Technical Memorandum

Subject: University of North Carolina at Pembroke Master Plan Memorandum
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Date: June 28, 2011

I. INTRODUCTION AND PURPOSE

The University of North Carolina at Pembroke (UNCP) is located in Robeson County, North Carolina on a 151 acre campus. The current enrollment at UNCP is approximately 6,900 students. UNCP is currently in the process of updating the campus master plan which will be utilized to guide future development on the campus.

This master plan technical memorandum (memo) evaluates the stormwater, water, sewer, and information technology (IT) infrastructure of the campus. The memo is based on information that UNCP has currently provided to Dewberry & Davis, Inc. (Dewberry). No additional field investigations or analyses have been performed as part of this memo. Dewberry met with Mr. Steve Martin AIA, UNCP Assistant Vice Chancellor of Business Affairs/Facilities Management, on April 19, 2011 and June 15, 2011 to review known issues and limited information. Current drawings of the campus utilities, record drawings of various campus improvements, fire flow data, and sewer lift station data and associated permits will be provided to Dewberry by UNCP in the future.

The purpose of the memo is to provide UNCP with existing utility conditions and issues associated with potential campus expansion. Additionally, recommendations and policy suggestions for future studies and efficiency opportunities are included. Preliminary planning level recommendations for improvements to the stormwater, potable water, sanitary sewer, and IT standards have been evaluated.

II. OVERVIEW

Stormwater infrastructure and nuisance flooding are significant issues. The master plan addresses these issues with additional landscaped areas, swales, rooftop water management, and reforestation. There may be capacity for expansion in potable water, sanitary sewer, and IT. However, for all systems, additional studies are needed to properly assess the condition and capacity of existing infrastructure. Specific recommendations are described in section IV.

III. EXISTING UTILITY SYSTEMS AND ISSUES

a. Stormwater

UNCP operates and maintains the stormwater infrastructure within the UNCP campus. According to documented reports and visual observations from staff, the campus is frequently experiencing "nuisance" flooding. The flooding has occurred in various areas on campus, with the most extreme cases located near Faculty Row and Oak Hall.

It is our understanding that UNCP currently addresses stormwater volume and quality control on an individual project basis. Best Management Practices (BMPs) have been implemented on the most recent construction projects. Certain additional measures, like adding underground storage, have been put in place to alleviate flooding. It is also our understanding the UNCP does not currently have a stormwater master plan in place.

Stormwater drainage generally flows west to east across campus. West of campus, stormwater drainage is collected in various culverts and channels, and piped under University Row and through campus. East of campus, stormwater outfalls under Odum Road into a series of channels, eventually flowing to Bear Swamp. Bear Swamp has a typical ground surface elevation of 162 feet. The typical ground surface elevation on campus is approximately 172 feet. The delineation of the existing drainage basins in included in Exhibit A.

From field observation, it is apparent that the downstream channels are not maintained on a regular basis. Pipes are clogged with sediment, channels are overgrown, and manmade dams have been added for vehicle access, blocking flow in the stormwater channels.

b. Potable Water

UNCP operates and maintains potable water mains within the campus. Potable water is supplied to the campus by the Town of Pembroke (Town). During our April 19, 2011 meeting Mr. Martin noted that the southern portion of campus has aging water infrastructure. Many of these water mains are 75-100 years old and the material is asbestos cement (AC) pipe. AC pipe of this age can become brittle, and also become a maintenance headache. Water mains located on the northern portion of campus are generally much newer and are either made of ductile iron or polyvinyl chloride (PVC).

A project to replace the aging water mains on the southern part of campus was begun 5-10 years ago. The project was taken to a design development level but was eventually cancelled due to costs and lack of funding.

In 2009, UNCP constructed a 300,000 gallon elevated water storage tank to increase fire protection capacity on the UNCP campus. Prior to the construction of the elevated water storage tank, UNCP had limited fire protection capacity, preventing the construction of additional buildings on campus. Based on conversations with Mr. Martin, the UNCP campus generally has adequate water pressure for average and peak domestic demands. Since the construction of the elevated water storage tank, it appears there is adequate volume and water pressure for fire protection for the current number of buildings on campus.

c. Sanitary Sewer

UNCP operates and maintains sanitary sewer mains and lift stations within the campus. The Town provides wastewater treatment for UNCP. Like the water system, the oldest sanitary sewer infrastructure is located on the southern portion of campus. Many of these sanitary sewer mains are 75-100 years old. Sanitary sewer mains located on the UNCP campus are mostly cast iron or ductile iron pipe.

Mr. Martin noted during our meeting that there are no capacity issues with the sanitary sewer system other than standard operational and maintenance issues. Additionally, it appears there are no significant inflow and infiltration (I&I) issues associated with the sewer system.

d. IT

The IT infrastructure at UNCP supports all data and standard voice communications for the campus. The core backbone of the system consists of a fiber optic ring between the primary main distribution frame and data center located in Oxendine Science Building and the secondary main distribution frame and data center located in Lumbee Hall. Almost all buildings on campus are connected to the fiber ring, while a few on the perimeter of campus, such as Carter Hall, are served by point-to-point wireless systems.

The existing fiber optic loop cabling was installed during the 1980s and according to Robert Orr, the Chief Information Officer; the fiber has become brittle and difficult to work with. Also, the cable was cut once and the University has experienced issues from the repair splicing. The University desires to include planned replacement of the fiber optic cabling in the master plan. While the network topology and switching is fully redundant, the network reliability is limited by the pathway infrastructure. Almost every building on campus has a single telecommunications ductbank entrance into its building distribution frame. If this ductbank was cut during construction the entire building would lose data and voice communications until it could be repaired. Inclusion of dual telecommunication entrance ductbanks for new buildings in the master plan is desired. The point-to-point wireless systems used for communications with outlying buildings have limited bandwidth and are not as reliable. As more services, such as

video and security, are moved to the IT network the wireless systems will become less effective. The master plan will need to include extending fiber to the campus perimeter.

In discussions with Kevin Pait, Director of Network and System Administration, it is our understanding that the University has been in discussions with MCNC concerning the routing of the Golden LEAF Rural Broadband Initiative (GLRBI) fiber optic lines and duct infrastructure through Pembroke. The proposed routing goes north from 3rd Street on Prospect Road, turns west on Physical Plant Drive, continues around the northwest edge of campus, and connects to University Road where it turns south and meets back up with 3rd Street. Parts of the discussions with MCNC have included provisions in the ductbank infrastructure for use by UNCP. It is recommended that the University extend ductbank along Old Main Road between Prospect Road and University Road connecting to the GLRBI infrastructure. This will provide a complete circular infrastructure around a majority of campus allowing an outer fiber optic ring to be constructed. A new linked outer ring along with replacement of the existing fiber optic loop will significantly increase the reliability and uptime of the University IT systems.

As the campus continues to expand a new main distribution frame and data center will be required at the northern end to supplement the existing centers at Oxendine Science Building and Lumbee Hall. Originally IT has planned to incorporate a center in the future Info Commons facility; however, the proposed location at the current site of Wellons Residence Hall and Jacobs Halls is too close physically to Oxendine Science Building to provide desired infrastructure separation. The new data center could be located in Allied Heath building or the future Business School.

IV. RECOMMENDATIONS AND FUTURE STUDIES

a. Stormwater

Recommended future studies of the stormwater system include:

- Collection of current, accurate inventory of the stormwater system and existing BMPs and control features.
- Hydraulic and Hydrologic Modeling of campus and the adjacent sub basins to assess the general response of the watersheds for a range of rainfall events and different land use conditions.
- Development of a stormwater master plan to evaluate conceptual design alternatives and identify the most reasonable, cost-effective solutions for the system.

Development of a master stormwater model will assist UNCP in identifying areas on campus where drainage improvements can be made to alleviate flooding. It will also help UNCP identify

offsite improvements that need to be made to provide relief to the campus during a rain event. It is crucial the UNCP work closely with the Town and Robeson County since we anticipate "buy-in" from the adjacent property owners will be vital.

Preliminary recommendations for stormwater improvements on campus include:

- BMP's – BMP's can be utilized to minimize localized nuisance flooding and enhance the water quality of stormwater runoff. Further development of the campus master plan will help identify areas where BMP's are appropriate.
- Reduction of Impervious Surface Area – Reducing impervious surface area will allow some of the stormwater runoff that typically accumulates on campus to seep into the ground. One example would be the exchange of the parking adjacent to Wellon's Residence Hall for a BMP and/or landscaped area.
- Vegetation Establishment – Establishing vegetation on campus will help enhance the water quality of the stormwater runoff on campus. Vegetation will also help promote uptake of stormwater runoff and may help control localized nuisance flooding.

One critical stormwater improvement will be implementing localized BMP's. There are various site constraints on the UNCP campus to consider when selecting a BMP including:

- Contributing drainage area
- Real estate availability
- Relief (elevation difference) across the basin
- Shallow water table
- Poorly draining soils

The North Carolina Department of Environment and Natural Resources (NCDENR) identifies some BMP's that work well with the constraints listed above including:

1. Stormwater Wetlands – per the NCDENR Stormwater BMP Manual "constructed wetlands are constructed systems that mimic the functions of natural wetlands and use physical, chemical, and biological processes to treat stormwater pollution." The stormwater wetland will also provide peak runoff attenuation and runoff volume management.
    - Advantage – can be aesthetically pleasing if properly maintained and can provide a good opportunity to incorporate landscaping and education into the BMP
    - Disadvantage – requires more real estate than typically detention facilities
2. Wet Detention Basins – per the NCDENR Stormwater BMP Manual "a wet detention basin is a stormwater management facility that includes a permanent pool of water for

removing pollutants and additional capacity above the permanent pool for detaining stormwater runoff." A wet detention basin will provide peak runoff attenuation and runoff volume management.

- Advantage – can be aesthetically pleasing when properly maintained and can provide a good opportunity to incorporate landscaping and education into the BMP
- Disadvantage – can be a nuisance if not properly maintained

3. Grassed Swales – per NCDENR Stormwater BMP Manual "a water quality grasses swale is a shallow open channel drainage way stabilized with grass or other herbaceous vegetation that is designed to filter pollutants." Grassed swales must be used with other BMP's to achieve significant runoff volume management.
   - Advantage – can reduce the cost of traditional curb and gutter infrastructure
   - Disadvantage – can be subject to standing water and encourage mosquitoes
4. Rooftop Runoff Management – per NCDENR Stormwater BMP Manual "rooftop runoff management is the development of vegetated roof covers and roof gardens, roof ponding areas and cisterns to detain and promote evapo-transpiration of runoff originating from roofs." Rooftop runoff management can reduce the impervious surface and ultimately reduce the runoff from the roof.
   - Advantages – reduces heat island effect, adds aesthetic value, conserves space, runoff collected in cisterns can be reused for irrigation on campus
   - Disadvantages – difficult to retrofit existing facilities, maintenance is required, can be costly

Incorporating localized BMP's on campus could also provide educational opportunities to students and faculty. Educational exhibits could be an opportunity for students and staff to learn about the function and purpose of the BMP. Enhanced landscaping and pedestrian friendly walkways near the BMP will also help contribute to a "park like" setting.

The current stormwater piping network on campus appears to be significantly undersized to handle the stormwater runoff from campus plus the additional offsite flow that is passing through campus. Current inventory shows pipes as small as six (6) inches with minimal slopes. Typically, we provide a minimum of eighteen (18) inch diameter storm pipes.

Based on the inventory provided to Dewberry, it appears that the offsite flow and the onsite flow share a stormwater piping network. After a hydrologic and hydraulic analysis is completed, recommendations may include strategies for developing separate stormwater conveyances to bypass offsite flow and increasing the existing stormwater piping network capacity by upsizing existing pipes or adding additional stormwater piping.

We also recommend the campus, in collaboration with the Town and NCDOT; develop a routine plan for maintenance of the existing stormwater infrastructure. The existing downstream culverts are currently clogged with debris and sediment. Also, the existing downstream ditches are blocked with earthen dams and are full of storm debris. The current downstream conditions appear to be significantly impacting the stormwater infrastructure on campus. Basically, during a large rain event, the water has nowhere to go and backs up in the system and causing flooding on campus.

b. Potable Water

Recommended future studies of the potable water system include:

- Updated mapping of the existing water system.
- Hydraulic model of the existing water system.
- Sizing and replacement of aging infrastructure after evaluating the water hydraulic model.

Average daily demands for the future buildings were calculated based on the 15A NCAC 2T rules. The 15A NCAC 2T rules document standard flow rates to use for average daily sanitary sewer demands. For the purposes of this technical memorandum it has been assumed that the average daily water demand is the same as the average daily sewer demand. Documentation of the demand calculations are included in Appendix B. Based on a review of the existing water system in the vicinity of each of the nine (9) future buildings, the following determinations were made:

Building #	Building Name	Size (GSF)	Average Demand (GPD)	Water Service
1	Info Commons	150,000	17,300	Replace existing in vicinity
2	GPAC Lobby Addition	15,000	1,800	Existing potentially adequate
3	Visitor's Center	25,000	2,900	Existing potentially adequate
4	Business School	60,000	6,900	Existing potentially adequate
5	Residence Hall	66,500	12,300	Existing potentially adequate
6	Academic A	71,600	8,200	Existing potentially adequate
7	Academic B	89,600	10,300	Existing potentially adequate
8	Academic C	54,100	6,200	Existing potentially adequate
9	Housing	44,100	8,100	No infrastructure available

These determinations show that the majority of water mains could potentially accommodate increased demand based on average demands for the proposed buildings and the existing water mains that would serve each building. Current and future potable water corridors are shown in Appendix C.

A hydraulic water model should be developed to determine the exact size service line required for each building and also to determine if minimum flow and pressure would be available during peak domestic demand fire flow scenarios. Additional information for each building regarding fire protection requirements should be incorporated in sizing the water main to each building so that if a separate fire protection service to the building is necessary, it can provide adequate flow and pressure to the fire protection pumps and equipment for each building.

As previously discussed, it is recommended that all AC pipe be replaced with ductile iron (DI) pipe or PVC pipe, when possible. Also, it is recommended that any new building service not be connected to existing AC water mains, if possible.

Regularly scheduled routine maintenance of the water infrastructure should also be implemented. Hydrant/system flushing programs, valve turning programs, hydraulic studies and modeling, along with scheduled capital improvement projects to replace aging water mains will help to prolong the service life of water mains (and associated appurtenances) and also maintain and/or improve water quality on campus.

Water efficiency programs should also be implemented to reduce water consumption, especially in times of drought. Future buildings could be designed to use low flow fixtures and recycle gray water for landscaping, existing buildings could be retrofitted to use low-flow fixtures, future landscaping should include more drought-tolerant plants, and systems to capture and reuse stormwater from the building. Educational programs can also be implemented for students, faculty, and staff on campus to teach the importance of reducing water consumption and ways this can be accomplished.

c. Sanitary Sewer

Recommended future studies of the sanitary sewer system included:

- Updated mapping of the existing sanitary sewer system.
- Hydraulic model of the existing sanitary sewer system.

Average daily demands for the future buildings were calculated based on the 15A NCAC 2T rules. The 15A NCAC 2T rules document standard flow rates to use for average daily sanitary sewer demands. Documentation of the demand calculations are included in Appendix B. Based on a

review of the existing sewer system in the vicinity of each of the nine (9) future buildings, the following determinations were made:

Building #	Building Name	Size (GSF)	Average Demand (GPD)	Sewer Service
1	Info Commons	150,000	17,300	Replace existing in vicinity
2	GPAC Lobby Addition	15,000	1,800	More research necessary
3	Visitor's Center	25,000	2,900	More research necessary
4	Business School	60,000	6,900	More research necessary
5	Residence Hall	66,500	12,300	Existing potentially adequate
6	Academic A	71,600	8,200	More research necessary
7	Academic B	89,600	10,300	More research necessary
8	Academic C	54,100	6,200	More research necessary
9	Housing	44,100	8,100	No infrastructure available

According to 15A NCAC 2T regulations regarding minimum sizing for private gravity sewer lines, there shall be no private gravity sewer conveying wastewater less than 6 inches in diameter. Governing regulations may require that some of the existing gravity sewers be upsized prior to connecting new buildings to them. The current and future sanitary sewer corridors are shown in Appendix D.

Additionally, if the new buildings require connection to an existing force main, both the existing pump stations and force main should be evaluated to determine if adequate capacity and pressure remains to support the new building.

A hydraulic sewer model should be devleoped to determine the exact size service line required for each building and also to determine if downstream mains and manholes could accommodate the increased flows.

Regularly scheduled routine maintenance to the sewer infrastructure should also be implemented. Manhole and cleanout inspection programs, regular inspection and maintenance of pumps and pump stations, reduction of fats, oils, and grease (FOGs) throughout campus, education of students, faculty, and staff regarding wastewater processing (what not to flush or pour down sinks), along with scheduled capital improvement projects to replace aging sewer mains will help to prolong the service life of sewer services, mains, and manholes.

d. IT

In discussions with Kevin Pait, Director of Network and System Administration, it is our understanding that the University has been in discussions with MCNC concerning the routing of the Golden LEAF Rural Broadband Initiative (GLRBI) fiber optic lines and duct infrastructure through Pembroke. The proposed routing goes north from 3rd Street on Prospect Road, turns west on Physical Plant Drive, continues around the northwest edge of campus, and connects to University Road where it turns south and meets back up with 3rd Street. Parts of the discussions with MCNC have included provisions in the ductbank infrastructure for use by UNCP. It is recommended that the University extend ductbank along Old Main Road between Prospect Road and University Road connecting to the GLRBI infrastructure. This will provide a complete circular infrastructure around a majority of campus allowing an outer fiber optic ring to be constructed. A new linked outer ring along with replacement of the existing fiber optic loop will significantly increase the reliability and uptime of the University IT systems.

As the campus continues to expand a new main distribution frame and data center will be required at the northern end to supplement the existing centers at Oxendine Science Building and Lumbee Hall. Originally IT has planned to incorporate a center in the future Info Commons facility; however, the proposed location at the current site of Wellons Residence Hall and Jacobs Halls is too close physically to Oxendine Science Building to provide desired infrastructure separation. A location for the new center will need to be determined.

V. CONCLUSIONS

a. Stormwater

- Based on preliminary review, it appears that the existing stormwater piping network on campus is significantly undersized. Hydrologic and hydraulic modeling should be utilized to determine suitable improvements that need to be made to the existing system. Improvements may include bypassing offsite flow and upsizing the existing stormwater infrastructure.
- Some improvements that can be made on campus include reducing impervious surface area, establishing vegetation, and creating BMP's where practical to address stormwater quantity and quality control.
- Regular routine maintenance should be implemented and performed on upstream, downstream, and campus stormwater infrastructure. The maintenance plan should include buy in from the Town and NCDOT.

b. Potable Water

- Some of the existing water infrastructure could potentially supply a portion of the nine (9) future buildings without major renovations or replacements.
- In general, all existing water mains that are AC material should be replaced with DI or PVC.
- A water hydraulic model should be utilized assist in sizing the water service to each building and determine the effects of the overall water system on campus. This model will also assist in determining compliance with local and State code regarding minimum standards for fire protection.

c. Sanitary Sewer

- Analysis of regulations governing private sewer systems will be required when determining connections between future buildings and the existing gravity sewer infrastructure.
- Analysis of the existing pump station and force mains on campus will be required to ensure capacity is available for connections with services to future buildings.
- A sewer hydraulic model should be developed to size the sewer service to each building and determine the effects of the overall sewer system on campus.

d. IT

- A phased plan for the replacement of the existing fiber optic loop cabling will need to be developed.
- Location of new main distribution frame and data center needs to be determined.
- The University needs to push for and take advantage of the additional pathways provided by MCNC under the Golden LEAF Rural Broadband Initiative (GLRBI).

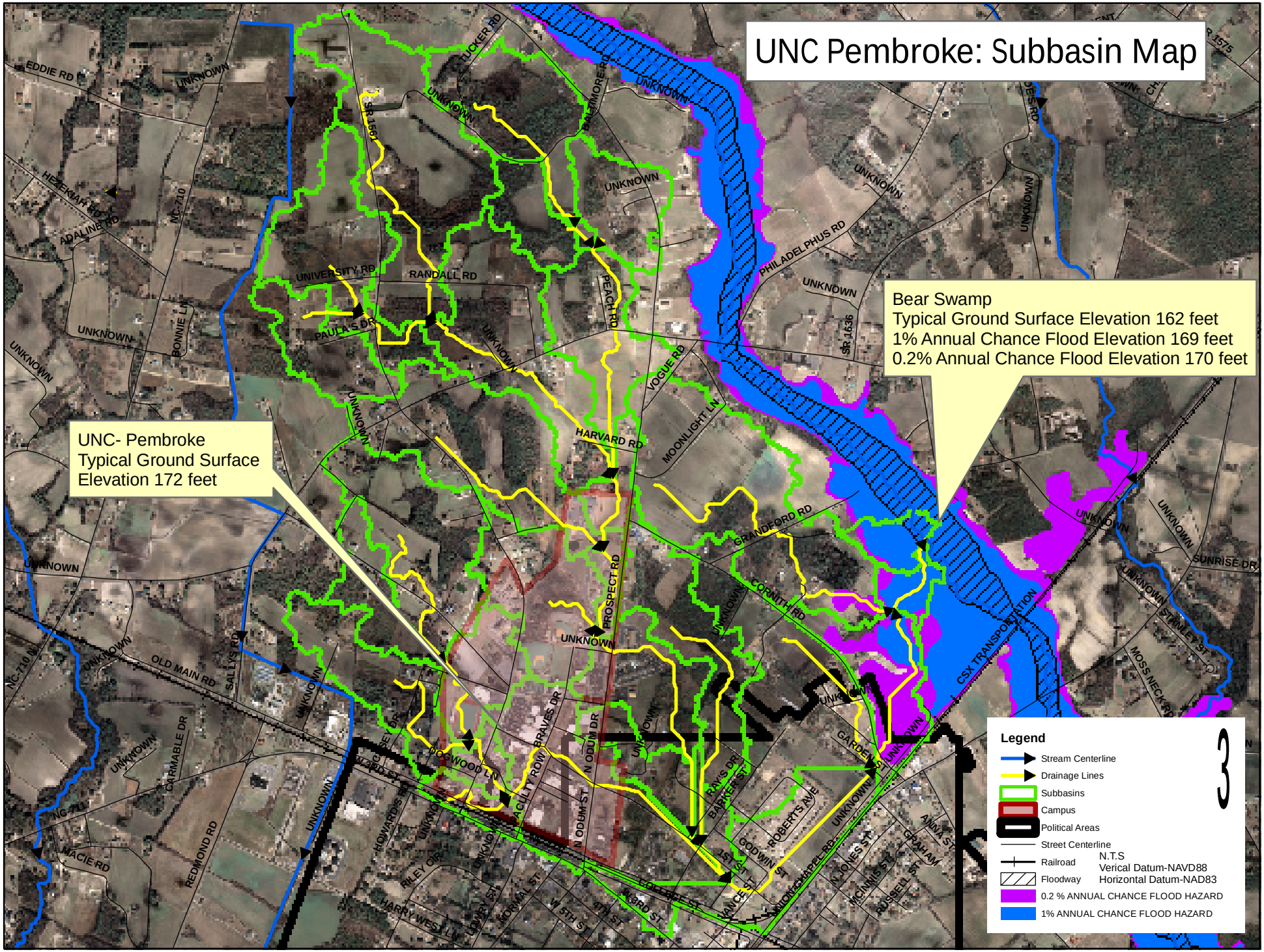
e. Water and Energy Efficiency

- Water efficiency programs should also be implemented to reduce water consumption, especially in times of drought. Future buildings should be designed to use low flow fixtures and recycle gray water for landscaping. Existing buildings could be retrofitted to use low-flow fixtures. Future landscaping should include more drought-tolerant plants, and create

stormwater systems to capture and reuse stormwater from the building. Educational programs can also be implemented for students, faculty, and staff on campus to teach the importance of reducing water consumption and ways this can be accomplished.

VI. APPENDICIES

Appendix A – Delineation of Existing Drainage Basins
Appendix B – Documentation of Potable Water and Sanitary Sewer Demand Calculations
Appendix C – Potable Water Corridors
Appendix D – Sanitary Sewer Corridors

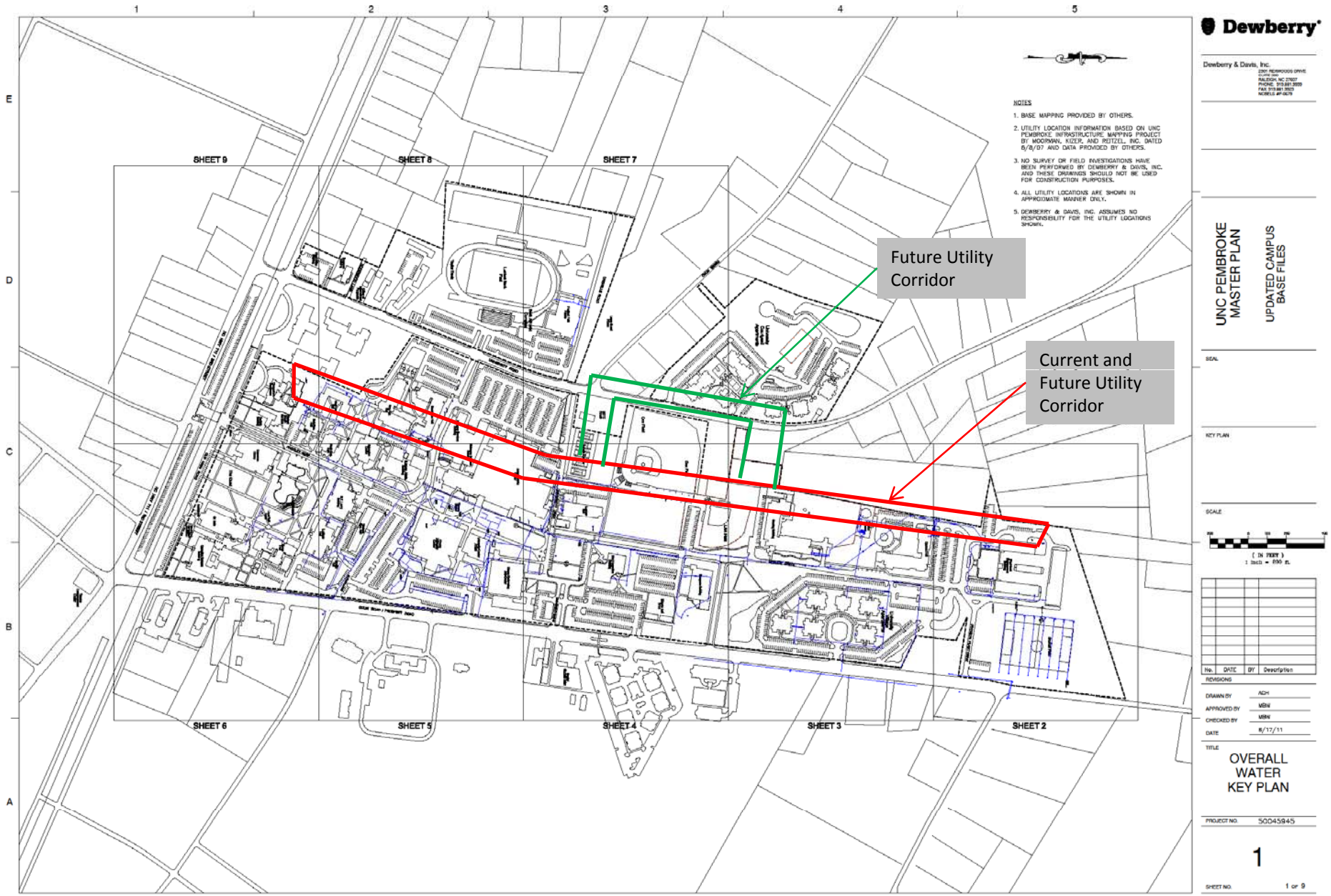

UNC Pembroke: Subbasin Map
Bear Swamp
Typical Ground Surface Elevation 162 feet
1% Annual Chance Flood Elevation 169 feet
0.2% Annual Chance Flood Elevation 170 feet
UNC- Pembroke
Typical Ground Surface
Elevation 172 feet
Legend
Stream Centerline
Drainage Lines
Subbasins
Campus
Political Areas
Street Centerline
Railroad
Floodway
0.2 % ANNUAL CHANCE FLOOD HAZARD
1% ANNUAL CHANCE FLOOD HAZARD
N.T.S
Verical Datum-NAVD88
Horizontal Datum-NAD83
3
EDDIE RD
HEZEKIAH RD
ADALINE RD
NC-710
UNIVERSITY RD
RANDALL RD
PAULA'S DR
BONNIE LN
TUCKER RD
SR 1567
BALTIMORE RD
PEACH RD
VOGUE RD
MOONLIGHT LN
HARVARD RD
PHILADELPHUS RD
SR 1636
GRANDFORD RD
CORINTH RD
PROSPECT RD
CSX TRANSPORTATION
SUNRISE DR
STANLEY ST
MOSS NECK RD
OLD MAIN RD
SALLYS RD
NC-710 W
CARMABLE DR
REDMOND RD
MACIE RD
HOWARD'S DR
RILEY DR
HARRY WEST LN
DOGWOOD LN
FACULTY ROW
BRAVES DR
N ODUM DR
N ODUM ST
RAVIS DR
BAKER ST
GODWIN ST
ROBERTS AVE
GARDEN ST
CHAPEL RD
N JONES ST
MCINNIS ST
RUSSELL ST
GRAHAM ST
ANNA ST
1ST ST
COLLEGE ST
VANCE ST
NORMAL ST
LOWERY ST
W 5TH ST
4TH ST
3RD ST

UNCP Master Plan Memorandum
Potable Water and Sanitary Sewer Demand Calculations
June 27, 2011
Appendix B

Building #	Building Name	Size (GSF)	Demand (GPD)*	Water Service**	Sewer Service**
A	Cypress Hall	122,755	14,117	Water main already designed	Sewer main already designed
B	Allied Health	87,500	10,063	Water main already designed	Sewer main already designed
1	Info Commons	150,000	17,250	Replace existing in vicinity	Replace existing in vicinity
2	GPAC Lobby Addition	15,000	1,725	Existing potentially adequate	More research necessary
3	Visitor's Center	25,000	2,875	Existing potentially adequate	More research necessary
4	Business School	60,000	6,900	Existing potentially adequate	More research necessary
5	Residence Hall	66,500	12,277	Existing potentially adequate	Existing potentially adequate
6	Academic A	71,600	8,234	Existing potentially adequate	More research necessary
7	Academic B	89,600	10,304	Existing potentially adequate	More research necessary
8	Academic C	54,100	6,222	Existing potentially adequate	More research necessary
9	Housing	44,100	8,142	No infrastructure available	No infrastructure available

*Rates based on 15A NCAC 02T .0114 Wastewater Design Flow Rates
Boarding Schools - (Building #'s 5 and 9) 60 gal/person/day, 325GSF per person
Building #'s 1,2,3,4,6,7,8 and A and B use estimated average of 115gal/day per 1000 gsf

APPENDIX C - POTABLE WATER CORRIDORS



APPENDIX D - SANITARY SEWER CORRIDORS