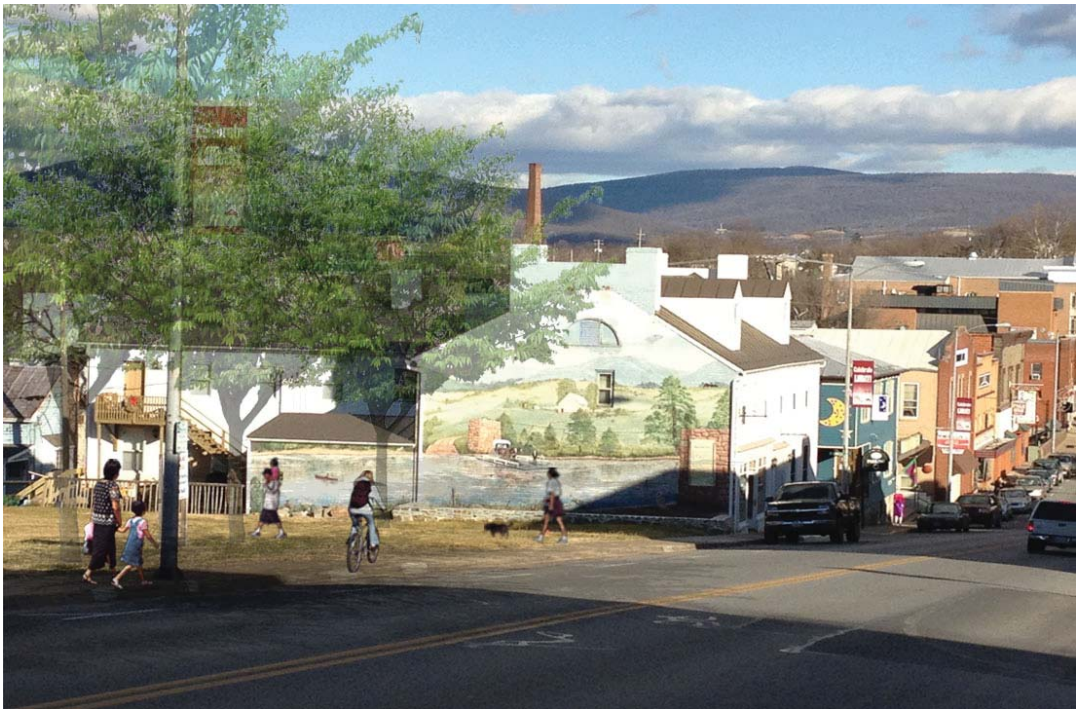
# Luray Conceptual Design Enhancement for Cliffside Pocket Park, Chinkapin Oak, and Main Street Trees



Prepared for the Town of Luray

June 2012

community design assistance center
College of Architecture and Urban Studies
Virginia Polytechnic Institute and State University

Project funding provided by a Virginia Department of Forestry
Urban and Community Forestry grant

# CDAC

The Community Design Assistance Center (CDAC) is an outreach center for the College of Architecture and Urban Studies and Virginia Tech that assists communities, neighborhood groups and non-profit organizations in improving the natural and built environment, through design, planning and research. Through the integration of the learning and working environment, the Center will execute projects that link instruction and research and share its knowledge base with the general public.

# Project Team

| | |
|---|---|
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# Acknowledgements


| | |
|---|---|
| Eleanor Ames | Member, Hawksbill Greenway Foundation |
| Weldon Bagwell | President, Page County Tree Board |
| Kenneth D. Beyer | President Hawksbill Greenway Foundation |
| Ed Brooks | Librarian, Virginia Tech |
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| D. Patrick O'Brien | Director, Luray Parks and Recreation |
| Vicki Pitts | Chairman, Luray's Tree & Beautification Committee |
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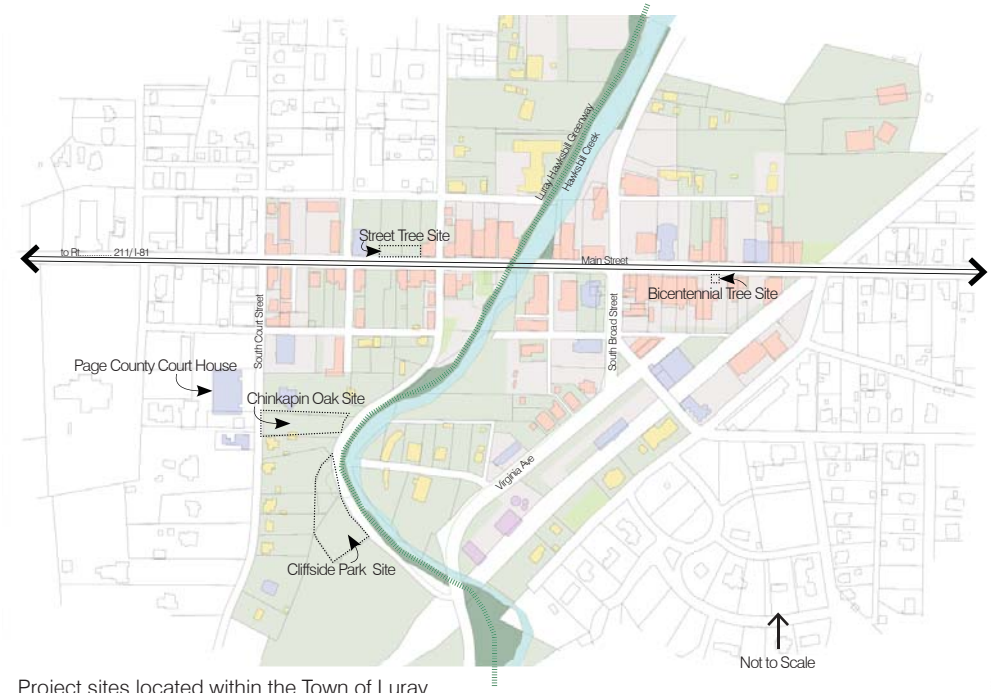
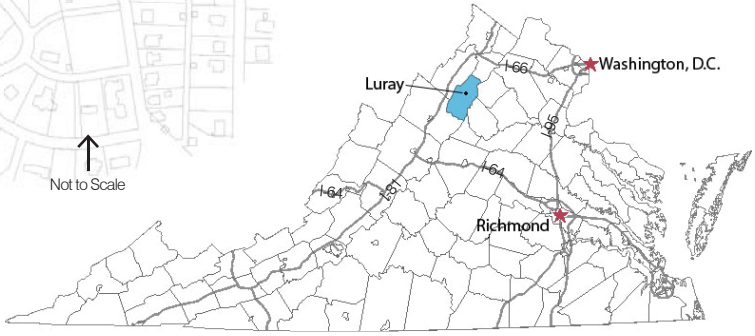
# Project Description




Project sites located within the Town of Luray


Page County regional context map




State map highlighting the Town of Luray and Page County

Located in Virginia's Shenandoah Valley and serving as Page County's county seat, Luray is a small town of approximately 5,000 residents. "Home to historical sites and popular attractions dominated in natural beauty and wonder, Luray offers residents and visitors a unique experience of both Virginia's delicately preserved past and commitment to a growing future." (http://www.luraydowntown.com/)

2012 marks the 200th anniversary of the Town of Luray. In honor of this milestone event, the Town would like to undertake a bicentennial project that would both mark the magnitude of this occasion and also create a community asset for future generations. To assist in this endeavor, the Community Design Assistance Center was asked to develop conceptual master plans for three areas in Town: Cliffside Pocket Park, the historic Chinquapin Oak, and Main Street street tree opportunities.

## *Cliffside Pocket Park*

Cliffside Pocket Park is a town-owned natural area adjacent to the Luray-Hawksbill Greenway. The space currently has a variety of natural and planned plantings, seating, a small gravel parking area, and a restroom. Adjacent residents are very interested in the future use of this site, valuing its biodiversity and serenity.

CDAC worked with Town staff and community members to prepare conceptual designs for this site. Specific programmatic elements considered includes a small amphitheater (capacity 25-40) that will serve as an educational venue and a covered picnic shelter.

View of Cliffside Pocket Park from Existing Restroom Shelter

## *Chinkapin Oak*

Located near Cliffside Pocket Park is a Chinkapin Oak of monumental proportions. Like the Town itself, this tree is also 200 years old! The tree is located on the Page County complex site and is surrounded by open, grassy areas, with excellent views to the Town below and mountains beyond.

The Page County Tree Board has encouraged both the Town and County to highlight and preserve this special tree. CDAC worked with the Town of Luray, Page County, Page County Tree Board members, and community members to develop conceptual design ideas to highlight and preserve this tree and to enhance adjacent spaces.

View of the Chinkapin Oak site from South Court Street

## *Main Street Tree Opportunities*

Street trees are a wonderful asset to any downtown, providing a host of environmental and experiential benefits. Luray's Main Street streetscape currently affords little opportunity for the addition of street trees without the loss of parallel parking. As this loss is currently deemed unacceptable, the Town has identified two areas of opportunity for the possible addition of street side trees. These areas are on privately owned lots adjacent to Main Street.

View of proposed street tree location on vacant Main Street lot

The first site is a grassy open lot between Court Street and the bridge over Hawksbill Creek. This space offers a good opportunity for the addition of street trees since it includes two vacant lots and serves as one of the entrances into Downtown Luray, coming from Rt. 211 and Interstate I-81. CDAC explored conceptual design options and potential tree species for adding street trees to these vacant lots.

The second site is located in front of a commercial area adjacent to Uncle Buck's Restaurant and across from the Luray Movie Theater as well as the Luray Municipal Building. The goal of this site is to not only bring more street trees to Main Street but to present Luray with a tree and surrounding public space that celebrates their Bicentennial.


View of the Bicentennial tree site from Main Street

# Design Process

CDAC team members Kaitlyn Illmensee (left) and Gunwoo Kim (right) walk down the Luray - Hawksbill greenway with Director of Luray Parks and Recreation, Pat O'Brien (middle).

CDAC team members discuss opportunities for the Chinkapin Oak tree with Pat O'Brien (left) and Ken Beyer (right center), President, Friends of the Luray-Hawksbill Greenway.

The CDAC design team began the project with an initial site visit in September 2011. The team met with Pat O'Brien, Parks and Recreation Director for the Town of Luray and Ken Beyer, President of the Friends of the Luray-Hawksbill Greenway to discuss the project and explore the areas of interest. The team spent time photographing, exploring and discussing each site and then returned to Blacksburg to prepare inventory and analysis maps and develop preliminary design concepts.

The CDAC team returned to Luray in October 2011 to meet with the Page County Tree Stewards and to verify site inventory measurements and site analysis findings. General design goals for the project sites were discussed and clarified and the design team began to develop preliminary conceptual designs.

Preliminary design concepts were presented to the client in January 2012 for review and comment. The preliminary designs were then refined into one final conceptual design for each site based on comments received from the client. These refined final conceptual designs were presented to Pat O'Brien, Ken Beyer, and the Page County Tree Board at their monthly meeting on February 3, 2012. The final concepts were then presented by Pat O'Brien to the Luray Town Council in March of 2012 for review. No additional changes were requested.

This short, supporting report was prepared to document the design process and highlight proposed design concepts for the town of Luray.

# Inventory and Analysis

Pat O'Brien (background) explains the natural ecology of the Cliffside Pocket Park and the opportunities for educational experiences on site.

CDAC team members discuss with the Page County Tree Board the importance of the Chinkapin Oak tree to the community and the need for its protection during future construction.

Ken Beyer (left) and Pat O'Brien (right) show the CDAC design team existing pocket parks located in downtown Luray.

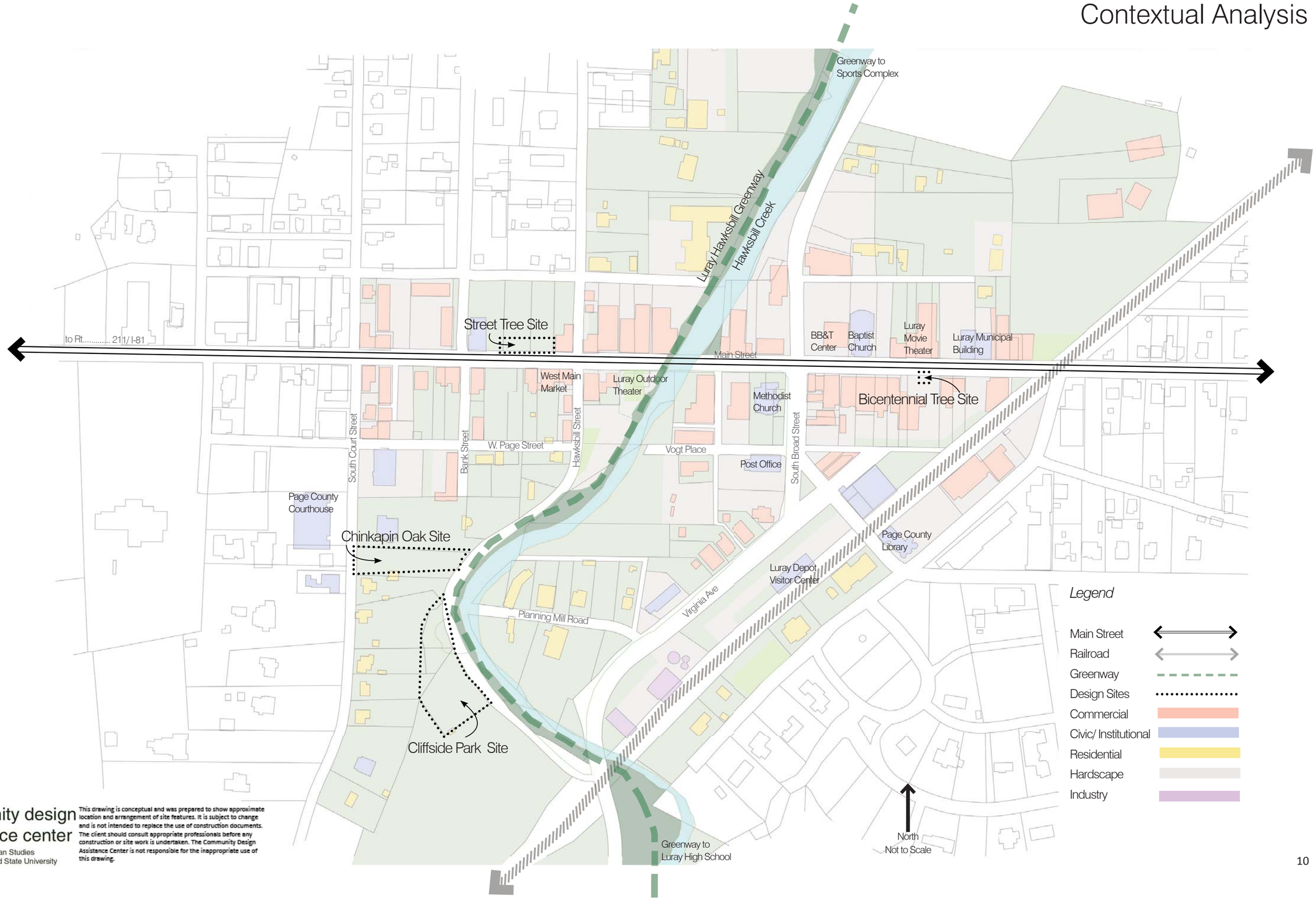
Pat O'Brien (right) points out the existing pool foundation on the Chinkapin Oak site to Kaitlyn Illmensee (left).

The CDAC design team began the site inventory and analysis phase of the project with and initial site visit to Luray, followed by an additional site visit to confirm site measurements as well as photograph additional site features. The CDAC team used information gathered during these visits to develop inventory and analysis drawings. First, the team developed a contextual analysis of the town of Luray, looking at its existing zoning, infrastructure, greenway design, hydrology, and key landmarks and their location in relation to the Luray - Hawksbill greenway and our selected sites.

Luray, home to the historic Luray Caverns, attracts more than 500,000 visitors each year. Next, the CDAC team explored with resource assistance from Ken Beyer, the history of the town of Luray to better understands its historical context, origins, and importance among the southwest Virginia Landscape.

Subsequently, the CDAC team developed site specific analyses of each proposed site. The site analyses examine grading and drainage patterns, hydrology, pedestrian circulation, traffic patterns, and existing vegetation, and hydrology. A soil samples were taken from the Chinkapin Oak Site, the Cliffside Park site, and the Main Street Tree site (vacant lot). Soil tests were run to help inform the plant selection for each site. A soil sample for the Bicentennial Street Tree site was not taken due to the existing hardscape on the site; information on structural soil, a suggested design intervention to increase soil volume for the Bicentennial Tree site, can be found in the Appendix.

# Contextual Analysis

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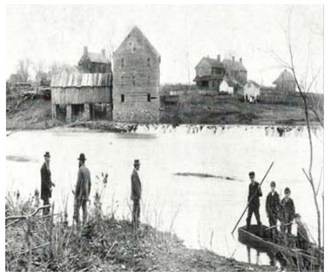
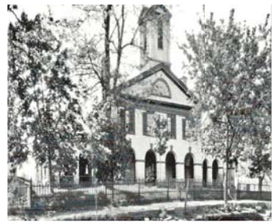
# Historical Analysis

## LURAY RAIL ROAD SYSTEM

**Locomotive** – An N &W 2-8-0 steam locomotive makes a stop at Luray Station in this Pancoast glass plate image taken in November 1895. The Liberty Bell, traveling from Philadelphia to the Charleston Exposition, would pass through Luray on January 7, 1902, when the train struck a freight in the night for stopped to enter a siding. The crew was killed and two bagge cars caught fire, but the bell, undamaged, would continue on by morning. (George Eastman House Collection.) The town revolved around the railroad, and at one time was bigger than Luray. Landowners of Port Republic, Virginia, had rejected a proposal to locate the railroad's division headquarters there, and Page County's fatering commitment to issue bunds to the railroad was a deciding factor to build here. And so the Shenandoah Valley Railraod commenced with the consturuction of Shenandoah Yard. (Virginia Tech Special Collections.)

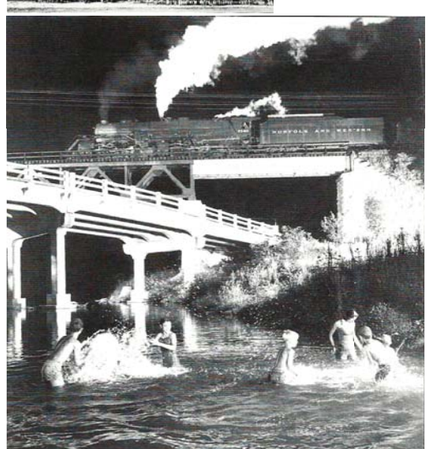


**Vacant Lot Street Side** - Kauffman' Mill, originally known as Mauck's Mill, was built in 1826 and sold to P.M. Kauffman in 1890. This turbine-powered mill was burned by the Union Army on October 2, 1864, and had barely been rebuilt when destroyed again by the flood of 1870. Seen in this 1895 photograph from left to right are Enoch V. Kauffman, Philip M. Kauffman, and John Kauffman, with their children in the boat. (Michael Brubaker Collection.)



**The Page County Courthouse** - was completed on December 23, 1883, at a cost of $6,000. Arriving late for session, Enos McKay compensated the court with a bell. Architect Malcolm F.Crawford and William B. Philips, who designed the structure, incorporated a steeple for the bell. For safekeeping, court records were stored in a cave outside Luray during the Civil War. When found damaged by water, many were recopied. The courthouse was occupied by both armies. (Virginia Historical Society Collection.)

The entire student body of the Luray Graded and High School walked across Court Street for this photograph, taken in front of the Page County Courthouse around 1923. In the center, dressed in black, are the boy's football and girls' basketball teams. From 1903 to 1950, the school had only 11 grades levels. When an additional grade was added, it caused the absence of any graduation ceremonies in 1951. (Dan Vaughn Collection.)



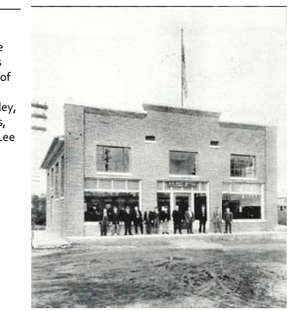
(O.Winston Link Musuem Collection, Roanoke, Virginia)

**Hawksbill Creek** - Time Freight 96, entering from the south, crosses the plate grider over U.S. Route 340 in Luray. The N&W Railrod was the last commercially operated stram railroad in America. Famed photographer O. Winston Link captured this image, one of his most famous, of childeren playing in Luray's Hawksbill Creek. The childern, from left to right, are Jerry Judd, his sister Marjorie, Reggie and Ginger Judd, Barry Good, and Tommy Judd. Link gave each a silver dollar for posing. (O.Winston Link Musuem Collection, Roanoke, Virginia)


**Theater** – Construction materials still lingered as the marquee presented the new theater's first feature of Calling Dr. Kildare, starring Lew Ayres and Lionel Barrymore. This modern state-of-the-art structure, opened in May 1939, had seating for 1,000. Admission was 15 cents for children and 30 cents for adult, 5 cents more than the Bridge Theater. (Dan Vaughn Collection.)

## LURAY CIVIC SYSTEM

**Luray M.E. Church** – Church members gathered for this portrait around 1900 in front of the congregation's third church building, located at the corner of Main and Broad Streets. With the first one destroyed in the Civil War and the second torn down, the cornerstrone was laid here on August 3, 1899, and dedicated on June 22, 1900. After being virtually destroyed by fire on November 15, 1931, it was rebuilt with native bluestone, reopening on November 13, 1932. (Dan Vaughn Collection.).



**Luray Post Office** - leaving the First National Bank Building in 1926, would move across North Broad Street into this spacious building, their fifth location. Posing in front of the new post office are, from left to right, Hughes Campbell, George Brown, Tom J. Biley, George Buririll, Ralph Rothgeb, D.B. Broyles, Hallar Beach, Everette Berrey, Jack Beach, Lee Berry, Lloyd Foltz, and Paul B. Broyles. (Dorothy Rothgeb Collection.)

**First National Bank of Luray** – Established in December 1901, the First National Bank of Luray initially opened two doors east, for construction would not begin until April 1903. Commonly called the First National Bank, in actuality the building housed numerous activities, including Stover Bros. Grocery, Luray Police Department, Luray Post Office, Roller Furniture, Luray Lending Library, Telephone Exchange, Lafayette Lodge, and others. Mid-1960s improvements of painted bricks and a revolving clock were short lived, being replaced in 1971. (Virginia Department of Historic Resources Collection.)

## LURAY STANLEY STATION

**School Parade on Main Street** – Parades have always been a popular entertaining pastime. Here, children from county schools march east past the photographer in the annual School Days Parade on Main Street in Luray, where a restaurant advertises, "Oysters, Any Style." The number of students in Pages was growing, and consolidation would soon take place, bringing to an end the area of the small, one room schoolhouse. (Peggy Miller Collection.)

## SCHOOL ACTIVITY

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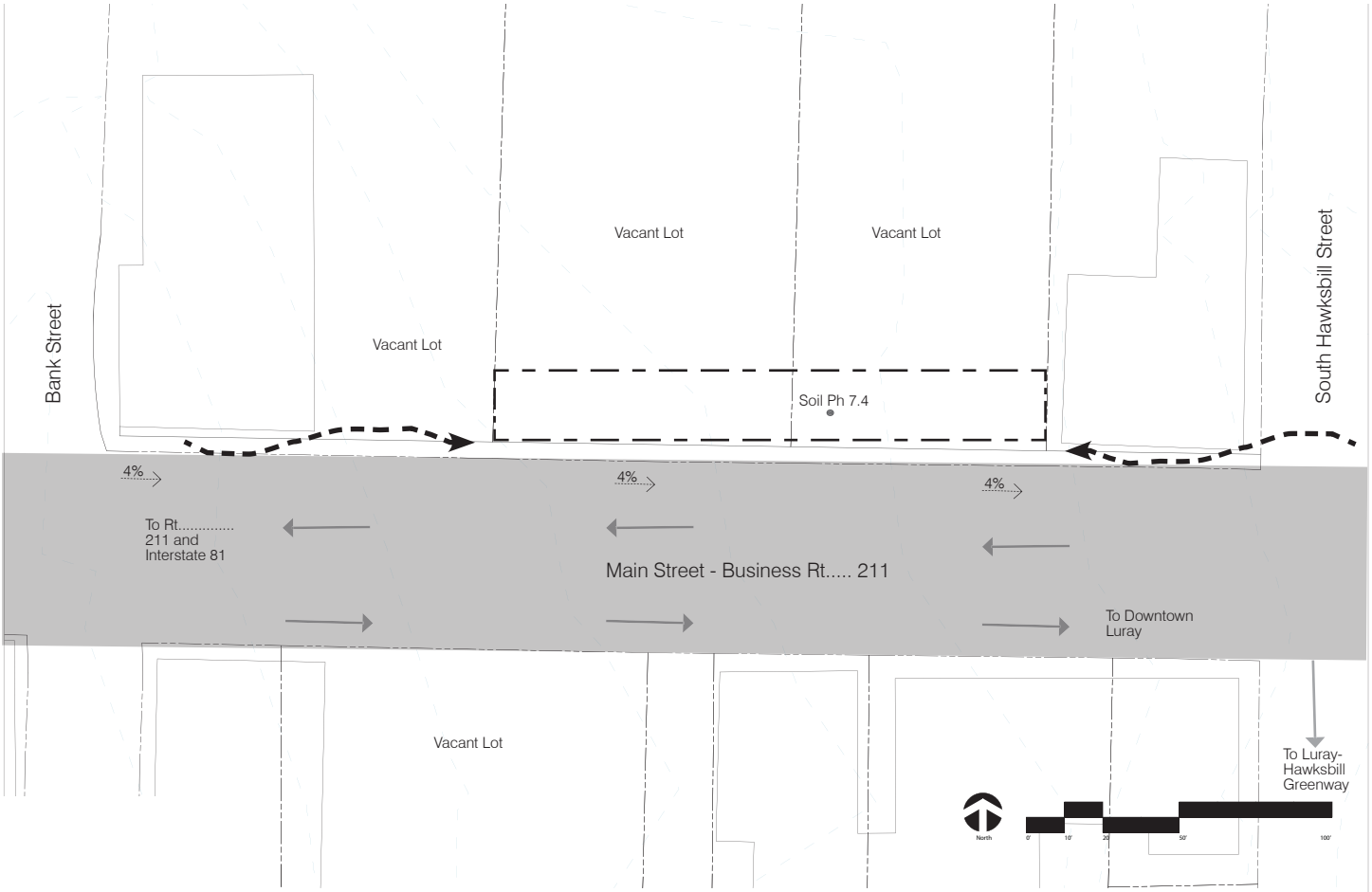
# Chinkapin Oak - Inventory and Analysis


Chickapin Oak Tree site (left) with existing building and retaining wall

# Cliffside Pocket Park - Inventory and Analysis


View of existing parking lot and restroom building from South Hawksbill Street

# Main Street Trees - Inventory and Analysis




Pedestrian Traffic

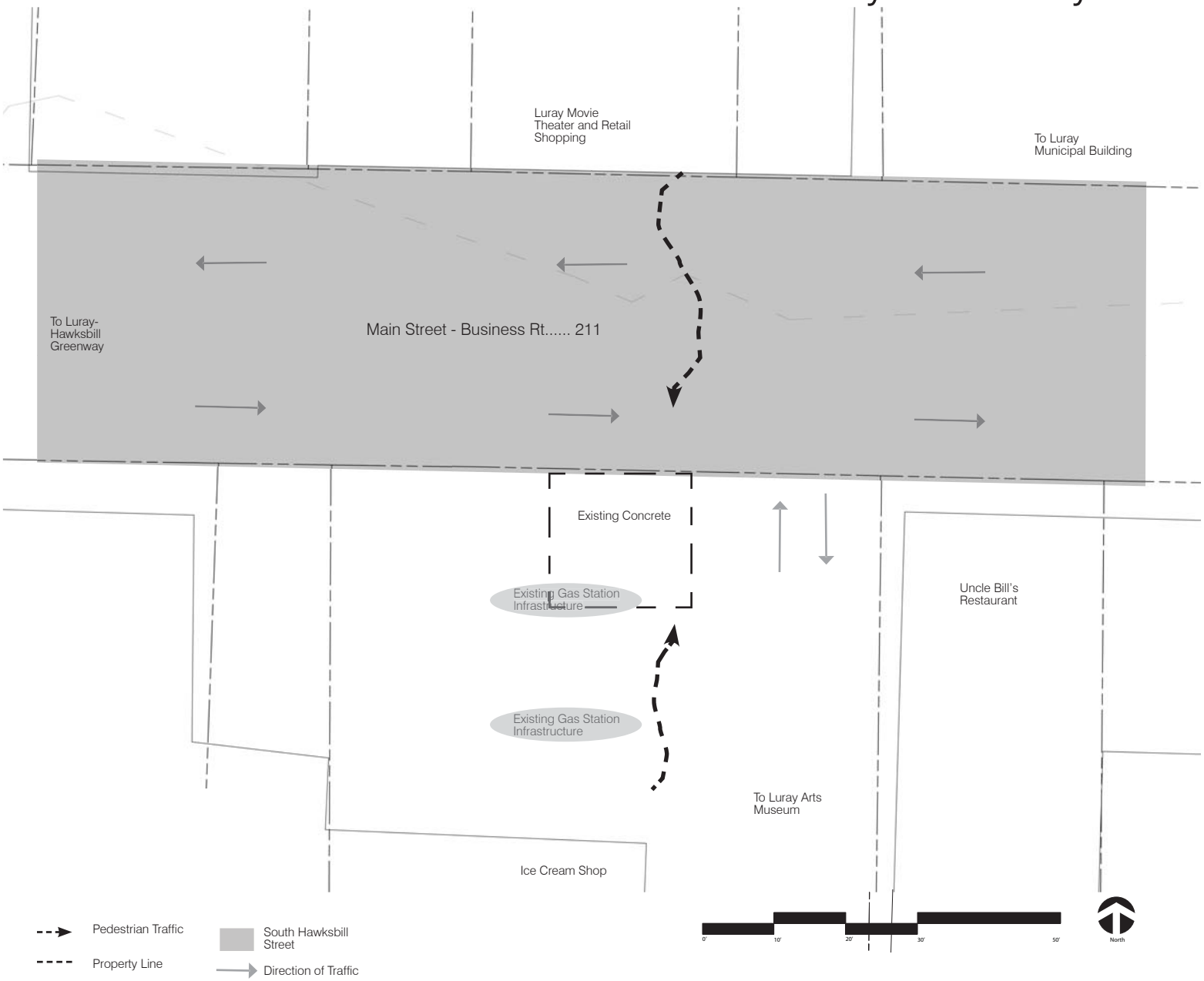
Design Area

South Hawksbill Street

Direction of Traffic

View or proposed street tree location from Main Street looking west

# Bicentennial Street Trees - Inventory and Analysis





View of proposed Bicentennial Tree location on Main Street

# Preliminary Design Concepts

Pat O'Brien (left) discusses with Gunwoo Kim (middle) and Kaitlyn Illmensee (right) the evolution of the Luray Hawksbill Greenway and the benefits it has brought to the town.

Permeable paving and other sustainable site design techniques are used through other sites in Luray.

The CDAC design team developed two preliminary design concepts for the Chinkapin Oak site, the Cliffside Pocket Park Site, the Main Street Tree sites, and the Bicentennial Street Tree site. These concepts were presented to the client in February of 2012. Descriptions of each concept design are found below. Illustrative 11x 17 pullouts of the design concepts for each site can be found on the following pages.

## *Chinkapin Oak*

The preliminary concept designs for the Chinkapin Oak site aimed to bring more people to the site while ensuring the safety and longevity of the tree itself. Concept A addressed the site with a formal brick walkway that brings visitors through the site entering from a patio on South Court Street with a secondary entrance coming from the parking lot and building. Concept A uses stone steppers to access a proposed pergola located on the existing concrete pool foundation. Concept B has a more organic approach, with a proposed crushed stone pathway meandering through the site, from the street to the proposed pergola. Concept B addresses the need for stormwater management mitigation, diverting the water from the parking lot outflow structure, slowing the water velocity through a dry creek bed, and then diverting the water back into the existing stormwater easement.

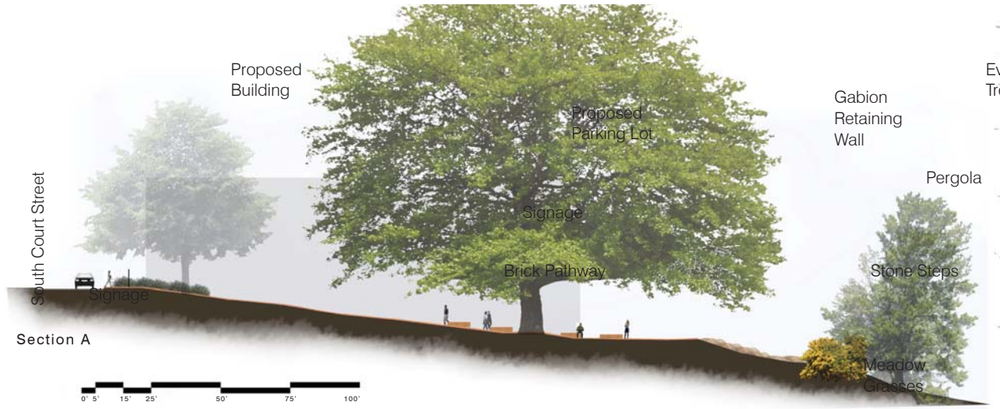
## *Cliffside Pocket Park*

The Cliffside Pocket Park preliminary designs aimed to create an educational space the included an amphitheater, native plantings, sustainable materials, and parking space. Concept A accomplished these goals through the design of a circular amphitheater located in the center of the site that uses local stones as seating. This concept locates the entrance of the site to the north coming through a natural planting area of meadow grasses and flood tolerant plant species. The walkway is designed to be made out of Trex material to simulate the feel of a boardwalk but be durable enough to withstand flood events. While Concept A has a more linear approach to the site design, Concept B takes a more sinuous approach creating an interactive experience with the landscape. Both concepts provide angled parking along South Hawksbill Street designed with permeable concrete.

## *Main Street Tree Opportunities*

The preliminary design of the street tree sites include design options for two different locations. The two preliminary concepts for the Main Street tree concepts show different spacing and tree species opportunities. The two proposed concepts for the Bicentennial Tree site highlight two different tree options as well as hardscaping and seating options. Concept A illustrates an upright tree planted in a square planter with seating on all 4 sides. This concept shows a brick patio as the chosen hardscaping material. Concept B illustrates a different tree species with understory shrubs and street front seating. The proposed hardscaping material in Concept B is a stone material.

# Chinkapin Oak - Preliminary Design Concepts




Pekin Lilac
*Syringa pekinensis 'China Snow'*

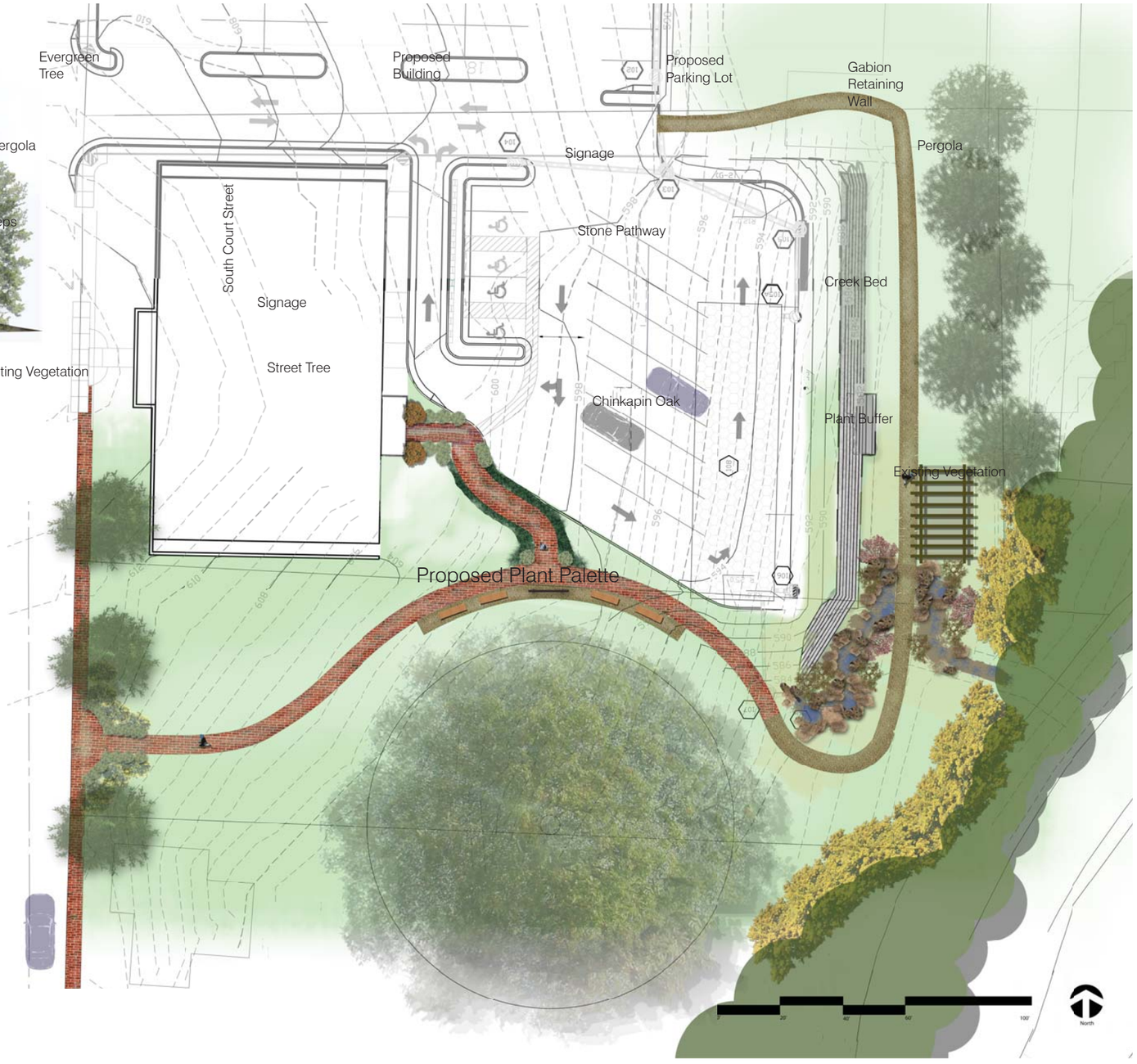
Littleleaf Linden
*Tilia cordata 'Summer Sprite'*

Bloodtwig Dogwood
*Cornus sericea*

Eastern Arborvitae
*Thuja occidentalis 'Globosa'*

Beautyberry
*Callicarpa americana*

Concept A Section

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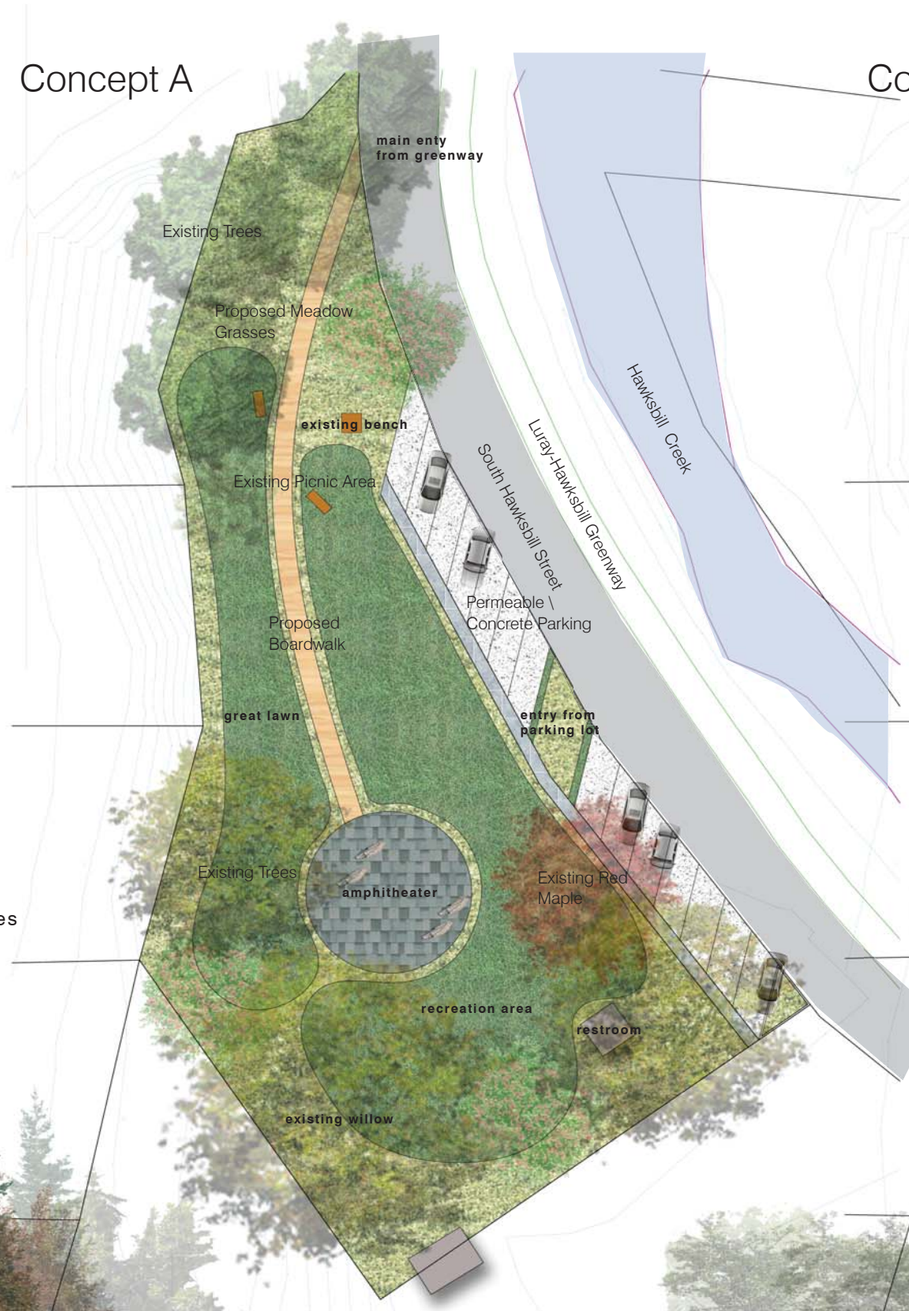
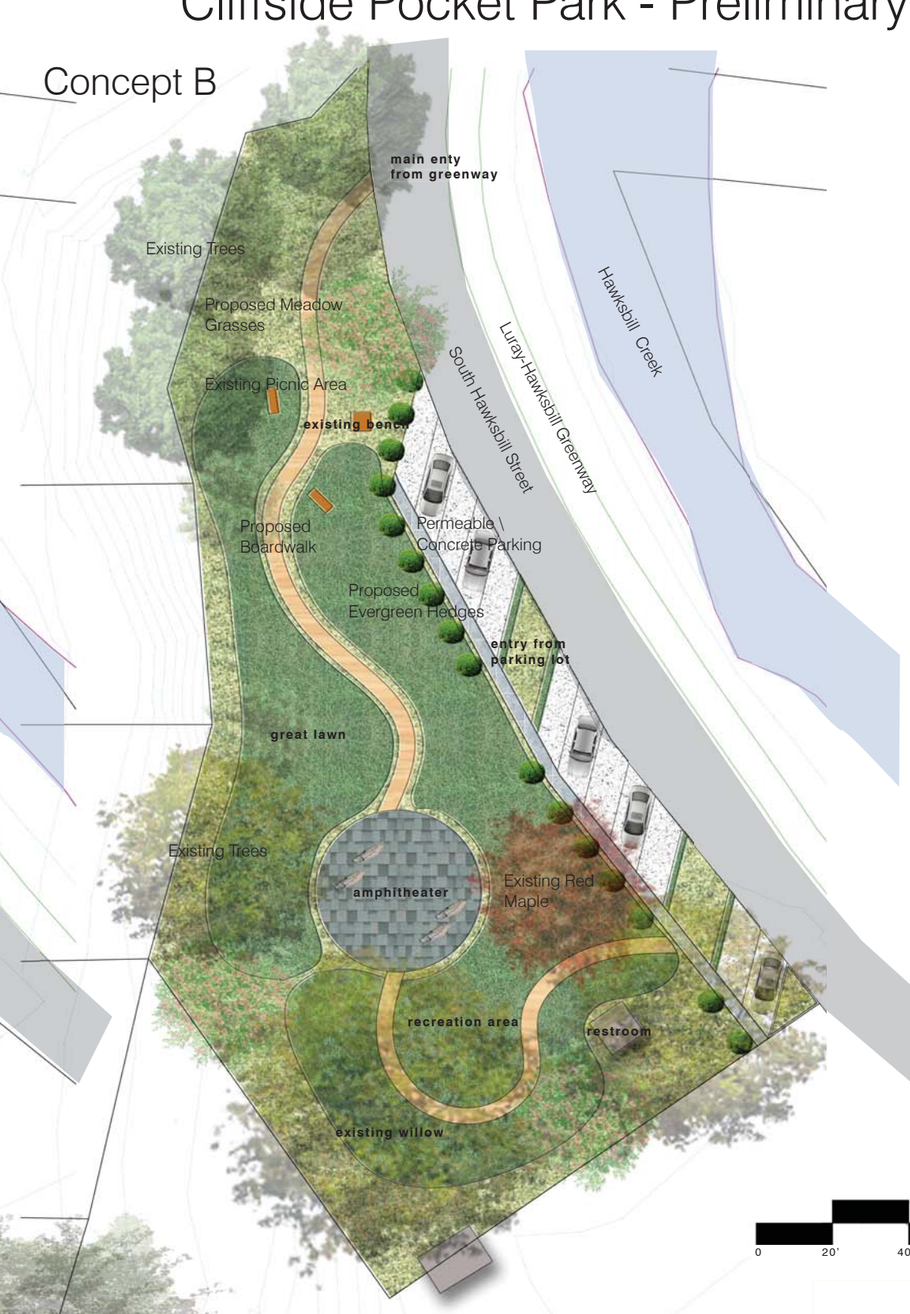
# Cliffside Pocket Park - Preliminary Design Concepts

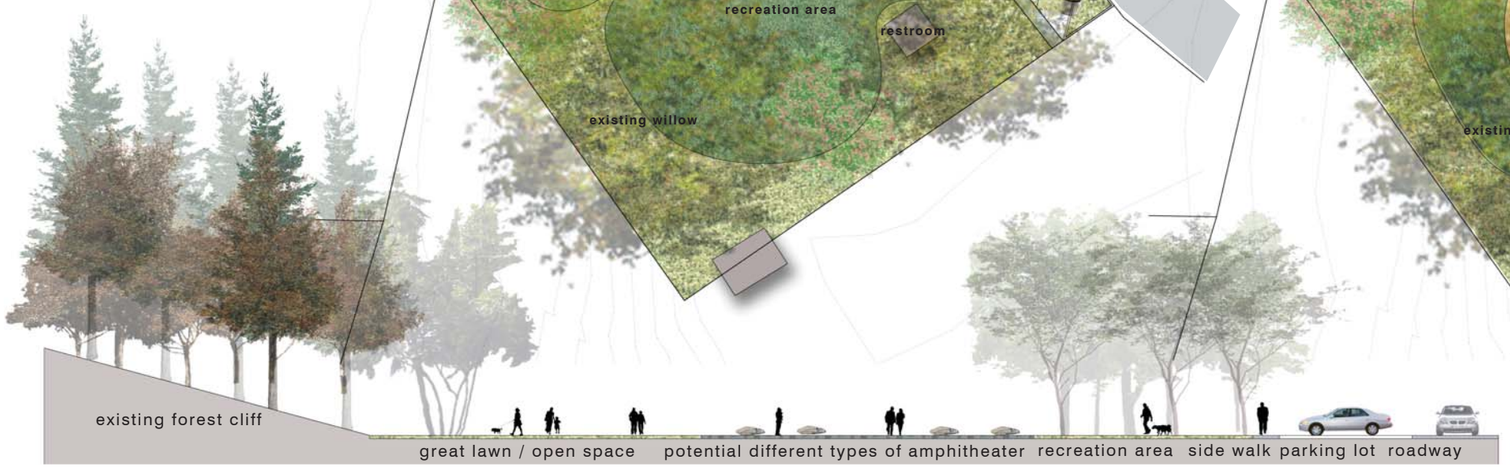
Potential different types of amphitheater

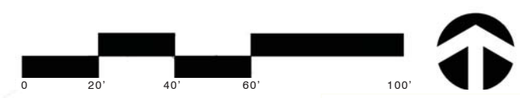
## Concept A




## Concept B

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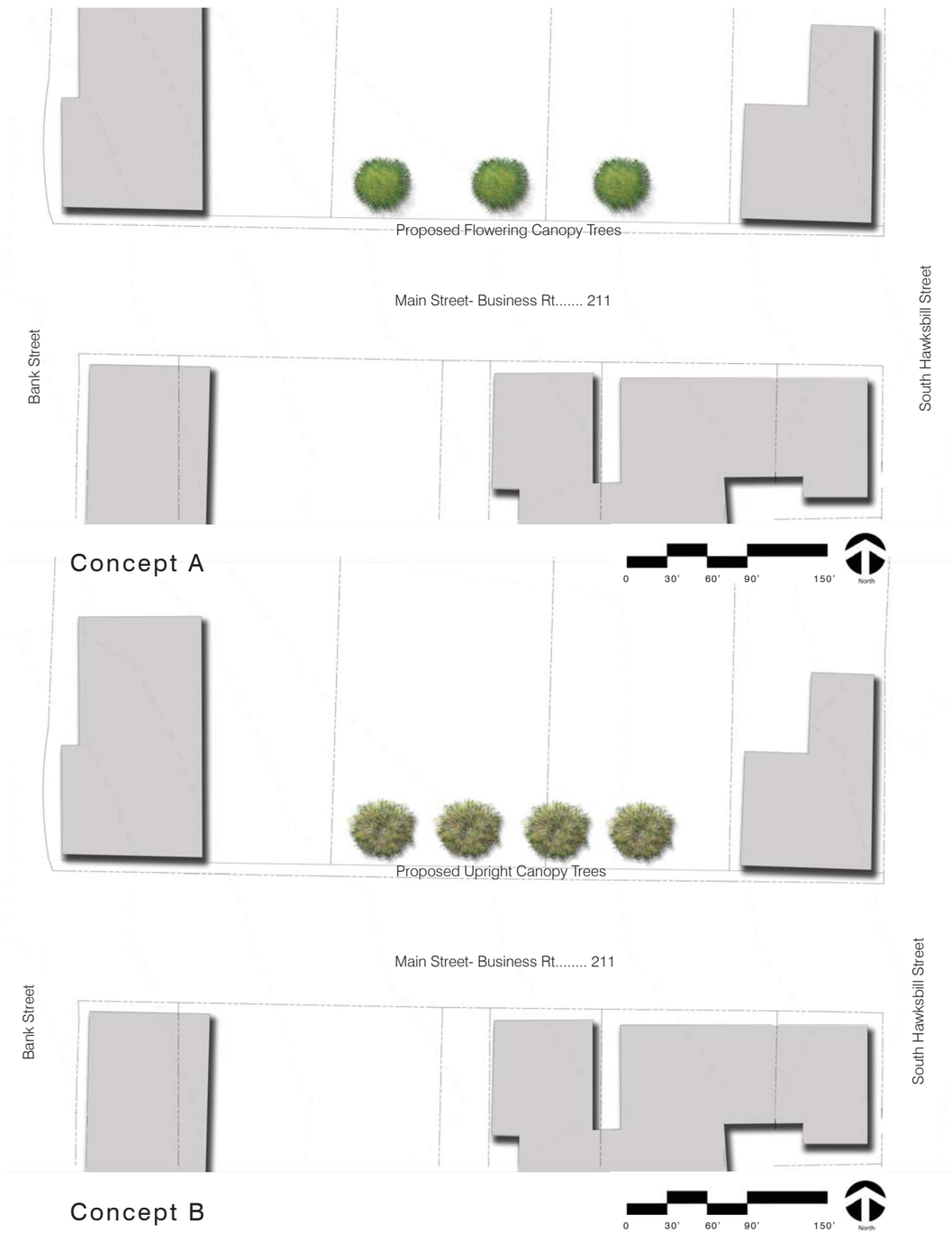
# Main Street Trees - Preliminary Design Concepts




Street Site West Perspective View 1

Street Site West Perspective View 2

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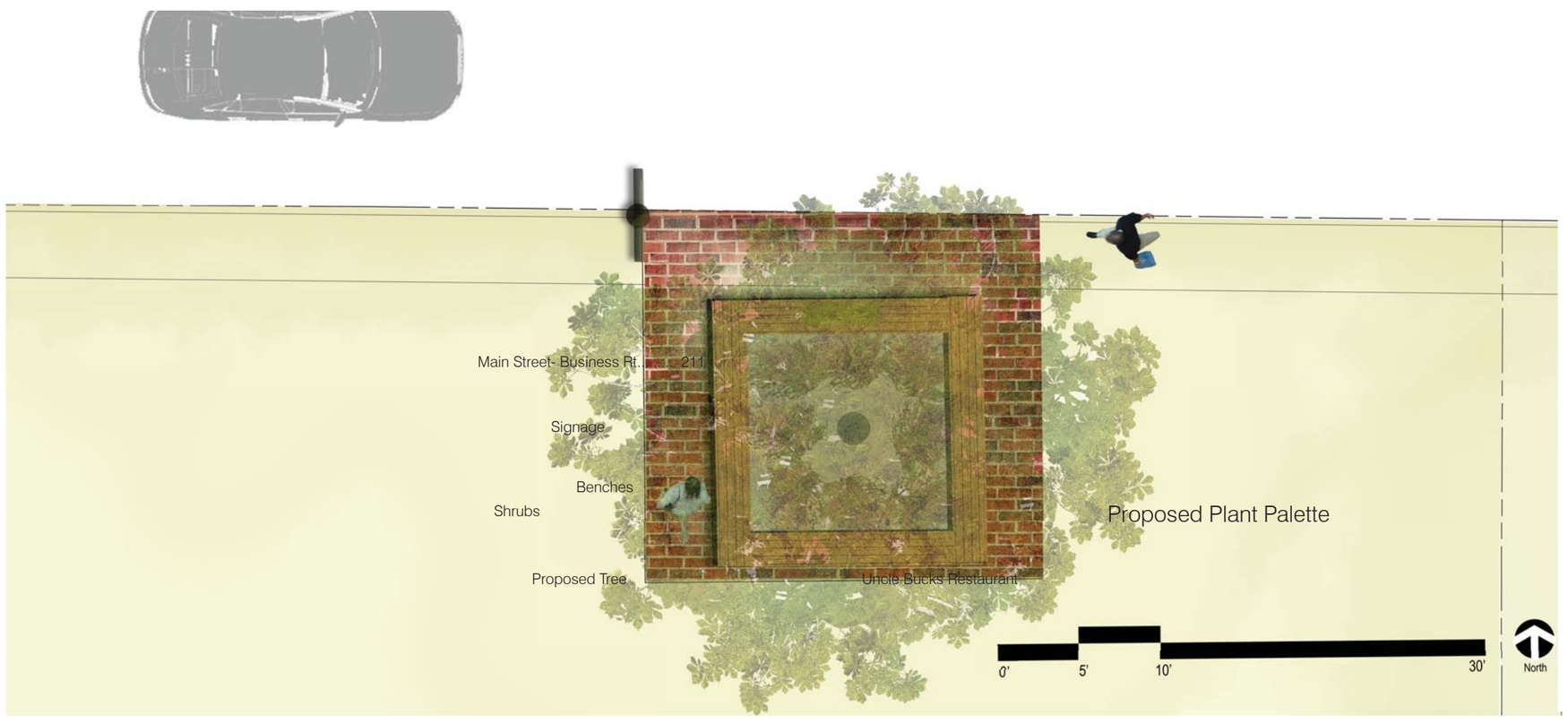
# Bicentennial Street Trees - Preliminary Design Concepts

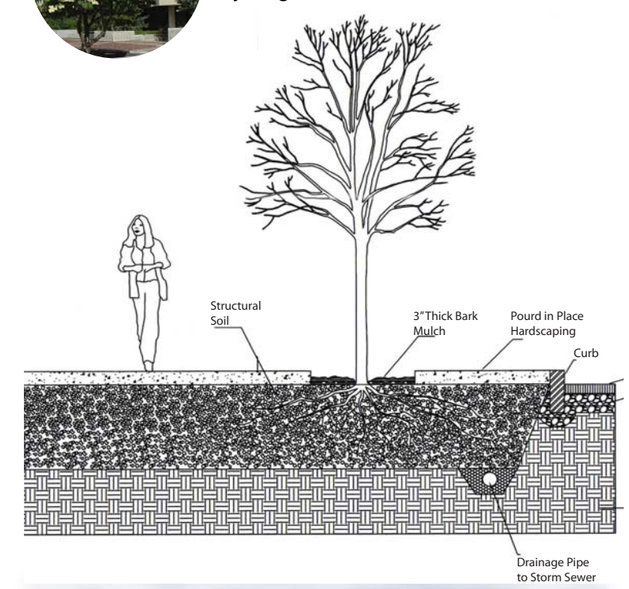

Lacebark Elm
*Ulmus parvifolia*

Geranium
*Geranium maccorhizum*

Persian Parrotia
*Parrotia persica*

Chinese Elm
*Ulmus parvifolia*

Japanese Lilac Tree
*Syringa reticulata*

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# Final Conceptual Master Plans

CDAC team members Gunwoo Kim (l) and Kaitlyn Illmensee (r) present final design concepts.

The CDAC design team and Parks and Recreation Director Pat O'Brien.

The CDAC design team took the feedback they received at the preliminary design presentation and refined the design concepts into a single, final conceptual master plan for each project site. These concepts were presented to the client in on February 23, 2012. Descriptions of each concept can be found below. Detailed 11x17 illustrative drawings of the final design concept for each site can be found on the following pages.

## *Chinkapin Oak*

The final conceptual master plan for the Chinkapin Oak Site used the formal brick paving proposed in Concept A as the primary hardscaping material. The pathway is offset away from the tree so that its construction will not severely impact the trees root system. The pathway transitions to a gravel pathway on the east side of the site to address the topography as it proceeds down the slope to the Pergola and then connects to the north side parking lot. This connection allows visitors to move through the side more efficiently while providing access to the street which is the connecting point to the Luray-Hawksbill Greenway. This site design utilizes the existing stormwater management outflow to mitigate the effects of stormwater on the site while providing an experiential quality with the dry creek bed. The design of the Chinkapin Oak site has minimal planting in addition to the tree to allows for the 200 year old Chinkapin Oak to be the main focus, however the additional proposed landscape aims to provide year round color and attraction for the site.

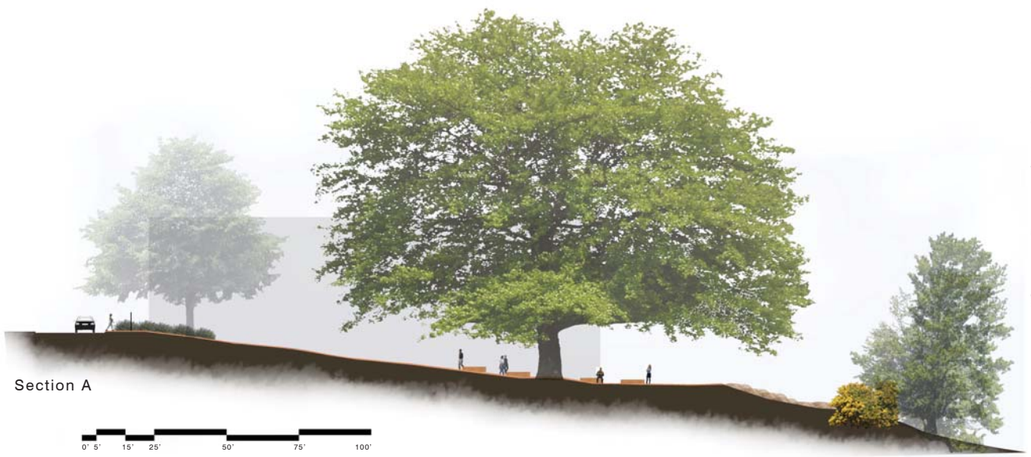
## *Cliffside Pocket Park*

The CDAC team prepared the final conceptual master plan for the Cliffside Pocket Park design that used the more sinuous pathway design from Concept B through the site. This proposed pathway, made out of the Trex boardwalk material connects you from the north entrance of the site, to the educational amphitheater, to the south entrance of the site and provides access to the existing restrooms. The final concept incorporates angled parking with permeable pavement. The plant palate is comprised of native species that will identified by educational signage throughout the site. A rain garden is proposed on the southwest side of the site to collect and clean stormwater runoff coming down the adjacent cliff.

## *Main Street Tree Opportunities*

The final Main Street Tree design left two options for the town of Luray showing differences in spacing and tree selection. The final Bicentennial tree concept includes brick hardscaping, to match the municipal building material with raised planter that will also serve as seating. The final concept incorporates signage and infrastructure into the planter to provide lighting and water. To maximize soil volume, structured soil is proposed adjacent to the planter. The planter will also provide space for annual and perennial plantings for year round color.

# Chinkapin Oak - Final Conceptual Master Plan




Pekin Lilac
*Syringa pekinensis 'China Snow'*

Littleleaf Linden
*Tilia cordata 'Summer Sprite'*

Bloodtwig Dogwood
*Cornus sericea*

Eastern Arborvitae
*Thuja occidentalis 'Globosa'*

Beautyberry
*Callicarpa americana*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Virginia Polytechnic Institute and State University

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# Cliffside Pocket Park - Final Conceptual Master Plan

River birch

Sweet magnolia

Woodland phlox

Cinnamon fern

Summersweet clethra

Beautyberry

Big bluestem

Winterberry

Cliffside Pocket Park section through amphitheater space


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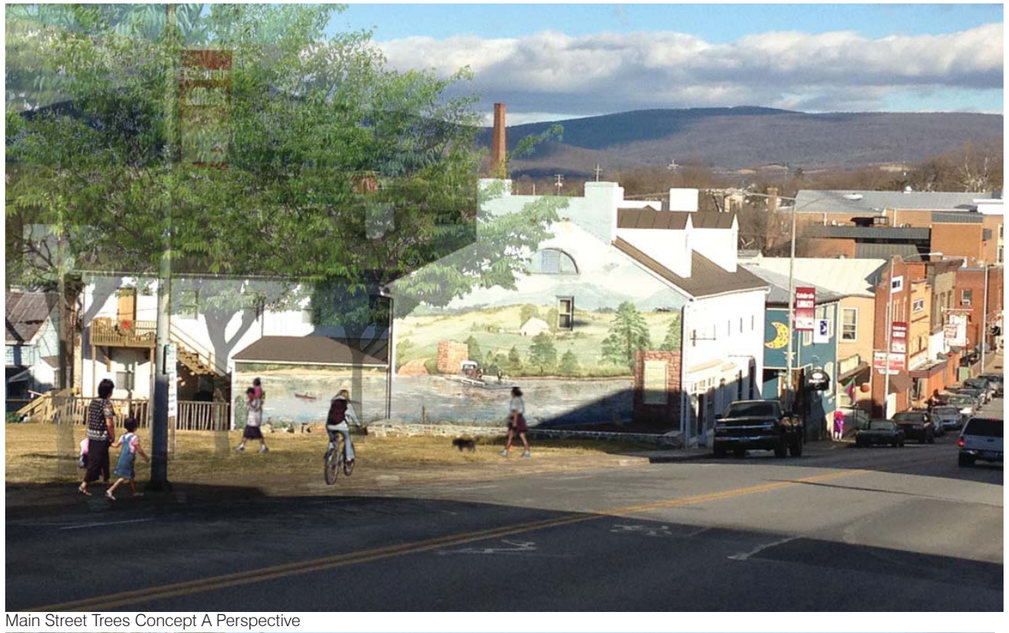
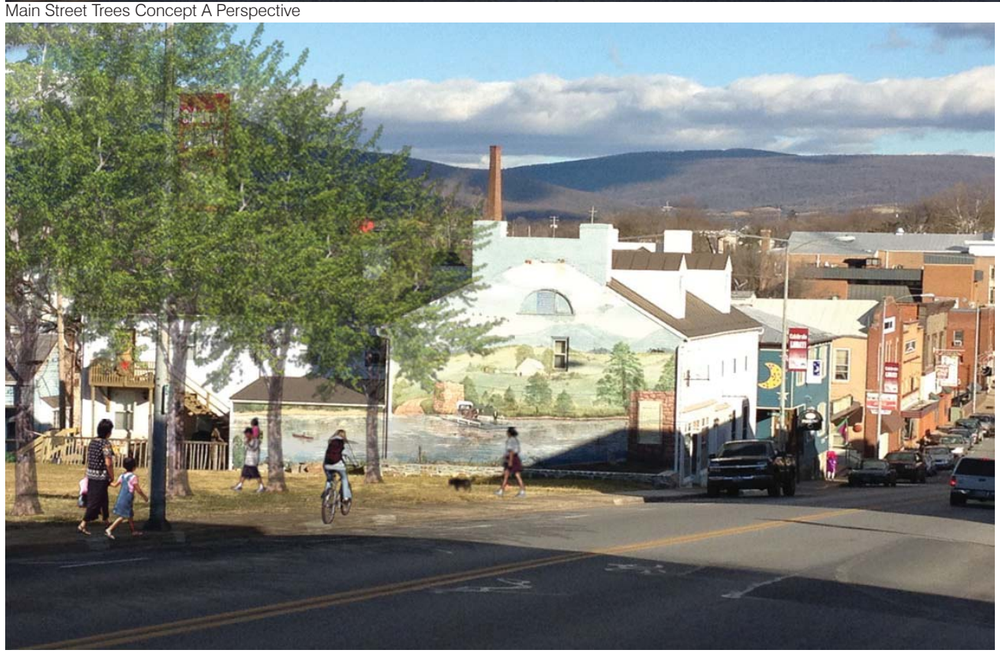
# Main Street Trees - Final Conceptual Master Plan



Main Street Trees Concept A Perspective



Main Street Trees Concept B Perspective


Concept A


Concept B

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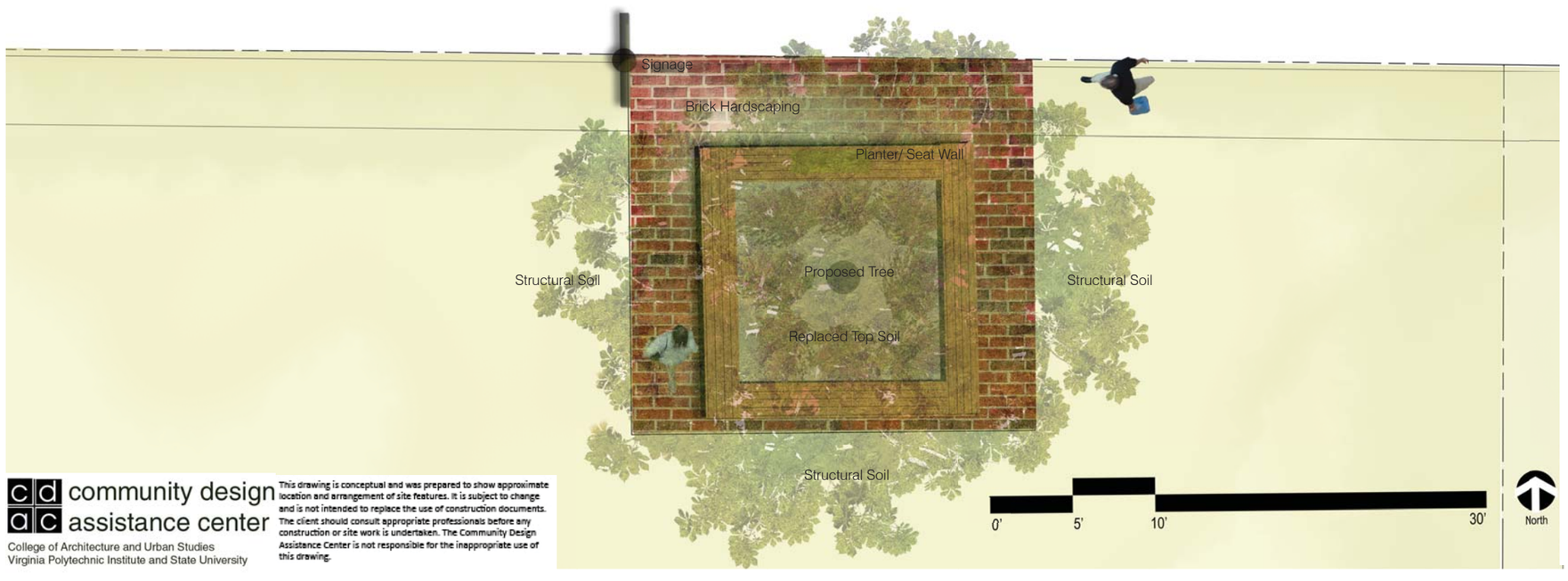
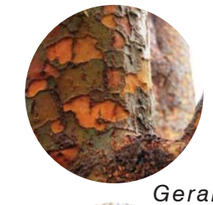
# Bicentennial Street Trees - Final Conceptual Master Plan

Bicentennial Tree site section along Main Street

0' 5' 15' 25' 50'

Main Street- Business Rt. 211



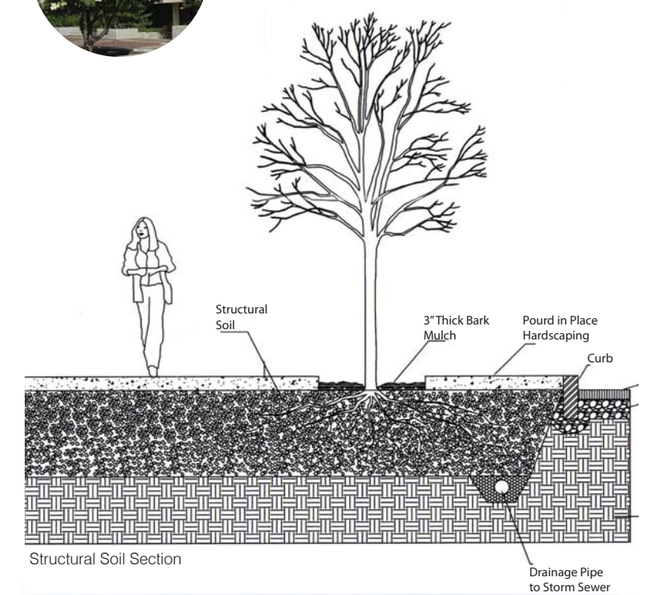
Lacebark Elm
*Ulmus parvifolia*

Geranium
*Geranium maccorhizum*

Persian Parrotia
*Parrotia persica*

Chinese Elm
*Ulmus parvifolia*

Japanese Lilac Tree
*Syringa reticulata*




Structural Soil Section

Bicentennial Tree Perspective

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# Conclusion

The Town of Luray provided the CDAC team with many unique opportunities and challenges for the design enhancement of the Chinkapin Oak Site, Cliffside Pocket Park, Main Street Tree, and the Bicentennial Tree design. Marking the Town's Bicentennial year of 2012, the CDAC team was privileged to work closely with the Town of Luray to complete conceptual designs for each site that preserves Luray's unique past, while helping its commitment to a growing future through sustainable design initiatives and beautifying Luray's historic downtown.

# Appendix

| Chinkapin Oak Site | | | | |
|---|---|---|---|---|
| Common Name | Botanic Name | Height | Width | Notes |
| | | | | |
| Street Tree | | | | |
| Littleleaf linden | *Tilia cordata 'Summer Sprite'* | 16' | 10' | Yellow flowers in early summer, sturdy tree for street use. |
| Serviceberry | *Amelanchier sp.* | 20-25' | | Autumn Brilliance' grows 20-25' high, according to Dirr. White blooms in spring, airy crown, nice fall color. Native. |
| Ironwood | *Carpinus caroliniana* | 20-30' | | Beautiful sinewy gray bark, nice fall color, hop-like flowers in spring (not strongly showy), can tolerate periods of wet/saturated soil, native. May be taller than we want, due to the power lines above this site. |
| Redbud | *Cercis canadensis* | 20-30' | 20-30' | |
| Pekin lilac | *Syringa pekinensis 'China Snow'* | 15-20' | 15-20' | Creamy white flowers in June, peeling copper-brown bark. |
| Japanese tree lilac | *Syringa reticulata 'Summer Snow'* | 20' | 15' | Creamy white, fragrant flowers, |
| Seven Sons flower | *Heptacodium miconioides* | 15-20' | 7-10' | White flowers in late summer, sepals turn a rose-burgundy color and last several weeks after the flowers drop. May need some pruning to train it for street tree use. |
| Edge Planting (shrubs 5-6' or lower) | | | | |
| | | | | |
| Smooth witherod | *Viburnum nudum 'Brandywine'* | | | Glossy green foliage that turns a deep red in the fall, pink and blue berries late summer/early fall. |
| Arrowood viburnum | *Viburnum dentatum* | depends on cultivar | depends on cultivar | White flowers in late spring, berries are anywhere from blue to blue-black. A tough plant that can adapt to a wide range of conditions. A few cultivars that would grow to the height we're looking for: 'Blue Muffin' (5-7' tall, though Dirr notes it could grow taller, blue fruits), 'Blue Blaze' (growing to about 5', wider than tall, blue fruits), 'Raspberry Tart' (4-5' tall, with good fall color). Native. |
| Oakleaf hydrangea | *Hydrangea quercifolia* | 4-6' can get bigger | | This plant can sucker from the base. To reliably keep this plant under 6' tall, choose a cultivar like 'Pee Wee' or 'Sikes Dwarf' that should be around 3', maybe 'Amethyst' if you want something taller. |
| Summersweet clethra | *Clethra alnifolia* | 4-8' | 4-6' | This plant suckers to form a nice colony. 'Hummingbird' grows 2-3 feet tall, 'Vanilla Spice' to 3-6' tall. Many other cultivars to choose from. Bees love this native plant. |
| Golden St. Johnswort | *Hypericum frondosum* | 3-4' | 3-4' | Bright yellow flowers on a rounded shrub with blue-green foliage. Rather tough native plant. |
| Beautyberry | *Callicarpa americana or japonica* | 4-6' | 4-6' | Nice, full shrub for massing, purple berries really stand out in the fall. C. japonica will be easier to find in trade than the native C. americana. |
| Graystem dogwood | *Cornus racemosa* | 2-15', depending on cultivar | | 'Muskingum' is 2' by 4', with red fall color. 'Huron' is 5-6' by 5-6' with red fall color. 'Snow Lace' is 6-9 by 6-9, purple fall color and lots of white berries. Sun to shade .Native. |
| Bloogtwig Dogwood | *Cornus sericea* | depends on cultivar | spreads by suckering | Arctic Fire' grows 3-4 feet tall, 'Bergeson's Compact' is another compact option. |
| Eastern arborvitae | *Thuja occidentalis 'Globosa'* | 3' | 3' | Rounded, evergreen shrub, native. |
| Inkberry | *Ilex glabra* | 3-5' | | native, evergreen, Select cultivar for branch retention (i.e. 'Green Magic'), sun to part shade, native. |

| | | | | |
|---|---|---|---|---|
| Rock-friendly groundcover | | | | |
| Common Name | Botanic Name | Height | Width | Notes |
| | | | | |
| Low perennials (less than 1') | | | | |
| Pasque flower | *Pulsatilla vulgaris* | | | Downy grey foliage with purple blooms in spring. |
| Candytuft | *Iberis sempervirens 'Autumn Beauty'* | | | This cultivar blooms white flowers in spring, and a second time in the fall. |
| Dianthus | *Dianthus gratianopolitanus 'Bath's Pink'* | | | Light pink blooms in spring. |
| pinks | *Dianthus deltoides 'Zing Rose'* | | | Deep red blooms in spring. |
| thyme | *Thymus occidentalis* | | | |
| Blue Spruce' stonecrop | *Sedum pruniatum 'Blue Spruce'* | | | Blue-green foliage with yellow blooms In summer. |
| stonecrop | *Sedum kamtschaticum* | | | Yellow blooms in summer. |
| Fulda glow' stonecrop | *Sedum spurium 'Fulda glow'* | | | Bronze-red foliage with rosy blooms in summer. |
| Angelina' stonecrop | *Sedum repestre 'Angelina'* | | | Chartreuse foliage that turns orange in fall. Yellow flowers in summer. |
| Blanket flower | *Gaillardia aristata* | | | Daisy flowers through summer in a range of yellow to red to orange. |
| Seathrift | *Armeria maritima* | | | Pink or white flowers in spring over green, grass-like foliage. |
| Rock cress | *Arabis caucasiata* | | | Pink or white flowers in spring. |
| field pussy toes | *Anntenaria neglecta* | | | Native plant with white blooms in spring. |
| Taller Perennials | | | | |
| Fireworks' goldenrod | *Solidago rugosa 'Fireworks'* | 3-4' | | Tough native plant with feathery yellow flowers in the fall. This is not the culprit for allergy sufferers as is sometimes thought. |
| Goldstrum' orange coneflower | *Rudbeckia fulgida var. sullivantii 'Goldstrum'* | 1-2' | | Steady bloomer in late summer, spreads to form a nice mass. Cultivar of a native plant. |
| butterflyweed | *Asclepias tuberosa* | 1-3' | | Native, drought tolerant plant with bright orange blooms in late summer. Attracts butterflies. |
| Coreopsis verticillata | *Coreopsis verticillata* | 1' | | Native plant blooming yellow over a long period in the summer. Many cultivars available. |
| smooth oxeye | *Heliopsis helianthoides 'Summer Nights'* | 3-6' | | Native plant blooming yellow over a long period in the summer. |
| wood lily | *Lilium philidelphicum* | 1-3' | | Native orange lily, blooms in summer. |
| bee balm | *Monarda fistulosa* | 3' | | Native with lavendar blooms in summer. |
| narrow-leaved mountain mint | *Pycnanthemum tenuifolium* | 2-3' | | Native with white blooms in summer. |
| black-eyed Susan | *Rudbeckia hirta* | 1-3' | | Native with orange blooms in summer. This plant is an annual, but can spread by seed. |
| smooth aster | *Symphiotrichum laeve* | 2-3' | | Native aster with light blue flowers in fall. |
| New england aster | *Symphiotrichum novae-angliae* | 3-6' | | Native aster with pink and purple flowers in the fall. Several cultivars available. |
| frost aster | *Symphiotrichum pilosum* | 1-3' | | Native aster with white blooms in fall. |
| lupine | *Lupinus perennis* | 1-3' | | Native plant with blue spire-like flowers in the spring. |
| Grasses | | | | |
| Prarie dropseed | *Sporobolus heterolepis* | 1.5-3' | | Graceful, thin arching blades form a mound that is topped by airy blooms in summer. Can spread by seed. |
| Northern sea oats | *Chasmanthium latifolium* | 3-4' | | Can spread aggressively, attractive seed heads, native. |

| Common Name | Botanic Name | Height | Width | Notes |
|---|---|---|---|---|
| | | | | |
| Shrubs | | | | |
| Virginia sweetspire | Itea virginica 'Henry's Garnet' | 3-4' | | White flowers in summer, burgundy fall color, suckers, native. |
| Summersweet | Clethra alnifolia 'Sixteen Candles' | 2-3' | | Fragrant white flowers in the summer, suckers, native. |
| Gro-low' sumac | Rhus aromatica 'Gro-low' | 1.5-2' | | Small yellow flowers in the spring, great fall color. |
| Hypericum | Hypericum frondosum 'Sunburst' | 3-4' | | Bright yellow flowers from June to July, nice blue green foliage. Native. |
| honeysuckle | *Lonicera flava* | 10-20' | 3-6' | This native blooms yellow in the spring, and can grow up a support, or trail on the ground as a groundcover. According to the Missouri Botanical Garden, this species is not aggressive like Japanese honeysuckle. |
| Virginia creeper | *Parthenosis quinuefolia* | 12-36' | | Very hardy native vine and groundcover, striking fall color. Berries are poisonous. |

| Cliffside Pocket Park | | | | |
|---|---|---|---|---|
| **Common Name** | **Botanic Name** | **Height** | **Width** | **Notes** |
| | | | | |
| Trees | | | | |
| | | | | |
| Korean fir | *Abies koreana* | 15-30' | | can tolerate periods of wet/saturated soils, evergreen, purple-blue cones |
| Arborvitae | *Thuja occidentalis* | 40-60' | 10-15' | evergreen, native, keep in full sun for best crown, not sure about how well it will tolerate wet soils, transplant B&B/container |
| Atlantic whitecedar | *Chamaecyparis thyoides* | 40-50' | 10-20' | According to Dirr, does best in boggy soils. Evergreen, native, may be hard to find in trade. |
| Bald cypress | *Taxodium distichum* | 50-70' | 20-30' | tolerant of wet soils, develop knees (keep away from paths), native |
| Basswood | *Tilia americana* | 60-80' | 30-40' | large leaves give a different texture, native, can tolerate periods of wet/saturated soil |
| Swamp white oak | *Quercus bicolor* | 50-60' | 50'-60' | |
| Tupelo | *Nyssa sylvatica* | 40-70' | 20-30' | can have brilliant fall color, native, can tolerate periods of wet/saturated soils |
| Tulip poplar | *Liriodendron tulipifera* | 80' | 40-50' | Unique blooms in spring, though high in the canopy and not always appreciable, native, can tolerate periods of wet/saturated soils |
| River birch | *Betula nigra* | 30-40’ | 20-30' | Tolerant of periods of wet/saturated soils, attractive bark, native |
| Yellowood | *Cladrastis kentuckea* | 30-50' | 40-50' | showy blooms in spring, native, not listed in Cornell's database as tolerant of wet soils |
| Ironwood | *Carpinus caroliniana* | 15-30' | 15-30' | beautiful sinewy gray bark, nice fall color, hop-like flowers in spring (not strongly showy), can tolerate periods of wet/saturated soil, native |
| Sweetbay magnolia | *Magnolia virginiana* | 15-30’ | 10-20' | mildly fragrant blooms in late spring, native, can tolerate periods of wet/saturated soils |
| Serviceberry | *Amalanchier sp.* | 20-25' | 20-25' | edible fruits, nice fall color, white blooms in early spring, not listed in Cornell's database as tolerant of wet soils but Dirr has observed it in swampy sites, native |
| Persimmon | *Diospyros virginiana* | 35-60' | 20-35' | Edible fruits, native, can tolerate periods of wet/saturated soils |
| Fringe tree | *Chionanthus virginicus* | 10-20' | 10-20' | fluffy white flowers in spring, large shrub to small tree, native |
| PawPaw | *Asimina triloba* | 15-20' | 15-20' | Edible fruits, native, can sucker, probably would do best with some shade, unique foliage |
| Shrubs | | | | |
| | | | | |
| Arrowood viburnum | *Viburnum dentatum* | depends on cultivar | depends on cultivar | White flowers in late spring, berries are anywhere from blue to blue-black. A tough plant that can adapt to a wide range of conditions. A few cultivars that would grow to the height we're looking for: 'Blue Muffin' (5-7' tall, though Dirr notes it could grow taller, blue fruits), 'Blue Blaze' (growing to about 5', wider than tall, blue fruits), 'Raspberry Tart' (4-5' tall, with good fall color). Native. |
| Summersweet clethra | *Clethra alnifolia* | 4-8' | 4-6' | This plant suckers to form a nice colony. 'Hummingbird' grows 2-3 feet tall, 'Vanilla Spice' to 3-6' tall. Many other cultivars to choose from. Bees love this native plant. |
| Red chokeberry | *Aronia arbutifolia* | 6-10' | | can tolerate wet/saturated soils, bright red fall foliage, red berries are attractive for a while after leaves fall, small white flowers in spring |
| Beautyberry | *Callicarpa americana or japonica* | 4-6' | 4-6' | Nice, full shrub for massing, purple berries really stand out in the fall. C. japonica will be easier to find in trade than the native C. americana. |
| Oakleaf hydrangea | *Hydrangea quercifolia* | 6-8' | | can tolerate periods of wet/saturated soils, nice white blooms in summer, red to wine fall foliage, some consider this coarse textured, can sucker from the base |
| | | | | |
| | | | | |

| Common Name | Botanic Name | Height | Width | Notes |
|---|---|---|---|---|
| Graystem dogwood | *Cornus racemosa* | 2-15', depending on cultivar | | 'Muskingum' is 2' by 4', with red fall color. 'Huron' is 5-6' by 5-6' with red fall color. 'Snow Lace' is 6-9 by 6-9, purple fall color and lots of white berries. Sun to shade. |
| Spicebush | *Lindnera benzoin* | 6-12' | | Yellow fall color, red berries persist for a while after leaves fall. Native. |
| Inkberry | *Ilex glabra* | 3-5' | 4-6' | Select cultivar for branch retention (i.e. 'Green Magic'). Native evergreen that grows in sun to part shade, can tolerate periods of wet/saturated soils. |
| Bottlebrush buckeye | *Aesculus parvifolia* | 10-15' | | Can tolerate periods of wet/saturated soils, bottlebrush flowers in summer, can spread pretty widely by suckering, not always easy to transplant, large foliage, striking from a distance, yellow fall color |
| Perennials | | | | |
| | | | | |
| New England aster | *Symphyotrichon novii-angliae* | 3' | | Bloom in the fall in a variety of purples and blues. Sun. |
| Purple coneflower | *Echinacea purpurea* | 3' | | This perennial is now available in shades of purple, white, and orange. Blooms mid-summer. Sun to part shade. |
| Joe-pye weed | *Eupatorium purpureum* | 5-6' | | Tall perennial with dome-shaped pink flowers in late summer to fall. Does best where it doesn't dry out. Sun. |
| Beebalm | *Monarda didyma* | 3-4' | | Sun to part shade. Hummingbirds love this plant. Blooms in pinks and reds. |
| Obedient plant | *Physostegia virginiana* | 2-3' | | N. Amer. Native. Sun to part shade. Blooms in late summer in shades of pink and white. |
| Blue-eyed grass | *Sisyrinchium angustifolium* | .5 – 1' | | Small blue flowers in spring, with some sporadic flowering later. |
| Woodland phlox | *Phlox divaricata* | 1' | | Blooms in spring in white and purple-blues. |
| Turtlehead | *Chelone glabra* | 2-3' | | Appreciates some shade, but I have seen it growing in full sun. Probably best for it to get enough moisture if it's growing in full sun. Pink and white blooms in fall. |
| Cinnamon fern | *Osmunda cinnamomea* | 2-3' | | Can grow taller in consistently moist soils. Missouri Botanic Garden notes this plant can grow in boggy soils along streams. (www.mobot.org/gardeninghelp/plantfinder/plant.asp?code=I570) Does best in areas with some shade. |
| Grasses | | | | |
| | | | | |
| Blue sedge | *Carex flacca* | 1' | | |
| Oak sedge | *Carex pennsylvanica* | 1' | | Foliage color and height depend on cultivar. Sun. Very tough plant. |
| Switch grass | *Panicum virgatum* | 3-6' | | FACU, Lady Bird Johnson Center sites this grows in wet soils, native, some pics look nice, not personally familiar with this grass, sourcing may be difficult, though I've found a few nurseries that will sell it online |
| Autumn bentgrass | *Agrostis perennans* | 1-3' | | FAC (USDA Plant database) LBJC says it can be aggressive in a good site, needs moisture, but too much can make it flop, does tolerate occasional flooding |
| Big bluestem | *Andropogon gerardii* | 3-6' | | UPL, Fine for neutral to calerous soils, can handle dry conditions. Not sure how it would do with occasional flooding, but really pretty grass and native. |
| Indian grass | *Sorghastrum nutans* | 3-4' | | facultative wetland species |
| | | | | |
| | | | | |

| Water/Shade Tolerant Plants | | | | |
|---|---|---|---|---|
| **Common Name** | **Botanic Name** | **Height** | **Width** | **Notes** |
| | | | | |
| Cinnamon fern | *Osmunda cinnamomea* | 3-5' | | |
| Great blue lobelia | *Lobelia siphilitica* | 2-3' | | |
| Turtlehead | *Chelone sp.* | 2-3' | | |
| Spiderwort | *Tradescantia virginiana* | 1-2' | | |
| Beebalm | *Monarda didyma* | 2-4' | | |
| Dutchman's breeches | *Dicentra cucularia* | 0.5' | | |
| Bleeding heart | *Dicentra examina* | 1-1.5' | | |
| Marsh marigold | *Caltha palustris* | 0.5' | | |
| Lady's slipper | *Cyprepedium calceolus* | 1' | | |
| Jack-in-the-pulpit | *Arisaema triphyllum* | 1-2' | | |
| Virginia bluebell | *Mertensia virginica* | 1' | | |
| | | | | |
| Red chokeberry | *Aronia arbutifolia* | 6-10' | 3-5' | Small white flowers in spring, bright red berries in fall. Nice red to orange fall color. Suckers for form colonies, native. |
| inkberry | *Ilex glabra* | 4-6' | 3-5' | Native evergreen, can sucker to form colonies. |
| Birch | *Betula nigra* | | | Could use a dwarf cultivar like 'Fox Valley' |
| winterberry | *Ilex verticillata* | 6-10' | | Bright red berries in the fall. |
| Ironwood | *Carpinus caroliniana* | 20-35' | 20-35' | |

| Main Street Trees | | | | | | |
|---|---|---|---|---|---|---|
| Common Name | Botanic Name | Height | Width | Notes | | |
| | | | | | | |
| Basswood | *Tilia americana* | 60-80' | 30-40' | Maybe not the thin canopy we're looking for, but in time, the tree could be limbed up to show the mural underneath. | | |
| Gingko | *Gingko biloba* | 50-80 | 40-50' | Could choose a more columar cultivar like Golden Colonnade. Very tough tree, with golden fall color. Specify a male cultivar to avoid messy and unpleasant smelling fruit. | | |
| Serviceberry | *Amalanchier sp.* | 20-25' | 20-25' | Small tree, but it does have a fairly thin canopy. Will have some petal liter. | | |
| Elm | *Ulmus 'Homestead', 'Patriot', 'Frontier'* | 50-60'? | 25-35'? | Possible replacements for American elm, maybe lift crown as tree ages so the mural can be seen underneath? | | |
| Thornless honeylocust | *Gleditsia triacanthos var. inermis* | 30-40' | | Thin canopy, but has been heavily planted. | | |
| European hornbeam | *Carpinus betulus 'Fastigiata'* | 30-40' | 20-30' | | | |

| Bicentennial Tree | | | | |
|---|---|---|---|---|
| **Common Name** | **Botanic Name** | **Height** | **Outline** | **Notes** |
| | | | | |
| Persian Parrotia | *Parrotia persica* | 20-30' | oval | Beautiful mosiac bark, subtle maroon flowers in late winter/early spring, great fall color, tolerates alkaline soil and drought. |
| Lacebark elm | *Ulmus parvifolia* | 30-40' | oval to rounded | Beatiful, exfoliating bark, tolerates alkaline soil and drought. This tree can grow taller in a landscape situation, but doubtful with the constrained rooting area this tree will have. |
| Japense tree lilac | *Syringa reticulata* | 20-30' | oval to rounded | Creamy flowers in summer, tolerant of alkaline soil and salt, drought tolerant. 'Ivory Snow' is noted as a heavily flowering cultivar. |
| Paperbark maple | *Acer griseum* | 20-30' | oval | Beautiful exfoliating bark, nice fall color. |
| Winter King' hawthorne | *Crateugus viridis 'Winter King'* | 20-30' | oval | White flowers in spring followed by bright red berries in fall, persist into winter. |
| Amur maackia | *Maackia amurensis* | 20-30' | round | White flowers in summer, rich brown bark which peels with maturity. Flowers followed by 2-3" pods. |
| Red horsechestnut | *Aesculus xcarnea 'Briotii'* | 30' | round | 10-12" pannicles of red flowers in summer, full green foliage. This species is less prone to leaf blotch and scorch than common horsechestnut. |
| Kousa dogwood | *Cornus kousa* | 20-30' | round to spreading | White flowers after leaves emerge, exfoliating bark with age and great fall color. Perhaps choose a more upright cultivar to make sure there's clearance under the branches. 'Doubloon', 'Steeple', or 'Silverstar'. |
| Allegheny serviceberry | *Amalanchier laevis* | 15-25' | oval | White flowers in early spring, great fall color. Native. Another option is Amalanchier arborea 'Robin Hill', a larger form growing 25-30'. |
| Winter King' hawthorne | *Crataegus viridus 'Winter King'* | 20-30' | round-spreading | White flowers in spring followed by bright red berries in fall, persist into winter. Cultivar of a native species. Can contract rust, though less susceptible than other hawthornes (Dirr). |
| Painted maple | *Acer truncatum* | 20-30' | round | Bright yellow flowers in spring, followed by purplish-green new leaves which mature to green. Fall color ranges through yellow, red and orange. |
| Perennials for the base of the tree | | | | |
| Woodland phlox | *Phlox divaricata* | 1’ | | Blooms in spring in white and purple-blues. |
| Robb's spurge | *Euphorbia robbiae* | 1.5' | | Spreads to form an evergreen mat with chartreuse flowers in spring. |
| Bishop's Hat | *Epimedium* | 1' | | Lots of cultivars to choose from with white to pink to yellow blooms in spring. Spread slowly to form a thick mat of foliage. |
| Geranium | *Geranium maccorhizum 'Biokovo'* | 1' | | Spreads to form a mat, flowers white or pink in the summer, orange and red fall color |
| Sedge | Carex Evergold | 1' | | Yellow sedge, forms a graceful mound. |
| Lenten rose | *Helleborus hybridus* | 1-2' | | Evergreen leaves, flowers bloom a variety of white, green, pink and maroon in late winter to early spring (depends on cultivar). |
| Hosta | *Hosta* | varies | | Many to choose from, tiny groundcover hostas to big specimens, yellow to blue to green to variegated leaves. Deer love these, don't try to mix the two. |
| Alleghany sedge | *Carex pennsylvanica* | less than 1' | | Fine textured, native groundcover. |
| Lady fern | *Athyrium filix-femina* | 1-3' | | Native fern, tolerates drier soils than many ferns. |
| Beth Chatto' cranesbill | *Geranium maculatum* | 1' | | Pink flowers in spring. Native. |
| woodland aster | *Aster divaricatus* | 1-2' | | White flowers in summer. Native. |
| Foamflower | *Tiarella cordifolia* | less than 1' | | Spreads to form a mat of green leaves, some cultivars have burgundy markings. Frothy white blooms in spring. Native. |

# *Virginia Cooperative Extension*
## Soil Test Report

Virginia Tech Soil Testing Laboratory
145 Smyth Hall (0465)
Blacksburg, VA 24061
www.soiltest.vt.edu

SEE ENCLOSED NOTES:
1 20

OWNER: COMMUNITY DESIGN ASSISTE
CDAC

COPY FOR: CHINKAPIN OAK PARK

SAMPLE HISTORY

| Sample ID | Field ID | LAST CROP | | LAST LIME APPLICATION | | SOIL INFORMATION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Name | Yield | Months Prev. | Tons/Acre | SMU-1 % | SMU-2 % | SMU-3 % | Yield Estimate | Productivity Group |
| CHINK | | | | | | | | | | |

LAB TEST RESULTS (see Note 1)

| Analysis | P (lb/A) | K (lb/A) | Ca (lb/A) | Mg (lb/A) | Zn (ppm) | Mn (ppm) | Cu (ppm) | Fe (ppm) | B (ppm) | S.Salts (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Result | 50 | 344 | 3628 | 428 | 27.9 | 10.6 | 0.4 | 4.0 | 1.1 | |
| Rating | H- | VH | VH | VH | SUFF | SUFF | SUFF | SUFF | SUFF | |

| Analysis | Soil pH | Buffer Index | Est.-CEC (meq/100g) | Acidity (%) | Base Sat. (%) | Ca Sat. (%) | Mg Sat. (%) | K Sat. (%) | Organic Matter (%) |
|---|---|---|---|---|---|---|---|---|---|
| Result | 6.9 | 6.40 | 11.3 | 0.5 | 99.5 | 80.0 | 15.6 | 3.9 | |

FERTILIZER AND LIMESTONE RECOMMENDATIONS

**Crop:** TREES. (246)

**619. Lime recommendations: NONE NEEDED.**

**261. FERTILIZER RECOMMENDATIONS: See Note 20 (enclosed).**

**990. We are trying to improve our service. PLEASE take a moment to complete our brief, anonymous customer survey at tinyurl.com/soiltestsurvey**

Lab ID: 11-48305 2011-11-29 VPI & SU CAMPUS / 911

# *Virginia Cooperative Extension*

## Soil Test Report

**Virginia Tech Soil Testing Laboratory**
**145 Smyth Hall (0465)**
**Blacksburg, VA 24061**
**www.soiltest.vt.edu**

**SEE ENCLOSED NOTES:**
1 20

OWNER COMMUNITY DESIGN ASSISTE
CDAC

COPY FOR CLIFFSIDE PARK

**SAMPLE HISTORY**

| Sample ID | Field ID | LAST CROP | | LAST LIME APPLICATION | | SOIL INFORMATION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Name | Yield | Months Prev. | Tons/Acre | SMU-1 % | SMU-2 % | SMU-3 % | Yield Estimate | Productivity Group |
| CLIFF | | | | | | | | | | |

**LAB TEST RESULTS (see Note 1)**

| Analysis | P (lb/A) | K (lb/A) | Ca (lb/A) | Mg (lb/A) | Zn (ppm) | Mn (ppm) | Cu (ppm) | Fe (ppm) | B (ppm) | S.Salts (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Result | 160 | 596 | 6483 | 525 | 24.7 | 25.7 | 0.8 | 6.4 | 2.2 | |
| Rating | VH | VH | VH | VH | SUFF | SUFF | SUFF | SUFF | SUFF | |

| Analysis | Soil pH | Buffer Index | Est.-CEC (meq/100g) | Acidity (%) | Base Sat. (%) | Ca Sat. (%) | Mg Sat. (%) | K Sat. (%) | Organic Matter (%) |
|---|---|---|---|---|---|---|---|---|---|
| Result | 7.4 | N/A | 19.1 | N/A | 100.0 | 84.7 | 11.3 | 4.0 | |

**FERTILIZER AND LIMESTONE RECOMMENDATIONS**

**Crop:** TREES. (246)

**619. Lime recommendations: NONE NEEDED.**

**261. FERTILIZER RECOMMENDATIONS: See Note 20 (enclosed).**

**990. We are trying to improve our service. PLEASE take a moment to complete our brief, anonymous customer survey at tinyurl.com/soiltestsurvey**

Lab ID: 11-48303 2011-11-29 VPI & SU CAMPUS / 911

# *Virginia Cooperative Extension*

## Soil Test Report

Virginia Tech Soil Testing Laboratory
145 Smyth Hall (0465)
Blacksburg, VA 24061
www.soiltest.vt.edu

SEE ENCLOSED NOTES:
1 20

OWNER COMMUNITY DESIGN ASSISTE
CDAC

COPY FOR STREET TREE WEST PARK

SAMPLE HISTORY

| Sample ID | Field ID | LAST CROP | | LAST LIME APPLICATION | | SOIL INFORMATION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Name | Yield | Months Prev. | Tons/Acre | SMU-1 % | SMU-2 % | SMU-3 % | Yield Estimate | Productivity Group |
| STREE | | | | | | | | | | |

LAB TEST RESULTS (see Note 1)

| Analysis | P (lb/A) | K (lb/A) | Ca (lb/A) | Mg (lb/A) | Zn (ppm) | Mn (ppm) | Cu (ppm) | Fe (ppm) | B (ppm) | S.Salts (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Result | 261 | 488 | 6483 | 585 | 49.6 | 19.7 | 0.4 | 3.1 | 1.7 | |
| Rating | VH | VH | VH | VH | SUFF | SUFF | SUFF | SUFF | SUFF | |

| Analysis | Soil pH | Buffer Index | Est.-CEC (meq/100g) | Acidity (%) | Base Sat. (%) | Ca Sat. (%) | Mg Sat. (%) | K Sat. (%) | Organic Matter (%) |
|---|---|---|---|---|---|---|---|---|---|
| Result | 7.4 | N/A | 19.2 | N/A | 100.0 | 84.2 | 12.5 | 3.3 | |

FERTILIZER AND LIMESTONE RECOMMENDATIONS

**Crop:** TREES. (246)

**619. Lime recommendations: NONE NEEDED.**

**261. FERTILIZER RECOMMENDATIONS: See Note 20 (enclosed).**

**990. We are trying to improve our service. PLEASE take a moment to complete our brief, anonymous customer survey at tinyurl.com/soiltestsurvey**

# Using CU-Structural Soil™ in the Urban Environment

Cornell University

**Urban Horticulture Institute**
Cornell University
Department of Horticulture
134A Plant Science Building
Ithaca, NY 14853
www.hort.cornell.edu/UHI

Founded in 1980 with the explicit mission of improving the quality of urban life by enhancing the functions of plants within the urban ecosystem, the Urban Horticulture Institute program integrates plant stress physiology, horticultural science, plant ecology and soil science and applies them to three broad areas of inquiry.

They are:

• The selection, evaluation and propagation of superior plants with improved tolerance of biotic and abiotic stresses, and enhanced functional uses in the disturbed landscape.

• Developing improved technologies for assessing and ameliorating site limitations to improve plant growth and development.

• Developing improved transplant technologies to insure the successful establishment of plants in the urban environment.

***Authors:***
Nina Bassuk, Urban Horticulture Institute, Department of Horticulture, Cornell University
Jason Grabosky, Department of Ecology, Evolution, & Natural Resources, Rutgers University
Peter Trowbridge, Department of Landscape Architecture, Cornell University

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***Layout & Graphics:***
Violet Jones & Wendy Wirth

***Photo Credits*:**
N. Bassuk, B. Kalter, & P. Trowbridge



***Cover Photo:***
Elm trees planted in CU-Structural Soil™ Square Park, NYC.

# The Case for CU-Structural Soil™:

## Why do we need it, what is it, and how is it used?

Urban trees experience a litany of environmental insults: soil and air pollution, heat loads, deicing salts, and impacts from utilities, vehicles, and buildings. The most significant problem that urban trees face, however, is the lack of useable soil volume for root growth, since trees are often an afterthought in city planning and streescape design. (Fig. 1.1)

Fig. 1.1 Tree root ball prior to being planted in a 4' x 5' tree pit in NYC.

Fig. 1.2 Compaction is necessary to create a load-bearing surface on which to lay pavement.

### Soil Compaction

Ongoing construction, including sidewalk and road repair, disturbs and compacts soil (Fig. 1.2), crushing macropores (Fig. 1.3). Loss of macropores has three negative consequences: restricted aeration, diminished water drainage, and creating a dense soil that is difficult for roots to penetrate. These effects limit useable rooting space.

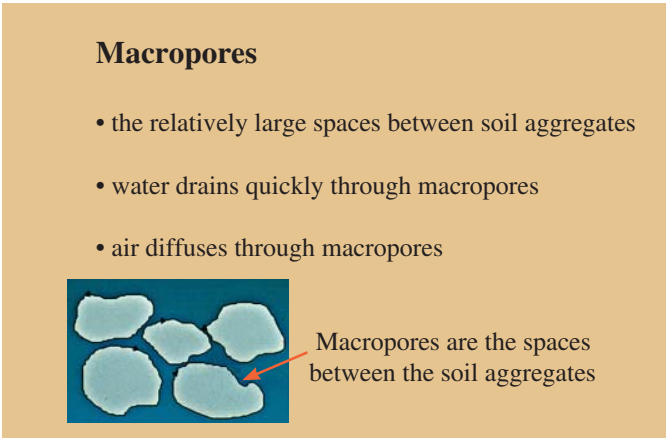



Fig. 1.3 Macropores are spaces between soil aggregates that allow water, air and subsequently root growth.

Fig. 1.4 Surface rooting of trees growing in compacted soils

### What happens when roots encounter dense, compacted soil?

When roots encounter dense soil, they change direction, stop growing, (Fig 1.5) or adapt by remaining abnormally close to the surface (Fig. 1.4) This superficial rooting makes urban trees more vulnerable to drought and can cause pavement heaving. However, if a dense soil is waterlogged, tree roots can also rot from lack of oxygen.

Fig. 1.5 Tree roots which are typically superficial can become 'containerized' by compacted soil under and around trees.

Fig.1.6 This photograph shows the effect of soil volume on tree growth. Both rows of willow oaks were planted at the same time on Pennsylvania Avenue, Washington, D.C. The trees on the right are in tree pits, and those on the left are in an open grassed area.

## The role of soil volume on tree growth

The soil in urban tree lawns or parks can be improved by amendment or soil replacement. Where soil volume is limited by pavement, tree roots suffer (Fig 1.6). The highly compacted soils required for constructing pavements do not allow root penetration, resulting in declining trees which are all too common in cities. Yet it is precisely these paved areas such as parking lots and streets that most need the mitigating effects of shade trees.

Healthy trees need a large volume of non-compacted soil with adequate drainage and aeration and reasonable fertility. CU-Structural Soil™ meets these needs while also fulfilling engineers' load-bearing requirements for base courses under pavement.

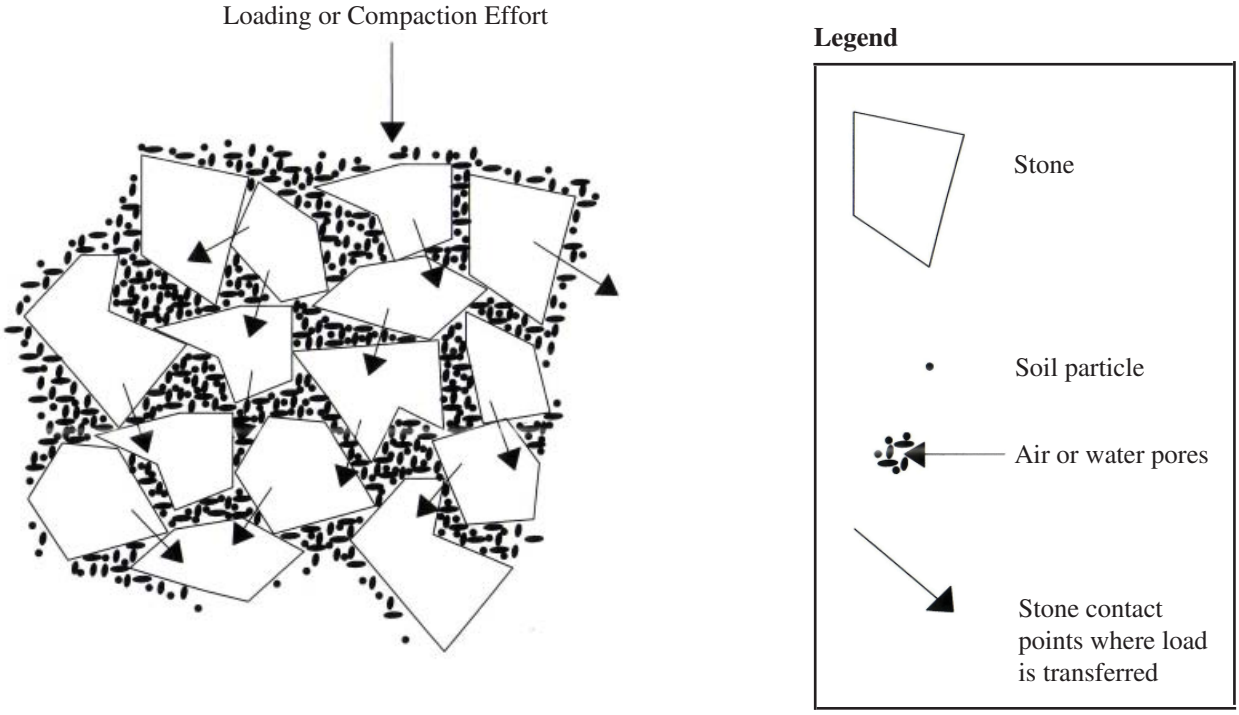



Fig.1.7 Conceptual diagram of CU-Structural Soil™ including stone-on-stone compaction and soil in interstitial spaces used as a base course for pavements.

## CU-Structural Soil™ Basics

CU-Structural Soil™ (U.S. Patent # 5,849,069) is a two-part system comprised of a rigid stone "lattice" to meet engineering requirements for a load-bearing soil, and a quantity of soil, to meet tree requirements for root growth. The lattice of load-bearing stones provides stability as well as interconnected voids for root penetration, air and water movement (Fig. 1.7). The uniformly graded 3/4"-1 1/2" angular crushed stone specified for CU-Structural Soil™ is designed to ensure the greatest porosity. Crushed or angular stone provides more compaction and structural interface of stone-to-stone than round stone. Because stone is the load-bearing component of structural soil, the aggregates used should meet regional or state department of transportation standards for pavement base courses.

Since among soil textures, clay has the most water and nutrient-holding capacity, a heavy clay loam or loam, with a minimum of 20% clay, is selected for the CU-Structural Soil™ system. CU-Structural Soil™ should also have organic matter content ranging from 2%-5% to ensure nutrient and water holding while encouraging beneficial microbial activity. A minimum of 20% clay is also essential for an adequate cation exchange capacity.

With carefully chosen uniformly-graded stone and the proper stone to soil ratio, a medium for healthy root growth is created that also can be compacted to meet engineers' load-bearing specifications (Fig. 1.8). The intention is to "suspend" the clay soil between the stones without over-filling the voids, which would compromise aeration and bearing capacity. CU-Structural Soil™ utilizes Gelscape® hydrogel as a non-toxic, non-phytotoxic tackifier, in addition to stone and soil components.

Fig. 1.8 From upper left, clockwise: uniformly-graded crushed stone of 3/4" - 1 1/2" diameter, pile and close-up; CU-Structural Soil™ after mixing; clay loam.

## Using CU-Structural Soil™ for Street Trees

CU-Structural Soil™ is intended for paved sites to provide adequate soil volumes for tree roots under pavements (Fig. 1.9). It can and should be used under pedestrian mall paving, sidewalks, parking lots, and low-use access roads. The Urban Horticulture Institute is currently conducting trials of its use under turf and porous asphalt to provide more porous parking areas. Research at Cornell has shown that tree roots in CU-Structural Soil™ profiles grow deep into the base course material, away from the fluctuating temperatures at the pavement surface. One benefit of this is that roots are less likely to heave and crack pavement than with conventional paving systems (Fig. 1.10).

Planting a tree into CU-Structural Soil™ is much like conventional planting. If possible, the pavement opening should be expandable (via removable pavers or using a mulched area) for the sake of the anticipated buttress roots of maturing trees (Fig. 1.11). CU-Structural Soil™ should be used at a depth of at least 24" but preferably 36" (Fig.1.12). CU-Structural Soil™ can be used right up to the surface grade where there is a pavement opening that is large enough to allow for tree installation.

Fig.1.9 Installing CU-Structural Soil™ in Ithaca, NY in 1997

Fig. 1.10 Sidewalk heaving caused by superficial tree root growth, Ithaca, NY

Fig. 1.11 Lindens in CU-Structural Soil™ in Boston, 2002

Fig. 1.12a Example of street tree planting using CU-Structural Soil™ under conventional concrete sidewalk in Brooklyn, NY

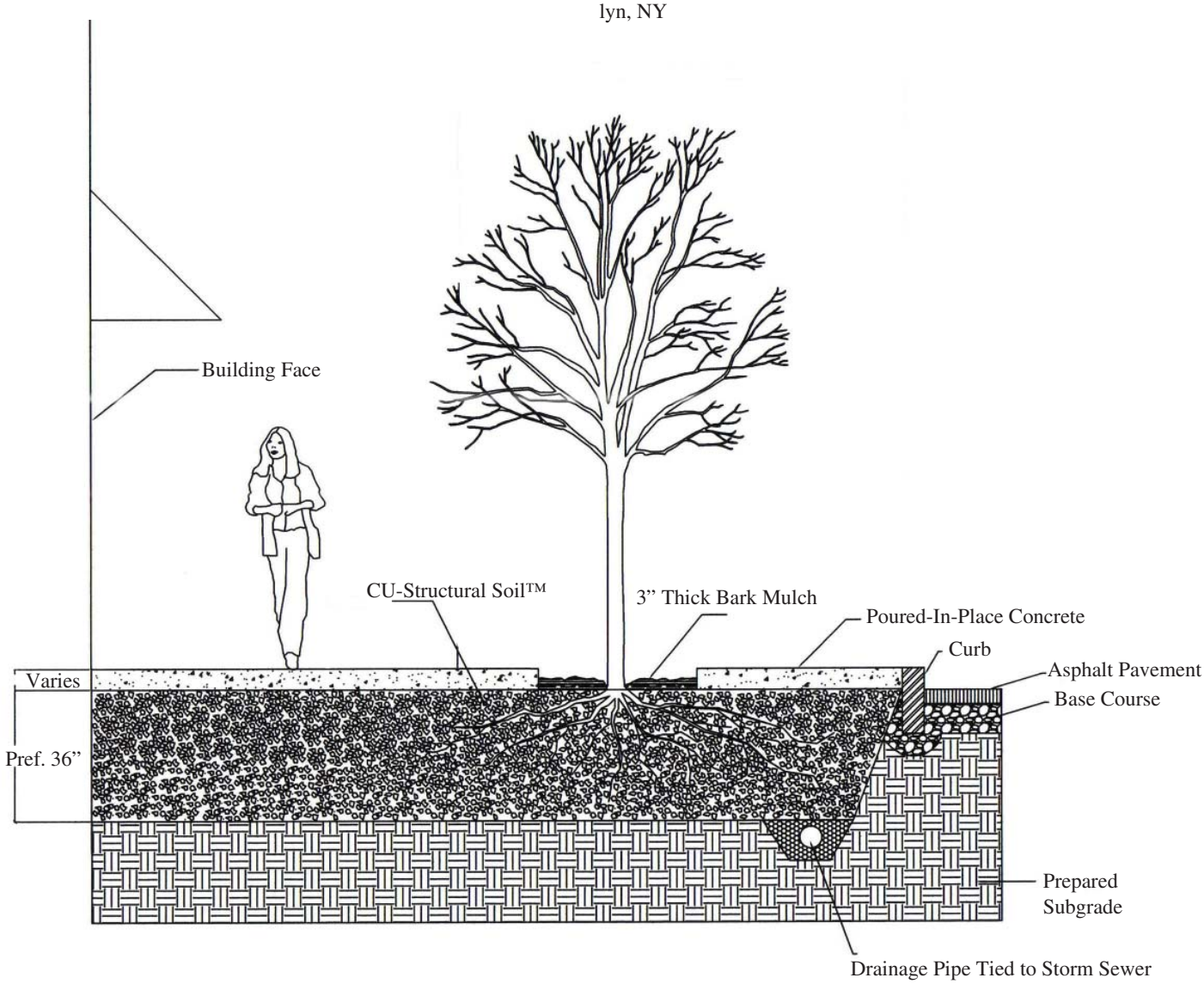



Fig. 1.12 Typical street tree planting using CU-Structural Soil™ under a sidewalk

## Trees in Parking Lots and Plazas:

CU-Structural Soil™ may also be used to enlarge a 'tree island' within a parking lot. With a large tree planting area, good, well draining topsoil can be used in the island and CU-Structural Soil™ added as an unseen rooting medium under the asphalt (Figs. 1.13 - 1.15).

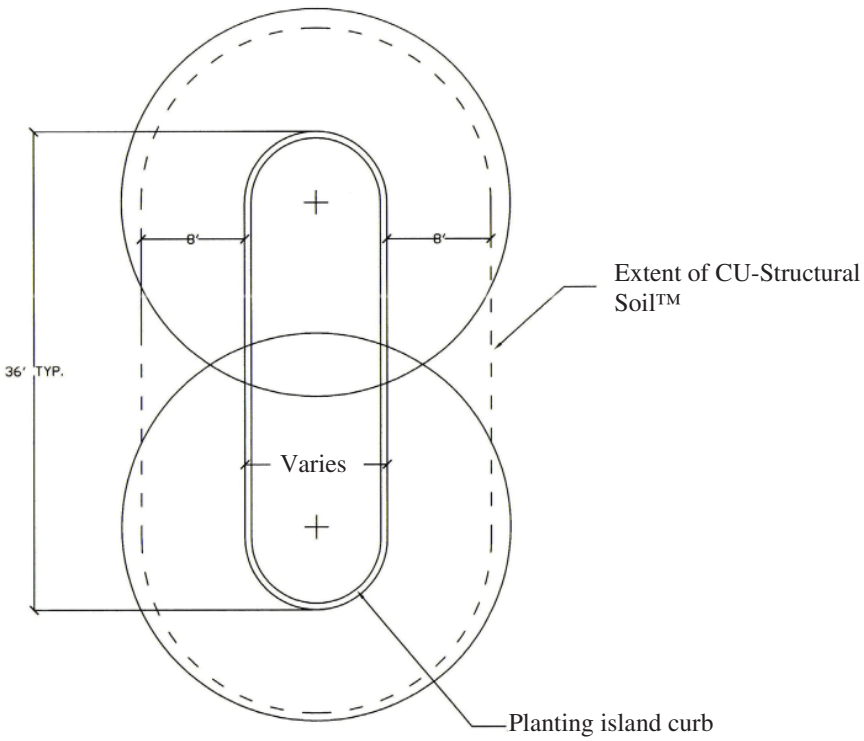



Fig. 1.13 Plan view of planting island

Fig. 1.14 Potential use of CU-Structural Soil™ to enlarge planting islands in parking lots without taking up parking space

Trees in parking lots, as well as paved plazas, benefit from the use of CU-Structural Soil™ (Fig.1.16 - 1.17). Whether there is a curb or not, good, well-drained topsoil may be used around the tree where the opening is at least 5' x 5'. If the opening is smaller, CU-Structural Soil™ may be used right up to the tree ball. Although it is not necessary to use an additional base course on top of CU-Structural Soil™, some engineers may want to do this, immediately under the pavement.

Given the large volume of CU-Structural Soil™ for tree roots to explore, irrigation may not be necessary after tree establishment—the decision depends on the region of the country and on site management. While there is less moisture in CU-Structural Soil™ on a per-volume basis than in conventional soil, the root system in structural soil has more room for expansion, allowing for increased water absorption. Supplemental water should be provided during the first growing season as would be expected for any newly planted tree. In regions where irrigation is necessary to grow trees, low-volume, under-pavement irrigation systems have been used successfully. Fertilizer can be dissolved into the irrigation water if necessary, although to date, nutrient deficiencies have not been noted, probably due to the large volume of rooting media.

Fig. 1.15 In this parking lot, there is only a 2 foot opening for tree planting. Here CU-Structural Soil™ was installed parallel to railroad tracks, 12' wide and 36" deep. With such a narrow opening, there is no reason to use a planting mix other than CU-Structural Soil™ around the tree ball.

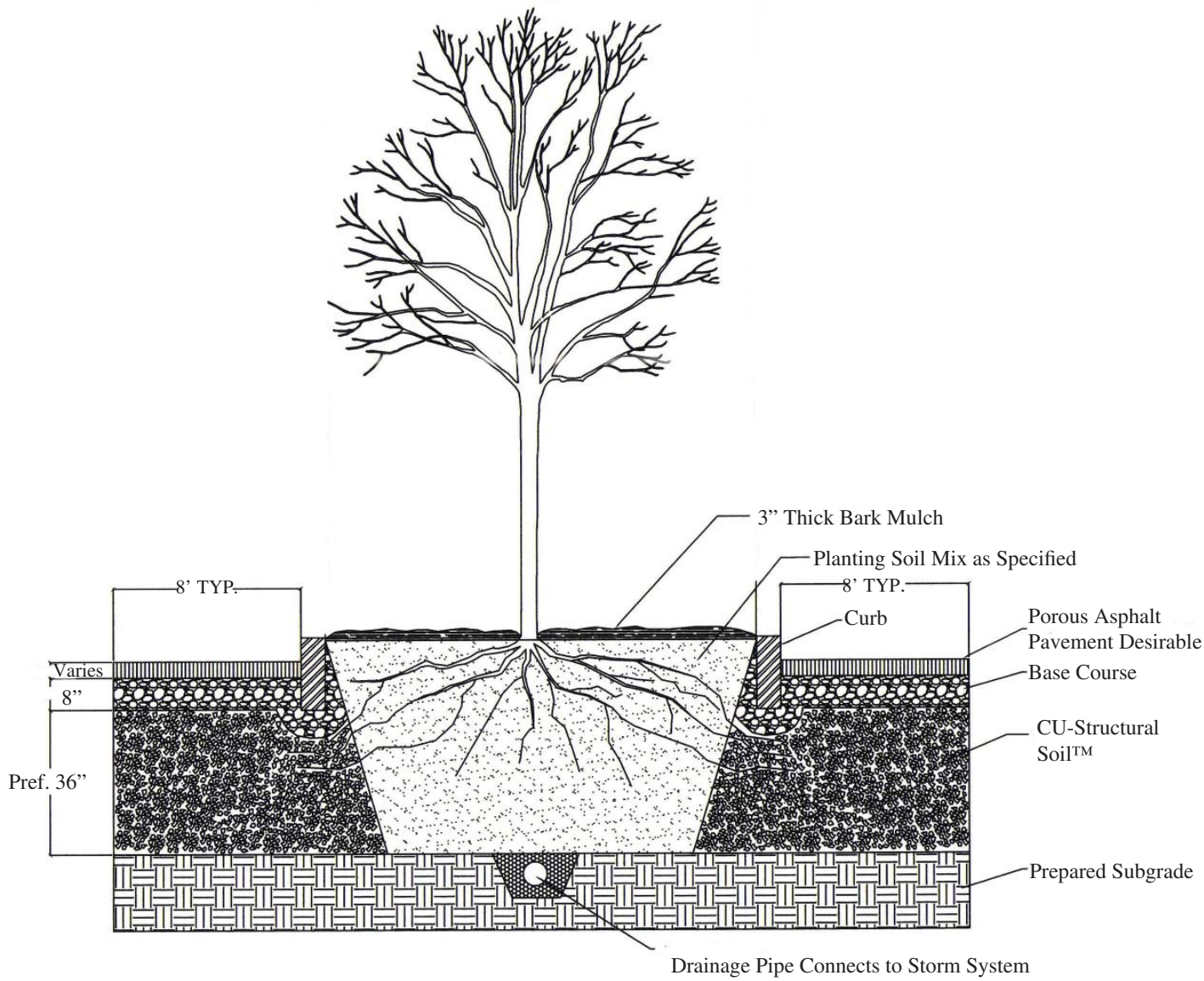



Fig. 1.16 Bare root tree in typical parking lot island or plaza

Fig. 1.17 English oaks planted in a plaza at Battery Park City, NYC

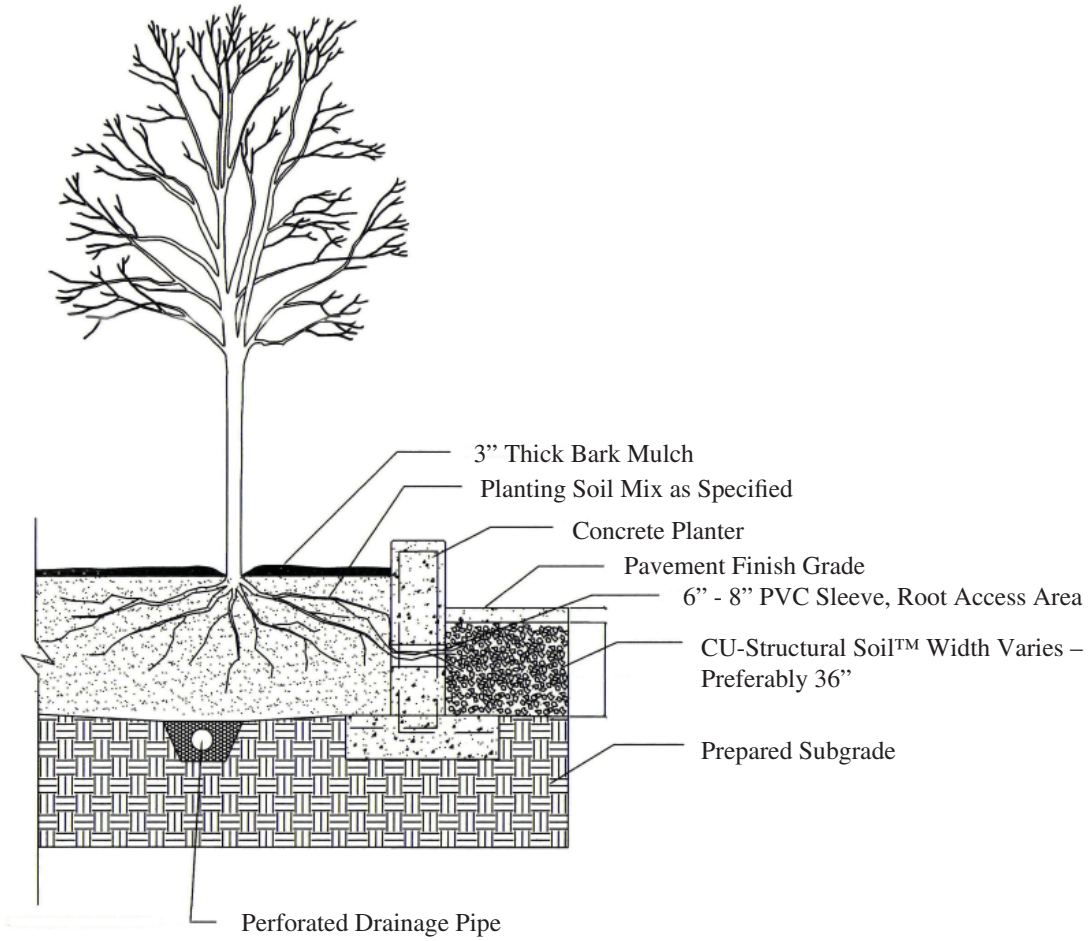



Fig. 1.18 Limited soil volume planter with root access into CU-Structural Soil™ under plaza pavement

Positive drainage below the root system is necessary in this system, since the sub-grade below the CU-Structural Soil™ may be compacted and impermeable. A perforated and wrapped drain, connected to storm drainage, should be placed between the CU-Structural Soil™ and the compacted sub-grade (Fig.1.18).

Where the curb footer goes to greater depth for a planter, a 6”- 8” PVC sleeve filled with uncompacted soil should be used to give tree roots access to the CU-Structural Soil™ beyond the planter wall (Figs 1.18-1.19).

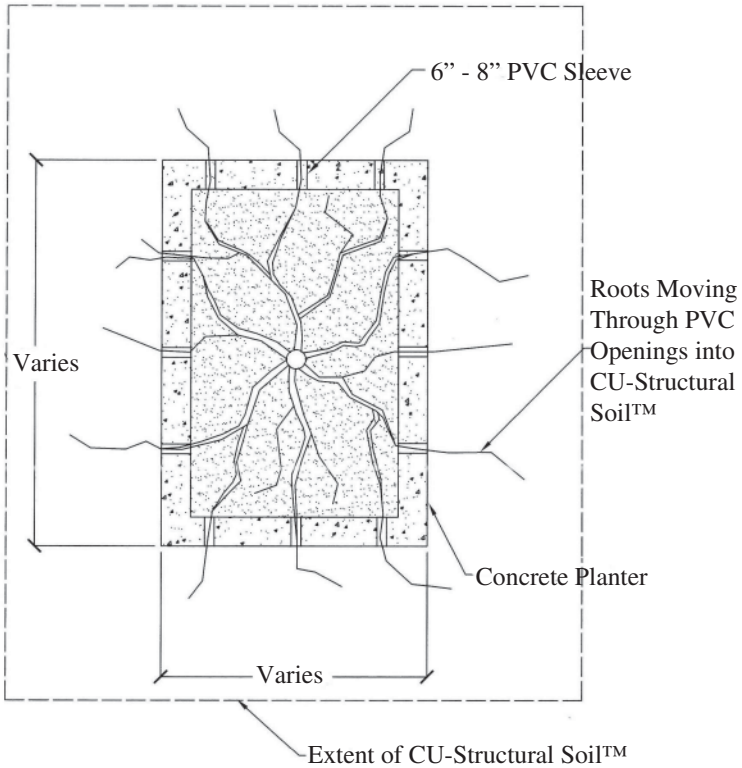



Fig. 1.19 Plan view of limited soil volume planter

## Creating break-out zones for trees in narrow tree lawns

Where there is an adjacent green space, whether a park or front lawn, CU-Structural Soil™ may be used as a channel for roots to safely grow under pavement into this green space (Figs. 1.20 - 1.23). Generally two 5' concrete flags are removed, then the area is excavated to 24"- 36" and CU-Structural Soil™ is backfilled into them. Paving slabs are then replaced in a conventional manner.

Fig. 1.20 Break-out zone with CU-Structural Soil™ under a sidewalk between a narrow tree lawn and adjacent landscape area

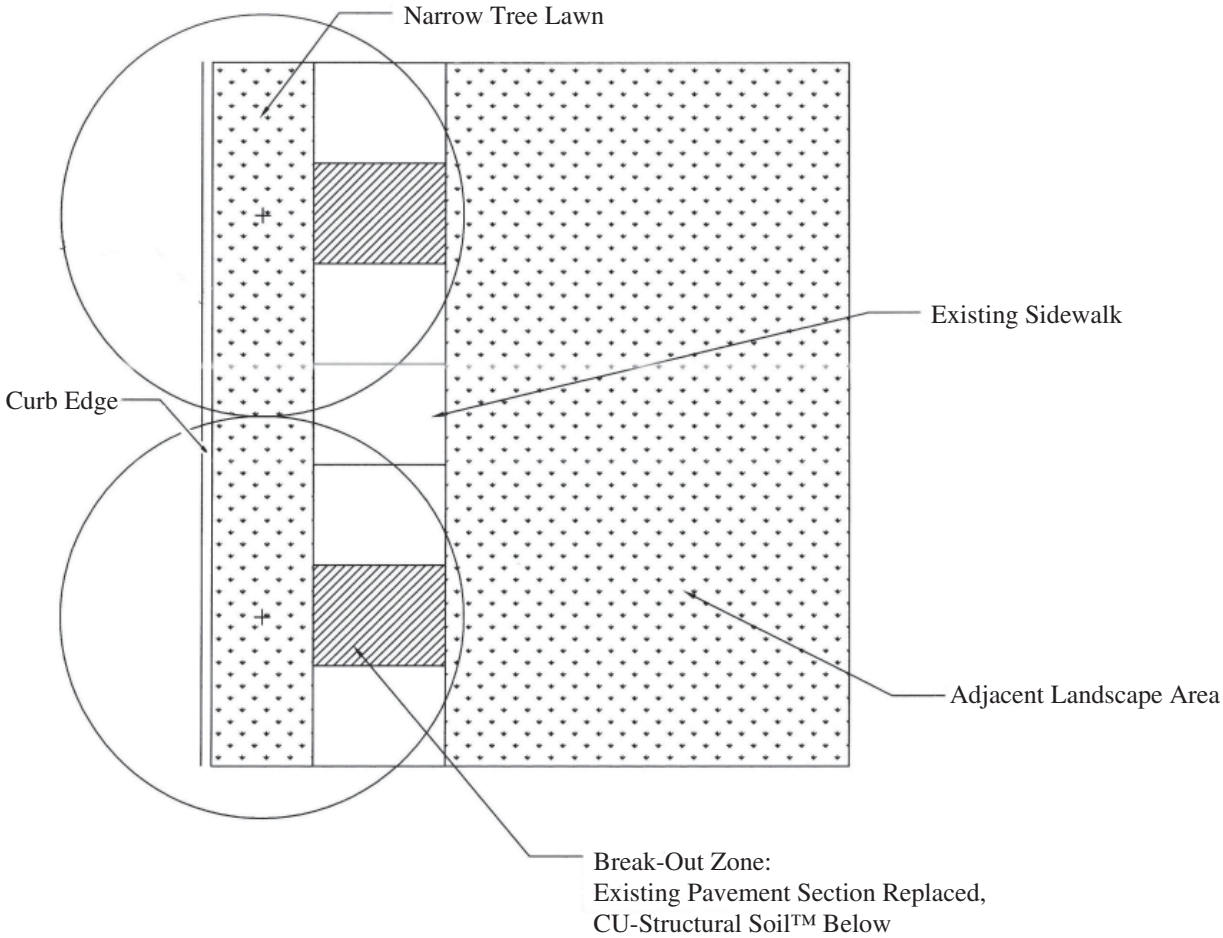



Fig. 1.21 Plan view of retrofitted CU-Structural Soil™ break-out zone

Fig. 1.22 Trees planted in Brooklyn, NY in 1997 where CU-Structural Soil™ was installed in a continuous trench 7' wide adjacent to the park fence.

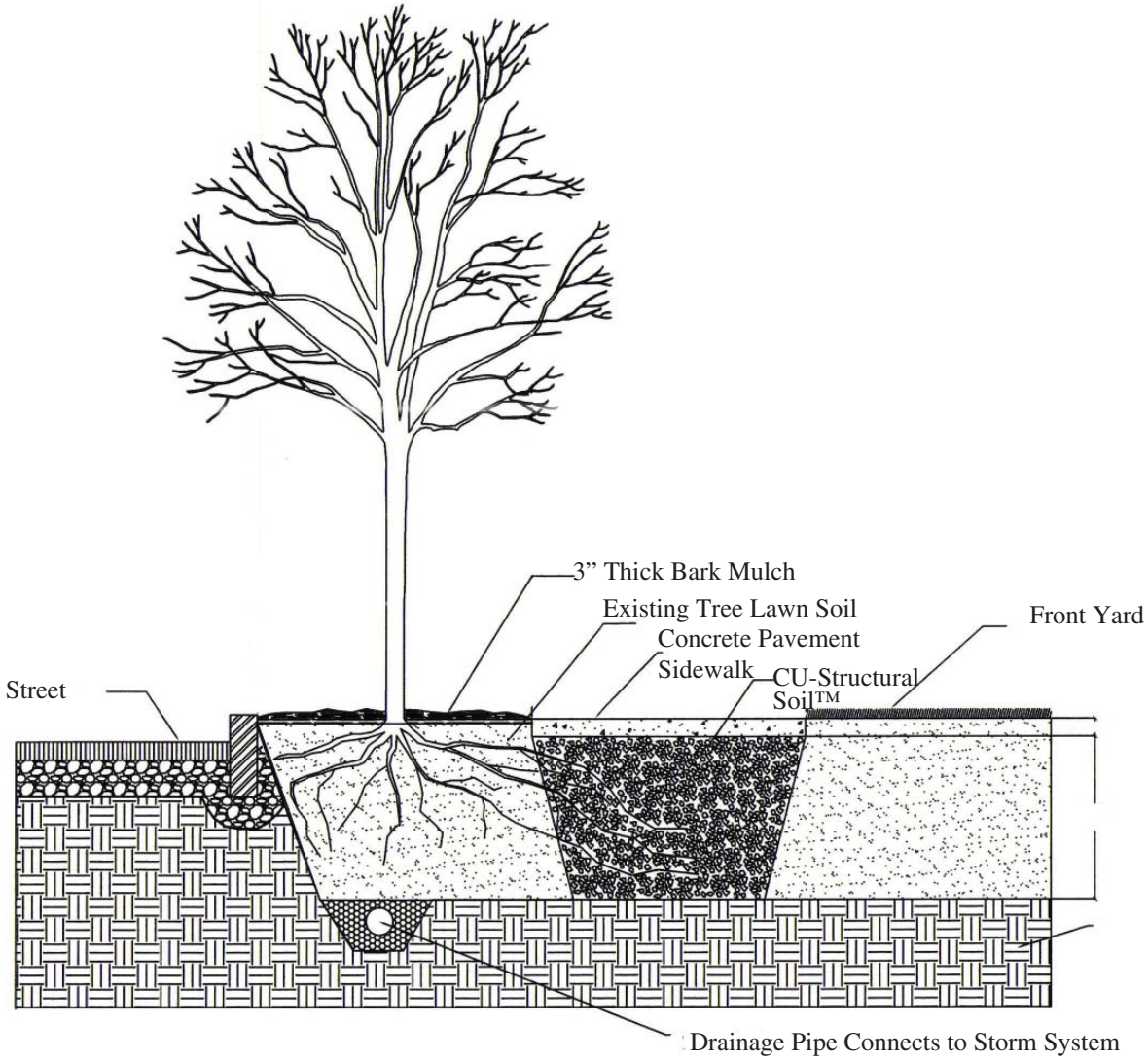



Fig. 1.23 CU-Structural Soil™ break-out zone from narrow tree lawn to adjacent landscape area

## CU-Structural Soil ™ use with permeable pavers

If non-mortared pavers are used, a setting bed of uniformly-graded coarse sand should be used, to a depth specified by paver manufacturer specifications. To discourage rooting in this layer, a geo-textile—one that does not restrict water movement—can be used between this material and the CU-Structural Soil™ (Figs. 1.24 - 1.25).

Fig. 1.24 Concrete unit pavers on a coarse sand setting bed on top of a continuous trench of CU-Structural Soil™ in Ithaca, NY

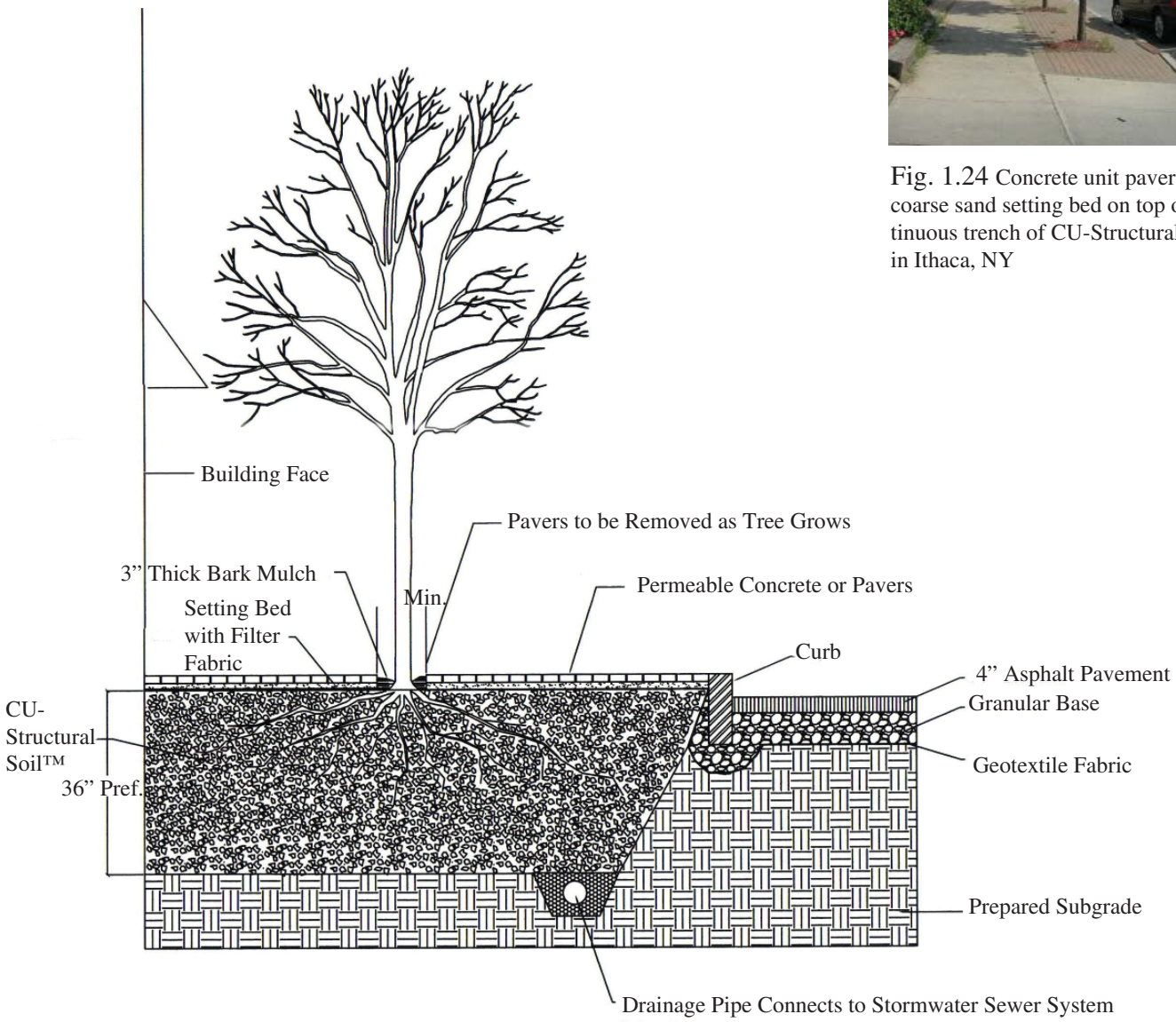



Fig. 1.25 Street tree detail with permeable pavers

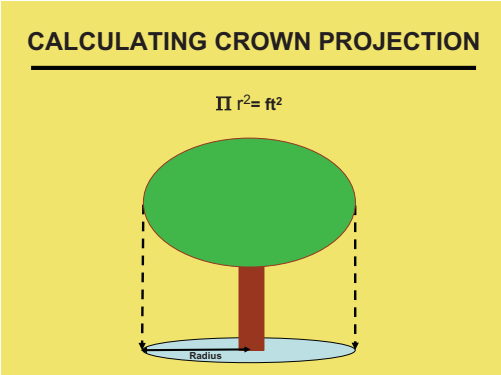
# Some Street Trees Appropriate for use in CU-Structural Soil™

(Guiding selection criteria: moderate to highly drought tolerant and alkaline soil tolerant trees)

| ***Botanic Name*** | **Common Name** |
|---|---|
| *Acer campestre* | Hedge Maple |
| *Acer miyabei* | Miyabei Maple |
| *Acer nigrum* | Black Maple |
| *Acer platanoides* | Norway Maple |
| *Acer pseudoplatanus* | Sycamore Maple |
| *Acer truncatum* | Painted Maple |
| *Carpinus betulus* | European Hornbeam |
| *Catalpa speciosa* | Northern Catalpa |
| *Celtis occidentalis* | Hackberry |
| *Cercis canadensis* | Redbud |
| *Cornus mas* | Cornelian Cherry |
| *Cornus foemina (Cornus racemosa)* | Gray Dogwood |
| *Corylus colurna* | Turkish Hazelnut |
| *Crataegus crus-galli* | Cockspur Hawthorn |
| *Crataegus phaenopyrum* | Washington Hawthorn |
| *Crataegus punctata* | Thicket Hawthorn |
| *Crateagus viridis* | Green Hawthorn |
| *Eucommia ulmoides* | Hardy Rubber Tree |
| *Fraxinus americana* | White Ash |
| *Fraxinus excelsior* | European Ash |
| *Fraxinus pennsylvanica* | Green Ash |
| *Ginkgo biloba* | Ginkgo |
| *Gleditsia triacanthos* | Honey Locust |
| *Gymnocladus dioicus* | Kentucky Coffee Tree |
| *Koelreuteria paniculata* | Goldenrain Tree |
| *Maclura pomifera* | Osage Orange |
| *Malus* spp. | Crabapple |
| *Parrotia persica* | Ironwood |
| *Phellodendron amurense* | Amur Cork Tree |
| *Platanus* x *acerifolia* | London Plane |
| *Populus alba* | White Poplar |
| *Populus deltoides* | Northern Cottonwood |
| *Populus tremuloides* | Quaking Aspen |
| *Pyrus calleryana* | Callery Pear |
| *Pyrus ussuriensis* | Ussurian Pear |
| *Quercus macrocarpa* | Mossy-Cup Oak |
| *Quercus muehlenbergii* | Chinkapin Oak |
| *Quercus robur* | English Oak |
| *Robinia pseudoacacia* | Black Locust |
| *Styphnolobium japonicum (Sophora japonica)* | Japanese Pagoda Tree |
| *Sorbus alnifolia* | Korean Mountain Ash |
| *Sorbus thuringiaca* | Oak-Leafed Mountain Ash |
| *Syringa reticulata* | Japanese Tree Lilac |
| *Tilia americana* | Basswood |
| *Tilia cordata* | Littleleaf Linden |
| *Tilia tomentosa* | Silver Linden |
| *Tilia* x *euchlora* | Crimean Linden |
| *Ulmus americana* | American Elm |
| *Ulmus carpinifolia* | Smooth-Leaf Elm |
| *Ulmus parvifolia* | Lace Bark Elm |
| *Ulmus* spp. | Elm Hybrids |
| *Zelkova serrata* | Japanese Zelkova |

(names in parentheses are older botanic names)

## Frequently Asked Questions




**What volume of CU-Structural Soil™ is needed for a given tree?**
The Urban Horticulture Institute at Cornell has found that, with the exception of the desert southwest, two cubic feet of soil is needed for every square foot of crown projection (the anticipated area under the drip line of the tree at expected maturity). Trees growing in CU-Structural Soil™ in areas that normally use irrigation to grow trees should also provide low volume drip irrigation in CU-Structural Soil™ installations.

**What is the recommended depth for CU-Structural Soil™?**
We suggest a minimum of 24" but 36" is preferred. A base course of gravel is not needed on top of CU-Structural Soil™ because it was designed to be as strong as a base course. Properly compacted to 95-100% Proctor Density or Modified Proctor Density, it has a CBR of 50 or greater.

**What is the recommended length and width for CU-Structural Soil™ installation?**
There is no established minimum. However, CU-Structural Soil™ was designed to go under the entire pavement area. This homogeneity would ensure uniform engineering characteristics below the pavement, particularly in regard to frost heaving and drainage. Ideally, the installation should focus on a whole sidewalk section from building face to curb, potentially for a whole block. If it is impossible to use the entire sidewalk area, using CU-Structural Soil™, it can be placed in a 5'- 8' wide trench parallel to the curb.

**Won't the soil migrate down through a CU-Structural Soil™ profile after installation?**
The excavation of a seven-year-old installation did not show any aggregate migration. The pores between stones in CU-Structural Soil™ are mostly filled with soil so there are few empty spaces for soil to migrate to.

**Does hydrogel break down over time?**
Over a long period of time, the soluble salts from which the hydrogel was produced, i.e. potassium (from potassium hydroxide) and ammoniacal nitrogen (from acrylamide) is released. The inert hydrogel becomes a minimum part of the soil system. Beyond that, we believe that colonizing roots and other organisms will, over time, replace the spatial and tackifying roles of the hydrogel. Research on this subject is on-going.

**What happens when roots expand in CU-Structural Soil™?**
There will come a time when the roots will likely displace the stone, but if the roots are, as we have observed, deep down in the profile, the pressure they generate during expansion would be spread over a larger surface area. We have seen roots move around the stone and actually surround some stones in older installations, rather than displace the stones.

**Is CU-Structural Soil™ susceptible to frost heave?**
This topic has not been rigorously tested, but we have not observed frost heave damage in the Ithaca, NY installations. Based on drainage testing and swell data on this extremely porous system, CU-Structural Soil™ appears quite stable.

**Can you add normal soil in the tree pit and CU-Structural Soil™ under the pavement?**
It would be desirable to use CU-Structural Soil™ under the tree ball to prevent the root ball from sinking. Planting trees directly in CU-Structural Soil™ provides a firmer base for unit pavers close to the root ball than does conventional soil. If the tree pit is sufficiently large, greater than 5' x 5', a conventional soil could be used in the open tree pit surrounding the root ball with CU-Structural Soil™ extending under the pavement.

**Can you use balled-and-burlapped, bare root, or containerized trees in CU-Structural Soil™?**
Trees from any production system can and have been used. It is important to water the newly planted tree as would be expected in any soil.

**Should CU-Structural Soil™ be used in urban areas without pavement over the root zone?**
CU-Structural Soil™ was designed to be used where soil compaction is required, such as under sidewalks, parking lots, medians, plazas, and low-access roads. Where soils are not required to be compacted, a good, well-draining soil should be used.

**Can you store large quantities of CU-Structural Soil™?**
CU-Structural Soil™ is produced by licensed producers and is preferably not stockpiled. It is mixed as necessary and should be delivered and installed in a timely manner. If any stockpiling is required, protection from rain and contamination should be provided.

**Can CU-Structural Soil™ be utilized under existing trees?**
There are several instances where CU-Structural Soil™ was utilized under and adjacent to existing trees. It appears that if few tree roots are damaged during the installation, the trees continue to grow well. Research is currently under way to investigate this issue.

**What are the oldest installations of CU-Structural Soil™, and where are they?**
The two oldest installations date to 1994; the first is a honeylocust planting at the Staten Island Esplanade Project in NYC, the second is a London plane tree planting on Ho Plaza on the Cornell campus, Ithaca, NY. There are now numerous installations of various sizes across the United States and Canada. For more information about installations, visit www.structuralsoil.com or contact Brian Kalter at Amereq, Inc. (see below).

## Obtaining CU-Structural Soil™

CU-Structural Soil™ has been patented and licensed to qualified producers to ensure quality control; its trademarked names are CU-Structural Soil™ or CU-Soil™. By specifying this material, the contractor is guaranteed to have the material mixed and tested to meet research-based specifications. There are licensed producers throughout the US and in Canada. To find the one in your region or to become a licensee, contact Brian Kalter (bkalter@amereq.com) or Fernando Erazo (FE@amereq.com) at Amereq Inc., 19 Squadron Blvd. New City, New York 10956. (800) 832-8788

## Further Information

See the Urban Horticulture Institute website:
www.hort.cornell.edu/uhi and go to Outreach > Structural Soil

A DVD showing videos of the mixing, installation and tree growth in CU-Structural Soil™ is available at:
www.hort.cornell.edu/uhi/outreach/csc/index.html

Or contact Dr. Nina Bassuk (nlb2@cornell.edu), (607) 255-4586

Research papers supporting this work: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• Trowbridge, P. and Bassuk, N.L. 2004. 'Trees in the Urban Landscape: Site Assessment, Design and Installation'. Chapter 3:61-81. Wiley and Sons, Inc.

Fig 1.26 In this three-year field study a normal soil profile under sidewalk pavement as well as one with CU-Structural Soil™ were compared. Species used were hedge maple, little leaf linden, and crabapple.