NC STATE UNIVERSITY

Campus Development Committee

March 24, 2025
Holladay Hall, Conference Room 18
2:30 PM – 3:30 PM

Attendance and Distribution
Committee Members Present: Warwick Arden; Charles Maimone; Alyson Wilson

Subcommittee representatives present: Alicia Knight; ~~Allen Boyette~~; Barbara Moses; Bill Davis; Cameron Smith; Dana Harris; Doug Morton; Eduardo Lorente; Lisa Johnson; Patrick Deaton; Sumayya Jones-Humienny

Guests: Carla Davis; Alia King, Jillian Buckholz, Kevin Laycock, Mitchell Kadowaki (Brailsford & Dunlavey)

Approval of the Minutes
The minutes of the January 27, 2025 meeting were approved and have been posted.

Consent Agenda (N/A)

Campus Planning Subcommittee Information
1. Delegated Authority Determinations: (N/A)

2. Action Items: (N/A)

3. Information Items:
    a. Climate Action Plan Update (Info. Item 25.02): C. Davis introduced and the Brailsford & Dunlavey guests presented the attached "CP3a 2025-03-24 CDC Climate Action Plan Summary" [pdf slide] presentation.
        i. Regarding whether future capital investments are included in the 20-year period, there are two options: 1) business as usual forecasting, or 2) factoring in known expenses, the preferred option, which includes the Cates West Development and Poole College of Management New Building projects.
        ii. Future infrastructure considerations include converting from steam to hot water.
        iii. Land will be reviewed for carbon offsets as well.
        iv. *The Committee requested adding the renovation of Poe Hall to the preferred forecast option and any other transformative technologies or sustainable decisions. They want to review the progress at the midpoint and at the end of this effort.*

    b. Nuclear Reactor Study Update (#202314002): D. Morton discussed the updates, which include:
        i. The proposed site is at the southwest part of Centennial Campus, at the intersection of Main Campus Drive and Trailwood Dr. The next step is to proceed with Advanced Planning, which would include: 1) the reactor design; 2) site surveys, site characterization safety and environmental assessments, and the preliminary facility design; and 3) regulatory and stakeholder engagement. The Advanced Planning funding request was to the State of NC for $6.5M per year for a two-year period and is included in Julie Smith's biennium request but is not part of the 2025-27 Biennium Six-Year Capital Request.

    c. COE Molten Salt Loop Renewable Energy Research Facility Study Update (Info. Item 24.10): D. Morton discussed the updates, which include:
        i. The Electric Power Research Institute (EPRI) had previously offered to fund a portion of the study; however, they have since retracted their offer. COE is currently negotiating with them. There are some remaining funds for this project.

d. College of Education Vision Study Update and Poe Renovation Next Steps (Info. Item 15.08): S. Jones-Humienny presented the "CP3d 2025-03-24 CDC CED Visioning-Poe Hall" [pdf slide] presentation for the purpose, program typology goals, design concepts, and site opportunities for the study of this comprehensive renovation project. C. Smith presented the next steps for the abatement, demolition and design-build project delivery.
    i. Phase 1 includes abatement and demolition that is under an emergency contract with D.H. Griffin Construction. $8.5M in funding is available but the contract needs an additional $6.5M. This $15M subtotal is part of the $185M grand total of the emergency funding request.
    ii. Phase 2 includes the programming and design for the renovation. The RFQ is being drafted and will be ready in April; however, $3.5M is needed to start Advance Planning.
    iii. D. Morton will share a list of residual project funds with C. Maimone to determine how to proceed with Advance Planning.
    iv. *The Committee requested to review the opportunities for implementation of the new office space standards for the Poe Renovation project, the Poole College of Management New Facility project, and all forthcoming projects. This review also applies to faculty office space.*

e. Cates West Development Update (Info Item 24.11): L. Johnson and D. Morton presented the "CP3e 2025-03-24 CDC Cates West Update" [pdf slide] presentation for governance structure, consultant selections, Phase 1's site development plan, programming and phasing plan, and the visioning study.
    i. The Board of Trustees approved the lead designer selection of Lord Aeck Sargent (LAS) partnered with Mithun Architects. The Cates West Development Core Team will build the rest of the design team and the CMR team with the lead designers.
    ii. Pete Fraccaroli will be added to the Core Team to represent Housing. Multiple stakeholders represent the six themed Task Forces.
    iii. *The Committee requested the entire Visioning document be shared with them.*

f. Data Center Studies Update, Related to Space Request #24-24: L. Johnson gave the update that the Data Center II has been proven not to fit on the Administration Services Building II site. The Cost of Work for six racks was estimated at $11M and for 12 racks it was estimated at $20M. The total project cost will be about 30% more. OIT is no longer interested in pursuing this option.
    i. *The Committee stated that the New Data Center Study is pausing to determine the overall campus need before starting the study in earnest.*

Project Execution Subcommittee Information Items

1. Project Status Updates: C. Smith presented the attached "PE1a-h 2025-3-24 CamDevCmte Pres-Execution" [pdf slide] presentation.
    i. CVM Equine Hospital Addition and Renovation: $70M in SCIF funding still needs approval and another $7M is being requested for approval by the OSBM. Design and Construction will not contract for more work than can be done in any given year.
    ii. Small Ruminant and Metabolism Education Unit Relocation: The project will obtain a design proposal to focus only on the small ruminants.
    iii. Poole College of Management New Building: The project team will walk the sites and start the site analysis this week for site selection.
    iv. Doak Baseball Field Improvements: The project is under construction for the pitching lab, batting cage, and fan amenities.
    v. COE New Building: The 10% funding for Advance Planning is set for FY 2027-28.

Other Business (N/A)

Next Meeting: May 2, 2025, from 9:00 am to 10:30 am

Meeting Adjourned: 3:30 PM

Second Nature Pro Bono Consulting Services from Brailsford & Dunlavey (March - June 2025)

About the Project

The NC State Sustainability Council recently applied for and was awarded $25,000 of pro bono consulting services to update the university's Climate Action Plan, which is a roadmap for reducing campus greenhouse gas emissions. Brailsford & Dunlavey (B&D) will provide a high-level overview that identifies technical opportunities to reduce emissions, as well as financial modeling for these solutions. Because 70% of campus emissions are from energy use, the project will also raise awareness of energy conservation efforts that both reduce utility costs and emissions.

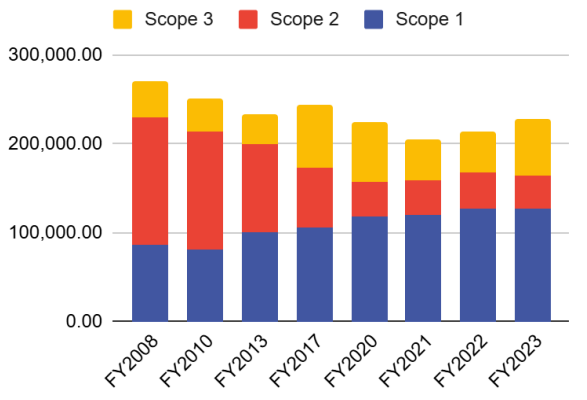
Background

In 2008, the then-Chancellor signed the American College and University Presidents' Climate Commitment, which committed NC State to be carbon neutral by 2050. The commitment is now rebranded as the Second Nature Climate Leadership Network[1], and NC State is among over 400 higher education institutions that have a public climate commitment within the Second Nature network. NC State's Climate Action Plan was last completed in 2010.

Current Conditions

Campus Emissions

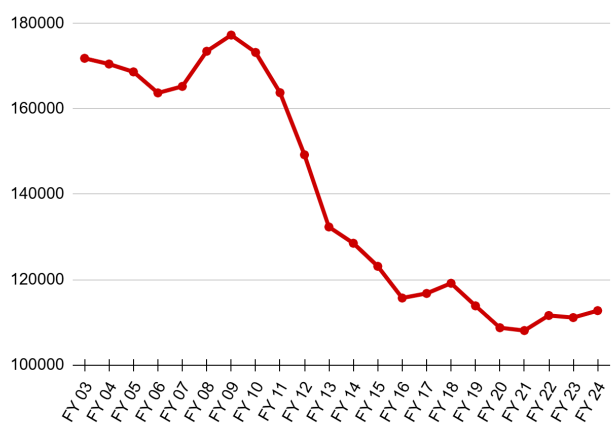
Despite university growth in students, employees and gross square footage, emissions have **declined 15.7%** since 2008



- Scope 1 (Direct emissions such as energy and fuel)
- Scope 2 (Emissions from electricity purchased)
- Scope 3 (Indirect emissions such as travel)

Campus Energy

Energy accounts for 70% of campus emissions. By reducing energy use, emissions and utility costs decline. Energy use intensity is **down 35%** since 2003.

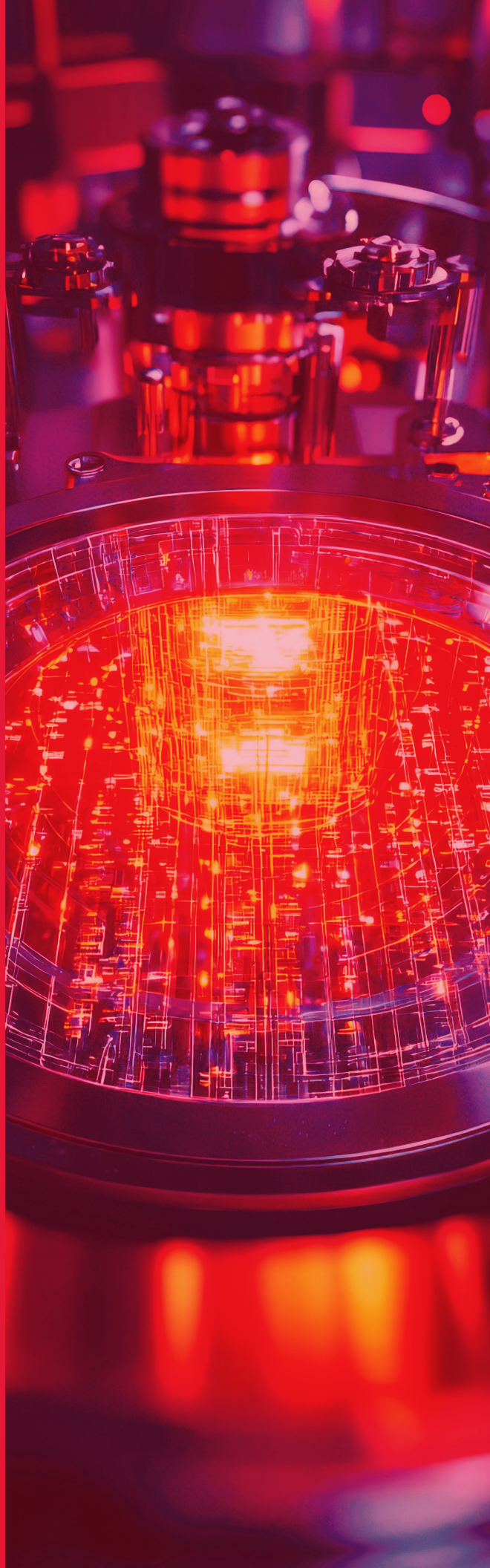


[1] Second Nature Website: https://secondnature.org/

NC STATE UNIVERSITY

FUELING NORTH CAROLINA

A Feasibility Study for a New Advanced Research and Test Reactor at NC State



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EXECUTIVE SUMMARY

The North Carolina General Assembly directed NC State to conduct a study to assess the feasibility of establishing a new advanced research and test reactor (RTR) at the University. This study is an important first step toward better positioning NC State – and, in turn, North Carolina – to be a national leader in advanced nuclear technology and to move the country toward global energy dominance and security. An advanced RTR will help support the state's power ecosystem and spur the innovation required to manufacture and deploy smaller, cheaper, and safer nuclear power reactors in North Carolina. This work has the potential to generate $1-2 billion in annual revenue for the state. For more than 70 years, NC State has safely operated a research reactor program, producing technology advancements and nuclear industry workforce.

The 2022 CHIPS and Science Act authorized $390 million to fund up to four advanced research reactors on university campuses. Being selected for this funding and building a new advanced RTR at NC State would help ensure North Carolina remains a national leader in implementing nuclear power as a clean, efficient, and affordable energy source.

Preferred Technology and Site Selection

NC State, supported by industry expert Hatch, recommends a multipurpose advanced sodium-cooled mixed/coupled spectrum design as the technology for the new advanced RTR. This multipurpose reactor would be a unique facility — the only sodium-cooled fast research and test reactor in the country. The proposed site for the advanced RTR is at the southwestern tip of Centennial Campus (just east of the intersection of Main Campus Drive and Trailwood Drive).

Next Steps

With the support of the North Carolina General Assembly, NC State recommends proceeding with Advanced Planning. ***This phase of work will include:***

Reactor design

- Estimated cost: $10M ($5M/year for two years)

Surveys, site characterization, safety and environmental assessments, and preliminary facility design

- Estimated cost: $2.4M ($1.2M/year for two years)

Regulatory and stakeholder engagement

- Estimated cost: $600K ($300K/year for two years)

The amount of funding required to support this scope of work is $6.5M per year over a two-year period, for a total of $13M. Additional state funding will build on the momentum gained during the feasibility study and help create the foundation for a robust preliminary design that ensures all functional, safety, and operational requirements are fully integrated into the project from the outset.

Most importantly, this crucial phase of the project will help position NC State as a ***strong contender for federal funding*** and will level the playing field with competing universities that have already completed the preliminary design phase.

OVERVIEW

For more than 70 years, NC State has safely operated a light-water-moderated nuclear research reactor program, equipping graduates with practical skills and the experience needed to fuel our state's economic development. Supported by our research, education, and training, this program directly produces technology advancements and nuclear industry employees.

At the direction of the North Carolina General Assembly, NC State has conducted a study to assess the feasibility of establishing and operating a new advanced RTR. This study is an important first step toward better positioning NC State – and, in turn, North Carolina – to be a national leader in advanced nuclear technology, and moving the country toward global energy dominance and security.

Electrical power is crucial for continued economic growth across the state. The availability of reliable, affordable electricity strengthens North Carolina by:

- Driving industrial productivity
- Attracting businesses
- Sustaining innovation
- Stimulating growth in the service sector

An advanced RTR at NC State will help support the state's power ecosystem and spur the innovation required to manufacture and deploy smaller, cheaper, and safer nuclear power reactors in North Carolina. This work has the potential to generate $1-2 billion in annual revenue for the state, according to the latest regional and state-level analysis by E4 Carolinas, the trade association for energy companies in North and South Carolina.

Why Build the NC State Advanced RTR Now?

Building the advanced RTR at NC State is the first step toward developing the technology that will make nuclear energy a scalable, sustainable, and affordable energy source. ***Nuclear energy will be a key part of a sustainable energy future, and the NC State advanced RTR will create opportunities for:***

- Developing the technologies and fuel we need to power small modular reactors and advanced reactors.
- Informing the use of small modular reactors to support AI data centers, manufacturing, power generation, and industry across the state.
- Strengthening North Carolina's position as a leader in technology, and in particular, making our state an incubator for new technology companies that will grow around Generation IV nuclear.
- Serving as a testbed for developing thermal energy storage technologies to maintain a resilient and diverse energy grid.
- Building the advanced nuclear energy workforce and training the next generation of engineers and scientists for various STEM-based careers.

Building a new RTR at NC State will help ensure North Carolina remains a national leader in implementing nuclear power as a clean, efficient, and affordable energy source.

In the following pages, we outline our recommendations and present more details on our proposed plans and considerations for the next steps, which include additional investment from the state, to best position NC State – and North Carolina – for federal funding.

NUCLEAR ENERGY LANDSCAPE AND BENEFITS TO NORTH CAROLINA

The Southeastern United States boasts a substantial group of companies with significant experience in nuclear power production. The region plays an important role in developing new nuclear technologies that are emulated worldwide. An advanced RTR at NC State will offer the Southeast a generational opportunity to help develop a clean energy system while maintaining low costs and meeting reliability goals.

As older reactors in the region — and in North Carolina — reach the end of their useful lives, new reactor construction must meet or exceed the energy-generating capacity of the reactors being decommissioned. Small modular reactors will help speed up that process and create additional resiliency for the overall power system in the state and across the Southeast. The availability of an advanced RTR will further strengthen North Carolina's position as an industry leader as the need for clean, reliable energy grows.

The nuclear industry makes sizable and unique contributions to North Carolina's economy. ***According to a recent report by energy trade association E4 Carolinas, the nuclear industry's economic impact on the state includes the following:***

5,384
direct employees

Support of
15,494
additional jobs across the state

$4.9B
in annual economic impact

$367.5M
in state tax revenue annually

Moving the Industry — and North Carolina — Forward

A new advanced RTR on NC State's campus, as recommended by the feasibility study and outlined in the following pages, will support and accelerate the deployment of advanced small modular reactors in North Carolina. By bridging research, industry, and education, the facility is essential to positioning the state as a leader in clean energy innovation, addressing critical challenges in energy security and decarbonization, and spurring economic development.

Nuclear energy currently provides 14% of North Carolina's nameplate electric power capacity, and the RTR will support exploring new ways to expand utilization. Partnerships with North Carolina utilities can help integrate advanced nuclear systems into the state's grid, creating a cleaner and more reliable

energy supply. Training programs and workforce development already established at NC State ensure the state has the talent needed to operate and maintain advanced reactors, supporting long-term energy sustainability.

What Industry Partners Are Saying

> *"The importance of this project for the State of North Carolina and the nuclear industry in North Carolina and across the U.S. cannot be overstated. The Gen. IV reactors are of sufficiently different form and type from the previous light water reactors that many of the existing nuclear industry workforce as well as new workers will need training and education on how these reactors operate. Having the first Gen. IV reactor on NC State's campus will make the university a central technology hub for accelerated deployment of advanced SMRs [small modular reactors] involving researchers and industry partners from the state, the nation, and around the world for decades."*
>
> **Dr. John Zino**
> Chief Consulting Engineer, Advanced Plant Technology, GE Hitachi Nuclear Energy

> *"Duke Energy sees value in North Carolina State University leading an effort to bring a mixed-spectrum research reactor to North Carolina and the United States. NC State has played a key role in supporting existing reactors through its PULSTAR research and related programs. The addition of a mixed-spectrum test reactor could offer valuable insights to the industry as it advances deployment of next-generation reactor technologies. The proposed NC State reactor enables research to further develop fuel cycle technology by enhancing neutronic modeling, refining uranium fuel utilization, transmuting hazardous transuranics into short-lived fission products, and providing operational learning opportunities. There is currently no mixed-spectrum test reactor in the U.S. and thus research supporting a closed-loop fuel cycle is uniquely positioned to support the deployment of advanced reactor technologies, which will enable clean, efficient, and safe power into the future."*
>
> **Chris Nolan, P.E.**
> Vice President, New Nuclear Generation Strategy and Regulatory Engagement, Duke Energy

> *"Nuclear power is poised to play an increasingly vital role in providing low-carbon, affordable, reliable energy. As the home to great universities that are developing new technologies and training the next generation of professionals in the industry, North Carolina is uniquely positioned to support nuclear energy's future. Advanced test reactors like the one that NC State is pursuing will be crucial to supporting these new designs and the workforce operating them."*
>
> **Craig Stover**
> Senior Program Manager, Advanced Nuclear Technology, Electric Power Research Institute

PULSTAR

NC State has been leading the way in nuclear research since 1953, when the first academic research reactor in the world — the Raleigh Research Reactor (R1) — opened on NC State's campus.

Today NC State's innovative engineers use the R-4 PULSTAR — the fourth reactor to be commissioned and operated at the university — to learn, teach, and collaborate on leading research. We're rising to the challenge of determining how we can implement advanced nuclear power as a clean electricity source. The NC State reactor is one of two PULSTAR reactors built, and the only one still in operation.

TECHNOLOGY SELECTION

To discuss the requirements that should drive the selection of the appropriate technology for the advanced RTR, NC State, supported by industry expert Hatch, brought together more than 100 stakeholders from industry, government, national laboratories, and universities. Our goal was to consider the needs of the state, potential industry and academic partners, federal funding partners, national laboratory collaborators, and NC State's interdisciplinary research community. We worked with these experts as well as NC State engineers, researchers, and administrators to explore potential technology for the NC State advanced RTR.

Key considerations:

- Safety
- Site requirements
- Overall supply chain, including fuel
- Environmental impacts
- Occupational safety and health
- Logistics
- Impact and value for innovative research and testing

Potential technologies considered:

- Light water reactors
- Sodium-cooled fast reactors
- High-temperature gas-cooled reactors
- Lead-cooled fast reactors
- Molten salt reactors

As a result of these discussions, NC State has selected the multipurpose advanced sodium-cooled mixed/coupled spectrum RTR as the technology for the university's new advanced RTR.

The sodium-cooled fast reactor (SFR) is a Generation IV advanced reactor technology that aligns ideally with the objectives of the CHIPS and Science Act and the US Department of Energy's strategic directions. Light water-based reactors do not offer new capabilities that have not already been explored and executed by other research reactors in the United States.

This multipurpose reactor would be a unique facility — the only SFR research and test reactor in the country.

This reactor would allow the demonstration of nuclear power's sustainability, given the university's goal of having it in operation for 50-70 years. It also has the potential to support a molten salt loop and tank for demonstrating thermal storage and power generation concepts. In addition, it has the potential for microgrid demonstration. The SFR is the most mature Generation IV technology.

Four other universities are considering applications to the Department of Energy under the CHIPS and Science Act.

- Abilene Christian University, in partnership with Natura Resources, is experimenting with using molten salts, rather than water, as a coolant for nuclear reactors with the goal of designing and building the first university-based molten salt research reactor.
- The University of Missouri is focused on expanding its existing flux-trap-type light water reactor to enhance critical medical isotope research and production for cancer treatments and theranostics.
- The University of Illinois at Urbana-Champaign, in partnership with the Ultra Safe Nuclear Corporation, is applying for a license to construct and operate a demonstration high-temperature gas reactor.
- Penn State University, in partnership with Westinghouse, is demonstrating Westinghouse's eVinci microreactor technology, which is a solid core heat pipe-cooled reactor.

HOW THE SODIUM FAST REACTOR WORKS

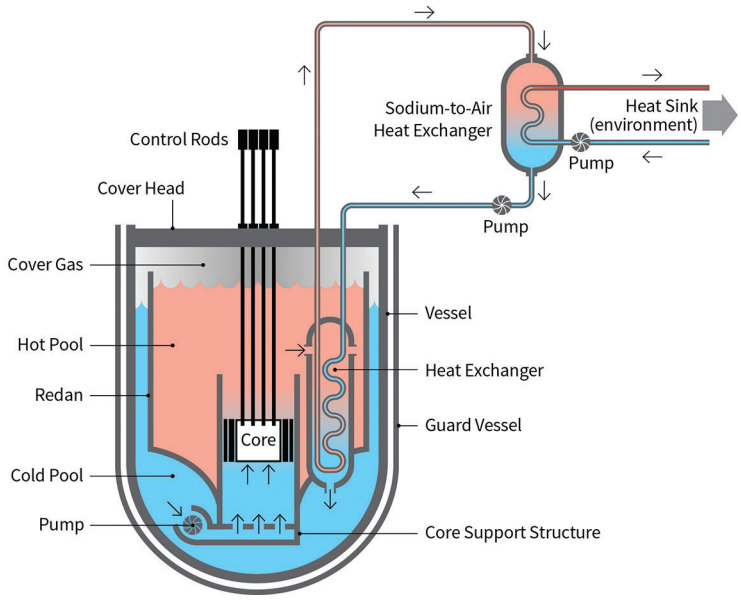


Figure 1. Schematic of the proposed sodium fast reactor system for the NC State advanced RTR.

Figure 1 shows a representative schematic of NC State's SFR system. The core of the SFR contains metallic fuel (U-10Zr). In the reactor design we are proposing, this fuel will be enriched to contain up to 19.75% U-235. Within the core, atoms split to generate energy as heat. The control rods are a bundle of B4C pins in a stainless steel cladding. When the rods are inserted into the core, they absorb neutrons and slow the fission chain reaction. As low-pressure liquid sodium from the cold pool is pumped through the core, the sodium is heated by the fissioning fuel and flows into the hot pool. An intermediate heat exchanger removes the heat to a secondary heat exchanger. Heat from the secondary heat exchanger can be released into the environment or stored in a thermal storage system, such as a molten salt loop and tank.

The secondary heat transfer loop and exchanger keep air and water from interacting with the primary sodium, effectively providing a redundant separation from potentially activated material. The secondary sodium is not radioactive. The inert cover gas also prevents chemical reactions between the primary sodium and air. The reactor vessel has a steel structure (the redan in figure 1) that keeps the hot pool separated from the cool pool. The reactor has both an internal reactor vessel and a surrounding guard vessel. If the reactor vessel should fail, the guard vessel contains the sodium and keeps the core covered and heat removal systems operational.

SAFETY

The advanced RTR will have significantly enhanced safety as compared to the current PULSTAR and commercial light water reactors. NC State will implement safety using "defense in depth," which provides multiple levels of prevention and protection against the release of radioactive materials by using proven technology, active engineered safety features such as control rods, and well-trained professional operators.

In addition, the safety case of the advanced RTR will be enhanced by:

1. **Safety-in-design** This approach integrates safety considerations at every stage of the advanced RTR design process, including the "fail-safe design principle" that ensures that in the event of a system failure, the reactor transitions to a safe state to protect public health, reactor personnel, and the environment.
2. **Walk-away nuclear reactor safety** The reactor remains safe and stable without requiring human intervention, external power, or mechanical action for extended periods, even in the event of an emergency.
3. **Physics-based self-sustaining mechanisms** Passive safety features such as gravity and natural circulation help ensure unparalleled levels of reliability.
4. **Higher redundancy** The advanced RTR will have three effective means of shutdown, whereas PULSTAR and light water reactors only have two.
5. **Superior safety performance** Fuel and cladding safety measures ensure a comfortable margin to avoid melting under all scenarios.
6. **Inherent negative reactivity feedback** As the temperature rises, regardless of the cause, the reactor's reactivity is reduced. This effectively makes the fission chain reaction unsustainable and reduces the reactor's power. The reactor is self-regulating and will always default toward a stable state, ensuring the safety of operators and the environment.
7. **Enhanced heat transfer performance** This feature allows for efficient management of residual and decay heat, which can be stored in the primary coolant for extended periods of time and can easily be managed through the establishment of natural circulation (one of the reactor's passive safety features).

8. **Two vessels** The function of the guard vessel is to contain the primary sodium in the highly unlikely event that the reactor vessel starts leaking. The gap between the guard vessel and the reactor vessel is sized such that an inspection of the vessels can be performed. However, the height of sodium in the pool would remain sufficient to ensure proper cooling of the core.
9. **Fire safety** The reactor has a dedicated sodium fire protection system. Suppression of liquid sodium fires is accomplished by a built-in, passive system.

SITE SELECTION

Our team began with a wide region of interest, encompassing more than 100,000 acres of university-owned land across North Carolina. Following screening processes outlined in technical reports from the Electric Power Research Institute and guidelines from the Nuclear Regulatory Commission (NRC), sites were evaluated against a range of safety and environmental criteria. Exclusionary criteria were developed to screen out sites with critical habitat for threatened and endangered species, watershed protections, significant wetland extent, or critical flood or fault hazards. This thorough analysis resulted in a range of candidate areas within the main campus precincts that met the safety and environmental criteria for siting an advanced RTR.

These areas were then evaluated against criteria related to student access, environmental impact, and infrastructure. Compatibility with other uses and alignment with the university's Physical Master Plan were also considered. The southwestern tip of Centennial Campus (just east of the intersection of Main Campus Drive and Trailwood Drive) was identified as the preferred location for the advanced RTR site.

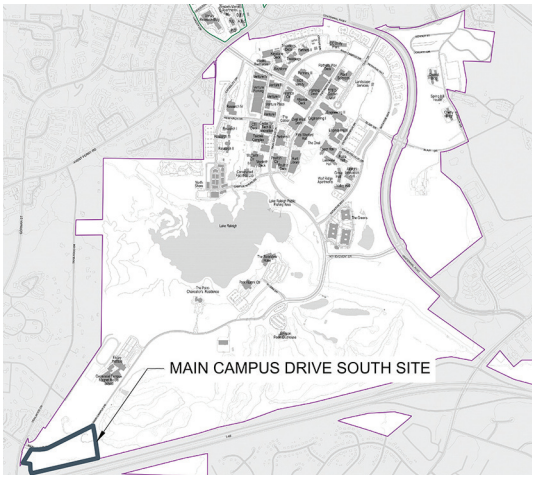


Figure 2. Main Campus Drive South Site

This approximately 16-acre site, referred to as Main Campus Drive South Site (figure 2), has been identified as a location for NC State engineering research for more than 20 years. An advanced RTR is compatible with this vision and also supports the 2023 Physical Master Plan's characterization of the site as a neighborhood of high-bay research space. As noted in the Physical Master Plan, this site provides adequate space for large vehicle entry and exit, can be developed using simpler construction methods, and provides space that allows for testing and research that requires separation from other academic uses.

Main Campus Drive and Trailwood Drive form the north and west boundaries of the site. The university's landscaping staging/laydown area is located across Main Campus Drive, while apartment complexes are located across Trailwood Drive. Lonnie Poole Golf Course is located directly to the east; Centennial Campus Magnet Middle School, the Friday Institute, and the NC State chancellor's residence (The Point) are located further to the northeast. Interstate 40 runs parallel to the southern boundary of the site (figure 3), and there is residential development to the south of the interstate. The risk of relatively high traffic and hazardous material transport along I-40 will be evaluated during the licensing process.

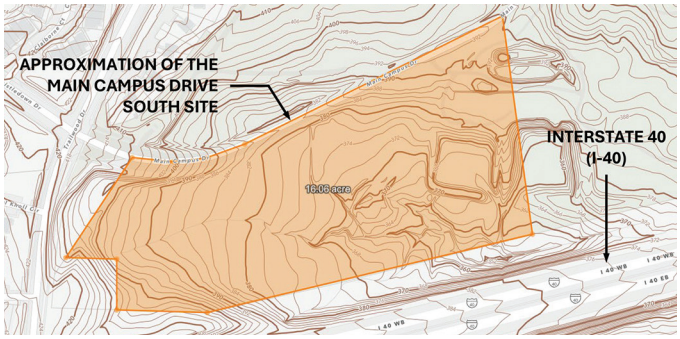


Figure 3. Topographic and location details for Main Campus Drive South Site

The conceptual plot plan (figure 4) shows the advanced RTR facility covering approximately five acres of the site. The facility is separated into a nuclear side and a non-nuclear side. The nuclear side contains the reactor itself (housed in the reactor building) and all systems pertaining to its safe and reliable operation. The nuclear side is protected by a site boundary compliant with NRC requirements and general security requirements. The non-nuclear side consists of an administration building and neutron beam hall, as well as site access roads and parking.

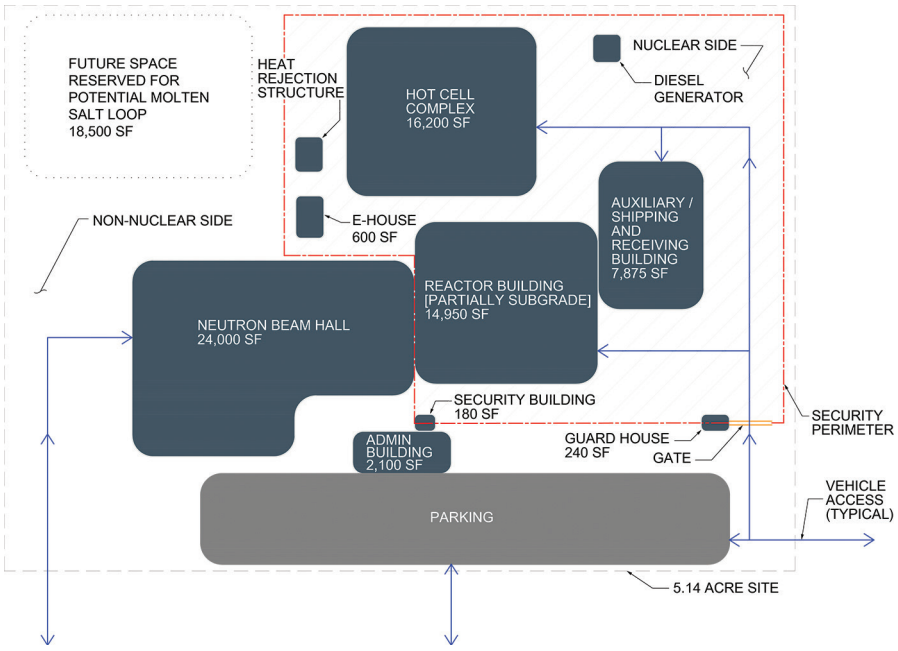


Figure 4. Conceptual plot plan

The Emergency Planning Zone (EPZ) is defined as an area where predetermined protective actions would be taken in the event of a potential release of radioactive materials due to an off-normal condition at the facility. The EPZ for the RTR facility is expected to be limited to the nuclear side. As part of the licensing process, the EPZ will be calculated and analyzed in compliance with the methodology approved by the NRC.

The site will require federal and state permits to address environmental impacts. Two constructed catch basins to the east of the site were identified in the National Wetlands Inventory; however, these are not designated by the State of North Carolina. As part of federal and state permitting processes, field surveys will be conducted to document intermittent streams, determine whether a wetland is present, and document any use of the site by listed and migratory bird species.

As with any nuclear facility, NC State's advanced RTR will generate radioactive waste throughout the facility's life cycle. Any waste produced will be disposed of according to the applicable regulations. Waste management systems will ensure the safe handling, storage, and disposal of all waste types while maintaining safety and environmental standards.

PRE-CONCEPTUAL COST ESTIMATES AND PROPOSED TIMELINE

The project is in the pre-conceptual design phase, and there will be significant design, estimation, and engineering work to complete as part of the next steps. To develop a high-level, pre-conceptual cost estimate, the team relied on similar project experience, cost estimating guides, and references from Argonne National Laboratory and Idaho National Laboratory. Equipment is a major component of the cost of a nuclear reactor facility. While building costs were estimated on a square footage basis, major equipment was identified and sized to establish an opinion of probable cost.

Input from industry representatives indicated that reference cost estimating is the most accurate method for early-phase nuclear projects. Therefore, the estimate was also validated against a reference project of similar scope, the OPAL 20-megawatt multi-purpose reactor in New South Wales, Australia.

$284M	+	**$116M**	+	**$104M**	=	**$504M**
Hard Cost of Work		*Associated Design and Construction Costs (soft costs)*		*Contingency*		*Total Cost*

The total capital cost for NC State's facility is estimated at $504 million. This figure represents the current cost of construction, construction contingency, design fees.

The proposed work includes site preparation; design; licensing; construction of the reactor building, hot cell complex, and neutron beam hall; and construction of supporting structures and infrastructure. ***Cost drivers for the project include the following:***

- Custom-designed reactor, as NC State's advanced RTR will be the only one of its kind
- Applications and capabilities requiring novel approaches
  - Research reactor based on a SFR with mixed spectrum capabilities
  - Beamline integration into a SFR
- Licensing effort that requires significant upfront design work to prepare a Preliminary Safety Analysis report for the NRC construction permit
- Establishment of a quality program, which is a requirement for nuclear reactor design and construction
- Limited market of qualified nuclear contractors
- Complexity and level of engineering required

The proposed construction start date is estimated at July 2029, with an end date of June 2034.

HOW THE ADVANCED RTR WILL BE USED

NC State's advanced RTR will have many potential uses, including:

- The development of environmentally friendly sources of clean, reliable, and affordable electricity
- The redevelopment and advancement of the U.S. microelectronics industry by providing imaging and testing for chips
- Non-destructive examination of materials (e.g., using neutron and radiation beam techniques)
- Limited research production of radioisotopes for industrial and medical use
- Forensic and transmutation irradiation and testing to study damage mechanism for materials and support nonproliferation
- Applications in fundamental science (e.g. fundamental nuclear physics, chemistry, etc.)
- Development of nuclear propulsion for deep space exploration
- Training of the next generation of engineers and scientists for STEM-based careers

Specific research capabilities include neutron imaging and fuel development. Neutron imaging is complementary to X-ray imaging. The lighter the material, the easier it is for X-rays to penetrate it. However, neutron radiation can pass through dense materials more easily than through light materials, which makes it a good option for imaging items with dense outer casings (see figures 5 and 6 for example use cases).

NC State could also focus on supplying high-temperature process heat to industries that traditionally rely on fossil fuels for heat-intensive processes. The advanced RTR can produce heat at temperatures well above those achievable by traditional light water nuclear reactors, making it well-suited for applications such as hydrogen production, desalination, chemical manufacturing, and materials processing.

This facility will support workforce development and industry deployment of advanced nuclear energy in North Carolina and beyond by compressing the timeline necessary to deploy small modular advanced nuclear reactors. Thus, it will ensure the long-term stability of our state's energy environment.

Figure 5. Neutron imaging of soybean roots in situ in a column of soil.

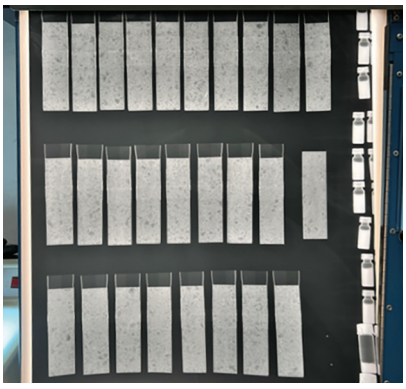


Figure 6. Neutron imaging examining concrete samples for damage under multiple conditions.

PROCUREMENT AND PARTNERSHIPS

Our team conducted a domestic supply chain evaluation to develop a procurement outlook for major components of the RTR. Many U.S. companies are working on commercializing their own proprietary SFR design, including General Electric Hitachi (GEH) and TerraPower. There are also several institutions across the country with expertise in SFR technology, including private entities like GEH, Arc Clean Technology, and Oklo, and public entities such as Argonne National Laboratory and Idaho National Laboratory. As with any project at NC State, we will endeavor to select the most qualified design firm and expertise to help us ensure success.

In addition to continuing the development of nuclear energy infrastructure and advancing clean energy technologies, the execution and completion of this project will enable NC State to establish meaningful partnerships and meet a strategic need for the nation. Potential opportunities for collaboration include utility companies, other universities, and national lab partners. ***We plan to collaborate with the following entities:***

National Lab Partners

- Argonne National Lab
- Oak Ridge National Lab
- Idaho National Lab
- Savannah River National Lab

University Partners

- Virginia Tech
- Virginia Commonwealth
- University of Florida
- Purdue
- South Carolina State
- Cape Fear Community College
- Wake Tech Community College
- NC A&T
- University of Tennessee
- University of Michigan
- University of South Carolina *(proposed)*
- MIT *(proposed)*

LICENSING REQUIREMENTS

Licensing requirements for advanced RTRs are governed by national regulatory agencies, principally the NRC. These requirements ensure that research reactors are designed, operated, and decommissioned safely, protecting public health and the environment.

Given the mission of NC State's proposed advanced RTR, the university can obtain a license under the Atomic Energy Act section 104c pursuant to 10 CFR 50.21(c) as a University Research Reactor facility. The advanced RTR design proposed does not currently impose any feasibility issues, but it does require significant work and engagement with the NRC to prepare a thorough construction permit application. Abilene Christian University has recently used this framework to acquire construction permits for its advanced reactor design.

Early design work on NC State's advanced RTR should begin to prepare the Preliminary Safety Analysis Report, with early NRC engagement on key design topics. Additionally, field activities should start to support the environmental report preparation.

NEXT STEPS

With the support of the North Carolina General Assembly, NC State recommends proceeding with Advanced Planning.

The Advanced Planning phase will involve the following work:

Reactor design

- Preliminary design work on key components (such as the reactor vessel and hot cells) to validate and further develop the cost estimate
- Core design and neutronics studies
- Thermal-hydraulics, safety transient analysis, and heat removal design studies
- Estimated cost: $10M ($5M/year for two years)

Surveys, site characterization, safety and environmental assessments, and preliminary facility design

- Initial site development plan
- Surveying and stormwater/grading design
- Site assessment and infrastructure planning
- Further development of the project budget, including quotes from vendors for major components, identification of proposed funding sources, and determination of project delivery method
- Preliminary safety analysis report
- Environmental impact assessment
- Estimated cost: $2.4M ($1.2M/year for two years)

Regulatory and stakeholder engagement

- Pre-engagement with the NRC
- Development of white papers and technical reports
- Stakeholder communications and public outreach
- Development of consortium, with the goal of developing a proposal in anticipation of the Department of Energy Funding Opportunity Announcement
- Estimated cost: $600K ($300K/year for two years)

The amount of funding required to support this scope of work is $6.5M per year over a two-year period, for a total of $13M. Additional state funding will build on the momentum gained during the feasibility study and help create the foundation for a robust preliminary design that ensures all functional, safety, and operational requirements are fully integrated into the project from the outset.

Most importantly, this crucial phase of the project will help position NC State as a strong contender for federal funding and will level the playing field with competing universities that have already completed the preliminary design phase.

2025-03-24 Campus Development Committee – CED Visioning for Poe Hall

College of Education Vision

- Purpose
- Participants
- Themes
- Vision Statement
- Program Typology Goals
- Design Concepts
- Site Opportunities

Next Steps

- All-college meeting 4/30
- Design-build project delivery
- Contractor selection
- Abatement and demolition
- Programming

CED Visioning for Poe Hall

Purpose

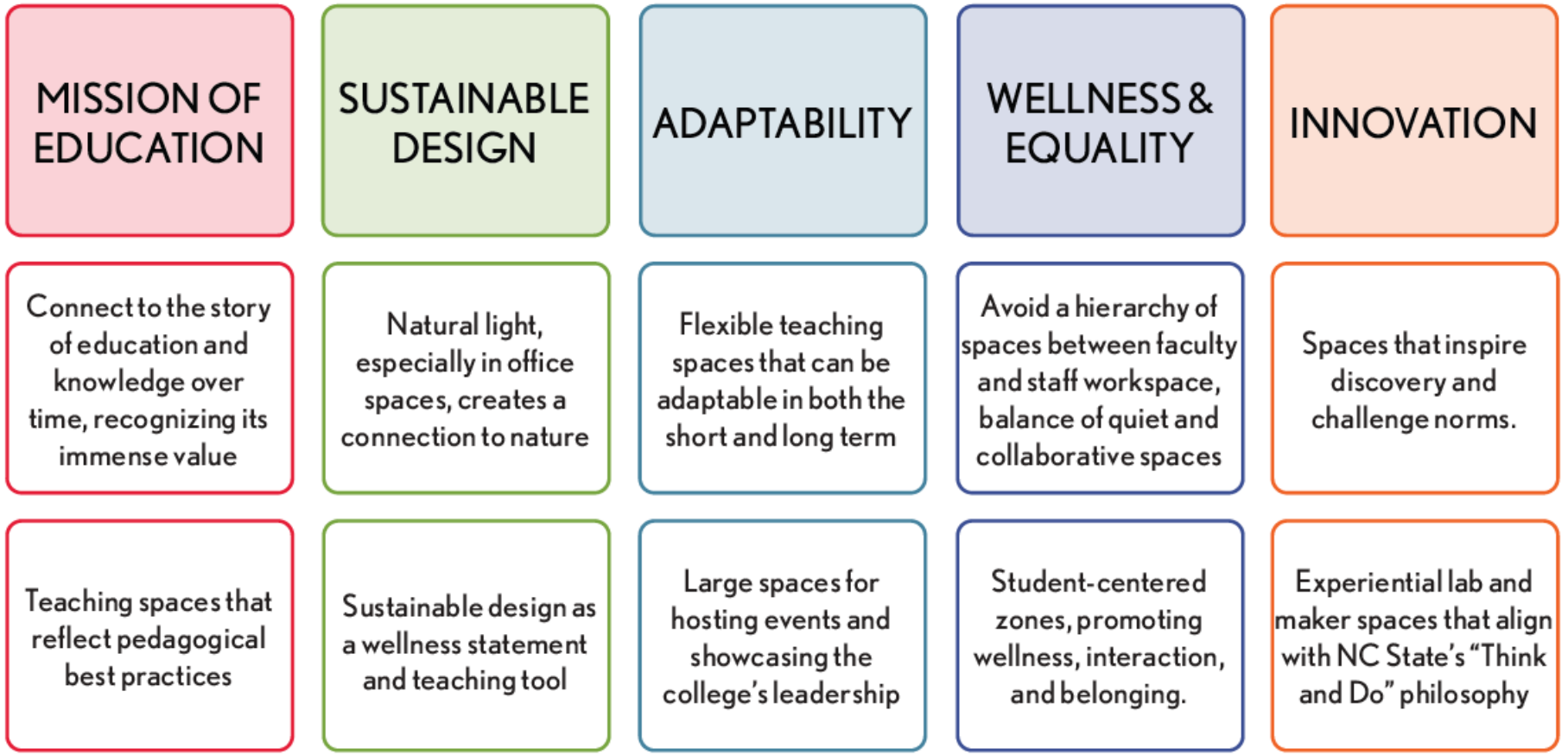
- Vision as guide for transformation of Poe Hall
- 100th anniversary of College of Education
- Future environment to align with mission & goals

Participants

- CED
  - Administration
  - Faculty and staff
  - Students
- Campus
  - EMAS/Classrooms, Libraries, Interdisciplinary Sciences, Facilities, and Sustainability
- Beyond
  - Alumni, External Educators and Partners

CED Visioning for Poe Hall

Focus Group Discussion Themes



CED Visioning for Poe Hall

Vision Statement Pillars

- Benchmark for unique needs
- Embody values
- Anticipate future evolution of learning, teaching, research, and engagement

VISION STATEMENT

The College of Education building will promote:

Valuing Education

Showcases the transformative power of education, highlighting its role as the foundation of all disciplines and its profound impact on individuals and society

Learning

Interactive spaces designed to evoke curiosity and prepare extraordinary educators, counselors, and leaders

Innovating

Cutting-edge teaching and research facilities that address the grand challenges facing education in North Carolina and beyond

Connecting

A welcoming, accessible environment that encourages wellness, social interaction, interdisciplinary exploration, and public engagement, creating a vibrant community where everyone feels valued

Sustaining

Designed to support the ecological and cultural mission of the College of Education and adapt to its evolving needs over time

CED Visioning for Poe Hall

Program Typology Goals

- Learning Spaces
  - Model the best classrooms
  - Flexible configurations for different pedagogies & sizes
  - Integrated modern technology
  - Simulate real-world teaching environments
  - Double as meeting spaces

CLASSROOM WITH GROUP-BASED LEARNING, NATURAL DAYLIGHT, MOVABLE WALLS AND FURNITURE

Learning Innovation Valuing Education

CED Visioning for Poe Hall

Program Typology Goals

- Labs & Fabrication Spaces
  - Dedicated, state-of-the art for hands on learning and digital fabrication
  - Located near main hallways
  - Showcase activities
  - Adaptable layouts with robust infrastructure
  - Interdisciplinary and experiential learning

EXAMPLE LABORATORY WITH AMPLE SPACE, FLEXIBLE FURNITURE, AND VIEWS TO THE EXTERIOR

Learning Innovation Valuing Education

CED Visioning for Poe Hall

Program Typology Goals

- Media & Ed Tech Resource Center (METRC)
  - The “heart of the college”
  - Easy to find
  - Adequate space for gathering, collaborating, studying
  - Open & accessible
  - Tech-enabled reservable rooms
  - New recording studio
  - Break room

LIBRARY WITH FRONT DESK, OPEN ACCESS TO BOOKS AND RESOURCES, STUDY AND COLLABORATION SPACE

Connecting | Valuing Education | Learning | Innovation

CED Visioning for Poe Hall

Program Typology Goals

- Social Spaces
  - Hearth spaces for the bldg.
  - Choice of variety of study and collaboration spaces
  - Informal seating areas near public corridors
  - Daylighting and views to natural areas
  - Noise control for quiet areas
  - Near shared breakrooms and wellness rooms

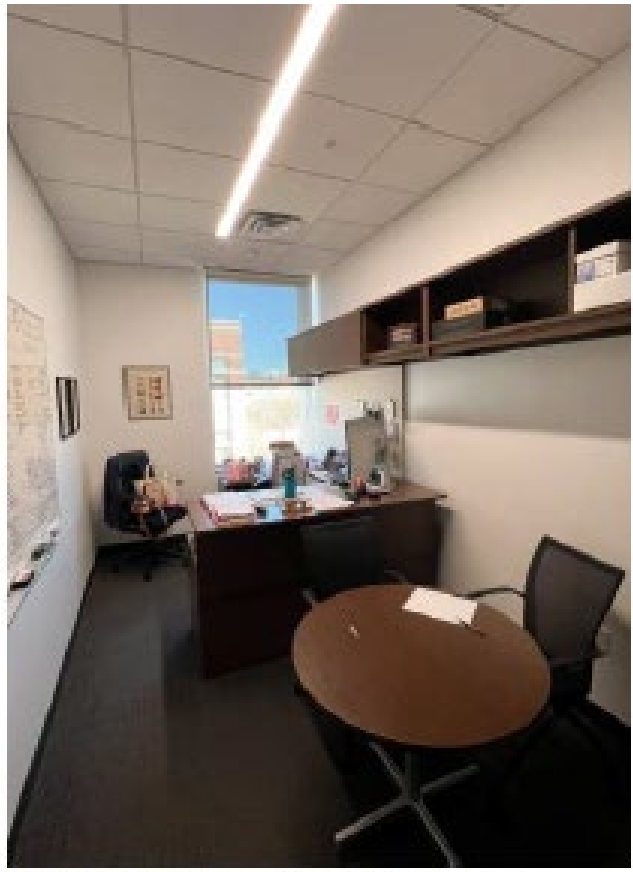
EXAMPLE LOUNGES WITH VARIETY OF SEATING, FLEXIBLE FURNITURE, AND AMPLE DAYLIGHTING

Connecting Sustaining

CED Visioning for Poe Hall

Program Typology Goals

- Office and Collaboration
  - Daylighting and views accessible to every work space
  - Mix of shared and private work spaces (new space standards)
  - Acoustic separation for private conversations
  - Variety of meeting room sizes
  - AV tech integration for hybrid meetings



EXAMPLE WORKSPACE WITH DAYLIGHTING, PRIVATE AND SHARED WORKSPACES, AND COLLABORATION ZONES

Innovation Learning Connecting

CED Visioning for Poe Hall

Program Typology Goals

- Shared Breakrooms
  - Kitchen with refrigerator, microwave, coffee & ice machines
  - Informal gathering spaces
  - Variety of seating options
  - Strategic locations to serve faculty, staff and students so no location is overwhelmed during peak times

CTI KITCHEN WITH LARGE ISLAND AND SEATING AREA

CED Visioning for Poe Hall

Program Typology Goals

- Multipurpose Event Spaces
  - Tech-enabled reservable rooms
  - Flat floor with movable furniture
  - Movable partition wall to divide room
  - Dimmable lighting and window shades/blinds
  - Adjacent table and chair storage
  - Located near a kitchen for catering events

TALLEY EVENT SPACE, FLEXIBLE FURNITURE FOR VARIOUS ARRANGEMENTS

Connecting Learning Innovation

CED Visioning for Poe Hall

Program Typology Goals

- Additional Spaces
  - **Wellness/Lactation** reservable rooms for medical, wellness, prayer/reflection needs
  - **Shared Workrooms** for team projects and collaboration
  - **Outdoor Space** with seating for socializing/working/relaxing in natural surroundings.
  - **Recording Studio** in Marketing Dept. for producing high-quality educational videos and presentations

Wellness/Lactation Rooms

EXAMPLE IMAGE

Shared Workrooms

UVA HEALTH AND WELLNESS BUILDING

Outdoor Space

TALLEY STUDENT CENTER

Recording Studio

D. H. HILL LIBRARY

CED Visioning for Poe Hall

Design Concepts

- Informal Social Zones
  - Near classrooms and along corridors
- Adaptability
  - Movable partitions and furniture for multiple configurations
- Human-Centered Design
  - Accessible, intuitive wayfinding, and natural lighting to enhance experience of being in the building
- Sustainable Design
  - Integration of environmentally friendly practices and materials to minimize environmental impacts

Informal Social Zones

FITTS-WOOLARD HALL

Adaptability

PENN GSE

Human-Centered Design

RTI HEADQUARTERS

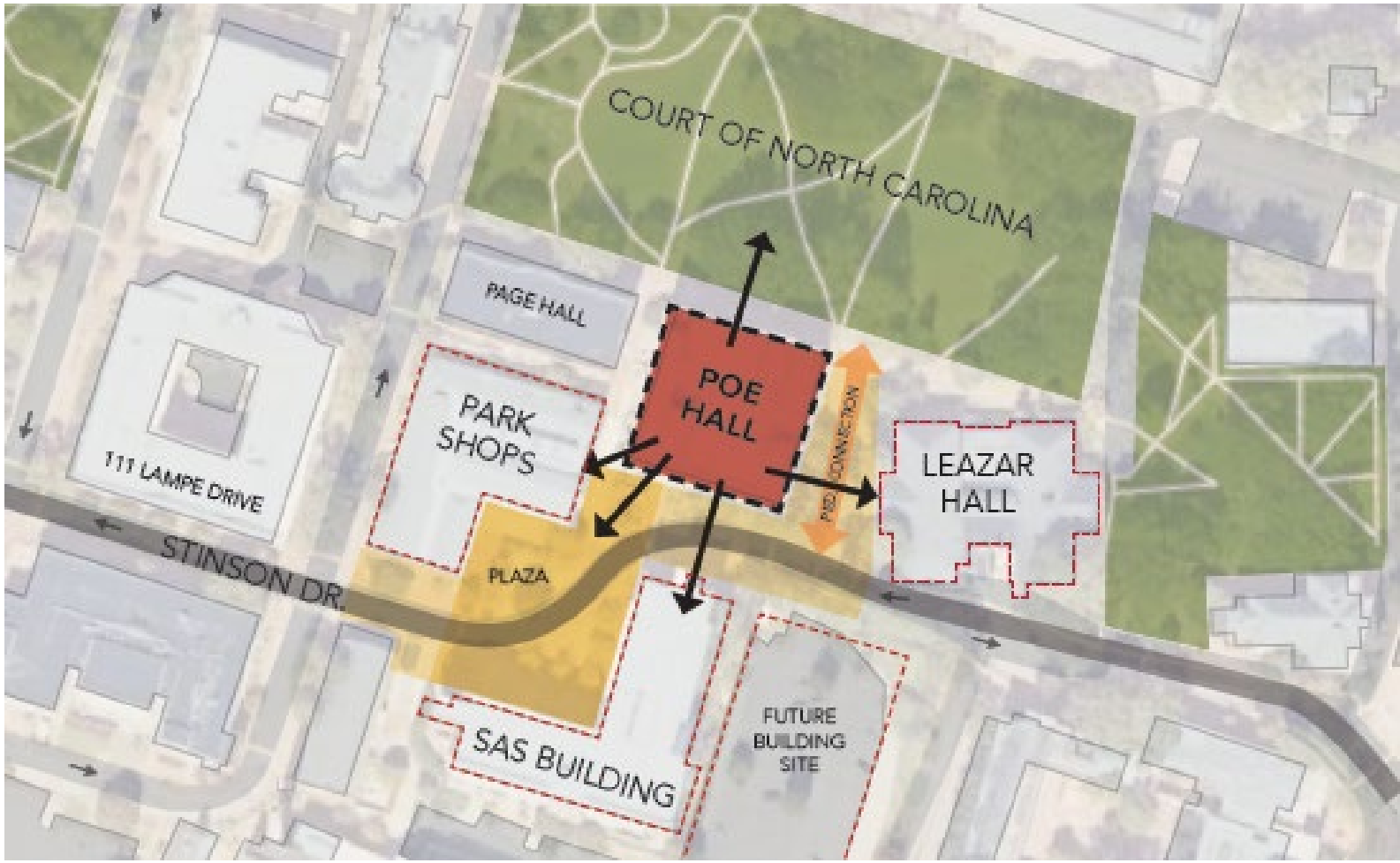
Sustainable Design

SOUTH STONE YARDS OFFICE BUILDING

CED Visioning for Poe Hall

Site Opportunities

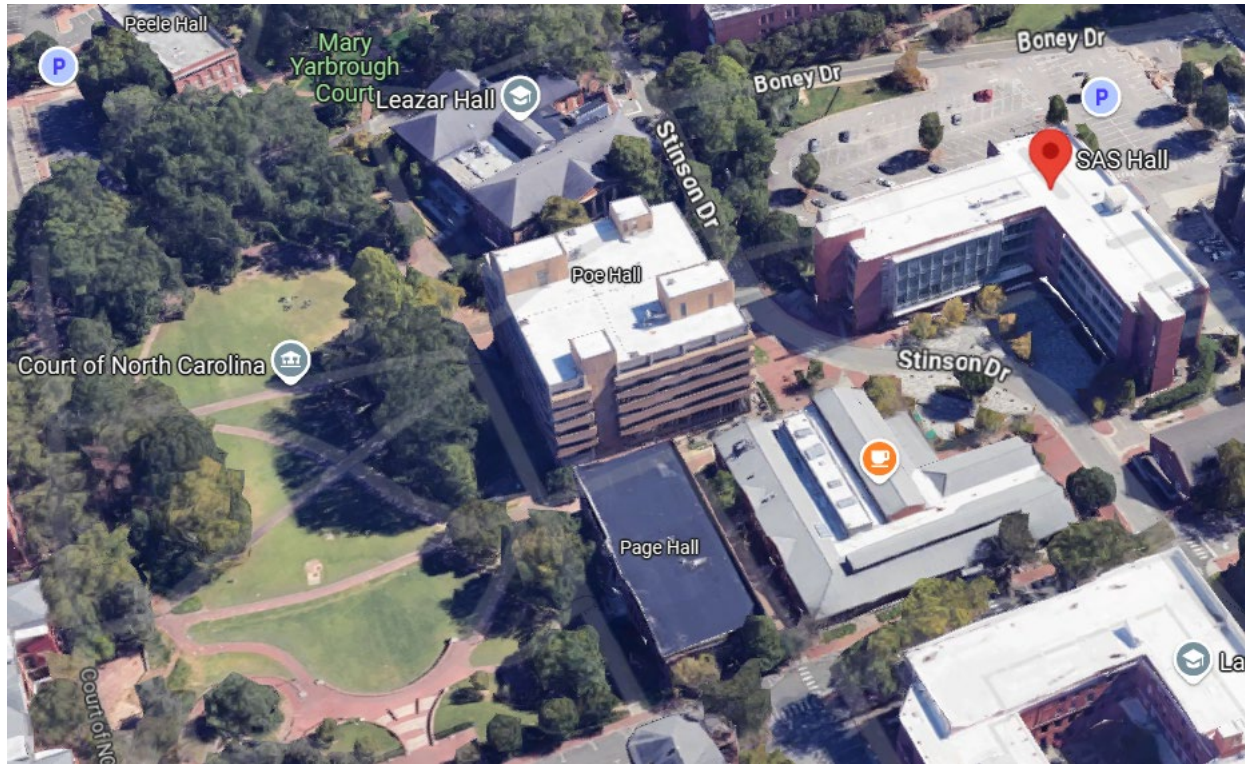
- **Natural Daylight and Views**: New exterior walls to provide more glazing for more daylight in and views out
- **Connection to the Court of NC**: Provide transparency to mature landscape
- **Outdoor Seating**: Expand areas for tables and chairs around the building for spontaneous interaction and community building
- **Connection with SAS Hall**: New design to relate to SAS and strengthen connection to outdoor plaza



CED Visioning for Poe Hall

Building Exterior Photos

- Opportunities:
  - Improve aesthetics and energy use through better envelope design
  - Better relate to context of neighborhood buildings with materials
  - Open up to Court of NC
  - Need to solve for HC access



VIEW FROM NORTH. FROM COURT OF NORTH CAROLINA

2025-03-24 Campus Development Committee – CED Visioning for Poe Hall

Next Steps

- All-college meeting 4/30
- Design-build project delivery
- Contractor selection
- Abatement and demolition
- Programming

ENTRANCE AT NORTHEAST CORNER

ENTRANCE AT SOUTHWEST CORNER, OUTDOOR SEATING AREA

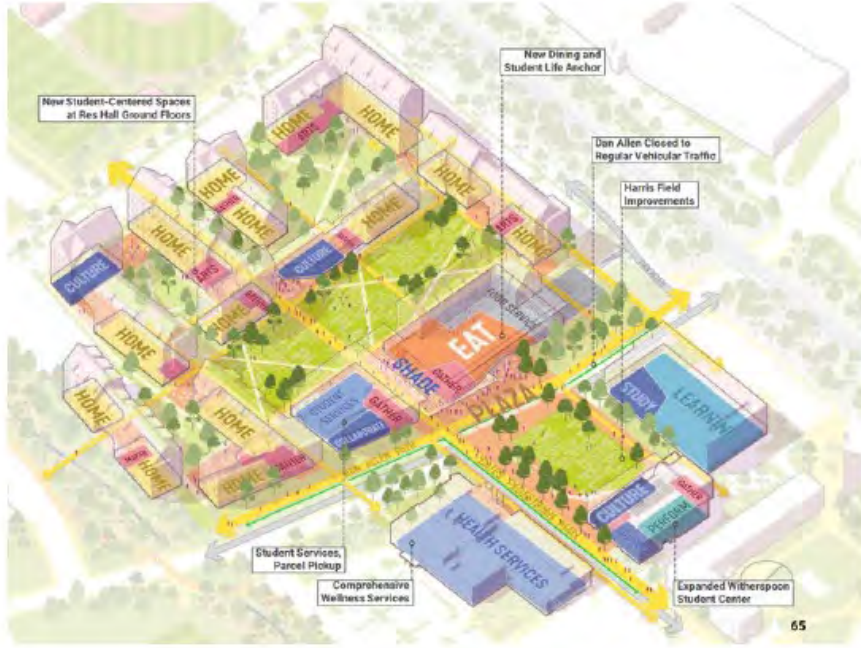
Cates West Neighborhood Development

Governance Structure

Consultant Selections
- Lead Designer Interviews – March 13
- Trustees Approval - March 17
- Subconsultant Interviews – April
- CMR Interviews – May 8

Initial Phase
- Site Master Plan
- Programming
- Phasing Plan

Visioning Study

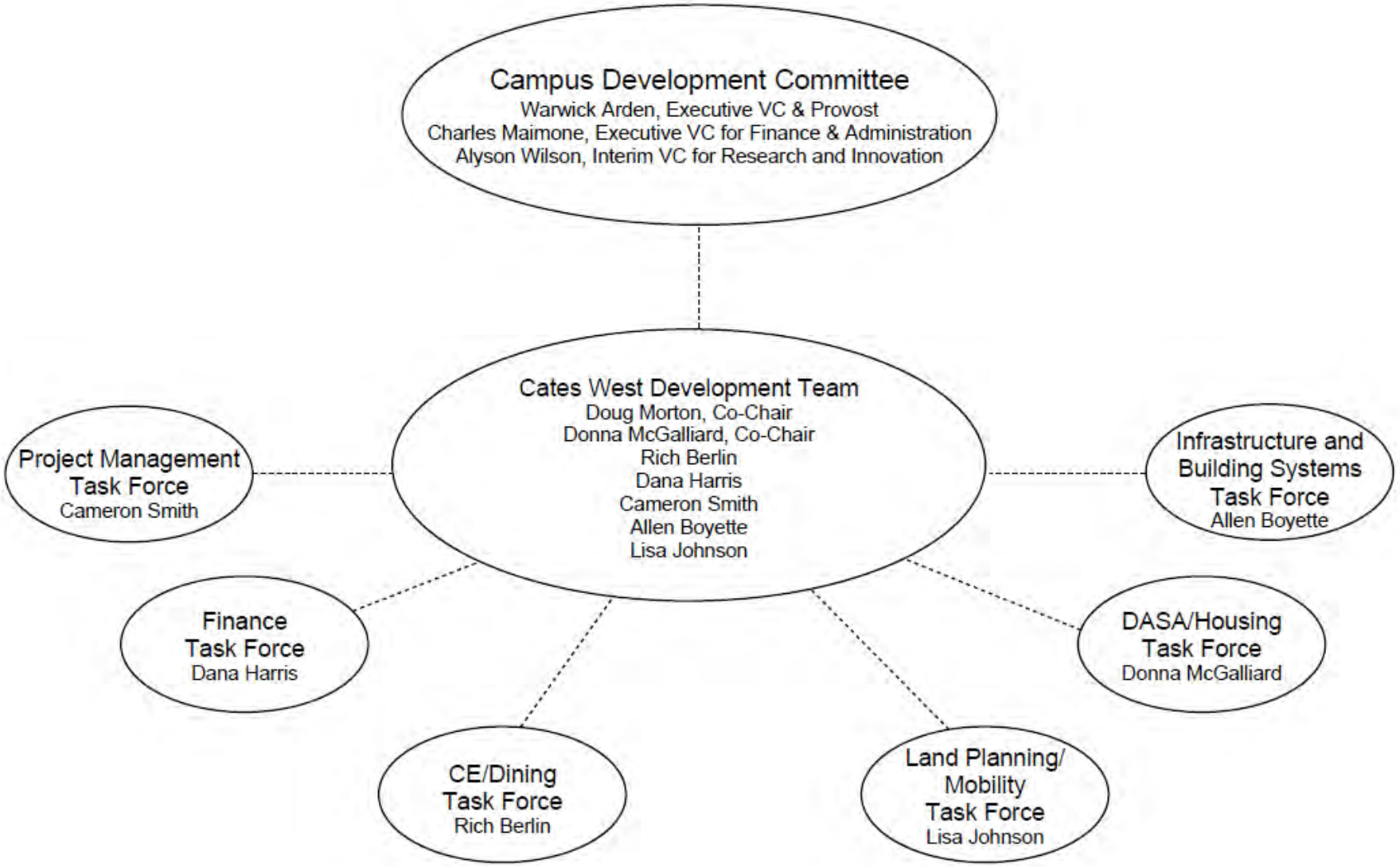


Neighborhood 'Hubs'

"At the heart of each of the campus centers ...is a Neighborhood Hub. These hubs are where academic, research, and student life intersect, creating a dynamic and vibrant activity node that supports each unique neighborhood"

NC State Framing the Future 2023 Physical Master Plan

Cates West Development – Governance Structure

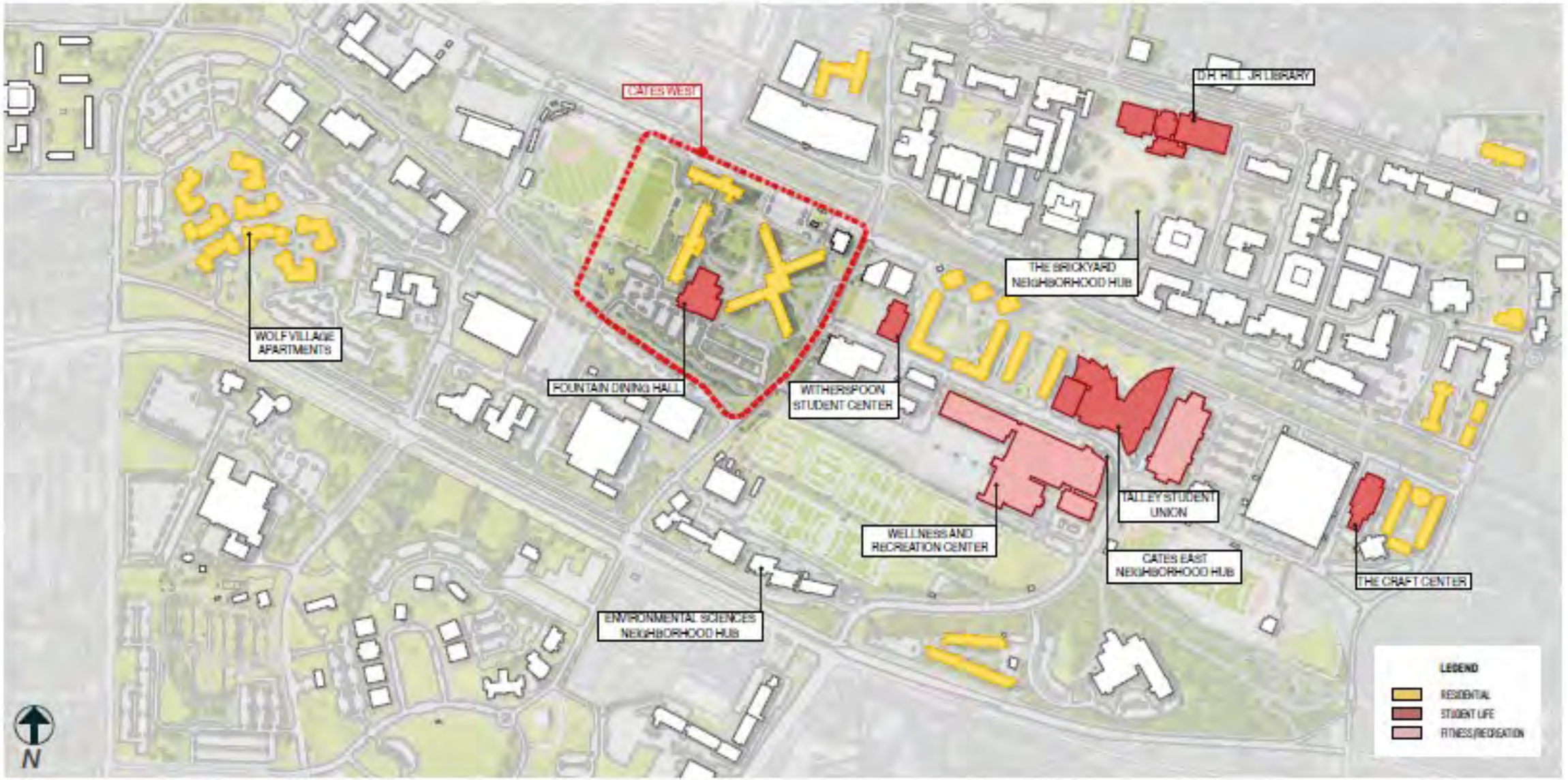


Cates West Neighborhood - Vision

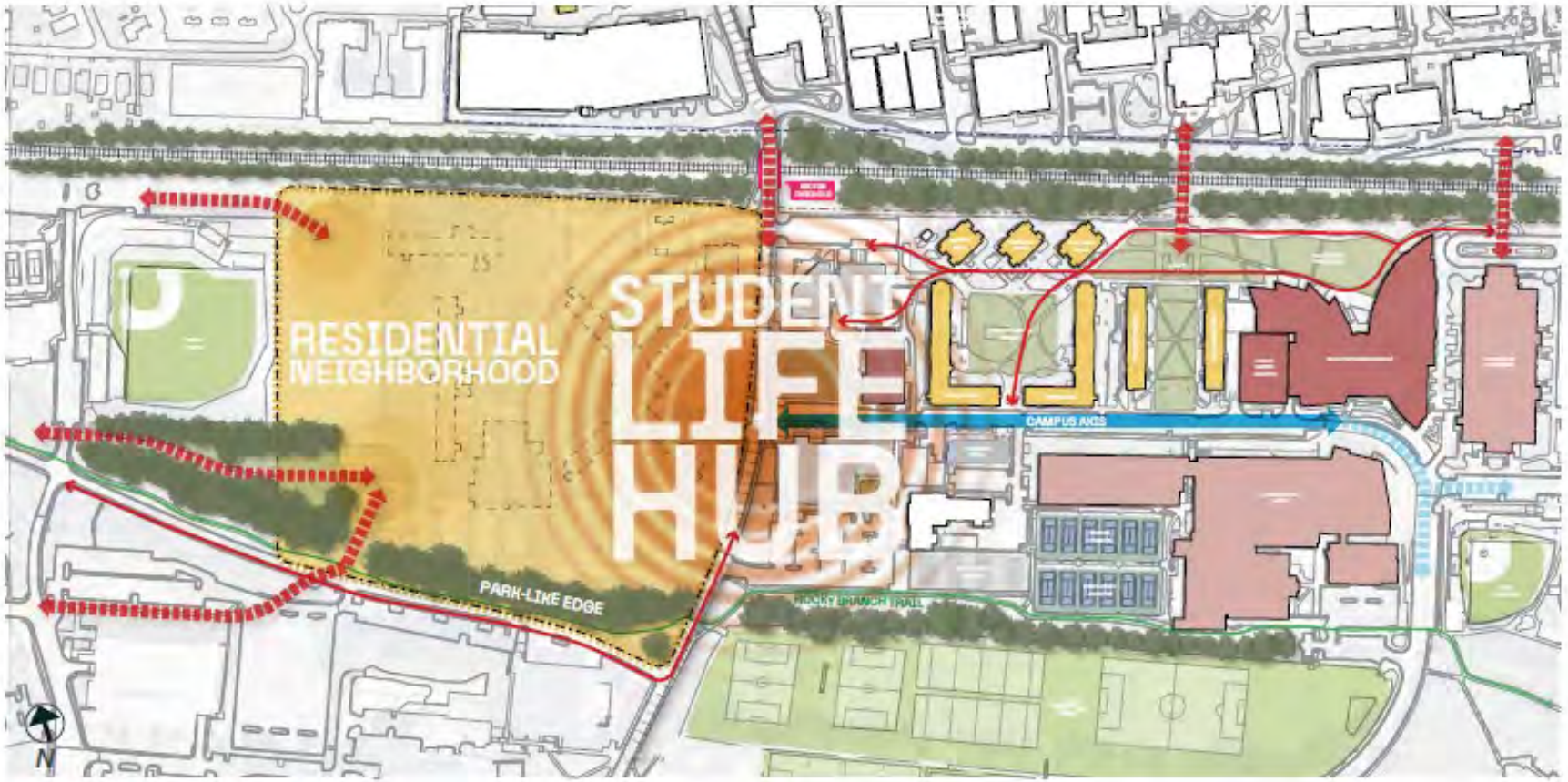
Cates West Neighborhood reimagines ***the student residential experience****. Residents flourish as they* ***live, learn, dine, and socialize****. Students value their balance of privacy and community in an environment that holistically supports their health, safety and well-being through an exceptional and inclusive residential experience.*

At the neighborhood's core lies the ***Dining Commons****, a vibrant node of activity, a 'hearth,'* ***warm and welcoming to all.*** *It's the pulse of the community, sparked by exceptional dining offerings, conveniences and activities, with flexible spaces that naturally attract and create spontaneous connections among academic and student life.*

Thoughtful design ***links indoor and outdoor spaces****, activating the landscape and seamlessly integrating the community's offerings into campus life, day and night. Together, the experience, the physical environment, and the activities create a robust sense of place that* ***inspires community engagement, promotes student success, and nurtures lifelong relationships****.*



Existing Site Plan



Cates West Site Analysis

- MAIN AXIS
- PEDESTRIAN PATH
- GREENWAY
- CAMPUS CONNECTIONS
- OUTDOOR RECREATION
- RESIDENTIAL
- STUDENT LIFE
- FITNESS/RECREATION

The Cates West site is shaped by several key physical features that will influence its development:

- Cates Avenue represents perhaps the strongest axis of student life activities on campus.
- The pedestrian underpass to the railroad tracks along Dan Allen Drive creates the opportunity for a defined threshold to the student life hub.
- The Rocky Branch Trail and surrounding trees provide a park-like edge to the site and serve as a pathway of connections extending beyond the site.
- The nearby existing student center / student life spaces offer an extension for the new neighborhood with a natural gradation from public to private as the site moves from East to West.

Residential

Re-imagine the residential experience
Create a strong sense of belonging

Dining

Culinary and community excellence
Late night and multi-functional

Student-Centered

Vibrant neighborhood living rooms
Welcomes + supports students

Outdoor

Student well-being
Campus + community connections

Themes and Spaces

The vision for the Cates West 'Hub' was shaped through a collaborative workshop process. Hanbury partnered with NC State University's key stakeholders in a series of three workshops designed to gather diverse ideas and shape a shared vision. These workshops included interactive sessions designed to identify key themes, spaces, and priorities. They focused on the future neighborhood's spatial characteristics and experiences, fostering student and community success while creating a vibrant community—a distinct Neighborhood Center that embodies the spirit of NC State. Conversations focused on defining a value proposition and framework for a new and exceptional student experience building upon the University's sense of place. Several key themes emerged throughout the iterative process:

- *Affordability*
- *A vibrant neighborhood center*
- *An enriched student experience*
- *Connectedness and community*
- *Inclusive spaces*
- *Flexibility and adaptability*
- *Indoor/Outdoor connections*
- *NC State Identity*

At the heart of these themes is a focus on desired outcomes, including re-imagining the holistic experience through residential, dining options, active student-centered spaces, support services, and developing a well-connected network of outdoor spaces.

2025-3-24 Campus Development Committee Meeting

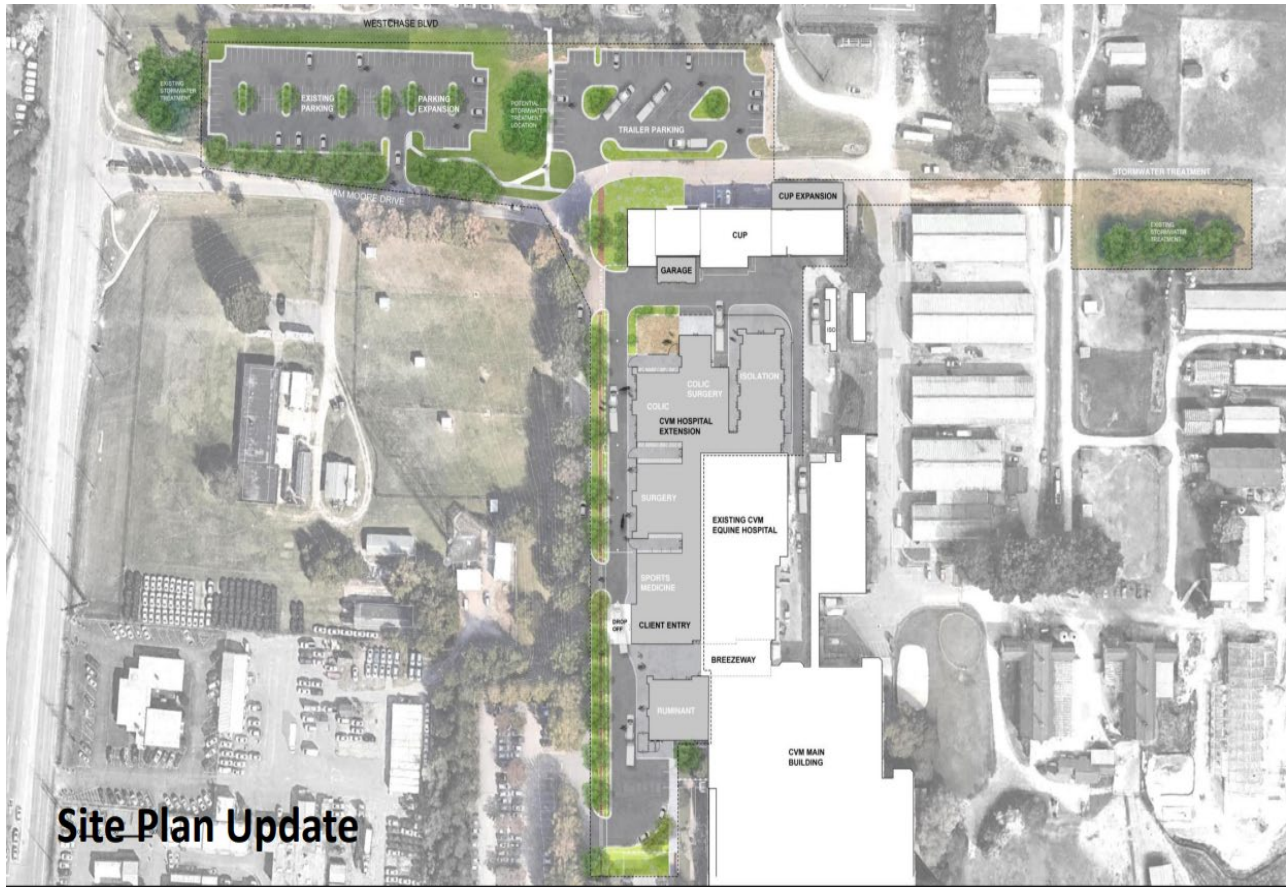
1. Projects in Execution
    a. CVM Equine Hospital
    b. Small Ruminants and Metabolism Education Unit
    c. Poole College of Management - New Building
    d. Baseball Renovation & Addition – Doak Field

Projects in Planning

- **Poe Hall Renovation**
  - Scope
    - Project will renovate the seven-story, 150,982 GSF, high-rise building built in 1970. Due to recent hazardous materials detected in the building and the subsequent displacement of the College of Education and Department of Psychology, the building will be abated, deconstructed, and renovated to accommodate the College of Education.
  - Schedule
    - Anticipated completion – TBD
    - Design-Build (Demolition and Abatement Plan)
    - Construction start – Summer 2025
  - Budget - $180M
    - $8.4M in SCIF Legislative Funding
  - Design-Builder (Demolition)
    - D.H. Griffin + Kimley-Horn
  - Design-Builder (Renovation)
    - TBD (awaiting capital authority to proceed)

Projects in Design

- **CVM Equine Hospital**
  - Scope:
    - Renovation and addition to the existing large animal hospital. The project expands research capabilities and provides services for equine veterinary care and surgical response. The project also includes expansion to the CVM Central Utility Plant
  - Schedule
    - Anticipated completion – Winter 2027
    - Design (Construction Documents)
    - Construction start – Spring 2025
  - Budget - $120M
    - $70M in SCIF Legislative Funding
    - $50M in CVM Receipts and Gifts
  - Designer
    - Flad Architects
  - Construction Manager at Risk
    - DPR Construction

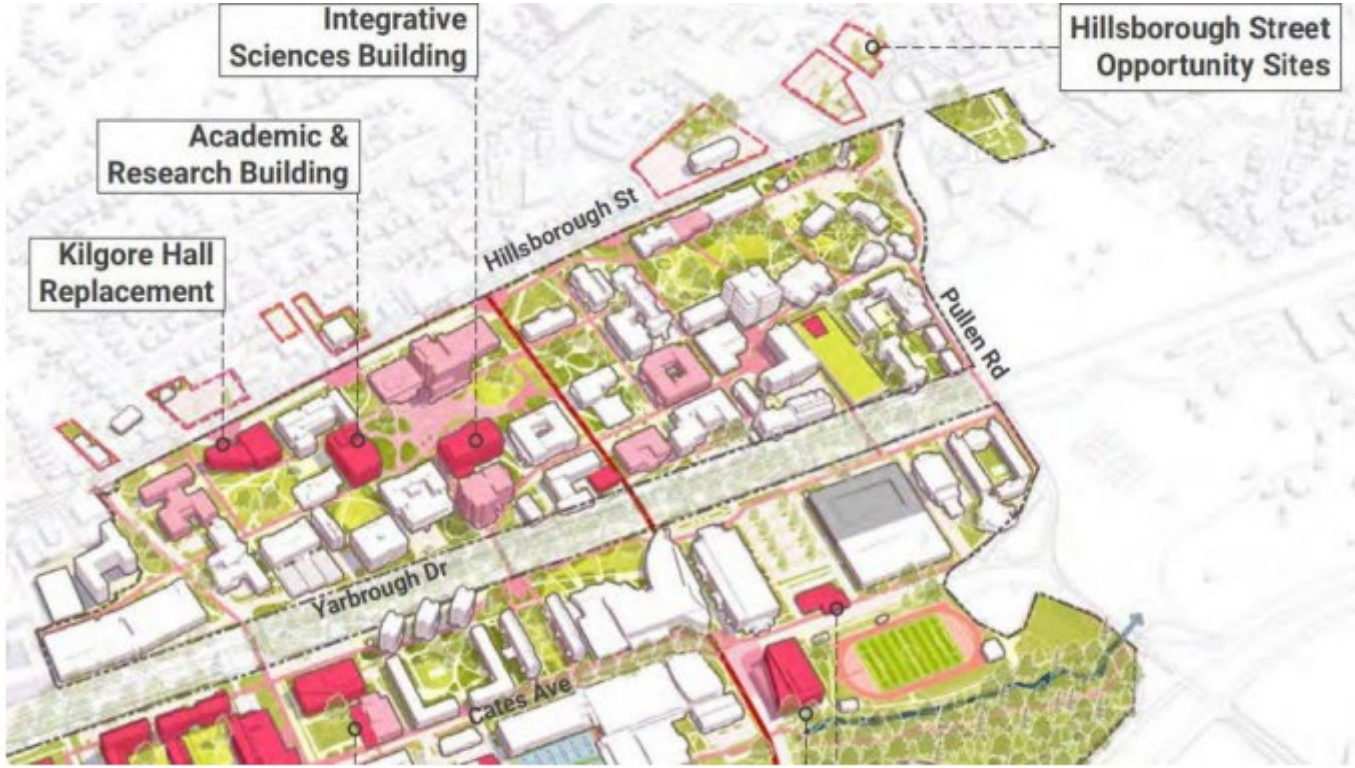


Projects in Design

- **Small Ruminants (SREU) and Metabolism Education Unit (MEU) Relocation**
  - Scope
    - Project relocates SREU to new facilities at Lake Wheeler and MEU to existing facilities (TBD). New facilities will be designed to meet housing and care standards (IACUC and USDA) while also addressing biosecurity, facility security and ADA compliance
  - Schedule
    - Anticipated completion – TBD
    - Design “on hold” (Schematic Design)
    - Construction start – TBD
  - Budget - $10M
    - $10M in Other Auxiliary Trust Funds (ACS)
  - Designer
    - Erdy McHenry Architecture
  - Construction Manager at Risk
    - TBD

Projects in Design

- **Poole College of Management – New Building**
  - Scope
    - This project provides a new state-of-the-art facility for the college currently located in Nelson Hall on the north campus precinct. The college includes four academic departments: Accounting, Business Management, Economics and Management, Innovation and Entrepreneurship
  - Schedule
    - Anticipated completion – Spring 2029
    - Design (Programming/Site Selection)
    - Construction start – Fall 2026
  - Budget - $20M
    - $4.5M in SCIF Legislative Funding
  - Designer
    - Gensler Architecture & Davis Kane Architects
  - Construction Manager at Risk
    - Barnhill & Holt Brothers



Projects in Construction

- **Baseball Renovation & Addition – Doak Field**
  - Scope
    - Multi-phase project will focus on improving competitive team performance spaces with a new batting cage and pitching lab facility, other facility components (new turf, LED Lighting, scoreboard, and sound system), and fan experience amenities (seating, concessions, shade structures, and premium entertainment space).
  - Schedule
    - Anticipated completion – Spring 2026
    - Construction complete – 15%
  - Budget - $20M
    - $20M in Athletics Funding
  - Designer
    - Ewing Cole
  - Construction Manager at Risk
    - New South Construction