Master Plan for Greene County Community Park

June 2008

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

The Community Design Assistance Center (CDAC) is an outreach center of 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 environments 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.

Community Design Assistance Center
101 South Main Street, Suite 2
Blacksburg, VA 24061
P: 540-231-5644
F: 540-231-6089
http://cdac.arch.vt.edu

Project Team

The CDAC design team for this project was comprised of the following members:

Kim Steika	Landscape Architecture Project Coordinator
Jordan Clough	Undergraduate Student, Landscape Architecture
Daniel Dart	Undergraduate Student, Landscape Architecture

Daniel Dart (Left) and Jordan Clough (Right) conducting site analysis

Jordan Clough (Left), Julius Bates (Center), Daniel Dart (Right) walking the site

Jordan Clough (Left) and Daniel Dart (Right) presenting final master plan

Acknowledgements

The CDAC design team would like to thank the Greene County Parks and Recreation Commission and County Staff for their help, support, and direction on this project. The team would specifically like to recognize Julius Bates and Stephanie Golon for their direction and assistance.

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Introduction

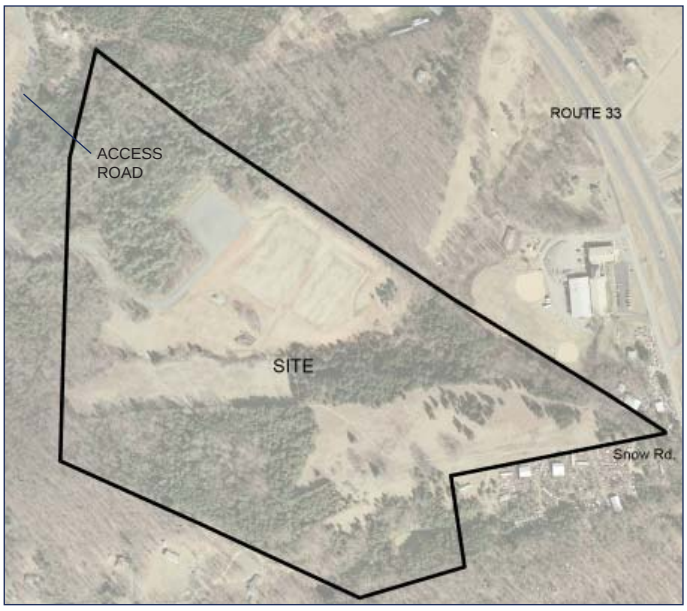
Greene County is located in Central Virginia, not far from the City of Charlottesville. The county is surrounded to the north by Page and Madison Counties, to the west by Rockingham County, and to the south by Albemarle County and to the east by Orange County. The Town of Stanardsville is centrally located within Greene County and has been the seat since the county's inception. Less than a mile south of Stanardsville is the location of Greene County Community Park.

Greene County Community Park "is a unique and important property in many aspects. Purchased by the County in 1996, the property is located within a mile of the historic Town of Stanardsville, which serves as the County seat of government. The community park is approximately 69 acres in size with topography that is generally rolling with several swales and steep slopes. Over two thirds of the park is forested with the balance remaining in open space. It features two creeks and a natural fed small pond." Taken from "Greene County Community Park Master Plan", prepared by Greene County.

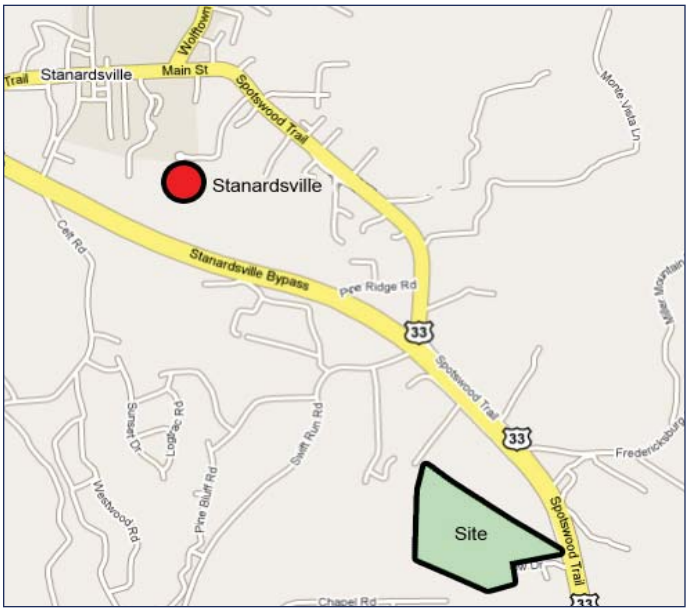
Existing on-site amenities include: two soccer fields, a playground, disc golf course, small picnic shelter, walking trails, and a gravel parking lot. All of the aforementioned amenities are generally located in the north central section of the park, with the exception of the disc golf course.

State Context Map

County Context Map



Site Context Map



Area Context Map

Project Description

In 1998, the Community Design Assistance Center (CDAC) prepared a basic concept plan for the park. However, at the time, no topographic information was available. In 2007, the County desired to update the master plan for the park since new site and topographic information was available.

Members of Greene County have expressed a desire to expand the park's facilities to maximize the park's potential within the community. A diverse set of recreational opportunities are needed to achieve the desired potential.

Currently, the park has two major draws for the community: soccer fields and a disc golf course. CDAC was asked to explore recreational possibilities that the park does not currently offer. Some elements considered as possible park additions include: skate park facilities, tennis and basketball courts, a community center with swimming pool, low impact development examples, comfort stations, and softball fields. Suggestions for improved vehicular circulation and pedestrian circulation were also discussed. Located along the western property boundary is a capped landfill that the CDAC team was also asked to consider as a potential site for recreation in park master plan revision process.

Design Process

The CDAC design team began the project with an initial site visit to Greene County Community Park on February 15th, 2008. The CDAC design team met with Greene County Parks and Recreation Director, Julius Bates, as well as members of Greene County Parks and Recreation Commission. The group discussed how the park was currently being used, possible additions to the park, and perceived recreational needs for the County.

During the initial site visit the CDAC design team documented existing site conditions and took photographs. These findings were compiled into a synthesis analysis of the park's opportunities and constraints. The initial analysis work included soils mapping, slope analysis, views to be buffered and views to be enhanced, and an overall synthesis analysis of all findings.

Members of the CDAC design team refined the site analysis documentation into several display boards. From these analysis drawings several diagrammatic concepts were developed to define different spatial layouts and forms that the park could take. From these conceptual diagrams two refined concepts were created, each focusing on different goals and objectives.

On April 17th, 2008, the CDAC design team returned to Greene County Community Park to present site analysis documentation, conceptual diagrams, and the two refined concepts. Upon the conclusion of the presentation, the CDAC design team, county staff, and members of the Greene County Parks and Recreation Commission discussed likes and dislikes about the two concepts. This feedback helped the CDAC design team refine the two concepts into a Final Master Plan for Greene County Community Park.

The final master plan was presented at the Greene County Administrative Building to the Parks and Recreation Commission on May 7th, 2008. Comments received from this meeting were used to guide final revisions that were made to the master plan.

April 17th, 2008: Daniel Dart (left) and Jordan Clough (right) present site analysis, diagram concepts and refined concepts.

May 7th, 2008: Jordan Clough (left) and Daniel Dart (right) present final master plan and sketches

This supporting report was prepared to document the design process and describe the design concepts proposed by the CDAC design team.

Site Inventory & Analysis

Greene County Community Park is a wooded park with mature trees, dense undergrowth, and a meandering stream that cuts across the property. Adjacent to the park property are a variety of land uses; to the north a school and several single family units, to the south single family units, to the east Route 33 and an abandoned junk yard, and to the west a capped landfill, a small animal shelter, and refuse facilities.

The initial site visit revealed several opportunities and constraints in the siting of recreational amenities. The CDAC design team, with the aid of Julius Bates, conducted a walking tour of the property noting potential problematic conditions as well as areas of great opportunity. During the walking tour several areas were noted as potentially problematic due to hydrology, soils, slope, and erosion.

SOILS MAP:

A soils analysis was conducted in order to identify areas that would be suitable for recreational development. The CDAC team utilized soil mapping information and analysis tools provided by the Natural Resources Conservation Service (NRCS). The soils analysis is divided into three maps: A soils description map, a map examining the suitability of soils for paved surfaces, and a building suitability soils map. The soils analysis revealed areas of the site that are limited in terms of buildings or paved surfaces such as courts, trails, roads, and parking lots. The building suitability soils analysis reveals that the majority of the site is considered "limited to severely limited" in terms of siting building structures. This means that soils would need to be modified in order to accommodate medium to large structures such as a proposed community center or large pavilions. The areas designated in yellow are areas that are more conducive to the location of buildings although modification would still be needed (see map on page 8). The suitability soils map for paved areas reveals that the majority of the site can handle paved surfaces with little to no soil modification. The soils analysis ultimately served as a guide for design concepts in terms of building location.

View of the stream corridor from entry road

View of capped landfill from entry road

Character of Greene County Community Park

SLOPE ANALYSIS:

Greene County Community Park consists of undulating topography; siting many forms of recreation requires a relatively flat area, therefore the slope analysis was an equally important guide for design concept development. The slope analysis illuminated areas of the site that require the least amount of earthwork to establish recreational amenities such as playing fields. The majority of the site is sloped at 5% – 10% which allows for smaller buildings and courts with minimal grading. This slope may prohibit larger fields and buildings with large footprints in some areas, as they may require considerable cut/fill. Most areas with steeper slopes (greater than 10%) are not desirable because of soil conditions and location.

The slope analysis revealed three key areas of potential or limitation. Area One is the area where the existing soccer fields, the parking lot, and the picnic shelter are located. The areas in and around these existing amenities are suitable areas for courts or any paved surface as well as a possible location for structures. Area Two is the ridge in the southern portion of the property that extends from the eastern border to the southern border just above the existing pond. This area is perhaps the most suitable area for a community center or additional soccer, football, or softball fields. This area would require the least amount of earthwork to establish desired amenities. Area Three is located in the southwestern portion of the property which consists of very steep slopes. Little in the way of structures or courts could be located here without major modifications.

LANDFILL:

The Greene County Parks and Recreation Commission asked the CDAC design team to explore possible recreational uses for the capped landfill, if any possibilities exist. It was discovered that the landfill in Greene County has a post-closure period of 30 years, in which the landfill is monitored and maintained. It has a post-closure permit that has allowable uses. To add recreational uses to the site, the permit would need to be amended (which is possible – it just requires that an application be submitted to the Department of

Key area one of the slope analysis: Adjacent to the parking lot a relatively flat area for courts or structures.

Key area two of the slope analysis: Largest and flattest area of the park that can be developed

View of capped landfill

Environmental Quality (DEQ). The Greene County Landfill has a clay cap (no synthetic membrane). The purpose of the cap is to keep out water that would leach pollutants out of the landfill into groundwater. The cap can not be penetrated for any reason, which would remove the possibility of plantings and any footings for structures that would need to be buried. The waste is buried in trenches. CDAC was unable to attain a map that indicated the location of the trenches. In addition, seventeen methane vents are proposed for the landfill, which could pose public health concerns if any uses were to occur on the landfill. Additionally, a tall grass meadow has been established on the landfill. These grasses help prevent erosion and thus protect the integrity of the clay cap. Mowing the grasses to a height more conducive to recreational uses is thus undesirable. Considering all the information and feedback received related to the landfill, the CDAC team feels it is best to maintain it as it is without public access. Adding a flowering mix to the grasses may create a positive visual appeal as visitors drive by the park entry.

VEGETATION ANALYSIS:

Upon the CDAC design team's initial visit a tree thinning operation was conducted to provide funds for future recreation. The tree harvest had some positive, unexpected results in regard to land cleared and graded in areas that were identified by the slope and soils analysis as potential areas for courts or structures. Area One of the slope analysis was completely cleared of trees. Courts or structures could be implemented immediately with some minimal additional grading. Cleared areas south of the entry road in the southwest portion of the property will have some lasting visual effects on the park aesthetics. Re-vegetation is needed is needed to ensure soil stabilization, erosion prevention, and visual enhancement of the area.

SYNTHESIS ANALYSIS:

The synthesis of the findings of the various site analyses was compiled into a single map. This map served as a guide for design decisions. Slope, soils, views, tree harvest areas where all taken into account.

Tree harvest area cleared for courts or structures

Tree harvest area: southwestern portion of park most woody plants destroyed


Entry road: gravel surface, mixed deciduous and evergreen forest


View of soccer fields from parking lot (erosion along hillside)


Playground next to parking lot and soccer fields


Exisitng picnic shelter


Natural character of frisbee golf course


View of creek that run through the site


View of southern vegetation with frisbee golf trail


View westward toward tree harvest area


View north toward soccer fields along southern vegetation


Frisbee golf basket (left), break in treeline leads to meadow


Eastern meadow


Eastern meadow site of old farmhouse, remnants present


Eastern meadow view of junkyard


Trails through the eastern meadow; view south toward small lake (not visible)


Exposed creek running through western forest


Western forest shows effects of tree harvest, highpoint of site


Tree harvesting area


Tree harvesting area


Path along creek


Post-tree harvesting next to existing parking lot

SOIL DESCRIPTIONS:

Map Unit: CgB

Chatuge sandy loam, 1 to 4 percent slopes
Chatuge is a gently sloping to moderately sloping, very deep, poorly drained soil. Typically the surface layer is sandy loam about 6 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a moderate available water capacity and a low shrink swell potential. This soil is occasionally flooded and is not ponded. The top of the seasonal high water table is at 6 inches. The land capability classification is 4w. The Virginia soil management group is OO. This soil is hydric.

Map Unit: ElB

Elioak loam, 2 to 7 percent slopes
Elioak is a gently sloping to moderately sloping, very deep, well drained soil. Typically the surface layer is loam about 6 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 2e. The Virginia soil management group is X. This soil is not hydric.

Map Unit: ElC

Elioak loam, 7 to 15 percent slopes
Elioak is a strongly sloping to moderately steep, very deep, well drained soil. Typically the surface layer is loam about 6 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 3e. The Virginia soil management group is X. This soil is not hydric.

Map Unit: EnC3

Elioak clay loam, 7 to 15 percent slopes, severely eroded
Elioak is a strongly sloping to moderately steep, very deep, well drained soil. Typically the surface layer is clay loam about 6 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 4e. The Virginia soil management group is X. This soil is not hydric.

Map Unit: GlC

Glenelg loam, 7 to 15 percent slopes
Glenelg is a strongly sloping to moderately steep, very deep, well drained soil. Typically the surface layer is loam about 5 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 3e. The Virginia soil management group is N. This soil is not hydric.

Map Unit: GlD

Glenelg loam, 15 to 25 percent slopes
Glenelg is a moderately steep to steep, very deep, well drained soil. Typically the surface layer is loam about 5 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 4e. The Virginia soil management group is N. This soil is not hydric.

Map Unit: Hb

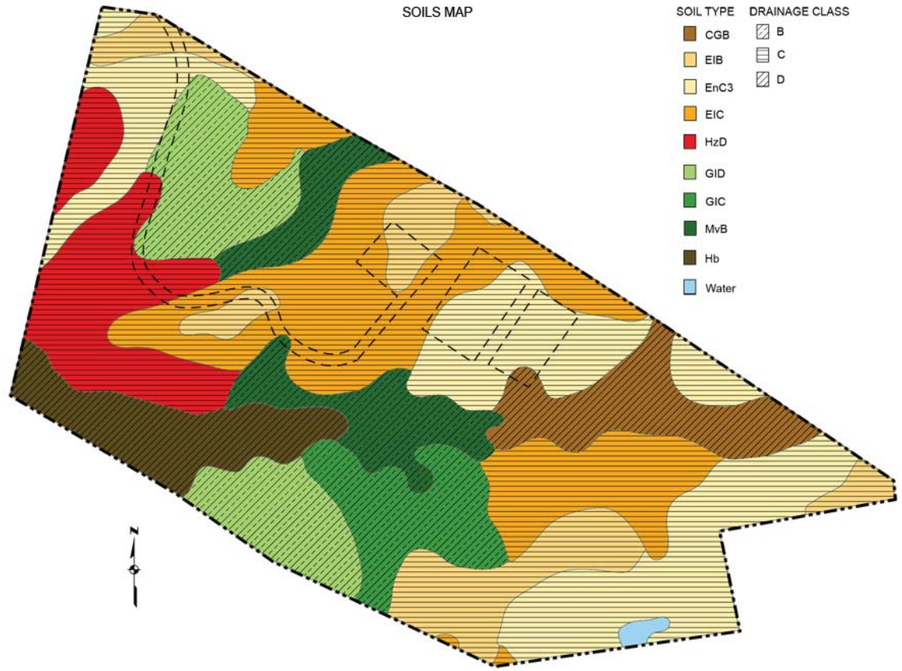
Hatboro loam
Hatboro is a nearly level to gently sloping, very deep, poorly drained soil. Typically the surface layer is loam about 15 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a low shrink swell potential. This soil is frequently flooded and is not ponded. The top of the seasonal high water table is at 3 inches. The land capability classification is 3w. The Virginia soil management group is HH. This soil is hydric.

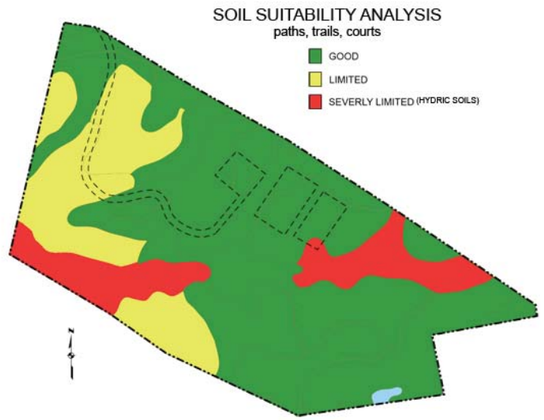
Map Unit: HzD

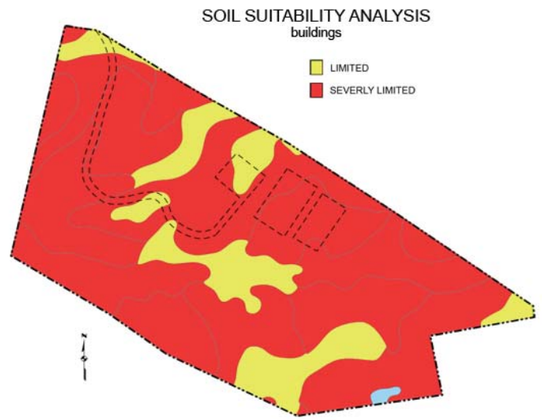
Hazel loam, 15 to 25 percent slopes
Hazel is a moderately steep to steep, moderately deep, excessively drained soil. Typically the surface layer is loam about 3 inches thick. The surface layer has a moderately low content of organic matter. The slowest permeability is moderately rapid. It has a low available water capacity and a low shrink swell potential. This soil is not flooded and is not ponded. The seasonal high water table is at a depth of more than 6 feet. The land capability classification is 6e. The Virginia soil management group is JJ. This soil is not hydric.

Map Unit: MvB

Meadowville fine sandy loam, 2 to 7 percent slopes
Meadowville is a gently sloping to moderately sloping, very deep, well drained soil. Typically the surface layer is fine sandy loam about 7 inches thick. The surface layer has a moderate content of organic matter. The slowest permeability is moderate. It has a high available water capacity and a moderate shrink swell potential. This soil is not flooded and is not ponded. The top of the seasonal high water table is at 48 inches. The land capability classification is 2e. The Virginia soil management group is G. This soil is not hydric.







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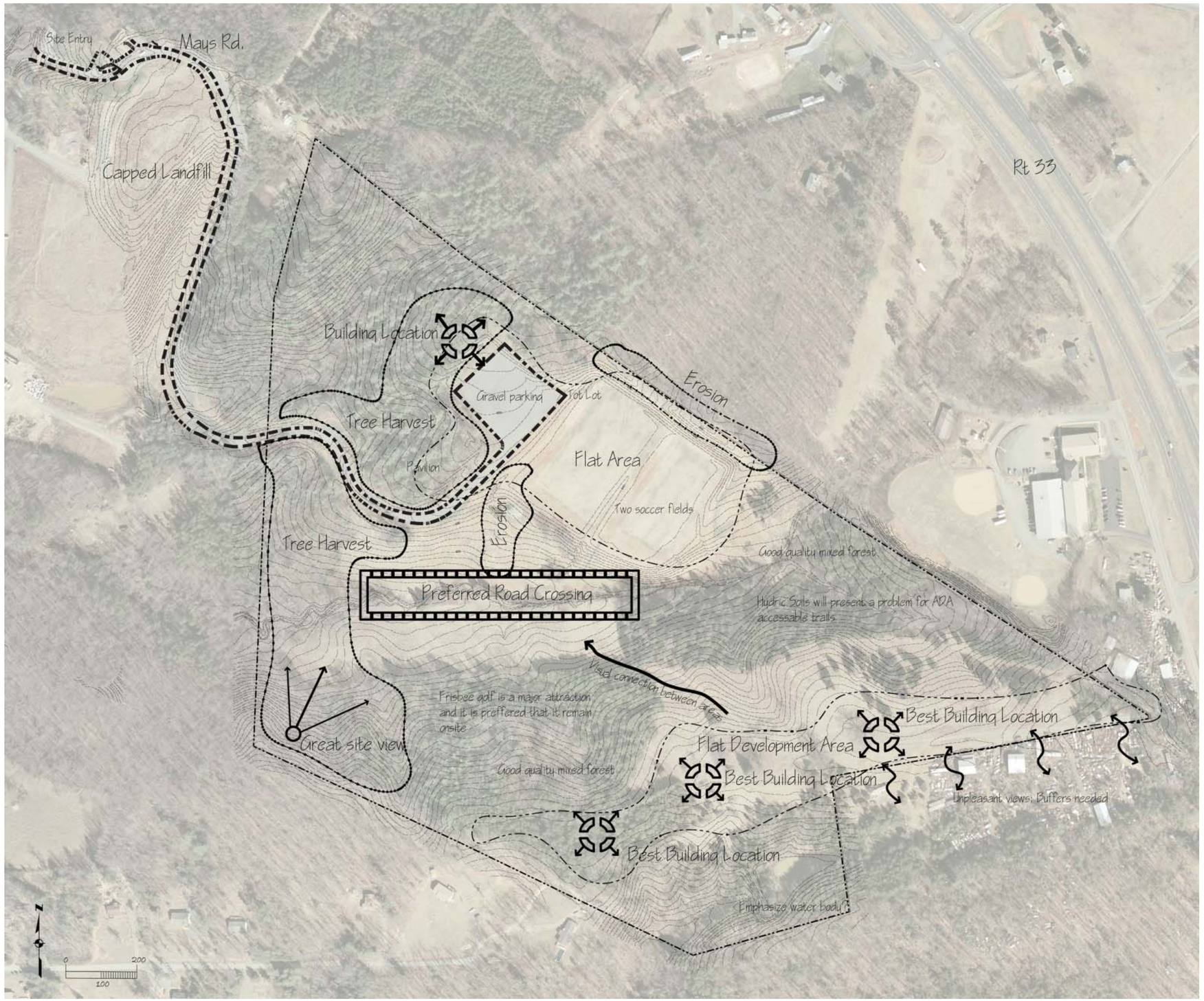
Slope Analysis



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Conceptual Diagrams

The following conceptual diagrams were developed in order to spatially define areas in which certain recreational activities could occur. The defined spaces are represented by simple shapes and the relationships are depicted by arrows. These concepts provided the first step in assessing the relationships between each area. Each of the following six diagrams represents a respective goal. How well each goal fit with the needs of the Greene County Parks and Recreation Commission resulted in a chosen diagram or diagrams.

FIELDS CONCEPT:

The fields concept was designed to maximize the amount of soccer and/or football fields that are in the park while attempting to keep cut and fill to a minimum. This concept locates a proposed community center along the edges of the existing parking lot, where it will serve as an arrival point. Within this concept most of the existing treeline would be untouched, with the exception of a connecting road. Most of the new fields and courts would be located along the ridgeline on the southeastern portion of the property.

MULTI-RECREATION CONCEPT:

The multi-recreation concept sought to provide the park with a diverse set of recreational opportunities. This concept included soccer fields, tennis courts, basketball courts, volleyball courts, disc golf, and a batting/golf cage. A small community center is sited in the southeastern portion of the property and will act as an arrival point. The community center would not include a pool and is considerably smaller in size compared to all other concepts. In this concept all of the existing treeline will remain intact. As in the fields concept, all proposed amenities have been located along ridgelines in order to reduce cut/fill volumes.

RECREATION CONCEPT #2:

This concept has similarities to the fields concept, however the proposed Community Center was placed in the southern portion of the property. The placement of the Community Center in the southern portion of the property creates space in the northern portion for the immediate implementation of tennis or basketball courts. Proposed soccer fields in the southern portion of the property would not be located along the aforementioned ridgeline and therefore would require clearing and grubbing as well as larger earthwork volumes.

RIDGELINE DEVELOPMENT CONCEPT:

This concept was formed in order to explore spatial possibilities for the southeastern ridgeline. The aim was to see how many recreational amenities would fit along the ridgeline without appearing visually cluttered. A soccer/football field, four tennis courts, two parking lots, and the community center could be reasonably located along the ridge without any conflicts. The northern portion of the property was left as is with the addition of four basketball courts. Spatially this concept will prove to be the most reasonable in terms of earthwork volumes, clearing, and overall cost.

NATURE CONCEPT:

A nature concept was explored to evaluate whether the park would be best left untouched in the southern portion of the property and with minimal upgrades in the northern portion. This concept was explored and eventually dropped due to the extensive damage caused by the tree harvest. It was determined that this area would not be the best example of forest habitat.

RECREATION CONCEPT #3:

This concept located additional fields near the creek as well as locating the community center in the southern portion. This concept was considered unreasonable, as the amount of earthwork required would offset any preferred spatial definitions.

FIELDS CONCEPT

MULTI-RECREATION CONCEPT

RECREATION CONCEPT #2

RIDGELINE DEVELOPMENT CONCEPT

NATURE PARK CONCEPT

RECREATION CONCEPT #3

Preliminary Design Concepts

From the aforementioned conceptual diagrams, two more detailed concepts were developed. These concepts draw particularly from the Fields Concept, the Ridgeline Development Concept and the Recreation Concept #3.

Concept A

Concept A strove to provide Greene County Community Park with a diverse set of recreational amenities while maintaining its rural characteristics. This refined concept was derived from two of the aforementioned spatial diagrams: multi-recreation concept and the ridgeline development concept. The entry road was realigned to create a "T" intersection where the existing road and the proposed road met. This type of intersection would require minimum paving material and promote easy way finding. The existing parking lot was retrofitted to include planted islands that encourage a more organized circulation within the parking area. This retrofitting also provided a safety buffer between the parking lot and the playground. To the east of the parking lot a small refreshment/restroom shelter was sited that would cater to park patrons using the playground or soccer fields. To the west of the parking lot is a golf/batting cage which provides another recreational amenity. The existing shelter was left untouched with the addition of grills. Native plantings or a rain garden are proposed south of the new refreshment/restroom shelter, to help alleviate erosion problems in the area.

Retro-fitted parking lot with playground setback. Shows "T" intersection and existing shelter

The southern portion of the property begins with a cobblestone bridge that would provide vehicular access to the community center. The community center was located to provide an arrival point. It will consist of an Olympic size swimming pool, two indoor basketball courts and rooms for offices and classrooms. The parking lot was located along the ridgeline as much as possible to minimize earthwork. Four tennis courts and a basketball court are located along the ridge in two of the flattest areas. The existing pond has been expanded and access improved to allow park patrons to enjoy the natural beauty of the park. Walking and/or biking trails extend to the northwest, allowing park patrons to access views of the park and also allow an interaction with nature. Along these paths, rest shelters are provided. The existing disc golf course was slightly altered with the addition of the connector road.

Community Center with swimming pool, tennis courts and basketball courts.

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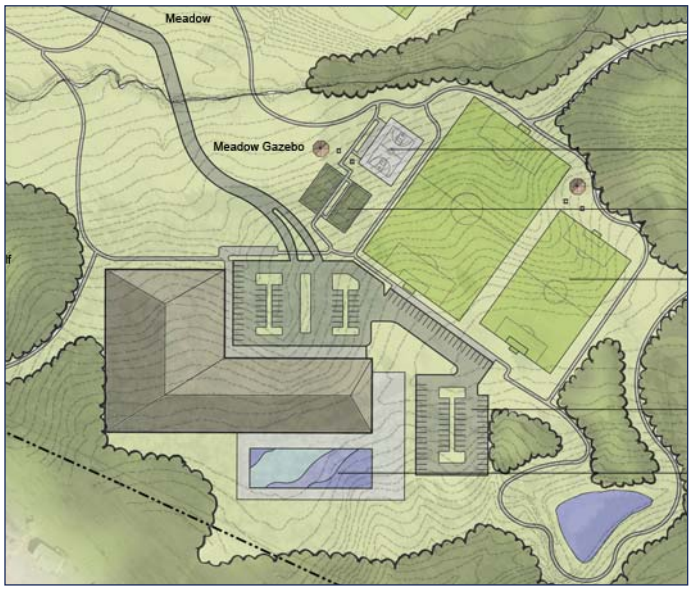
Concept B

Concept B considered several conditions in the placement of fields and buildings. The northern portion of the property begins with an upgraded entry to the existing parking lot. A "Y" intersection is to be adjoined to the existing road, the eastern portion of the "Y" intersection is proposed and the western portion is existing. The northern portion of the property includes an expanded parking lot that extends into the cleared area northwest of the existing parking lot. Planted islands have been retrofitted into the parking area to promote an organized circulation pattern. In addition to parking lot redesign, several tennis and basketball courts are sited diagonally to the parking lot. A golf/batting cage was located next to the proposed courts, although the siting of this amenity would require the existing shelter to be relocated. A refreshment/restroom shelter was also located in a similar area as Concept A, although the form of the building was altered. Concept B relocates the existing playground to an area more removed from the primary parking lot. Several gazebo shelters are located next to the tennis and basketball courts as well as near the soccer fields. The disc golf area and nature trails were expanded to link the two sides of the site and provide access to all areas of the park.

Concept B centralizes amenities that are needed immediately into the areas around the existing parking lot

The southern portion of the property begins with the community center. The community center was placed on the most suitable soil and along the ridgeline. This will minimize the amount of soil that has to be moved to site this large building. This placement also provides users with a good view of the rest of the park and makes the community center visible from the entrance drive. The community center will consist of an Olympic size swimming pool, offices, and a gym. Concept B chose to site additional soccer fields and tennis/basketball courts close to the community center for easy access. The courts and sports fields were placed as to centralize the activities and create the possibility for a pedestrian connection across the creek. Proximity to parking was regarded as imperative to this concept's design of the fields and courts. Significant grading will be required. As in Concept A, walking/biking trails were designed to highlight the rural character of the park.



Phase two: Community Center with swimming pool, tennis courts and basketball court, and additional fields.

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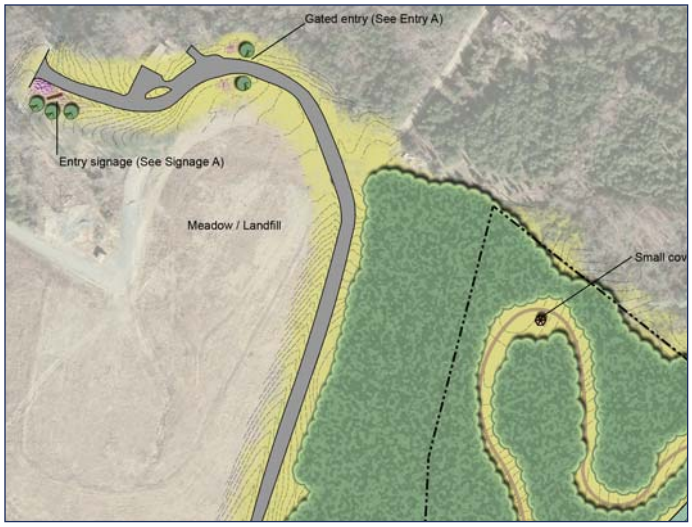
Final Master Plan

The final master plan was designed as a long term vision for the park that can be implemented in phases. In many cases building footprints can serve as courts long before the buildings are constructed, as well as fields and parking lots. The plan allows for versatile implementation as funds become available. In the following description, areas will be referred to as "Phase one" and "Phase two." Phase one is considered the area north of the stream, with the exception of the proposed road. Phase two is considered the area south of the stream and includes the "Y" intersection in phase one.

The final master plan recommendations for Greene County Community Park begin at the entry to the park by the animal shelter. The existing park sign is highlighted with colorful vegetative plantings. The entry gate is also enhanced by proposed plantings. A new small shelter and parking are proposed to the right of the entry road. Sand volleyball courts are envisioned adjacent to the shelter. This area has already been cleared through the tree harvest process, minimizing the amount of work to implement.

The "Y" intersection from Concept B was utilized in the final master plan; existing and proposed roads are defined by different shades of gray. Phase I of the final master plan closely resembles Concept A, as the parking lot was merely retrofitted and not expanded. Within the parking lot, two half basketball courts have been added that can be utilized as courts or serve as additional parking when needed. Four doubles tennis courts were located adjacent to the parking lot on the flat, cleared area. The existing shelter will remain with the addition of grills and more picnic tables. The playground has been buffered from the parking lot with vegetation to provide additional separation from cars. Next to the playground, a small shelter was added, giving parents a covered place to sit and watch their children play. A refreshment/restroom shelter is proposed near the existing soccer fields.

Phase two begins with the road extension and vehicular bridge. Signage directs users to additional park amenities. Phase two is highlighted by an entry view of the community center. The community center was



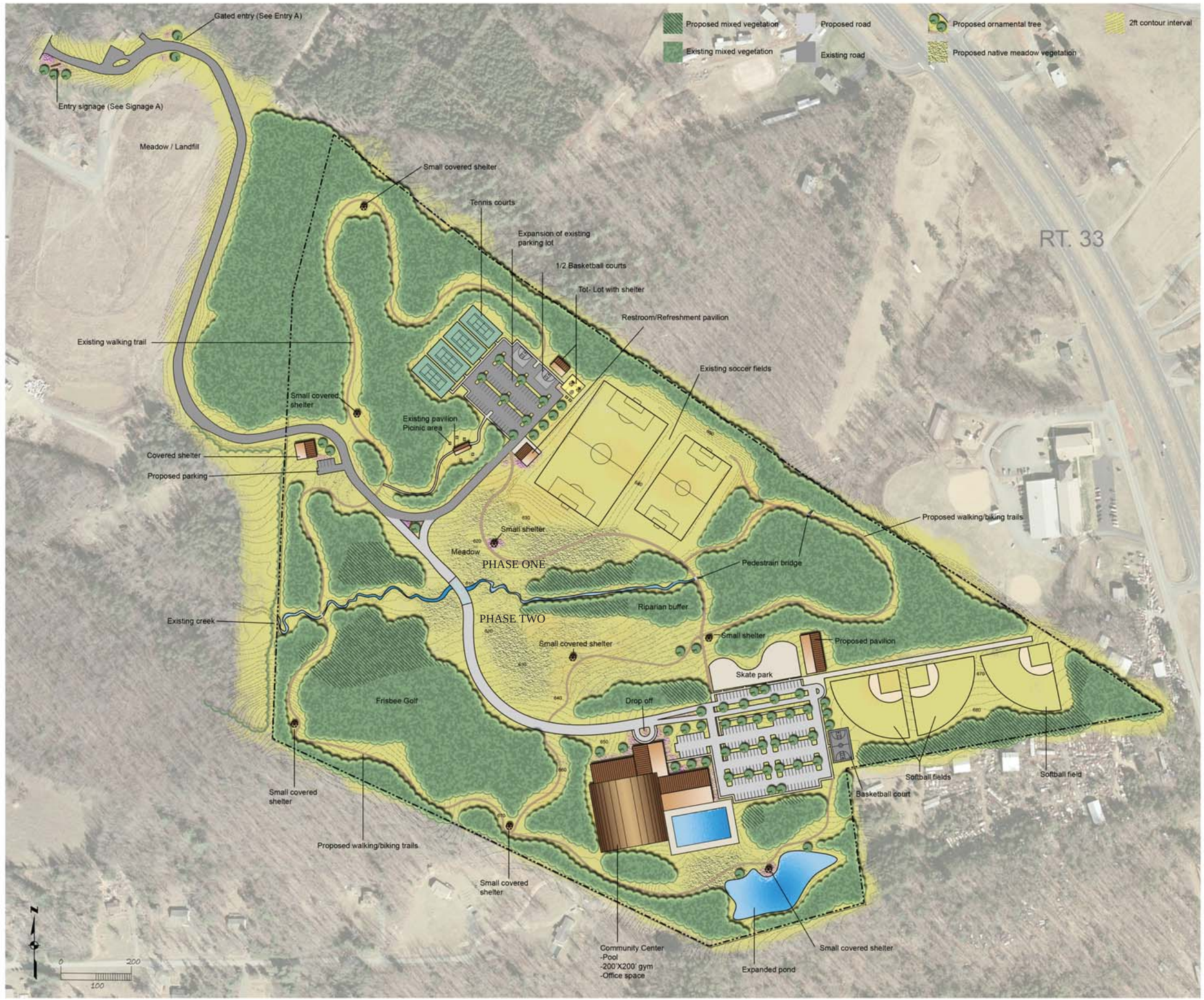
Outside of the park boundary along the entrance road is the vegetated park sign and gate

Phase one: Volleyball shelter, upgraded parking lot, tennis courts, relocated playground with shelter and directional signage.

located here to take advantage of the slope and soils. The community center consists of an Olympic sized swimming pool, offices, a gym that will house one horizontal and two vertical basketball courts, and a vehicular drop off area. The parking lot was designed to utilize the slope as much as possible and screen the view of cars with slope and vegetation. To take advantage of the high slopes on the north side of the proposed parking lot, skate park facilities are proposed along with a shelter. Three softball fields are located along the southeastern ridgeline and can be accessed by a pedestrian walkway. One outdoor basketball court sits adjacent to the parking lot.

The existing pond has been expanded and will provide a natural amenity to the park. Several nature trails extend outward from the community center. These paths provide access to all areas of the park. Along these paths are small rest shelters and pedestrian bridges, as needed, that span the creek. The creek has been planted with a riparian buffer and native meadow grasses line the slopes that extend down to the creek. These plantings will reduce the effects of erosion that currently plague those areas. The disc golf course remains in its current location.

Phase two: Community Center with swimming pool, skate park, basketball court, and additional softball fields.



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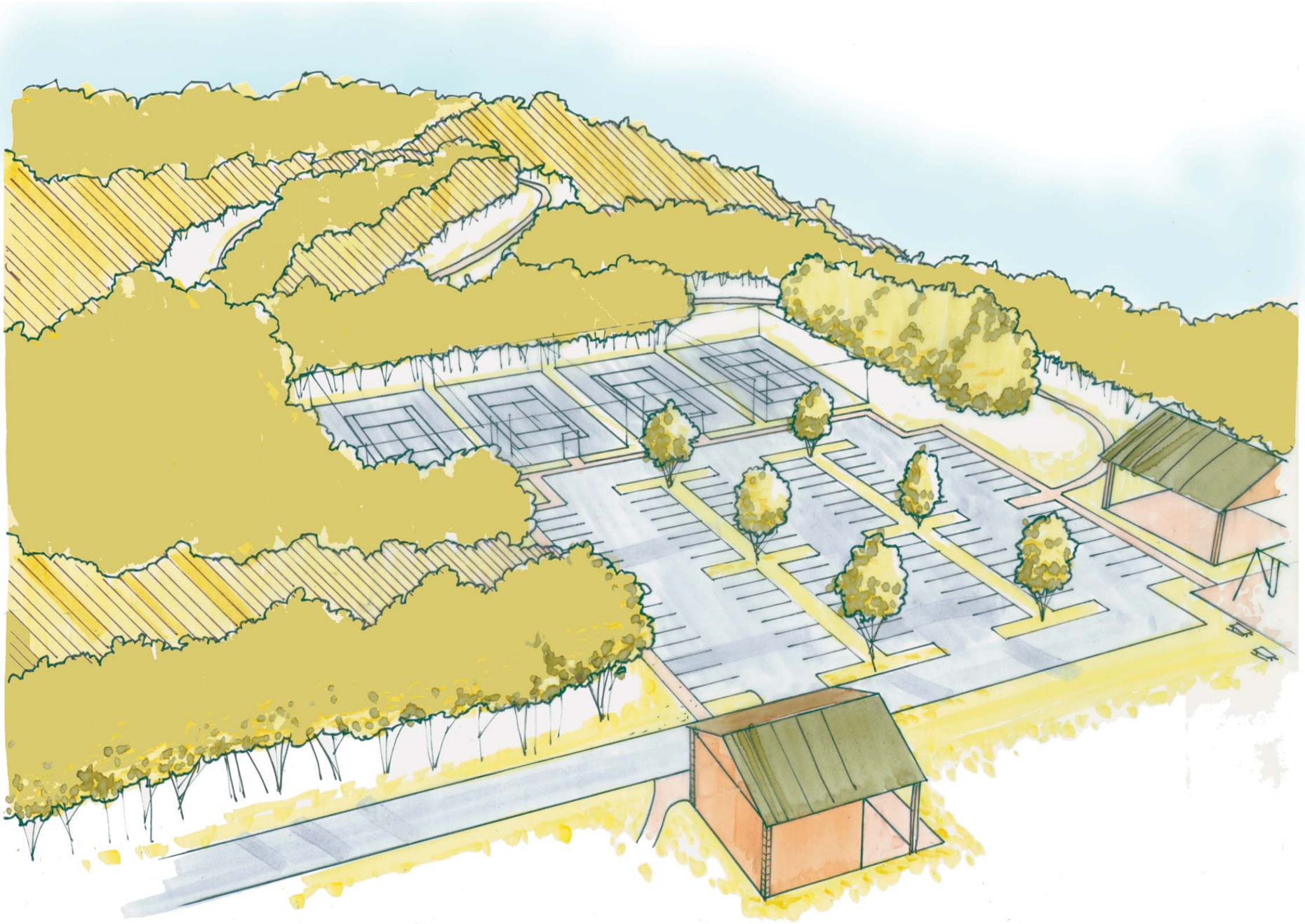

Aerial sketch of phase one shows refreshment building, tennis courts, and retrofitted parking lot.

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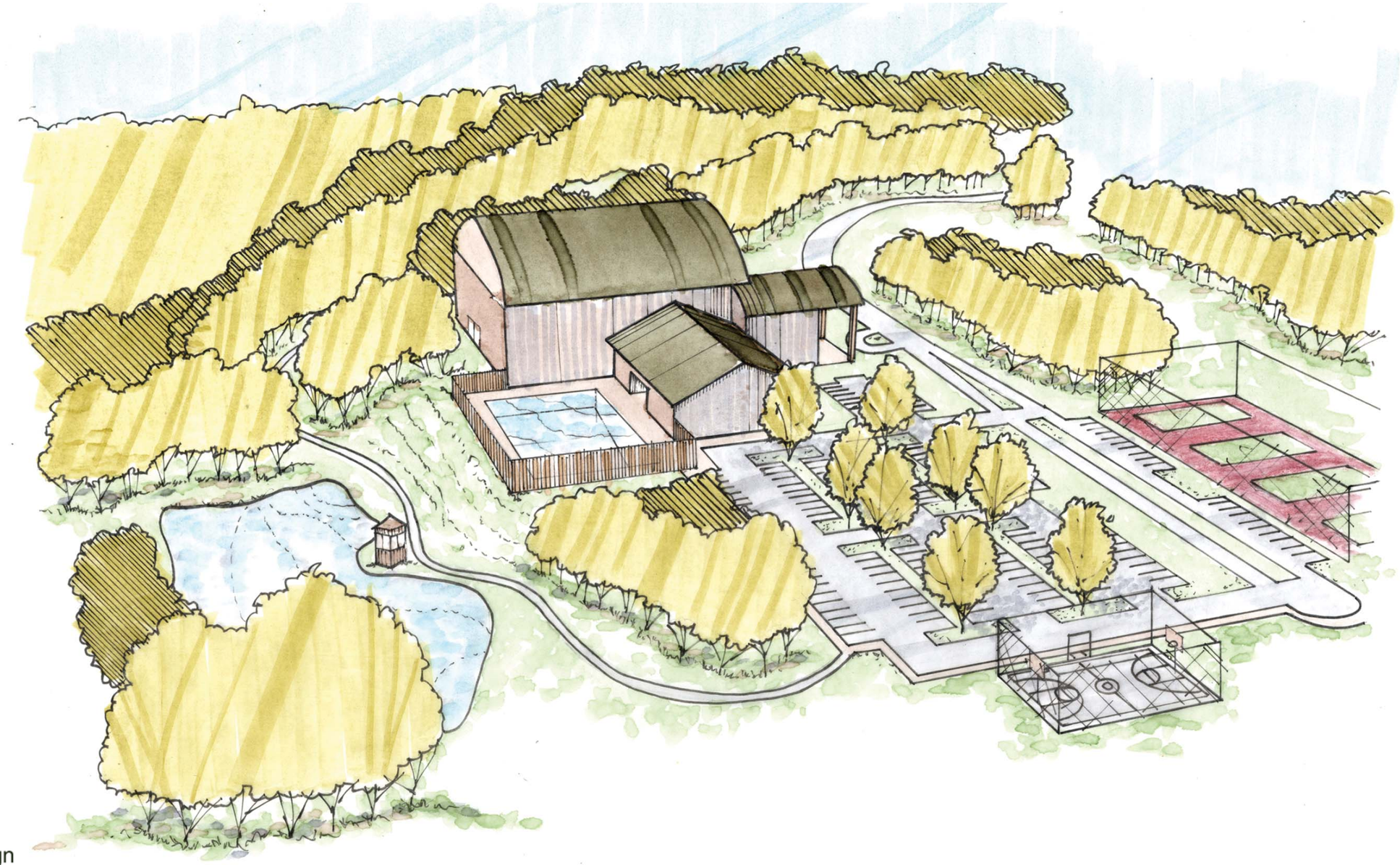

Aerial sketch of Phase two shows community center, basketball court, and skatepark

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Colorful vegetative entry sign

Perspective sketch of bridge and community center

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Planted Entry Sign and Perspective of Bridge View

Conclusion

Upon completion, Greene County Community Park will provide the local community with an irreplaceable asset and an opportunity to participate in a diverse set of recreational choices. The park will be a great place for people of all ages and abilities to enjoy and will represent the county's rural character while meeting the growing need for recreational opportunity.

CDAC design team and board members walking the existing soccer fields

APPENDICES

Appendix A: Rain Gardens

Appendix B: Riparian Buffer Plant Suggestions

Appendix C: Field and Court Dimensions

Appendix A: Rain Gardens

The following information has been taken from the Virginia Department of Forestry's website: http://www.dof.virginia.gov/rfb/rain-gardens.shtml

What is a rain garden?

A "rain garden" is a man-made depression in the ground that is used as a landscape tool to improve water quality. The rain garden forms a "bio-retention area" by collecting water runoff and storing it, permitting it be filtered and slowly absorbed by the soil. The bio-retention concept is based on the hydrologic function of forest habitat, in which the forest produces a spongy litter layer that soaks up water and allows it to slowly penetrate the soil layer. The site for the rain garden should be placed strategically to intercept water runoff.

A nutrient removal or "filtering" process takes place as the water comes in contact with the soil and the roots of the trees, shrubs and vegetation. This process accounts for the improved water quality. The first flush of rain water ponds in the depression of the rain garden, and contains the highest concentration of materials washed off impervious surfaces such as roofs, roads, and parking lots.

Creating a rain garden

Rain gardens are suitable for any land use situation, residential, commercial and industrial. A rain garden should be placed so that impervious surfaces will drain into the depression area. Its purpose is to minimize the volume and improve the quality of water entering conventional storm drains and nearby streams.

Each site should be considered unique. Microclimates (light, temperature and wind), and the size of the drainage area will influence the size of the rain garden and plant selection process. Software is being developed for sizing the gardens. The shape of the garden is not as important as the area available for bio-retention. The size of the bio-retention area should be 5% to 7% of the drainage areas multiplied by the crop "c" coefficient (the ground cover type). For example, a 3/10 acre drainage area would use a rain garden of about 600 square feet, or 15 x 40 feet.

The Virginia Department of Foresty has developed a technical guide, with step by step directions to create a rain garden as well as a suggested plant list. Portions of this guide are downloadable from http://www.dof.virginia.gov/rfb/rain-gardens.shtml. A hardcopy of the guide as well as a CD with the guide in PDF format have been sent to the client, along with this supporting report.

Rain gardens are composed of several components. The following description of the different rain garden components and their functions as been taken from http://www.dof.virginia.gov/rfb/rain-gardens.shtml.

A rain garden at work in Blacksburg, Virginia

A rain garden under construction

Components of a rain garden

Grass buffer: A grass buffer strip slows water as it enters the rain garden and its surface filters particulates from the runoff.

Ponding area: The ponding area stores the water, provides for evaporation, and allows the particulate material, not filtered by the grass buffer, to settle to the bottom. The ponding area should have a depth of 6 inches, sufficient to provide adequate water storage, but should not pond in excess of four days (to avoid mosquito and other insect breeding).

Mulch/organic layer: The mulch/organic layer provides for the decomposition of organic material, and also plays an important role in the removal of metals. Shredded hardwood mulch is the preferred choice, since it allows for maximum surface area for binding and resists flotation/washout.

Planting soil: Organic matter in the form of leaf mulch (20%) blended into a sandy soil (50%) with and about 30% top soil. The planting soil mixture provides a source of water and nutrients for the plants to sustain growth. Clay particles adsorb heavy metals, hydrocarbons and other pollutants.

Plants: A planting plan design should include species that tolerate extremes. There will be periods of water inundation and very dry periods. Most riparian plant species will do well in rain gardens. The choice of species should include plants that mimic forest habitat and have an aesthetic landscape value such as flowers, berries, interesting leaves or bark. Groundcovers, perennials shrubs and trees should be incorporated into the planting design.

Additional information on rain garden history, benefits, construction and maintenance can be found at:
http://www.raingardens.org/Index.php
http://clean-water.uwex.edu/pubs/home.htm#rain

The following pages offer concise suggestions for designing and constructing a rain garden.

Amending the soil with a premium blend soil mix.

This garden, under construction in the picture above, is now planted and hard at work.

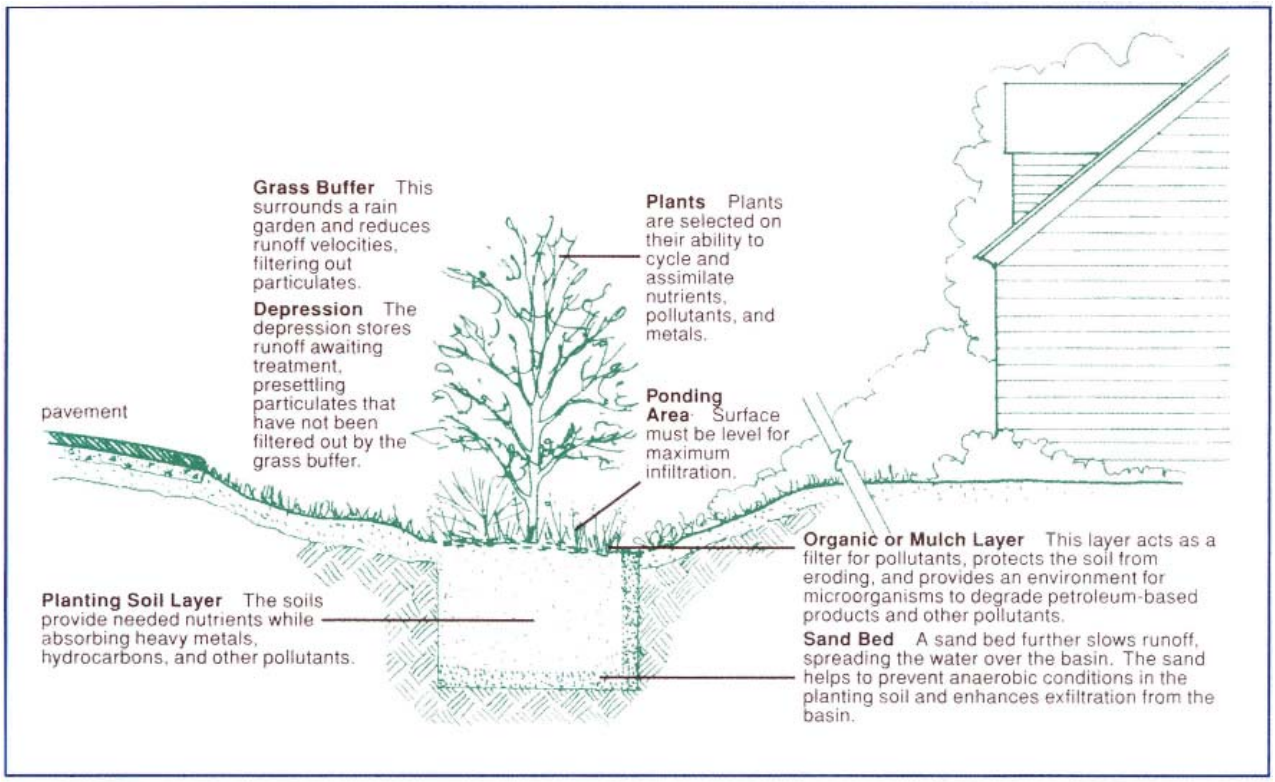


Figure 3: Cross section of a Rain Garden
http://fairfaxcounty.gov/nvswcd/youyourland/landscape.pdf

Before You Start

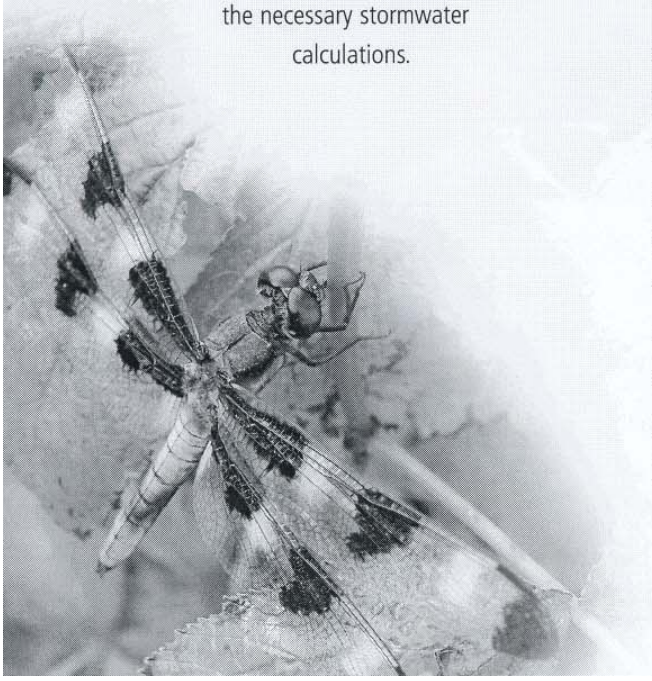
Professional tools for designing rain gardens are free! You can get spreadsheets to calculate project size and price, engineering manuals, plant information, the latest research, and more at the following URL:

www.raingardens.org/docs/bioretention_tools.pdf

Creating a Functional Design

Put your rain garden in the right place; down-slope from building foundations and up-slope from storm drain infrastructure. The most practical way to determine rain garden location is to visit the site. Re-grade to ensure stormwater goes into the rain garden. Direct overflow and under-drain flow to enter existing stormwater infrastructure.

Size the rain garden correctly. Do not guess the amount of stormwater going into your rain garden. Use the free tools to perform the necessary stormwater calculations.

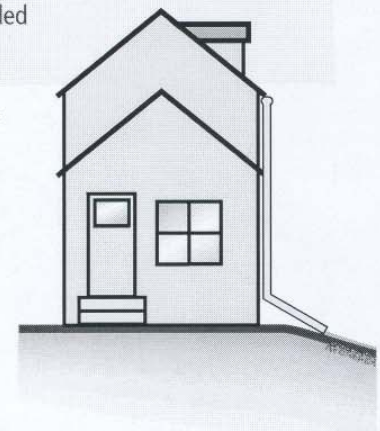


Evaluate existing soils. You should replace soils with an absorbent soil mix to ensure water will soak in. However, the characteristics of local soils also affect your rain garden. The in-situ soils must be able to infiltrate at a speed that prevents saturation. If they do not, you will need to design an under-drain and overflow plan. Special considerations apply in clay soils.

Be sure to budget for necessary costs. Contractors who have never designed and constructed a rain garden before will want to do things the way they have always done them. The project may require additional supervision; plan for this expense. Group meetings are a good way to share information with project managers, engineers, excavators and landscapers.

Create an attractive design. Rain gardens feature easy-care plants that are native to your region. Landscapers can create a planting layout that is both beautiful and functional, with attractive designs and drifts of color. Seeded or naturalistic rain gardens are economical and function well, but some people find them inappropriate in formal settings.

Give your rain garden a tended appearance (neatly defined borders, not weedy looking). Landscapers new to rain gardens or native plants may need guidance in plant selection. Do not choose aggressive species that you will need to divide frequently.

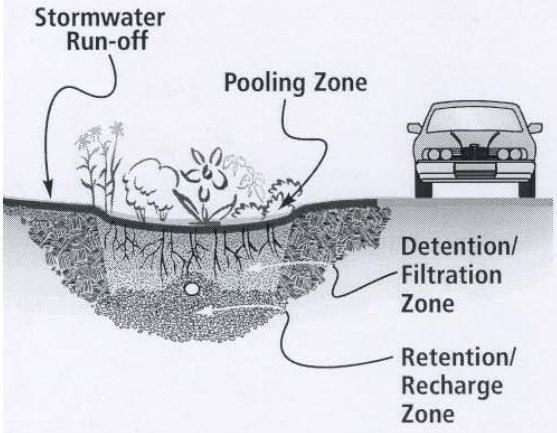


Constructing a Successful Rain Garden

Seek contractors experienced with rain gardens, or those open to acquiring new skills.
Contractors unfamiliar with rain gardens may misunderstand the concept. Be sure you are actually creating a rain garden. The goal of a rain garden is to soak stormwater into the soil quickly, not to create a pond.

Replace soil to a depth that insures infiltration. ***Soil preparation is essential for success.*** Replace existing soils with a loose soil mix appropriate for your site. In heavy clay areas, research and experience indicate that a mix of sand and compost (no topsoil) works well. Additional drainage infrastructure will contribute to reliable infiltration. This prevents soil compaction, soil saturation and standing water.

Avoid soil saturation, especially in cold climates where the rain garden soil may freeze.
Be sure you have excellent infiltration and drainage. Overflow and under-drain plans are part of a successful project. A three-inch layer of shredded hardwood mulch helps keep the soil from freezing. Do not use bark chips, which wash away.



Stage construction carefully to avoid erosion.
Protect the rain garden from erosion and sediment during and after construction. Sediment can seal the surface. Install effective erosion controls, and leave them in place until all site construction, including other landscaping, is completed.

The most common cause of failure of a rain garden is soil compaction. It is essential to avoid compaction of soils during all phases of construction.
Do soil placement and grading from the side. Prevent vehicles from driving on the rain garden. Place barriers to protect from foot and construction traffic.

Retrofits can be successful if you apply all design considerations.
You can sometimes convert existing detention or retention ponds into rain gardens. However, many smaller rain gardens scattered throughout a development will function better than converting a large pond at a remote location.

Maintaining a Beautiful Rain Garden

Care for your rain garden regularly.
Regular maintenance is required to keep your rain garden looking good and functioning well. Be sure to include this in your plan and your budget!

WATER: Water daily the first few weeks after planting, then regularly until plants are established. Later on, water in a drought if this is practical. You can install irrigation, and only turn it on manually as needed.

WEED: Weed on a regular basis, especially the first year. Educate people working in the rain garden. They may identify native plants as weeds.

MULCH: A rain garden planted with plugs or container plants benefits from a layer of shredded hardwood mulch. This reduces weeding and watering and helps establish the plants. It also prevents surface sealing of the rain garden, and removes specific pollutants from pavement runoff.

FERTILIZE: Should not be necessary. Native plants should thrive in the prepared soil mix. Avoid use of herbicides, pesticides, and fungicides in and around the rain garden.

KEEP SALT OUT OF THE RAIN GARDEN:
Salt destroys soil biology and damages plants. It builds up in the soil, and, over time, you will need to replace soil and plants. Use alternate deicers, but sparingly. If you cannot avoid salt, filter through the rain garden and carry away salty water with an under-drain.

Get the free bioretention tools!
www.raingardens.org/docs/bioretention_tools.pdf.

www.raingardens.org

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one garden at a time

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We promote keeping stormwater on site in the Great Lakes basin, and, thanks to our website, everywhere else in the world.

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2006 PUBLICATION 426-043

Urban Water-Quality Management

Rain Garden Plants

Mike Andruczyk, Extension Agent, Chesapeake
Lynnette Swanson, Extension Agent, Norfolk
Laurie Fox, Horticulture Associate, Hampton Roads Agricultural Research and Extension Center
Susan French, Extension Agent, Virginia Beach
Traci Gilland, Extension Agent, Portsmouth

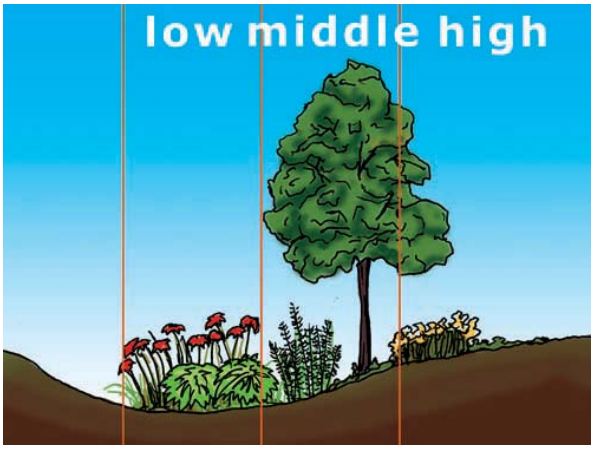
A rain garden is a landscaped area specially designed to collect rainfall and storm-water runoff. The plants and soil in the rain garden clean pollutants from the water as it seeps into the ground and evaporates back into the atmosphere. For a rain garden to work, plants must be selected, installed, and maintained properly.

Plant Selection

- Choose plants tolerant of both occasional flooding as well as dry periods.
- Choose noninvasive plants that are adapted to the local environment.
- Choose a mixture of species. A good rule of thumb is one plant species for every 10 to 20 square feet. For example – a 140-square-foot garden would have 7 to 14 different plant species.
- Choose plants for vertical layering – a mix of tall-, medium-, and low-growing species.

Plant Installation

- Install plants in their proper moisture zones (see Fig. 1).
- Plant shrubs and perennials in groups of three to five of the same species. Trees can be planted in groups or individually.
- Plant taller and larger plants in the center or at one end of the garden, depending on the views.
- Plant shorter plants where they can be seen easily, around the garden edges, in front of larger plants, or underneath taller plants.



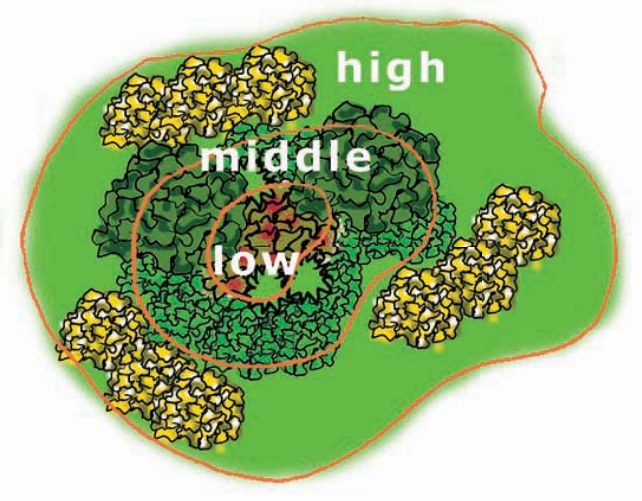


Figure 1. Rain Garden

www.ext.vt.edu

Produced by Agriculture and Extension Communications, Virginia Tech

VT/0606/W/426043

- Space and plant perennials so that their canopies will grow together and cover the ground to minimize weeds.
- Space and plant trees and shrubs according to their mature size. For example – beautyberry shrubs, that grow to six feet wide, should be planted three feet apart.
- Planting outside and around the rain garden area helps the garden blend into the overall landscape.
- More information can be found in *Tree and Shrub Planting Guidelines*, Virginia Cooperative Extension publication 430-295.

Maintenance

- Add two to four inches of organic mulch to the entire newly planted rain garden. Do not cover the crowns of the perennials. Replenish mulch in the fall as needed.
- Avoid fine cut or lighter weight mulches as they tend to float in wet conditions.
- Prune any dead, diseased, or damaged plants as soon as the problem is noticed. More information on pruning woody plants can be found in Virginia Cooperative Extension publications 430-455 through 430-462 (see References).
- Prune the foliage of perennials when they die back for the winter and ornamental grasses before new growth begins in the spring.
- Remove or spot treat weeds as necessary.
- Water the garden during its establishment and extended dry periods. One inch of water per week is recommended.

Plant Lists

Trees, shrubs, and perennials are listed with both their common and *scientific* names. Ask at local garden centers for specific cultivars, varieties, and size at maturity.

Trees

Use trees only in rain gardens larger than 150 square feet.

Alder	*Alnus serrulata (glutinosa)*
Arborvitae	*Thuja occidentalis*
Atlantic White Cedar	*Chamaecyparis thyoides*
Austrian Pine	*Pinus nigra*
Bald Cypress	*Taxodium distichum*
Black Gum	*Nyssa sylvatica*
Carolina Silverbell	*Halesia tetraptera*
Common Persimmon	*Diospyros virginicus*
Dawn Redwood	*Metasequoia glyptostroboides*
Downy Serviceberry	*Amelanchier arborea*
Eastern Redbud	*Cercis canadensis*
Eastern Red Cedar	*Juniperus virginiana*
Green Ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis occidentalis*
Hornbeam	*Carpinus caroliniana*
Japanese Cryptomeria	*Cryptomeria japonica*
Japanese Zelkova	*Zelkova serrata*
Katsura Tree	*Cercidiphyllum japonicum*
Lacebark Elm	*Ulmus parvifolia*
Loblolly Pine	*Pinus taeda*
Planetrees (Sycamores)	*Platanus* spp.
Red Maple	*Acer rubrum*
River Birch	*Betula nigra*
Swamp White Oak	*Quercus bicolor*
Sweetbay Magnolia	*Magnolia virginiana*
Sweetgum	*Liquidambar styraciflua*
Water Oak	*Quercus nigra*
Weeping Willow	*Salix babylonica/alba*
Willow Oak	*Quercus phellos*
Witch Hazel	*Hamamelis virginiana*
Yaupon Holly	*Ilex vomitoria*

Shrubs

American Beautyberry	*Callicarpa americana*
Anise	*Illicium parvifolium*
Arrowwood	*Viburnum dentatum*
Bottlebrush Buckeye	*Aesculus parviflora*
Buttonbush	*Cephalanthus occidentalis*
Carolina Allspice	*Calycanthus floridus*
Chokeberry	*Aronia arbutifolia*
Cranberrybushes	*Viburnum opulus/trilobum*
Devilwood	*Osmanthus americana*
Dogwoods	*Cornus amomum/racemosam/sericea*
Elderberry	*Sambucus canadensis*
False Indigo	*Amorpha fruticosa*
Fetterbush	*Leucothoe racemosa*
Groundsel Bush	*Baccharis halimifolia*
Highbush Blueberry	*Vaccinium corymbosum*
Inkberry	*Ilex glabra*
Leucothoes	*Leucothoe axillaris/fontanesiana*
Oakleaf Hydrangea	*Hydrangea quercifolia*
Possumhaw	*Ilex decidua*
Rose of Sharon	*Hibiscus syriacus*
Shadblow Serviceberry	*Amelanchier canadensis*
Spicebush	*Lindera benzoin*
Steeplebush	*Spiraea tomentosa*
Summersweet Clethra	*Clethra alnifolia*
Swamp Azalea	*Rhododendron viscosum*

Swamp Rose	*Rosa palustris*
Virginia Sweetspire	*Itea virginica*
Wax Myrtles	*Myrica cerifera/pennsylvanicum*
Willows	*Salix caprea/discolor/matsudana sachalinensis/purpurea*
Winterberry	*Ilex verticillata*

Perennials

Arrowhead	*Sagittaria latifola*
Asters	*Aster spp.*
Beardtongue	*Penstemon digitalis*
Beebalm	*Monarda didyma*
Blackeyed Susan	*Rudbeckia hirta*
Blue Lobelia	*Lobelia siphilitica*
Bluestar	*Amsonia tabernaemontana*
Calla Lily	*Zantedeschia* spp.
Canna Lily	*Canna* spp.
Cardinal Flower	*Lobelia cardinalis*
Crinum Lily	*Crinum* spp.
Daylilies	*Hemerocallis* spp.
Gingers	*Hedychium* spp.
Goldenrod	*Solidago flexicaulis*
Hardy Begonia	*Begonia grandis*
Hibiscus	*Hibiscus coccineus/moscheutos*
Ironweed	*Vernonia noveboracensis*
Irises	*Iris lousiana/pseudacorus/versicolor/virginica*
Joe-Pye Weed	*Eupatorium* spp.
Leopard Plant	*Ligularia tussilaginea*
Liatris	*Liatris spicata*
Lilyturf	*Liriope muscari*
Lizard Tail	*Saururus cernuus*
Lungwort	*Pulmonaria* spp.
Marsh Marigold	*Caltha palustris*
Monkey Flower	*Mimulus ringens*
Obedient Plant	*Physotegia virginiana*
Pickerelweed	*Pontederia cordata*
Plantain Lily	*Hosta* spp.
Primroses	*Primula* spp.
Rain Lilies	*Zephyranthes* spp.
Red Columbine	*Aquilegia canadensis*
Siberian Bugloss	*Brunnera macrophylla*
Spiderwort	*Tradescantia* spp.
Strawberry Begonia	*Saxifraga stolonifera*
Swamp Milkweed	*Asclepias incarnata*
Swamp Sunflower	*Helianthus angustifolius*
Turtleheads	*Chelone lyonii/obliqua*
Virginia Bluebells	*Mertensia virginica*
Wild Ginger	*Asarum canadense*
Windflowers	*Anemone*

Ferns

Christmas Fern	*Polystichum acrostichoides*
Cinnamon Fern	*Osmunda cinnamomea*
Holly Fern	*Cyrtomium falcatum*
Japanese Painted Fern	*Athyrium nipponicum*
Lady Fern	*Athyrium felix-femina*
Royal Fern	*Osmunda regalis*
Tassel Fern	*Polystichum braunii*
Wood Ferns	*Dryopteris* spp.

Grasses and Grass-like

Broom Sedge	*Andropogon virginicus*
Feather Reed Grass	*Calamagrostis acutiflora*
Foxtail Grass	*Alopecurus pratensis*
Rushes	*Juncus* spp.
Sedges	*Carex* spp.
Sweetflag	*Acorus* spp.
Switchgrass	*Panicum virgatum*

Groundcovers

Bugleweed	*Ajuga* spp.
Foamflower	*Tiarella cordifolia*
Green and Gold	*Chrysogonum virginianum*
Lilyturf	*Liriope spicata*
Mazus	*Mazus reptans*
Plumbago	*Ceratostigma plumbaginoides*
St. Johnswort	*Hypericum calycinum*

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A Guide to Successful Pruning, Evergreen Tree Pruning Calendar, Virginia Cooperative Extension publication 430-461, *http://www.ext.vt.edu/pubs/nursery/430-461/430-461.html*

A Guide to Successful Pruning, Shrub Pruning Calendar, Virginia Cooperative Extension publication 430-462, *http://www.ext.vt.edu/pubs/nursery/430-462/430-462.html*

Editorial Contributors

Barry Fox, Extension Specialist, Virginia State University

Adria Bordas, Virginia Cooperative Extension Agent Fairfax County

Karen Carter, Virginia Cooperative Extension Agent Henrico County

JoAnne Gordon, Horticulturist, City of Norfolk

Appendix B: Riparian Buffer Plant Suggestions

Riparian forest buffers are areas of trees, shrubs, and other vegetation found next to stream channels and other waterways. They are modeled on natural communities such as bottomland hardwood forest, coastal scrub, and upland oak-hickory-pine forests. Conversion of these riparian forests to other land uses has contributed to ecological problems in our waterways and the Chesapeake Bay including sedimentation, nutrient and toxic chemical pollution, and reduction of fish habitat.

Riparian wetlands are characterized by plant species adapted to periodic flooding and/or saturated soils. They support a high diversity of plant and animal species. More energy and materials, born by moving water, enter, are deposited in, and pass through riparian ecosystems than any other wetland ecosystem. Drier upland forests adjacent to waterways also provide many of the same ecosystem values.

* Riparian forest buffers help control the rate and volume of water flowing in streams and rivers, greatly influencing flood levels. Water flowing through a riparian forest is slowed by the vegetation, leaf litter, and porous soils found there.

* The leaf litter acts as a filtration system by capturing sediment from upland runoff. This action also helps to filter out phosphorous bonded to sediment particles. Sediments, and any nutrient which may be bonded to them, become part of the forest soil rather than clouding our waterways.

* Chemical and biological processes of the forest remove nutrients, such as phosphorous and nitrogen, and store them in the soil or as plant tissue. Pesticides are also converted to nontoxic compounds by various chemical and microbial activities within the forest. This helps to protect fish, which are most threatened by pesticide pollution.

* Riparian forest soils act as areas of water storage. Plants take up water into their tissues and release it into the atmosphere.

* A canopy created by riparian forest provides shade and controls water temperature, which is essential for instream organisms, including trout and the invertebrate food source on which they depend. Instream, the leaf litter and woody debris from the canopy and forest create food and habitat vital to the aquatic food web.

* Riparian forests provide food and habitat for a variety of terrestrial wildlife and serve as safe corridors for movement between habitats. Habitat conversion and fragmentation have reduced wildlife habitat and limited the ability of animals to move between existing habitats. Riparian forests provide for both these needs.

* Riparian forest buffers offer recreation to fishermen, birders, hikers, canoeists, and picnickers. The diversity of habitats and life and the scenic beauty provided by riparian forests can be enjoyed by many people in so many different ways.

These ecological functions combine to make riparian forest buffers critical investments in human and ecological health and well-being today, and for our children tomorrow. Recognizing these values, the Chesapeake Bay Program has set a goal of replanting 2,010 miles of Bay shoreline by the year 2010. Virginia's share of this goal is 610 miles.

RIPARIAN VEGETATION ZONES

Four riparian vegetation zones are identified in this brochure. Zone 1, the emergent vegetation zone, is permanently to semi-permanently flooded and often dominated by grasses, sedges, rushes, and herbaceous plants. Zone 2, the riverside thicket, may be seasonally to temporarily flooded and is often characterized by emergent species, shrubs, and a few tree species. Zone 3, the saturated forest, has soils which are saturated to poorly drained. Zone 4, the well-drained forest, is also known as upland forest. Zones 3 and 4 are dominated by trees, but also contain shrub and herb layers in the understory.

Native Plants: Riparian Plants

Recommended Uses	Native Regions	Minimum Light Requirements	Riparian Vegetation Zones
W = Wildlife	M = Mountains	S = Full Shade	1 = Emergent
H = Horticulture and Landscaping	P = Piedmont	P = Partial Sun	2 = Riverside Thicket
C = Conservation and Restoration	C = Coastal Plain	F = Full Sun	3 = Saturated Thicket
D = Domestic Livestock Forage			4 = Well-drained Forest

Native Riparian Plants

Scientific Name	Common Name	Uses				Region			Light			Zone			
		W	H	C	D	M	P	C	S	P	F	1	2	3	4
Herbaceous plants															
Acorus americanus (A. calamus)	sweet flag		x	x		x	x	x		x	x	x			
Amsonia tabernaemontana	blue star		x				x	x	x	x				x	x
Arisaema triphyllum	Jack-in-the-pulpit		x			x	x	x	x					x	x
Asarum canadense+	wild ginger		x	x		x	x	x	x						x
Asclepias incarnata	swamp milkweed	x	x	x		x	x	x		x	x	x	x		
Aster novae-angliae	New England aster		x	x		x				x	x			x	
Aster novi-belgii	New York aster	x	x	x				x		x	x	x	x		
Aster umbellatus	flat-top white aster		x	x		x	x			x	x			x	
Bidens cernua+	nodding beggar-ticks	x	x	x		x	x	x		x	x	x	x		
*Boltonia asteroides**	aster-like boltonia		x					x			x	x	x	x	
Caltha palustris	marsh marigold		x	x		x		x		x	x			x	
Chamaecrista fasciculata+	partridge pea			x		x	x	x			x				x
Chelone glabra	white turtlehead		x	x		x	x	x	x	x			x	x	
Chrysogonum virginianum	green and gold		x	x		x	x	x	x						x
Coreopsis tripteris	tall coreopsis		x	x		x	x	x		x	x		x	x	x
Delphinium tricorne	dwarf larkspur		x			x	x		x	x					x
Dicentra cucullaria	Dutchman's breeches		x			x	x		x						x
Equisetum hyemale	horsetail, scouring rush			x		x	x	x	x	x	x		x	x	x
Eupatorium coelestinum	mistflower	x	x	x		x	x	x	x	x	x			x	x

Eupatorium fistulosum	Joe Pye weed	x	x	x		x	x	x		x	x		x	x	x
Eupatorium perfoliatum	common boneset			x		x	x	x		x	x	x	x	x	
Helenium autumnale	sneezeweed	x	x	x		x	x	x		x	x	x	x	x	
Helianthus decapetalus	ten-petaled sunflower	x	x	x		x	x	x		x	x			x	x
Heliopsis helianthoides	oxeye sunflower	x	x	x		x	x	x		x	x			x	x
Hibiscus moscheutos	Eastern rosemallow	x	x	x		x	x	x			x	x	x		
Iris virginica	Virginia blue flag		x	x			x	x		x	x	x	x		
Kosteletskya virginica	seashore mallow	x		x				x			x	x	x		
Lilium superbum	Turk's cap lily		x			x	x	x		x	x			x	x
Lobelia cardinalis	cardinal flower	x	x	x		x	x	x		x	x	x	x	x	
Lobelia siphilitica	great blue lobelia	x	x	x		x	x	x	x	x				x	x
Maianthemum racemosa	false Solomon's seal		x	x		x	x	x	x	x				x	x
Mertensia virginica	Virginia bluebells		x	x		x	x		x	x				x	x
Mimulus ringens	monkeyflower		x	x		x	x	x			x	x	x	x	
Monarda didyma	bee balm	x	x	x		x			x	x				x	x
Nymphaea odorata	American water lily	x	x	x		x	x	x			x	x			
Oenothera fruticosa	sundrops	x	x	x		x	x	x			x	x	x	x	x
Peltandra virginica	arrow arum	x	x	x			x	x		x	x	x	x		
Phlox divaricata	woodland phlox		x	x		x	x			x				x	x
Phlox paniculata	summer phlox		x	x		x	x	x		x	x			x	x
Podophyllum peltatum+	mayapple	x	x	x		x	x	x		x	x				x
Polemonium reptans	Jacob's ladder		x			x	x	x	x	x					x
Pontederia cordata	pickerel weed	x	x	x			x	x			x	x			
Rhexia virginica	Virginia meadow-beauty	x		x		x	x	x			x			x	
Rudbeckia laciniata	cut-leaved coneflower	x	x	x		x	x	x		x	x		x	x	x
Sagittaria latifolia	broadleaf arrowhead	x	x	x		x	x	x			x	x	x		
Saururus cernuus	lizard's tail		x	x		x	x	x		x	x	x	x		
Senecio aureus+	golden ragwort	x		x		x	x	x	x	x			x	x	x
Solidago rugosa+	rough-stemmed goldenrod	x		x		x	x	x		x	x		x	x	x
Verbena hastata	blue vervain	x		x		x	x			x	x		x	x	
Vernonia noveboracensis	New York ironweed	x	x	x		x	x	x		x	x		x	x	x
Viola cucullata	marsh blue violet	x	x	x		x	x	x		x	x			x	
Viola pubescens	yellow violet	x	x	x		x	x		x	x					x
Zephranthes atamasco	Atamasco lily		x	x				x		x	x		x	x	x
Ferns and fern allies															

Athyrium asplenioides	Southern ladyfern		x	x		x	x	x	x					x	x
Botrychium virginianum	Rattlesnake fern		x			x	x	x	x	x					x
Onoclea sensibilis+	sensitive fern		x	x		x	x	x		x	x			x	x
Osmunda cinnamomea	cinnamon fern		x	x		x	x	x	x	x			x	x	
Osmunda regalis	royal fern		x	x		x	x	x		x				x	x
Polystichium acrostichoides	Christmas fern		x	x		x	x	x	x						x
Thelypteris palustris	marsh fern		x			x	x	x		x	x	x	x	x	
Woodwardia virginica+	Virginia chain fern		x	x				x	x	x	x	x	x		
Grasses, sedges, reeds															
Agrostis perennans	autumn bentgrass			x		x	x	x	x	x	x	x	x	x	x
Andropogon gerardii	big bluestem	x	x	x	x	x	x			x	x		x	x	
Andropogon glomeratus	bushy bluestem		x	x		x	x	x		x	x			x	
Arundinaria gigantea	wild cane, river cane	x		x		x			x	x	x		x	x	x
Carex crinita var. crinita	long hair sedge	x	x	x		x	x	x		x	x	x	x	x	
Carex lurida	sallow sedge	x		x		x	x	x		x	x	x	x	x	
Carex stricta	tussock sedge	x		x		x	x	x		x	x	x	x	x	
Chasmanthium latifolium	river oats, spanglegrass		x	x		x	x	x	x	x	x		x	x	x
Dichanthelium clandestinum	deer-tongue	x		x	x	x	x	x		x	x	x	x	x	x
Dichanthelium commutatum	variable panicgrass	x	x	x	x	x	x	x	x	x					x
Dulichium arundinaceum	dwarf bamboo	x		x	x	x	x	x		x	x	x	x	x	
Elymus hystrix (Hystrix patula)	bottlebrush grass	x	x			x	x	x	x	x	x				x
Elymus virginicus	Virginia wild rye	x		x		x	x	x	x	x			x	x	x
Juncus canadensis	Canada rush	x		x			x	x		x	x	x	x	x	
Juncus effusus	soft rush	x		x		x	x	x		x	x	x	x	x	
Leersia oryzoides	rice cutgrass	x		x		x	x	x		x	x	x	x	x	
Panicum virgatum	switch grass	x	x	x		x	x	x		x	x	x	x	x	
Saccharum giganteum	giant plumegrass	x	x	x			x	x		x	x	x	x	x	
Scirpus cyperinus	woolgrass bulrush	x	x	x		x	x	x		x	x	x	x	x	
Sparganium americanum	American bur-reed	x		x		x	x	x		x	x	x			
Tripsacum dactyloides	gama grass	x	x	x	x	x	x	x		x	x	x	x	x	x
Typha latifolia	broad-leaved cattail	x		x		x	x	x			x	x			
Zizania aquatica	wild rice	x	x	x				x			x	x			
Vines															
Bignonia capreolata	crossvine	x	x			x	x	x	x	x			x	x	x
Celastrus scandens	climbing bittersweet	x	x			x	x	x	x	x	x				x

Clematis virginiana	virgin's bower		x			x	x	x		x	x	x	x	x	x
Parthenocissus quinquefolia	Virginia creeper	x	x	x		x	x	x		x	x		x	x	x
Shrubs															
Alnus serrulata	common alder	x	x	x		x	x	x	x	x	x	x	x	x	
Aronia arbutifolia	red chokeberry		x	x		x	x	x	x	x			x	x	x
Aronia melanocarpa	black chokeberry		x	x		x	x	x		x	x		x	x	x
Callicarpa americana	American beautyberry	x	x					x	x	x				x	x
Cephalanthus occidentalis	buttonbush		x	x		x	x	x		x	x	x	x		
Clethra alnifolia	sweet pepper-bush	x	x	x				x	x	x				x	
Cornus amomum	silky dogwood	x		x		x	x	x	x	x			x	x	
Hydrangea arborescens	wild hydrangea		x			x	x	x	x	x					x
Ilex decidua	possumhaw	x	x	x			x	x	x	x			x	x	x
Ilex verticillata	winterberry	x	x	x		x	x	x		x	x		x	x	x
Itea virginica	Virginia willow	x	x	x				x	x	x			x	x	
Leucothoe racemosa	fetterbush, sweetbells		x	x		x	x	x		x	x		x	x	
Lindera benzoin	spicebush	x	x	x		x	x	x	x					x	x
Myrica cerifera	Southern wax myrtle	x	x	x				x	x	x		x	x	x	x
Rhododendron viscosum	swamp azalea		x	x		x	x	x		x	x		x	x	
Rubus allegheniensis	Alleghany blackberry	x	x	x		x	x				x		x	x	x
Salix sericea	silky willow		x	x		x	x	x		x	x		x	x	
Sambucus canadensis	common elderberry	x	x	x		x	x	x			x		x	x	x
Spiraea alba	narrow-lvd. meadowsweet	x	x	x		x					x		x	x	
Spiraea latifolia	broad-lvd. meadowsweet	x	x	x		x					x		x	x	x
Vaccinium corymbosum	highbush blueberry	x	x	x		x	x	x	x	x	x		x	x	x
Viburnum dentatum	So. arrow-wood viburnum	x	x	x		x	x	x		x	x				
Viburnum prunifolium	black-haw viburnum	x	x	x		x	x	x		x	x				
Small trees															
Amelanchier arborea	downy serviceberry	x	x	x		x	x	x		x	x				x
Amelanchier canadensis	Canada serviceberry	x	x	x		x	x	x			x		x	x	x
Amelanchier laevis	smooth serviceberry	x	x	x		x				x	x				x
Asimina triloba	paw paw	x	x	x		x	x	x	x	x				x	x
Cornus alternifolia	alternate-leaf dogwood	x	x	x		x	x		x	x					x
Crateagus flava	October haw	x	x			x	x	x		x	x			x	
Morus rubra	red mulberry	x	x	x		x	x	x	x	x				x	x
Ostrya virginiana	Eastern hop-hornbeam		x			x	x	x	x	x					x

Persea borbonia	redbay, sweet bay		x	x				x	x	x				x	
Rhus glabra	smooth sumac	x	x	x		x	x	x			x			x	x
Salix nigra	black willow			x		x	x	x		x	x	x	x	x	
Medium to Large Trees															
Acer rubrum	red maple		x	x		x	x	x			x	x	x	x	x
Betula lenta	sweet birch, black birch	x	x	x		x	x			x	x			x	x
Betula nigra	river birch	x	x	x		x	x	x			x		x	x	
Diospyros virginiana	persimmon	x	x	x		x	x	x	x	x	x		x	x	x
Fraxinus americana	white ash	x	x			x	x	x		x	x		x	x	x
Fraxinus pensylvanica	green ash	x	x	x		x	x	x		x	x		x	x	
Juglans nigra	black walnut	x		x		x	x	x		x	x		x	x	x
Liquidambar styraciflua	sweetgum		x	x		x	x	x	x	x	x		x	x	x
Liriodendron tulipifera	tulip-tree, tulip poplar	x	x	x		x	x	x			x			x	x
Nyssa aquatica	water tupelo	x	x	x				x		x	x	x			
Nyssa sylvatica	black gum	x	x	x		x	x	x		x	x		x	x	x
Oxydendrum arboreum	sourwood		x			x	x	x		x				x	x
Pinus taeda	loblolly pine	x	x	x			x	x			x		x	x	x
Platanus occidentalis	sycamore			x		x	x	x		x	x		x	x	x
Quercus bicolor	swamp white oak	x		x		x	x	x	x	x			x	x	
Quercus laurifolia	swamp laurel oak	x		x				x		x	x		x	x	
Quercus michauxii	swamp chestnut oak	x	x				x	x		x	x		x	x	x
Quercus nigra	water oak	x		x				x	x	x			x	x	x
Quercus palustris	pin oak	x	x	x		x	x	x	x	x			x	x	
Quercus phellos	willow oak	x	x	x			x	x		x	x		x	x	x
Taxodium distichum	bald cypress		x	x				x			x	x			

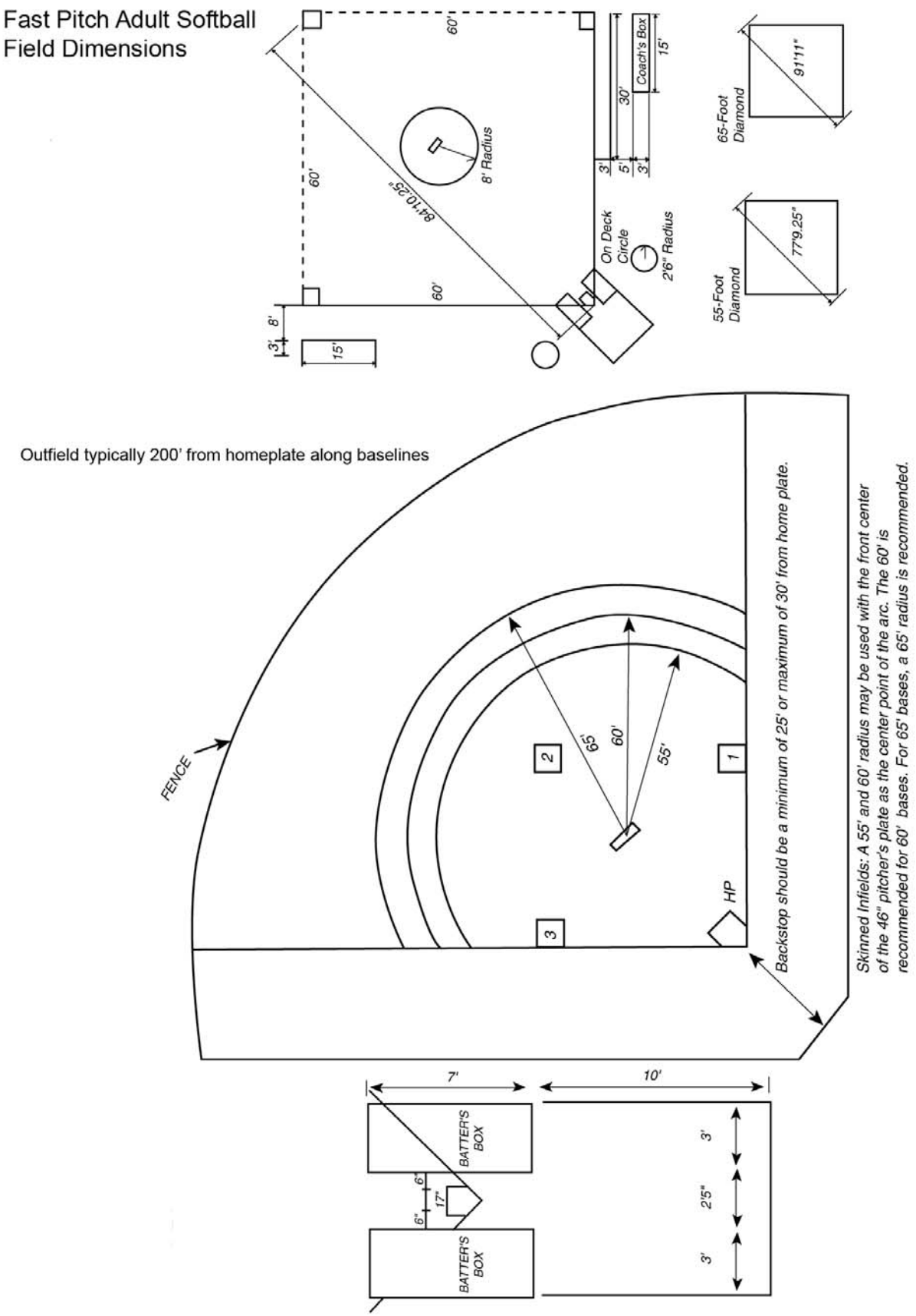
+May be aggressive in garden setting.

*Due to the rarity and sensitivity of habitat in Virginia, these species are recommended for horticultural use only.

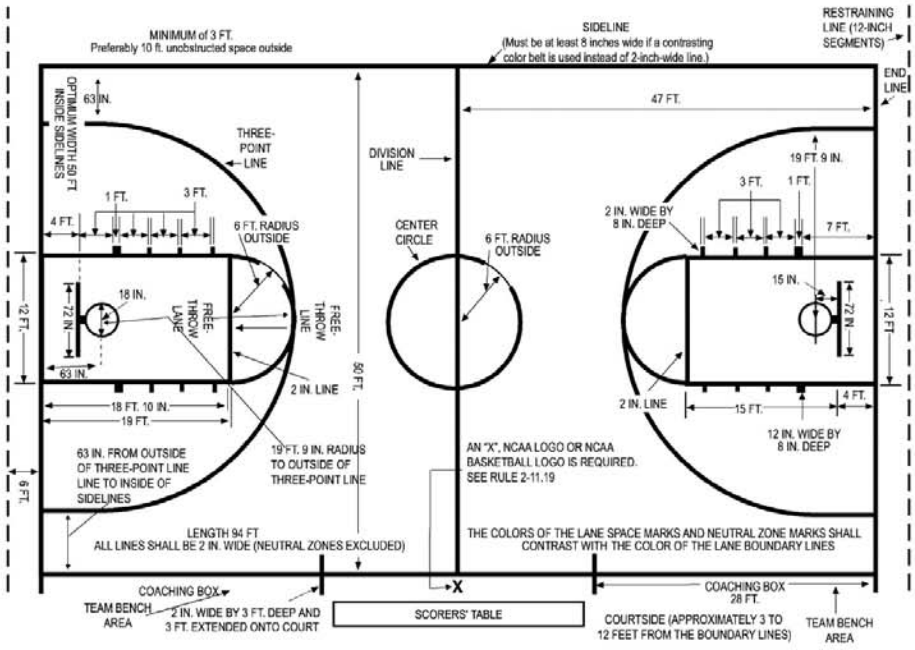
Planting these species in natural areas could be detrimental to the survival of native populations.

Virginia Department of Conservation and Recreation: http://www.dcr.virginia.gov/natural_heritage/riparian.shtml

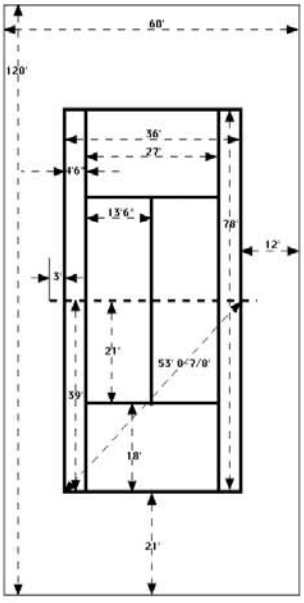
Appendix C: Field and Court Dimensions



Collegiate Basketball Court Dimensions



Doubled Tennis Court Dimensions



Sand Volleyball Court Dimensions