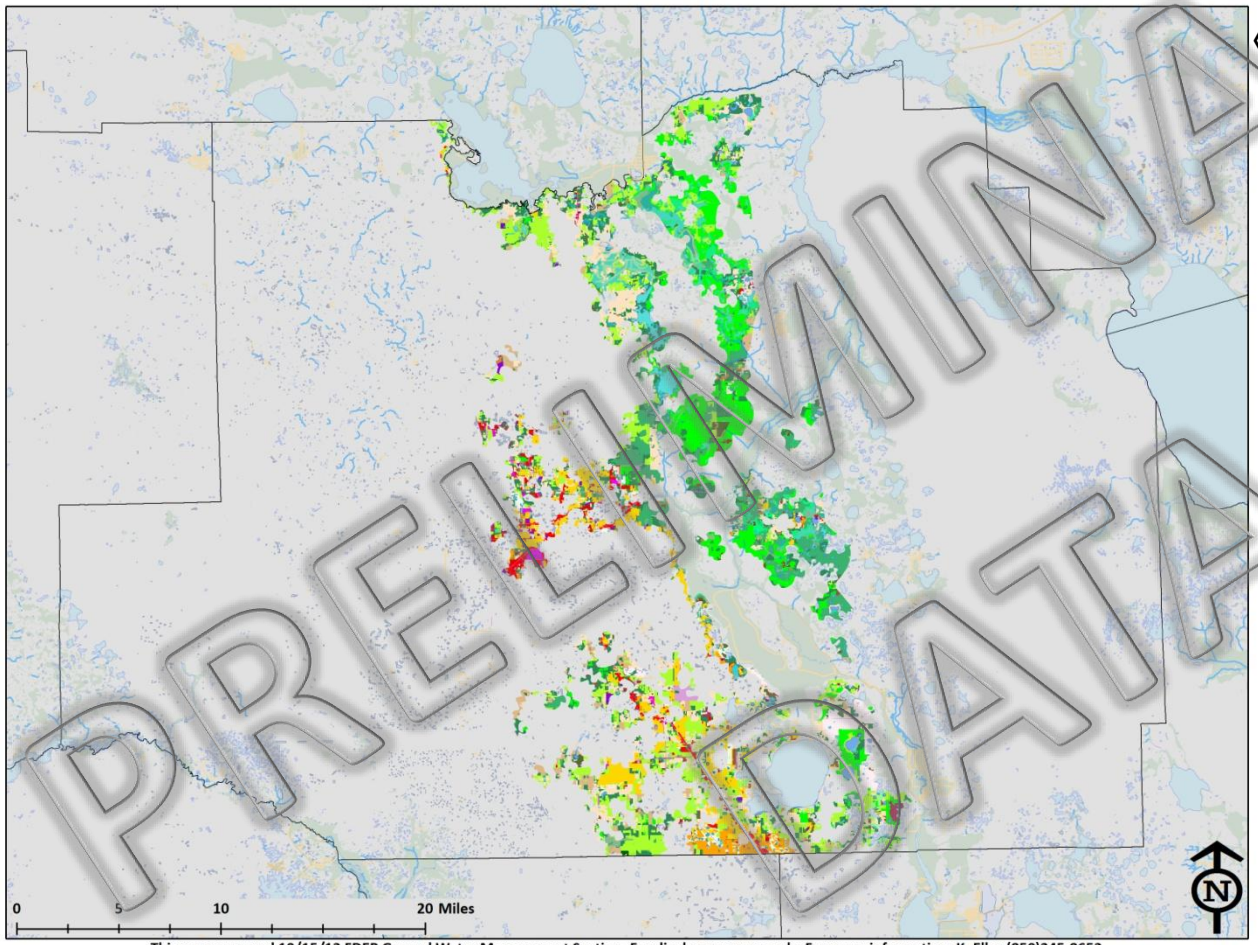

- EXAMPLE:
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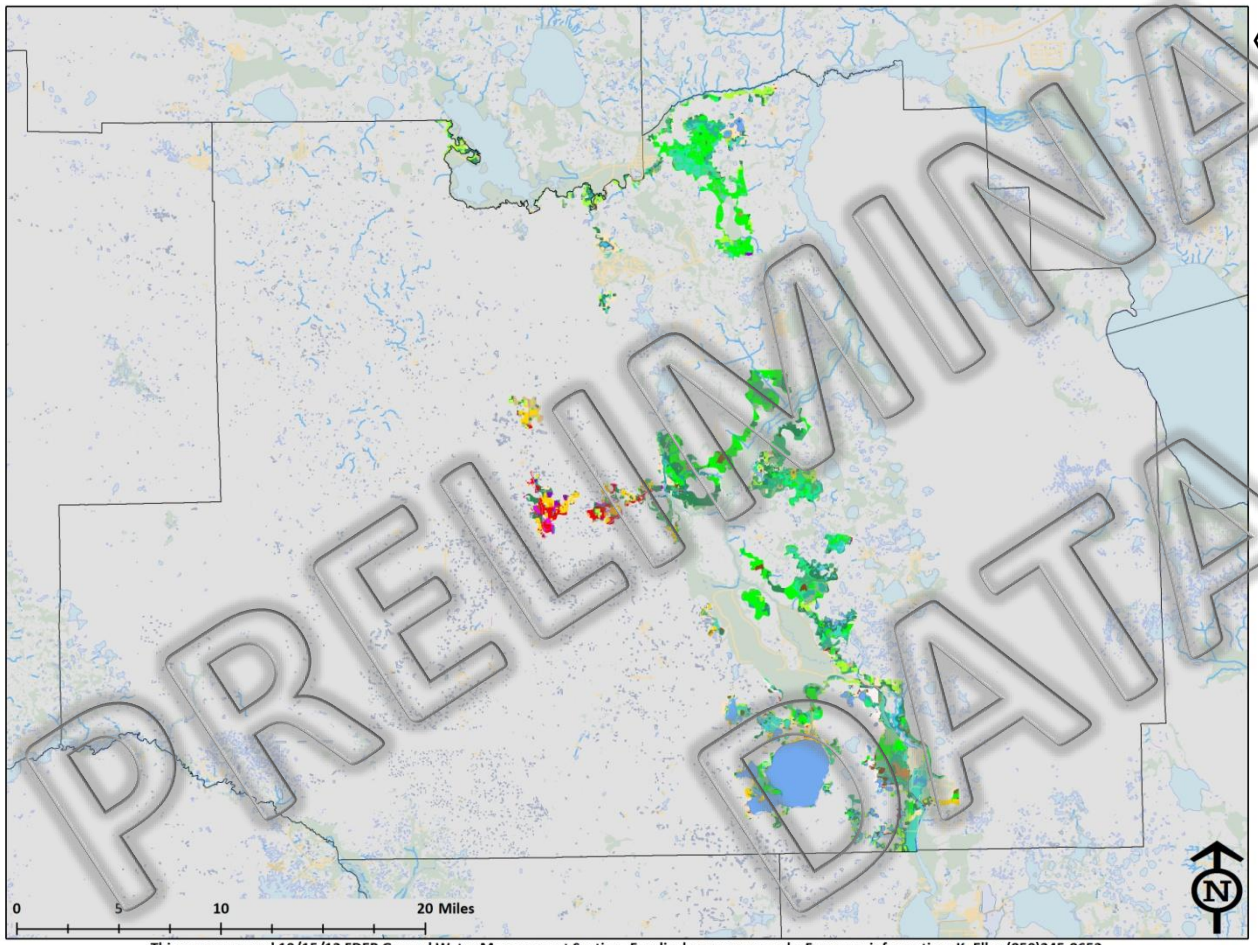
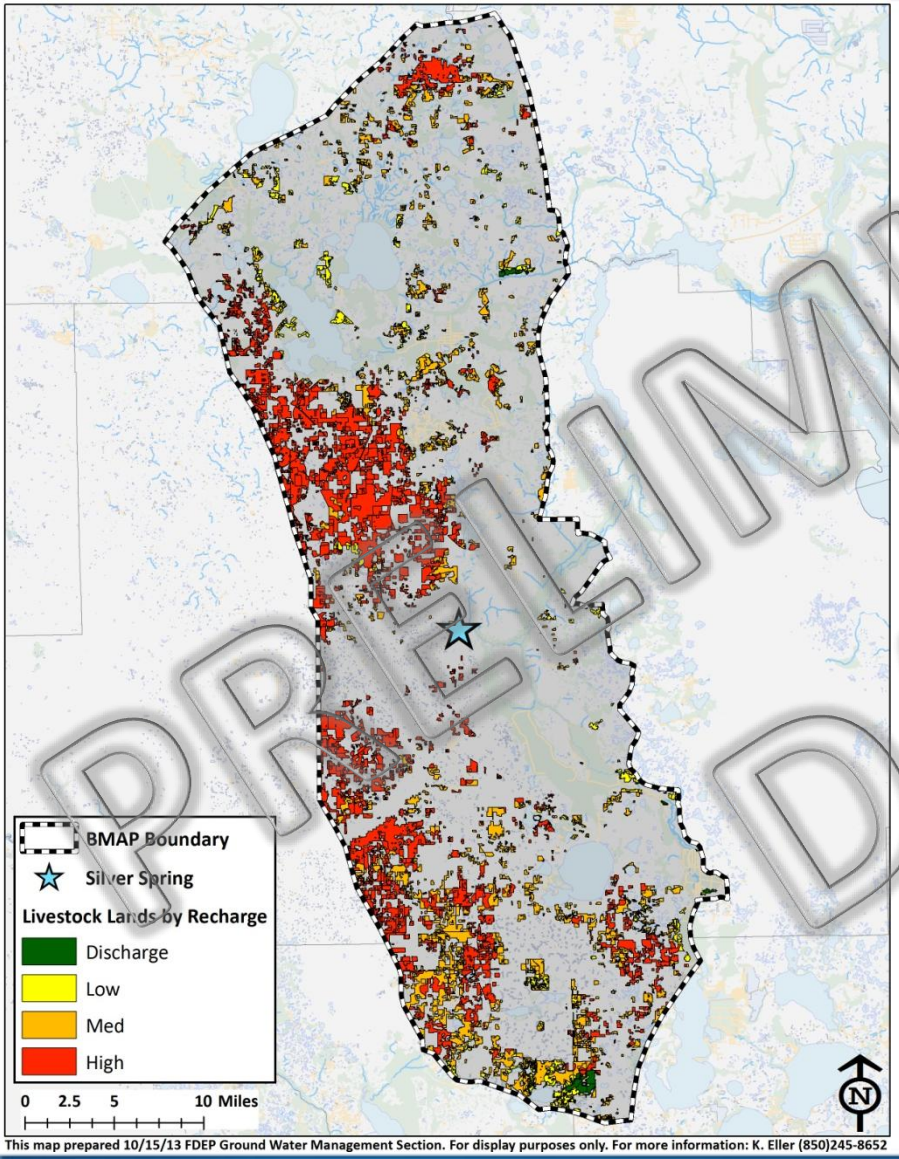
    - Marion County- 78,891 ha
    - BMAP Area- 31,739 ha, 40%
    - **High Recharge- 22,834 ha, 28.9%**
    - **Medium Recharge- 7,658 ha, 9.7%**

Livestock: Land use Percentages



- EXAMPLE:
  - Marion County livestock lands
    - Marion County- 78,891 ha
    - BMAP Area- 31,739 ha, 40%
    - **High Recharge- 22,834 ha, 28.9%**
    - **Medium Recharge- 7,658 ha, 9.7%**
    - **Low Recharge- 1,190, 1.5%**

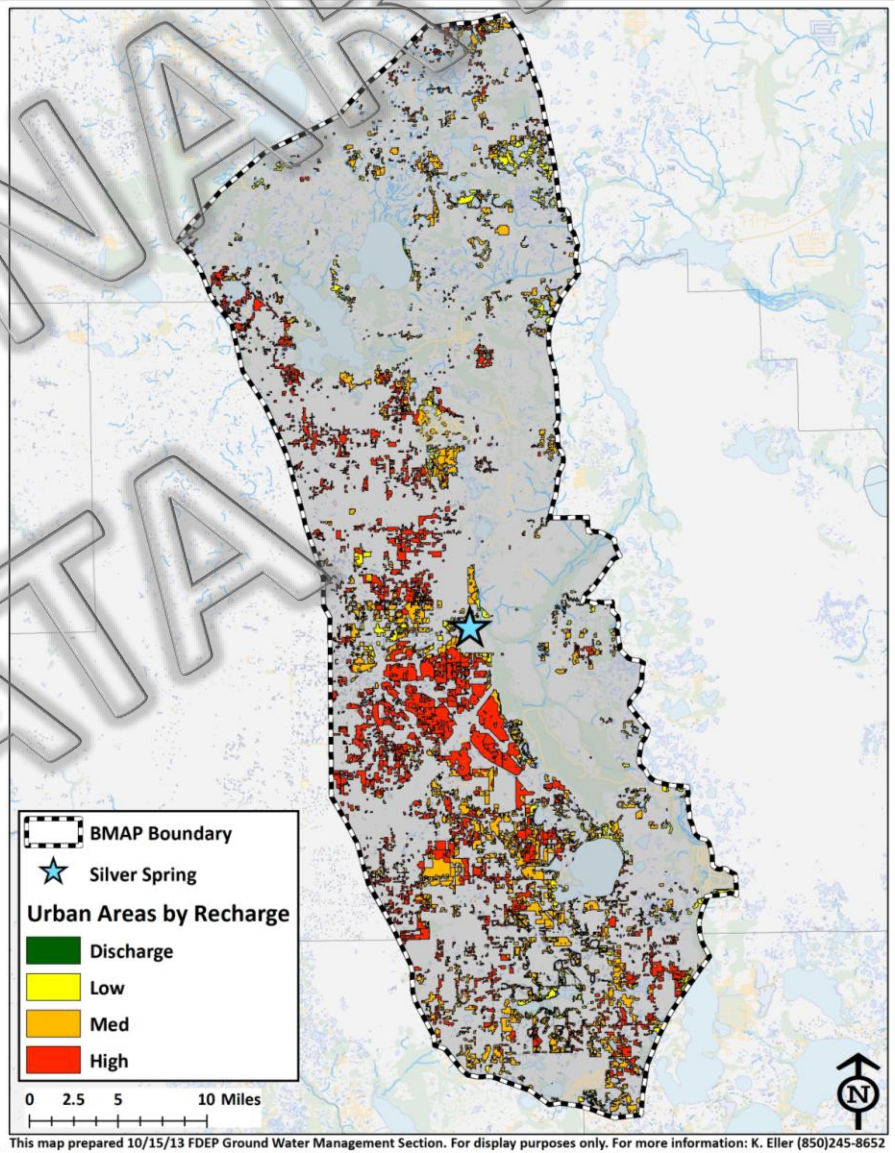
Livestock



- Full county data multiplied by the land use percentages
- Horse Farms
  - Only 62% of the horse population is contributing nitrogen
  - Resulting estimate of 14,507 horses
- Approximate BMAP cattle population is 48,716
- N Input to land surface
  - High: 1,832,351 kg-N
  - Medium: 1,141,842 kg-N
  - Low: 369,952 kg-N

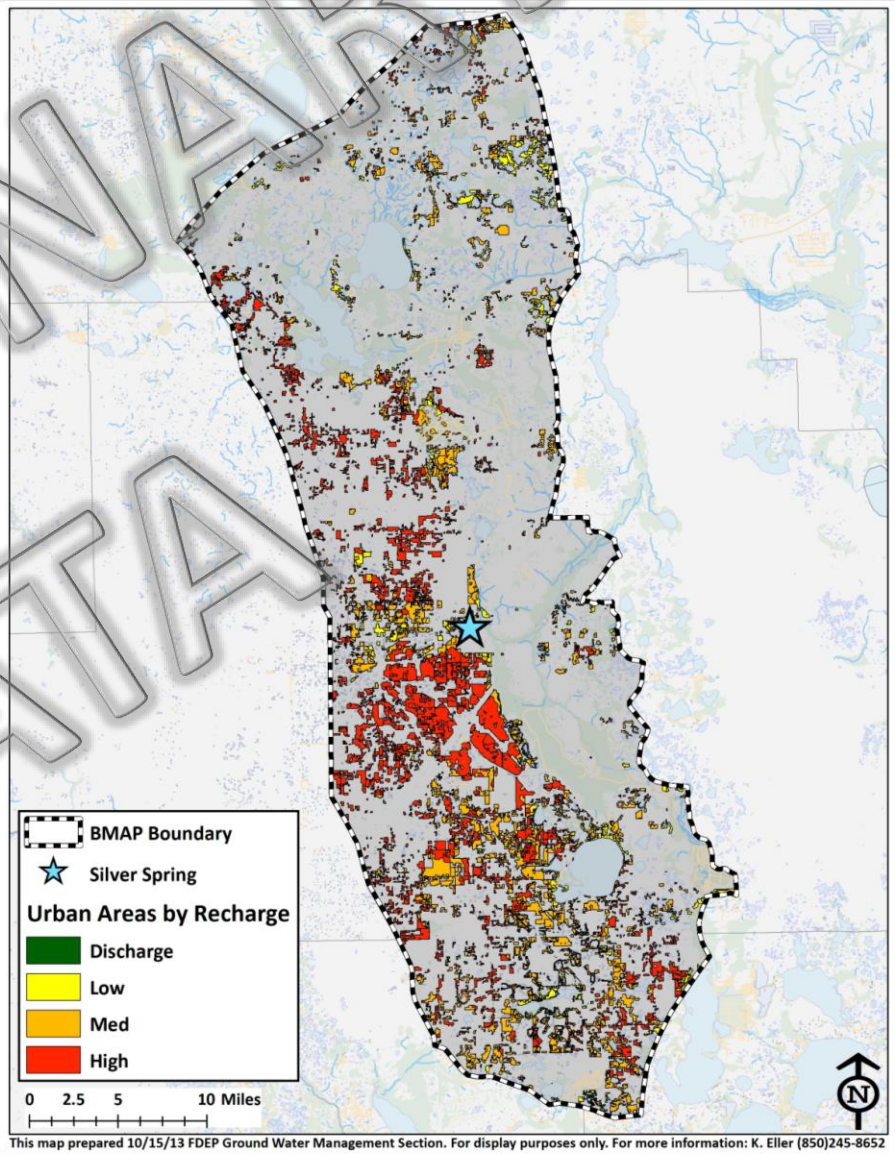
Fertilizers: Urban

- FL Dept of Ag Fertilizer Sales Data
  - Annual data
  - Total Fertilizer Sold
  - Total N in Fertilizer Sold
  - Total Fertilizer for Non-Farm Applications
  - Full County data ONLY
- Land use percentages were used to appropriate the fertilizers applied with the BMAP boundary

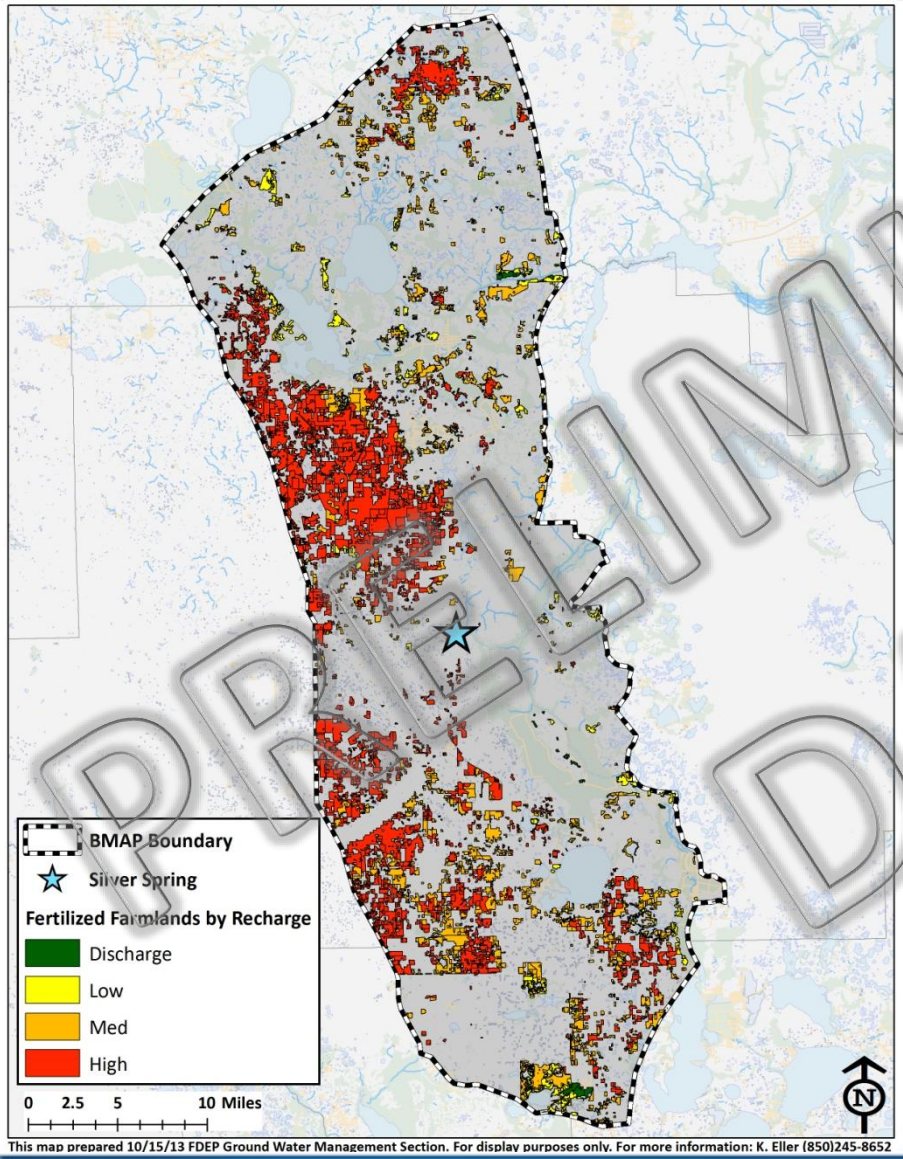


Fertilizers: Urban

- Land use Categories
  - High Density Residential
  - Medium Density Residential
  - Low Density Residential
  - Golf Courses
- N Input to land surface
  - High: 250,606 kg-N
  - Medium: 276,607 kg-N
  - Low: 63,407 kg-N

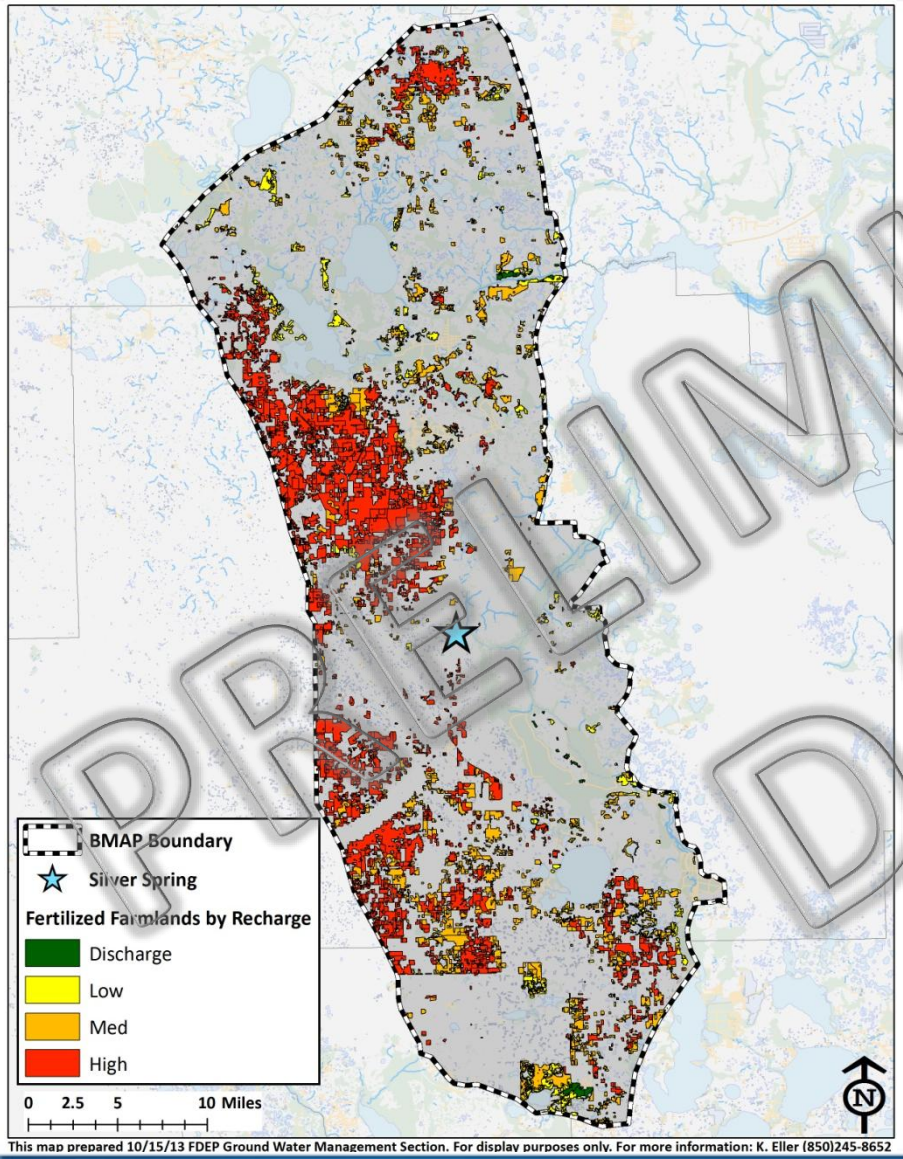


Fertilizers: Farmlands



- Based on application rates
- 49,177 ha of fertilized farmlands
- Land use Categories
  - Improved Pastures- 53.1%
  - Horse Farms- 24.3%
  - Field Crops- 17.0%
  - Citrus Groves- 1.8%
  - Row Crops- 0.9 %
  - Tree Crops- 0.8%
  - Tree Nurseries- 0.7%
  - Mixed Crops- 0.6%
  - Ornamentals- 0.6%
  - Sod Farms- 0.2%

Fertilizers: Farmlands



- Application Rates based on IFAS annual recommended rates
  - 30 lb N/ac: pastures
    (100-150 lb N/ac every 3-4 yrs)
  - 150 lb N/ac: crops and groves
  - 80 lb N/ac: trees and nurseries
  - 130 lb N/ac: sod farms
- Horse Farms
  - 27% at 30 lb N /ac
  - 18% at 100 lb N /ac
- N Input to land surface
  - High: 1,514,482 kg-N
  - Medium: 965,370 kg-N
  - Low: 262,935 kg-N

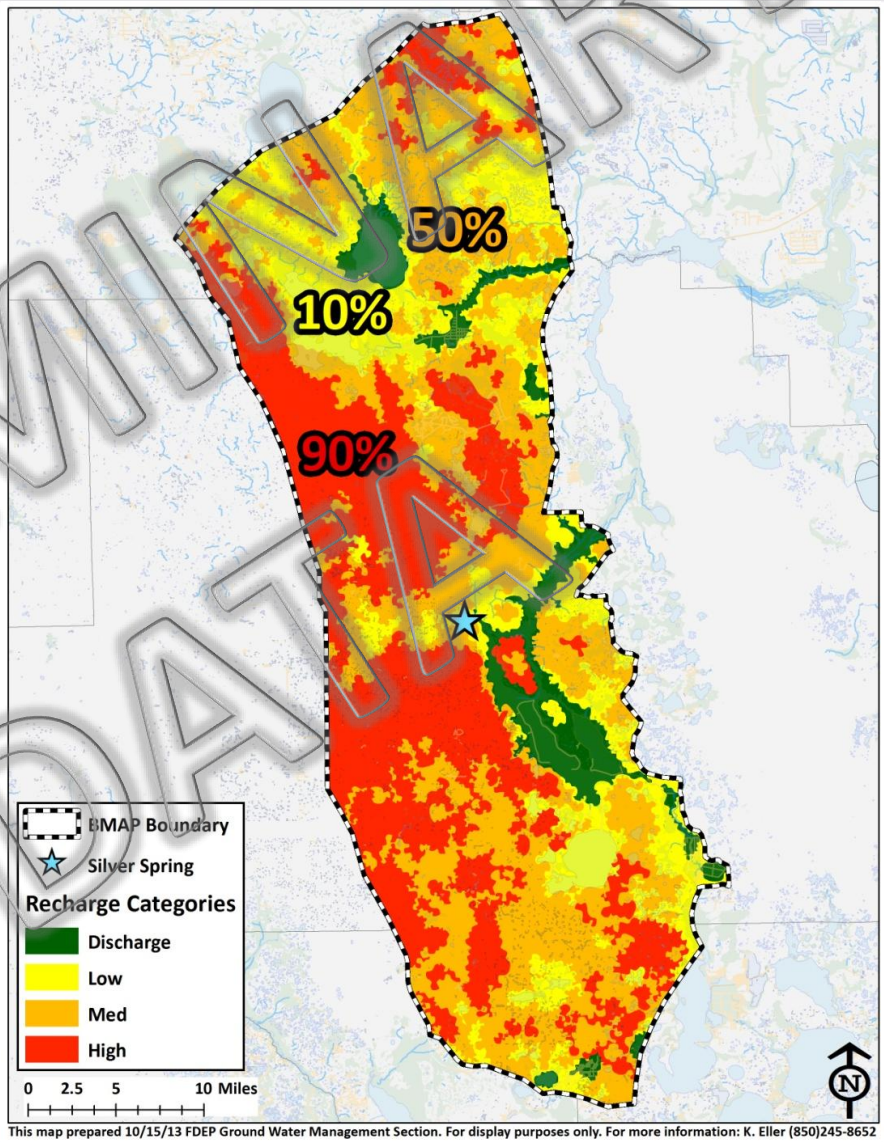
Attenuation Factors

- Factors represent the percentage of uptake from the environment
- Based on factors used in similar past studies and found in relevant literature

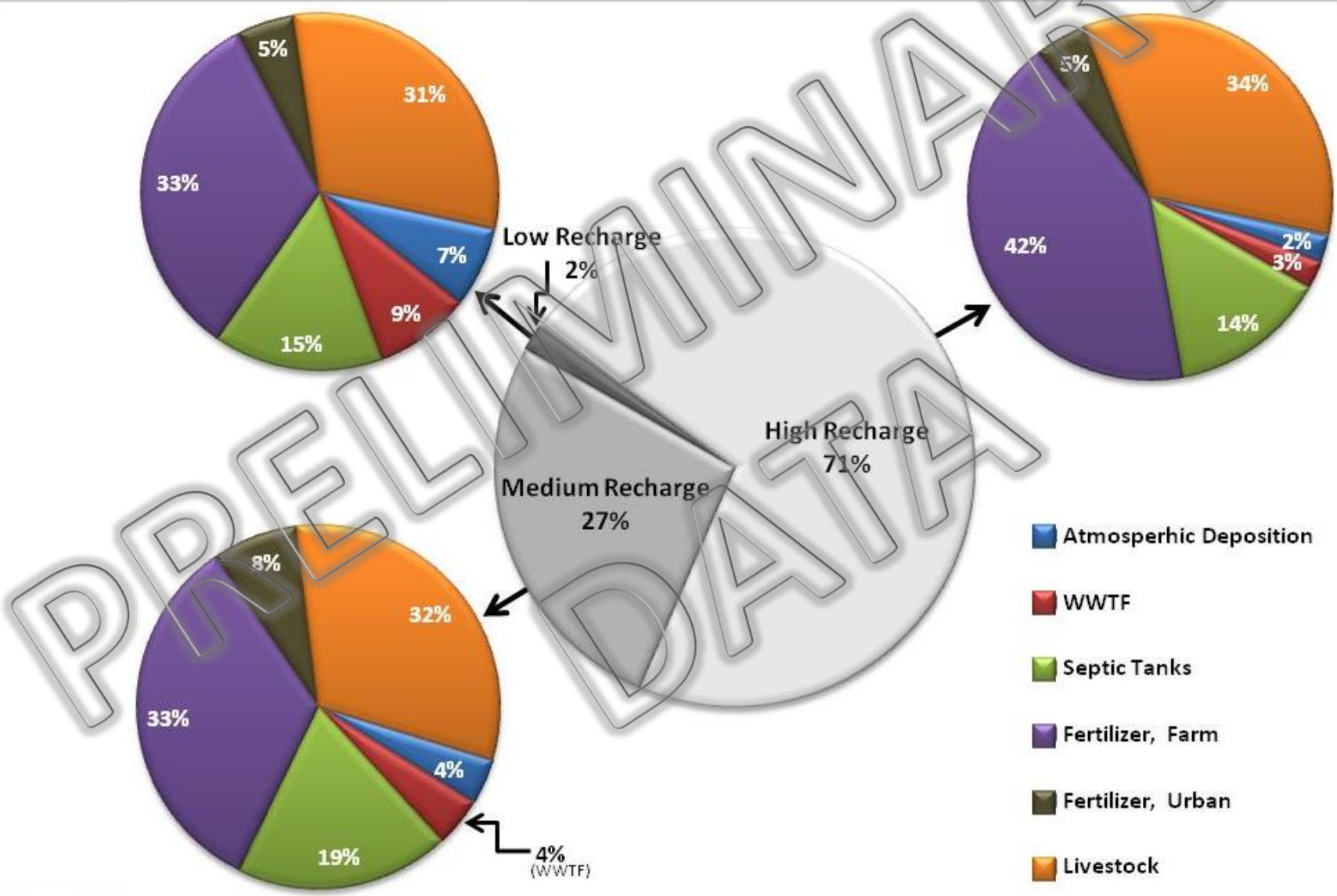
Loading Category	Attenuation Factor
Atmospheric Deposition	90%
Wastewater Treatment Facilities	60%
Septic Tanks	45%
Farm Fertilizers	70%
Urban Fertilizers	80%
Livestock	80%

Recharge Factors

- Factors describe the percentage of recharge expected



Annual Average Loading to Ground Water



Next Steps

The N loading estimates for the BMAP area are **preliminary** and likely will be revised. More detailed information is needed on:

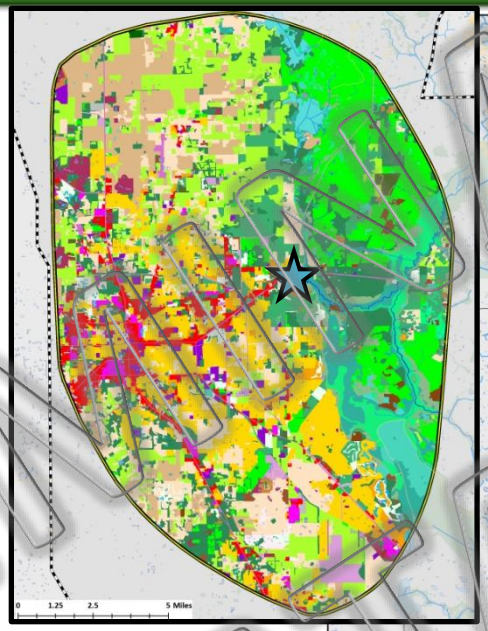
- Numbers of horses and cattle in the BMAP area

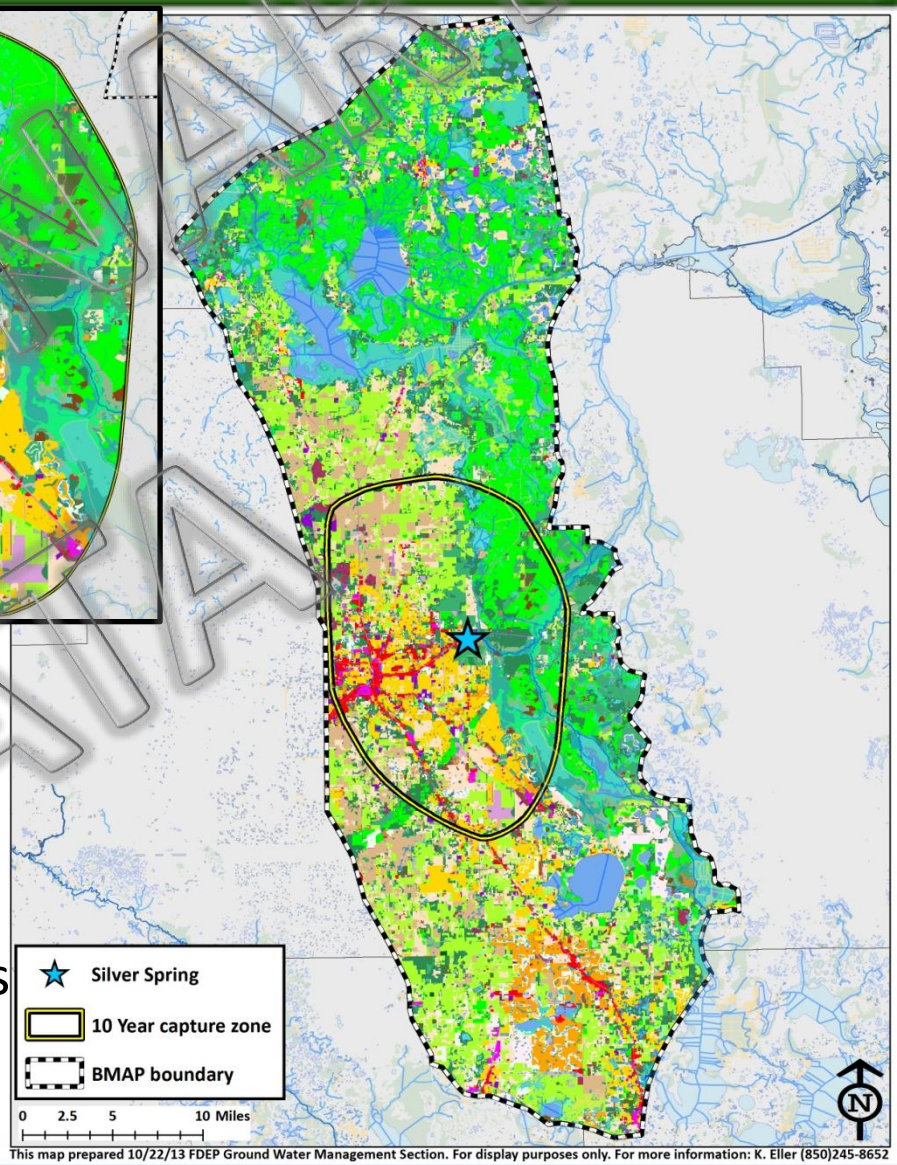
- Fertilizer application rates

- Stormwater volumes for drainage wells in low/medium rate recharge areas

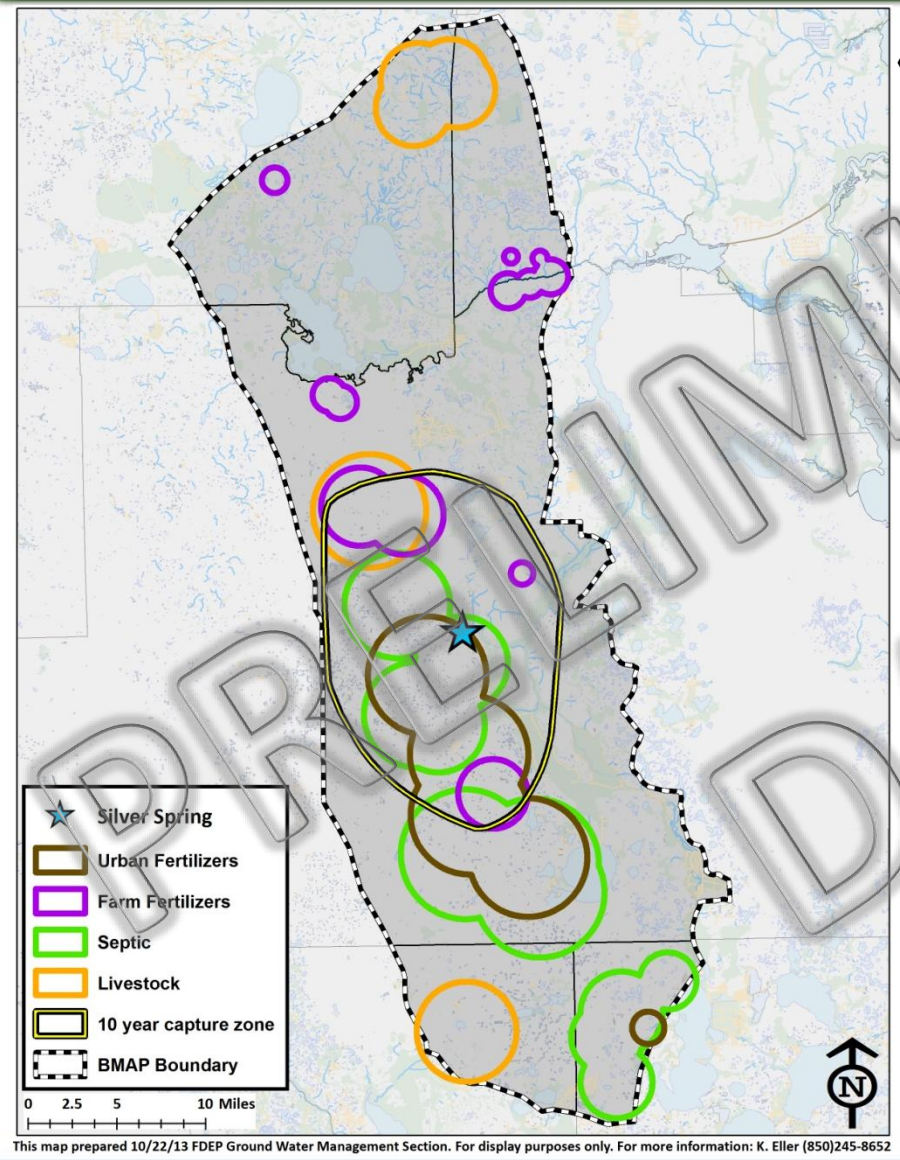
Next Steps

- Evaluate source proximity to Silver Spring
- 10 year capture zone
  - 21% of the BMAP area
  - 38% Urban areas
  - 16% Livestock Lands
  - 12% Croplands
  - Contains:
    - 8 of the 21 WWTFs
    - 35% of the BMAP Urban areas
    - 29% of the BMAP septic tanks

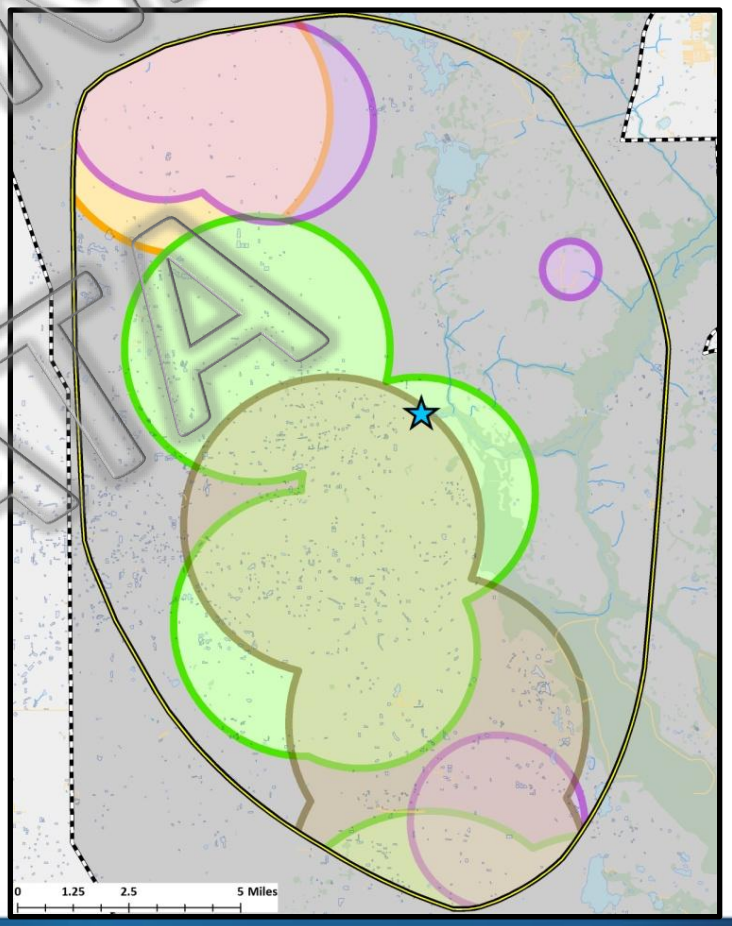




Next Steps



- Utilizing spatial statistical tools to determine areas of concentrated source loading



QUESTIONS??

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Ground Water Protection Section

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