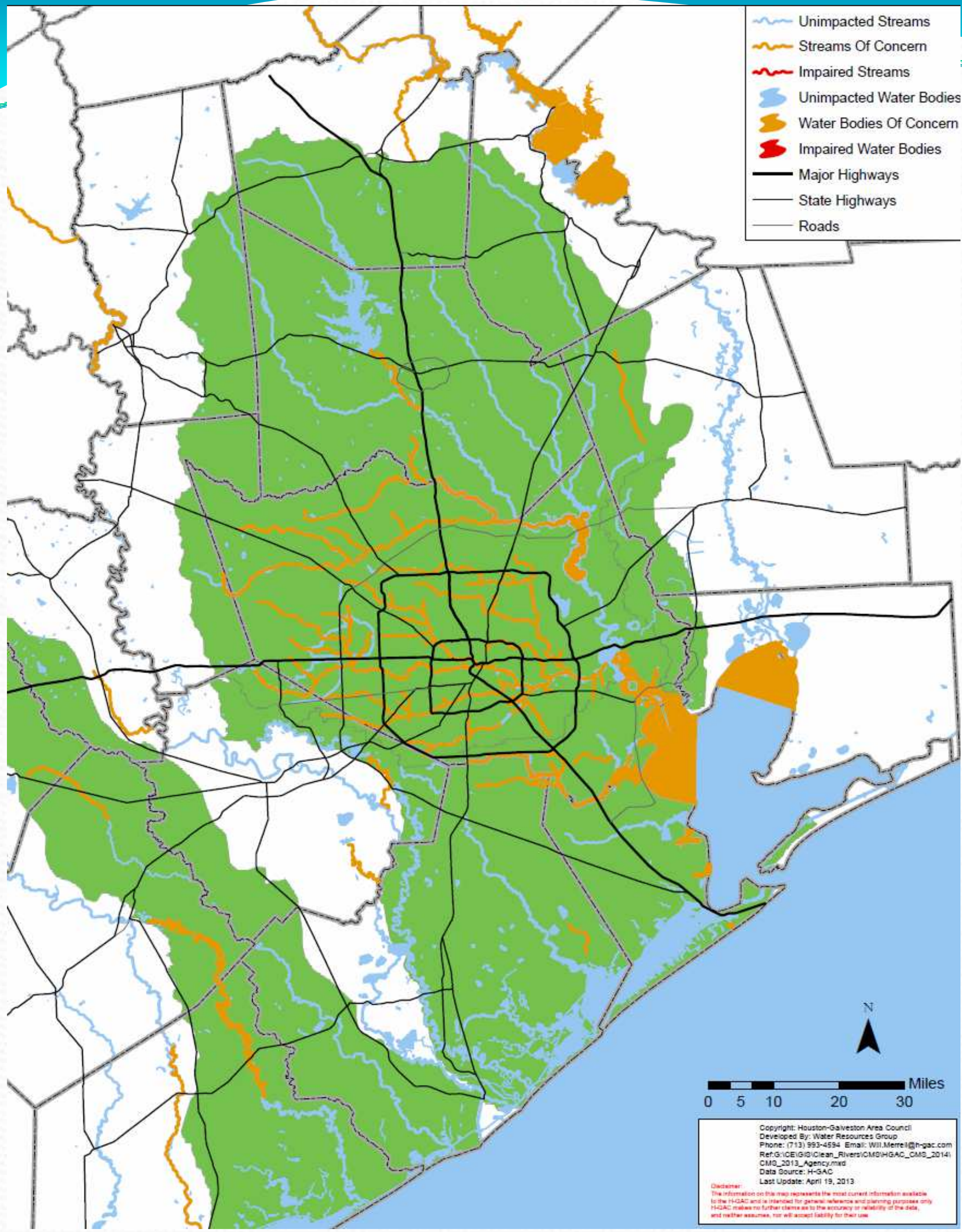
An Evaluation of Nutrient and Geospatial Data Relationships in Selected Watershed of the Houston-Galveston Region



Approximately 29%

of <u>stream miles</u> or

47% of <u>stream segments</u>

in the H-GAC area

have a nutrient concern.

The Project

- Identify correlations between land cover and/or land use and ambient nutrient concentrations in selected streams
- Perform advanced statistical analyses to evaluate spatial and temporal variations

Water Quality Data

- Collected by CRP partners and TCEQ
- Only routine, ambient fixed station WQ data from SWQMIS
- Collected after December 31, 1995
- Parameters:

Total phosphorus
Orthophosphate phosphorus
Nitrate+nitrite
Nitrate
Ammonia
TKN

E. Coli
Enterococci
Temperature
Specific conductance
DO
Secchi transparency
TSS
pH
Chlorophyll *a*

GIS Data

- H-GAC geospatial warehouse: tabular (non-geographic) and spatial (geographic) datasets
  - CRP stream network and stations datasets
  - Land cover data sets (1996, 2001, 2006, and 2011)
  - Soils
  - Elevation
  - Texas Road network
  - Imperviousness
  - Wastewater outfall dataset
  - USGS HUC 8 and HUC 12 layers

Hydrology Data

- Flow
  - USGS gages
  - Ambient monitoring
- Daily precipitation
  - NOAA Climatic Data Center
  - Harris County Flood Control District
- Monthly average WWTF discharge data
  - TCEQ

Methodology

- Identify stations for analysis
- Identify and delineate subwatersheds
- Define and evaluate subwatershed characteristics
- Analyze land cover change
- Statistically analyze relationships between land cover and receiving water quality data
- Develop load estimates for constituents of concern

Methodology

- Identify stations
  - Minimum 20 flow data points
  - Presence / absence of WWTF upstream of monitoring station
  - Major land cover type throughout watershed
  - From > 350 sites only 14 met the criteria

Station ID	Location	Longitude	Latitude
11367	LAKE CREEK	-95.578629	30.253798
11334	CANEY CREEK	-95.192123	30.148779
17746	PEACH CREEK	-95.169838	30.137611
11312	SPRING CREEK	-95.405762	30.092131
11120	CEDAR BAYOU	-94.985440	29.972281
11125	GARNERS BAYOU	-95.234062	29.933887
11332	CYPRESS CREEK	-95.598610	29.973663
11369	GREENS BAYOU	-95.228333	29.849722
11387	WHITEOAK BAYOU	-95.396942	29.775000
11139	BRAYS BAYOU	-95.412033	29.697258
11135	SIMS BAYOU	-95.445953	29.618767
11467	DICKINSON BAYOU	-95.170050	29.435925
11484	CHOCOLATE BAYOU	-95.323160	29.371076
12147	SAN BERNARD RIVER	-95.893330	29.313055

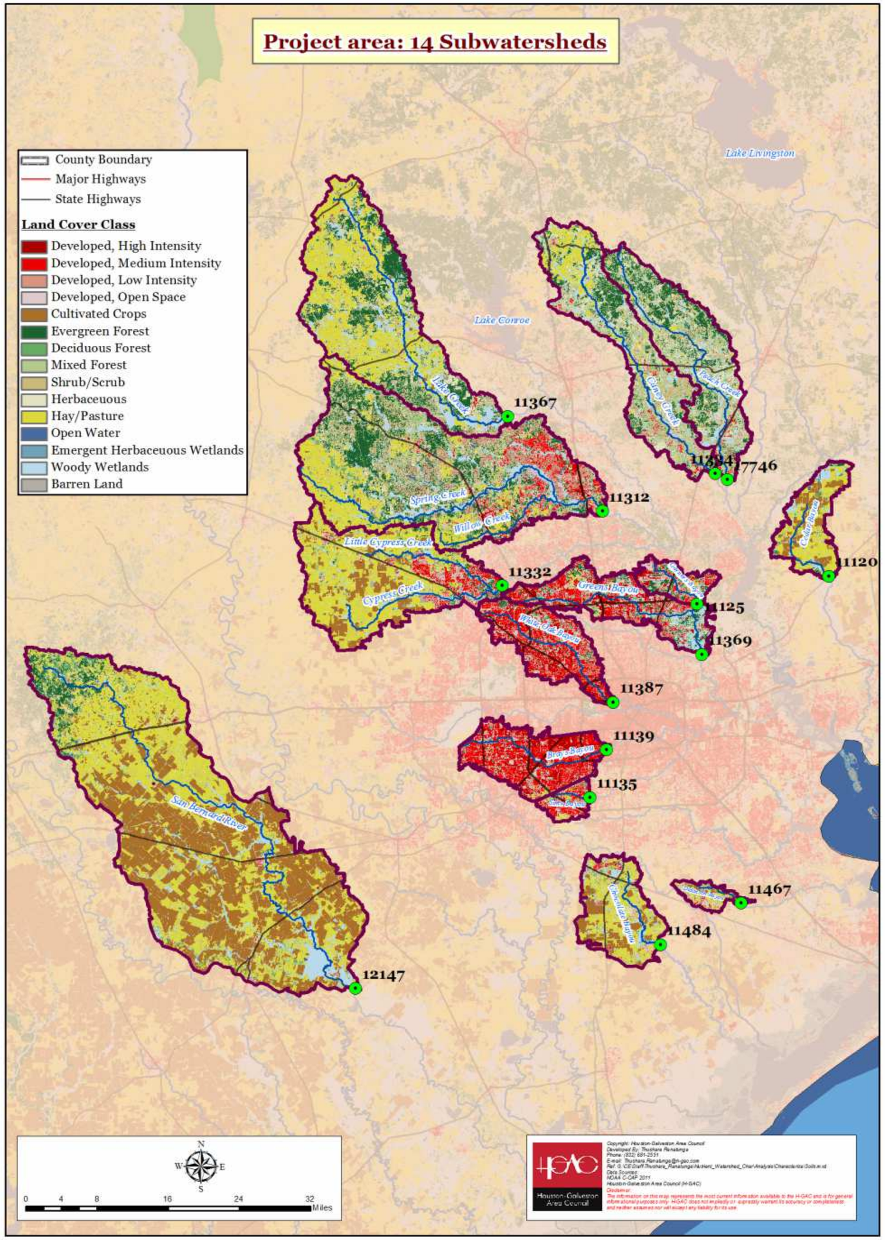
Methodology

- Identify and delineate subwatersheds
  - HUC-8 watershed boundaries (USGS)
  - H-GAC Clean Rivers Program stream network data layer
  - Monitoring stations data layer
  - Digital Elevation Model (DEM) w/ 10 M resolution
  - 1 – foot contour line data layer

Methodology

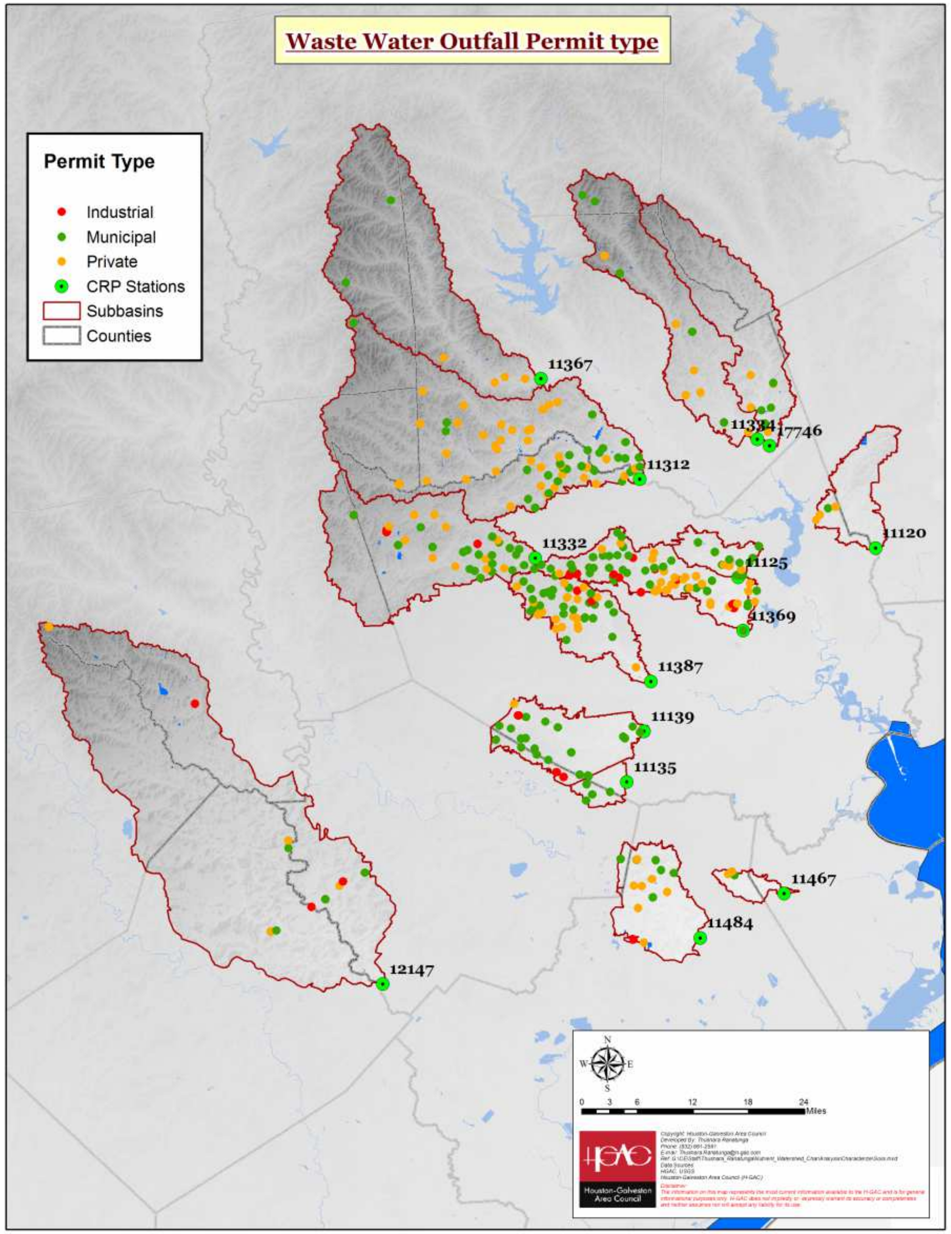
- Define and evaluate subwatershed characteristics
  - Land cover types – NOAA C-CAP Land Cover 2011

14 sites selected for analysis



Methodology

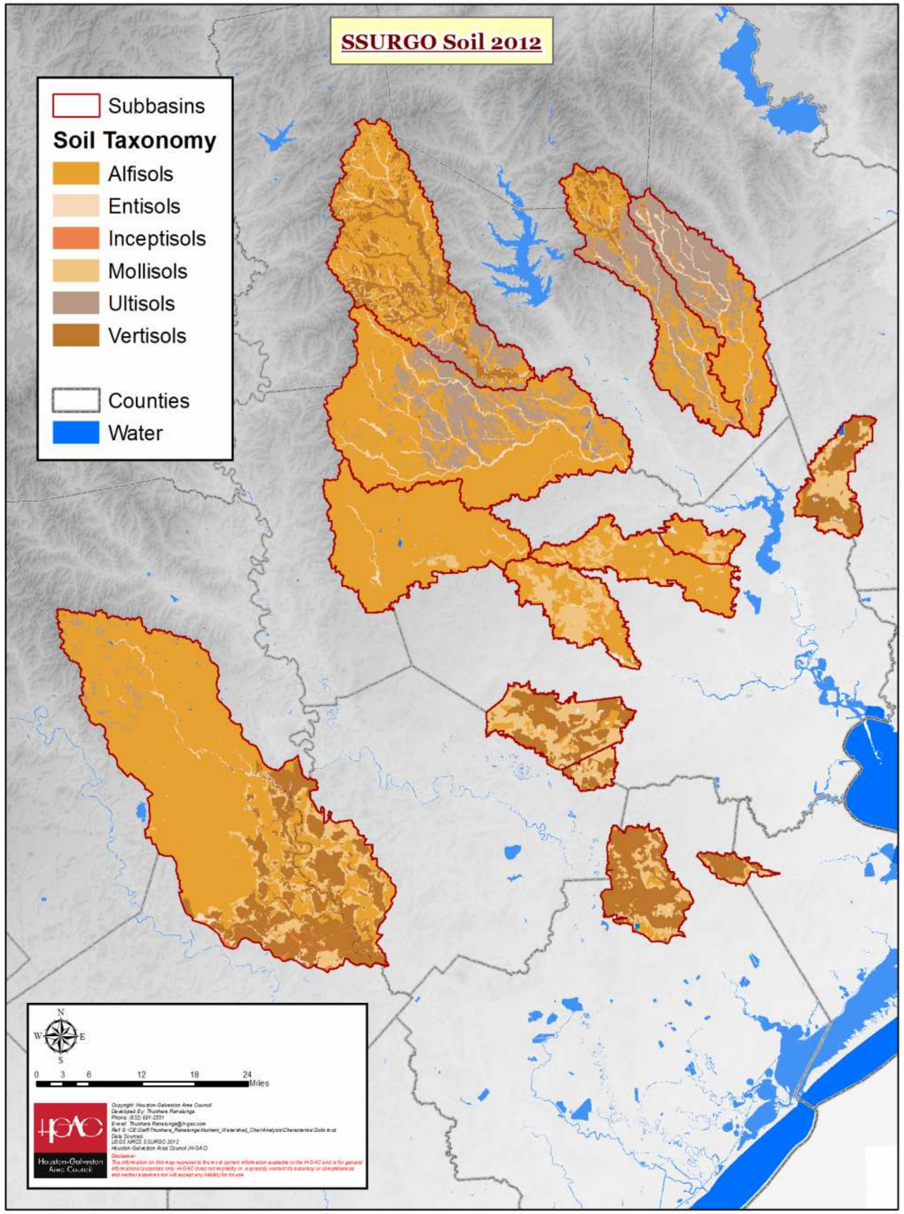
- Define and evaluate subwatershed characteristics
  - Number of upstream WWTFs with average permitted discharge (where available)



Methodology

- Define and evaluate subwatershed characteristics

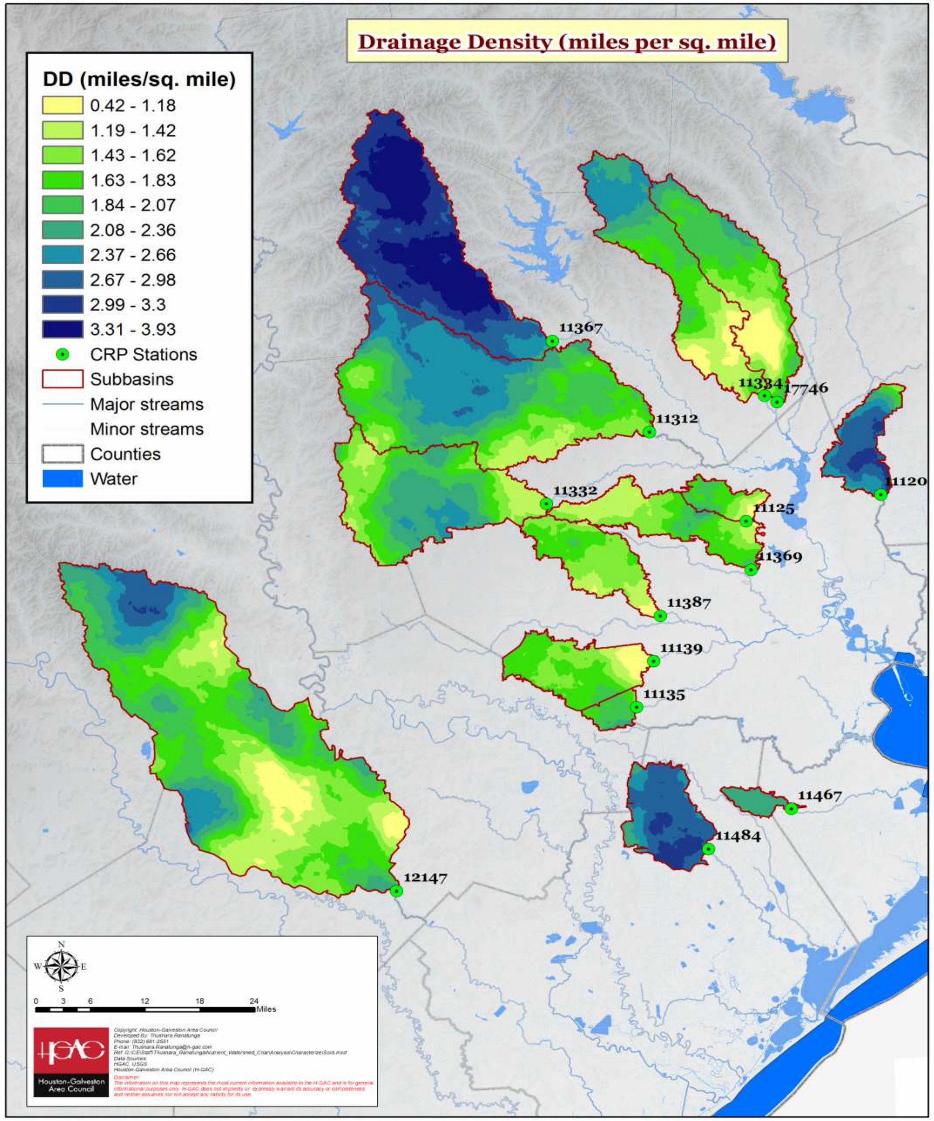
  - Soil types (including hydrological soil groups)



Methodology

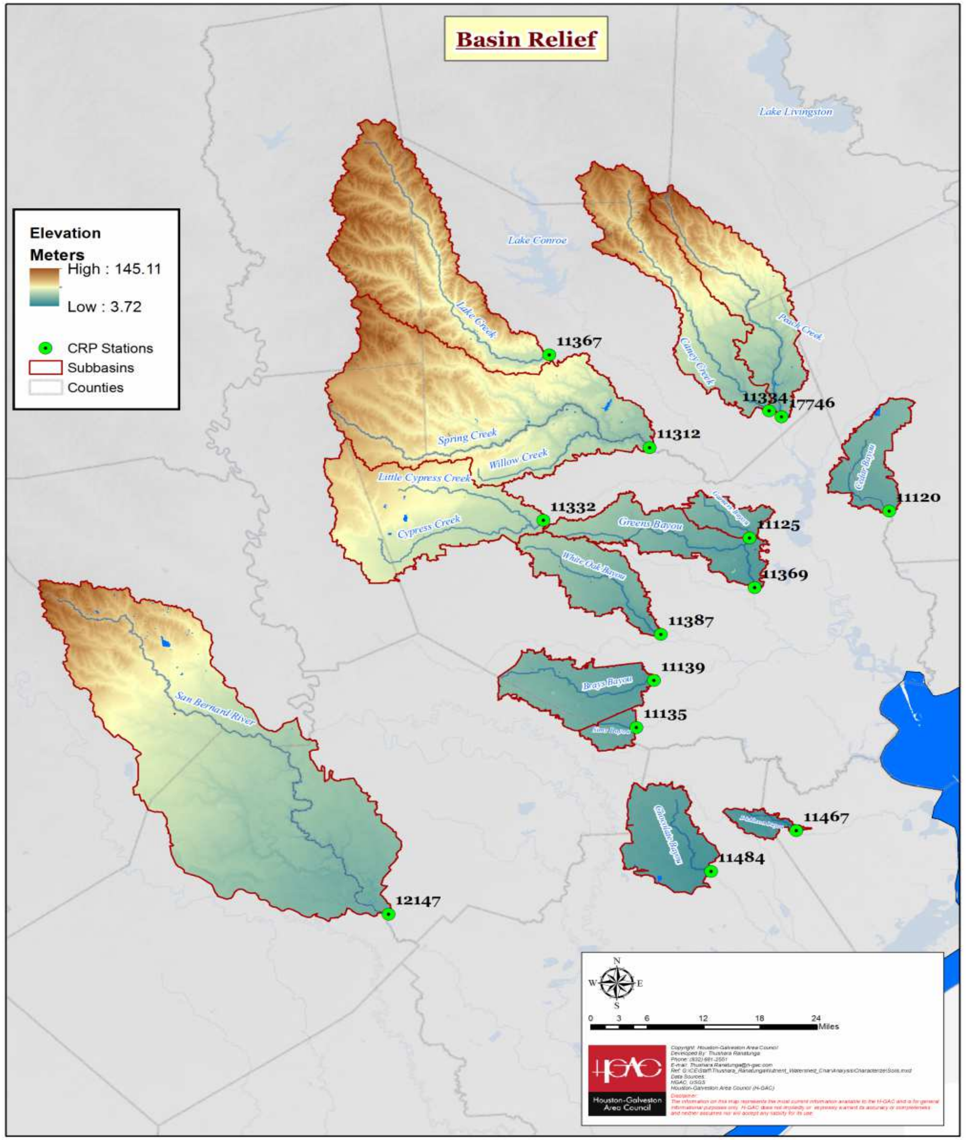
- Define and evaluate subwatershed characteristics

    - Drainage density and drainage area



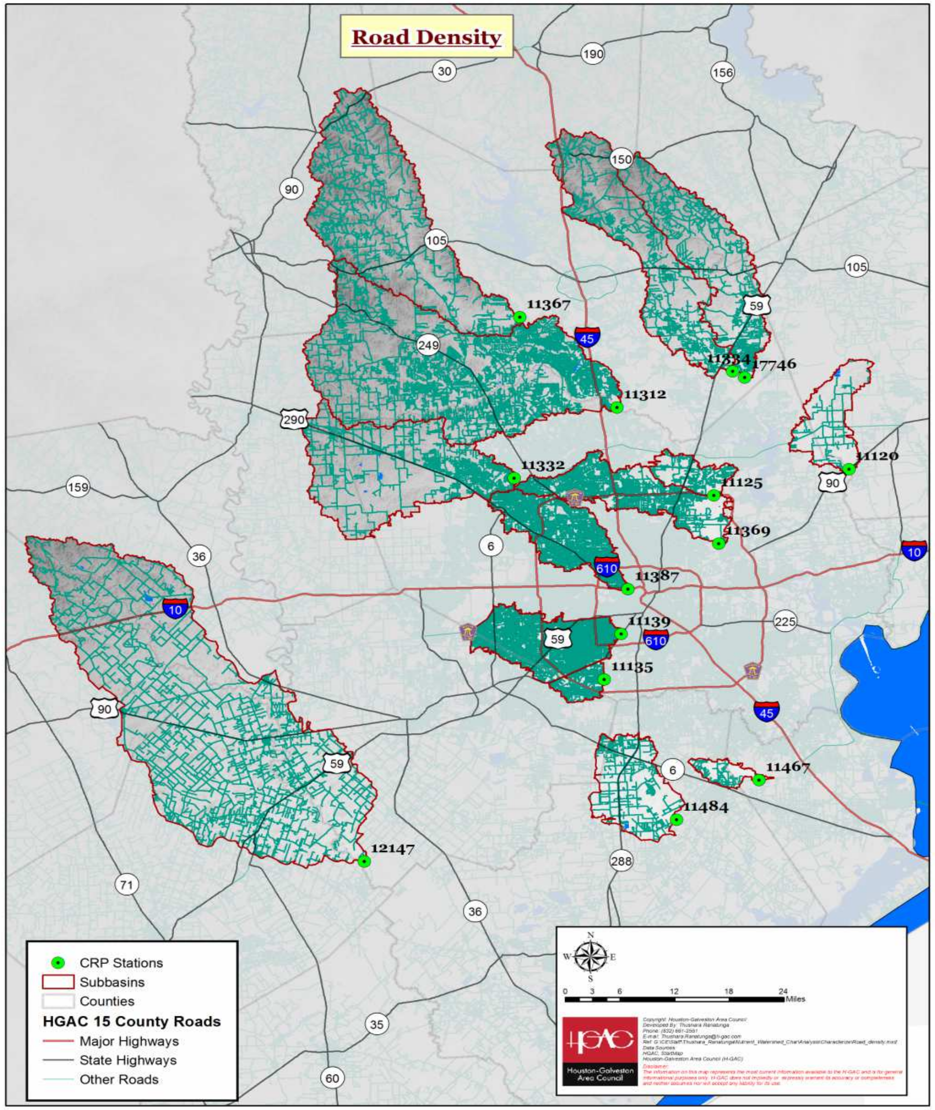
Methodology

- Define and evaluate subwatershed characteristics
  - Basin relief (including minimum, maximum and average elevation)



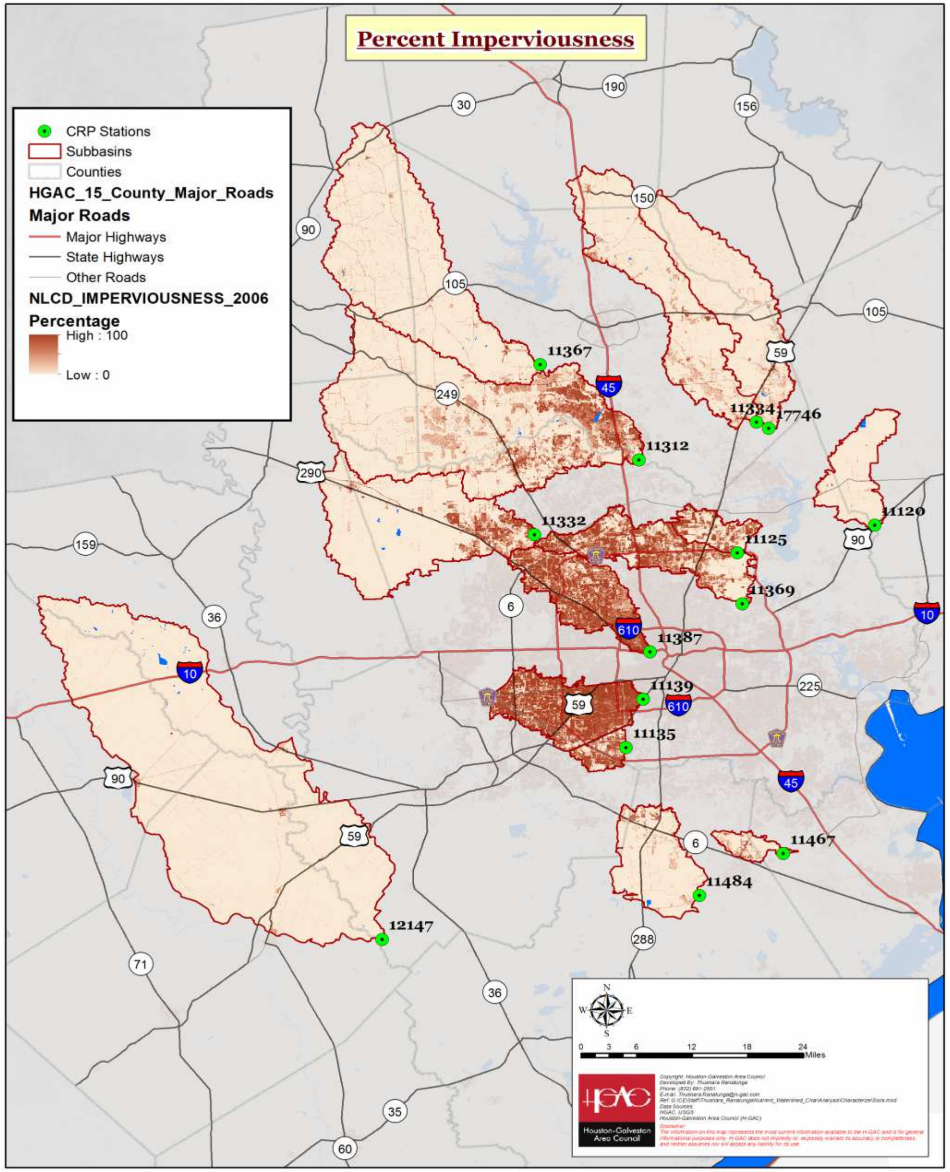
Methodology

- Define and evaluate subwatershed characteristics
  - Road density



Methodology

- Define and evaluate subwatershed characteristics
  - Imperviousness

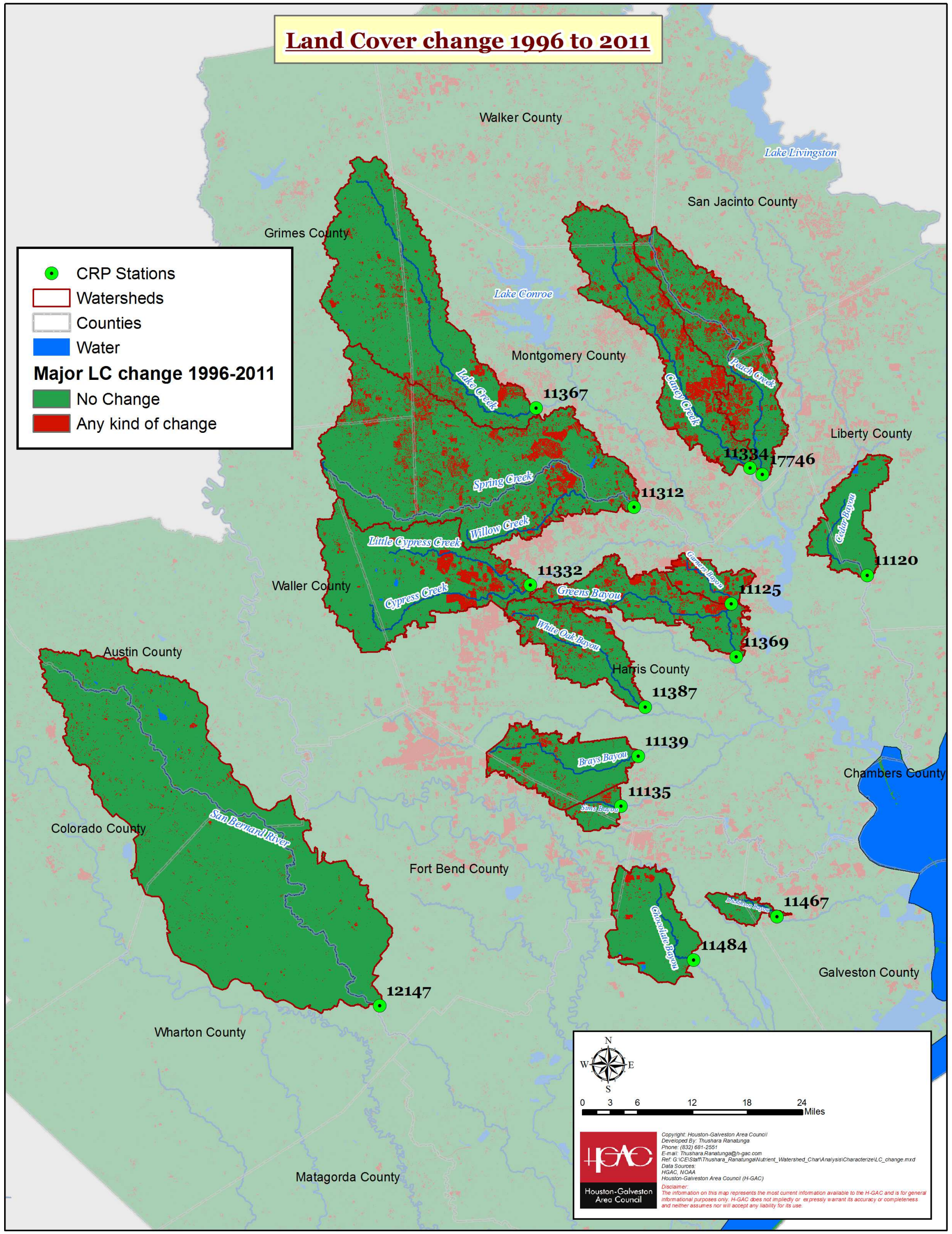


Land Use / Land Cover Categories Used in this Project

NOAA C-CAP 22 Class Classification	HGAC 9 Class Classification
Open Water (21)	Water (1)
Palustrine Aquatic Bed (22)	
Estuarine Aquatic Bed (23)	
Open Space Developed (5)	Developed Open Space (2)
Low Intensity Developed (4)	Developed (3)
Medium Intensity Developed (3)	
High Intensity Developed (2)	
Unconsolidated Shore (19)	Bare Land (4)
Barren Land (20)	
Deciduous Forest (9)	Forest (5)
Evergreen Forest (10)	
Mixed Forest (11)	
Scrub Shrub (12)	Scrub/Shrub (6)
Grassland (8)	Grasslands (7)
Pasture/Hay (7)	Cultivated (8)
Cultivated Land (6)	
Palustrine Forested Wetlands (13)	Wetlands (9)
Palustrine Scrub Shrub Wetlands (14)	
Estuarine Forested Wetlands (15)	
Estuarine Scrub Shrub Wetlands (16)	
Palustrine Emergent Wetlands (17)	
Estuarine Emergent Wetlands (18)	

Applied 9 Class Classification to all datasets (1996, 2001, 2006, and 2011)

Land Cover Change 1996 to 2011



Methodology

- Statistically analyze relationships between land cover and receiving water quality data
  - Increasing: > 5% change
  - Stable: + 5% to – 5%
  - Decreasing: < -5% change

Statistical Analysis

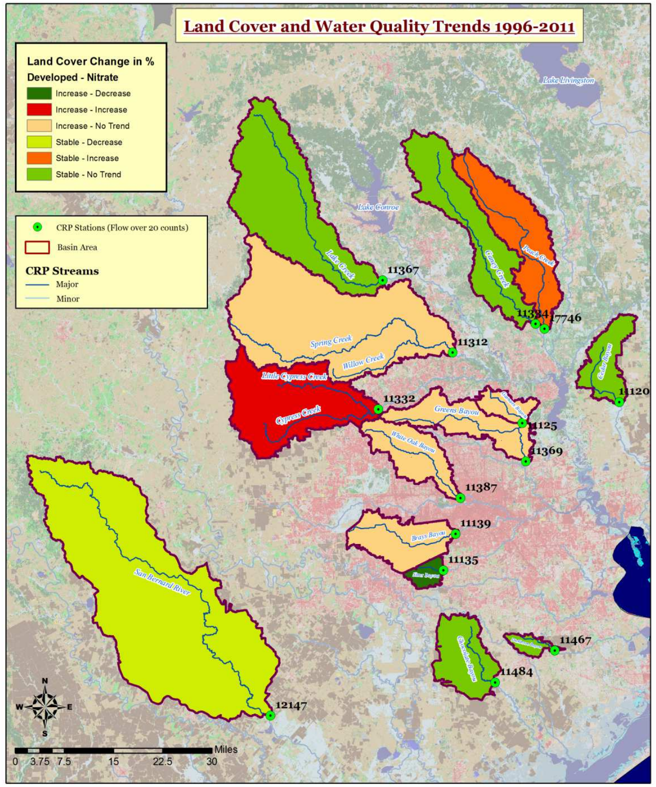
- Trends Analysis
- Regression Models
- Correlation Analysis
- Analysis of Variance
- Analysis of Covariance (General Linear Mondel)
- Canonical Correlation
- Discriminant Analysis

Methodology

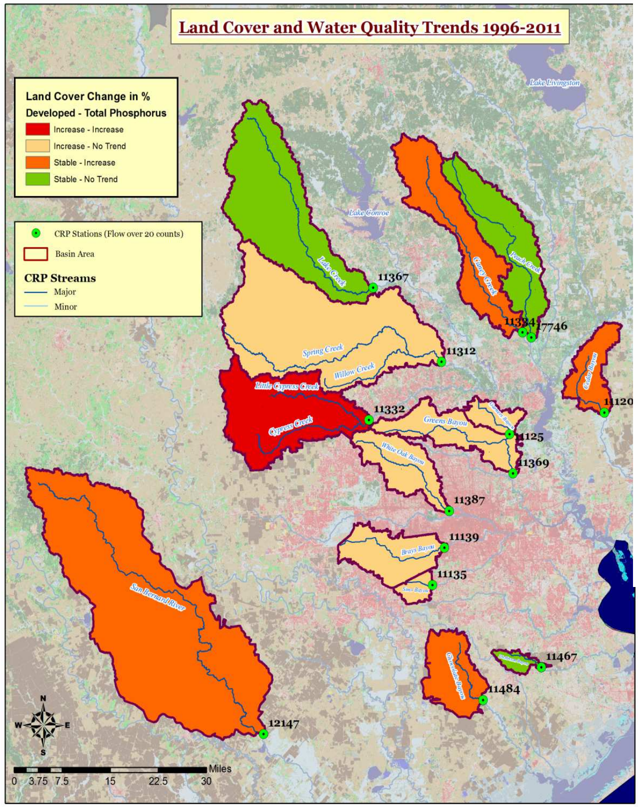
- Develop Load Duration Curves (LDC) estimates for constituents of concern
    - Calculated and plotted for each of the 14 stations for :
        - Nitrate
        - Total Nitrogen (TN)
        - Total Phosphorus (TP)

Results

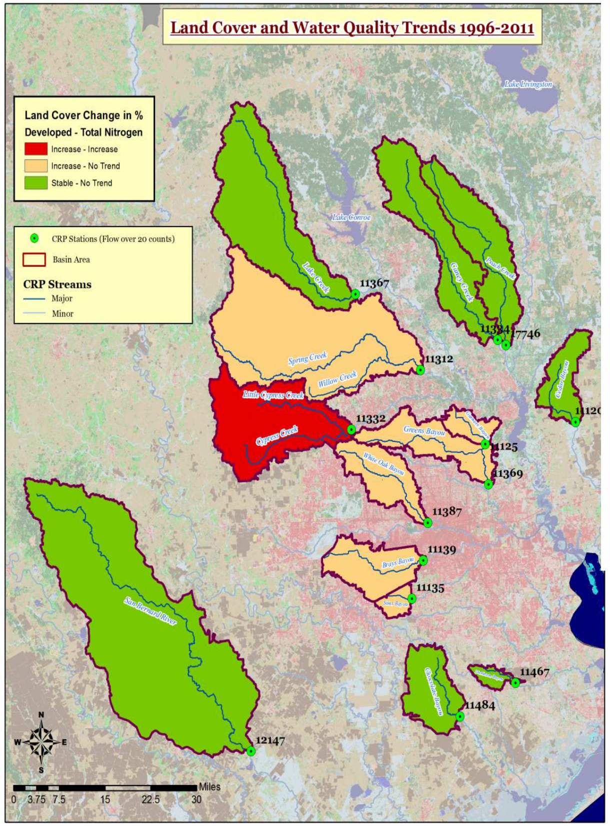
Developed Land and



Nitrate

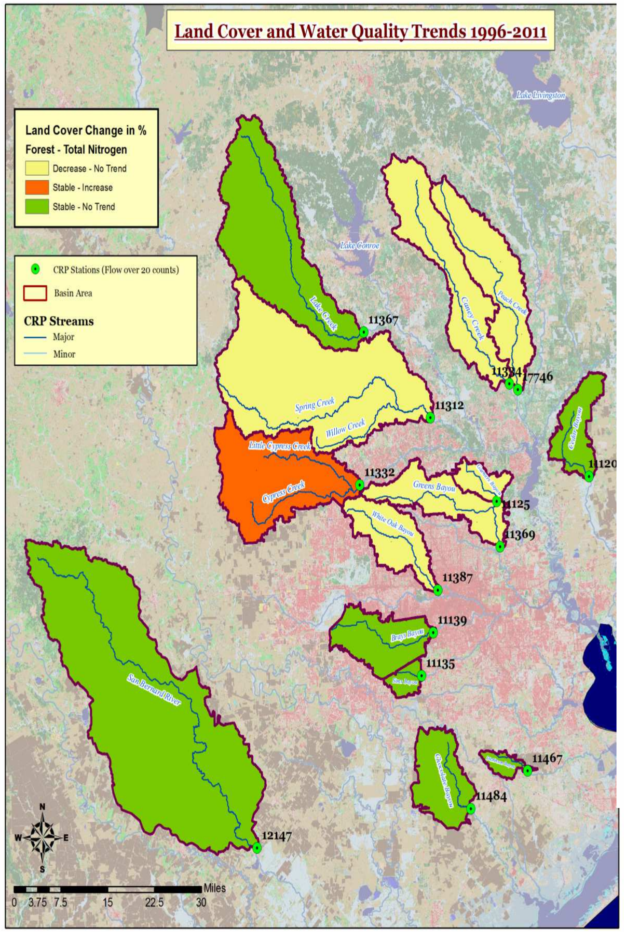


Total Phosphorus

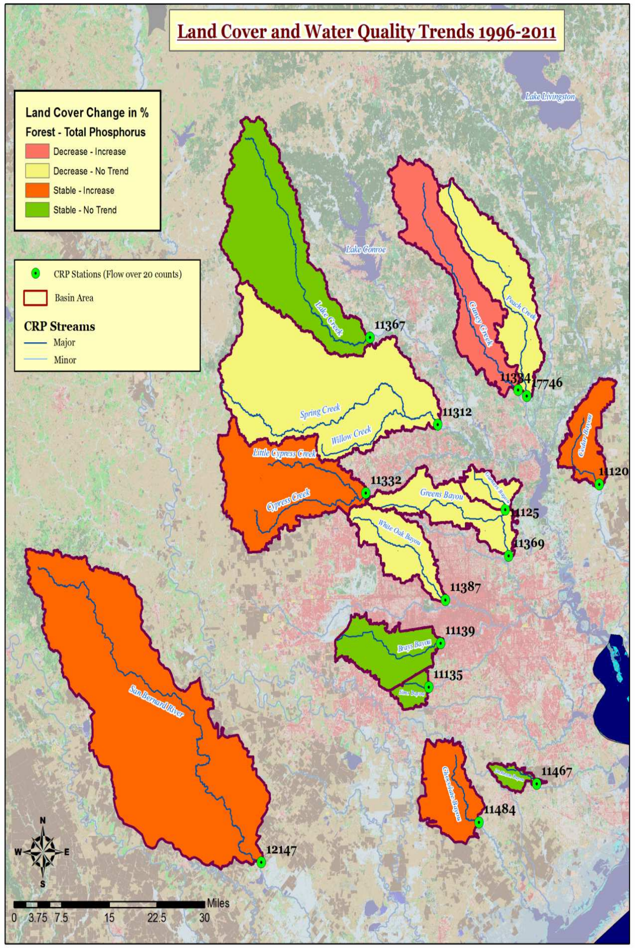


Total Nitrogen

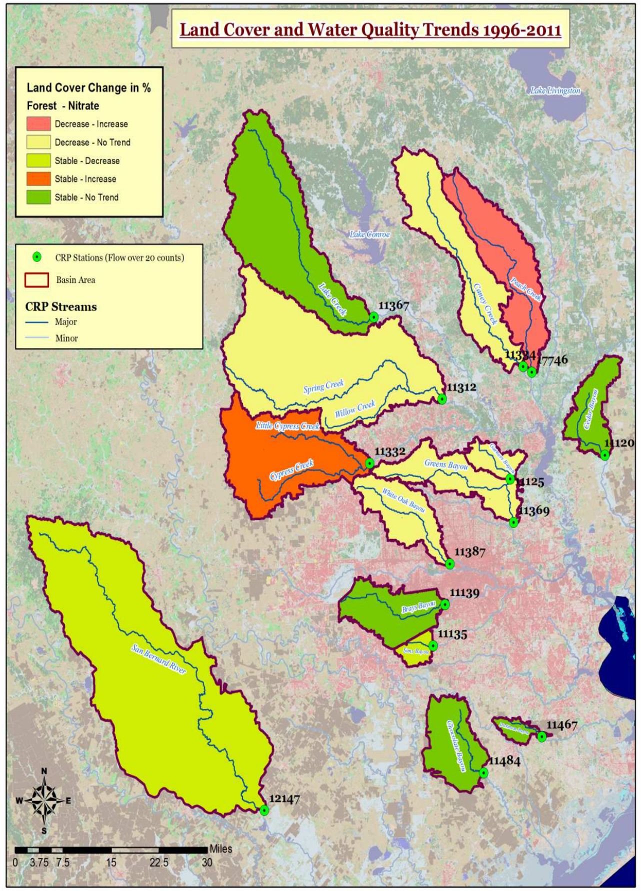
Forest Land Cover and



Total Nitrogen

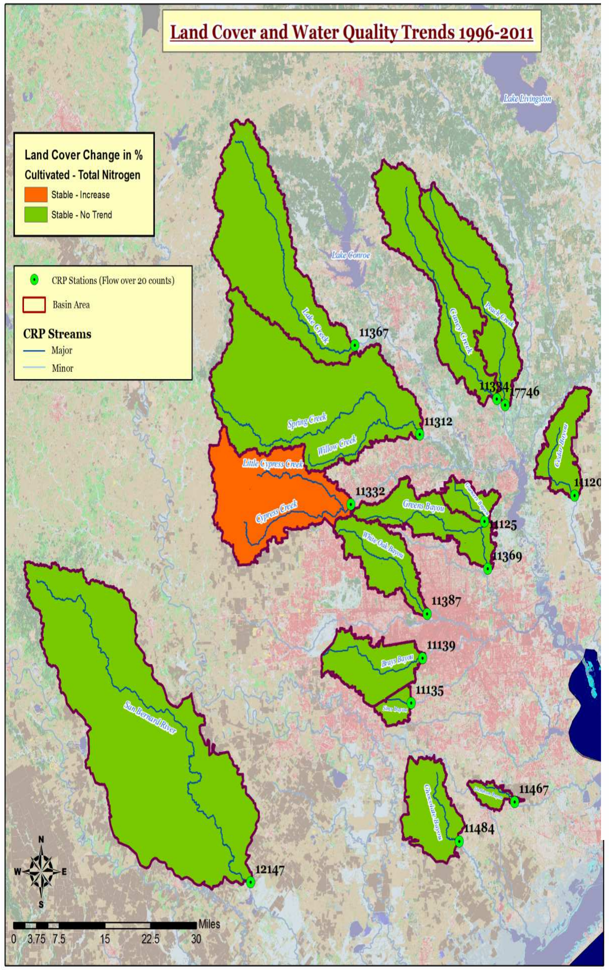


Total Phosphorus

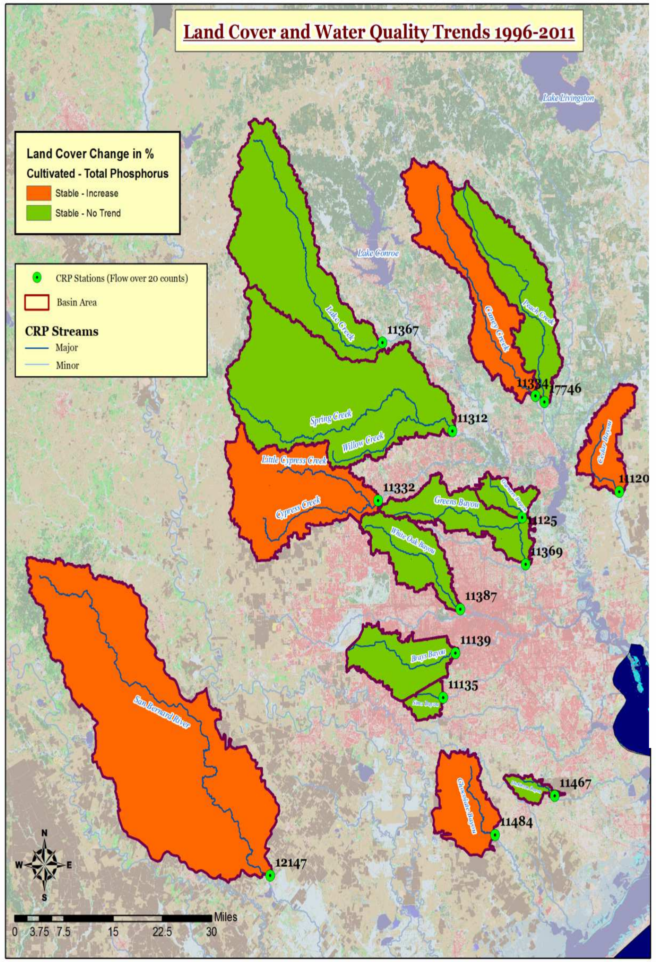


Nitrate

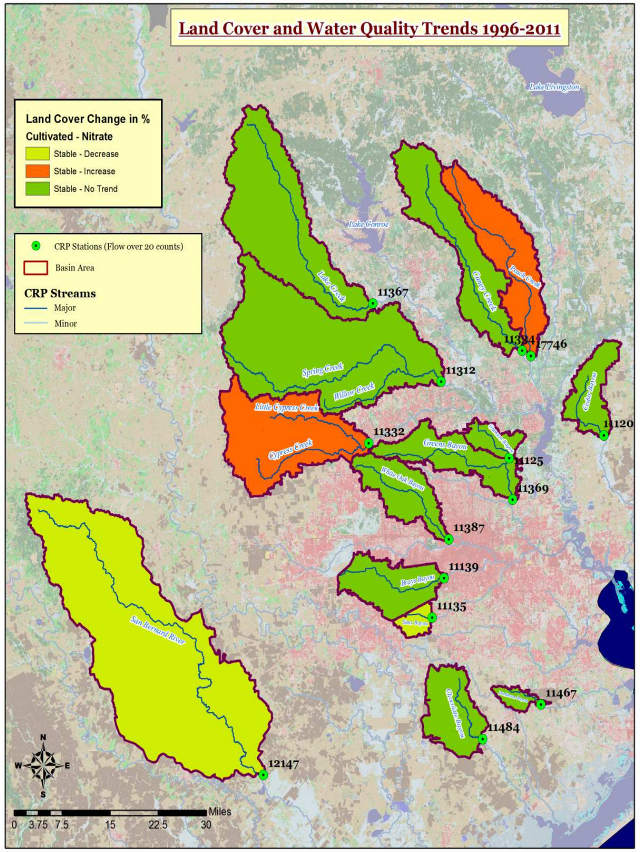
Cultivated Land and



Total Nitrogen

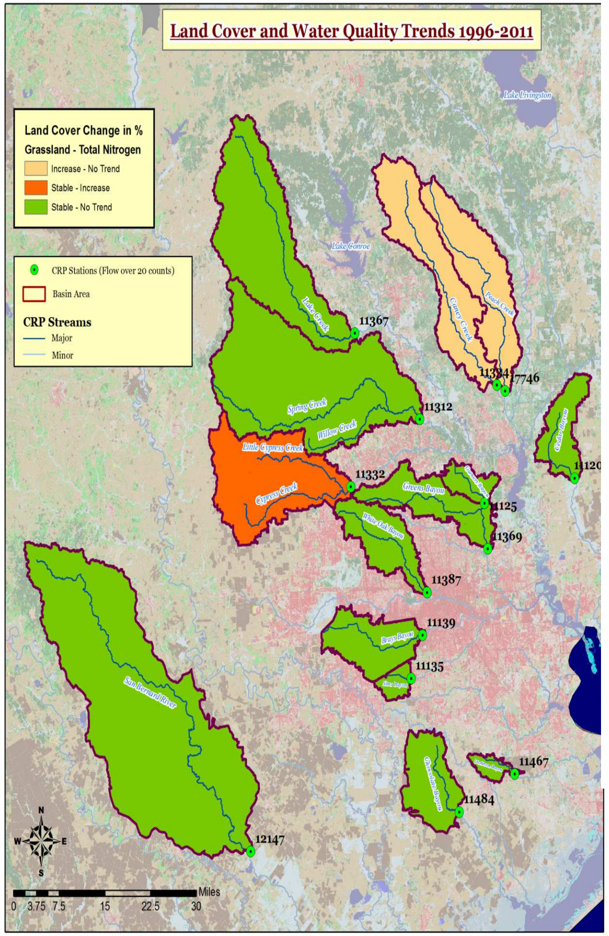


Total Phosphorus

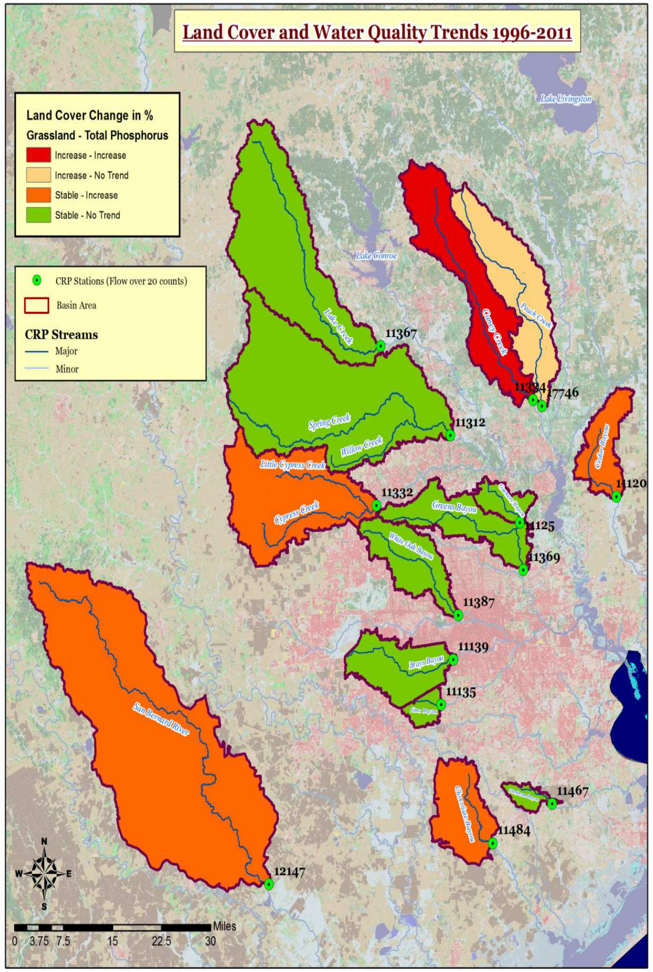


Nitrate

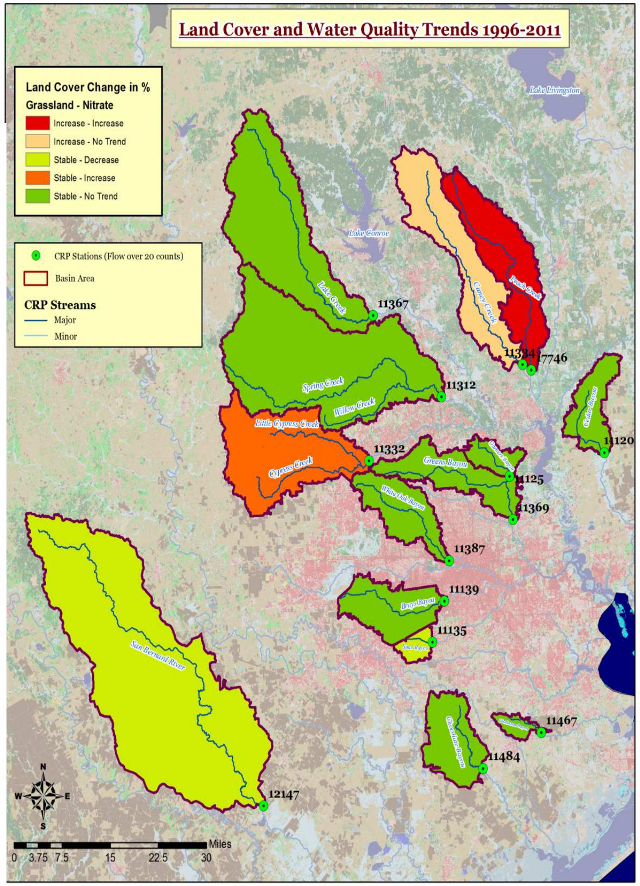
Grass Land and



Total Nitrogen

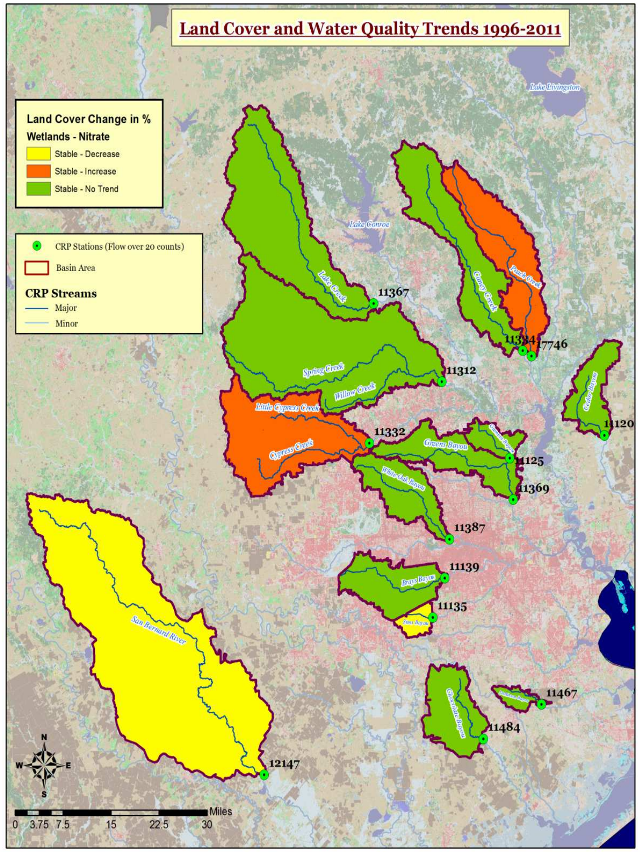


Total Phosphorus

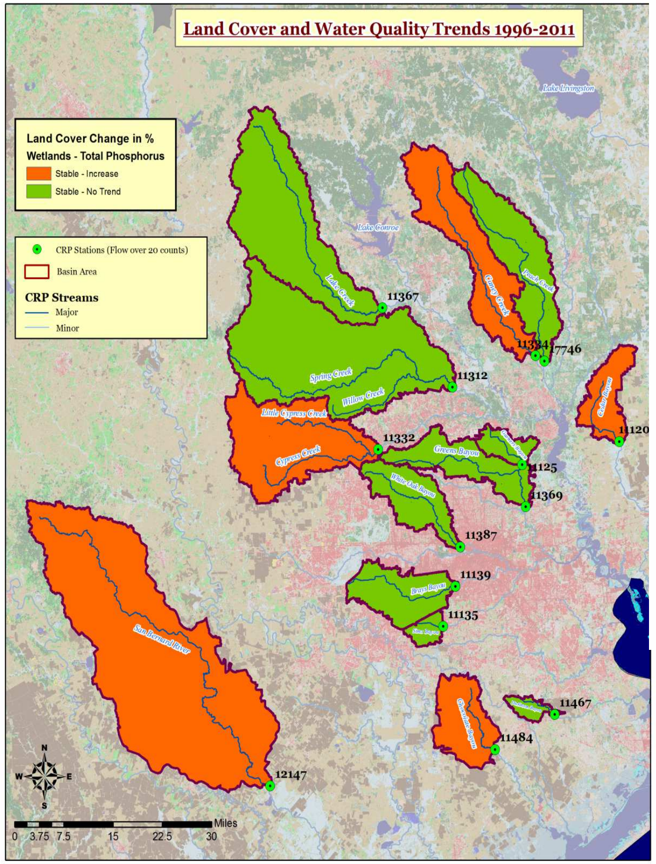


Nitrate

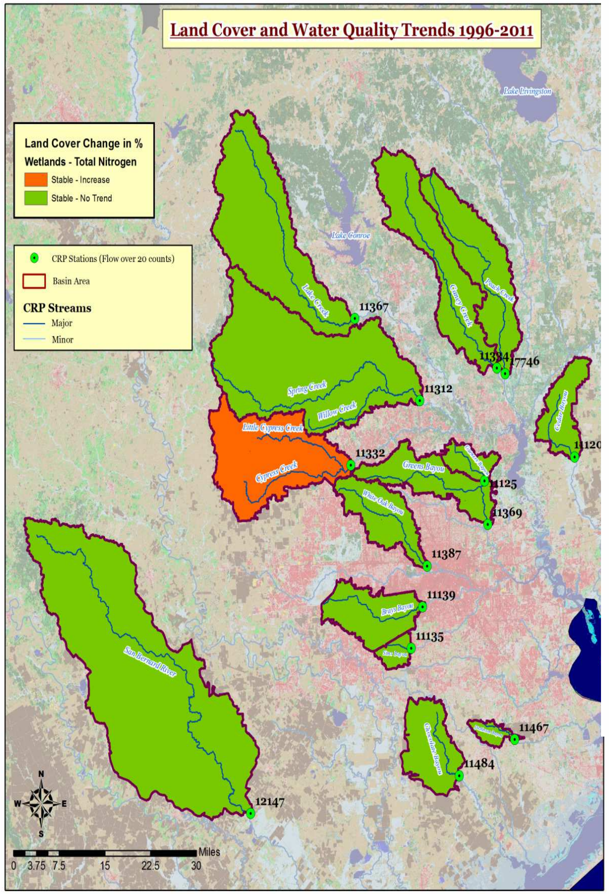
Wetlands and



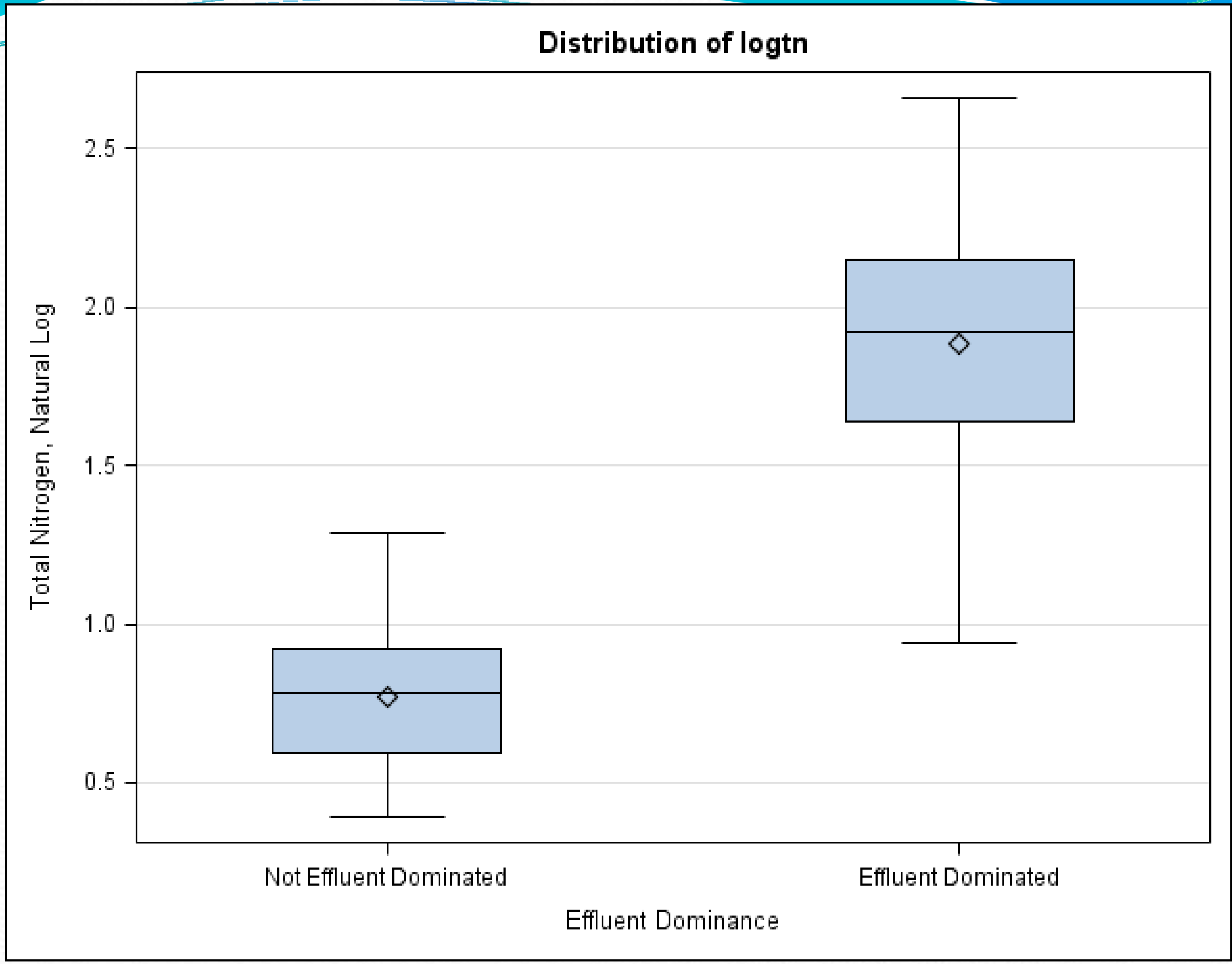
Nitrate



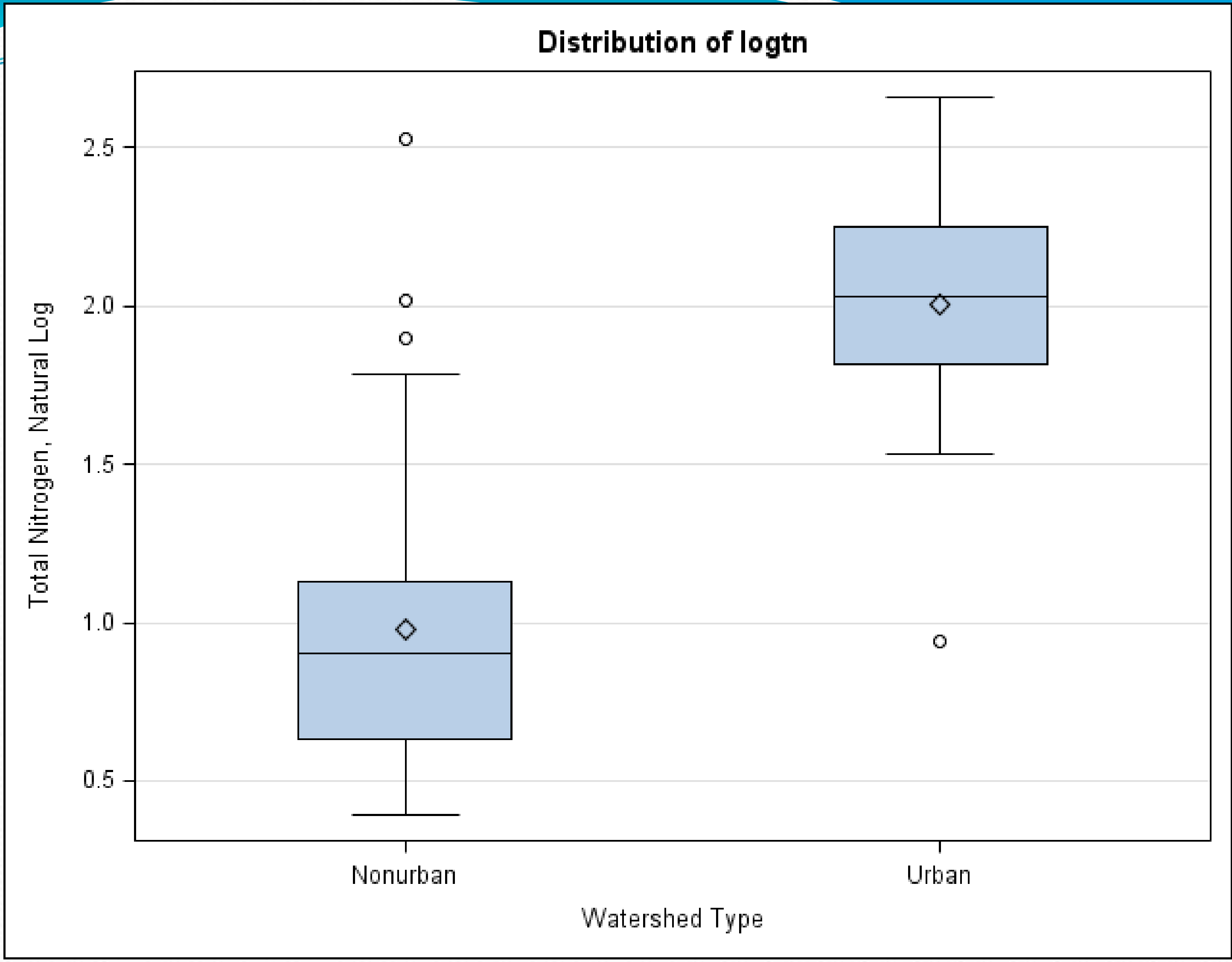
Total Phosphorus



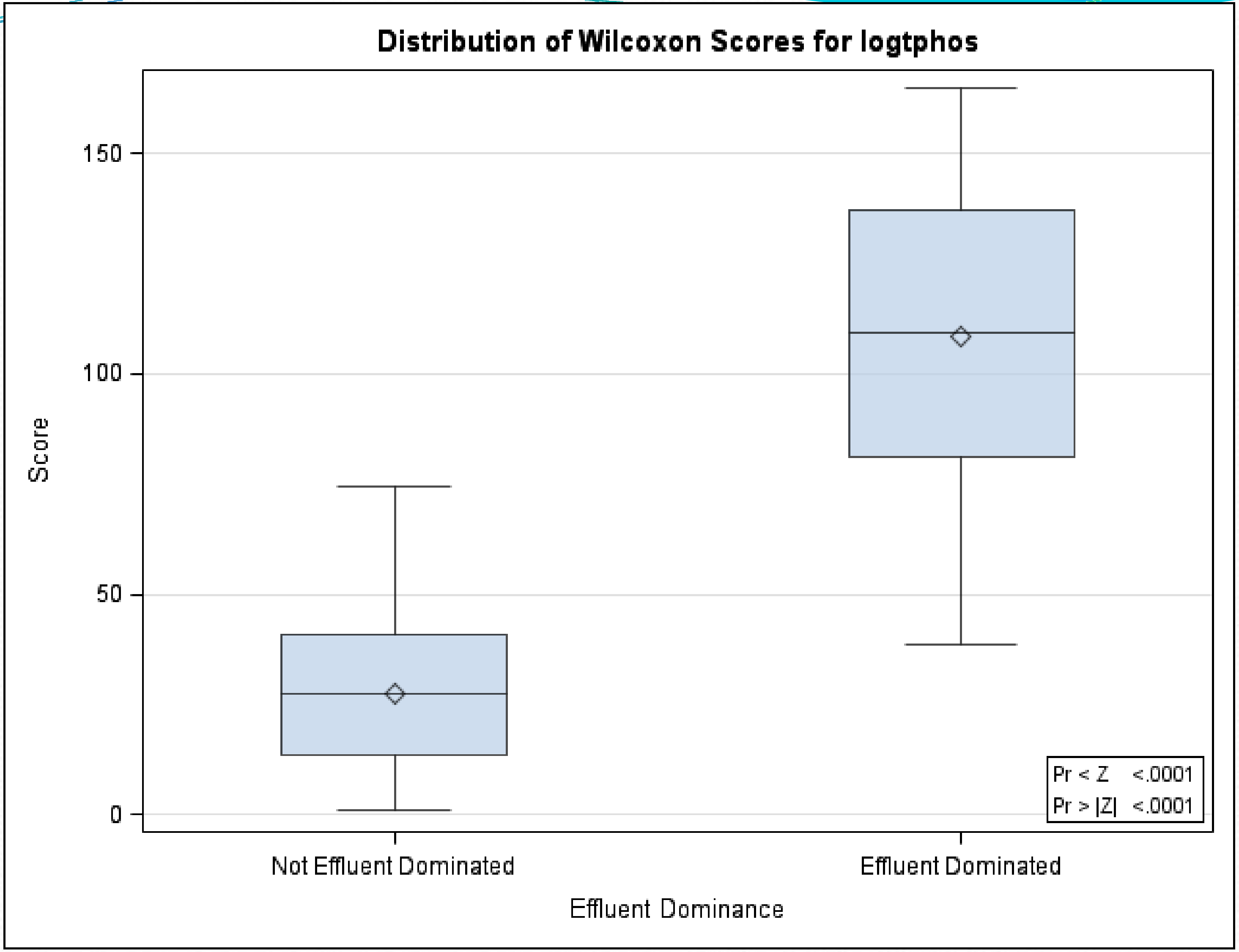
Total Nitrogen



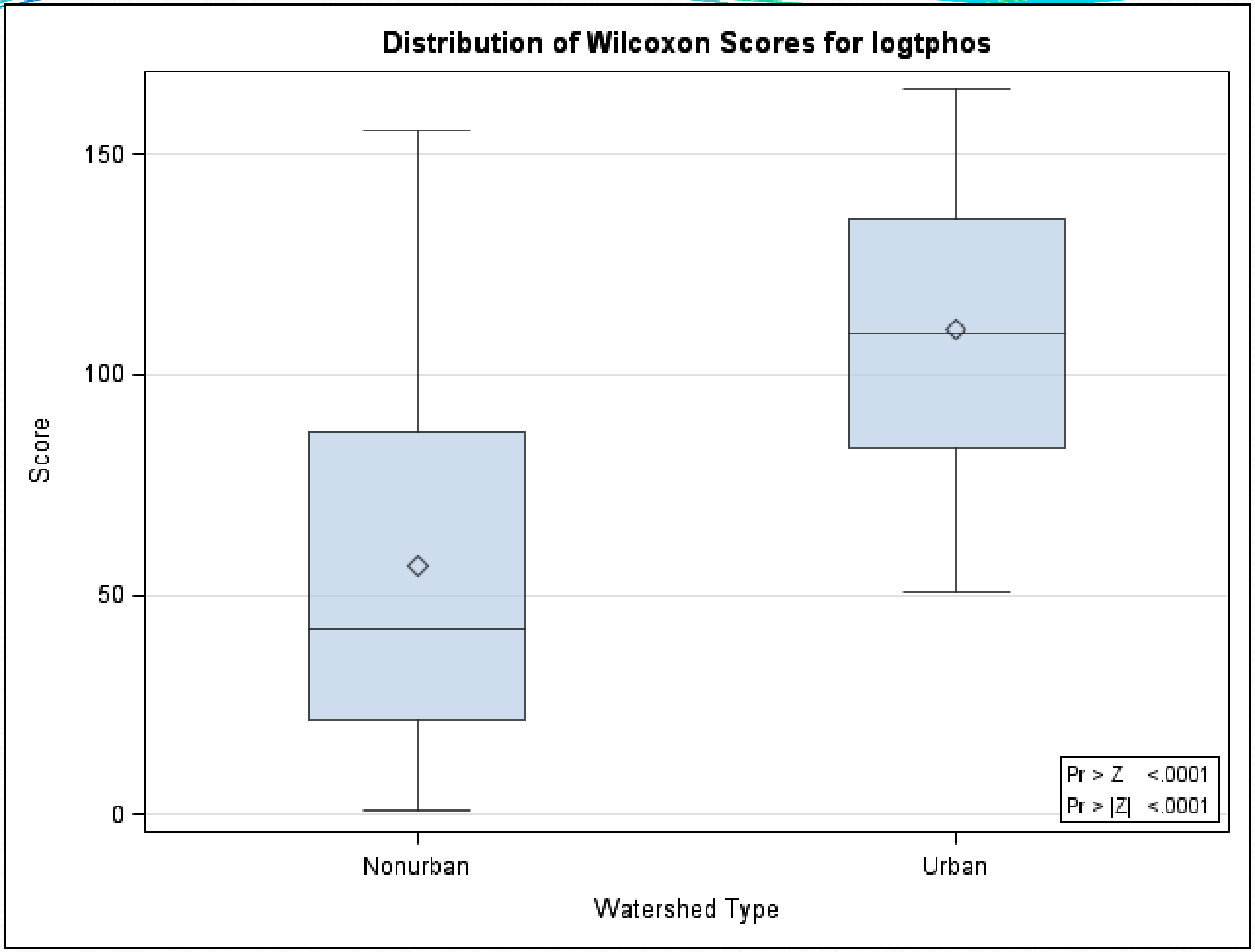
Distribution of Total Nitrogen for Ratio of Effluent Levels



Distribution of Total Nitrogen by Watershed Type



Distribution of Wilcoxon Scores for Total Phosphorus by Effluent Dominance



Distribution of Wilcoxon Scores for Total Phosphorus by Watershed Type

Summary

- Data from fourteen monitoring locations were analyzed
- Land cover change analysis – forested and cultivated land has highest loss
- Wastewater treatment plant effluent is a major source of nutrients
- Amount of discharge positively correlated with overall nutrient concentrations found in area waterways

Summary continued

- Nutrients concentrations are higher in urban watersheds
- Nutrients from impervious surface runoff could not be separated from wastewater contributions
- Sources present during low to mid-range flows are the largest sources of concern – point source, OSSFs, and riparian area
- Less developed watersheds show lower nutrient levels and no trend in any flow regime

Conclusions

- Real but relatively weak associations between land cover/land use and in-stream nutrient concentrations
- Wastewater effluent masked the influence of land cover variations
  - When removed, sample size was too small to reliably detect variables
- Nutrient concentrations are positively correlated with developed area and inversely related to forested land and wetlands

Path Forward

- Initial study was exploratory
- More/better data over a longer period is required
  - Reliable wastewater discharge data
  - Rainfall data collected closer to monitoring stations
- Delineate smaller study areas (watersheds) upstream of stations
  - Influence of nutrients maybe from nearby sources as opposed to coming from further upstream
- Need more data from streams NOT dominated by wastewater effluent
- Protect forested lands and wetlands – they are vital to water quality

Questions?

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