Biscuit Run Park Phase 2 Development

A Technical Report submitted to the Department of Civil and Environmental Engineering

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Grace Franklin

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Technical Project Team Members

Mark Ayala

Emmy Chen

Jordan Colbert

Joe Inacio

Bailey Stumbaugh

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Prof. James A. Smith, Department of Civil and Environmental Engineering

1. Introduction

1.1. Background

As the population of Albemarle County increases, its southern extent has experienced a growing disparity in access to public green space and recreational facilities. In response, the construction of a new county park – Biscuit Run – has been set in motion by local officials. The goal of this park is to create recreational opportunities and improve quality of life, while also preserving natural and historical resources in a developing area. The new park will include walking and cycling trails, athletic fields, pavilions, play areas, and scenic views of Carter Mountain. Spanning 1,190 acres, the park will be situated between Route 20 (Scottsville Road) and Old Lynchburg Road, stretching south from I-64 to just north of Black Branch. Phase 1 of construction for this park concluded in October 2024, which included a new paved entrance to the park and the first section of an entrance road to a trailhead parking lot. The park opened in December 2024, while further construction continued. Phase 2 construction is currently proposed to include extensions of the entrance roads, larger parking lots, terraced sports fields, and a trail system.

1.2. Problem Statement

The goal of this project was to evaluate the progress of Phase 1, evaluate site conditions, and design a portion of the park to better fit a theme of "living with nature" while still meeting the need for more recreational space. CAD design deliverables for Phase 2 were created using Civil 3D for a designated portion of the park, and construction management tasks were completed to reflect the schedule and cost estimate associated with the design.

1.3. Design Objectives & Scope & Measures of Success

Working on the second phase of the park's development, the team designed a portion of the park featuring paved trails, two athletic fields, and a bioretention basin in accordance with the 'living with nature' theme. The extent of this work within the park's Phase 2 Master Plan Map is included below in Figure 1. Following the development of a phasing plan, Emmy and Grace focused on stormwater management (SWM) design and environmental protection, Joe and Bailey focused on trail design, and Mark and Jordan focused on field design as well as construction management. Bailey left the project in January 2025, causing the work distribution to change. Trail design had concluded by this point, so Joe shifted focus to help Mark and Jordan with their construction management tasks for the remainder of the project.

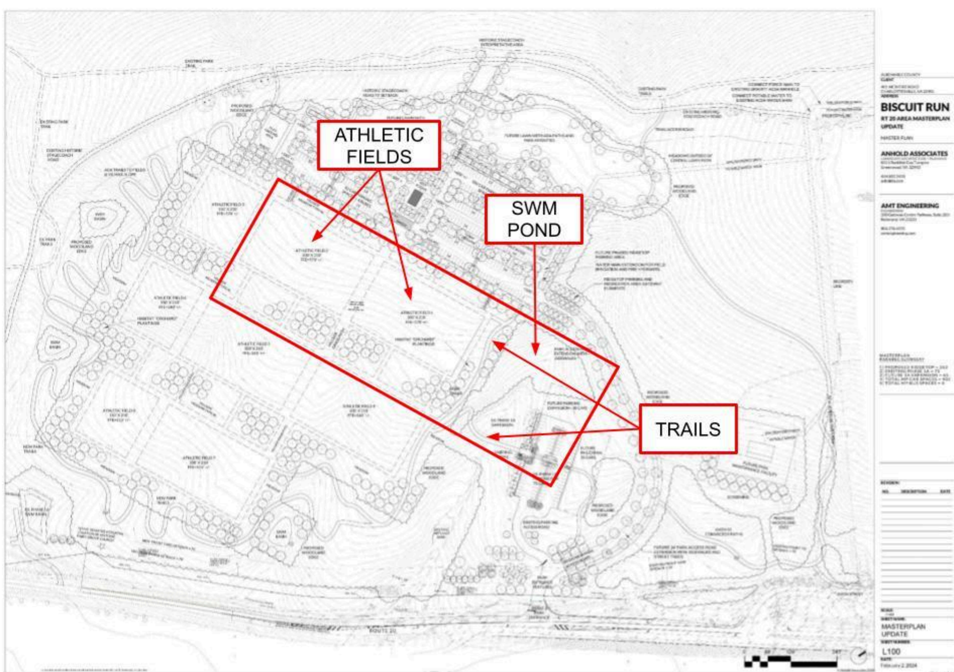


Figure 1: Phase 2 Master Plan for Park with Design Area of Interest

Additionally, relevant standards provided by groups such as the Virginia Department of Environmental Quality (VDEQ), the Virginia Department of Transportation (VDOT), and the Americans with Disabilities Act (ADA) were followed strictly throughout the process. Efforts were made to not only meet these requirements, but to exceed them with the goal of making the park as accessible and sustainable as possible. Appendix C includes detailed descriptions and examples of the standards used.

CAD drawings and the associated sheet set were delivered depicting the placement of facilities, grading, stormwater management, ADA compliance, environmental protection, and general implementation with respect to the park's trails and athletic fields (see Appendix D.1). Images of final design components included in this report (Figures 2, 6 - 17) are sourced from the final sheet set. Drawings were also created for the erosion and sediment control plan for Phase 2 of construction.

Throughout the design process, the group identified risks that could arise with its implementation, with each concern being quantified into time and money. Risks were addressed through a change in the proposal's design or phasing plan. Ultimately, a set of CAD drawings, construction management documents, and a presentation detailing both were delivered to UVA and the project team at AMT Engineering in April of 2025.

2. Design

Figure 2 depicts the proposed post-construction site layout, which features trails, fields, and stormwater BMPs. The process of designing each of these components is discussed in further sections. The full sheet set including all drawings can be found in Appendix D.1. Appendix D.1 can also be referenced for access to all supporting materials for the design.

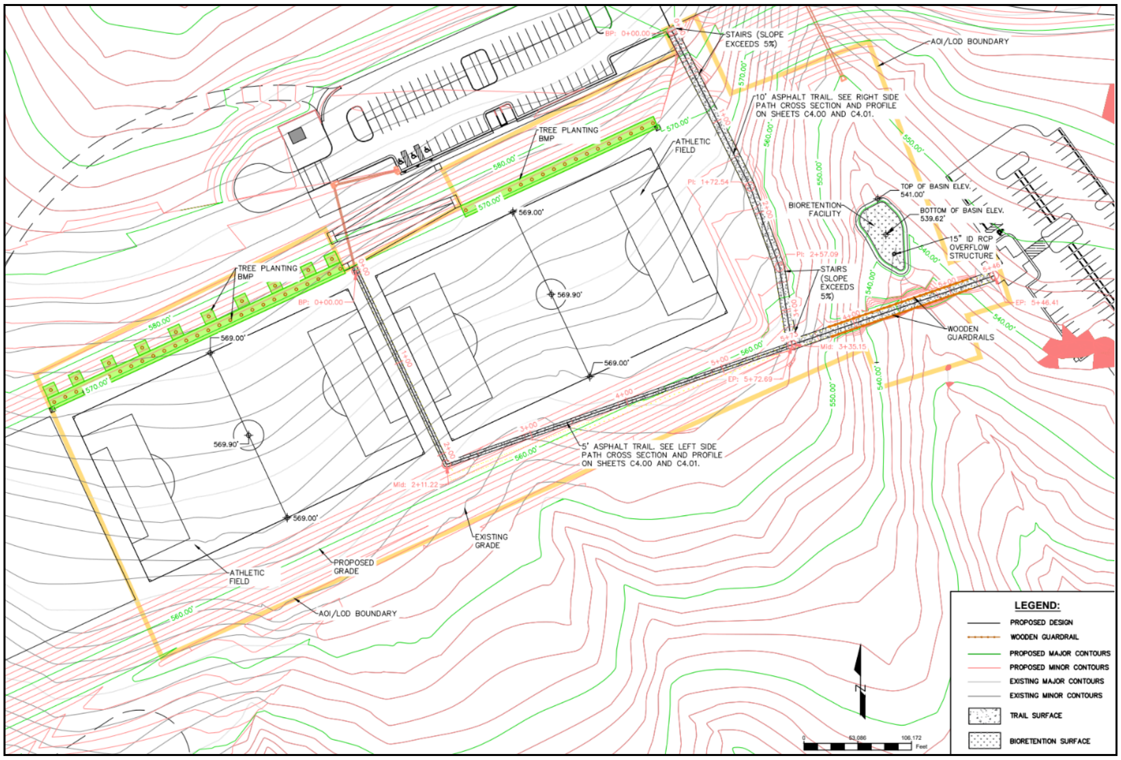


Figure 2: Proposed Site Design

2.1. Preliminary Research

Due to the nature of this project, the group was encouraged by the advisors to spend a significant amount of time researching Biscuit Run Park and sustainable park design. This research included looking into the history of the area and understanding how the property has changed hands over the years. The group also studied the current master plan shared by the industry advisor, Don Rissmeyer, as well as county reports and news articles. The Albemarle GIS database and Google Maps were used to get a better understanding of the roads, amenities, and neighborhoods around the site. The VDEQ's Environmental Justice Screen confirmed that the neighborhoods to the north and west of the park are low income communities and ~80% of the residents are people of color. Research into existing environmental conditions was also conducted. The existing land is mostly forested, and the entire site consists of type B soils (*Web*

Soil Survey, n.d.). Some general research into sustainable park design that could be applied to Biscuit Run is included in Appendix D.3.

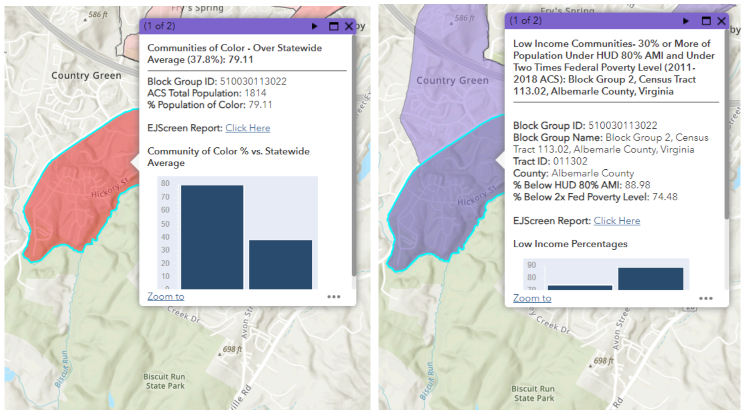
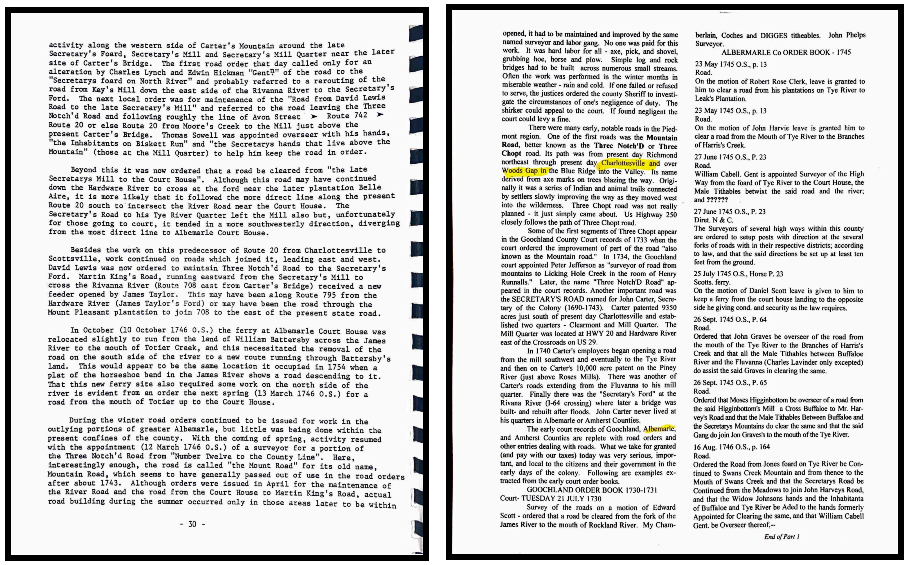


Figure 3: Virginia DEQ Environmental Justice Screen Website Data

Research was also conducted into local stakeholders' perspectives. Directly across Route 20 sits Brookhill Farm, an equestrian center. Because previous master plans for the site included equestrian trails, the owners were contacted to see if they had previously discussed the possibility of a partnership. They responded that they had not been contacted by the park planners. They pointed out that mixed-use trails could be dangerous, but one solution could be for trails to be assigned different uses on different days.

A meeting was arranged with Peter Krebs, who works as an advocate for the Piedmont Environmental Council. In 2023, Krebs wrote an article titled "Making Biscuit Run Park Available to Everyone", in which he detailed the importance of walkability and neighborhood connections. The conversation about access, equity, and community were extremely informative and allowed the group to design a more inclusive Biscuit Run.

A historic carriage road that runs through Biscuit Run Park was also investigated to provide additional context, and some relevant documents are shown in Figure 4.



activity along the western side of Carter's Mountain around the late Secretary's Foard, Secretary's Mill and Secretary's Mill Quarter near the later site of Carter's Bridge. The first road order that day called only for an alteration by Charles Lynch and Edwin Hickman "Gent?" of the road to the "Secretarys foard on North River" and probably referred to a rerouting of the road from Key's Mill down the east side of the Rivanna River to the Secretary's Ford. The next local order was for maintenance of the "Road from David Lewis Road to the late Secretary's Mill" and referred to the road leaving the Three Notch'd Road and following roughly the line of Avon Street ➤ Route 742 ➤ Route 20 or else Route 20 from Moore's Creek to the Mill just above the present Carter's Bridge. Thomas Sowell was appointed overseer with his hands, "the Inhabitants on Biskett Run" and "the Secretarys hands that live above the Mountain" (those at the Mill Quarter) to help him keep the road in order.

Beyond this it was now ordered that a road be cleared from "the late Secretarys Mill to the Court House". Although this road may have continued down the Hardware River to cross at the ford near the later plantation Belle Aire, it is more likely that it followed the more direct line along the present Route 20 south to intersect the River Road near the Court House. The Secretary's Road to his Tye River Quarter left the Mill also but, unfortunately for those going to court, it tended in a more southwesterly direction, diverging from the most direct line to Albemarle Court House.

Besides the work on this predecessor of Route 20 from Charlottesville to Scottsville, work continued on roads which joined it, leading east and west. David Lewis was now ordered to maintain Three Notch'd Road to the Secretary's Ford. Martin King's Road, running eastward from the Secretary's Mill to cross the Rivanna River (Route 708 east from Carter's Bridge) received a new feeder opened by James Taylor. This may have been along Route 795 from the Hardware River (James Taylor's Ford) or may have been the road through the Mount Pleasant plantation to join 708 to the east of the present state road.

In October (10 October 1746 O.S.) the ferry at Albemarle Court House was relocated slightly to run from the land of William Battersby across the James River to the mouth of Totier Creek, and this necessitated the removal of the road on the south side of the river to a new route running through Battersby's land. This would appear to be the same location it occupied in 1754 when a plat of the horseshoe bend in the James River shows a road descending to it. That this new ferry site also required some work on the north side of the river is evident from an order the next spring (13 March 1746 O.S.) for a road from the mouth of Totier up to the Court House.

During the winter road orders continued to be issued for work in the outlying portions of greater Albemarle, but little was being done within the present confines of the county. With the coming of spring, activity resumed with the appointment (12 March 1746 O.S.) of a surveyor for a portion of the Three Notch'd Road from "Number Twelve to the County Line". Here, interestingly enough, the road is called "the Mount Road" for its old name, Mountain Road, which seems to have generally passed out of use in the road orders after about 1743. Although orders were issued in April for the maintenance of the River Road and the road from the Court House to Martin King's Road, actual road building during the summer occurred only in those areas later to be within

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opened, it had to be maintained and improved by the same named surveyor and labor gang. No one was paid for this work. It was hard labor for all - axe, pick, and shovel, grubbing hoe, horse and plow. Simple log and rock bridges had to be built across numerous small streams. Often the work was performed in the winter months in miserable weather - rain and cold. If one failed or refused to serve, the justices ordered the county Sheriff to investigate the circumstances of one's negligence of duty. The shirker could appeal to the court. If found negligent the court could levy a fine.

There were many early, notable roads in the Piedmont region. One of the first roads was the **Mountain Road,** better known as the **Three Notch'D** or **Three Chopt** road. Its path was from present day Richmond northeast through present day Charlottesville and over Woods Gap in the Blue Ridge into the Valley. Its name derived from axe marks on trees blazing the way. Originally it was a series of Indian and animal trails connected by settlers slowly improving the way as they moved west into the wilderness. Three Chopt road was not really planned - it just simply came about. Us Highway 250 closely follows the path of Three Chopt road.

Some of the first segments of Three Chopt appear in the Goochland County Court records of 1733 when the court ordered the improvement of part of the road "also known as the Mountain road." In 1734, the Goochland court appointed Peter Jefferson as "surveyor of road from mountains to Licking Hole Creek in the room of Henry Runnalls." Later, the name "Three Notch'D Road" appeared in the court records. Another important road was the SECRETARY'S ROAD named for John Carter, Secretary of the Colony (1690-1743). Carter patented 9350 acres just south of present day Charlottesville and established two quarters - Clearmont and Mill Quarter. The Mill Quarter was located at HWY 20 and Hardware River east of the Crossroads on US 29.

In 1740 Carter's employees began opening a road from the mill southwest and eventually to the Tye River and then on to Carter's 10,000 acre patent on the Piney River (just above Roses Mills). There was another of Carter's roads extending from the Fluvanna to his mill quarter. Finally there was the "Secretary's Ford" at the Rivana River (I-64 crossing) where later a bridge was built- and rebuilt after floods. John Carter never lived at his quarters in Albemarle or Amherst Counties.

The early court records of Goochland, Albemarle, and Amherst Counties are replete with road orders and other entries dealing with roads. What we take for granted (and pay with our taxes) today was very serious, important, and local to the citizens and their government in the early days of the colony. Following are examples extracted from the early court order books.

GOOCHLAND ORDER BOOK 1730-1731

Court- TUESDAY 21 JULY 1730

Survey of the roads on a motion of Edward Scott - ordered that a road be cleared from the fork of the James River to the mouth of Rockland River. My Chamberlain, Coches and DIGGES titheables. John Phelps Surveyor.

ALBERMARLE Co ORDER BOOK - 1745

23 May 1745 O.S., p. 13
Road.
On the motion of Robert Rose Clerk, leave is granted to him to clear a road from his plantations on Tye River to Leak's Plantation.

23 May 1745 O.S., p. 13
Road.
On the motion of John Harvie leave is granted him to clear a road from the Mouth of Tye River to the Branches of Harris's Creek.

27 June 1745 O.S., P. 23
Road.
William Cabell. Gent is appointed Surveyor of the High Way from the foard of Tye River to the Court House, the Male Tithables betwixt the said road and the river; and ??????

27 June 1745 O.S., P. 23
Diret. N & C.
The Surveyors of several high ways within this county are ordered to setup posts with direction at the several forks of roads with in their respective districts; according to law, and that the said directions be set up at least ten feet from the ground.

25 July 1745 O.S., Horse P. 23
Scotts. ferry.
On the motion of Daniel Scott leave is given to him to keep a ferry from the court house landing to the opposite side he giving cond. and security as the law requires.

26 Sept. 1745 O.S., P. 64
Road.
Ordered that John Graves be overseer of the road from the mouth of the Tye River to the Branches of Harris's Creek and that all the Male Tithables between Buffaloe River and the Fluvanna (Charles Lavinder only excepted) do assist the said Graves in clearing the same.

26 Sept. 1745 O.S., P. 65
Road.
Ordered that Moses Higginbottom be overseer of a road from the said Higginbottom's Mill a Cross Buffaloe to Mr. Harvey's Road and that the Male Tithables Between Buffaloe and the Secretarys Mountains do clear the same and that the said Gang do join Jon Graves's to the mouth of the Tye River.

16 Aug. 1746 O.S., p. 164
Road.
Ordered the Road from Jones foard on Tye River be Continued to Swans Creek Mountain and from thence to the Mouth of Swans Creek and that the Secretarys Road be Continued from the Meadows to join John Harveys Road, and that the Widow Johnsons hands and the Inhabitanta of Buffaloe and Tye River be Aded to the hands formerly Appointed for Clearing the same, and that William Cabell Gent. be Overseer thereof,--

End of Part 1

Figure 4: Scans from Albemarle County Road Orders (Pawlett)

2.2. Trail Design

Trail design began with the development of a trail layout in and around the athletic fields, connecting to the existing sidewalk and trail network outside of the Area of Interest (AOI). A preliminary layout was drawn in Civil3D, shown in yellow in Figure 5. The design was revised based on comments from the advisors, as shown in Figure 6. Data concerning the square footage of impervious surface area was collected for runoff volume calculations.

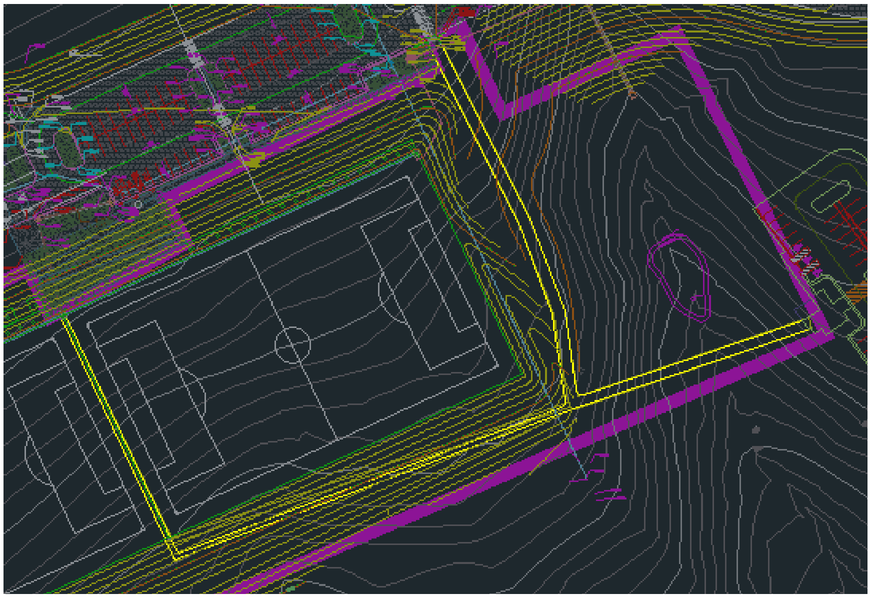


Figure 5: Preliminary Trail Layout in Civil 3D

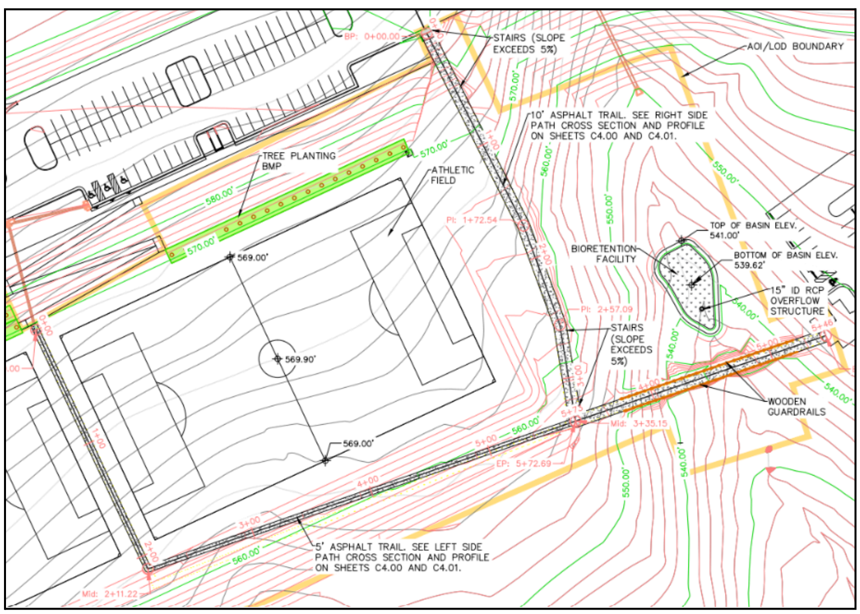
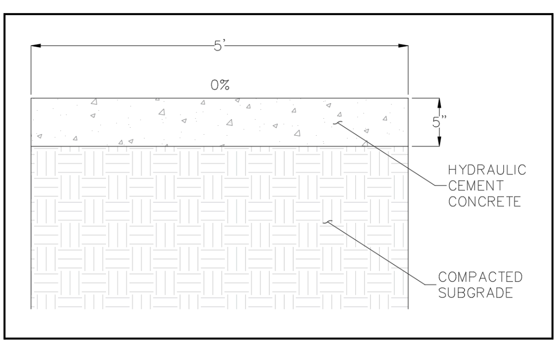


Figure 6: Final Trail Design in Civil 3D

In order to integrate the paths into a complete site grading plan, an alignment along the path trajectory was created. The elevation points of the alignment were set to match other features, such as connection points to existing sidewalks and the field crossing, as well as to ensure ADA compliance in both slopes and widths. A profile was generated, with which the alignment was converted into a corridor. Finally, the corridor was converted into a surface that could be merged with the other relevant surfaces to show the proposed grade for the site. The pathway near the bioretention pond required additional grading to ensure the smooth flow of runoff between the fields and the pond. Thus, the grading around the pond was modified into a bowl-like shape that was conducive to the flow of stormwater into the bioretention pond.

The main portion of the trail (also called the Left Side Path, following the southern edge of the AOI before turning to run between the two fields) is fully wheelchair-accessible. The 'shortcut' segment of the trail (also called Right Side Path, located between the east field and retention pond), however, had too steep of an elevation change to be wheelchair accessible without significant alterations. Since the main portion of the trail already provides access to all site features, the decision was made to leave the 'shortcut' segment non-accessible. Instead, stairs were implemented to bridge the elevation gap most efficiently. The stairs were divided into two sets, one at the upper parking lot connection and one at the lower trail intersection. This provides users with an implicit understanding of which route is accessible. A wooden guardrail was implemented along the portion of the trail passing the bioretention due to the steep slopes nearby. Cross sections and profiles of the trails are shown below in Figures 7 and 8.



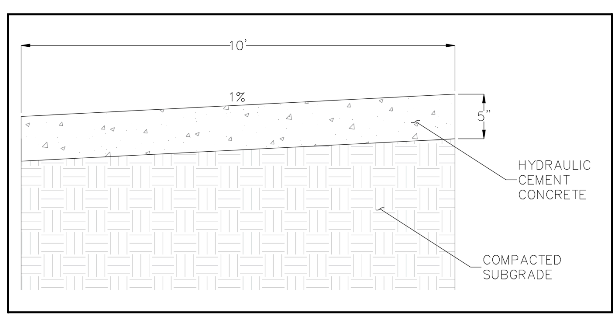


Figure 7: Trail Cross Sections

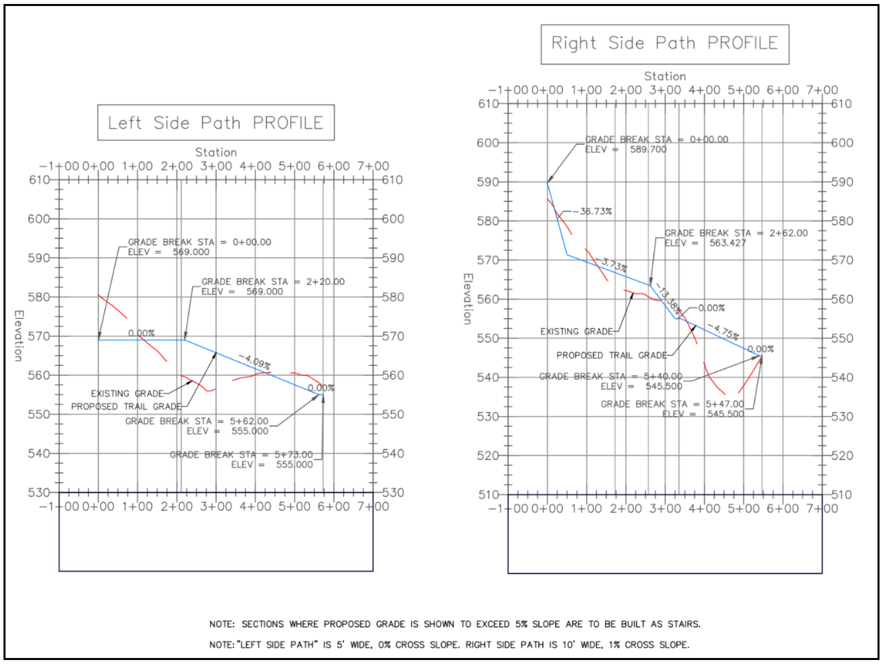


Figure 8: Trail Profiles

2.3. Stormwater Management and Environmental Sustainability

Research was conducted on stormwater management (SWM) and stormwater best management practices (BMP) using the Virginia Runoff Reduction Method (VRRM) and the Virginia Department of Environmental Quality (DEQ) Stormwater Management Handbook standards. Based on rough estimates of post-development land use, preliminary VRRM calculations for the area of interest (AOI) were conducted (see Appendix D.5). Through this analysis, a better understanding of which BMPs would be appropriate for the site was gained.

For the formal VRRM analysis, uncovering the nutrient removal requirements for the site depended on the trail and athletic field design. Changes in the amount of impervious land cover had significant impacts on the nutrient removal requirements. As a result, the VRRM spreadsheet underwent multiple iterations as the trails and fields were developed (see Appendix D.5). The AOI was divided into three drainage areas as outlined in Figure 9. Drainage Area A includes the upstream hills, which contain a tree planting BMP, and the athletic fields, which include an underground rainwater collection system (approximated as infiltration in VRRM). Drainage Area B includes the valley where the bioretention BMP is located, around which the trail system will connect the parking lots to the fields. Lastly, Drainage Area C includes the downstream hills, which is counted as mixed open land, with the exception of the trail (impervious). In all drainage areas, most of the land that is not occupied by trails, fields, or BMPs will be planted and maintained as mixed open land (shrubbery and vegetation that requires minimal maintenance), with some turf as necessary for convenience and accessibility.

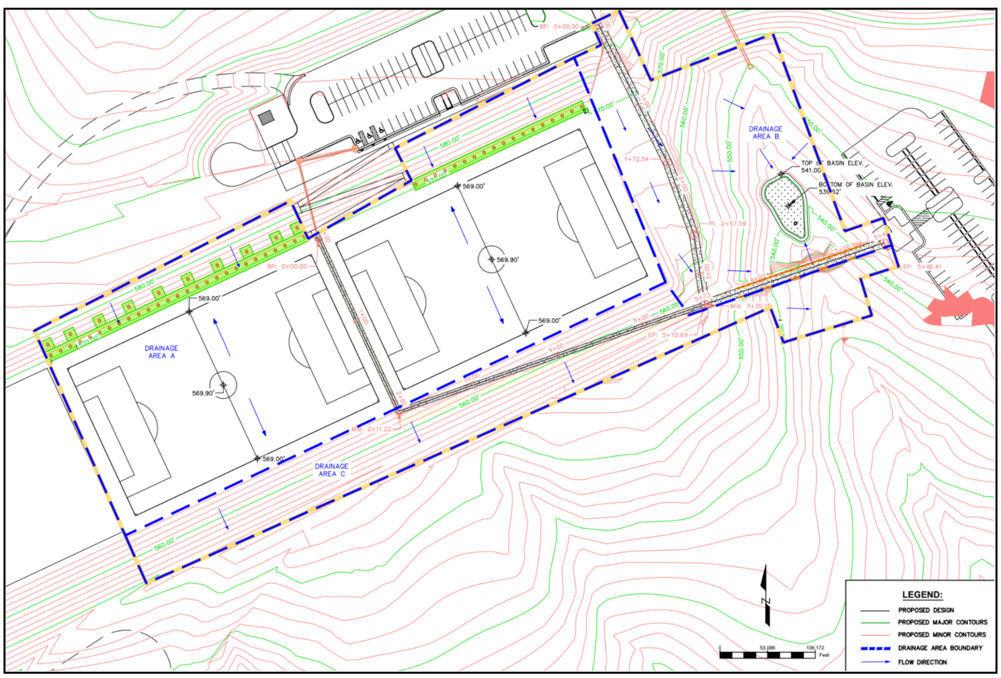


Figure 9: AOI and Labelled Drainage Areas

A rainwater collection system was designed underneath the athletic fields. The rain collection system consists of natural grass, engineered soil media, and an underdrain to collect and move water. The system is similar to an underground green roof. However, because the field is not replacing an impervious surface it cannot be considered a green roof in VRRM. Instead, infiltration was selected as the best approximation, with the grass being used as a pretreatment method. While the design is not exactly the same as an infiltration BMP, its nutrient removal rates are proposed to be similar. A cross section of the design is shown below in Figure 10, and the layout is shown in Figure 11.

A 1% crown was added to the design of the sports fields, which is a standard design choice when grading fields. The slight convex slope from the center of the field towards its edges prevents water from pooling on the playing surface and ensures proper drainage. Therefore, it directs rainwater away without affecting the field’s functionality or playability. The crown helps maintain a consistent playing surface by efficiently channeling rainwater off the field, which reduces the risk of damage to the turf or soil and minimizes the need for frequent maintenance. Furthermore, this design enhances durability by allowing for extended use without significant downtime after rain events, making it a practical and sustainable choice.

The fields were graded into two sections, splitting each field across the centerline with polylines. Rectangular feature lines were then created from the polylines in order to enable elevation editing. Manually, the significant points across the feature lines were changed to show a 1% grade across both fields. These feature lines were then added on to the combined surface as breaklines to grade the fields.

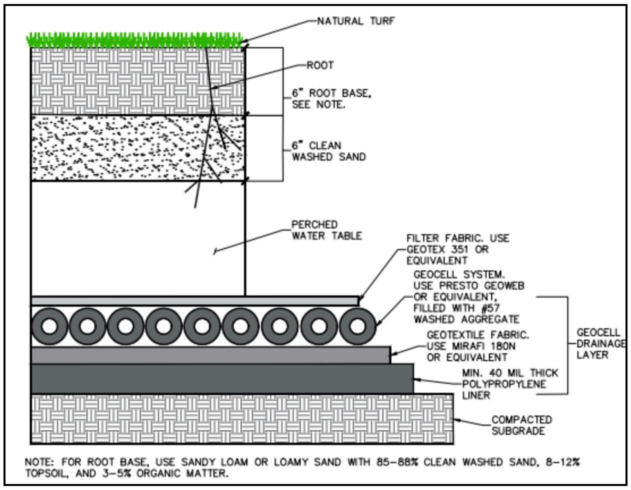


Figure 10: Field Design Cross Section

Figure 11: Field Design Layout

The tree planting BMP used on the upstream hills requires a total of 55 trees, according to P-FIL-09 in the DEQ handbook. The steeper slopes of the hillsides, sunlight availability, soil types, drainage, and special needs were all taken into consideration for species selection, and recommended trees are detailed on the Tree Planting BMP Design Criteria & Schedule Document (see Appendix D.7).

The bioretention BMP is Type 1 with no underdrain. The lack of underdrain was confirmed to be appropriate using the equations in the DEQ handbook. Based on the completed calculations, 0.02 acres of surface area were required, but the final design increased this area to 0.06 acres. This decision was made to improve the aesthetic value of the BMP, while also decreasing the nutrient removal requirements for the site. Bioretention is considered as 'forest' land cover in VRRM, which generates the least amount of nutrient pollution out of all land cover types. Thus, increasing the surface area of the bioretention BMP decreases the amount of total phosphorus that must be removed. The bioretention design follows the P-FIL-05 DEQ handbook equations and uses the minimum depths provided for all media layers. See Appendices D.5 - D.6 for calculations, and D.8 for planting recommendations.

An off-line bioretention system was selected for the site. Therefore, the bioretention includes an overflow structure pipe, sized to handle 100-year storm flows, which connects to an underground pipe that serves as a diversion structure for excess water. The design of this diversion pipe was determined to be outside the scope of this project and is not discussed in depth. Flow that exceeds the bioretention's design capacity will be captured by the overflow pipe and brought offsite via the diversion pipe. The overflow pipe was sized using the sharp-crested weir formula, where flow rate was calculated using TR-55 for a 100-year storm and weir length equaled pipe circumference (see Appendices D.5 and D.6).

The bioretention was graded in Civil 3D with 3:1 side slopes, using strategically chosen elevations to ensure the net fill value was minimal. Slopes of 2:1 were used outside of the bioretention basin to reconnect to existing grade without interfering with the trail design. Grass cover that does not require frequent mowing will be used on these steeper slopes to decrease the necessary maintenance. A cross-section of the bioretention and its layout are shown below.

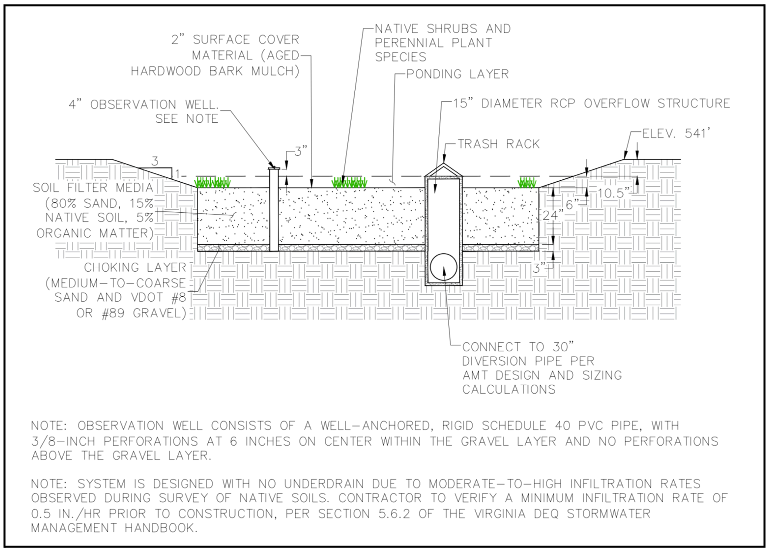


Figure 12: Cross-section of Bioretention

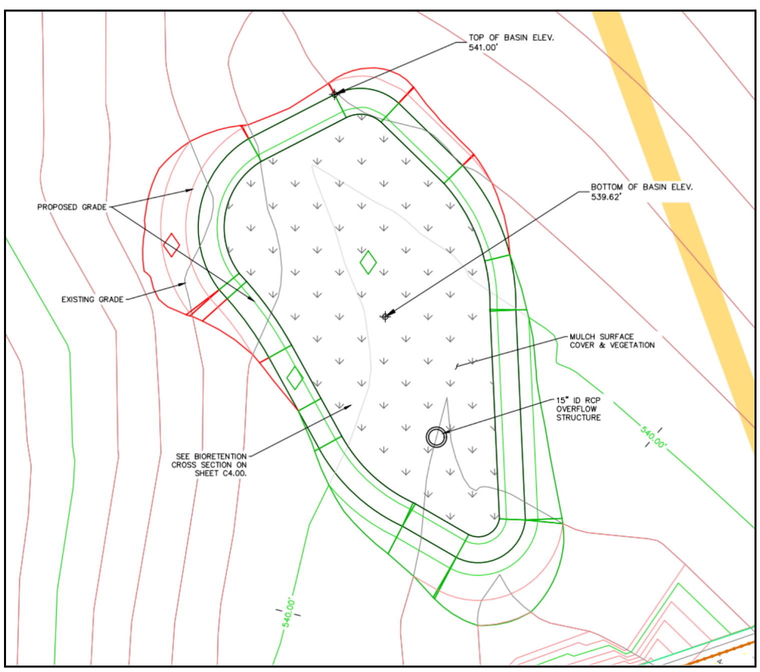


Figure 13: Bioretention Layout

The trails are graded to drain towards the bioretention and other BMPs so that all runoff rainwater is sustainably managed. With the addition of these BMPs, the site currently exceeds its total phosphorus load reduction requirements by 0.02 lb/year. The excess removal of nutrients should contribute to the site's resilience towards climate change.

2.4. Erosion and Sediment Control Plan

The Erosion and Sediment Control (E&S) plan was designed collaboratively to ensure all critical elements were properly mapped and aligned with project specifications. As shown in Appendix D.9, a temporary drawing was created, enabling placement of key components before developing the final E&S plan with the corresponding legend and design features.

One of the central components of the plan was the installation of 1,575 feet of silt fence (C-PCM-04), positioned with a minimum 5-foot setback from construction zones in accordance with VDOT standards. This setback was important to allow for effective filtration while minimizing interference with ongoing construction activities. The silt fence was not set around the sediment basin to maximize its ability to capture and retain sediment-laden runoff and debris from the surrounding disturbed areas. Given the size of the project, the team determined that a super silt fence was not necessary for this scope of work. The Limits of Disturbance (LOD), 6.48 acres, was outlined to accurately define the areas impacted by the project, ensuring that all disturbed land is properly monitored and contained. For slopes steeper than a 3:1 ratio, particularly near the fields and sediment basin, blanket matting (C-SSM-05) was installed to stabilize the soil and prevent erosion in these sensitive areas. Riprap (C-ECM-13) was strategically placed in areas of higher elevation north of the sediment basin, covering 202 square yards, to help slow water runoff and filter debris before it entered the basin. Additionally, the temporary construction entrance was designed by repurposing the existing roadway on site. The existing roadway leads to the east side of the construction area where the silt fence was left open to allow for easy access, providing a stable pathway for trucks and heavy equipment.

Each of these measures ensure that the site remains protected against erosion and sedimentation throughout the project's duration. The locations of these features are shown in Figure 14 below.

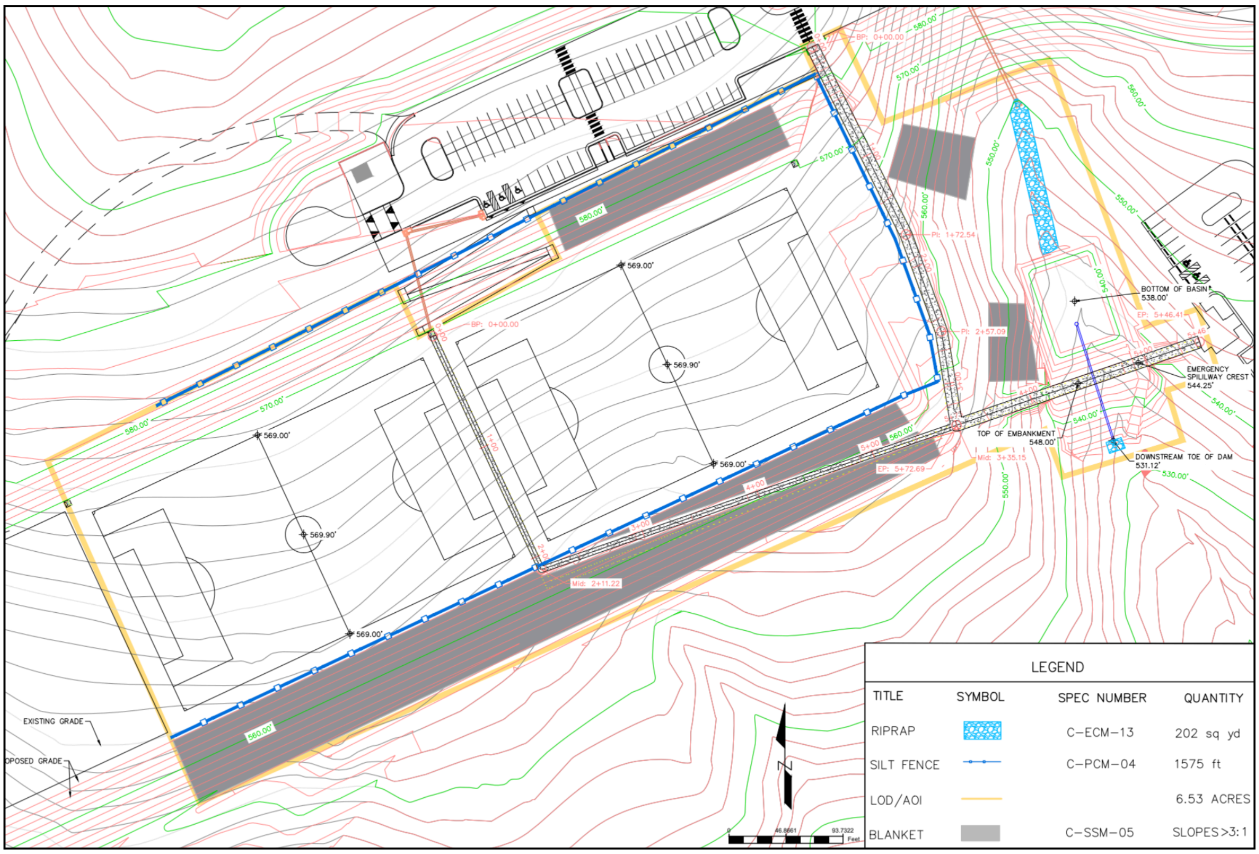


Figure 14: Erosion and Sediment Control Plan Layout

After the E&S plan was established and post-construction BMPs were finalized, the temporary sediment basin was designed. The calculations for the sediment basin can be found in Appendix D.10. These calculations were done according to the process described in C-SCM-12 of the DEQ Stormwater Management Handbook, with the assistance of a spreadsheet provided by AMT Engineering. The calculations were then used to create detailed cross-section drawings of the basin and its spillways, shown in Figures 15 and 16.

The goal of this design was to retrofit the existing Phase 1 sediment basin. As many Phase 1 features as possible were preserved, such as the size of the barrel pipe and the elevation of the basin bottom, as well as the general location of the basin. However, certain features such as the basin shape had to change. This was because the team lacked access to the software being used by AMT (HydroCAD), and the limit of disturbance (LOD) for this project was much smaller than the LOD used by AMT. This made it hard to preserve certain features; for example, all of the math required to size the basin correctly had to be done by hand, making it difficult to recreate the irregular shape of the Phase 1 basin. Instead, the basin was designed to have the shape of a truncated rectangular pyramid with 2:1 side slopes. Baffles were determined to be required for the design, as the length to width ratio is below 2:1.

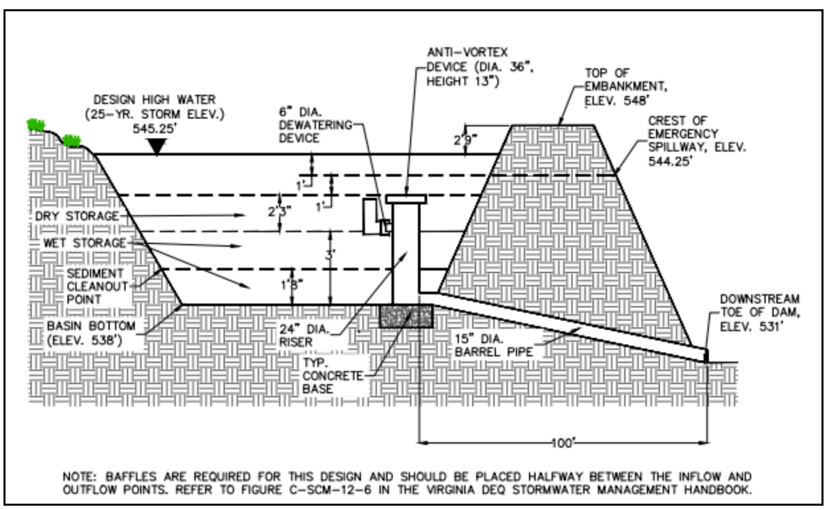


Figure 15: Sediment Basin Detail Drawings

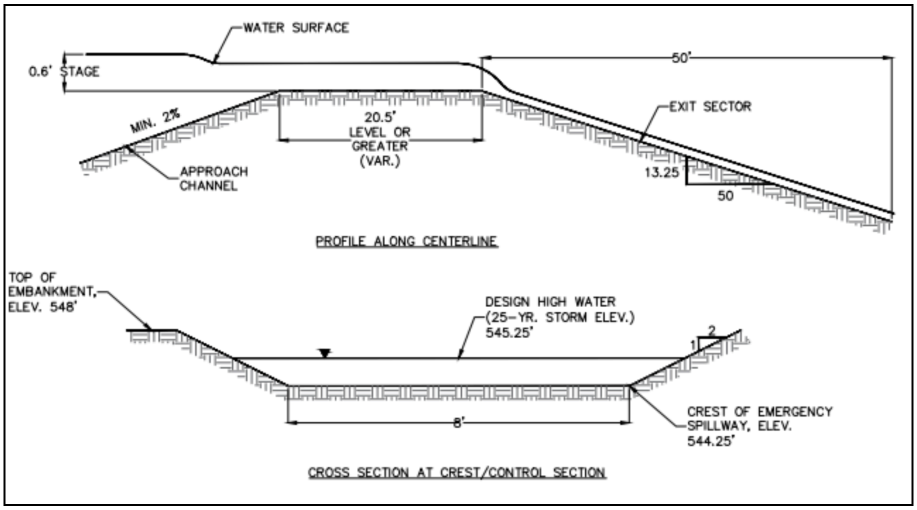


Figure 16: Sediment Basin Emergency Spillway Detail

Grading the spillways and basin into CAD presented a significant challenge, as the grading for the sediment basin was more advanced than the grading for other features of the site design. The design of the basin included many iterations, as it had to account for changes being made to the erosion and sediment control plan. Appendix B includes descriptions of the iterative process, while Appendix D.10 includes documents to show how design changed over time.

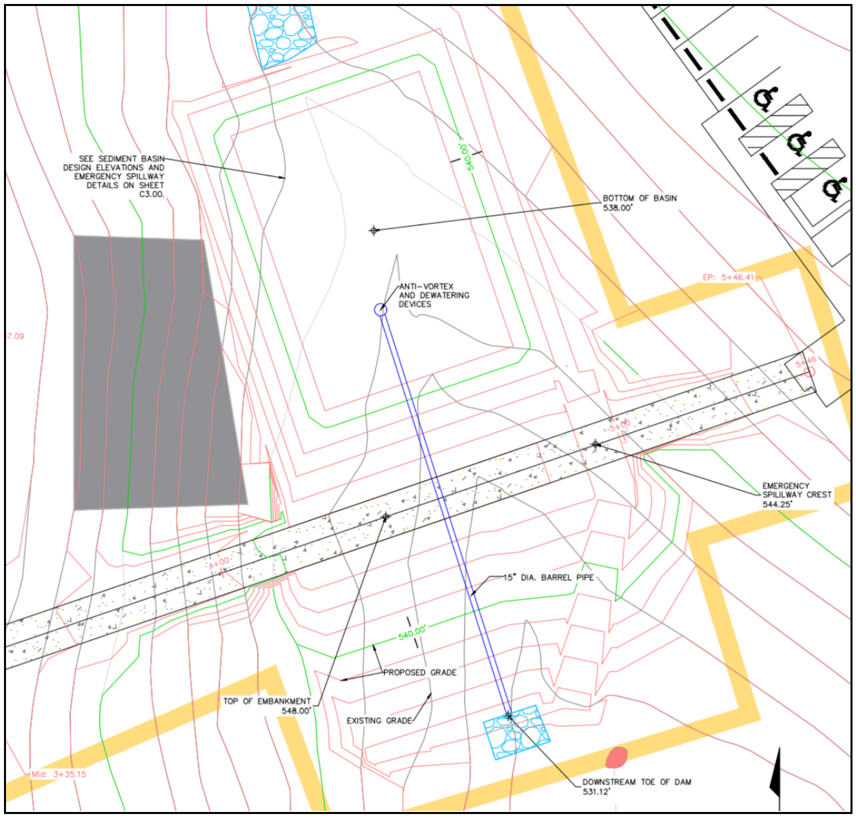


Figure 17: Sediment Basin Layout

2.5. Construction Scheduling & Phasing Plan

The construction schedule for the Biscuit Run Park project was developed to reflect a logical and realistic timeline of preconstruction and construction activities based on project-specific needs, industry standards, and guidance from advisors (see Appendix D.11). The final schedule was created using Primavera P6 and includes all major tasks, durations, dependencies, and a clearly defined critical path.

Activities were organized under a Design-Bid-Build (DBB) contract delivery method, which was selected as the most appropriate for this project. DBB is a traditional and widely used approach in public sector work where the design is completed before bidding begins. This structure supports a competitive bidding process and allows the owner to finalize design and budget expectations before selecting a general contractor. Since the Biscuit Run Park project schedule includes detailed design, preconstruction tasks, and full construction sequencing, the DBB method aligns well with its structure and risk profile. The schedule clearly separates design, bidding, and construction phases.

During the bidding phase, the schedule includes critical activities such as issuing a Request for Qualifications (RFQ), developing a shortlist, issuing a Request for Proposals (RFP), and conducting proposal reviews and interviews. Identifying regulatory requirements and securing approvals is a key activity and is scheduled before the RFP is sent out to ensure that bidding documents reflect all necessary constraints and permitting conditions.

A major scheduling milestone is the completion of the final design report, which occurs at the end of the spring semester. This milestone serves as a transition point in the schedule since no contractor bidding or construction activities can begin until after the design is finalized. This sequencing ensures that bidders can base their proposals on complete design documents which reduces the risk of costly changes during construction. In order to reflect realism, the schedule uses a calendar with a five day work week, excluding weekends and federally recognized holidays from activity durations. Each task begins on the first available workday after its predecessor finishes, aligning with typical Monday–Friday construction operations.

A phasing plan was made from the final schedule (see Figure 18 and Appendix D.12), which groups tasks into six logical phases:

1. Preconstruction & Planning
2. Site Preparation & Mobilization
3. Earthwork & Utilities
4. Infrastructure Construction

5. Trail & Field Features

6. Landscaping, Closeout & Commissioning

Each phase was defined by assigning activity codes. This allows the schedule to be grouped, sorted, and visually color-coded for better clarity. This phasing structure reflects a progressive and practical build-out of the site. The chart helps stakeholders visualize how work will proceed from early-stage mobilization through final turnover.

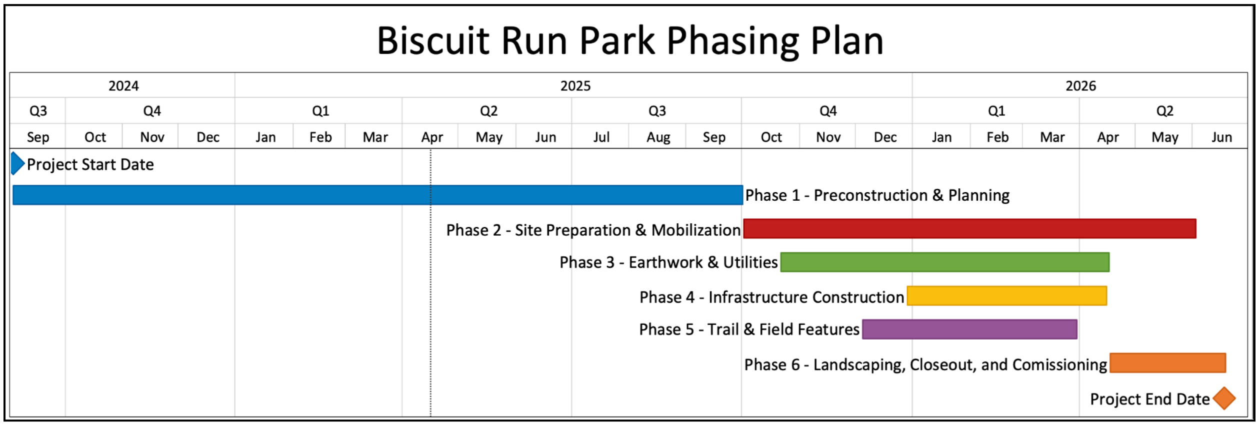


Figure 18: Phasing Plan

Finally, the critical path (see Appendix D.11) runs through essential tasks such as final design, site mobilization, grading, athletic field work, stormwater management, and final landscaping. Recognizing this path ensures that any delays to these key tasks will directly affect the project completion date.

Overall, the Biscuit Run Park schedule was developed with consideration for delivery method, logical sequencing, real-world construction constraints, and project-specific timing. The resulting timeline offers a clear framework for execution and project control.

2.6. Cost Estimation

The cost estimations for the athletic fields are focused on field size, surface type, soil preparation, and drainage systems. Using historical data, the estimated cost to implement the Underground Stormwater Retention System and the Permavoid Capillary System per field are $270,000 and $648,000, respectively. Cost estimates were developed for performance turf and natural grass. Performance turf construction costs range from $11 to $18 per square foot, leading to total costs of $594,000–$972,000 per field. For natural grass, costs are significantly lower at $4 to $9 per square foot, equating to $216,000–$486,000 per field. Native soil and engineered soil were considered for field bases. Using native soil aligns with performance turf costs ($11–$18/sq. ft.), resulting in total expenses of $594,000–$972,000 per field. Engineered soil is more expensive, ranging from $15 to $23 per square foot, with total costs between $965,250 and $1,242,000. Using comparative cost analysis tables, the recommendation is to use natural grass due to its cost-effectiveness compared to performance turf. Additionally, implementing an underground stormwater retention system aligns with both budgetary constraints and functional requirements for effective drainage. The final cost estimation using our chosen parameters of natural grass, underground retention system, native soil, and a 54,000 sqft field totaled to be around $500,000 per field.

Following the detailed estimates for the athletic fields, an additional hard costs estimation was generated focused on site grading, fill material, bioretention components, and erosion and sediment control elements. Soft costs such as labor, surveying, and other required permits were intentionally excluded from the final cost estimation, for practical reasons. Using Civil 3D calculations and notes from our bioretention grading, the team determined a total of approximately 438 cubic yards of fill would be needed, accounting for both general fill and material lost from the bioretention cut. This translates to roughly 37 dump truck loads, based on an average truck capacity of 12 cubic yards. Cost estimates for hauling fill dirt ranged widely from $150 to $450 per truck, so a median value of $300 was selected to account for regional variability, bringing the total hauling cost to about $11,100.

Additional estimates were made for concrete trail construction, riprap, matting, silt fencing, tree planting, and specialty bioretention soil layers. For example, the 8329 square feet of trail area (5" thick hydraulic cement concrete) was estimated to cost $52,056 based on a unit price of $56.25 per square yard. Riprap installation totaled 202 square yards at $45 per yard, with an estimated depth of 26 inches resulting in a volume of 47,368 CF and a total weight of over 2,100 tons—estimated to cost just under $96,000. Other key estimates include $27,500 for 55 trees, $1,025 for mulch, and $4,093 for bioretention plantings and these estimates were adjusted from AMT's unit prices. Additional field layer materials, such as the Geocell, liner, and filter fabric are already included in the cost estimates for the fields. The Bioretention Soil Profile Materials also combines sand, gravel, and organic matter estimates. These numbers reflect realistic mid-range values and were selected to balance cost certainty with contingency for site-specific variability. Details regarding cost estimation for the fields and the rest of the project can be found in Appendix D.13.

Biscuit Run Park - Phase Two Construction					
PROJECT NO.22-0137.004					
May 2025					
County of Albemarle, VA					
Construction Costs					
#	Description	Unit	Quantity	Unit Price	Total Price
1	Dump Truck Loads	EA	37	$300	$11,100.00
2	Athletic Fields	EA	2	$500,000	$1,000,000.00
3	Hydraulic Cement Concrete	SY	925.44	$56	$52,056.00
4	Wooden Guard Rail	LF	293.00	$50	$14,650.00
5	RipRap w/ Filter Fabric underneath	TONS	2,132	$45.00	$95,920.20
6	E&S Blankets/Mats	SY	871	$30	$26,136.00
7	Silt Fencing	LF	1,575	$7	$11,025.00
8	Trees	EA	55	$500	$27,500.00
9	Mulch	SY	205	$5	$1,025.00
10	Bioretention Soil Profile Materials	CF	4145	$5	$20,725.00
11	Sediment Basin Excavation	CY	890	$30	$26,700.00
12	Bioretention Excavation	CY	185	$30	$5,550.00
13	Bioretention Plants	SY	205	$20	$4,093.40
14	Pipe 15 inch diameter concrete	LF	100	$35	$3,508.75
15	4” Diameter Rigid Schedule 40 PVC Pipe	EA	1	$22	$22.00
				Construction Subtotal (Phase 2) =	**$1,300,011.35**

Figure 19: Phase Two Construction Estimate

2.7. Finalized Sheet Set

Once all aspects of design were completed, the CAD drawings were formatted to plot properly into a sheet set. This involved adjusting object styles, making iterative adjustments, and matching industry standards for format when possible. The sheet set is attached in Appendix D.1 and includes the proposed site design, the E&S plan, and the relevant details, cross sections, and profiles. Stormwater management calculations and construction management deliverables are submitted separately for clarity. Images used in Figure 2 and 5-17 are sourced from the sheet set in Appendix D.1, and the full sheet set can be referenced for additional context.

3. <u>Design Constraints</u>

All stormwater designs were constrained by the regulations set forth by the Virginia Department of Environmental Quality. BMPs had to be designed to handle the prescribed loads, but due to the narrow scope of the project and limited professional experience, the BMPs used also had to remain small in size and simple in design. This meant that the amount of impervious area had to be kept to an absolute minimum, which greatly constrained trail design. Additionally, ADA requirements constrained trail design and required that an accessible route connected all points of interest. To accommodate both of these constraints, trail design had to strategically navigate steep terrain while also limiting impervious areas and cut/fill values. Slight cross slopes were also used in some portions of the trail to better facilitate the movement of stormwater towards the appropriate BMPs. Straight paths with sharp turns were favored over curved paths with soft turns due to these constraints, although the goal had initially been to create organic and natural trails.

The prioritization of balancing sustainability with function also provided some constraints. Advanced field designs which allow athletic fields to function as stormwater reservoirs or management systems were initially considered. However, these designs are incredibly expensive and are not fully justified for high school-level athletic programs, so a simpler design was chosen. Stormwater BMPs for the site were also designed to remove all required nutrients, so that nutrient credits did not have to be purchased. This required many iterations of BMP design as well as trail and field design, but due to the environmental constraints the effort was prioritized.

Material constraints were relevant to field and trail design. Artificial turf was initially considered for the athletic fields due to high local demand and preferable stormwater characteristics, but the high cost associated with its installation was too significant to overcome. Natural turf was selected instead, despite its drawbacks. Pervious pavement was considered for the trail system, as it allows for greater infiltration of stormwater during rain events and can improve sustainability. However, pervious pavement options all require flat grades, which were unrealistic to obtain due to the site's characteristics. Because of this, hydraulic cement concrete was chosen for improved durability and practicality.

Finally, site limitations provided constraints for all aspects of the design. As mentioned previously, steep slopes made ADA accessibility difficult to achieve and eliminated the possibility of using permeable pavement. Additionally, the entire site is located on a hillside, which requires a terraced design in order to accommodate the athletic fields. Successfully grading a terraced hillside into AutoCAD software would be incredibly difficult due to the level of experience held by the team, so this constraint had to be overcome by using a pre-graded surface provided by the team's advisors. The provided surface only accounted for the athletic fields, so a significant amount of grading was still completed by the team for the trails, bioretention facility, and sediment basin design. A steep ravine also cuts through the site and greatly affects the movement of stormwater. The ravine is too large to fill, so all designs relating to stormwater (bioretention and sediment basin) had to be located conveniently within the ravine. This made it difficult to balance cut and fill values, and also greatly constrained the layout of the site.

4. Conclusions and Discussion

The goal of this project was to redesign a portion of Biscuit Run Park to balance conservation with recreation, to better fit a theme of "living with nature." The group's research into local demographics motivated this goal, as well-designed green spaces can bring significant benefits to communities (Jennings et al., 2016). The primary focus of the design was two athletic fields, a paved trail system, and the stormwater management facilities needed to accommodate the site. Care was taken to make sure the area was fully accessible and as environmentally sustainable as possible, while still providing recreational facilities and remaining financially feasible. The trails were designed to provide accessible routes to all points of interest while supporting the stormwater management system. The fields were designed to provide greater stormwater infiltration without compromising recreational value. The stormwater management system prioritized the use of green BMPs such as a bioretention facility, which provide aesthetic value in addition to environmental sustainability. All components of the final design contribute to sustainability and recreational value, in order to facilitate "living with nature."

A full erosion and sediment control plan was also created in addition to the final site design, including the placement of silt fences, protective mats on steep slopes, riprap, and other stabilizing structures. A sediment basin was retrofitted from the previous phase to handle runoff during construction, contributing to environmental sustainability efforts and limiting the impact of construction on local communities. Finally, construction management tasks such as phasing, scheduling, and cost estimation were completed based off of the proposed design. These tasks ensured that the proposed design was as sustainable as it was effective and practical.

Although the proposed design is thoroughly comprehensive, limitations on time, resources, and experience have had impacts. Future iterations should incorporate field studies to better understand site conditions, such as soil composition and local hydrology. Additionally, access to resources such as HydroCAD may contribute to better informed designs of certain stormwater management features. Our BMPs were, instead,manually undertaken and thus are more susceptible to human error. Professional insight regarding construction scheduling and cost estimation may result in more accurate predictions. Learning about the complexities of construction phasing and the challenges of Civil3D during the design phase also led to some difficulties; for example, the bioretention should not have been added to the “combined” or proposed surface prior to the sediment basin being designed. Because the bioretention and sediment basin were placed in the same location, the bioretention’s grading interfered with the sediment basin grading. Hindrances such as these could have been avoided if the team had more practical knowledge about scheduling design tasks at the onset of this project.

By participating in an authentic park development project, with emphasis placed on inclusivity and environmental stewardship, our team gained immense hands-on experience with the relevant software, environmental and structural standards, community engagement, and iterative processes of civil engineering design.

Appendices

A. Detailed Schedule

1. Original Schedule

Activity ID	Activity	Duration (days)	Start	Finish	Group Members	Predecessors
Initial Planning & Research			**9/9/2024**	**9/30/2024**		
A	Stakeholder Meetings	218	9/9/2024	4/15/2025	All	none
B	Review Park's Master Plan and Sustainable Park Design Principles	18	9/9/2024	9/27/2024	All	A (SS)
C	Finalize Scope of Work & Objectives	21	9/9/2024	9/30/2024	All	A (SS)
Site Visits & Data Collection			**10/1/2024**	**10/14/2024**		
D	Community Outreach and Engagement	13	10/1/2024	10/14/2024	Grace	C
E	Site Visit for Physical Exploration	1	10/7/2024	10/8/2024	All	none
F	Conduct Environmental Assessments (SWM, stream crossings)	6	10/8/2024	10/14/2024	Grace & Emmy	E
Preliminary Design Phase			**10/15/2024**	**12/5/2024**		
G	Trail Layout	7	10/15/2024	10/22/2024	Bailey & Joe	E
H	Trail Grading	28	10/22/2024	11/19/2024	Bailey & Joe	G
I	Sports Field Rain Collection System Research and Estimating	14	10/15/2024	10/29/2024	Jordan & Mark	E
J	Sports Field Grading and Design Improvement	14	10/29/2024	11/2/2024	Jordan & Mark	I
K	VRRM Analysis for Site	14	10/15/2024	10/29/2024	Grace & Emmy	E
L	Preliminary Phasing Plans	14	11/5/2024	11/19/2024	Jordan & Mark	G, J, K
M	Phase 2 BMP	17	11/19/2024	12/5/2024	Grace & Emmy	L
N	Phase 2 BMP design	17	11/19/2024	12/5/2024	Grace & Emmy	L
O	Trail & Field BMP Design	17	11/19/2024	12/5/2024	Grace & Emmy	L
P	ADA Compliance and Accesibility Considerations	51	10/15/2024	12/5/2024	All	M,N,O (FF)
Q	Safety Planning (Crime Prevention Through Environmental Design)	51	10/15/2024	12/5/2024	All	M,N,O (FF)
Project Lull			**12/6/2024**	**1/13/2025**		
R	Winter Break	38	12/6/2024	1/13/2024	All	Q
Review & Risk Assesment			**1/14/2025**	**2/3/2025**		
S	Construction Schedule & Cost Estimate	6	1/14/2025	1/20/2025	Jordan & Mark	Q
T	Environmental & Community Impact	6	1/14/2025	1/20/2025	Grace & Emmy	S (SS)
U	Review by Stakeholders	7	1/20/2025	1/27/2025	All	T
V	Revision of Trail Design	7	1/27/2025	2/3/2025	Bailey & Joe	U
W	Revision of Field Design	7	1/27/2025	2/3/2025	Jordan & Mark	V (FF)
Phasing Plan Development			**2/4/2025**	**3/3/2025**		
X	Develop Detailed Phasing Plan for Trails, Athletic Fields, and Stormwater Management	19	2/4/2025	2/23/2025	Grace & Emmy	none
Y	Coordinate Timing of Construction Phases with Environmental & Community Factors	13	2/18/2025	3/3/2025	Jordan & Mark	none
Environmental Impact Mitigation			**3/4/2025**	**3/24/2025**		
Z	Finalize Phase 2 BMP Design	7	3/4/2025	3/11/2025	Grace & Emmy	Y
AA	Finalize Trail & Field BMP Deisgn	7	3/11/2025	3/18/2025	Grace & Emmy	Z
BB	Natural Resource Protection Plans	6	3/18/2025	3/24/2025	All	AA
CC	Research Necessary Permits	20	3/4/2025	3/24/2025	All	Z (SS)
CAD Drawing Finalization			**3/25/2025**	**3/31/2025**		
DD	Final Design Adjustments Based on Risk Assesments & Feedback	4	3/25/2025	3/29/2025	All	CC
EE	Create Detailed CAD Drawings for Trails, Fields, and Infrastructure Elements	6	3/25/2025	3/31/2025	All	DD
FF	Minor Feature Plans	4	3/27/2025	3/31/2025	All	EE
Review & Approval by UVA and AMT Engineering			**4/1/2025**	**4/5/2025**		
GG	Submission of Preliminary CAD Drawings & Phasing Plan	0	4/1/2025	4/1/2025	All	FF
HH	Review Feedback from UVA & AMT Engineering	2	4/2/2025	4/4/2025	All	HH
II	Address Comments and Make Necessary Revisions	3	4/2/2025	4/5/2025	All	GG
Final Presentation Preperation			**4/6/2025**	**4/14/2025**		
JJ	Prepare Final Set of Drawings, Reports, and Documentation	7	4/6/2025	4/13/2025	All	II
KK	Develop Presentation for UVA & AMT Engineering	7	4/6/2025	4/13/2025	All	JJ
LL	Address Any Final Questions or Concerns From Stakeholders	2	4/12/2025	4/14/2025	All	KK
Final Delivery			**4/14/2025**	**4/15/2025**		
MM	Submit Finalized CAD Drawings & Phasing Plans	1	4/14/2025	4/15/2025	All	LL
NN	Present Findings & Design to UVA and AMT Engineering	1	4/14/2025	4/15/2025	All	LL
OO	Final Presentation	1	4/14/2025	4/15/2025	All	LL

2. Updated Schedule

Activity ID	Activity	Duration (days)	Start	Finish	Group Members	Predecessors
Initial Planning & Research			**9/9/2024**	**9/30/2024**		
A	Stakeholder Meetings	218	9/9/2024	4/15/2025	All	none
B	Review Park's Master Plan and Sustainable Park Design Principles	18	9/9/2024	9/27/2024	All	A (SS)
C	Finalize Scope of Work & Objectives	21	9/9/2024	9/30/2024	All	A (SS)
Site Visits & Data Collection			**10/1/2024**	**10/14/2024**		
D	Community Outreach and Engagement	13	10/1/2024	10/14/2024	Grace	C
E	Site Visit for Physical Exploration	1	10/7/2024	10/8/2024	All	none
F	Conduct Environmental Assessments (SWM, stream crossings)	6	10/8/2024	10/14/2024	Grace & Emmy	E
Preliminary Design Phase			**10/15/2024**	**12/5/2024**		
G	Trail Layout	7	10/15/2024	10/22/2024	Bailey & Joe	E
H	Trail Grading	28	10/22/2024	11/19/2024	Bailey & Joe	G
I	Sports Field Rain Collection System Research and Estimating	14	10/15/2024	10/29/2024	Jordan & Mark	E
J	Sports Field Grading and Design Improvement	17	10/29/2024	11/15/2024	Jordan & Mark	I
K	VRRM Analysis for Site	14	10/15/2024	10/29/2024	Grace & Emmy	E
L	Permanent BMP Design	23	10/30/2024	11/22/2024	Grace & Emmy	H, J, K
M	Trail & Field BMP Design	23	10/30/2024	11/22/2024	Grace & Emmy	H, J, K
N	Preliminary Phasing and ESC Plan	23	11/12/2024	12/5/2024	Jordan & Mark	L,M
O	Preliminary Phase 2 Construction Detention Pond Design (calculations)	17	11/19/2024	12/5/2024	Grace & Emmy	N
P	ADA Compliance and Accessibility Considerations	51	10/15/2024	12/5/2024	All	M,N,O (FF)
Q	Safety Planning (Crime Prevention Through Environmental Design)	51	10/15/2024	12/5/2024	All	M,N,O (FF)
Project Lull			**12/6/2024**	**1/13/2025**		
R	Winter Break	38	12/6/2024	1/13/2024	All	Q

Activity ID	Activity	Duration (days)	Start	Finish	Group Members	Predecessors
Initial Activities			**1/14/2025**	**1/27/2025**		
S	Revision of Trail Design	7	1/14/2025	1/20/2025	Joe	R
T	Revision of Field Design	7	1/14/2025	1/20/2025	Jordan & Mark	R
U	Environmental & Community Impact	7	1/14/2025	1/20/2025	Grace & Emmy	R
V	Review by Stakeholders	7	1/21/2025	1/27/2025	All	S,T
Phasing Plan Development			**2/4/2025**	**3/3/2025**		
W	Develop E&S Plan for Trails, Fields, and SWM	14	1/28/2025	2/10/2025	Joe, Jordan, Mark	V
X	Sediment Basin Design	25	2/10/2025	3/7/2025	Grace	W
Y	Develop Detailed Phasing Plan	10	2/11/2025	2/24/2025	Joe	W
Z	Construction Schedule Development	10	2/25/2025	3/7/2025	Jordan	Y
Spring Break			**3/8/2025**	**3/16/2025**		
AA	No Work Scheduled	8	3/8/2025	3/16/2025	All	none
Design and Estimation			**3/17/2025**	**4/10/2025**		
BB	Construction Estimate	14	3/17/2025	3/31/2025	Mark	Y
CC	Research Necessary Construction Permits	7	3/17/2025	3/24/2025	Jordan	AA
DD	Final Design Adjustments for BMP According to Feedback	14	3/17/2025	3/31/2025	Emmy & Grace	AA
EE	FInal Design Adjustments for Trail & Fields According to Feedback	10	4/1/2025	4/10/2025	Jordan, Mark, Joe	DD
CAD Drawing Finalization			**4/11/2025**	**4/20/2025**		
FF	Create Detailed CAD Drawings for Trails, Fields, and Infrastructure Elements	3	4/11/2025	4/14/2025	All	EE
GG	Review Feedback from UVA & AMT Engineering	3	4/15/2025	4/17/2025	All	FF
HH	Address Comments and Make Necessary Revisions	1	4/18/2025	4/19/2025	All	GG
Final Presentation Preperation			**4/19/2025**	**4/14/2025**		
II	Prepare Final Set of Drawings, Reports, and Documentation	3	4/19/2025	4/21/2025	All	HH
JJ	Develop Presentation for UVA & AMT Engineering	3	4/21/2025	4/23/2025	All	II
Final Delivery & Key Deadlines			**4/17/2025**	**4/28/2025**		
KK	FInal Poster		4/17/2025		All	
LL	Present Findings & Design to UVA and AMT Engineering		4/25/2025		All	
MM	Final Presentation		4/25/2025		All	
NN	Final Paper Due		4/28/2025			

3. Explanation of Changes

The schedule underwent multiple changes throughout the course of the project. Most of these changes were not due to missed deadlines, but rather due to the group learning how civil and construction projects progress over time. For example, Phase 2 BMP, Phase 2 BMP Design, and Trail & Field BMP Design were originally all made into their own tasks. This was because the group did not fully understand what went into each of these tasks, and thus failed to realize that all 3 of these tasks are essentially the same thing. The group had also initially decided to create the construction phasing plan between the conclusion of VRRM analysis and the beginning of BMP design, which was unnecessary. The group later realized that BMP design and phasing plans can occur simultaneously, and there was no need to wait for phasing to conclude before beginning to design BMPs. The design of the sediment basin was also added to the schedule and scope by the request of the project advisor, Don. Some of the changes saved the group time, while other changes added time. The net result in the fall semester was not significant, as the group was able to meet all the goals that were initially set.

There were also some significant changes to the schedule for the spring semester. The group had initially set many placeholder tasks in this semester, such as Revision of Trail Design and Finalize Phase 2 BMP Design. The group had actually been receiving feedback from advisors and revising designs for these things since the fall semester, so there was no need for these tasks. These placeholder tasks had been used because the group was uncertain about what would actually need to be done in the spring when the schedule was initially created in September. By January, the group had a much better understanding of what still needed to be done (E&S, phasing, budget, plotting sheets), so a new schedule was created for the spring. The group was also informed of additional deadlines they were not originally aware of, so the finish date of the project was adjusted to reflect this.

In summary, the group remained committed to meeting deadlines and goals on time. All changes to the schedule were discussed and planned ahead of time, to reflect the group's growing knowledge regarding the sequence and flow of civil engineering and construction projects.

B. Design Evolution

There were many examples of iterative design throughout this process. Section 2.2 of the main report demonstrates one example of this in Figures 4 and 5, where the trail design was re-done to better meet the standards of the group's advisors. Bailey also worked with Emmy to make sure the trail grading worked with the site's stormwater management plan, adjusting cross slopes, path widths, and other features until the needs accessibility and environmental sustainability were both fully addressed. One example of this is that the entire trail system used to be 10' in width, but this was causing issues when accounting for stormwater management as there was too much impervious cover resulting in high nutrient removal requirements. The high removal requirements were difficult for Emmy and Grace to meet through their stormwater management BMPs, so Bailey went back to his trail design and narrowed sections of it, so that part of the trail is only 5' in width, and part of it remained at 10' width.

There was also a significant amount of iteration in the design of stormwater BMPs for the site, as detailed in Section 2.3 of the main report and Appendix D.5. Not only did the stormwater calculations need to be updated each time a change was made to the site design, but after site design was finalized, further iteration was needed to determine the most optimal combination of bioretention, infiltration, and tree BMPs for the site. Multiple different sizes of bioretention facilities were proposed, and with guidance from Don the 0.06 acre size was selected. Initially, the bioretention had been designed to be 0.1 acres in surface area, but this resulted in the site exceeding the required levels of nutrient removal. The group was initially excited about this from an environmental standpoint, but Don suggested that the bioretention be made smaller so as to be more affordable. There was also iterative design for the sediment basin, which was placed in the same location as the Phase 1 sediment basin and the future bioretention pond. Multiple different shapes (trapezoidal prisms, truncated rectangular pyramids) were tested for the basin, and calculations had to be redone in each case (see Appendix D.10). The truncated rectangular prism was selected as it best approximated the traditional shape of sediment basins.

Additionally, while Jordan, Joe, and Mark worked on creating the erosion and sediment control plan, Emmy continuously updated her calculations to make sure they reflected the most up-to-date limits of disturbance (see Appendix D.10). Once the sediment basin sizing calculations were determined based on this E&S plan, Grace began to grade the basin, embankment, and emergency spillway into CAD. After drawing in feature lines at their indicated elevations, the basin elements were graded to the proposed surface at 2:1 slopes. After checking that everything tied in to the proposed surface correctly, the grading contours were used to create a sediment basin surface, which was then added on top of the combined surface.

The fields also underwent iterative design. As mentioned in Section 2.6 of the main report, multiple different options were considered for each component of the fields. Decisions were ultimately made based on the cost and efficiency of each option. The fields also had to be graded with a slight crown (1% slope) in the center, so as to facilitate the infiltration of rainwater. This was done iteratively in CAD, as the group had to develop technical grading skills and refine their initial design until it was acceptable. Multiple different grading techniques were used before settling on the final design, including Grading Creation Tools, Feature Lines, and Break Lines in Civil3D.

C. Engineering Standards

Different aspects of the project necessitate adherence to different sets of standards.

While the expansive trail systems within the park may adhere to different guidelines pertaining to their functions and intended accessibility level, the scope of this project focuses specifically on the area of integrated sports facilities. As per the ADA Accessibility Guidelines supplement regarding recreational facilities, such areas must comply with 2010 ADA standards to make accessible routes to each field in the complex. The most important requirements for such walkways are the maximum running slope (5%), maximum cross slope (2%), and minimum width (4 feet). The minimum width used in this design was 5 feet, the maximum cross slope was 1%, and any areas where running slopes greater than 5% used stairs (alternative ADA routes were provided to bypass these). Implementation of additional features such as handrails was decided based on their contribution to the safety of the park, if not explicitly required by VDOT or ADA standards. Specifically for curb ramps at parking lot connections, VDOT standards will take precedence regarding their construction elements.

The athletic fields themselves have been selected to be soccer fields. The local market is primarily geared toward middle- and high school-aged sports; because of this, NFHS (National Federation of State High School Associations) minimum standards will be used for the field design. These standards pertain to field slope and size elements. The recommended size for the playing pitch is 55 to 80 yards by 100 to 120 yards. The provided fields are 60 yards by 100 yards. The planned surface medium is natural grass with a subsurface drainage system, in alignment with the park’s overall emphasis on natural elements. The minimum slope for such designs is 1%, which is the value employed in the design.

With regards to stormwater management, best management practices (BMP) were designed using the requirements and equations in the Virginia DEQ's Stormwater Management Handbook version 1.1 (June 2024). The bioretention facility was designed using P-FIL-05, and the tree planting BMP used P-FIL-09. Sediment basin design also follows the regulations in the Virginia DEQ Handbook, C-SCM-12. Water quality through these systems are maintained in accordance with the VRRM (Virginia Runoff Reduction Method) version 4.1 (July 2024) spreadsheet and requirements. All BMPs were designed to be able to handle the volumes calculated by VRRM, using the equations specified by the Virginia DEQ Handbook. The TR-55 method (Technical Release 55, as defined by the USDA) is also used to calculate some relevant flow rate and time of concentration values. Examples and proof of these calculations are provided in Appendix D. Adherence to these standards and avoiding alternatives such as nutrient credits was crucial to this project due to the emphasis on sustainability.

For erosion and sediment control, standards from the Virginia DEQ Stormwater Management Handbook and VDOT were used. Silt fence placement was determined using C-PCM-04 with a minimum 5-foot setback from construction zones in accordance with VDOT standards. Blanket matting for slopes steeper than a 3:1 ratio were placed using C-SSM-05 to stabilize the soil. Riprap was placed using C-ECM-13 around pipe outfalls.

D. Technical Deliverables

1. Final Sheet Set, All Supporting Materials, Condensed Supporting Materials

2. Advisor Meeting Agendas & Notes (by date)
    - September 16, 2024

- September 30, 2024
- October 9, 2024
- October 21, 2024
- October 28, 2024
- November 4, 2024
- November 11, 2024
- November 18, 2024
- November 25, 2024
- December 2, 2024
- January 15, 2025
- January 22, 2025
- January 29, 2025
- February 5, 2025
- February 12, 2025
- February 26, 2025
- March 5, 2025
- March 19, 2025
- March 26, 2025
- April 2, 2025
- April 9, 2025

3. General Research & Resources Document

4. Stagecoach Road Research Document

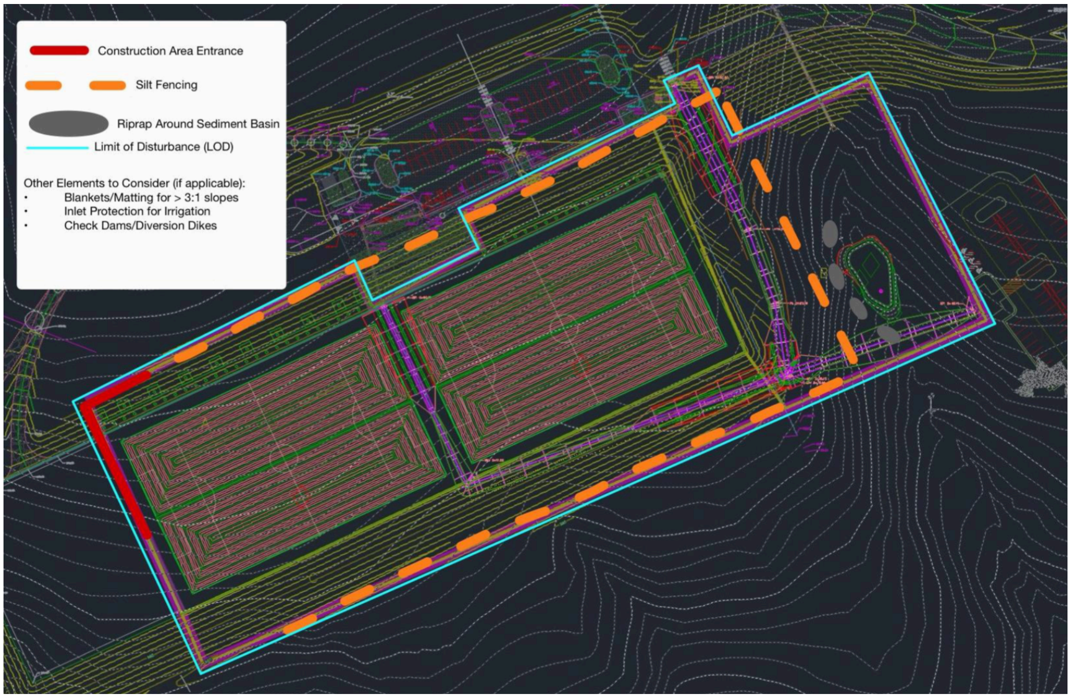
5. Iterative Research & Calculations for Stormwater Management
    - October 4, 2024: Preliminary VRRM (From Interim Report)
    - October 23, 2024: Updated VRRM & Bioretention Sizing
    - October 24, 2024: Updated VRRM w/ New AOI
    - October 28, 2024: Trying Out Different Bioretention Sizes
    - October 31, 2024: Erosion & Sediment Control Notes
    - November 4, 2024: VRRM & BMP Sizing General Notes
    - November 4, 2024: BMP Design & Cost Estimates
    - November 11, 2024: BMP Design & Grading
    - November 14, 2024: Bioretention & Overflow Sizing Calculations & Diagrams
    - December, 2024: Final Version of VRRM of Fall Semester
    - April 21, 2025: Final VRRM Calculations

6. TR-55 Spreadsheet, TR-55 100-Year Spreadsheet

7. Tree Planting BMP Design Criteria & Schedule Document

8. Bioretention BMP Design Criteria & Schedule Document

9. Temporary Construction Infrastructure Feature Map



10. Temporary Sediment Basin Design:

- December 2, 2024: Preliminary Temporary Sediment Basin Calculations
- December 4, 2024: Updated Calculations (Better Retrofit)
- January 27, 2025: Updated Geometry and Calculations
- January 30, 2025: Updated Calculations (New LOD)
- March 26, 2025: Final Calculations

11. Construction Scheduling:

- Activity Schedule
- Gantt Chart
- Critical Path

12. Phasing Plan:

- Preliminary Plan
- Phasing Plan Activity Codes
- Phasing Plan Chart

13. Cost Estimates:

- Athletic Fields
- Construction Estimates

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