Spring 5-2007

Cherokee Farm Development Site

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Senior Design CE400

Spring 2007

University of Tennessee

27 April 2007

This years senior design class was asked design a university research building on the Cherokee Farm site, just across the Tennessee River. The campus extension is to be used primarily as a research facility but it will also serve to alleviate over crowding on the main campus. The initial building will be approximately 50,000 square feet and will be five stories tall, four more buildings are proposed for the site in the future. On site parking was also considered. The use of the parking on the site could be utilized for major events such as football games. We felt it necessary to utilize as much green space on the site as possible, and also tried to incorporate the greenway expansion into our site design. The project consisted of all aspects of a typical construction job. The class was split into groups according to different aspects of the job. The groups were, Transportation, Geotechnical, Environmental, Structural and Construction and Planning. Their individual contributions to the project are presented in the following report.

Construction and Planning

The construction and planning group was assigned the task of laying out a site plan for Cherokee Farms, developing a demolition plan for the existing site, generating a grading plan for the future site, performing a construction staging plan, cost estimations for the project, and coordinating between groups.

During the process of laying out a site plan, the construction group developed three different alternatives. These layouts consist of an initial building and allow for four future buildings on the site. The first alternative placed the buildings close to Alcoa Highway, facing the river, in the shape of a half circle. The second alternative placed the buildings along the river in the same formation. The third alternative placed the buildings in the center of the site in a staggered formation, leaving a courtyard in the center. After consulting with the Transportation group, the construction group decided on the first alternative. This site plan allows for the best entrance and exit ramps from Alcoa Highway.

Access to the facilities was left to the transportation group. The Construction group designed a large truck access road behind the buildings. This road allows access to loading docks behind the buildings without interfering with the regular traffic. On the existing site, there are twenty buildings. The demolition plan shows the removal of each of these buildings. The existing roads on the site are mostly gravel therefore no demolition is required.

The grading plan required the most time throughout the project. Due to the existing grade of the land, two detention basins were designed. Detention basin A is located at the Northeast end of the site. Detention basin B is located southwest of the buildings, between the parking garage and the entrance road. Our grading plan is designed to channel water flow to each detention basin based on the natural flow of the land. Having two detention basins allows for a cheaper grading plan as well as a smaller reliance on underground sewage. Since there are two detention basins located on either side of the site, the grading plan follows a crown formation, peaking at the building located at the center of the site.

Cost estimations were done for the entire site, including site demolition and soil movement. Information was obtained from each group. Using the information given to us, the cost estimations should be relatively close to the actual cost of construction.

Site Layout

In determining the location of the proposed buildings we considered several key factors. Aesthetics of the site layout was the first consideration. The building design and layout held a high priority due to the fact the site is part of the University Of Tennessee. The site will reflect the University's prestige and commitment to excellence. The second factor considered was the site's constructability. The soil properties of the site vary with location which alters the design of the buildings greatly. The third factor considered was economic constraints. Naturally we want to keep cost to a minimum without affecting the integrity of the site. Lastly, the logistics and roadways on the site influenced the decision. Considering these factors we came up with three alternatives and compared them against each other using a design alternative matrix.

Alternative one placed the buildings in a half moon shape, with the fronts of the buildings facing the river near the top of the property. Alternative two placed the buildings in a half moon shape near the river, with the fronts facing Alcoa Highway. The third alternative placed the buildings in a staggered pattern at the top of the site with a courtyard in the middle.

The Aesthetics of the site played a major role in determining the site design. Two factors influenced this decision; the green space and building layout. Of the three options, alternative one and two had the best score for green space as well as building layout. Alternative three did not leave much room for the green space; therefore it had a lower score in the design matrix.

The constructability of the site was also considered in the design matrix. Four factors were considered in this aspect of the matrix: earthwork requirements, subsurface constraints, design complexity, and building location. The results from the lab tests run on soils obtained from the site concluded the top of the site contained the best properties for construction. The complexity of design for all three options was considered to be the same and the locations of the buildings were all similar with alternative one being the best choice. Alternative one was shown to be the best choice from this section in the matrix.

Economics also played a role in the decision making process. We were concerned with efficient land use of the site and considered the building layouts. Alternative three showed the most efficient use of the land, while alternatives one and two were considered to be the same. Alternative one did give us the least amount of impact on future development and therefore was rated the best option for the economic section of the matrix.

The fourth aspect of the matrix considered site access and site orientation. Alternatives one and three were equal in site access. The design of new on and off ramps played a major role in our decision making. Alternative two allowed for the best site access due to the fact it was the furthest away from the highway. This allowed for the easiest design of the new on/off ramps, however, alternatives one and two still proved to be the best choices due to site orientation.

After considering all aspects of the design matrix, alternative one proved to be the best choice for the design of the site. Aesthetics and Logistics were weighted the highest in the matrix while constructability and economics were lower. We felt that the economic changes due to the orientation and location of the buildings would not differ greatly between the alternatives and the aesthetics should play a vital role in the decision making process.

Demolition Plan

The Cherokee Farm site was previously used as a dairy farm and research center. Multiple buildings on the site needed to be removed to make room for the new development.

The site has 20 existing buildings, all of which must be removed. The existing buildings would not be complicated to remove but would take some effort. A detailed list of these buildings follows:

1) Four, one story tin buildings with slabs
2) Two story brick building with interior walls and footings
3) One story house
4) Two, Carports with slab
5) Block building with slab
6) Tin shed with above ground tanks
7) Six, tin pole barn with thin slab
8) Block building with tin roof and slab
9) Three, metal silos with slabs
10) One story house with footings
11) Two story tin building with slab

All roads on the property were considered to be gravel; therefore no consideration was given to them. Detailed cost estimation for the removal of existing structures can be found in the appendix.

Grading Plan

In designing the Cherokee Farm site the Construction and Planning group felt it best to try and keep the site as close to the natural grade as possible. There were a couple of reasons for doing this. The first was to keep costs down. The second was a TVA restriction which prevented building below the eight hundred and twenty two foot elevation mark. This restriction prevents flood problems from the Tennessee River. Archeological artifacts are also present along the river edge. Our construction cannot disturb these sites.

The existing grade of the site in the area of the proposed building had to be leveled out. A finished floor elevation of nine hundred and six feet was decided upon for the initial building. This decision allowed for the grade around the building to be sloped away from the building foundation without causing drastic changes in the existing grade. On the southern edge of the property, above the proposed building, there was an existing crest with an elevation of eight hundred and forty six feet. It was decided the grade should gradually slope up to this point instead of removing the crest completely. Leaving this vertical crest meant that the runoff would be directed at the proposed buildings. In order to deal with this runoff, catch basins would have to be installed along the service road behind the buildings.

On the southern side of the buildings, the grade had multiple depressions requiring fill in order to allow for the new off ramp from Alcoa Highway. The grade on the southern side of the new off ramps was not altered in any way to keep costs down. One of the main areas of concern with grading plan was on the southwest corner of the buildings. The grade in this area was drastically greater than other areas of the site. Multiple ideas were proposed for this area but it was concluded that a detention basin would be the best fit for the area. Detention Basin B was designed on the interior of the proposed roadway. This meant the detention basin would be in between the roadway, parking garage, and building 5. This was a simple solution to a major problem. The area in which the basin sits was previously unused and it provided the best solution to the runoff problem while allowing for the least possible change in grade.

The grade in front of the buildings had to be sloped up to the buildings' base to allow for the parking structure, which is to be situated directly in front of the buildings. The grade in this area was also considerably steeper than allowed by professional standards and codes. In order to solve this problem the slope of the grade was drawn out to allow for car traffic in the area. The changes made increased the runoff of the area. To solve this problem, Detention Basin A was implemented. On the northeaster side of the property, between the building and Alcoa Highway the grade was also a problem. The removal of the existing roadway next to Alcoa Highway allowed for the new grade to be drawn out to the highway. The new grade allowed for a more gradual slope which will help control the runoff down to the second detention basin.

Detention Basin A is located on the northern side of the property, on the west side of Alcoa Highway. This basin will catch the runoff from the front of the buildings, as well as behind the buildings and the eastern side of Alcoa Highway. On the eastern side of the highway the grade required minimal change. However, the grade was directing the runoff directly towards the proposed off ramp. In order to solve this problem, a pipe is installed to carry the runoff from the eastern side of the highway over to a head wall.

Construction Staging Plan

A construction staging plan was implemented in order to allow the contractors access to the site in an efficient manner. The plan assumes the demolition plan has already been completed and the new roadways have already been installed. Since the initial construction is only for Building Three, the site will be able to support all materials for the single building. There is an ample area on either side of the building for storage of materials and goods. Parking for the workers was also considered. The new roadways will allow easy access to the site for all workers and will provide access to parking areas in front of the building site.

Cost Estimates for Construction

The construction and planning team's duties included preparing a cost estimate for the design implementation. Other groups submitted drawings or quantities to construction team for this task. The construction team then took this information and developed estimates based on the divisions of work provided in the RSMeans Building Construction Cost Data book. The construction team chose to use this method of estimating based on the ease and frequent use of the book in the construction industry. Based on the type of work being done by the Senior Design Class, the construction team determined which divisions of work were applicable to the project. After analyzing the information the team determined that the work fell into two division of work, those being the site construction and concrete divisions. Estimations in these divisions included the following: demolition, grading work, concrete and steel, road construction, and environmental issues.

Before construction begins on the Cherokee Farm Site some demolition must be completed. Members of the construction and planning team printed a GIS aerial view of the existing site and made a visit to the site. The team then took the notes about each building on the site. Notes were taken regarding the height of the buildings, the material the buildings were made from, how much infrastructure was on the inside of each building, and the type of foundations the buildings rested upon. A detailed map with notes can be seen in the drawing package. After completing this, the construction team referred to the Means Construction book and determined what each building required to be demolished. The team provided the following estimate listed in the appendix in Tables one and two. Each task is listed and referenced according to the RSMeans numbering system. The construction team estimated the total cost of demolition to be $115,000.

The next task to be completed is grading work. The construction team developed a grading plan that would divert water to a detention pond designed by the environmental team. The team developed the grading plan to tie into existing elevations, provide sufficient drainage, and get cut and fill volume quantities fairly equal. The construction team needed cut and fill quantities to provide an accurate estimate. The construction team members decided to determine these volumes by using the method of grids. This method was chosen because it was easy, quick, and provided an accurate estimate for the earthwork quantities. The team decided to use 200' by 200' grids since the site was fairly large. The team worked on calculating these volumes and came up with the following cut and fill values: 177030 cubic yards of cut and 155407 cubic yards of fill. This required 21623 cubic yards of cut to be hauled away as spoil. The construction team estimated this total process to cost $1,012,000. A detailed estimate is provided in the appendix, Table one.

The next step in the process was to develop an estimate for the planned foundations. The Geotechnical team designed a driven pile system for the site. The construction team took the quantities given to the team and estimated the number of vertical linear feet of piles needed. The piles consist of PP 24*1.00, meaning a 24" diameter with 1" thick walls. According to the RSMeans book the construction team determined how much a crane would be needed to perform the driving of the piles. The construction team took these quantities with respect to site construction division and provided an estimate of $2,060,000. Detailed information such as vertical linear feet, prices, etc. are listed in the appendix under Table two. The dimensions of the foundation were needed next to provide an estimate for concrete quantities. The team took this information and determined the takeoff for the placing and quantities of concrete to be used. In order to place the concrete the team needed to determine the amount of forms needed to place the concrete. The team determined the amount of square footage of contact area to do this. According to the dimensions provided by the Geotechnical group the construction team estimated the forms to cost $24,000. Referring to the appendix in Table two, the construction team estimated the cost of the foundation's concrete and placement to be $18,000. This information was determined by using the RSMeans book from the concrete division of work.

The next step was estimate the concrete and reinforcing steel bars that will be used in the building of the structure. The structural team designed 5 stories buildings that will be built on the site. The construction team determined the amount of concrete and rebar quantities according to the structural design drawings and cross-sections. The drawing included the dimensions of the beams, girders, columns, and shear walls; the drawings also included the top view and side view of the structure. The construction team decided to use forms in place for the girders, beams, and columns. The concrete beams and girders contain #3 and #9 rebar; and the columns contain #4 and #14 rebar. According to the amount of concrete determined from the cross-sections, the cost of the structures including labor will be $618,000.The crane and handling cost for concrete is $3,500. The rebar materials and labor cost is estimated to be $115,000. The construction team estimated the total cost for the structure to be $737,000. The details of the estimate for constructing the skeleton type structure are located in appendix Table two.

The final step for the cost estimation process was to determine the cost of transportation facilities. The transportation team determined to use flexible pavement for the roadways that will be on the site. The road contains a 12 in deep ¾ in crushed stone base, 3 in thick binder, and 3 in thick wearing course. The construction team calculated the amount of aggregates and asphalt for the entire road according to the cross-sectional drawing of the pavement and the length of roadways. According to the RSMeans book, the construction team estimated the cost of the entire roadway to be $681,000. To comply with the project scope, the construction team estimated the total amount of greenway to be installed. The transportation team decided to use concrete as the material.

The concrete will be laid at 4" thick and 4 feet wide. The total amount to install this will be $61,000.00. The detailed estimation is provided in appendix Table one.

Progress was then made on completing the environmental estimations. The construction team was given an AutoCAD file of the environmental team's designs. Accompanying this file was papers listing the notation and length and diameter of the storm drainage system. The construction team then created an Excel file and listing the each segment of pipe, length, and diameter. Team members then ran a statement in Excel and found the total length of pipe for each pipe diameter. The team looked at the cross-sections provided and found the average depth of trench for the pipe. The construction team then referred to the RSMeans book and determined the section of work that best fit the environmental team's storm drainage system. The construction team estimated the total cost of pipe and installation to be $290,000.00. A detailed table including the specific task notation as listed in RSMeans is provided in the appendix, Table one. In order for the storm drainage to be installed, excavation of trenching will take place. The construction team used the cross-sections provided and total length of pipe installed to estimate a volume to be cut and backfilled. After referring to the RSMeans book, the team estimated the total cost of excavation for the storm drainage to be $54,000.00. The construction team then referred to the AutoCAD file submitted by the environmental team to determine the number of catch basins to be installed. A total of 65 basins are to be installed at a price of $20,378.00. Also referring to the AutoCAD file the team estimated the amount of retention basins to be installed. According to the information provided the construction team estimated 14800 cubic yards to be installed at a total price of $24,000.00. Regulations controlling sedimentation erosion, the environmental team recommended using a silt fence outlining the site. The construction team estimated the total linear feet of silt fencing to create a perimeter around the site to be $5,300.00. The team next worked on creating for the water distribution. The environmental team informed the construction team of 1350 feet of 8" PVC pipe to be installed. Water lines are to be laid 3 feet below the surface. The total price of installing water to the facility is $42,000.00.

In conclusion, the construction team only estimated the cost for site work, division two; and concrete, division three. Since the other division is not necessary on this project. The total cost for the project, which is including the demolition, earth work, piping, foundation, structure, and road pavement, is $5,900,000.

Transportation

The transportation group was given the responsibilities of providing access to the facility via Alcoa Highway, designing parking, and providing facility access via the Greenway. The group was made up of the following members: Allen Cheng, Brian Haas, Omari Hand, Joe Hull, Steve Pushkarou, Sharion Smith, Chris Williams, and Joyce Wells. The team was broken up into sub-groups in order to provide better efficiency for design work. The Alcoa Highway sub-group consisted of Allen Cheng, Joe Hull, and Joyce Wells. The parking sub-team included Steve Pushkarou and Sharion Smith. Finally, Omari Hand and Chris Williams made up the Greenway team. Brian Haas was the team leader for the transportation aspect of the project.

The team first began looking at the best possible way to provide access to the facility from Alcoa Highway. Initially, the team thought it would be best to utilize the existing interchange between Alcoa Highway and the University of Tennessee Medical Center. This interchange was broken up into four components which were to be viewed separately: access to the facility from US 129 (Alcoa Highway) northbound, access from US 129 southbound, access to US 129 northbound, and access to US 129 southbound. It was determined that the easiest way to gain facility access from US 129 southbound was to make an exit branching to the right from the current interchange with the UT Medical Center.

It was much more difficult to find a feasible solution for the other three components. The reason for this was that the traffic would somehow need to make it from the facility to the Medical Center by either going over or under Alcoa Highway. Three options for accomplishing this were discussed: make a bridge from the Medical Center over Alcoa Highway to the new site, modify the existing one-way overpass to allow for two-way traffic, and utilize the existing small underpass near the center of the site. The bridge was quickly dismissed because of the associated costs. It was found that the best possible option was to use a combination of using the existing overpass and the existing underpass.

After careful traffic flow considerations, it was determined that traffic leaving the site would use the underpass while traffic coming from US 129 northbound would use the overpass. However, there were several concerns with this proposal. Major bridge widening construction would need to happen in order to make the bridge two-way. Furthermore, a new cloverleaf type interchange would need to be built for all traffic going to the Medical Center from US 129 southbound. This would need to be done so that there would be no conflict between Medical Center traffic from US 129 southbound and crossing Cherokee Farm traffic from US 129 northbound. In addition, the existing exit for US 129 southbound traffic would need to be exclusively for Cherokee Farm access, with a second ramp as discussed above for Medical Center traffic.

In addition to the concerns with overpass construction, there were also concerns about using the underpass for outgoing traffic. The current state of the underpass is not sufficient for one lane of site traffic, much less for two-directional flow. Therefore, the underpass would need to be tripled in width. Furthermore, the current clearance is insufficient for delivery trucks. An additional concern with using the underpass would be the increase in traffic at the entrance of the Medical Center. Currently, the entrance seems to be very confusing, especially to those who have not been there before. Adding another branch to this area would further add to the confusion. Also, very high traffic volumes were recording during peak day travel hours for the existing entrance and exit to the Medical Center, so much as that one of the streets experienced backups of a couple tenths of a mile. After weighing all pros and cons of this proposal, it was determined that the team must begin studying alternatives.

The only alternative to using an exiting interchange is to create a new interchange. Therefore, it was determined that a new interchange must be constructed for site access. Again, the interchange was broken into the four components as discussed previously.

The only component considered for the first alternative that could also be applied to the second alternative is the facility access for vehicles traveling on US 129 southbound. Two options were considered for this component: use the same setup as discussed with utilizing the existing interchange with the Medical Center, and constructing a new ramp just north of the interchange. It was decided that a new ramp should be constructed due to the decreased pavement length needed to access the facility with this option as compared with branching the exit from the existing interchange. In addition, this option would provide more green space away from the buildings.

As with the component above, there were two options for designing the ramp for traffic leaving the facility going southbound on US 129. One option was to use a ramp as seen with a diamond shaped interchange that would enter US 129 south of the Medical Center interchange. The second option was to use a cloverleaf design so that the traffic would enter US 129 north of the Medical Center interchange. Option two was selected due to the fact that in the event of an emergency, traffic entering north of the Medical Center would have easy access to the existing ramp. Also, there may have been insufficient space for which to build the diamond shaped ramp.

The components entering and leaving the facility east of Alcoa Highway (to and from US 129 northbound) saw the same challenges faced in alternative one. However, with this alternative the team was able to utilize the existing road going under Alcoa Highway near the Tennessee River bridge abutment just south of the river. The other two options were to once again widen the underpass tunnel or build an overpass. The decision was simple to use and widen the existing road under Alcoa Highway near the river from one to two lanes. Although space seemed to be tight in that area, there was sufficient space to widen the road to two 12-ft lanes with no shoulders.

Once the design of the Alcoa Highway interchange was complete, the team needed to design the onsite roads leading to parking and drop-off. Traffic would enter and exit the facility using a one-way clockwise loop around the site. Traffic coming from US 129 southbound would converge with delivery trucks coming from the truck bay and passenger drop-off vehicles at the southwest corner of the site. From there, vehicles would use the one-way loop consisting of 2 lanes to access the parking garage, truck bay, or drop-off area. Vehicles wishing to access the parking garage would do so via a 90-degree right turn while drop-off and delivery vehicles would have access by continuing around the loop. Vehicles entering the site from US 129 northbound would drive under Alcoa Highway to a stop sign at the northwest corner of the facility. From there, the only option would be to turn left onto the one-way loop. Vehicles wishing to access the parking garage could do so by branching to the right and all other vehicles would continue to drop-off and delivery. All exiting vehicles would leave from the northwest corner at the stop sign mentioned above.

The team decided to classify the roadways as minor collectors, although no good definition exists for the type of roads at this site. Therefore, it was required for a two-lane road to have a minimum width of pavement of 32 feet. To meet this requirement, 12-ft lanes were used along with 4-ft shoulder on each side of the road. The only place on the site where the road does not meet the above requirements is while driving under the Tennessee River Bridge. Due to space between the bridge abutment and pier, it would be impossible to have 32 feet of pavement width at that location. Using the pavement width mentioned above, it was calculated that the total roadway area is roughly equal to 225,000 square feet. This number does not include the area at the truck bay.

The team had two options for the pavement surface: concrete and asphalt. After careful consideration, asphalt was chosen with the following depths starting from the surface layer: 2 inches of surface using Grading D asphalt, 3 inches of binder using Grading B asphalt, and 10 inches of aggregate base using Class A Grade B crushed stone. The materials and thicknesses were chosen to match the Knoxville Metropolitan Planning Committee standards from minor collector streets. The advantage of using asphalt instead of concrete is that asphalt is cheaper. The disadvantage is that asphalt does not have as long of a useful life as concrete, but due to the relatively low volumes of traffic expected compared to that of a freeway, the useful life of the pavement is not as important as cost for this particular site.

Other dimensions listed under the Knoxville MPO standards include a suggested super elevation of 2%, and maximum grade of 10%, and a minimum K value of 50. All requirements were met except for the minimum K value at certain locations. Calculations showed that around the sharpest curve the maximum safe speed for a large tractor trailer was 35 mph. Therefore, the posted speed limit will be 25 mph with a yellow warning sign alerting drivers to reduce their speed to 25 mph on the exit ramps.

The two options for the parking facility were to build a parking garage or a flat lot. The team decided to choose the option of building a parking garage. The disadvantage of the garage is that it would cost more to build. However, the advantages included being able to maximize green space and have less impervious area, which would minimize water runoff.

The team looked a number of existing garages on the University Of Tennessee campus including the 11th Street and Neyland Stadium garages. The team decided to model the garage on the Cherokee Farm site after the 11th Street garage, mainly due to its simple design and good visibility for vehicles turning into oncoming traffic inside the garage. The parking spaces will be angled at 75 degrees and have vertical dimensions of 15 feet and horizontal dimensions of 8.5 feet. Further details are shown in the plan set.

After looking at the Knoxville MPO standards for parking, the team realized that the standards did not account for laboratory facilities of college buildings. Therefore, the team decided to use the standards for professional offices. This standard stated that there should be one parking spot per 250 square feet of usable office space. After calculating, it was known that exactly 1,000 parking spaces were needed, including 20 handicapped spots. By modeling the garage after the 11th Street parking garage, roughly 200 parking spaces could fit on one level. Therefore, it was decided that the parking garage would be 5 levels tall.

The greenway will follow the same cross-section as it currently exists on Neyland Drive, which is 10 feet in width. Current construction provides access to the south side of the Tennessee River via the Alcoa Highway bridge. From the end of the bridge, it will follow the path of the road leading from Alcoa Highway to the site. Once it reaches the one-way loop, it will follow the path of the Tennessee River while also branching towards the buildings where a bicycle rack will be placed. These two branches will meet on the southwest side of the site and continue south.

Geotechnical

Dr. Randall Gentry requested the geotechnical team to analyze the soil conditions and design a foundation for proposed construction of a new research facility on the University of Tennessee Dairy Farm. A site map can be seen in Figure A1 of the Appendix. The proposed site is to be graded according to the planning and construction committees' grading plan. A 50,000 square foot research facility with space to add four additional facilities is to be constructed on the site. The site is to contain access roads to connect with Highway 129 and parking areas for faculty and students.

Evaluation Matrix

An evaluation matrix was created to determine the method of sampling, lab testing, and foundation design. The matrix showing the various alternatives appears in Tables A1 through A3 in the Appendix. The team decided to use the Civil Engineering Department's drill rig to drill the boreholes. Because of its simplicity, the unconfined compression test was used to determine the strength parameters of the soil. Driven pipe piles were used as the foundation due to the soil type and their ability to support large loads.

Site Reconnaissance

The geotechnical team began research by investigating previous geotechnical reports and geological maps. Because the area was dedicated to farming with a few lightly loaded structures, previous geotechnical reports were not found for the site. According to a geological map from TN GIS, Figure A2, the soil is composed of a combination of limestone, dolomite, shale, chert, siltstone, and sandstone. Our group then visited the site to see the current conditions. Most of the land is used for pastures and agriculture, therefore the top layer of the soil is highly organic. To get a better representation of the sub-surface soil profile, our group must drill boreholes at various locations.

Drilling

After consulting with Dr. Eric Drumm, we decided to drill three boreholes at key locations on the site. From the layout proposed by the planning and construction team, we marked locations on the top, middle, and lower portions of the site to be drilled. The top area of the site was chosen because most of the development will take place in this area. Because the semi-circle building layout extends to the middle portion of the site, we decided to drill a hole corresponding to the outer building. With the assistance of Larry Roberts, Josh Baines, and the Civil Engineering Department's drill rig, our team set out to drill the boreholes. Each hole was drilled with a hollow stem auger to a depth of 35 feet and samples were taken at various depths. We collected two Shelby tube samples from each hole along with several split spoon samples to obtain N values. Additionally, an engineered soil profile for each hole can be seen in Figures A3 and A4. The soil samples were taken to the lab to for classification and testing

Lab Testing

At the lab, the disturbed soil samples were analyzed to determine unit weight, water content, and classification. A sieve analysis with wash 200 and an Atterberg limits test classified the soil as high plasticity silt on the upper part of the site and low plasticity silt in the middle region. Figures A5 and A6 show the grain size distribution curves for the two samples. The unit weight of the soil ranged from 17.5 kN/m^2 to 19 kN/m^2. Unconfined compression tests were performed on the undisturbed Shelby tubes samples.

The undrained shear strength is 1400 psf for the upper region and ranges from 670-870 psf in the middle region. Figure A7 shows the Mohr's circles obtained for each borehole. These values describe the classification and strength parameters of the soil which can be applied to the foundation design.

Foundation Design

In order to handle the large loads produced by the reinforced concrete and the vibrations caused by testing equipment, the geotechnical team decided to use a deep foundation consisting of driven piles. Steel pipe piles, PP24x1.00, were chosen because they can support large loads and can be driven to deep depths. The pipe piles come in various diameters and can be easily manufactured. Using the undrained shear strength obtained from the unconfined compression test, the tip bearing capacity was found to be 11,300 psf for the upper region and 4400 psf in the middle area. The side friction between the pile and the soil was determined using the alpha method, which consisted of two steps: first finding alpha, then using that result to determine the side friction. In the upper area of the site which consisted of high plasticity silt, a friction value of 770 psf was obtained. For the middle portion containing low plasticity silt, a friction value of 660 psf was calculated. Given there would be a minimum of 3 piles per foundation, it was assumed that each applied load would be evenly distributed among the piles. Since drilling was not taken to bedrock in testing, the piles will be drilled to a 100 foot depth or until bedrock is reached. At 100 feet, the pile will be supported by both tip bearing and side friction. If bedrock is reached first, driving can be terminated if the bedrock is determined to be stable. With 100 foot pile length, pipe diameter was chosen in order to minimize the number of piles used in the foundation design and still maintain a feasible layout. Several pipe diameters were tested and ultimately a 2 foot diameter was selected in the design of both foundations. For a typical center column, a group of five piles is required in the upper region of the site and a group of seven piles is needed in the middle section. A group of three piles is needed for the corner columns in the upper and middle regions. The perimeter columns require a group of three piles for the upper area and four piles in the middle section of the site. Table A4 summarizes the pile configurations. Each pile has a diameter of two feet and will be driven to a depth of 100 feet or bedrock which ever is reached first. Pile foundation detail drawings are attached with master project drawings.

Recommendations

The proposed site is located on an old dairy farm resulting in a large amount of organic soil. Because organic soil does not have a high soil strength, it will have to be removed and replaced with similar engineered fill. The organic soil may cause large amounts of settlement over time leading to potential structural and aesthetic problems. The research facility is to be built on a driven pile foundation. Because of the high friction strength of the soil and the presence of karst topography, the geotechnical team feels that the piles will provide the best support for the large structure.

Structures

As part of the University of Tennessee's plan to expand their campus facilities to the dairy farm located adjacent to Alcoa Highway, the structure's group assignment was to design a structure to be used primarily as a laboratory facility. The structure was to be five stories with 50,000 square feet of floor space. This structure classifies in Business Occupancy Group B, laboratory use (nonhazardous) and therefore must facilitate occupancy of approximately fifty people per floor and/or a total occupancy of 250 people.

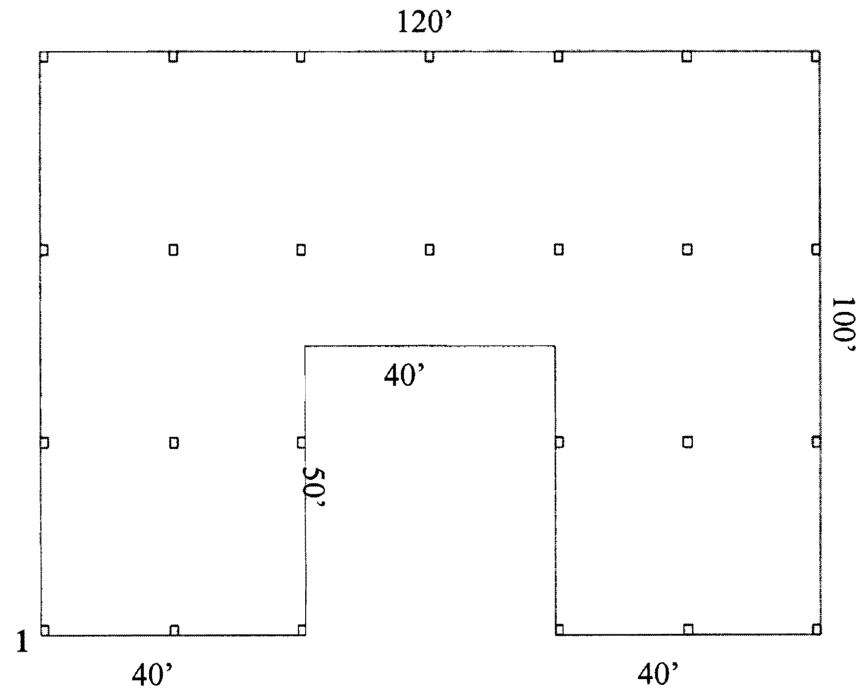
The first step for designing the structure was to determine all loads to be supported. Specific loads required by the owner were a one ton point load applied by a tank and a one ton load evenly distributed across the entire floor. Both were to be applied on the bottom floor. The roof must support a twelve thousand and two hundred pound point load applied by the roof top unit (A Carrier chiller unit, 16LJ 14, was selected for this building as suggested by a professional advisor). According to the Standard Building Code, 1997 edition, used by the city of Knoxville, a structure of this size and function must also support the following loads:

Partitions Dead Load	20psf
Live Load	60psf
Roof Live Load	12psf
Roof Dead Load	10psf
Snow Load	10psf
Wind Live Load	14.9psf

Our second step in the design process was to determine a building footprint and construction materials. When considering the overall design of this structure we considered seven criteria. One of the most important criteria was the building's price as figured from the total cost of materials and construction. Equally important was the structure's function, it must be able to minimize vibrations and maximize laboratory space. Scheduling (constructability, speed of construction and time constraints) was also important to the design. Building layout, beam spans, and contactor availability were secondary criteria, but important in the final decision. Being a laboratory facility, aesthetics was considered as a least important criterion. Using these criteria we considered three separate alternatives. A matrix of these alternatives evaluated based on the afore mentioned criteria can be referenced in Table 1 of the appendix.

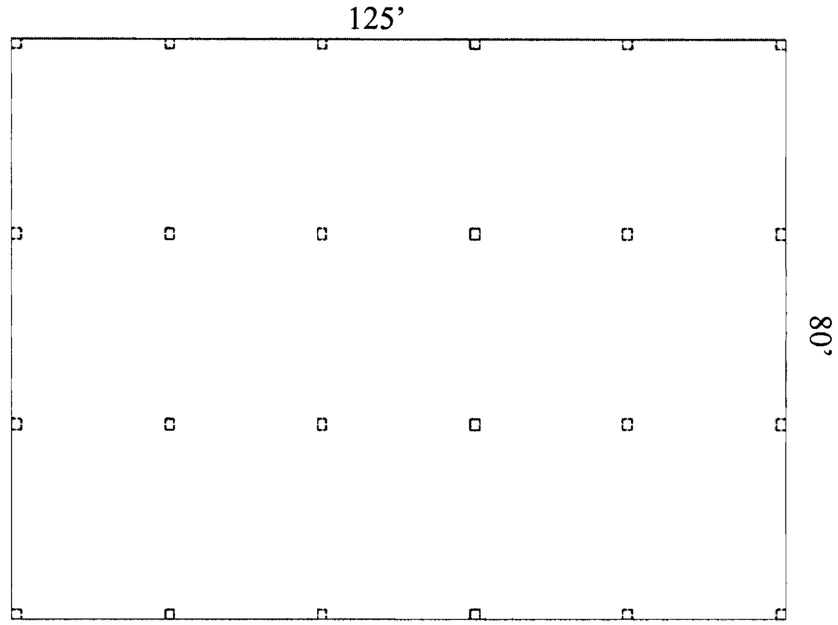
First, a U-shaped building constructed entirely of reinforced concrete. See Figure 1 below for layout dimensions.

Figure 1: Layout of Alternative



Our second alternative had a rectangular shape (see Figure 2 below). It was to be constructed primarily of reinforced concrete. The roof joists and girders would be prefabricated steel. The third alternative has the same rectangular layout (see Figure 2 below), but constructed of structural steel with concrete slabs.

Figure 2: Layout of Alternatives 2 and 3



The second alternative, a rectangular reinforced concrete structure with prefabricated joists and girders, met our criteria best. Concrete was chosen primarily due to its, "...natural characteristics and mass advantages for vibration reduction" (Craig Ellis of HDR Inc.). With the raising prices of steel, concrete will be a less expensive option. A rectangular structure can be easily constructed of concrete and the availability of contractors in the Knoxville area will allow for an early start date and quick construction.

After selecting our footprint and construction materials, specific components now had to be designed. Calculations for these components can be found in the appendix. The metal roof decking and insulation will be supported by 14H5 bar joists, supported by 20G5N7k steel girders and two 20G5N13k girders under the roof top unit. Selection tables are included in the appendix. The remaining structure will be made of 4,000 pounds per square inch (psi) concrete with 60,000 psi reinforcing steel. The slabs will be six inches thick with no.4 bars spaced every twelve inches in both directions for flexural reinforcement and for temperature shrinkage and crack control. Intermediate beams will support the slab between column lines. They will be twenty inches deep and twelve inches wide with four no.8 bars in the bottom tension region and no.3 stirrups spaced every eight and a half inches. The girders will be constructed as T-beams with an overall depth of thirty inches and a width of eighteen inches. Twelve no.8 bars will stiffen the girders, four in the top compression region and eight in the bottom tension region; no.3 stirrups will be spaced every thirteen inches. Using all the loads from each floor and the roof loads, the columns were designed. Exterior columns will be twenty-four inch square with eight no.11 bars arranged in a square and no.4 ties spaced every twenty-two inches. These columns will experience applied moments plus axial forces and an interaction diagram provided in the appendix as Figure 3 shows their capacities. Interior columns will be eighteen inch square with eight no.11 bars arranged in a square and no.4 ties every eighteen inches. A shear wall will be constructed to resist all lateral forces due to wind. The walls will be twelve inches thick and have a required length of twelve feet. The vertical reinforcement will be no.6 bars at twelve inches on center in two layers and the horizontal reinforcement will be no.4 bars at twelve inches on center also in two layers. These walls will be used to enclose the elevator shaft and stair wells. Detailed drawings of each component as well as building plans and sections are included in the project drawing package (S drawings).

We feel that we have designed a building that will give the University of Tennessee flexibility with the use of their laboratory building. It was designed to meet all safety codes and specifications. This design should provide the university with a long-lasting functional facility.

Water Facilities

KUB owns a water transmission line (16") that runs along Alcoa Highway with 4 stand pipes and 3 fire hydrants on Cherokee Farm. The small stand pipes connect the transmission line to private lines on Cherokee Farm. The first stand pipe (2"), #28631, is located in the upper portion of the property (near TN River). The second stand pipe (unknown size), #34114, is located in front of the temporary entrance to the farm. Just south is the third standd pipe (2"), #28632. The forth stand pipe (1"), #40280, is located in the southern portion of the property. The first fire hydrant, #2543, is located just south of stand pipe #28631. Fire hydrant #2544 is located just north of stand pipe #34114 and fire hydrant #2545 is located just south of stand pipe #28632. See table 1 for hydrant flows and pressures. To minimize the length of pipe to be laid for our facility the best place to tap KUB's water transmission line was determined to be 600 feet below fire hydrant #2543.

There are two types of water demand (daily demand and fire flow) to consider when determining the appropriate size for the facility. When determining needed fire flow for the Cherokee Research Facility two situations were analyzed; with sprinklers and without sprinklers. Per ISO Guide for Determination of Needed Fire Flow, the needed fire flow for each building without sprinklers is 2500 gallons per minute and with sprinklers the fire flow is 1550 gallons per minute. The facility should have sprinklers installed not only for the reduction of needed fire flow but also for insurance advantages, like reduction in price. The daily water demand for the facility was calculated using a TDEC approved equation adopted by KUB. The equation states that the daily water demand for the facility is equal to .1 gallons per day per square foot of floor space. There are five buildings on our site and each building has 50,000 sq. ft. of floor space. Therefore, for the entire facility the water demand is 25,000 gallons per day.

The recommendation for the water line type is polyvinyl chloride. PVC is readily available and performs well under these circumstances. The water line will tap KUB's transmission line approximately 600 feet below fire hydrant #2543. The first proposed line will be approximately 600 feet long to reach the first building. An additional 200 feet of pipe is to be laid between buildings. A total of 1400 feet of new pipe should be installed to accommodate all five facilities.

Because of the substantial amount of new pipe, there is considerable pressure loss through the system. During a fire situation all facilities should have a minimum pressure of 20 psi. Every floor of every building was checked to ensure adequate pressure existed. The worst case for our situation is the top floor of the last building. An eight in. pipe will provide sufficient capacity to accommodate the required demand of the facility.

KUB requires a complete set of calculations and computer simulations to be submitted for approval of capacity. KUB applies a tapping fee upon receipt of approval of capacity. Once payment is made the proposed line can be connect to the transmission line.

Sanitary Sewer Facilities

The University of Tennessee Cherokee Farm has a small private line (4" or 6") that drains wastewater to the University Of Tennessee Medical Center. According to Terry Ledford at UT Physical Plant, UT Medical Center owns a private pump station. UT Medical Center pumps its wastewater into KUB's sanitary sewer line and KUB transports the wastewater across the river to Kuwahee Wastewater Treatment Plant. When the five buildings of Cherokee Campus are complete the estimated wastewater flow will be 25,000 gallons per day. For KUB to monitor new wastewater service, all developing projects must apply to the Capacity Assurance Program. An application must be submitted along with a specified payment to KUB. The new project is then simulated by computer design. If a project is acceptable a letter of acceptance is sent from KUB. KUB has ensured adequate sewer capacity for Cherokee Campus.

The Cherokee Campus will continue to use the pump station that UT currently uses to transport waste away from the farm currently on the site. Building a force main for so small a flow is impractical, running over $1,000,000 for the pump station and the installation of the line.

There were two options for installing a force main on the site. The first was to bore under the river and tap into KUB's Neyland Drive trunk sewer. This option required approximately 1000 feet of 8" gravity sewer and approximately 2000 feet of 4" force main. The cost for the line was estimated at $300,000. The second option was to keep the sewage on the south side of the river using an open cut trench for installation. This option included approximately 6600 feet of 4" force main. The installation of this line was estimated to be $250,000. A pump station would have to be built for either option. The costs were not computed accurately for the potential pump station, but it would likely be in the neighborhood of $700,000.

These costs estimates are rough, but they are still far too high when an adequate system is already in place. This is why the null option was chosen for the transmission of wastewater away from the site.

Drainage Infrastructure

On this site reinforced concrete sewers were chosen to transport storm water to the detention basins. The sewers themselves were designed for a 25 year storm. The minimum size used on the site was 18", with a maximum size of 36". The slopes were kept between .5 and 5%, except in situations where the topography was extremely steep, and there the slopes were capped at 7%.

A curb and gutter approach was chosen over drainage ditches because storm sewers were already going to be required to capture the runoff from the parking structures in places. Ditches were still used where the topography allowed, but over 98% of the runoff from impervious surfaces is captured in the storm sewers. TDOT standard D-CB-12SB catch basins were used at all points on the site.

EIS/Permitting

An Environmental Impact Statement (EIS) was prepared for the proposed research facility. The results of the EIS showed no major environmental or social impacts following new construction. The facility will not be a major source of water or air pollution. The site does not contain any threatened or endangered species. Subsurface investigations did not reveal any karst formations that would limit new construction. The proposed facility will not encroach upon any archeological sites in the area.

Two permits, the NPDES General Permit for Industrial Storm Water and the NPDES General Permit for Construction Storm Water, are required for the planned development of the UT Cherokee Campus. The Construction Permit requires a Storm Water Prevention Pollution Plan (SWPPP) to be submitted along with the permit and a

7.5 minute USGS map before 30 days of construction. Within the SWPPP, which is attached in the appendix, the existing site information, project description, special requirements, spills contingencies, runoff calculations, construction sequence, soil erosion control practices, and a stabilization plan with proposed used of best management practices are included. The Notice of Intent for the construction permit must be granted before construction on the site may begin. The goal of this SWPPP is to have the construction activity carried out in a manner to prevent any discharge that would cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of the waters on the property or downstream of the property for fish and aquatic life, livestock watering and wildlife, recreation, navigation or industrial or domestic water supply.

Storm water Detention Requirements

Storm water detention is a somewhat recent necessity for new developments. This need is evident by the rampant flash flooding experienced in urban areas developed before full effects of altering an area's hydrological conditions had been realized. Changing a site's physical characteristics such as slope, hydrologic soil type, paving over pervious areas, and vegetative changes can all result in a drainage problems for areas downstream in the watershed. These facts have caused the federal, state, and local governments to enforce storm water laws to ensure proper foresight in site development.

The City of Knoxville has set requirements for storm water quantity and quality that are stringent enough to meet federal and state requirements. These requirements are illustrated in the Best Management Practices Manual produced by the City of Knoxville, and this manual can be found at http://www.ci.knoxville.tn.us/engineering/bmp_manual/.

The City mandates that storm water from the 1, 2, 5, 10, and 100 year storms with a National Resource Conservation Service (NRCS) Type II 24-hour rainfall distribution have a peak discharge that is not greater after development has occurred. The values for the Knoxville area of these and other design storms are given as Table 1

Frequency	Rainfall (in.)
1 Year	2.5
2 Year	3.3
5 Year	4.1
10 Year	4.8
25 Year	5.5
50 Year	6.1
100 Year	6.5
500 Year	7.6

Table 1

In addition to storm water quantity, storm water quality has also become regulated. Knoxville requires 75% of total suspended solids during a 24 hour drawdown time be removed. This is accomplished by employing a "first flush" design. First flush treats the first runoff to enter a detention basin by using various methods including a gravel bed or box, sand filtration, or a subsurface drainage system. The City of Knoxville's requires either the first 0.5 inches of runoff or the first 4500 cubic feet of runoff, whichever is greater, be treated and released within the 24 to 72 hour timeframe following a rain event.

Other design considerations for dry detention basins recommended by the City include a trash rack for litter collection with a maximum of opening of 2 inches, shade trees, a length to width ratio of at least 2:1 with 3:1 preferred, 15% design volume increase as a factor of safety, accessibility, large openings gated over, gentle side slopes with being 3:1 the preferred ratio. Layout concerns include a minimum embankment width of 5 feet at the crest, accounting for settlement in the embankment, at least 2 feet of freeboard for the outlet structure and 1 foot of freeboard for the 100 year water surface elevation, and a back slope drain is preferred. Outlets must be constructed of durable materials with concrete being the material of choice. Sediment fore bays are required if embankments are to be used in erosion control during construction, and they need to have 5% to 10% of the total volume separate from the main detention. Outlets should be less than 4 feet deep. Any embankment that holds more than 30 acre-feet volume of water or is higher than 6 feet is subject to additional requirements under the Tennessee Safe Dams Act. Finally, low flow channels, antiseep collars, and antivortex devices are encouraged but not required.

The first step in the detention design process is site investigation. Characteristics of interest include area, topographic attributes, soil types and percentages, and existing structures and vegetation. Information for all these attributes can be found at a few GIS type websites including Knoxville's KGIS (http://www.kgis.org) and NRCS's Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/). A detailed map showing soil types and areas of disturbance is included as Attachment 1. With these considerations in mind, a determination of the type of detention must be made. The Cherokee Farm site would best be suited for a dry detention basin as shown by the Decision Matrix in Table 2.

Weight Factor	5	4	3	2	1	
Activity	Function	Site Suitability	Sustainability	Cost	Aesthetic	Total
No Detention	1	2	1	3	3	21
Dry Detention	2	3	3	2	2	37
Wet Detention or combination Wet/Dry	3	1	1	1	2	26

Table 2 – Detention Decision Matrix

The next step is to calculate predevelopment and post development flows. When comparing the existing topography to the proposed grading plan, the development area comprises just less than 45 acres. This area is best split into two watersheds labeled A1 and A2. Time of concentrations for the areas need to be determined for these calculations, and Attachments 2 and 3 show the predevelopment and post development time of concentration delineations.

A variety of methods exist for runoff calculations, and the method preferred by the City of Knoxville is the Soil Conservation Service (SCS) method. The time of concentration is computed using the SCS Lag Method. These calculations have been performed in a software program entitled Haestad Method's PondPack©. This is the program used by the City of Knoxville for checking detention plans and as built performances. PondPack has been used for all calculations involved in the detention design for the Cherokee Farm Site. The following tables show the watersheds soil characteristics pertinent for runoff calculations.

Land Use	CN	Acres
Pasture	69	20.22
Impervious Areas	98	4.18
Gravel Area	85	0.5

Table 3 – A1 Predeveloped Land Use

Land Use	CN	Acres
Pasture	69	19.55
Impervious Areas	98	1.2
Gravel Area	85	0.777

Table 4 – A2 Predeveloped Land Use

Land Use	CN	Acres
Newly Graded Pervious Area	85	16.93
Impervious Areas	98	7.97

Table 5 – A1 Postdeveloped Land Use

Land Use	CN	Acres
Newly Graded Pervious Area	85	15.77
Impervious Areas	98	5.77

Table 6 – A2 Postdeveloped Land Use

Total Hydraulic Length (ft)	Composite CN	Average Slope (ft/ft)	Time Of Concentration (hours)
1446	74.19	.1035	.2642

Table 7 – A1 Predeveloped Time of Concentration

Total Hydraulic Length (ft)	Composite CN	Average Slope (ft/ft)	Time Of Concentration (hours)
1158	71.222	.1035	.2390

Table 8 – A2 Predeveloped Time of Concentration

Total Hydraulic Length (ft)	Composite CN	Average Slope (ft/ft)	Time Of Concentration (hours)
1586	89.841	.04005	.2703

Table 9 – A1 Postdeveloped Time of Concentration

Total Hydraulic Length (ft)	Composite CN	Average Slope	Time Of Concentration
1354	89.225	.0647	.1921

Table 10 – A2 Postdeveloped Time of Concentration

These calculations yield the estimated volumes for two separate detention ponds, A1 and A2, as shown in Tables 11 and 12.

Estimated Storage for 100 Year Event	Estimated First Flush Volume
2.6 acre-ft	1.038 acre-ft

Table 11 – A1 Volume Estimates

Estimated Storage for 100 Year Event	Estimated First Flush Volume
2.5 acre-ft	0.895 acre-ft

Table 12 – A2 Volume Estimates

Upon inspection of the peak values, estimated storage, site layout, grading plan, two areas were chosen for detention basins. These have been named Pond A1 and Pond A2, and details can be found in the submitted drawings. Pond A1 has a footprint of 0.8 acre, 6 foot embankment, and a concrete riser as detailed in the drawings. Pond A2 is similar in size with a footprint of .76 acre, a depth of 6 foot, and a concrete riser also detailed in the drawings.

The following figures show the outflow versus elevation curves for both ponds.

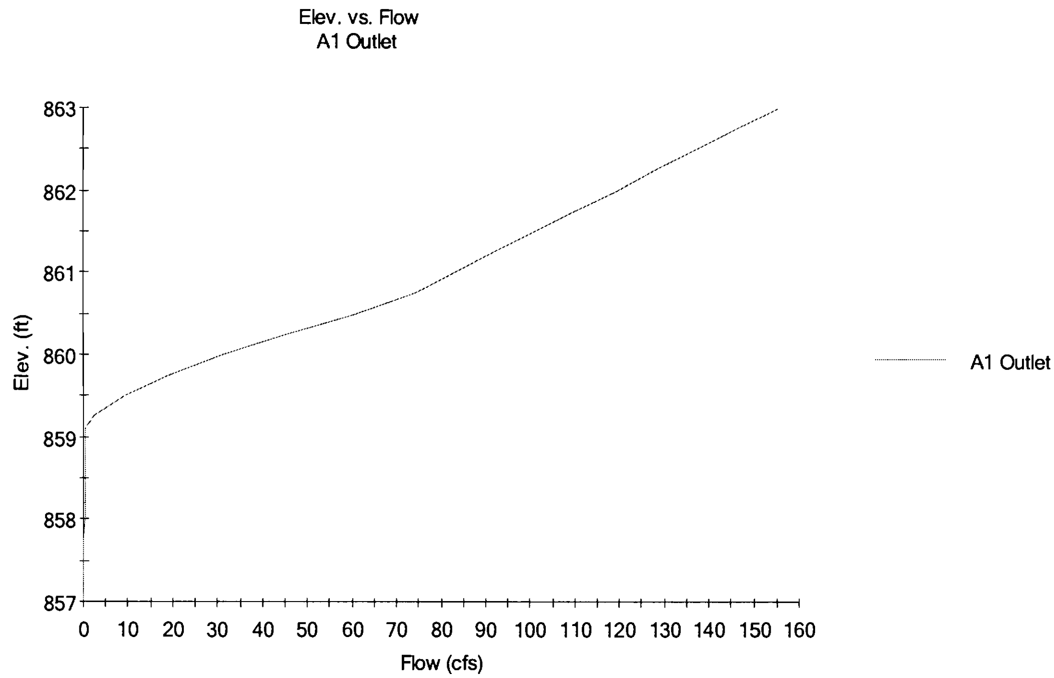


Figure 1 – A1 Elevation vs. Outflow

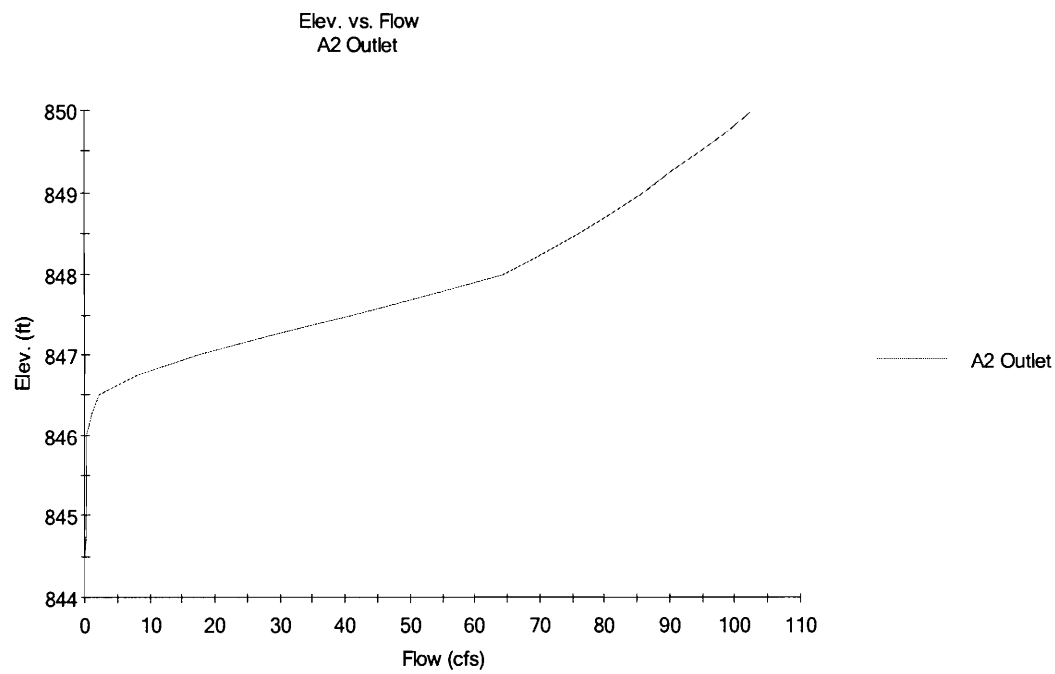


Figure 2 – A2 Elevation vs. Outflow

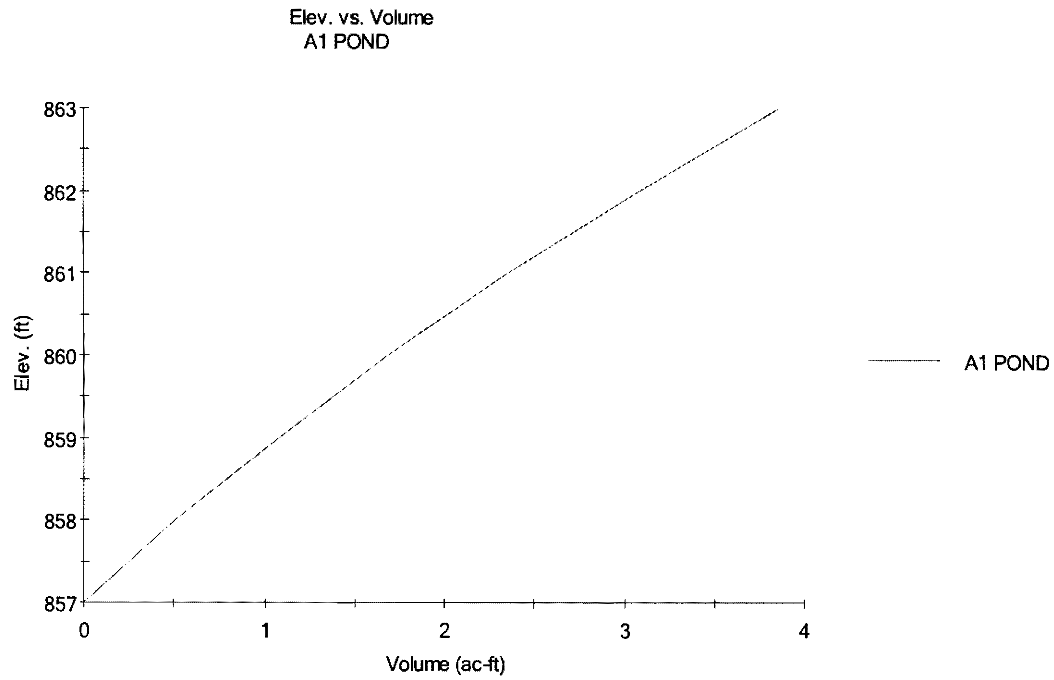


Figure 3 – A1 Elevation vs. Storage

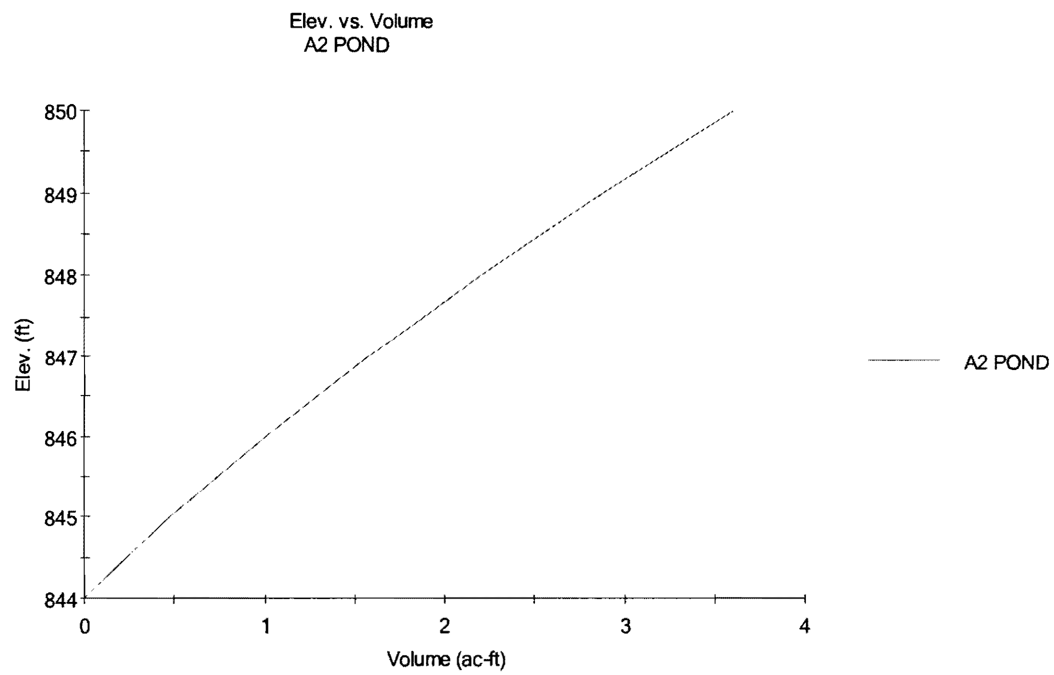


Figure 4 – A2 Elevation vs. Storage

The first flush volume was determined to be greater than 4500 cubic feet, and therefore the first 0.5 inches is required to be detained. Using equations as detailed in the Knoxville BMP Manual, the first flush calculations are shown as Table 13.

	Volume (acre-ft)	Height (ft)	Orifice Size (in)	Estimated Release Time (hour)
A1	1.038	2.0	3.00	36.35
A2	0.895	1.8	2.75	39.31

Table 13 – First Flush Results

The final requirement for the City of Knoxville are predevelopment, postdevelopment, and routed hydrographs showing that there is no increase in the peak discharge after development. The following figures illustrate that this is indeed the case, and the figures are grouped by storm event in their own respective watersheds, starting with A1.

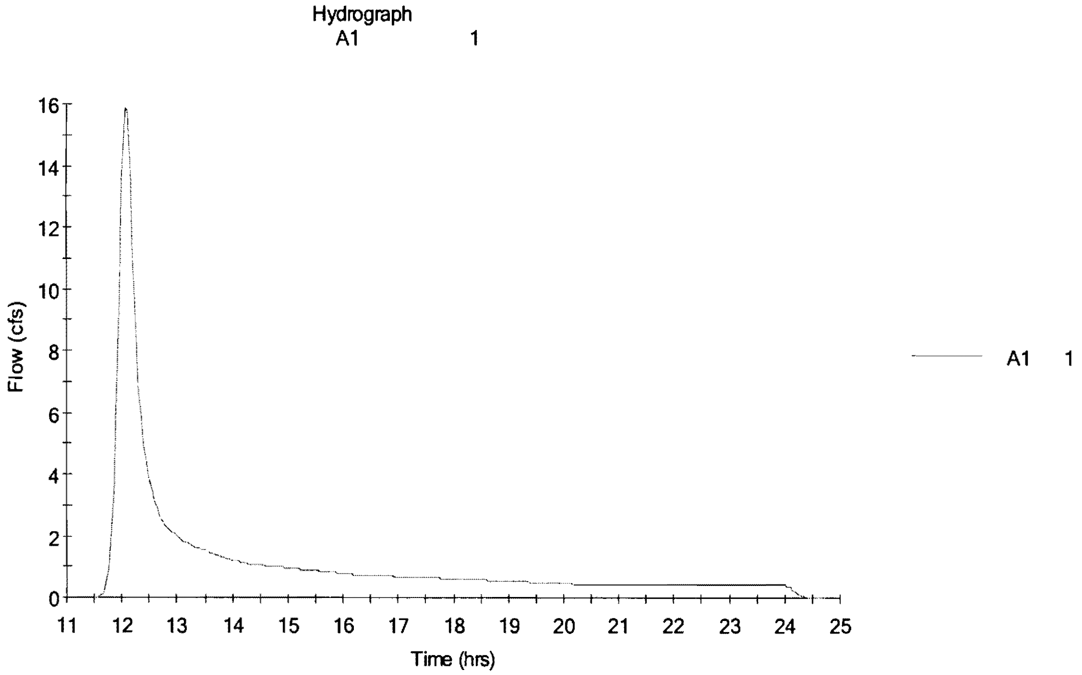


Figure 5 – A1 Predevelopment 1 Year

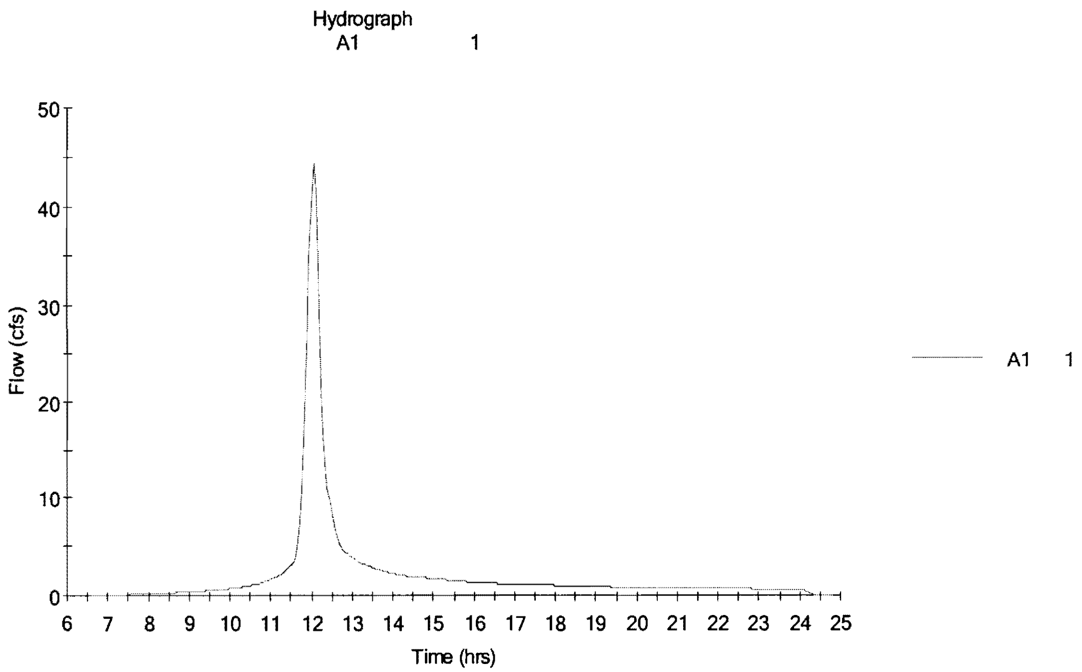


Figure 6 – A1 Postdevelopment 1 Year

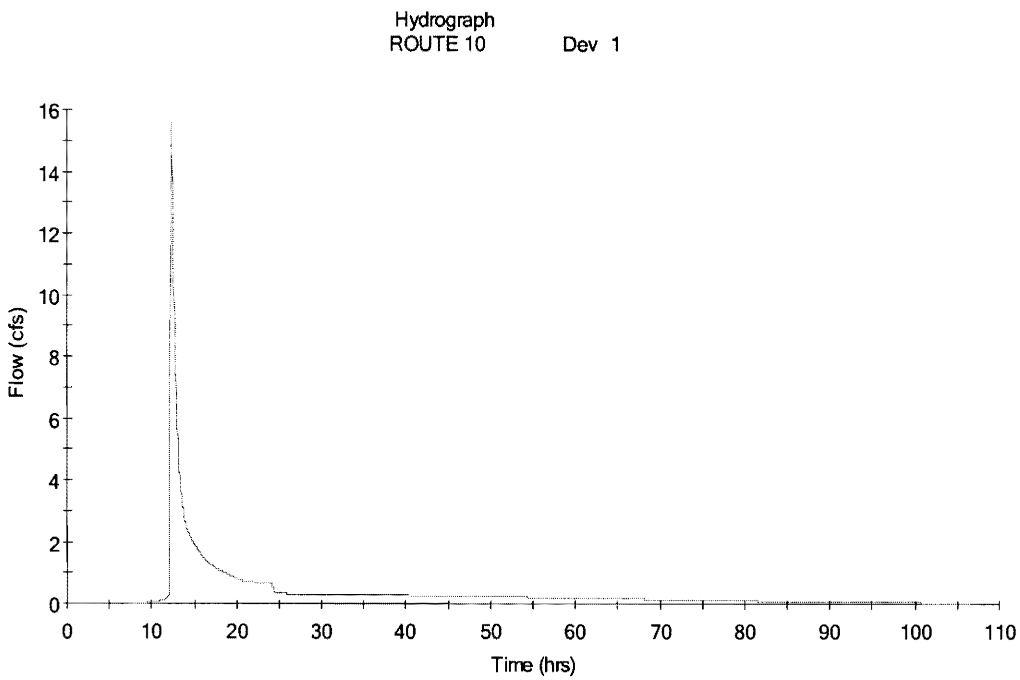


Figure 7 – A1 Routed 1 Year

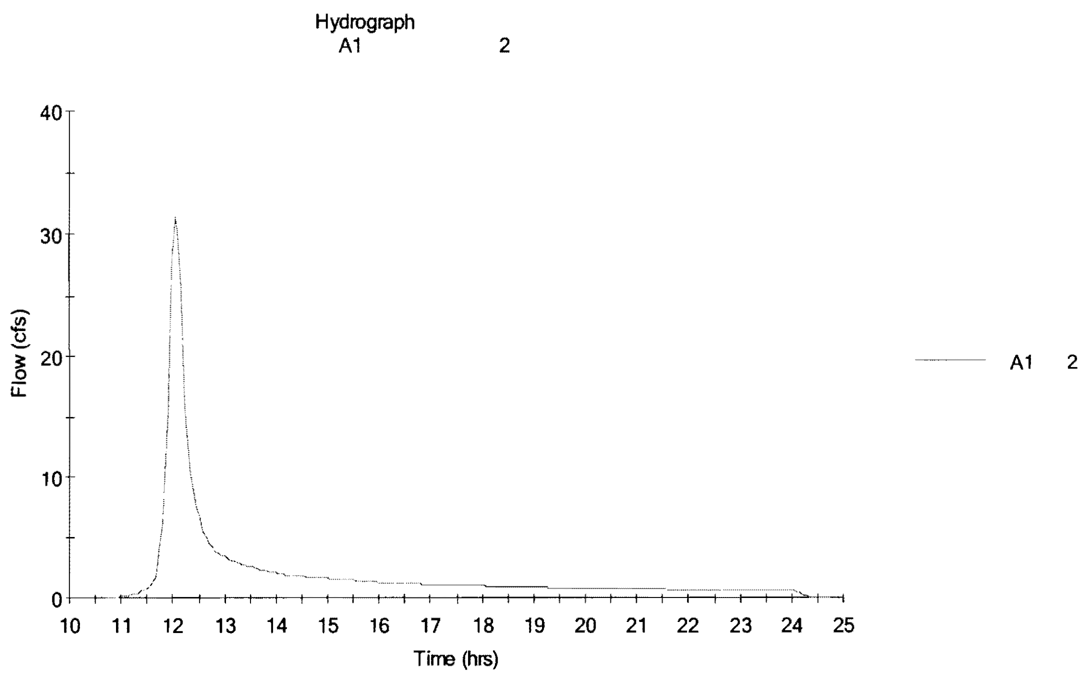


Figure 8 – A1 Predevelopment 2 Year

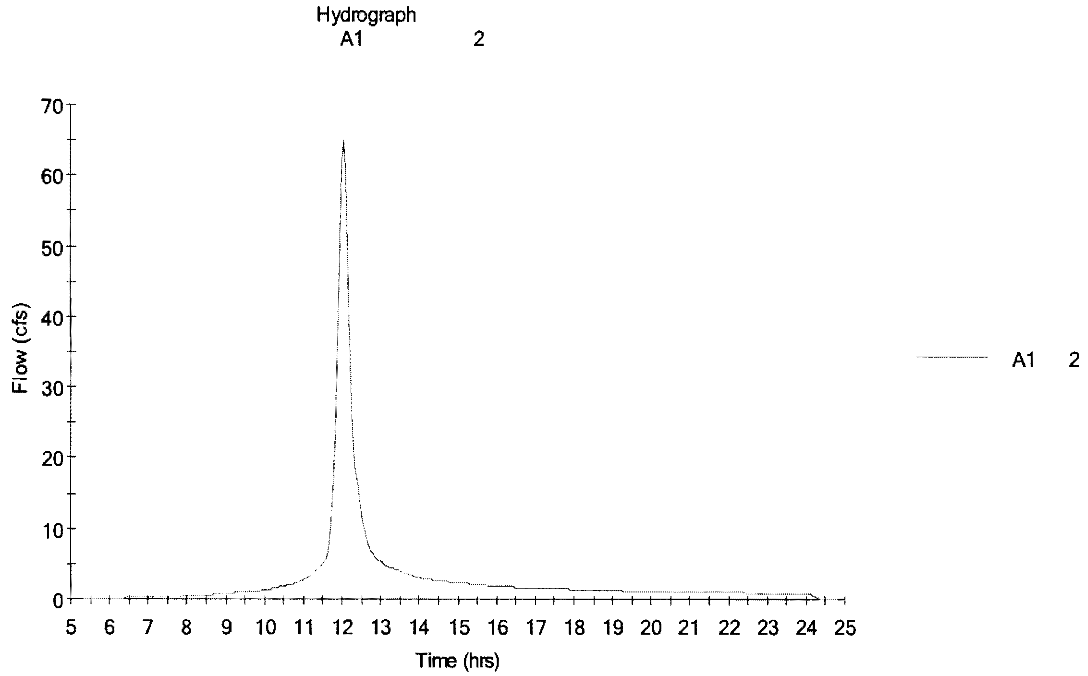


Figure 9 – A1 Postdevelopment 2 Year

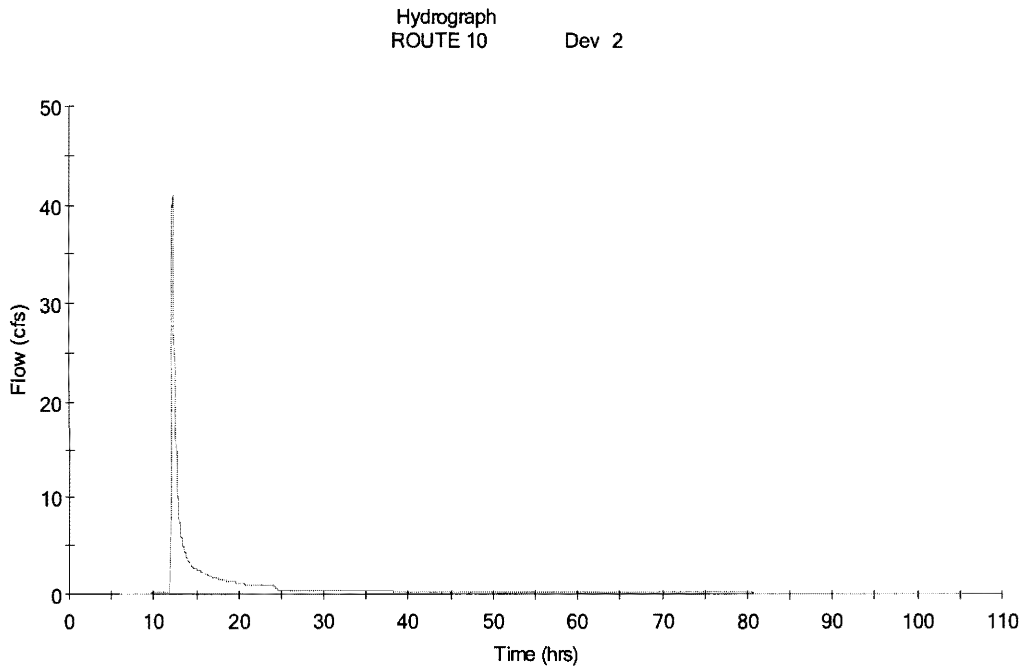


Figure 10 – A1 Routed 2 Year

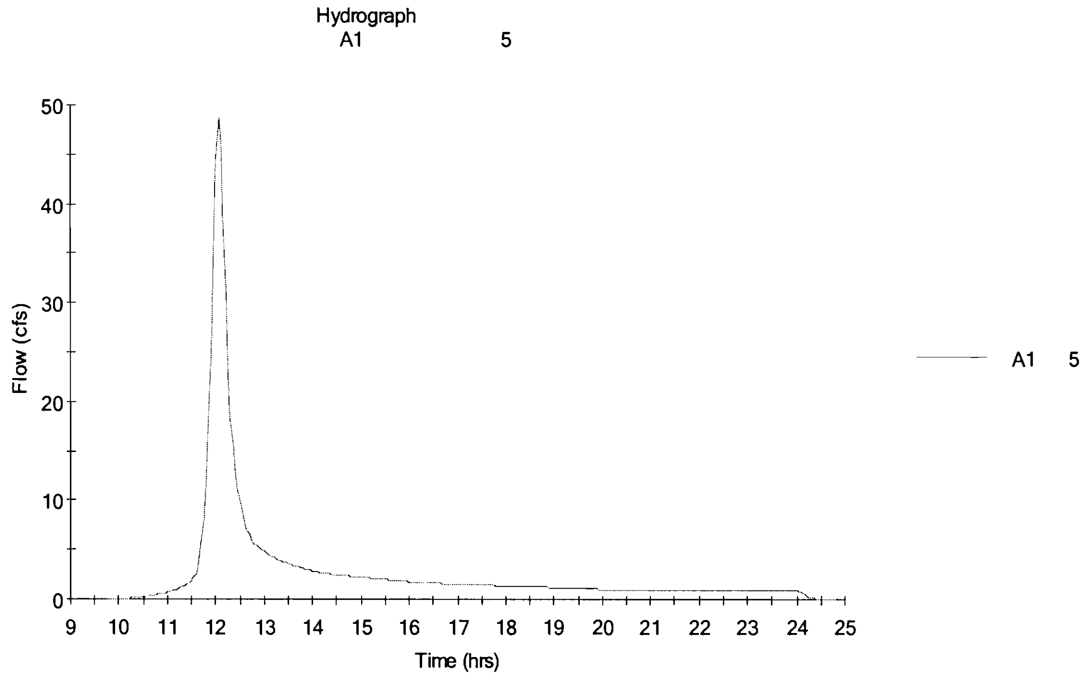


Figure 11 – A1 Predevelopment 5 Year

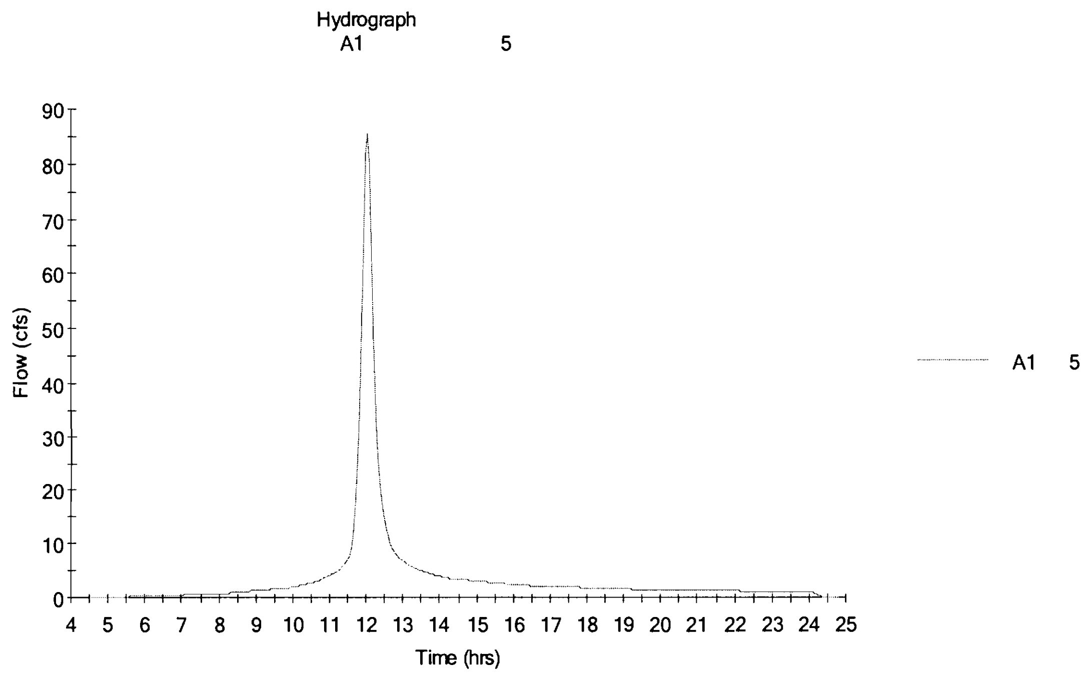


Figure 12 – A1 Postdevelopment 5 Year

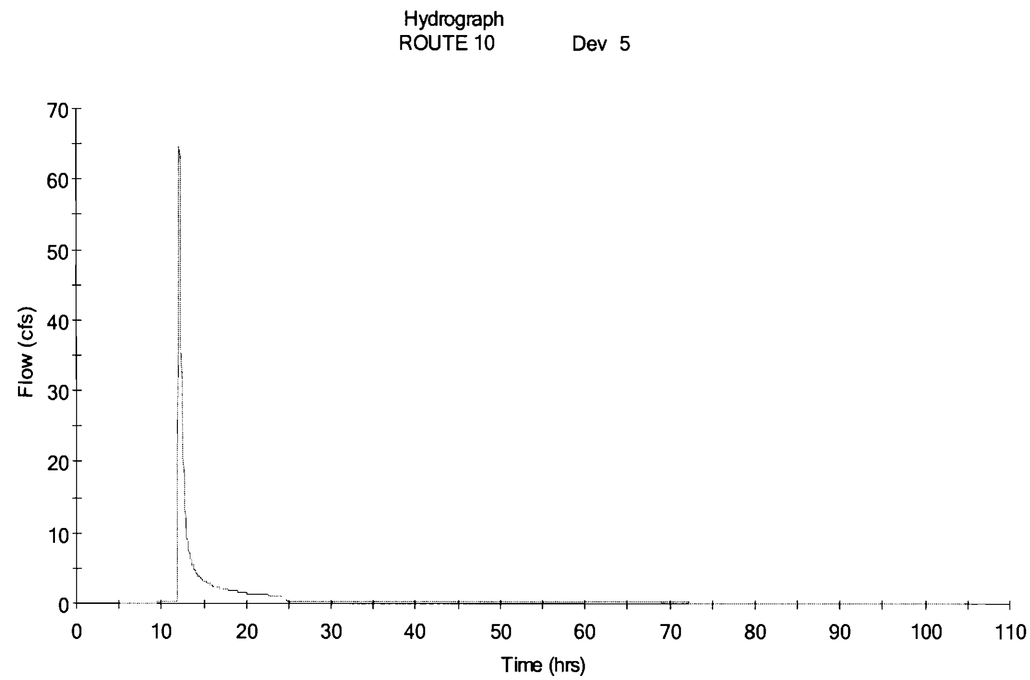


Figure 13 – A1 Routed 5 Year

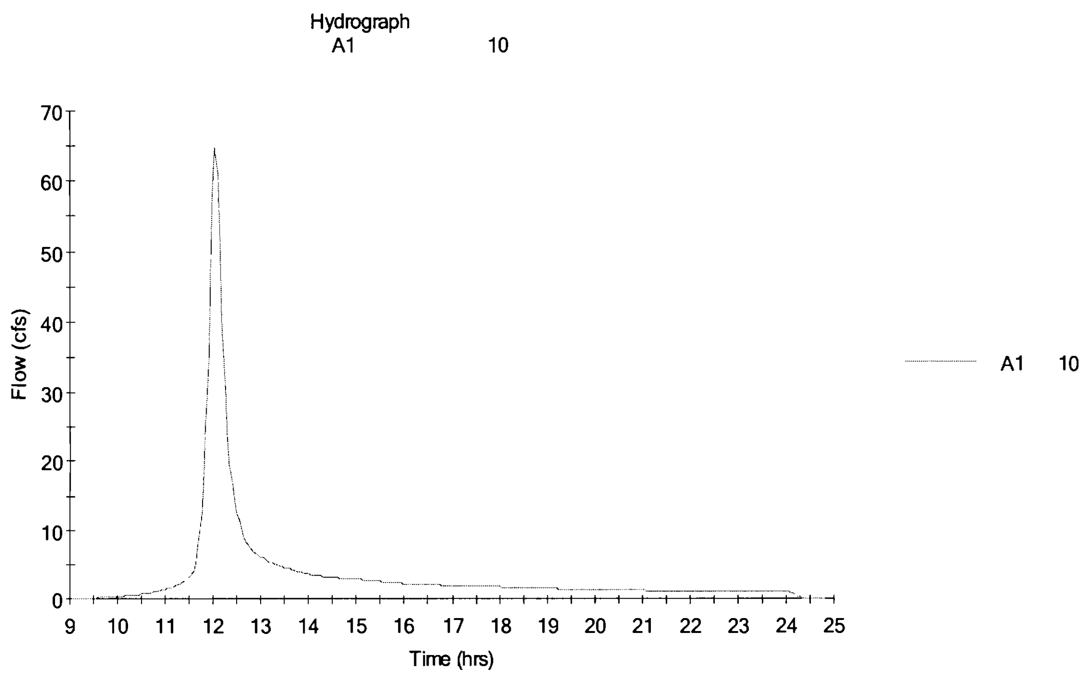


Figure 14 – A1 Predevelopment 10 Year

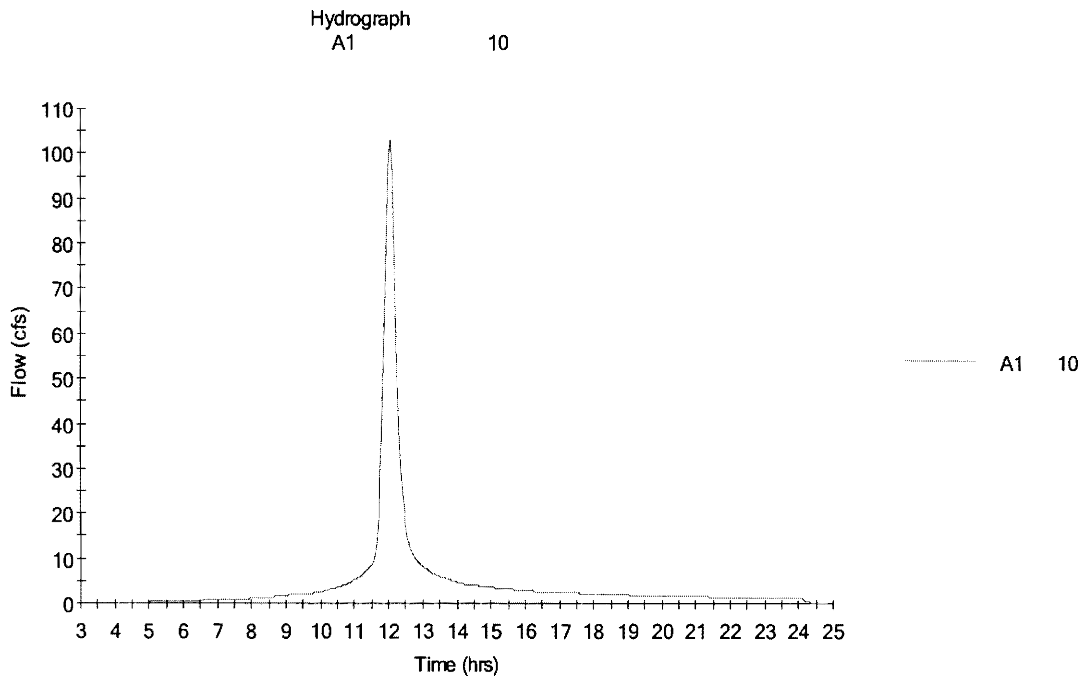


Figure 15 – A1 Postdevelopment 10 Year

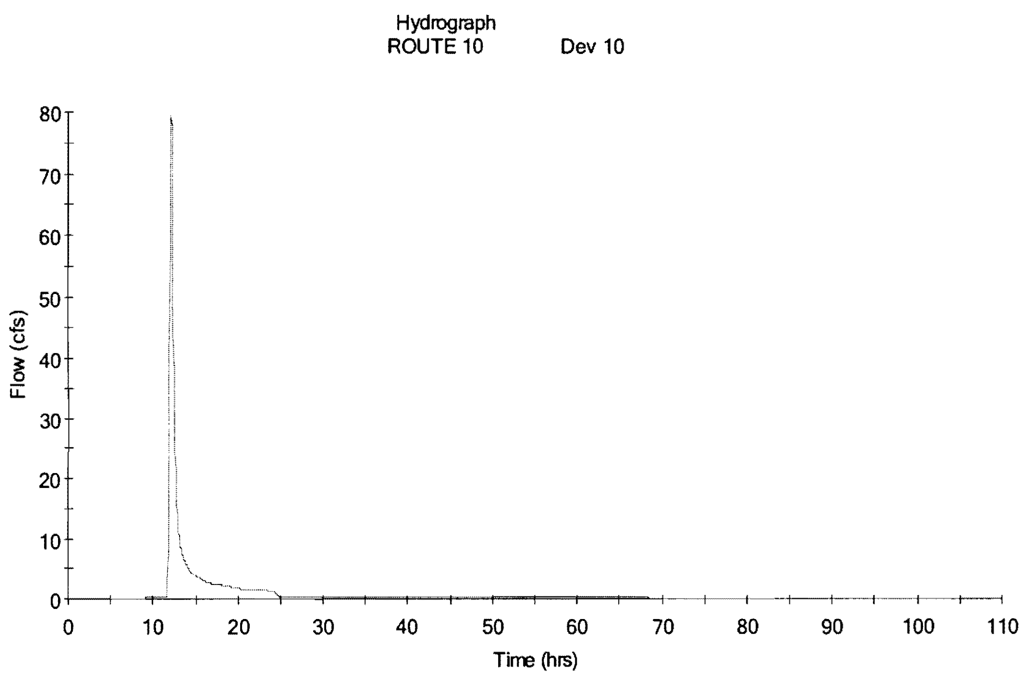


Figure 16 – A1 Routed 10 Year

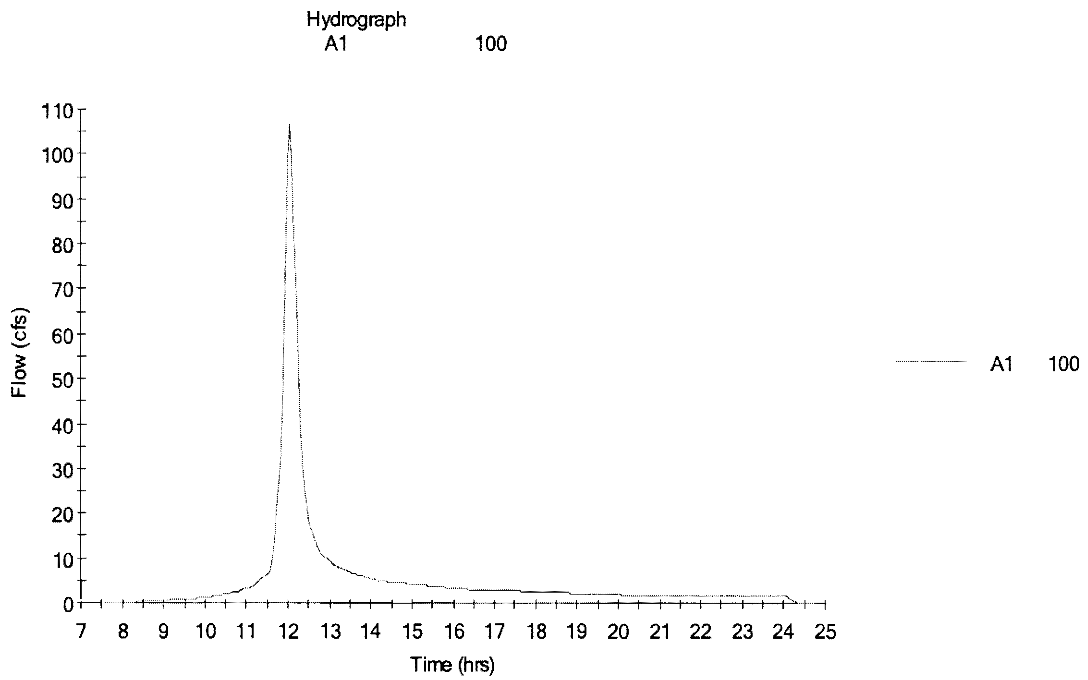


Figure 17 – A1 Predevelopment 100 Year

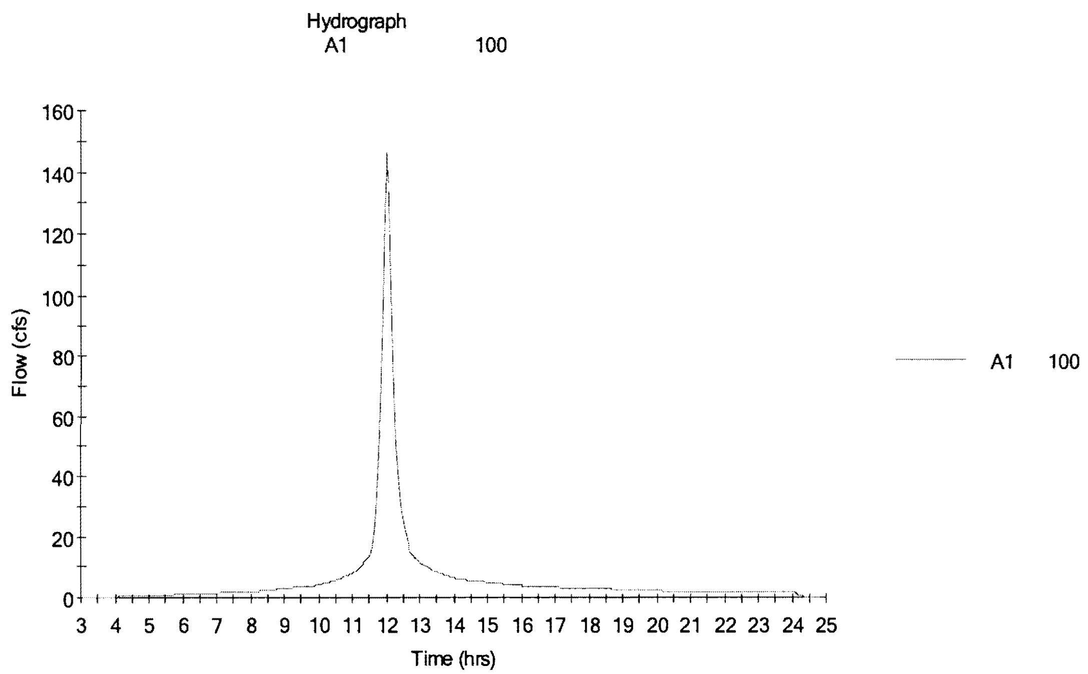


Figure 18 – A1 Postdevelopment 100 Year

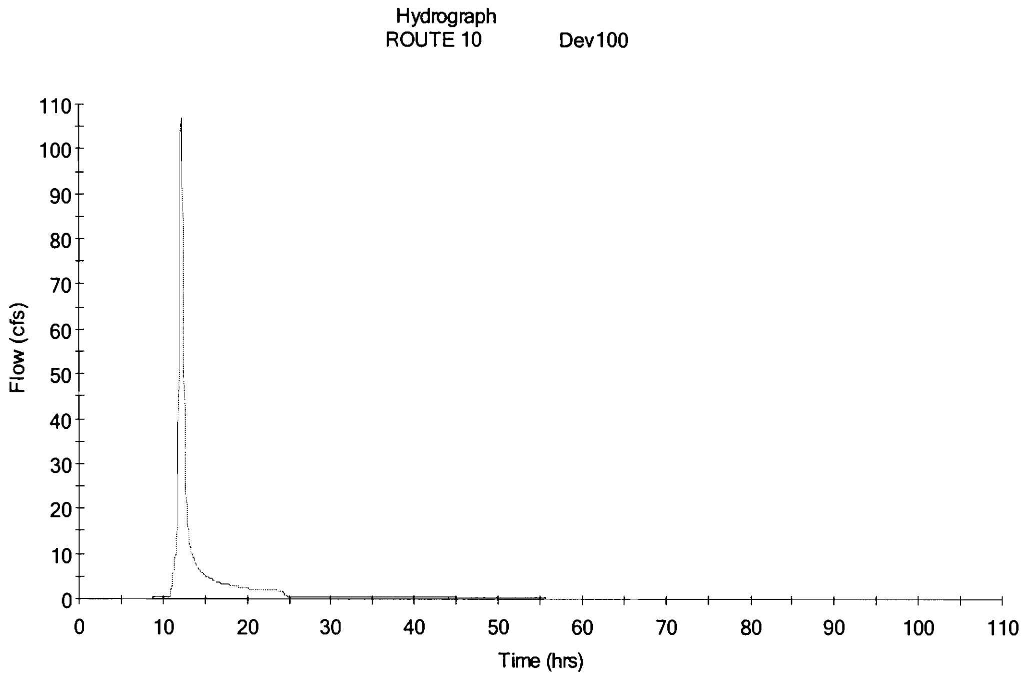


Figure 19 – A1 Routed 100 Year

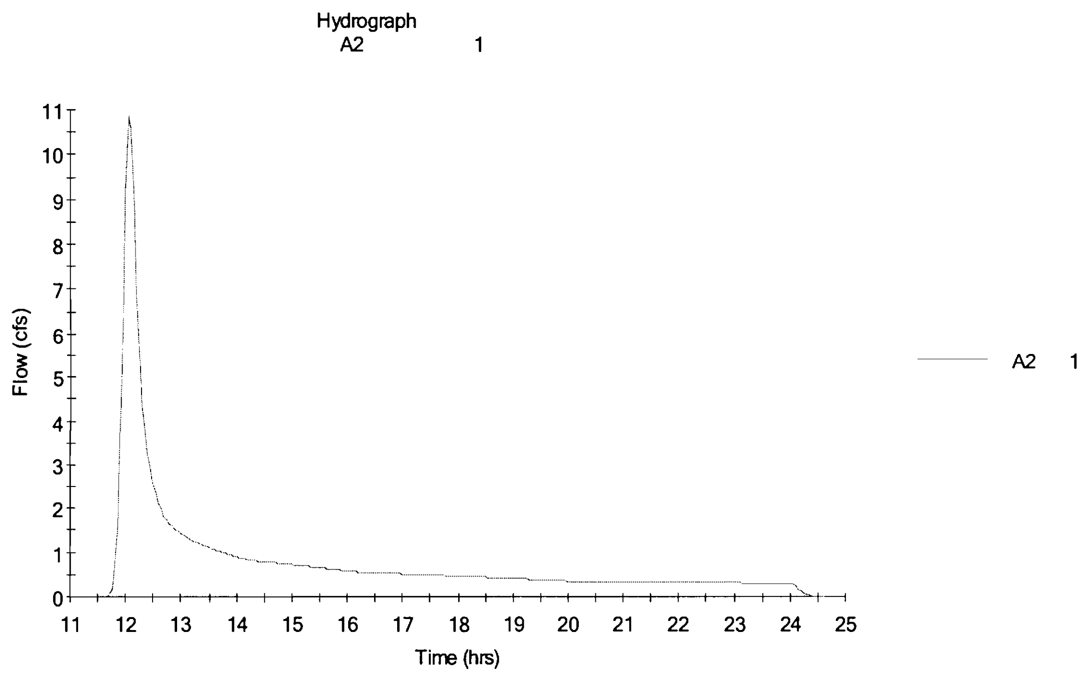


Figure 20 – A2 Predevelopment 1 Year

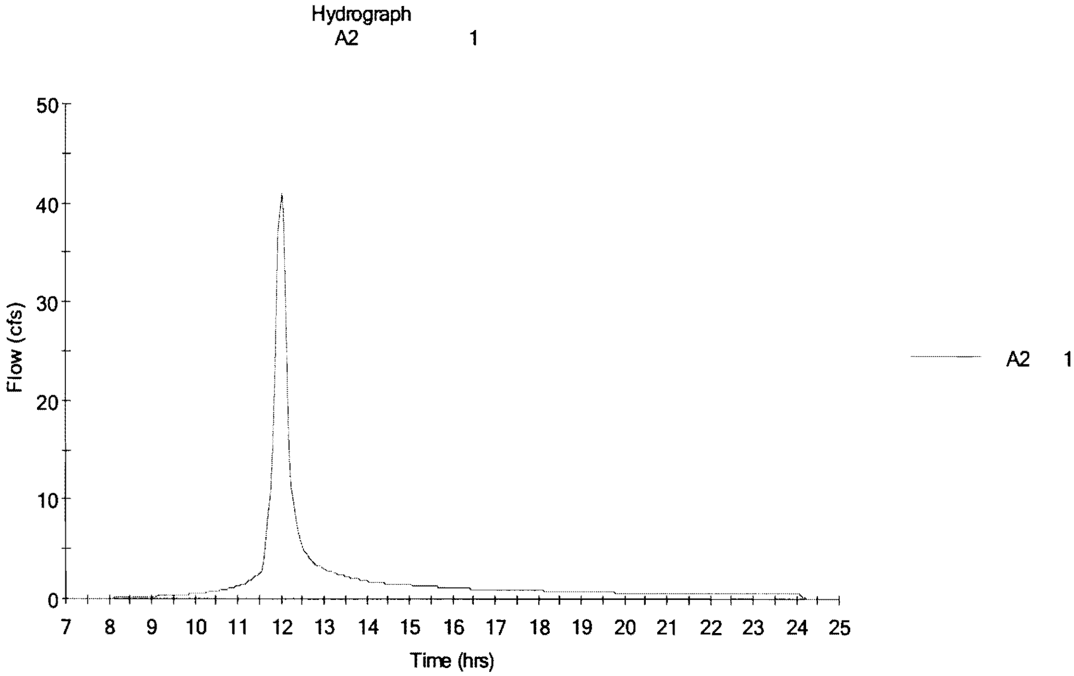


Figure 21 – A2 Postdevelopment 1 Year

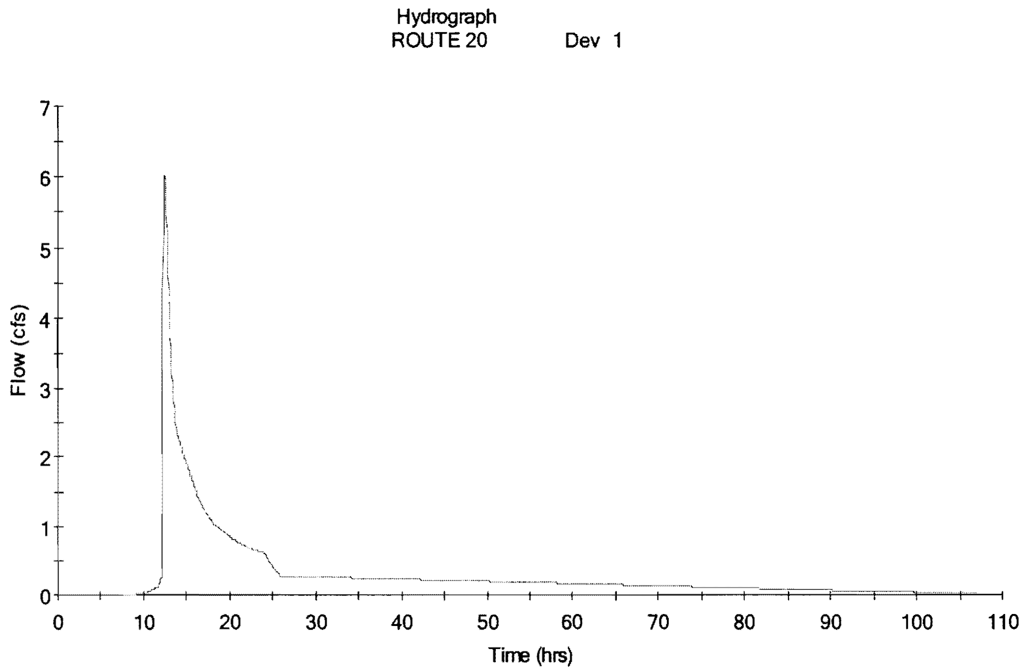


Figure 22 – A2 Routed 1 Year

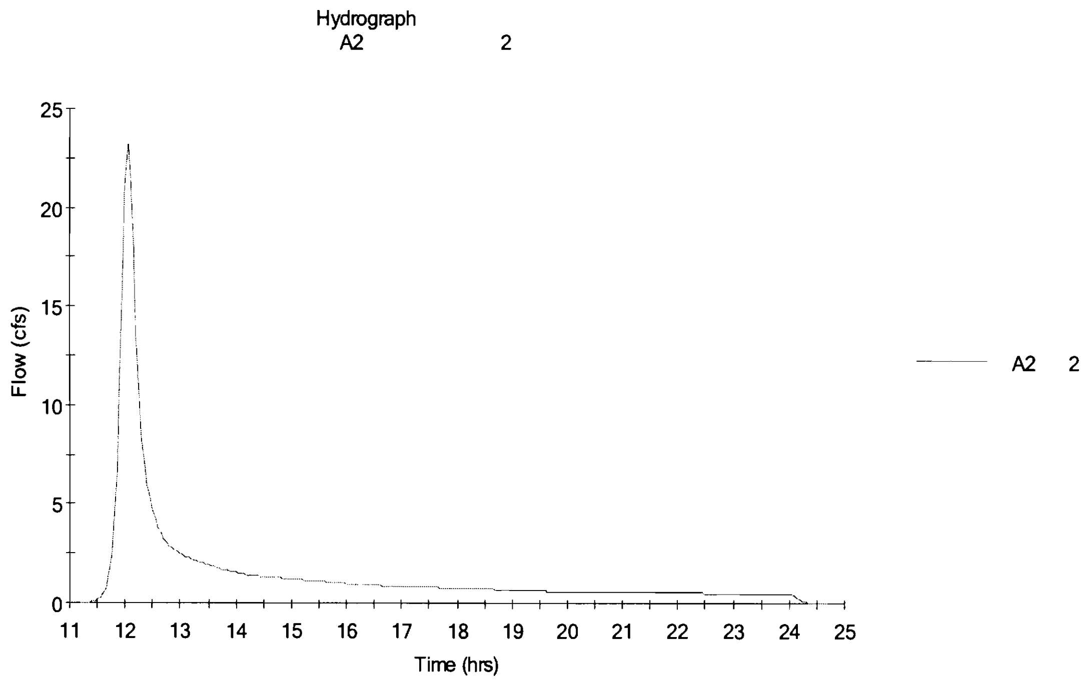


Figure 23 – A2 Predevelopment 2 Year

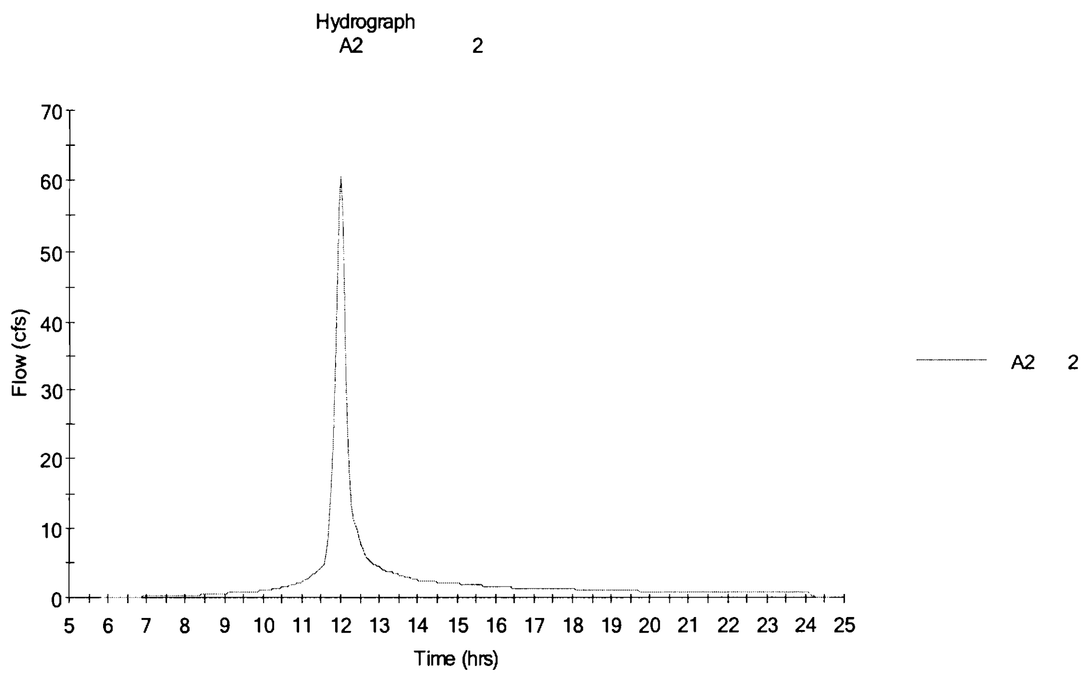


Figure 24 – A2 Postdevelopment 2 Year

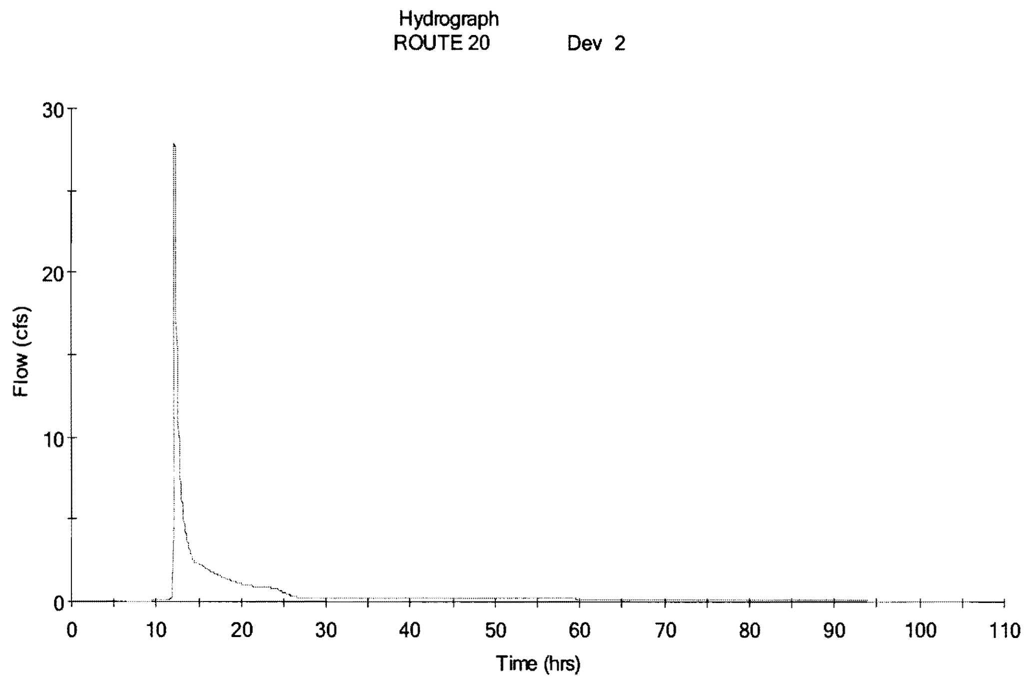


Figure 25 – A2 Routed 2 Year

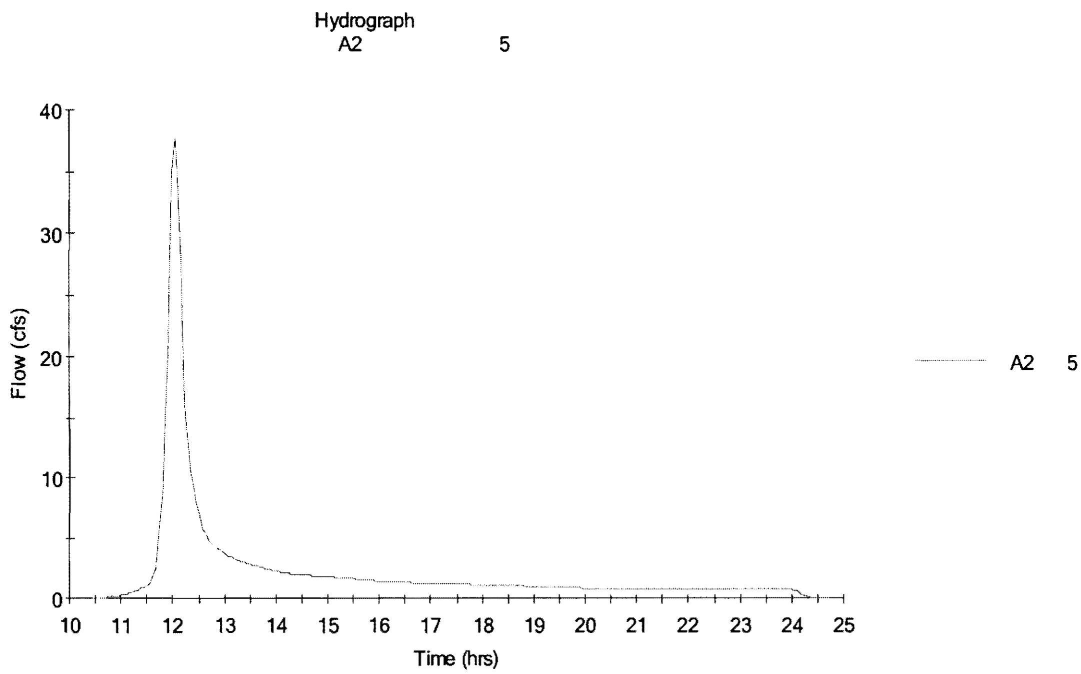


Figure 26 – A2 Predevelopment 5 Year

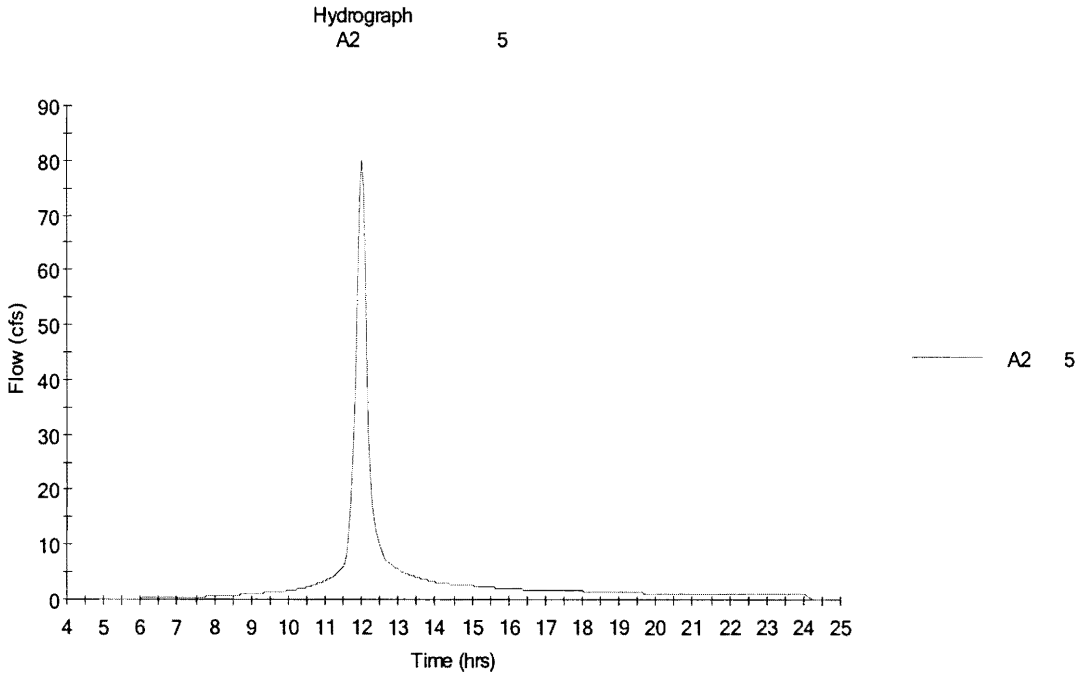


Figure 27 – A2 Postdevelopment 5 Year

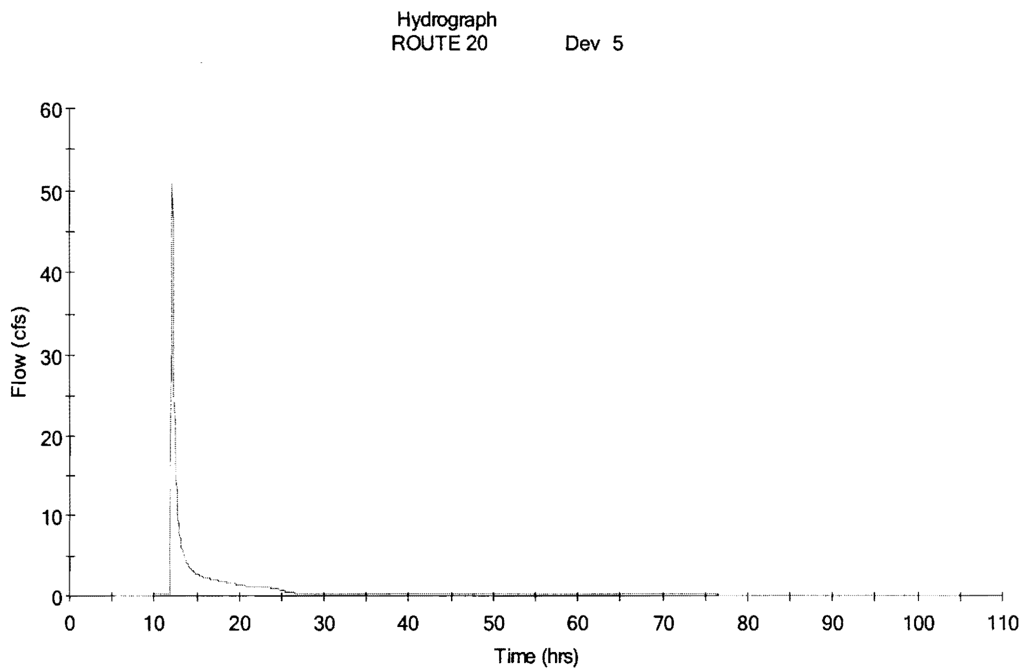


Figure 28 – A2 Routed 5 Year

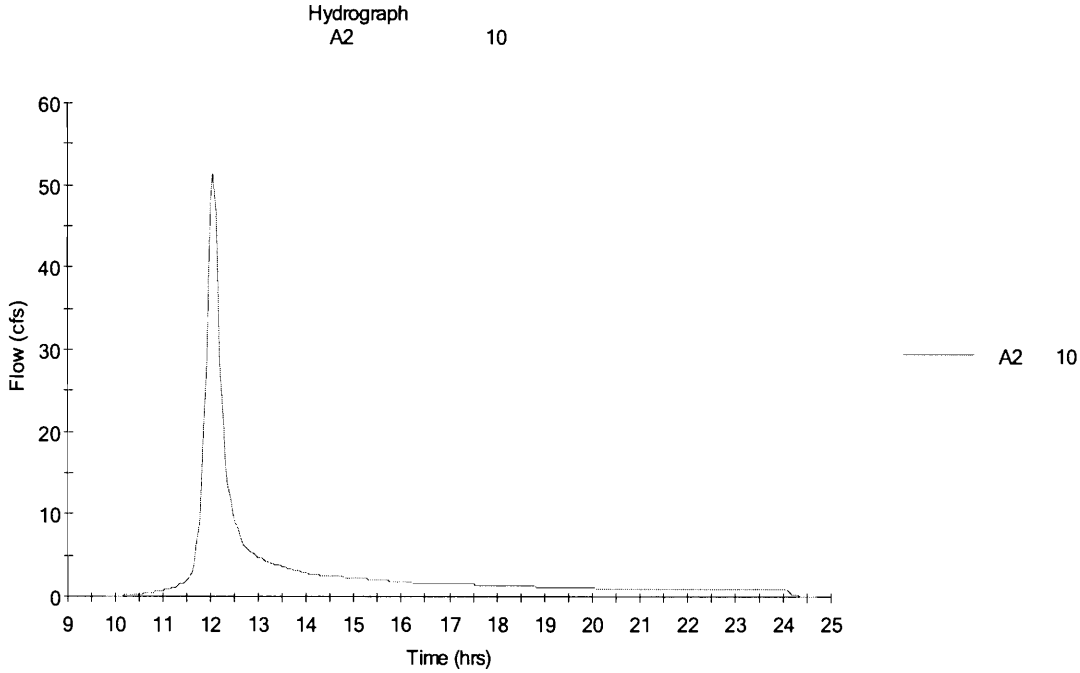


Figure 29 – A2 Predevelopment 10 Year

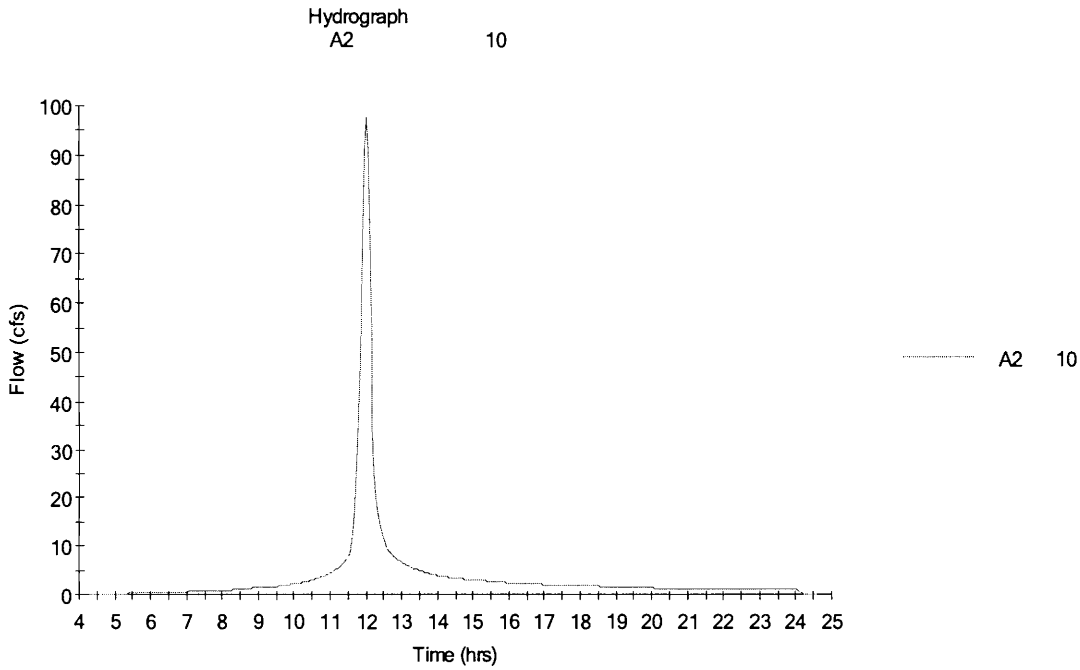


Figure 30 – A2 Postdevelopment 10 Year

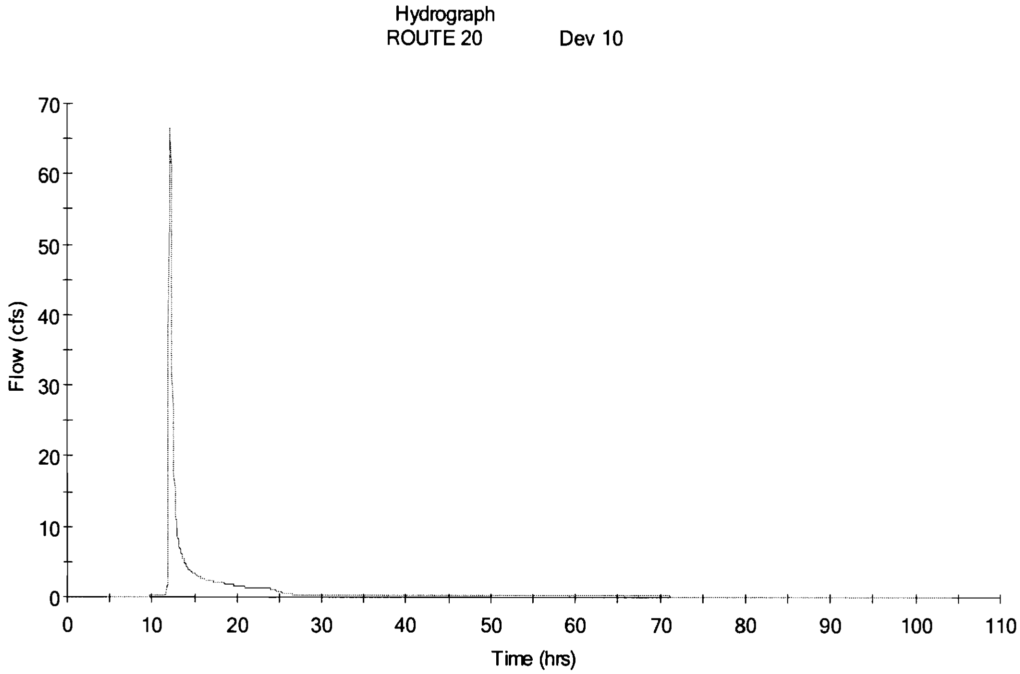


Figure 31 – A2 Routed 10 Year

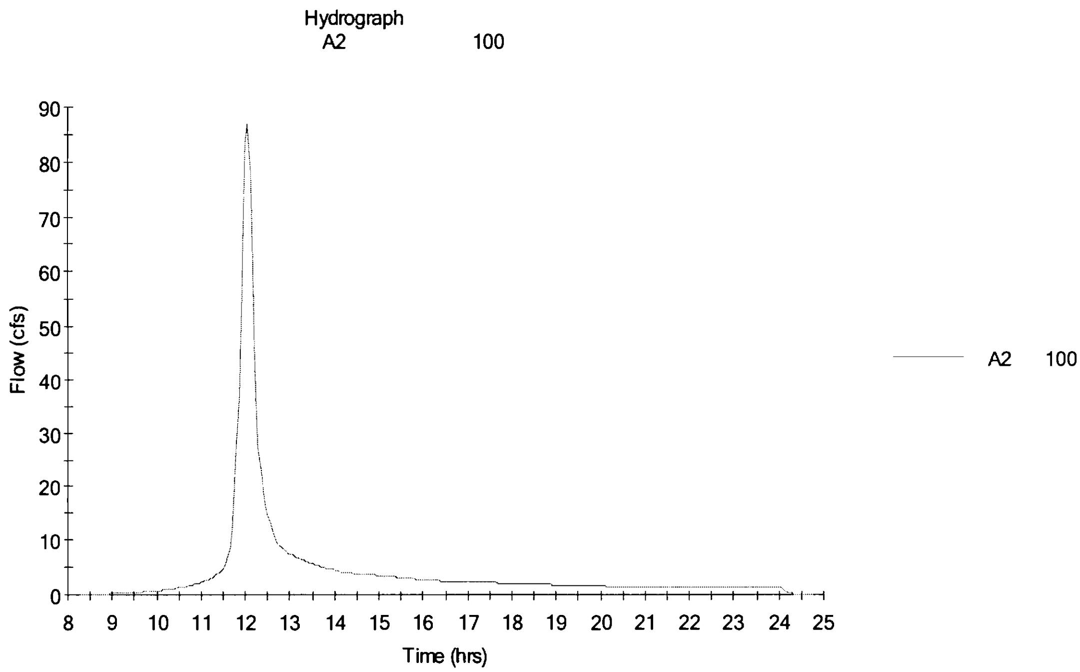


Figure 32 – A2 Predevelopment 100 Year

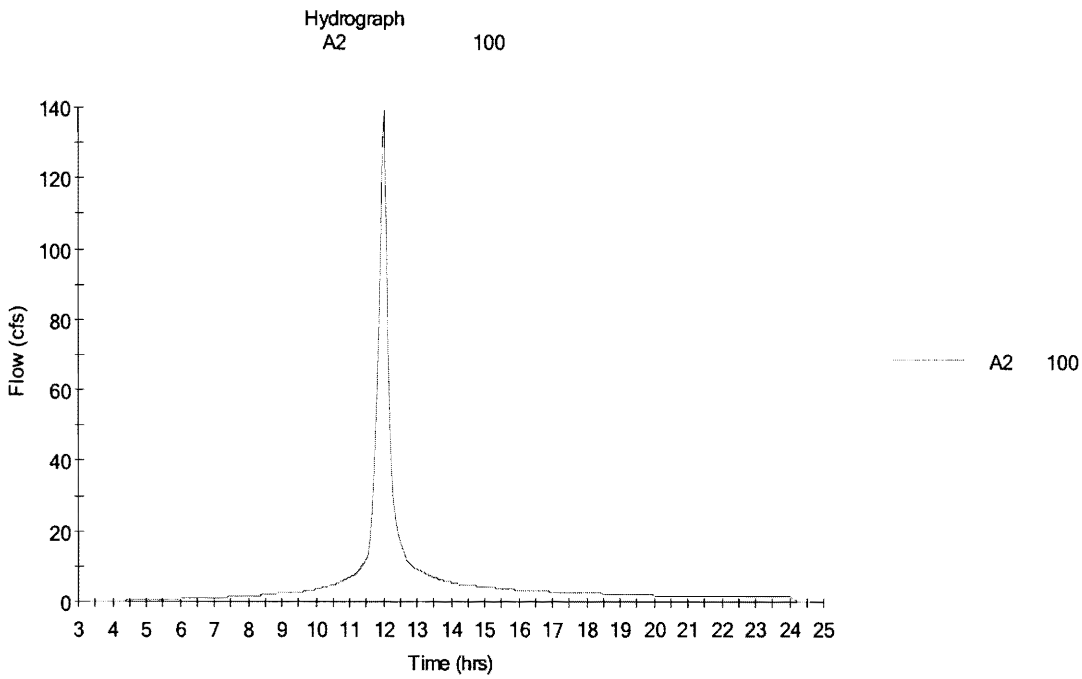


Figure 33 – A2 Postdevelopment 100 Year

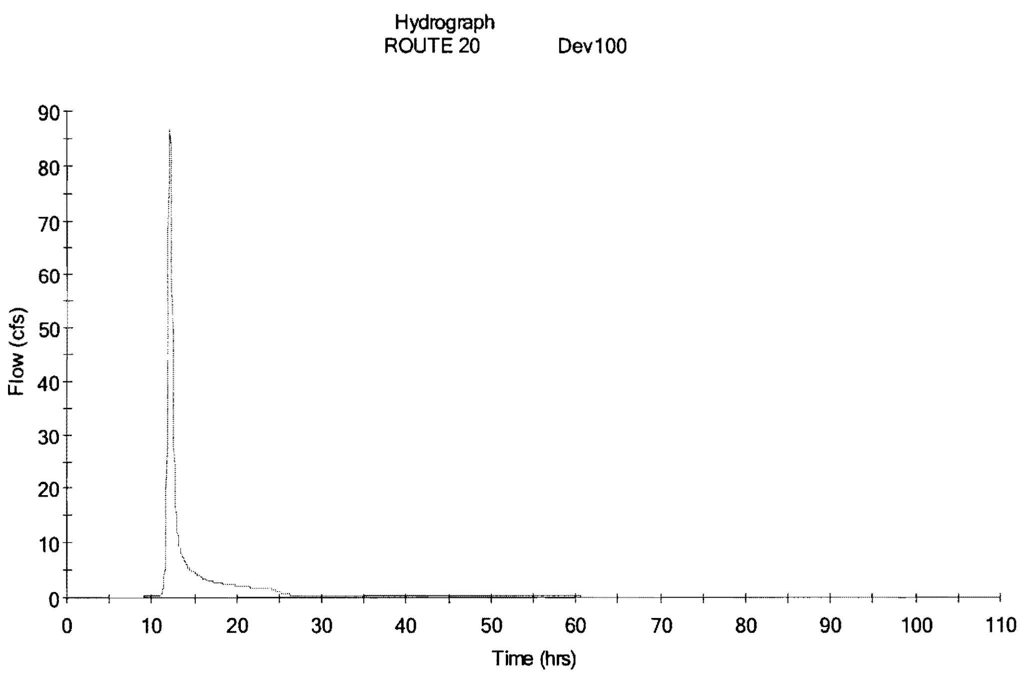


Figure 34 – A2 Routed 100 Year

In summation, this development project is feasible. The main goals of the project were to keep with the campus master plan, extend the greenway south, and alleviate overcrowding on the main campus. This development will enable the University to keep these goals and attain these goals. This development will allow the University to reach the goals of its mission to the state of Tennessee. It will also allow for more space on the main campus, since class sizes have raised in the past few years. This tract of property is an untapped resource that the University should utilize in the near future.

Reference:

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"ASTM Standards" 20 April 2005. <http:login.ihserc.com.proxy.lib.utk.edu:2050/login/erc?loginCode=PROCESS_SUBACCT_LOGIN>.

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Geosystems Boring Software

Appendix

Construction and Planning appendix

Geotechnical Appendix

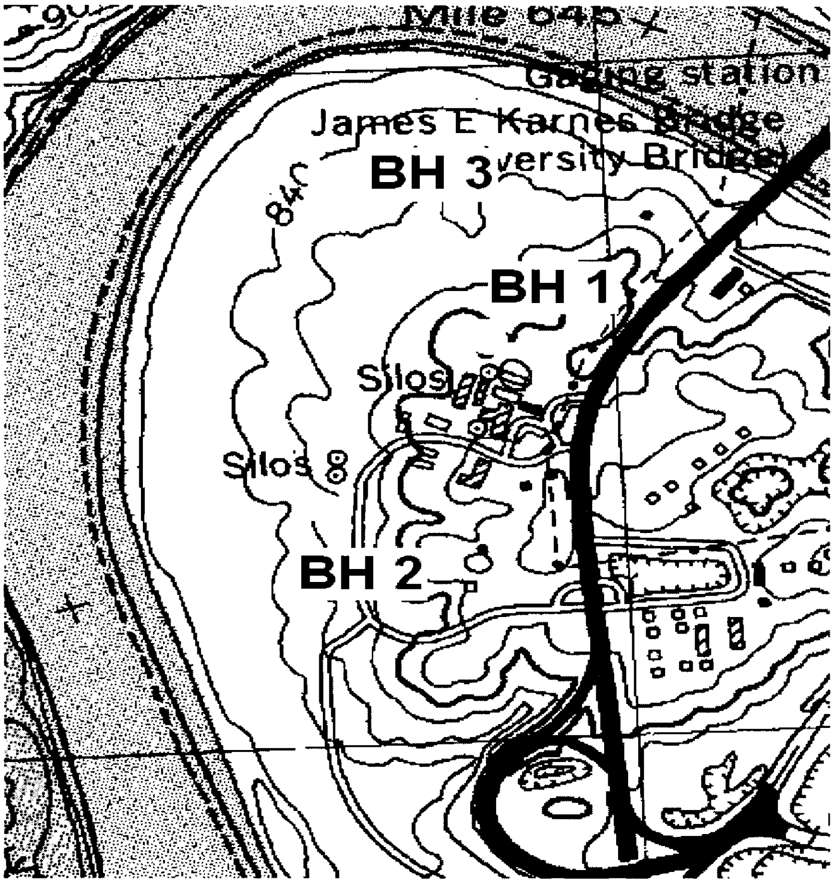


Figure A1 Borehole Location Map

Site Exploration

Alternative 1

Description: Use hollow stem auger to drill exploratory borings. At various depths, take split spoon and shelby tube samples.		
Feasibility	4	UT has a drill rig, needs to be easily accessible
Economic	5	Cost of a lunch for the operators
Information	5	Get stiffness counts, disturbed and undisturbed samples

Alternative 2

Description: Use cone penetration to examine subsurface. Records continuously up to desired depth.		
Feasibility	2	Hard to operate at consistent speed with UT drill rig
Economic	3	Requires trained operators
Information	3	Do not get samples just read out from computer

Table A1

Lab Testing Alternative 1

Description: Unconfined compression test		
Feasibility	5	Easy setup and measurement
Information	3	Provides information that needs to be interpretated

Alternative 2

Description: Tri-axial compression test		
Feasibility	2	Hard setup and training required
Information	5	Provides better information about state of soil in the ground

Alternative 3

Description: Consolidation test		
Feasibility	3	Test takes time to conduct
Information	3	Information is limited and hard to relate

Table A2

Foundation Design

Alternative 1

Description: Driven Piles		
Feasibility	4	Easy to install
Support Capabilites	4	Did not find bedrock but stiff clay soil
Economics	5	Depends on length of pile and how many

Alternative 2

Description: Drilled Shafts		
Feasibility	3	Have to drill large shafts
Support Capabilites	4	Did not find bedrock but stiff clay soil
Economics	4	Depends on number of shafts

Alternative 3

Description: Large Mat Foundation		
Feasibility	3	Have to pour foundation
Support Capabilites	3	Might experience settlement
Economics	4	Depends on amount of concrete

Table A3

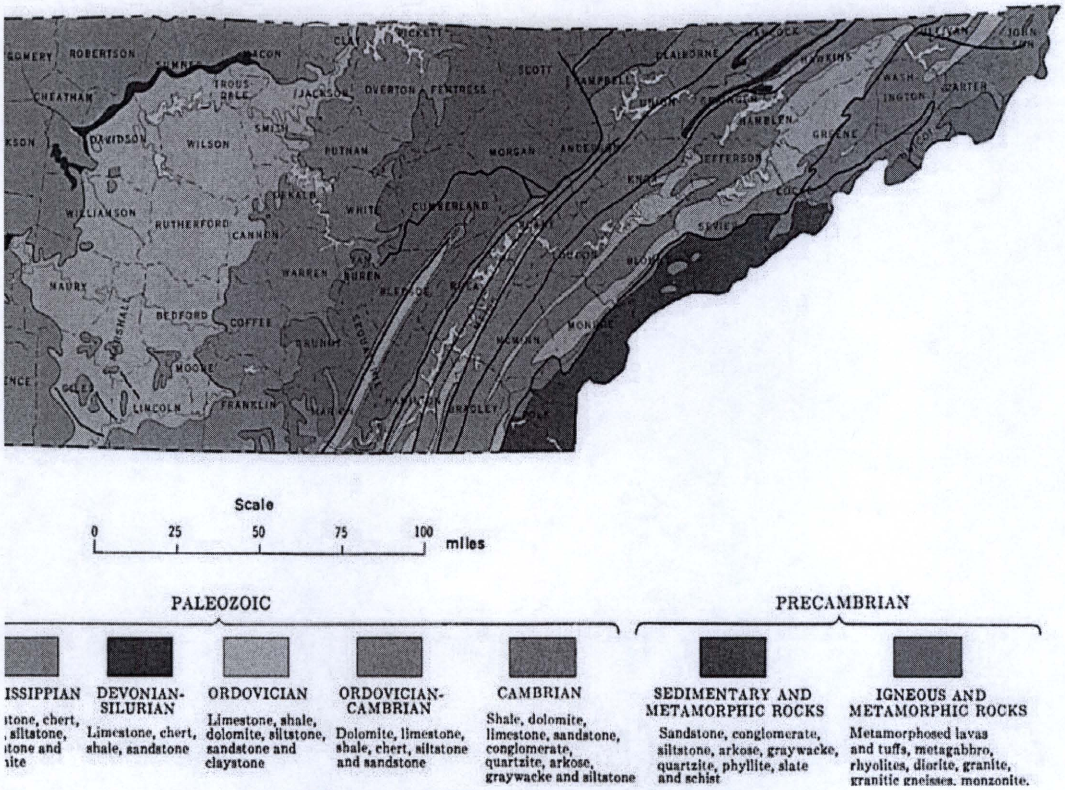


Figure A2 TN GIS Geological Map

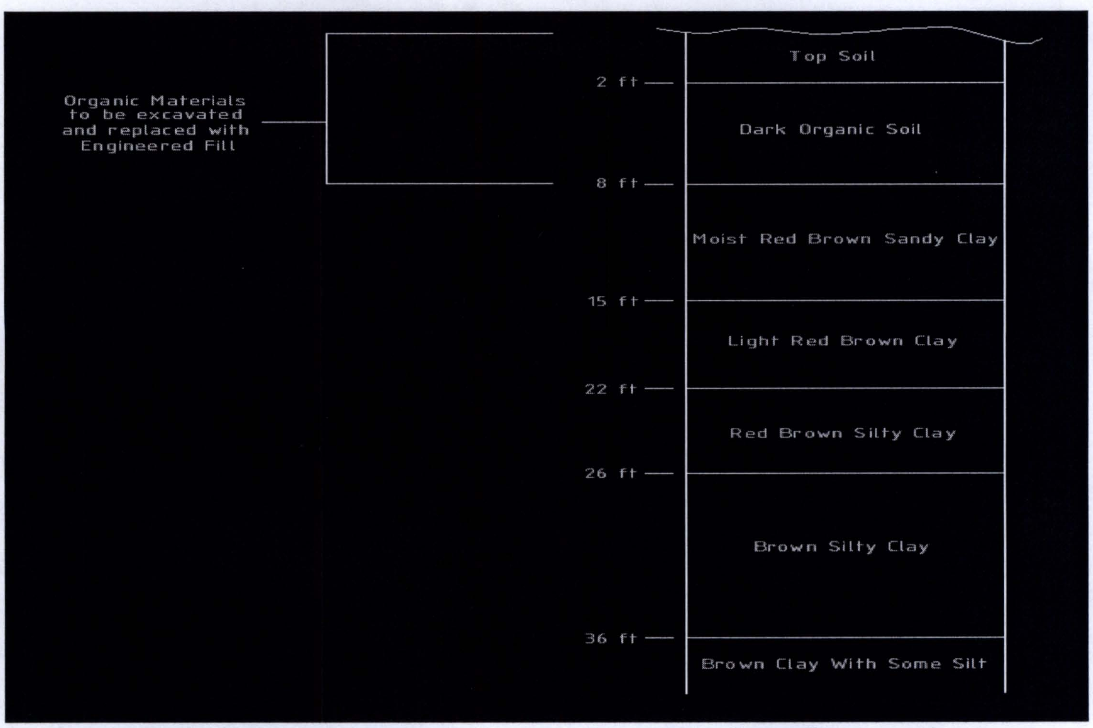


Figure A3 Borehole 1 Engineered Soil Profile

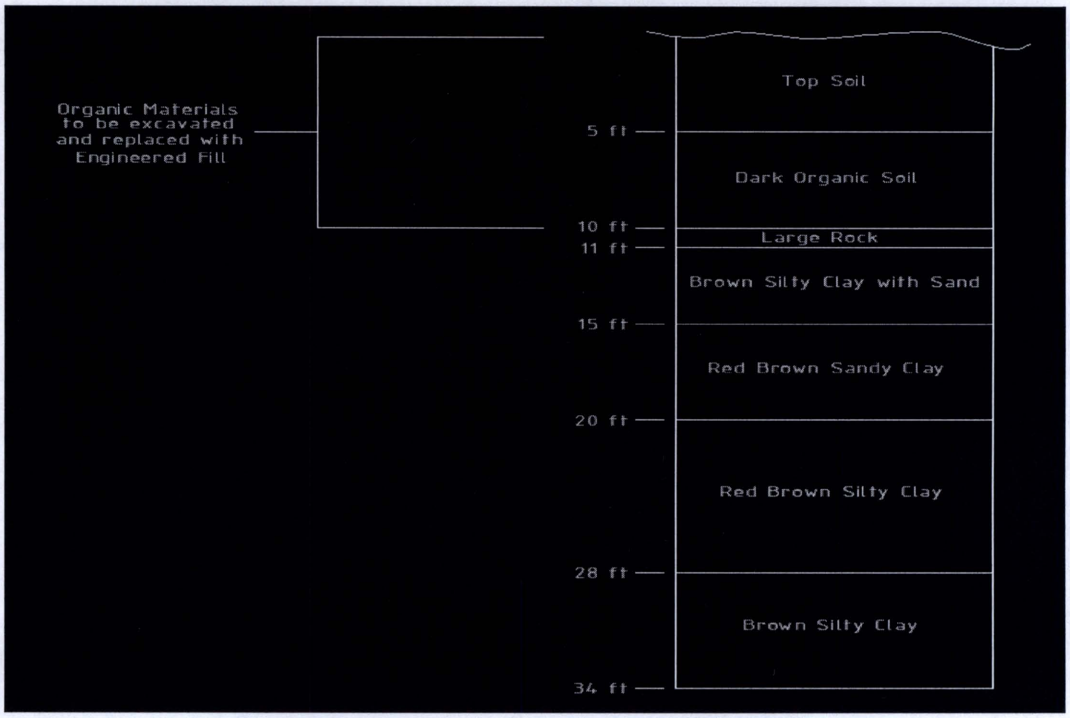


Figure A4 Borehole 2 Engineered Soil Profile

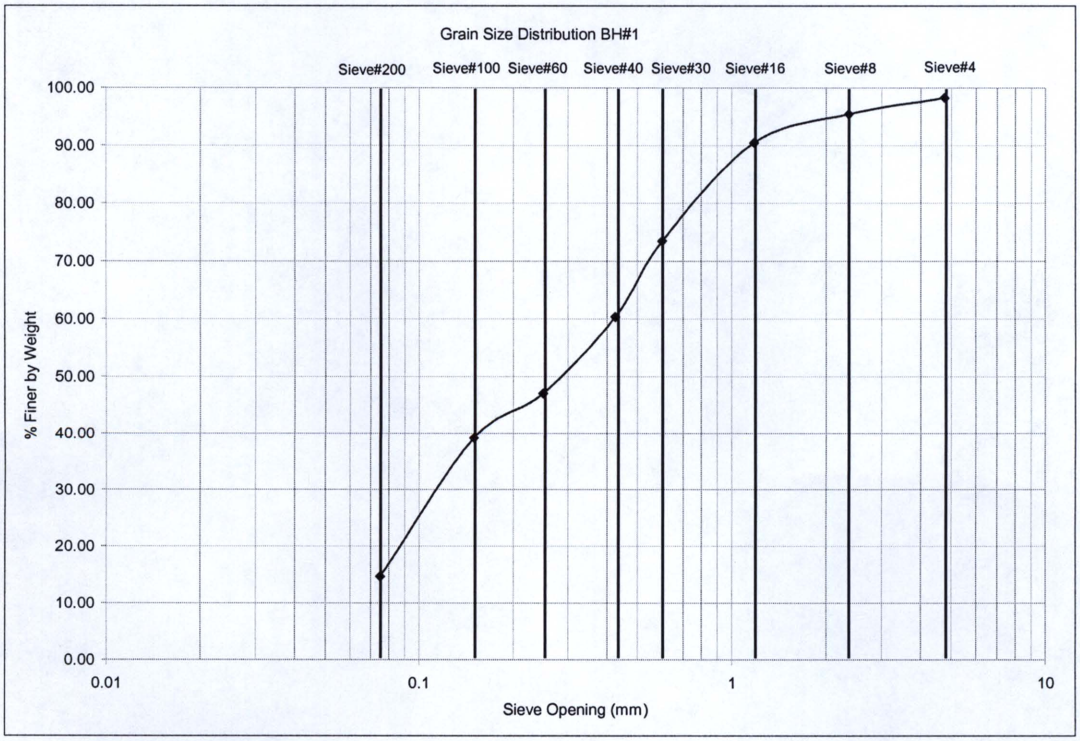


Figure A5

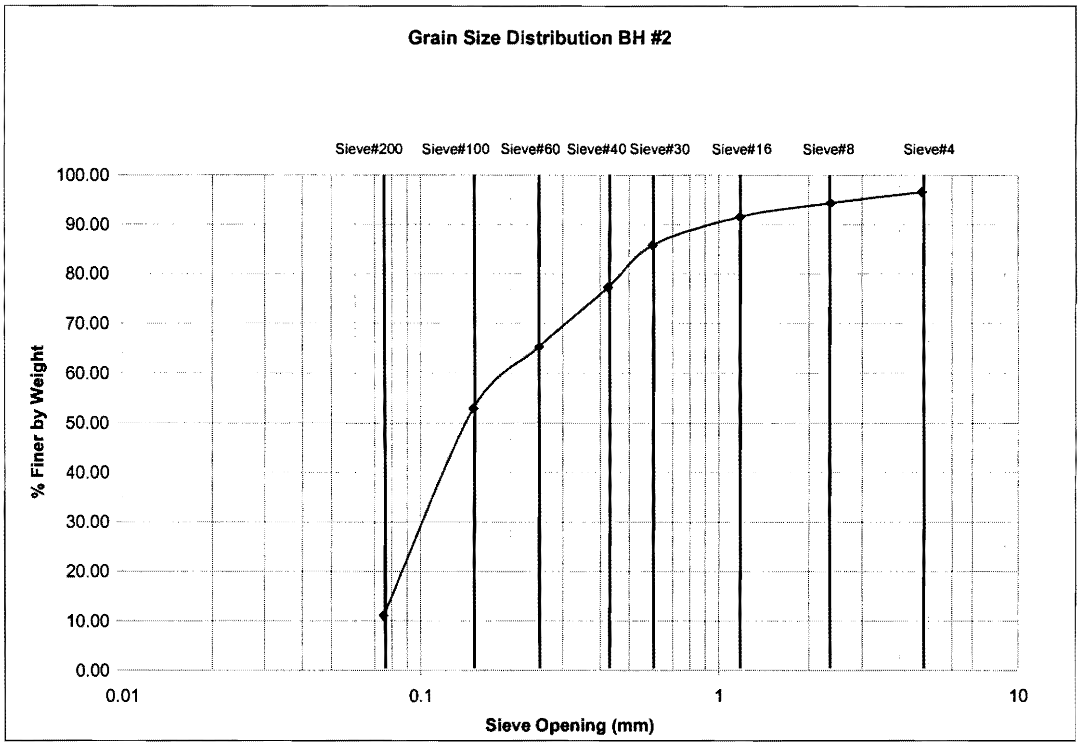


Figure A6

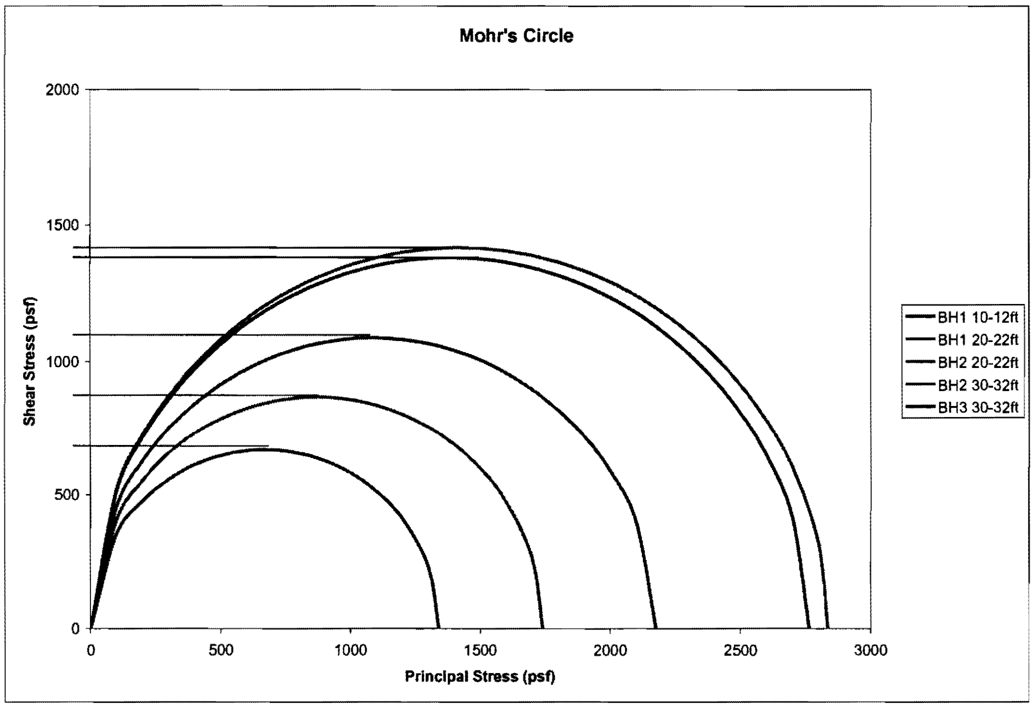
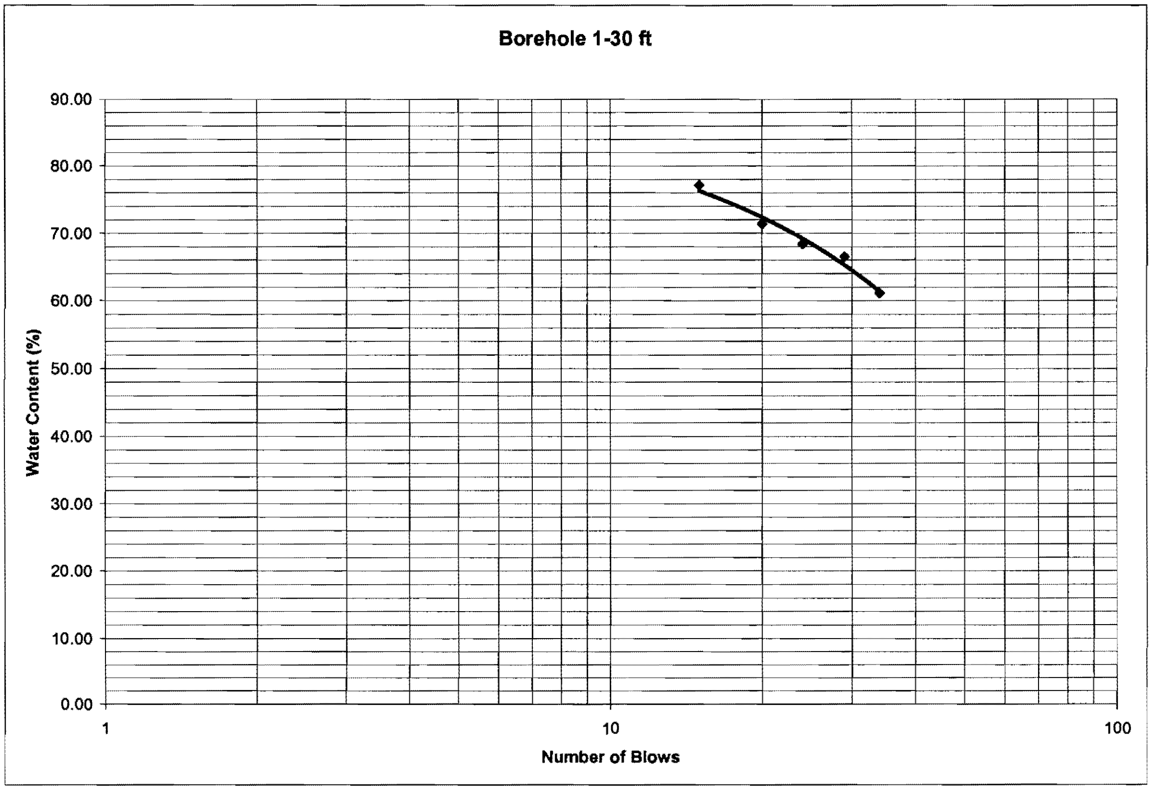


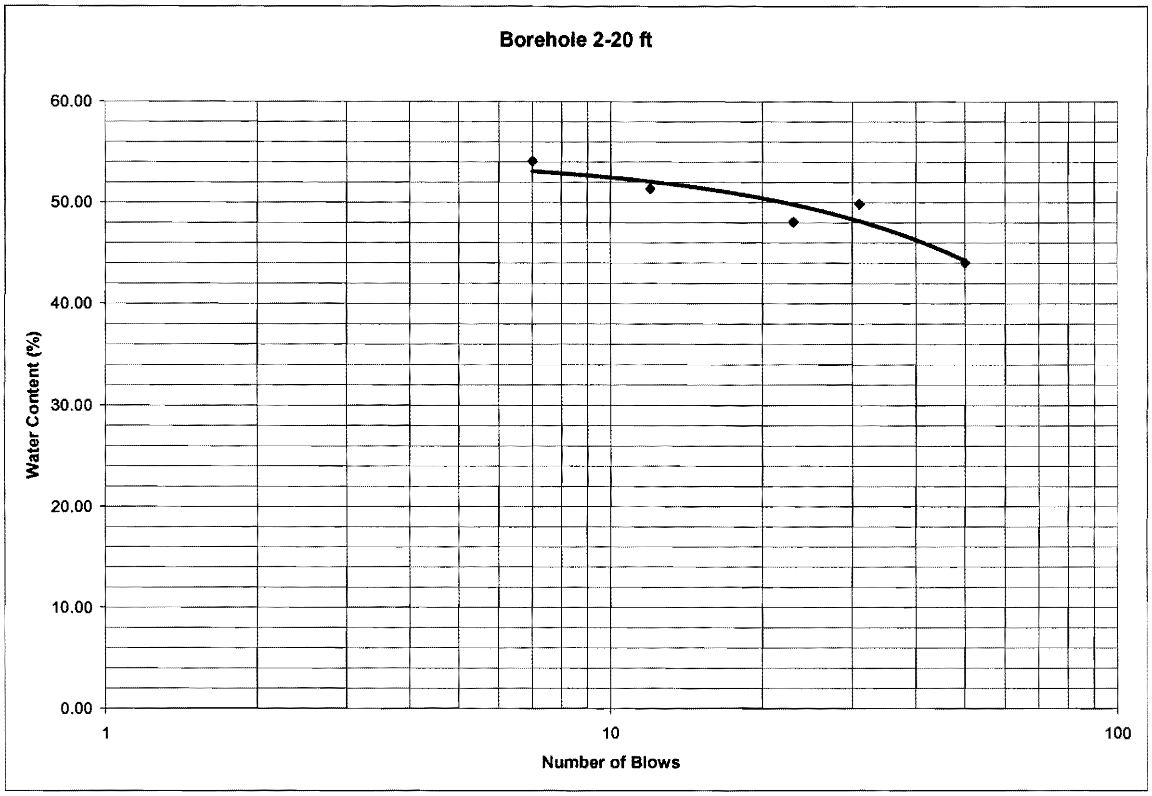
Figure A7 Shear Stress vs. Principal Stress

Bore Hole	Location	$P_{a(total)}$ kips	No. of Piles
1	Center	961	5
	Perimeter	577	3
	Corner	577	3
2	Center	943	7
	Perimeter	539	4
	Corner	404	3

Table A4 Allowable Bearing Pressure and Number of Piles



Atterberg Limits – Bore Hole 1



Atterberg Limits – Bore Hole 2

Bore Hole	Liquid Limit	Plastic Limit	Plastic Index	Soil Type
1	69	41.8	27.2	MH
2	49	36.7	12.3	ML

Soil Classification Bore Holes 1 and 2

Bore Hole	N_c	S_u	q'_t
1	8	1418	11344
2	6.5	670	4355
3	8	1088	8704

Results of Net Unit Toe Bearing resistance

Bore Hole	Depth (ft)	S_u	Alpha	f_s
1	10-12 ft	1382	0.559	772.5
1	20 - 22	1418	0.541	767.1
2	20 - 22	870	0.815	709.1
2	30 - 32	670	0.915	613.1
3	30 - 32	1088	0.706	768.1

Results of Side Friction Alpha Method

Bore Hole	Depth (ft)	S_u	Alpha	f_s
1	10-12 ft	1382	0.559	772.5
1	20 - 22	1418	0.541	767.1
2	20 - 22	870	0.815	709.1
2	30 - 32	670	0.915	613.1
3	30 - 32	1088	0.706	768.1

Side Friction of Bore Holes

Pile Diameter (ft) **2**

Layer Depth (ft)	Height (ft)	f_s	A_s	f_s*A_s	A_t	q'_t	q'_t* A_t
	4	772.5	25.13274	19416	13	11344	142552.9
14 - 20	6	772.5	37.69911	29124			
20 - 25.5	5.5	767.1	34.55752	26510			
25.5 - 35	9.5	767.1	59.69026	45791			
35-100	65	767.1	408.407	313305			
$P_{a\ (per\ pile)}$	192233	lbs					

Bore Hole 1 Pipe Bearing Pressure

Pile Diameter (ft) **2**

Layer Depth (ft)	Height (ft)	f_s	A_s	f_s*A_s	A_t	q'_t	q'_t* A_t
	4	709.1	25.13	17822	13	4355	54726.54
16- 20	4	709.1	25.13	17822			
20-29	9	709.1	56.55	40099			
29-35	6	613.1	37.70	23113			
35-100	65	613.1	408.41	250394			
$P_{a\ (per\ pile)}$	134659	lbs					

Bore Hole 2 Pipe Bearing Pressure

$$\alpha = 1 - 0.5((S_u\text{-}500\ \text{lb/ft}^2)/1000\ \text{lb/ft}^2)$$

Equation . Alpha Factor

$$f_s = \alpha * S_u$$

Equation . Side Friction for Piles

$$Pa = (q't*At + \Sigma\ Fs*As)/F$$

Equation . Allowable Bearing Pressure

Structures Appendix

Tables and Figures

Table 1: Comparison of Alternatives

Figure 3: Column Interaction Diagram

Calculations

Joist/girder Selection Tables

Slab

Beams

Columns

Shear Wall

Table 1: Comparison of Alternative designs

	Weight Factor	Alternative* 1	2	3
Price	3	2	3	1
Function	3	3	3	1
Schedule	3	1	2	3
Layout	2	2	3	3
Aesthetics	1	2	2	2
Beam Spans	2	1	1	3
Contractors	2	3	2	1
Totals		32	38	31

*Alternative 1: Concrete U-shaped structure

Alternative 2: Concrete rectangle

Alternative 3: Steel rectangle

TDEC
Storm Water Pollution Prevention Plan
for
University of Tennessee Cherokee Campus
Knoxville, TN

Prepared for:

University of Tennessee

800 Andy Holt Tower
Knoxville, TN 37996

Prepared by:

Environmental and Water Resources Division
UT Civil Engineering Senior Design
Perkins Hall
Knoxville, Tennessee, 37996

April 27, 2007

TABLE OF CONTENTS

General Information

This Storm Water Pollution Prevention Plan (SWPPP) follows the guidelines of the Tennessee General NPDES Permit (TNR100000) for Storm Water Discharges Associated with Construction Activity (TNCGP). The Environmental Division of the University of Tennessee Civil Engineering Senior Design Group has complied Best Management Practices to address storm water pollution on the proposed development site on the Cherokee Campus. This document describes the implementation of practices used to reduce pollutants in storm water related discharges from the construction of a new research facility.

As instructed by Part III.F of the TNCGP, this plan and all attachments are hereby submitted to the local Environmental Assistance Center (EAC), along with the complete, correctly signed Notice of Intent (NOI). Construction will not be initiated prior to receipt of a Notice of Coverage (NOC) from the Tennessee Department of Environment and Conservation.

Owner: University of Tennessee, Knoxville

800 Andy Holt Tower
Knoxville, TN 37996

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who mange the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Representative of Owner and Title	Signature	Date
Randall Gentry, Executive Director		

Primary Contractor: Move Dirt Excavating, Inc.
300 Somewhere St.
Knoxville, TN 37916
(865) 655-4688
Contact person: John Doe – Owner
Email: johndoe@aol.com

I certify under penalty of law that I have reviewed this document and any attachments. Based on my inquiry of the construction site owner identified above, and/or my inquiry of the person directly responsible for assembling this Storm Water Pollution Prevention Plan, I believe the information submitted is accurate. I am aware that this Plan, if approved, makes the above- described construction activity subject to NPDES permit number TNR100000, and that certain of my activities on-site are thereby regulated. I am aware that there are significant penalties, including the possibility of fine and imprisonment for knowing violations and for failure to comply with these permit requirements.

Company name of Primary Contractor	Signature	Date
Move Dirt Excavating, Inc.		

duration of the project. These items will be available for the use of all operators and site personnel visiting the site. A notice will be posted near the construction entrance(s) with a copy of the NOC with the tracking number assigned by the EAC, the name and telephone number of a contact person for the development, and a brief description of the project.

Any new contractor on the project that has any responsibility to install, inspect, or maintain erosion or sediment control measures will sign the contractor's certification on a copy of the NOI and will submit it to the local EAC. Environmental and Water Resources Division (EWR, Inc.) will submit a Notice of Termination (NOT) after the complete installation and successful establishment of the final stabilization activities on the site.

It is the intention and goal of the TNCGP and this SWPPP that any discharge from the construction site described in this document meet State Water Quality Standards for Fort Loudon Lake. The construction activity will be carried out in a manner to prevent any discharge that would cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of the waters on the property or downstream of the property for fish and aquatic life, livestock watering and wildlife, recreation, navigation or industrial or domestic water supply.

This plan may be amended. When the plans are revised, the contractor will implement the changes within 48 hours after the need for modification is identified.

Existing Site Conditions

The property consists of 196 acres located south of the University of Tennessee main campus across the Tennessee River. The property lies off of Alcoa Highway and just south of Buck Karnes Bridge. The soil found at this site is mostly classified as Waynesboro loam. For more information concerning the soil properties of the site, contact the Geotechnical Division of the Civil Engineering Senior Design Group.

The current curve numbers of the existing site conditions are outlined in the Appendix. There are not current storm drain systems on the site since the majority of the site is undeveloped due to its previous role as a dairy farm. The site, which is located along mile 644 of Fort Loudon Lake, will have no construction or disturbance within Tennessee Valley Authority's flood easement along elevation line 822 ft.

Project Description

The Cherokee Campus Research Facility consists of a 5 story building with future development space for four similar buildings, a parking garage, and a detention basin. To prepare for the new facility, grading of the site for installation of road and buildings will be completed. Demolition of the current dairy farm facilities (20 buildings total) and removal of light vegetation will be done for the allowance of the needed grading and earthwork. Approximately 109 acres will be disturbed to complete the grading and earthwork plan. According to the Notice of Intent application this will require a permit fee of $3000. Please contact the Construction Division of the Civil Engineering Senior Design Group for more information concerning the grading plan. A grading plan is also attached in the Appendix.

Each of the five buildings will have a footprint of 80 feet by 125 feet. Also, a parking facility with a footprint area of 38,130 square feet will be constructed as well. New roadways will also be constructed for access to the site. All of these will add a significant amount of impervious area to the site, which will be abated with a detention basin. This detention basin will serve as a temporary sediment retention basin until the site is fully stabilized. The basin will then be converted to serve as a storm water detention pond under the requirements of the City of Knoxville.

Additional fill material from off the site or off-site disposal of excess material is not anticipated in the grading plan. If this need is determined later, it is the responsibility of the contractor to contact EWR, Inc. to revise this SWPPP.

303(d) Special Requirements

Discharges from the project enter Fort Loudon Lake, which is 303(d) listed as being impaired by Polychlorinated biphenyls (PCBs). According to Part III.F. of the TNCGP, this plan and all attachments is being submitted to the local EAC, along with the completed NOI. In addition, project inspections will be performed by qualified personnel before anticipated storm events (or series of storm events such as intermittent showers over one or more days), within 24 hours after the end of a storm event of 0.5 inches or greater, and at least once per week. Inspections will cover, at a minimum, all disturbed areas that have not undergone final stabilization, sediment control structures, outfall points, and streams. The inspections will be conducted with the purpose of determining whether erosion prevention and sediment control measures are effective in preventing impacts to receiving waters. If during these inspections it is discovered that repair or maintenance is required of any temporary or permanent control measure, the action taken to correct the problem will be documented.

If the controls are installed and maintained correctly but are found to provide an inadequate level of protection, EWR, Inc. will make revisions to this plan and these revisions will be implemented by the contractor. The inspector will certify on a weekly basis that the inspection described above has been performed and whether or not all of the erosion and sediment control measures are installed and in working order. The record of certifications on the form will be submitted to the local EAC by the 15th of the month following the end of the quarter. Quarters are January- March, April-June, July-September, and October-December. The inspector will maintain a rain gage and a daily log of readings.

Spill and Non-Stormwater Contingencies

All fueling of equipment and vehicles used for the project must be conducted away from any wet weather conveyance and/or streams. Any spillage must be removed immediately and contaminated soils placed on heavy plastic and covered or placed into approved containers to prevent contact with storm water. All fuel tanks will be kept in a containment area. Oils, lubricants, and other vehicle fluids, paints, and solvents will be stored in a containment area as well.

If a release containing a hazardous substance in an amount equal to or in excess of a reporting quantity established under either 40 CFR 117 or 40 CFR 302 occurs during a 24-hr period, the contractor will immediately notify Jason Brady at (865) 521-6777, the National Response Center (NRC) (800-424-8802) and the Tennessee Emergency Management Agency (TEMA) (emergencies: 800-262-3300; non-emergencies: 800-262-3400); as well as the local TDEC Environmental Assistance Center.

Construction traffic, concrete trucks and other vehicles are required to wash out at an area away from all storm drains, wet weather conveyances, and streams. Each contractor is responsible for providing litter control for trash generated by any crew working on the project. The contractor must contain and dispose of paint cans, oil cans, used oil, filters, epoxy's, and related items by taking them to any approved Hazardous Waste Disposal Center.

Runoff Calculations

PondPack®, an urban hydrology and detention pond modeling software, was used to estimate pre- and post-development runoff. The calculations indicate that there will be an increase in runoff coefficient and in a peak discharge as a result of the project. Therefore, the sediment basin will be converted to a storm water basin for post-construction. Worksheets for the runoff calculations are attached in the Appendix.

Construction Sequence

1. **The Erosion and Control Plan incorporates a buffer zone consisting of silt fences and check dams to protect Fort Loudon Lake from pollution. Safety fencing around the site will also be installed to indicate construction limits.**
2. **Temporary sediment barriers will be installed down slope of the disturbance since the site slopes toward Fort Loudon Lake. Erosion prevention and sediment control best managements practices (BMP) identified in the SWPPP will be installed per the Tennessee Erosion and Control Handbook and the Knoxville BMP manual.**
3. **Land disturbing activity at the project site will begin after identifying the construction entrance and exit and the equipment/ material staging storage areas. Run-on will be safely diverted away when possible.**
4. **Excavation work will begin after site demolition activities are complete or have moved away from initial excavation areas.**
5. **Construction of the roadbed, parking, primary utilities, sidewalks, and storm drains will be initiated. The catch basin for storm water will be sealed off from storm water during excavation activities.**
6. **Storm drain inlet protection will be installed when the proposed permanent system is in place and functioning.**
7. **Sediment will be removed from the sediment traps, silt fences and other sediment controls before design capacity of the structure has been reduced by 50%.**
8. **Maintain a clean construction site by picking up litter, debris, and construction chemicals exposed to storm water and before anticipated storm events.**
9. **Stabilization will be accomplished as soon as practicable after attainment of final grade and no later than seven days after attaining final grade.**

Stabilization Plan

The Best Management Practices discussed in this SWPPP were selected based upon their effectiveness when installed and maintained properly. The BMP's for the Cherokee Campus development will consist of the following: check dams (stone), construction exit(s), diversion(s), geotextile matting, sediment basin(s), sediment trap(s), silt fence, slope drain(s), and storm drain inlet protection. The contractor as necessary shall employ the installation of additional erosion control measures based on actual project conditions, erosion control documents, and the approved SWPPP. Refer to TDEC's Erosion and Sediment Control Handbook, Latest Edition for Vegetative, Structural, and Stream Alteration Best Management Practices.

1. Minimum erosion and sediment control(s), general criteria and requirements:

   a) The construction-phase erosion and sediment controls are designed to retain sediment on site. The operators shall place stone check dams in wet weather conveyances that drain more than 1 acre. The maximum spacing between dams shall be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

   b) All control measures shall be properly selected, installed, and maintained in accordance with the manufacturer's specifications and good engineering practices. If periodic inspection(s) or other information indicates a control has been used inappropriately, or incorrectly, the contractor must replace or modify the control for specific site situations.

   c) If sediment escapes the construction site and/or easement, off-site accumulations of sediment that have not reached a stream must be removed at a frequency sufficient to minimize offsite impacts. The contractor shall not initiate remediation/restoration of a stream without first consulting the TDEC Division of Water Pollution Control. Note that this SWPPP DOES NOT authorize access to private property. It is the Contractor's responsibility to obtain the necessary permissions/approvals to access private property.

   d) Sediment will be removed from inlet sediment traps, silt fences, sedimentation ponds, and other sediment controls as necessary, and must be removed when design capacity has been reduced by 50%.

   e) Litter, construction debris, and construction chemicals exposed to storm water shall be picked up prior to anticipated storm events (e.g., forecasted by local weather reports), or otherwise prevented from becoming a pollutant source for storm water discharges (e.g., screening outfalls, daily pick-up, etc.). After use, silt fences should be removed after site has achieved stabilization or otherwise prevented from becoming a pollutant source for storm water discharges.

f) Offsite material storage areas (also including overburden and stockpiles of dirt, etc.) used solely by the contractor are considered a part of the project and shall be maintained according to TDEC regulations & guidelines.

g) Pre-construction vegetative ground cover shall not be destroyed, removed or disturbed more than 20 calendar days prior to grading or earth moving activities unless the area is seeded and/or mulched or other temporary cover is installed.

h) Clearing and grubbing must be held to the minimum necessary for grading and equipment operation.

i) Construction must be sequenced to minimize the exposure time of graded or denuded areas.

j) Construction must be phased for projects in which over 50 acres of soil will be disturbed. Areas of the completed phase must be stabilized within 21 calendar days after another phase has been initiated.

k) Erosion and sediment control measures must be in place and functional before earth moving operations begin, and must be constructed and maintained throughout the construction period. Temporary measures (overnight or weekend) may be removed at the beginning of the workday, but must be replaced prior to storm events at the end of the workday.

l) The following records must be maintained by the contractor and be available for the TDEC regulator to review:

- Dates when major grading and land disturbance activities occurred;
- Dates when construction activities temporarily or permanently cease on a portion or all of the site;
- Dates when temporary and/or permanent stabilization measures are initiated.

m) Stabilization measures must be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than seven days after the construction activity in that portion of the site has temporarily or permanently ceased. Except in the following conditions:

- Where the initiation of stabilization measures by the seventh day is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practicable.
- Where construction activity on a portion of the site is temporarily ceased, and earth-disturbing activities will be resumed in 15 days, temporary stabilization measures do not have to be initiated on that portion of the site.
- Temporary or permanent soil stabilization must be accomplished within 15 days after final grading or other earthwork. Permanent stabilization with

perennial vegetation (using native herbaceous and woody plants where practicable) or other permanently stable, non-eroding surface will replace any temporary measures as soon as practicable.

n) **Structural controls shall not be placed in sinkholes, streams, or wetlands except as authorized by a Section 404 permit and TDEC Aquatic Resource Alteration Permit.**

o) The contractor must use velocity dissipation devices at discharge locations and along the length of any outfall channel to provide a non-erosive flow velocity. This will ensure the natural, physical, and biological characteristics and functions of the soil are maintained and protected (e.g., no significant changes in the hydrological regime of the receiving water).

2. Other items requiring control:

a) No solid materials, including building materials, shall be discharged to waters of the United States, except as authorized by a Section 404 permit and/or Tennessee Aquatic Resource Alteration Permit.

b) Off-site vehicle tracking of sediments and the generation of dust shall be minimized on all projects. Sites exits must prevent the tracking of sediment, mud, or soil onto adjacent roadways.

c) Disturbed areas and areas used for storage of materials exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the plan shall be observed to ensure they are operating correctly.

d) Maintenance needs identified by inspections or other means shall be accomplished before the next storm event if possible, but in no case more than seven days after the need is identified. If maintenance prior to the next anticipated storm event is impracticable, maintenance must be scheduled and accomplished as soon as practicable.

Environmental Impact Statement
for
University of Tennessee Cherokee Campus
Knoxville, TN

Prepared for:

University of Tennessee
Knoxville, TN 37996

Prepared by:

Environmental and Water Resources Division

UT Civil Engineering Senior Design

Perkins Hall

Knoxville, Tennessee, 37996

April 19, 2007

Executive Summary

This environmental impact statement concerns the conversion of the current UT dairy farm into a series of research facilities. The property is located off Alcoa Highway, south of the UT main campus and adjacent to the UT Medical Center. The area is currently used for agricultural research and would be relocated south to accommodate new construction.

The area is developed with some existing infrastructure. Water demand will need to be expanded, while wastewater flow will be channeled into the UT Medical Center system.

The new construction would have minimal impact on the wildlife, air quality, water quality, and vegetation of the area. The greatest impacts would be on hydrology and erosion. Design Alternative III, which is use of multiple basins, is the preferred alternative

History

The UT Dairy Research and Education Center was established in 1929. Areas of research include dairy rations, breeding, genetics, water quality and dairy waste. The center maintains a milk producing herd of Jersey cows for research purposes. The center is noted for its research into the effects of nutrition upon production. UT regularly hosts field days here for dairy operators to share in new research and exchange management practices.

Existing Conditions

The area to be developed is approximately 109 acres. Because of the primary function as a grazing area, the vegetation is mostly poorly manicured grass with a few small trees. Much of the topography slopes downward towards the Tennessee River, while some slopes to Alcoa Highway.

Hydrology

The proposed development lies within the Tennessee River watershed. It is adjacent to the Goose watershed, but it will not be affected by any construction runoff. Most runoff flows towards the Tennessee River, while the remainder flows towards the nearby Alcoa Highway. The current UT Dairy Farm has no contaminants, such as TCE, that may enter the watershed during development.

Geology

The site contains no major geologic features that will impede construction, or that will be adversely affected by development. The soil type is mostly Waynesboro Loam with some Sandy Loam and Whitwell Loam closer to the waterline. Subsurface investigations did not reveal the presence of any karst formations or voids within fifteen feet of the surface that would delay development.

Wildlife

Federal law, under the provisions of Section 7 of the Endangered Species Act of 1973, requires that any construction that adversely affects the habitat of a federally endangered species be review by the USFWS. The Tennessee Wildlife and resource commission designates which species are threatened by diminishing habitat. The area to be developed currently can not support large mammals or migratory birds. Species of concern are fish and bats. Fish species will not be threatened because any hazardous materials will not enter the watershed. The area also has no karst formations (caves) so bats are not a concern.

Social Impacts

The area of the proposed research facility is owned by the University and will not adversely affect any near by residences or businesses. The largest near by population is the UT Medical Facility. Expanded utilities for the research facility will not be a burden on hospital resources. Also, transportation infrastructure modifications will not create congestion between the hospital and the facility.

Air Quality

The new research facility will have minimal impact on air quality. The main air pollutant of concern in the East Tennessee region is ozone (US EPA 2002). The facility will not produce any of the airborne contaminants that cause lower atmospheric ozone. Increased vehicle traffic will produce emissions that contribute to ozone. Furthermore, it will not produce any particulates or contaminants.

Water Quality

Water quality is of particular concern because of the proximity to the Tennessee River. There are currently no hazardous materials on the site requiring special treatment during demolition and grading of the area. The new facility will collect all hazardous materials used in research and therefore they will not enter the wastewater system.

Another major concern is oil and other vehicular fluids entering the watershed. The proposed parking garage and other parking areas will collect all rainwater runoff. Oils from this runoff will be collected in the detention basins, eliminating the need for water/oil separators in the parking area drainage.

Vegetation

There is a limited amount of vegetation on the site. There is no large or dense vegetation that will require removal prior to construction. Much of the area is cattle grazing area with poorly manicured grass. There are a few trees that line the current UT Medical Center exit ramp, but these are not impedance to new development.

Archaeology

Archeological sites within proximity to the proposed construction lie within the floodplain. Therefore, any future development will not hinder ongoing excavation.

Design Alternatives

Alternative 1- No Build

The first alternative to runoff collection is not to construct any control measures. This is a poor design consideration for several reasons. This would allow parking lot contaminants to enter the watershed and would cause public health concerns because of the near by water treatment plant. This would also cause erosion concerns. Lastly, construction without runoff control measures is illegal

Alternative 2- Wet/Dry Detention Basin

These detention basins are designed to completely empty between storm events. These basins are more effective on a smaller scale. This type of basin would have to be expanded or replaced in the event of future university expansion. This kind of basin is not as effective in removal of oils and would require further environmental controls.

Alternative 3- Multiple Detention Basins

Multiple detention basins in place of a singular large one is the preferred design alternative. This design works most effectively with the proposed grading plan and will not impede future construction. Multiple basins can provide the capacity for future expansion without a large surface area. These detention basins will utilize a fresh flush design eliminating the need for water/oil separators.

Cherokee Farm Development Site

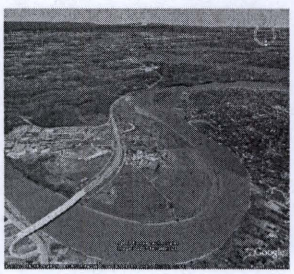
The UNIVERSITY *of* TENNESSEE
CIVIL & ENVIRONMENTAL ENGINEERING
SENIOR DESIGN PROJECT – Spring 2007
Project Manager – Dr. Randy Gentry, P.E.
Team Leaders

Construction and Planning – James Vaughn
Transportation – Brian Haas
Geotechnical – Matthew Redmond
Structural- Joey Barbeauld
Environmental – Paul Steele

Project Introduction

- Part of UT's Master Plan
- Additional Campus
- State of the art research facilities

Project Site



Project Scope

- Develop UT Dairy Farm Site
  - 50,000sq ft research facility with site work for four future buildings
  - Alleviate overcrowding on main campus
  - Continue Campus Greenway South

Construction and Planning

James Vaughn, Sam Graham, Chun Yip Chan,
Landon Smelcer, Kevin Crumley, Joe Haddix, Brack Brown

•PROJECT: Cherokee Farms Site Development
•LOCATION: UT Dairy Farm Knoxville, Tennessee

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Project Scope

- Site Plan
- Demolition Plan
- Construction Staging Plan
- Grading Plan
- Estimates and Take-offs

Site Layout

- Goals
  - Follow Campus Master Plan
    - Maximize green space
    - Eliminate surface parking lots and on-street parking
    - Develop well-defined pedestrian interconnections
    - Promote use of internal transit system

Zoning

- Currently A-1
- Needs to be changed to BP-1

Site Layout

Alternative 1

- **Pros**
  - Very Aesthetic
  - Low Earthwork Requirements
  - Low Impact on Future Development
- **Cons**
  - Inefficient Land Use

Site Layout

Alternative 2

- **Pros:**
  - Highly Accessible
  - Very Aesthetic
- **Cons:**
  - Subsurface Constraints
  - Poor Earthwork Requirements
  - Near flood plain

Site Layout

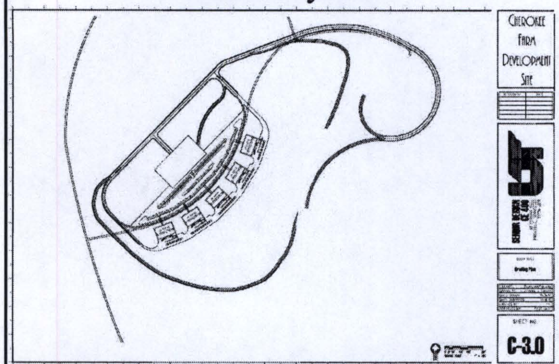
Alternative 3

- **Pros:**
  - Efficient use of land area
  - Good Accessibility
- **Cons:**
  - Poor earthwork requirements
  - High impact on future developments

Design Alternative Matrix

Item	Category	Weight (1-11)	Category Weight	Alternative Score (1-5)		
				Option 1	Option 2	Option 3
A	AESTHETICS		3			
	1. Green Space			4	4	3
	2. Site/Building Layout			5	5	4
B	CONSTRUCTIBILITY		1			
	1. Earthwork Requirements			5	3	2
	2. Subsurface Constraints			4	3	3
	3. Design Complexity			4	4	4
	4. Building Location			5	4	3
C	ECONOMICS		2			
	1. Efficient Land Use			3	3	4
	2. Sustainability					
	3. Less Impact on Future Development			5	4	2
D.	LOGISTICS & TRANSPORTATION		4			
	1. Site Access			4	5	4
	2. Site Orientation and Layout			5	5	4
			Total:	44	40	33

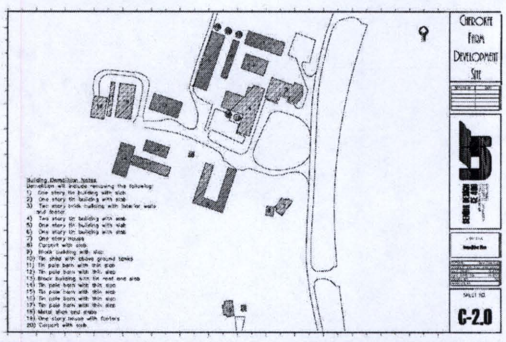
Site Layout



Demolition Plan

- Printed off GIS aerial view and visited site
- Twenty existing buildings
- Detailed list can be found in the appendix of the Project report and the Drawing Packet.

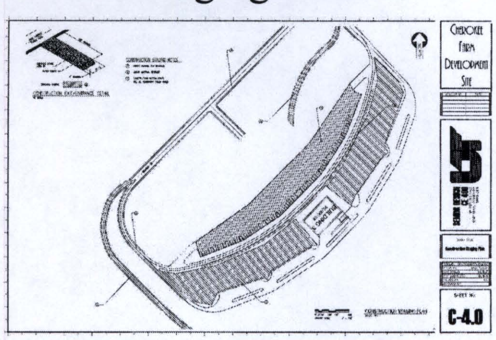
Demolition Plan



Staging Plan

- Establish areas to park during construction
- Also areas for on-site material storage.

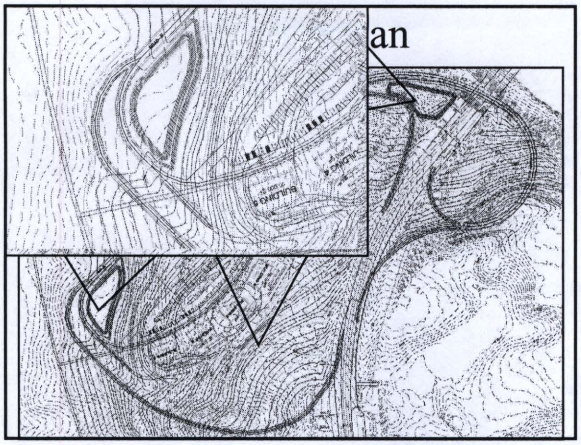
Staging Plan



Grading Plan

- Try to match Cuts and Fills.
- 822ft elevation boundary
- Allow for drainage away from buildings
- 2 detention ponds

an



Transportation

Allen Cheng, Brian Haas, Omari Hand, Joe Hull, Steve Pushkarou, Sharion Smith, Joyce Wells, Chris Williams

•PROJECT: UT Dairy Farm

•LOCATION: Knoxville, Tennessee

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SENIOR DESIGN PROJECT – Spring 2007

Overview

- Site Access
- Parking
- Greenway

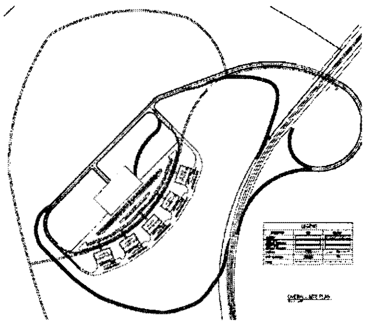
Alcoa Highway Interchange

- Use of UT Medical Center Interchange
  - Confusing as is
  - High traffic volume at peak hours

Alcoa Highway Interchange

- Separate Interchange
  - More land use
  - Less traffic disruption
  - Less confusing

Onsite Roads



- One-way clockwise loop
  - Minimizes traffic control devices
- 12-ft lanes with 4-ft shoulders
- Asphalt Pavement

Parking

- Parking Garage used
- Modeled after 11th Street Garage
- 5 levels, roughly 1,000 parking spaces

Greenway

- 10-ft width
- Follows perimeter of site
- Branch with access to facility

Geotechnical Team

Matthew Redmon, Elizabeth Carls, Daniel Newton, Julius Smith, Michael Hogan, Luke Newman, Matt Allen

•PROJECT: UT Dairy Farm

•LOCATION: Knoxville, Tennessee

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SENIOR DESIGN PROJECT – Spring 2007

Project Statement

- Proposed site for development is the University of Tennessee Dairy Farm
- Construct a 50,000 square foot research facility with space to add four additional facilities
- Access roads will connect with Highway 129 and parking areas for faculty and students will be on-site
- Dr. Randall Gentry requested the geotechnical team to analyze the soil conditions and design a foundation for the new research facility
- The proposed site is to be graded according to the planning and construction committees grading plan

Evaluation Matrix

- An evaluation matrix was created to determine the method of sampling, lab testing, and foundation design
- The team decided to use the Civil Engineering Department's drill rig to drill the boreholes with a hollow stem auger
- Because of its simplicity, the unconfined compression test was used to determine the strength parameters of the soil
- Driven pipe piles were used as the foundation due to the soil type and their ability to support large loads.

Evaluation Matrix- Site Exploration

Alternative 1

Description: Use hollow stem auger to drill exploratory borings. At various depths, take split spoon and shelby tube samples.

Feasibility	4	UT has a drill rig, needs to be easily accessible
Economic	5	Cost of a lunch for the operators
Information	5	Get stiffness counts, disturbed and undisturbed samples

Alternative 2

Description: Use cone penetration to examine subsurface. Records continuously up to desired depth.

Feasibility	2	Hard to operate at consistent speed with UT drill rig
Economic	3	Requires trained operators
Information	3	Do not get samples just read out from computer

Evaluation Matrix- Lab Testing

Alternative 1

Description: Unconfined compression test

Feasibility	5	Easy setup and measurement
Information	3	Provides information that needs to be interpretated

Alternative 2

Description: Tri-axial compression test

Feasibility	2	Hard setup and training required
Information	5	Provides better information about state of soil in the ground

Alternative 3

Description: Consolidation test

Feasibility	3	Test takes time to conduct
Information	3	Information is limited and hard to relate

Evaluation Matrix- Foundation Design

Alternative 1

Description: Driven Piles

Feasibility	4	Easy to install
Support Capabilites	4	Did not find bedrock but stiff clay soil
Economics	5	Depends on length of pile and how many

Alternative 2

Description: Drilled Shafts

Feasibility	3	Have to drill large shafts
Support Capabilites	4	Did not find bedrock but stiff clay soil
Economics	4	Depends on number of shafts

Alternative 3

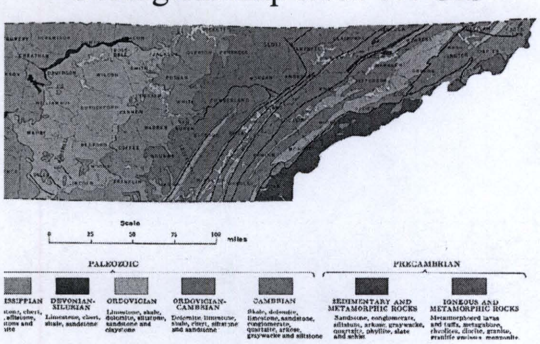
Description: Large Mat Foundation

Feasibility	3	Have to pour foundation
Support Capabilites	3	Might experience settlement
Economics	4	Depends on amount of concrete

Site Reconnaissance

- Began research by investigating previous geotechnical reports and geological maps
- Because the area was dedicated to farming with a few lightly loaded structures, previous geotechnical reports were not found for the site
- The soil is composed of a combination of limestone, dolomite, shale, chert, siltstone, and sandstone
- Most of the land is used for pastures and agriculture, therefore the top layer of the soil is highly organic

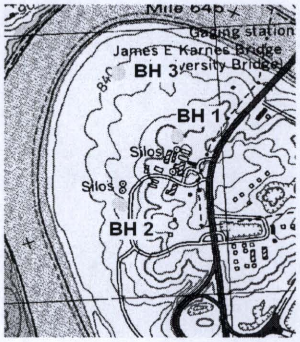
Geological map from TN GIS



Drilling

- To get a better representation of the sub-surface soil profile, our group must drill boreholes at various locations
- After consulting with Dr. Eric Drumm, we decided to drill three boreholes at key locations on the site
- We marked locations on the top, middle, and lower portions of the site to be drilled
- The top area of the site, BH1, was chosen because most of the development will take place in this area
- Because the semi-circle building layout extends to the middle portion of the site, we decided to drill BH2 corresponding to the outer building

Borehole Locations



Sampling

- With the assistance of Larry Roberts, Josh Baines, and the Civil Engineering Department's drill rig, our team set out to drill the boreholes
- Each hole was drilled with a hollow stem auger to a depth of 35 feet and samples were taken at various depths
- We collected two Shelby tube samples from each hole along with several split spoon samples to obtain N values

Borehole #1

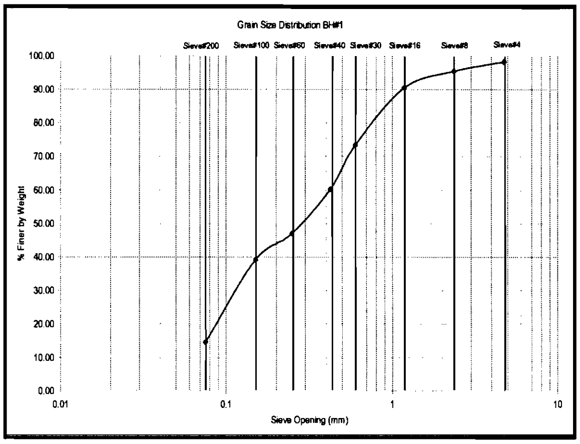
- Soil Description- Brown sandy clay at shallow depths, changes to reddish-brown silty clay at deeper strata
- Split spoon samples were taken at 15 feet and 35 feet, N values obtained were 8 and 7
- At 15 feet the soil is considered firm
- At 35 feet the soil is considered firm
- 3" shelby tube samples taken at 10 feet and 20 feet

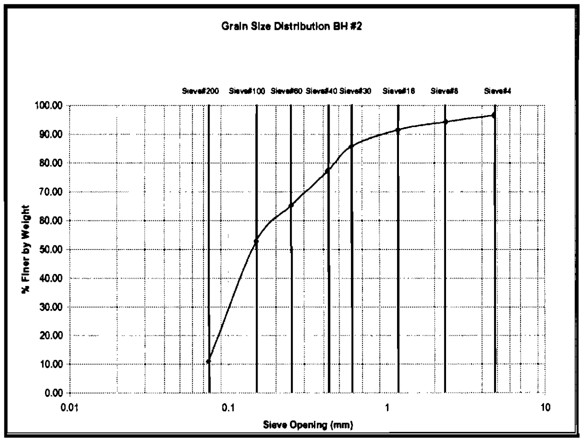
Borehole #2

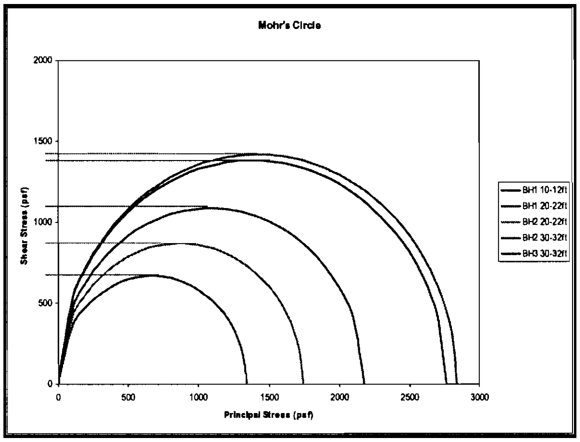
- Soil Description- Brown sandy clay at shallow depths, changes to reddish-brown silty clay at deeper strata, at 10 feet chert and limestone were found
- Split spoon samples were taken at 15 feet and 35 feet, N values obtained were 22 and 6
- At 15 feet the soil is considered very stiff
- At 35 feet the soil is considered firm
- 3" shelby tube samples taken at 20 feet and 30 feet

Lab Testing

- The disturbed soil samples were analyzed to determine unit weight and classification
- The unit weight of the soil ranged from 17.5 kN/m^2 to 19 kN/m^2
- A sieve analysis with wash 200 and an Atterberg limits test classified the soil according to USCS
- Borehole 1 is a high plasticity silt, MH
- Borehole 2 is a low plasticity silt, ML
- Unconfined compression tests were performed on the undisturbed Shelby tubes samples
- The undrained shear strength is 1400 psf for Borehole 1 and ranges from 670-870 psf for Borehole 2







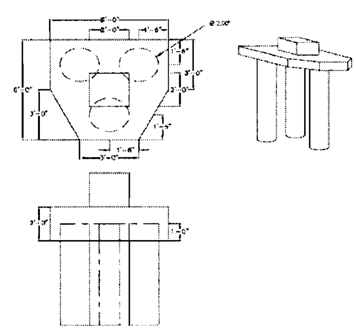
Foundation Design

- In order to handle the large loads and vibrations caused by testing equipment, the geotechnical team decided to use a deep foundation
- Driven steel pipe piles, PP24x1.00, were chosen because they can support the large loads and can be driven to deep depths
- The tip bearing capacity was found to be 11,300 psf for BH1 and 4400 psf for BH2
- The side friction between the pile and the soil was determined using the alpha method
- In the upper area of the site which consisted of high plasticity silt, a friction value of 770 psf was obtained
- For the middle portion containing low plasticity silt, a friction value of 660 psf was calculated

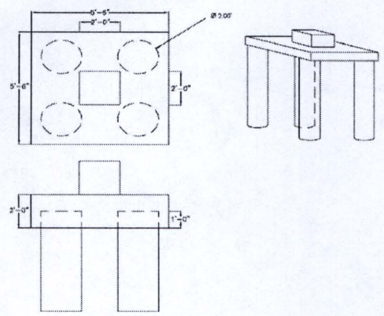
Foundation Design

- For the upper area of the site, BH 1
  - Typical center column-group of five piles are required
  - Corner column-group of three piles are needed
  - Perimeter column-group of three piles are required
- For the middle area of the site, BH 2
  - Typical center column-group of seven piles are required
  - Corner column-group of three piles are needed
  - Perimeter column-group of four piles are required
- Each pile has a diameter of two feet and will be driven to a depth of 100 feet or bedrock
- At 100 feet, the pile can be supported by both tip bearing and side friction
- If stable bedrock is reached first, driving can be terminated

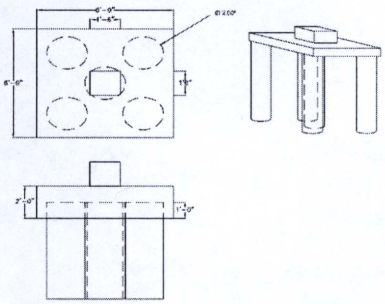
Three Pile Foundation



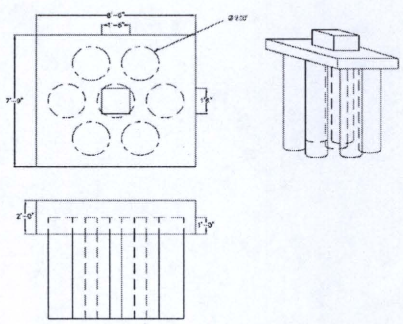
Four Pile Foundation



Five Pile Foundation



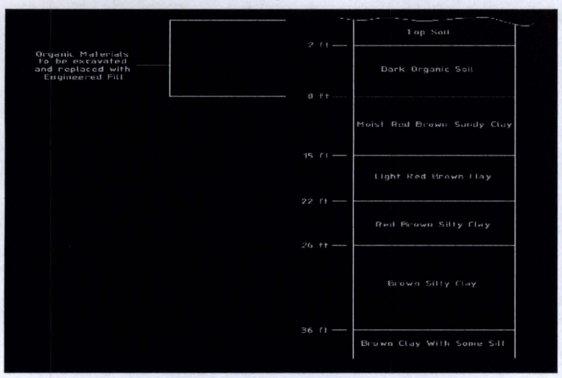
Seven Pile Foundation



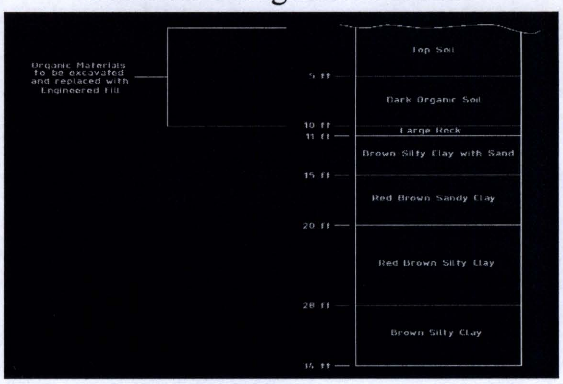
Recommendations

- The proposed site is located on an old dairy farm resulting in a large amount of organic soil
- Because organic soil does not have a high soil strength, it will have to be removed and replaced with engineered fill
- The organic soil may cause large amounts of settlement over time leading to potential structural and aesthetic problems
- The research facility is to be built on a driven pile foundation
- Because of the high friction strength of the soil and the presence of karst topography, the geotechnical team feels that the piles will provide the best support for the large structure.

Borehole 1 Engineered Profile



Borehole 2 Engineered Profile



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Coduto, Donald. Foundation Design: Principles and Practices. Upper Saddle River, NJ. Prentice Hall, 2001.

Coduto, Donald. Geotechnical Engineering: Principles and Practices. Upper SaddleRiver, NJ. Prentice Hall, 1999.

Geosystems Boring Software

The Structures Group

Sherry Ault, Joey Barbeauld, Matt Goranson, Brad Simpson, Brett Skyllingstad, Tyler Williams

•PROJECT: UT Dairy Farm

•LOCATION: Knoxville, Tennessee

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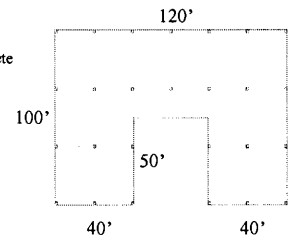
CIVIL & ENVIRONMENTAL ENGINEERING
SENIOR DESIGN PROJECT – Spring 2007

Scope of Work

- Design a new lab facility
  - Specifications
    - 5 story building
    - 50,000 ft^2 floor space
- Prepare all structural drawings

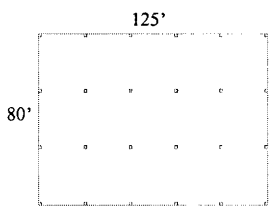
Design Alternatives

- Alternative 1
  - Materials:
    - Reinforced Concrete beams, slabs, columns, and roof
  - Layout
    - U Shaped



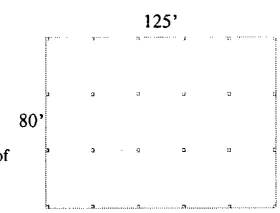
Design Alternatives

- Alternative 2
  - Materials:
    - Reinforced Concrete beams, slabs, and columns
    - Pre-fabricated Joists/Girders on roof
  - Layout – Rectangle



Design Alternatives

- Alternative 3
  - Materials:
    - Structural Steel columns and beams
    - Concrete slabs
    - Pre-fabricated Joists/Girders on roof
  - Layout – Rectangle



Design Selection Criteria

Category	Description
Price	Total cost of materials and construction
Function	Minimize vibrations and maximize lab space
Schedule	Constructability, speed of construction, time constraints
Layout	Interior layout and lab space
Aesthetics	Exterior look of materials
Beam spans	Steel vs. Concrete
Contractors	Availability and number of competitors

Design Selection

	Weight Factor	Alternative 1	Alternative 2	Alternative 3
Price	*3*	2	3	1
Function	*3*	3	3	1
Schedule	*3*	1	2	3
Layout	*2*	2	3	3
Aesthetics	*1*	2	2	2
Beam spans	*2*	1	1	3
Contractors	*2*	3	2	1
Totals		32	**38**	31

Why Concrete?

"Cast-in-place concrete has natural characteristics and mass advantages for vibration reduction"

Quoted From:

UNMC Durham Research Center
http://www.unmc.edu/durham/unique.htm
Screen clipping taken: 2/8/2007, 10:49 PM

Why Concrete?

"Constructed of concrete rather than steel to minimize vibrations for lab equipment…"

Quoted From:

Resources: Fall 2000
http://www.cahe.nmsu.edu:16080/pubs/resourcesmag/fall00/futurebld.html
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Why Concrete?

"Additionally, many biotech tenants want a facility with low vibration characteristics. Again, concrete works well for this application…"

Quoted From:

NAIOP's Development Magazine - Special Section Article
http://www.naiop.org/developmentmag/specialsections/200502index.cfm
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Occupancy

- ~50 people per floor
- 250 total occupancy
- Business Occupancy Group B Laboratory Use (nonhazardous)

Loads

Given Loads
- 1 Ton point load on bottom floor for a tank
  (Location to be determined)
- 1 Ton evenly distributed load throughout bottom floor for maintenance equipment

General Loads

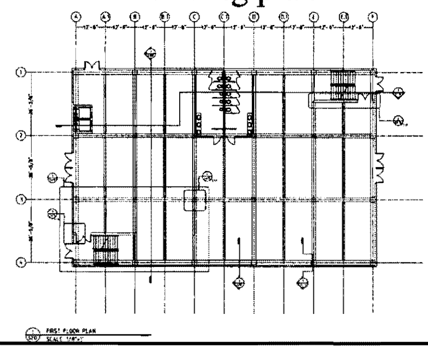
Partitions Dead Load	20psf
Live Load	60psf
Roof Live Load	12psf
Roof Dead Load	10psf
Snow Load	10psf
Wind Live Load	14.9psf

Load information taken from:
Standard Building Code, 1997 Edition (Used by Knoxville, TN)

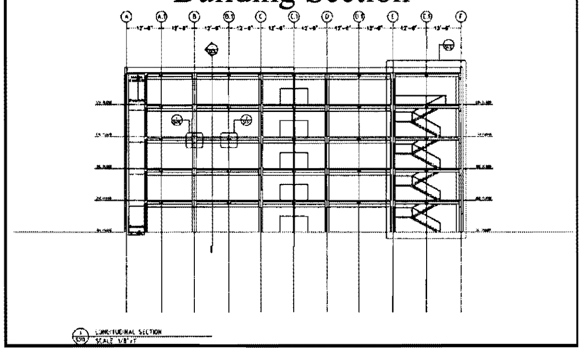
Design Components

- Slab
- Concrete beams
- Concrete girders
- Roof frame system
- Columns
- Shear walls

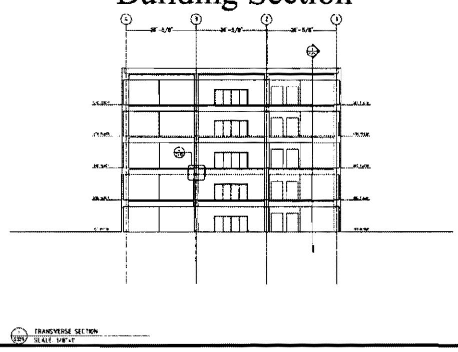
Building plan



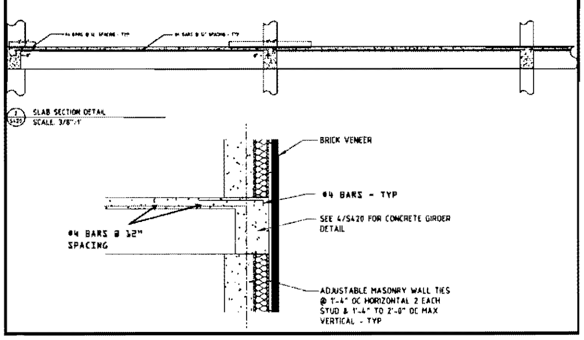
Building Section



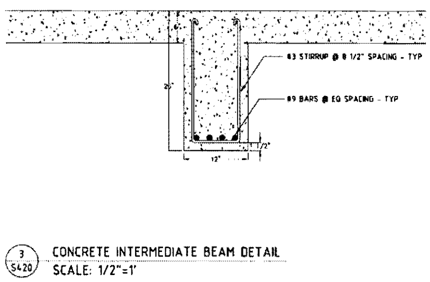
Building Section



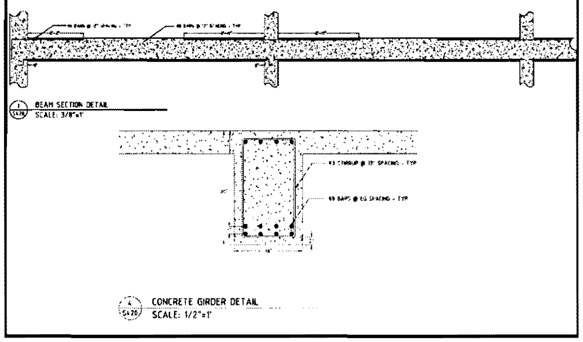
Slab



Concrete beam



Concrete Girder



Roof

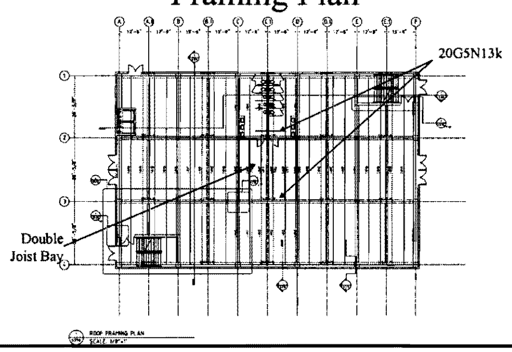
Roof Top Unit

- 16LJ 14 by Carrier
- Capacity: 135 tons (125 tons required)
- Dimensions: 148"x 51"
- Weight: 12,200lbs.
- Location: center of roof

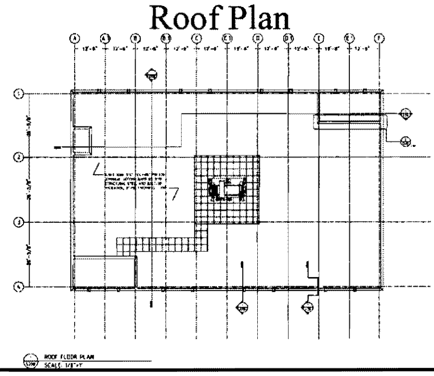
Roof

- Joists
  - 14H5
  - Double joists under unit
- Girders
  - 20G5N7k
  - 20G5N13k (Under unit)

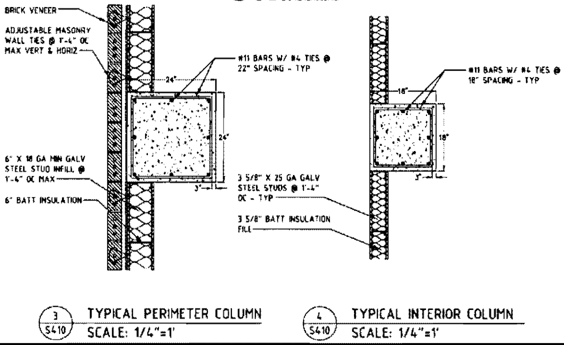
Framing Plan



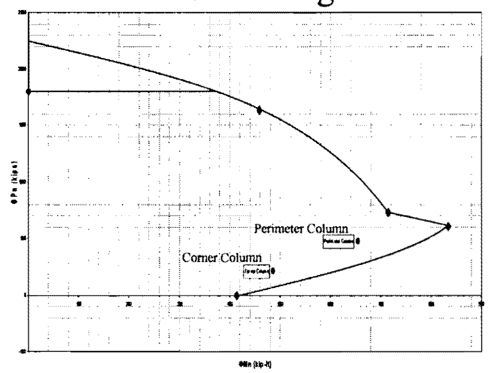
Roof Plan



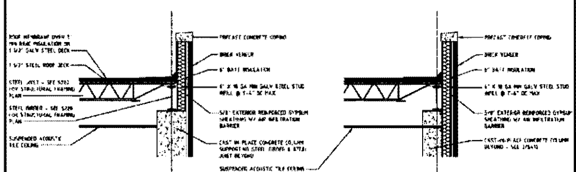
Column



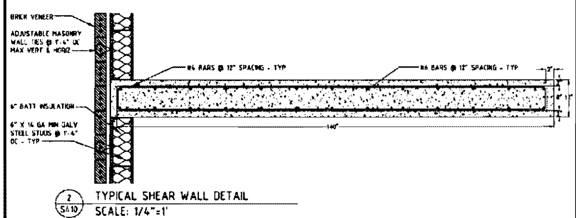
Interaction Diagram



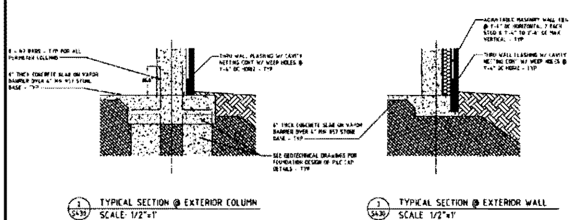
Steel Joist



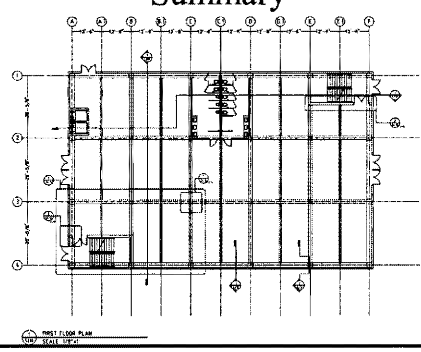
Shear Wall



Foundation



Summary



Environmental and Water Resources

Paul Steele, Tom Zimmerman, Heather Hill, Susan DeLand,
Larry Dockery and Jon Hagy

- PROJECT: UT Dairy Farm
- LOCATION: Knoxville, Tennessee

The UNIVERSITY *of* TENNESSEE
CIVIL & ENVIRONMENTAL ENGINEERING
SENIOR DESIGN PROJECT – Spring 2007

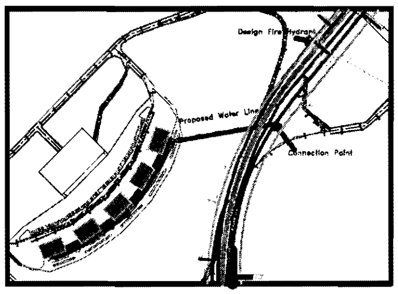
Objectives

- Provide water and wastewater to the site
- Control erosion and sediment runoff
- Detain stormwater
- Evaluate environmental impact

Water Design

- Existing facilities include a 16" transmission line, 3 hydrants, and small connector lines.
- Daily water demand – 25,000 gpd
- Fire flow demand (with sprinklers) – 2,500 gpm
- Minimum fire flow pressure – 20 psi
- Recommendation – 1,400 lf of 8" polyvinyl chloride pipe added to connect all buildings.

Water Diagram

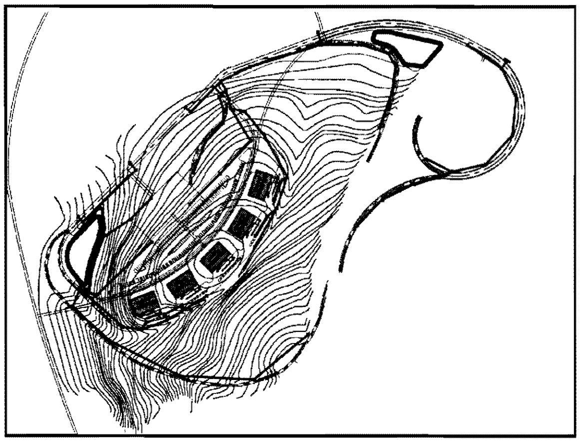


Wastewater Infrastructure

- Existing buildings deliver wastewater to UT Hospital by a small line, flow is then pumped to KUB's line and then siphoned across the Tennessee River to be treated.
- Wastewater demand – 25,000 gpd
- Capacity Assurance Program with KUB has assured ample capacity for our facility
- Design considerations – minimum velocity for force main is 2 fps
- The amount of flow for the facility will not create enough velocity, therefore developing a force main is not feasible
- Recommendation - Cherokee Research Facility should connect to UT Hospital's pump station using the existing facilities.

Drainage

- The site is divided into two watersheds.
- We are using a curb and gutter system to collect stormwater off of the roads.
- The sewers were designed for a 25 year storm.
- The sewers are all reinforced concrete pipe, most of which is 18".

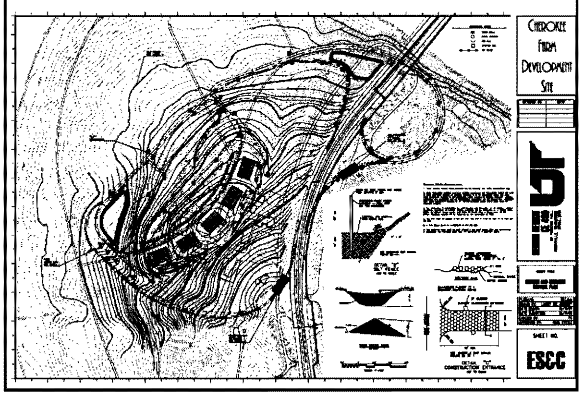


Stormwater Detention

- The site has two detention ponds to detain the stormwater.
  - North pond:
    - 6ft deep, .8 acre foot print
  - South pond
    - 6 ft deep, .76 acre footprint
- We are using a first flush design to clean the stormwater as it exits the ponds.

Erosion and Sediment Control

- The two detention ponds will be utilized as sediment basins during construction.
- Silt fence is to be installed per plan.
- Construction entrances and check dams also utilized to control sediment.



Environmental Impact

- Facility will not produce any significant water or air pollution
- Only pollutants will be vehicular emissions
- Parking lot runoff will be collected by detention basins
- Any hazardous material produced by facility will not enter watershed or wastewater system
- Area contains no threatened or endangered species
- New construction will not disturb existing archeological sites
- Excavation will not require removal of large trees or vegetation

Estimates

- Demolition - $115,000
- Grading - $1,012,000
- Foundation - $2,102,000
- Structure - $737,000
- Roadways - $741,000
- Environmental – $555,3000

Estimates

Total – $5.9 million

Disclaimer – total does not include finishing for the structure(i.e. HVAC, electrical, windows, doors, etc.)

Questions?