

Section 1 Summary

This report assesses the stormwater runoff rates for the proposed Mast Road Apartments. In this study, the 1-inch, 2-year, 10-year, 25-year, 50-year, and 100-year Type-III 24-hour duration storm events were analyzed for the proper function of the proposed drainage system. A capacity analysis was also completed for the proposed closed drainage system to evaluate its operation during a Type-III 25-year storm event. In addition, a capacity analysis was completed for the proposed gravel wetland to evaluate its operation during each of the storm events listed above.

The drainage system was designed to balance flows for the pre- and post-development conditions for the 2-year, 10-year, 25-year, and 50-year storm events in accordance with section 9.03 of the Town of Durham Site Plan Review Regulations, and the New Hampshire Department of Environmental Services (NHDES) Alteration of Terrain (AoT) program. An Alteration of Terrain Application will be filed with the NHDES with all supporting documentation required beyond the information contained in this study. In addition a Stormwater Management Checklist in accordance with section 9.03 of the Town of Durham Site Plan Review Regulations has been filed separately with the Site Plan Review Application. The following summarizes the findings of the study.

1.1 Project Description

The proposed project consists of an apartment style housing development, located on approximately 16.8 acres and a shared access drive located on a 1 acre vacant lot owned by the University of New Hampshire. All proposed work is located on the north side of Mast Road in Durham, NH. The site is bounded by UNH's West Edge Parking Lot and Stormwater Center to the north, agricultural land to the west, a vacant lot to the east and Mast Road to the south.

The proposed project consists of the construction of a 460-bed multi-unit housing development and clubhouse with associated site improvements. Site improvements include off-street parking, outdoor amenities, underground utilities, site lighting, landscaping and a stormwater management system that consists of deep sump catch basins, porous pavement, a gravel wetland and three rain gardens.

The proposed project will result in approximately 12.9 acres of disturbance. Construction is anticipated to commence in the spring of 2013 and be completed in the summer of 2014.

1.2 On-Site Soils Description

The site's topography has a high point of elevation 112 while the low point has an elevation of 74. The soil conditions onsite range from well-drained to poorly drained soils as indicated in the Site Specific Soil Survey prepared by Stoney Ridge Environmental, LLC (see Appendix B).

The on-site soil conditions were mapped by Stoney Ridge Environmental, LLC in April 2012 and consist of moderately well drained and somewhat poorly drained Boxford silt loam (Hydrologic Soil Group C), poorly drained Scitico silt loam (Hydrologic Soil Group C), moderately well drained and somewhat poorly drained Eldridge fine sandy loam

(Hydrologic Soil Group C), well drained Charlton fine sandy loams (Hydrologic Soil Group B), well drained Hollis-Charlton Complex (Hydrologic Soil Group C/D), moderately well drained Chatfield Variant Deep (Hydrologic Soil Group C), rock outcrops and previously disturbed urban land.

1.3 Pre- and Post-Development Flow Comparison

The pre- and post-development watershed areas have been analyzed at five (5) distinct points of analysis (PA1, PA2, PA3, PA4, & PA5). While the points of analysis remained unchanged, their contributing sub-catchment areas were varied between pre- and post-development conditions. These adjustments were made to reflect the differences in drainage patterns between the existing and proposed conditions. The overall areas analyzed as part of this Drainage Report were held constant.

The peak discharge rates at the five (5) points of analysis were determined by analyzing Type III 24-hour storm events. The storm events and their respective rainfall totals below were obtained from the New Hampshire Rainfall Tables, by the New Hampshire Department of Environmental Services.

TABLE 1
Type III Storm Events

Design Storm	Rainfall Total (inches)
2-year	3.0
10-year	4.3
25-year	5.2
50-year	5.7
100-year	6.4

"Appendix A. - New Hampshire Rainfall Tables" by New Hampshire Department of Environmental Services. Data Interpolated from "Technical Paper No. 40 (TP40) rainfall Frequency Atlas of the Eastern United States". Access to PDF found at:

http://des.nh.gov/organization/divisions/water/stormwater/documents/wd-08-20b_apxa.pdf

Table 2 compares pre- and post-development peak runoff rates during each design storm event. As depicted in Table 2, post-development runoff rates are less than pre-development runoff rates.

TABLE 2

Comparison of Pre- and Post-Development Flows (cfs)

Point of Analysis	2-year (Pre/Post)	10-year (Pre/Post)	25-year (Pre/Post)	50-year (Pre/Post)
PA1	7.06/5.90	14.97/11.43	21.02/18.57	24.50/24.24
PA2	3.15/2.63	6.66/5.09	9.35/6.92	10.89/7.95
PA3	1.40/1.11	2.94/2.58	4.12/3.94	4.80/4.47
PA4	1.60/1.60	3.07/2.70	4.20/3.52	4.84/3.96
PA5	1.17/0.91	2.49/1.83	3.50/2.53	4.07/2.93

1.4 Structure Analysis

The proposed closed drainage system was analyzed for inlet and outlet control for the Type-III 25-year storm event. As described in *Section 7 - Structure Analysis* of this report, the closed drainage system is anticipated to operate without ponding and flooding on site during the 25-year design storm event.

1.5 Best Management Practices

Best Management Practices have been incorporated into the drainage design, which provide for temporary erosion control measures during the construction of the project, permanent erosion control measures after construction is complete and stormwater treatment measures that will help mitigate adverse impacts to stormwater quality resulting from common pollutants related to development. Temporary measures are fully depicted on the sheet entitled "Erosion Control Notes and Details" in the Site Plans. Temporary measures include construction sequencing, silt fence barriers, a stabilized construction entrance, inlet protection barriers and provisions for stabilization of inactive areas. Permanent erosion control measures include turf and vegetation establishment on all non-impervious disturbed areas. Stormwater quality will be enhanced by the utilization of deep sump catch basins (for pre-treatment), oil/grease separator hoods, porous pavement, a gravel wetland and three rain gardens.

Section 6

Long Term Operation and Maintenance Plan

The intent of this Long Term Operation and Maintenance Plan is to identify the areas of this site that need special attention and consideration, as well as implementing a plan to assure routine maintenance.

By identifying the areas of concern as well as implementing a frequent and routine maintenance schedule, the site will maintain a high quality of stormwater runoff.

6.1 Contacts

6.1.1 Individual

Jeff Githens
Peak Campus Development, LLC
2970 Clairmont Road, Suite 310
Atlanta, Georgia 30329
Phone: (404) 920-5361

(Note: The contact information for the Contact/Responsible Party shall be kept current. If ownership changes, the Operation and Maintenance Plan must be transferred to the new party.)

6.1.2 Management Company

Peak Campus Development, LLC
2970 Clairmont Road, Suite 310
Atlanta, Georgia 30329
Phone: (404) 920-5361

6.2 Inspections

6.2.1 Inspection Schedule

The stormwater system shall be inspected at a minimum quarterly, and after rainfall events of one (1) inch or more.

6.2.2 Maintenance Items

Maintenance of the following items shall be recorded and reported as required by the Town of Durham. Inspection and maintenance forms have been included in Appendix A.

- Parking Lot Sweeping
- Litter/Debris Removal
- Restoration of Eroded Areas
- Catchbasin Cleaning
- Porous Asphalt Cleaning
- Gravel Wetland Maintenance
- Rain Garden Maintenance

Overall Site Operation and Maintenance Schedule		
Maintenance Item	Frequency of Maintenance	Operation
Litter/Debris Removal	Weekly	Management Company
Pavement Sweeping - Sweep impervious areas to remove sand and litter.	2 - 4 times annually	Parking Lot Sweeper
Porous Asphalt Cleaning - Vacuum porous asphalt areas to remove sand and litter.	2 - 4 times annually	Parking Lot Vacuum Sweeper Truck
Gravel wetland - Trash and debris to be removed including at outlet structure. - Embankment to be mowed. - Any required maintenance shall be addressed.	Periodically (At least two (2) times annually)	Management Company
Rip Rap Aprons - Trash and debris to be removed. - Any required maintenance shall be addressed.	Annually	Management Company
Catch Basin (CB) Cleaning - CB to be cleaned of solids and oils.	Annually	Vacuum Truck
Landscaping - Landscaped areas to be maintained and mulched.	Maintained as required and mulched each Spring	Management Company

Porous Asphalt Inspection/Maintenance Requirements		
Inspection/ Maintenance	Frequency	Action
Inspect for Signs of Deterioration and Spalling	Annually	- Repair as required
Monitor for proper Infiltration	Periodically	- Inspect the area for infiltration rate. - If required: hire qualified professional to assess the condition of the facility to determine measures required to restore the filtration function, including but not limited to removal of accumulated sediments or reconstruction of the filter.
Clean Porous Asphalt	2 - 4 times annually	- Vacuum Sweeper to clean entire porous asphalt area (Note: power washing may be required on heavily soiled areas to dislodge particles prior to sweeping/vacuuming).

Gravel Wetland Inspection/Maintenance Requirements		
Inspection/ Maintenance	Frequency	Action
Monitor to ensure that Gravel Wetland functions effectively after storms.	Four (4) times annually (quarterly) and after any rainfall event exceeding 2.5" in a 24-hr period.	- Trash and debris to be removed. - Any required maintenance shall be addressed.
Inspect Vegetation	Annually	- Inspect the condition of all gravel wetland vegetation. - Prune back overgrowth. - Replace dead vegetation. - Remove any invasive species. -Coordinate with UNH Stormwater Center for further vegetation management guidelines.
Inspect Drawdown Time - The system shall drawdown within 48- hours following a rainfall event.	Annually	- Hire qualified professional to assess the condition of the facility to determine measures required to restore the filtration function, including but not limited to removal of accumulated sediments or reconstruction of the filter.

Additional Gravel Wetland Operation and Maintenance Requirements:

- **1st Year Post-Construction:** Inspection frequency shall be after every storm in the first year following construction.
- Inspect to be certain system drains within 24 - 48 hours (within the design period, but also not so quickly as to minimize stormwater treatment).
- Watering plants as necessary during the first growing season.
- Re-vegetating poorly established areas as necessary.
- Treating diseased vegetation as necessary.
- Inspect soil and repair eroded areas, especially on slopes, at a minimum quarterly.
- Check inlets, outlets, and overflow spillway for blockage, structural integrity and evidence of erosion.
- **Cleaning Criteria for Gravel Wetland Treatment Cells:** Sediment shall be removed from the gravel wetland surface when it accumulates to a depth of several inches (>10 cm) across the wetland surface. Materials shall be removed with rakes rather than heavy construction equipment to avoid compaction of the gravel wetland surface. Heavy equipment may be used if the equipment is located outside the gravel wetland, while a backhoe shovel reaches inside the gravel wetland to remove sediment. Removed sediments shall be dewatered (if necessary) and disposed of in accordance with all local, state and federal requirements. Removal of vegetation within the gravel wetland shall occur every three (3) growing seasons, or the end of the summer of the third year. This is to prevent decay and release of nutrients from accumulated biomass.

Rain Garden Inspection/Maintenance Requirements		
Inspection/ Maintenance	Frequency	Action
Monitor to ensure that Rain Gardens function effectively after storms.	Four (4) times annually (quarterly) and after any rainfall event exceeding 2.5" in a 24-hr period.	- Trash and debris to be removed. - Any required maintenance shall be addressed.
Inspect Vegetation	Annually	- Inspect the condition of all Rain Garden vegetation. - Prune back overgrowth. - Replace dead vegetation. - Remove any invasive species.
Inspect Drawdown Time - The system shall drawdown within 48-hours following a rainfall event.	Annually	- Assess the condition of the facility to determine measures required to restore the filtration function, including but not limited to removal of accumulated sediments or reconstruction of the filter.

Rip Rap Inspection/Maintenance Requirements		
Inspection/ Maintenance	Frequency	Action
Visual Inspection	Annually	- Visually inspect for damage and deterioration. - Repair damages immediately.

6.2.3 Disposal Requirements

Disposal of debris, trash, sediment and other waste material should be done at suitable disposal/recycling sites and in compliance with all applicable local, state and federal waste regulations.

6.2.4 Snow & Ice Management for Standard Asphalt and Walkways

Snow storage areas shall be located such that no direct untreated discharges are possible to receiving waters from the storage site (snow storage areas have been shown on the Site Plan). Salt storage areas shall be covered or located such that no direct untreated discharges are possible to receiving waters from the storage site. Salt and sand shall be used to the minimum extent practical (refer to the NHDES AOT Stormwater Management Manual, Volume 2, for de-icing application rate guidelines).

6.2.5 Snow & Ice Management for Porous Asphalt

- Maintenance personnel shall meet with UNHSC for the latest guidance on snow and ice management for porous asphalt areas.
- Maintenance personnel shall be properly trained as to the locations of porous asphalt pavement and operations and maintenance requirements for the porous asphalt pavement.
- The porous asphalt areas shall be plowed after every storm in accordance with standard plowing operations for standard pavement and as required to maintain safe conditions. Special plow blades may be used to prevent scarring but are not necessary (raised blade plowing is not recommended).
- The UNHSC has documented up to a 75% net salt reduction for de-icing measures over the course of a winter season. However, salt reduction is site dependent due to pavement shading, hours of operation, storm intensities, temperatures, etc. Salt/de-icing chemicals shall be applied as needed to maintain a safe and accessible site at all times. The following recommendations for salt/de-icing chemical application may be applicable:
 - Additional salt/de-icing chemical application may be needed during challenging storm events, particularly mixed precipitation events.
 - Salt/de-icing chemical application prior to storm events may be required to maintain a safe and accessible site during the first part of a storm.
 - Salt/de-icing chemical application during and after storm events may be required to control compact snow and ice not removed by plowing.
 - Salt/de-icing chemical reduction may be realized between storm events depending on black ice formation.
- Sand application is not recommended for porous asphalt areas or areas that drain to porous asphalt areas due to an increased maintenance burden.

6.2.6 Annual Updates and Log Requirements

The Owner and/or Contact/Responsible Party shall review this Operation and Maintenance Plan once per year for its effectiveness and adjust the plan as necessary.

A log of all preventative and corrective measures for the stormwater system shall be kept on-site and be made available upon request by any public entity with administrative, health environmental or safety authority over the site.

Stormwater System Inspection and Maintenance Report

General Information			
Location			
Date of Inspection/Maintenance		Start/End Time	
Personnel			
Type of Inspection <input type="checkbox"/> Regular <input type="checkbox"/> Pre-storm event <input type="checkbox"/> During storm event <input type="checkbox"/> Post-storm event			
Weather Information Has there been a storm event with over one (1) inch of rain since the last inspection? <input type="checkbox"/> Yes <input type="checkbox"/> No If yes, provide: Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):			
Weather at time of this inspection? <input type="checkbox"/> Clear <input type="checkbox"/> Cloudy <input type="checkbox"/> Rain <input type="checkbox"/> Sleet <input type="checkbox"/> Fog <input type="checkbox"/> Snowing <input type="checkbox"/> High Winds <input type="checkbox"/> Other: Temperature:			

	BMP Description	BMP Operating Properly?	Maintenance Needed/Performed	Maintenance Since Last Report
1	Porous Asphalt (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
2	Porous Asphalt (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
3	Porous Asphalt (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
4	Porous Asphalt (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
5	Porous Asphalt (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
6	Rain Garden (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
7	Rain Garden (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
8	Rain Garden (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
9	Grassed Swales (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
10	Grassed Swales (location)	<input type="checkbox"/> Yes <input type="checkbox"/> No		
11	Deep Sump Catch Basins	<input type="checkbox"/> Yes <input type="checkbox"/> No		
12	Gravel Wetland	<input type="checkbox"/> Yes <input type="checkbox"/> No		