# UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
# GREENHOUSE MASTER PLAN

June 2026

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## Executive Summary

Greenhouse spaces on University of Illinois Urbana-Champaign support critical research in plant biology, crop sciences, and numerous interdisciplinary research initiatives. While several new greenhouses have been constructed in the last five years, much of the existing greenhouse space on campus require capital improvements and replacements to serve current research needs and prevent the loss of critical research.

Recommendations include decommissioning and replacement of several aged greenhouses, including Shelford Vivarium, Natural History Survey Greenhouse, and the USDA Nematology Greenhouse. Major capital investments are needed for the Turner Hall Greenhouse, the Plant Biology Laboratory, and the Natural Resources Studies Annex greenhouse. Finally, a new, interdisciplinary sciences building with classrooms, labs, offices and greenhouses is recommended to be constructed north of the existing Plant Sciences Laboratory. This new facility would create synergy with existing greenhouse spaces and the new IBRL 2.0, as well as provide additional needed classrooms to south campus. New facilities will be designed with the infrastructure available to support new growth chambers, which are in high demand, and which give researchers more precise control over their research environments. Facilities with greenhouse spaces meeting Biohazard Safey Levels (BSL) 1 and 2 will also support expanding research opportunities.

Updates to the campus design standards are recommended to make future greenhouse projects easier to execute. Facilities & Services has engaged design consultants to update numerous campus design standards, including a new set of standards for greenhouses. This effort will align our campus standards with industry standards and best practices, improving project delivery and providing better construction project outcomes.

# Introduction

The Greenhouse Master Plan Task Force was formed in July 2023 by Interim Provost William Bernhard to do the following:

1. Develop an inventory of existing greenhouse resources on campus, including pertinent information such as size, location, current space assignment, equipment, function, and facility condition.
2. Prepare a guiding document for future greenhouse developments.
    a. Determine which current assets need capital reinvestment versus decommissioning.
    b. Determine what additional equipment and facilities are needed to deliver upon projected research goals.
    c. Evaluate optimal location of future greenhouse developments and explore potential collaborative opportunities.
    d. Develop relevant building standards for the greenhouse typology.
3. Estimate future capital needs for greenhouse spaces and identify potential funding sources.

Greenhouses are an invaluable resource for our university's education and research mission. This Greenhouse Master Plan provides an assessment of current conditions and a roadmap to meet future needs.

A survey of campus greenhouse users solicited feedback about the conditions and issues related to the facilities. Findings showed that the older facilities were generally in poor condition and, while the staff did a good job of managing operations, there were many shortcomings with which researchers had to contend. Among the most common complaints in our existing greenhouses were the following:

- Poor temperature control
- Ceiling heights too low for some types of research
- Leaks
- Poor Space availability
- Lack of blackout curtains
- Poor irrigation
- Electrical service issues
- Need for more growth chambers
- Lack of storage
- Lack of adjacent lab space

Survey responses were considered by the committee as they assembled the existing inventory data, developed proposed building standards, and prioritized capital improvement recommendations.

## Existing Inventory

The existing campus greenhouses include over 173,000 square feet spread across 17 separate facilities, with ages ranging from 109 years old to brand new in 2024. The major users are the College of Agricultural, Consumer, and Environmental Sciences (ACES), the College of Liberal Arts & Sciences (LAS), the Institute for Genomic Biology (IGB) and the Institute for Sustainability Energy, & Environment (ISEE).

| ***Building Name*** | ***Department/Unit*** | ***Greenhouse Area Net Square Feet*** | ***Year Built*** | ***Facility Condition index**** | ***Recommendation*** |
|---|---|---|---|---|---|
| Shelford Vivarium | Evolution Ecology Behavior | 1,276.59 | 1916 | 0.817 | Maintain until redevelopment of site, then decommission and replace |
| Turner Hall Greenhouses | ACES | 55,660.49 | 1969 | 0.474 | Capital Reinvestment |
| Natural History Survey Greenhouse | IL Natural History Survey | 9,306.89 | 1942 | 0.528 | Decommission and replace |
| Medical Sciences Building | Entomology | 838.04 | 1975 | 0.400 | Maintain |
| USDA Nematology Greenhouse | Plant Biology | 2,876.00 | 1987 | 0.475 | Decommission and replace |
| Plant Sciences Laboratory | Plant Biology & ACES | 51,759.42 | 1988 | 0.464 | Capital Reinvestment |
| Natural Resource Studies Annex | IL Natural History Survey/Crop Sciences | 11,557.69 | 1973 | 0.646 | Capital Reinvestment |
| Woody Ornamentals Greenhouse | Crop Sciences | 2,825.78 | 1982 | 0.900 | Replace |
| Shelford Vivarium Greenhouse | Evolution Ecology Behavior | 1,401.25 | 2007 | 0.200 | Maintain until redevelopment of site, then decommission and replace |
| Energy Farm Greenhouse 1 | Crop Sciences | 2,028.51 | 2013 | 0.150 | Maintain |
| Fruit Research Farm - Greenhouse #1 | Crop Sciences | 1,427.03 | 2014 | 0.120 | Maintain |
| Retractable Roof Greenhouse | Plant Biology | 7,185.36 | 2017 | 0.000 | Maintain |
| Energy Farm Greenhouse 2 | Crop Sciences | 1,004.42 | 2009 | 0.120 | Maintain |
| Energy Farm Greenhouse 3 | Crop Sciences | 1,122.58 | 2011 | 0.120 | Maintain |
| RIPE High-Throughput Phenotyping Facility | Institute for Genomic Biology | 7,812.78 | 2020 | 0.000 | Maintain |
| CABBI Greenhouse | ISEE | 14,192.00 | 2024 | 0.000 | Maintain |
| Allerton Visitor's Center - RAPCC | Allerton Park & Retreat Center | 1,217.85 | Unknown | 0.400 | Maintain |
| **TOTAL** | | **173,492.68** | | | |

* The Facility Condition Index (FCI) is the cost for existing deferred maintenance for a building divided by the replacement cost for the building. It provides a data point for facility planning that identifies buildings whose conditions are so poor they should be considered for decommissioning and replacement rather than repair and renovation. The higher the FCI, the more likely the need to replace the building.

More detailed descriptions and photos of each greenhouse facility on campus follow.

**Shelford Vivarium Greenhouse**

This facility was built in 1916 and houses plant research labs, aquatic research labs, storage, greenhouse, and vivarium.

1. Roof side wall height: 13’-2” verify
2. Floor Area: 1,277 NASF
3. Glazing: Single pane glass, good condition
4. Structure: Aluminum, fair condition
5. Floor: Concrete, fair condition
6. Climate Controls: Wadsworth, fair condition
7. Heating: Fin tube radiant perimeter heat, poor condition
8. Cooling: Ridge vent, exhaust fans, and evaporative coolers, fair condition
9. Humidity: None

10. Lighting: HID, good condition
11. Irrigation: Manual
12. Site drainage and runoff ponds: Good
13. Equipment: Sink

Ongoing Issues: Building is in very poor condition, lacks an elevator and has many accessibility deficiencies, and has a very large deferred maintenance backlog, including heating and cooling systems, building envelope problems, antiquated restrooms and plumbing systems, and other issues. The building, due to the extreme amount of deferred maintenance, is recommended to be decommissioned and the research relocated to alternate facilities.

The Shelford Vivarium is located in the north side of campus, west of the Bardeen Quad, in a part of campus that was identified for redevelopment in the 2017 Campus Master Plan. With growth pressures from the Grainger College of Engineering, a new Engineering Sciences Teams Center (ESTC) building is proposed for the site. A site selection committee for the project evaluated potential locations and both Shelford and the Computing Applications Building to the north were approved by the Chancellor's Capital Review Committee in August of 2024. A caveat to the approval was that Grainger would be required to pay for new facilities and relocation of the existing buildings' occupants. While the ESTC project is temporarily on hold while raising funds, it is expected to move forward eventually.

Recommendations: Relocate research and demolish building.

**Turner Hall Greenhouses**

This is the largest greenhouse on campus. It is in the ACES campus conveniently located near Turner Hall and other ACES buildings. Turner Greenhouses supports research projects from ACES, NRES, and IGB, class labs, along with extension and RSO projects. Turner Greenhouses hosts the Crop Sciences plant collections and the USDA Corn Germplasm collection. Many of the rooms are used for unregulated projects, but the newer southwest addition can hold up to biohazard level two projects in air-conditioned spaces. The wide walkways in these greenhouses are helpful for tours and class labs.

1. Roof side wall height: 11’-0” verify
2. Floor Area: 55,660 NASF
3. Glazing: Single pane glass, poor condition
4. Structure: Aluminum, good condition
5. Floor: Concrete, fair condition
6. Climate Controls: Vary. Titan 2007, fair condition, Argus, excellent condition.
7. Heating: Fin tube radiant perimeter heat and unit heaters, poor condition
8. Cooling: Evaporative coolers, ridge and side vents and exhaust fans, poor condition
9. Humidity: no active humidity controls
10. Lighting: HID, fair condition, LEDs, good condition
11. Irrigation: manual, poor. No water treatment so pH varies seasonally.
12. Site drainage and runoff ponds: Good

13. Equipment: Growth chambers, cold room, USDA seed germplasm, autoclave, two soil ground bed greenhouse rooms.

Ongoing Issues: The building is aged and needs significant capital investment to repair and renovate it. It is the largest greenhouse on campus and is a critical facility for much of campus' agricultural research. It's location near the heart of the ACES campus makes it impractical to replace with a new facility elsewhere on campus. Expansion of the facility is also desired to address space constraints that hamper ever-growing faculty and research requests.

Recommendations: Renovate and construct new addition.

**Natural History Survey Greenhouse**

This 1940's greenhouse serves to house Miscanthus germplasm and propagation It has been identified by F&S as a maintenance problem.

1. Roof side wall height: 6'-0"
2. Floor Area: 9,307 NASF

3. Glazing:  Single pane glass, poor condition
4. Structure: Wood framing, poor condition
5. Floor:  Concrete, fair condition
6. Side walls: Concrete, fair condition
7. Climate Controls:  Individual pneumatic thermostats, fair condition
8. Heating: perimeter and under-bench steam heat pipes (bare, no fins), poor condition
9. Cooling: Ridge vents (manual) and unit coolers, poor condition
10. Humidity: None
11. Lighting: HID (rooms 4 and 7 only), fair condition
12. Irrigation: automated drip and sprinkler system built by end-users
13. Site drainage and runoff ponds: None
14. Equipment: Sink

Ongoing Issues:  Building is in very poor condition, lacks accessibility, and is in a part of campus that is identified for redevelopment.

Recommendations: Relocate research and demolish building.

**Medical Sciences Building**

The Medical Sciences greenhouse is located on the roof of the Medical Sciences Building and is currently used for entomology research.

14. Roof side wall height: 10’-2”
15. Floor Area: 838 NASF
16. Glazing: Single pane glass, fair condition
17. Structure: Aluminum framing, good condition
18. Floor: Concrete, good condition
19. Climate Controls: Wadsworth, poor condition
20. Heating: Fin tube radiant perimeter heat and unit heaters, poor condition
21. Cooling: Ridge vent and exhaust fans, fair condition
22. Humidity: None
23. Lighting: HID, fair condition
24. Irrigation: manual
25. Site drainage and runoff ponds: None
26. Equipment: Sink

Ongoing Issues: Roof leaks during heavy rains, difficulty maintaining temperatures during very hot or very cold days and clogging of floor drain with soil.

Recommendations: Consider replacing glazing with more efficient glazing materials or improving air infiltration rates fixing slipped glass, gaps in ridge vents, and covering/winterize exhaust fans and louvers, renovate heating and cooling systems including checking steam traps, rusted fins, etc., replace controls. Confirm if there’s a soil trap, consider spill containment pallet or tray system to prevent soil from repotting activities from reaching the drain. Have Crop Sciences greenhouse manager to review conditions and make additional recommendations. Add energy curtain to retain heat.

**USDA Nematology Greenhouse**

Located north of the Plant Sciences Laboratory, the USDA Nematology Greenhouse was built in 1972, and is used for research affiliated with the Realizing Improved Photosynthetic Efficiency (RIPE) project.

1. Roof side wall height: 8'-0" +/-
2. Floor Area: 2,876 NASF
3. Glazing: Single pane glass, fair condition
4. Structure: Aluminum, fair condition
5. Floor: Concrete, fair condition
6. Climate Controls: Wadsworth
7. Heating: Gas unit heaters, poor condition
8. Cooling: Evaporative cooling pads, ridge vent and exhaust fans, fair condition
9. Humidity: Aqua-Fogger
10. Lighting: HID, fair condition, LEDs, good condition
11. Irrigation: Manual
12. Site drainage and runoff ponds: Good
13. Equipment: One Conviron Gen2000 growth chamber

Ongoing Issues: Building is in fair to poor overall condition, including deteriorated masonry side walls, aging roof at head house, aged glazing, and low sidewall height. It is also located where a Plant Sciences

Lab addition is recommended.  Note that access to the building

Recommendations: Maintain building until expansion of Plant Sciences Lab is funded.  Relocate research and demolish building.


**Plant Sciences Laboratory**

This is the second largest greenhouse on campus.  It is conveniently located at the edge of the main ACES campus and provides research greenhouse space for various labs mainly from the Colleges of ACES and College of LAS. PSL Greenhouse rooms can host Biohazard level one material and there are several air-conditioned rooms that support pathogen and insect research. PSL Greenhouses have an outstanding botanical plants collection and Conservatory on the northeast side of PSL Greenhouses along with a custom soil shop and storeroom that supports researchers onsite and the surrounding campus area.

1. Roof side wall height: 11’-0” verify
2. Floor Area:  51,759 NASF
3. Glazing:  Single pane glass, poor condition
4. Structure: Aluminum, fair condition
5. Floor:  Concrete, fair condition

6. Climate Controls:  Argus, excellent condition
7. Heating: Fin tube radiant perimeter heat and unit heaters, fair condition
8. Cooling: Evaporative coolers, ridge and side vents and exhaust fans, fair condition
9. Humidity: No active humidity controls.
10. Lighting: HID, fair condition, LEDs, good condition
11. Irrigation: Automatic and manual. Acid injections and water softener system onsite for water treatment.
12. Site drainage and runoff ponds: Poor
13. Equipment: Growth chambers, coolers, grinder, autoclave, RO system, acid injector, four soil ground bed greenhouse rooms, storeroom and shop. Chemical mixing room, root washing room and nematology lab.

Ongoing Issues:  The building is aged and needs significant capital investment to repair and renovate it. It is the second largest greenhouse on campus and is a critical facility for much of campus' agricultural research.  It's location near the heart of the ACES campus makes it impractical to replace with a new facility elsewhere on campus.  Expansion of the facility is also desired to address space constraints that hamper ever-growing faculty and research requests.

Recommendations: Renovate and construct new additions.

**Natural Resources Studies Annex**

This building houses laboratories and greenhouse spaces for the Illinois Natural History Survey. It is in

1. Roof side wall height: 8’-0”
2. Floor Area: 11,558 NASF
3. Glazing: Single pane glass, poor condition
4. Structure: Aluminum
5. Floor: Concrete, fair condition, and soil
6. Climate Controls: Argus, poor condition
7. Heating: Fin tube radiant perimeter heat and unit heaters, poor condition
8. Cooling: Ridge vent, side vents and exhaust fans, fair condition
9. Humidity: None
10. Lighting: HID, fair to poor condition
11. Irrigation: manual
12. Site drainage and runoff ponds: None
13. Equipment: Sinks

Ongoing Issues: Building is in fair to poor condition and requires a significant investment to repair infrastructure including heating, cooling, controls, lighting, and glazing.

Recommendations: Renovate to meet current standards and needs.

**Woody Ornamentals Greenhouse**

This small greenhouse, built in 1982, served Crop Sciences until it was damaged by a storm. There are discussions and plans to relocate components of the Sustainable Student Farm to this location to improve access and visibility. This location is closer to a campus bus route, allowing the expansion of educational offerings and serving better as an outward-facing educational space for the College of ACES. The existing concrete pad to the north is large enough to add several more hoop houses.

1. Roof side wall height: 8'-0"
2. Floor Area: 1,277 NASF
3. Glazing: Double wall acrylic, poor condition
4. Structure: Galvanized steel hoop, fair condition
5. Floor: Soil
6. Climate Controls: Sterling, unknown condition
7. Heating:
8. Cooling: Exhaust fans, unknown condition
9. Humidity: None
10. Lighting: None
11. Irrigation: manual
12. Site drainage and runoff ponds: Good
13. Equipment: None

Ongoing Issues:  Building is in poor condition, but essential structure (galvanized steel hoop) remains in fair condition. It is in a part of campus that is identified for redevelopment which includes a new greenhouse structure.

Recommendations: Renovate to meet the needs of the redevelopment plan for relocating the sustainable student farm.

**Shelford Vivarium Greenhouse**

This facility was built in 2007 and houses aquatic research tanks.

1. Roof side wall height: 8’-6”
2. Floor Area:  1,401 NASF
3. Glazing:  Double wall polycarbonate, translucent UV blocking, good condition
4. Structure: Galvanized steel, good condition
5. Floor:  Concrete, good condition
6. Climate Controls:  Micro-Grow, good condition
7. Heating: Unit heaters, good condition

8. Cooling: Exhaust fans, evaporative coolers, good condition
9. Humidity: None
10. Lighting: HID, good condition
11. Irrigation: Manual, water treatment tanks
12. Site drainage and runoff ponds: Good
13. Equipment:

Ongoing Issues: Building is in good condition, with only minor rusting issues at metal supports.

Recommendations: Maintain; relocate if deemed necessary for campus expansion.

**Energy Farm Greenhouse 1**

These greenhouses were constructed in 2013 to support Crop Science research. While it does not have a head house, the nearby Energy Barn has a laboratory for use by researchers.

1. Roof side wall height: 20'-0"
2. Floor Area: 2,029 NASF
3. Glazing: Double wall polycarbonate, good condition
4. Structure: Galvanized Steel / Aluminum, good condition
5. Floor: Concrete, good condition

6. Climate Controls:  Link4 , scheduled for upgrade to Wadsworth Seed controller Spring 2025
7. Heating: Hydronic Radiant floor / fin tube heating (biomass) and unit heaters (1 hydronic, 2 propane), good condition
8. Cooling: Ridge and side vents, 2 louvered intakes and 1 exhaust fan, good condition
9. Humidity: NONE
10. Lighting: HID, poor condition.  Fixtures were not ideal for greenhouse and have increasing electrical failures.
11. Irrigation: Automatic
12. Site drainage and runoff ponds: Good
13. Equipment: None

Ongoing Issues:  Link4 controller is not as reliable as needed for research greenhouse.  Lights are reaching end of life and requiring increasing maintenance.

Recommendations: Maintain.

**Energy Farm Greenhouses 2 and 3**

These greenhouses were constructed between 2013 and 2021 to support Crop Science research. While they do not have head houses associated with them, there is a nearby building, the Energy Barn, which has a laboratory for use by researchers.

1. Roof side wall height: 8’-0”
2. Floor Area: 1,004 and 1,123 NASF
3. Glazing: Poly, good condition
4. Structure: Galvanized Hoop, good condition
5. Floor: Aggregate.
6. Climate Controls: Link4, fair condition scheduled for upgrade to Wadsworth Seed controller Spring 2025
7. Heating: Propane unit heaters, good condition
8. Cooling: Exhaust fans, good condition
9. Humidity: None
10. Lighting: None
11. Irrigation: automatic
12. Site drainage and runoff ponds: Good
13. Equipment: None

Ongoing Issues: Propane unit heaters are not adequate on lowest temperature nights of winter. Diesel fueled “Salamander” heaters are needed at peak heating. Ideal to add concrete floors with radiant floor heating supplied by nearby biomass boiler system. Future improvements include replacing the existing poly-film with semi-rigid plastic panels (e.g. polycarbonate) for reduced maintenance and greater durability.

Recommendations: Maintain.

**Fruit Research Farm Greenhouse #1**

This small greenhouse, built in 2014, serves Crop Sciences…

1. Roof side wall height: 8’-0”+/-
2. Floor Area: 1,427 NASF
3. Glazing: Poly, good condition
4. Structure: Aluminum hoop house
5. Floor: Concrete, soil, good condition
6. Climate Controls: Thermostat, good condition
7. Heating: None
8. Cooling: Circulation and exhaust fans, good condition
9. Humidity: None
10. Lighting: limited HID, good condition
11. Irrigation: manual
12. Site drainage and runoff ponds: Good
13. Equipment: None

Ongoing Issues: None.

Recommendations: Maintain.

**Retractable Roof Greenhouse**

This medium sized greenhouse, built in 2021, serves Plant Biology, and is used to test drought resistance by reducing the amount of rain that reaches the crops below. This structure was the topic of much discussion regarding the facilities standards that were applied during construction. The overall impression was that the standards exceeded what was necessary for this type of structure.

1. Roof side wall height: 16’-0” +/-
2. Floor Area: 7,185 GSF
3. Glazing: Poly
4. Structure: Aluminum, excellent condition
5. Floor: Soil
6. Climate Controls: None
7. Heating: None
8. Cooling: None
9. Humidity: None
10. Lighting: none
11. Irrigation: None

12. Site drainage and runoff ponds: None
13. Equipment: Retractable roof, cameras

Ongoing Issues: None.

Recommendations: Maintain.


**RIPE High-Throughput Phenotyping Facility**

This new greenhouse, finished in 2020, is in the Research Park. It was developed to support Institute for Genomic Biology research. Heating and cooling in the facility is provided by geothermal heat exchangers.

1. Roof side wall height: 12'-0"
2. Floor Area: 7,813 NASF
3. Glazing: Double wall polycarbonate, excellent condition
4. Structure: Aluminum, excellent condition
5. Floor: Concrete, excellent condition
6. Climate Controls: Argus, excellent condition

7. Heating: Radiant floor heat, fin tube perimeter heat and unit heaters, excellent condition
8. Cooling: Evaporative coolers, ridge and side vents and exhaust fans, excellent condition
9. Humidity: Misters
10. Lighting: LED, excellent condition
11. Irrigation: automatic, including fertigation
12. Site drainage and runoff ponds: Excellent
1. Equipment: Rapid throughput phenotyping, growth chambers, RO water, cold room, grinder, autoclave, cameras, blackout curtains.

Ongoing Issues: None.

Recommendations: Maintain.

**Plant Biology Innovation Greenhouse**

The most recent addition to campus, this greenhouse serves CABBI. It includes a head house with eight growth chambers as well as a solar panel array.

2. Roof side wall height: 12’-0”

3. Floor Area:  14,192 NASF
4. Glazing:  Double wall acrylic, excellent condition
5. Structure: Aluminum, excellent condition
6. Floor:  Concrete, Excellent condition
7. Climate Controls:  Argus, excellent condition
8. Heating: Radiant hydronic floor heat and unit heaters, excellent condition
9. Cooling: Evaporative cooling via unit coolers on roof of headhouse, ridge vent, exhaust fans, solar shades, excellent condition
10. Humidification: foggers
11. Lighting: LED, excellent condition
12. Irrigation: Automatic, including fertigation system
13. Site drainage and runoff ponds: Excellent
14. Equipment: Rapid throughput phenotyping, growth chambers, RO water, cold room, grinder, autoclave, photovoltaic system.

Ongoing Issues:  Some water infiltration issues at roof vents have impacted phenotyping experiments and are being resolved with the contractor.

Recommendations: Maintain.

**Allerton Visitor's Center – RAPCC**

This small, historic production greenhouse is operated by Allerton Park. It is not a research facility and is supported by Allerton operational funds.

1. Roof side wall height: 8'-0"
2. Floor Area: 1,277 NASF
3. Glazing: Single pane glass, poor condition
4. Structure: Wood, poor condition
5. Floor: Concrete, fair condition
6. Climate Controls: Unknown
7. Heating: Fin tube radiant perimeter heat and unit heaters, poor condition
8. Cooling: Ridge vent and exhaust fans, fair condition
9. Humidity: None
10. Lighting: HID, fair condition
11. Irrigation: manual
12. Site drainage and runoff ponds: None
13. Equipment: Sink

Ongoing Issues: Building is aged but is adequate for current needs.

Recommendations: Maintain.

## A Guide for Future Development

New and renovated facilities to deliver upon projected research goals were identified and prioritized. These are for replacement of existing facilities to be decommissioned as well as additions and new facilities to deliver planned research. They are listed in order of priority based on the 2017 Campus Master Plan, strategic departmental and research goals, and committee feedback.

## Capital Project Priorities

1. Decommission and Replace Natural History Survey Greenhouse: This project would provide a long-term solution for a collection of irreplaceable research plants which are currently housed in a very aged and deteriorating greenhouse structure. The new structure would be located at the Energy Farm and would include a head house. A short-term solution of renovating a portion of the NRSA Greenhouse for housing these research plants was also considered.

2. Decommission and Replace Shelford Vivarium: This project would decommission the Shelford Vivarium, which has a large amount of deferred maintenance and accessibility issues. New spaces would be provided at the existing research ponds on the South Farms for a new vivarium, labs, and storage. The new facility could potentially reduce pressure at Morrill Hall and Burrill Hall as well. The greenhouse portion of Shelford would be replaced with a new greenhouse at the Energy Farm. An Investment for Growth proposal was submitted for this replacement.

3. Construct New Greenhouse/Lab/Classroom Facility: This project would construct a new facility located north of Plant Sciences Lab on existing surface parking lot which would include lecture halls and classrooms on first floor, possibly a café, labs and offices on the second floor, and greenhouses on the roof. It would require new parking structure to be constructed to replace surface lot. This could be an underground parking lot beneath the new building, or a freestanding parking structure nearby. A freestanding structure could also address the planned future expansion of IBRL over an existing surface parking lot nearby. Co-locating researchers improves opportunities for collaboration and creates operational efficiencies for greenhouse staffing. A recent University of California at Berkely development could serve as an example.

4. Renovate and Expand Turner Hall Greenhouses: This project would include expansion of the greenhouse with a new addition to the northwest, phased replacement of existing greenhouses, improvements to ventilation, drainage, and screening to prevent light pollution for light-sensitive experiments. Infrastructure support for more growth chambers is also included. Temporary hoop houses could be installed to help with phasing for seasonal classroom greenhouse space.

5. Renovate and Expand Plant Sciences Lab: This project would include expansion of the greenhouse with a new addition to the southeast, renovation and expansion of existing laboratories, phased replacement of existing greenhouses, improvements to ventilation, drainage, and screening to prevent light pollution for light-sensitive experiments. Infrastructure support for more growth chambers is also included. Existing lab space could be converted to growth chamber space if a new facility to the north is constructed.

6. Renovate Natural Resources Studies Annex: This project would replace existing leaky glazing, aged heating and cooling systems, non-functional controls system, inadequate electrical service, and aged lighting. A new reverse osmosis irrigation system could also be included if funds were available. Once completed, the renovated space could support the temporary relocation of research from either the Natural History Survey Greenhouse or the Shelford Vivarium.

7. Develop future greenhouses at Research Park: New greenhouse facilities in the Research Park would benefit from developer agreements that allow rapid capital project execution. They would also benefit from proximity to the recently constructed RIPE and CABBI Greenhouses. Challenges to this location include a lack of adjacent lab space which makes transporting transgenic corps difficult, and limited appeal for researchers to travel from their location on campus to the Research Park compared to new and renovated facilities on the ACES campus. Recently expanded bus service to the Research Park might improve that concern.

8. Develop future greenhouses at east side of campus: The 2017 Campus Master Plan shows two new proposed science facilities north of Krannert Center for Performing Arts. Greenhouse facilities installed on the roofs of these new buildings would expand research opportunities near LAS and Plant Sciences researchers and create synergistic opportunities for partnerships with ACES, Carle Illinois College of Medicine, and Grainger College of Engineering. In addition to opportunities for collaboration there would be operational efficiencies for greenhouse operations.

## Optimal Location

As part of the committee's work, the optimal location for future greenhouse development was discussed. The primary location for future development was identified as the ACES Campus/South Quad area. The main draw for this location is the proximity to the primary researchers who currently use greenhouses. These adjacencies create efficiencies in operation and possibilities for shared resources.

The intent of these recommendations is to inform the next iteration of the UIUC campus master plan. Any new buildings and additions shown here would require approval by the Board of Trustees.

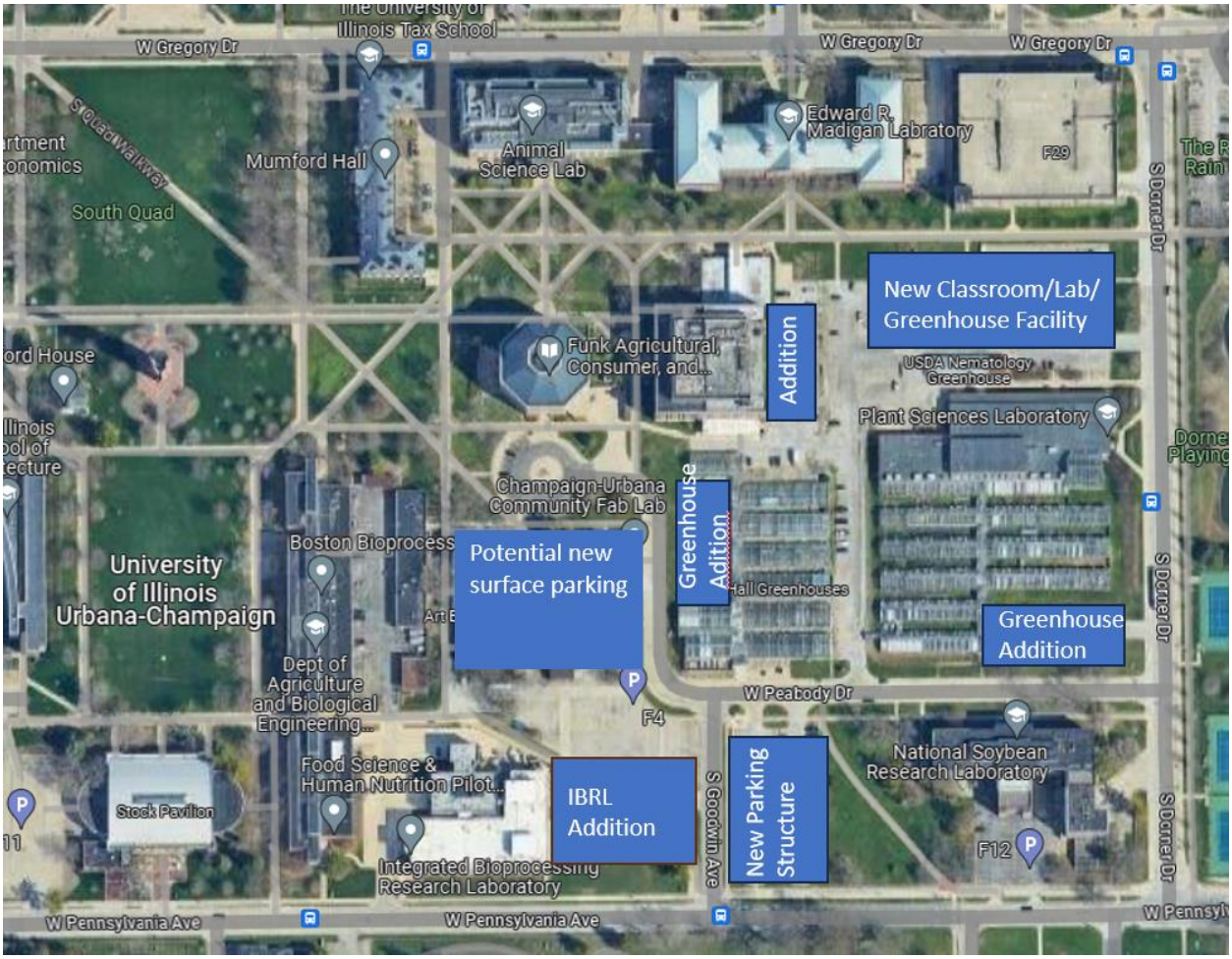


*Figure 1 - Proposed Greenhouse Expansions at ACES Campus / South Quad*

Secondary locations for new greenhouses are in the Research Park close to the RIPE and CABBI Greenhouses. Tertiary locations include new greenhouses on the roof tops of new science buildings planned for expansion of the Science Corridor on Matthews and Goodwin Avenues adjacent to the Main Quad.

## Proposed Building Standards

Building standards for greenhouses was discussed at length. Two overarching concerns were identified. The first was that many existing and planned greenhouses are being held to standards that are excessive for hoop house style greenhouses and for retractable roof greenhouses. The committee proposes an update to Facilities and Services' design standards to allow these types of greenhouses to be considered more like equipment or like pole barns in terms of construction standards. The second concern was that U. of I. has no building standards for greenhouses in terms of glazing, HVAC controls, or other relevant components to modern greenhouses.

An effort by Facilities & Services to address these concerns is in process. Two external consultants are to be hired to update existing and develop new campus design standards to better align with industry standards and best practices. Feedback from local contractors will also be solicited. The contracts are being developed with the consultants and should be in place by the beginning of 2025.

It was noted that, while campus design standards can be updated and modified, there are certain code-related requirements that will continue to apply. Campus interests need to be covered from a liability standpoint. The occupancy and use of the greenhouses and associated spaces inform the codes which apply. Temporary, seasonal, and agricultural storage buildings are treated differently than classroom and lab buildings. If hoop house and retractable roof greenhouses are designated as equipment it would be possible for grant funding to cover the costs.

The following list was developed as recommendations for design standards for future greenhouse projects.

1. Roof side wall height:
    a. Recommend 16' to 20' even for smaller plants (CABBI is 16')
    b. 20' is ideal to allow for even air/temperature mixing, more space for lights, foggers, shades, etc.
2. Floor Area:
    a. No set requirements
    b. A variety of sizes is suggested
    c. Consider reconfigurable space
    d. Separation requirements
        A. Design BSL1 as a minimum to address pests, quarantine issues.
        B. Curtains for pest control
        C. Screened intake and screened exhaust
            1. BSL1 small pollinators
            2. BSL2 more fine
    e. Recommend head house floor area to be 20% of area under glass, with 10% as minimum.
        A. Head house to provide space for research, including:
            1. On-site processing of regulated materials
                a. Grinders
                b. Autoclave

        c. Bench space for biomass separation processing
        d. Drying ovens
    2. Laboratory space
    3. Cold storage
    4. Seed storage (humidity controlled)
    5. Pesticide storage/mixing
    6. Soil prep/mixing (soil shop)
    7. Field soil work (ground beds)
    8. Autoclave, grinder, potting areas
    9. Drying ovens
    10. Encourage shared service spaces, near the loading dock
    11. Potentially space and utilities/support for growth chambers
3. Glazing:
    a. Recommend double acrylic or equal as campus standard
        A. good longevity
        B. good insulator
        C. High light transmission
        D. resilient to hail, impacts
        E. Used on CABBI Greenhouse
        F. Consider performance standards equal to double acrylic and allow for others to be used as new materials are developed.
        G. Flexibility for change in future use (plants, animals, etc.)
        H. Etheylene Tetrafluoro Ethylene (EFTE) can be considered as another option with the caveat that the maintenance of EFTE requires an investment in specialized equipment to provide access to roof areas for repair/replacement of damaged EFTE film.
            1. Superior light transmission
            2. Good durability
            3. Self-cleaning
            4. Good insulator
            5. anti-drip
    b. Recommend vents/retractable roofs, where used, to have hinges at base of roof instead of peak.
        A. Recommend updating design standards to allow greenhouse walls and retractable roofs to be treated like equipment and not be held to a higher, unrealistic or unreasonable standard. Does it need to be institutional grade?
            1. Include discussions with F&S to update design standards to allow research equipment.
4. Floor:
    a. Recommend a blend of concrete floors and ground beds.
        A. Suggest removable floors that could be used at ground beds when needed.
        B. Ground beds are incompatible with BSL-2 requirements.
5. Knee Walls:
    a. Desirable for energy efficiency, protects from lawnmowers, mechanical systems and radiant heat.
6. Climate Controls:
    a. Argus or Priva
        A. Consider performance specification to allow competent manufacturers to be

included.
        B. Include discussion of sole source as a campus option for interoperability, staff training, improved efficiencies, maintenance, etc.
        C. Smaller greenhouses and hoop houses may use simpler control systems such as Wadsworth, Micro-Grow, or others.
7. Heating
    a. Recommend radiant floor heating supplemented with perimeter heat and unit heaters.
        A. Radiant floor heating is more expensive to install but is less expensive to operate.
    b. Geothermal should be considered if possible.
    c. Energy curtains.
        A. Cooling/shading
        B. Heat-reflecting
    d. Waste heat capture / heat exchanger with hot water storage tank.
    e. Consider experimental heating approaches
        A. Compost heat
        B. Solar hot water
        C. Phase change materials
        D. Incorporate sustainable research.
        E. Excess heat capture and storage
8. Cooling
    a. Recommend evaporative cooling (swamp coolers), except where research requires chillers.
    b. Chilled water for growth chambers
    c. Consider geothermal.
    d. Energy curtains.
9. Humidity
    a. Misters
    b. Dehumidification usually accomplished with ventilation and heating.
10. Lighting
    a. LED lighting.
        A. Only include tunable lighting if experiments require higher level lighting spectrum adjustability.
        B. Spaces with unreliable heating might benefit from using HID lighting, which add heat. There may be drawbacks during cooling seasons.
    b. Shading with retractable shade cloth
        A. Either separate from or incorporated with energy curtains.
        B. Consider opaque glazing for specialty uses (animal facilities).
11. Irrigation
    a. Reverse osmosis filtration
        A. Acid injection system as alternative for smaller locations.
    b. Storage tank to allow entire greenhouse to be irrigated simultaneously.
    c. Automated fertigation system recommended.
    d. Floor drains
    e. Trench drains
    f. Manual irrigation suitable depending on use.
12. Security
    a. Card access system

    b. Cameras
13. Safety
    a. Worker safety
    b. Lockers/showers
    c. Tornado shelter
14. BSL
    a. Recommend BSL-2 standard for new greenhouses
        A. Screens
        B. Concrete floors with drains to sanitary sewer
        C. Lockable doors
        D. Other?
15. Site drainage and runoff ponds
    a. Discussed as needed for project.
16. Fire Alarms
    a. F&S requests new fire alarms to conform with campus standards for ability to connect with master system.
17. Site Considerations
    a. Assessment of solar angles and obstructions from adjacent buildings
    b. Site drainage
18. Division of Responsibilities
    a. Budget model integration
    b. DOR and design standards

## Future Capital Needs

| ***Project Name*** | ***Cost*** | ***Funding Source*** |
|---|---|---|
| Natural History Survey Greenhouse Decommission and Replacement | $ 7,000,000.00 | To be determined |
| Shelford Vivarium Greenhouse Decommission and Replacement | $ 17,500,000.00 | To be determined |
| New Greenhouse/Lab/Classroom Facility | $ 200,000,000.00 | P3/State Funding |
| Turner Hall Greenhouses Renovation and Expansion | $ 56,000,000.00 | AFMFA/State Funding |
| Medical Sciences Building Repairs | $ 300,000.00 | LAS/Grants |
| Plant Sciences Laboratory Renovation and Expansion | $ 52,000,000.00 | AFMFA/State Funding |
| Natural Resource Studies Annex Renovation | $ 7,000,000.00 | To be determined |
| Woody Ornamentals Greenhouse Repairs | $ 450,000.00 | Crop Sciences/Grants |
| Energy Farm Greenhouse 1 Updates | $ 150,000.00 | Crop Sciences/Grants |

| | | |
|---|---|---|
| Energy Farm Greenhouse 2 Updates | $ 100,000.00 | Crop Sciences/Grants |
| Energy Farm Greenhouse 3 Updates | $ 110,000.00 | Crop Sciences/Grants |
| TOTAL | $ 344,110,000.00 | |

Estimated budgets are based on $1,000 per square foot for major renovations and new lab/greenhouse buildings, $700 per square foot for new greenhouses without major lab components, $500 per square foot for greenhouse renovations without major lab components, and $150 per square foot for hoop house repairs.

**Recent renovation costs are provided for reference:**

- 2024 Argus upgrades to Plant Sciences Lab Greenhouse and Turner Hall Greenhouses: $830,000
- 2023 LED Lighting Replacement (approximately 644 fixtures) for PSL Greenhouse: $707,120
- 2022 LED light replacement for Turner Hall Greenhouse Revolving Loan Fund 370 fixtures: $555,000
- 2024 Growth Chambers purchased: $530,000
- 2025: Wadsworth controller replacement at Energy Farm Greenhouse 1: $58,500
- Replacement of Natural History Survey Greenhouse 0134
    - Current greenhouse space: 6,750 greenhouse space, 2,662 head house space, 416 circulation space. Approx. 10,000 square feet total.
    - Estimate for new greenhouse: 10,000 square foot x $700/square foot = $7M replacement cost.
- CABBI-style greenhouse structure only estimated to cost approximately $300 per square foot
    - Includes Venlo construction, passive rack and pinion ventilation, horizontal shade and energy screens, vertical energy screens, doors, hydronic heating system, evaporative cooling units, air transfer shutters for cooling central corridor, fogging system, vertical airflow fans, irrigation, benching, grow lights, hanging bars for grow lights, control system.
    - Excludes permits, inspections, site/room prep., utilities, control system, jobsite security, material storage, prevailing wages, union wages, certified payroll.

**Funding Sources**

Possible funding sources were discussed by the committee. Large scale projects, such as Turner Hall and Plant Sciences Lab renovations, would require some level of State funding. Existing deferred maintenance issues at Turner and PSL would also qualify for AFMFA deferred maintenance funding.

LA new greenhouse/lab/classroom facility would likely require State funding. The inclusion of new classrooms would make that more attractive. Alternatively, the new facility could be delivered through a P3 method if a funding source for payments was identified. A large advancement campaign could leverage the benefits of a state-of-the-art facility, including graduate and undergraduate research, hydroponics, etc. with industry partners and interested alumni.

Research grants from groups that support capital components, such as the National Science Foundation, have been successfully used to support the CABBI and RIPE Greenhouses. Such capital improvements must be carefully pitched for specialized needs, as generic facilities typically do not qualify. Inclusion of community workshops can help improve the likelihood of grant approval. Specific agriculture research grants are included in federal farm bills and DCEO grants and have been successfully used on campus. A review with intergovernmental relations is recommended to help with this effort.

Finally, small capital improvement projects might be funded with future Investment for Growth funding.

## Conclusion

Our greenhouses are valuable assets for groundbreaking research and innovation. While some progress has been made with construction of new facilities, there is a strong need to invest in the renovation and expansion of existing facilities such as Turner Hall Greenhouses and Plant Sciences Lab. There is also considerable risk of losing critical research in some of our poorer facilities, such as the Natural History Survey Greenhouse. While funding is challenging to acquire with the many competing interests across campus, the critical research that burnishes the UIUC reputation as a leader in agricultural and plant sciences research make the investment extremely important.