

4. DEVELOPMENT PLAN

INSTITUTION: NORTHEASTERN UNIVERSITY

TEAM: NEUSS HUSKY POWER

USE CASE: NORTH CAROLINA STATE UNIVERSITY



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Site Overview

North Carolina State University (NCSU or NC State) is a public research university with its main campus in Raleigh, North Carolina. The university was founded in 1887 as a land-grant institution and hosts a community of over 40,000. The Raleigh campus has five precincts. One of these precincts is Centennial Campus, which is one of the premier research parks in North America—uniting NC State students and faculty, national and international partners, and the wider community of Raleigh. Centennial Campus sits on more than 1,100 acres within Raleigh. The university also has an energy use intensity (EUI) reduction goal of 40% by 2025 (as compared to a 2002 baseline). As of fiscal year 2021, the university has achieved a 37% EUI reduction (see report) and a 24.5% reduction in greenhouse gas emissions. Centennial Campus is a combination of private buildings and university buildings, state-owned land (for university use) and endowment-owned land. The university owns over 4 million square feet on Centennial Campus.

Solar Rooftop analysis is being done on 9 campus buildings that are among the highest energy users, as well as installing ground-mount and floating solar panels in locations that have been deemed suitable based on a pre-installation analysis. This project is aimed at reducing energy consumption and promoting the use of renewable energy sources to make the campus more sustainable and environmentally friendly. As will be outlined in subsequent sections of the Development Plan, the project team has deemed it necessary to split the development into three phases that will begin concurrently. This will consist of the rooftop solar and resiliency batteries in Phase 1a, the ground mount solar in Phase 1b, and the floating solar in Phase 1c.

Authority Having Jurisdiction (AHJ)

As can be seen in Figure 1, the NCSU Centennial campus falls within the Raleigh city limits, therefore the designated Authority Having Jurisdiction (AHJ) is the City of Raleigh. As such, they have provided a plethora of tools to help streamline the development process for more standard deployments.

ArcGIS ▾ City of Raleigh Planning Jurisdiction and City Limits

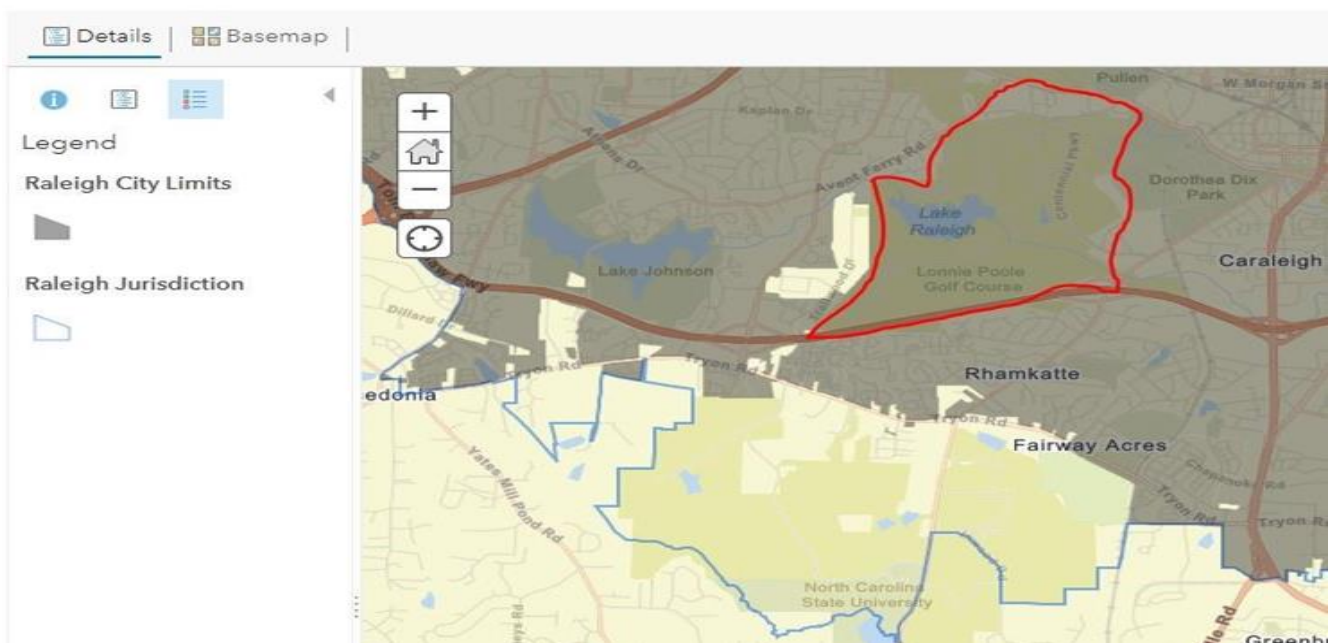


Figure 1. City of Raleigh Planning Jurisdiction and City Limits

The City of Raleigh has provided a variety of tools to streamline the development process, but reference of the Unified Development Ordinance ([UDO](#)) is critical to ensure all permits and codes are properly addressed for the size and type of development.

In order to follow the correct permitting path, it is important to determine which review Tier each Phase falls within given UDO 10.2.8.B. Given the addition of a battery energy storage system and size of the rooftop systems exceeding 10,000 sqft, Phase 1a will fall into a Tier 3 Site Review. Additionally, Phase 1b and 1c are being constructed on previously vacant plots of land and disturb more than 12,000 sqft of earth each, so they will also qualify for a Tier 3 Site Review. These Tiers can be verified through an optional Site Plan Tier Verification request through the City's, [Permit and Development Portal](#), but the project would only stand to benefit if it could reduce the Phase 1a rooftop solar requirements to a Tier 1 Review. This is unlikely, but if this is a possibility, the project team could consider splitting Phase 1a into two phases: one for the rooftop and one for the battery energy storage systems. This would alleviate any mismatches in required review timelines and eliminate the risks of approval due to fire related concerns of the storage systems.

Before beginning work on the application, the project team plans to submit a Sketch Plan Review. While this is a voluntary and paid service, it will serve two purposes: it will ensure that all ordinances and codes have been properly interpreted, and it will engage the appropriate stakeholders from the city and community early in the development process. This approach will compress the final review process and create buy-in from the AHJ.

Once the project application class has been verified, the submittal requirements include:

- [Non-Residential Permit Application](#)
 - Non-residential rooftop solar PV systems are permitted in all major zoning districts
 - Additional code considerations include:
 - UDO Section 1.5.7.D.2.g: PV systems are allowed to exceed the zoning district defined maximum building height regulations by up to 12 feet
 - UDO 1.5.4.D.2.b: Ground mounted and floating solar PV systems will maintain a 3-foot setback from existing lot lines
 - To apply for a permit for a ground mounted or floating solar PV system on a property with an established use complete the Non-Residential Permit Application and select "Other" as the "Work Type".
- Plans to include:
 - A minimum of the PV array, inverters, combiners, controllers, solar array mounting system, riser diagram, and wiring schematic.
 - Provide rooftop fall protection, clearance, and egress when roofs are publicly occupied.
 - Include a copy of Appendix B for the applicable items.
- Specification sheets and manufacturer's installation instructions for all manufactured system components that make up the Solar PV System.
- Third-party approvals are to be submitted to the NC Department of Insurance Office of the State Fire Marshal.
- The Electrical Permit is applied for through the non-residential permit by listing the electrical subcontractor's information.
- Notice of Lien Agent, ensure the parcels are properly recorded and registered to NCSU at [Wake County Register of Deeds Office](#)
- The [Administrative Site Plan](#), which is a substantial subcomponent of the permit application process.

- The [Administrative Site Review Packet](#) outlines the required submission documents, and they include a Cover Sheet, Existing Conditions, Demolition Plan (NA), Proposed Site Plan, Proposed Grading Plan, Proposed Stormwater Plan, Proposed Utility Plan, Lighting Plan, Proposed Tree Conservation Plan, Proposed Landscape Plan, and Architectural Elevations
- The multi-stage review process for a Tier 3 Review can be seen in Figure 2, but it will include a pre-application conference and submissions of the Site Review Plan, Infrastructure Construction Drawings, and then the Building Review Application. Each stage will need to be approved by the AHJ's Development Services Director.
- Figure 3 details the various subcomponents that will be taken into consideration during the review process



Figure 2. Permit Review

4. Table of Applicable Standards

Standard	UDO Sections	Tier 1	Tier 2	Tier 3
Amenity	Sec. 1.5.3; 7.2.6	—	e	*
Setbacks	Chapters 2, 3	a, d	a, d	*
Build-To	Chapters 1, 2, 3	a, d	a, d	*
Height	Chapters 1, 2, 3, 4, 5, 6, 7, 11	a, d	a, d	*
Pedestrian Access	Chapters 1, 2, 3, 4, 7, 8, 10	a, d	a, d	*
Transparency	Chapters 1, 3, 7	a, d	a, d	*
Blank Wall	1.1.11.; 1.5.10; Chapter 3	a, d	a, d	*
Ground Floor Elevation	Chapters 1, 2, 3	a, d	a, d	*
Parking Setbacks	Chapters 1, 2, 3, 4, 5, 6	a	a	*
Transition	Chapters 2, 3, 4, 5, 6	—	a, c	*
Landscaping	Chapters 5, 6, 7	g	*	*
Protective Yard	Chapters 2, 3, 4, 5, 6, 7, 8	*	*	*
Parking	Chapters 3, 4, 5, 6, 7	*	*	*
Parking Structure Design and Screening	Chapters 3 and 7	a, d	a, d	*
Lighting	Chapters 3, 4, 5, 6, 7, 10	a, d	a, d	*
Site Access	Chapter 8	a, d	a, d	*
Driveway	Chapters 1, 2, 3, 5, 6, 7, 8, 9	a, d	a, d	*
Signage	Chapters 6, 7, 10	a	a	a
Tree Conservation/Preservation	Article 9.1	—	*	*
Forestation	9.1.9	c	c	*
Stormwater	9.2	*	*	*
Public Improvements				
Right of way dedication	Chapter 8	—	—	*
Road widening/construction/utilities	Chapter 8	f	f	*
Curb and gutter	Chapter 8	—	—	*
Sidewalk	Chapter 8	b	b	*
Tree lawn/Street trees	Chapter 8	b	b	*
Transit infrastructure	Article 8.11	—	c	*
Bus Shelter	Article 8.11	—	c	*

Key: — = Not Applicable * = Applicable

Footnotes:
a - Not applicable to the existing improvements on the site at the time of site plan review.
b - Required only when the site is located in the DX district or subject to an urban frontage.
c - Not applicable to a change in use of an existing building[s].
d - Applicable if demolition and reconstruction of an entire structure is proposed.
e - Applicable to establishing a civic use on vacant property and any Tier One or Two Site Plan involving the total demolition of all buildings on site, excluding like-for-like reconstruction.
f - Art. 8.7 Utilities is applicable if the development is voluntarily connecting to city water or city sewer for the first time.
g - Screening requirements as described in Sec. 7.2.5 and Sec. 7.2.6 are applicable.

Figure 3. Table of Applicable Standards

The project team will utilize the City of Raleigh's Permit and Development Portal to upload all required documents and proactively stay up to date on permit timelines and statuses.

Once the application has been submitted, reviewed, and approved and a permit has been issued, the project team will have six months to begin construction, or else the permit will expire. Furthermore, if work is discontinued for more than a 12-month period, the permit will expire.

Interconnection Permitting (N/A):

All connections are being made behind the University owned substation, and as such, they will be considered behind-the-meter. Seeing as no power will be exported to the grid, no interconnection permit will be required.

Land Use & Zoning Ordinances

In order to develop the various sustainable energy systems, the existing and potential change of zoning needs to be properly determined. Through review of the City's [Zoning Map](#) (Figure 4), it was determined that Phase 1a and 1c fall under the Office Mixed Use (OX-) designation. The Phase 1b ground mount system falls under a Planned Development (PD) Zone.

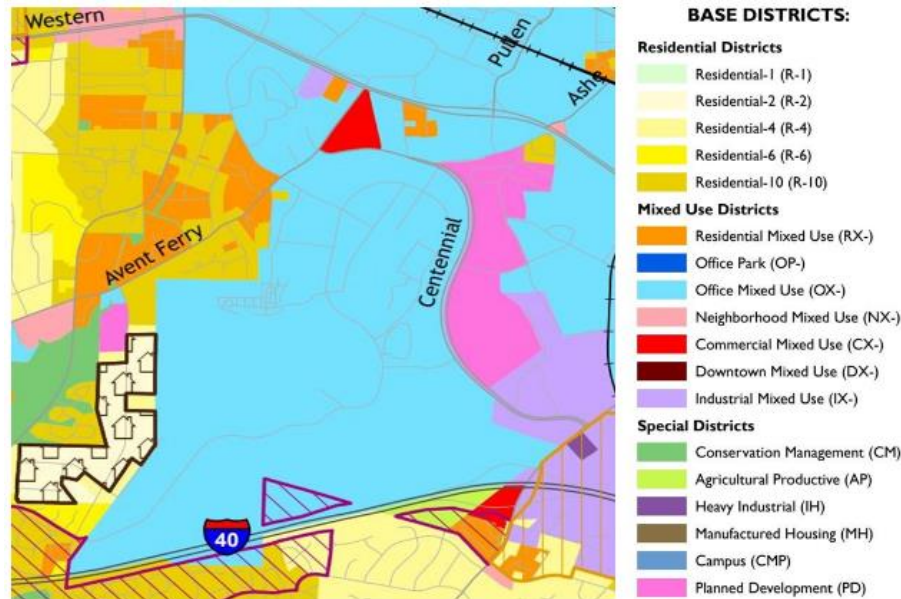


Figure 4. City of Raleigh Zoning Map

The appropriate land use for each phase will be defined by UDO 3.1.C for OX- and UDO 4.7.2 for PD. The PV and battery systems are referred to by UDO 6.3.3.A.1.c. as a "Sustainable Energy System (UDO 6.3.3.A.1.c)," and they must be qualified as "Minor Utilities (UDO 6.1.4)" through the previously mentioned Administrative Site Plan review process. The UDO 6.1.4 Allowed Principal Use Table (Figure 5) clearly defines this eligibility and permitting path.

UDO 10.2.4.D.3 outlines that a Rezoning Application and Master Plan Application must be submitted in complete form to initiate a Planned Development (PD) rezoning process. The establishment of a PD is meant to serve as a "relief mechanism from the prescriptive standards of a general use zoning district," and it is "intended to be used to achieve a higher quality of project design than could be accomplished through the strict application of a general use district or set of general use districts, without adversely impacting the adequate facilities required to serve the property and surrounding area."

The University has already undergone this Rezoning Process to establish the current PD Zone to serve the purposed of their Master Plan. The project team's proposed Phase 1b would lead to an alteration of the existing PD. Per UDO 10.2.4.B, this alteration would qualify as a Non-Administrative Amendment, as it significantly deviates from the intended use of the originally proposed PD. While a detailed description of how the proposed Phase 1b ground mount system will not physically impact the Master Plan will be detailed in the following section, the project team would still need to initiate the Rezoning Process defined by UDO 10.2.4. This flow can be seen in Figure 6. This process will most notably require a review from the Public Planning Commission and City Council. If any changes or alterations arise throughout this meeting, they will need to be addressed and reopened at a subsequent public hearing. Not only will this significantly increase the permitting time for Phase 1b, but it opens

the door for a potential denial of the Phase entirely. These are the primary reasons for the separation of these Phases, and the mitigation strategies will be expounded upon in subsequent sections.

USE CATEGORY Specific Use	RESIDENTIAL					MIXED USE								SPECIAL				Definition/ Use Standards
	R-1	R-2	R-4	R-6	R-10	RX-	OP-	OX-	NX-	CX-	DX-	IX-	CM	AP	IH	MH		
College, community college, university	--	--	--	--	--	--	P	P	--	P	P	P	--	--	--	Sec. 6.3.1.C.		
School, public or private (K-12)	L	L	L	L	L	L	L	L	L	L	L	L	--	L	--	Sec. 6.3.1.D.		
PARKS, OPEN SPACE AND GREENWAYS	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Sec. 6.3.2.A.		
MINOR UTILITIES	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	Sec. 6.3.3.A.		
MAJOR UTILITIES, EXCEPT AS LISTED BELOW	--	--	--	--	--	--	--	--	--	--	--	S	--	--	S	Sec. 6.3.3.B.		
Telecommunication tower (<250 ft)	L	L	L	L	L	L	L	L	L	L	L	L	--	L	L	Sec. 6.3.3.C.		
Telecommunication tower (≥250 ft)	S	S	S	S	S	S	S	S	S	S	S	S	--	S	S	Sec. 6.3.3.D.		
Water/Wastewater treatment plant - Government	L	--	--	--	--	--	--	--	--	--	--	L	--	--	L	Sec. 6.3.3.E.		
COMMERCIAL																		
DAY CARE, AS LISTED BELOW:																Sec. 6.4.1.A.		
Day care, home	L	L	L	L	L	L	--	L	L	L	L	L	--	L	--	Sec. 6.4.1.B.		
Day care center	S	S	S	S	S	S	L	L	L	L	L	L	--	--	--	Sec. 6.4.1.C.		
INDOOR RECREATION, EXCEPT AS LISTED BELOW:	--	--	--	--	--	--	--	--	P	P	P	P	--	--	--	Sec. 6.4.2.A.		
Adult establishment	--	--	--	--	--	--	--	--	--	S	S	S	--	--	S	Sec. 6.4.2.B.		
Dance, martial arts, music studio or classroom	--	--	--	--	--	--	--	P	P	P	P	P	--	--	--			
Health club	--	--	--	--	--	L	P	P	P	P	P	P	--	--	--	Sec. 6.4.2.C.		
Sports academy	--	--	--	--	--	--	--	P	P	P	P	P	--	--	--	Sec. 6.4.2.D.		
MEDICAL	--	--	--	--	--	L	P	P	P	P	P	P	--	--	--	Sec. 6.4.3.A. & B.		
OFFICE	--	--	--	--	--	L	P	P	P	P	P	P	--	--	P	Sec. 6.4.4.A. & B.		
OUTDOOR RECREATION, EXCEPT AS LISTED BELOW:	--	--	--	--	--	--	--	--	--	P	P	P	--	--	--	Sec. 6.4.5.A.		
Golf course	L	L	L	L	L	--	--	--	--	P	--	P	--	--	--	Sec. 6.4.5.B.		
Outdoor sports or entertainment facility (≤250 seats)	P	P	P	P	P	P	P	P	P	P	P	P	--	P	--	Sec. 6.4.5.C.		
Outdoor sports or entertainment facility (>250 seats)	S	S	S	S	S	S	S	S	S	S	S	S	--	S	S	Sec. 6.4.5.C.		
Key: P = Permitted Use L = Limited Use S = Special Use -- = Use Not Permitted																		

Key: P = Permitted Use L = Limited Use S = Special Use -- = Use Not Permitted

Figure 5. UDO Allowable Use Table



Figure 6. Rezoning Process

Special Use Permit (Contingent):



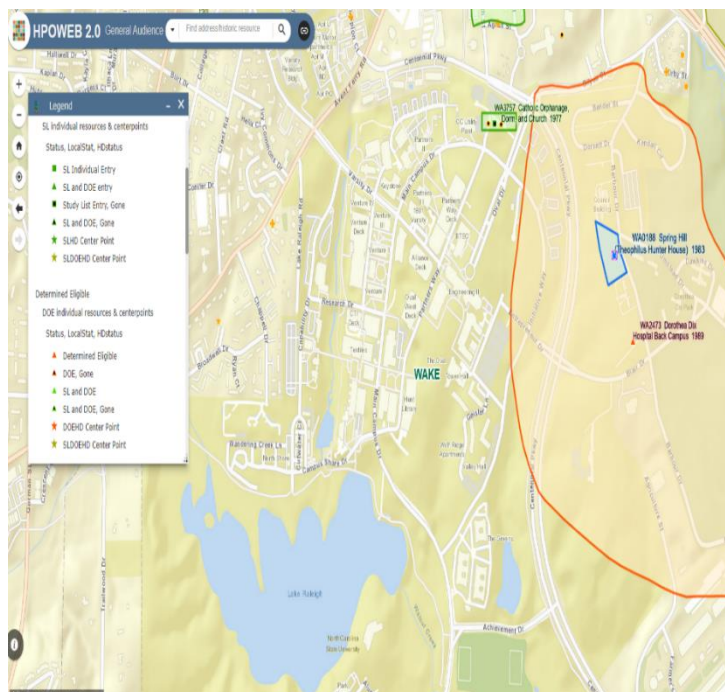
Figure 7. Special Use Permit Process

While the UDO 6.1.4 Allowed Principal Use Table indicates that Minor Utilities need only undergo the standard Non-Residential Permit Application, if the Planning Director, Planning Commission, or City Council determine that any of the Phases do not represent the stated intent of the existing zoning and maintain continuity with the surrounding community, then the project team may be required to initiate a Special Use Permit (UDO 10.2.9). The process is outlined in Figure 7. Similar to the Rezoning approval process, this will involve a review by the Planning Director and then a Public Hearing. Ideally, this will be avoided entirely by engaging the AHJ early in the permitting application process, so they understand the project intent and minimal impacts that these systems will have on the campus. If the team is required to move forward with a Special Use Permit, they will attempt to coordinate Public Hearings along a similar timeline as to that of the PD Rezoning process that will be carried out for Phase 1b to reduce any further project delays.

Historical/Cultural Resources

The project team will to the North Carolina State Historic Preservation Office (SHPO). Once an ER tracking number has been issued, we will engage a third-party survey to perform a Historic Structure Survey Report and Archaeological Survey Report. While there are no buildings that are 50 years or older readily viewable via satellite imaging, it is important to engage a professional service to ensure the project complies with all state ordinances.

The initial application will include a detailed project description, past usage of the project area, and proposed ground disturbance in terms of area and depth. We will also submit a detailed project area map. A marked-up tax parcel map would be the most appropriate. Finally, we will include extensive photos that indicate a general site layout and delineate any findings of interest from the survey.



Given initial reviews of the National Register's ArcGIS tool HPOGIS, we do not believe there will be any historic building impacts. The orange outlined area is currently under a Determination of Eligibility (DOE) in relation to the Theophilus Hunter House, however, the same area is currently slated for Planned Development. Phase 1b encroaches on the southwest border of this DOE, but it should not have a significantly greater impact than the existing plan to clear and develop dorms on the parcels in closer proximity to the Historic Landmark.

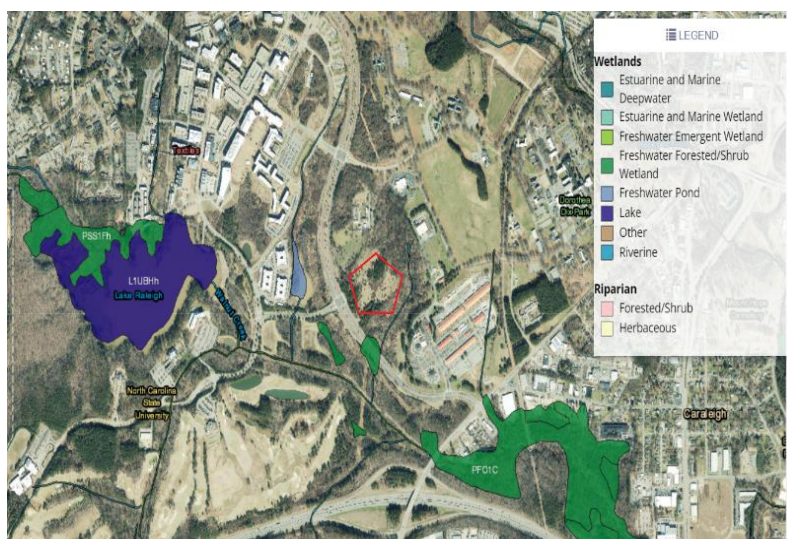
Finally, seeing as the parcels intended for a ground-mount system are being constructed on previously undisturbed land, there is a low to medium probability that the Archaeological Survey returns significant findings.

We will perform any remediation, mitigation, or preservation operations pursuant to the NC SHPO's review.

Environmental Impact –Wetlands

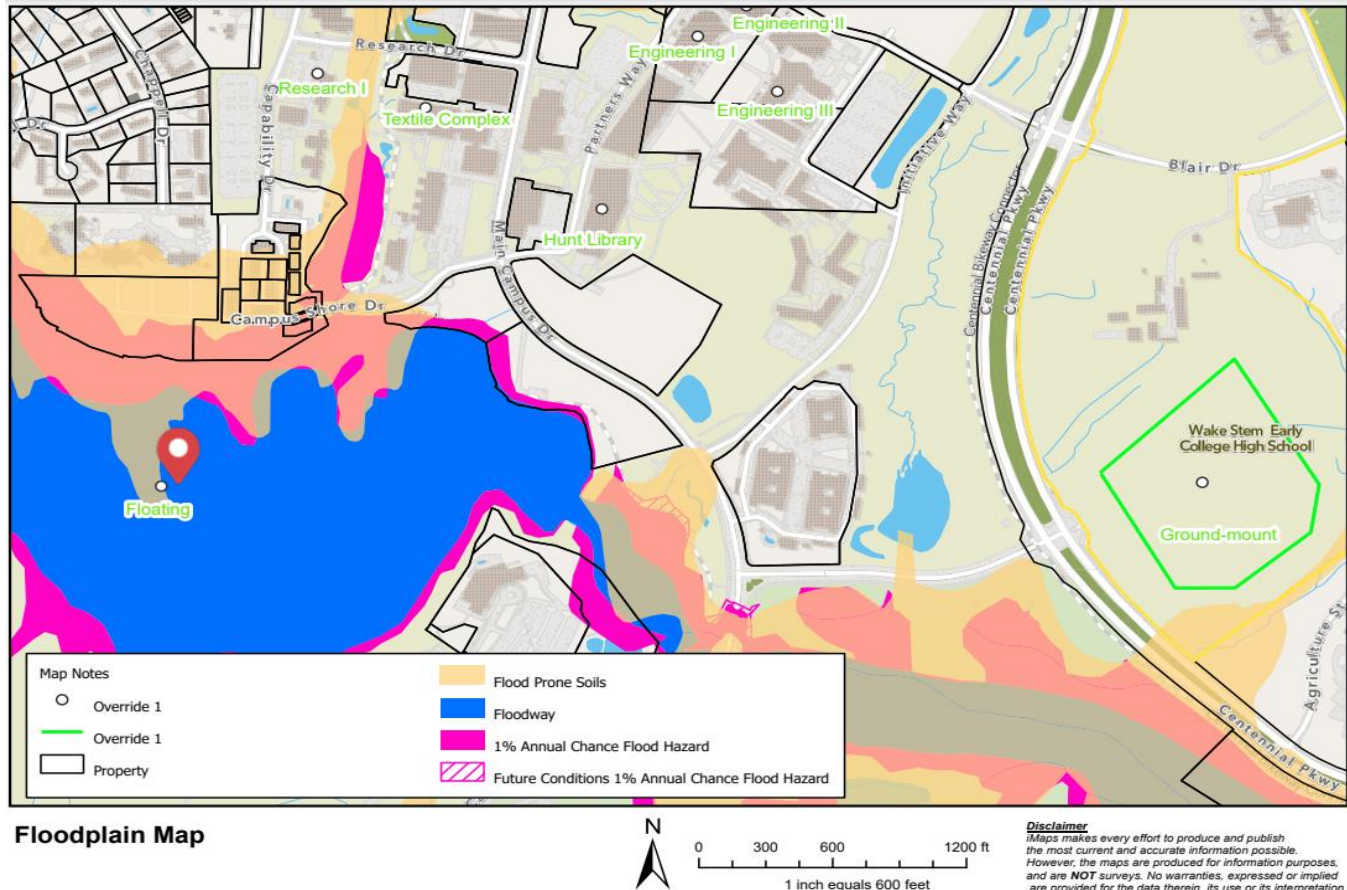
The North Carolina State University campus has a Freshwater Forested/Shrub Wetland marked in the figure as green around the lake Raleigh where the floating solar is planned to be installed. The proposed project will impact isolated wetlands or wetlands the US Army Corps of Engineers (USACE) determines are not jurisdictional under Section 404 of the Clean Water Act, then an isolated and other non-jurisdictional wetlands and waters permit from NC DWR will be required.

The National Wetlands Mapper also shows nearby Freshwater Forested/Shrub Wetlands,



but none of these protected areas are on the planned zones of solar ground mount installations as marked by the red outline. The figure shows the potentially affected areas within the North Carolina State University, though the other proposed PV systems for the campus should not be affected as they are Roof mount solar.

Floodplain Analysis

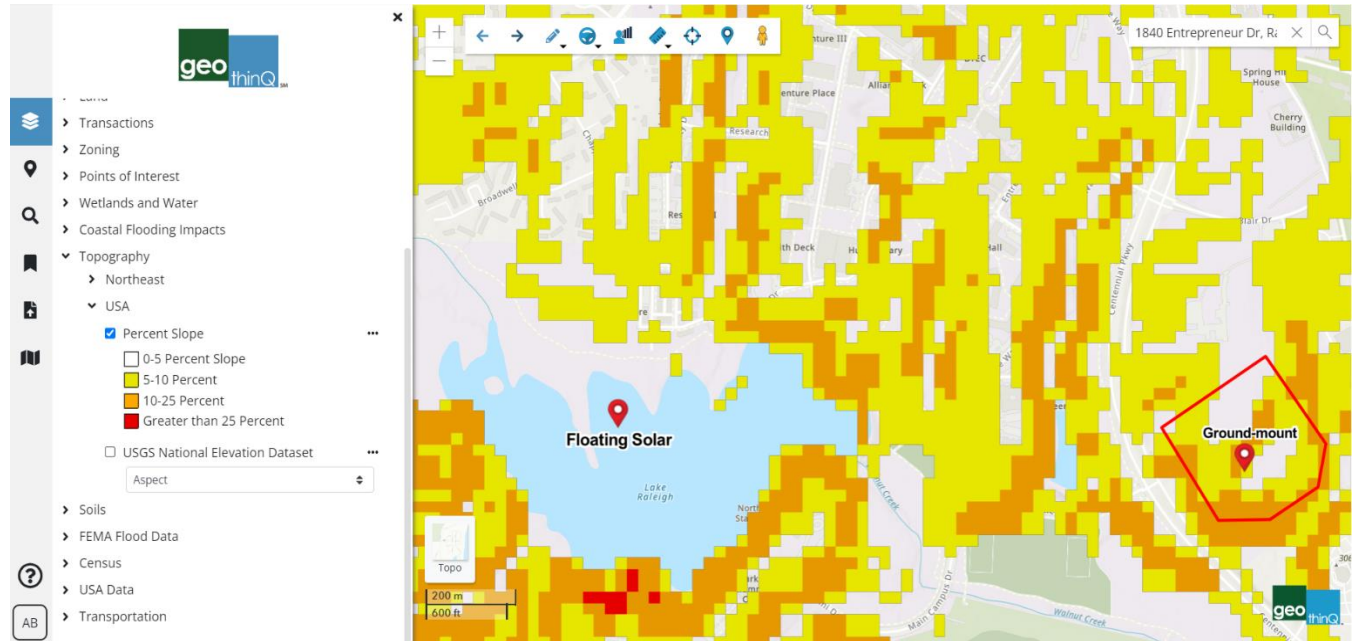


floodplain analysis has been conducted for the identified site at the Centennial Campus of North Carolina State University, Raleigh, NC for a solar project. Based on the analysis, the ground-mounted solar installation is not situated in floodways and is not at risk of being affected by floodplain soil and flood hazards in the near future. However, the site for the floating solar installation falls within a floodway, which means that a floodplain development permit is required from the local AHJ (Raleigh Board of Adjustment). To obtain the permit, a No-Rise certification stating that the project will not increase flood height must be provided by a registered engineer. In terms of flood risk mitigation design, the following measures will be implemented:

- The lowest edge of all photovoltaic panels will be elevated at or above the 100-year water surface elevation when in full-tilt position.
- The electrical service equipment, bottom of the structural frame of temporary construction trailers, and inverter will be elevated at least 1 foot above the 100-year water surface elevation.

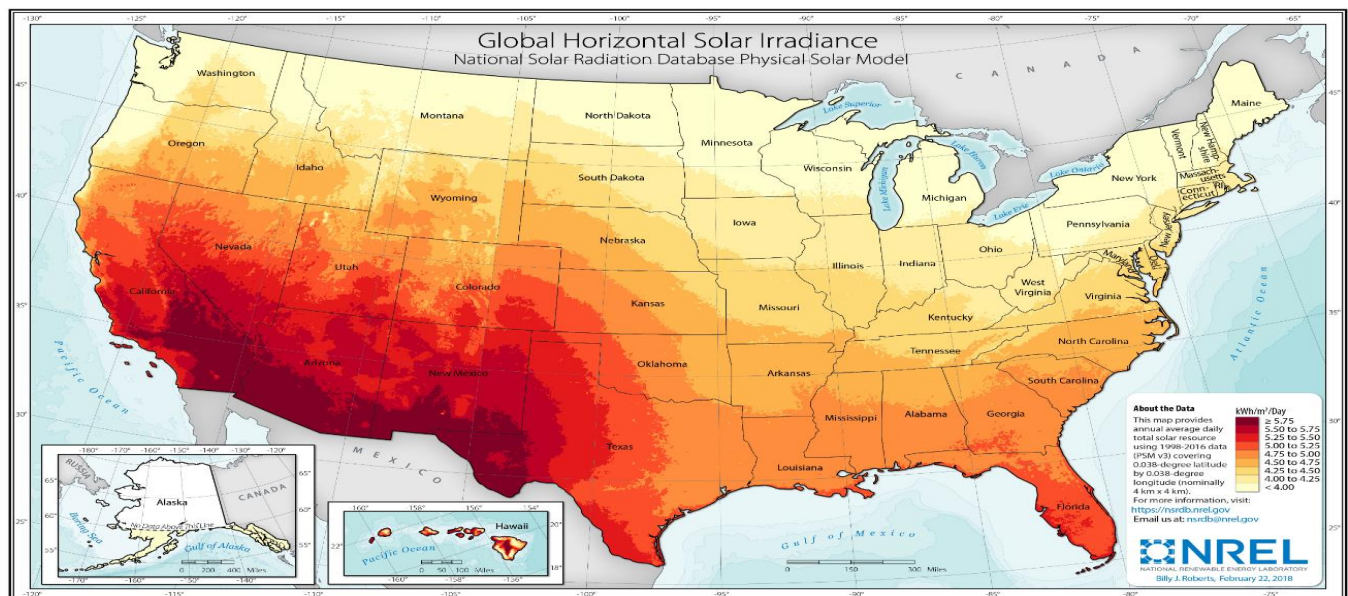
Furthermore, the floodplain analysis for the rooftop solar site reveals that the region is free from any flood-prone soils, and the property is already developed.

Topography & Climate Condition

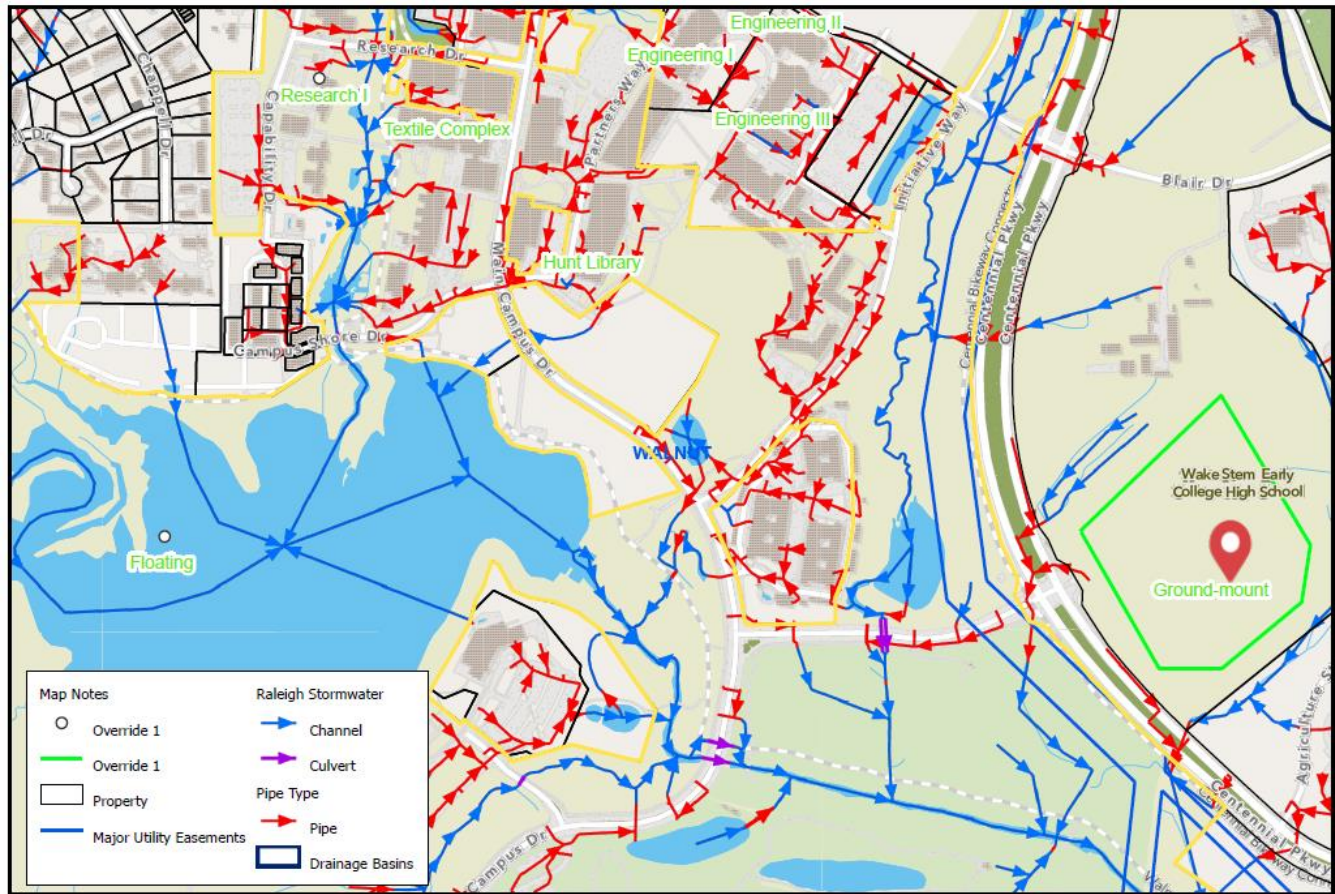


The area surrounding NCSU has an elevation ranging from 200 to 400 feet above sea level and is characterized by gently rolling hills. While there are a few minor hills and valleys on campus, most of the area has a slope ranging from 5-10 percent, as determined by the USGS National Elevation Dataset (NED) analysis at a 30-meter spatial resolution.

Overall, the geography of NCSU is well-suited for the installation of solar panel systems. The mostly flat terrain of the campus makes it easy to install solar panels without the need for expensive mounting equipment. Additionally, the region receives sufficient sunlight throughout the year, which is crucial for the optimal operation of solar panels.



Conditions & Surrounding Land use



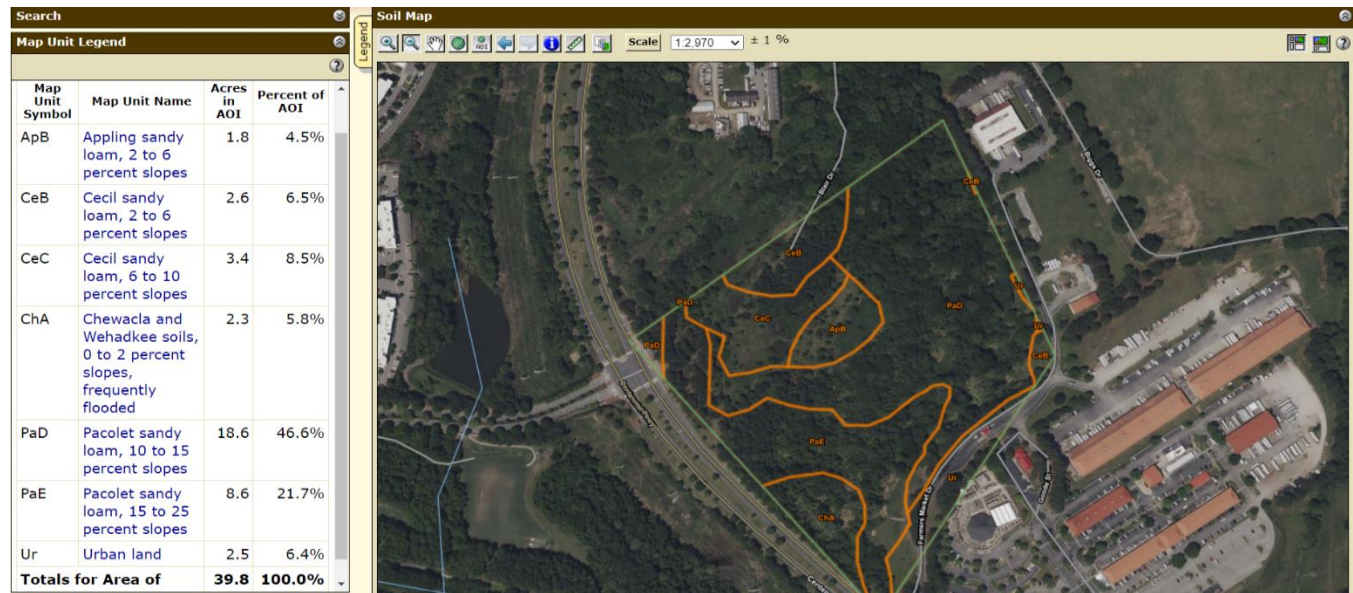
Surrounding Area Map

The pre-installation analysis for the ground mount and floating solar project at NCSU campus has been conducted, and old pipelines and utility lines have been mapped to ensure compliance with regulations and avoid potential hazards. The analysis revealed that the proposed sites for the solar installation are free from such items, which is a positive finding that eliminates the need for any adjustments or modifications to the project plan.

The lack of old pipelines or utility lines in the vicinity of the proposed sites is a favorable condition for the installation of solar panels. It ensures that the project can be executed safely, efficiently, and in compliance with all regulations.

Based on this pre-installation analysis, we recommend proceeding with the solar project installation at NCSU campus without any concerns related to old pipelines or utility lines.

USDA Web Soil Survey



PaD – Pacolet sandy loam, 10 to 15 percent slopes covers around 46.6% of the total Ground-Mount area.

The pre-installation analysis for the ground mount solar project at NCSU included a soil survey, which revealed that approximately 50% of the total ground mount area is covered by PaD – Pacolet sandy loam with 10 to 15 percent slopes. This soil type is characterized by a well-drained, loamy soil texture, which is favorable for the installation of solar panels.

However, the presence of a 10 to 15 percent slope may pose some challenges for the installation process. The slope can affect the orientation and angle of the solar panels, which may impact their performance. It may also require additional excavation and leveling work to ensure that the solar panels are installed on a stable and even surface.

To mitigate these challenges, we recommend adjusting the installation plan to account for the slope. This may include adjusting the orientation and tilt angle of the solar panels or using additional equipment and materials to level the surface.

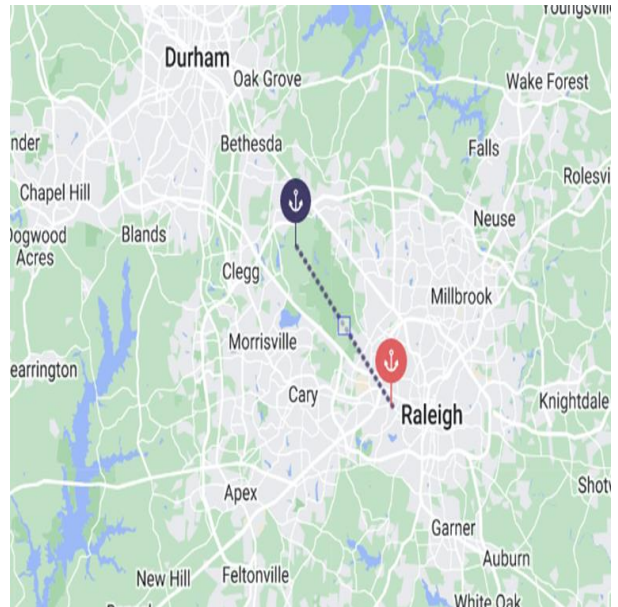
Overall, the soil survey for the ground mount solar project at NCSU has identified the presence of PaD – Pacolet sandy loam with 10 to 15 percent slopes, which may require modifications to the installation plan. However, with careful planning and adjustments, the installation can be carried out successfully, ensuring the optimal performance of the solar panels.

A soil erosion permit is required for construction activities that have the potential to cause soil erosion. We will need to complete an application for the soil erosion permit, the application typically requires information about the project, including the location of the construction site, the estimated duration of the project, and the proposed erosion control measures. An Erosion Control Plan will be implemented considering water quality protection during and after construction. This may include measures to prevent sediment from entering nearby streams, lakes, or wetlands. A natural habitat protection plan will serve to protect wildlife habitats, wetlands, and other sensitive areas. An emergency response case will be developed for a sudden increase in erosion or sedimentation or other unforeseen circumstances. The plan will include regular monitoring and maintenance such as inspections, sediment removal, and repair or replacement of damaged soil.

Federal Aviation Administration – Obstruction Evaluation Study

If the distance from the center of the solar plant to the nearest airport is within 5 nautical miles only then we need to apply for the FAA approval. The nearest airport to the solar plant is Raleigh-Durham (RDU) International Airport. Using the nautical miles calculator shown in the figure above, we can see that the distance to the nearest airport is 7.7 nautical miles and hence there is no need for an FAA permit.

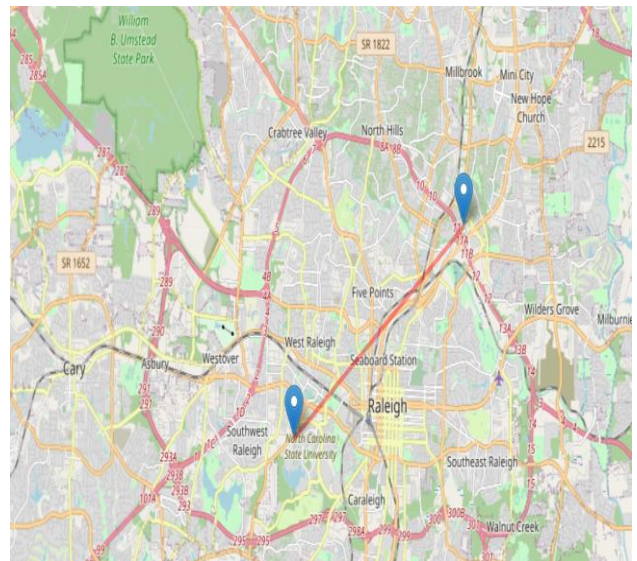
Additionally, we can use the SGHAT (Solar Glare Hazard Analysis Tool) tool to determine when and where solar glare can occur throughout the year from a user-specified PV array as viewed from user-prescribed observation points. The potential ocular impact from the observed glare and a prediction of the annual energy production are also determined. Configurations can be quickly modified (e.g., tilt, orientation, shape, location) to identify a design that mitigates glare while maximizing energy production. The use of solar panels with a coating to reduce the amount of glare produced can also be used to minimize this effect.



Department of Defense Permit Analysis

To analyze whether a solar installation is permitted on a location near DOD property, the following steps were taken:

- The location of the DOD property: The closest US DOD installations to NCSU Centennial's campus are USAREC, Raleigh Battalion. Address: 3117 Poplarwood Court Suite 218 Raleigh, NC 27604 (which is located 7 miles).
- Develop a plan to mitigate potential impacts: The plan to mitigate any potential impacts will be taken like installing screening or landscaping to reduce visual impacts, implementing measures to protect wildlife or natural resources, and ensure that the installation is safe and meets all necessary safety standards.
- Consider lighting and electrical emissions: The design and construction of Solar Energy Facilities (SEFs) at NCSU will try to mitigate any electrical emissions that would interfere with aircraft communication systems or navigation equipment, as stated in the most recent AICUZ (Air Installation Compatible Use Zone) report, as well as low-level military training routes as then utilized by any branch of the US Dept. of Defense.



Based on the above analysis, it can be concluded that the NCSU solar installation is permitted at the identified location and has a plan that meets all necessary requirements and mitigates any potential impacts.

Critical Habitats (Fish & Wildlife Survey)

We analyzed the area around our solar installations using the US Fish and Wildlife Services [IPaC Information for Planning and Consultation](#) tool to see how the project might affect the habitat and species that live there. Our analysis revealed that there are no critical habitats at our solar system's location. However, endangered species and migratory birds may exist in our proposed solar areas, according to the Ecological services database (listed below). We must conduct a site survey to determine the presence of these species; if the survey reveals that they exist, we must obtain the necessary permits and take the necessary conservation measures before we can build our solar system.

Endangered Species:		Migratory Birds:	
Endangered Species	Category	Migratory Birds	Breeding Season
Mammals - Tricolored Bat	Proposed Endangered	Bald Eagle	Sep 1 to Jul 31
Birds-Red-Cockaded Woodpecker	Endangered	Black-billed Cuckoo	May 15 to Oct 10
Amphibians-Neuse River Waterdog	Threatened	Cerulean Warbler	Apr 28 to Jul 20
Fishes-Carolina Madtom	Endangered	Chimney Swift	Mar 15 to Aug 25
Clams-Atlantic Pigtoe	Threatened	Kentucky Warbler	Apr 20 to Aug 20
Clams-Dwarf Wedgemussel	Endangered	Prairie Warbler	May 1 to Jul 31
Insects-Monarch Butterfly	Candidate	Prothonotary Warbler	Apr 1 to Jul 31
Flowering Plants-Michaux's Sumac	Endangered	Red-headed Woodpecker	May 10 to Sep 10
		Rusty Blackbird	Breeds elsewhere
		Wood Thrush	May 10 to Aug 31

Permit Matrix

	Permit	Responsible Agency	Applicable System
1	Non-Residential Building Permit	City of Raleigh	All
2	Electrical Permit	City of Raleigh	All
3	Fire Code Compliance Permit	NC Dept. Office of State Fire Marshall	All
4	Zoning Permit	City of Raleigh	GPV
5	Special Use Permit (Contingent)	City of Raleigh	GPV, FPV
6	Commercial Construction permits (stormwater impacts, land grading activities, soil disturbance, Erosion and Sedimentation Control)	NC Dept. of Environmental Quality, City of Raleigh	GPV
7	Floodplain Development Permit	City of Raleigh	FPV
8	Wetland Impacts Permit	NC Division of Water Resources	GPV, FPV

*RPV – Rooftop Photovoltaic Solar, GPV – Ground-mount Photovoltaic Solar, FPV – Floating Photovoltaic Solar, All – RPV, GPV, FPV

Codes & Authority

National Electrical Codes:

The National Fire Protection Association (NFPA) developed NEC codes (National Electrical Code) to ensure safe electrical installations in buildings and structures. These codes specify the minimum requirements for electrical installations in terms of electrical system and equipment design, installation, and operation. Compliance with NEC codes is required to obtain jurisdictional permits for our solar system's construction.

Following are the NEC codes that our solar proposal will ensure to follow.

Our PV systems must comply with **NEC article 690 - Solar Photovoltaic (PV) Systems**, which enforces codes to follow for solar PV systems such as array circuits, inverters, and controllers. The following are some of the key sections addressed in this article.

1. **Electrical System Grounding:** To protect against electric shock and electrocution, all electrical systems must be grounded.
2. **Disconnecting Means:** A disconnecting means that is easily accessible, visible, and capable of locking in the open position is required for each PV system.
3. **Wiring Methods:** PV system wiring methods must adhere to NEC Article 690 and include the use of PV wires.
4. **Rapid Shutdown:** In the event of an emergency, PV systems must have rapid shutdown functionality that allows the system to be de-energized as quickly as possible.
5. **Voltage and Current Limits:** The voltage and current limits of a PV system must comply with NEC Article 690.

Our battery storage system must comply with **NEC Article 706 - Energy Storage Systems**, which applies to all energy storage systems with a capacity greater than 1 kWh, whether stand-alone or in conjunction with other electric power production sources. We must comply with this code because our proposal includes a battery storage system to serve critical loads.

NEC Article 708 - Critical Operations Powers Systems (COPS) applies to the installation, operation, monitoring, control, and maintenance of the portions of the premises wiring system intended to supply, distribute, and control electricity to designated critical operations areas if elements of normal system are disrupted.

NEC Article 710 - Stand-Alone Systems, which applies to electric power production systems that operate in island mode and are not connected to a utility or other electric power production and distribution network. In our case, this system will require compliance with 6 rooftops that are directly connected to the building's AC panel and are not connected to any other distribution network.

NEC Article 682 – Natural and Artificially Made Bodies of Water which applies to any installation of electrical wiring and equipment in or near natural or artificially made bodies of water. This code requires that our floating solar plan be compliant with this.

National Fire Protection Codes:

As part of the development plan for solar installations at NCSU Centennial's campus, compliance with fire codes and regulations is crucial for ensuring the safety of people and property. The following codes and guidelines are applicable to the development of solar projects on building rooftops, floating solar, and ground-mount solar:

NFPA 1 Fire Codes: NCSU requires compliance with the NFPA 1 Fire Code for solar panel installations. This code provides comprehensive guidelines for installing solar panels and requires, among other things, that photovoltaic power sources, electric shock danger terminals, and the type of PV system rapid shutdown have permanent labels to inform emergency responders of potential electrical hazards. Additionally, the NFPA 1 Fire Code mandates

clearances around rooftop and ground-mounted solar panels to prevent the spread of fire and provide access for firefighting vehicles and personnel.

NFPA 1 code 11.12.2. This code guarantees that emergency responders are made aware of any possible electrical dangers in an emergency.

NFPA 1 code 11.12.3. According to the width of the building, this code requires clearances around rooftop solar panels of 4 or 6 feet to stop the spread of fire and provide access for firefighting vehicles.

NFPA 1 code 11.12.4 mandates a clearance of 10 feet around any ground-mounted solar panels to give firefighters enough room to reach and move around them in an emergency.

Office of State Fire Marshal's Standards: NCSU also requires compliance with the Office of State Fire Marshal's standards for solar panel installations. These standards include,

Code 503.1, which mandates the provision of fire access roadways within 150 feet of all parts of the building.

Code 503.2 requires the pathways have a minimum width of 20 ft and vertical clearance of at least 13 ft 6 inches.

Code 507.1 mandates the installation of water supply systems.

Code 507.5 requires the installation of fire hydrants.

Code 503.4 also mandates that fire access routes should not be blocked. Additionally, emergency personnel must have radio coverage according to Section 510.

Adherence to the NFPA 1 Fire Code and the guidelines established by the Office of State Fire Marshal is essential for protecting people and property and ensuring compliance with state requirements for solar panel installations.

International Energy Conservation Codes:

The International Energy Conservation Code (IECC) developed by the International Code Council (ICC) is a set of building codes that establish minimum energy efficiency standards in new construction for building elements.

Chapter C501 of the IECC provides guidelines for alterations, repairs, additions, and changes of occupancy of existing buildings and structures. According to Section C501.1, alterations, repairs, additions, and changes of occupancy must comply with Section C502, C503, or C504.

Section C501.2 specifies that the IECC cannot be used to require the removal, alteration, or abandonment of, nor prevent the continued use and maintenance of, an existing building or building system that was legally in existence at the time of the code's adoption.

Section C501.4 outlines those alterations, repairs, additions must comply with the provisions for alterations, repairs, additions, or relocation in various codes, including the International Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, North Carolina Existing Building Code, and NFPA 70.

Section C501.5 stipulates that materials permitted by the applicable code for new construction should be used for new and replacement materials, except when otherwise required or allowed by the IECC. Repairs using similar materials are permitted, provided they do not create hazards to life, health, or property.

Chapter C502 provides guidelines for additions to existing buildings. An addition must conform to the provisions of the IECC as they relate to new construction, without requiring the unaltered portion of the existing building or

building system to comply with the IECC. An addition shall not create unsafe or hazardous conditions or overload existing building systems.

Chapter C503 provides guidelines for alterations to existing buildings. Alterations must conform to the provisions of the IECC as they relate to new construction, without requiring the unaltered portions of the existing building or building system to comply with the IECC. Alterations shall not create an unsafe or hazardous condition or overload existing building systems. New building envelope assemblies that are part of the alteration must comply with specific sections of the IECC.

Chapter C504 provides guidelines for repairs to existing buildings. The repair of building systems must not make the building less conforming than it was before the repair was undertaken.

Chapter C505 provides guidelines for changes of occupancy or use. New work performed in spaces undergoing a change in occupancy must comply with the IECC's requirements. Unaltered portions of the existing building or building supply system are not required to comply with the IECC.

Construction and Staging Approach

In addition to financial savings, the objective of this project is to increase energy resiliency and promote a more sustainable, environmentally friendly campus by reducing dependency on fossil fuel-based generation. In that spirit, the development methodologies and staging approach of physical needs for equipment, vehicles, and temporary storage will also aim to follow the most sustainable and ecologically friendly practices possible. A list and approach for each Phase is as follows:

Material Flow: The project team will work with subcontractors and suppliers to create an accurate estimate of array assembly times. This completion rate will be utilized to coordinate a materials delivery schedule with the appropriate suppliers that limits the amount of inventory onsite to less than one weeks' worth of work. This will increase the number of required deliveries, but it will decrease the impacts and disruption to NCSU's campus operations. Material will be shipped to the site in a 40' shipping containers that can be staged near the respective construction site.

Temporary Storage and Offices: Temporary storage will be required for equipment and supplies throughout the various construction phases. This will include the previously mentioned shipping containers and, potentially, an offsite, proximate warehouse. Ideally, NCSU can furnish a temporary office for project team personnel, but the project team will deploy a portable field office/trailer if this is not an option.

Workforce: The project needs to be sustainable from both an environmental and a community standpoint. The project team plans to employ local union labor that will be compensated at the prevailing wages. Per the IRA, this will also qualify the project for the boosted ITC. Additionally, nearly all of the products that have been selected for the design fall under the SolarEdge product suite. The installers and NCSU facilities team will undergo training that will demonstrate best practices for installation and O&M, respectively. This will streamline the installation process, reduce construction errors, and qualify the site for the 2-year AdvantagEdge product warranty program. This program covers all panels, inverters, etc., and it reimburses the owner for any generation underperformance.

Safety: Proper signage and fencing will be erected around each worksite to ensure compliance and safety.

Phase 1a: Rooftop Solar and Resiliency Batteries

The hybrid ballasted system equipment will be hoisted onto the rooftops via crane where all connections and racking will be finished in line with standard practices. If road access is not sufficient for the cranes, a protective barrier or laydown may be required to mitigate damage to the campus's grass and grounds. It has been assumed that there is adequate physical mounting and connection space in each buildings' electrical room. The project team will coordinate with NCSU's IT to establish controls connections for each system.

Equipment: solar panels, batteries, mounting hardware, electrical cables, tools, safety equipment

Vehicles: trucks for delivering and transporting equipment, crane for rooftop access

Phase 1b: Ground Mount Solar

The 20 acres previously outlined will need to be logged and cleared. The site will require minimal grading as the system layout was designed along areas of minimal grade, and it is intended to follow the natural south facing slope. This will increase the system output and reduce the ecological impacts of fully grading and disturbing the topsoil. While this will require more diligent vegetation management during operation, maintaining the healthy microbiomes and grasses will improve soil retention and provide structural support for the pilings. Furthermore, the stormwater and wetlands impact reviews may find that the project requires the implementation of water diversion infrastructure or detention ponds. Retaining as much of the natural flora and fauna underneath the panels as possible will help reduce the impacts of runoff as well.

Equipment: solar panels, mounting hardware, electrical cables, inverters, transformers, tools, safety equipment

Vehicles: trucks for delivering and transporting equipment, bulldozers and graders for site preparation

Phase 1c: Floating Solar

Arrays will be preassembled on the eastern bank of Lake Raleigh and floated into a place where final anchoring and float connections will be made via watercraft.

Equipment: floating solar panels, mounting hardware, electrical cables, inverters, transformers, floats, tools, safety equipment

Vehicles: trucks for delivering and transporting equipment, boats, or other watercraft for installation work

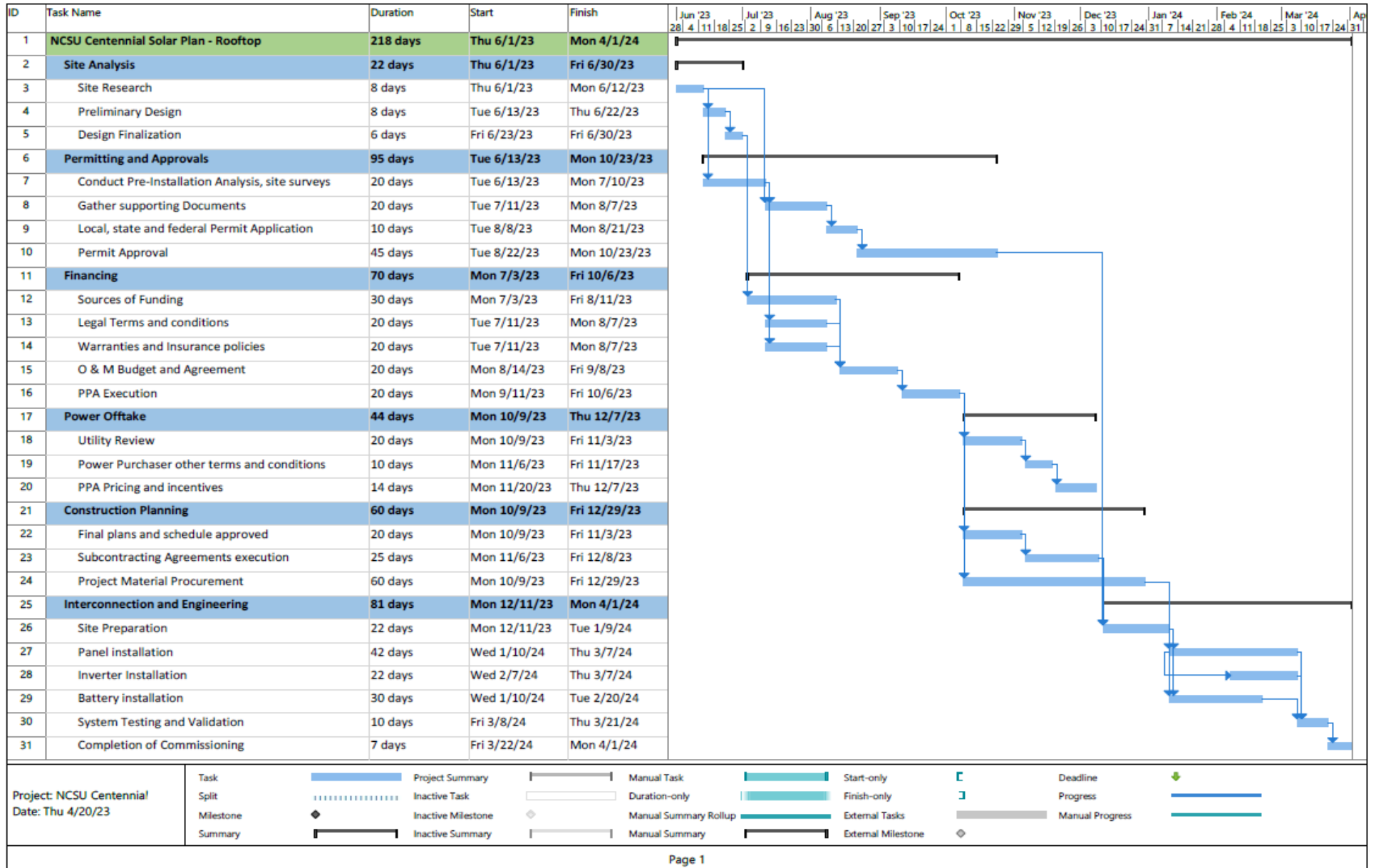
Planned Outages: The project team will work with NCSU's facilities team to coordinate no more than two planned outages for the interconnection points in question. One outage for Phase 1a and one for Phase 1b and 1c together. This outage will ideally take place overnight or on the weekend to reduce impacts on normal campus operations.

Insurance and Damages: The developer will maintain a \$5 million umbrella coverage throughout the duration of the project. While payment may be settled with the responsible contractor, the developer is liable for any and all property damage or human injury that occurs during the project. The developer will leave the site at completion in an equal or better state than prior to the start of construction.

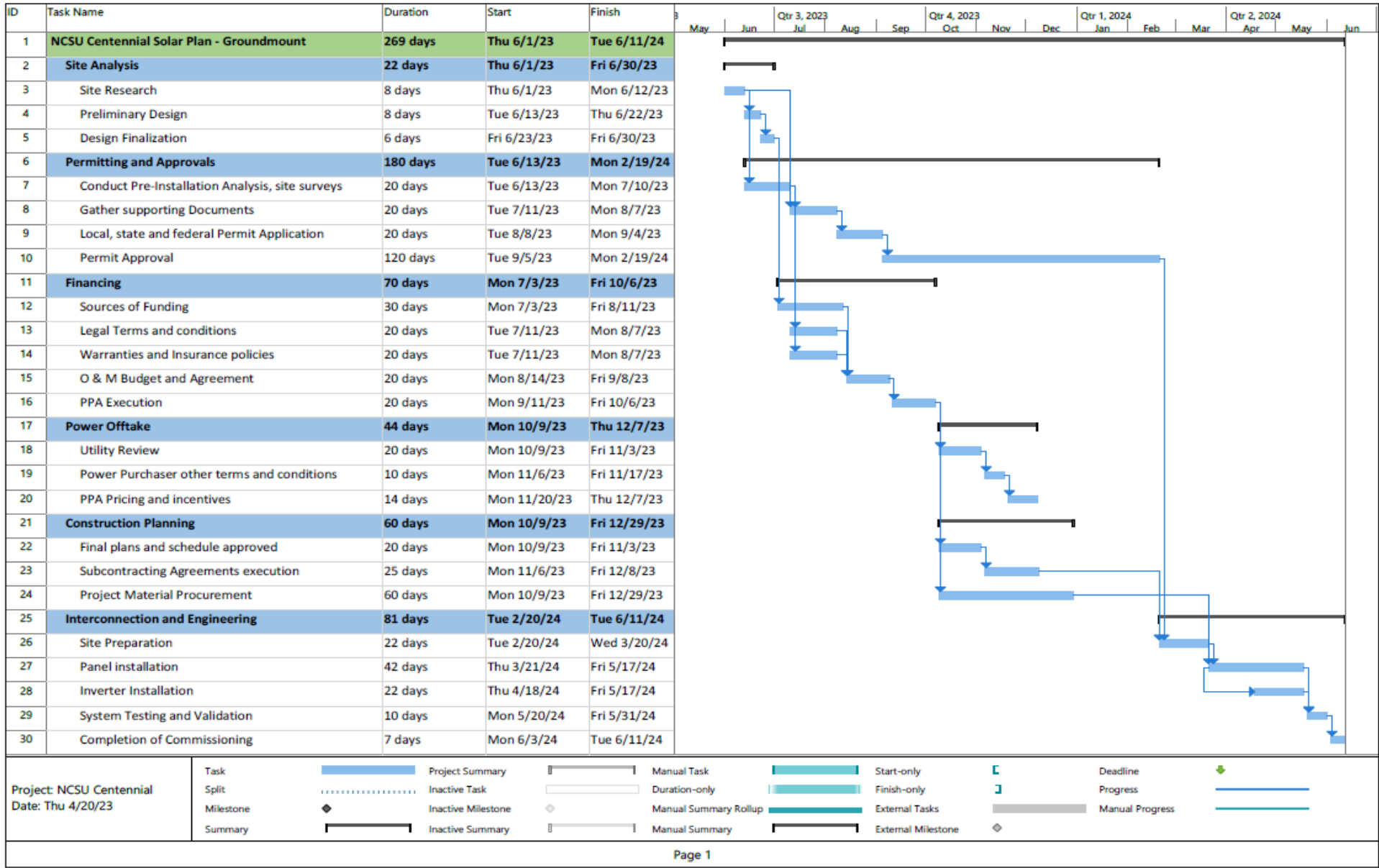
Recycling and Waste: The project team will maintain a designated area with commercial dumpsters for recycling and waste disposal. The site will be tidied at the end of each workday. The team will schedule pickups as needed.

Additional Considerations: The project team will coordinate with local authorities to obtain permits for road closures or other temporary modifications to support equipment delivery and installation.

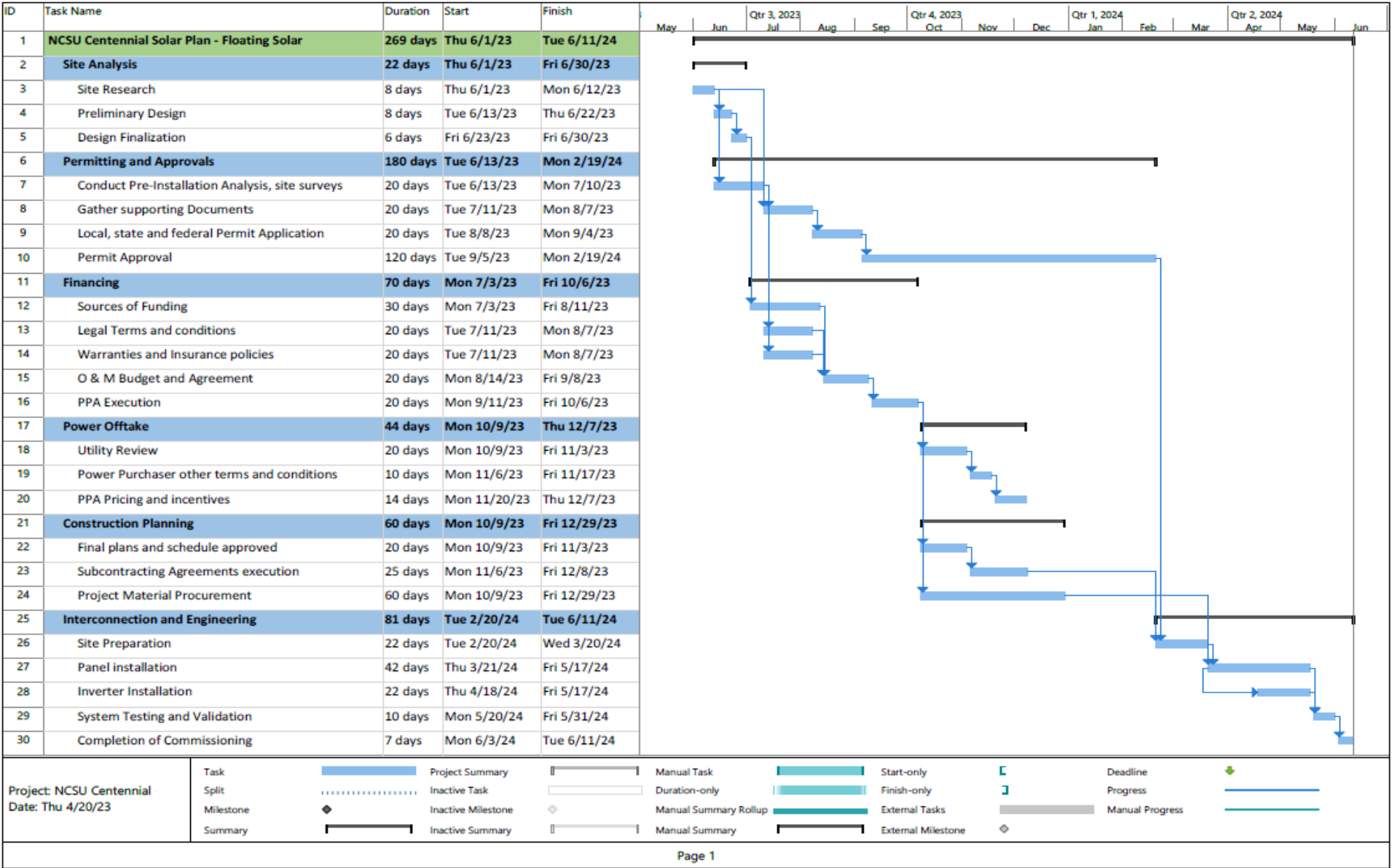
Permitting & Construction Timeline – Phase 1a: Rooftop Solar and Battery Energy Storage Systems



Permitting & Construction Timeline – Phase 1b: Ground Mount Solar



Permitting & Construction Timeline – Phase 1c: Floating Solar



Distributional Energy Equity

Community Engagement

At North Carolina State University, community involvement for ground-mounted, rooftop, and floating solar panels can take many forms. For example, we can arrange workshops, seminars, and promotional campaigns to educate the community about the advantages of solar power, how they function, and how it can contribute towards the overall sustainability of the community. In addition, the project can provide hands-on training and research opportunities for students, faculty, and staff, promoting innovation and entrepreneurship.

The following communities could be impacted by the solar PV projects at NCSU Centennial campus:

- **Campus community:** The NCSU campus community includes students, faculty, staff, and visitors who will benefit from the solar PV project.
- **Local community:** The local community surrounding the campus will also benefit from the solar PV project. The project can create job opportunities and support local businesses, particularly if local suppliers, contractors, and labor are involved in the project.
- **Environmental justice communities:** Environmental justice communities, particularly communities of color and low-income communities, have historically borne the brunt of environmental pollution. Including these communities in the solar PV project can help address these historical injustices and ensure that the benefits of the project are distributed equitably.

Energy Distributional Justice Impact

Energy distributional impact at NCSU Centennial campus can have the following benefits:

- **Resilience:** A solar PV project on the NCSU Centennial Campus will improve the resilience of the campus by providing a reliable source of renewable energy that can operate independently of the grid. This is particularly important during emergencies, such as severe weather events or power outages, when the campus can continue to operate critical facilities and services.
- **Utility bill savings:** The solar PV system can help reduce the energy bills of the university, freeing up resources for other campus priorities. As a public institution, NCSU has a responsibility to ensure that the benefits of the solar PV project are distributed equitably across the campus community, including low-income students, faculty, and staff.
- **Enterprise development:** Solar PV project on NCSU Centennial Campus will also create opportunities for enterprise development and job creation. The project will involve local suppliers, contractors, and labor supporting the local economy.
- **Environmental justice:** The solar PV project on the NCSU Centennial Campus will also promote environmental justice by reducing the carbon footprint of the campus and mitigating the effects of climate change. The project can also help address the disproportionate impacts of pollution and environmental degradation on marginalized communities, particularly communities of color and low-income communities.

Overall, a solar PV project at the NCSU Centennial Campus can have significant energy distributional justice impact. It is important to ensure that the project's benefits are distributed equitably across campus and that it aligns with the university's sustainability goals and commitments.

Aesthetic appearance after implementation

- **Rooftop Solar:** Rooftop solar panels will be a discreet and attractive solar PV installation, blending in with the existing architecture of the buildings. The panels will be mounted flush with the rooftop, creating a seamless appearance. This can help maintain the visual appeal of the campus while still generating renewable energy.
- **Ground-mount Solar PVs:** Ground-mounted solar panels will provide a unique aesthetic appeal, when incorporated as an artistic integration with trees along the adjacent roadway, while still prioritizing energy generation potential in the project's design and implementation. It is crucial to ensure that the installation does not negatively impact passersby or local wildlife while also maximizing the panels' energy generation.
- **Floating Solar:** Floating solar panels will be an innovative and visually striking option for solar PV installation over Lake Raleigh. Floating solar panels can provide unique aesthetic value and can be a wonderful way to generate renewable energy while also promoting sustainable water use and management.

Risk Identification and Mitigation

Condition	Explanation	Mitigation	Severity	Probability	Risk
Planned Development Rezoning-GPV	To develop Phase 1b, the existing PD must be amended to reflect the new plans. This may add significant time and run the risk of outright denial of the permitting process.	Engage the AHJ early in the planning process to create buy-in. Highlight the sustainable development approach and positive impacts the system will have for NCSU's community.	High	Med	High
Financial Risk	Unexpected project delays or inability to source cost-effective materials may result in significant cost overruns.	Develop a robust financial plan with contingency, insurance coverage, and conservative development timelines.	Med	Med	Med
Historic Land Use	Phase 1b is on the fringe of a DOE zone for the Theophilus Hunter House. This may result in design or remediation requests from the NC SHPO.	The project team will perform any remediation, mitigation, or preservation operations pursuant to NC SHPO's review.	Med	Med	Med
Land Grading	Phase 1b may require extensive grading work to prepare the site for solar panel installation.	Design the system in areas of minimal grade. Use cutting-edge solar trackers that allow installation along natural contours.	Med	Med	Med
Migratory Birds	Phase 1b or 1c may contain critical habitats for the endangered species listed previously.	Conduct a site survey, and work with US FWS to develop an appropriate permitting and mitigation plan.	Med	Low	Low
BESS-Fire Marshall Approval	Failure to obtain approval from the Fire Marshall for the Battery Energy Storage System (BESS) can result in delays, changes or cancellation of Phase 1a for safety concerns.	Work with the State Fire Marshall early in the siting process. Utilize UL listed BESS technology and implement appropriate fire suppression and monitoring measures.	Med	Low	Low

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