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Sustainable Design and Infrastructure Workshop
Infrastructure Work Groups: November 7-8, 2006

AYERS SAINT GROSS ARCHITECTS + PLANNERS
AEI Affiliated Engineers
Biohabitats Incorporated
ELEMENTS
MARTIN ALEXIOU BRYSON
RK&K
STONEBRIDGE

Infrastructure Workshops

Sustainable Design & Infrastructure Workshops

DISCOVERY PHASE

- November 6-8: Exploring Possibilities for Carolina North, Part 1
- November 27-29: Exploring Possibilities for Carolina North, Part 2
- December 12-14: Development of Parameters
- January 8-10: Presentation of Draft Results/ Begin Technical Studies

- February: Technical Studies
- March: Technical Studies

Landscape, Natural Habitat, Water Quality

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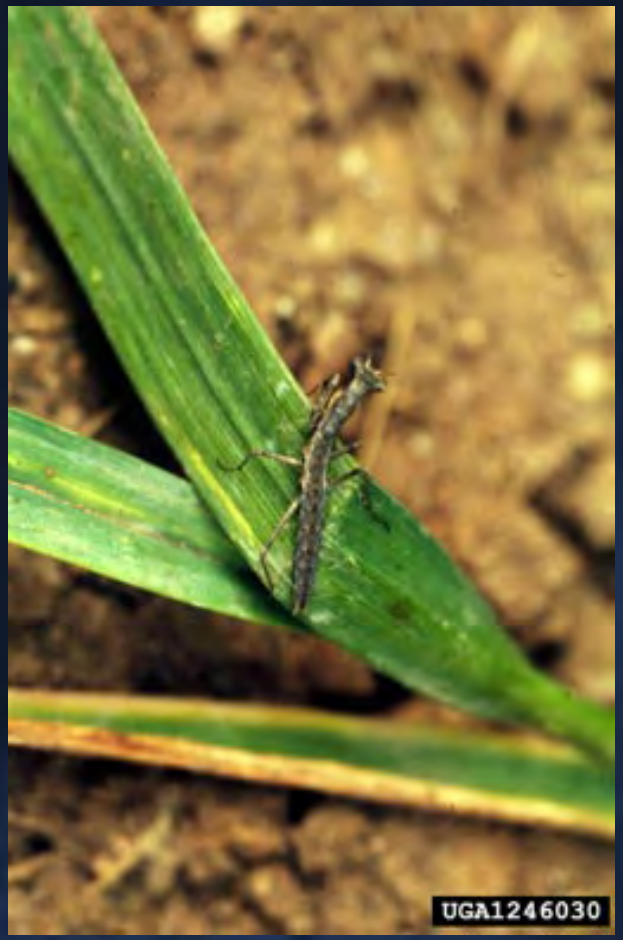
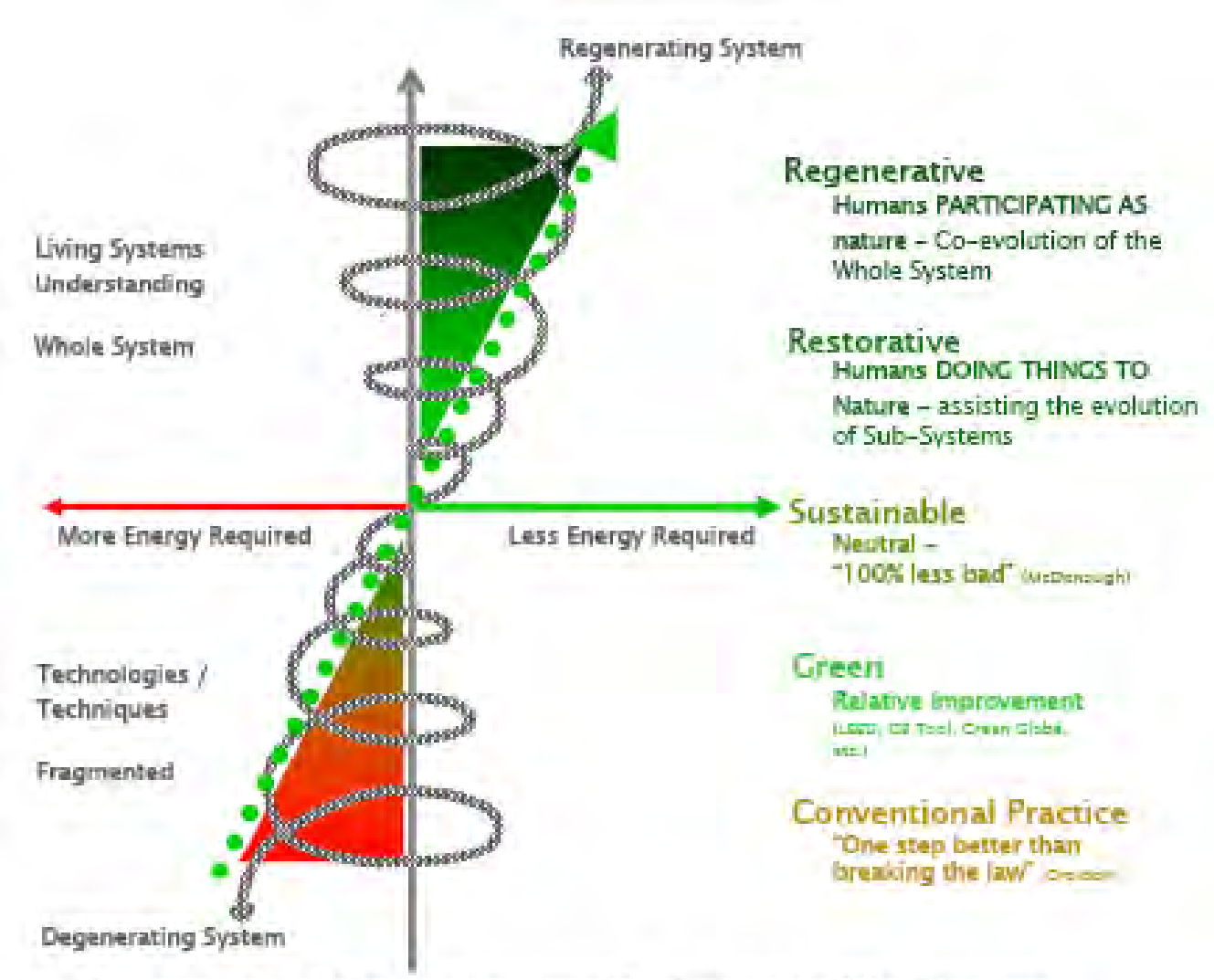
Task at Hand

- What do we mean by sustainable environmental design within the context of landscape, natural habitat and water quality?
- What are the various scales (i.e., regional, site, building footprint) that should be addressed?
- What opportunities/possibilities and supporting metrics should be considered?
- How can we quantify these, while allowing for adaptive management?
- What are the constraints facing each consideration?



Biohabitats



Trajectory of Environmentally Responsible Design

William Reed, 2006

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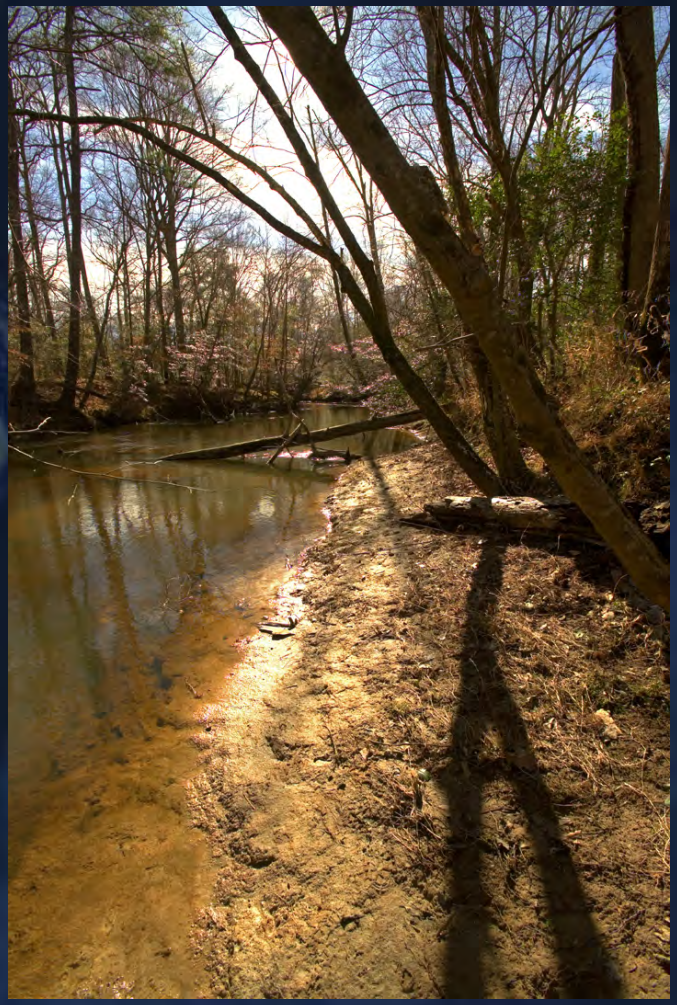
Background and Available Tools

- Ecological Characterization and land development suitability analysis for the Carolina North property

- Purpose of the study – Identify land areas that are most conducive to land development with regards to regional and local ecological processes, functions and resiliency

- Focus of the study:
  - conservation, restoration and development
  - regional, local and site
  - temporal
  - process and function



Process

- Identify overarching opportunities/possibilities based on:
  - Landscape
  - Natural Habitat
  - Water Quality
- Identify supporting metrics based on:
  - role in governing ecological processes and resiliency (cause and effect relationships)
  - relationship to regional landscape processes
  - aesthetics
  - natural capital values
  - social and cultural values
- Scientific and value driven
- Consensus driven

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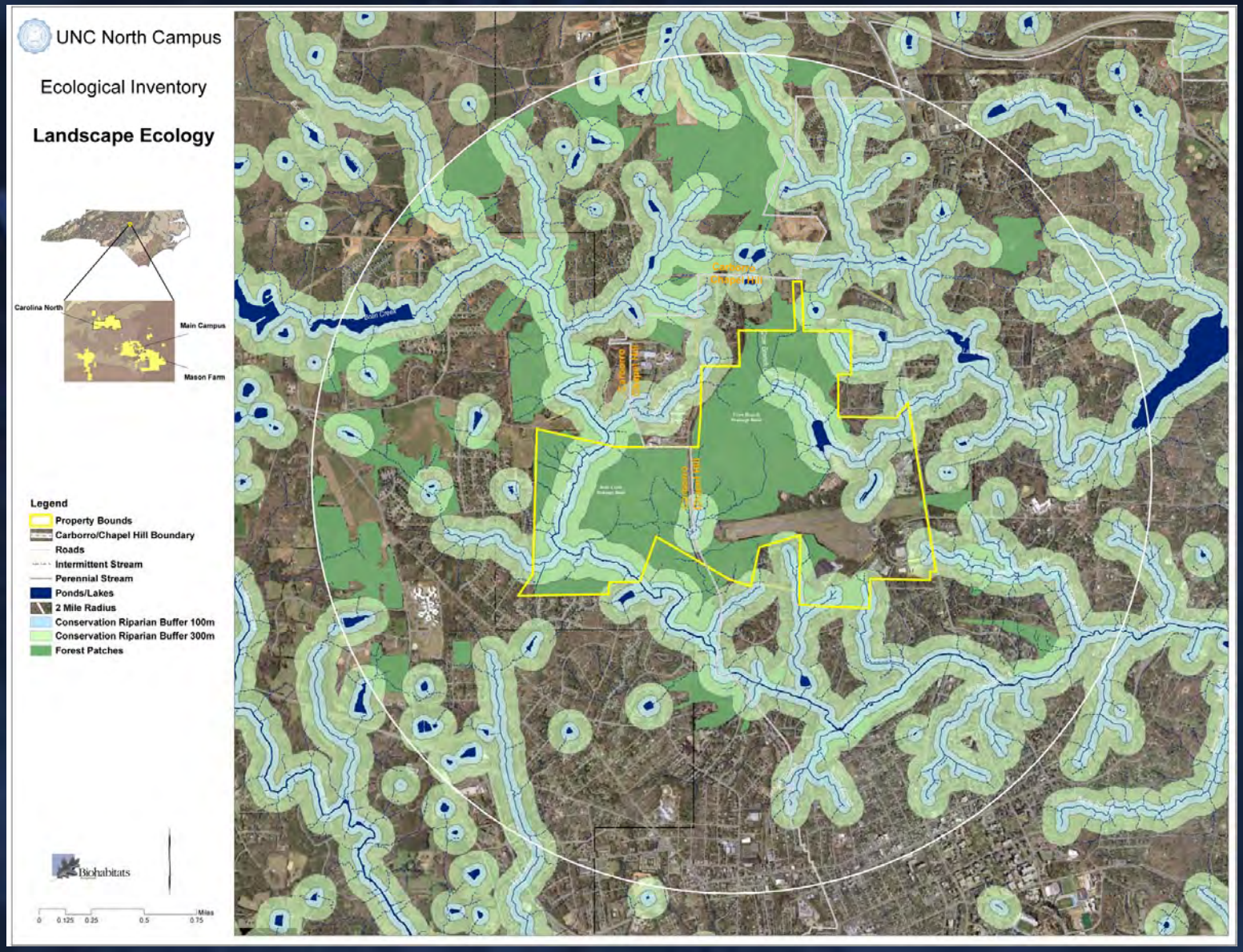
Regional Scale



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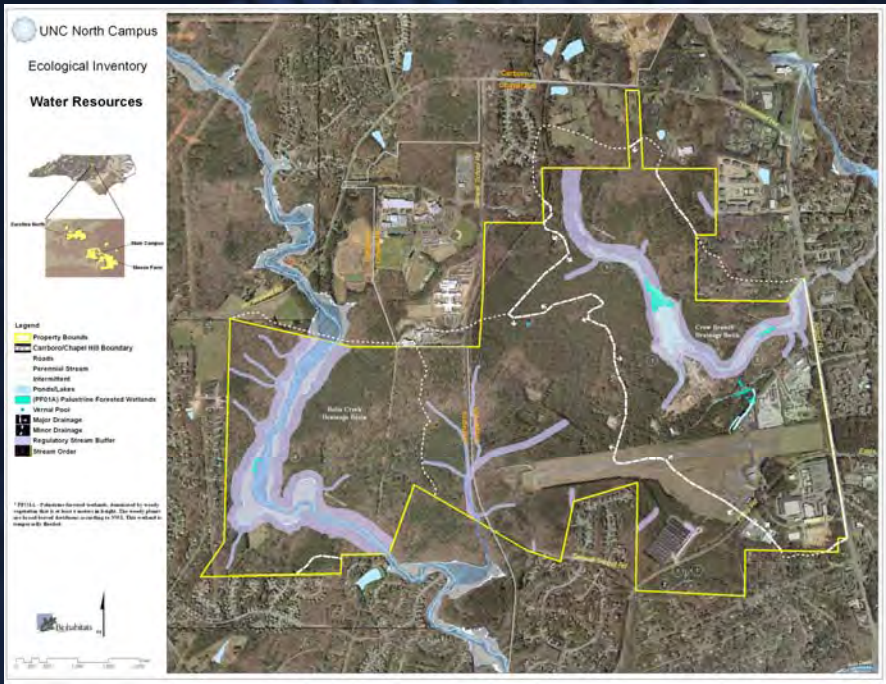
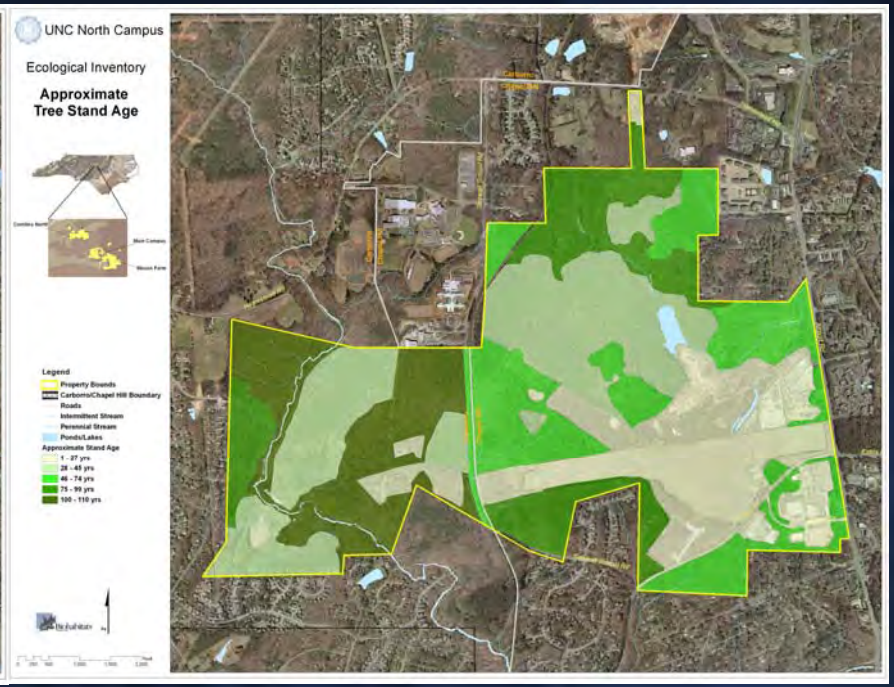
Site Scale





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Building Footprint Scale

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Environmental Sustainability Guidelines - Example

Opportunity:

Protect and restore Rock Creek's water quality and morphological floodplain.

Metrics:

- Treat the first one-inch of stormwater runoff from all impervious surfaces to remove pollutants.
- Eliminate all direct (piped) untreated discharges to Rock Creek.
- Manage the 2-year runoff event to mimic pre-development (forest) conditions for volume and peak discharges.
- Limit impervious surfaces to less than 25% of the entire site area and disconnect directly connected areas wherever feasible.
- Eliminate the use of potable water for irrigation in 10 years.

Environmental Sustainability Guidelines - Example

Opportunity:

Conserve existing natural areas and protect trees to provide habitat and promote biodiversity.

Metric:

- Identify all existing trees with a caliper larger than 6”, and preserve a minimum of 80% of them, or replace in-kind caliper. Replacement kind shall be additive. For example, if a 6” caliper tree is removed, it can be replaced by six, 1” caliper trees. Additive in-kind replacement facilitates reforestation by providing the opportunity for the future growth of six, 6” trees as opposed to a larger caliper tree that was planted as a 1:1 replacement.

Way Forward

- ✓ Build on the knowledge gained today
- ✓ Explore options, listen to all viewpoints and push boundaries
- ✓ Be as explicit and specific as possible
- ✓ Understand and balance short-term and long-term opportunities and constraints

Stormwater, Water & Sewer Systems

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Water, Wastewater & Stormwater Systems

- Topics to Consider
- Utility Infrastructure Sustainability Guidelines (Example)
- Water System
- Wastewater System
- Stormwater System

Topics to Consider

- Potential for water conservation and water, wastewater, and stormwater treatment at Carolina North
- Availability and capacity of existing on-site and off-site water, stormwater, and wastewater facilities
- Explore opportunities for on-site treatment of water, wastewater and reclaimed water for Carolina North
- Explore operating and maintenance capabilities and preferences
- Phasing
- Utility tunnel / corridor concept/ direct bury of pipelines/ natural systems

Topics to Consider

- Understanding of UNC and OWASA water conservation and water, wastewater and stormwater treatment goals
- Availability and capacity of existing on-site and off-site water and wastewater facilities
- Understanding of OWASA's recommendations for water, wastewater and reclaimed water for Carolina North
- Understanding of UNC staff's water, wastewater and stormwater O&M capabilities and preferences; ownership
- Water demands and wastewater flow projections for the various phases of Carolina North development
- Evaluate utility tunnel / corridor concept versus direct bury of pipelines

Utility Infrastructure Guidelines (Example)

Water Sustainability Guideline

Use non-potable water supply as primary source for all landscaping irrigation needs.

Wastewater Sustainability Guideline

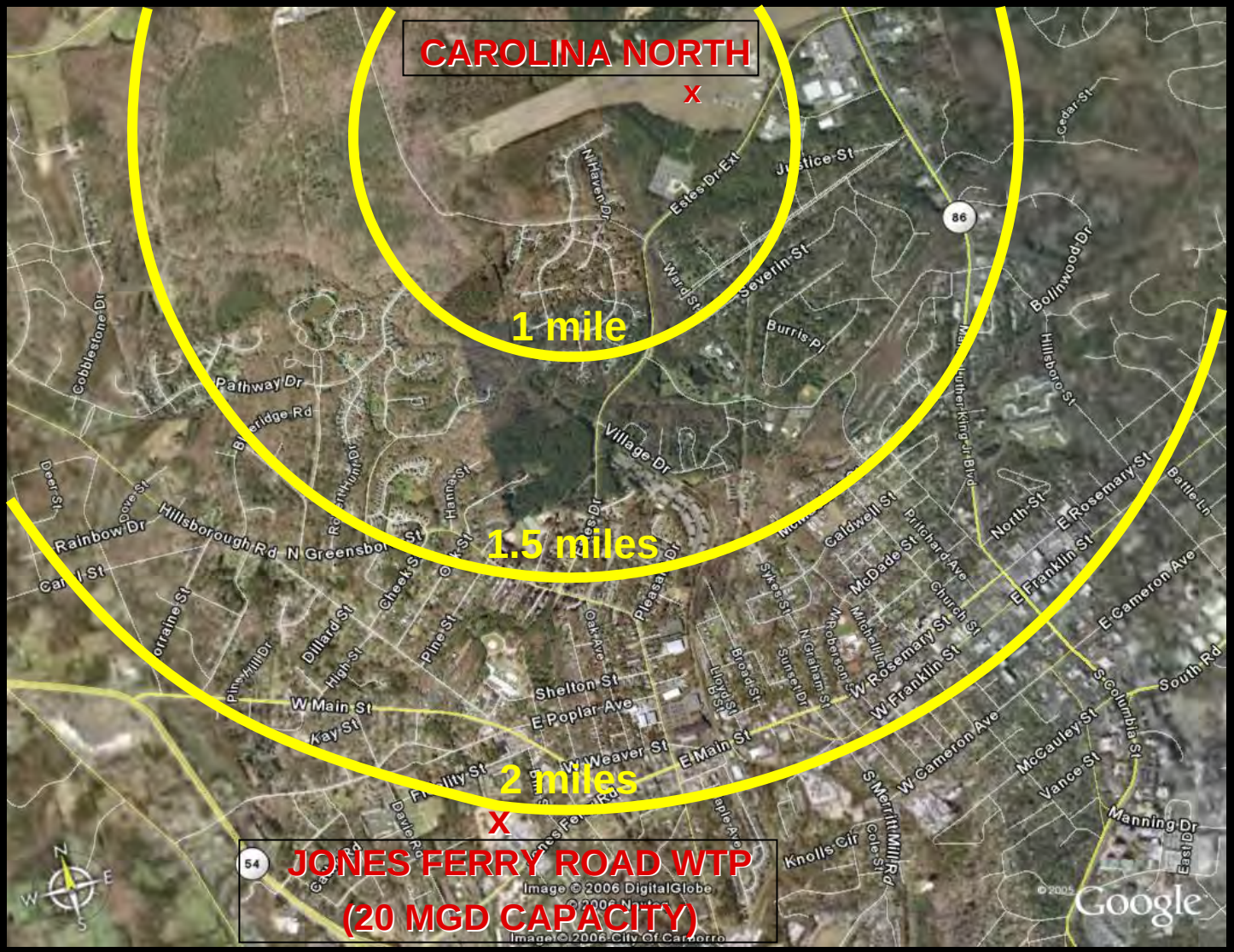
Reduce total wastewater discharge to public system by incorporating graywater reuse methods for toilet flushing in all facilities.

Stormwater Conveyance Sustainability Guideline

Provide disconnected surface runoff from roadway surfaces through the use of open section roads (i.e. no curb and gutter).

Water System

- Consider connection to OWASA's existing water distribution system



N.T.S – DISTANCES ARE APPROXIMATE

Water System

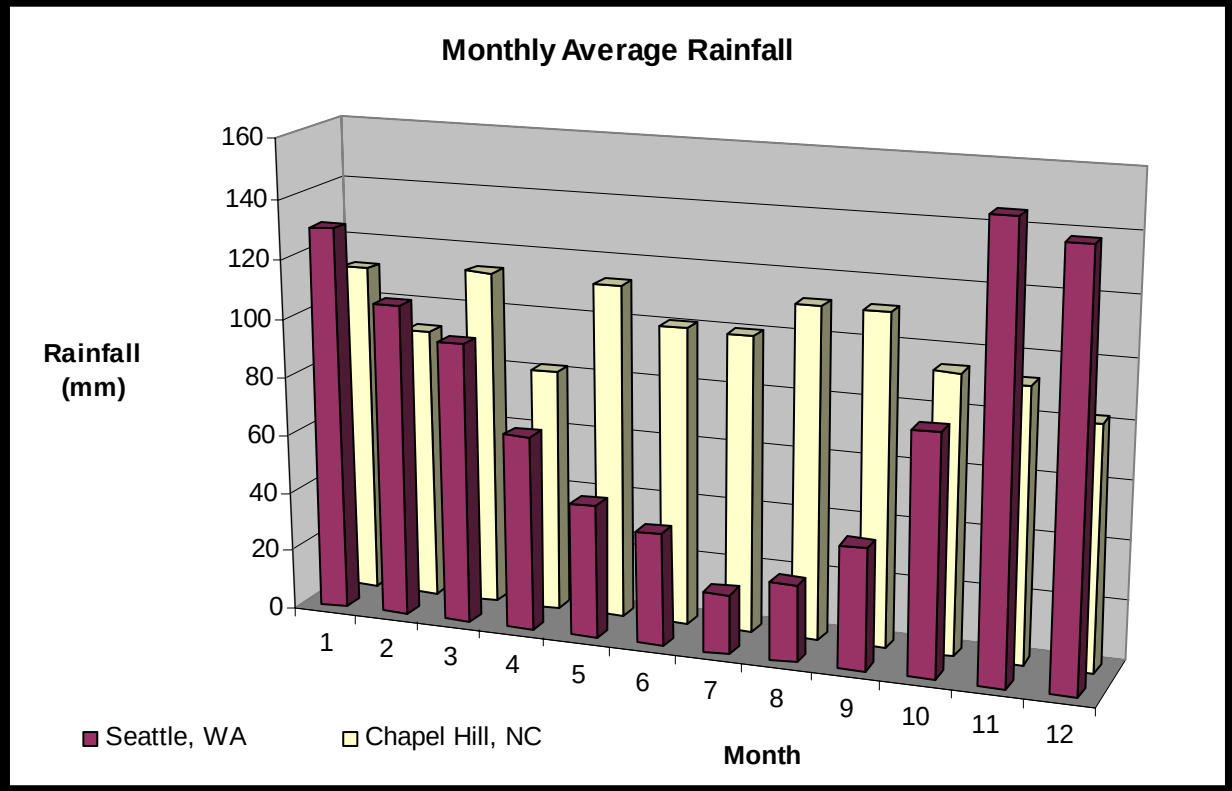
- Develop new independent water sources
  - Surface water
  - Ground water
  - Combination
- Water Conservation & Re-use
- Reclaimed Water

Water Reservoir

Water Well

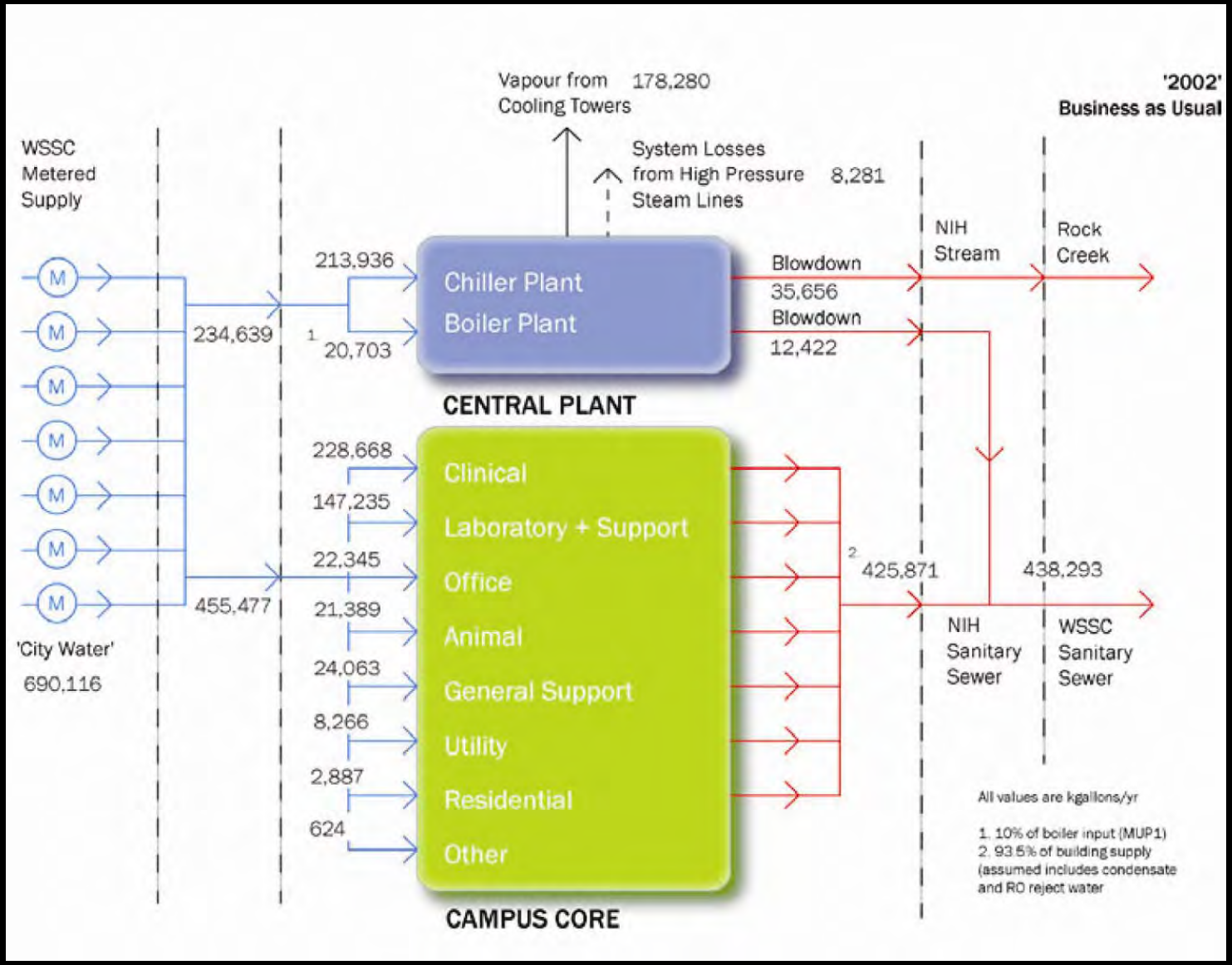
Water Re-use

Water Availability



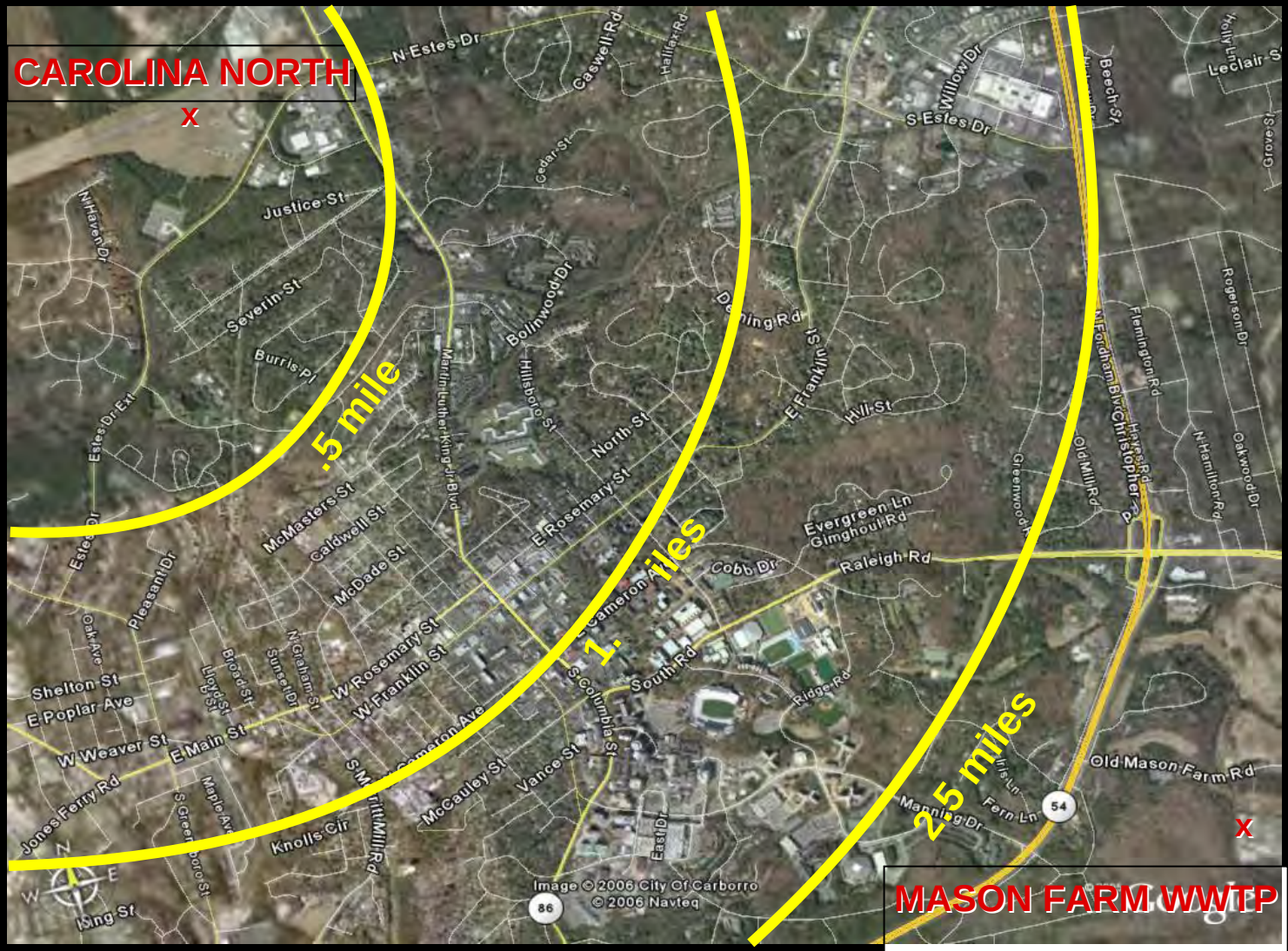
Seattle Annual Total: 940 mm
Chapel Hill Annual Total: 1200 mm

Building Water Consumption



Wastewater System

- Consider connection to OWASA's existing wastewater collection system



N.T.S – DISTANCES ARE APPROXIMATE

Wastewater System

- Obtain OWASA's reclaimed water for various non-potable purposes:
  - Cooling towers
  - Irrigation of athletic fields and landscaped areas
  - Toilet flushing
  - Firefighting

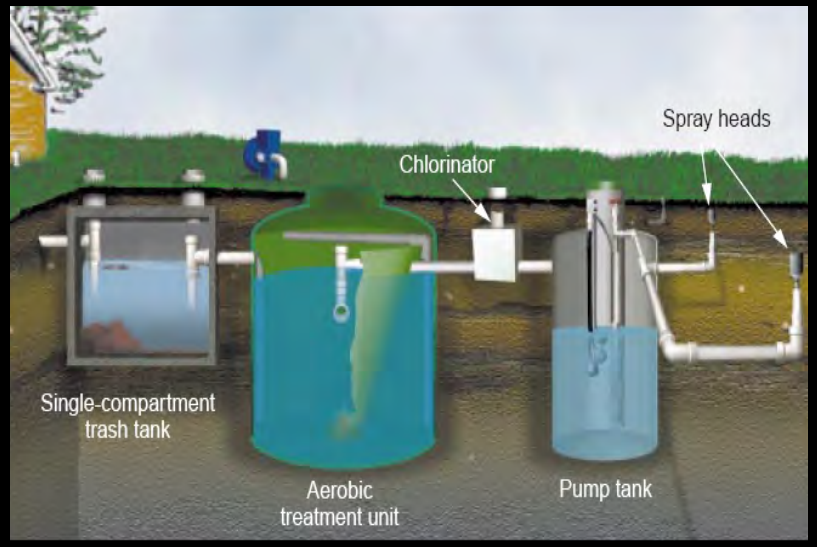
Water Tank and Cooling Tower

Field Irrigation

Wastewater System

- Construct innovative on-site wastewater treatment facility
  - Constructed wetlands
  - Sand filters
  - Aerobic treatment units
  - Leaching field chambers
  - Drip and spray irrigation
  - Potable use of treated wastewater
  - Composting Facility

Constructed Wetland



Aerobic Treatment Unit (ATU)

Stormwater System

- Use of innovative Low Impact Development (LID) stormwater treatment methods
  - Bioretention
  - Green Roofs
  - Permeable Pavement
  - Cisterns
  - Tree Box Filters
  - Soil Amendments

Green Roof

Cisterns

Stormwater System

- Use of innovative Low Impact Development (LID) stormwater treatment methods
  - Green Streets

Stormwater Conveyance

- Make stormwater a public amenity
- Daylight streams
- Re-create natural drainage courses

Stream Daylighting

Internal Transportation, Parking & Roads

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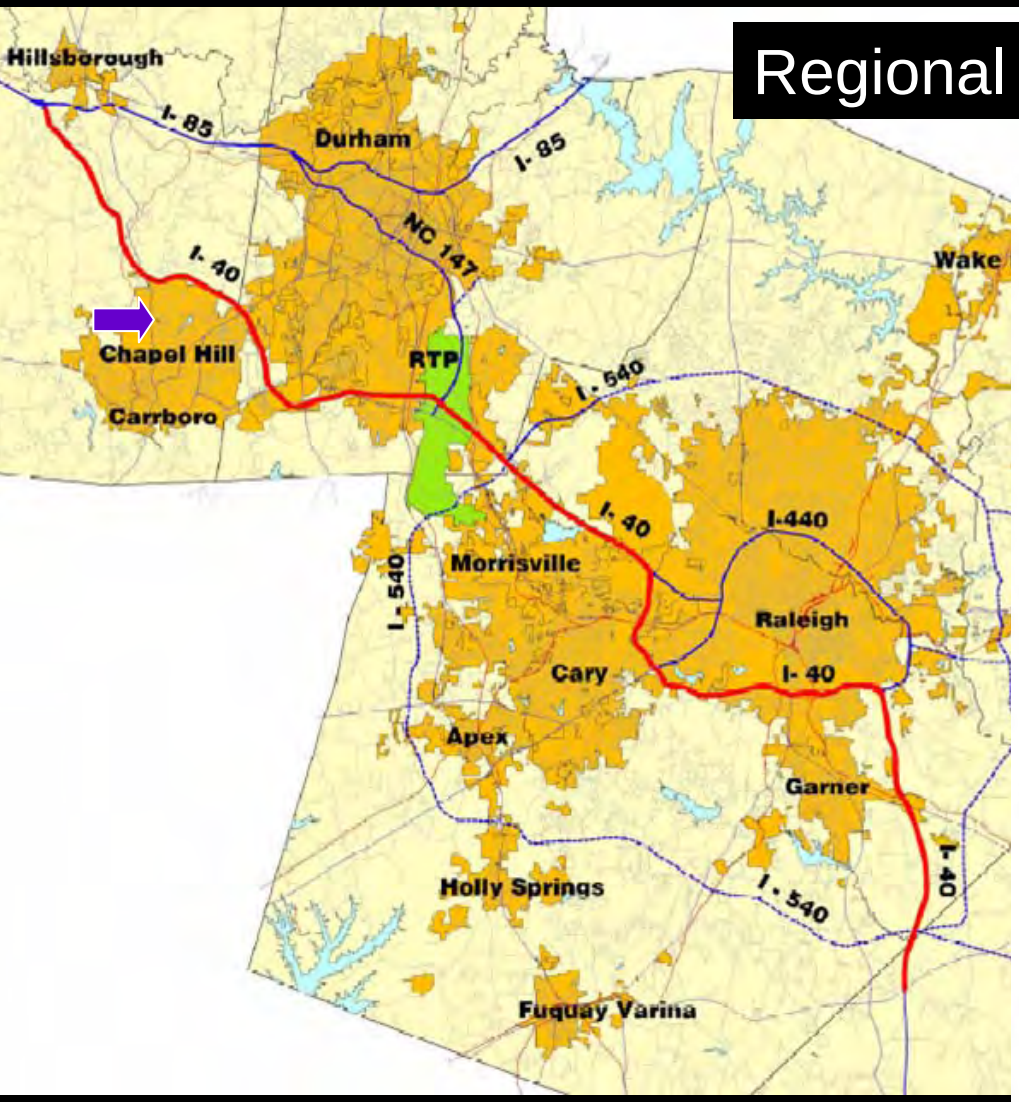
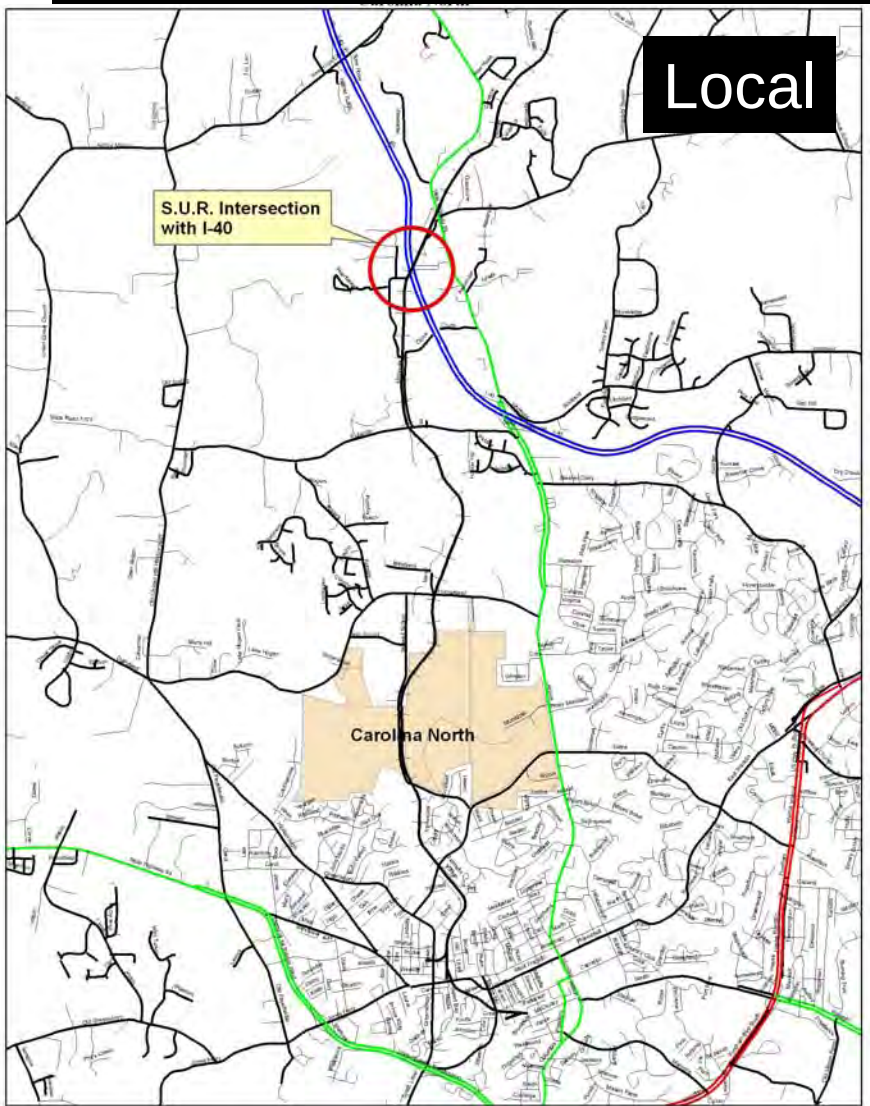
Examples of Transportation Guidelines

- Design site to maximize use of transit for travel to the site
- Create a safe, convenient, and pleasant pedestrian network of paths and routes, including livable streets
- Encourage bicycle use

Geographical Context





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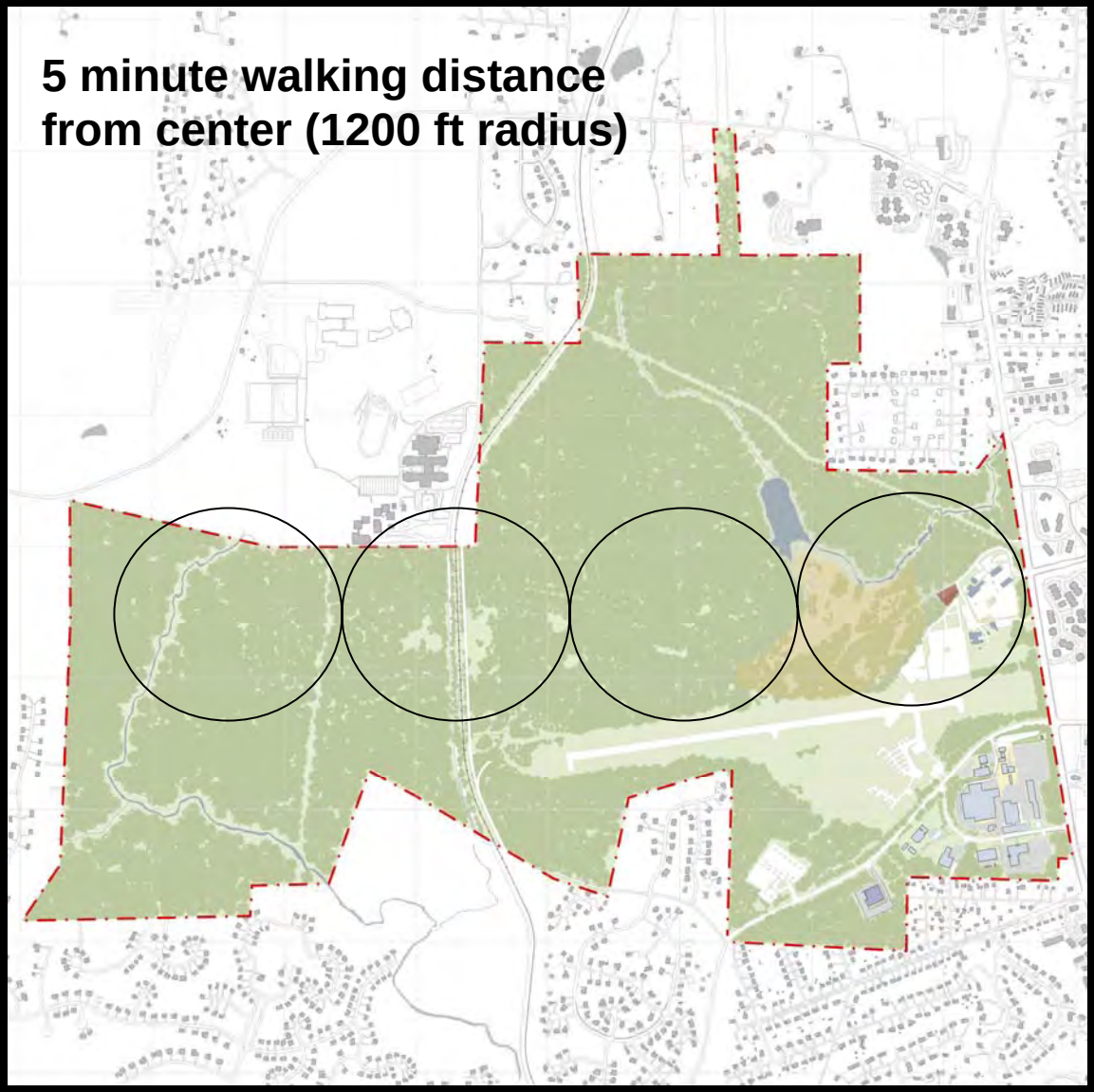
Carolina North Site



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Transportation Elements

- Transit
- Roads and streets
- Pedestrians
- Bikes
- Parking
- Site access/connections
- Phasing
- Priorities
- Other?

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Task at Hand

- What do we mean by sustainable transportation?
- How does it apply to Carolina North?
- What opportunities help us achieve our goals?
- What are the challenges, barriers?
- What is the range of possibilities? – broad and specific
- How to quantify them?

Building Typology

How Buildings Behave

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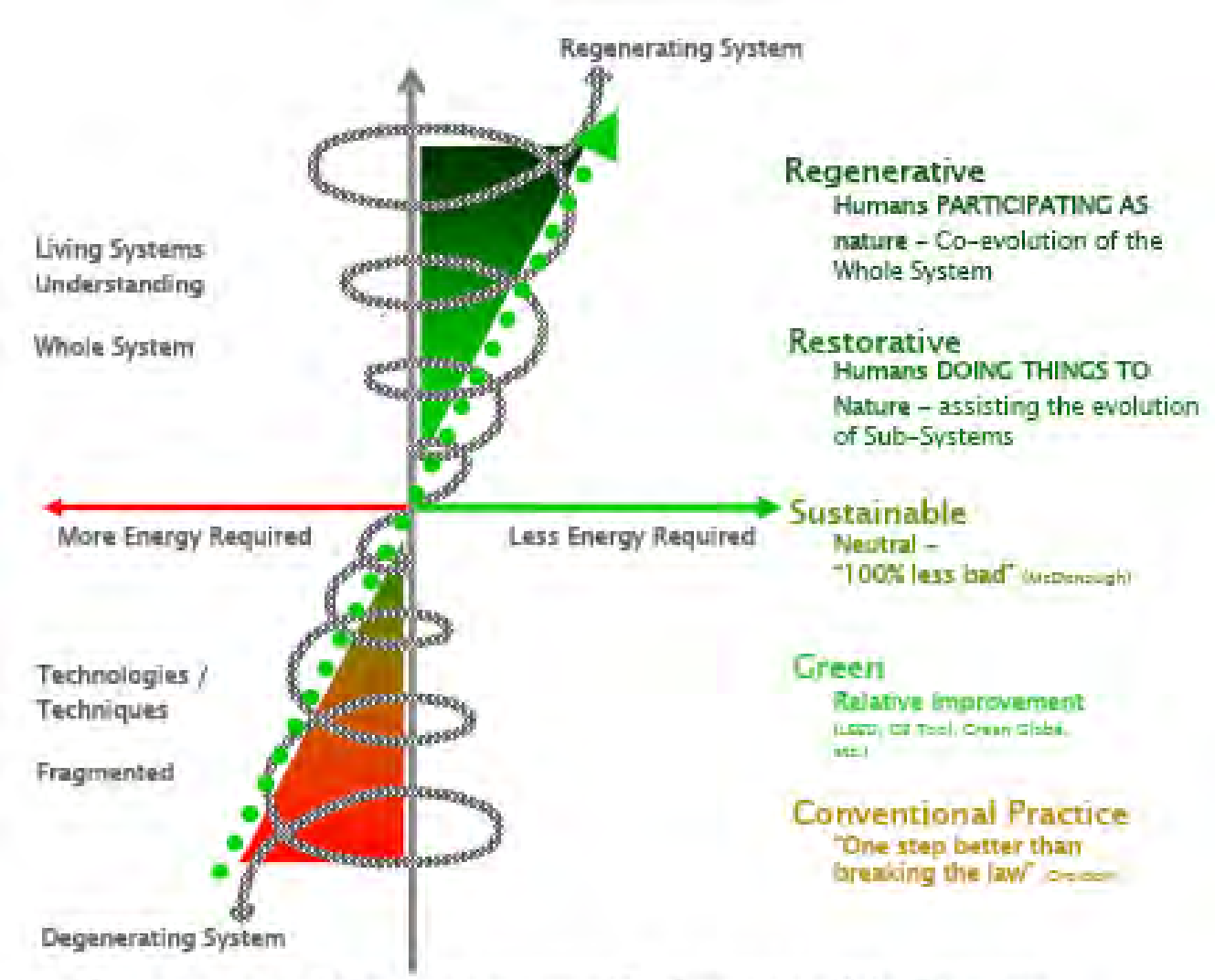

Trajectory of Environmentally Responsible Design

William Reed, 2006

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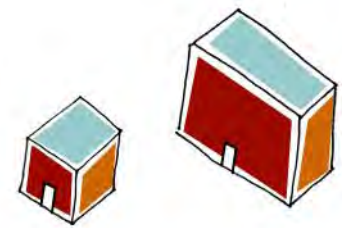
Building Behavior 101

Challenge # 1
Design Teams often don't understand the **Basics**

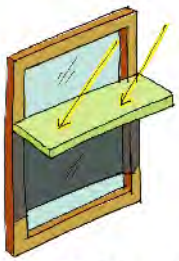
- Site Selection
- Orientation
- Massing
- Shading



Optimal Mass

Optimized Envelope

Optimized Orientation



Optimized Shading

Different Building Types Behave Differently

Challenge # 2
Design teams often don't understand how the **Basics** change with **Building Type** and **Climate**, leading to problems

- Misapplied Technology
- Higher construction cost
- Lower environmental performance
- Prioritization opportunities lost

Why would we **design** them as if they are all the same?

Standard Technology

Downtown Phoenix, Arizona

Downtown Anchorage, Alaska

The building industry moved away from design for:

- **Climate**
- **Culture**
- **Place**

Toward uniform standards:

- **Fixed windows to control air flow and humidity**
- **All heating and cooling is mechanical**
- **Building codes require uniform comfort standards**
- **Building materials come from anywhere in the world**
- **Manufacturers limit warrantees to controlled conditions**

Big Mistakes or Big Successes

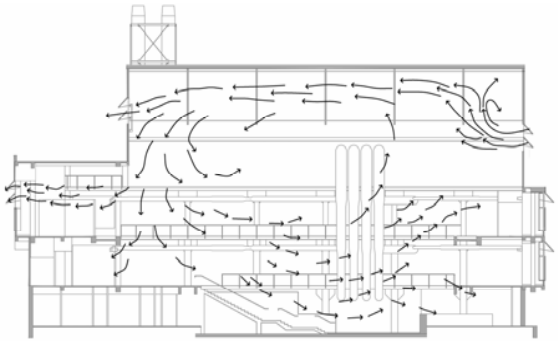
Challenge # 3 - Education must happen at the project's **early** stages - Site Selection to Schematic Design

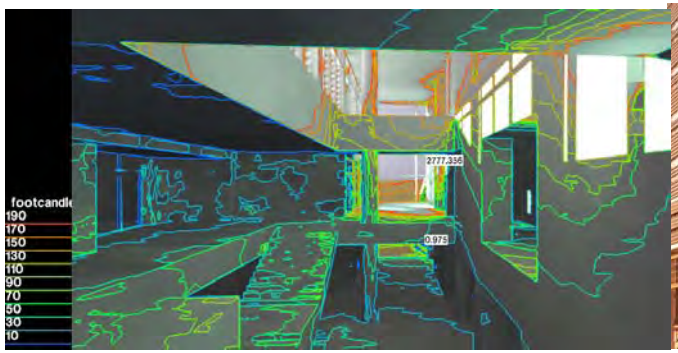
"By the end of Schematic Design only15-20% of the design fees have been spent…but 50-80% of the environmental impact and operating costs have already been determined depending on the building type and size"

How do we teach the basics of integrated, climate responsive design that is specific to building type?

ELEMENTS

Identify Macro Strategies





Energy Efficiency Measures

12 Saving Strategies Identified

- Building Orientation
- Building Massing
- Natural Ventilation
- Passive Solar
- Thermal Mass
- Optimized Envelope
- Optimized Glazing
- Optimized Shading
- Optimized Lighting
- Daylight Dimming
- Efficient Equipment
- Optimized Mechanical Systems

Water Efficiency Measures

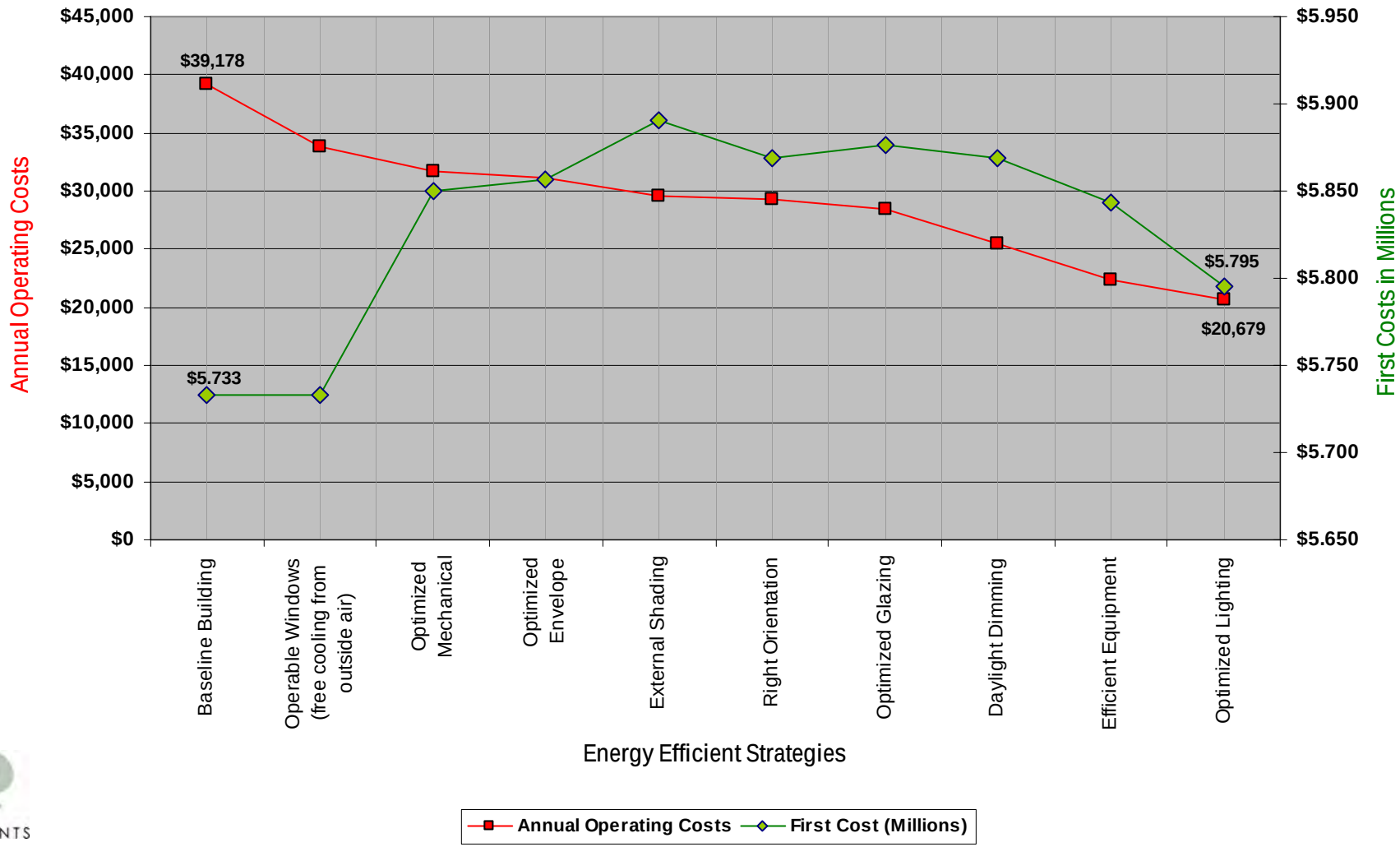
6 Saving Strategies Identified

- Waterless Urinals
- Native Landscaping
- Low Flow Fixtures
- Low Flow Water Closets
- Rainwater Harvesting
- Graywater System

ELEMENTS

Apply Most Efficient Renewable System

Trends for Capital and Operating Costs



ELEMENTS

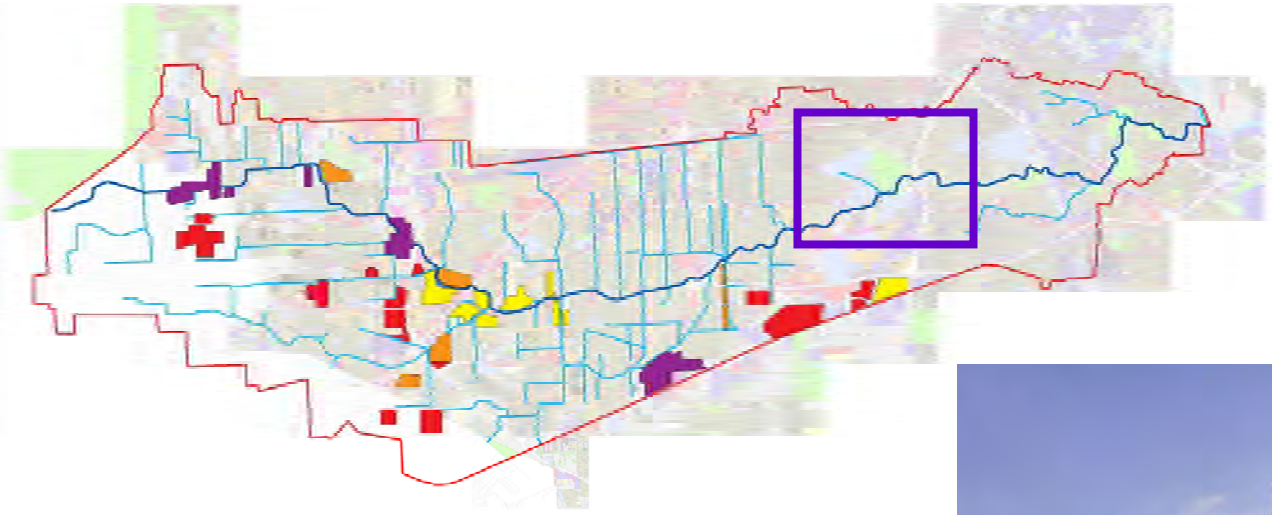
Daylighting and Student Performance

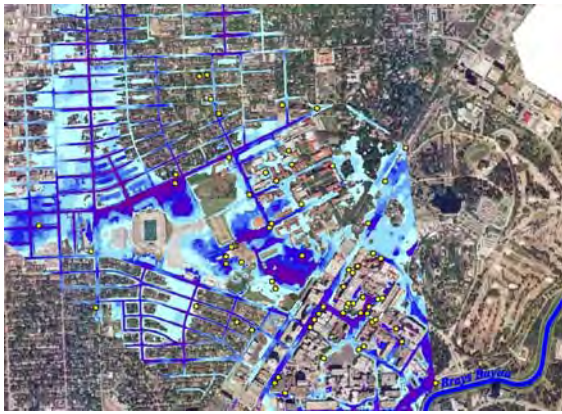
Daylighting, Windows, Skylights

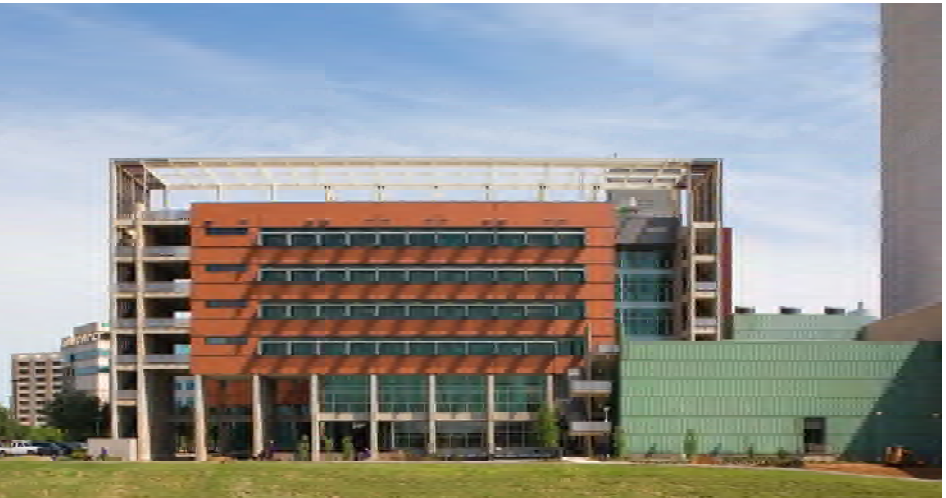
- 15-25% faster progress on math and reading tests
- 7-18% higher test scores

Ref:
Heschong Mahone Group, "Daylighting in Schools: An Investigation into the Relationship Between Daylight and Human Performance," 1999. Available at: http://www.h-m-g.com/
Follow up studies verified the rigor of analysis and subsequent research continues to show positive correlation between daylighting and student performance.

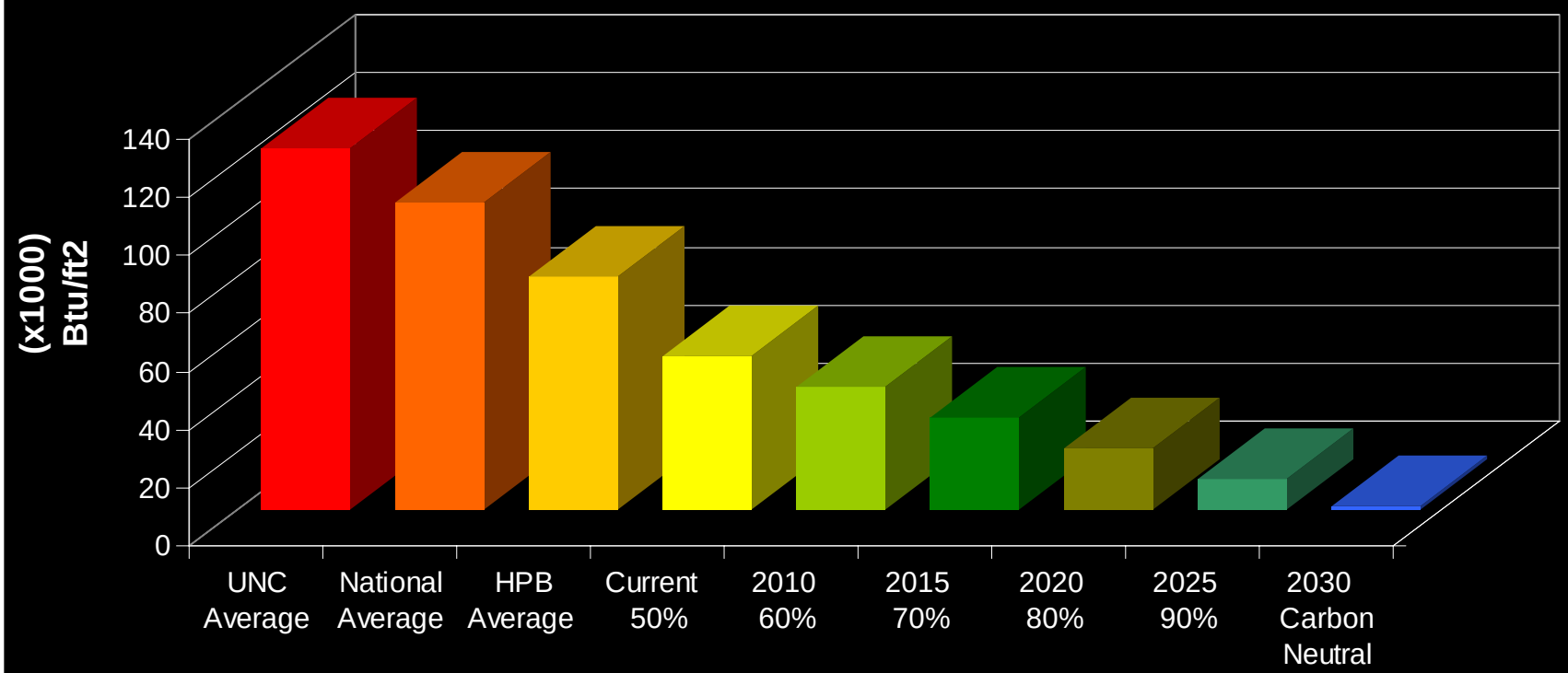
Integrated Pedagogical Opportunities







Energy Intensity for Administrative Building Type



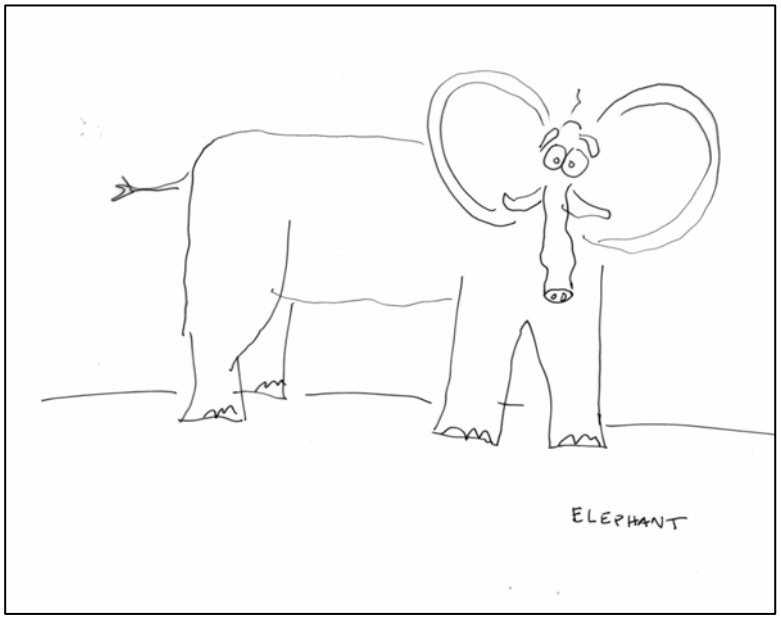
Sources:

UNC Average: Derived from data provided by University of North Carolina
National Average: 2006 Building Energy Data Book of Department of Energy

ELEMENTS

Potential Building Types for Carolina North

1. Administration
2. Computational
3. Classroom/Lecture
4. Mixed Land Use: retail, residential & office
5. Residential: medium density multi-family
6. Operation & Maintenance
7. Lab Building
8. Science Building
   - Chemistry-type
   - Biology/physical science
9. Public Use: Library, Auditorium
10. Utility Generation



The Laboratory

"fumehoodis openus"

Possibilities to explore

- Building Types
- Response to Climate
- Baseline Design Standards
- Integration of Users
- Synergistic Building Types
- Collaboration Space
- Pedagogical Opportunities
- Human Health and Productivity
- Adaptability
- Carbon Footprint
- A Living Building

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Utility Infrastructure, Energy Generation & Consumption

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Thermal Utilities & Power

Outline

- New Approaches
- Thermal Utility Discussion
- Electrical Discussion

New Approaches

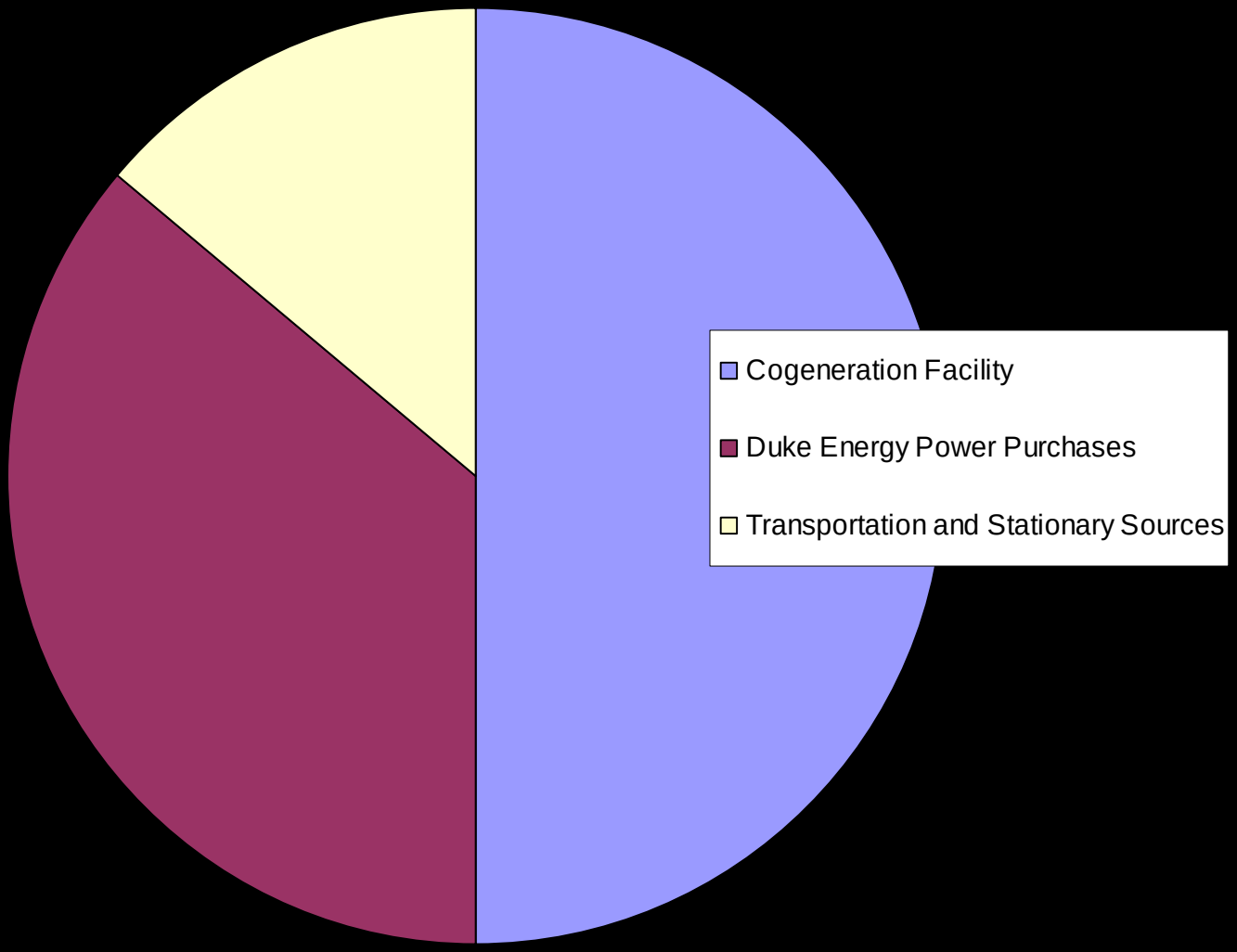
- CRed Efforts
- Demand side management
- New Technologies
- Barriers

The Greenhouse Effect

UNC – Town of Chapel Hill CRed Program Commitment

- Current Annual Emissions
  - 9 metric tons per person
- Current Commitment (Per Capita Reduction)
  - 60% Reduction by 2050
  - 45% Reduction by 2045
  - 30% Reduction by 2040
  - 20% Reduction by 2030
  - 10% Reduction by 2015

Campus CO_2 Inventory



Our Mission

- Maintain “Best in Class” systems
- Carolina North- “Once in a Lifetime Opportunity”
- Sustainability = Efficiency
- Find non-carbon based alternatives
- Provide the technical bridge from “green commitments” to practical solutions

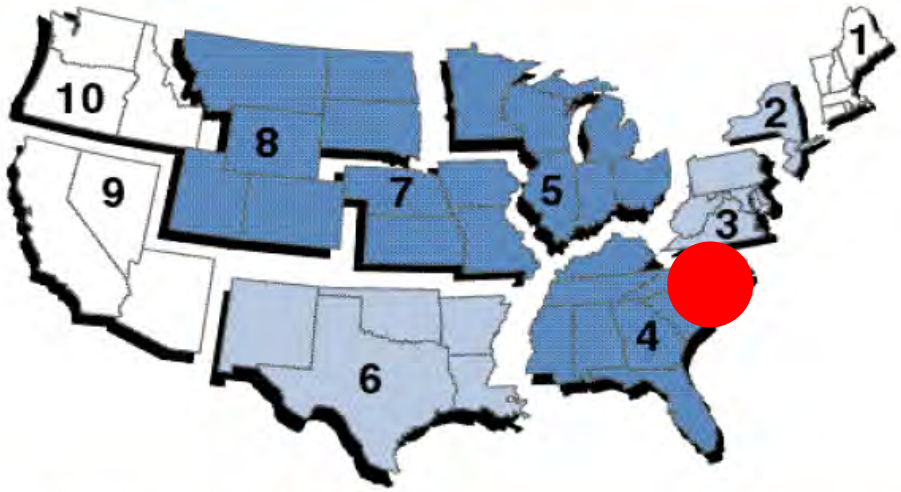
Thermal Utilities

- Primary Fuel Options
  - Landfill Gas
  - Hog Waste
  - Woody Biomass
  - Natural Gas/Propane Air
  - Solar
  - Groundwater
- Central v. Regional v. Local Generation
- Distribution Methods
  - Steam v. Hot Water
  - Methods and Materials




Electrical Power

- Duke Energy
  - “Green” Power Purchase
- Off-Site Generation
- Co-generation On-Site
- Distribution
  - Central Substation
  - Multiple Substations

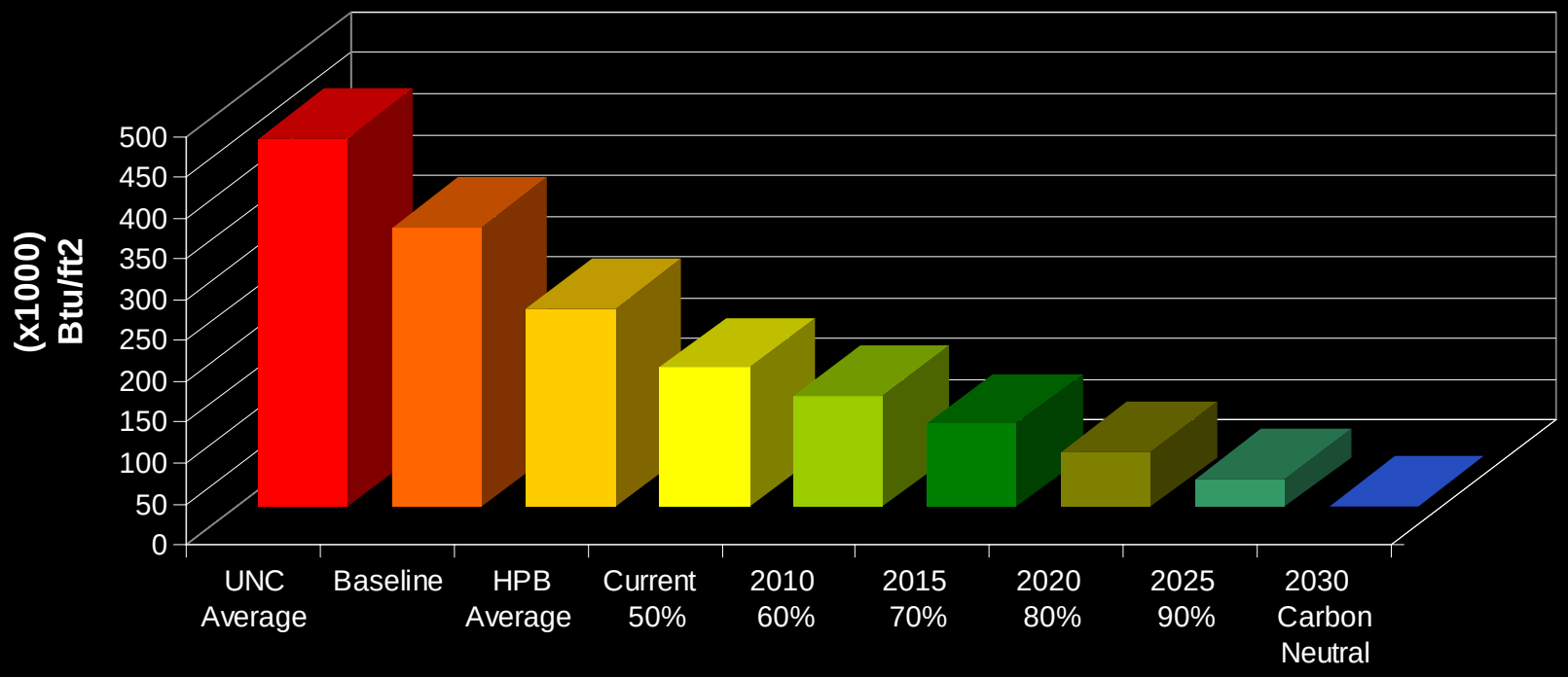


Map of pollution prevented per 1,000 kWh saved.

EPA Pollution Emission Region	Carbon Dioxide pounds/year	Sulfur Dioxide pounds/year	Nitrogen Oxide pounds/year
1	1,100	8.8	3.1
2	1,200	7.5	2.9
3	1,600	7.1	5.5
5	1,800	22.9	7.7
6	1,700	4.9	5.5
7	2,000	7.7	8.6
8	2,200	7.3	7.1
9	1,000	2.4	3.3
10	100	1.1	0.7

ELEMENTS

Energy Intensity for Laboratory Building Type



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HPB Average: Derived from High Performance Building Case Studies on the BuildingGreen.com Database.

ELEMENTS

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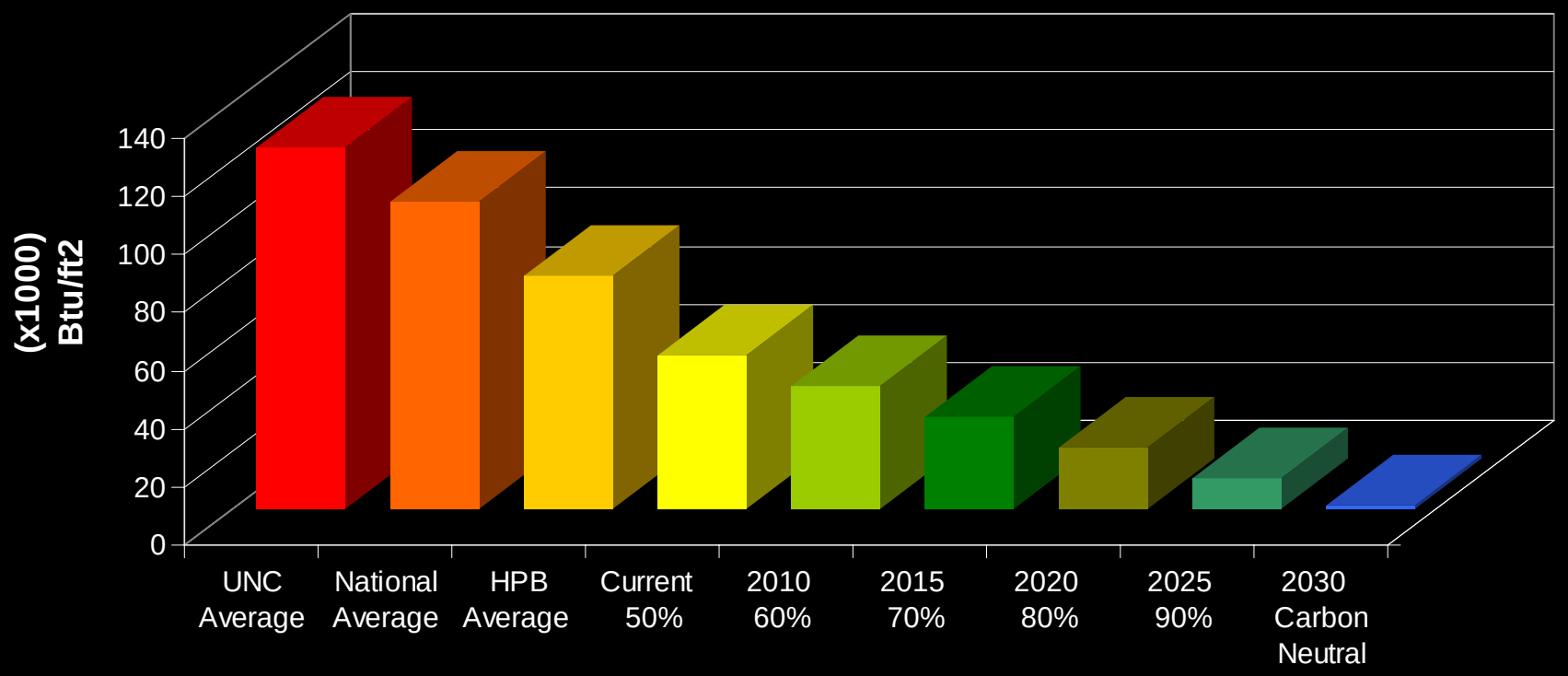

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