PRINCETON UNIVERSITY

SUSTAINABILITY ACTION PLAN

Toward 2026 and Beyond

04.2019

PRINCETON UNIVERSITY | Office of Sustainability

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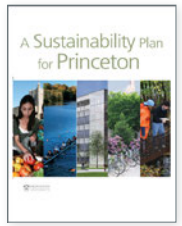
Action Areas

Building on the

2008 Sustainability Plan



The 2008 Sustainability Plan was Princeton's first formal commitment to sustainability, engaging academics, operations and the campus community. The plan established 2020 **operational improvement targets** and **annual performance reporting**. It also included piloting our now well-established **campus-as-living-lab** approach, and cultivating campus engagement through **outreach and communications initiatives**.

A feature of that plan was target-setting beyond what we knew we could achieve at the time, creating "**innovation gaps**" that stimulated creative problem-solving. We applied this approach to our first **greenhouse gas emissions reduction target** of reaching 1990 CO_2 levels by 2020 **without the purchase of market offsets**, and other performance areas.

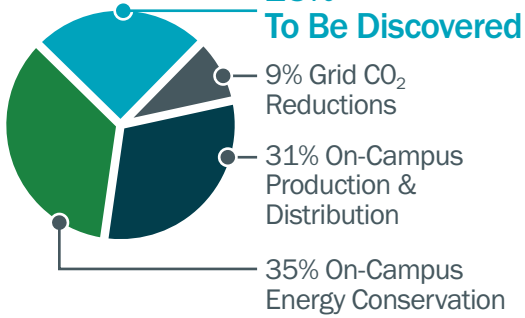
Mid-Course Evaluation

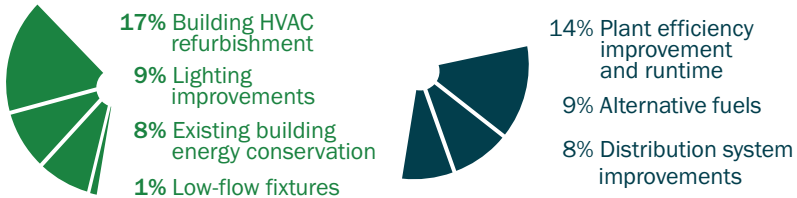
During the implementation of the 2008 Sustainability Plan, we invited an external review by leaders in the field. Outcomes from that review included the formation of governance committees to facilitate sustainability planning and decision-making.

Through those committees, institutional **Sustainability Principles** were adopted in 2014, and **Decision-Making Criteria** for Greenhouse Gas Emissions Reduction in 2015. Each informed major multi-year endeavors such as the **2026 Campus Plan**, and this Sustainability Action Plan.

Our Approach: Closing the Innovation Gap

In 2008, Princeton developed strategies to reach 1990 levels of CO_2 emissions by 2020, with a portion of strategies to-be-discovered. Today, we have nearly closed that gap.





Program Highlights: 2008-2018

USING THE CAMPUS AS A LAB (CAL)

109 Course-based CAL experiences*

23 CAL faculty research initiatives

48 Independent student CAL research projects (Master's theses, senior theses, junior papers and comparable work)

ENGAGEMENT ACROSS CAMPUS

10+ Student sustainability groups formed

100+ Student EcoReps trained

100+ Staff Ambassadors trained

*Includes courses with a campus-as-lab focus, activity and/or course projects undertaken by students.

Operational Snapshots: 2008-2018

Less Paper Purchased **50%**

Less Pesticides Used **39%**

Less CO_2 Emissions **10%**

Less Campus Landfill Waste **8%**

Decrease in Consumer Recycling Rate **23%**

63% More Local Food Purchased

44% More Commuters Using Alternative Transportation

31% More 100% Post-Consumer Recycled Paper Purchased (of the total purchased)

15% More Water Used Campus-wide

Our Framework for

Sustainability Action Toward 2026 and Beyond

Vision

To cultivate, embody and celebrate an ethos of sustainability at Princeton University in service to humanity and the world.

Mission

Princeton University exemplifies repeatable best practices and innovation in sustainability to accelerate action at all scales, from personal to global.

Scales of Action[1]

Our sustainability objectives and targets are intended to stretch beyond what we know we can accomplish today, while our strategies place a premium on accountability and collaboration across University departments. We will build evidence through academic and operational studies and demonstration projects that use our campus as a lab. These efforts will be paired with communications and outreach initiatives, informed by behavioral science, to engage campus community members and partners, grapple with challenges, and celebrate progress.

The students, staff and faculty who shape the academic, physical and social character of the campus are critical leaders and ambassadors for realizing the culture and sustainability outcomes we seek. As we move toward 2026 and beyond, there will be much that we test and learn and, as new opportunities arise, our strategies will evolve.

WHY IS EVERY INDIVIDUAL IMPORTANT?

We strive for an ethos of sustainability where individual members of Princeton's campus community encounter and create powerful daily experiences that build the knowledge, skills and resolve to tackle the sustainability challenges facing humanity.

"Our global environment faces challenges of unprecedented scope and complexity. Princeton can play a leadership role not only by developing innovative solutions through teaching and research, but also by establishing best practices in our campus operations and community behaviors that serve as models for the world. This plan sets out ambitious but attainable goals that will guide us toward a more sustainable future."

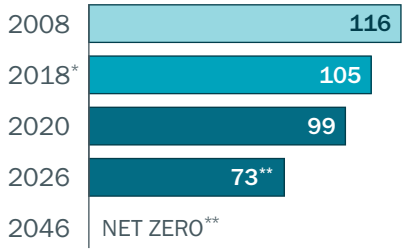
Princeton University President
Christopher L. Eisgruber

Dashboard: Objectives & Targets

2008 Baseline | 2018 Performance | Future Targets

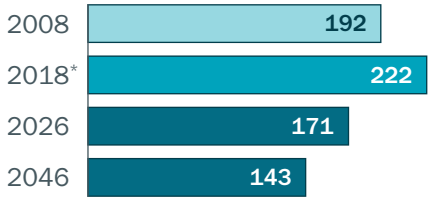
Reduce Greenhouse Gas Emissions to Net Zero

Campus emissions
(metric tons CO_2 x 1000)



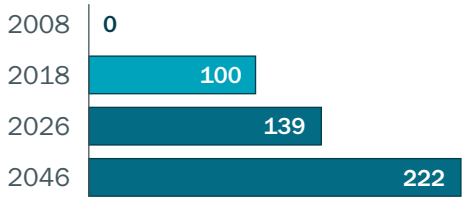
Reduce Water Usage

Campus water usage
(gallons x 1,000,000)



Increase Area Under Enhanced Stormwater Management

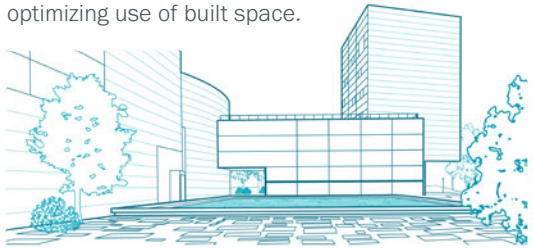
Enhanced stormwater management area (acres)



Design and Develop Responsibly

Objective

Implement an integrative design process in new construction and renovations to meet University sustainability performance targets while making more efficient use of land, and optimizing use of built space.

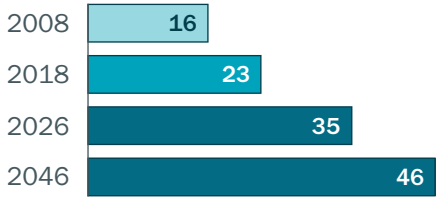


Cultivate Healthy and Resilient Habitats

Tracked forested area with improved habitat connectivity and quality (acres)

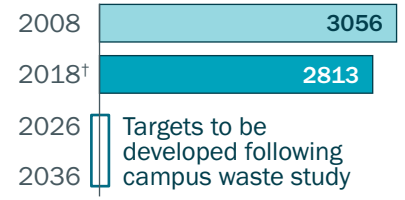
Increase Commuters Using Alternatives to Single-Occupancy Vehicles

Alternative commuters
(% of all commuters)

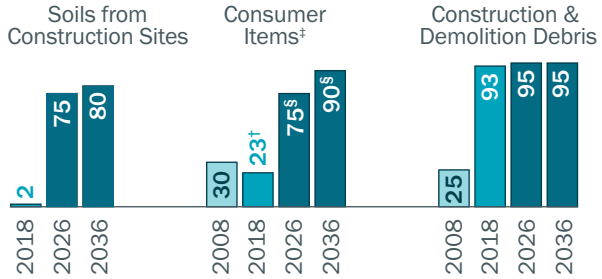


Reduce Waste and Expand Sustainable Purchasing

Campus Landfill Waste
(tons)



Recycling and Reuse
(%)



*2018 represents an average of 2017 and 2018 performance data. **Targets reflect CO_2 equivalence (CO_2e). ***Baseline established via GIS analysis. †2018 represents an average of 2016 and 2018 performance data (comprehensive 2017 data were unavailable). ‡Consumer items consist of recyclable paper, cardboard, glass, metal and plastic. §Targets to be confirmed following campus waste study.

Action Areas

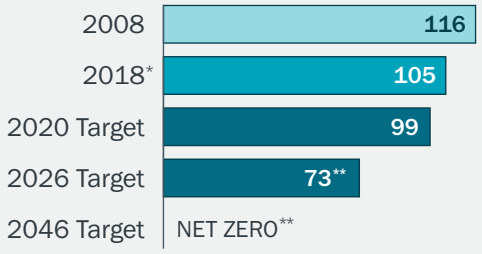
Reduce Greenhouse Gas Emissions to Net Zero

OBJECTIVE

Accounting for campus growth, achieve carbon neutrality by 2046 — Princeton's 300th anniversary — through the use of repeatable, scalable and innovative solutions.

Targets

Campus emissions (metric tons CO_2 x 1000)



*2018 represents an average of 2017 and 2018 performance data.
**Targets reflect CO_2 equivalence (CO_2e)

Global Context, Local Action

According to the Intergovernmental Panel on Climate Change, humanity now experiences the consequences of 1°C of average planetary warming, including rising sea levels and more extreme weather. Changes in human behavior at all scales are required to prevent the predicted catastrophic consequences of more than 1.5°C warming.[2]

Between 2005 and 2014, college campuses in the U.S. reduced their greenhouse gas emissions by more than 6 percent, with many institutions in the coastal Northeast region averaging a reduction of more than 16 percent.[3] Princeton is also demonstrating significant reductions in emissions over time.

Toward 2026 and Beyond

Princeton's new target is to reach net zero campus greenhouse gas emissions — reducing both direct emissions from on-site energy production and fleet fuel use, and indirect emissions from purchased electricity — by 2046. Additional indirect emissions from commuting, procurement and other activities will be tracked and reduced where feasible.

Our pathway to carbon neutrality relies on both known and unknown strategies, spanning new on-site energy infrastructure, the potential purchase of new renewable electricity generation off-site, and changes in everyday behavior across the campus community.

PHOTO BY RAE PEREZ

PRINCETON UNIVERSITY'S SOLAR FIELD

Installed in 2012, the University's 4.5-megawatt solar photovoltaic field houses 16,500 panels on 27 acres of Princeton property. The array produces nearly 6 percent of the University's total annual electricity needs. In approximately 2020, after it is paid for, Princeton has the option to claim the carbon reduction from the system. Electricity generation data are publicly available via a live feed, and undergraduate classes visit the field monthly throughout the academic year. In 2018, the solar field became home to a flock of 100 sheep, whose grazing enriches the soil and eliminates the need for mechanical mowing.

Reduce Greenhouse Gas Emissions to Net Zero

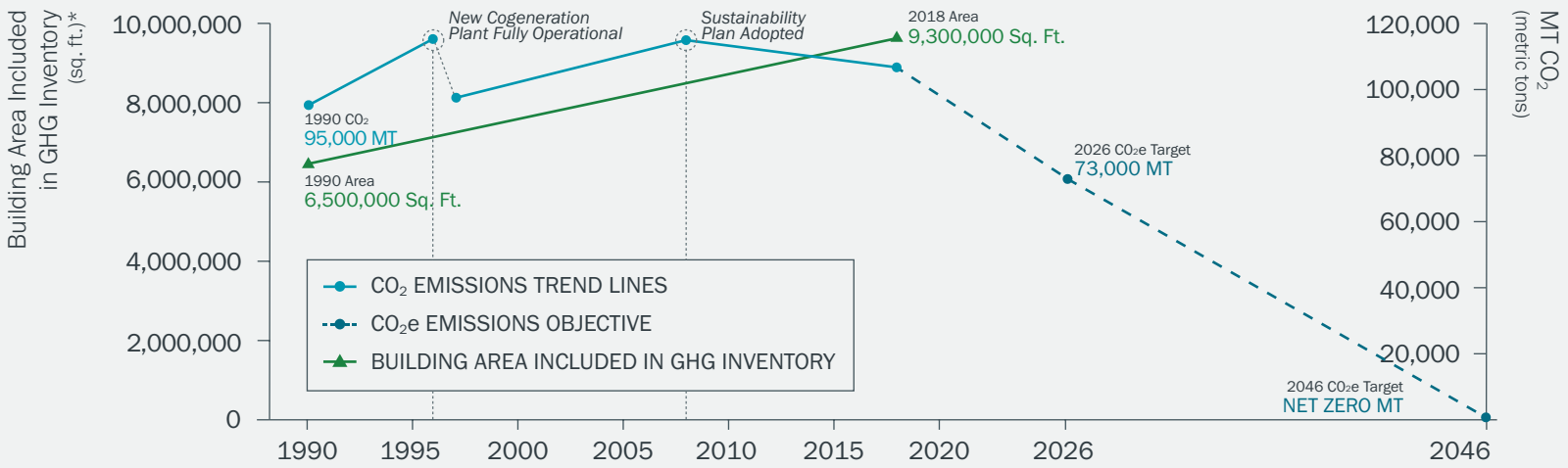
Princeton's Progress To Date

Since 2008, Princeton's efforts to reduce campus carbon dioxide emissions to 1990 levels by 2020 (without the purchase of market offsets) have been very successful. **Even after adding 2 million gross square feet of built space since 1990, we are on the verge of achieving our 2020 absolute reduction target of 18 percent.**

Notable contributions to that progress include the development of campus "Greenhouse Gas Reduction Decision-Making Criteria" by a faculty-led CO_2 Task Force, improved central plant efficiencies, installation of ground source heat pump (**geoexchange**) systems, a **$45 million investment** in existing building energy-efficiency improvements with a collective five-year-or-less payback, and the potential claim around 2020 of carbon emissions reduction from our **4.5-megawatt on-campus photovoltaic array**.

However, while our campus systems are highly efficient, we continue to combust fossil fuels (natural gas) as our primary energy source — a practice we will transition away from as we strive for net zero campus emissions. The strategies identified in this plan set the stage for that transition.

Annual Campus Greenhouse Gas Emissions and Campus Square Footage



*Represents all buildings that are connected to the main campus utility systems, including power purchased from the regional grid. Also included are off-campus buildings that house significant energy-consuming programs, including Lakeside Apartments, 701 Carnegie Center and the High-Performance Computing Research Center, as well as emissions from Athletics and Facilities fleet vehicles. The reported gross square footage of building area reflects those included in the greenhouse emissions inventory, verified to capture the vast majority of campus emissions.

PHOTO BY CHRISTOPHER LILLJA

GEOEXCHANGE WELLS

To date Princeton has installed several ground source heat pump (geoexchange) systems on campus, contributing to improved efficiency and a reduction in fossil fuel use. Current systems are installed at Lakeside Apartments, Lawrence Apartments, the Lewis Arts complex (pictured above) and Campus Club. Going forward, Princeton will construct even more extensive geoexchange systems to facilitate the transition away from fossil fuel combustion.

Decision-Making Criteria

In 2015, the University's faculty-led CO_2 Task Force recommended the following criteria to guide greenhouse gas reduction decisions. Since then, these criteria have been integrated with campus and infrastructure master planning, as well as operational planning.

- Establish a clear pathway to carbon emissions neutrality by 2046 (Princeton's 300th anniversary).
- Adopt a self-imposed greenhouse gas emissions budget of approximately 1,750,000 tons of CO_2e, representing the total net emissions that are allowed from on-campus (scope 1 and 2) operations from now into the indefinite future.
- Greenhouse gases have a cumulative impact on climate and we recommend against postponing reductions due to the expectation of new future technologies. Steady reductions in annual greenhouse gas emissions between now and 2046 should occur, though the actual reduction curve may not be linear.
- By 2046 obtain carbon neutrality in a scalable fashion that is compatible with a dramatic nation-wide reduction in greenhouse gas emissions. In future campus development, all projects should answer the question, "Will today's decision facilitate a movement towards the objective of nationwide decarbonization?"
- Princeton's current policy is to reduce on-campus emissions without the purchase of offsets of any kind. Maintain the rationale that paying others so we can continue to pollute is not an effective global solution to climate change. However, if necessary to reach carbon neutrality, off-campus initiatives which reduce emissions may be allowable as long as they are additional to anything already in place, are independently verifiable, and ultimately will contribute to a globally scalable greenhouse gas mitigation strategy. Consideration of net negative carbon emissions technologies is possible.
- Adopt both technical and behavioral solutions to achieve greenhouse gas emission neutrality.
- Strive to coordinate academic research and teaching with carbon neutrality goals, including using the campus as a laboratory for new technologies and approaches. Initiatives to help spur innovation and leverage the University's research prowess, educational mission and student/alumni network could lead to important breakthroughs.
- Facilitate replication of successful greenhouse gas mitigation approaches. Communication of Princeton's initiatives to students, alumni and the public should be emphasized.

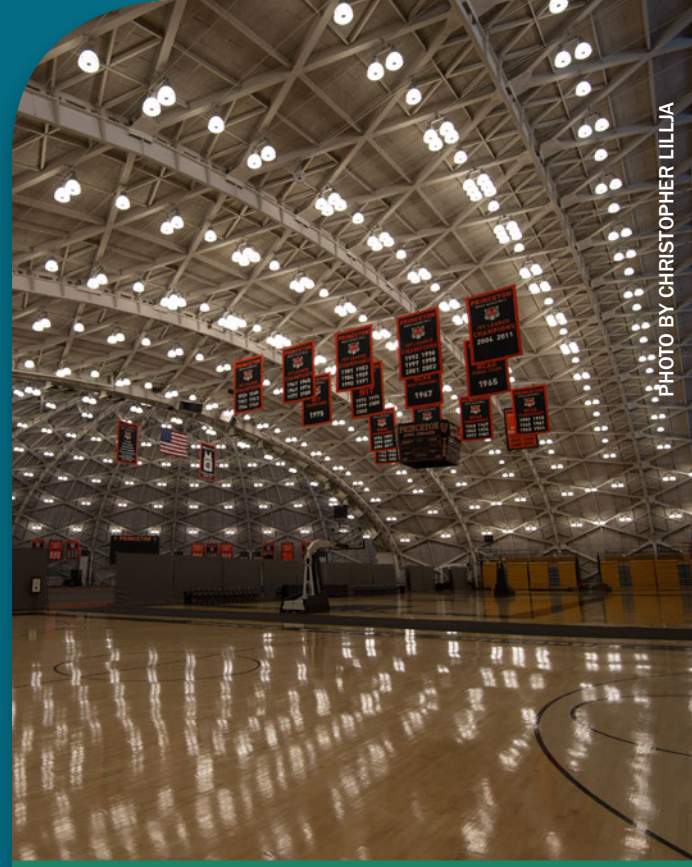
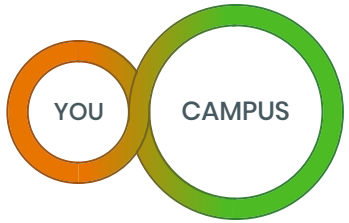


PHOTO BY CHRISTOPHER LILLJA

LED LIGHTING RETROFIT INITIATIVE

The Facilities Engineering and Campus Energy group undertook a massive LED lighting upgrade program encompassing 110,000 lamps and fixtures and affecting nearly 10 million square feet of building area across campus, between 2014 and 2017. Replacing and recycling that number of lamps and fixtures with LEDs saves approximately 14 million kilowatt hours, 9,690 metric tons of net CO_2, and realizes an annual energy cost savings of $1.2 million. This LED upgrade is responsible for achieving 11 percent of our strategies to reach 1990 emissions levels by 2020.

Action Items



Strategies Toward 2026 and Beyond

Convert from natural gas-fueled campus steam production to a heating hot water system with geoexchange wells and heat pumps.

Renew allocation of $50 million in energy-efficiency improvements for existing buildings.

Expand solar power generation on campus, and evaluate off-campus renewable electricity options that meet our decision-making criteria.

Track and reduce key indirect greenhouse gas emissions sources (Scope 3 emissions).

Investigate long-term fuel alternatives that verifiably contribute to a fossil-free future.

Re-evaluate our greenhouse gas emissions inventory (Scope 1 and 2) to assure that all significant sources of campus-based emissions are included.

Align effective practices to reduce indirect and direct greenhouse gas emissions across campus through coordinated departmental action plans.

Advance evidence-based greenhouse gas emissions reduction solutions by continuing to actively engage students and faculty to serve on advisory committees and by supporting campus-as-lab research endeavors.

Reinforce Princeton's climate action objectives during key programs, including but not limited to orientation for all students, faculty and staff; campus tours; Princeton Preview for undergraduates; visiting weekends for graduate students; residential life and campus dining; athletics; Reunions and other events.

Apply behavioral science approaches to promote widespread adoption of mindful energy-use behaviors, through programs, building design and other methods.

Scale action beyond Princeton through partnerships, such as the International District Energy Association and the Microgrid Resources Coalition, which was co-founded with multiple partners by Princeton's Facilities' Engineering and Campus Energy department.

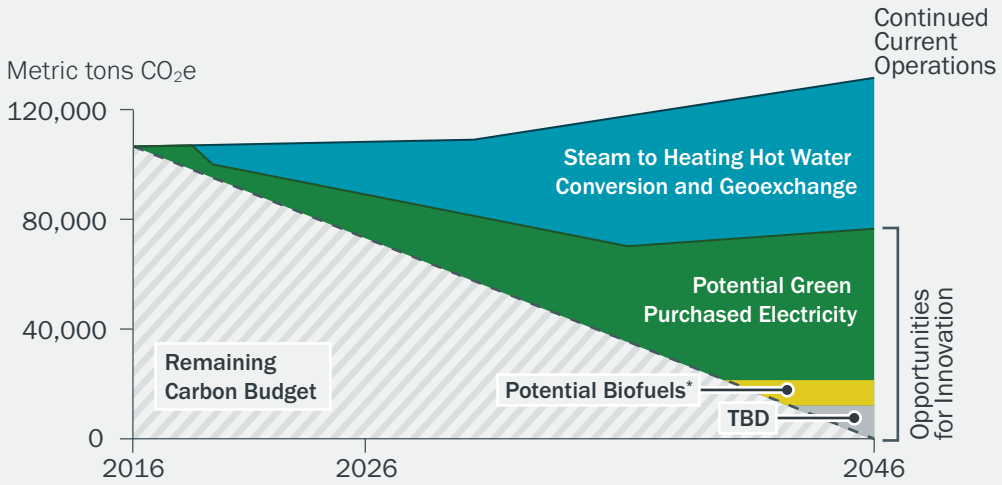
Anticipated CO_2e Reduction Strategies

2026 TARGET

Reduce campus greenhouse gas emissions to 73,000 metric tons CO_2e irrespective of growth and without the purchase of market offsets.

2046 TARGET

Net zero campus greenhouse gas emissions per year.



*Biofuels require rigorous study to be confirmed as verifiable sustainable alternatives to fossil fuels.

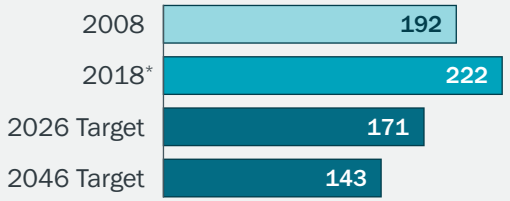
Reduce Water Usage

OBJECTIVE

Reduce water consumption both campus-wide and per person.

Targets

Campus water usage (gallons x 1,000,000)



*2018 represents an average of 2017 and 2018 performance data.

Global Context, Local Action

By 2025 an estimated 1.8 billion people will live in areas of extreme water scarcity.[4] The vast majority — 70 percent — of global water usage is tied to agriculture, so food consumption choices alone have far-reaching impact.[5] Farming is also among the top users of water in the United States, along with electricity production and domestic consumption.[6]

In the Northeast of the United States, many higher education institutions have reduced water consumption.[7] Counter to that regional progress, however, water usage at Princeton has increased over the past decade.

Toward 2026 and Beyond

Using 2008 as our baseline year, our objective is to reduce per-person and campus-wide consumption, irrespective of institutional growth. Our target is to reduce annual campus water usage by 26 percent by 2046. We will emphasize the conservation of potable water in energy systems and domestic usage, and use reclaimed and rain water in its place where appropriate.

We also aim to use the campus environment to build a sense of connection between our everyday choices and water, as well as other natural resources, so that we encourage mindful consumption as a lifelong habit.

PHOTO BY NICK DONNOLI

PRINCETON VERTICAL FARMING PROJECT

For her senior thesis, Jesenia Haynes '18, analyzed the water and energy use of growing kale and lettuce at Princeton's indoor Vertical Farming Project compared to a conventional farm. Jesenia's study found that the vertical system produced larger yields, and used less water, than conventional farming for both kale and lettuce. However, the vertical farm used far more energy than conventional farming for both crops. Continued research will evaluate potential improvements to vertical farming at Princeton, and also vertical farming in general. The Princeton Vertical Farming Project was initiated by Geosciences Associate Research Scholar, Paul Gauthier, in 2017.

Reduce Water Usage

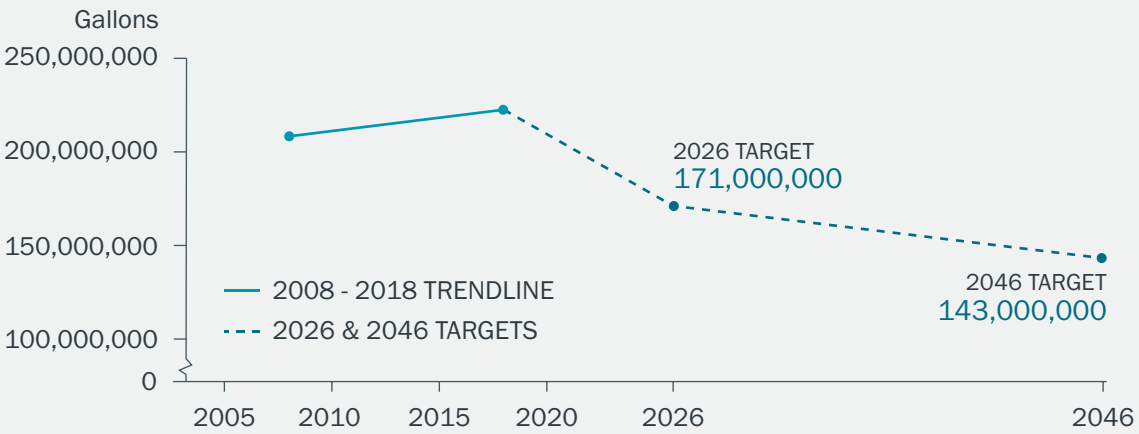
Princeton's Progress To Date

For more than a decade, Princeton has taken significant steps to reduce water usage on campus through **conservation at the central plant, implementing tray-free dining in all dining halls, athletic and landscape management practices and installing low-flow plumbing fixtures, high-efficiency washing machines and dishwashers**. Despite those efforts, campus water usage has increased 15 percent since 2008, in part due to growth in the campus population and built space, which requires more water for heating and cooling.

Princeton's Campus Dining program has made significant progress in addressing off-campus water usage through its commitment to health and sustainability. The Princeton Crafted Burger, a part-beef, part plant-based entree introduced in 2016 reduced the red meat in each patty by 40 percent, compared to an all-beef burger. Given the high water use footprint of beef compared to plant-based options, this reduction demonstrates **meaningful, scalable action toward curtailing water scarcity in the world**.

Campus Water Usage

While per person water usage has been relatively stable since 2008, our total water usage has increased with campus growth. Our objective is to reduce absolute water usage, even as we grow.



*Represents an average of 2017 and 2018 data.

Water Usage by Type*

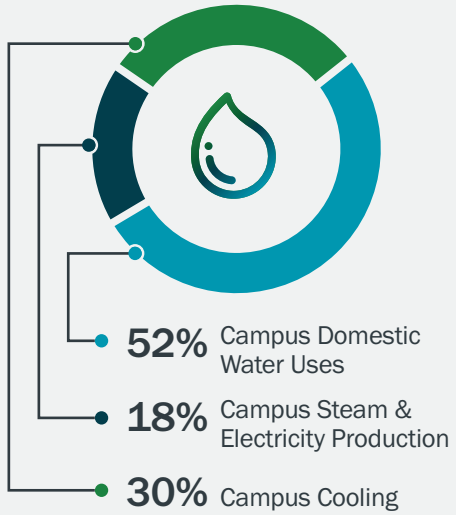
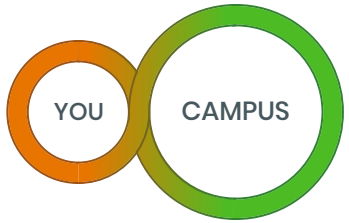


PHOTO BY CHRISTOPHER LILLIA

BEDFORD ATHLETIC FIELD

Bedford Field features an optimal playing surface for field hockey with specialized water conserving artificial turf. The playing surface was designed to absorb and hold water over a longer period of time than standard artificial turf, extending ideal playing conditions and providing enough drainage to prevent puddles. The field also features an Underhill water cannon system, with eight retractable heads providing uniform water distribution over the entire playing surface. This efficient system can produce the required conditions in only six minutes using 2,000 gallons of water, compared to the old system that used as much as 12,000 gallons with each application.

Action Items



Strategies Toward 2026 and Beyond

Reduce water usage at Princeton's central plant, the single top water user on campus, by converting to more sustainable energy infrastructure over time.

Continue to assess and implement water-conserving landscape practices, plumbing fixtures and building systems, and engage users in maximizing their effectiveness.

Standardize installation of dual piping in new buildings and major renovations where possible to facilitate use of reclaimed water and harvested rainwater for toilets.

Install additional water metering and sub-metering to enable better performance tracking, including water usage associated with irrigation.

Continue to evaluate the feasibility of reclaimed wastewater technologies.

Align campus water conservation targets across key water-using departments and activities, and continue to assess indirect water usage associated with campus procurement activities.

Advance evidence-based solutions that reduce our water use by encouraging students, faculty and staff to use the campus as a living lab.

Reinforce Princeton's water-reduction targets during key planning efforts, including campus design and development activities, establishment of landscape management practices, and procurement practices.

Apply behavioral science approaches to promote widespread adoption of mindful water use behaviors, including through programs and building design.

Scale action beyond Princeton through advocacy that encourages local and state-wide water conservation.

PHOTO BY ©CHRISTOPHER LILLA

COGEN PLANT WATER USAGE

Princeton's central energy plant uses millions of gallons of water each year. Water is evaporated as part of the campus cooling process, and is also used to control pollution by injecting it into the combustion zone of gas turbines. In recent years, half of campus water use stems from these activities. A new heat pump and geoexchange facility, currently in planning, will reduce our use of the gas turbine and cooling towers over time, therefore dramatically reducing campus water use.

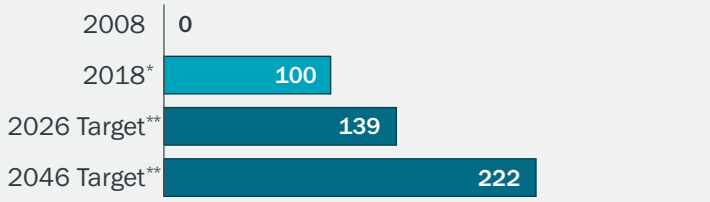
Increase Area Under Enhanced Stormwater Management

OBJECTIVE

Expand the area on campus that meets high standards for improved surface water quality and reduced runoff, and monitor outcomes so that best practices can be shared.

Targets

Expand enhanced stormwater management area (acres)



*2018 status refers to stormwater management areas that can absorb 90th percentile rainfall events. **2026 and 2046 targets include the newly proposed Lake Campus that may include management of 95th percentile rain events.

Global Context, Local Action

Intensified urbanization coupled with more frequent, heavier rain events across the globe are contributing to increased stormwater runoff, exacerbating pollution and flooding. Heavy downpours are only expected to become more frequent and intense as global temperatures increase.[8]

In the United States, stormwater is already among the fastest growing sources of water pollution, and the most significant water quality challenge in New Jersey.[9,10]

More than a decade ago, stormwater management became an area of focus in Princeton's campus planning and sustainability efforts, leading to more than 20 projects that have reduced runoff while helping to restore the quality of the local watershed.

Toward 2026 and Beyond

As we look ahead, our strategies expand the area under enhanced management as we address the quantity and quality of campus stormwater runoff to Lake Carnegie, the D&R Canal and other regional waterways. Our strategies also include an ongoing outflow monitoring program to track the impacts of campus management.

PHOTO BY TIM SMITH

ANALYZING ECOLOGICAL INTEGRITY

In the fall of 2017, Artemis Eyster '19, initiated the undergraduate seminar Analyzing Ecological Integrity. Artemis led seven students in developing a detailed methodology for assessing the ecological health of Princeton's natural habitats. Artemis and her classmates shared their outcomes with campus planners to help inform land-use decisions in the 2026 Campus Plan.

Increase Area Under Enhanced Stormwater Management

Princeton's Progress To Date

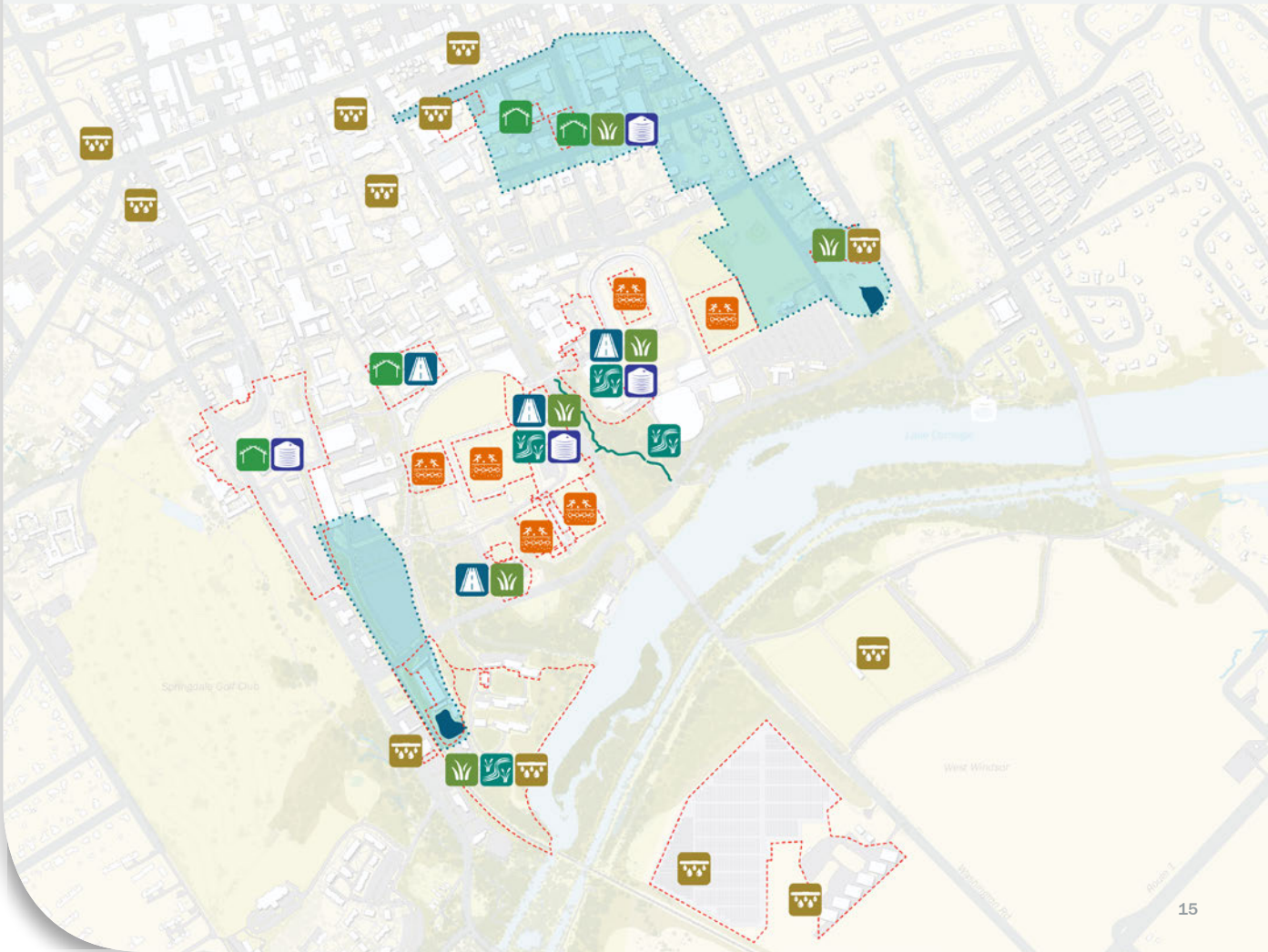
In 2008, the University began implementing enhanced stormwater management through a campus-wide, ecosystem-based approach. Since that time, more than **20 stormwater projects** — ranging from porous pavement to green roofs — have been implemented across **100 acres of the campus**. To date, these strategies have contributed to reducing annual runoff by approximately **23 million gallons (35 percent)**, while improving the quality of remaining runoff.

PHOTO BY CHRISTOPHER LILLJA

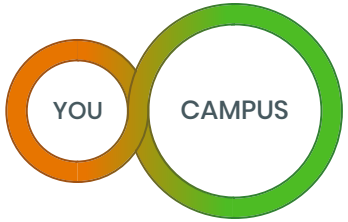
GREEN ROOF AT SHERRERD HALL

Campus Stormwater Management Summary, 2006-2018

- Porous Pavement
- Green Roof
- Bioretention and Rain Gardens
- Stream/Buffer Restoration
- Subsurface Infiltration
- Under-field Storage
- Rainwater Harvesting
- 2016 Campus Plan Projects (Completed 2006-2018) that meet campus stormwater goals
- Drainage Areas for Regional Detention Basins



Action Items



Strategies Toward 2026 and Beyond

Pursue opportunities to restore stream corridors, lake edges and wetlands.

Achieve enhanced stormwater management objectives through new construction projects and campus landscape solutions (e.g., subsurface infiltration, bioretention, stormwater harvesting, green roofs, porous pavement, natural storm water treatment landscapes, green infrastructure corridors, etc.).

Implement an ongoing monitoring program for campus stormwater outflow quality and quantity.

Study the feasibility of converting conventionally farmed campus land to sustainable farming practices with minimal synthetic chemical inputs.

Advance evidence-based stormwater management solutions by actively encouraging students, faculty and staff to use the campus as a living lab.

Raise the visibility of active stormwater management research across the University community through communications such as temporary interpretive signage in the landscape and experiential learning activities in courses.

Apply behavioral science approaches to promote interaction with integrative stormwater management and habitat areas on campus.

Scale action beyond Princeton through information-sharing and collaboration with, for example, local municipalities and watershed organizations.

PHOTO BY CHRISTOPHER LILLA

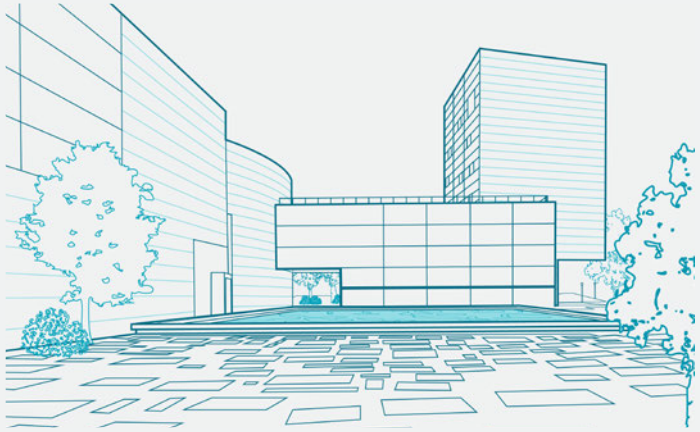
FRICK CHEMISTRY LABORATORY RAIN GARDEN

Rain gardens retain and filter stormwater, providing benefits to the local watershed and stream systems by encouraging stormwater infiltration and reducing erosion. In 2010, the rain garden at the Frick Chemistry Laboratory was the first installation of its kind on campus, with others following at the Princeton Neuroscience Institute, Peretsman-Scully Hall, and the Andlinger Center for Energy and the Environment. Additional installations are planned that blend habitat enhancement and recreation with stormwater management.

Design and Develop Responsibly

OBJECTIVE

Implement an integrative design process in new construction and renovations to meet University sustainability performance targets while making more efficient use of land and optimizing use of built space.



Lewis Arts complex

Global Context, Local Action

By 2050 nearly 70 percent of the world's growing population will reside in urban areas.[11] The continued conversion of land to urban uses is a source of cumulative damage to human health and the global biosphere,[12] unless we implement a significant change in approach.

New Jersey is the most densely populated state in the nation, with nearly 95 percent of its population already living in urban areas.[13] Sustainable design and development are critical in reversing the damage from past development patterns.

As it grows, Princeton intends to be an exemplar of green design and infrastructure while cultivating a strong sense of place and belonging.

Toward 2026 and Beyond

Princeton's next generation of action is to practice integrative design when developing indoor and outdoor environments, toward achieving ambitious sustainability targets. Central to our design objectives is to visibly and experientially reinforce sustainable habits and choices.

In addition to approaches that improve operational sustainability, our design strategies now encourage the personal and institutional behaviors that will contribute to our broader sustainability and community-building objectives. Another priority is to build and use space more efficiently, requiring that we consider how effectively those spaces are utilized from an occupancy and scheduling perspective.

PHOTO BY CHRISTOPHER LILLJA

ANDLINGER CENTER FOR ENERGY AND THE ENVIRONMENT

The Andlinger Center for Energy and the Environment opened in October 2015, and supports a vibrant and expanding program of research and teaching in the areas of sustainable energy development, energy conservation, and environmental protection and remediation. The center features green roofs, rain gardens, energy-efficient lighting and controls, daylight harvesting, rainwater and condensate harvesting, low-flow plumbing fixtures, shower facilities for bicycle commuters, and more.

Princeton's Progress To Date

The 2016 Campus Plan embraced ambitious **sustainable building guidelines** that were adopted in 2008. As a result, more than **2 million square feet** of building area was constructed according to those guidelines, **largely on existing hardscape**. That plan also included new stormwater management strategies that reduced campus runoff by an estimated **35 percent**.

New projects and major renovations over the past decade that removed hardscape and helped improve stormwater infiltration include the Frick Chemistry Laboratory, Sherrerd Hall, the Julis Romo Rabinowitz Building, Andlinger Center for Energy and the Environment, and Lakeside Graduate Housing. Third-party developed projects have also met high sustainability standards. Lakeside Apartments earned **LEED Silver** certification from the U.S. Green Building Council, and both 701 Carnegie Center and the High Performance Computing Research Center earned **LEED Gold**. A summary of sustainable features in these and other projects is available on the Facilities website.

In 2008 Princeton was an early adopter in implementing an internal **carbon pricing strategy** integrated with its **Life Cycle Cost Assessment** (LCCA) to inform decisions in the building planning process.

PHOTO BY BILL TIMMERMAN

2008-2018
Progress Snapshots

60,000
square feet of green roofs on four buildings

110,000
lighting fixtures replaced with LEDs

30,000
gallons of rainwater storage capacity for flushing 142 toilets in three lab buildings

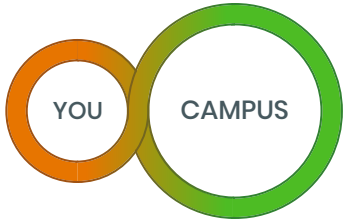
262
Drink Local filtered-water stations*

*Filtered-water stations are now standard in new construction.

LAKESIDE GRADUATE HOUSING

Completed in spring 2015, Lakeside Graduate Housing is home to more than 700 graduate students. The complex meets or exceeds Princeton's sustainable design standards and has achieved LEED Silver Certification. Walking, biking and mass transit are promoted through pathways connecting to campus, bicycle storage and a TigerTransit shuttle stop. Other sustainability features include stormwater management, sustainable material selection, energy-efficient lighting and controls, Energy STAR appliances, geothermal heating and cooling, low-flow plumbing fixtures, and more.

Action Items



Strategies Toward 2026 and Beyond

Implement an Integrative Design Process (IDP) in capital projects.

For major projects, obtain third-party green building certification where feasible, equivalent to LEED Gold standards or better depending on building type.

Continue to apply the biannually revised Design Standards Manual (DSM), which defines minimum building performance and Life Cycle Costing Assessment requirements for systems and materials.

Maximize efficient use of land by integrating layered functions such as stormwater management and geothermal wells integrated into athletic fields, etc.

Optimize use of space through efficient building design, compact development footprints and improved room scheduling.

Analyze major building systems and materials with an internal "carbon pricing" assessment as well as a newly adopted comparison with the cost of installing off-campus green power infrastructure.

Develop a comprehensive post-occupancy building performance evaluation process that includes user feedback.

Encourage campus-as-lab investigations when new construction or land-use change opportunities arise.

Raise the visibility of sustainable building features through communications such as interpretive signage and experiential learning activities in courses.

Implement a Sustainability Advocacy Committee to serve as the steward of campus sustainability targets and objectives across all capital projects.

Reinforce Princeton's design and development goals during key programs, including orientation for all new design teams and administrative leadership, and collaborative sessions with local municipal and nonprofit teams.

Apply behavioral science approaches during design and operations that nudge the behavior of building occupants to reduce the use of resources.

Scale action beyond Princeton through engagement, such as with architectural and design associations, and by building relationships with practitioners who can apply novel ideas adopted on campus in our region and beyond.

Expand the on-site reuse of soils from construction sites to reduce the costs and environmental impacts associated with transporting and processing soils off-site.

PHOTO BY PAUL WARCHOL

ARTS AND TRANSIT PROJECT

The Arts and Transit Project was completed in 2017 and features a park-like setting for the creative and performing arts. The project includes a new multi-modal transit plaza, which features covered bicycle parking and connects to mass transit options, including the bus and train station. Other sustainability features include stormwater management, sustainable material selection, daylight harvesting, geothermal heating and cooling, and green roofs.

Cultivate Healthy and Resilient Habitats

OBJECTIVE

Apply a restorative ecosystem approach in landscape management to regenerate healthy habitats across campus and invite engagement with nature.

Targets

Tracked forested area with improved habitat connectivity and quality (acres)

*Baseline established via GIS analysis.

Global Context, Local Action

Global development patterns have led to the conversion of more than half of the planet's natural habitats, with similar patterns occurring in New Jersey, more so than any other coastal state.[14,15] Forested habitats have become fragmented, compromising the ecosystem functions of the remaining patches, limiting the movement of species and hampering biodiversity.[16]

Recognizing the value of healthy habitats for human well-being and biodiversity, especially as development pressures increase, Princeton has taken a campus-wide ecosystem approach to landscape management by expanding woodland and native meadow plantings and renewing more natural rainwater and stream flows in the landscape.

Toward 2026 and Beyond

As the Princeton campus grows, we are deepening our focus on cultivating healthy habitats that are integrated into the experiential fabric of the campus and more resilient to climate change disruption. We will start with a focus on the connectivity and quality of forested habitats on campus in the context of state-wide connectivity efforts that promote the movement of wildlife across the landscape as they seek shelter, food, mates and other resources. We expect to develop this approach to include other habitat types over time.

PHOTO BY OFFICE OF SUSTAINABILITY

PRINCETON'S WOODED WALKWAYS

Pathways through natural areas on campus provide practical, recreational and mental wellness benefits. During our busy days, we can get where we need to go while getting an infusion of nature. The physiological and mental benefits of even a few moments outdoors are well documented. Integrating natural areas with the built environment of the campus is part of our campus planning philosophy.

Cultivate Healthy and Resilient Habitats

Princeton's Progress To Date

Over the past decade, Princeton has followed an **ecosystem approach** to landscape management. Our practices have focused on protecting soils and restoring ecological function, reducing synthetic chemical use, encouraging stormwater to filter into the landscape, emphasizing native perennial plantings, and conserving water.

Since 2008, we have added or **enhanced 12 acres of forested habitat** by extending the Lake Carnegie woodlands onto campus along stream corridors. This has helped to improve ecological balance by connecting fragmented natural areas. Integral to this effort was the **restoration of meanders and pools** to a portion of the degraded Washington Road stream, including removal of invasive species. We also have **reduced pesticides** used in landscape management by 39 percent, contributing to improved water quality and human health.

PHOTO BY CHRISTOPHER LILLJA

2008-2018
Progress Snapshots

+2,370
net increase in number of trees on campus as part of 12 acres of expanded woodland plantings

39% ↓
decrease in pesticide use

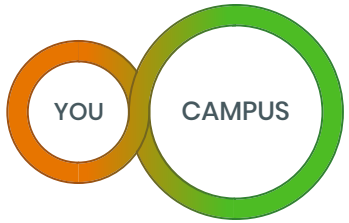
+5
acres of impervious area were converted to open space

+1,400
linear feet of Washington Road stream restored

WASHINGTON ROAD STREAM

In 2012, the University completed a restoration of meandering and stepped form for a portion of the stream along Washington Road to mitigate erosion and flood risks and improve the riparian habitat. A portion of the stream measuring 1,400 feet was reshaped following years of degradation resulting in part from stormwater runoff. Preliminary analysis of nutrient composition, dissolved oxygen and water clarity from several research projects and undergraduate coursework indicates a healthier stream environment compared to pre-restoration conditions. Long term data monitoring of water quality and stream levels at several points along the stream has continued under the Hydrometeorology Research Group.

Action Items



Strategies Toward 2026 and Beyond

Build in a more compact manner and engage in habitat preservation, restoration and enhancement, while integrating other land-use priorities (stormwater management, recreation, etc.).

Invite engagement with nature and the outdoors through building and landscape design strategies, communications during key orientation programs, and coordination with various campus health and wellness programs.

Develop and implement a forest stewardship plan.

Continue to develop and refine the Princeton Index for Land-use and Ecological Assessment (PILEA) habitat quality assessment tool.

Continue to develop and implement an integrative pest management plan across campus.

Advance evidence-based sustainable habitat and landscape management solutions by actively encouraging students, faculty and staff to develop studies and recommendations as well as rigorous tracking and assessment tools.

Scale action beyond Princeton through information-sharing and collaboration with, for example, organizations including the NJ Division of Fish and Wildlife Connecting Habitat Across New Jersey (CHANJ) program.

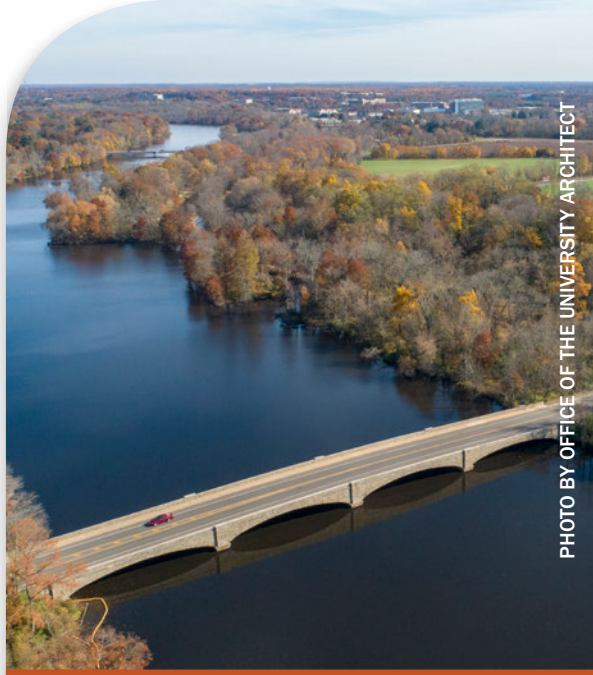


PHOTO BY OFFICE OF THE UNIVERSITY ARCHITECT

PRINCETON INDEX FOR LAND-USE AND ECOLOGICAL ASSESSMENT

With anticipated campus growth, we have renewed our objective to steward and restore campus natural areas. We will direct our attention first to the forested and wetland corridors along Lake Carnegie, and the forested “fingers” that reach up into the campus along the streams. Toward that end staff, with student and faculty input, have developed a habitat quality assessment tool called the Princeton Index for Land-use and Ecological Assessment (PILEA). Along with stormwater outflow monitoring, PILEA will inform land use planning and ongoing management practices, and will also serve as a progress tracking tool.

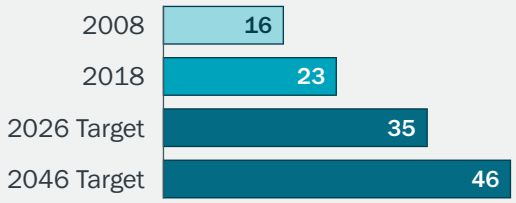
Increase Commuters Using Alternatives to Single-Occupancy Vehicles

OBJECTIVE

Nearly double the percentage of alternative commuters by mid-century and expand the use of campus as an incubator for lifelong sustainable transportation habits.

Targets

Alternative commuters (% of all commuters)



Global Context, Local Action

Fossil fuels burned for road, rail, air and marine transportation together comprise the fourth-largest contributor to global greenhouse gas emissions[17], with significant climate change and human health implications.

In the United States, and in New Jersey, transportation activities are on par with electricity production as the largest sources of emissions[18,19], making the transition to green transportation solutions a top priority.

The University has responded with a Transportation Demand Management (TDM) program to promote ridesharing and the use of public transportation, increasing the number of commuters using these and other alternative modes.

Toward 2026 and Beyond

Princeton's strategies support commuters in transitioning toward more sustainable transportation modes through an expanded transportation demand management (TDM) program called Revise Your Ride. The University also is expanding access to on-campus and regional transportation services and supporting more widespread availability and use of electric vehicles.

PHOTO BY OFFICE OF SUSTAINABILITY

RIDE LIKE THE PRESIDENT

"Bicycling has become an important part of my life as president. I try to bike to my office and back home every day, even when the weather is pretty bad. I love my bicycle routine … it's a great way to get around and it helps to promote our sustainability goals by cutting back on the number of single-occupancy vehicles and parking spots on campus."

-Princeton University President Christopher L. Eisgruber

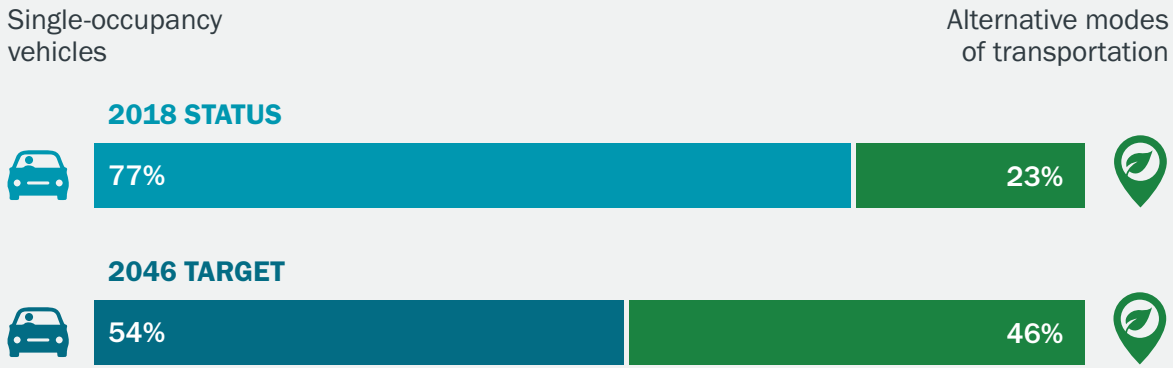
Princeton's Progress To Date

Princeton's efforts to date to reduce the number of single-occupancy vehicle (SOV) commuters to campus through its TDM incentive program have exceeded expectations. Between 2008 and 2017, the program contributed to shifting the behavior of **750 former SOV drivers toward alternative modes**, including rail and bus transit, carpools, vanpools, and biking or walking.

As of 2018, **1,560 faculty and staff members** — or 23 percent of all commuters — use more sustainable alternatives to SOVs, contributing to improved regional air quality, reduced traffic congestion and reduced greenhouse gas emissions. Princeton also offers affordable **car share and bike share** programs that are increasing in popularity.

Revise Your Ride

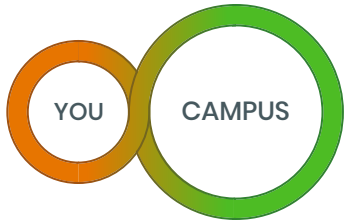
Revise Your Ride is a new TDM program informed by behavioral science to increase commuters using alternative modes of transportation, and to decrease single-occupancy vehicles.



Alternative modes of transportation include:

- Carpool
- Rail
- Walk
- Telecommute
- Bus
- Bike

Action Items



Strategies Toward 2026 and Beyond

Expand transportation demand management strategies, including increased access to on-campus and regional transit services, and enhanced on-campus and regional cycling and pedestrian infrastructure.

Track and reduce, where possible, greenhouse gas emissions from all campus transportation and fleet operations.

Advance evidence-based transportation solutions by encouraging students, faculty and staff experts to engage as advisors and researchers using the campus as a lab.

Encourage lifelong sustainable transportation habits by promoting walking, biking, videoconferencing, vehicle sharing, consolidated trips and other alternatives.

Scale action beyond Princeton through information-sharing and partnerships with, for example, local municipalities, regional transit authorities, and peer networks.

PHOTO BY OFFICE OF SUSTAINABILITY

REVISE YOUR RIDE

In October 2017, Princeton launched Revise Your Ride (RYR). University employees who participate in the program by walking, biking, taking the bus or train, or joining a carpool or vanpool receive financial and other benefits. Enhancing the existing commuter TDM benefits offered for the past decade, RYR has significantly increased the number of employees commuting in alternative ways. Collectively, the 1,560 RYR participants in 2018 avoided driving an estimated 4.5 million single-occupancy vehicle miles, preventing the release of almost 1,200 metric tons of carbon emissions.

Reduce Waste and Expand Sustainable Purchasing

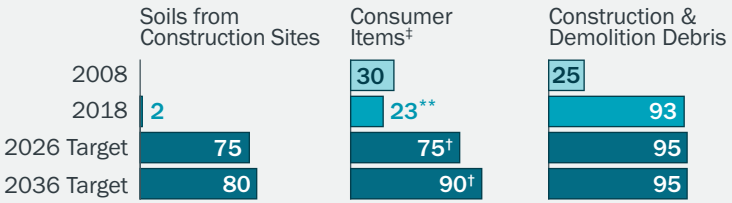
OBJECTIVE

Strive for zero waste through behavioral and operational strategies that include reduction, reuse and recycling criteria in purchasing decisions, and expand these criteria to encourage social and environmental benefits in the full life cycle of purchased goods and services.

Targets

Campus Landfill Waste (tons)

Recycling and Reuse (%)



*2018 represents an average of 2016 and 2018 performance data (comprehensive 2017 data were unavailable). **2018 represents an average of 2017 and 2018 performance data. †Targets to be confirmed following campus waste study. ‡Consumer items consist of recyclable paper, cardboard, glass, metal and plastic.

Global Context, Local Action

Unless global consumption habits change, human use of natural resources is expected to double by 2050 and waste to increase by 70 percent.[20,21]

The United States is one of the most disproportionately heavy consumers of global resources and generates more waste per person than any other nation on the planet[21], motivating many organizations — including Princeton — to change course.

While Princeton has modestly decreased its overall campus landfill waste over time, the total amount of waste generated annually per person today still remains much higher (780 pounds)[22] than the average across North American higher education institutions (400 pounds), and higher still than the Northeast regional campus average (580 pounds).[23]

Toward 2026 and Beyond

Given the pressing need for a culture of responsible consumption, our objective is to set ambitious waste reduction and recycling targets, while linking what we purchase with what is reusable and/or recyclable.

Part of responsible consumption also includes ensuring diversity in the vendor pool and addressing social and environmental justice dimensions of products and services. Such concerns can encompass resource extraction, manufacturing, labor and/or disposal practices.

To advance planning, our strategies include a new baseline campus waste study to inform short- and long-term targets.

PHOTO BY OFFICE OF SUSTAINABILITY

ZERO WASTE CENTERS

In 2016, as part of her final project for ENV327: Investigating an Ethos of Sustainability at Princeton, Allie Klimkiewicz ’19 proposed the idea of highly visible student staffed resource recovery stations at large events, based on behavioral science principles. After successful pilots in 2017, the Office of Sustainability’s student EcoReps, including Ashley Drengler ’19 and Erin Redding ’19 pictured above, began implementing “Zero Waste Centers” at targeted events, including the Tiger Chef Challenge and the Reunions P-rade.

Initial results indicate that such stations, if visible and staffed, can be effective educational and engagement tools and can prevent recycling contamination.

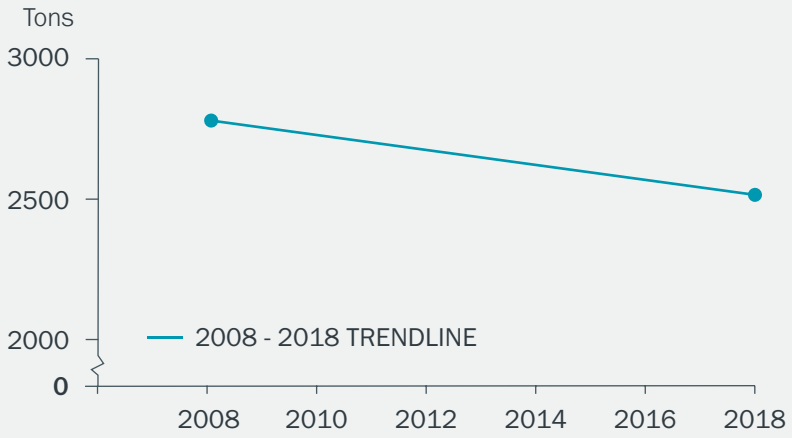
Princeton's Progress To Date

Since 2008, the results of Princeton's efforts to reduce waste and move toward an ethos of conscious consumption have been mixed. The challenges that remain require full community engagement to overcome.

While our overall campus **landfill waste volume has decreased by 8 percent** since 2008, our **per-person waste remains high** within the higher education sector. In addition, our **recycling rate for consumer items** (including mixed paper, cardboard, glass, metal and plastic) has actually gone **down 23 percent** since 2008, largely due to contamination of our recycling stream with food scraps and items that are not recyclable in today's global markets, as well as inconsistencies in messaging and containers that confuse audiences. Given the behavior and infrastructure challenges, general consumption and disposal norms have proven stubbornly tough to shift.

At the same time, we have **increased the diversion rate of construction and demolition debris**, one of our largest waste streams, from approximately 25 percent in 2008 to an award-winning average of 93 percent as of 2018. We now are aiming to substantially increase **reuse of soil** on campus from construction projects.

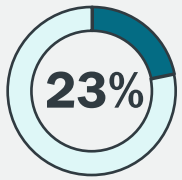
Campus Landfill Waste



Recycling Rate

Our recycling rate for consumer items* has declined to 23 percent, largely due to contamination of the recycling stream, low awareness, and unclear messaging.

2008 BASELINE RECYCLING RATE



2018 ESTIMATED RECYCLING RATE

*Recyclable paper, cardboard, glass, metal and plastic

PHOTO BY CHRISTOPHER LILLJA

CONSTRUCTION AND DEMOLITION DEBRIS RECYCLING PROGRAM

Princeton continues to track toward its target to recycle 95 percent of construction and demolition debris for new and renovated buildings. William Bausmith, who manages this recycling program for the University, achieves this high rate through contractual requirements, providing incentives for positive behavioral changes, and web-based recycling reporting systems. His efforts garnered the New Jersey Department of Environmental Protection 2017 Recycling Award.

Expanding Sustainable Purchasing

Purchasing is a powerful driver in almost all sustainability action areas: what we buy has profound implications for people and ecosystems locally and globally, all along the supply chain — from production to use to disposal.

In 2008, Princeton's objective was to encourage social and environmental sustainability in the supply chain when purchasing goods and services. For example, to date:

- 44 percent of all food purchased for the dining halls is local
- 92 percent of electronics purchased are EPEAT® Gold-registered
- 88 percent of paper purchases meet our standard of 100 percent post-consumer recycled content
- 66 percent of cleaning products purchased are Green Seal® certified

Looking ahead, we strive to incorporate into our purchasing decisions more holistic, full-lifecycle considerations such as land and water used during production, greenhouse gases generated at every stage, and whether items are reusable, recyclable or compostable.

When purchasing food for campus consumption, for example, we will prioritize local, sustainable and plant-based ingredients, with a preference for products that address social inequities and unsafe working conditions, and minimize environmental impacts stemming from water use and greenhouse gas emissions. We will also continue to increase the ranks of diverse suppliers that qualify as minority-owned, woman-owned, LGBTQ-owned and veteran-owned businesses.

In 2008, Princeton began to encourage sustainability in the supply chain

when purchasing goods and services, while simultaneously striving to reduce waste and increase recycling.

2008-2018

Progress Snapshots

44%

of food purchased is local, up from 27% prior to 2008

88%

of standard office paper purchased is 100% post-consumer recycled paper, up from 67% in 2008

66%

of cleaning products are Green Seal® certified, up from 34% in 2010

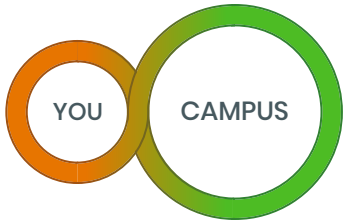
PHOTO BY NICK DONNOLI

CECILIA'S SENIOR THESIS

The choices we make every day in dining venues help drive food procurement practices.

For her senior thesis, Cecilia Shang '18, used the campus as a lab by applying behavioral science to influence more sustainable food choices in the dining halls. By testing certain "nudges," including the order in which food options were arranged along with informational signage, she found that her intervention successfully increased vegetable consumption, while decreasing resource-intensive meat consumption. She found that simple solutions can be implemented with very little cost, and could be applied to any dining venue.

Action Items



Strategies Toward 2026 and Beyond

Conduct a campus-wide waste audit, with focused studies of Move-out and Reunions, to develop informed waste diversion and reduction targets and strategies.

Study the feasibility of a materials-sorting facility on campus.

Advance sustainable procurement through University policies and practices, with the potential to catalyze environmental and social change in supply chains, from producer to consumer.

Encourage responsible campus events by consistently applying sustainable event guidelines that include preferred caterers, menus and waste-reduction strategies.

Increase our recycling rate of consumer items through education, standardizing receptacles and labeling, and by returning to multi-stream recycling to reduce contamination.

Reduce recycling contamination by expanding the collection of food scraps beyond the current dining hall composting program to other strategic locations on campus.

Increase reuse of a broader range of items on campus through expanding what is collected by the Resource Recovery Program, and optimizing the student Move-out and Resale program, among other efforts.

Increase reuse of soil from construction projects by expanding our soil reuse yard, minimizing the environmental burden of transporting soil off campus and importing new soil.

Continue to divert edible food to the community in our efforts to reduce food waste.

Continue award-winning construction and demolition debris recycling program.

Continue to expand resource conservation strategies, including composting all leaves and trimmings on-site; reducing unnecessary paper usage; responsibly recycling electronics and accessories; and extending the lifespan of textiles through clothing swaps, repair options and donations, among many others.

Align effective sustainable purchasing and waste management practices across campus through coordinated departmental action plans.

Advance evidence-based sustainable purchasing and waste solutions by actively encouraging students, faculty and staff to use the campus as a living lab.

Reinforce Princeton's purchasing and waste goals during key programs, including orientation for all students, faculty and staff; Move-in and Move-out; Princeton Preview for undergraduates; visiting weekends for graduate students; residential life opportunities; athletic events; vendor supply fairs and other events.

Scale action beyond Princeton through engagement with various organizations such as the National Waste & Recycling Association, the Association of New Jersey Recyclers, the Post-Landfill Action Network, and the Stockholm Resilience Center, among others.

PHOTO BY OFFICE OF SUSTAINABILITY

S.C.R.A.P. LAB
Sustainable Composting Research At Princeton

"My involvement in environmental initiatives as an undergraduate at Princeton inspired me to dig deeper, and now I enjoy literally getting my hands dirty as the manager of The S.C.R.A.P. Lab. It has been extremely rewarding to see the impact of my work in attracting diverse student employees, challenging gender stereotypes, engaging staff across multiple departments, encouraging behavior change, and supporting faculty research. I look forward to continuing to challenge the norm that food scraps are waste, and investigating their use as a valuable resource to revitalize soils and reduce fossil fuel inputs in agriculture."

-Gina Talt '15,
Food Systems Project Specialist,
Office of Sustainability

Endnotes

1 The Scales of Action framework was originally conceptualized by the MIT Office of Sustainability as Scales of Impact. Find out more.

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This plan is ambitious, with an intent to inform three decades of institutional decision-making. And it strives to be honest about clear progress as well as intractable challenges as we grapple and tinker with solutions. It also reflects the wisdom and intent of the many student, faculty, staff, alumni, external reviewer and administrative partners who have been and continue to be essential in achieving its objectives.

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We hope this plan illustrates a pathway to positive impact that we can each cultivate in our daily routines and decisions. Thank you for your role in advancing sustainability efforts at Princeton and everywhere, on behalf of people and the planet.

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The Princeton Sustainability Committee in October 2018 after its monthly meeting.

Appendices

Princeton's Sustainability Principles

In 2014, the University's Sustainability Steering Council adopted the following principles to guide campus sustainability efforts.

- Princeton's most meaningful efforts will come from its research, the education of its students and the leadership of its graduates.
- Princeton's sustainability goal setting is informed by methodical, evidence-based and multi-perspective analyses.
- Near-term (two 10-yr) sustainability goals "stretch" beyond those that are currently achievable, and they exist within a visionary, aspirational framework.
- Planning and development related to the physical campus have sustainability as a core priority.
- Princeton fosters community-wide awareness and action and is an exemplar of repeatable best practices for other institutions.
- Holistic benefits (educational, cultural, research) as well as financial considerations over multiple time horizons are integral components of Return-on-Investment analyses related to campus sustainability implementation.
- Princeton carbon emissions reductions produce results that are "additional" to regulatory or market driven reductions that would happen anyway, and are rigorously verifiable.
- Princeton is committed to a "campus as a living laboratory" approach that engages the campus community in rigorous inquiry and demonstration of principled pathways to sustainability.

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