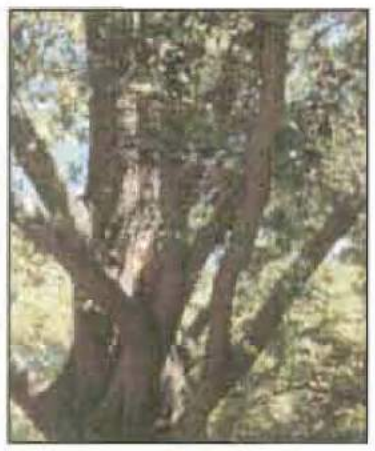
THE UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL

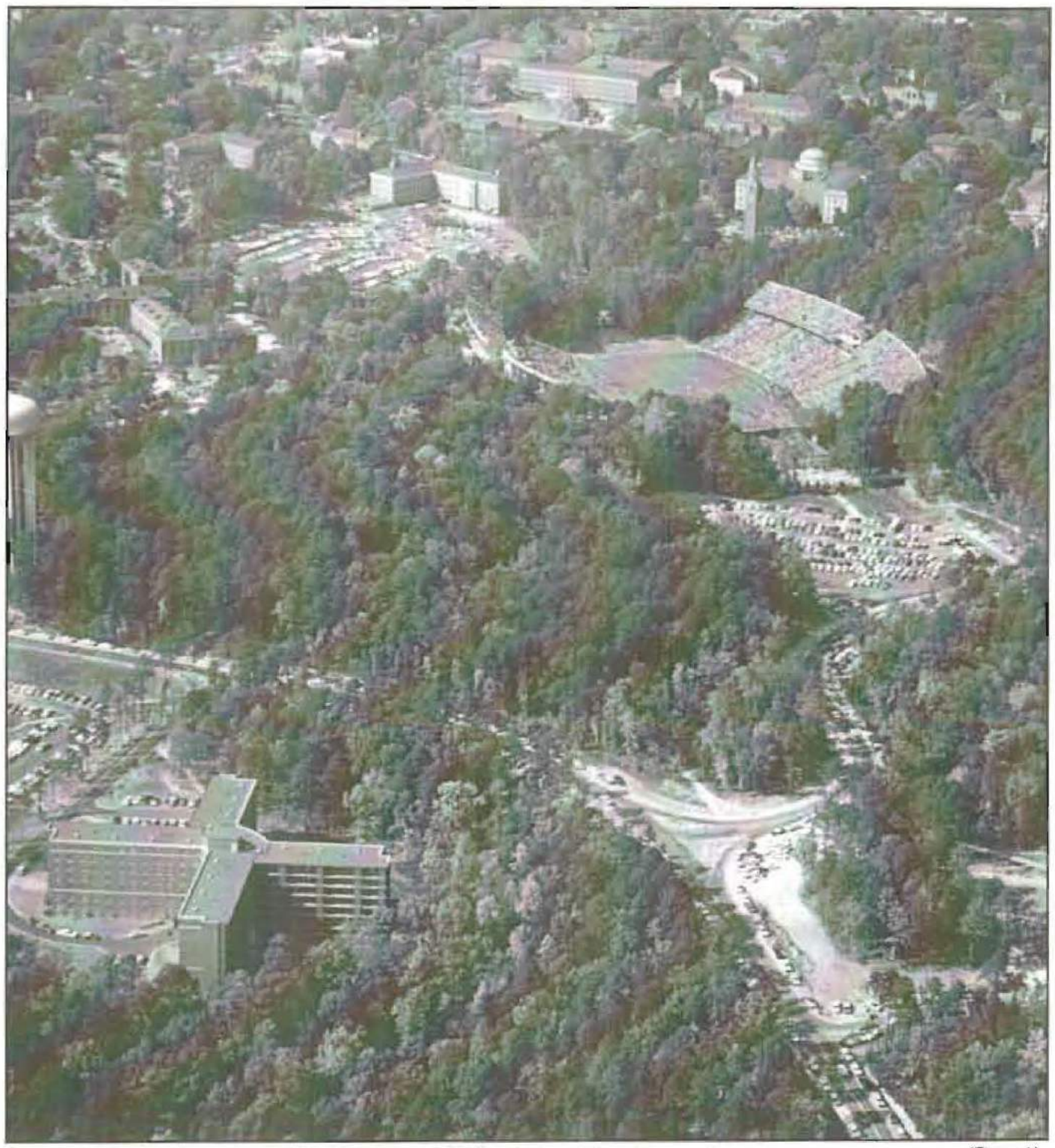


ENVIRONMENTAL MASTER PLAN

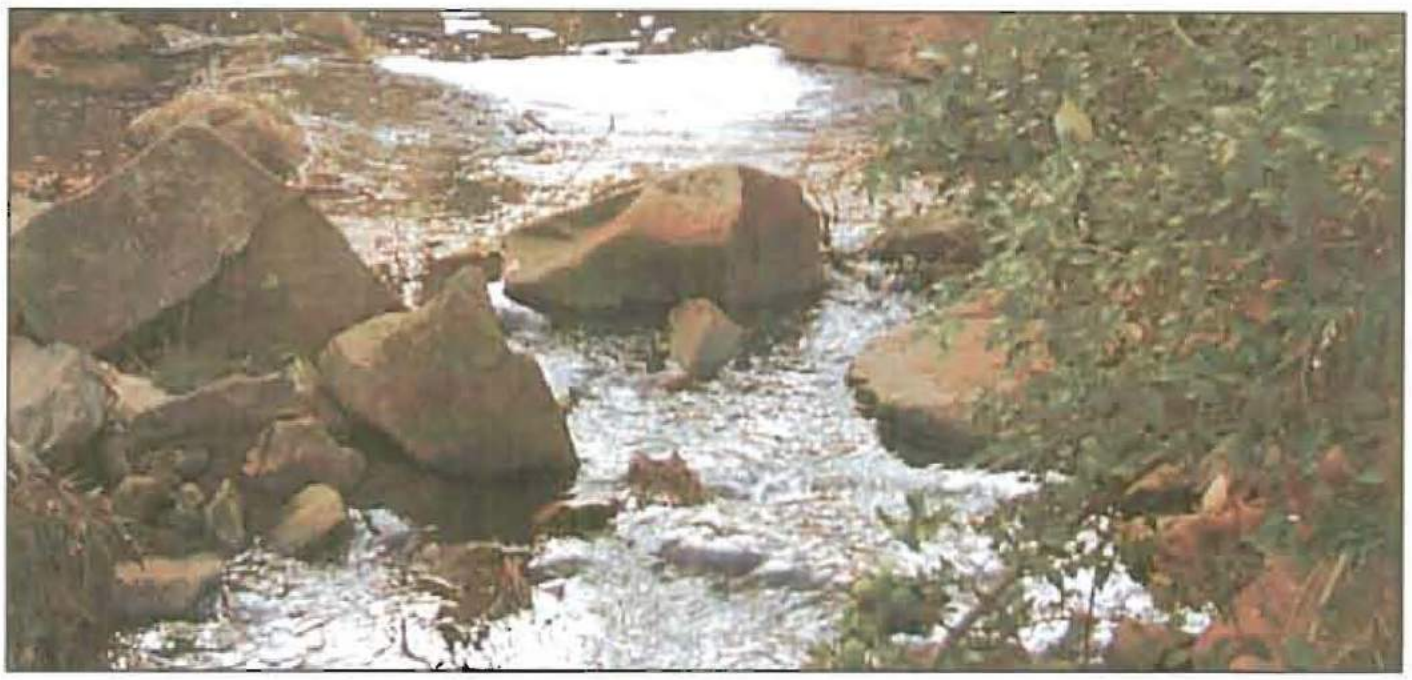
FINAL • REPORT

JANUARY 2002

TABLE OF CONTENTS



Historic view of the University of North Carolina at Chapel Hill looking north from Manning Drive. (Figure 1)



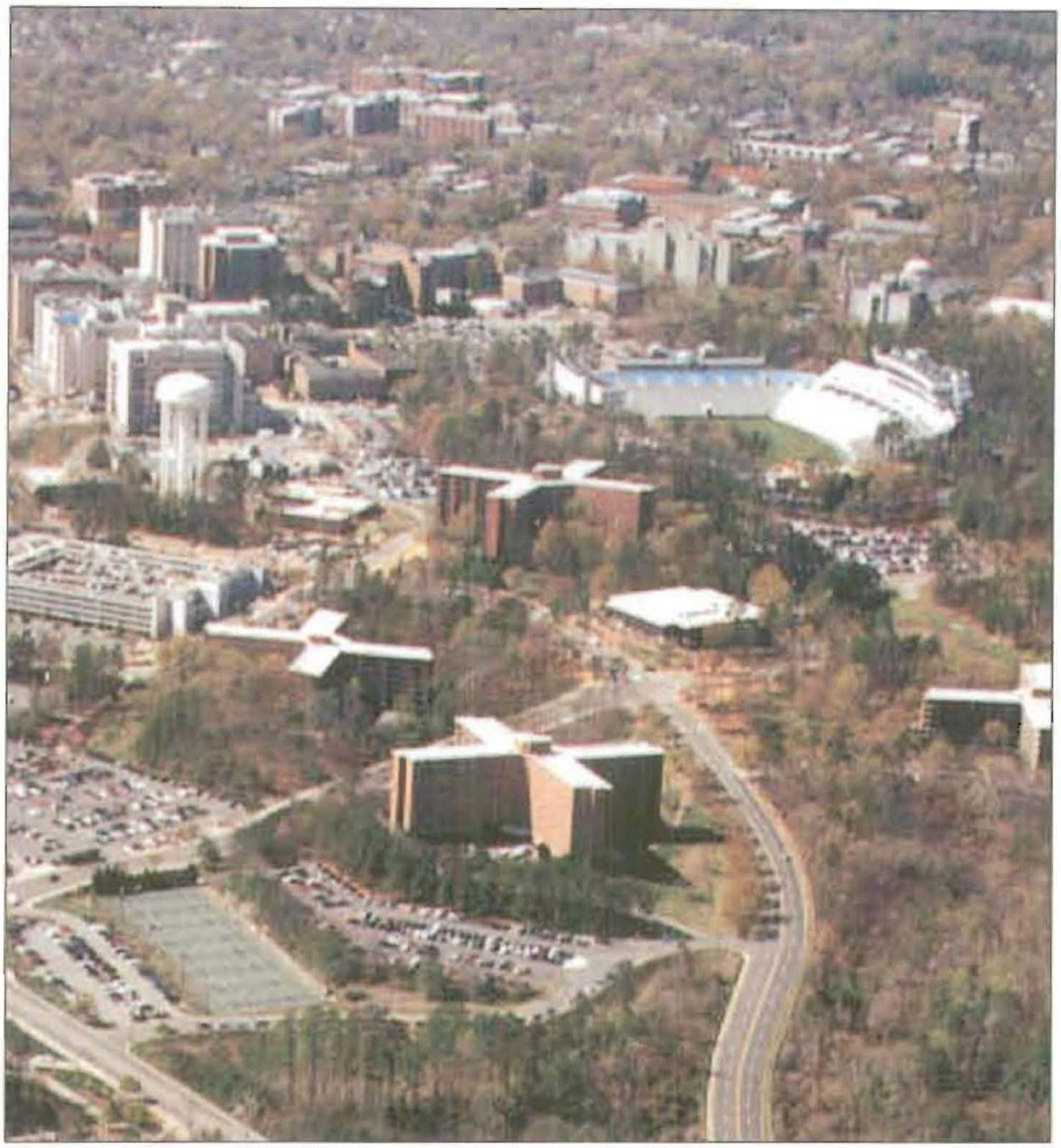
The Purpose of the Environmental Master Plan

The University has been engaged in the Master Plan process for the past three years, with the assistance of Ayers Saint Gross and guidance from the University staff and faculty, as well as dialogue with the Chapel Hill community. During this process, it became apparent that a number of environmental issues required definition and warranted special consideration. The formulation of planning and design strategies that would ensure the environmental quality of the University and the surrounding community had to be integrated in the design process. The final Comprehensive Master Plan must assure that future development sustains that quality and reflects the environmental concerns of both the University community and the town of Chapel Hill.

After careful consideration of the diverse environmental issues, the University concluded that the environmental component of the Comprehensive Master Plan would have three major objectives:

- Evaluate the quantity and quality of land and water resources at the University of North Carolina at Chapel Hill, on both the Main Campus and the Mason Farm property.
- Guide the Comprehensive Master Plan in protecting and restoring environmentally sensitive areas of the Campus.
- Develop growth strategies that mitigate the water resource impacts of existing and new development on the Main Campus and downstream, as well as address the requirements of future water quality regulations.

The Comprehensive Master Plan Committee and the Advisory Group provided guidance to the environmental consulting team of Andropogon Associates and Cahill Associates throughout this process. The initial challenge was to test the premise that the Master Plan could accommodate significant additional square footage of University facilities, while preserving and even enhancing critical natural resources of land and water. These resources include the Campus setting itself, the priceless heritage of natural habitats under University control in the Mason Farm Biological Reserve and the water resources which the University impacts through its building program and stormwater management facilities. Even as the Campus develops in the next decades, the University plans to be a model of sustainable development and recognizes that the health of the land and water resources of the Campus, and the surrounding community, are directly dependent on their preservation and restoration.



Current view of the University of North Carolina at Chapel Hill looking north from Manning Drive. (Figure 2)

Morgan Creek downstream of the Campus. (Figure 3)

Environmental Goals

The planning process began by establishing the following environmental goals in order to address key water and land resource issues that will serve to guide future development in a sustainable fashion at the University of North Carolina at Chapel Hill.

1. Balance growth with preservation of the natural drainage system.

- Reinforce the inherent natural beauty of the the Campus by creating building patterns that preserve stream corridors and forested steep slopes.
- Make every building project the opportunity to restore some part of the "natural infrastructure."
- Protect water quality by reducing or eliminating non-point source pollutants scoured from the land surface, including soil, and minimizing erosion and the consequent sedimentation of streams.

2. Manage stormwater as an opportunity not as a problem.

- Maximize present and future on-site infiltration of stormwater to recharge groundwater and absorb potential floodwaters.
- Provide for capture and reuse of rainwater.
- Manage total stormwater volume on site, zero percent net increase in run-off.

3. Recognize that the University of North Carolina at Chapel Hill is part of the Cape Fear Watershed.

- Enhance and protect the water quality of the surface streams to meet National Pollutant Discharge Elimination System (NPDES) water quality standards.
- Protect Jordan Lake, a major downstream drinking water supply and recreation area.

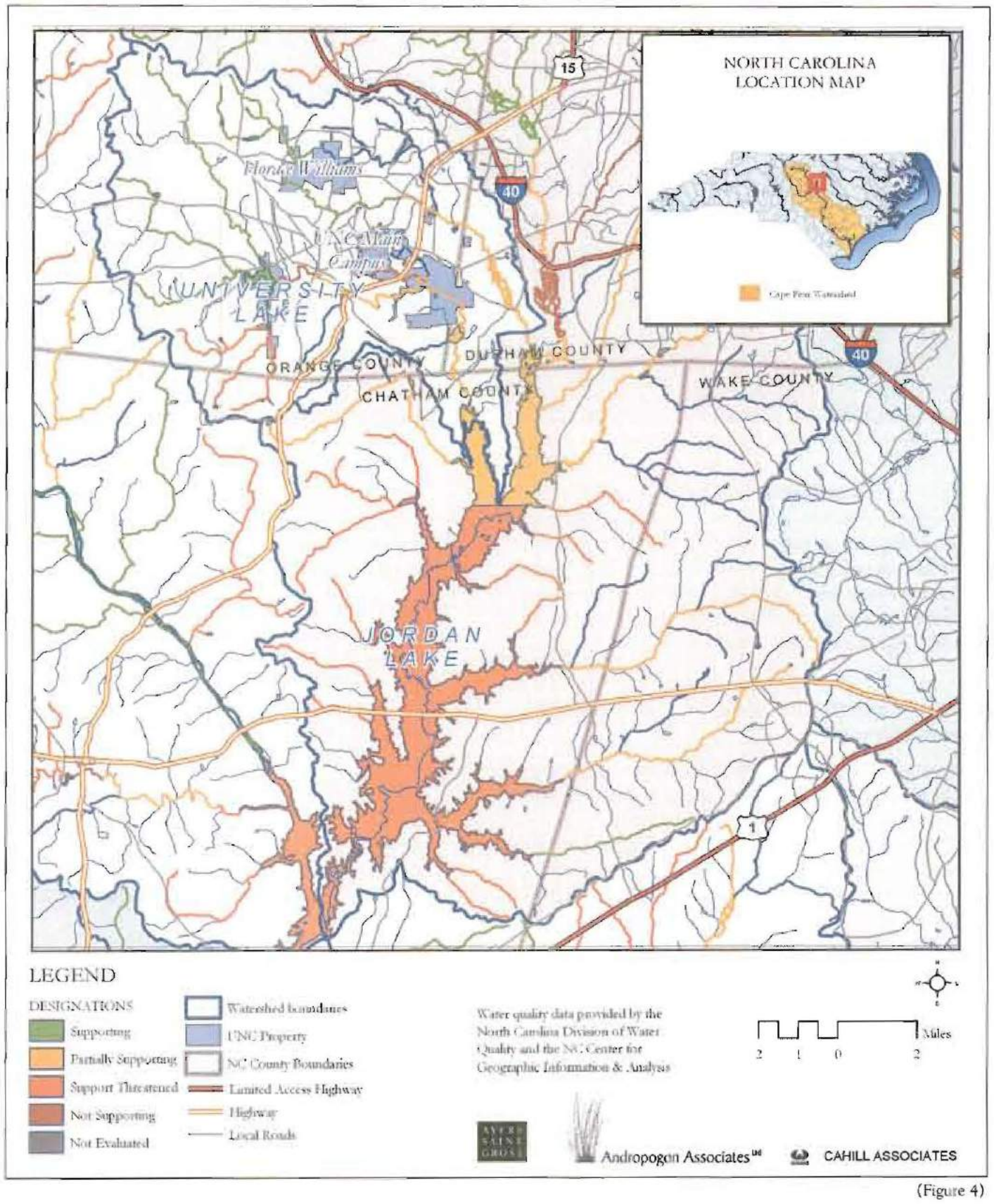
4. Reinforce the University's position as a Role Model.

- Create and enforce University policies that permanently protect environmentally sensitive land, reinforce and strengthen open space policies and plan for habitat protection.
- Reassign key land parcels to named protected areas.
- Apply appropriate management strategies to certain critical land areas, such as Morgan Creek floodplain, to ensure that management measures preserve the ecological functions of stream corridors, swales and drainage corridors.
- Monitor and assess all short and long-term land and water resource management objectives.

One of the primary goals of the Comprehensive Master Plan has been to infill needed program space within

N O R T H C A R O L I N A

1 9 9 3 S T R E A M C L A S S I F I C A T I O N S



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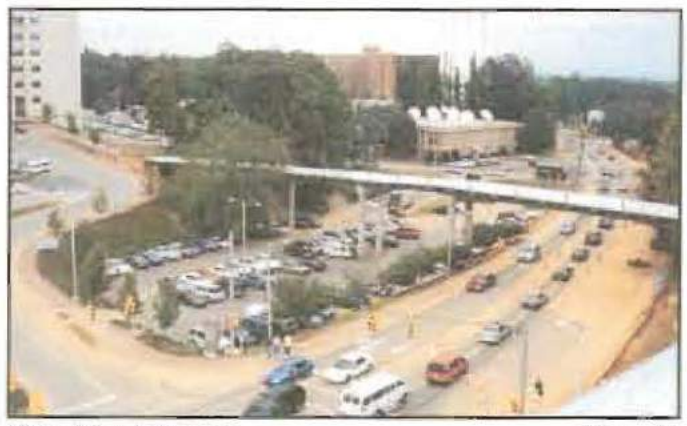


View of South Campus. (Figure 5)

Eroded stream banks and low base flow of a local stream south of the Campus. (Figure 6)

present Campus boundaries, rather than to contribute to sprawl in the surrounding countryside. A second goal (Essence of North Carolina) is to humanize the large scale of the southern end of the Main Campus. This was to be done by re-creating the pattern of development that was so successful and beloved in the Historic Core in the northern end—interconnected greens defined by broad, low buildings. However, in examining the environmental structure of the Main Campus, one drawback to realizing this second goal was immediately apparent. The landforms of the southern end of the Main Campus are not the same as those of the northern end. Rather than a single broad, gently sloping plateau, the landforms of the southern end are characterized by rolling knolls dissected by small stream valleys, bounded by steep valley walls.

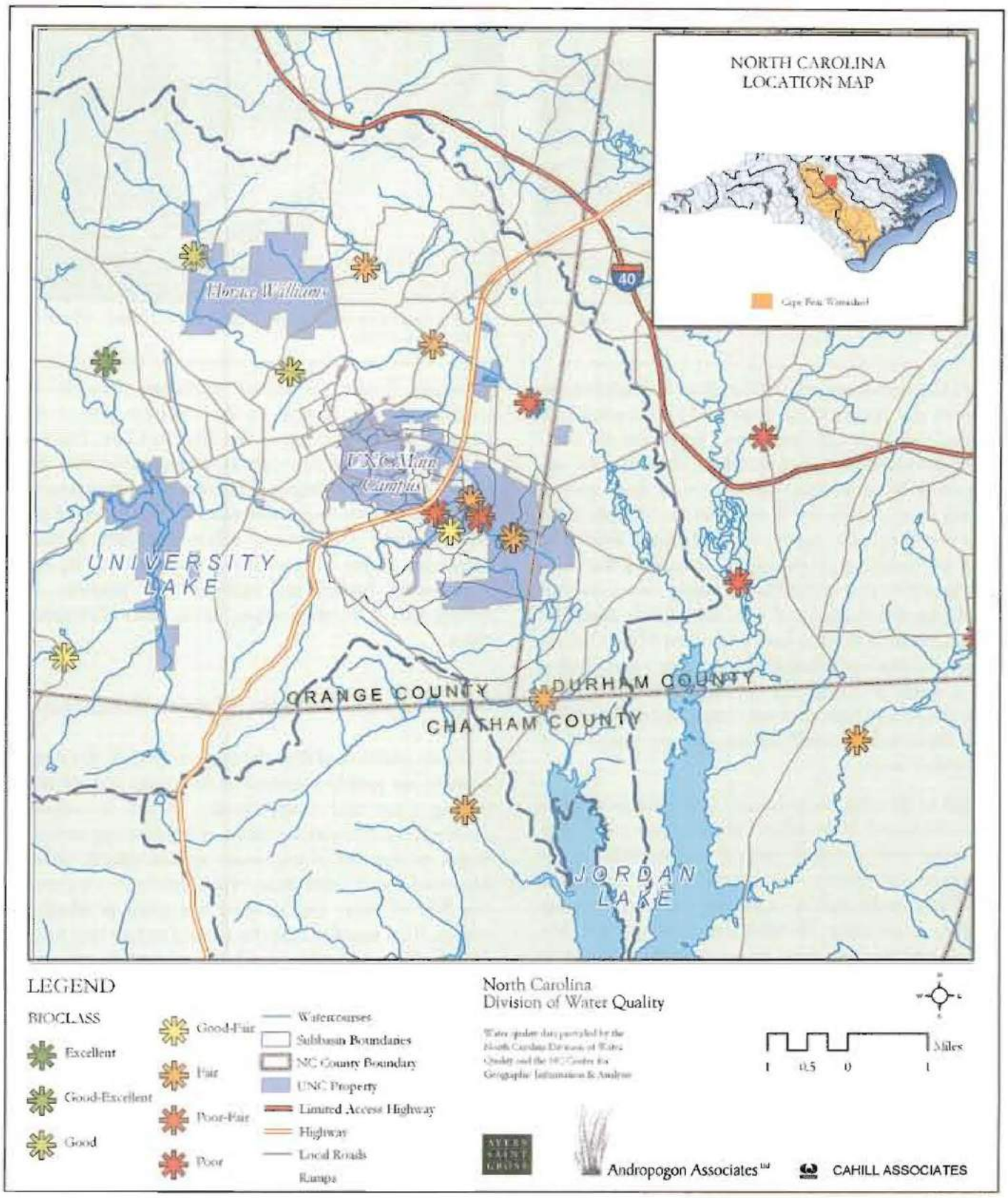
In order to develop the required University facilities in the southern end of the Main Campus while protecting, preserving and restoring critical components of the environmental system, new structures and pavements should not be located in a stream valley or drainage channel, or on steep, forested slopes. Where possible, the opportunities provided by tearing down unwanted older facilities should be used to restore drainage channels, streams and floodplains, and to reforest slopes presently in structure or turf.

The health of the land and the water systems of the Campus are directly dependent on their preservation and restoration within the fabric of development. In the southern end of the Main Campus, proposed new development was re-examined to preserve and, where possible, to restore the riparian corridor; open, flowing streams, wetlands, floodplain and adjacent steep forested slopes. These two natural landscape elements are special resources, unique to the southern end of the Campus, and do not exist in the Historic Core. The valleys with their streams can be incorporated into the matrix of new buildings and become the direct equivalent to the greens and interconnecting walkways of the Historic Core. This concept allows for a new lowland pedestrian system that would be complemented by skyways—aerial bridges and walkways that preserve the rolling hills of South Campus, rather than obliterating them.

The Importance of Water Resource Management

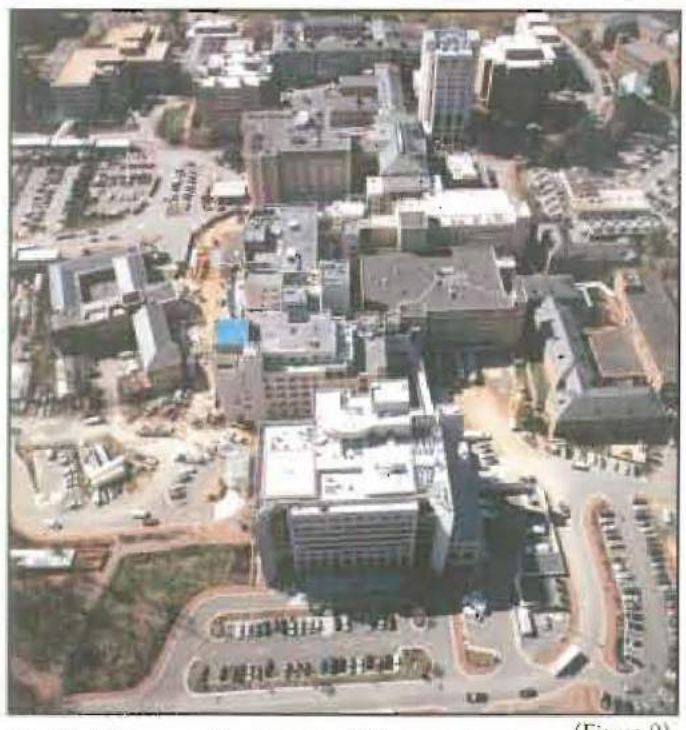
It is now understood that the impacts of both flood and drought are greatly increased as the result of poor land management and inappropriate design of related stormwater conveyance systems. Most existing conventional stormwater management systems simply collect increased runoff from impervious surfaces, concentrate the flow of water and increase the speed at which it travels. This runoff scours the ground surface and transports pollutants, both natural and man-made, in a turbid flow to all water bodies downstream. In this watershed, the impacts are evident, from Meeting of the Waters Creek to Jordan Lake.

Traditional concerns of stormwater management have focused on flood prevention. While this is still an important concern, we now understand that the same land development practices that increase the frequency and magnitude of flooding also reduce the base flow in our local streams by preventing groundwater recharge. Thus the extremes of flood and drought are just the


NORTH CAROLINA
LOCATION MAP
Horace Williams
UNC Main Campus
UNIVERSITY LAKE
ORANGE COUNTY
DURHAM COUNTY
CHATHAM COUNTY
JORDAN LAKE
40
LEGEND
BIOCLASS
Excellent
Good-Excellent
Good
Good-Fair
Fair
Poor-Fair
Poor
Watercourses
Subbasin Boundaries
NC County Boundary
UNC Property
Limited Access Highway
Highway
Local Roads
Ramps
North Carolina
Division of Water Quality
Miles
1 0.5 0 1
Andropogon Associates
CAHILL ASSOCIATES

(Figure 7)

A view of Battle Creek in Battle Park, a significant natural area of North Campus. (Figure 8)



Health Affairs area showing over 70% impervious cover. (Figure 9)

physical symptoms of poor stormwater management. These impacts are evident throughout the community, from eroded channels of local streams turned dry in late summer to increasing eutrophic conditions in all impoundments.

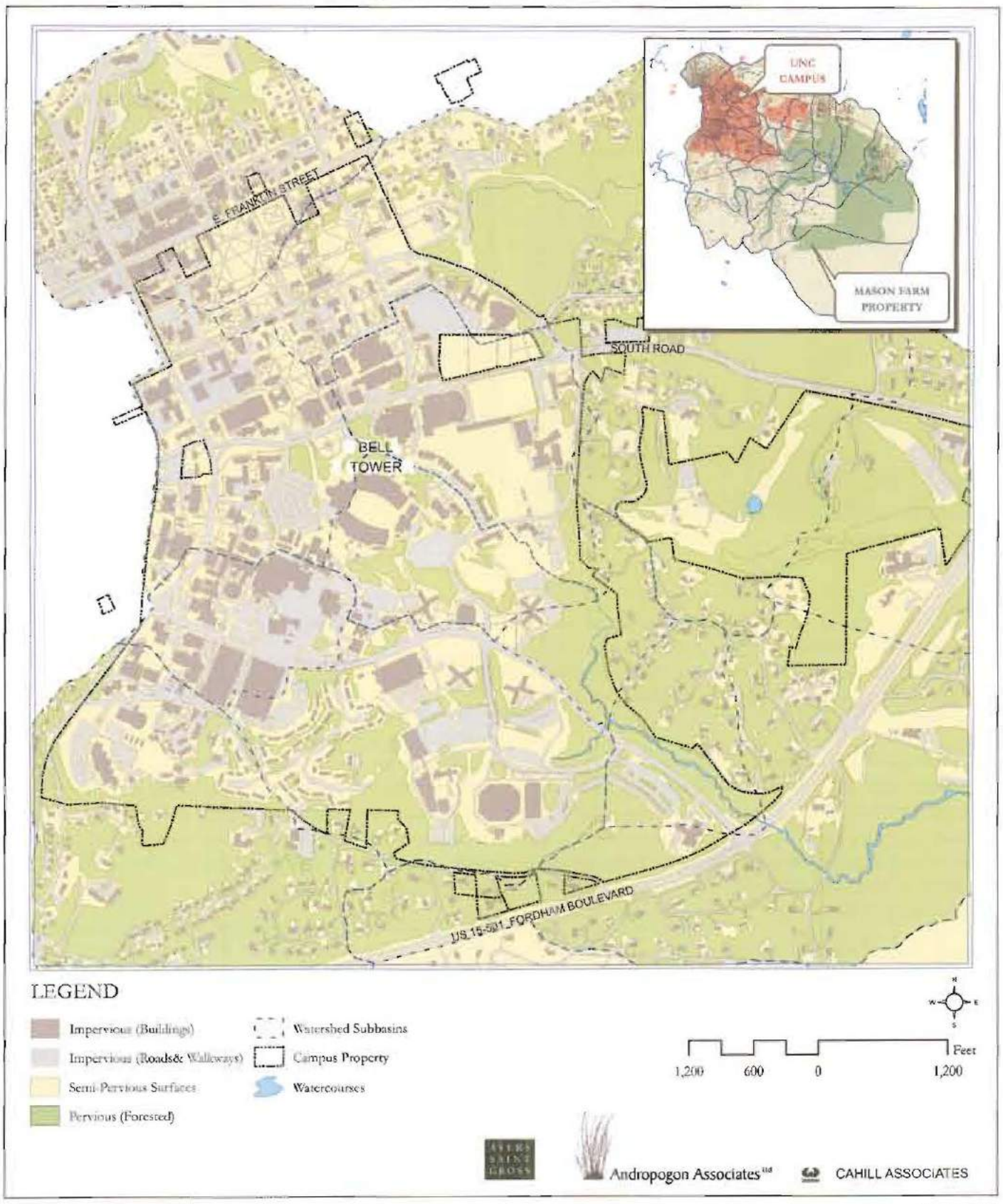
The problems of stormwater quality and quantity start in the headwaters of each small drainage area. Thus the development of solutions must begin on the upland of the Main Campus, considering the collective impact of the land development patterns that have evolved at the University of North Carolina at Chapel Hill, and that guide future growth.

Evolving federal regulation will shortly require the University to mitigate water quality impacts from both old and new development on streams such as Morgan, Meeting of the Waters, and Bolin Creeks. Under Phase II of the National Pollutant Discharge Elimination System (NPDES) program, the discharge of stormwater that degrades water quality downstream will require a permit issued to each municipality larger than 10,000 people. Prior studies in the Cape Fear Watershed, of which the University of North Carolina at Chapel Hill is a part, have identified impervious surfaces and urban land uses as the root cause of these problems.

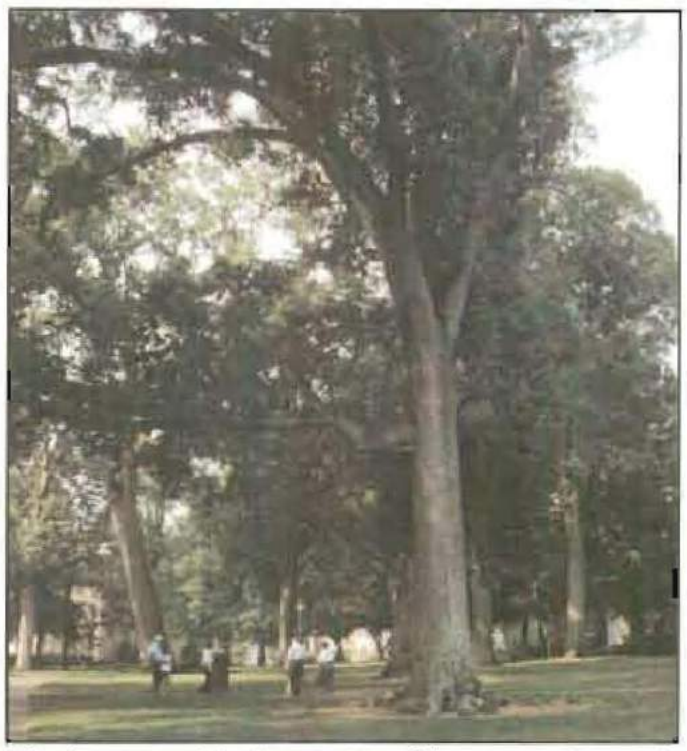
Other new Federal programs (Total Maximum Daily Load, (TMDL) will also require rhar contributing watersheds reduce the loads of key pollurants, such as nitrogen and phosphorous, to improve water quality downstream. Their implementation will mitigate the degradation of aquatic habitats in small local streams, where the impacts are first experienced. Silt covered stream bottoms, eroded streambanks and water bodies choked with aquatic vegetation, all reflect the problems of urban runoff on local drainage.

All applications for Phase II permits must be received by the North Carolina Division of Water Quality (DWQ), before March 1, 2003. It is this urgency that drives many of the recommendations of the Environmental Component. The increased development proposed by the Comprehensive Master Plan has been reviewed and modified to help to ensure that there is no further impact to the quality and quantity of water—both upstream and downstream.

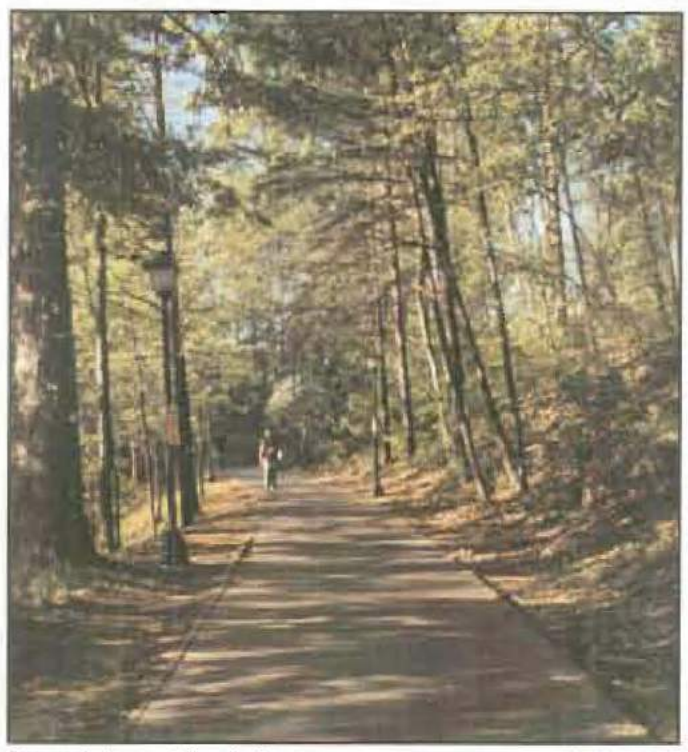
EXISTING SURFACE PERMEABILITY



(Figure 10)



Relic forest trees of the Historic Core of the Main Campus. (Figure 11)



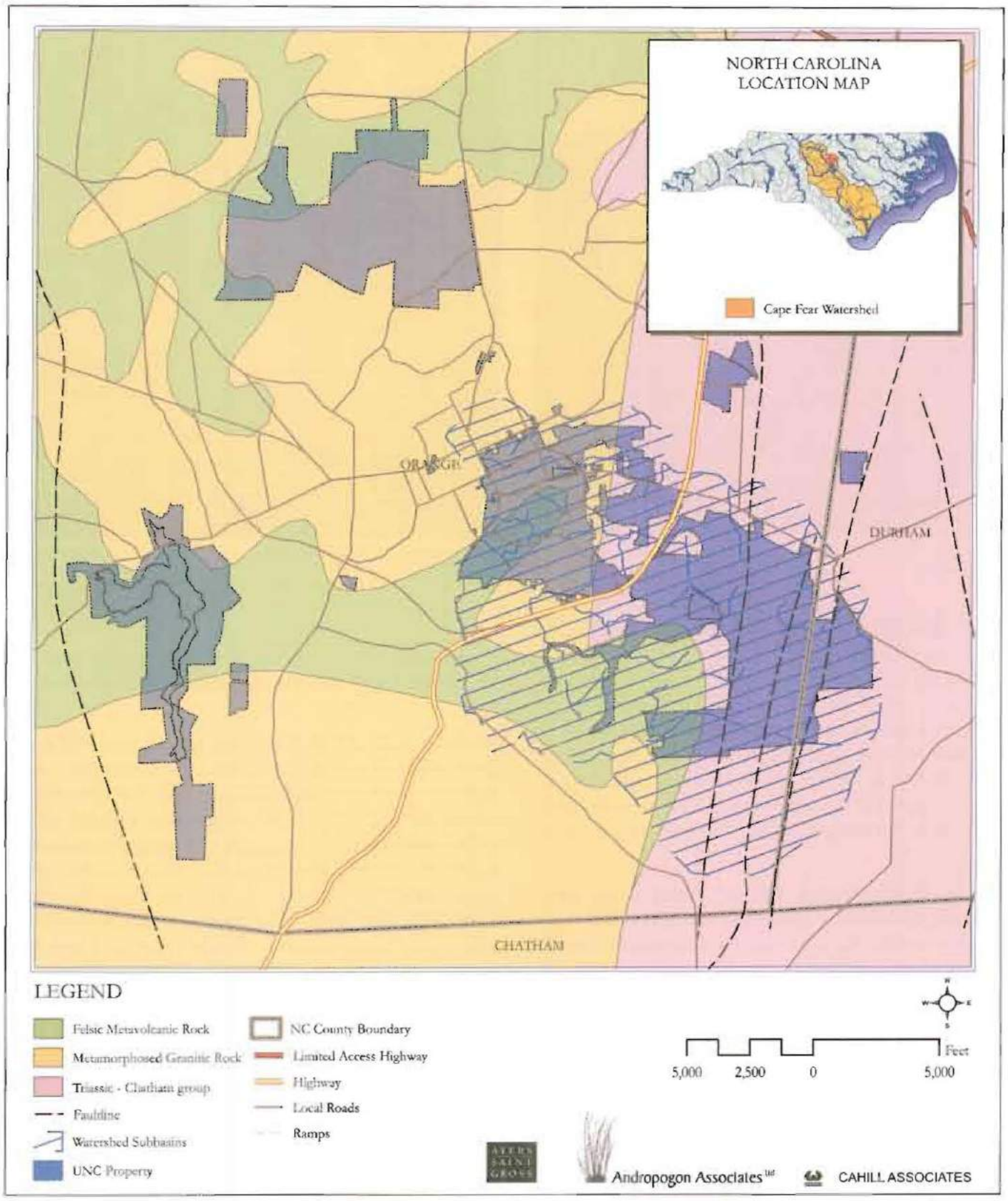
Forested slopes of South Campus. (Figure 12)

The Importance of Land Management

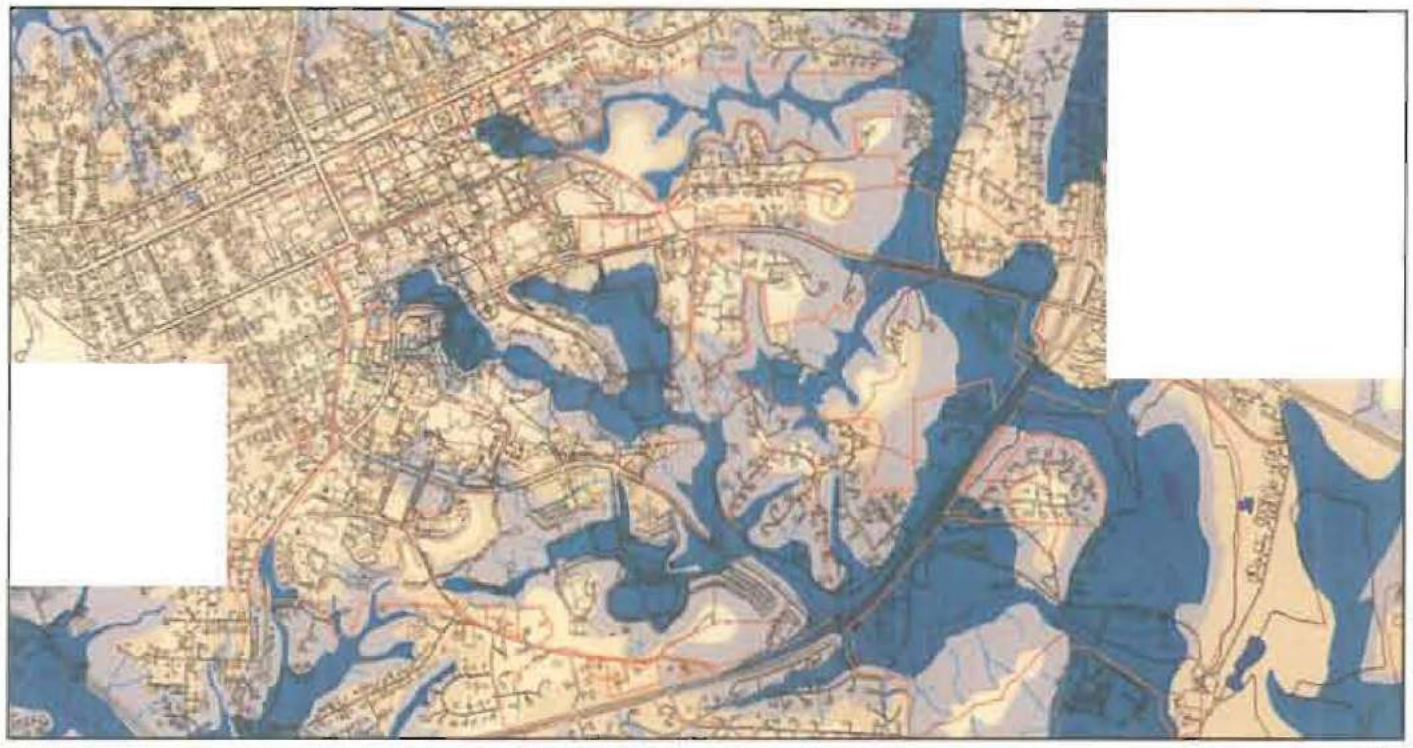
In contrast to the management of water supply and wastewater problems in the past, the solutions to stormwater quality and quantity will not be found in flow rate control and treatment at the end of the stormwater pipe. Better land use and land management decisions provide the starting point for a sustainable water resource management program within each watershed.

As the University and adjacent communities have evolved from a rural to an urban characteet, with greater density of development and impervious surfaces, there is increasing concern about how the remaining land will be developed, with greater recognition that some of that land should remain undeveloped. In Chapel Hill, 90% of the land within the Town's Urban Services Area (approximately 16,800 acres) is presently developed. Half of the Town is predominately residential, but the University, classified as institutional land use, comprises 20% of the Town's land. (Town of Chapel Hill Date Book, February 2000, 5.1) As the single largest landowner in the Orange County region, including large tracts of currently undeveloped land, the University is both master and victim of its land use decisions.

The University of North Carolina at Chapel Hill faces the dilemma of needing to develop the Campus in a way that is both coherent and attractive. The rich natural and cultural heritage of the Campus makes it a special place, with landform and physiography providing the canvas on which this place is developed. The three Campus landscapes include (1) the flat, open greens of the Historical Core, with their huge relic forest trees, in the northern part of the Main Campus, (2) the forested slopes and streams, and their narrow floodplains, in the southern part of Main Campus and (3) the broad floodplains and steep bluffs of the Mason Farm property. These critical landscape elements, if protected and restored, will continue to provide a green framework for the buildings and related facilities unique to the Chapel Hill Campus. They will also play a vital role in protecting the water resources into which they drain. From an institutional perspective, it is these elements of the Campus landscape that are remembered and treasured, by both students and alumnae, as a special quality of the University.


NORTH CAROLINA
LOCATION MAP
Cape Fear Watershed
ORANGE
DURHAM
CHATHAM
LEGEND
Felsic Metavolcanic Rock
Metamorphosed Granitic Rock
Triassic - Chatham group
Faultline
Watershed Subbasins
UNC Property
NC County Boundary
Limited Access Highway
Highway
Local Roads
Ramps
5,000
2,500
0
5,000
Feet
Andropogon Associates ltd
CAHILL ASSOCIATES

(Figure 13)



LEGEND
KNOLL
FLAT PLATEAU
PLATEAU FINGERS
VALLEY SIDES
VALLEY BOTTOM
RIDGE LINE
STREAMS
HISTORIC STREAMS
SWALES

(Figure 14)

Regional Physiography

Analysis of the land and water resources of the Campus begins with an understanding of the regional physiography and the geology from which it is derived. Physiography describes the form of the land surface—the response of the original bedrock to uplift by the forces of plate tectonics and by erosion by eons of rainfall that has sculpted the different rock types into hills, valleys, plateaus and ridges. The flow and movement of water underground is also controlled by the geology, as the system of fractures in the bedrock creates flow pathways which carry water underground as groundwater and back to the surface as springs and seeps.

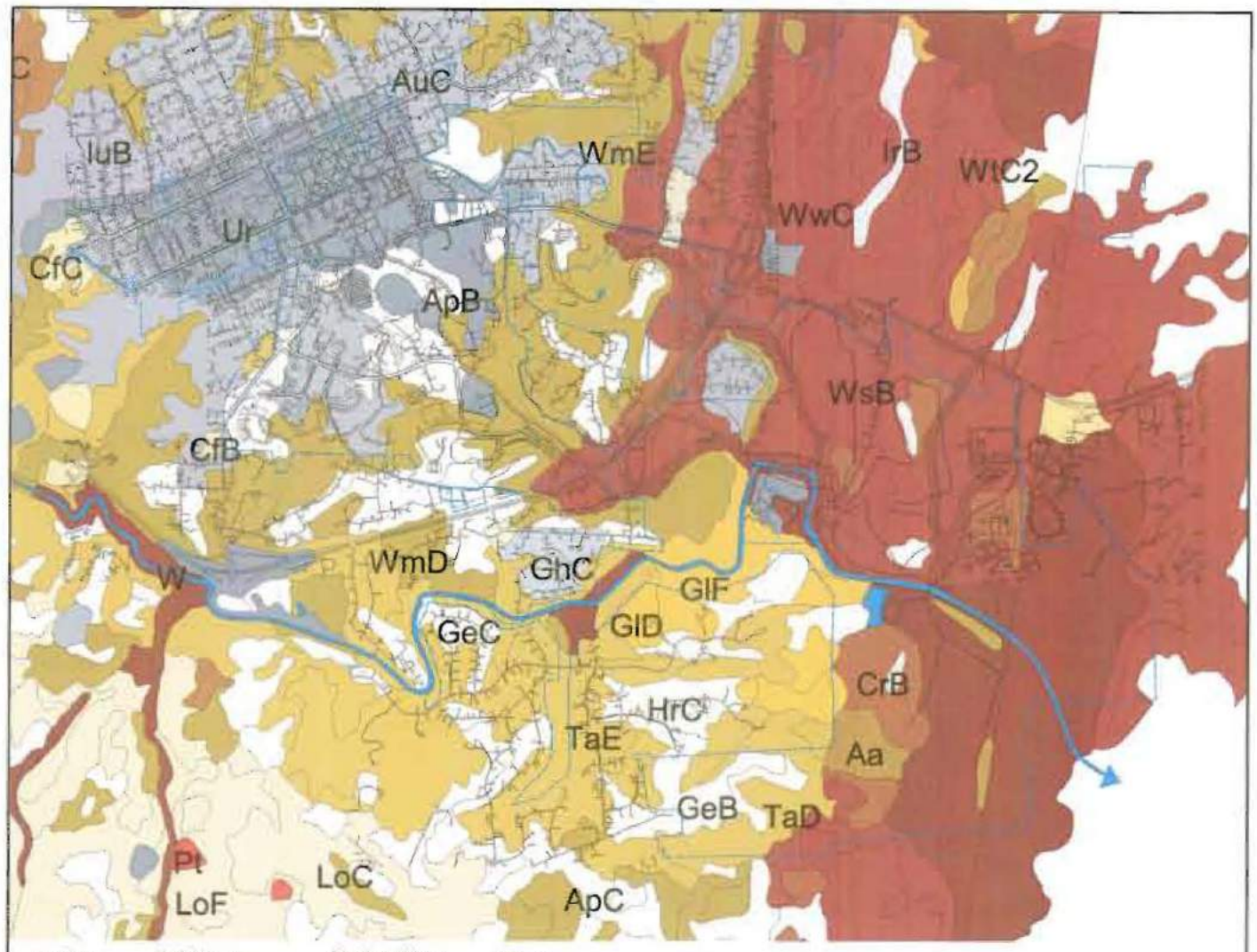
The University of North Carolina at Chapel Hill is located in both Orange and Durham Counties, in a transitional area located between two physiographic regions—the piedmont and the coastal plain. The landforms of this area, known as the North Central Piedmont, are described as a "vast plain of rolling knolls and hillocks dissected gently by minor streams, more boldly by the creeks and rivers" (Godrey p.12). The Campus includes all of these landforms from the broad, flat plateaus where the University was first located, to the wide, low-lying floodplains of Morgan Creek, in the southeastern portion of the Mason Farm Property.

Two major geologic formations underlie the University of North Carolina at Chapel Hill Campus.

1. Dense metamorphic granitic formations in the western part of the region.

2. Triassic formations in the east.

Figure 13 shows an overlay of drainage sub-basins for the Campus over the bedrock, and illustrates the relationship between bedrock and watersheds. Local watersheds are not divided along the boundaries of different rock types, but only reflect local landforms and surface drainage pathways. However, regional drainage is from the west to east, reflecting the slope of the land down towards the ocean, flowing to the Triassic basin and then southeast to the coastal plain.



Soil Sym.	Soil Name	Depth to Water	Slope
Ch	Chewacla loam	0.5-1.5	nearly flat
WsE	White Store loam	0.5-1.5	10 to 25%
WsC	White Store loam	0.5-1.5	6 to 10%
WsB	White Store loam	0.5-1.5	2 to 6%
WwC	White Store Urban land complex	0.5-1.5	2 to 8%
WtC2	White Store clay loam eroded	0.5-1.5	6 to 15%
CrB	Creadmoor fine sandy loam	1.0- 2	2 to 8%
EnC	Enon loam	1.0-2.0	6 to 12%
EnB	Enon loam	1.0-2.0	2 to 6%
Aa	Altavista fine sandy loam	1.2-2.5	0 to 3%
Cp	Congaree fine sandy loam	2.5 – 4	nearly flat
WmE	Wedowee sandy loam	>6.0	15 to 25%
WmD	Wedowee sandy loam	>6.0	8 to 15%
WxF	Wilkes gravelly loam	>6	15 to 45%
WxD	Wilkes gravelly loam	>6	8 to 15%
TaE	Tatum silt loam	4 –6.0	15 to 25%
TaD	Tatum silt loam	4 –6.0	8 to 15%
GlF	Goldston slaty silt loam	>6.0	15 to 45%
GlD	Goldston slaty silt loam	>6.0	6 to 15%
PfE	Pinkston fine sandy loam	>6.0	10 to 25%
CfE	Cecil fine sandy loam	>6.0	10 to 25%
CfC	Cecil fine sandy loam	>6.0	6 to 10%
CfB	Cecil fine sandy loam	>6.0	2 to 6%
LoC	Louisburg sandy loam	>6.0	6 to 15%
LoF	Louisburg sandy loam	>6.0	15 to 45%
Ur	Urban land		2 to 10%
AuC	Appling Urban land complex	>6.0	2 to 10%
GhC	Georgeville Urban Land	>6	2 to 10%
IuB	Iredell-Urban land complex	>6.0	1 to 8%
IrB	Iredell-gravelly loam	>6.0	1 to 4%
GeC	Georgeville silt loam	>6.0	6 to 10%
GeB	Georgeville silt loam	>6.0	2 to 6%
HrE	Herndon silt loam	>6.0	2 to 6%
HrC	Herndon silt loam	>6.0	6 to 10%
ApC	Appling sandy loam	>6.0	6 to10%
ApB	Appling sandy loam	>6.0	2 to 6%
HwC	Hiwassee clay loam	>6.0	6 to 10%
HwB	Hiwassee clay loam	>6.0	2 to 6%
Gu	Gullied Land	No valid estimates/Properties too varied	

(Figure 15)

The Coker Arboretum in the Historic Core of Main Campus. (Figure 16)

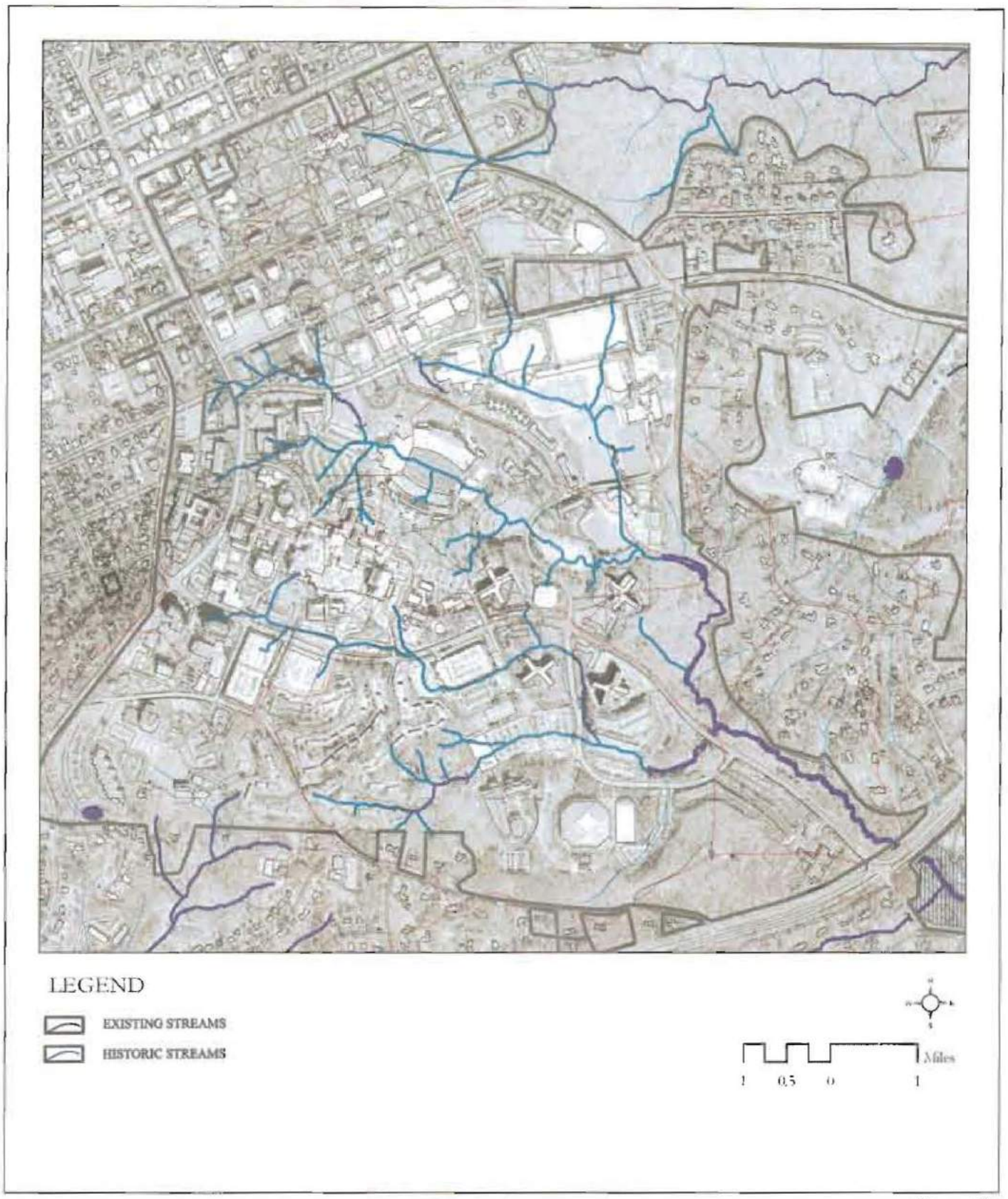
Soils, Slopes and Floodplains

Soils that have weatheted from these two major geologic formations reflect both the parent rock and the climatological conditions that form them. These soils are fully described in the Orange County Soils Report, and are only briefly summarized here.

In most of the Historic Core, urban soils predominate on made-land and its properties are extremely site-specific. These soils are the product of the grading and mixing that often accompanies development. It is typical to find almost 18 inches of fill in these areas. These soils are often heavy clays with a tendency to shrink and swell, and are frequently compacted by human use. This land and the soil porosity have been significantly altered from its natural form through cutting and filling practices. The drainage patterns and infiltration rates must be determined by site investigations and soil testing on urban soils.

In the southern portion of Main Campus, the Appling Soil Series predominates. These soils are moderately well drained and have a low organic matter content in the surface layer and are not as susceptible to erosion. These soils support the forests of the steeper valley slopes that are of particular hydrologic value. These remaining forested areas are a critical recharge source for both Meeting of the Waters and Morgan Creek.

On the floodplain of the Mason Farm property, the soils were formed from the fine materials washed from the uplands. In these areas the water table is very near the surface and these soils are frequently waterlogged. Chewacla and White Store soils predominate in this area which has a high water table of 0.5 to 1.5 feet from the surface of the land. Over forty percent of the Mason Farm property lies within the 100 year floodplain, and is within the Town of Chapel Hill Resource Conservation District (RCD).



(Figure 17)

Historic Streams

The streams we see today on the University property are only remnants of the natural drainage patterns that existed historically. However, even buried streams continue to influence drainage patterns because groundwater follows long established sub-surface pathways, regardless of where the piped stream has been re-directed.

According to historic University maps provided by the Facilities Planning Department, an extensive stream network flowed through the undeveloped region now known as South Campus. College Branch, a tributary of Meeting of the Waters Creek, originated slightly west of the Venable Building, and flows southeast under South Road, before linking up with its main stem. This tributary flows directly underneath the Kenan Memorial Stadium, built in the late 1920s. When constructed, a series of under-drains were built to keep the stadium field dry. As the necessary expansion and growth of the University occurred, other natural stream channels have been buried and put in pipes. As pressure to accommodate the automobile grew along with the development in the southern end of the Main Campus, many of the small stream valleys were filled in and paved over for parking.

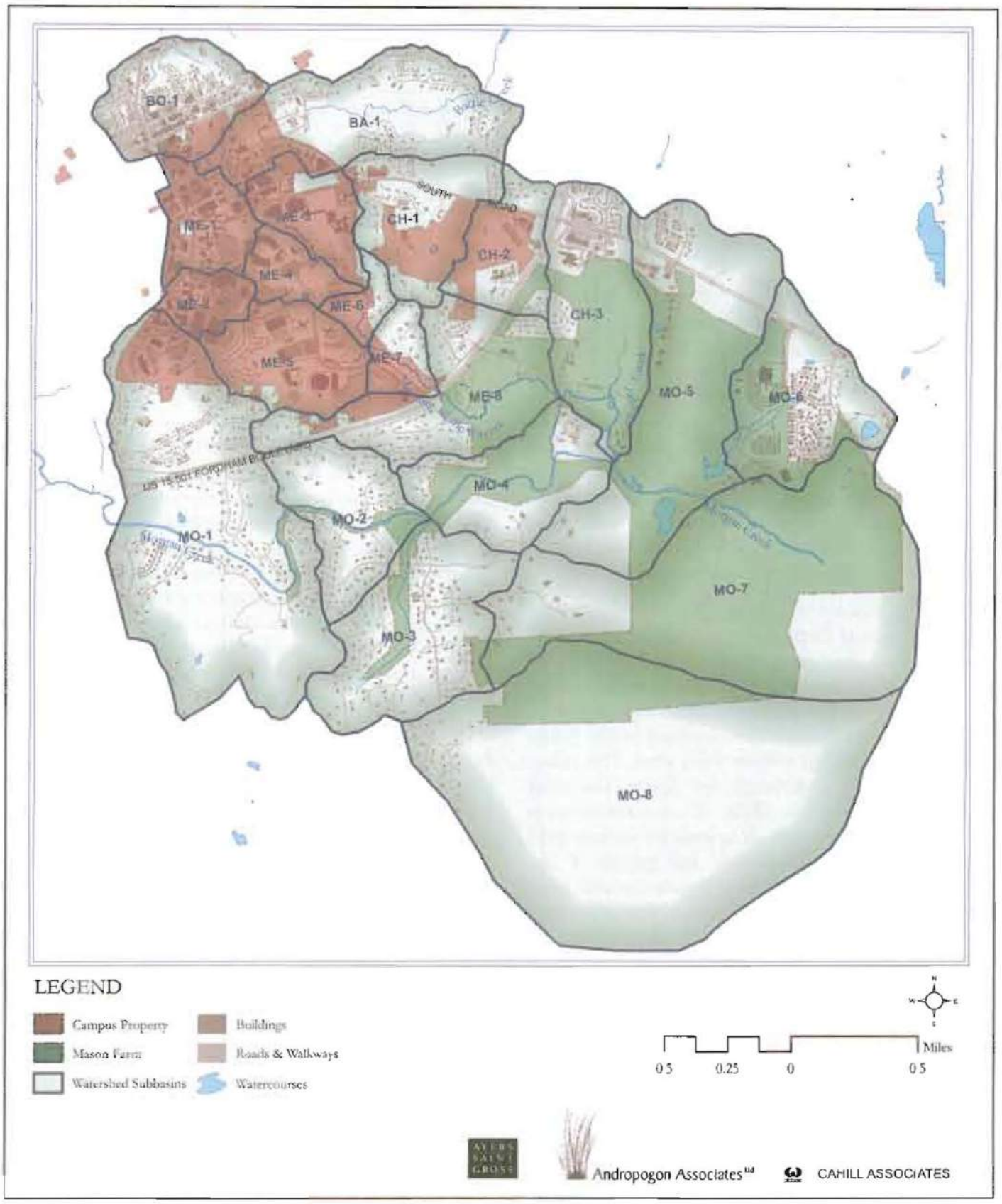
Two large important stream valleys are presently preserved at the University as open space — Battle Creek in Battle Creek Park at the northeastern end of the Campus and the Meeting of the Waters Creek in the Pinetum on the western border. A remnant valley of a tributary of College Branch also remains today, located just west of the Bell Tower and east of the Bell Tower Parking Lot. Unfortunately, in its current state, the storm drain system outlets to this small relic stream.

Existing Water Quality

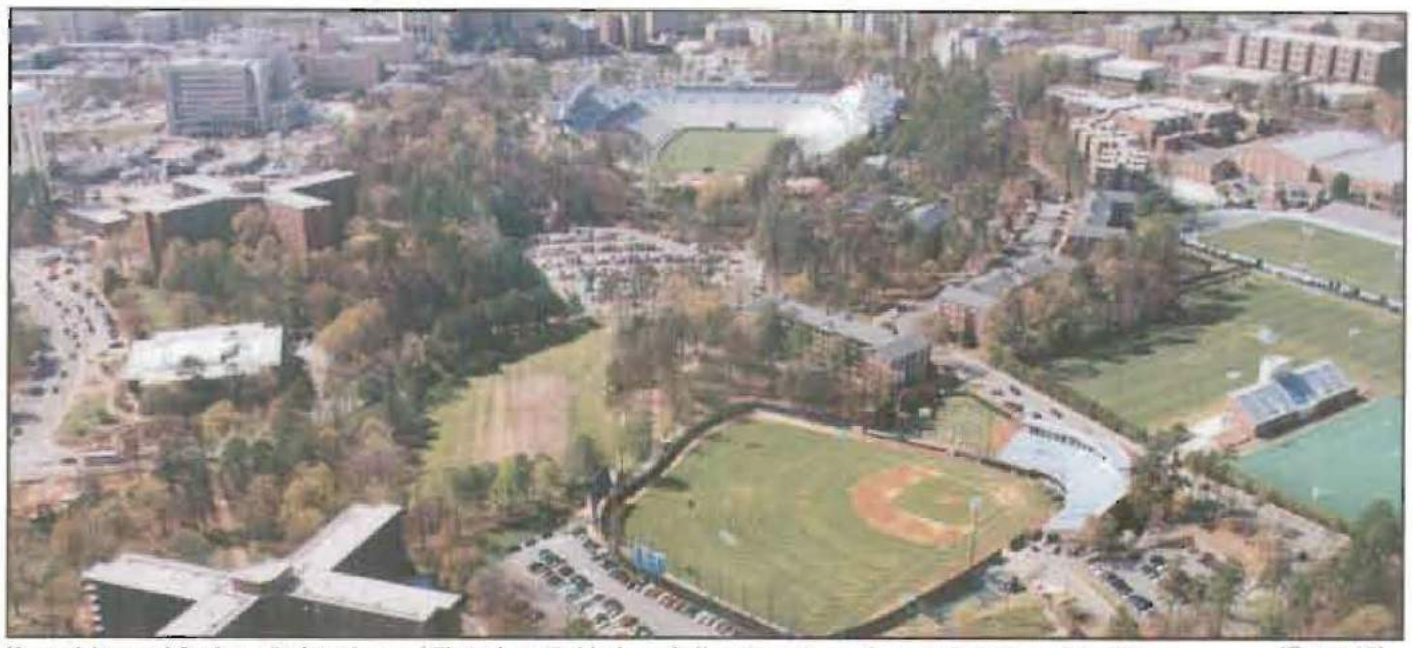
As illustrated previously, the University is located within the larger Cape Fear River Basin. Specifically, the southern-most portion of the Campus is located within sub-basin 6, as identified by the North Carolina Division of Water Quality (DWQ). This sub-basin includes Morgan Creek, Meeting of the Waters Creek, and Bolin Creek, along with large sections of the town of Chapel Hill. Sub-basin 6 drains entirely to Jordan Lake, which drains to the Haw River, which flows into the Cape Fear River. In comparison with other sub-basins in the Cape Fear River basin, sub-basin 6 contains a large proportion of urban areas.

Biological assessment data from Morgan Creek indicate a downstream decline in water quality. Good or excellent water quality results are recorded from upstream sites, and Fair or Poor bio-classification ratings appear as the stream flows through the urban and suburban sections of Chapel Hill. Meeting of the Waters is identified as not supporting (NS), because of an impaired biological community. In stream habitat, degradation, along with urban non-point source pollution, is the probable cause of this impairment. In addition, two segments of Morgan Creek are identified as partially supporting (PS) and not supporting (NS) because of an impaired biological community. Possible causes of impaitment are identified as sedimentation and urban non-point soutce pollution.

W A T E R S H E D S U B B A S I N S



(Figure 18)



Kenan Memorial Stadium, Parking Lot and Ehringhaus Field where College Branch, a tributary of Meeting of the Waters, once flowed. (Figure 19)

Restoring the Hydrologic Balance

Cycles of flood and drought are a natural process, but the current practices of land development greatly increase these impacts on the hydrologic cycle. The Environmental Master Plan identifies areas of the University where this cycle has been altered by existing land practices and estimates the potential of future impacts. It also suggests methods and approaches to planning and design that will restore that balance, and with it the health of the entire water system.

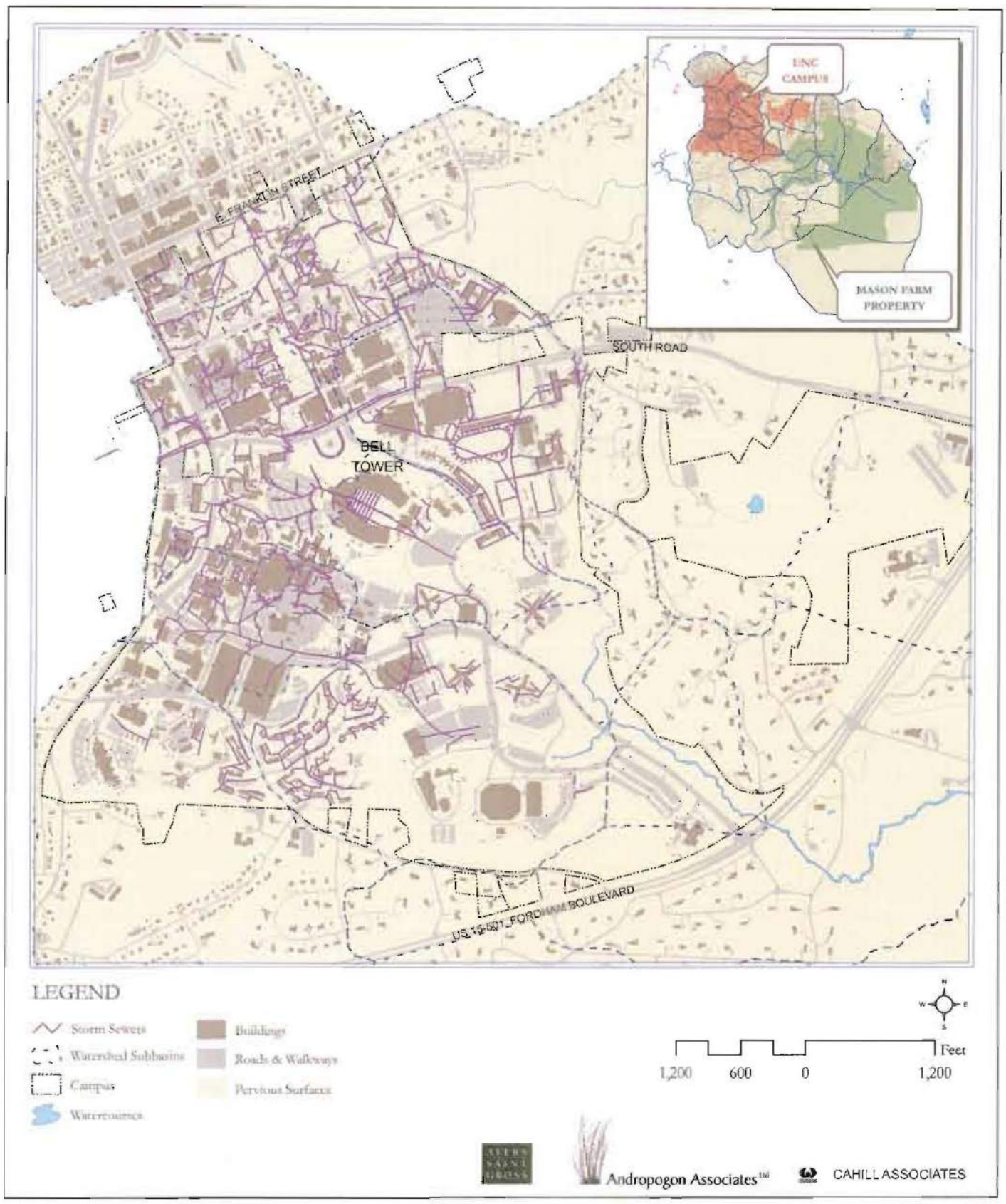
Historic maps of the Campus reveal that an extensive stream network once flowed through the region of Main Campus south of South Road. College Branch, a tributary of Meeting of the Waters Creek, originated slightly west of the Venable Building and flows southeast under South Road, before linking up with its main stem. This tributary currently flows directly underneath the Kenan Memorial Stadium; when the stadium was constructed in the late 1920s, a series of under-drains were built to keep the stadium field dry and interconnected with the now buried stream.

As development pressures and the need to accommodate the automobile grew, other small stream valleys were filled in and paved over for parking. These buried streams continue to influence drainage patterns because groundwater follows long-established sub-surface pathways, regardless of where the piped stream has been redirected.

The southern portion of the Campus is comprised of subbasins that contain a high percentage of impermeable surfaces. This has exacerbated the amount and speed of stormwater runoff, as well as the amounts of non-point source pollutants that reach Morgan Creek. The consequences downstream, including the North Carolina Botanical Garden, the Mason Farm Biological Reserve, and adjacent community parks such as Jones Park, are severe. In particular, stream channels have migrated and their banks are destabilized as they adjust to handle the increased water volume, increased velocities and the increased sediment load.

The vegetation of the floodplain corridor is also severely impacted by the change in the hydrologic balance. Many species, such as beech and oak are dependent upon closeness to the water table in order to weather times of drought and cannot survive continued lowered table conditions. If adequate levels of recharge are not sustained over time, changes in vegetation are likely. These conditions are a direct result of the engineering of runoff and illustrate the consequences of failing to include the conservation of natural hydrologic patterns.

STORM SEWER NETWORK



(Figure 20)

Small streams become inundated during floods and dry with a low base flow between storm events. (Figure 21)

The Hydrologic Cycle

Water cannot be understood as an isolated system. It is dynamic and moves from the oceans to the atmosphere, to the land and back to the oceans. During and after rainstorms, water moves across the land as stormwater runoff when the surface of the land is impermeable or becomes saturated. A portion of this rain or snowfall soaks into the ground and percolates slowly through the soil and weathered bedrock to a zone of saturation. Here water slows but does not stop, draining along the gradient of the water table through fractures, or pore spaces in the rock. It reappears weeks or months later at the surface of the land as springs or seeps. These sub-surface pathways reflect the underlying geology. Water that has infiltrated into the ground and emerges in the stream channel is called "base flow." The springs and small tributaries known as "first order" streams combine to form larger creeks and stream such as Meeting of the Waters and Morgan Creeks. The shape and location of streams is also determined by the groundwater discharge or base flow combined with surface runoff of stormwater.

In the Piedmont, rain falls with sufficient intensity to produce surface runoff approximately thirty days in a given year. During the remaining eleven months, base flow keeps the streams flowing. In an undisturbed and forested landscape in the North Carolina Piedmont, the annual rainfall averages about forty-five inches a year. Of this total, only a relatively small fraction runs off the ground during storms—on the order of eight to ten inches a year. A much larger amount of thirty-four to thirty-six inches soaks into the soil mantle. Much of this water is returned to the air as evaporation and transpiration from the vegetation. Approximately 15% or about 6 to 8 inches finds its way to the aquifers in the deeper bedrock, to reappear as base flow in the streams.

The paved surfaces of our developed communities disrupt this natural hydrologic cycle. They unbalance the equation and turn rainfall into runoff. Every square foot of impervious surface—roofs, roads, parking lots, etc. — produces as much as three additional square feet of runoff per year. The immediate effect of this change in the hydrologic balance is the torrents of muddy water pouring off roofs and rushing down streets in a storm. Not so obvious is the critical loss of base flow to local streams. The net result is a stream which is either inundated by floods with unstable banks and a rapidly migrating channel or dry and without the water to support aquatic life.

The damaging effects of flood and drought are the unnecessary results of thoughtless and unsophisticated land development. This report will pinpoint areas of the University where the hydrologic cycle is out of balance and suggest methods and approaches to planning and design that will help to restore that balance and with it the health of the water system.

Table 1. UNC-Chapel Hill: Existing (1998) Land Cover Characteristics by Sub-Basins
October 2001

Sub-Basin	Total Area (acres)	Total Sub-basin Area Within UNC Property (acres)	(%)	Total Impervious Area* (acres)	(%)	Total Pervious Area** (acres)	(%)
Battle Creek							
BA-1	257	134	52%	52	20%	205	80%
Bolin Creek							
BO-1	145	20	14%	67	46%	79	54%
Chapel Creek							
CH-1	157	77	49%	20	13%	137	87%
CH-2	106	53	50%	17	16%	90	84%
CH-3	217	138	64%	37	17%	180	83%
Meeting of the Waters Creek							
ME-1	89	86	97%	50	56%	39	44%
ME-2	48	48	100%	37	78%	10	22%
ME-3	88	78	89%	33	38%	54	62%
ME-4	54	54	100%	20	38%	33	62%
ME-5	137	132	96%	44	32%	93	68%
ME-6	32	18	55%	4	13%	28	87%
ME-7	49	24	49%	9	19%	40	81%
ME-8	244	22	9%	32	13%	213	87%
Morgan Creek							
MO-1	608	51	8%	75	12%	533	88%
MO-2	157	16	10%	16	10%	142	90%
MO-3	261	33	12%	25	10%	236	90%
MO-4	179	83	46%	7	4%	172	96%
MO-5	407	227	56%	29	7%	378	93%
MO-6	197	85	43%	48	24%	149	76%
MO-7	674	438	65%	8	1%	667	99%
MO-8	979	133	14%	5	0%	974	100%

*Includes Building Rooftops, Roads and Walkways
**Includes both Pervious and Semi-pervious Surfaces

Table 2. UNC-Chapel Hill: Existing (1998) Land Cover
Land Cover Analysis by Campus Property
October 2001

Sub-Basin	Total Sub-Basin Area Within UNC Property (acres)	UNC Property Total Impervious Area (acres)	(%)	Woodland (acres)	Lawn/ Maintained Grass & Shrubs (acres)	UNC Property Total Pervious Area (acres)	(%)
Battle Creek							
BA-1	134	25	19%	76	33	109	81%
Bolin Creek							
BO-1	20	7	37%	0	13	13	63%
Chapel Creek							
CH-1	77	4	5%	55	18	73	95%
Meeting of the Waters Creek							
ME-1	86	48	56%	3	35	37	44%
ME-2	48	37	78%	0	10	10	22%
ME-3	78	33	42%	7	38	45	58%
ME-4	54	19	36%	10	24	34	64%
ME-5	132	44	33%	39	49	88	67%
ME-6	18	2	11%	13	3	16	89%
ME-7	24	6	24%	13	5	18	76%
ME-8	22	1	6%	18	2	20	94%
Morgan Creek							
MO-1	51	19	36%	12	20	33	64%
Totals	742	245		247	250	497	

Table 3. UNC-Chapel Hill: Master Campus Development Plan
Land Cover Analysis by Campus Property
October 2001

Sub-Basin	Total Sub-Basin Area Within UNC Property (acres)	UNC Property Total Impervious Area (acres)	(%)	Woodland (acres)	Lawn/ Maintained Grass & Shrubs (acres)	UNC Property Total Pervious Area (acres)	(%)
Battle Creek							
BA-1	134	29	21%	76	29	105	79%
Bolin Creek							
BO-1	20	9	46%	0	11	11	54%
Chapel Creek							
CH-1	77	4	5%	55	18	73	95%
Meeting of the Waters Creek							
ME-1	86	55	64%	2	29	31	36%
ME-2	48	36	76%	0	11	11	24%
ME-3	78	39	49%	6	33	39	50%
ME-4	54	23	42%	9	22	31	57%
ME-5	132	70	53%	17	43	60	45%
ME-6	18	3	18%	13	2	14	81%
ME-7	24	8	33%	9	6	15	64%
ME-8	22	8	35%	10	5	14	65%
Morgan Creek							
MO-1	51	25	49%	9	17	26	51%
Total	742	308		204	226	431	

Note: Proposed water feature areas have been excluded from the analysis because they do not possess properties of either pervious or impervious surfaces for the runoff analysis.

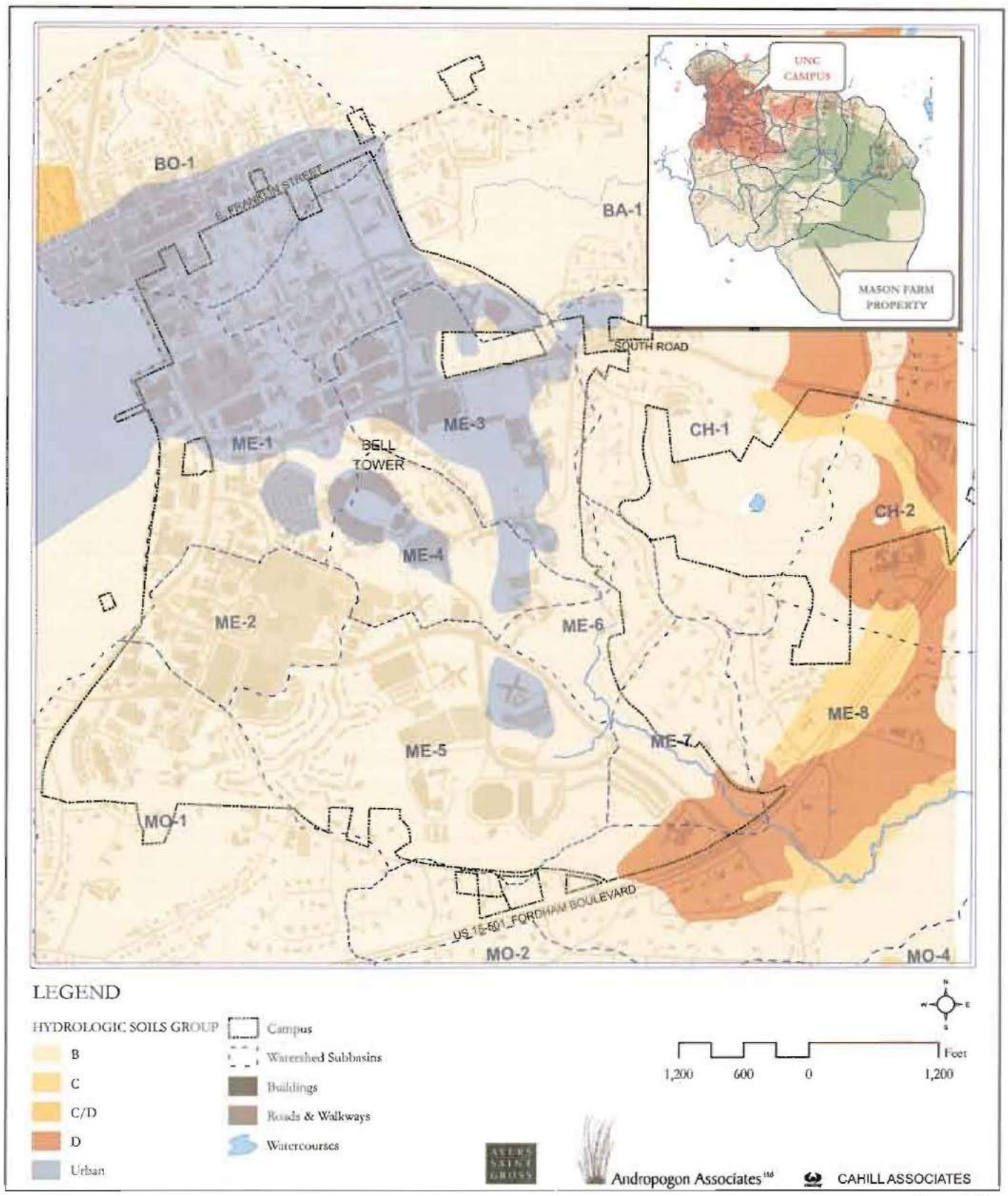
Watersheds and Drainage Patterns

The report divides the University property into coherent small drainage units or sub-basins. While it often goes unnoticed that the University is part of two larger watersheds, it is even more difficult to identify the smaller drainage divides. Local ridges and high points, as well as drainage infrastructure, divide the Campus into 21 smaller watersheds or sub-basins (Figure 18). Within each sub-basin the land surface drains to a given surface stream or swale, although many of these drainage elements have been buried overtime and are not obvious (Figure 17). Most Campus residents are totally unaware of these drainage elements as they move across the Campus and do not divide the landscape into watersheds but this structure will serve to measure the basic land and water system for much of the analysis that follows.

Since these sub-basins form the basic unit of the analysis, both natural and man-made land cover characteristics are aggregated by sub-basin. Because the planning boundaries that exist within the Campus property rarely coincide with sub-basin boundaries, the analysis first examines sub-basin characteristics on a watershed basis in order to evaluate the overall health of each sub-basin (Table 1). The US EPA states that watersheds that experience urban growth resulting in impervious cover greater than 25% are highly impaired and present tremendous challenges to remedy. Many sub-basins within and surrounding the University property have already been impacted by development with impervious percentages exceeding 25%. Therefore, as we look toward the future and proposed expansion of the Campus, it is important that we are sensitive to the existing sub-basin conditions as we plan within the boundaries of the University.

In order to document the net impacts of development on stormwater runoff volume, the changing patterns and composition of the land cover are aggregated by sub-basin as well as the analysis planning area (Tables 2 and 3). For example, the total amount of stormwater runoff, as well as the pollutant load generated during a storm, can be estimated by measuring the amount of impervious surface that covers the sub-basin area within University property. This information lends itself to a comparison of existing sub-basin characteristics on Campus and the future characteristics proposed by the Campus Master Plan.

MAIN CAMPUS
HYDROLOGIC SOILS GROUP



(Figure 22)

UNC Rainfall and Runoff Estimates based on the Cover-Complex Method					(Assumes all soils are hydrologic group B)			
Rainfall (inches/24 hours)		1-yr	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
		3	3.6	4.7	5.4	6.4	7.2	8.0
Land Cover/Use	Curve Number	Runoff (inches/24 hours)			Impervious			
Roofs, pavement	98	2.8	3.4	4.5	5.1	6.2	7.0	7.8
Residential use	85	1.6	2.1	3.1	3.7	4.7	5.4	6.2
Pervious								
Lawn, fields	70	0.7	1.1	1.8	2.3	3.1	3.8	4.5
Meadow, shrubs	65	0.5	0.8	1.5	1.9	2.7	3.3	3.9
Woodland	60	0.3	0.6	1.1	1.5	2.2	2.7	3.3

(Table 4)

The Water Balance Model

This report will use a "water balance model;" a form of bookkeeping based on the hydrologic cycle, to analyze the effects of the impervious and pervious surfaces at the University on the amounts and quality of runoff, as well as to highlight the net changes in the entire water system. The model is based on the idea that the hydrologic cycle, as described above, is an input/output system. For example, if water is not recharged within the sub-basin where it falls, this loss cannot be made up on another site in an unrelated sub-basin. When the natural hydrologic cycle is sufficiently changed by development, only solutions that replace water that previously infiltrated the ground (or evaporated and transpired by vegetation) will address the broad issues. These issues include increasing flood and drought peaks, non-point source pollution, the excessive nutrient loads that are carried to local reservoirs, and loss of soil and natural vegetation with their complex interrelationships to the health of both land and the water.

The various methods and materials that are proposed for sustaining the hydrologic balance on the developing Campus are intended to replicate the natural balance. Their efficiency can be tested using the Water Balance Model as detailed solutions evolve in different portions of the Campus. For example, the most highly impervious portions of the Campus offer very limited opportunities to return runoff to the soil mantle, since little open land remains. In these locations, structural systems that intercept rainfall on rooftops and return it to the atmosphere by vegetative systems attempt to replicate the lost vegetation from the land surface, and can reduce the runoff volume increase by 50%. Other systems that capture and re-use rainfall also serve to replace the natural functions of the soil.

Various types of impervious surfaces will generate greater or lesser concentrations of pollutants, and these differences can also be documented by the model and included in the analysis of mass transport of sediment conveyed by runoff. All of these analyses of the natural and man-made systems require a form and structure, which takes the form of the topologic boundaries of the sub-basins created by the drainage patterns.

Hydrologic Soil Groups

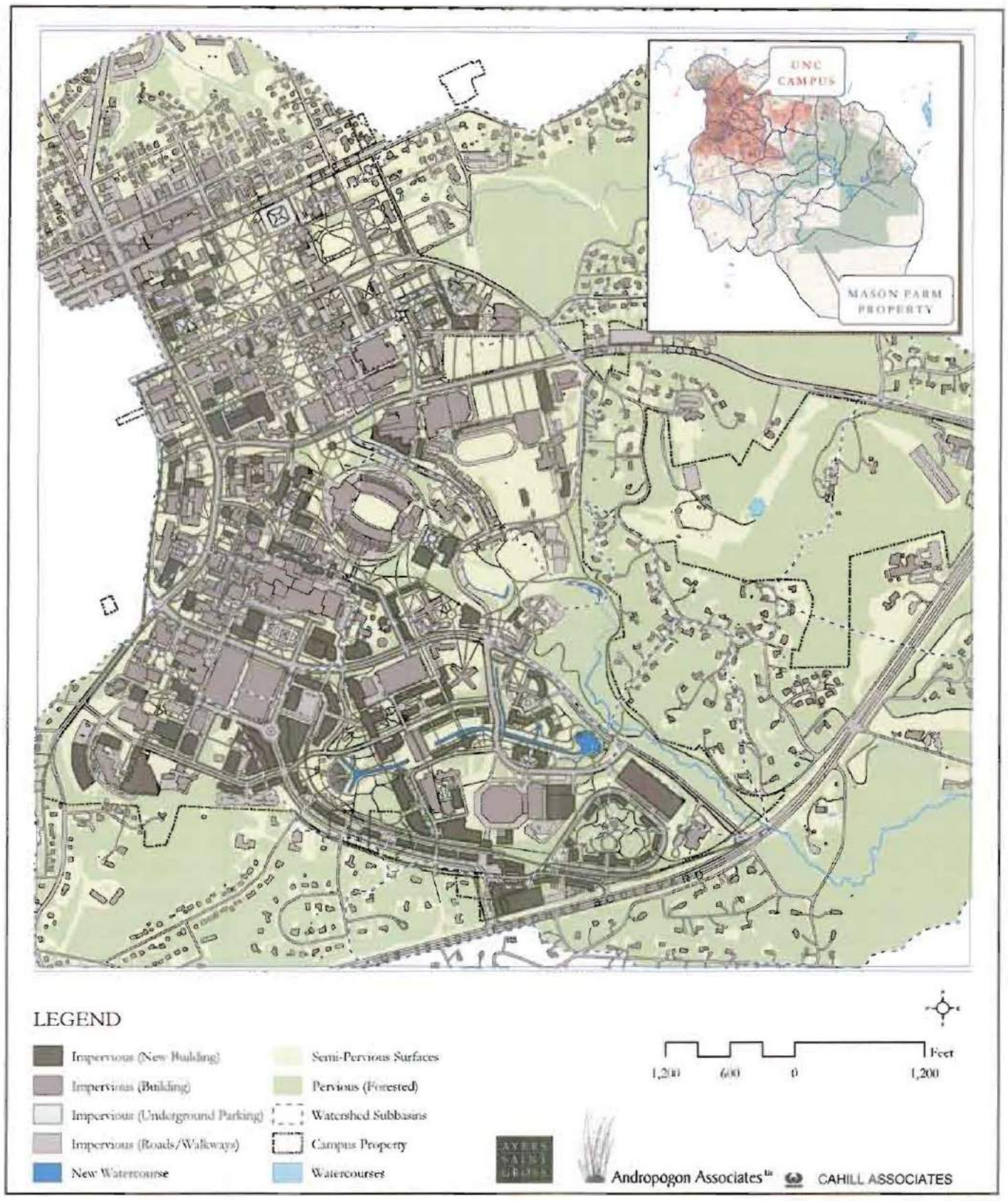
To understand if it possible to infiltrate water within the area Campus, it is necessary to identify the undeveloped degree of soil permeability. This physical property of soils largely governs the amount of stormwater runoff during precipitation. The USDA—SCS analysis of soil series by drainage characteristics has resulted in a classification system that ranks soil by its ability to infiltrate rainfall. The system classifies each soil in a hydrologic group ranked from A (dry) to D (wet), with the group providing the best soil drainage conditions. In Figure 22, soils with a greater infiltration capacity that are less likely to produce runoff are shown in lighter colors, while the wetter, less permeable soils are shown in darker colors.

As can be seen in Figure 22, Main Campus, south of South Road is comprised mostly of B soils. These soils may be suitable for infiltration and recharge techniques. Mason Farm is comprised of both C and D soils, shown in Figure 22. These soil groups have a lower infiltration rate and consist of soils that are poorly drained.

Soils that have been significantly altered by filling or regrading are shown in gray, and may have variable drainage properties. The Historic Core of Main Campus consists largely of these altered soils, and any conclusions about drainage characteristics here must be determined by field tests.

MASTER PLAN

SURFACE PERMEABILITY



(Figure 23)

Large relic trees on the Campus greens. (Figure 24)

Campus parking area with a wooded edge. (Figure 25)

Land Cover Types

In order to quantify the amounts of stormwater runoff currently generated and to estimate the increase in runoff after redevelopment of the Campus, land cover types were identified by permeability. Land Cover is generally considered as pervious or impervious. However, in order to model more accurately how a change in land cover will impact the runoff volume produced by a given rainfall, an additional classification has been created to describe the land surface that has been disturbed and probably re-compacted, and planted in turf or other landscaped areas. Therefore, three land cover types can be described by permeability; pervious, semi-pervious and impervious as described below:

1. Pervious - Natural forest and woodland that are considered fully pervious for infiltration.

2. Semi-Pervious - Lawns and landscaped areas where compaction and grading during construction have reduced soil permeability are considered semi-pervious.

3. Impervious - Surfaces that include all the paved surfaces that are built to ensure that water does not penetrate.

Areas in forest retain spongy, absorbent soils that hold water and allow it to seep slowly back in to the groundwater. On the southern portion of Main Campus, some of the slopes have been left in forest and are the major areas of recharge returning stormwater to the aquifer. On the flat plateaus of the Historic Core, the land is covered in a mixture of impermeable paved areas and semi-permeable grassy open space—"the greens."

Turf varies in the amount of runoff it produces. While well-maintained grass produces little runoff, turf in poor health, on compacted soils, or on steep slopes may produce volumes up to 25% (Watershed Protection Techniques, 2(1): 239-246). In these cases, the improvement of turf grass health, or its replacement with vegetation better suited to harsh growing conditions, may provide water quality benefits.

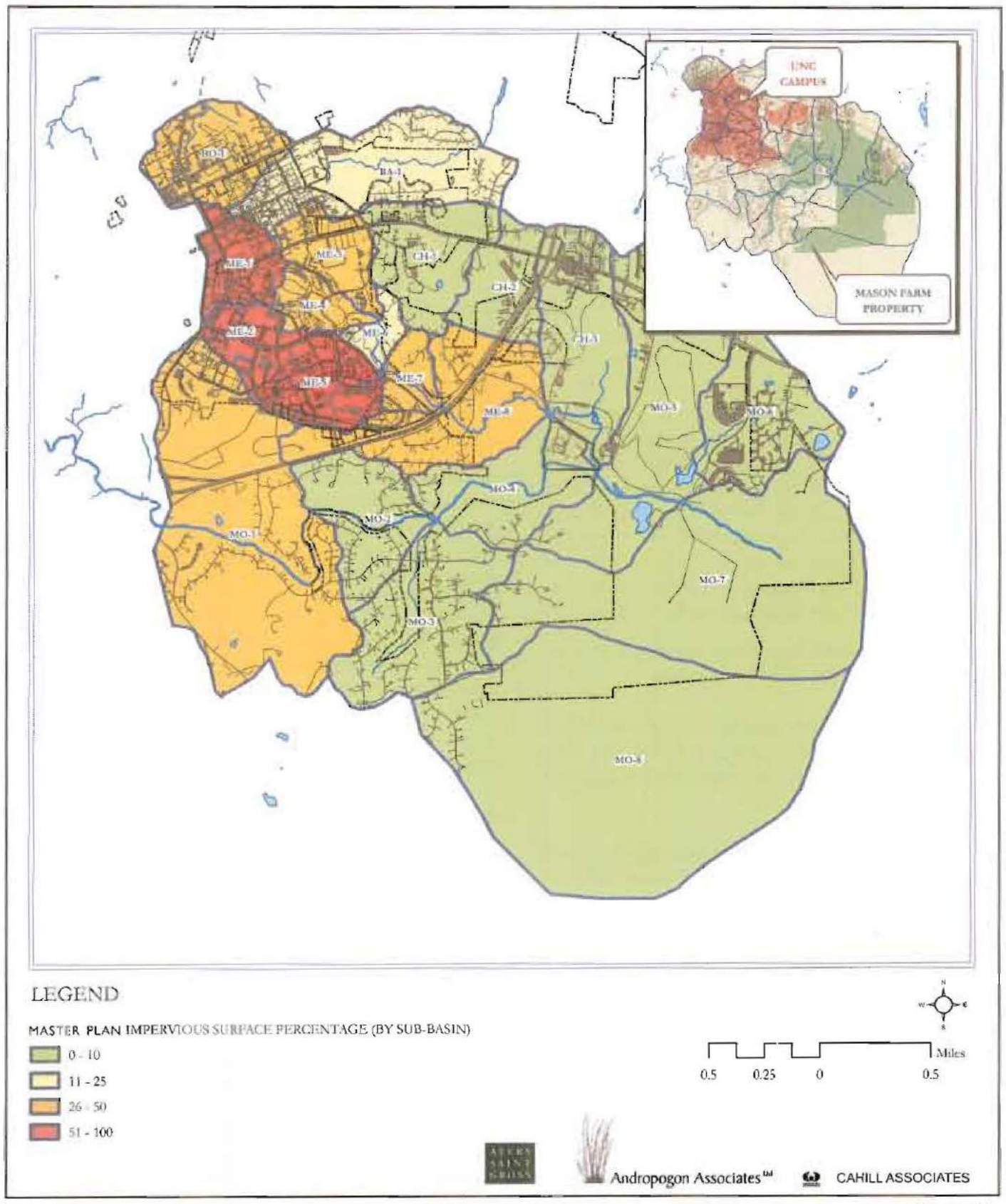
The relative timing of fertilizer applications and water inputs – from irrigation or heavy rainfall – will also influence the leaching and transport of nutrients to groundwater. The careful monitoring and management of lawn care can, therefore, make a difference to groundwater quality within the current landscape.

At present, the soils of the "greens" are heavily compacted. Soil compaction occurs when surface weight, whether it is repeated foot traffic or machines, collapses the spaces where water, air, and soil organisms can move, creating a hard, solid, non-living mass. Soil compaction is an insidious problem because the effects are often underestimated. Heavily compacted soils act as a barrier to root growth, inhibit the exchange of atmospheric gases and also restrict the infiltration of water. Significant recharge cannot occur in these areas unless the compacted surface layer is broken through and replaced with a porous substrate.

The high percentage of impermeable surface on the South Campus has exacerbated the amount and speed of stormwater runoff, as well as the amounts of non-point source pollutants that reach Meeting of the Waters, Morgan Creek and other surface tributaries that lie south of the Campus. Consequences to these stream channels that flow in The Notth Carolina Botanical Garden, the Mason Farm Biological Reserve and adjacent community patks such as Jones Park are severe. In particular, stream channels have migrated and their banks have been destabilized in an effort to handle the increased water volume and velocities and the increased sediment load.

M A S T E R P L A N

P E R M E A B I L I T Y P E R C E N T A G E



(Figure 26)

Table 5. Comparison of Net Increase in Runoff Volume for 2-Year and 100-Year Storm Events

	2-Year		100-Year	
Sub-Basin	**Existing Volume Ac-In**	**Master Plan Volume Ac-In**	**Existing Volume Ac-In**	**Master Plan Volume Ac In**
BA-1	162	171	593	605
BO-1	39	43	115	121
CH-1	64	64	294	294
ME-1	202	216	540	561
ME-2	136	134	335	332
ME-3	155	169	448	468
ME-4	96	105	291	302
ME-5	221	291	687	790
ME-6	17	19	70	73
ME-7	32	39	111	119
ME-8	17	36	81	112
MO-1	91	108	275	301
	1234	1395	3839	4079

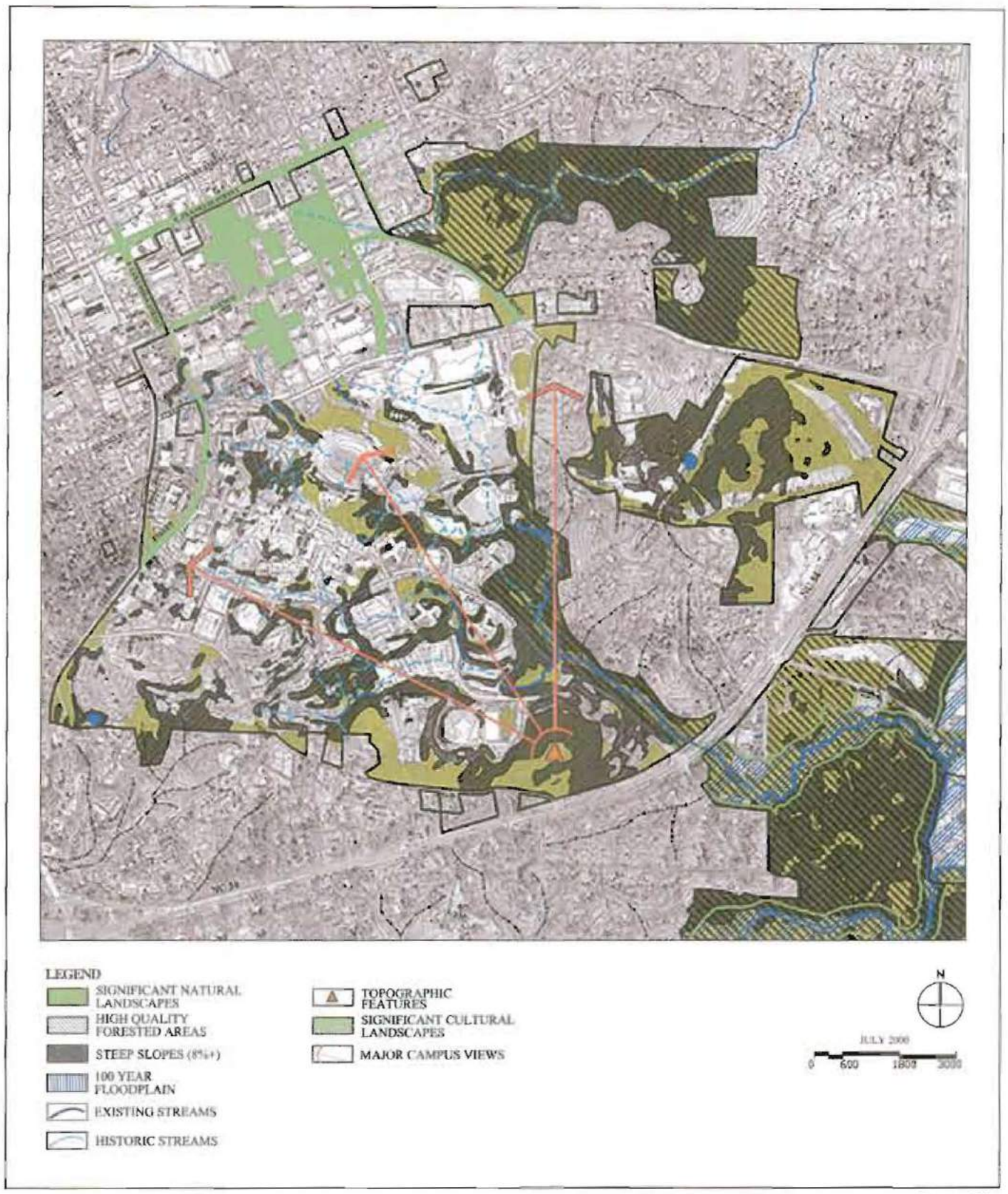
	2-Year	100-Year
Net Increase for Master Plan	**161 ac-in** **13 ac-ft**	**239 ac-in** **20 ac-ft**

Stormwater Runoff Estimates

In the Water Balance Model, the description of land cover composition by sub-basin is used as the basis to estimate how much of a given rainfall amount will be transformed into direct and immediate runoff. Using a methodology called the Cover-Complex Method (USDA, SCS, 1967), the combination of vegetative cover and soil hydrologic group is classified by a term called Curve Number. This is a designation that refers to a set of curves derived from the basic equations for rainfall-runoff relationships. Based on these estimated Curve Numbers, each type of cover can be used to calculate the net runoff for a given frequency and amount of rainfall, as shown in Table 4.

The statistics developed in Table 5 can be considered preliminary based on the best available existing data. The initial comparison of 1998 impervious cover and projected Master Plan impervious cover indicated a net increase of only a few acres. The net increase of 13.5 acre-feet is still a relatively small increase in runoff volume from the Campus, but serves as the initial target for volume mitigation measures. A more meaningful statistic is the total runoff volume during a 2-year frequency rainfall of 3.6 inches, a figure that represents some 96% of the total rainfall in a normal year. This total volume of 1,234 acre-inches (161 acre-feet) from the Campus would fill the football stadium (4.3 acres at mid-height) to a depth of almost 25 feet. It is this volume of runoff that flows from the Campus downhill to the receiving surface streams every year.

MAIN CAMPUS
ENVIRONMENTAL STRUCTURE



(Figure 27)

Low buildings define large, green, open spaces on North Campus. (Figure 28)

Large surface parking areas built in the stream valleys. (Figure 29)

Environmental Organizing Principles

The patterns of existing land use and development in each of the three major Campus areas are best understood by considering how they evolved. The historical development in the northern portion of the Campus reflects and respects the natural physiography of the land. By contrast, new development in the southern portion has tended to obliterate landforms, streams and natural vegetation.

Main Campus – North

North Campus is the Historic Core of the University and was developed as a 19th century American Village where houses and public buildings surround large, open, green spaces. Like the villages it symbolically represents, the Historical Campus was developed on the broad flat uplands, with the only stream valley of significance preserved as Battle Creek Park. The development form is characterized by:

- Low buildings that define large, green, open spaces. These common, open spaces have a continuous floor of lawn, punctuated with informal groupings of large canopy trees.
- Buildings are set in a matrix of green with green fronts, sides and backs.
- There is an equal ratio of building to green space.
- The Campus is connected by myriad pedestrian walkways that include the sidewalks of tree -lined streets.

Main Campus - South

South Campus is located in the transition area between the uplands of the Historic Core and the lowlands of Mason Farm. The rolling hills are highly dissected by short, broad stream valleys with steep slopes. Many of these stream valleys were filled and built over. This development pattern is characterized by:

- Wide, curving arterial roads that divide South Campus into superblocks.
- Landforms of hills and valleys that have fostered a rudimentary pedestrian network.
- Large multistoried buildings and undefined open space.
- Buildings and impervious surfaces that cover more than half the land in many sub-basins.
- Steep slopes largely left in forest remnants with stream valleys filled for parking.

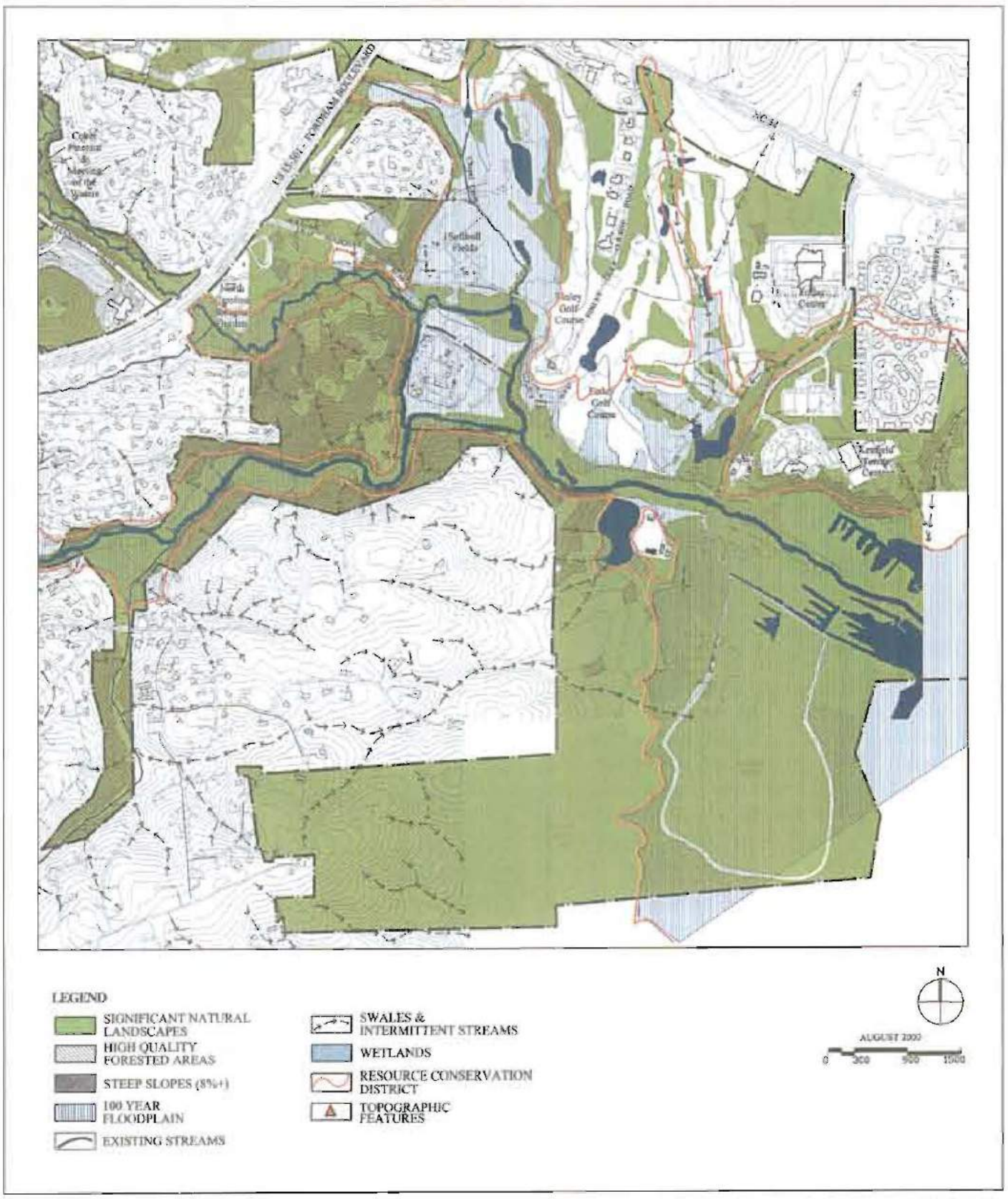
Since most of the proposed master plan development will occur in the southern end of Campus, a desire to mitigate future impacts led to the formulation of several case studies which integrated new land use and stormwater management strategies into the Comprehensive Master Plan. Impacts to the water system of adjacent sites posed by existing and proposed development were identified.

Mason Farm Property

The 1,356 acre University property known as the Mason Farm Property, is a part of the 3,800 acre Mason Farm/Morgan Creek Natural Area. This significant wildlife refuge is the least fragmented large tract of bottomland remaining in the Jordan Lake wildlife system.

E N V I R O N M E N T A L S T R U C T U R E

M A S O N F A R M P R O P E R T Y



(Figure 30)

The physiography of The Mason Farm Property is dominated by the broad, flat floodplain of Morgan Creek. (Figure 31)

Forty percent (40%) of the Mason Farm property lies in the 100-year floodplain and is the lowest elevation in Orange County, where all water flows before reaching Jordan Lake. Buildings and impervious surfaces cover less than 1/8 of the land in this area where the newest development has been office parks and golf course recreation in the low hills just above the floodplain to the northeast. Approximately 184 acres have been identified as suitable for development in a report titled Study of University of North Carolina Outlying Properties, JJR, 1996. That study states that while the tract is well located fot regional access and already committed to a variety of uses, the University is also committed to preserving and protecting the environmentally sensitive areas. That same study lists the existing uses of the Mason Farm property as:

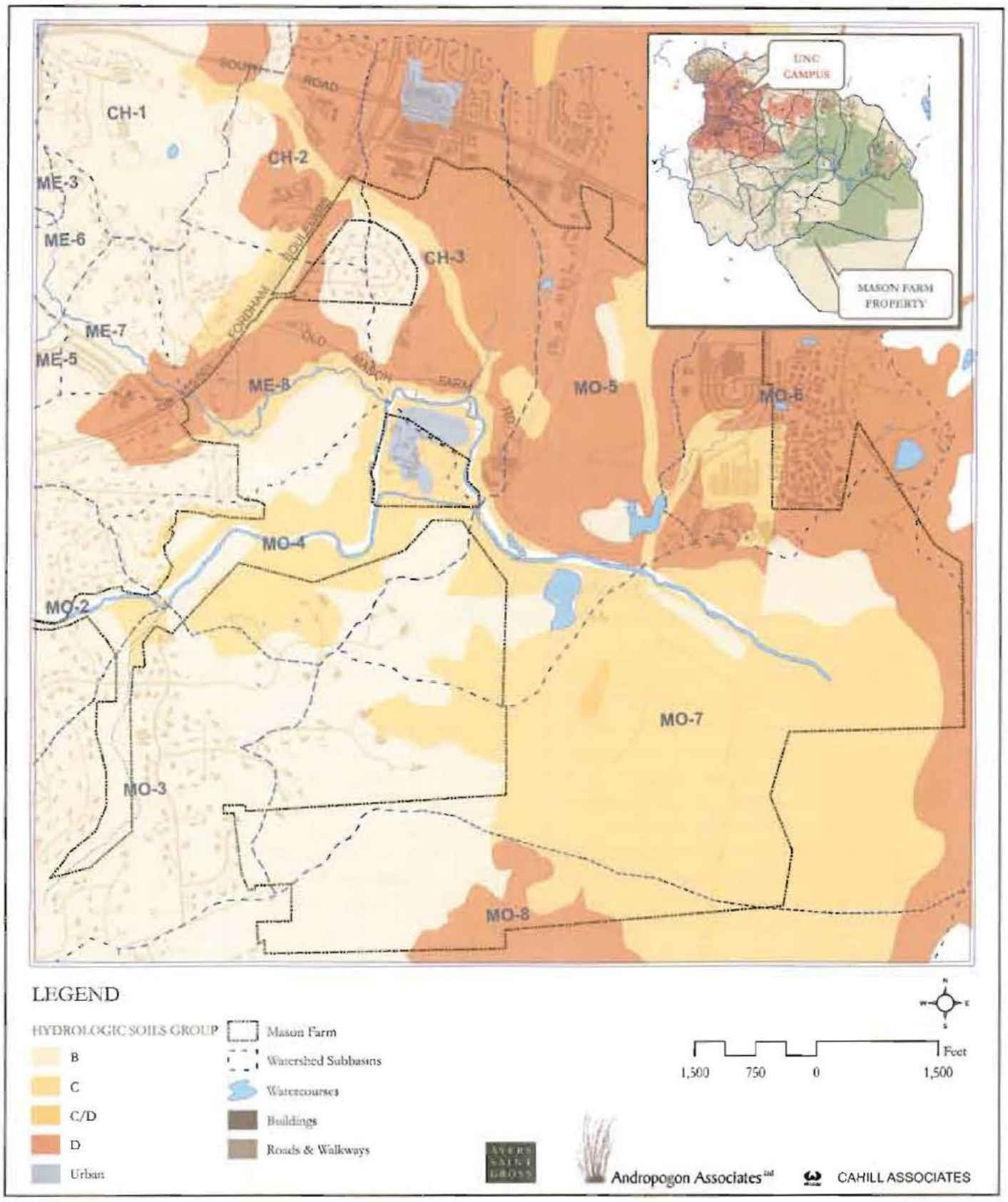
- Mason Farm Biological Reserve, North Carolina Botanical Garden and associated Arboreta (558 acres)
- Finley Golf Course (239 acres)
- Friday Continuing Education Center
- The University of North Carolina at Chapel Hill Hospitals Administration Building
- Cone Kenfield Tennis Center
- Municipal Park and Ride Lot
- OWASA Water Treatment Plant
- The Ronald McDonald House
- The Faculty Recteation Club and other recreational facilities
- Center for School Leadership
- Joint Day Care Centet
- WUNC Radio Station

Gently rounded hills with steep slopes on the eastern sides surround the low-lying, broad, flat, floodplain of Morgan Creek to form the North Carolina Botanical Garden and the Mason Farm Biological Reserve. As a critical part of a larger regional resource – the values of the Mason Farm Biological Reserve will become increasingly significant to the University and to the larger community as the surrounding unprotected natural areas are lost to development. These values include:

Biological and Ecological Diversity

M A S O N F A R M P R O P E R T Y

H Y D R O L O G I C S O I L S G R O U P



(Figure 32)

Lowland forest at Mason Farm Biological Reserve. (Figure 33)

Below is a description of the significant plant communities provided by the North Carolina Botanical Garden and managed by them within the boundaries of the property:

- The Piedmont/Coastal Plain Heath Bluff, occurring in four areas along Morgan Creek on the flank of Laurel Hill. This community type is uncommon and local throughout its range.
- Piedmont/Mountain Swamp Forest, making up much of the Big Oak Woods. This community type, always rare, has been greatly reduced in extent and now is extremely rare. The occurrence of an old growth example of this size without significant hydrologic alteration is unique in North Carolina and probably throughout the southeastern Piedmont
- Oak – Hickory Forest, occurring on diabase dikes on the western side of Mason Farm. This example is one of the most mature in the state.
- Piedmont/Low Mountain Alluvial Forest, occurring along Morgan Creek below the Heath Bluffs. As a well-developed mature example of a Piedmont community, this forest provides an important buffer for the very fragile Heath Bluffs across the creek that cannot tolerate exposure to drying winds and removal of the canopy.
- Acidic Oak-Hickory Forest, occurring on the south-facing slopes of the Nature Trail Hill. This is a high quality, mature forest remnant that provides a buffer for the sensitive rhododendron community in the Hunt Arboretum on the opposite side of Morgan Creek.

High Quality Vegetation

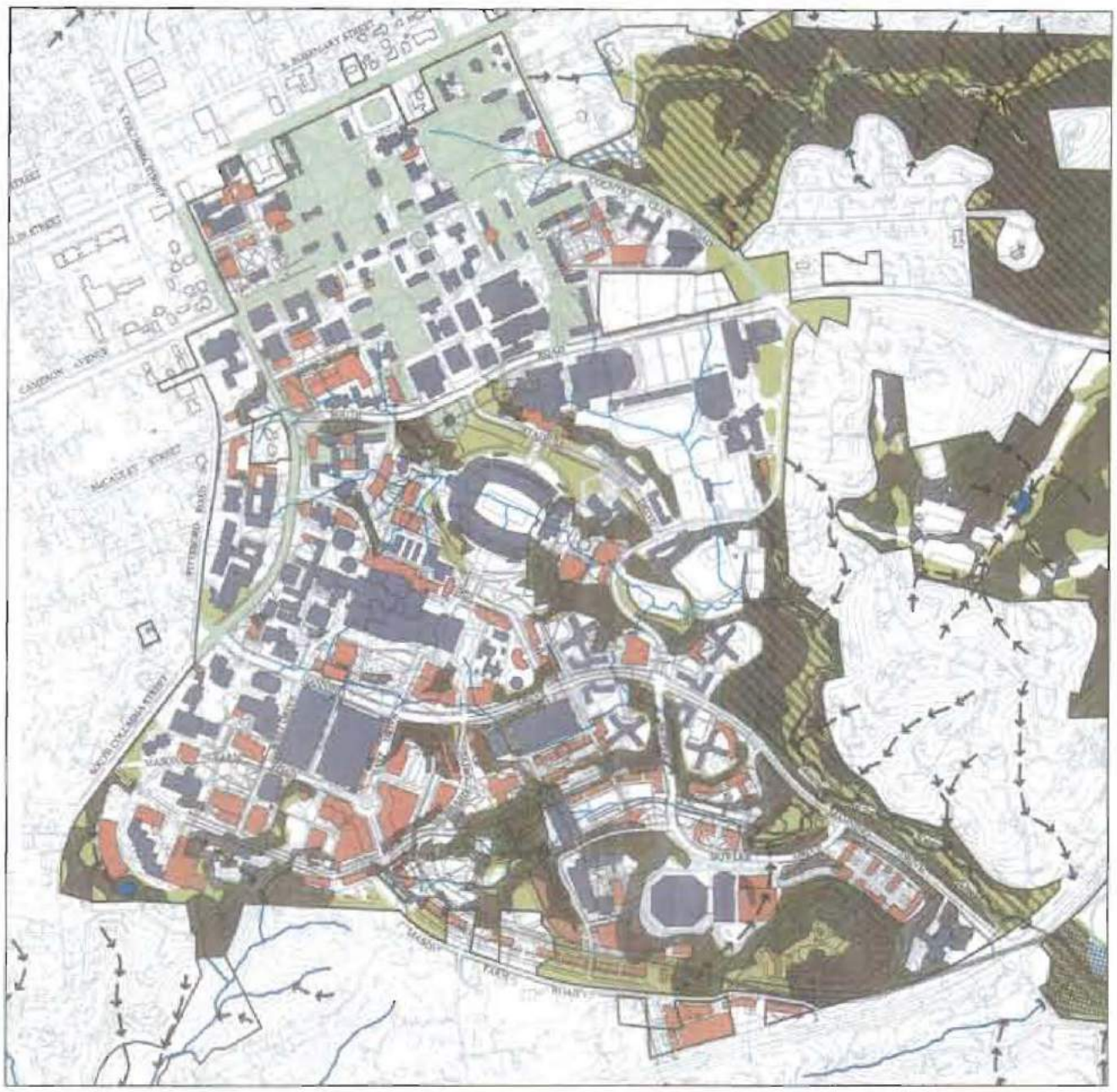
The maturity (old growth) and size of the significant plant communities on the Mason Farm Property provide unique educational and long-term biological research opportunities for the University. In addition, the floodplain of Morgan Creek with its broad, wet meadows and wet forests, filter pollutants and hold migrating sediments, providing flood storage and biological cleansing for the waters of Jordan Lake.

Wildlife Refuge

The Mason Farm /Morgan Creek Natural Area is the largest and most significant wildlife refuge within the entire New Hope /Jordan Lake system. This refuge supports a number of North Carolina rare and endangered species.

"Here biologists have found 800 species of plants, 216 species of birds, 29 species of mammals, 28 species of fish, 28 species of reptiles, 23 species of amphibians, and 67 species of butterflies. These numbers include six regionally rare animal species...and three plant species that occur here are considered rare...." (North Carolina Botanical Garden, A guide to the Old Farm Trail).

As a part of this significant area, the University property is a priceless statewide heritage, a future reserve for the University for ecological studies and the North Carolina Botanical Garden, and a model public facility for the University. It is also vital to the preservation of water quality and quantity in Jordan Lake. The land use and management priorities should be organized here to protect the Morgan Creek floodplain and ensure the preservation of the significant forest communities in the floodplain and on the forested slopes.



LEGEND

- SIGNIFICANT NATURAL LANDSCAPES
- HIGH QUALITY FORESTED AREAS
- STEEP SLOPES (8%+)
- 100 YEAR FLOODPLAIN
- EXISTING STREAMS
- HISTORIC STREAMS
- SWALES & INTERMITTENT STREAMS
- WETLANDS
- RESOURCE CONSERVATION DISTRICT
- SIGNIFICANT CULTURAL LANDSCAPES
- EXISTING BUILDINGS
- PROPOSED BUILDINGS
- PROPOSED ROADS & WALKS

(Figure 34)

Unlike most university campuses, the University of North Carolina at Chapel Hill has retained much of its natural setting and integrated the forested landscape into a remarkably pleasant Campus. (Figure 35)

Ehringhaus Field is one of two areas on the Campus where a buried stream could be "daylighted." (Figure 36)

Land Development Guidelines

The University property considered in this study—The Historic Core, the Mason Farm Property, and Main Campus-South—are each located on different landforms; essentially uplands, lowlands, and the transition between the two. These differences in landform create various environmental constraints to development; constraints that do not strictly prohibit development opportunities but make it much more difficult and expensive. More importantly, the existence of these constraints results in significant loss of land and water resources if new development is imposed on the land. Three goals were developed to help guide the integration of the Comprehensive Master Plan design with the Environmental Master Plan recommendations:

1) To develop the southern end of the Campus with required University facilities while protecting, preserving, and restoring key components of the environmental system.

2) To preserve the significant natural resources of the Mason Farm Property.

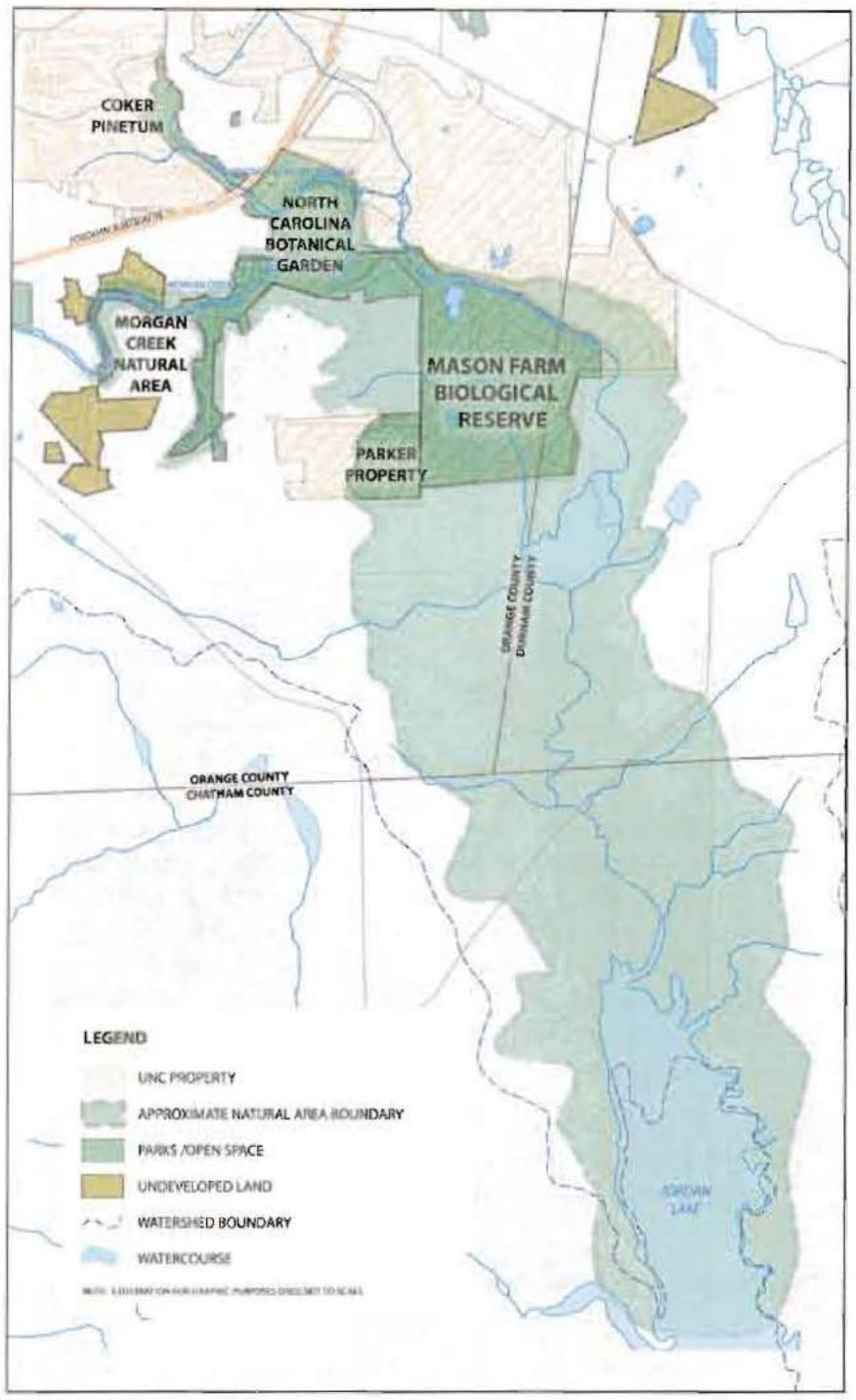
3) To repair the eroding fabric of the Historic Core of the Campus.

Fot the University this means that new development would not be located in a stream valley or drainage channel or on steep, forested slopes. Where possible, the opportunities provided by tearing down unwanted older facilities would be used to restore drainage channels, and streams and their floodplains, and to reforest slopes presently in buildings, paving or turf.

The Historic Core of the University developed on a wide plateau to the north where few stream valleys dissect this broad flat upland. Much of this land was repeatedly cleared of the native woodlands as part of the area's agricultural past. However, several large remnant trees from the original forest can still be found on the significant open spaces of this area of the Campus at Polk and McCorkle Places and in the Coker Arboretum. These mature trees are especially important to the landscape quality in the Historic Campus providing a sense of age and continuity. This land was well suited for the pattern of large T-shaped or M-shaped buildings that defined these central greens. These historic greens are designed as large shadow lawns with a carpet of turf shaded by large canopy trees. As the need for new facilities increased, the University grew to the south with intensive development of the Hospital and Health Sciences resulting in a landscape with a very high percentage of impervious surfaces.

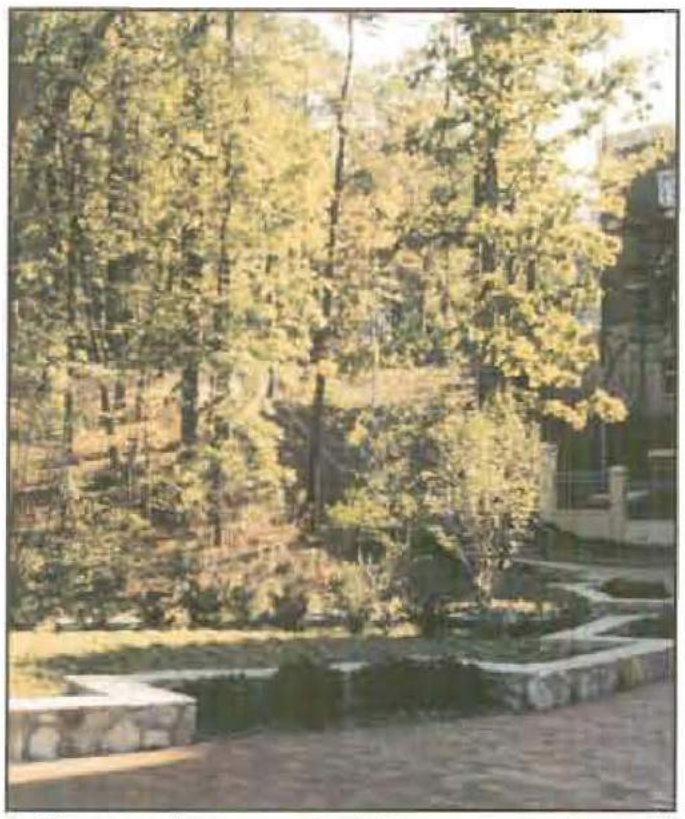
The Environmental Structure Maps (Figure 27, 30) identify key components of the natural infrastructure and the cultural landscape. The natural components—water, vegetation, soils, etc.—are living systems. Degradation and fragmentation compromise the integrity of these systems and their ability to function. In general, most conventional development ignores these systems; they are considered unimportant and expendable. Land is often unnecessarily graded, disrupting soil, vegetation and water systems. Hills are leveled and berms and mesas created in flat- land. Vegetation is also often unnecessarily bulldozed away.

MASON FARM / MORGAN CREEK NATURAL AREA



Andropogon Associates™ CAHILL ASSOCIATES

(Figure 37)



Buildings framed in forest on South Campus. (Figure 38)

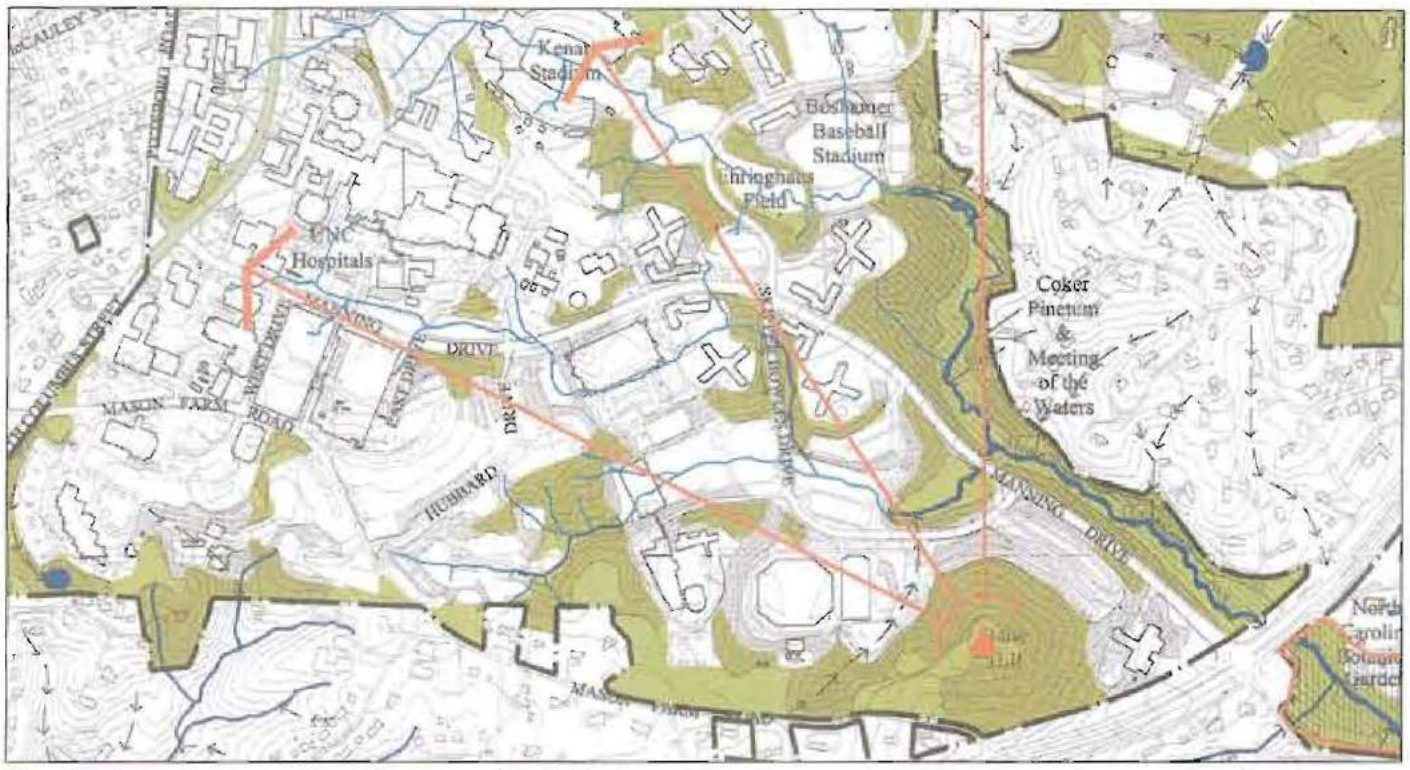
Lowland meadows at Mason Farm Biological Reserve. (Figure 39)

A critical natural component that shapes the southern portion of Campus is the steep slopes. Although the entire University site was initially cleared for farming, the steeper slopes eventually grew back as forest when these more marginal lands were abandoned. Today the wooded hillsides of the Coker Pinetum, Kenan Stadium, the high-rise dorms, and other areas of the southern end of Campus are a very important part of what makes the University of North Carolina at Chapel Hill a unique and memorable place.

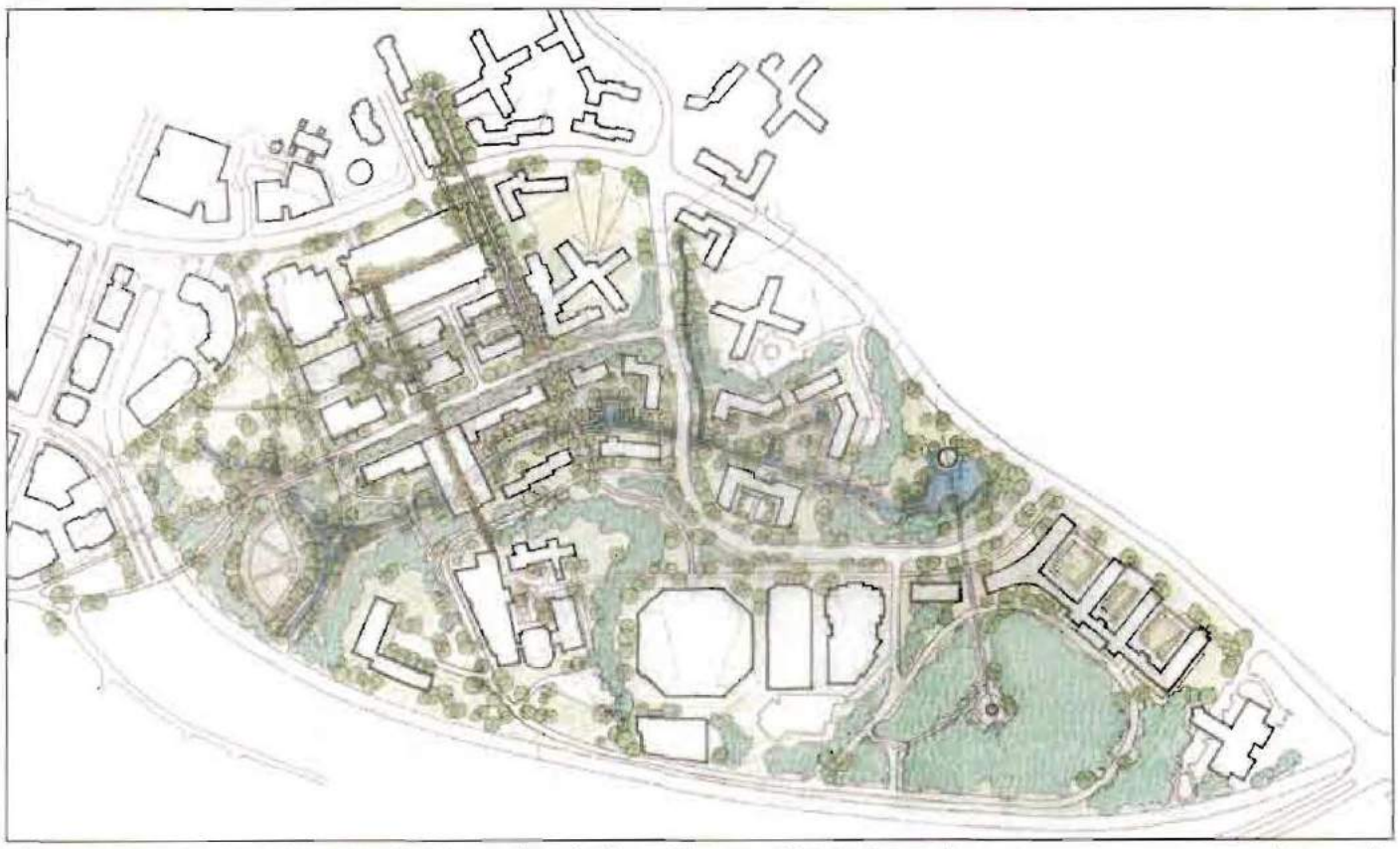
The Mason Farm property is a part of The Mason Farm/Morgan Creek Natural Area and is the largest and most significant wildlife refuge within the entire New Hope /Lake Jordan system. This refuge supports a number of North Carolina rare and endangered species. While no future development is planned in this area, several modifications to existing structures could demonstrate a number of the better management practices recommended for consideration in this Plan.

It is also recommended that the University consider several small but important extensions for protection. These extensions are in lands owned by the University and are directly adjacent to lands presently managed by the North Carolina Botanical Garden. Guaranteed preservation and better management of these areas would directly improve the health of Meeting of the Waters Creek, Morgan Creek and Jordan Lake. These areas include:

- The corridor along Route 54 from Glenwood Elementary School to the North Carolina Botanical Garden. This land is no longer a part of the Finley Golf Course and could be managed as a greenway corridor with a collaborative programming serving a variety of needs.
- Coker Pinetum extension – a property isolated by Manning Drive to the southeast, Ehringhaus Dormitory drive and parking lot to the west, and the Coker Pinetum on the north. This forested, very steeply sloped area is critical to watershed protection and restoration efforts.



Plan showing environmentally sensitive areas of South Campus. (Figure 40)



Sketch showing recommendations to the Master Plan which would protect identified natural resources. (Figure 41)

Environmental Case Studies

One goal of the Comprehensive Master Plan was to provide much-needed University facilities, while at the same time protecting, preserving and restoring key components of the environmental system. In the southern portion of Main Campus, proposed new development was re-examined to preserve and, where possible, to restore the riparian corridor; including open, flowing streams, wetlands, flood plain and adjacent steep forested slopes. These steep forested stream valleys are special resources, unique to the southern end of the Campus, and do not exist in the broad flat plateau where the Historic Core is located.

Three proposed development areas were considered as case studies; the new buildings centering on the Dean E. Smith Center, several additional structures comprising Health Affairs South and the new Ramshead Building with the related redevelopment of adjacent Ehringhaus Field. Each of the studies exploted opportunities to integrate new land preservation and restoration strategies, as well as provide "better management practices," as part of intensive new development.

The three areas listed below were identified during the master planning process as environmentally sensitive. They all occur on the southern end of Main Campus. Each of these areas presents an opportunity to integrate new land preservation and restoration strategies, as well as better management practices as reflected in the following guidelines:

Smith Center Area

- Reconnect and restore the riparian area of stream valley fragments to improve water quality and mitigate flooding.
- Develop the valley riparian section as the major pedestrian network, recreational amenity and green commons for this area.
- Locate building site on the upland plateaus and slope terraces with pedestrian walkways that bridge the valleys rather than cutting or filling them.
- Organize buildings to create courtyards and small greens and to maximize stormwater infiltration or capture and reuse of stormwater.

Health Affairs South including Manning Drive

- Do not build on steep forested slopes or within the small ravines.
- Use lawn as a ground cover only in flat areas.
- Create infiltration and recharge beds under porous paving parking areas where the conditions allow.

Ramshead and Bell Tower

- Retrofit existing problem areas to convert impervious surface to permeable ones.
- Restore Ehringhaus Field by raising the field level with well drained soil, in conjunction with daylighting the stream in a new bed at the southern edge.
- Preserve the historical character of the stadium by preserving and enhancing the forested slopes wrapping the buildings.
- Foster pedestrian connections between the north and the south of Main Campus.

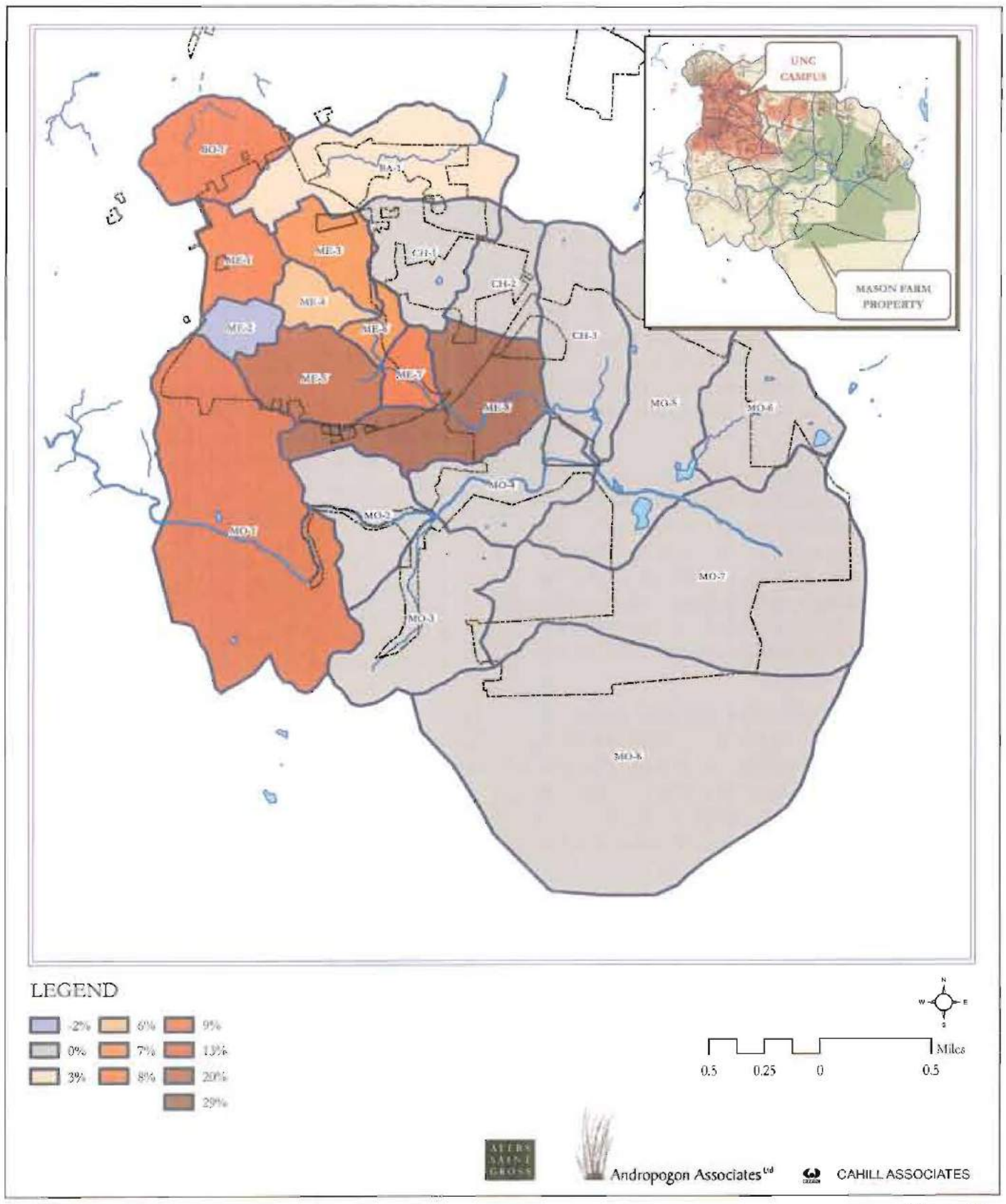
These three case study areas were revised in the Comprehensive Master Plan to reflect the following key recommendations:

1) **Significant natural areas are protected from development.**

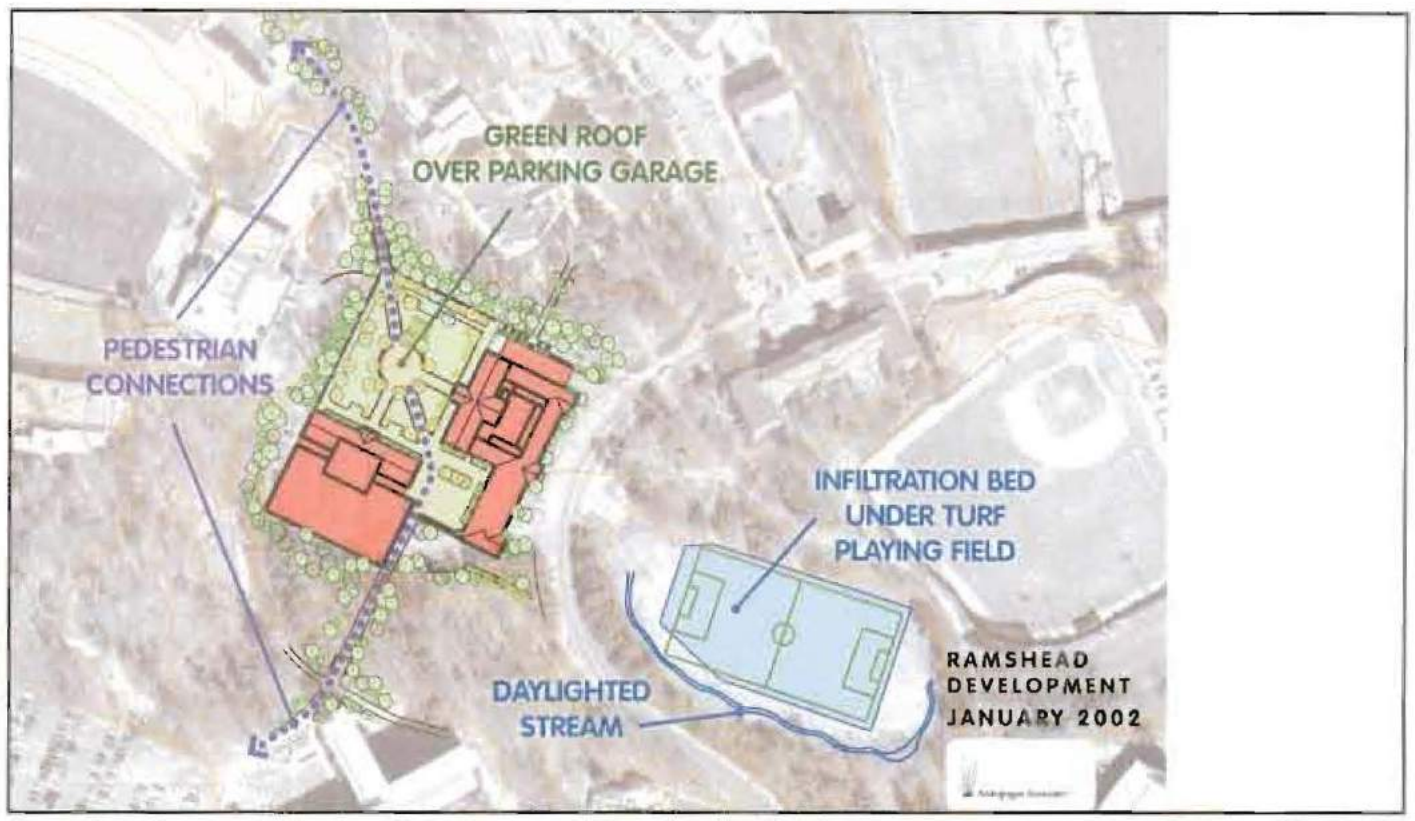
2) **Two areas of the Campus have been identified where buried streams can be daylighted – Ehringhaus Field and the area north of the Smith Center. These stream corridors could become a part of the pedestrian network of the Campus.**

3) **The final design of the southern portion of the Campus reflects the rolling topography of the land and the proposed buildings are sited away from the steep forested areas.**

CHANGE IN SURFACE PERMEABILITY



(Figure 42)



Proposed development for Ramshead Parking garage and Ehringhaus Field. (Figure 43)

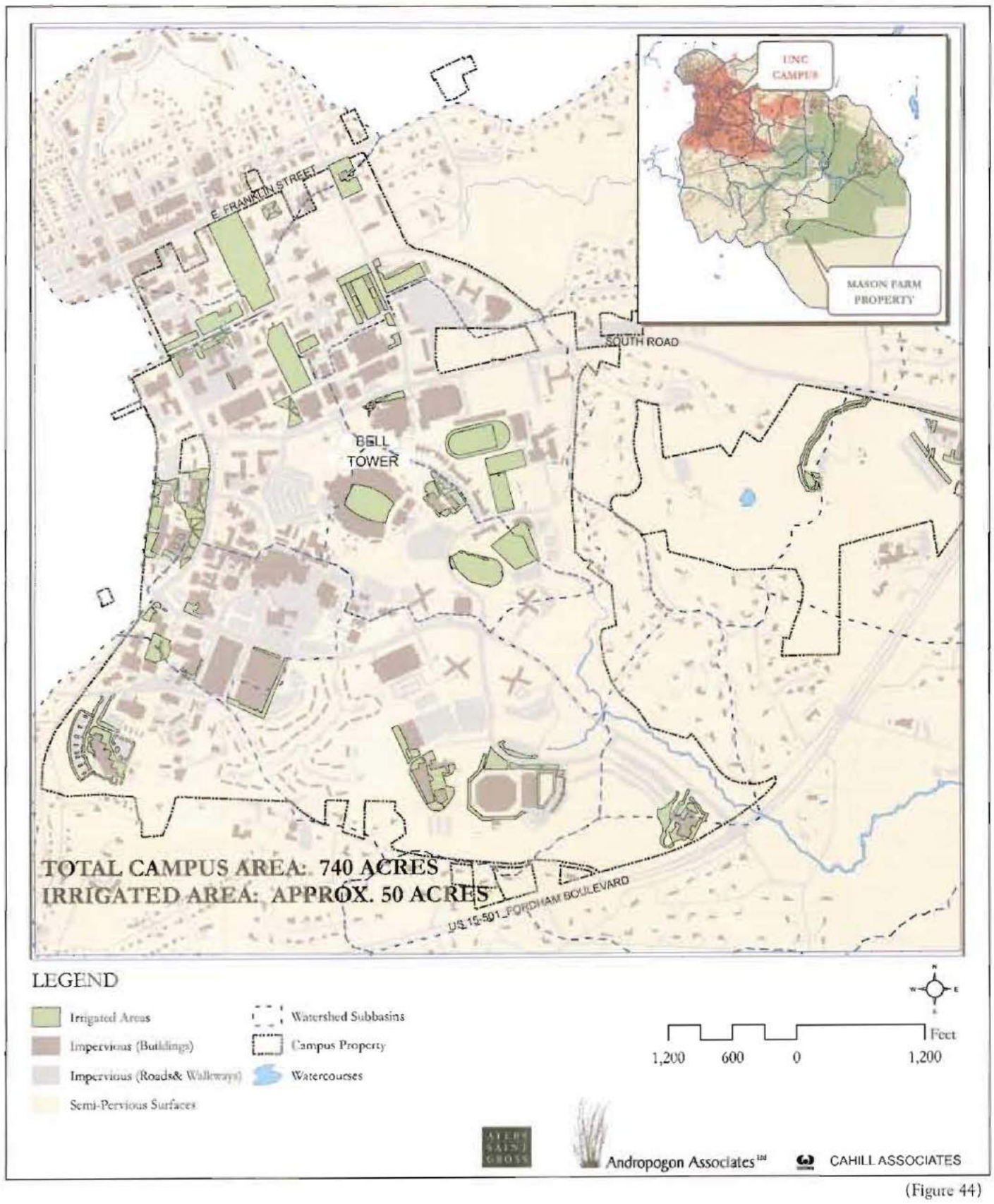
Land Development — Implementation Strategies

Successful land development for the University will require the ability to meaningfully change and reduce the cumulative impacts to the water and land resources within its boundaries. It will also require a comprehensive management process to lead the implementation of measures that are outlined in the Plan. New strategies for the existing and proposed development at the University of North Carolina at Chapel Hill are proposed to restore and sustain the hydrologic balance. These strategies include protection and re-establishment of areas critical to the hydrologic cycle and by approaches to project planning, design, and construction that increase groundwater recharge and promote water quality.

As development plans proceed at the University, it will be important to require design and engineering consultants to be familiar with the Comprehensive Master Plan and its environmental directives. Sensitive design during the planning and design development process before construction is critical. New design projects, as well as retrofit design, should demonstrate the integration of these directives — including protection of environmentally critical areas and alternative stormwater management plans.

Planning and Design

- Require mitigation for all environmentally critical areas that must be built on, or for any sub-basin that is already over 50% impervious.
- Minimize grading by fitting the building to the site, not the site to building.
- Limit disturbance and soil damage and the removal of natural vegetation in site design and location of the building.
- Site lawns only on flat or terraced areas.
- Minimize Impervious and Semi-Pervious Surfaces by:
  - Reducing new road and building coverage.
  - Reducing lawns to essential ateas.
- Convert impermeable surfaces to permeable ones by replacing them with vegetation, porous paving, or other potous materials.


UNC CAMPUS
MASON FARM PROPERTY
E FRANKLIN STREET
SOUTH ROAD
BELL TOWER
TOTAL CAMPUS AREA: 740 ACRES
IRRIGATED AREA: APPROX. 50 ACRES
US 15-501 FORDHAM BOULEVARD
LEGEND
Irrigated Areas
Impervious (Buildings)
Impervious (Roads& Walkways)
Semi-Pervious Surfaces
Watershed Subbasins
Campus Property
Watercourses
Feet
1,200 600 0 1,200
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(Figure 44)

Abandoned Golf course fairways presently managed as turf. (Figure 45)

Horticultural Rose Garden. (Figure 46)

Long-term Landscape Management

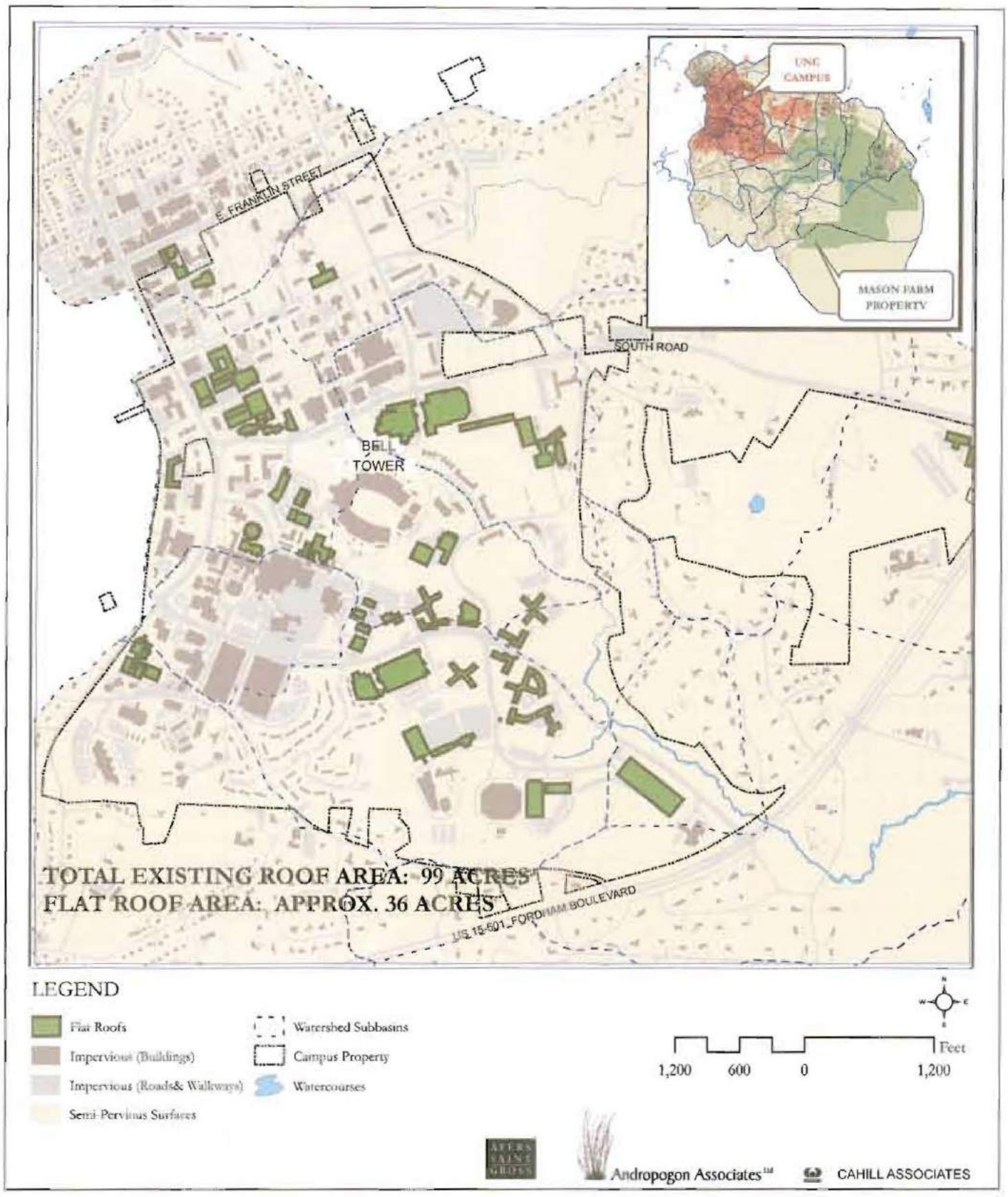
- Restrict high maintenance "gardens" to designated "sacred" landscapes; for example, the Bell Tower, the Coker Arboretum and the Rose Garden at the Planetarium. Such gardens work well on the rops of garages where large canopy trees cannot be planted.
- Reduce pesticides and chemical fertilizers.
- Use integrated pest management and organic soil amendments.
- Create an Environmental Management Plan.

Turf and the maintenance of turf is important within Main Campus, both as a 'working surface' for athletics facilities, and as part of the Campus green. However, turf is also used as an 'all purpose' ground cover in many areas where it is difficult to grow and maintain. This is an expensive practice; as turf requires significant resources to maintain well. In many areas, such as steep slopes, excessively shady areas, and out-of-the-way places that receive little foot traffic, alternative planting types would have both an environmental benefit and reduce the maintenance needed. These kinds of plantings can still convey an elegant and well-cared-for appearance, which is appropriate with the image and 'public face' of the University.

Design a New Stormwater Management System

The initial analysis of stormwater impacts produced for the University of North Carolina at Chapel Hill Campus demonstrates quite clearly that a significant burden is imposed on the local stream drainage system, both in terms of increased volume and non-point source pollutants. What currently exists in terms of the few locations where detention basins have been constructed is inadequate to deal with either of these problems. The proposed additional development will only exacerbate these problems, without a major new strategy for stormwater management imposed on both the existing and new development landscape. A new system of both structural measures and non-structural land management practices will be required to prevent any increase in runoff volume and pollutant load, and in fact must go well beyond the proposed criteria to achieve any improvement over existing conditions.

A number of potential measures have been discussed during the course of the planning process. All of these proposed "better management practices" are intended to meet the stormwater principles of runoff volume reduction, aquifer recharge, restoration of stream channel and floodplain, and water quality enhancement; but different combinations will be applicable in any given sub-basin. Most critically, all efforts should be made to infiltrate stormwater runoff in the uplands where the soils are suitable. In those sub-basins that are highly impervi-


UNC CAMPUS
MASON FARM PROPERTY
E. FRANKLIN STREET
SOUTH ROAD
BELL TOWER
TOTAL EXISTING ROOF AREA: 99 ACRES
FLAT ROOF AREA: APPROX. 36 ACRES
US 15-501_FORDHAM BOULEVARD
LEGEND
Flat Roofs
Impervious (Buildings)
Impervious (Roads& Walkways)
Semi-Pervious Surfaces
Watershed Subbasins
Campus Property
Watercourses
Feet
1,200 600 0 1,200
Andropogon Associates
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(Figure 47)

The Morris Arboretum's porous paving parking lot was built in 1987. This photograph, taken in 1998—11 years later— shows that the asphalt in this lot has not broken up or been scuffed by heavy use. The asphalt remains as porous as when it was built and has required no maintenace. (Figure 48)

ous, such as the Hospital area or east branch of Meeting of the Waters, very little open land remains in which to apply infiltration technologies. If at-grade solutions are not feasible, structural measures in the building itself, such as vegetated roof systems that retain rainfall and return it to the atmosphere as evapottranspiration, may be the only option available. Some of the measures that are expected to meet the program criteria include:

- Creation of aquifer infiltration beds under large areas of pavement with pervious surfaces.
- Collection of stormwater (including roof drainage) in cisterns for reuse in irrigation.
- Construction of green roofs to store, evaporate and transpire water.
- Design of infiltration beds as vegetated planting strips along streets and in open areas.
- Requirements of building setbacks to provide a continuous mass of green facing the Campus stteets.

No single solution will accomplish all of the volume and water quality goals, but the process begins by asking the question, "What can be done within any given portion of the University to restore the natural drainage system?"

"Sedimentation is the number one contaminant of surface water in the state." (North Carolina Department of Environment and Natural Resources) (Figure 49)

Site Protection During Construction

Increases in erosion and sedimentation over the next decade are likely, as an estimated eighty-seven (87) acres of construction disturbance will occur on the Campus. It has been estimated that without erosion and sedimentation adequate controls, erosion rates on a construction site can be increased by a factor of 2,000.

- Identify sensitive environmental areas on each individual site; include swales and all natural drainage features, the root systems of significant trees and natural forest vegetation.
- Require project architects and consultants to provide protection methods. Specify site protection in contracts that includes financial motivation for the contractor.
- Require the Contractor to post adequate bond to pay for damage to the landscape.
- Designate access routes and storage areas that avoid sensitive natural areas and the trunks and root systems of individual trees.
- Use hand ttenching for utility lines or re-route to avoid trees and their root systems
- Identify, inventory, and map all significant old canopy trees, showing the actual driplines of the tree canopy. Protect tree trunks with boarding, and protect canopy driplines with construction fencing.
- Avoid compacting soil where there is important vegetation to remain or to be reestablished. Protect tree root systems from being driven over by heavy equipment.
- Use silt fencing to protect drainage swales, and steep slopes from erosion.
- Place construction fence just above the bteak of the slope and use construction fencing to prevent dumping, and trespassing by vehicles and people.
- Monitor and repair construction fences on a daily basis.

Restoration and Retrofit Strategies

- Replace missing heritage trees in greens of the Historic Core with new American forest canopy trees.
- Daylight buried streams, where possible, by taking them out of pipes and restoring them to open, free flowing channels with floodplains.
- Recreate wetlands in floodplains for flood storage and biofiltration.
- Restore forest cover on steep slopes.

University Role Models Connecting Word and Deed

"More than ever, we are recognizing that environmental problems are among the most complex facing us. Scientific understanding of these problems is essential, but science and technology alone will not solve them. It is imperative that research universities involve large numbers of students and faculty in the pursuit of a prosperous society and a healthy environment. Moreover, all students must understand the environment/human dilemma so they can be active participants in the quest for a sustainable society." (The Carolina Environmental Program at the University of North Carolina at Chapel Hill)

In making a commitment to meet the challenges of forthcoming environmental and regulatory compliance, the University has adopted the strategies of proactive environmental management. Proactive environmental management begins with presiding over change, and, as the University is well aware, the key to success in implementing institutional innovation is management and a clear vision. In considering the process of innovation and managing change, three overarching questions emerge:

#1. How will environmental objectives be successfully integrated into each of the hundreds of individual projects expected to occur in the next decade?

The key will be an overhaul of the design review process for new projects. Just as progress is being made to incorporate the nationally recognized LEED Green Building Rating System into the review process for new campus buildings, the University will need to redefine the design review process to conform to specific criteria regarding environmental issues. A new conceptual framework that helps to generate ideas, evaluate impacts to compare alternatives, refine initiatives, and establish performance targets will be the most valuable.

#2 Many different stakeholders and diverse values exist within the boundaries of the University property. How will these diverse interests be represented?

Clearly stated environmental goals and principles for the Universtiy will help to guide overall development and focus stakeholders. The desired result is a gradual recognition of the benefits of sustainable development even when there are wide-ranging stakeholder interests. Because participatory planning is an on-going dialogue and involves the continuing education of everyone involved, it creates trust, builds confidence and enthusiasm for the goals, and broadens the base of public support. However, the goals will also need policy guidance at the highest levels of the University administration to ensure that greater knowledge both of techniques and purpose will lead to qualitative improvements as the University develops.

#3 Who will take responsibility for implementing and monitoring sustainable development at the University?

How will responsibility be shared and integrated throughout the University to implement and monitor sustainable strategies? Who will have decision-making authority and determine policy for land and water resource management?

Recommended Strategies

#1 Monitor and measure the economic and environmental benefits of sustainable design.

To assist with and justify policy decisions, the economic and environmental benefits of sustainable development and land management can be identified, quantified, and monitored. Initial investigations should focus on these basic questions: What are the environmental costs of environmental degradation at the University – of poor water quality, of treating excessive stormwater runoff, of sedimented streams, of flash floods, of erosion, of compacted soil, of replacing trees injured due to inadequate construction protections? How large are these costs, and where do they arise? For example, constructing and maintaining storm sewers requires significant capital. In contrast, reducing the amount of traditional stormwater infrastructure with techniques that infiltrate, store, capture, and reuse rainwater as a resource, results in less runoff, which in turn reduces sewer pipe sizes, maintenance and energy costs, and will more likely comply with forthcoming regulations. Such alternative techniques and best management practices produce tangible benefits in ecological, social and economic terms. Yet, it will be difficult to demonstrate the value and benefits of sustainable strategies without an understanding of the symptoms and costs of environmental degradation. Environmental accounting is the first step toward

acknowledging the value of ecosystem services such as clean water, healthy soil, and vegetation that enhances the quality of life on campus. Furthermore, resilient, healthy landscapes are better able to withstand natural and costly stressors such as floods or droughts.

#2 Utilize the knowledge base that exists within the University community during the planning and review process for new projects.

The University of North Carolina at Chapel Hill has considerable in-house resources who are knowledgeable about alternative techniques and sustainable design strategies, as well as the practicalities of implementation and ongoing maintenance. They could assist both design consultants and the University in the design and review process for new projects. Facilitating and strengthening the exchange of experience and ideas among research faculty, operations and maintenance staff, and facilities planning and design staff is recommended. This could take the shape of a formal committee, or it could be structured more fluidly on a project-specific basis.

 # 3 Participate in regional environmental initiatives.

It is our experience that many of the environmental issues on University property – flood control, water quality, preserving natural areas – will be most effectively addressed collaboratively since they extend beyond the purview of any single land owner. By expanding its outreach and initiating discussions with the Town of Chapel Hill and community representatives about these issues, the University can address local concerns before they become big issues. Public/Private Partnerships foster watershed awareness and planning, interdepartmental cooperation, and implementation of resource management and protection strategies. The University of North Carolina at Chapel Hill is more likely to see timely results for environmental initiatives, and will be able to present a united front for projects that require state and federal permits and regulatory review by adopting strategic partnerships.

Fostering Living Landscapes

"A land ethic, then, reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity." (Aldo Leopold)

The basic premise of sustainable landscape design is to allow the ongoing processes that sustain all life to remain intact and to continue to function along with development. While the first tenet of sustainable landscape design, and one that is actually often overlooked, is "don't destroy the site," in reality we have already destroyed too much and we can no longer measure the sustainability of a design by its minimal impact on the natural systems of a site. Today, almost every site that landscape architects work on has been abused. Sustainable design must go beyond the modest goal of minimizing site destruction to one of facilitating site recovery by reestablishing the processes necessary to support natural systems. This approach is not "naturalistic landscaping" or "preserving endangered species" but the preservation, restoration, and creation of self-sustaining, living environments.

Sustainable design is not a unified philosophy for which there is one accepted, rigorous method. Perhaps most important, it is a process of raising consciousness and changing basic attitudes attitudes so ingrained we are often unaware that they shape our design and management of the land. These changes require that we actually see the present deteriorarion of the landscape, that we recognize the impacts of our interventions, and that we understand each site and each piece of a site as parts of larger systems.

The key to sustainable design is the systems approach sometimes called a holistic view. Most of us are aware that nothing exists in isolation and that everything is interconnected. Many of the skills of the design professions (which include engineering), however, are geared to solving arbitrarily defined problems and providing solutions that may appear reasonable from the point of view of a single professional discipline or single client, but unfortunately, cannot resolve the multidimensional problems of the land. With sustainable design, we are not looking at single-focus solutions to single-focus problems, such as drainage, sewage disposal, or erosion control, but rather at the management of a whole set resources.

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