THE RAMS HEAD CENTER:
GREEN ROOF, CISTERNS, AND INFILTRATION

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Abstract

The Rams Head Center is a multi-use development at the University of North Carolina – Chapel Hill which includes a large parking garage covered by a one-acre green roof plaza. The facility is in a valley adjacent to the stadium, and the green roof serves as a crucial link between two sides of the campus. The center’s roof leaders are visibly conveyed to a cistern located beneath the plaza walkways. The 56,000-gallon cistern is constructed of recycled plastic units and provides irrigation for the plaza. The plaza includes lawn, trees, seating areas, and walkways. Beneath the vegetation is a gravel layer that conveys stormwater across the roof and provides subsurface irrigation for the trees. During large storms, the entire green roof system discharges into a bioswale, a stormwater infiltration bed, and a re-created stream segment.

Rams Head was designed as part of the UNC Chapel Hill Stormwater Master Plan, which includes a second smaller green roof and future plans for additional green roofs as well as other innovative BMPs. UNC has implemented a rigorous stormwater management program to prevent any increase in urban runoff volume as the campus grows and expands, and Rams Head is a major part of this program. The 4-year construction process was completed in September 2005.

Background and Project Description

The University of North Carolina at Chapel Hill (UNC-CH) is currently undergoing a $1.5 billion construction program, the most substantial in its 211-year history, funded in part by the country’s largest higher education bond initiative and guided by an award-winning 2001 Campus Master Plan (1, 3, 7). As part of this expansion and planning effort and in agreements with the Town of Chapel Hill, the University set rigorous environmental goals, including (5):

- Balance growth with preservation of the natural drainage system
- Manage storm water as an opportunity, rather than as a problem
- Manage total storm water volume on-site
- Enhance and protect the water quality of streams
- Reinforce the University as a Role Model

The $75 million Rams Head Center is one of the first major projects in this effort and consists of a 700-space, 3-story parking garage topped by a two story 55,000 gross square foot (GSF) student dining facility, a two story 45,000 GSF campus recreation building, and a 40,000 SF
vegetated roof plaza (6). Designed by a diverse team including Ayers/Saint/Gross Architects, Cahill Associates (Stormwater), Roofscapes (Vegetated Roof Consultant), Andropogon Associates (Landscape Architect), Walker Parking, Affiliated Engineers (M/E/P), and Stewart Engineering (Structural), Rams Head Center is the first mixed-use project constructed by UNC-CH and serves to advance one of the major goals of the Campus Master Plan – to better link the north and south campuses (4).

Rams Head is situated in a valley below the stadium (Figure 1) that was previously covered by a large surface parking lot. It now serves as a main pedestrian corridor between the historic north campus and the largely residential south campus, offering a usable recreational and special event space. Rams Head plaza reflects the University’s beautiful and historic ‘shade lawns’, while at the same time achieving significant environmental benefits through rainfall capture/reuse, evapotranspiration, storage, infiltration, and demonstration.

![Figure 1. Project Site during Construction](image)

**Rams Head Stormwater Management System**

The stormwater management system consists of number of innovative elements including a vegetated roof plaza (the focus of this paper), cistern, vegetated swale with check dams, reinforced-turf fire lane, storage/infiltration system under an artificial turf soccer field, a re-created ephemeral stream, and water quality inserts (Figure 2). In addition to managing stormwater from the project site, the system captures runoff from the town-owned Ridge Road and approximately 17 acres of surrounding campus area.
Vegetated Roof Plaza

The 40,000 square foot green roof plaza includes a 56,000-gallon cistern, a permanent water storage zone (32,000 gallons) under the planting soil to support trees and shrubs, as well as visual stormwater connections and signage to raise community awareness of water resource issues. Figures 3 and 4 show the finished plaza area from different perspectives.

Because considerable soil depth was required to support the tree types desired by the University, the design team sought to utilize this space, especially under pathways where soil wasn’t necessary, as an opportunity for enhanced stormwater management. The strategy evolved through design changes to the plaza and surrounding buildings, value engineering, and through input from the University and the North Carolina State Construction Office (2).

The vegetated portion, or “North Plaza”, is essentially divided into two functional zones. First, the cistern is situated under approximately 6,800 square feet of pathways and planters in front of the two elevated buildings (Figure 5). The remainder of the plaza contains planted areas and brick pathways over a 4-inch water storage zone in a gravel layer.

It is important to note that the plaza was designed for this unique application and did not rely on proprietary systems or their components but utilized materials available from multiple sources.
The basic principles of the design for the cistern system include:

- Runoff from a portion (about 35,000 square feet) of the adjacent Recreation and Dining buildings is conveyed to a cistern (approximate capacity of 56,000 gallons) under the walkways and planters in front of these buildings via nine downspout nozzles and surface inlets with water quality inserts.
- Once the cistern is full (when the water level is 16 inches above the plaza slab), rainwater flows into a riverstone gravel layer beneath the remainder of the plaza via twenty-four 2-inch by 8-inch rectangular pipes spread throughout the cistern walls (Figure 6).
- During extreme events, the cistern can also discharge off the plaza through two “emergency overflows” that begin to flow when the water level in the cistern reaches 18 inches.
- During the irrigation season, the cistern valve is kept closed so that the irrigation system can draw water from the cistern (with a potable back-up system if the cistern is ever empty).
- Outside the irrigation season, the cistern valve is left open so that the cistern will fill during rain events and then slowly drain into the riverstone layer beneath the central plaza (acting as an extended detention system).
The basic principles of the design for the remainder of the vegetated plaza (non-cistern areas) include:

- Four inches of rainwater is stored beneath vegetated areas in a riverstone layer above the slab to provide water to tree roots (approximately 32,000 gallons total) during the growing season.
- A network of 6- and 8-inch diameter perforated pipes and two sections of high capacity storage media (Rainstore) were designed to quickly and efficiently distribute water throughout the plaza and to overflows as necessary.
- Three “through-slab drains” with adjustable drain collars (normally set 4 inches above the slab to maintain the 4-inch water level) near the center of the plaza efficiently discharge water through the slab during extreme events.
- A long (approx. 145 feet) 4-inch high concrete weir housed in a concrete masonry unit (CMU) chamber along the north side of the plaza maintains the 4-inch water level while allowing rapid discharge off the plaza when the water level gets above 4 inches during storms.
  - Four low flow outlets discharge water which overtops the concrete weir (or passes through the scupper drain during the winter).
  - A scupper drain with a 3-inch diameter outlet pipe in one of the access boxes allows the 4-inch water level to be emptied during the winter or for maintenance.
- Seventeen small surface catch basins with water quality inserts in the lawn areas convey runoff to the riverstone/perforated pipe drainage layer if necessary.

**Cistern Design**

The L-shaped cistern is situated beneath the walkway in front of the Dining building and the walkway and planters in front of the Campus Recreation building. The cistern covers approximately 6,800 square feet of the North Plaza and has a permanent capacity of over 56,000 gallons. The design specified that the cistern be made of a strong, durable material with a very high water storage capacity. The contractor selected a material called Rainstore manufactured by Invisible Structures, Inc. As shown in Figure 8, Rainstore is comprised of high-density polyethylene (HDPE) hollow cylinders connected in a grid and it comes in square sections 40 inches per side and 4 inches high. The cistern is comprised of five stacked sections of Rainstore.
for a total depth of 20 inches (Figure 7). As specified by the manufacturer for this type of use, the units were installed “upside-down” so that the sharp side points up and away from the waterproofing system. Although the manufacturer claims that the Rainstore itself can support a load of over 110 PSI and is H-20 rated with a minimum of 12 inches of cover, this cover requirement is not met everywhere on the plaza so the heaviest vehicle allowed on the plaza without additional reinforcing is a Gator (or equivalent small maintenance vehicle). Permanent bollards are located at all entry points to prevent larger vehicle access.

![Figure 7. Rainstore (high capacity storage media) in the cistern area](image)

As shown on the attached plan, 35,177 square feet of the adjacent buildings (19,540 SF from Campus Recreation and 15,637 SF from the Dining Hall) drain to the plaza surface via nine primary downspout nozzles. If this drainage is fully conveyed to the cistern via the surface inlets below the downspout nozzles (as intended), the cistern will be filled by approximately 2.7 inches of rainfall on the adjacent roof areas (in one or more storms). On average, Chapel Hill receives approximately 24 inches of rainfall from April 15th to October 15th, therefore there is the potential to fill and empty the cistern up to 9 times per growing/irrigation season. Assuming that the areas irrigated with cistern water (about 24,000 SF) receive 1.25 inches of irrigation water per week, the cistern can supply just over 3 weeks of complete irrigation without any replenishment.

**Landscape Design**

Plantings on the rooftop plaza attempt to bring the better qualities of the UNC landscape to South Campus by emulating plant palettes of the more historic parts of campus. Oak allées and remnant forest canopy trees line the historic brick walkways of Polk and McCorkle Places on North Campus. The Rams Head Center plaza contains native canopy trees such as White Ash, Red Maple and Yellowwood which will mature over time creating a shaded lawn similar to the more mature landscapes on campus. Lawns cover the greater part of the ground plane on the plaza, providing recreational space for students at this hub of pedestrian traffic. Groundcover and flowering perennial plantings fill the beds in front of the recreation building and along the north wall, providing separation between the edge of the roof parapet wall and the nearby brick walkway. In order to maintain an open landscape typical of campus quads, the planting design
on the roof does not include shrubs. This eliminates hiding spots and students feel safer walking through the space. (Landscape design description provided by Herb Kupfer, Andropogon Associates.)

**Seasonal Operation**

During the irrigation season (starting about 3 weeks before actual irrigation is to begin), the cistern drain valve and the scupper drain valve are closed to begin to fill up the cistern and the 4-inch water storage zone. When irrigation is finished for the year, these valves are fully opened again for the winter. One or more of the adjustable collars in the “through-slab drains” (Figure 8) can also be removed in order to drain the 4-inch water storage layer for winter operation (to be replaced in the spring).

![Image of through-slab drain](image)

Figure 8. Through-slab drain (shown without grate or adjustable collar on right)

**Regular Maintenance**

Catch basins/inlets and water quality inserts (Figure 9) are cleaned out on a regular basis depending on the amount of debris accumulation (catch basins in the lawn receive much less flow and accumulate less material and therefore require less frequent cleaning than those along major pathways such as the cistern inlets). “Access” and “valve boxes” must be kept clear to maintain access and valves will be maintained as necessary. Rigorous vegetative cover should be maintained to prevent soil loss – any erosion at downspouts or elsewhere should be addressed promptly.
Over the life of the building, other maintenance may be required under unexpected circumstances. This might include cleaning/repairing the CMU concrete masonry unit chamber that houses the 4-inch high concrete weir along the north wall of the plaza (Figure 10), snaking the perforated pipe system, replacement of the cistern valve or scupper drain valve, etc.

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Other Construction Photographs

Figure 11. Bricks being placed above cistern

Figure 12. Flood test of cistern area

Figure 13. Geotextile & root protection

Figure 14. Perforated pipes in riverstone layer
References


