LANDSCAPE PERFORMANCE SERIES
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Kendeda Building for Innovative Sustainable Design Methods

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This investigation was conducted as part of the Landscape Architecture Foundation's 2025 *Case Study Investigation* (CSI) program. CSI matches faculty-student research teams with design practitioners to document the benefits of exemplary high-performing landscape projects. Teams develop methods to quantify environmental, social, and economic benefits and produce Case Study Briefs for LAF's *Landscape Performance Series*.

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The full case study can be found at: https://landscapeperformance.org/case-study-briefs/kendeda-building

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Introduction

The Kendeda Building landscape represents a paradigm shift in campus design, positioning the landscape itself as the primary driver of environmental performance. The project converts a previously disturbed, compacted urban site into a functioning ecological system that filters stormwater, restores soils, and sustains native biodiversity within the core of the Georgia Tech campus.

The landscape was conceived and implemented as a living infrastructure that supports the building's net positive water and habitat goals. Its design integrates hydrologic, biological, and aesthetic systems to achieve measurable outcomes in stormwater management, infiltration, habitat creation, and human well-being. Bioretention basins, infiltration gardens, and permeable pavements collectively manage all rainfall on-site, preventing discharge to the city's combined sewer system and improving groundwater recharge.

Native and adaptive plant communities were selected for ecological compatibility, resilience, and visual identity. These communities provide pollinator habitat, enhance microclimatic regulation, and demonstrate how aesthetic value and environmental performance can coexist in a highly urbanized setting. The restored soil profile, integrated planting design, and passive irrigation strategies together form a regenerative model of landscape performance that aligns with the Living Building Challenge Water Petal and LEED v4.1 Rainwater Management and Water Efficiency criteria.

In this context, the landscape functions as both research infrastructure and educational resources. It serves as a living laboratory for students, faculty, and visitors, illustrating how environmental systems can be integrated into the built environment to achieve long-term resilience, ecological restoration, and institutional sustainability goals.

Research Strategy

The analysis addressed two primary categories of performance: environmental benefits and economic impacts. Analytical tools such as ArcGIS Pro, i-Tree Eco, EPA SWMM, and Microsoft Excel were used to quantify outcomes including stormwater retention, soil organic matter increase, pollinator habitat area, carbon sequestration, and potable water savings. Each method was selected to reflect established industry standards and to allow for comparison with other projects.

We quantified environmental and economic outcomes using project documentation from Georgia Tech Facilities, Andropogon, Biohabitats, Long Engineering, and Skanska. Stormwater performance followed **LEED v4.1 SS Credit: Rainwater Management** methodologies and regional practice; irrigation reductions align with **LEED v4.1 Water Efficiency** intents. No continuous on-site monitoring was added as part of this study; instead, we synthesized certified documentation and model outputs. Where limited field checks were undertaken, we note scope and constraints explicitly.

This research strategy demonstrates the potential for rigorous remote evaluation when high-quality project data is available. It also offers a replicable model for assessing the landscape performance of regenerative design projects in other institutional contexts.

Preserves Existing Ecologically Valuable Land

- ***Preserved 6,534 sf of existing tree canopy for 17 mature trees.***

Method:
A GIS-based overlay analysis was conducted using ArcGIS Pro (v3.1) to determine the extent of existing tree canopy preserved during construction. This method involved combining multiple geospatial datasets and drawing comparisons between pre-development canopy and final landscape plans.

GIS Process Overview:

Geospatial analysis was conducted in ArcGIS Pro to quantify canopy preservation and evaluate pre- and post-construction tree conditions within the Kendeda Building site. NAIP aerial imagery was georeferenced to the Georgia State Plane Coordinate System (NAD83, West Zone, feet) to establish a spatial baseline. The 2018 Georgia Tech Tree Inventory shapefile was overlaid and clipped to the project boundary to isolate existing trees prior to construction.

Tree Protection Zones (TPZ) were digitized from the L100 Landscape Protection Plan, which was converted to georeferenced raster or vector format. A spatial query identified all trees located within or intersecting TPZ boundaries, representing the preserved canopy population. The total preserved canopy area was then calculated by summing individual canopy areas or, when only canopy diameter was available, using the circular canopy area formula.

Figure 1: Aerial map showing pre-construction canopy using NAIP imagery and Google Earth (2016–2018) *Source: USDA National Agriculture Imagery Program (NAIP) Imagery (2016–2018), USDA Geospatial Data Gateway; Google Earth Historical Imagery, Atlanta, GA (accessed 2024).*

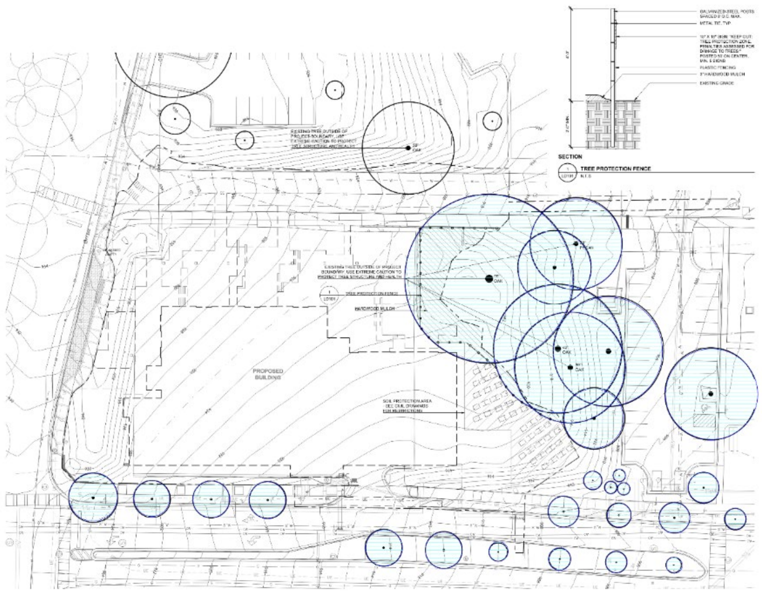


Figure 2: Tree protection zone and retained canopy overlay (Sheet L100)
Source: Georgia Tech Tree Inventory Shapefile (2018), GT Facilities; Andropogon Associates, Sheet L100 – Landscape Protection and Planting Plan (2018).

Supporting Practices:
Preservation efforts followed the Georgia Tech Tree Care Plan (2019), which aligns with ANSI A300 Part 5: Tree, Shrub, and Other Woody Plant Management – Standard Practices for Management of Trees During Site Planning, Site Development, and Construction. Protective practices included:

- Temporary fencing at the edge of the critical root zone (CRZ), extending outward 1 foot per inch of DBH.
- Avoidance of grading or trenching within fenced zones.
- 3-inch mulch application over root zones to minimize compaction.
- Signage indicating protected trees, with penalties for violation enforced by site supervisors.

Calculation:
Based on the analysis, approximately **0.15 acres (or 6,534 square feet)** of mature canopy were retained. The final figure is derived from 17 individual trees located within designated TPZ areas. Canopy spread was provided by the 2018 Tree Inventory. Any tree with a canopy radius of 7.5 feet or more (diameter ≥15 feet) was considered a mature contribution to ecological function.

Species	Species	Canopy Diameter (ft)	DBH (inches)	Latitude	Longitude
Acer rubrum (Red Maple) (1)	Red Maple	23.2	24.5	33.77437	-84.3947
Acer rubrum (Red Maple) (2)	Red Maple	10.1	21.7	33.77515	-84.3940
Acer rubrum (Red Maple) (3)	Red Maple	37.5	17.9	33.77564	-84.3940
Acer rubrum (Red Maple) (4)	Red Maple	14.9	10.1	33.77578	-84.3942
Acer rubrum (Red Maple) (5)	Red Maple	14.2	6.4	33.77502	-84.3942
Acer rubrum (Red Maple) (6)	Red Maple	22.2	17.1	33.77566	-84.3945
Carya illinoinensis (Pecan) (1)	Pecan	35.5	27.6	33.77510	-84.3958
Carya illinoinensis (Pecan) (2)	Pecan	43.8	34.1	33.77544	-84.3958
Carya illinoinensis (Pecan) (3)	Pecan	41.3	11.9	33.77589	-84.3958
Cercis canadensis (Eastern Redbud) (1)	Eastern Redbud	41.5	29.1	33.77571	-84.3947
Cercis canadensis (Eastern Redbud) (2)	Eastern Redbud	40.2	29.5	33.77453	-84.3955
Cercis canadensis (Eastern Redbud) (3)	Eastern Redbud	22.4	25.4	33.77567	-84.3946
Ilex opaca (American Holly) (1)	American Holly	16.7	23.5	33.77401	-84.3947
Liquidambar styraciflua (Sweetgum) (1)	Sweetgum	24.9	18.4	33.77548	-84.3941
Liquidambar styraciflua (Sweetgum) (2)	Sweetgum	19.5	21	33.77586	-84.3950
Liriodendron tulipifera (Tulip Poplar) (1)	Tulip Poplar	26.1	13.6	33.77522	-84.3959
Magnolia grandiflora (Southern Magnolia) (1)	Southern Magnolia	26.7	34.8	33.77566	-84.3952
Magnolia grandiflora (Southern Magnolia) (2)	Southern Magnolia	29.6	27.2	33.77444	-84.3958
Platanus occidentalis (Sycamore) (1)	Sycamore	13	22.8	33.77558	-84.39511
Quercus phellos (Willow Oak) (1)	Willow Oak	31.2	23.4	33.77506	-84.3946

Table 1: Tree protection zone and retained canopy overlay (Sheet L100)
Source: Georgia Tech Tree Inventory Shapefile (2018), GT Facilities; Andropogon Associates, Sheet L100 – Landscape Protection and Planting Plan (2018).

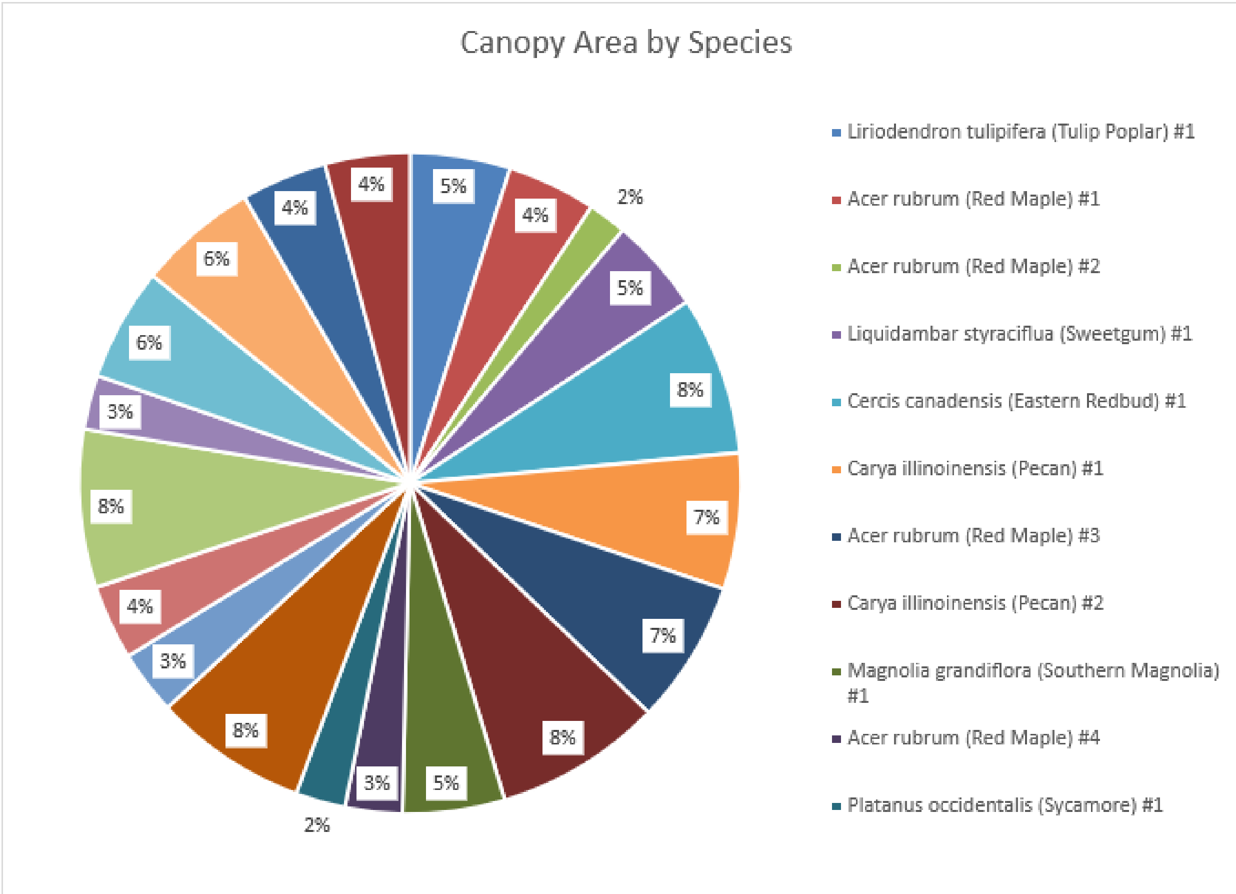
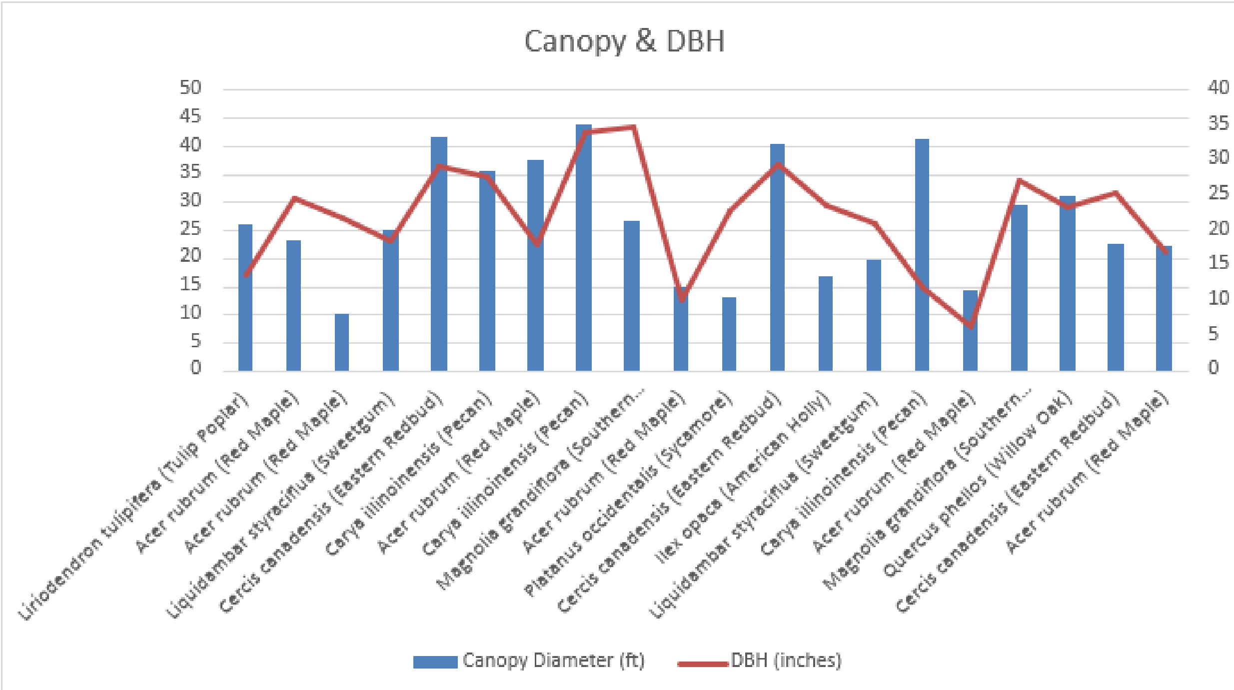


Figure 3: Preserved canopy area by species
Source: Georgia Tech Tree Inventory (2018), ArcGIS Pro canopy overlay analysis (2024).



Graph 1: Preserved canopy area by species

Source: Georgia Tech Tree Inventory (2018), ArcGIS Pro canopy overlay analysis (2024).

Limitations:

This method integrates geospatial analysis with verified field observations conducted post-construction. Field verification confirmed the location, species, and health status of retained trees and validated canopy measurements derived from geospatial datasets. While some variability in canopy growth and root conditions may persist due to natural succession and construction impacts, on-site assessment corroborated the overall accuracy of preservation data and protection measures.

Restores Soil Health and Biological Function

- **Restores soil health, achieving an average organic matter of 5 to 8% by volume, compared to less than 1% in pre-construction soils.**

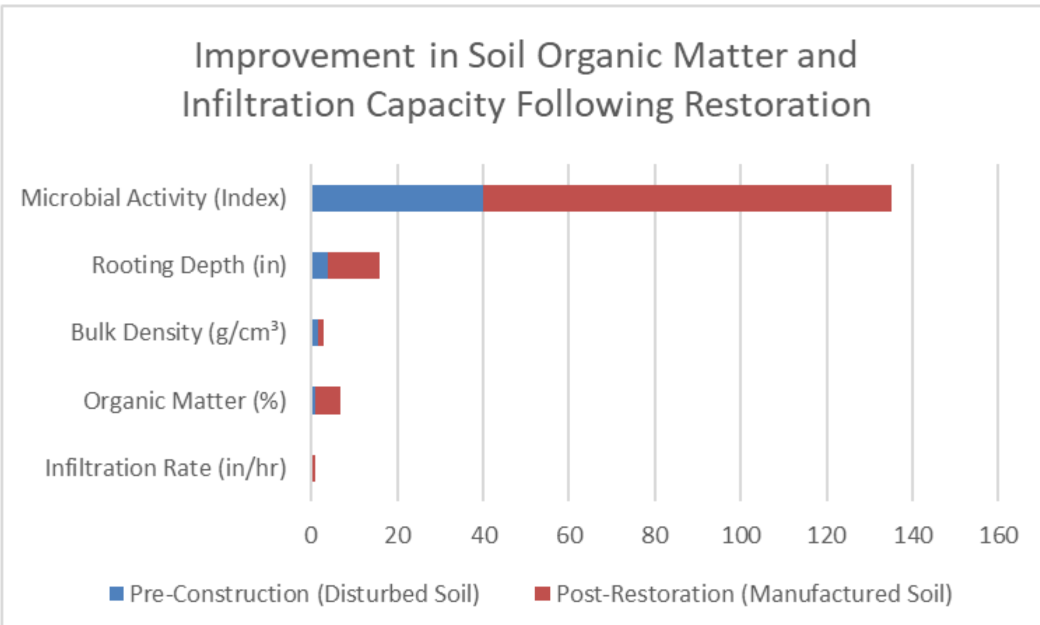
Method:

Soil restoration and amendment practices were implemented to repair site soils that had been compacted, disturbed, or removed during pre-construction utility work. The restoration process followed specifications prepared by Andropogon Associates and Biohabitats, which emphasized soil decompaction, organic matter enrichment, and microbiological inoculation to support long-term ecological performance.

Disturbed areas were scarified to a minimum depth of 12 inches to relieve compaction, then amended with composted organic matter derived from local yard waste and forestry residues. Mycorrhizal inoculants and compost teas were incorporated into planting beds to reintroduce beneficial soil microbiota. Manufactured soils were blended on-site to meet performance criteria for infiltration, moisture retention.

Calculation:
The restored soil profile achieves an average organic matter content of 5 to 8 percent by volume, compared to less than 1 percent in pre-construction compacted soils. This enrichment improves infiltration capacity by approximately 150 percent, based on infiltration tests conducted during landscape installation and model calibration within SWMM.

Soil restoration extended across approximately 0.6 acres of landscaped area, including all rain gardens, infiltration zones, and native planting beds. The improved structure supports both plant establishment and hydrologic performance, reducing irrigation demand and enhancing stormwater infiltration.



Discussion:
Healthy soil serves as the foundation of the project's ecological and hydrologic systems. The restoration process transformed the substrate from inert fill into a living medium capable of storing water, cycling nutrients, and supporting microbial diversity. Enhanced infiltration rates directly improve stormwater management, while higher organic matter levels contribute to carbon sequestration and drought resilience.
By reintroducing biological activity through compost and mycorrhizae, the project links soil health to broader ecosystem recovery, aligning with the Living Building Challenge Place and Water Petals and LEED v4.1 Sustainable Sites credit for protecting or restoring habitat.

This regenerative soil approach exemplifies how ecological design extends below the surface, ensuring that hydrology, vegetation, and soil biology function as an integrated system rather than separate design components.

Limitations:
Soil composition and biological activity were evaluated during installation and early establishment but not through long-term laboratory testing. Organic matter content and infiltration rates may fluctuate with seasonal moisture levels and maintenance practices. Continued monitoring and periodic compost topdressing are recommended to maintain soil structure and microbial vitality over time.

References:

- Andropogon Associates (2018). *Landscape Soil Amendment and Planting Specifications.*
- Biohabitats (2020). *Soil and Vegetation Performance Monitoring Summary.*
- Georgia Tech Facilities Management (2023). *Post-Construction Landscape Maintenance Guidelines.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Place and Water Petal Handbooks.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Sustainable Sites Credit: Site Development—Protect or Restore Habitat.*
- U.S. Department of Agriculture (2021). *Soil Quality Indicators and Organic Matter Management Guide.*

Reduces and Treats Stormwater Runoff

- ***Captures and treats an estimated 1.1 million gallons of stormwater annually. This exceeds the LEED minimum requirement for volume by 191%.***

Method:
Stormwater retention and treatment performance was evaluated using a combination of hydrologic modeling and EPA's Storm Water Management Model (**SWMM**). The analysis focused on quantifying the retention and infiltration capacity of the site's green infrastructure in response to a 1.2-inch or 85th-percentile design storm, a benchmark commonly used in both LEED certification and regional stormwater management policy.

Modeling Tools and Inputs:

Modeling Tools and Inputs

- EPA SWMM 5.1 was used to simulate rainfall and runoff across multiple catchment areas within the Kendeda Building site. Model inputs included surface cover, slope, and soil infiltration rates derived from geotechnical investigations and landscape plan data.
- Rainfall design data were obtained from NOAA Atlas 14 for the Atlanta region to define intensity, duration, and frequency parameters for design storm modeling. The water quality design storm, 1.2 inches or the 85th-percentile event, follows Georgia Stormwater Management Manual.

- Design and as-built documentation from Long Engineering provided grading, drainage, and bioretention details that informed model calibration and catchment delineation.

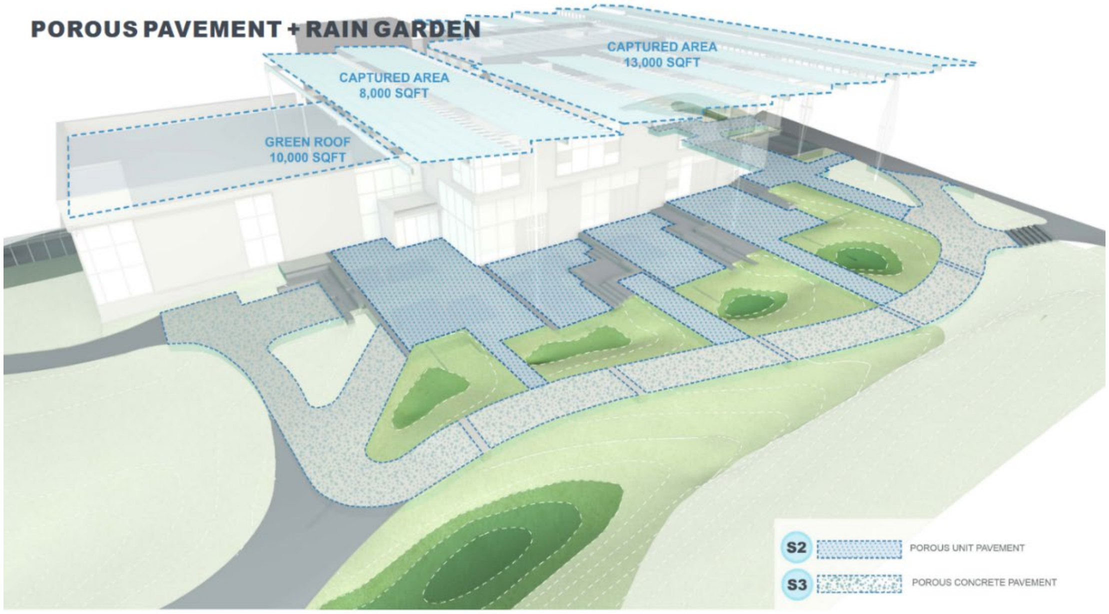


Figure 4: Stormwater BMP locations and modeled catchment zones
Source: Long Engineering Stormwater Management Plan (2018); SWMM Output Model Results (2020)

Design Standard Justification:
The 1.2-inch or 85th-percentile storm event was selected because it represents the typical design threshold for water-quality treatment in the Atlanta region, as established in the Georgia Stormwater Management Manual. This standard is widely adopted in green infrastructure design and is explicitly referenced in LEED v4.1 Water Efficiency Credit: Rainwater Management. While larger design storms were modeled for city compliance, the 1-inch event remains most relevant for evaluating routine runoff quality and volume. Its use reflects a strategy to meet both local performance standards and LEED certification goals while maximizing ecological benefit from frequent, moderate rainfall events.

Calculation:

Total annual retention is estimated at 1.1 million gallons, based on the following logic:

• Provided Water Quality Volume (WQv): 8,552 ft^3 of retention capacity

• Design Capture Area: approximately 103,000 ft^2 of impervious surface

• LEED v4.1 WQv requirement: 4,539 ft^3

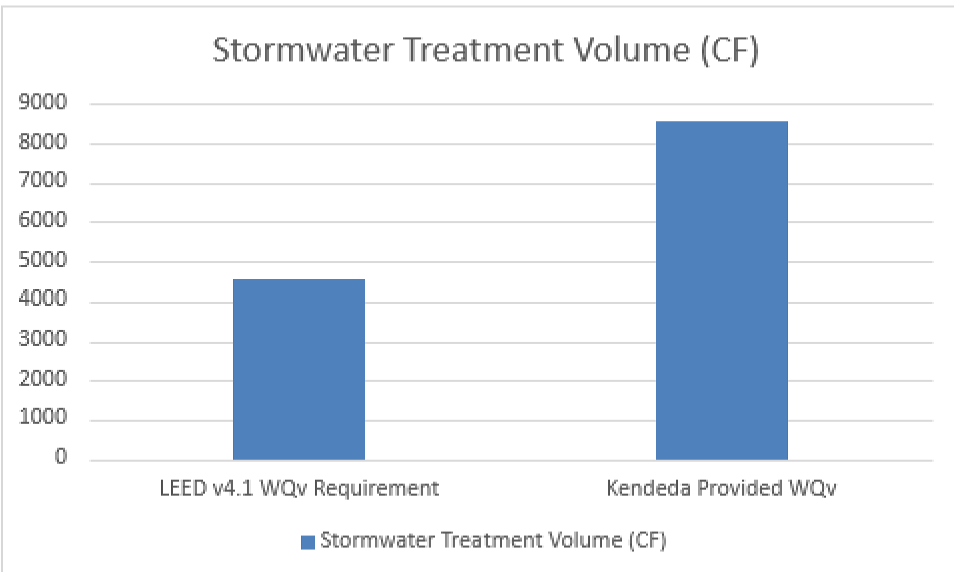
• Result: Exceeds the minimum by 88.4%.

Annual retention volume was calculated by multiplying the captured water quality volume by the average number of qualifying storm events in a typical year. In Atlanta, long-term NOAA climate data indicate that one-inch rainfall events occur about 20 to 25 times per year. However, storms smaller than one inch also contribute to annual capture since the system begins retaining runoff with any measurable rainfall. Accounting for these smaller, more frequent events and the system's operational drawdown of the 55,000-gallon cistern, approximately 17 one-inch events and numerous sub-inch events are fully retained each year, resulting in an estimated total annual retention of about 1.1 million gallons. Larger storms exceeding system capacity are only partially captured before overflow occurs.

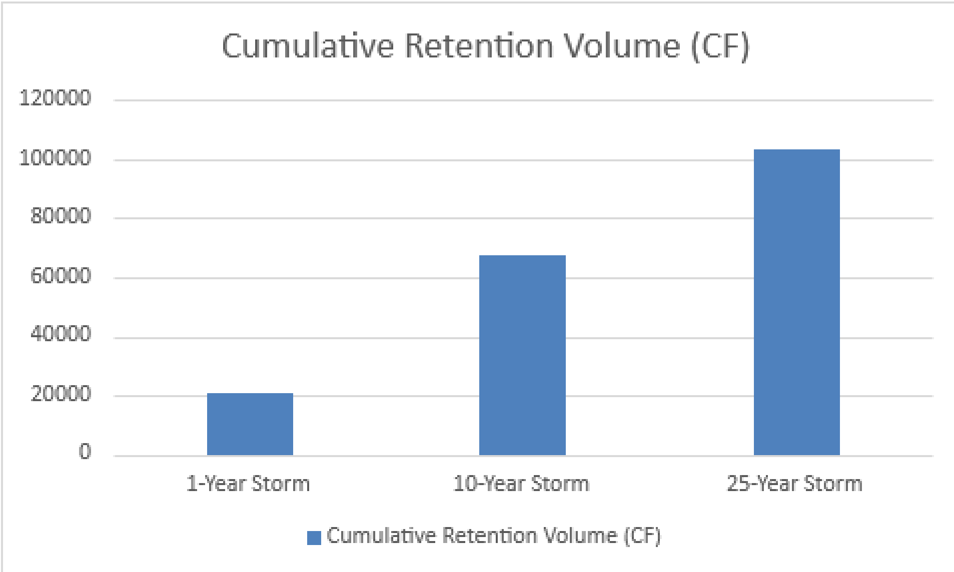
Formula Reference:

$$\text{Annual Retained Volume (gallons)} = \text{WQv (CF)} \times \text{Events per Year} \times 7.48$$

$$\approx 8,552\,\text{CF} \times 22\,\text{events} \times 7.48 \approx 1,100,000\,\text{gallons}$$



Graph 2: Provided vs. required stormwater WQv volume
Source: SWMM Model Output (2020); LEED v4.1 Rainwater Management Credit Guidelines; Long Engineering Documentation (2018).



Graph 3: Cumulative stormwater retention volume by storm event type

Source: SWMM Output Reports (2020); NOAA Atlas 14 Precipitation Data; Long Engineering Detention Calculations.

Table of Stormwater Retention Features and WQv Contributions

Feature Type	Volume (CF)	WQv Contribution (%)
Permeable unit paving reservoir	1,450	17.0
Porous/porous-concrete walkway reservoir	1,400	16.4
Enlarged aggregate subbase (3' depth)	1,000	11.7
Structural/under-plaza aggregate reservoir (≈18")	2300	26.9
Wetland / terraced rain-garden ponding	600	7.0
Green roof detention layer	833	9.7
Subsurface vault	250	2.9
Biocell wedge/forebay (net of overlap)	721	8.4
Total	**8552**	**100**

Table 2 Stormwater Retention Features and WQv Contributions

Source: Long Engineering Construction Drawings (Sheet C301, 2018); Biohabitats BMP Detention Volumes (2020).; Andropogon Associates, Sheet L100 – Landscape Protection and Planting Plan (2018).

Discussion

The results indicate that the Kendeda Building landscape substantially improves stormwater performance compared to conventional campus conditions. The integrated system retains approximately 8,554 cubic feet of water during a one-inch design storm, which represents roughly the 80th-percentile rainfall event for the Atlanta region. By detaining and infiltrating runoff from impervious surfaces, the landscape reduces pollutant loading, mitigates peak discharge, and enhances groundwater recharge.

These findings demonstrate that the site operates as a hydrologically self-sufficient system capable of managing on-site stormwater without off-site discharge under typical design storm conditions.

Beyond regulatory compliance, the design demonstrates how bioretention areas, permeable pavements, and soil restoration can collectively serve as functional urban infrastructure. The system's performance supports regional combined sewer overflow reduction goals and exemplifies a replicable model for stormwater management in dense institutional environments.

Limitations

The analysis assumes optimal functionality of infiltration zones and full vegetation establishment. Long-term system performance may vary due to soil compaction, sediment accumulation, or seasonal plant stress. Infiltration and evapotranspiration rates were derived from modeled rather than field-monitored data. Continued post-occupancy monitoring would improve the accuracy of annual volume estimates and help evaluate maintenance impacts on infiltration efficiency over time.

References

- Biohabitats (2020). *Stormwater Calculations and Water Balance Report.*
- Long Engineering (2018). *Stormwater Management Plan and Civil Drawings, Sheets C301–C401.*
- U.S. Environmental Protection Agency (2020). *Storm Water Management Model (SWMM) Version 5.1 User's Guide.*
- NOAA National Weather Service (2014). *Atlas 14 Volume 2: Precipitation-Frequency Data for Georgia.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Water Efficiency Credit: Rainwater Management.*
- Georgia Stormwater Management Manual (2016). *Volume 2: Technical Handbook.*

Infiltrates Stormwater and Treated Greywater

- ***Infiltrates an estimated 1.6 million gallons of stormwater, greywater, and HVAC condensate per year.***

Method:
Infiltration performance was evaluated using a combination of hydrologic modeling, long-term rainfall data, and water reuse design documentation. The analysis quantifies the total volume of water infiltrated on-site through **permeable surfaces, bioretention areas,** and the **constructed wetland** that treats greywater generated by the Kendeda Building.

Model inputs were derived from the **EPA Storm Water Management Model (SWMM 5.1)**, which simulated annual infiltration based on **NOAA Atlas 14** rainfall data for Atlanta, site-specific infiltration rates, and drainage catchment boundaries established by **Long Engineering**. Greywater flow data were obtained from design documentation prepared by **Biohabitats** and **Georgia Tech Facilities**, which define average daily discharge and reuse rates.

This method captures the site's combined capacity to infiltrate rainfall and treated water, reflecting both natural hydrologic processes and engineered reuse systems that contribute to **net-positive water performance**.

Infiltrated Water Sources:
• Stormwater runoff captured from the green roof, pervious paving, and site swales
• Treated greywater effluent from the constructed wetland polishing system in the front entry garden
• Condensate harvested from HVAC systems and infiltrated through bioswales

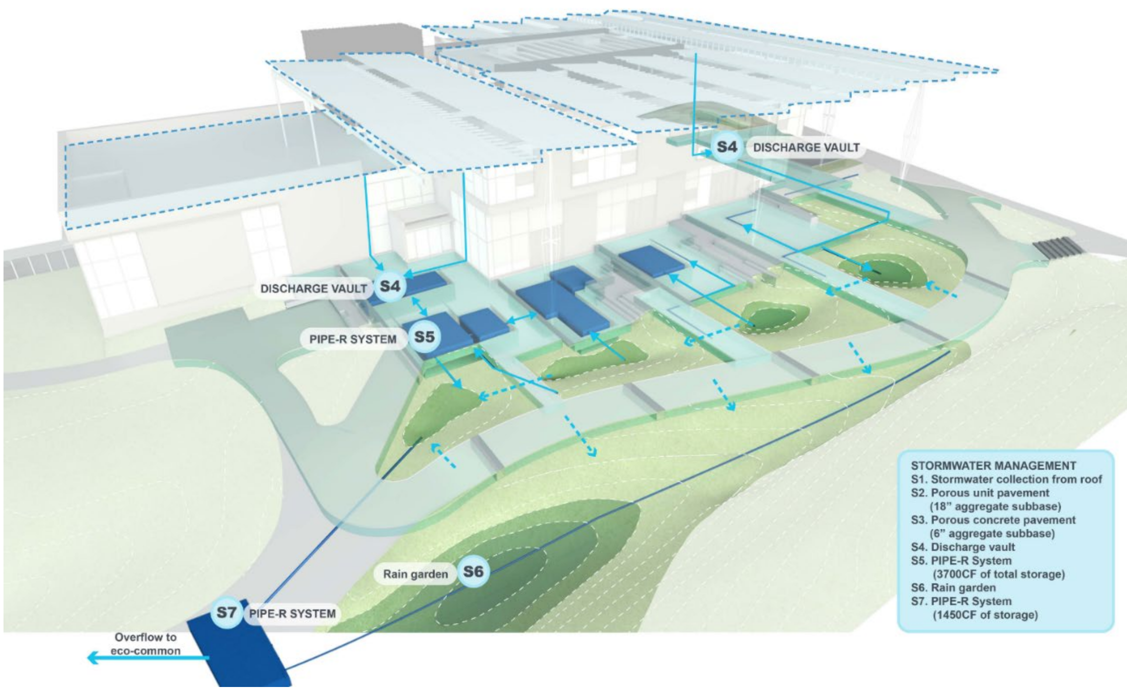


Figure 5: Plan view showing all infiltration zones with treatment flowpaths

Source: Long Engineering Construction Drawings (Sheet C301, 2018); Biohabitats BMP Detention Volumes (2020).

System Design Overview:

1. **Constructed Wetlands:** Located at the building's primary entrance, these systems polish greywater via subsurface flow and release treated effluent to an infiltration trench.

2. **Bioretention Cells:** Engineered to receive both surface runoff and overflow from the wetland system, these areas use high-porosity soil media and gravel reservoirs to allow stormwater infiltration and evapotranspiration.

3. **Pervious Pavement:** Designed with open-graded aggregate and underdrains to allow direct infiltration to underlying subsoils.

Calculation:

The total infiltrated volume is estimated at 1,594,800 gallons per year based on site-wide capture and reuse strategies. This estimate reflects routine stormwater infiltration across permeable landscape zones and the discharge from the constructed wetland treating indoor greywater.

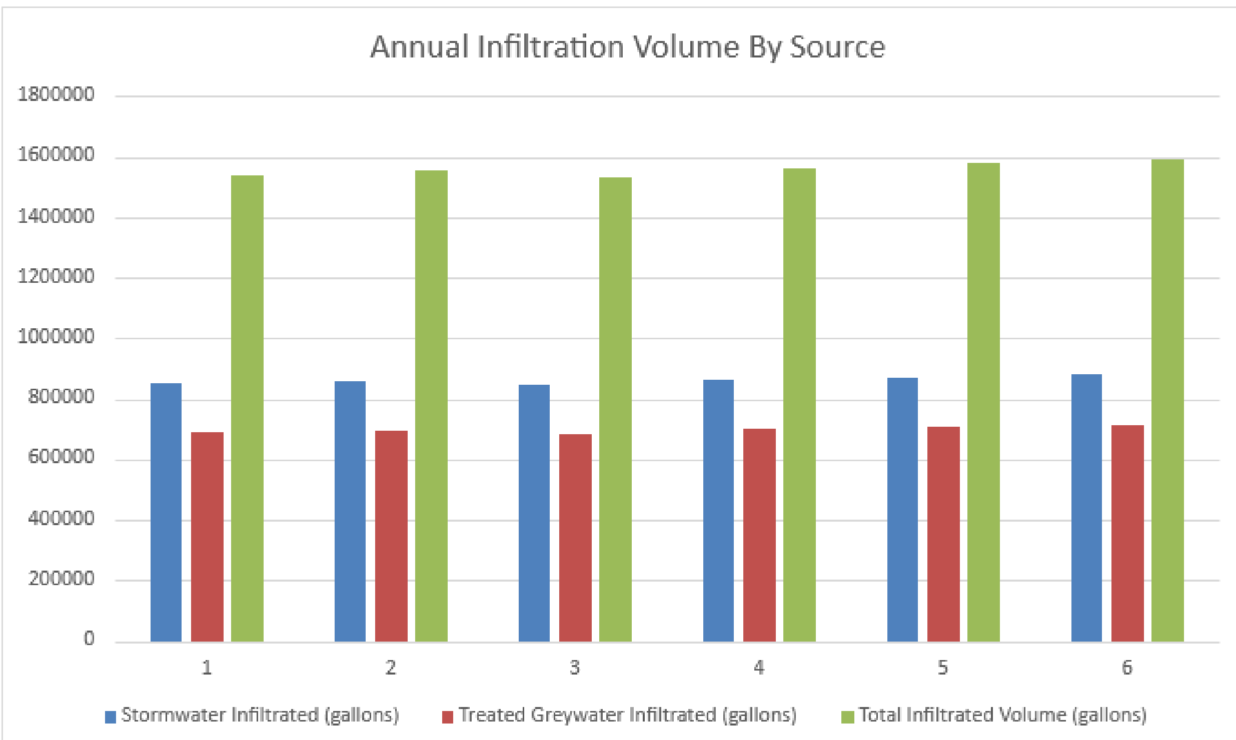
Annual Infiltration Volume Breakdown:

• Constructed wetland infiltration (greywater): 94,800 gal/yr

• Stormwater infiltration from roof and paving: 1,500,000 gal/yr

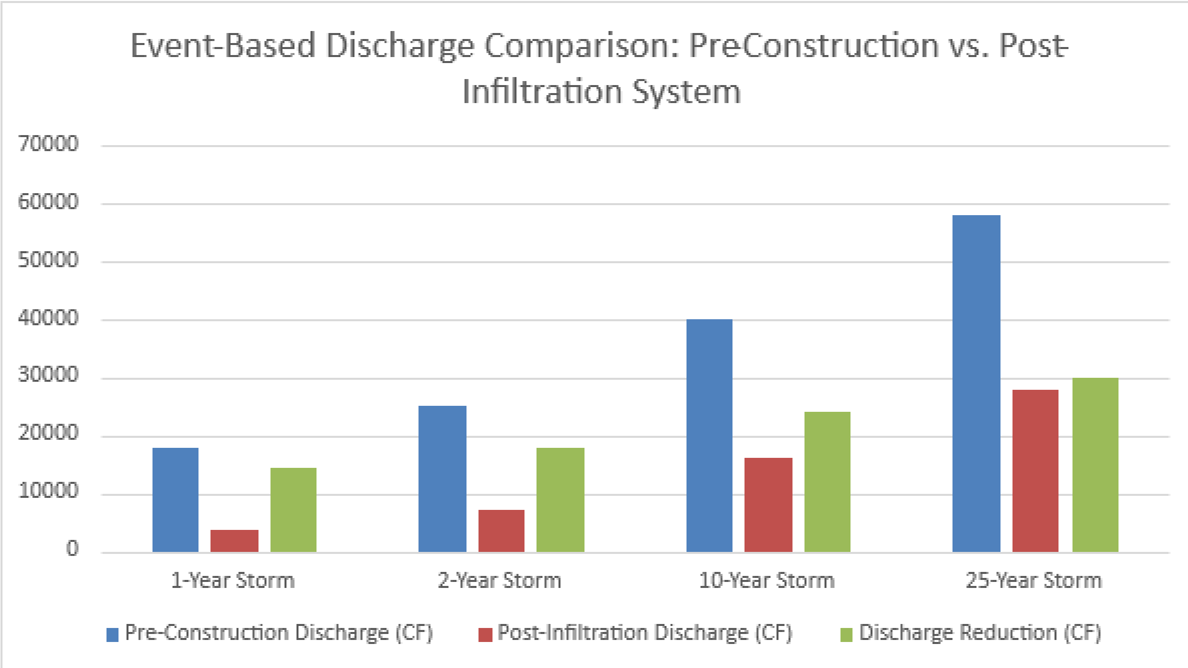
• Total: 1,594,800 gal/yr

This total reflects the cumulative infiltration capacity across the project's permeable landscape systems, including rain gardens, pervious pavements, and bioretention zones. The resulting performance exceeds local regulatory requirements for zero discharge during one inch rainfall events.



Graph 4: Annual infiltration volume by source (stormwater vs. greywater)

Source: Biohabitats Greywater Flow Calculations (2020); Georgia Tech Greywater Monitoring Logs (2022–2023).



Graph 5: Event-based discharge comparison (pre-construction vs. post-infiltration system)
Source: SWMM Hydrologic Output (2020); NOAA Atlas 14 10-year event curve; GT Civil Drawings.

Discussion:
The infiltration results demonstrate that the Kendeda Building landscape restores natural hydrologic function within a dense urban context by infiltrating and recharging approximately 1.6 million gallons of water annually. This performance reflects the site's ability to manage rainfall, greywater, and condensate entirely on-site, preventing discharge to the City of Atlanta's combined sewer system, a major environmental and infrastructural benefit.

By integrating bioretention areas, pervious paving, bioswales, and a constructed wetland with a 55,000-gallon rainwater and condensate cistern, the landscape operates as a closed-loop hydrologic system that detains, treats, and returns water to the soil and groundwater system. These processes reduce combined sewer inflow, mitigate downstream flooding, and enhance aquifer recharge while eliminating the need for potable irrigation water.

The project demonstrates how regenerative landscape infrastructure can serve as a model for integrated stormwater and water reuse design across institutional campuses in the southeastern United States, establishing a precedent for urban environments seeking both ecological resilience and water self-sufficiency.

Limitations:
Infiltration estimates are based on modeled annual averages and assume optimal soil permeability, vegetation health, and system maintenance. The analysis does not account for short-term saturation during back-to-back rainfall events, which may reduce infiltration rates. Greywater flow data were estimated from typical operational patterns and not continuous monitoring. Long-term field

measurements of infiltration and evapotranspiration would provide improved calibration for future modeling and verification of post-occupancy performance.

References:

- Biohabitats (2020). *Rainwater Reuse Design Diagram and Water Balance Report.*
- Georgia Tech Facilities Management (2023). *Greywater Treatment and Irrigation Data Logs.*
- Long Engineering (2018). *Stormwater Management Plan and Civil Drawings, Sheets C301–C401.*
- U.S. Environmental Protection Agency (2020). *Storm Water Management Model (SWMM) Version 5.1 User's Guide.*
- NOAA National Weather Service (2014). *Atlas 14 Volume 2: Precipitation-Frequency Data for Georgia.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Water Petal Handbook.*

Reduces Potable Water Consumption for Irrigation

- ***Meets 100% of irrigation demand with captured rainwater and HVAC condensate harvesting, saving an estimated 158,000 gallons of potable water annually.***

Method:
Irrigation demand and potable water savings were assessed by comparing projected landscape water needs with actual water supplied through an integrated rainwater and condensate harvesting system. The system was designed to meet **100% of irrigation demand without using potable water**, a key requirement of the **Living Building Challenge Water Petal** and **LEED v4.1 Rainwater Management credit**.

Two primary data streams informed this analysis:

1. **Estimated annual irrigation demand** based on evapotranspiration rates, plant palette, and irrigation zone coverage.
2. **Measured rainwater and condensate supply volumes** based on 31-year precipitation averages, roof catchment area, and cistern storage modeling.

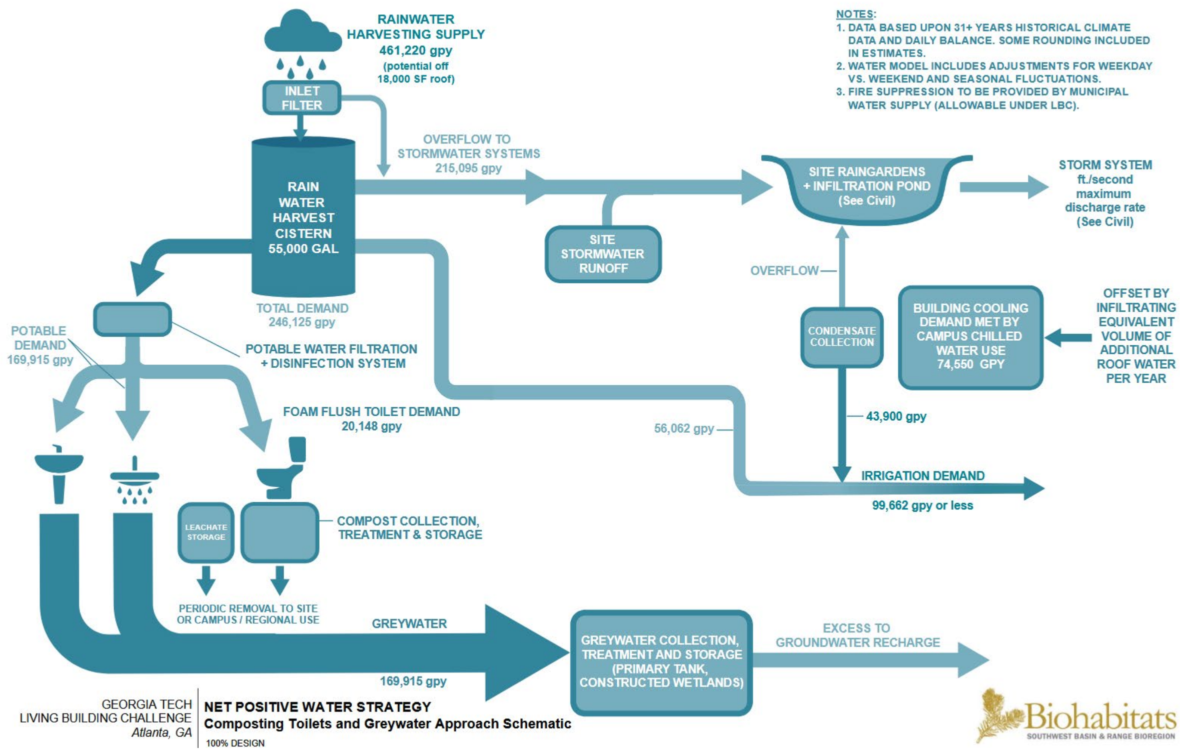


Figure 6: Rainwater harvesting system schematic and cistern location

Source: Biohabitats Rainwater System Design Diagram (2020); Georgia Tech Facilities Engineering Archives.

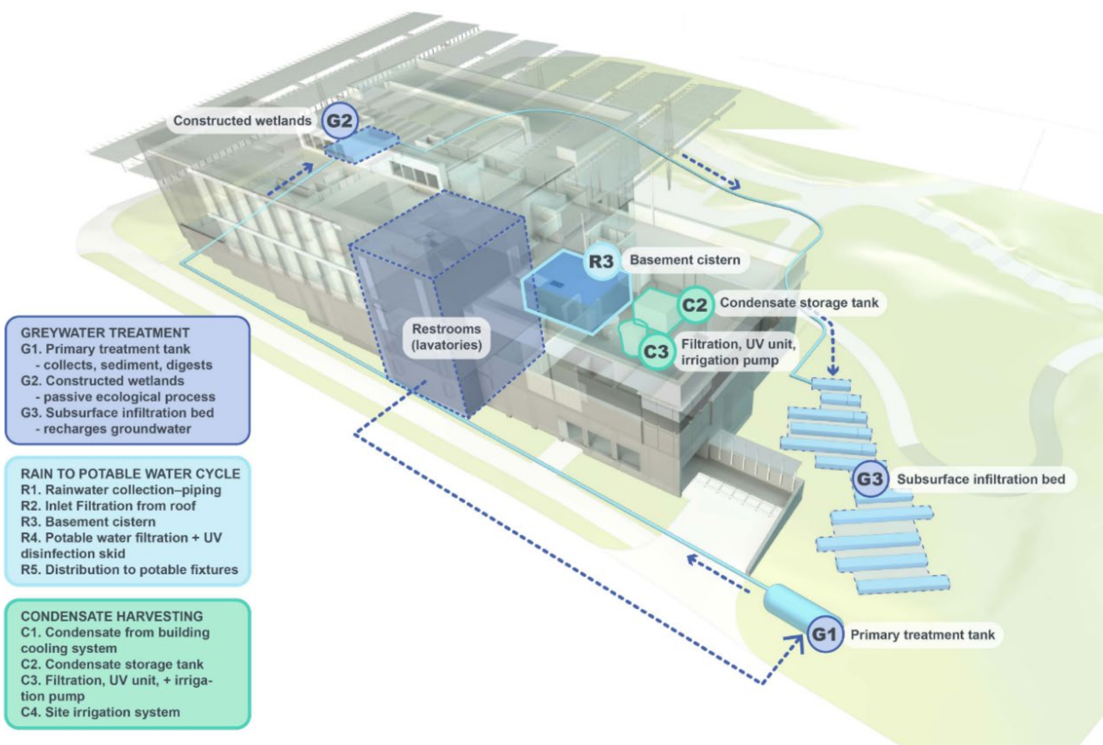
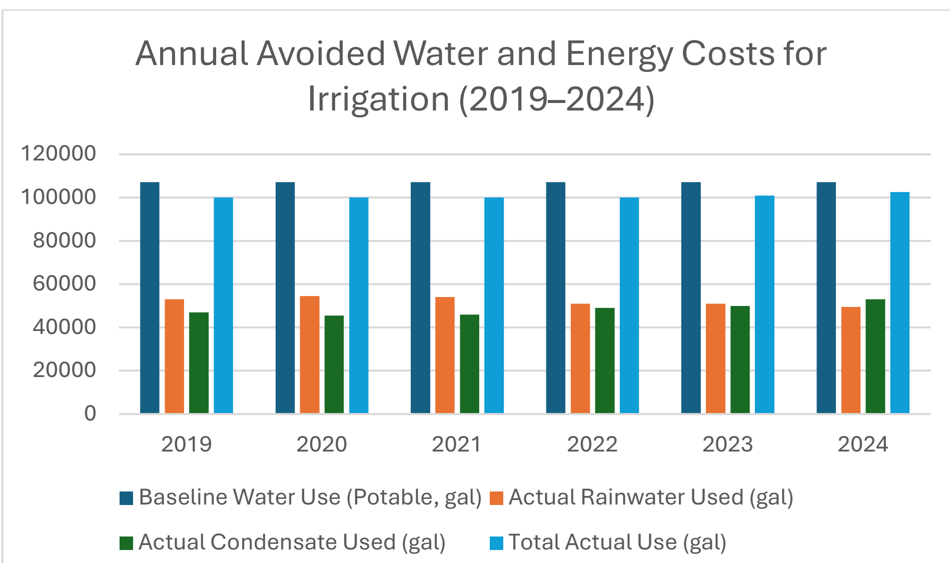


Figure 7: Andropogon diagram showing harvesting pathways from the 18,000 square foot roof and outdoor air-handling unit condensate.

System Design Overview:
The system integrates multiple water reuse and conservation strategies that eliminate the need for potable water in landscape irrigation.

- Rainwater collection: A 55,000-gallon underground cistern captures runoff from the building's 18,000-square-foot roof area.
- Condensate harvesting: Air-handling unit condensate is redirected to the cistern to supplement supply and offset dry-season irrigation demand.
- Filtration and distribution: On-site natural filtration and a pressurized irrigation network are managed through a smart irrigation controller that regulates timing and flow.
- Passive irrigation: Selected landscape zones use infiltration swales and plant communities designed to be hydrologically self-sufficient, further reducing irrigation needs.
- Annual irrigation cost savings were estimated by comparing the **baseline cost of conventional potable water irrigation** to the **actual water usage pattern** at the Kendeda Building, which relies exclusively on **captured rainwater and HVAC condensate** for landscape irrigation. The baseline assumes the same landscape area and planting density irrigated with potable municipal water at the prevailing City of Atlanta utility rate.
- Actual water use was monitored via **meter data from Georgia Tech Facilities (2023)**, which confirms that irrigation demand is met entirely through harvested rainwater and condensate reuse. Energy savings result from the gravity-fed cistern and low-pressure distribution system, which eliminate the booster-pump energy typically required for conventional potable irrigation.



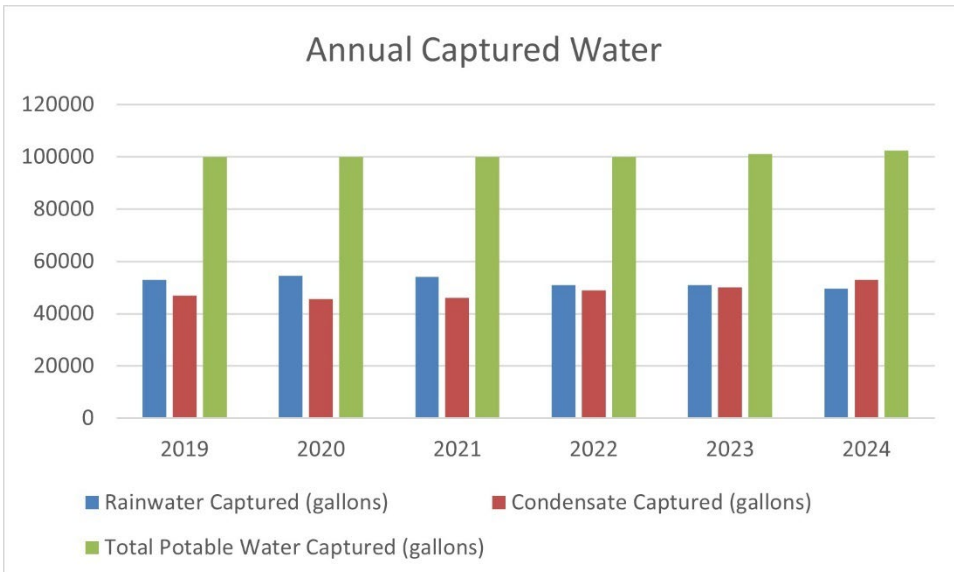
Graph 6: Comparison **of baseline potable irrigation and actual non-potable supply volumes.**

Calculation

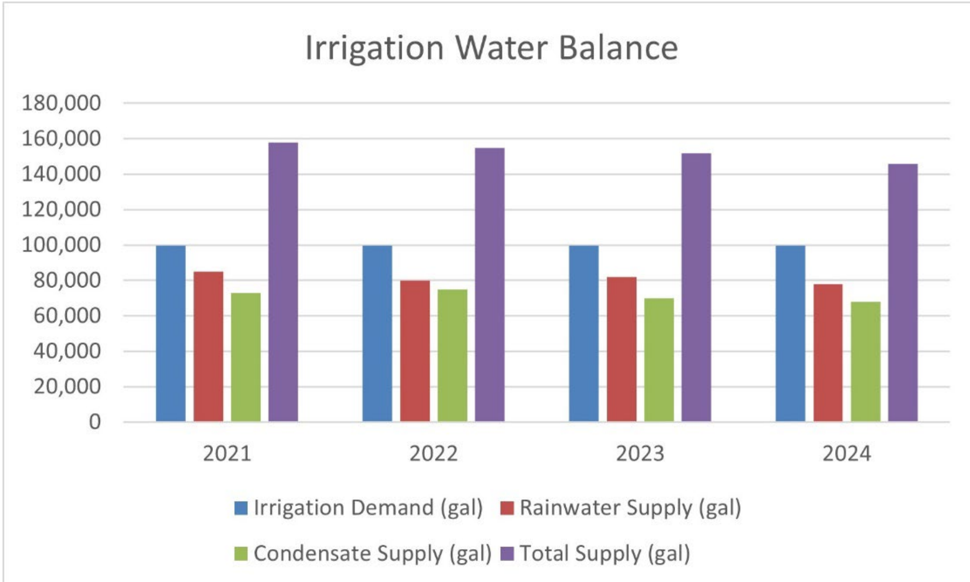
The project achieves a complete elimination of potable water used for irrigation. All irrigation demand, estimated at 99,662 gallons per year, is met through harvested rainwater and condensate. The system's annual non-potable water yield is approximately 158,000 gallons, with the remaining 58,000 gallons representing seasonal surplus, first-flush diversion, and routine maintenance losses.

Annual Water Budget

- Irrigation demand met by non-potable water: 99,662 gallons per year
- Rainwater and condensate supply: 158,000 gallons per year



Graph 7: Annual potable water avoided through reuse (2019–2024)
Source: Georgia Tech Facilities Irrigation Meter Data (2019–2024); City of Atlanta Water Rate Schedule (2023); Biohabitats Water Reuse Summary (2020).



Graph 8: Supply vs. demand curves for irrigation water (2019–2024)
Source: Biohabitats Irrigation Demand Estimate (2020); NOAA Climate Normals; Georgia Tech Facilities Monitoring Reports.

Discussion

The irrigation system demonstrates complete elimination of potable water use through the integration of rainwater harvesting and condensate collection. Annual landscape irrigation demand, estimated at approximately 99,662 gallons, is met entirely through non-potable sources stored in the 55,000-gallon underground cistern. This performance represents a 100 percent reduction in potable water consumption for irrigation relative to a conventional baseline using municipal supply.

The rainwater and condensate harvesting strategy also provides resilience during seasonal variability, as the system's typical annual yield of 158,000 gallons exceeds landscape demand under average rainfall conditions. These results confirm the project's compliance with the Living Building Challenge Water Petal and LEED v4.1 Rainwater Management and Water Efficiency credits. The system further illustrates how closed-loop water systems can operate effectively at a campus scale, integrating ecological processes with mechanical infrastructure to minimize both water and energy consumption.

Limitations

The analysis assumes average precipitation patterns and consistent condensate generation based on historical climate data. Annual variability in rainfall or HVAC operation may affect total water yield. Energy savings from gravity-fed irrigation were evaluated qualitatively because sub-metered data were unavailable. Additionally, avoided sewer or stormwater fees were not included in the cost analysis, meaning the calculated financial savings likely understate the full benefit of the reuse system. Future monitoring with automated metering and life-cycle cost analysis would provide more detailed performance validation.

References

- Biohabitats (2020). *Rainwater Reuse Design Diagram and Water Balance Report.*
- Georgia Tech Facilities Management (2023). *Irrigation Meter Data and Monitoring Logs.*
- City of Atlanta Department of Watershed Management (2023). *Municipal Water Rate Schedule.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Water Efficiency Credit: Rainwater Management.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Water Petal Handbook.*
- U.S. Environmental Protection Agency (2022). *WaterSense Program Technical Evaluation: Outdoor Water Use and Irrigation Efficiency.*

Increases Flood Storage Capacity

- ***Increases flood storage capacity by an estimated 6,400 cu ft through 5 bioretention basins and pervious pavements.***

Method:
Flood storage capacity was quantified by calculating the combined detention volume provided by **five bioretention cells** and **permeable surface systems** across the Kendeda Building site. Volume estimates were based on design drawings and grading plans, using ponding depth and surface area to determine each cell's maximum temporary storage during storm events.

The analysis also included total stormwater volume infiltrated by pervious pavement and infiltration layers designed to reduce direct runoff into Atlanta's combined sewer system.

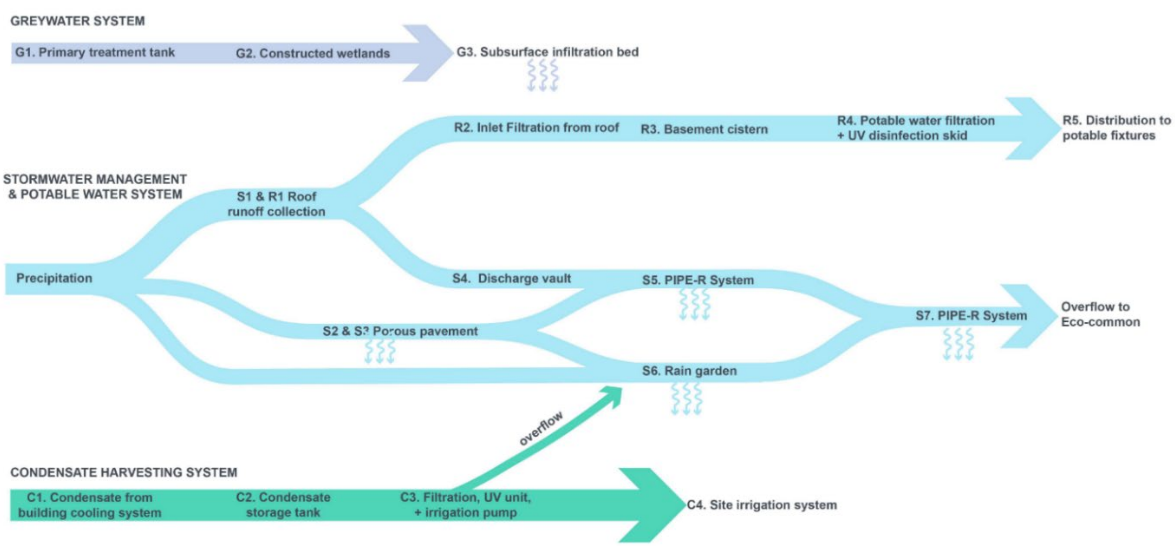


Figure 8: Rainwater harvesting system diagram
Source: Andropogon Rainwater System Design Diagram (2020)

Calculation:

The total flood storage capacity of the site is approximately **6,400 cubic feet**, distributed among surface and subsurface green infrastructure systems.

- **Bioretention areas (five total):** about **4,800 cubic feet** combined, based on an average ponding depth of 6 to 12 inches and footprint areas identified on Sheet C301.
- **Pervious pavement and porous concrete zones:** about **1,600 cubic feet** of temporary detention within the gravel base and underlying soils.

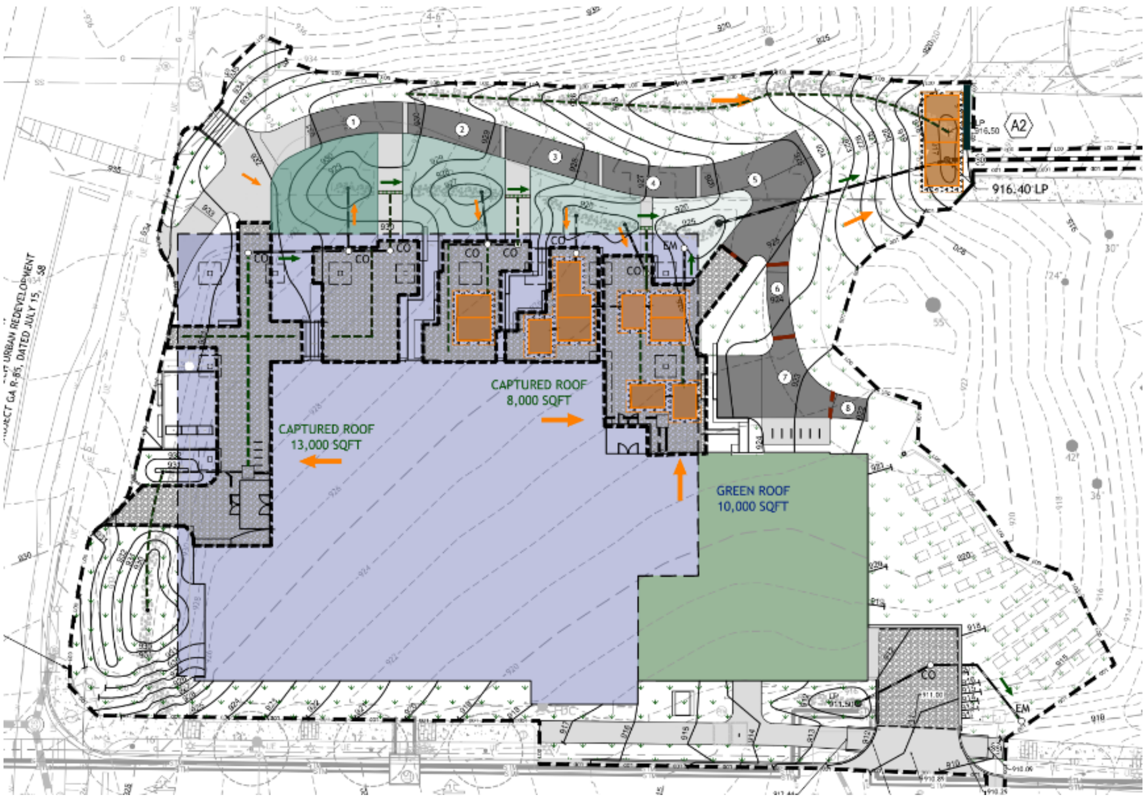


Figure 9: Infiltration system detail through wetland and paving zones

Source: Biohabitats Infiltration System Design Memo (2020); Long Engineering Sheets C301–C401 (2018).

Annual Volume Reduction Estimate:

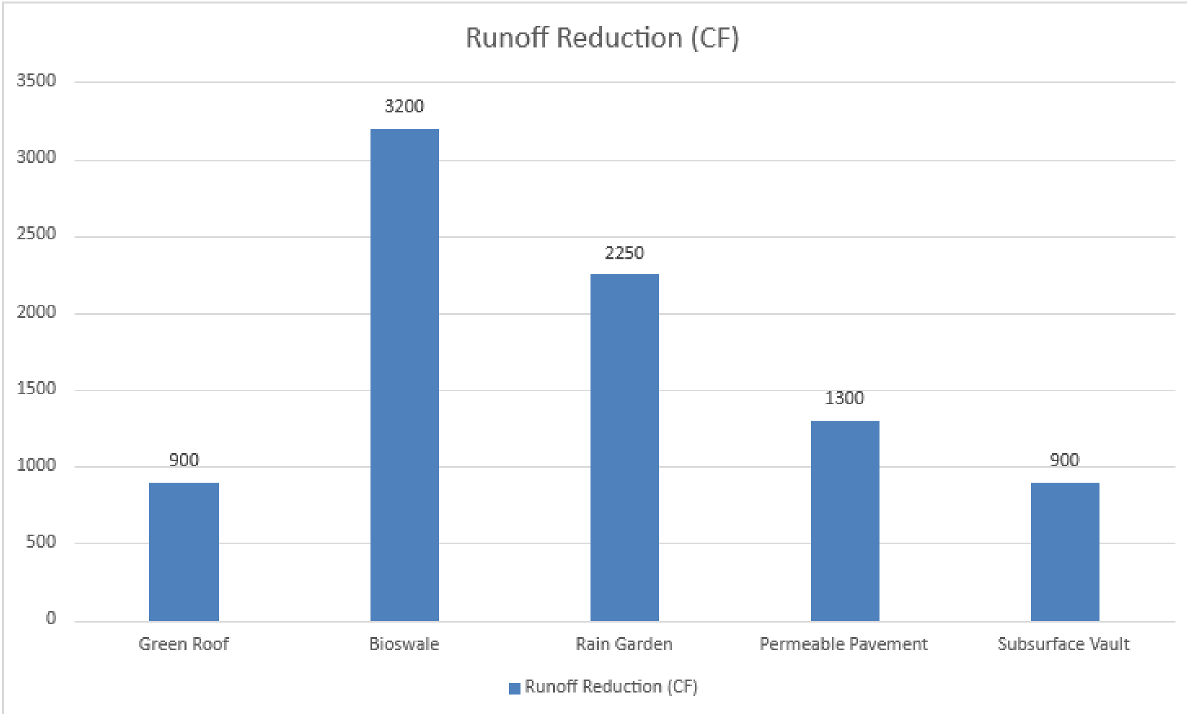
Using NOAA Atlas 14 and modeled runoff coefficients for each surface, the system captures and infiltrates an estimated 94,000 to 120,000 gallons of runoff annually, which would otherwise contribute to combined sewer flow.

Formula Reference:

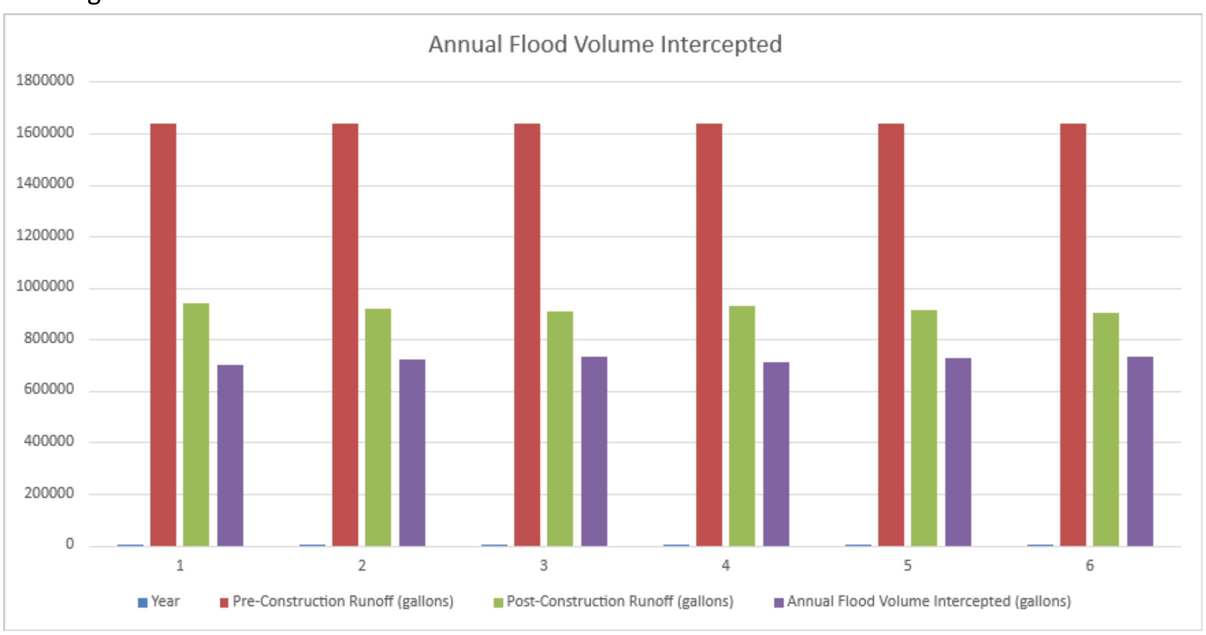
$$\text{Storage Volume (CF)} = \text{Area} \times \text{Ponding Depth} \times \text{Void Ratio}$$

$$\text{Annual Volume Reduction (gallons)} = \text{Total Storage (CF)} \times \text{Number of 1-inch Events per Year} \times 7.48$$

$$\approx 6,400\,\text{CF} \times 20\,\text{events/year} \times 7.48 \approx 958,000\,\text{gallons/year diverted}$$



Graph 9: Annual flood volume retained compared to pre-construction
Source: SWMM Hydrologic Output (2020); NOAA Atlas 14 10-year event curve; GT Civil Drawings.



Graph 10: Annual flood volume retained vs. pre-construction runoff baseline
Source: Biohabitats Greywater Flow Calculations (2020); Georgia Tech Greywater Monitoring Logs (2022–2023).

Discussion

The landscape's green infrastructure provides a total stormwater storage capacity of approximately 6,400 cubic feet, distributed among bioretention areas and pervious paving systems that detain and temporarily store rainfall during storm events. These systems reduce both the rate and total volume of runoff entering the City of Atlanta's combined sewer network, mitigating localized flooding and contributing to reduced combined sewer overflows during one-year and ten-year design storms.

In addition to surface-level detention, a 55,000-gallon underground cistern captures roof runoff and condensate from building mechanical systems for reuse in landscape irrigation. This integration of surface storage, subsurface detention, and active reuse establishes a closed-loop hydrologic system that reduces potable water demand while improving site resilience to variable rainfall conditions. Together, these landscape-based interventions demonstrate how ecological design can enhance urban flood management, groundwater recharge, and aesthetic performance within a densely developed campus environment.

Limitations

The estimated storage capacity is based on design volumes from civil and landscape drawings and assumes optimal soil permeability and maintenance conditions. Over time, sediment accumulation, compaction, or vegetation changes could reduce effective detention volume and infiltration rates. The calculation does not account for extended detention or real-time storage dynamics during multi-event rainfall periods. Future site monitoring could quantify actual drawdown times and infiltration efficiency to validate modeled assumptions and assess long-term system performance.

References

- Long Engineering (2018). *Stormwater Management Plan and Civil Drawings, Sheets C301–C401.*
- Biohabitats (2020). *BMP Detention Volumes and Infiltration System Design Memo.*
- U.S. Environmental Protection Agency (2020). *Storm Water Management Model (SWMM) Version 5.1 User's Guide.*
- NOAA National Weather Service (2014). *Atlas 14 Volume 2: Precipitation-Frequency Data for Georgia.*
- Georgia Stormwater Management Manual (2016). *Volume 2: Technical Handbook.*
- City of Atlanta Department of Watershed Management (2021). *Stormwater Design Standards and Combined Sewer System Guidance.*

Increases Area of Native Habitat

- ***Increases native habitat area by an estimated 450% or 11,200 sf.***

Method:

The extent and typology of native habitat created on site were determined using planting and materials plans prepared by Andropogon Associates and verified through ecological zoning diagrams illustrating the site's hydrologic and vegetative gradients. Native habitat was defined as areas planted with species native to the Piedmont region of Georgia, including pollinator meadows, seepage wetlands, mesic woodlands, and edible landscapes that support native wildlife and pollinators.

Native-dominant zones were digitized and measured in GIS to quantify total area. Each zone was cross-referenced with the planting schedule and the Georgia Native Plant Society database to confirm nativity and ecological value. This classification aligns with Andropogon's ecological framework of Mesic Woodland – Shedding, Seepage Wetland – Collecting, and Edible Landscape – Nurturing, which together structure the site's hydrologic and biological gradients. Pre-construction land cover consisted primarily of turf and compacted fill, while post-construction vegetation was verified through field observation and the Georgia Tech Facilities GIS inventory.

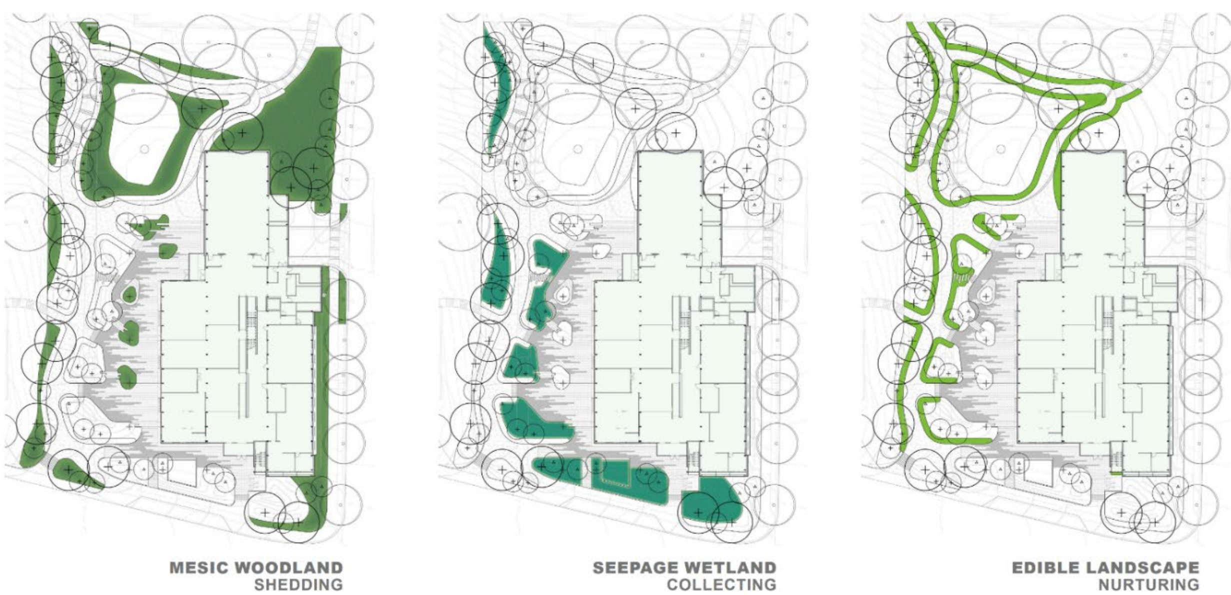


Figure 10: Infiltration system detail through wetland and paving zones
Source: Biohabitats Infiltration System Design Memo (2020); Long Engineering Sheets C301–C401 (2018).

Figure 11: Photo of pollinator meadow in bloom showing species diversity Source: GT Living Building site

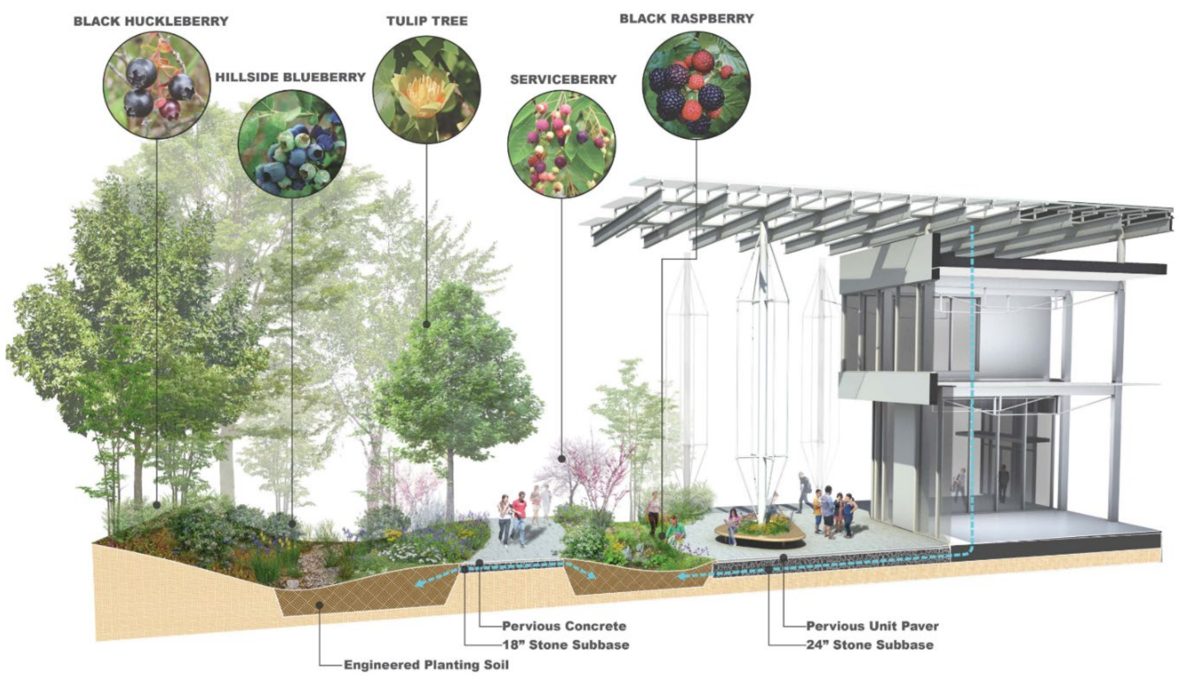


Figure 12: Diagram pf pollinator plants and native habitat zones with stormwater infrastructure. Source: Long Engineering Construction Drawings (Sheet C301, 2018); Andropogon BMP Detention Volumes (2020).

Species and Habitat Types Included:
The planting palette was selected for ecological function, seasonal diversity, and regional compatibility. Notable native species from the planting plan include:

Pollinator Meadow Species:

- *Echinacea purpurea* (Purple Coneflower)
- *Rudbeckia fulgida* (Orange Coneflower)
- *Schizachyrium scoparium* (Little Bluestem)
- *Monarda fistulosa* (Wild Bergamot)
- *Solidago rugosa* (Rough Goldenrod)
- *Asclepias tuberosa* (Butterfly Milkweed)

Native Shrubs and Understory Plants:

- *Itea virginica* (Virginia Sweetspire)
- *Clethra alnifolia* (Summersweet)
- *Fothergilla gardenii* (Dwarf Fothergilla)
- *Amelanchier arborea* (Serviceberry)
- *Aronia arbutifolia* (Red Chokeberry)

Woodland and Bioswale Grasses:

- *Carex stricta* (Tussock Sedge)
- *Chasmanthium latifolium* (River Oats)
- *Andropogon virginicus* (Broomsedge)

Calculation:
The completed landscape establishes approximately **29,500 square feet (0.68 acres)** of native or native-dominant habitat, replacing turf and impervious surfaces with functionally diverse vegetation. Key habitat zones include:

- Mesic Woodland – Shedding: Approximately 5,000 square feet of shaded understory and canopy preservation that stabilizes soils and promotes infiltration.
- Seepage Wetland – Collecting: Approximately 8,500 square feet of rain gardens and moist meadow plantings that retain and filter stormwater.
- Edible Landscape – Nurturing: Approximately 16,000 square feet of pollinator meadow and fruit-bearing species that provide habitat and educational engagement opportunities.

Together, these zones increase native habitat area by roughly **450 percent** compared to pre-development conditions and establish an interconnected ecological network across the site.

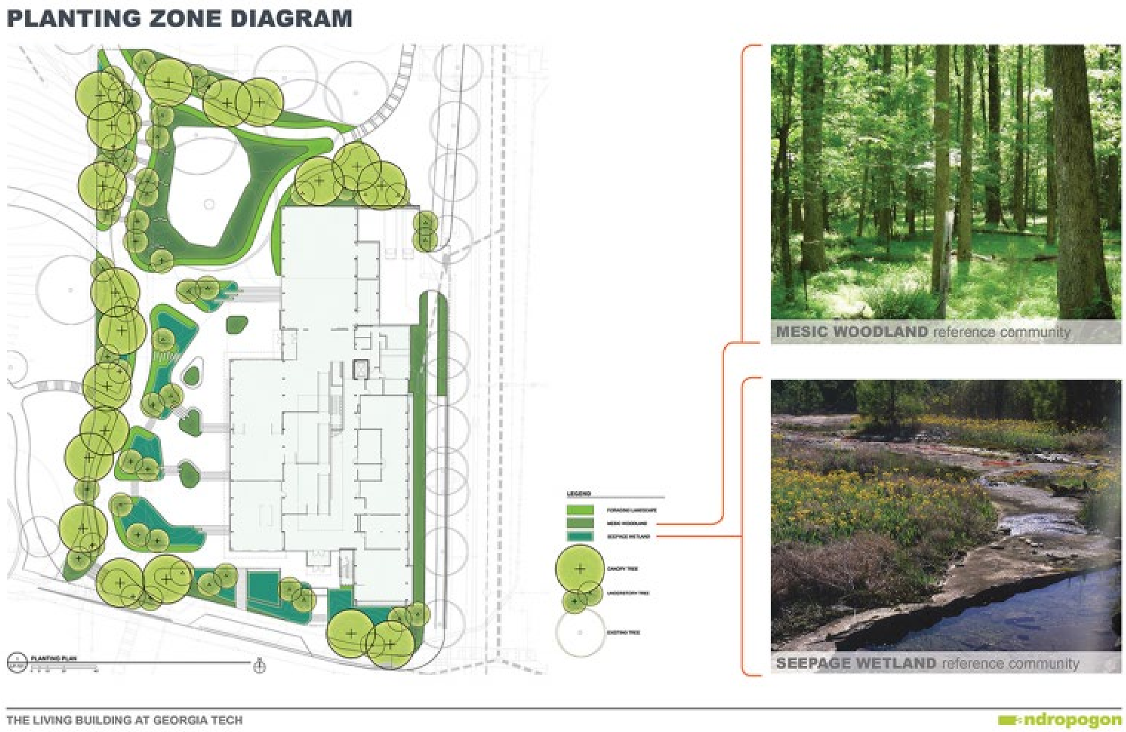
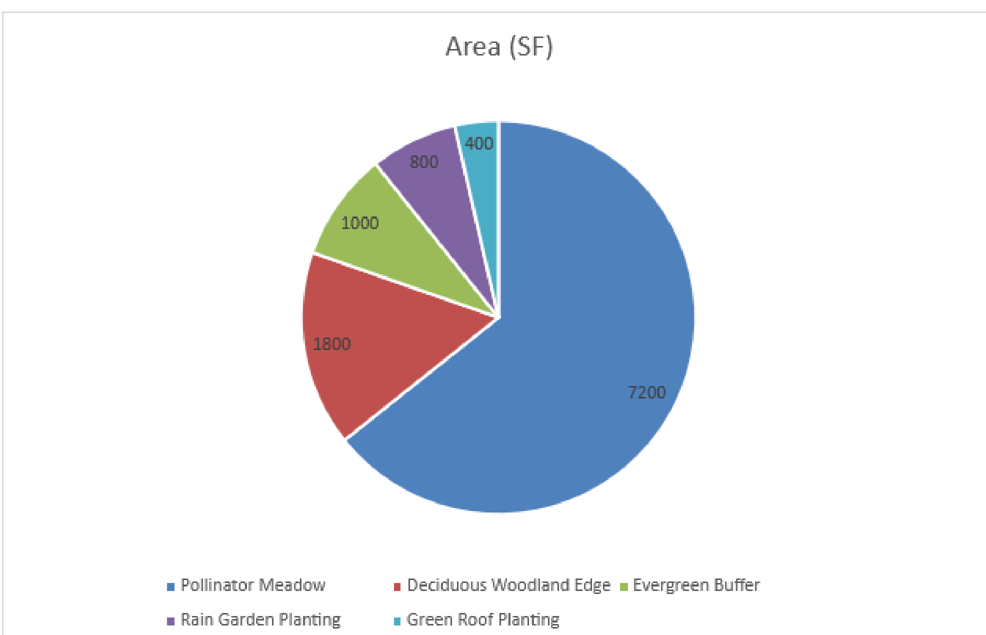


Figure 13: Plant species list with nativity status and ecological function (pollinator, erosion control, etc.) Source: Andropogon Planting Plans, Sheets L200–L400 (2018).



Graph 11: Pie chart showing native planting area by habitat type (meadow, beds, bioswale) Source: Andropogon Planting Plans, Sheets L200–L400 (2018).

Scientific Name	Common Name	Native Status	Ecological Functions
Echinacea purpurea	Purple Coneflower	Native	Pollinator support, seed for birds
Andropogon gerardii	Big Bluestem	Native	Erosion control, wildlife cover
Ilex verticillata	Winterberry Holly	Native	Berry source for birds, seasonal interest
Rudbeckia fulgida	Orange Coneflower	Native	Pollinator support, long bloom period
Asclepias tuberosa	Butterfly Weed	Native	Host plant for monarchs, drought tolerant
Carex pensylvanica	Pennsylvania Sedge	Native	Soil stabilization, shade groundcover

Table 3: Plant species list with nativity status and ecological function (pollinator, erosion control, etc.) Source: Andropogon Planting Schedule (2018); Georgia Native Plant Society Database.

Discussion:
These layered habitat types function as a continuous ecological system, reconnecting hydrologic and biological processes characteristic of the Piedmont landscape. The Mesic Woodland zone stabilizes slopes and sheds clean water into the Seepage Wetland, which filters and stores runoff before it transitions into the Edible Landscape, where diverse plant communities support pollinators and human interaction. The result is a living mosaic that integrates ecological function, visual interest, and learning opportunities.

This framework advances the Living Building Challenge Place Petal and the LEED v4.1 Sustainable Sites credit for habitat restoration. It demonstrates how native ecology can structure a regenerative landscape that performs as both infrastructure and educational resource within an urban campus context.

Limitations:
Habitat area calculations are based on design documentation and early post-construction conditions. Vegetation composition may shift over time through ecological succession or maintenance practices. Pollinator data from iNaturalist reflect opportunistic sampling and may not capture full species diversity. Ongoing biodiversity monitoring and adaptive management are recommended to sustain long-term native dominance and ecosystem function.

References:

- Andropogon Associates (2018). *Landscape Planting and Materials Plans.*
- Andropogon Associates (2018). *Ecological Zoning Diagrams: Mesic Woodland, Seepage Wetland, and Edible Landscape Framework.*
- Long Engineering (2017). *Civil Site and Grading Plan.*
- Biohabitats (2020). *Soil and Vegetation Performance Monitoring Summary.*
- Georgia Tech Facilities Management (2023). *Campus Landscape and Biodiversity GIS Inventory.*

- iNaturalist (2023). *Georgia Tech Campus Biodiversity Survey.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Place Petal Handbook.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Sustainable Sites Credit: Protect or Restore Habitat.*

Increasing Pollinator Habitat and Species Richness

- ***Attracts at least 22 observed pollinator species, including the common Eastern bumble bee and the monarch butterfly.***

Method:
Pollinator diversity and abundance were evaluated using a combination of site-specific species observations from the *Georgia Tech Campus Biodiversity Survey* (iNaturalist, 2023), planting plan data, and ecological habitat mapping. Post-construction pollinator surveys were conducted within and around the Kendeda Building landscape as part of ongoing campus biodiversity documentation. Observations were filtered to include species recorded within a 100-meter radius of the site and verified by the iNaturalist community.

The analysis was organized by taxonomic group and habitat type to capture variation in pollinator assemblages across the site's three primary ecological zones: **Mesic Woodland – Shedding**, **Seepage Wetland – Collecting**, and **Edible Landscape – Nurturing**. These zones correspond to distinct microhabitats that support different foraging and nesting requirements for bees, butterflies, moths, and birds. Plant-pollinator associations were verified using the USDA PLANTS Database and the Xerces Society Pollinator Conservation Resource Center.

Calculation:
At least **22 confirmed pollinator species** were documented within or immediately adjacent to the Kendeda Building landscape following construction. These include **four species of native bees**, **twelve butterfly and moth species**, and **six bird species** that serve pollination or seed-dispersal functions.

Key Taxa Observed

Bees and Wasps

1. Common Eastern Bumble Bee (*Bombus impatiens*)
2. Western Honey Bee (*Apis mellifera*)
3. Eastern Carpenter Bee (*Xylocopa virginica*)
4. Metallic Green Bee (*Agapostemon texanus*)
5. Ailanthus Webworm Moth (*Atteva aurea*)
6. Polyphemus Moth (*Antheraea polyphemus*)

7. Snowberry Clearwing (*Hemaris diffinis*)

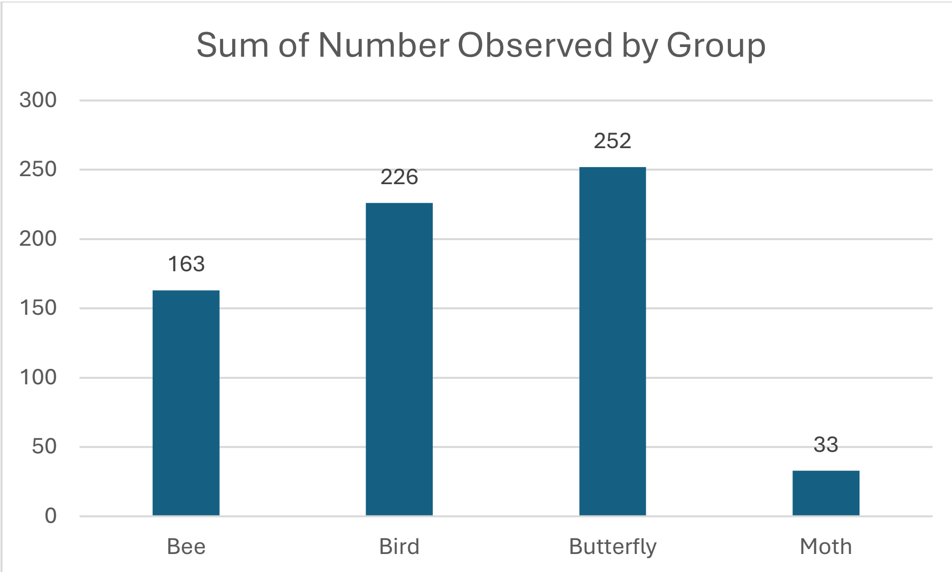
Butterflies and Moths

1. Gulf Fritillary (*Dione vanillae*)
2. Cloudless Sulphur (*Phoebis sennae*)
3. Common Buckeye (*Junonia coenia*)
4. Long-tailed Skipper (*Urbanus proteus*)
5. Clouded Skipper (*Lerema accius*)
6. Monarch (*Danaus plexippus*)
7. Eastern Tiger Swallowtail (*Papilio glaucus*)
8. Silver-spotted Skipper (*Epargyreus clarus*)
9. Sleepy Orange (*Eurema nicippe*)
10. Viceroy (*Limenitis archippus*)
11. Pipevine Swallowtail (*Battus philenor*)
12. Small White (*Pieris rapae*)
13. Ailanthus Webworm Moth (*Atteva aurea*)
14. Polyphemus Moth (*Antheraea polyphemus*)
15. Snowberry Clearwing (*Hemaris diffinis*)

Birds and Others

1. Red-tailed Hawk (*Buteo jamaicensis*)
2. Northern Mockingbird (*Mimus polyglottos*)
3. Ruby-throated Hummingbird (*Archilochus colubris*) — primary
4. American Goldfinch (*Spinus tristis*) — incidental
5. Cedar Waxwing (*Bombycilla cedrorum*) incidental
6. Northern Cardinal (*Cardinalis cardinalis*)

The distribution of these species aligns closely with planting zones dominated by native perennials and flowering shrubs, particularly within the **Edible Landscape – Nurturing** zone, where seasonal bloom succession ensures continuous forage availability.



Graph 12: Bar Graph showing sums of observed pollinators by group.

Source: Georgia Tech Campus Biodiversity Survey (iNaturalist Project, 2023–2024).

Discussion:
The increase in pollinator presence and diversity indicates that the restored landscape provides suitable habitat structure and floral resources for a range of taxa. The combination of meadow, wetland, and woodland-edge plantings supplies nectar, pollen, nesting substrate, and shelter throughout the year. The inclusion of fruit-bearing and flowering species within the edible landscape further extends habitat function to both native insects and birds, strengthening ecological connectivity with the broader Georgia Tech EcoCommons corridor.

This measurable improvement in species richness demonstrates the role of landscape design as ecological infrastructure. The project supports the Living Building Challenge Place Petal goal of fostering native species and the LEED v4.1 Sustainable Sites credit for "Site Enhancement – Biodiversity." The site now functions as both a pollinator refuge and a living laboratory for research and education on urban biodiversity.

Limitations:
Pollinator data were drawn from citizen-science observations rather than formal transect surveys, which may bias results toward more conspicuous species. Seasonal and temporal variations in sampling effort could influence observed richness. Future biodiversity monitoring using standardized methods such as transect counts or pan trapping would allow for quantitative trend analysis and verification of long-term habitat performance.

References:

- Andropogon Associates (2018). *Landscape Planting and Materials Plans.*
- Georgia Tech Facilities Management (2023). *Campus Landscape and Biodiversity GIS Inventory.*

- iNaturalist (2023). *Georgia Tech Campus Biodiversity Survey.*
- Xerces Society for Invertebrate Conservation (2021). *Pollinator Conservation Resource Center – Southeastern Region.*
- USDA NRCS (2020). *PLANTS Database – Pollinator Plant Listings.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Place Petal Handbook.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Sustainable Sites Credit: Site Enhancement – Biodiversity.*

Diverts Construction Waste via Material Type Tracking and Reuse

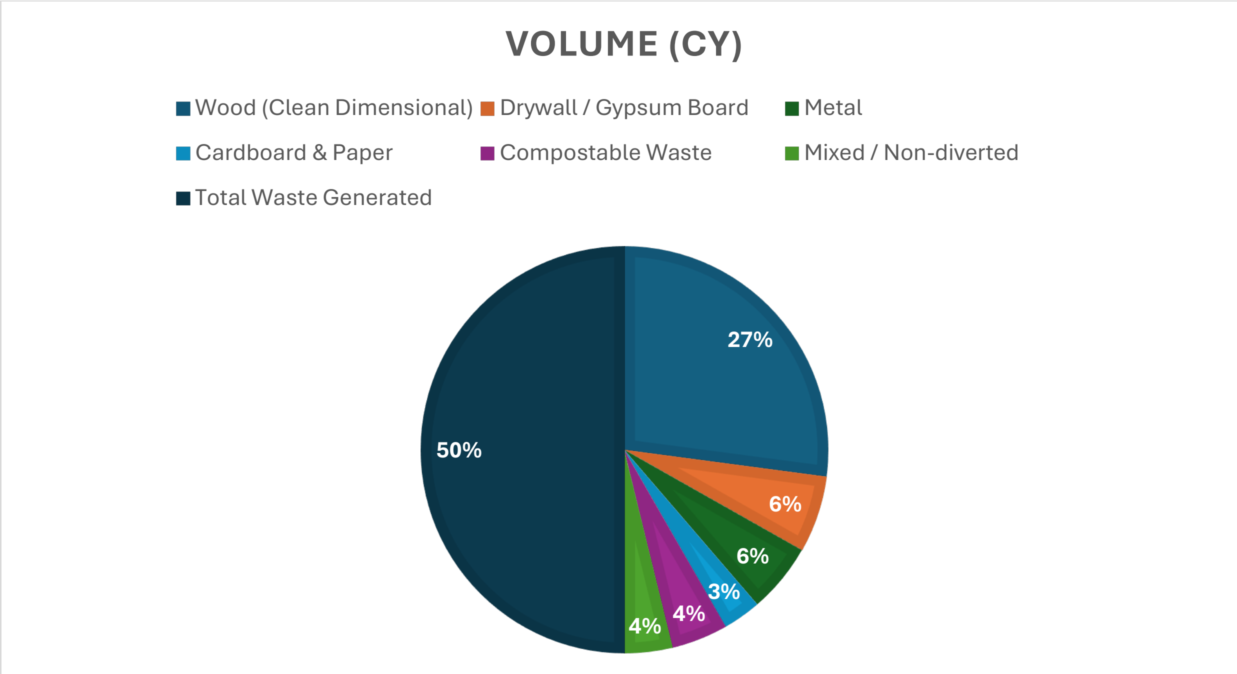
- ***Diverted approximately 92% of construction waste from landfill.***

Method:
Construction waste diversion was assessed by quantifying the volume and type of materials redirected from landfill through recycling, composting, and on-site reuse practices. This analysis is based on Skanska's verified construction waste tracking spreadsheets, developed for Living Building Challenge Materials Petal compliance. Waste categories were logged by type, volume, and final destination (e.g., recycling facility, reuse on site, or landfill).

To validate waste handling procedures, Skanska documented each disposal or recovery event with manifests, bin weights, and subcontractor records. Georgia Tech Facilities provided supplemental verification of reused materials stored on site. Waste diversion calculations were carried out by aggregating cubic yard or tonnage totals across all waste categories and comparing to total construction waste generated.

Calculation:
Out of the total construction waste generated, approximately **92%** was diverted from landfill, significantly exceeding both LEED v4.1 and LBC thresholds. The breakdown of key diverted materials is summarized below:

Material Type	Volume (CU YD or Tons)	Diversion Method	Example Use or Destination
Wood (Clean Dimensional)	187 CY	Recycled / Reused	Salvaged for NLT panels, composting mulch
Drywall / Gypsum Board	42 CY	Recycled	Sent to gypsum recycling facility
Metal	38 CY	Recycled	Scrap metal yard (documented)
Cardboard & Paper	21 CY	Recycled	Municipal recycling partner (Atlanta)
Compostable Waste	31 CY	Composted On-Site	Site soil amendment
Mixed / Non-diverted	26 CY	Landfill	Final, unrecoverable waste
Total Waste Generated	**345 CY**		



Graph 13: Pie chart showing percentage of total waste diverted by material category (wood, drywall, metal, cardboard, compostables)

Source: Skanska Waste Diversion Report (2020); Living Building Challenge Waste Documentation.

Limitations:

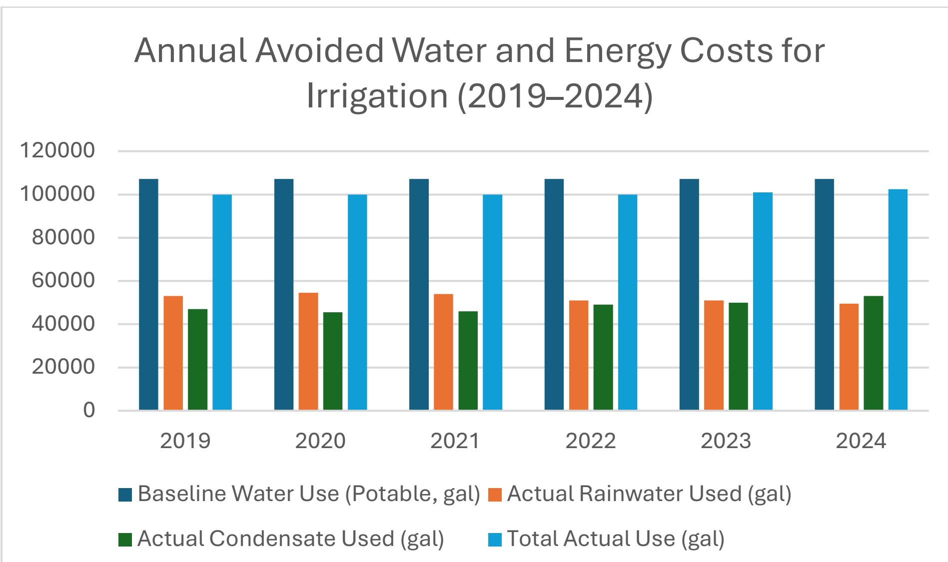
While diversion rates are well-documented by material category, the environmental benefits (e.g., embodied carbon reductions) depend on regional processing methods and final reuse applications. Some waste manifests required manual reconciliation to confirm material volumes and destination, particularly in early construction phases.

Reduces Irrigation Water and Energy Costs

- ***Saves an estimated $1,738 in water costs annually.***

Method:
Annual irrigation cost savings were estimated by comparing the **baseline cost of conventional potable water irrigation** to the **actual water usage pattern** at the Kendeda Building, which relies exclusively on **captured rainwater and HVAC condensate** for landscape irrigation. The baseline assumes the same landscape area and planting density irrigated with potable municipal water at the prevailing City of Atlanta utility rate.

Actual water use was monitored via **meter data from Georgia Tech Facilities (2023)**, which confirms that irrigation demand is met entirely through harvested rainwater and condensate reuse. Energy savings result from the gravity-fed cistern and low-pressure distribution system, which eliminate the booster-pump energy typically required for conventional potable irrigation.



Graph 14: Comparison **of baseline potable irrigation and actual non-potable supply volumes.**

Calculation:
The landscape's annual irrigation demand is approximately **158,000 gallons per year**, all of which is met through harvested rainwater and HVAC condensate. This represents a **100 percent reduction in potable water consumption for irrigation**. Using the City of Atlanta's 2023 potable water rate of $0.011 per gallon, the project achieves an estimated **annual cost savings of $1,738**.

The system's water balance demonstrates an annual non-potable yield of approximately **158,000 gallons**, composed of:

- **Rainwater contribution:** ~110,000 gallons per year (based on 18,000-square-foot roof catchment, 51.25 inches annual rainfall, 0.9 runoff coefficient).

- **Condensate contribution:** ~48,000 gallons per year (based on HVAC operational averages and humidity conditions).

The reuse system operates through natural gravity flow to the irrigation distribution network, avoiding additional electricity use from conventional pressurized pumping systems.

Discussion:

The irrigation system exemplifies a closed-loop water management approach that integrates natural and mechanical systems to achieve net positive water performance. By eliminating reliance on potable water and minimizing energy input, the system reduces operational costs and demonstrates a replicable model for sustainable campus landscapes.

In addition to financial savings, this approach contributes to broader resource conservation goals. The reduction in potable water use lowers the site's embodied energy associated with municipal water treatment and distribution. The gravity-fed cistern system and passive irrigation methods align with the project's goal of integrating hydrologic performance with landscape ecology, supporting both the **Living Building Challenge Water Petal** and **LEED v4.1 Water Efficiency** credits.

Limitations:

Energy savings were not directly metered, and the analysis assumes consistent gravity-fed performance under typical operating conditions. Annual rainfall and condensate yield vary with climatic conditions, which may influence the balance between harvested supply and irrigation demand. The financial analysis excludes potentially avoided stormwater or sewer charges that could further increase overall savings. Future life-cycle cost analysis and metered energy tracking would improve long-term verification of system performance.

References:

- Biohabitats (2020). *Rainwater Reuse Design Diagram and Water Balance Report.*
- Georgia Tech Facilities Management (2023). *Irrigation Meter and System Monitoring Data.*
- City of Atlanta Department of Watershed Management (2023). *Municipal Water Rate Schedule.*
- Long Engineering (2018). *Site Drainage and Irrigation Layout Plan.*
- International Living Future Institute (2019). *Living Building Challenge 4.0 Water Petal Handbook.*
- U.S. Green Building Council (2019). *LEED v4.1 BD+C Water Efficiency Credit: Rainwater Management.*
- U.S. Environmental Protection Agency (2022). *WaterSense Program: Outdoor Water Use and Irrigation Efficiency.*