ST. PAUL CAMPUS ECOLOGICAL MASTER PLAN

Campus of the Environment

The Kestrel Design Group
May 8, 2006

OUTLINE

INTRODUCTION:

Plan
Campus

ANALYSIS:

Habitat
Geology
Hydrology

ECOLOGY:

Definition
Principles
Sustainability

OPPORTUNITIES:

Green Roofs
Green Corridors
Green Classrooms

MANAGEMENT:

Implementation Strategies
Best Management Practices
Sarita Wetland Ecology Center
Precedents

INTRODUCTION

NEEDS FOR THE PLAN

- Comply with Stormwater Runoff Permit
- Restore Sarita Wetland
- Designate Outdoor Research and Classroom Resources
- University's Mission of Teaching, Research, and Outreach
- Regents Policy on Sustainability and Energy Efficiency
- President's Initiative on the Environment and Renewable Energy
- Archibald Bush Foundation Grant for Sustainability
- Municipal Separate Storm Sewer System
- MN Sustainable Building Guidelines; Buildings, Benchmarks and Beyond

STATEMENT OF INTENT: NATURAL

- Decrease impervious surfaces on campus
- Decrease stormwater runoff and flooding
- Increase stormwater treatment and infiltration
- Recharge ground water and baseflow
- Restore pre-settlement hydrology
- Improve water quality
- Revegetate with native plant communities
- Improve habitat structure and biodiversity
- Designate a network of outdoor classrooms
- Organize the open space network on campus
- Improve campus sustainability
- Improve ecological functioning

INTRODUCTION

STATEMENT OF INTENT: CULTURAL

- Aesthetic improvements to campus identity
- Develop campus gateways
- Create synergy and excitement
- Multi-disciplinary approach to campus management
- Involve students in the process
- Promote demonstration, education, and research
- Broaden the mission of the agricultural fields
- Become one of top 3 research institutions in nation
- Campus of the Environment
- Connect University to community beyond
- Pedestrian and alternative modes of transport
- Reduce sprawl and energy consumption

INTRODUCTION

THE UNIVERSITY OF MINNESOTA ST. PAUL CAMPUS

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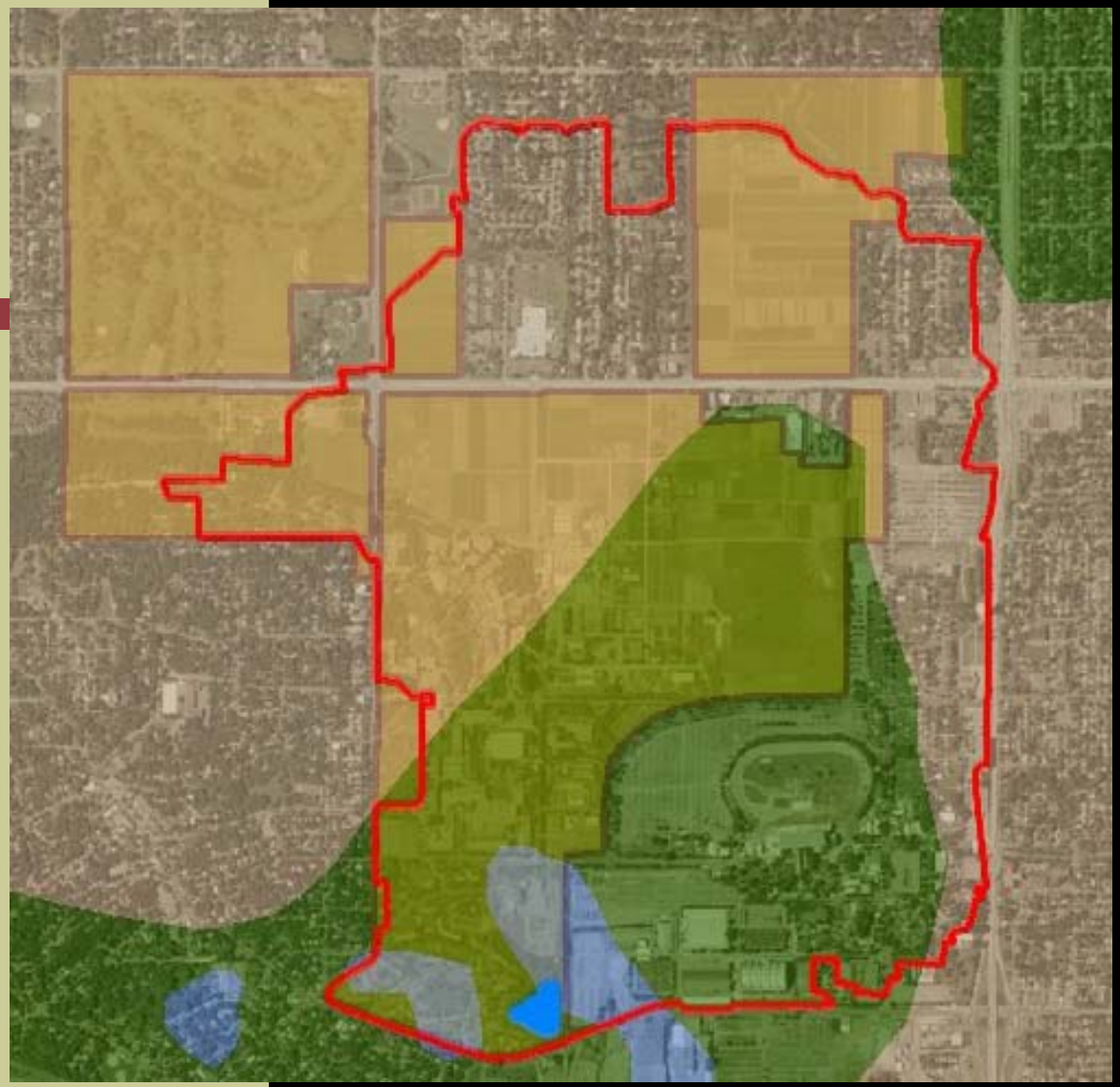
SUMMARY OF ANALYSIS

- Geology
- Topography
- Soils
- Stratigraphy
- Hydrogeology
- Ground Water
- Water Pollution Sensitivity
- Microclimate
- Original Vegetation
- Existing Vegetation
- Existing Animals
- Migration
- Landuse
- Figure/Ground Diagram
- Landcover Types
- 1853 Public Land Survey
- 1857 Ramsey County Plat
- 1887 H.W.S. Cleveland Plan
- Historic Watershed Boundary
- Impacts of Development
- Sub-Watershed Ratings
- Hydrology
- Water Quality
- Storm Sewer System
- Development Suitability
- Recreation
- Infrastructure
- Pedestrian/Auto Conflicts
- Gateways
- Scenic Quality

ANALYSIS

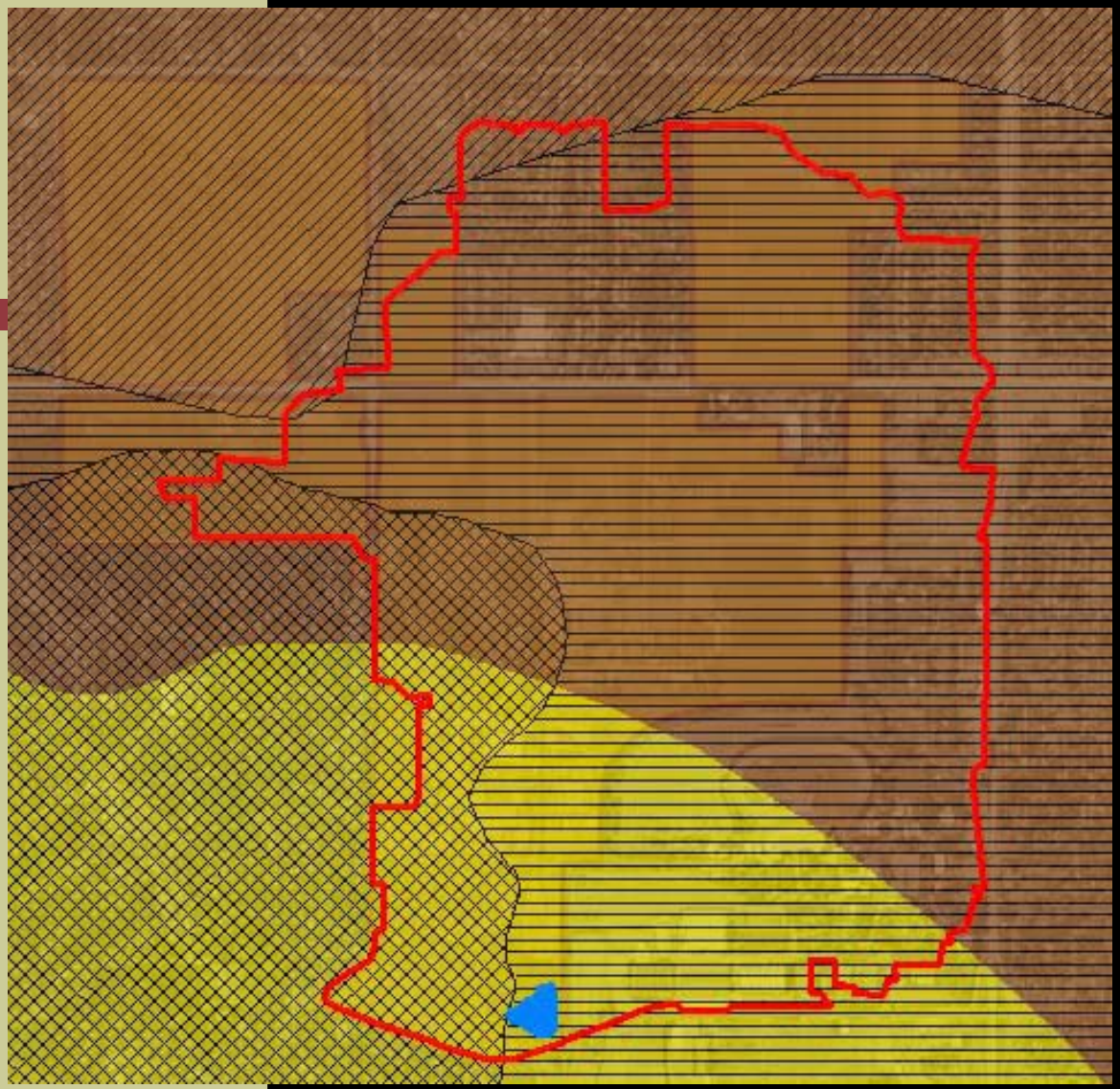
ORIGINAL VEGETATION



Entirely Vegetated Landscape

ANALYSIS

GEOLOGY



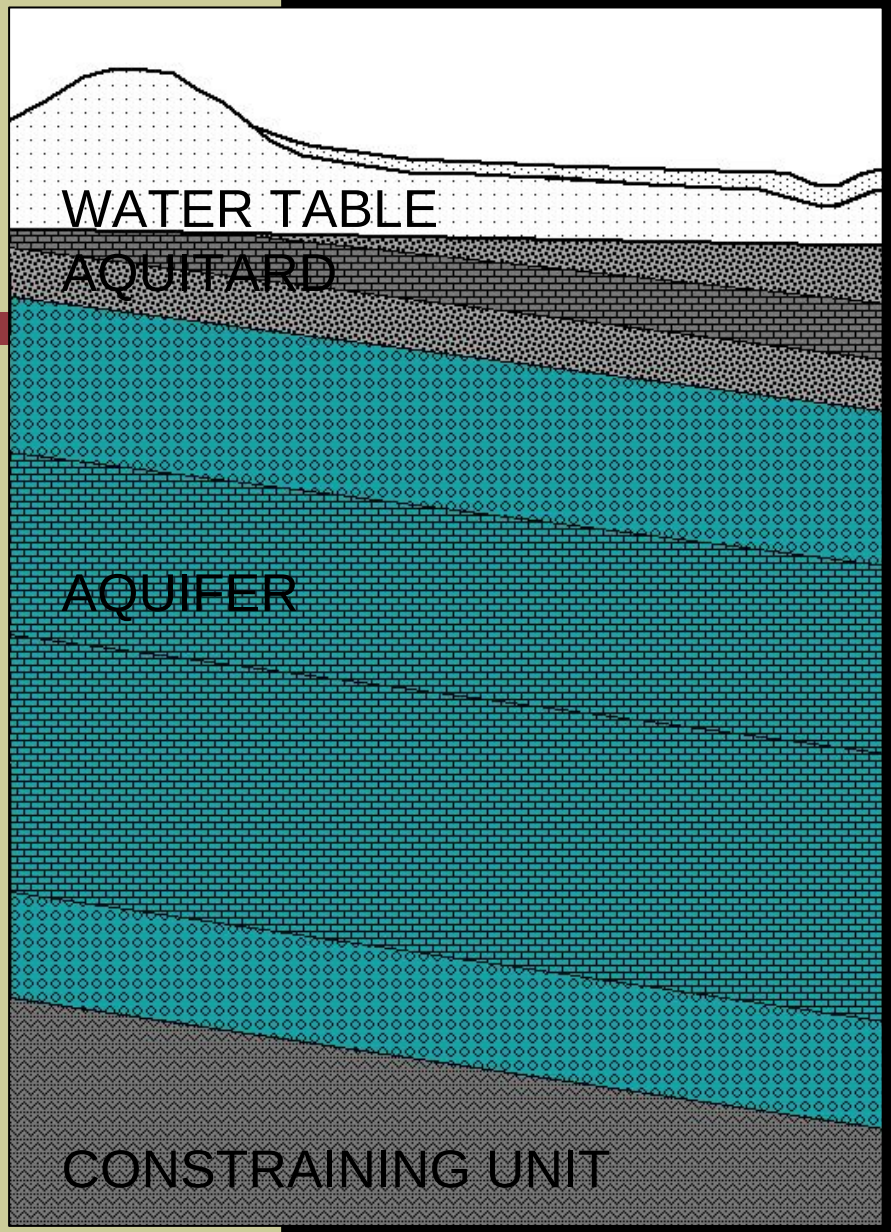
SURFICIAL GEOLOGY
- Glacial Morraine
- Kame Deposit
- Outwash Plain

BEDROCK GEOLOGY
- Decorah Shale
- Platteville Limestone

100 to 150 Feet of Sand and Gravel on Top of Bedrock

ANALYSIS

STRATIGRAPHY



Glacial Outwash
Glacial Till
Decorah Shale
Platteville Limestone
Glenwood Shale

St. Peter Sandstone

Shakopee Formation

Oneota Dolomite

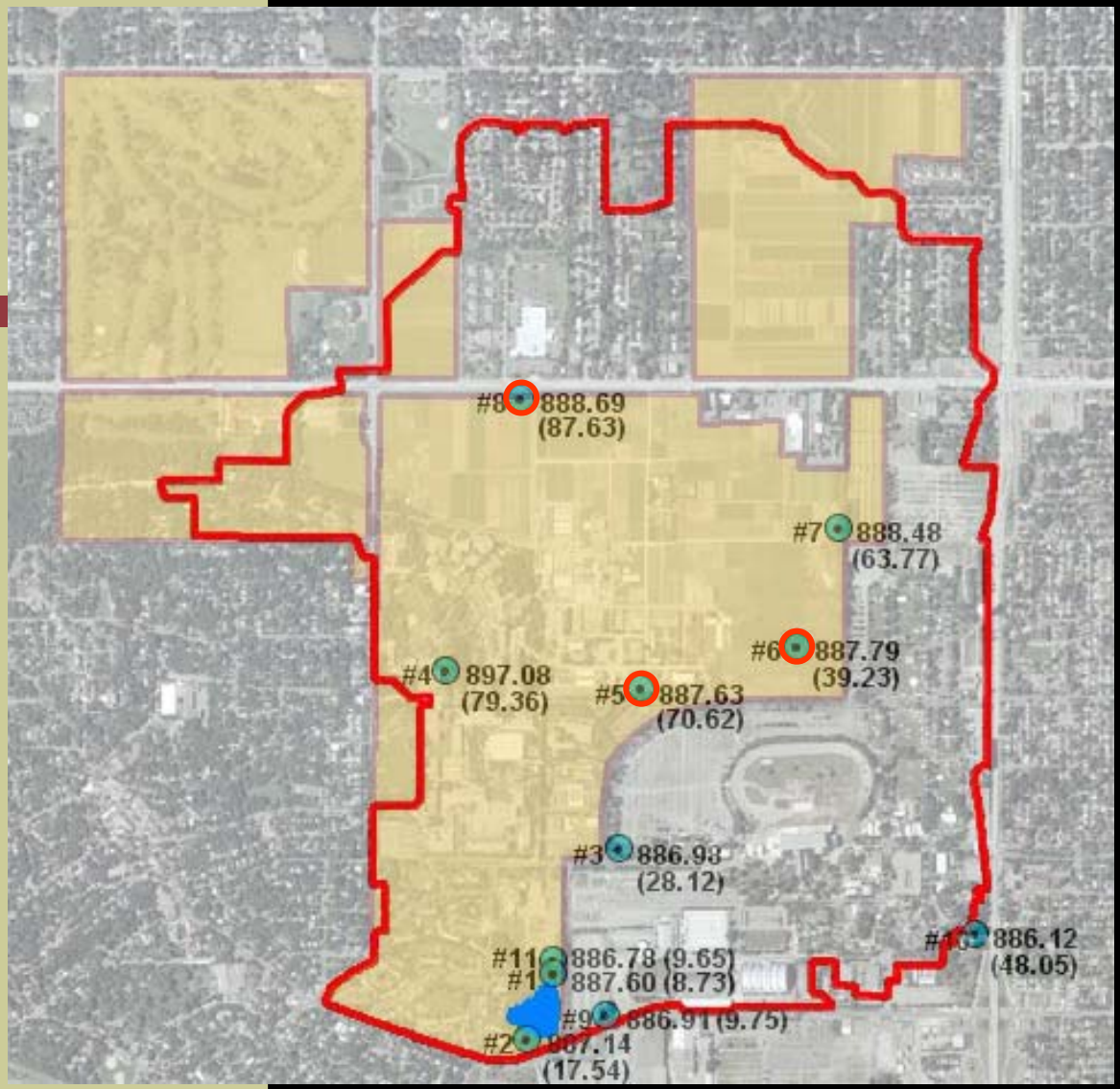
Jordan Sandstone

St. Lawrence Formation

Aquifer Protected, Water Table Susceptible to Contamination

ANALYSIS

HYDROGEOLOGY



Eleven wells monitored by students every fall as part of their coursework

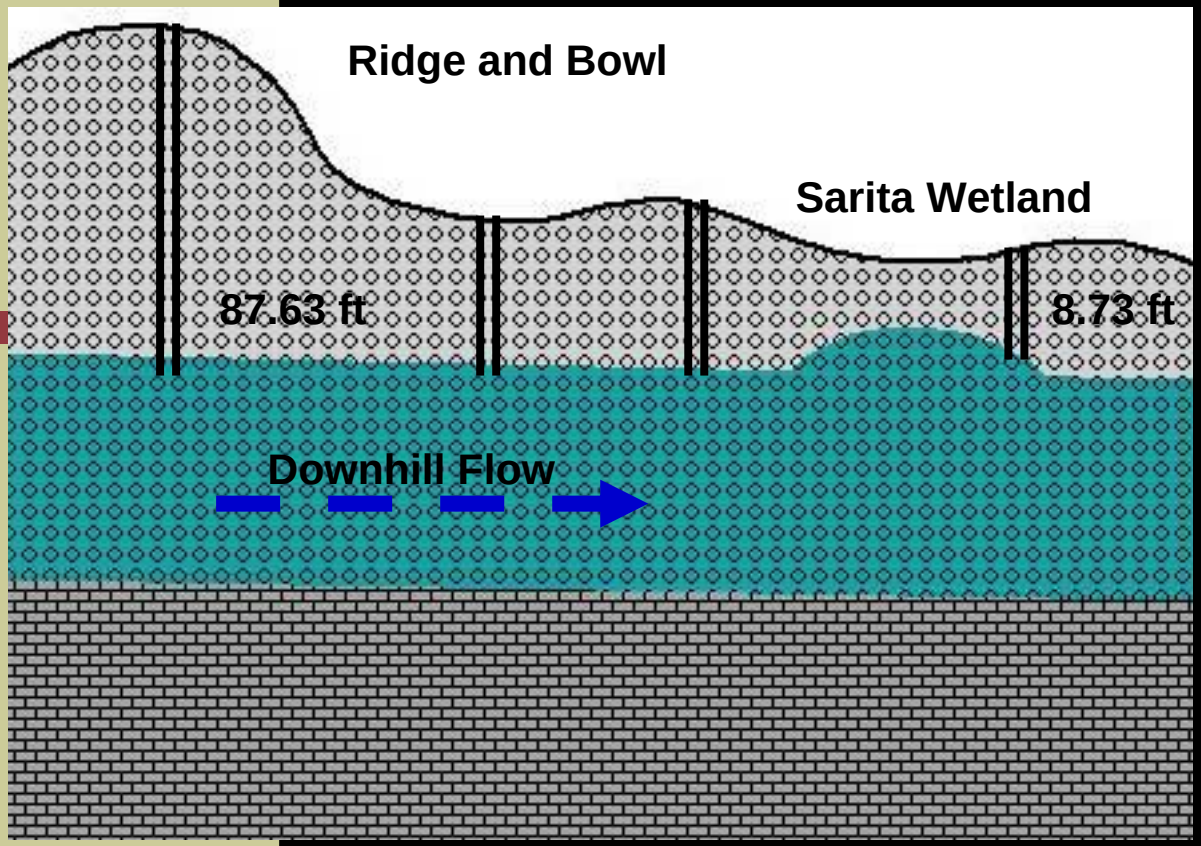
Water surface elevation (Depth to water)

Elevated levels of calcium, magnesium, chloride, and nitrogen in 3 of 11 wells suggest human impact from fertilizers, road salt, animal manure, and/or human waste water in local water table

PEER Engineering and Environmental Resources, Inc
Monitoring Wells, 2002

ANALYSIS

HYDROLOGY



Surficial Glacial Deposits

Sarita Recharge Mound

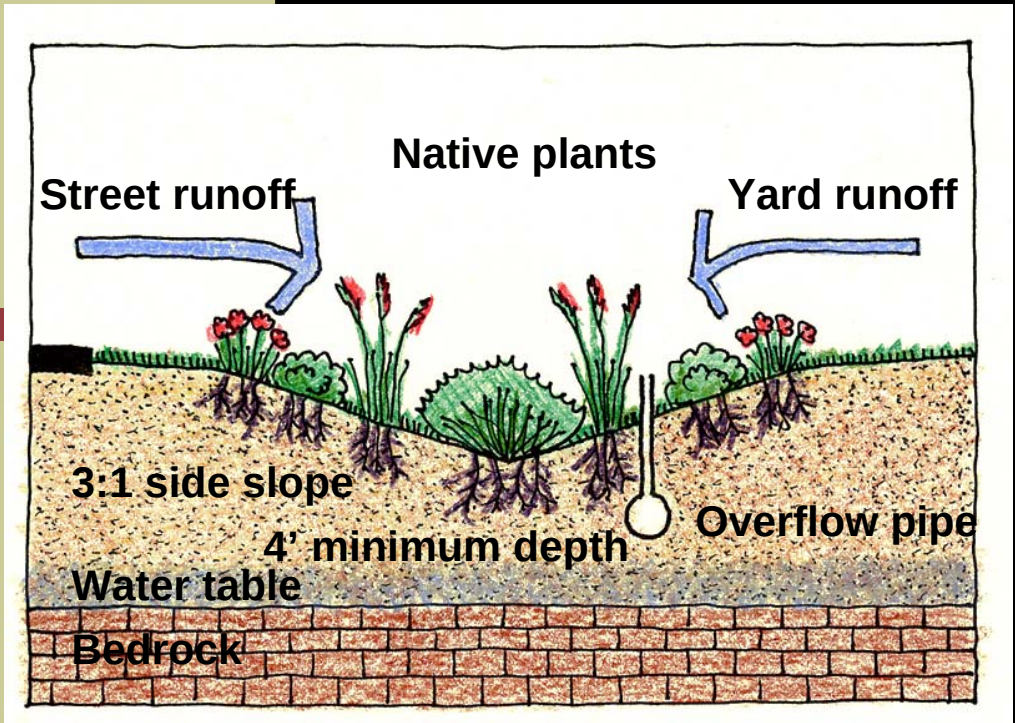
Perched Water Table

Bedrock Aquitard

Uniform hydraulic gradient with 2 feet of head drop per mile reflects the uniform nature of glacial deposits on campus.
Ten foot recharge mound beneath Sarita and Forebay.
Varying well depths (8.73 to 87.63) to uniform surface gradient.
Highly permeable soils of sand and gravel good for infiltration.

ANALYSIS

RAIN GARDENS



TYPICAL DESIGN

1) No curb and gutter allows infiltration of runoff
2) Native plants, soil particles filter and clean runoff
3) Minimum 4' depth of soil before water table, bedrock
4) Overflow pipe prevents flooding
5) 3:1 side slope

TOP REASONS FOR FAILURE

1) Improper siting on clayey or disturbed soils fail to drain
2) Lack of on-site soil testing to determine hydraulic capacity
3) Lack of on-site hydrogeologic investigation of water table
4) Soil compaction reduces hydraulic capacity
5) Excessive sediment clogs infiltration system
6) Soil media or filter fabrics clog infiltration system
7) Excessive drainage contaminates ground water

- Barrett L. Kays, *Landscape Architecture* May, 2006

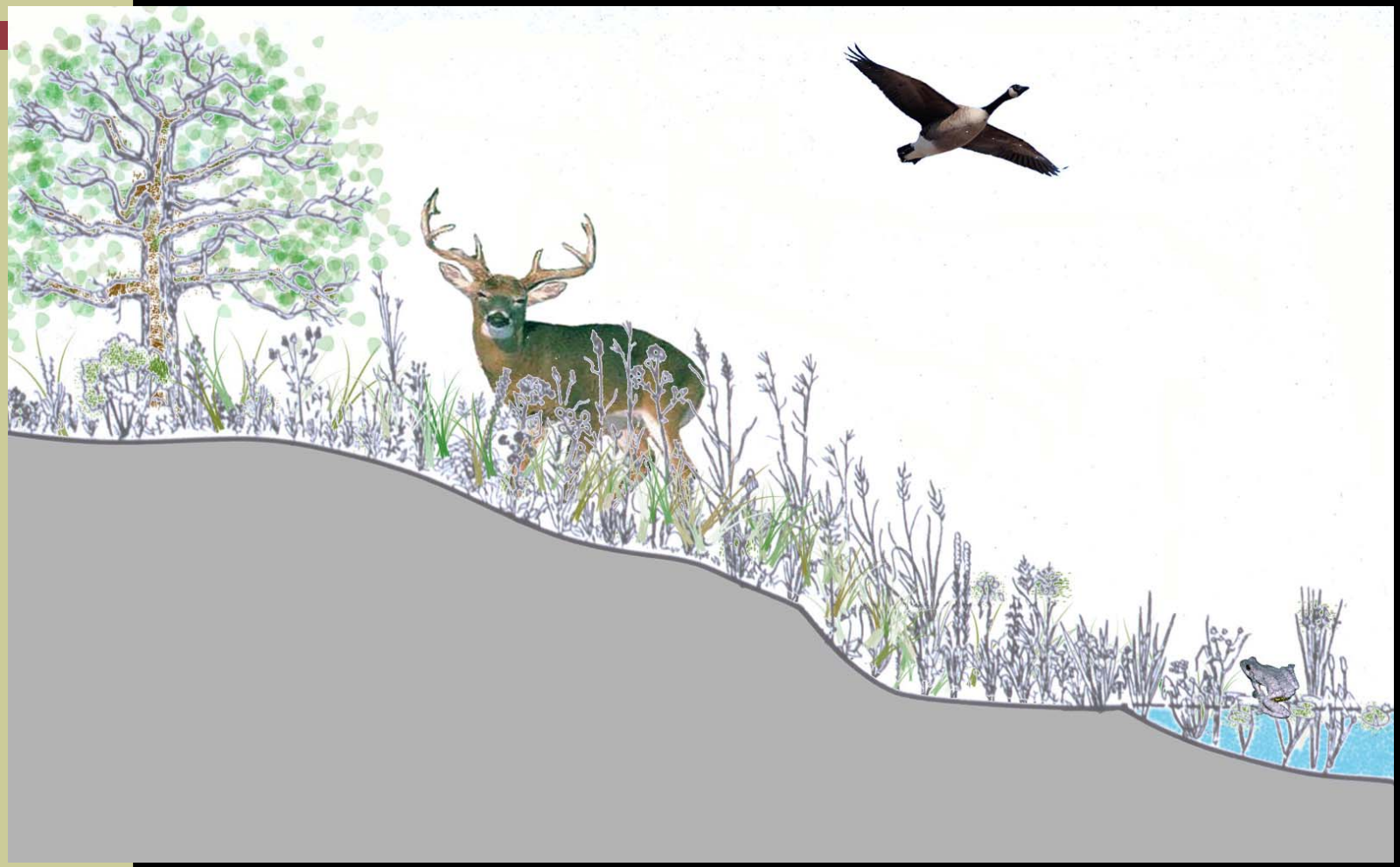
ANALYSIS

HABITAT CONNECTIONS

Global Migration - Geese

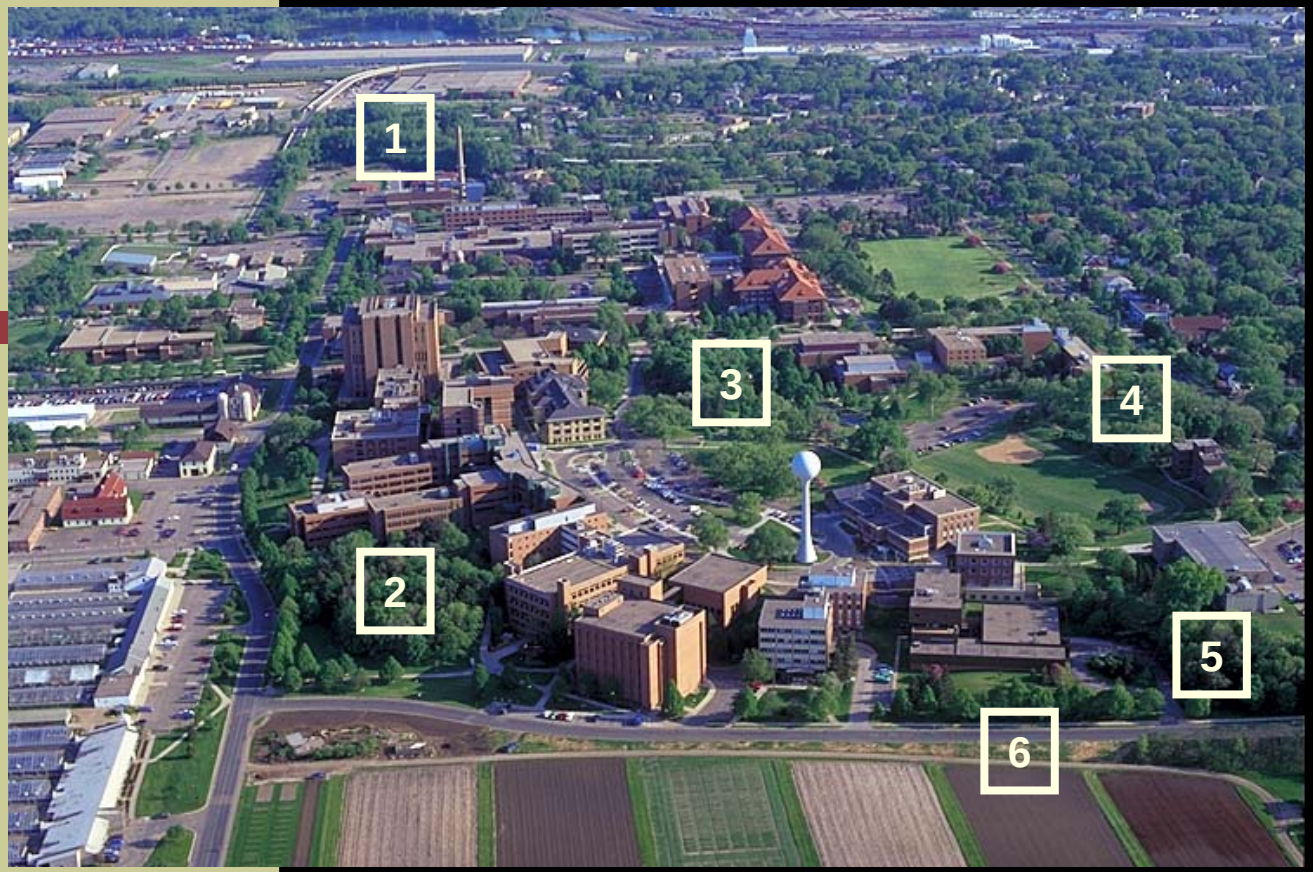
Regional Migration - Deer

Local Migration - Treefrogs



ANALYSIS

HABITAT FRAGMENTATION



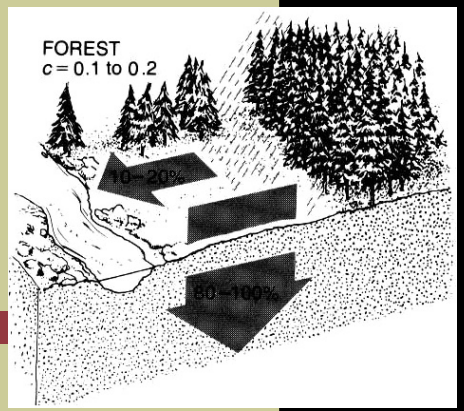
ANALYSIS

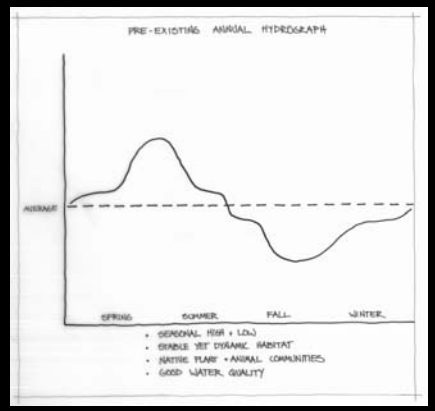
IMPERVIOUS SURFACES

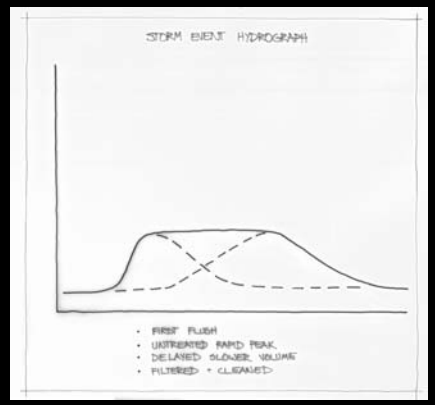
Watershed = 838 Acres
Watershed = 31% Impervious
Water Impairment at 10 – 20%

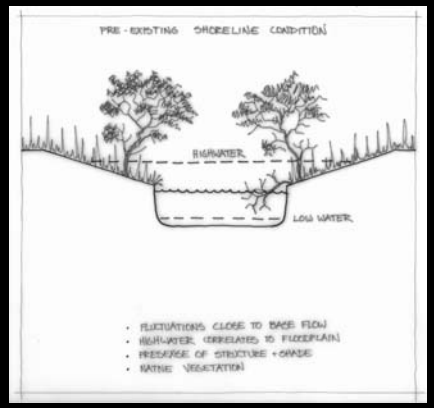
ANALYSIS

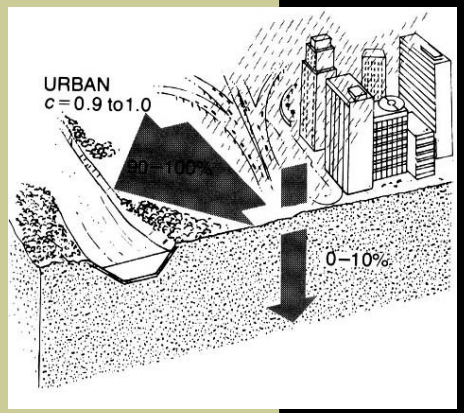
HYDROLOGIC CHANGES WITH SETTLEMENT

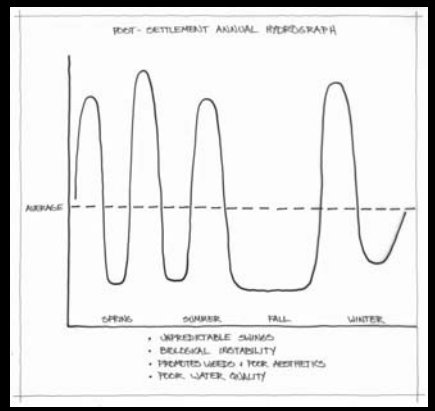


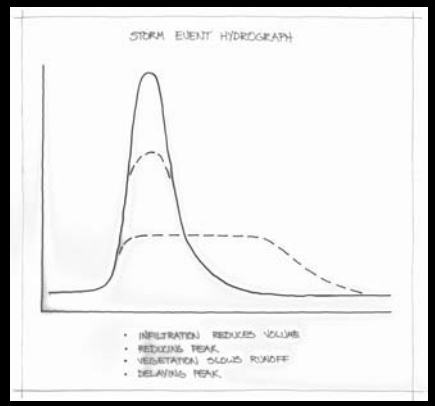


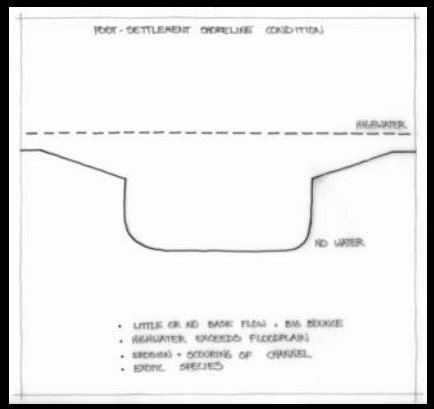












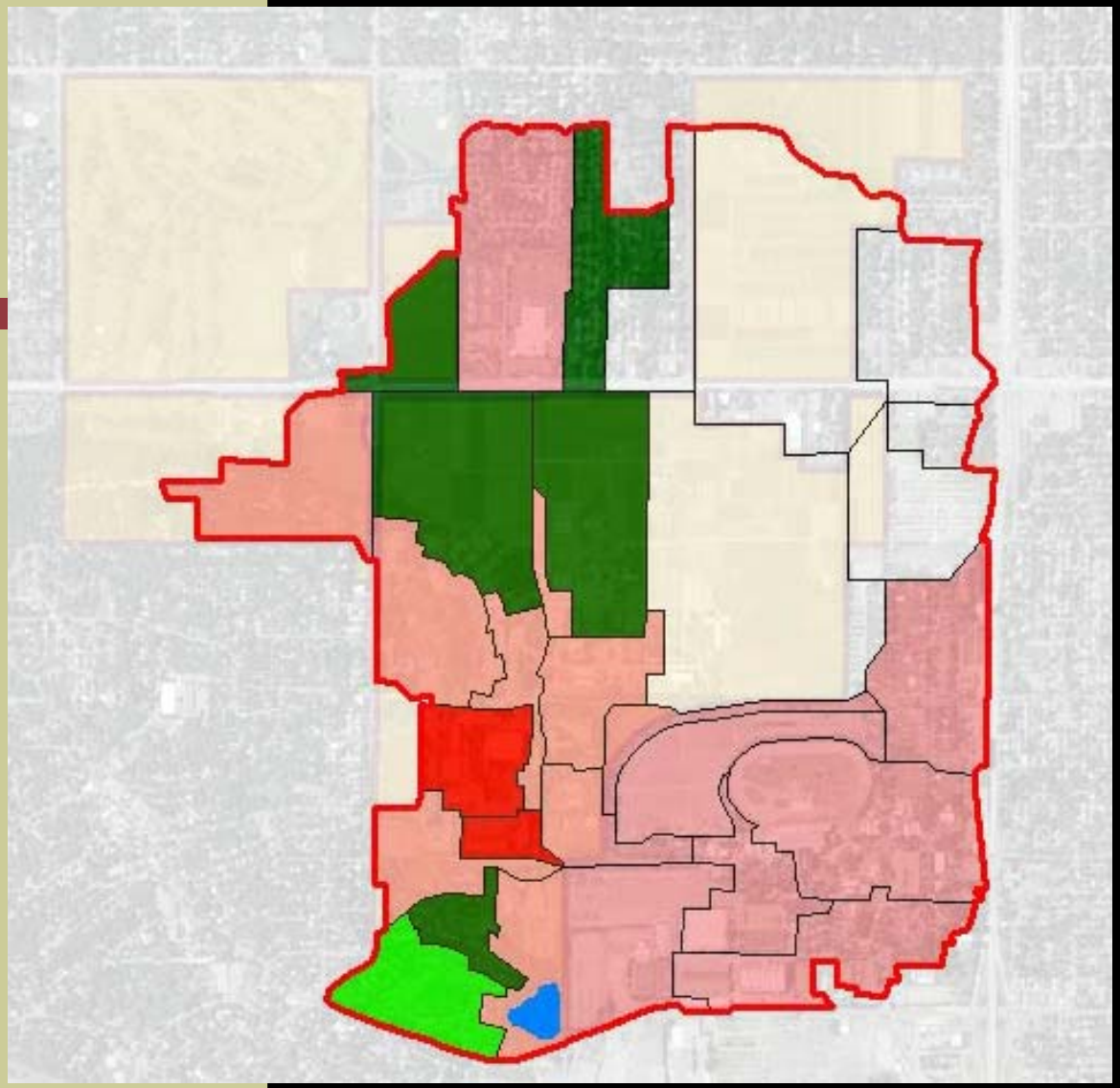
POST-SETTLEMENT CHANGES
Change from Infiltration to Runoff
Change from Stable Balance to Unpredictable Bounce
Change from Slow Clean Release to Fast Dirty First Flush
Change from Structure to Erosion

CONSEQUENCES OF HYDROLOGIC CHANGES

Annual discharge of 419.38 acrefeet of water from Sarita is equivalent to 300 feet long by 150 feet wide and 406 feet deep. Annual sediment load of 122,155.44 pounds into Sarita is equivalent to filling with 61 tons of sand and dirt every year. Annual phosphorus load of 382.08 pounds entering Sarita is equivalent to maximize crop yields on 8 acres of farm fields.

ANALYSIS

SUB-WATERSHED RATINGS



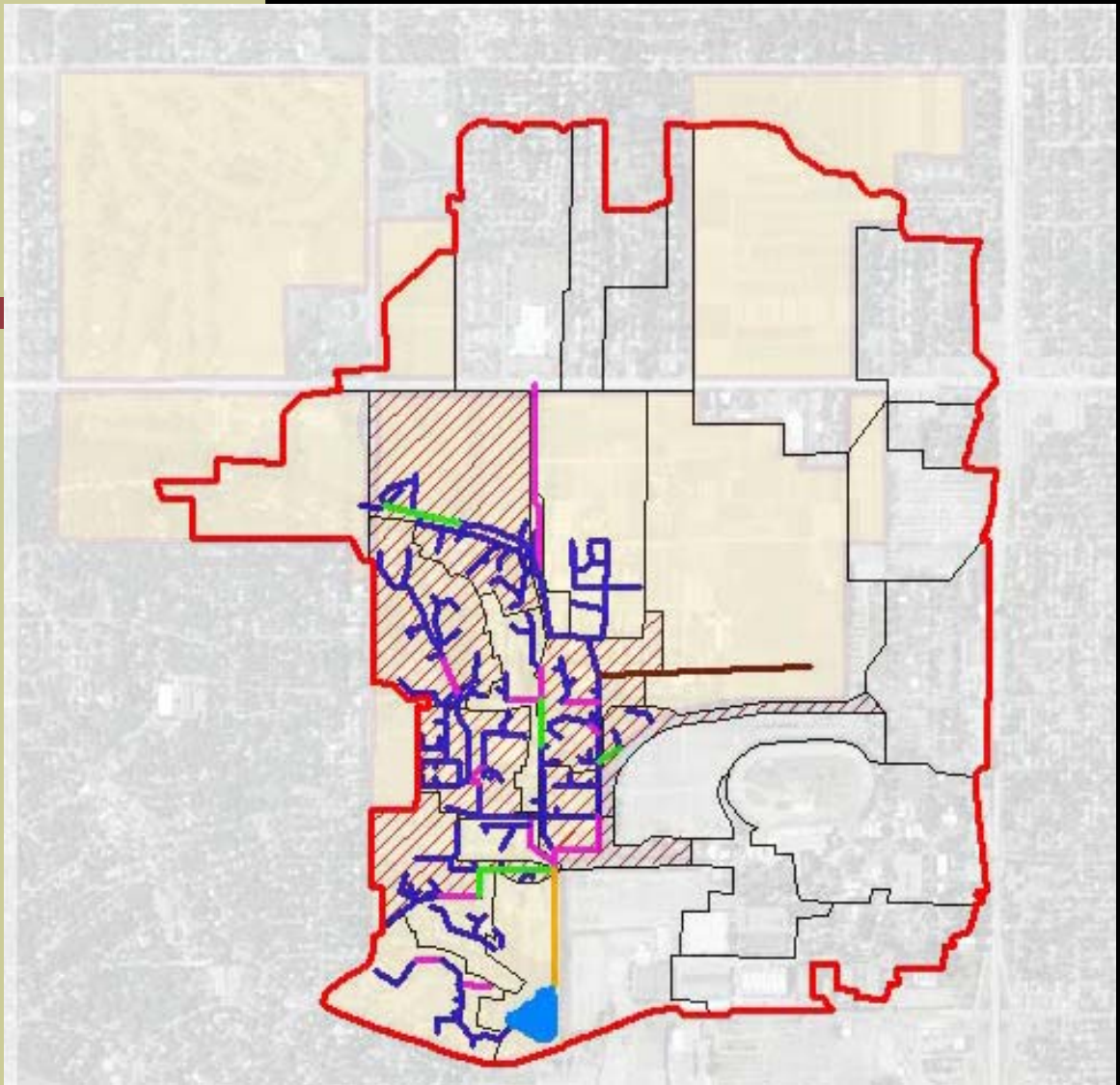
CONTRIBUTION TO WATER VOLUME, SEDIMENT, AND PHOSPHORUS LOAD DUE TO IMPERVIOUS

- Way above average
- Above average
- Below average
- Way below average
- Not at all

Emmons and Olivier Resources, Inc
Sarita Wetland Hydraulic Study, 2001

ANALYSIS

STORM SEWER INFRASTRUCTURE



STORM SEWER PIPES
- At capacity
- Under capacity
- Upgrade
- Enlarge ditch
- Sheep pasture

INLET CAPACITY
- Adequate
- Inadequate

Short Elliot Hendrickson, Inc
Storm Sewer Utility Planning Study, 2004

ANALYSIS

ENGINEERING APPROACH

Increase sewer pipe size
to handle volume of water

Treats water as waste and throws it away
Doesn't consider downstream consequences

ECOLOGICAL APPROACH

Decrease volume of water
to fit existing sewer pipes

Treats water as resource and saves it
Cleans water, mimics hydrologic cycle

WHAT IS AN ECOLOGICAL APPROACH?

DEFINITION OF ECOLOGICAL

"… any form of design that minimizes environmentally destructive impacts by integrating itself with living processes."

-- Van der Ryne and Cowan 1996

BIOMIMICRY

Look to nature for design inspiration to meet human needs in harmony with the environment. Nature's had 3.8 billion years of evolution to work out solutions to the same problems confronting the human race.

-- Janine Benyus 1997

CRADLE TO CRADLE

Design processes rather than objects. There is no such thing as waste in nature. There is no scarcity or pollution when we view material objects as nutrients continually circulating through healthy systems.

-- William McDonough and Michael Braungart 2002

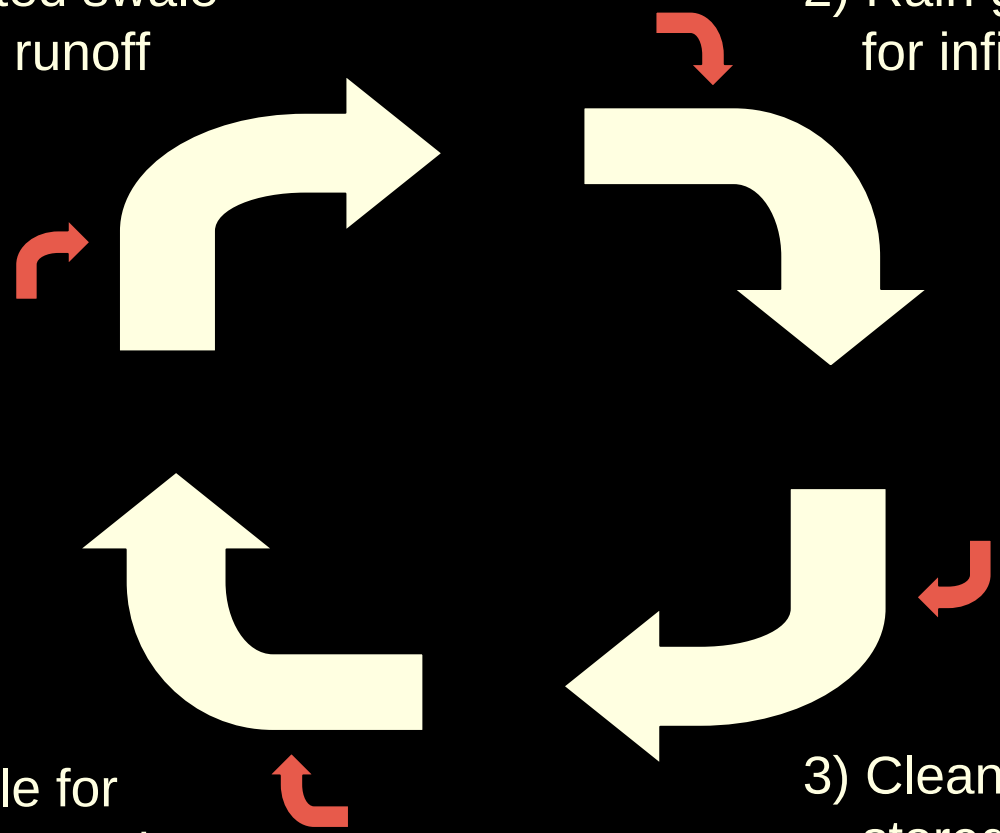
WORKING WITH NATURAL PROCESSES

THE POWER OF POSITIVE FEEDBACK LOOPS
Small inputs of energy and effort reinforce natural processes and let them do the bulk of the work for free.

FUNCTIONAL:

1) Vegetated swale collects runoff

2) Rain garden for infiltration



3) Clean water stored in Earth for free

4) Available for our reuse and base flow

WORKING AGAINST NATURAL PROCESSES

THE HIGH COST OF CONTROL
Huge inputs of energy and effort are required to overcome natural processes.

DYSFUNCTIONAL:

1) Continual resizing of storm sewer pipes

2) Downstream flooding, levees

3) Water treatment plants and Dead Zone in Gulf

4) Aquifer depletion for irrigation and municipal use

ECOLOGICAL PRINCIPLES OR PROCESSES TO WORK WITH

THE ENERGY CYCLE
Plants and animals are intricately linked by their mutual support. Each creates the conditions necessary for the other's survival.

LANDSCAPE ECOLOGY
The study of patterns in the landscape at the scale necessary to successfully integrate humans and nature.

THE HYDROLOGIC CYCLE
Most rainwater soaks into the ground where it moves slowly through the earth as part of the groundwater regime.

SOIL FORMATION
Soil can be considered a living organism. Fertile soil is the most valuable natural resource available to mankind.

BIOLOGICAL DIVERSITY
The organisms living in an ecosystem are responsible for the continued health, functioning, and productivity of that system.

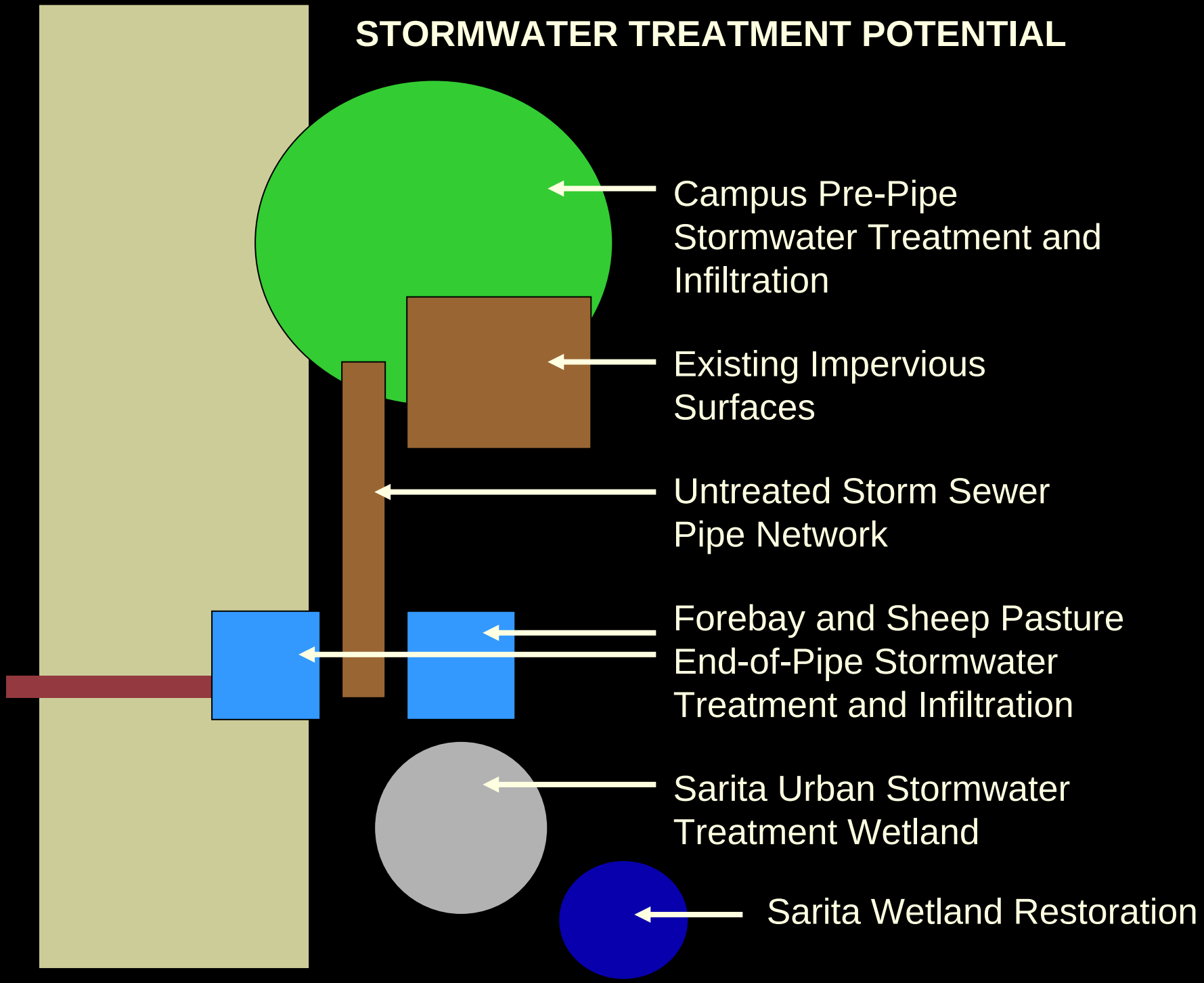
TARGET SPECIES AND WILDLIFE CORRIDORS
Retain existing vegetation cover and structure including groundcover, shrub layer, canopy, and dead logs.

GOALS OF A SUSTAINABLE PLAN

1) Enhance Biological Diversity
    a) Native Plant Communities
    b) Landscape Ecology
2) Improve Water Quality
    a) Surface Water
    b) Ground Water
3) Protect Valuable Resources
    a) Cultural
    b) Natural
4) Promote Multiple Modes of Transportation
    a) Mass Transit
    b) Pedestrian
5) Reduce Fossil Fuel Dependence
    a) Alternative Renewable Sources
    b) Reduce Consumption
6) Generate Low Impact on Environment
    a) Materials
    b) Construction
7) Nourish Human Development
    a) Sense of Community
    b) Health, Safety and Education

OPPORTUNITIES

STORMWATER TREATMENT POTENTIAL



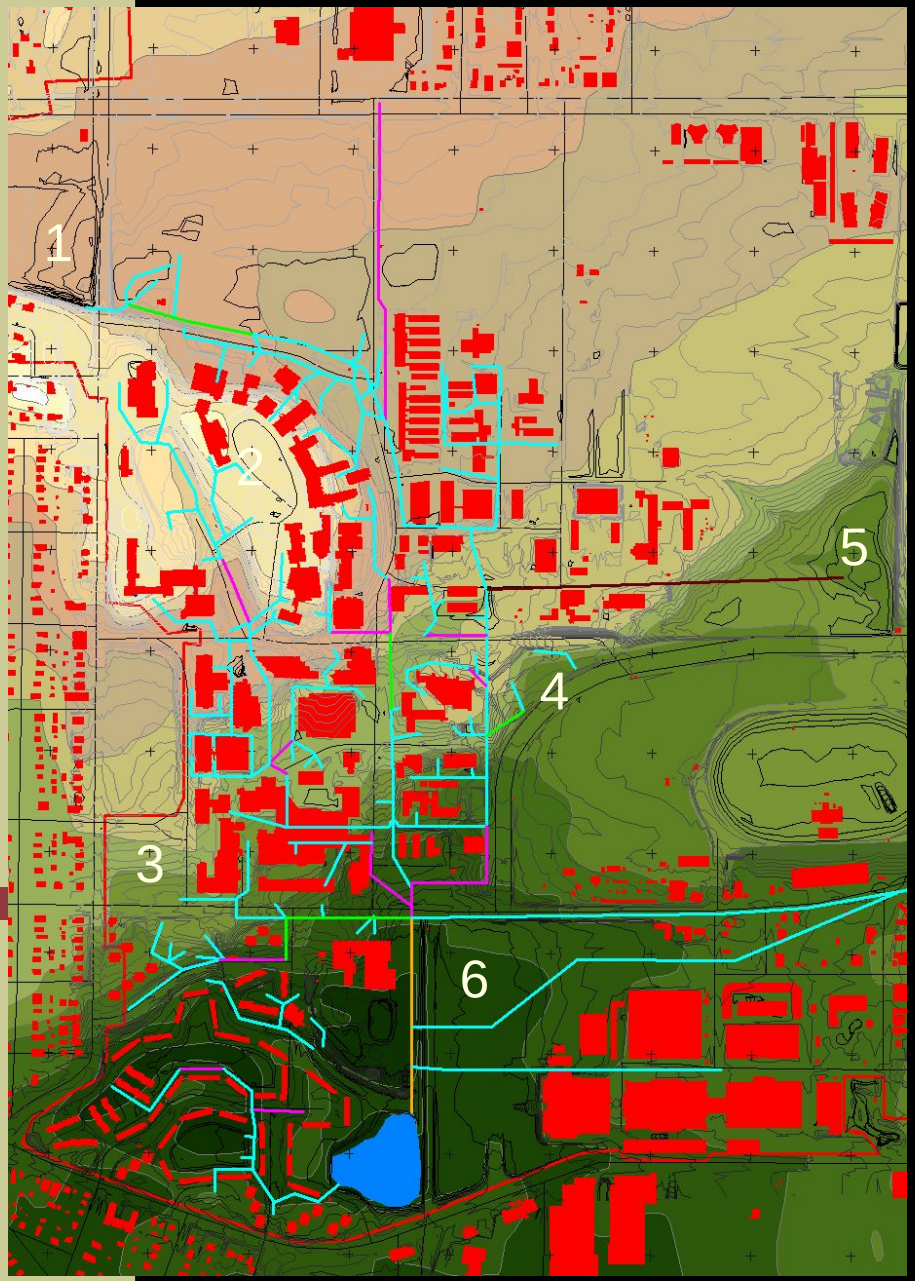
OPPORTUNITIES

GREEN ROOF POTENTIAL

Dark red sub-watersheds contain more impervious surfaces (63% and 71%) and so contribute the most runoff, sediment, and phosphorus to Sarita and become the highest priority candidates for green roofs to reduce their amount of impervious surfaces.

OPPORTUNITIES

INFILTRATION POTENTIAL



Don't Increase Pipe Size to Handle Water Volume In Constricted Locations

- Under Capacity Pipes
- At Capacity Pipes
- Upgrade Pipes
- Enlarge Ditch
- Sheep Pasture Diversion

Instead Reduce the Volume of Water Entering the Pipes Upstream of Constrictions

1) Bell Museum
2) The Ridge
3) Carter Parking Lot
4) Buford Parking Lot
5) Sheep Pasture
6) State Fair

OPPORTUNITIES

CAMPUS OF THE ENVIRONMENT

OUTDOOR CLASSROOM POTENTIAL

1) Gibb's Farm
2) Bell Museum
3) Larpenteur Ave
4) Prairie Strip
5) Mullen's Woods
6) The Ridge
7) The Lawn
8) Carter Parking
9) Gortner Ave
10) Buford Parking
11) Sheep Pasture
12) State Fair
13) Sarita Wetland

Campus Greenbelt Improves Gateways, Identity and Image
Organize Network of Open Space and Pedestrian Travel

OPPORTUNITIES

REGIONAL CORRIDOR POTENTIAL

Green corridors create wildlife habitat, reduce impervious surfaces, increase infiltration, create pedestrian connections, and improve aesthetics.

Regional connections could be made to Como Park, Newell Park, McCarrons Lake, the Minneapolis Campus, the Mississippi River, or by replacing Highway 280 and its unsafe entrance ramps with a slower speed green parkway.

MANAGEMENT

IMPLEMENTATION OF PLAN; MULTIPLE VALUES

CREATE A FRAMEWORK OF OUTDOOR PLACE-HOLDERS
Create spaces for student classes to design experiments

OUTDOOR CLASSROOM DESIGNATION
Designate outdoor classrooms as unique teaching and research resources and identify key issues to address

MULTI-DISCIPLINARY APPROACH
Integrate multiple functions in the landscape including ecology, agriculture, habitat, recreation, and stormwater management

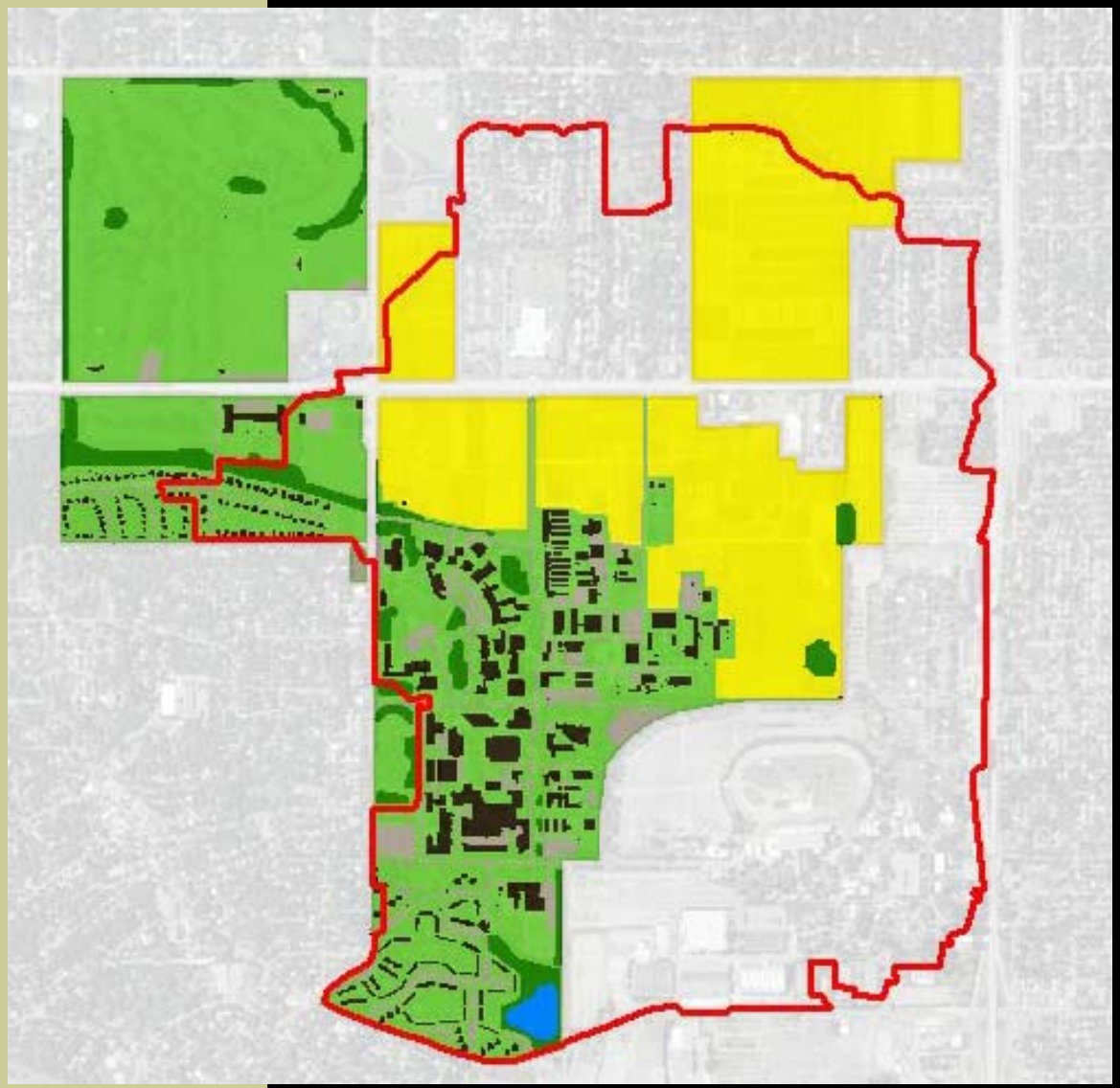
ESTABLISH A COMMITTEE TO MANAGE CAMPUS
A committee representing the entire University community should be involved in making decisions for outdoor spaces

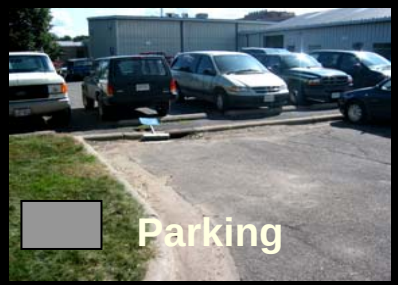
REDUCE SPRAWL AND IMPERVIOUSNESS
Preserve open space, replace parking lots with green ramps

FORM PARTNERSHIPS BEYOND THE UNIVERSITY
Work with the State Fair, DNR, and residential neighborhoods

MANAGEMENT

PARAMETERS OF THE PLAN





This plan applies to outdoor spaces

OUTDOOR SPACES MANAGEMENT PLAN

1) Agriculture
   a) Row Crops
   b) Pasture
2) Open Space
   a) Boulevard
   b) Front Yard
   c) Ornamental Plantings
   d) Recreation
3) Natural Areas
   a) Forest
   b) Savanna
   c) Prairie
   d) Wetland
   e) Rain Garden
4) Rooftops
   a) Flat Roofs
   b) Pitched Roofs
5) Streets and Parking Lots
   a) Streets
   b) Parking Lots
   c) Parking Ramps

BEST MANAGEMENT PRACTICES

Decrease impervious surfaces
Reduce stormwater runoff volume
Increase infiltration of surface water
Minimize movement of sediment, nutrients
Improve water quality
Improve habitat structure and biodiversity
Connect habitat patches and natural areas
Provide safe and aesthetic pedestrian paths

Model pre-settlement hydrology:
50% infiltration, 40% evapotranspiration, 10% runoff

Develop budget to study the sources and sinks on campus
(Savannick 2004, Alexander et al. et classica 2005)

Reduce Phosphorus contributions in each subcatchment 50%

Meet MN Sustainable Building Guidelines for
Water/Environment (developed by CSBR and CALA)

MANAGEMENT

AGRICULTURAL BMPs

Row crops and experimental research plots intensively managed during the growing season

BMPs: Slow ditch runoff

- Collect runoff in cisterns for irrigation use
- Redirect drain tiles to infiltration basins
- Livestock fencing and waste containment
- Integrated pest management
- Vegetative buffers at field borders
- Nutrient management (pesticides and fertilizers)
- Residue management (no till)
- Waste management

OPEN SPACE BMPs

Turf grass, ornamental plantings, and street trees with compacted soil that prevents water infiltration

BMPs: No mow grasses

- Replace turf with native ground covers
- Nutrient management (fertilizers and pesticides)
- Prairie/Forest plantings
- Collect runoff in cisterns for irrigation use
- Expand forest canopy evapotranspiration
- On-site Infiltration

NATURAL AREAS BMPs

Fragments of native vegetation, structure with canopy understory, and ground layer

BMPs: Remove exotic invasive species

- Connect patches with corridors
- Increase diversity
- Create buffers
- Expand forest canopy evapotranspiration

ROOFTOP BMPs

Historic mall buildings with peaked terra cotta roofs
Most buildings have flat gravel ballast roofs that route precipitation directly into storm sewers

BMPs: Green Roof technology

- Rain barrels
- Minimize impervious area
- Separate roof runoff from street runoff

STREET AND PARKING BMPs

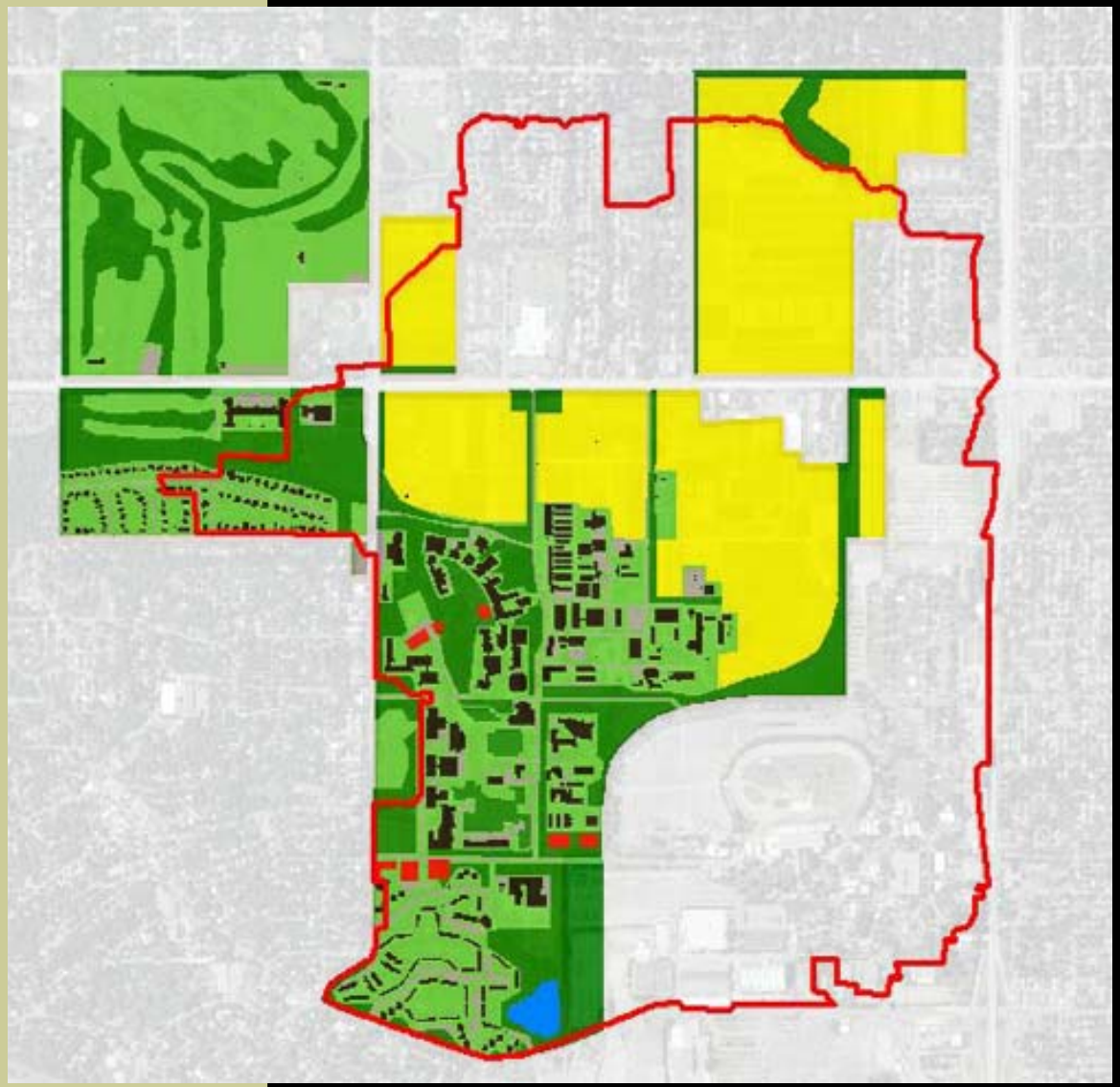
Paved impervious surfaces with stormwater runoff directed to storm sewers and warmed by hard surfaces
Runoff velocity creates erosion, picks up nutrients and pollutants
Runoff volume creates bounce in Sarita Wetland

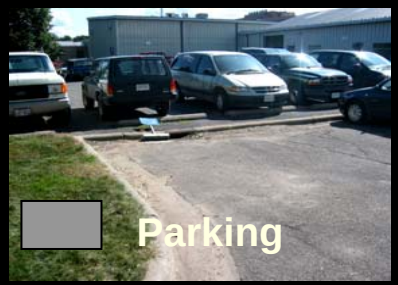
BMPs: Bio-infiltration (rain gardens, swales)

- Parking lot island infiltration
- Pervious unit pavers
- Pervious asphalt paving
- Narrower roads and service areas
- Vegetative shading 50% of surface
- Underground cisterns for slow release
- Reduce curb and gutter

MANAGEMENT

ECOLOGICAL MASTER PLAN





MANAGEMENT

SARITA WETLAND ECOLOGY CENTER

MANAGEMENT

SARITA WETLAND ECOLOGY CENTER

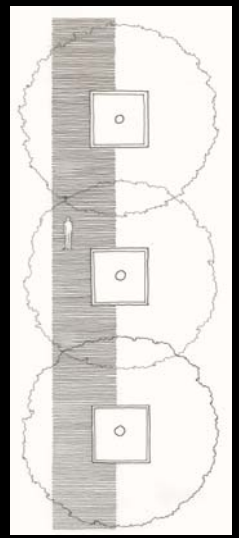
(Student Work)

SPRING

SUMMER

FALL

WINTER



SARITA WETLAND ECOLOGY CENTER PROGRAM

A. Outdoor Lab Exercises

- Infrastructure for Storm Water Research
- Designated research plots with ability to isolate from runoff or artificially manipulate with groundwater; separate from “Public” part of the site
- Quantitative hydrology
- Groundwater monitoring
- Surface runoff monitoring

B. Demonstration of Urban Forestry and Sustainable Landscape

- Phyto-remediation for heating plant site
- Demonstration of Best Management Practices (BMPs)
- Sustainable materials, low energy consumption facilities
- Low Impact Design (LID): pervious paving, green roofs
- Runoff infiltration wherever possible

C. Teaching Features

- Enhance habitat for insects, herps, birds, and mammals
- Plant identification and observation
- Water level and contour elevation markers
- Outdoor classroom for 20-30 students
- Exotic species studies
- Bird behavior studies (observation blinds and habitat)

SARITA WETLAND ECOLOGY CENTER PROGRAM

D. Maintenance Features

- Soil bioengineering and bank stabilization

E. Habitat Features

- Study of native and experimental habitat types
- Designed so that native plants can grow and prosper
- Incorporate 1:20 or 1:10 wetland slope with 6” bounce

F. Recreation and Access

- Artistic form of the landscape should be aesthetically beautiful and ecologically appropriate
- Boardwalk or controlled access to parts of the wetland
- Clearly defined entry points/gateways
- Increased awareness and connectivity to the campus
- Trail system that can withstand flooding
- Interpretive signage
- Seating for viewing and contemplation
- Internet access for research (wireless?)
- Safety/security, liability issues addressed by design
- Control public and University access
- Storage for equipment and supplies

MANAGEMENT

PRECEDENTS

The ORWRP at OSU is designed to be one of the most comprehensive wetland research and education facilities in the nation. It is located on a 30-acre site and features two 2.5-acre deep-water marshes, a river water delivery system, infrastructure for research and education, and a visitors' pavilion.

PRECEDENTS

THE JOHNSON CENTER FOR BIRDS AND BIODIVERSITY AND THE SAPSUCKER WOODS

The Cornell Lab of Ornithology at the Johnson Center for Birds and Biodiversity, located in Sapsucker Woods Sanctuary, is a nonprofit institution whose mission is to interpret and conserve the earth's biological diversity through research, education, and citizen science focused on birds. Their programs work with citizen scientists, government and nongovernment agencies across North America and beyond. They believe that bird enthusiasts of all ages and skill levels can and do make a difference.

MANAGEMENT

PRECEDENTS

The London Wetland Centre is part reserve, part zoo, part garden, part interactive science museum and discovery centre. It is a global safari taking visitors through 14 naturalistic wetland habitats. Each habitat features hidden "signs of life" for would-be explorers to discover, and a representative collection of threatened wildfowl.