TREE INVENTORY AND HEALTH STATUS

KENAN WOODS/STADIUM AREA

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May 6, 2008

OBJECTIVE: To identify the tree species of Kenan Woods and estimate relative health. Based on the species composition and performance, develop strategic recommendations for care of existing trees and project recommendations for future planting.

METHODS: Each tree was identified as true-to-species as feasible. Many trees had long slender boles (trunks), small crowns, and were 50 to 70' high. Condition of trees was based on density of foliage (crown), presence of dead limbs, and trunk injury. Each tree was afforded a "low", "moderate", or "high" rating. For example, many of the pines are geriatric with sparsely needled crowns and many dead limbs. Crowns are small in relation to tree height (60 to 70') as the needles were subjected to excess shade from the competing deciduous, broadleaf trees. The number of dead limbs in the pines should be cause for concern, especially during football weekends. Most pines, therefore, were rated "low".

The general floristic health of each area was determined by diversity of species, woody and herbaceous, and condition of trees. Seedling regeneration is an

indication of minimal human traffic, organic-rich, deep, moisture-retentive soils, and reproductive overstory trees. Areas such as A1 - A6 (NE Kenan Woods) were devoid of *any* seedling regeneration.

RESULTS:

Total Tree Composition of Kenan Woods

Table 1 lists the species, number, and condition. There were approximately 1296 trees accessioned with only 126 (9.7%) rated "high"; conversely 839 (64.6%) rated "low". *Carya* species, particularly *C. tomentosa*, along with *Quercus alba*, constituted the majority of the "highs". Thirty (29%) of *C. tomentosa* rated "high"; 20 (12.7%) of all *Q. alba*. Only 9 of 215 (4.2%) *Pinus* species rated "high". The pines are definitely on the senescent side of their useful life.

Acer rubrum, *Carya glabra*, *Carya tomentosa*, *Cornus florida*, *Liquidambar styraciflua*, *Nyssa sylvatica*, *Oxydendrum arboreum*, *Pinus echinata*, *Pinus taeda*, *Prunus serotina*, *Quercus alba*, and *Quercus stellata* were 82% (1065) of the total tree matrix. Removing *Oxydendrum arboreum* and *Cornus florida*, both understory species with none in the "high" category, reduces the percentage to 67.8% (816 trees). Approximately 49 species, plus a few unknowns, comprised the total Kenan Woods. There were several invasive species, *Morus alba*, *Paulownia tomentosa*, *Prunus* ×*yeodensis*, but in minimal quantities of 3, 7, and 7, respectively.

Native species are the greatest contributors to Kenan Woods. Depending on the area (see Table 1), natives should be the principal species of choice and necessity, particularly *Acer, Carya* and *Quercus* taxa. The *Pinus* species are at the end of their useful life. Replanting pines is acceptable but full sun areas should be designated. The understory trees, particularly *Cornus florida*, are suffering. Not a *single* dogwood achieved "high". Dogwoods contribute magnificent flowers in April and fall color in October - November. Ideally, add more in the Kenan Woods areas that are less trafficked. A recommended list of native trees for Kenan Woods appears in Tables 6 and 7.

Four Kenan Woods/Stadium Quadrants

Tables 2 - 5 reflect Northeast, Northwest, Southwest and Southeast areas around the stadium. Northeast is designated by A1 - A7 on the map, Northwest by B1 - B19, Southwest by C1 - C15 and Southeast by D1 - D16, respectively. Evaluation of each section follows.

Table 2: Northeast Quadrant

Tree numbers state the obvious…only 8.9% "high" condition (of 224 trees). Woods were thin, canopies more open, trees not large in height/trunk diameter. Essentially no regeneration due to foot traffic and soil conditions. Remarkably, white oaks, *Quercus alba*, were superior to other taxa. Some new planting of pines and white and willow oaks had occurred. The newly planted trees were in

reasonable condition. The Northeast Quadrant is the most obvious area for immediate and sustained tree planting.

Table 3: Northwest Quadrant

This is the largest area surveyed and houses the most trees (644), approximately half of the total. Jim Urban's soil analysis indicated deeper profiles than the rock-laden Northeast Quadrant. Eleven percent of the trees were in "high" condition with the deep rooted *Carya* spp. contributing 36.6% of the "highs". Species diversity was greater and combined with improved soils and less-trafficked areas produced 38% "high" to "moderate" condition trees compared to 29% "high" to "moderate" condition trees in the Northeast Quadrant. Also, in the B17 to B19 areas, seedling regeneration was high, particularly on the slope above the NC Hall of Fame Plaza.

Table 4: Southwest Quadrant

Only one undisturbed area, now fenced for the Genomics Building construction, designated as C1 and C2 on the map, showed significant regeneration. All other areas were highly managed with pine straw mulch and subjected to considerable foot traffic. White oak, *Quercus alba*, constituted 23% (32 of 138) of the total trees. Most were in "low" to "moderate" condition. Only eight *Carya* taxa were present with five (58%) "moderate" to "high". The Southwest Quadrant was obviously in a state of flux with construction and it would be noble to save the best trees which number only 10 or 7.3% of the total.

Table 5: Southeast Quadrant

The assessments were concentrated along the walks and heavily trafficked areas. The areas, D1 - D16, are marked on the map. The trees in areas D1 - D6 (D7) are suffering from traffic (human) and runoff from the adjacent parking lot. Oaks represented 34% of the total trees with most (94%) in “low” to “moderate” condition. Seedling regeneration and a rich understory occurred in the D8 to D16 sections that followed the sloping path to the east side of the stadium. *Carya glabra* and *C. tomentosa* were again some of the best trees with 54% rated “moderate” to “high”. The *Carya* and *Quercus* species are considered climax species, i.e., the end point of succession. They are more shade-tolerant, have deeper root systems, and possibly more effectively compete for water and nutrients. The data show conclusively that without hickories and oaks, Kenan Woods would be the poorer. In fact, 33% of Kenan Woods is represented by *Carya* and *Quercus* species.

Planting Strategies

In trafficked areas like A1 - A6 (A7), plant larger trees (3” or greater) and/or protect newly planted areas until established. Utilize signage to encourage people to respect newly planted areas. “The Regreening of Kenan Woods…Please Respect the New Tree Plantings”. To reestablish pines, open, sun-laden areas will be necessary. New *Pinus taeda*, Loblolly Pine, have been successfully installed in the Northeast Quadrant.

The overstory, climax trees are the heartbeats of Kenan Woods. The majority of visitors to Kenan Woods have no idea whether they are beneath maple, hickory, oak, tupelo, or tuliptree. They appreciate and sense the beauty and expect the same, year-in: year-out. To foster this arboricultural legacy, sustained, energetic tree planting must be embraced. Ideally, develop 5- to 10(20)-year replanting strategies based on how many trees are lost each year, poorest areas (A-sections), and need to gradually replace geriatric trees. Maintain, possibly increase, species diversity with *Acer*, *Carya*, *Fagus*, *Ilex, Liriodenron*, *Nyssa*, *and Quercus*. In specific genera, like *Nyssa*, the utilization of the many new, superior fall-coloring selections is a worthy consideration.

The understory trees provide great flowers and fall color with *Cornus florida* currently 14% of the total trees recorded. Future plantings should include the anthracnose- and mildew-resistant cultivars from the Appalachian Series from the University of Tennessee. Other small understory trees are included on the list (see Table 7).

In the Northwest and Southeast areas, where foot traffic is less intense, groupings/masses of native viburnums and other native shrubs would enrich the understory, provide flowers, fruit and fall color, and stabilize the soil. Six viburnums are native in a five-mile radius of the stadium including *V. acerifolium* (in Kenan Woods), *V. dentatum*, *V. nudum*, *V. prunifolium*, *V. rufidulum* and *V.*

rafinesquianum (in Kenan Woods). All are shade-tolerant, adaptable, and would enrich the woods.

This assessment provides a framework for future planting and maintenance of Kenan Woods. Kenan Woods did not reach this current state in a small window of time, nor will it dissipate quickly. By thoughtful replanting and maintenance, the basic character will be perpetuated and enhanced.

Table 1. Total Tree Species, Condition and Numbers in Kenan Woods

Scientific Name	Dead	High	Low	Moderate	Grand Total
	4				4
Acer barbatum				1	1
Acer leucoderme		1	5		6
Acer rubrum		3	32	14	49
Acer saccharum		5	1	4	10
Carya glabra		5	18	18	41
Carya spp.		2	2	1	5
Carya tomentosa		30	39	34	103
Cedrus deodara				1	1
Celtis spp.			1		1
Cercis canadensis		1	10	12	23
Chionanthus virginicus				1	1
Cornus florida			165	16	181
Cornus kousa		1			1
Diospyros virginiana			2	3	5
Fagus grandifolia		3			3
Fraxinus pennsylvanica			2		2
Fraxinus spp.			3		3
Ilex ×attenuata			1	1	2
Ilex decidua		4			4
Ilex opaca			1		1
Juniperus virginiana			13	1	14
Lagerstroemia		6	6		12
Liquidambar styraciflua		2	24	6	32
Liriodendron tulipifera		8	6	10	24
Magnolia ×soulangeana		1			1
Magnolia grandiflora		1		1	2
Morus alba			3		3
Nyssa sylvatica		11	72	13	96
Oxydendrum arboreum			60	8	68
Paulownia tomentosa			7		7
Pinus echinata		1	73	21	95
Pinus taeda		8	84	28	120
Platanus ×acerifolia				1	1
Prunus ×yedoensis		1	3	3	7
Prunus serotina			61	2	63
Quercus alba		20	56	81	157
Quercus coccinea			5	2	7
Quercus falcata		2	2	6	10
Quercus marilandica			1	1	2
Quercus nigra			1		1
Quercus palustris				1	1
Quercus phellos		2		2	4
Quercus rubra		1	6	11	18
Quercus shumardii		1		2	3
Quercus spp.			3		3
Quercus stellata		3	41	16	60
Quercus velutina		2	6	3	11
Robinia pseudoacacia			6		6
Sassafras albidum			2		2
Ulmus americana			7		7
Ulmus parvifolia			2		2
Ulmus spp.			5	1	6
Zelkova serrata			1	3	4
Grand Total	**4**	**125**	**838**	**329**	**1296**

Table 2. Tree Species, Condition and Numbers in A1 - A7, Northeast Kenan Woods

Scientific Name	High	Low	Moderate	Grand Total
Acer rubrum		3		3
Carya glabra		2		2
Carya tomentosa		11	6	17
Cercis canadensis	1		2	3
Cornus florida		30		30
Cornus kousa	1			1
Ilex decidua	4			4
Juniperus virginiana		4		4
Lagerstroemia		5		5
Liquidambar styraciflua		4		4
Liriodendron tulipifera		2		2
Magnolia ×soulangeana	1			1
Magnolia grandiflora	1			1
Nyssa sylvatica		8	1	9
Oxydendrum arboreum		1	1	2
Pinus echinata		41	13	54
Pinus taeda	3	19	3	25
Prunus ×yedoensis		1	1	2
Prunus serotina		1		1
Quercus alba	5	9	12	26
Quercus coccinea		4	1	5
Quercus falcata		1		1
Quercus marilandica		1		1
Quercus nigra		1		1
Quercus phellos	2		2	4
Quercus rubra		1		1
Quercus shumardii	1		2	3
Quercus spp.		2		2
Quercus stellata		3		3
Quercus velutina		2	1	3
Robinia pseudoacacia		1		1
Ulmus parvifolia		2		2
Grand Total	**19**	**159**	**45**	**223**

Table 3. Tree Species, Condition and Numbers in B1 - B19, Northwest Kenan Woods

Scientific Name	Dead	High	Low	Moderate	Grand Total
	4				4
Acer barbatum				1	1
Acer leucoderme		1	5		6
Acer rubrum		2	17	7	26
Acer saccharum		1	1		2
Carya glabra		3	5	11	19
Carya spp.		2	2	1	5
Carya tomentosa		21	19	21	61
Cedrus deodara				1	1
Celtis spp.			1		1
Cercis canadensis			9	10	19
Cornus florida			99	10	109
Diospyros virginiana				3	3
Fagus grandifolia		1			1
Fraxinus spp.			3		3
Ilex opaca			1		1
Juniperus virginiana			5	1	6
Lagerstroemia		6	1		7
Liquidambar styraciflua		2	20	5	27
Liriodendron tulipifera		5	2	8	15
Morus alba			1		1
Nyssa sylvatica		8	42	9	59
Oxydendrum arboreum			28	4	32
Pinus echinata		1	9	2	12
Pinus taeda		5	48	20	73
Prunus ×yedoensis		1	2		3
Prunus serotina			43	2	45
Quercus alba		7	11	27	45
Quercus coccinea				1	1
Quercus falcata		2		5	7
Quercus marilandica				1	1
Quercus palustris				1	1
Quercus rubra			2	10	12
Quercus spp.			1		1
Quercus stellata		2	16	10	28
Quercus velutina		1			1
Robinia pseudoacacia			1		1
Ulmus americana			1		1
Ulmus spp.			3		3
Grand Total	**4**	**71**	**398**	**171**	**644**

Table 4. Tree Species, Condition and Numbers in C1 - C15, Southwest Kenan Woods

Scientific Name	High	Low	Moderate	Grand Total
Acer rubrum		5	6	11
Acer saccharum	1		1	2
Carya glabra	2	1	1	4
Carya tomentosa	1	2	1	4
Cercis canadensis		1		1
Chionanthus virginicus			1	1
Cornus florida		8	3	11
Fraxinus pennsylvanica		1		1
Ilex ×attenuata			1	1
Juniperus virginiana		3		3
Liquidambar styraciflua			1	1
Liriodendron tulipifera	1		1	2
Nyssa sylvatica		5		5
Oxydendrum arboreum		4	1	5
Pinus echinata		4	3	7
Pinus taeda		16	5	21
Platanus ×acerifolia			1	1
Prunus ×yedoensis			1	1
Prunus serotina		2		2
Quercus alba	3	11	18	32
Quercus rubra		3		3
Quercus stellata	1	7	1	9
Quercus velutina	1			1
Robinia pseudoacacia		3		3
Sassafras albidum		2		2
Zelkova serrata		1	3	4
Grand Total	**10**	**79**	**49**	**138**

Table 5. Tree Species, Condition and Numbers in D1 - D16, Southeast Kenan Woods

Scientific Name	High	Low	Moderate	Grand Total
Acer rubrum	1	7	1	9
Acer saccharum	3		3	6
Carya glabra		10	6	16
Carya tomentosa	8	7	6	21
Cornus florida		28	3	31
Diospyros virginiana		2		2
Fagus grandifolia	2			2
Fraxinus pennsylvanica		1		1
Ilex ×attenuata		1		1
Juniperus virginiana		1		1
Liriodendron tulipifera	2	2	1	5
Magnolia grandiflora			1	1
Morus alba		2		2
Nyssa sylvatica	3	17	3	23
Oxydendrum arboreum		27	2	29
Paulownia tomentosa		7		7
Pinus echinata		19	3	22
Pinus taeda		1		1
Prunus ×yedoensis			1	1
Prunus serotina		15		15
Quercus alba	5	25	24	54
Quercus coccinea		1		1
Quercus falcata		1	1	2
Quercus rubra	1		1	2
Quercus stellata		15	5	20
Quercus velutina		4	2	6
Robinia pseudoacacia		1		1
Ulmus americana		6		6
Ulmus spp.		2	1	3
Grand Total	**25**	**202**	**64**	**291**

Table 6. Tree Planting Recommendations:
Inspired Choices for Large Trees

Acer barbatum (subsp. *barbatum*)
Acer leucoderme (subsp. *leucoderme*)
Acer rubrum (edges only)
Acer saccharum
Aesculus flava
Carya species in abundance
Cladrastis kentukea
Fagus grandifolia
Fraxinus americana
Gymnocladus dioica
Ilex opaca
Liriodendron tulipifera
Magnolia acuminata and large-leaf natives like *M. macrophylla, M. tripetala,* etc…
Nyssa sylvatica (new cultivars)
Pinus species
Quercus species
Sassafras albidum
Taxodium distichum
Tilia americana
Ulmus americana (new Dutch Elm Disease resistant cultivars)

Table 7. Understory Planting Recommendations: Small Trees and Shrubs

Aesculus pavia
Aesculus sylvatica
Amelanchier species
Callicarpa americana
Calycanthus floridus
Carpinus caroliniana
Chionanthus virginicus
Cornus florida
Cotinus obovatus
Diervilla species
Fothergilla species
Halesia tetraptera
Hamamelis virginiana
Hydrangea arborescens
Lindera benzoin
Ostrya virginiana
Stewartia ovata
Styrax grandifolius
Symplocos tinctoria
Vaccinium elliottii
Viburnum species (in abundance)

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Section	Sub-section	Note
NE	A1 - A7	Entire NE section sweeping up from the tutoring building and parking deck to small parking area.
NE	A1 - A7	Dead limbs/hangers on all of the pines.
NE	A7	Western-most section abutting the tutoring building. Mixed new plantings and regeneration. Needs junk cleared out.
NE	A7	Scattered: *Juniperus virginiana, Ilex opaca, Cornus florida, Liquidambar styraciflua, Robinia pseudoacacia, Prunus serotina, Acer rubrum, Ilex vomitoria, Parthenocissus quinquefolia, Campsis radicans.*
NW	B1 - B19	Entire NW section sweeping from small parking area around Bell Tower.
NW	B1 - B9	Sections B1 - B9 each 40 feet wide
NW	B10 - B19	Area abutting Bell Tower on West
NW	B6	Lots of *Ilex opaca* and *Ilex vomitoria* seedlings in this section.
NW	B6	Thicket of *Acer rubrum* and *Liquidambar styraciflua* also *Ligustrum sinense.*
NW	B7	Grove of *Oxydendrum arboreum, Acer rubrum, Cornus florida* , and *Prunus serotina* all low.
NW	B8	Thicket of *Oxydendrum arboreum, Cornus florida, Liquidambar styraciflua* , and *Prunus serotina* all low.
NW	B10	*Elaeagnus pungens* --invasive.
NW	B17	Understory filled with *Elaeagnus pungens, Ligustrum sinense, Ligustrum lucidum, Hedera helix* (on ground and in trees), *Euonymus fortunei* (on ground), *Morus alba* and *Lonicera japonica.*
NW	B18	Along with B19, richest woodlands yet assessed. Lots of small seedlings in the undergrowth--only assessed trees >3" caliper. Rootsprouts, herbaceous material, and regenerating saplings.
NW	B18	Abundant: *Nyssa sylvatica, Prunus serotina* , and *Cornus florida* .
NW	B18	Scattered: *Parthenocissus quinquefolia, Toxicodendron radicans, Arum arifolium, Euonymus fortunei, Hedera helix, Viburnum rafinesquianum, Acer leucoderme, Magnolia grandiflora, Smilax* spp.

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Section	Sub-section	Note
NW	B19	Along with B18, richest woodlands yet assessed. Lots of small seedlings in the undergrowth--only assessed trees >3" caliper. Rootsprouts, herbaceous material, and regenerating saplings.
NW	B19	Abundant: *Nyssa sylvatica, Prunus serotina* .
NW	B19	Scattered: *Toxicodendron radicans, Arum arifolium, Acer leucoderme, Acer rubrum, Cornus florida, Vitis rotundifolia.*
SW	C1a - C15	Section includes SW section of stadium sweeping from a broad patio with *Zelkova serrata* and *Platanus* spp. (C1a) east to the South gate.
SW	C1 - C2	Would like to see C1 and C2 saved.
SW	C1	Scruffy undergrowth consisting of *Rubus* spp., *Hedera helix, Euonymus fortunei* , *Liquidambar styraciflua* and *Prunus serotina.*
SW	C1	Grove of small Hickories (*Carya* spp.).
SW	C2	Assorted scruffy understory vegetation and seedlings consisting of abundant *Hedera helix, Quercus alba, Liquidambar styraciflua, Lonicera japonica* and *Pinus taeda.*
SE	D1 - D16	SE Woods sweeps east from the South gate to Tutoring building and parking deck.
SE	D9 - D16	Sections D9 - D16 are 8 roughly 40' x 40' squares that hug the path sloping down the hill along the SE side of the stadium.
SE	D2	Large thicket of understory brush including: *Prunus serotina, Crataegus* spp*., Nyssa sylvatica* and *Viburnum rafinesquianum.*
SE	D4	Understory *Cercis canadensis* , *Arum arifolium* .
SE	D6	Abundant in understory: *Prunus serotina, Acer rubrum.*
SE	D7	Very rich woodland. Understory shows seedlings of many species and vigorous regeneration. Recommend cleaning out garbage plants and replanting with natives.
SE	D7	Large trees NOT noted in this section.
SE	D7	Abundant: *Acer rubrum, Quercus alba, Nyssa sylvatica, Viburnum rafinesquianum, Prunus serotina, Vitis roundifolia, Viburnum acerifolium* (thickets).

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Section	Sub-section	Note
SE	D7	Scattered: *Ilex opaca, Carya* spp.*, Acer saccharum, Smilax* spp.*, Magnolia grandiflora, Ligustrum sinense, Rubus* spp., *Arum arifolium.*
SE	D7	Invasive: *Morus alba* (scattered)*, Elaeagnus umbellata, Toxicodendron radicans* .
SE	D8	Understory not as rich as D7.
SE	D8	Abundant: *Viburnum acerifolium.*
SE	D8	Scattered: *Acer rubrum, Nyssa sylvatica, Cornus florida, Prunus serotina.*
SE	D9	Abundant: *Vitex rotundifolia, Lonicera japonica, Cornus florida* (regenerated) and *Toxicodendron radicans* .
SE	D9	Scattered: *Parthenocissus quinquefolia, Acer rubrum, Nyssa sylvatica, Prunus serotina, Acer saccharum, Viburnum acerifolium, Viburnum rafinesquianum, Magnolia grandiflora.*
SE	D10	Abundant: *Vitex rotundifolia, Lonicera japonica, Cornus florida* (regenerated) and *Toxicodendron radicans* .
SE	D10	Scattered: *Parthenocissus quinquefolia, Acer rubrum, Nyssa sylvatica, Prunus serotina, Acer saccharum, Viburnum acerifolium, Viburnum rafinesquianum, Magnolia grandiflora.*
SE	D11	Abundant: *Toxicodendron radicans* , *Prunus serotina, Ampelopsis brevipedunculata.*
SE	D11	Scattered: *Parthenocissus quinquefolia, Viburnum rafinesquianum.*
SE	D12	Abundant: *Parthenocissus quinquefolia* , *Toxicodendron radicans* .
SE	D12	Scattered: *Viburnum acerifolium, Viburnum rafinesquianum, Rubus* spp.*, Hedera helix.*
SE	D13	Abundant: *Euonymus fortunei* , *Toxicodendron radicans* .
SE	D13	Scattered: *Parthenocissus quinquefolia, Viburnum rafinesquianum, Ligustrum sinense, Elaeagnus pungens, Arum arifolium.*
SE	D14	Abundant: *Euonymus fortunei, Toxicodendron radicans.*
SE	D14	Scattered: *Parthenocissus quinquefolia, Viburnum rafinesquianum, Ligustrum sinense, Elaeagnus pungens, Arum arifolium* (3 large *Elaeagnus pungens* 10' x 10').

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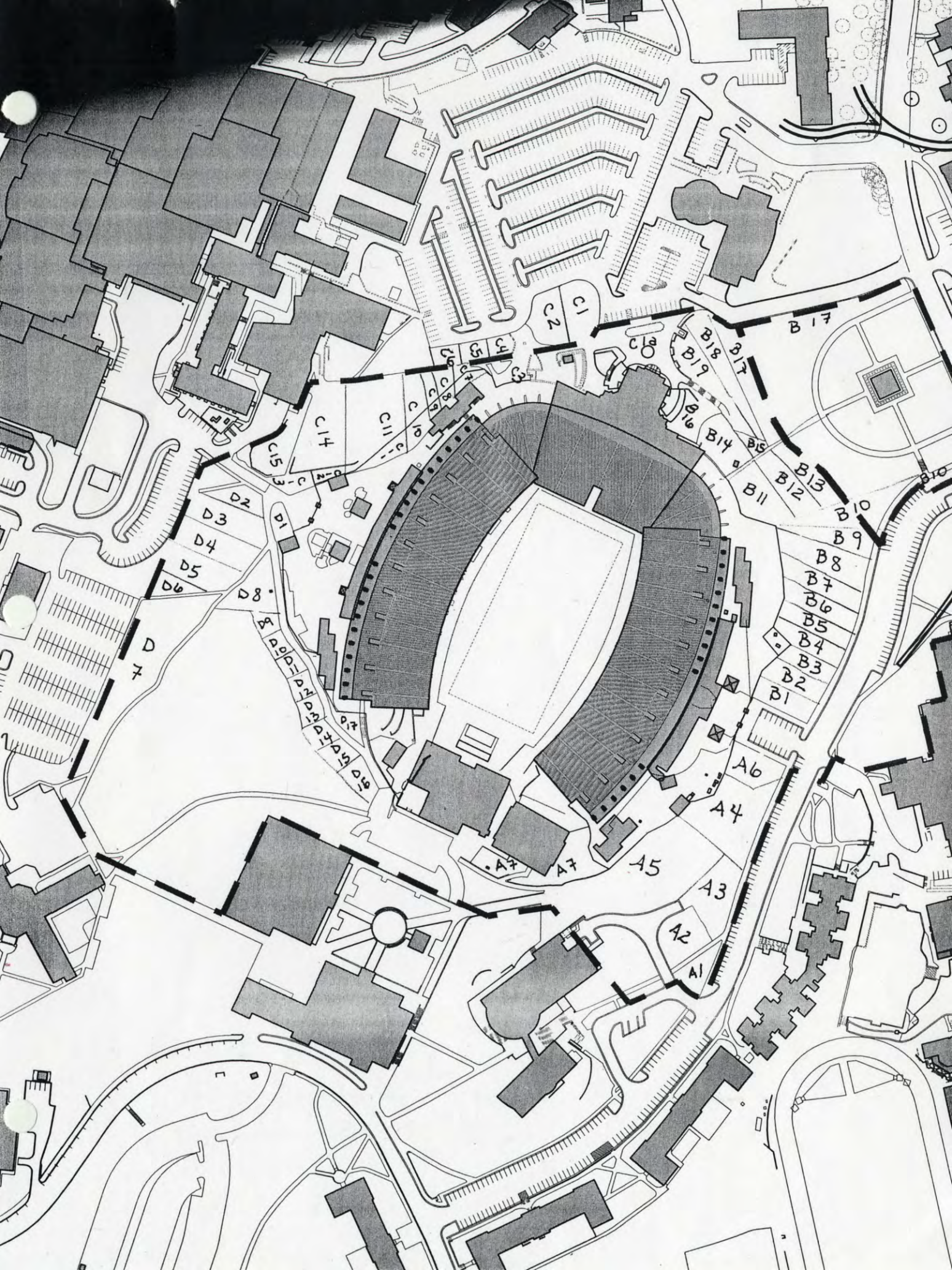
Section	Sub-section	Note
SE	D15	Same as D13 and D14 but sparser vegetative cover.
SE	D15	Abundant: *Euonymus fortunei, Toxicodendron radicans.*
SE	D15	Scattered: *Parthenocissus quinquefolia, Viburnum rafinesquianum, Ligustrum sinense, Viburnum rufidulum, Euonoymous americanus, Elaeagnus pungens* (including 3 giant ones)*, Arum arifolium* .
SE	D16	Same as D13 and D14 but sparser vegetative cover.
SE	D16	Abundant: *Euonymus fortunei, Toxicodendron radicans.*
SE	D16	Scattered: *Parthenocissus quinquefolia, Viburnum rafinesquianum, Ligustrum sinense, Elaeagnus pungens, Osmanthus heterophyllus, Arum arifolium.*


C1
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A6
A7
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17