Consumptive Use of Septic Wastewater Treatment Systems: Demonstration of a Paired Watershed Approach

Metropolitan North Georgia Water Planning District

Wastewater TCC

July 10, 2008

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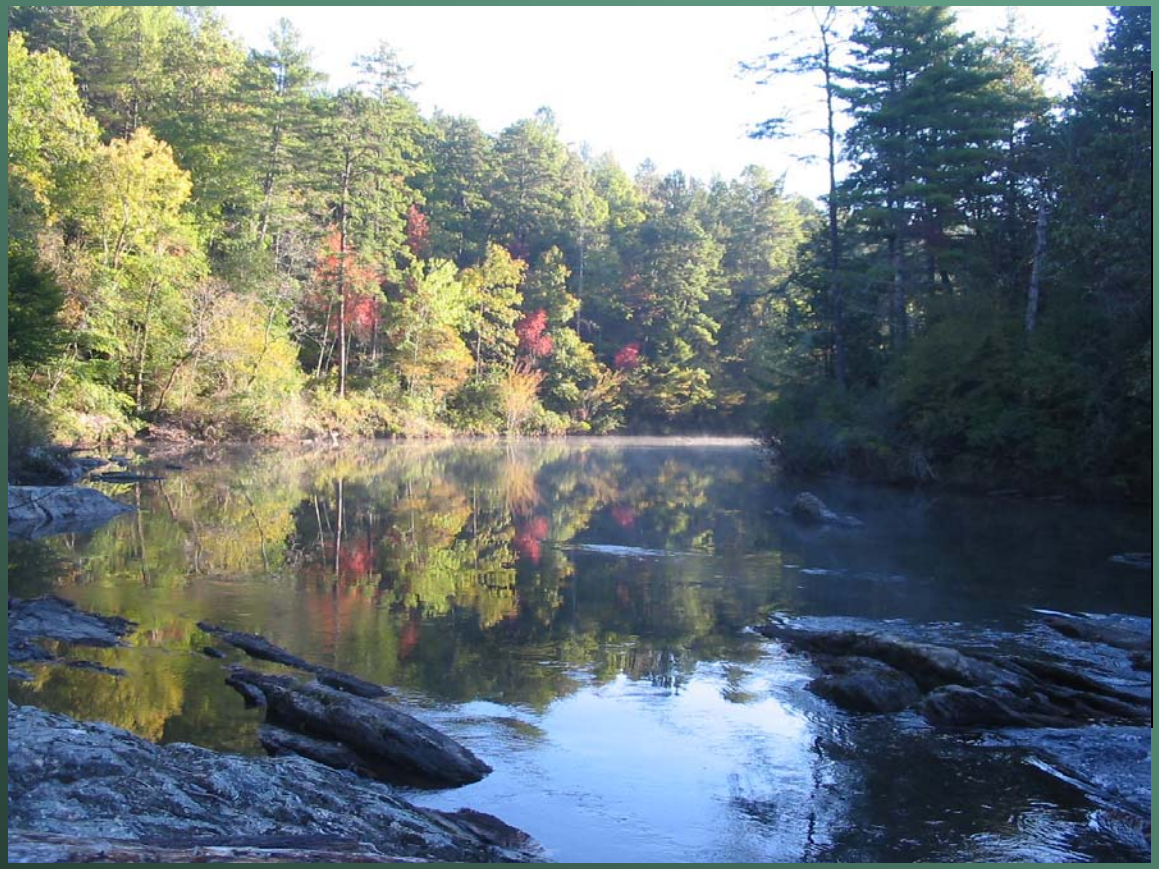
U.S. Geological Survey



Preliminary results. Subject to revision.

Consumptive Use of Septic Wastewater Treatment Systems: Demonstration of a Paired Watershed Approach

Outline

- **Background – Septic Systems in District**
- **Urban GW Recharge & Septic Systems**
- **Paired Watershed Approach**
  - **Stream Baseflow Analysis**
  - **Water-Use Analysis**
- **Results and Discussion**

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Preliminary results. Subject to revision.

Background

>Over 26% of the Metro Atlanta region's homes have Onsite Wastewater Septic Systems

>Consumptive Use of Septic Systems is undefined in State Water Plan and ACF negotiations

>Common perception in Georgia that Septic Systems are highly consumptive

Georgia Comprehensive State-wide Water Management Plan

SECTION 9: WATER RETURN MANAGEMENT PRACTICES

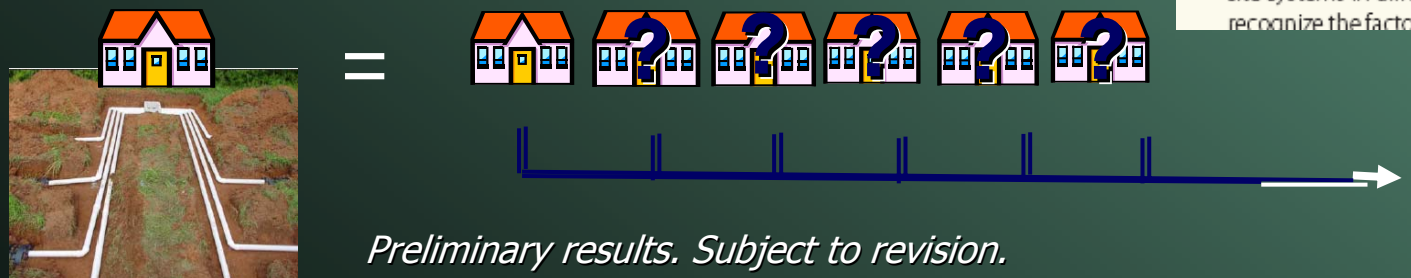
Policy: On-Site Sewage Management Systems

(1) Properly sited, constructed, and maintained on-site sewage management systems are a cost-effective, long-term option for meeting public health and water quality goals, particularly in less densely populated areas.

(3) Managing the effect of on-site sewage management systems on the quantity of water returned to surface water sources may be a component of managing consumptive use. The significance of this component will vary with the condition of individual water sources and the characteristics of the uses of that source. This component of consumptive use is more important to manage in areas where the source of the water is surface water, and where consumptive use from that source is approaching its consumptive use assessment.

Implementation Actions

(1) The Division's guidance for regional planning written pursuant to section 14 of this plan may address region-specific benchmarks for return flows to individual water sources and mechanisms for meeting those benchmarks. This guidance will be based on the best available information on quantities and timing of surface water returns from on-site systems in different parts of the state. The guidance will recognize the factors that determine the relative significance



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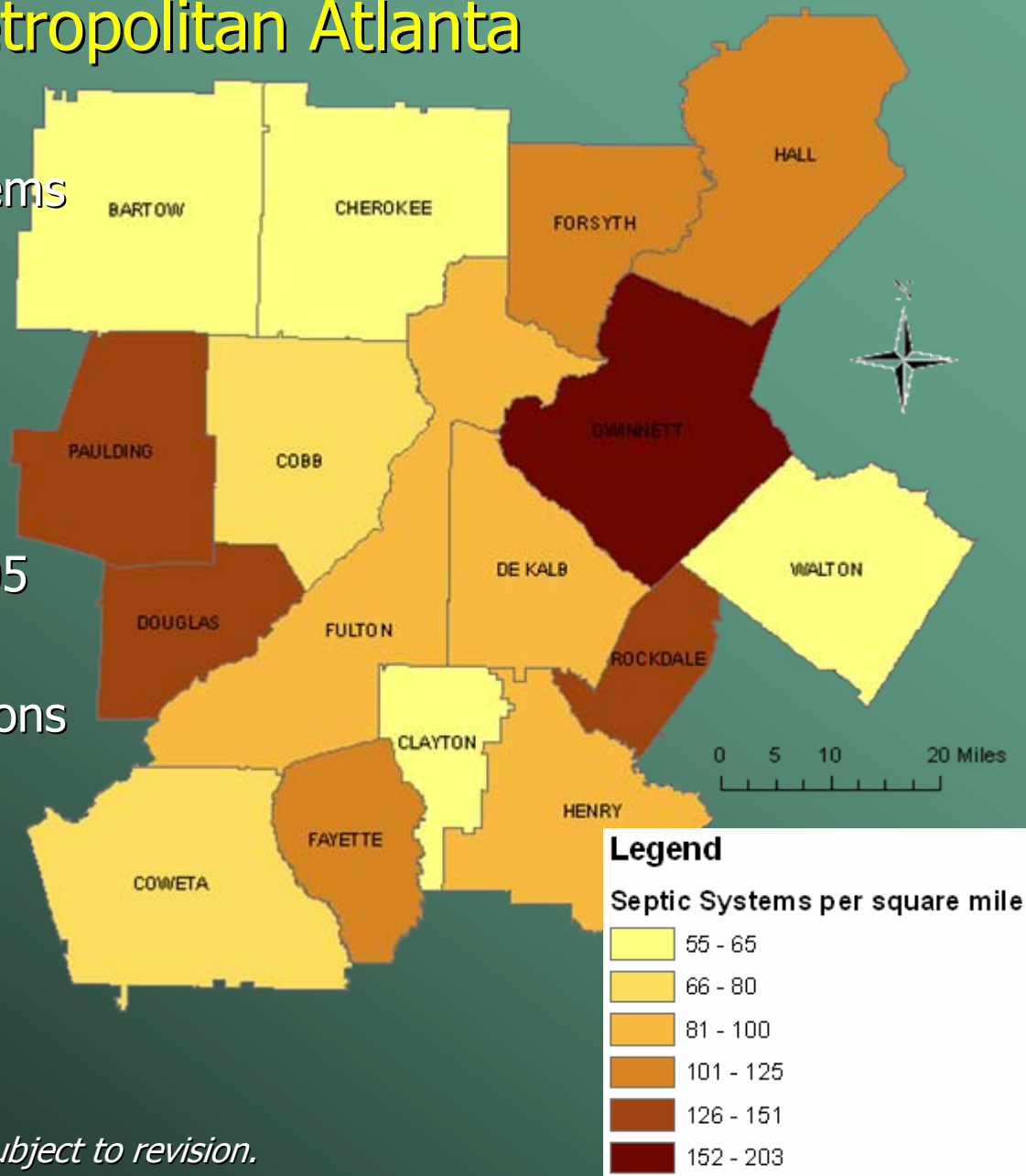
Septic Systems in Metropolitan Atlanta

- An Estimated 526,000 Systems in 16-county area in 2005
- An Estimated 12,000 New Systems per Year
- About 26% of Residences
- Very Rough Estimate of 2005 Septic System Water Use ≈ (526,000 x 75gpcd x 3 persons x 0.75 indoor)
  ≈ 90 MGD
  ≈ ¼ to ½ C.U. Estimates



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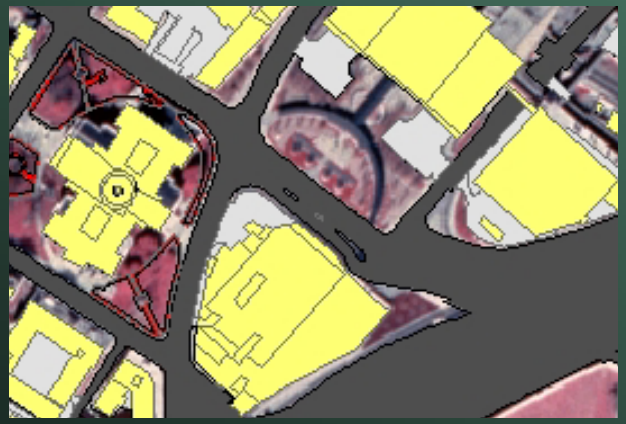
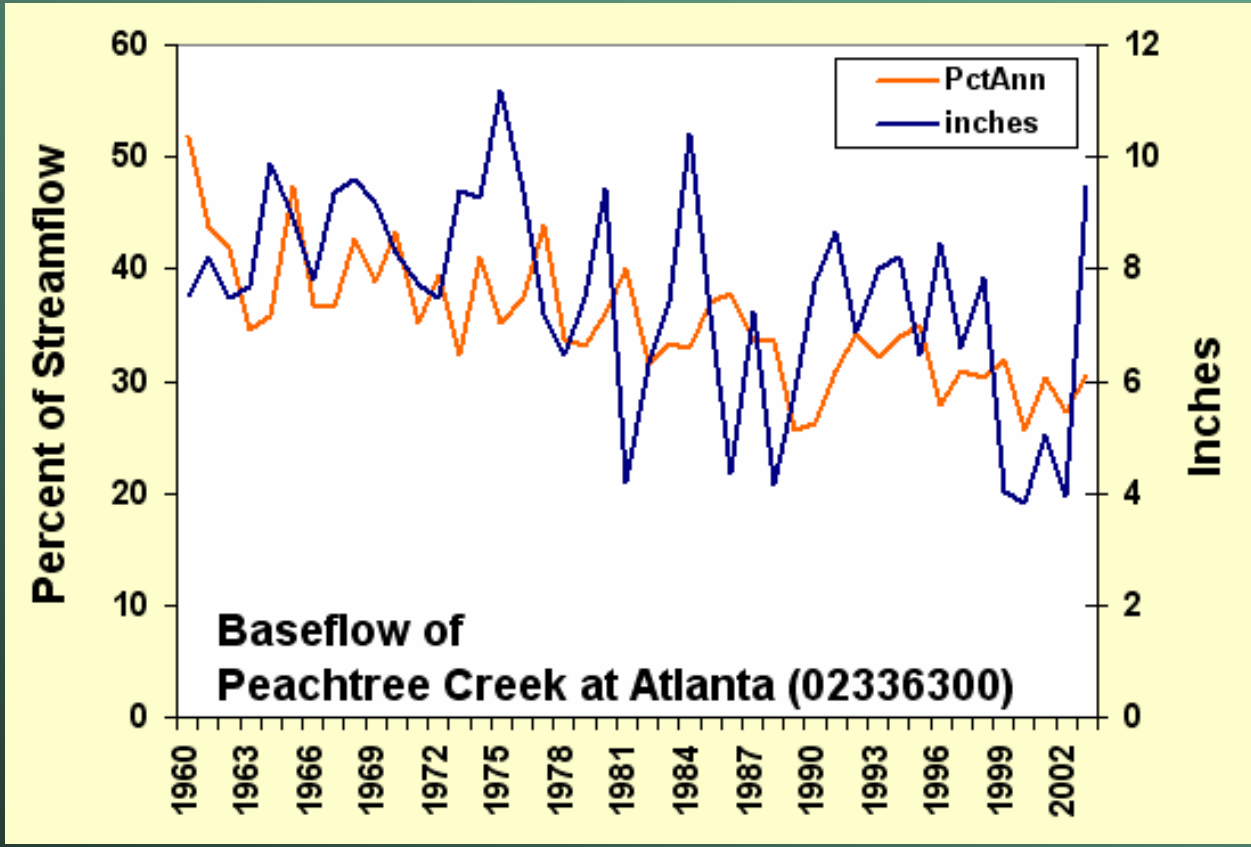
Urban factors potentially decreasing ground-water recharge and stream baseflow

- Impervious Surfaces
- Constructed Drainage Paths
- Altered Land Cover





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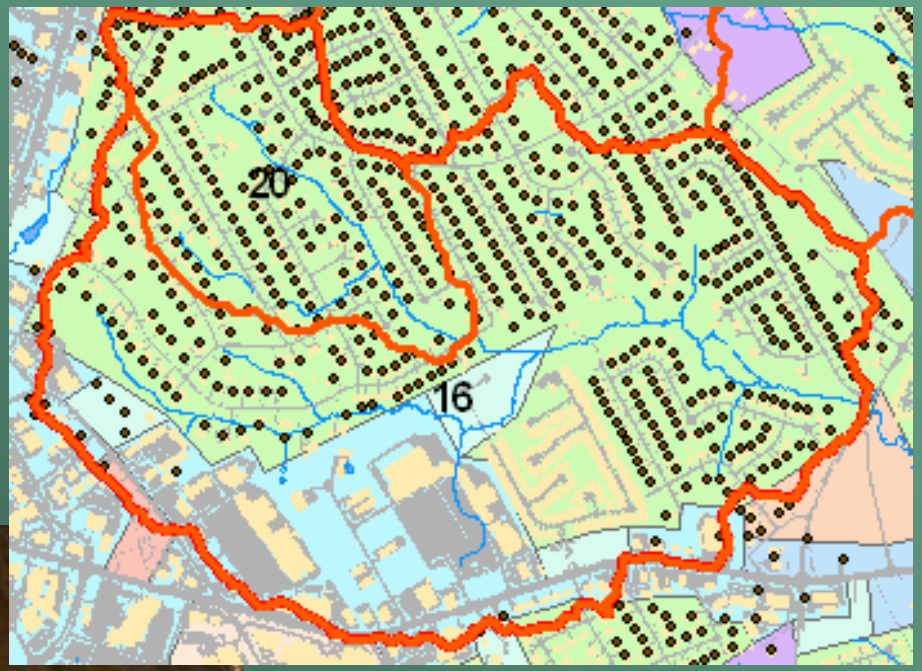
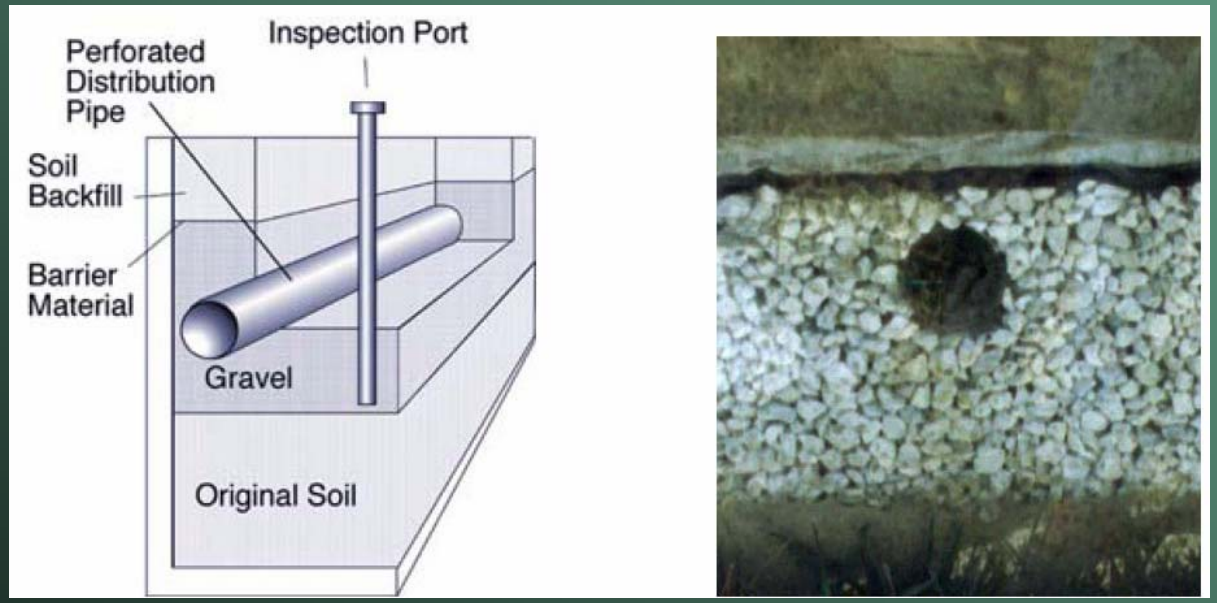
Urban factors potentially increasing ground-water recharge and baseflow

- Leaking Water Supply Mains
- Septic System Absorption Fields
- Excess Irrigation
- Infiltration Ponds
- Leaking Storm Sewer Systems
- Reduced Evapotranspiration



Hydrology of Septic System Absorption Fields

- In percolating soils with adequate transmissivity
- Generally not in root zone; relatively low ET
- Relatively level areas
- Steady Flow, relative to natural recharge sources



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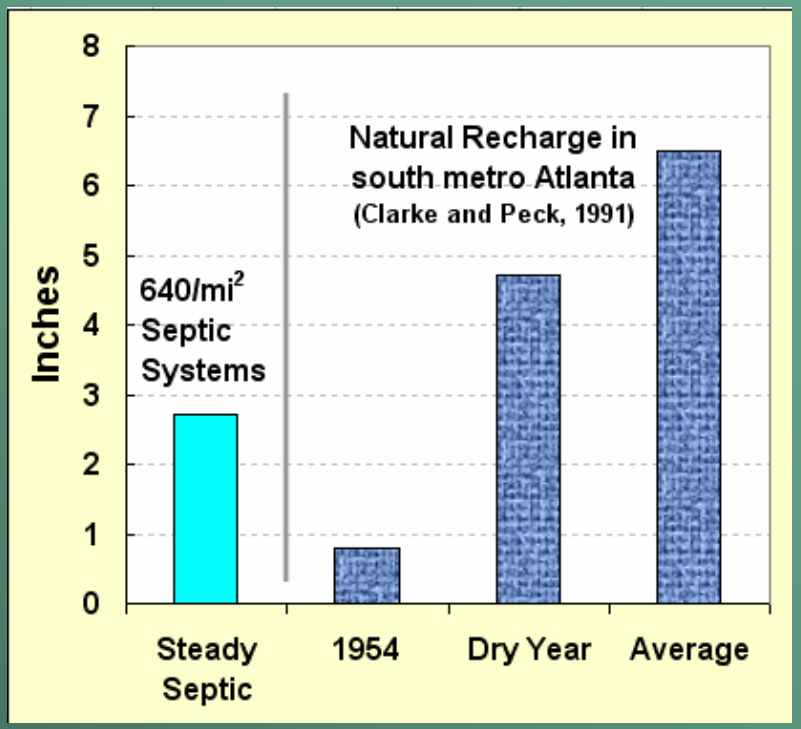
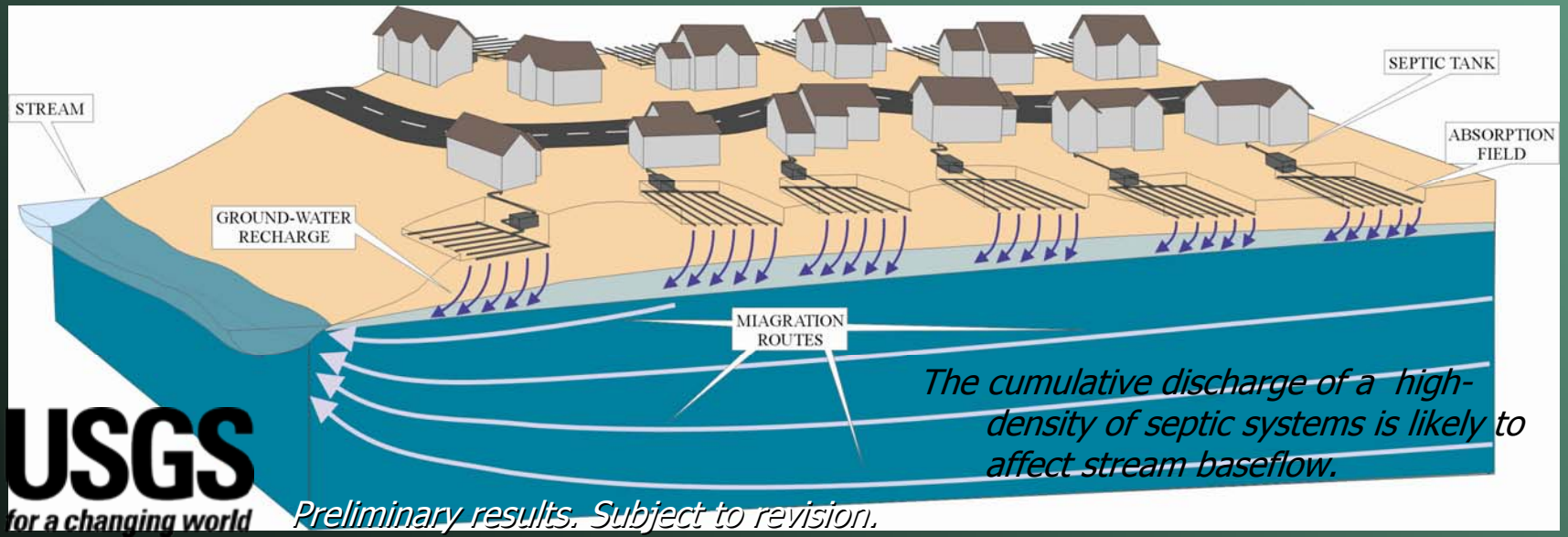
Hydrology of Septic System Absorption Fields

A hypothetical basin with 640 septic systems per square mile with 200gpd per system produces **2.7 inches** of ground-water inflow per year.





The cumulative discharge of a high-density of septic systems is likely to affect stream baseflow.

Preliminary results. Subject to revision.

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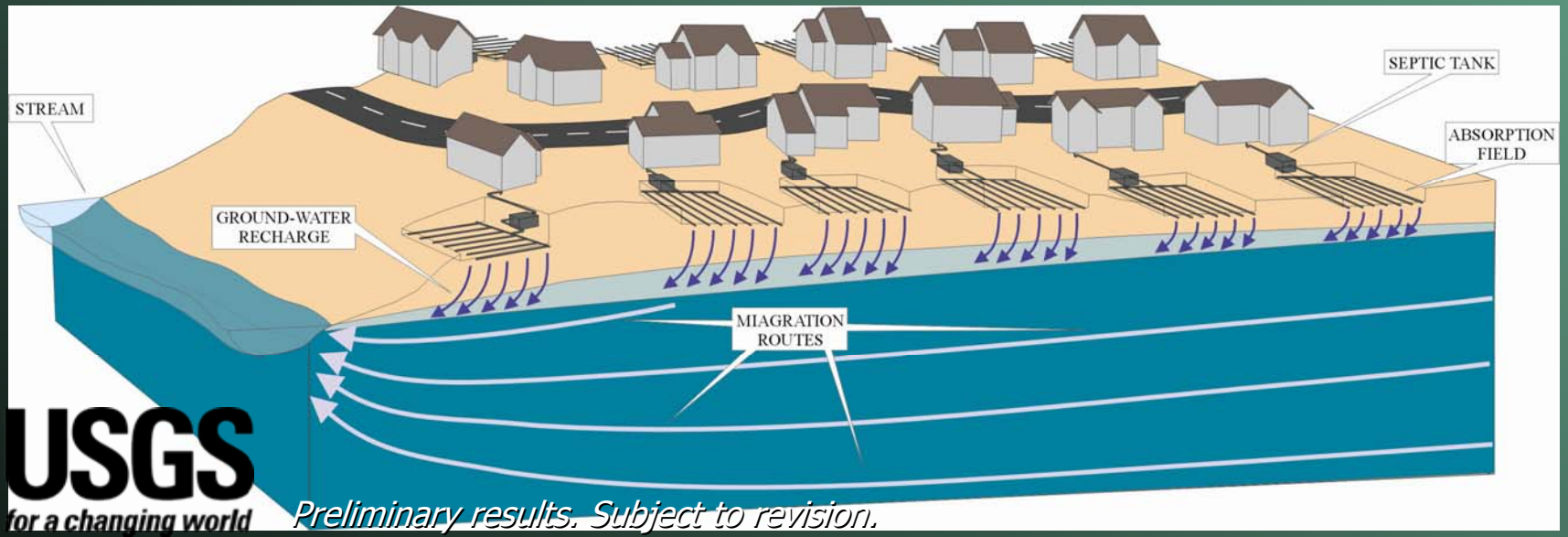
Hydrology of Septic System Absorption Fields

Stream baseflow will begin to increase when the 'head', the hydraulic slope of the ground-water table increases. The time required for this head increase depends on soil hydraulic conductivity and other factors and is variable.

The increase in hydraulic gradient and stream baseflow will occur before the actual water from septic systems reaches the stream.



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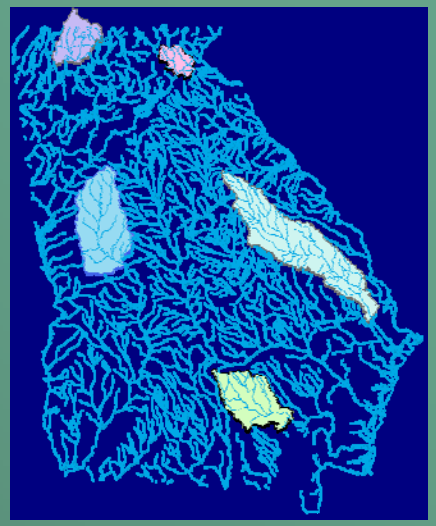
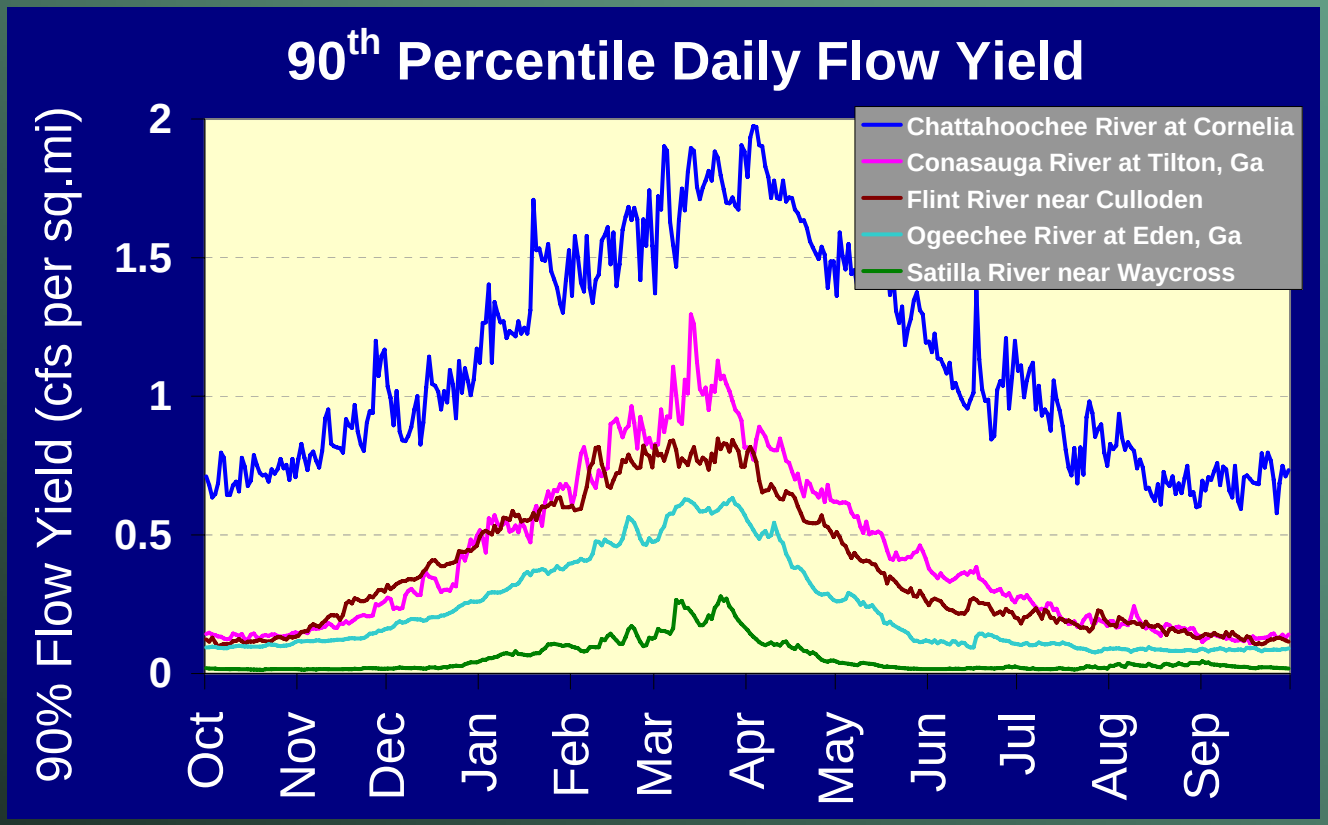
Natural factors affecting stream baseflow



- Climate
- Geology/ soils
- Topography / slope
- Vegetative Land cover

Stream Baseflow varies by several hundred percent seasonally, year to year, and across the State

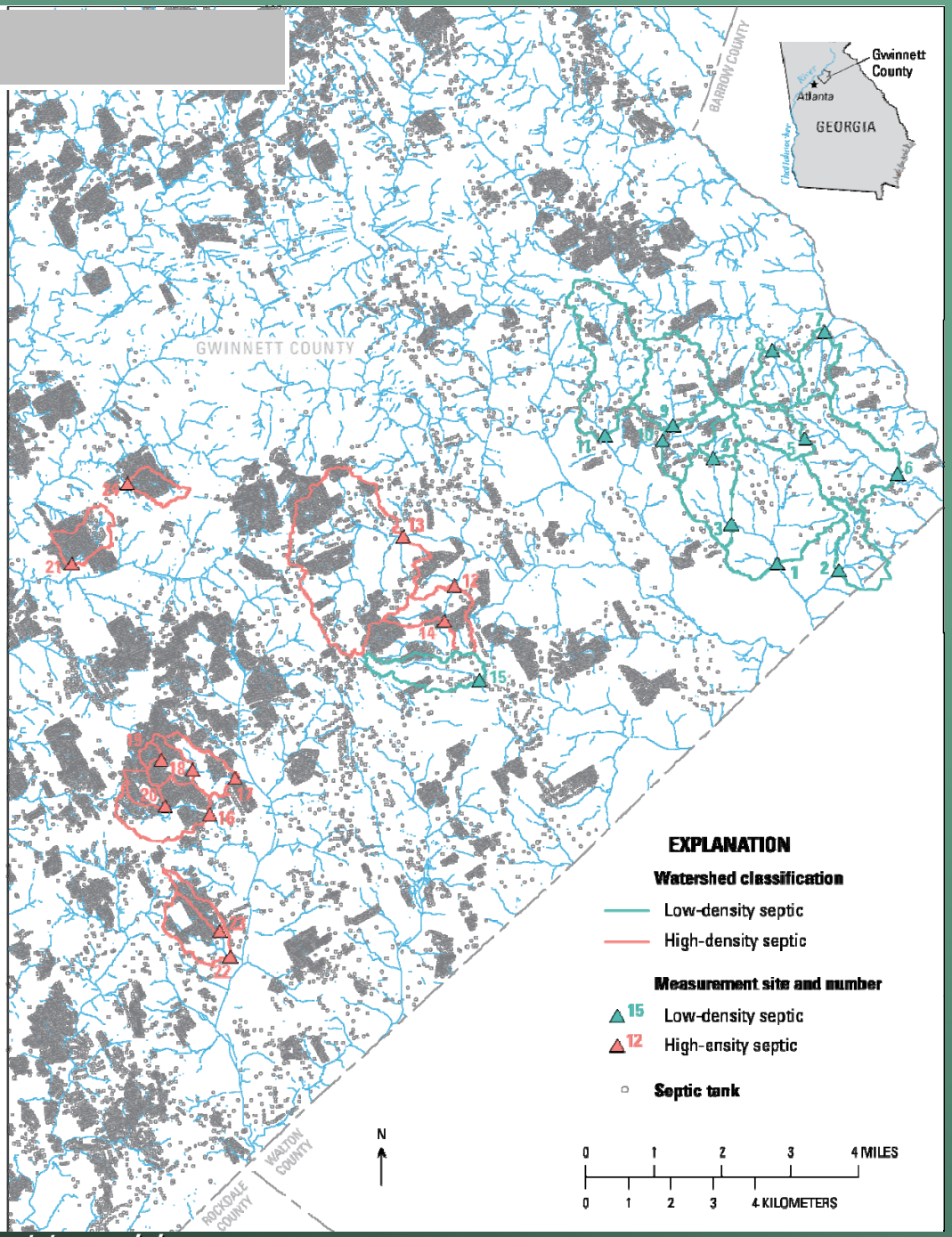


Preliminary results. Subject to revision.

Paired Watershed Approach

Watershed Selection Goals:

- Uniform geology
- Uniform Climate
- Baseflow Conditions
- Accurate Measurement Sites
- Adequate Spatial Data
- High- & Low- Density of Septic Systems



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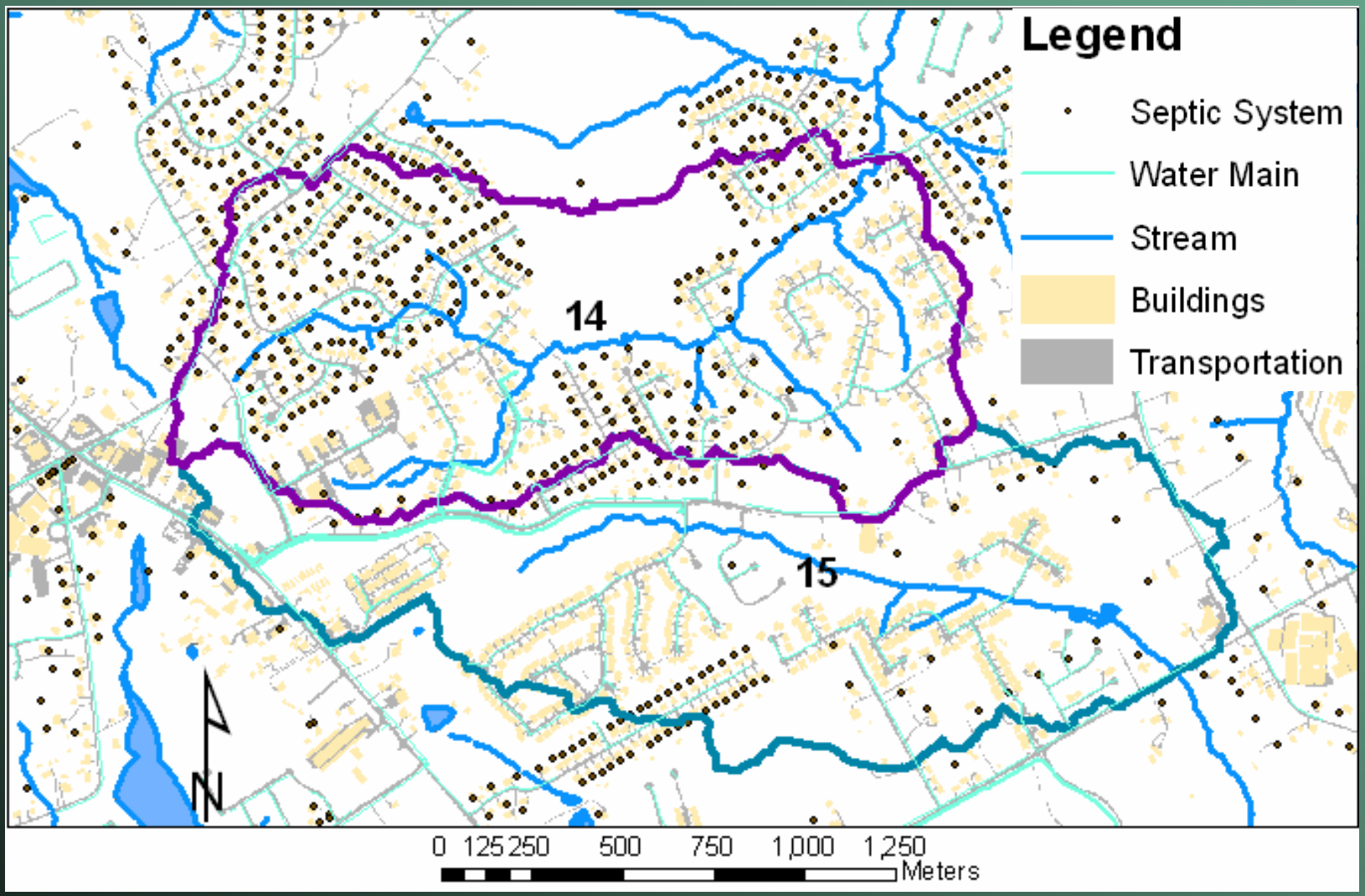
Preliminary results. Subject to revision.

Paired Watershed Approach



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Preliminary results. Subject to revision.

Paired Watershed Approach

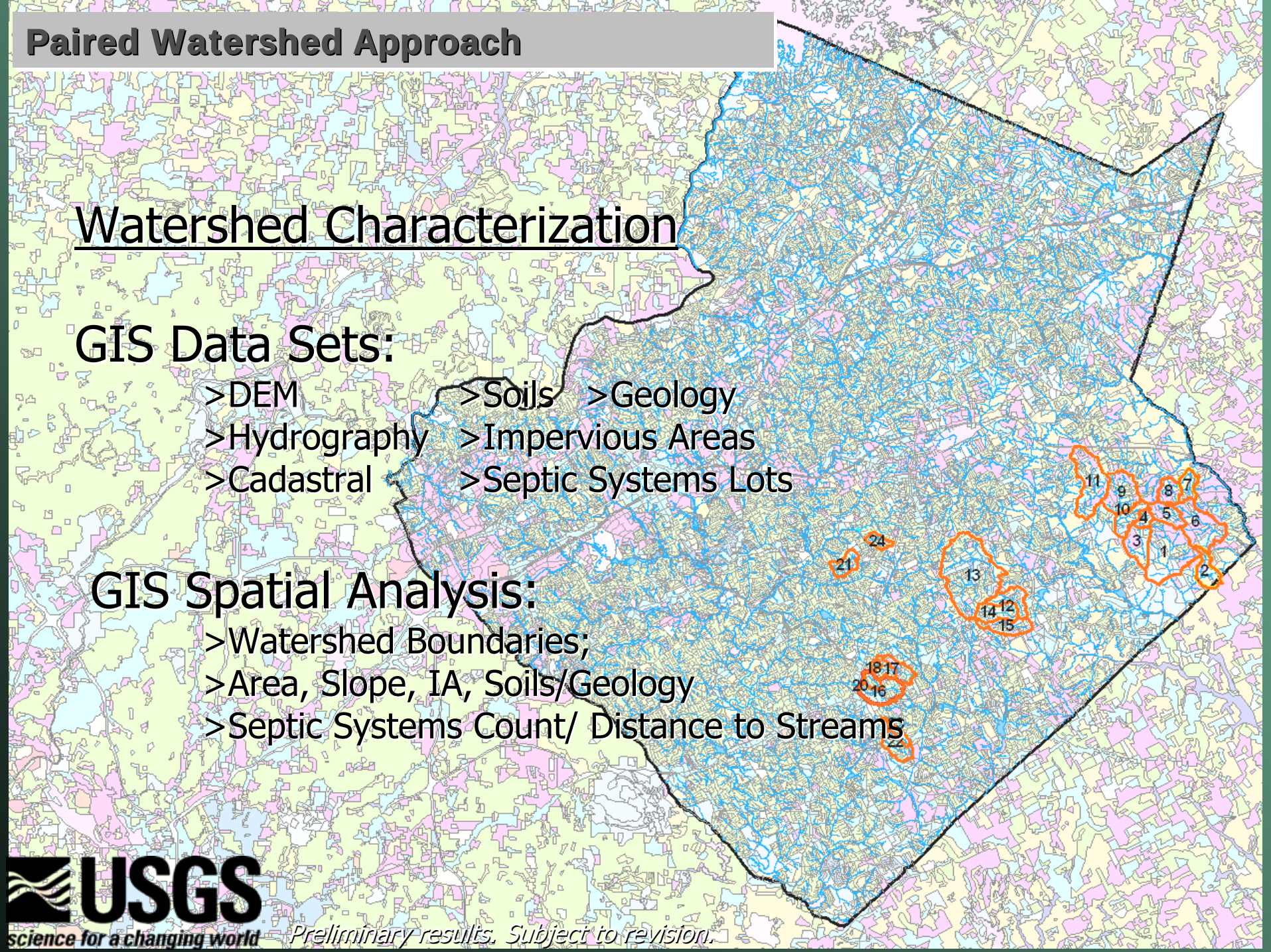
Watershed Characterization

GIS Data Sets:

>DEM >Soils >Geology
>Hydrography >Impervious Areas
>Cadastral >Septic Systems Lots

GIS Spatial Analysis:

>Watershed Boundaries;
>Area, Slope, IA, Soils/Geology
>Septic Systems Count/ Distance to Streams



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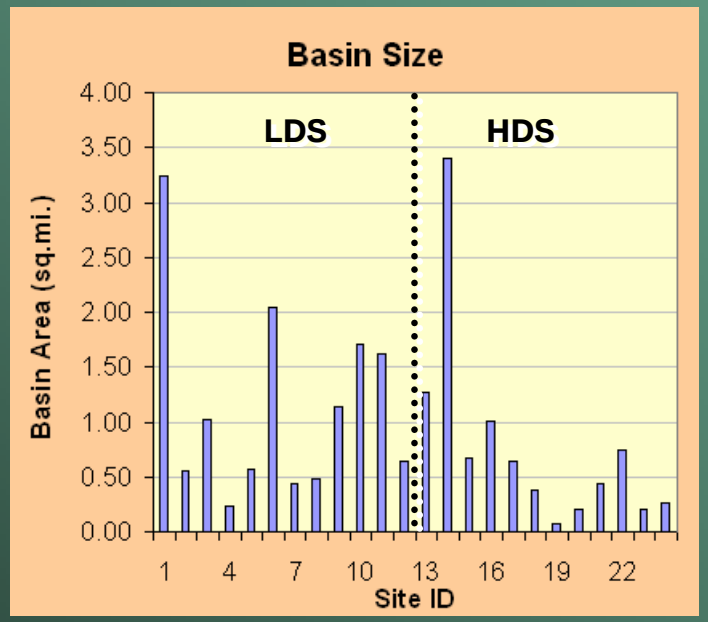
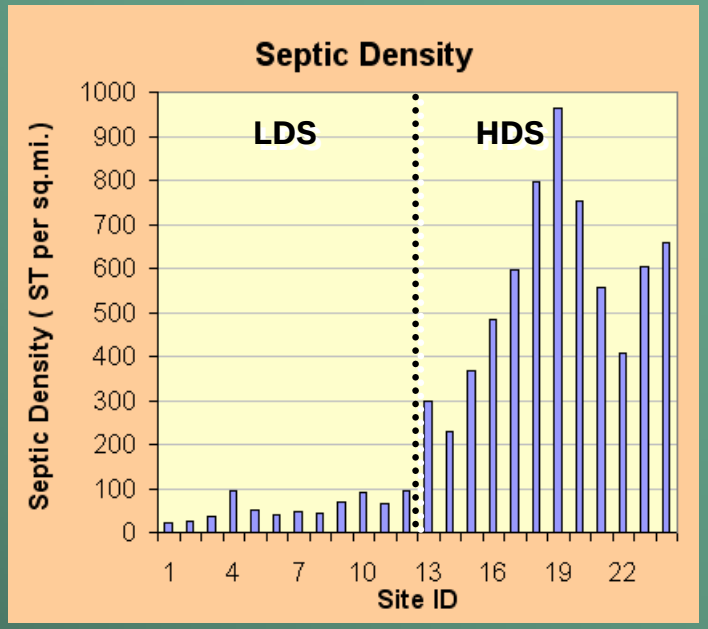
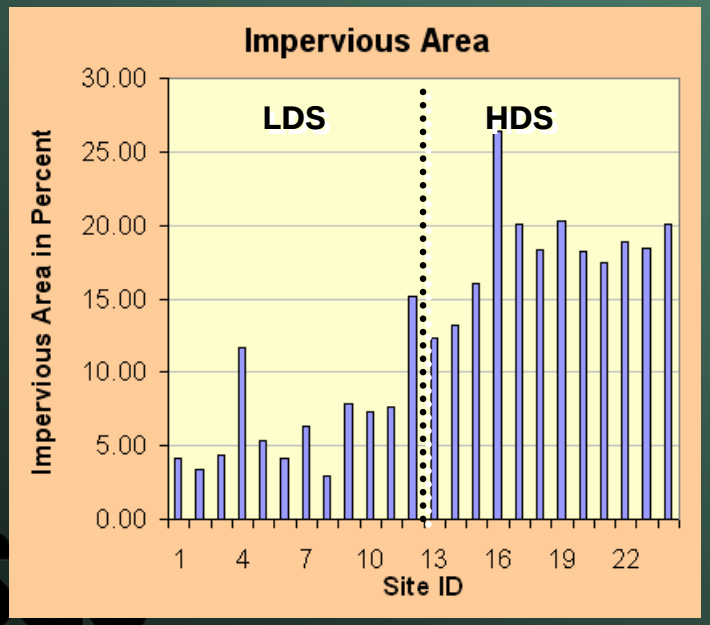
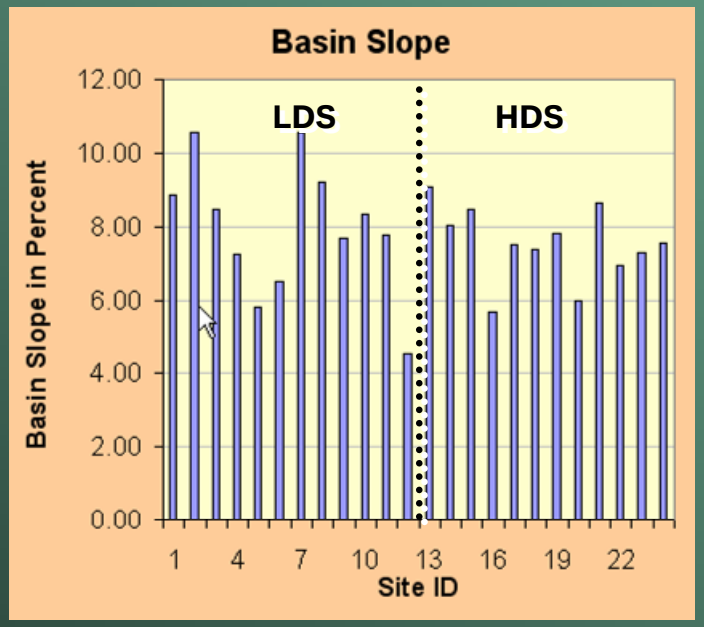
Paired Watershed Approach









Preliminary results. Subject to revision.

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Paired Watershed Approach – Stream Baseflow Analysis

Parameters Measured:

- Streamflow
- Turbidity
- Conductance
- Fluorescence

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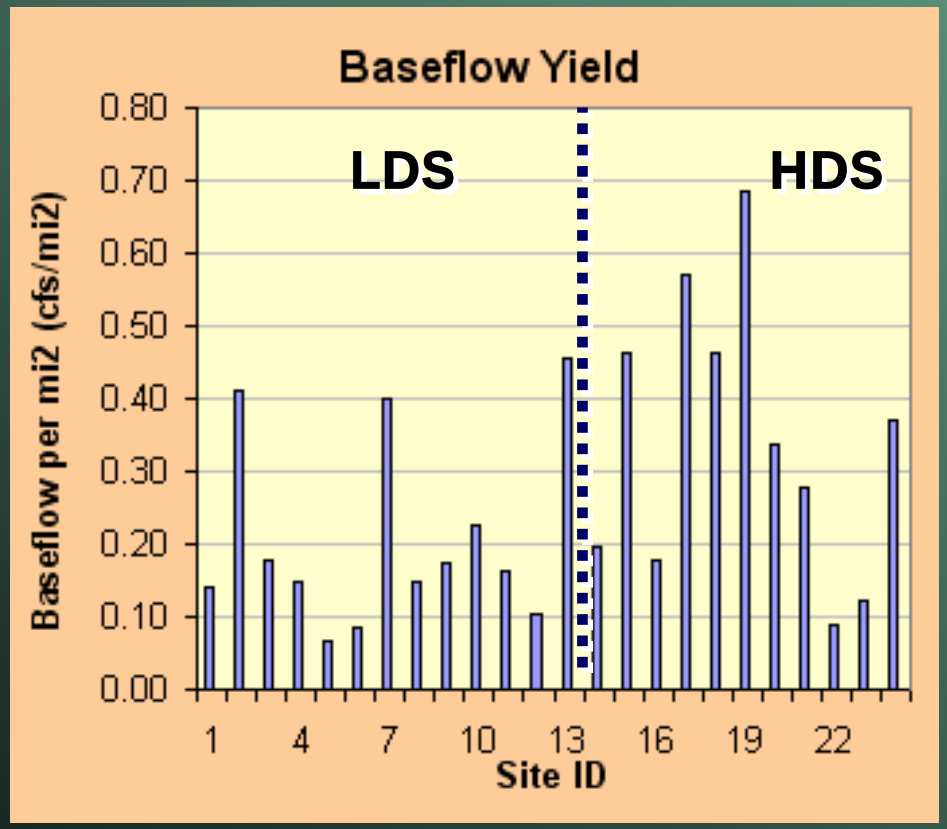
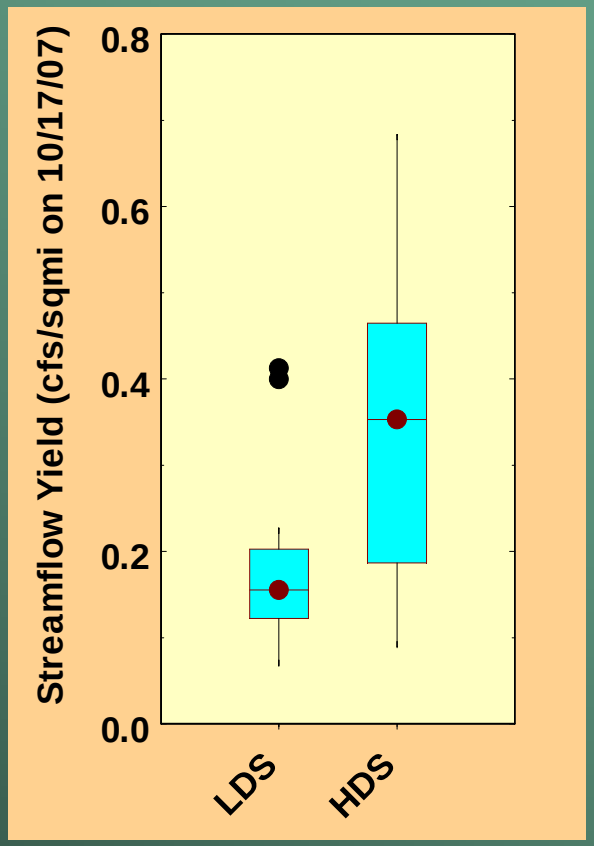
Preliminary results. Subject to revision.

Measurement Summary: Baseflow Yield

*Average Baseflow Yield was about **100%** greater in High Density Septic Systems than Low Density Septic basins on Oct 16-17, 2007.*



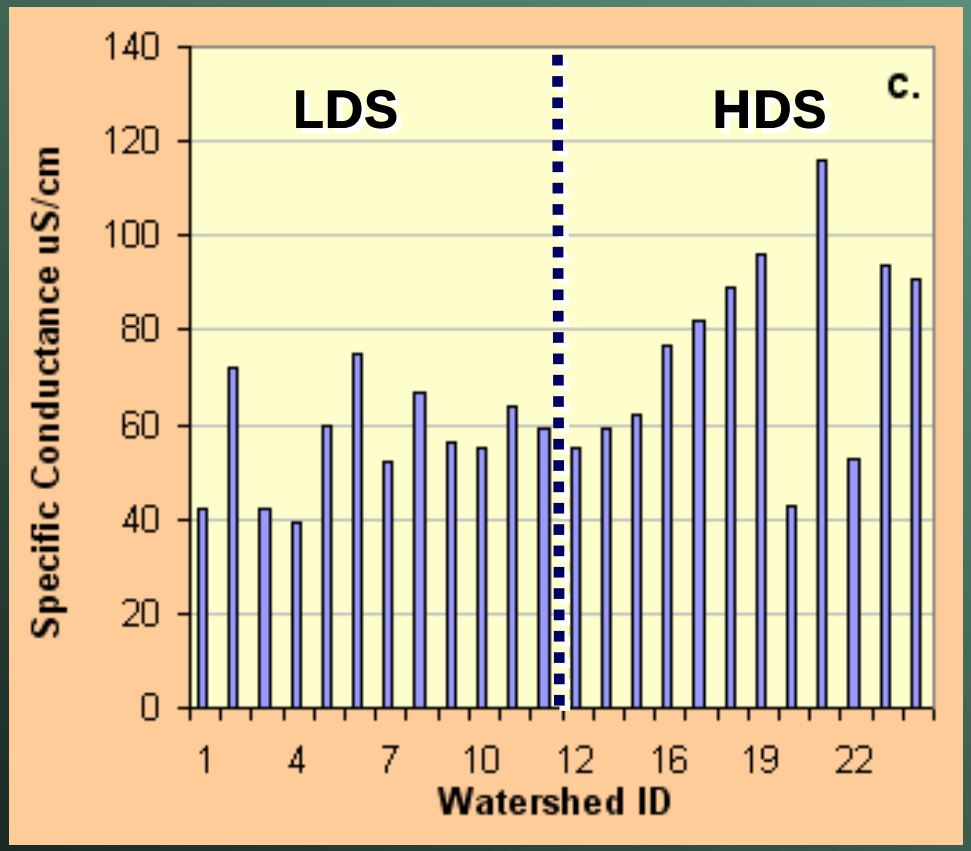


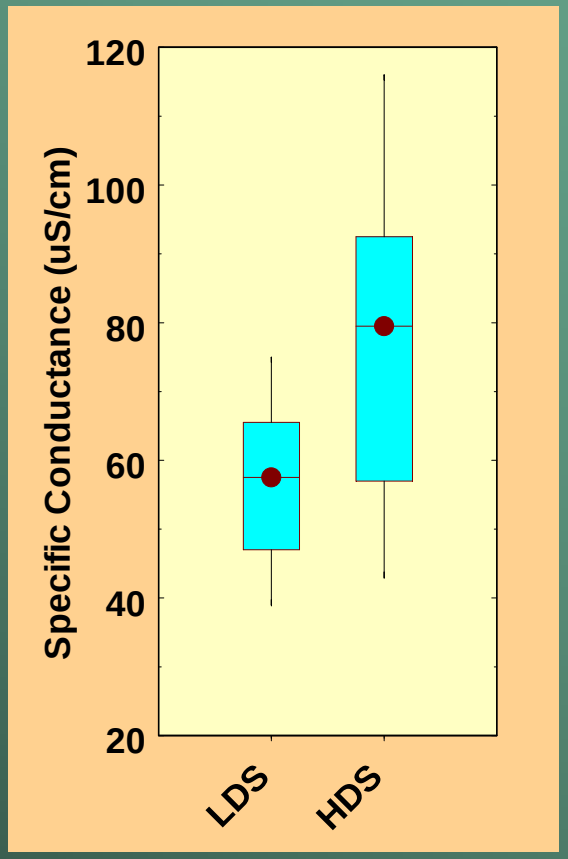
Statistically significant increase (p-value <0.01)

Preliminary results. Subject to revision.

Measurement Summary: Specific Conductance

Specific Conductance was greater in High Density Septic Systems than Low Density Septic basins on Oct 16-17, 2007.



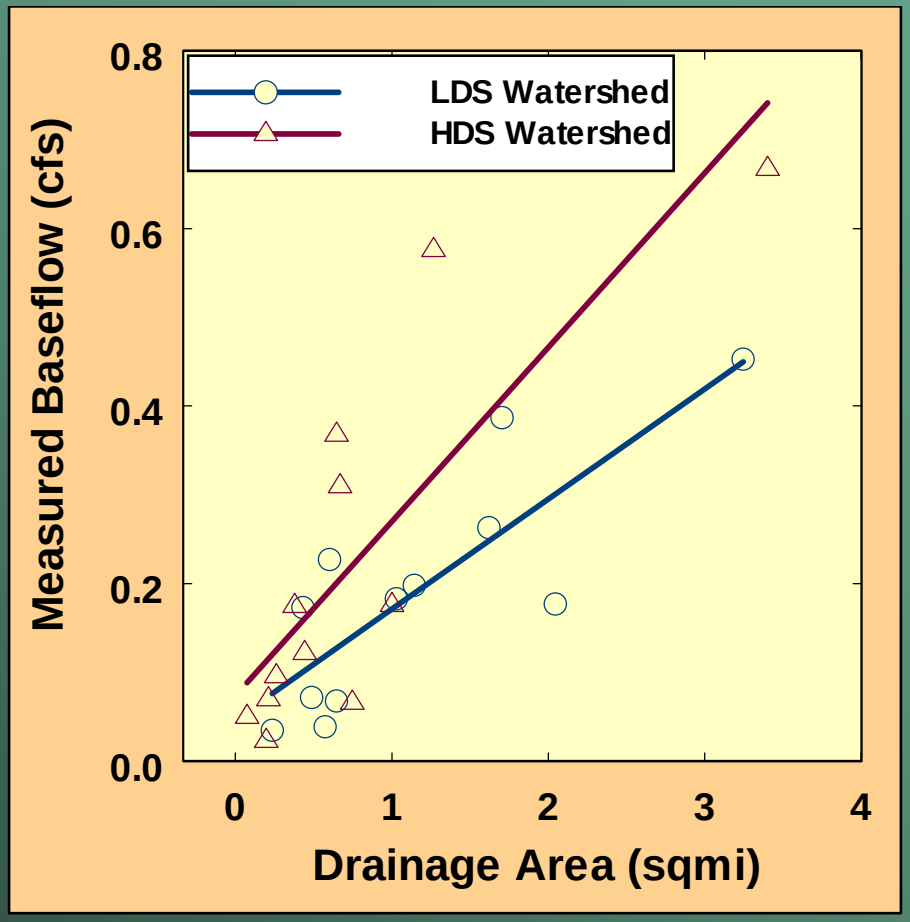


Statistically significant increase (p-value <0.01)

Preliminary results. Subject to revision.

Analysis of Flow Differences

Q_{BSF} = function of
[drainage area, slope, precipitation, geology, evapotranspiration, land cover, excess irrigation, withdrawals, returns, impoundments, water main leakage, Septic System recharge]

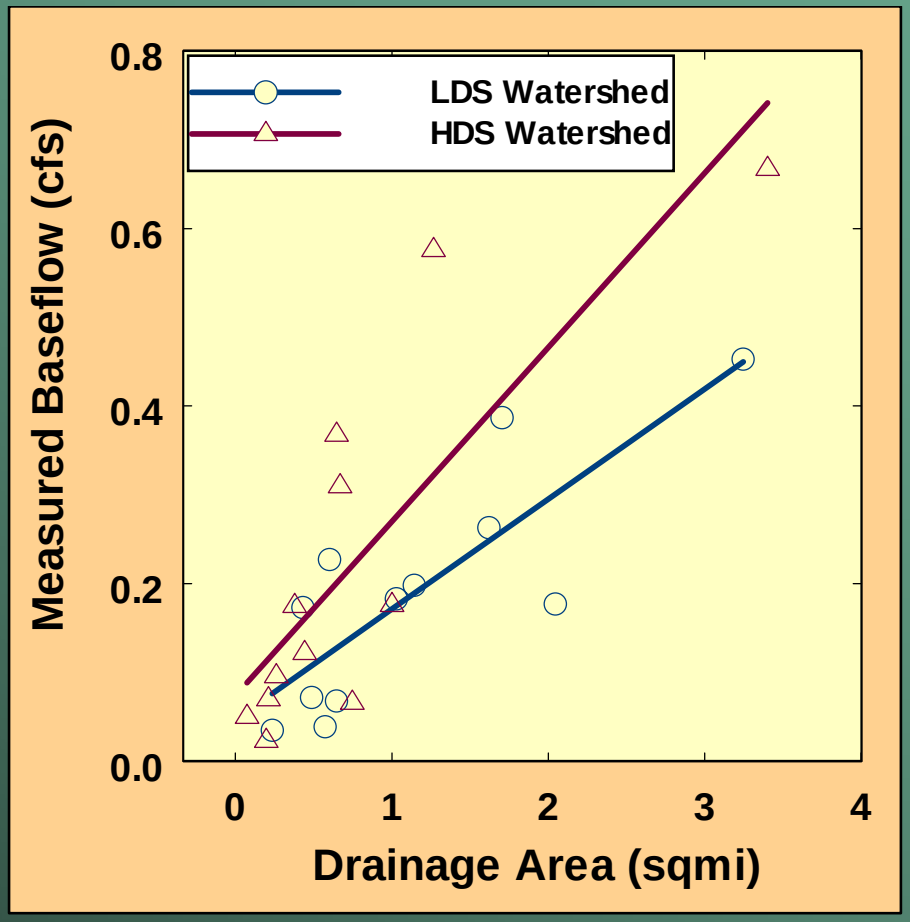


Preliminary results. Subject to revision.

Analysis of Flow Differences

Q_{BSF} = *function of*

[*drainage area, slope,*
~~*precipitation, geology,*~~
~~*evapotranspiration,*~~
~~*land cover,*~~
~~*excess irrigation,*~~
~~*withdrawals, returns,*~~
~~*impoundments,*~~
water main leakage,
Septic System recharge]



Residual Baseflow = Septic + ε

Preliminary results. Subject to revision.

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Analysis of Flow Differences

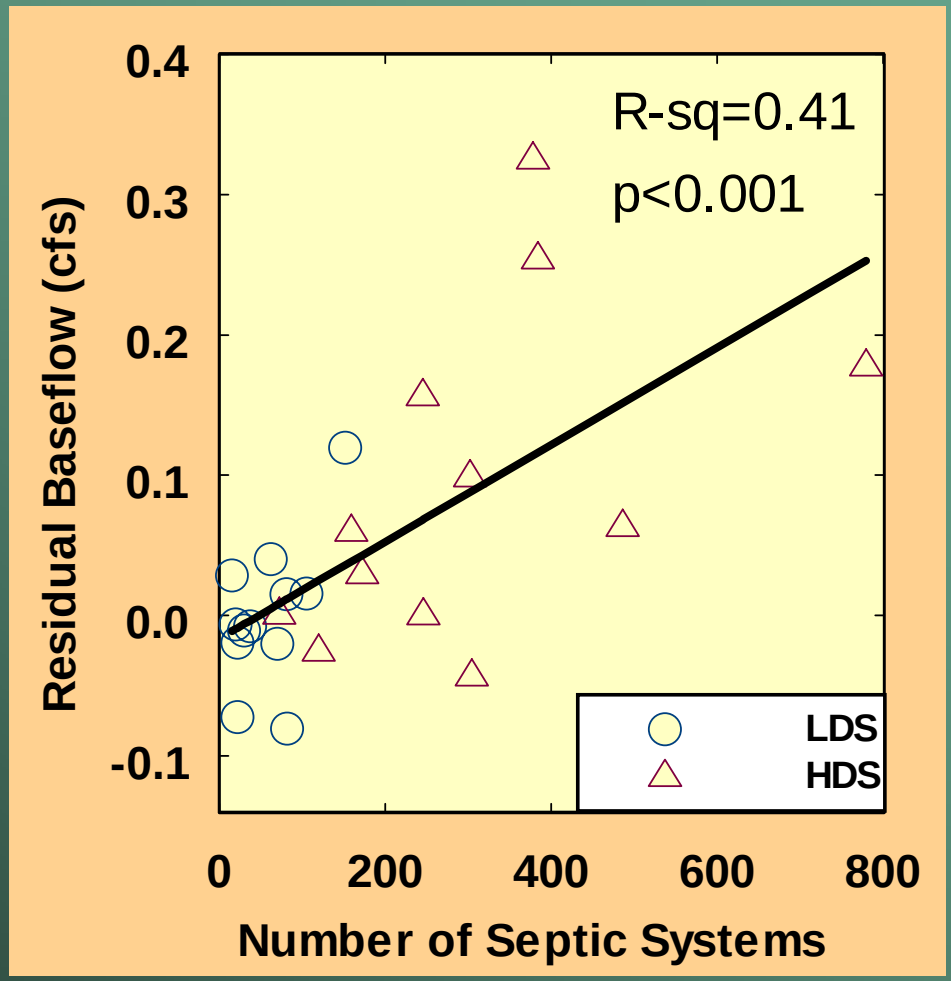
Residual Baseflow = Septic + ε

$$\overline{\left(\frac{Q_{residual_HDS}}{N_{septic\ systems}}\right)} = 166\,GPD/ST$$

StdErr of Mean = 62 *GPD/ST*

67% CI is 104 to 228 *GPD/ST*;

90% CI is 54 to 277 *GPD/ST*



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Outline

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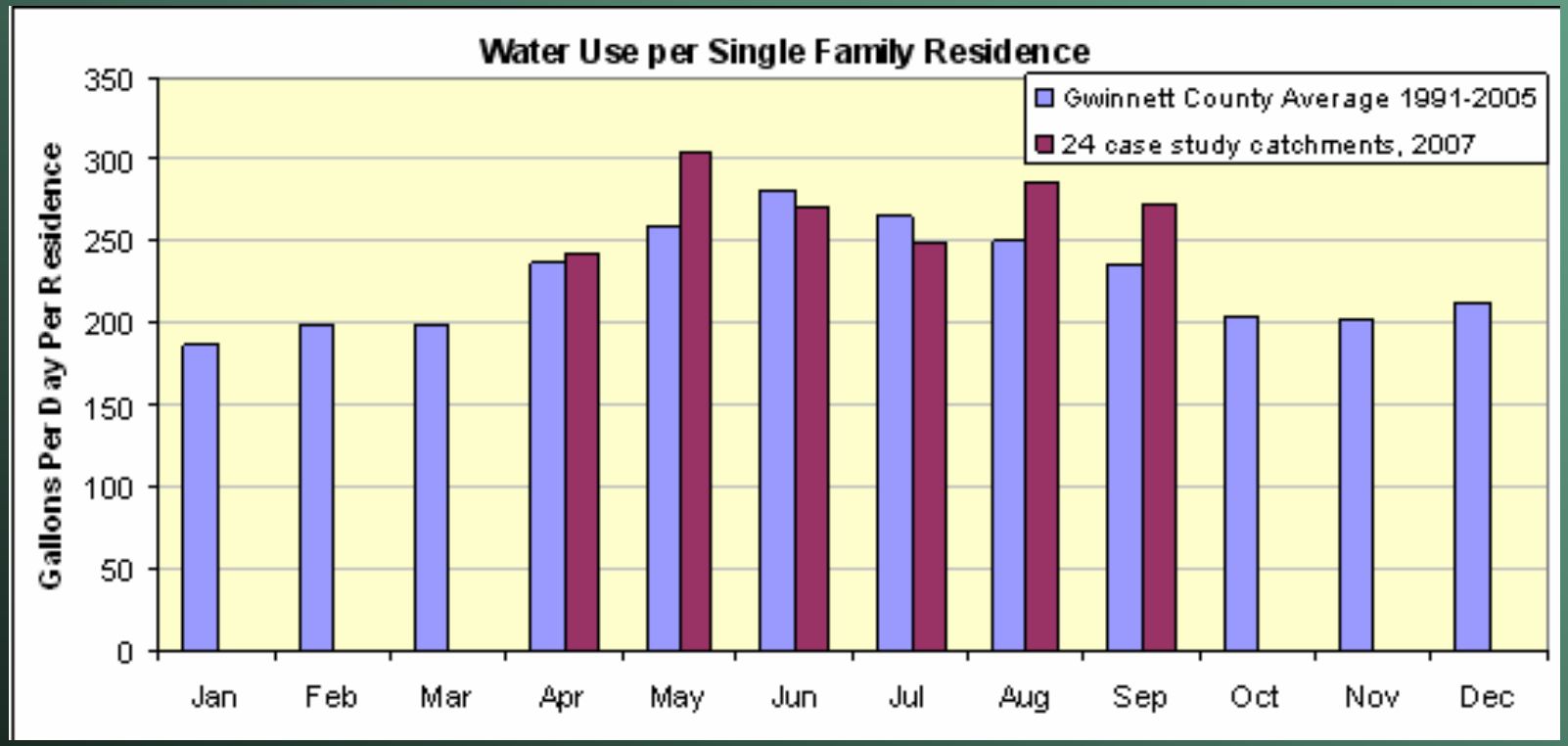
Paired Watershed Approach – Water-Use Analysis

- Average per single family household water use 1991-2005 by month
- Per house indoor use has changed little 1991-2005
- Actual per household use for April – Sept 2007 greater due to watering, prior to total watering ban
- Indoor use estimated as average Dec-Feb use: 200 GPD/house



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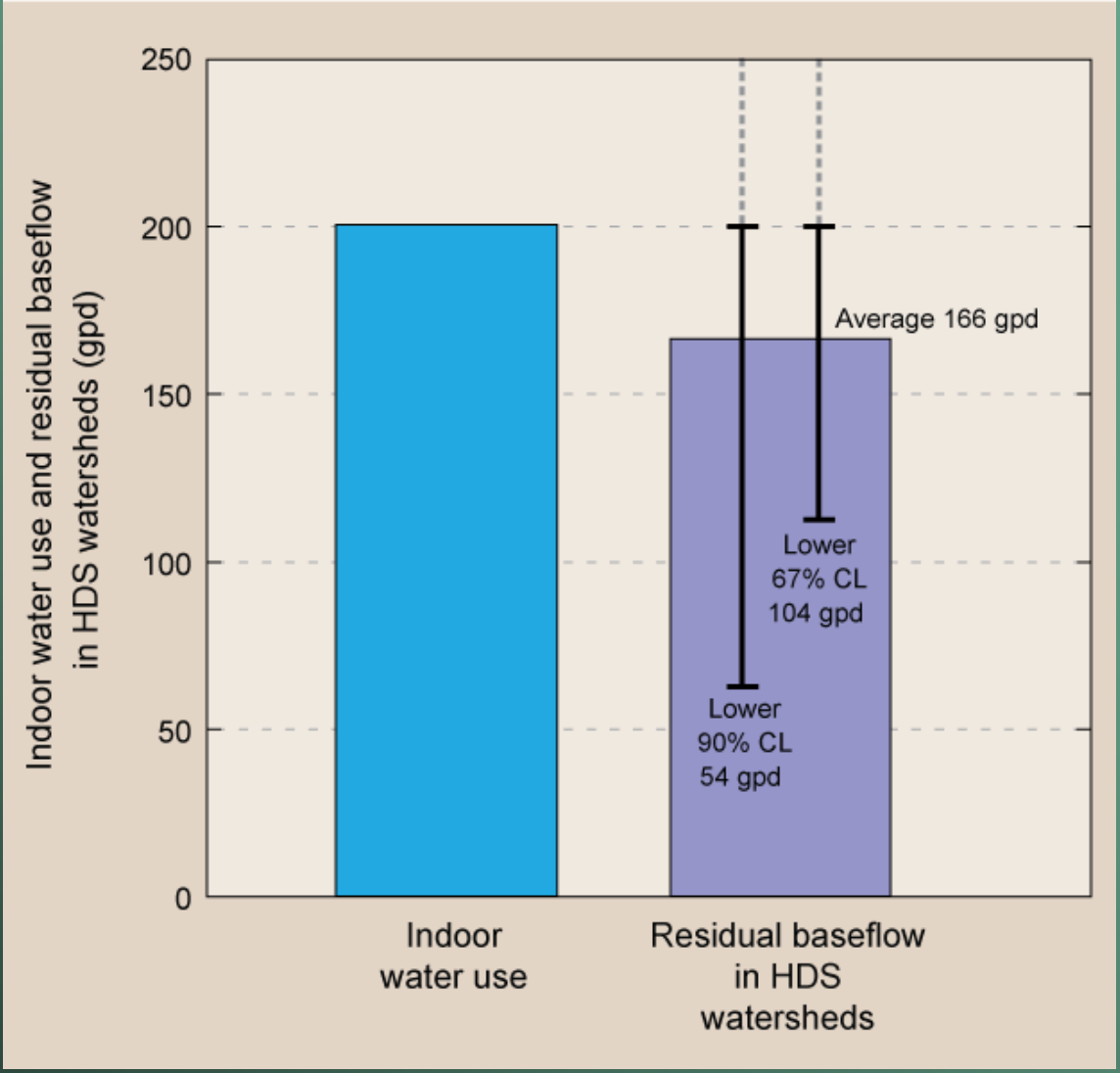
Paired Watershed Approach – Results and Discussion

For this geologic unit,
For the Fall of 2007, the consumptive use of septic systems is:

$$\left(\frac{200-166}{200}\right)=17\%$$

At 67% Confidence Int, CU is 0% to 48%

At 90% Confidence Int, CU is 0% to 73%



Annual Consumptive Use is Still Unknown

Preliminary results. Subject to revision.

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Limitations and Need for further investigation

The results of this pilot study indicate that the approach works. However, the pilot study results do not provide the information needed for policy on consumptive use of on-site septic treatment systems. An adequate investigation will require the approach to be applied:

In different geologies / soils
In 4 seasons for an annual average consumptive use
In additional land uses
At different watershed Scales

The approach does not address consumptive use associated with interbasin transfers.

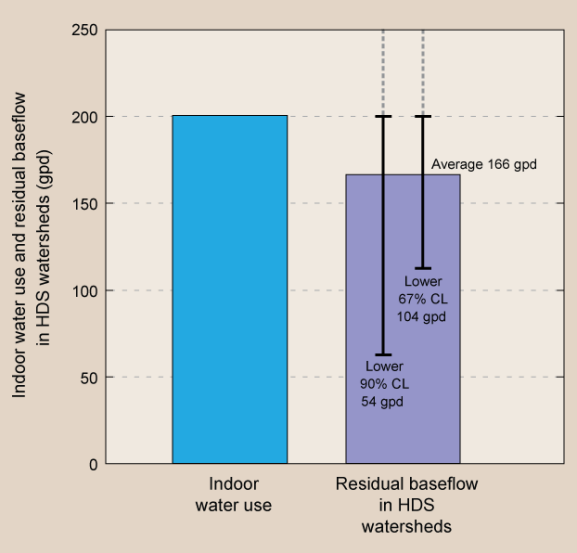
The approach does not address water-quality impacts from septic-system return flows.

Preliminary results. Subject to revision.

Paired Watershed Approach – Results and Discussion

Recommendations:

-Four to Five geologic settings for Metro Atlanta
-24 to 30 basins (12 to15 pairs) per study area.
-Measure streamflow & conductance in 4 seasons.
-Sample / analyze for Phosphorus / Sewage tracers, 2 seasons
-Ideal time is during watering restrictions
-GIS data sets development is a labor intensive component.



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