*USNRC Project No. 99902094*

**ENVIRONMENTAL REPORT**

**Revision 0**

**submitted by**

**THE UNIVERSITY OF ILLINOIS**

**Illinois Microreactor RD&D Center**

**in collaboration with**

NANO Nuclear Energy Inc.

**to**

**U.S. NUCLEAR REGULATORY COMMISSION**

**Office of Nuclear Reactor Regulation**

**Division of Advanced Reactors and Non-Power Production and Utilization Facilities**

**March 31, 2026**

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## LIST OF ACRONYMS AND ABBREVIATIONS

| Term | Description |
|---|---|
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| AADT | annual average daily traffic |
| APE | Area of Potential Effects |
| ASCE | American Society of Civil Engineers |
| ASME | American Society of Mechanical Engineers |
| BCC | birds of conservation concern |
| BGEPA | Bald and Golden Eagle Protection Act |
| bgs | below ground surface |
| BMP | best management practice |
| bpf | blows per foot |
| C&D | construction and demolition |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| cm | centimeters |
| $CO_2e$ | carbon dioxide equivalent |
| CP | Construction Permit |
| CPS | Clinton Power Station |
| dB | decibels |
| dBA | A-weighted decibels |
| DOE | U.S. Department of Energy |
| DOT | U.S. Department of Transportation |
| EPA | U.S. Environmental Protection Agency |
| EPRI | Electric Power Research Institute |
| ER | Environmental Report |
| $ft^3$ | cubic feet |
| FY | fiscal year |
| GHG | greenhouse gas |
| gpd | gallons per day |
| GSL | Geological Survey Laboratory |
| HALEU | High-Assay Low-Enriched Uranium |
| HARGIS | Illinois Historic Preservation Online Services |
| HEPA | high-efficiency particulate air |
| HPS | Helium Purification System |
| hr | hour |
| HTGR | High Temperature Gas-cooled Reactor |

## LIST OF ACRONYMS AND ABBREVIATIONS

| Term | Description |
|---|---|
| HTS | Heat Transport System |
| HVAC | heating, ventilation, and air conditioning |
| IAW | Illinois American Water |
| iCAP | Illinois Climate Action Plan |
| IDA | Illinois Department of Agriculture |
| IDNR | Illinois Department of Natural Resources |
| IEPA | Illinois Environmental Protection Agency |
| IHPA | Illinois Historic Preservation Agency |
| IHX | Intermediate Heat Exchanger |
| IPaC | Information for Planning and Consultation |
| ISG | Interim Staff Guidance |
| ISHPO | Illinois State Historic Preservation Office |
| km | kilometers |
| $KNO_3$ | potassium nitrate |
| lb | pounds |
| LCF | Latent Cancer Fatality |
| $L_{dn}$ | day-night sound level |
| $L_{eq}$ | equivalent sound level |
| LEU+ | Low Enriched Uranium Plus |
| LLRW | low-level radioactive waste |
| LOS | level of service |
| LTP | license termination plan |
| LWR | light water reactors |
| $m^2$ | square meters |
| $m^3$ | cubic meters |
| MBTA | Migratory Bird Treaty Act |
| MEI | maximally exposed individual |
| MF3 | Multifamily 3 - High Density Multifamily Residential/Limited Business |
| MHA | maximum hypothetical accident |
| MMR | Micro Modular Reactor |
| mph | miles per hour |
| mrem | millirem |
| mSv | millisieverts |
| MW | megawatts |
| MWe | megawatt electrical |
| MWth | megawatt thermal |
| $NaNO_3$ | sodium nitrate |

# LIST OF ACRONYMS AND ABBREVIATIONS

| Term | Description |
|---|---|
| NCDC | National Climatic Data Center |
| NEPA | National Environmental Policy Act |
| NOAA | National Oceanic and Atmospheric Administration |
| NOx | nitrogen oxides |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | Nuclear Physics Laboratory |
| NRC | U.S. Nuclear Regulatory Commission |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| PNNL | Pacific Northwest National Laboratory |
| PPE | personal protective equipment |
| PSAR | Preliminary Safety Analysis Report |
| psf | pound per square foot |
| RCCS | Reactor Cavity Cooling System |
| RCRA | Resource Conservation and Recovery Act |
| RG | Regulatory Guide |
| ROI | region of influence |
| SPCC | Spill Prevention, Control and Countermeasure |
| SPT | Standard Penetration Tests |
| SWPPP | Stormwater Pollution Prevention Plan |
| TRISO | TRi-structural ISOtropic |
| U. of I. | University of Illinois Urbana-Champaign |
| U.S. | United States |
| U.S.C. | United States Code |
| U-235 | uranium-235 |
| UCSD | Urbana-Champaign Sanitary District |
| USDA | U.S. Department of Agriculture |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| yr | year |

# CHAPTER 1 INTRODUCTION

## 1.1 INTRODUCTION OF THE ENVIRONMENTAL REPORT

In accordance with Title 10 of the Code of Federal Regulations (CFR) Part 50, which pertains to the "Domestic Licensing of Production and Utilization Facilities," and the supporting guidance, the University of Illinois Urbana-Champaign (U. of I.) has prepared this Environmental Report (ER) to support an application for the Construction Permit (CP) to construct of a Nano Nuclear Energy Inc. KRONOS™ Micro Modular Reactor (MMR). The proposed non-power research reactor facility will be situated to the east of the existing Abbott Power Plant on the U. of I. campus, located within the twin cities of Urbana and Champaign, Illinois. The U. of I. research reactor facility will be a utilization facility as described in 10 CFR 50.21(c) that is useful in the conduct of research and development activities of the types specified in Section 31 of the Atomic Energy Act of 1954, as amended, and the activities meet the 10 CFR 50.2 definition of research and development. The U. of I. reactor will not be a commercial or industrial facility as specified in 10 CFR 50.21(b) or in 10 CFR 50.22.

This ER accompanies the CP application as mandated by 10 CFR 50.30(f). Its primary objective is to furnish the United States (U.S.) Nuclear Regulatory Commission (NRC) with the essential information required to develop an Environmental Assessment or an Environmental Impact Statement, as applicable, in compliance with the provisions of 10 CFR 51 Subpart A, which implements Section 102(2) of the National Environmental Policy Act (NEPA). This chapter of the ER introduces the assessment of environmental effects related to the construction, operation, and decommissioning of the proposed facility, as well as its effects on the surrounding environment.

The structure of this ER adheres to the guidance specified in the Final Interim Staff Guidance (ISG) augmenting NUREG-1537, Part 1, Section 12.12, concerning ERs, and the Revised Draft ISG from July 2012 for Section 12.12. This ISG encapsulates the NRC's most current recommendations for the preparation of ERs for non-power reactors. Additionally, this ER considers the guidance provided by the NRC in COM-ISG-029, *Environmental Considerations Associated with Micro-reactors*. The purpose of this USG is "to modify existing guidance and provide supplemental guidance to assist the NRC staff in determining the scope and scale of environmental reviews of micro-reactor applications."

This ER offers a detailed description of the project, assesses potential alternatives, and delineates the methods and sources employed in the environmental analysis. It also characterizes the existing environment at the site and its surroundings while summarizing the anticipated effects of the project throughout its construction, operation, and eventual decommissioning.

The purpose and need for the proposed federal action are provided in Section 1.3, while a more in-depth description of the project itself is provided in Chapter 2 of this report.

## 1.2 SITE HISTORY

U. of I., a distinguished public land-grant research university established in 1867, is located in the twin cities of Urbana and Champaign, Illinois. Recognized as a not-for-profit educational institution under 10 CFR 170.3 and 10 CFR 170.5, U. of I. boasts a proud legacy of academic excellence. The Nuclear, Plasma and Radiological Engineering department, one of twelve departments within U. of I.'s Grainger College of Engineering, originated as an interdisciplinary program in 1958 and has consistently been at the forefront of nuclear research. Notably, U. of I. operated a TRIGA® Mark II reactor on its campus from 1960 until 1998. The TRIGA® reactor was successfully decommissioned, and the reactor site was released for unrestricted use in 2013. The proposed reactor project has received robust support from both U. of I. leadership and the congressional delegation of Illinois.

The proposed research reactor facility will be constructed on the western edge of the U. of I. campus. As illustrated in Figure 1-1, the proposed Licensed Area encompassing the reactor facility is situated east of the Abbott Power Plant and immediately north of the Geological Survey Laboratory (GSL) building. The Site Boundary, which in accordance with 10 CFR Part 20.1003, encompasses land that is owned, leased, or otherwise controlled by the licensee (U. of I.), extends beyond the Licensed Area and includes the GSL, the Abbott Power Plant, and the U. of I. Personnel Services building. The Abbott Power Plant is a hybrid facility utilizing both natural gas and coal, serving the university-owned and operated electrical and steam distribution systems. It is important to note that the GSL is excluded from the proposed Licensed Area, as there are no plans to use this structure as part of the reactor facility.

The surrounding vicinity is characterized by mixed land use that encompasses residential and industrial zones, as well as various U. of I. facilities, including office buildings and educational laboratories, alongside nearby recreational fields. Historical aerial imagery dating back to 1940 confirms that the site, apart from an existing parking lot, has not experienced significant development. Adjacent features, such as cooling towers on the northern adjoining property, have remained largely unchanged since 1969 (Reference 7-1). The Abbott Power Plant is visible in photographs dating back to 1940. Additionally, the GSL building, is documented in the 1948 aerial photograph, while the U. of I. Personnel Services building appears in 1969 imagery (Reference 7-1). Residential areas to the north and east are also evident in the 1940 aerial views (Reference 7-1).

## 1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The proposed federal action entails the issuance of a nuclear reactor CP in accordance with the provisions of 10 CFR 50, which would authorize the construction of a research reactor on the U. of I. campus. U. of I. has been entrusted by the State of Illinois with the mission to "enhance the lives of citizens in Illinois, across the nation, and around the world through leadership in learning, discovery, engagement, and educational development." In alignment with these objectives and U. of I.'s clean energy initiatives, U. of I. has formed a partnership with Nano Nuclear Energy to deploy the KRONOS MMR, an advanced microreactor design that builds upon established high-temperature gas-cooled reactor technology. It is anticipated that the proposed research reactor will be licensed and operated as a Class 104 (c) "production or utilization facility" for non-power purposes, specifically categorized under 10 CFR 50.21(c), which pertains to research and test reactors. This type of licensing distinguishes the facility from commercial power reactors, indicating that it is primarily intended for research or testing rather than electricity generation.

The research reactor facility will function as a research, education, and training facility aimed at advancing reactor technology to become a widely deployable, marketable, economical, safe, and reliable solution for a clean energy future. Furthermore, U. of I. plans to use the research reactor in combination with the existing Abbott Power Plant to demonstrate zero-carbon district heating and power for campus buildings as part of the facility's research and training activities. In addition to supporting U. of I.'s clean energy objectives, the proposed facility will serve as a vital workforce training resource for a new generation of engineers, nuclear scientists, and operators.

## 1.4 APPLICABLE REGULATORY REQUIREMENTS, PERMITS, AND REQUIRED CONSULTATIONS

The construction and operation of the proposed reactor necessitate the acquisition of various permits and consultations from federal, state, local, and other relevant authorities. Table 1-1 provides a summary of the permits and approvals required for both construction and operation, along with their current statuses. Similarly, Table 1-2 outlines the necessary consultations for these activities and details their respective statuses.

The research reactor site is described in Chapter 3 of this ER. A comprehensive review of the site, which included an analysis of historical aerial imagery and a physical walkdown of the proposed project sites, revealed no evidence of jurisdictional wetlands or other "waters of the United States" within the boundaries of the proposed project site (Reference 7-1). Consequently, no permitting or consultation with the U.S. Army Corps of Engineers is anticipated.

The research reactor is designed to adhere to all applicable environmental quality standards and regulatory requirements. Furthermore, no potential administrative delays or other issues have been identified that would impede the necessary agency consultations or approvals.

**Table 1-1 Permits and Approvals Required for Construction and Operation**

| Agency | Regulatory Authority | Permit or Approval | Activity Covered | Status |
|---|---|---|---|---|
| U.S. Nuclear Regulatory Commission | Atomic Energy Act<br>10 CFR 50.50 | Construction Permit | Construction of the facility. | Addressed in the construction permit application. |
| | 10 CFR 50.57 | Operating License | Operation of the facility. | To be addressed in the operating license application. |
| | 10 CFR 40 | Source Material License | Possession, use, and transfer of radioactive source material. | To be addressed in the operating license application. |
| | 10 CFR 30 | By-Product Material License | Production, possession, and transfer of radioactive by-product material. | To be addressed in the operating license application. |
| | 10 CFR 70 | Special Nuclear Material License | Receipt, possession, use, and transfer of special nuclear material. | To be addressed in the operating license application. |
| | National Environmental Policy Act (NEPA)<br>10 CFR 51 | Environmental Assessment or Environmental Impact Statement in accordance with NEPA | Site approval for construction and operation of a radiation facility. | Addressed in this ER. |
| Federal Aviation Administration | Federal Aviation Act<br>14 CFR 77 | Construction Notice | Construction of structures that potentially may impact air navigation (greater than 200 feet).<br><br>Construction of structures above a 1 to 100 slope from the nearest runway. | The maximum reactor facility building height will be below the 200-foot threshold; therefore, not required.<br><br>Notification should not be required. |

**Table 1-1 Permits and Approvals Required for Construction and Operation (Continued)**

| Agency | Regulatory Authority | Permit or Approval | Activity Covered | Status |
|---|---|---|---|---|
| U.S. Environmental Protection Agency | Resource Conservation and Recovery Act 40 CFR 261 and 262 | Acknowledgement of Notification of Hazardous Waste Activity | Generation of hazardous waste. | Notification to be made at time of construction. |
| | Clean Water Act 40 CFR 112, Appendix F | Spill Prevention, Control and Countermeasure (SPCC) Plans for Construction and Operation | Storage of oil during construction and operation. | SPCC Plans are to be prepared prior to construction. |
| U.S. Department of Transportation | Hazardous Material Transportation Act | Certificate of Registration | Transportation of hazardous materials. | Registration application not yet submitted. |
| U. of I. Facilities & Services Safety & Compliance Group will submit to Illinois EPA | Federal Clean Air Act | Air Pollution Control Construction Permit | Construction of an air pollution emission source that is not specifically exempted. | Permit application is not yet submitted. |
| | Federal Clean Air Act | Air Pollution Control Operation Permit | Operation of an air pollution emission source that is not specifically exempted. | Permit application is not yet submitted. |
| | Federal Clean Water Act | Construction Storm Water Discharge Permit | Discharge of storm water runoff from the construction site. | Notice of Intent to be covered by general permit not yet submitted. |
| | Federal Clean Water Act | Industrial Storm Water Discharge Permit | Discharge of storm water runoff from the site during facility operation. | Notice of Intent to be covered by general permit not yet submitted. |
| U. of I. Facilities & Services Code and Compliance and Fire Safety group | | Building Plan Review | Illinois has adopted state-wide building codes, however, permits and regulatory building requirements are administered at the local/municipal level. [a] | Plans are not yet submitted. |

**Table 1-1 Permits and Approvals Required for Construction and Operation (Continued)**

| Agency | Regulatory Authority | Permit or Approval | Activity Covered | Status |
|---|---|---|---|---|
| City of Champaign–Public Works (for E Armory Ave); U. of I. for S Oak Street | | | Permanent closure of section of S Oak St. and/or E Armory Ave. | Plans not yet submitted; City of Champaign has jurisdiction over E Armory Ave. U. of I. controls jurisdiction over associated section of S Oak Street. [b] |
| U. of I. Facilities & Services Code Compliance & Fire Safety Group | | Site Plan Approval | Administrative approval of the site layout and plans for parking, lighting, landscaping, etc. | Plans are not yet submitted for review. |
| | | Building Permit | Construction of buildings. | Permit application is not yet submitted. |
| | | Plumbing Plan Approval | Installation of plumbing systems. | Permit application is not yet submitted. |
| | | Heating, ventilation, and air conditioning (HVAC) Plan Approval | Installation of HVAC systems. | Permit application is not yet submitted. |
| | | Fire Sprinkler and Alarm Permit | Installation of sprinkler and alarm systems. | Permit application is not yet submitted. |
| | | Occupancy Permit | Occupancy of completed buildings. | Permit application is not yet submitted. |
| | | Conditional Use Permit | Construction of multiple buildings on the same site. | When the site property is annexed by the City, the property will automatically be zoned for industrial use. |

**Table 1-1 Permits and Approvals Required for Construction and Operation (Continued)**

| Agency | Regulatory Authority | Permit or Approval | Activity Covered | Status |
|---|---|---|---|---|
| U. of I. Facilities & Services Safety & Compliance Group | | Storm Water Plan Approval (may be included in Site Plan Approval) | Administrative approval of grading and drainage plans. | Plans are not yet submitted for review. |
| | | Erosion Control Permit (may be included in Site Plan Approval) | Administrative approval of erosion control plans. | Plans are not yet submitted for review. |
| | | Sanitary Sewer and Water Supply Facility Approvals | Administrative approval of construction, installation, and operation of connections to the municipal sewer and water supply systems. | Permit application is not yet submitted. |

(a) Source: Reference 7-2

(b) Source: Reference 7-3

Note: No jurisdictional wetlands or waters of the United States have been identified on the site; therefore, authorization under Section 404 of the Clean Water Act is not expected to be required for construction or operation.

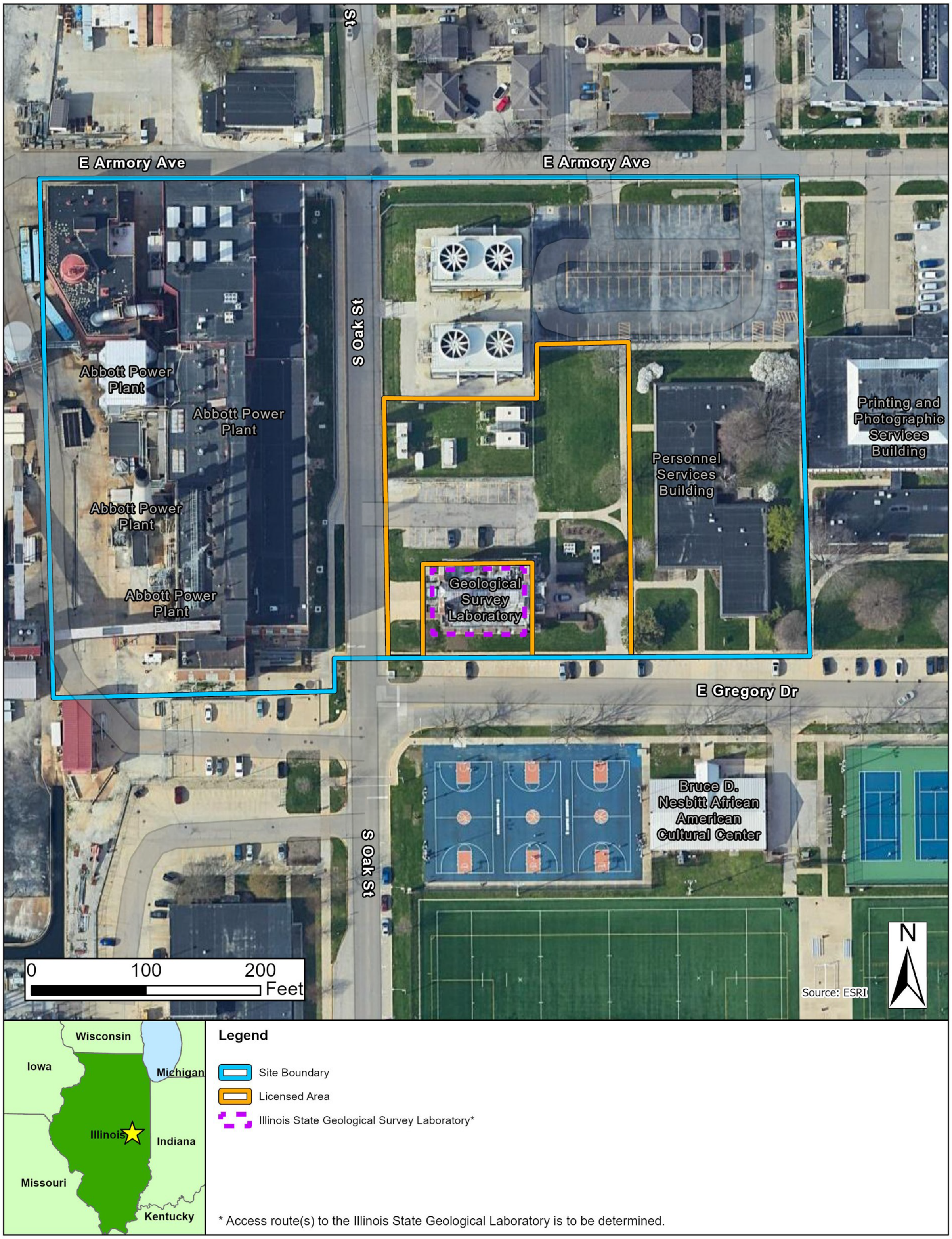
**Table 1-2 Consultations Required for Construction and Operation**

| Agency | Regulatory Authority | Required Consultation | Surveys Required | Status |
|---|---|---|---|---|
| U.S. Fish and Wildlife Service (USFWS) | Endangered Species Act, 16 United States Code (U.S.C.) 1536, Section 7 | Consultation regarding potential to adversely affect federal listed species and designated critical habitat. Initial informal consultation may continue to formal consultation if action is likely to adversely affect listed species or critical habitat. | No impacts anticipated; therefore, no surveys are expected. | Information supportive of a biological assessment of potential effects from the project on federal listed species is included in the ER. As part of informal consultation, NRC is expected to develop a biological assessment and request USFWS concurrence with effects determinations for each species of either no effect or may affect but not likely to adversely affect. |
| | Bald and Golden Eagle Protection Act, 16 U.S.C. 668-668c | If nest is present, follow National Bald Eagle Management Guidelines and contact local USFWS Field Office for additional guidance as needed to avoid disturbance. | Field survey for the presence of nests in the vicinity of the project. | Field survey to be conducted. |
| Illinois Department of Natural Resources – Division of Natural Heritage | Illinois Endangered Species Protection Act, (520 ILCS 10/1) | Assessment of potential for projects to affect rare species with a state protected status. | No impacts anticipated; therefore, no surveys are expected. | No consultation regarding the proposed action has been conducted. |
| Illinois State Historic Preservation Office | | Consultation regarding potential to adversely impact historic resources; concurrence with no adverse impact. | No impacts anticipated; therefore, no surveys are expected. | No consultation regarding the proposed action has been conducted. U. of I. Campus Historic Preservation Officer will coordinate submittal. |

**Table 1-2 Consultations Required for Construction and Operation (Continued)**

| Agency | Regulatory Authority | Required Consultation | Surveys Required | Status |
|---|---|---|---|---|
| Native American Nations | National Environmental Policy Act<br><br>National Historic Preservation Act<br><br>Native American Graves Protection and Repatriation Act | Consultation regarding protection of traditional Native American religious and cultural resources. | No impacts anticipated; therefore, no surveys are expected. | No consultation regarding the proposed action has been conducted. |

**Figure 1-1 U. of I. Research Reactor Site Boundary and Licensed Area**



# CHAPTER 2 PROPOSED ACTION

## 2.1 PROPOSED ACTION

This Environmental Report (ER) is prepared to facilitate the U.S. Nuclear Regulatory Commission's (NRC) environmental review of federal actions as mandated by the National Environmental Policy Act (NEPA). The NRC's proposed federal action in this case is the proposed issuance of a Construction Permit (CP) and a subsequent Operating License to support the development of a non-power research reactor facility on the campus of the University of Illinois Urbana-Champaign (U. of I.). This facility is intended to utilize the Nano Nuclear Energy Inc. KRONOS™ Micro Modular Reactor (MMR) technology for restoring and enhancing educational opportunities lost due to the shutdown and decommissioning of U. of I.'s TRIGA® Mark II research reactor (shutdown in 1998 and decommissioned in 2013). U. of I. is the applicant, owner, and future licensee of the facility, with Nano Nuclear Energy serving as the reactor designer and providing support on the preparation of documents for the CP Application. As owner and licensee, U. of I. will have the necessary authority and control related to the construction and operation of the facility once the CP and the future Operating License are issued. Key safety features of the research reactor facility are outlined in the Preliminary Safety Analysis Report (PSAR).

- U. of I. is seeking review and approval of the CP Application by the NRC to facilitate the construction of safety-related structures, systems, and components of the proposed facility. Construction is anticipated to commence in 2027 or as soon as the CP has been issued. The construction phase is projected to require an average of 40 onsite workers, with peak staffing levels reaching as many as 55 workers. Additionally, the construction duration is expected to involve 130 semi-truck deliveries/ pickups of heavy equipment plus approximately 2,520 dump truck visits to transport materials for earthwork and site preparation and 320 concrete truck deliveries for concrete placement. Assuming a 2-year construction schedule, construction will involve approximately 1,485 shipments each year.
- Material consumption estimates, as detailed in Table 2-1, include approximately 12,000 to 16,000 gallons (45,000 to 61,000 liters) of diesel fuel required for the initial startup of the molten salt system (i.e., salt melting and raising to operating temperatures). Additionally, assuming 4 gallons (15.14 liters) of diesel fuel is consumed per delivery during construction (20-mile [32-km] route at 5 miles per gallon [0.47 liter per kilometer]), a total of 11,880 gallons (44,970 liters) of fuel will be consumed. Approximately 4,000 gallons (15,000 liters) of additional diesel fuel will be consumed by construction equipment. Diesel fuel is assumed to be the bounding fuel type for these activities. The types of construction equipment expected to be utilized during this phase are listed in Table 2-2.
- Construction activities are estimated to effect approximately 4.5 acres (18,210 square meters [$m^2$]) of land, of which an estimated 1.01 acres (4,087 $m^2$ permanently disturbed to accommodate the Licensed Area of the facility.

Prior to startup, helium gas and nitrate salt will be delivered to the site. For initial system start-up, helium will be supplied in standard high-pressure cylinders with dimensions of 9.25-inch (0.23 meters) diameter and 55-inch (1.4 meters) height each having an internal volume of approximately 3,700 cubic inches or 2.1 cubic feet ($ft^3$) (1.63E-05 cubic meters [$m^3$]). A single standard semi-trailer transport will be necessary for startup.

The Thermal Energy Storage System, containing the molten salt secondary coolant, will consist of approximately 1.98 million pounds (900,000 kilograms [kg]) of molten nitrate salt, composed of 60 percent sodium nitrate ($NaNO_3$) and 40 percent potassium nitrate ($KNO_3$) by weight. For the initial startup, the nitrate salt is expected to be delivered in large bags with a capacity of 2,645 pounds (1,200 kg) each. Given a density of 118.61 pounds per $ft^3$ (1,900 kg per $m^3$), the startup will require 1.98 million pounds (900,000 kg) of nitrate salt, or approximately 750 bags. Assuming a shipment weight limit of 77,161 pounds (35,000 kg) per delivery, 26 shipments of nitrate salts will be necessary for startup.

During the operational phase, the facility is estimated to require an average of nine workers per weekday for staffing. Required staffing include licensed operators, health physics staff, administration, management, engineering, and instrumentation and mechanical support. Two licensed operators are also required for nonstandard work hours and weekends. As many as twelve additional researchers, instructors, and/or students may also be present on a daily basis. Logistics during operations will include an estimated monthly average of one offsite waste shipment and four truck deliveries (approximately one delivery per week).

Helium gas will be used within the facility's systems. Based on the maximum expected helium leakage rate a few helium cylinders per year may be needed. During refueling, which is approximately every 3 years when operating at full power, the helium inventory may be replaced. The nitrate salt coolant does not degrade within the system operating limits, and unless a leak occurs in the molten salt system, no routine shipments of nitrate salt will be required during operations.

There will be no waste nitrate salt, so no storage is needed for interim waste salt storage. Any hazardous materials stored on-site will include small quantities of lubricants for rotating equipment and cleaning materials and consumables used for maintenance. A bounding value of approximately 20,000 gallons (75,708 liters) of diesel fuel for the standby diesel generator would be contained in an onsite bulk storage tank.

At the conclusion of the facility's licensed operational life, the operating license will be amended for approval by the NRC to initiate decommissioning activities. All radioactive equipment and materials will be disposed of in compliance with applicable local and federal laws and regulations. Post-operational decommissioning activities are expected to be bound by estimates of not more than 170 workers on average, with peak staffing levels reaching no more than 340 workers as provided for the larger Kairos Hermes non-power reactor facility (Reference 7-4). The size of the U. of I. site does not support this number of workers; therefore, actual staffing will be well below these bounding numbers. The truck traffic associated with decommissioning will be small given the size of the facility and assumed approximately equivalent to the construction traffic of a monthly average of 65 truck deliveries plus not more than 2,520 trucks hauling demolition waste from the site for a total of not more than 3,300 trucks. Assuming 1 year (260 workdays in a year) for deconstruction and demolition and all traffic expected in a 12-month period, the daily volume will likely not exceed 13 trucks per day. Materials consumed during decommissioning are estimated to include approximately 13,200 gallons (49,967 liters) of diesel fuel, assuming 4 gallons of fuel per shipping event. Table 2-2 provides details on the types of construction equipment expected to be utilized during the decommissioning phase.

**Table 2-1 Estimated Materials Consumed During Construction Phase**

| Material | Amount |
|---|---|
| Concrete Volume | 3,600 cubic meters (4,708 cubic yards) |
| Structural Steel Mass | 5,500 metric tons (6,062 tons) |
| Diesel Fuel (Nitrate Salt initial melting) | 12,000 to 16,000 gallons |
| Diesel Fuel (Deliveries and construction vehicles) | 15,880 gallons |

**Table 2-2 Proposed Equipment Used in the Construction and Decommissioning Phases**

| Equipment | Present During Construction (Y or N) | Present During Decommissioning (Y or N) |
|---|---|---|
| Bulldozer | Y | Y |
| Road Grader | Y | N |
| Front End Loader | Y | Y |
| Backhoe Excavator | Y | Y |
| Compactor | Y | Y |
| Dump trucks | Y | Y |
| Pile Drivers | Y | N |
| Backhoe excavator | Y | Y |
| Diaphragm wall excavator | Y | N |
| Wet Mix Concrete Trucks | Y | N |
| Drill | Y | N |
| Jack Hammer | Y | Y |
| Diesel Generators | Y | Y |
| Crusher | Y | N |
| Mobile Cranes | Y | Y |
| Cherry Picker | Y | N |
| Flatbed Truck | Y | Y |
| Truck (small) | Y | Y |
| Semi-trailer Trucks | Y | Y |
| Water pumps | Y | Y |

## 2.2 SITE LOCATION AND LAYOUT

### *2.2.1 Project Site Location*

The project's Licensed Area (Figure 1-1) encompasses 1.01 acres (0.41 hectares) and is located at the parking area and neighboring area north of the existing Geological Survey Laboratory (GSL) building near the intersection of South Oak Street and West Gregory Drive on the U. of I. campus. The proposed reactor will be located at approximately 40° 6' 16" and -88° 14' 28" (Figure 2-1).

Table 2-3 lists nearby federal facilities, industrial facilities, transportation, and residential facilities. Table 2-4 lists the sensitive locations (e.g., parks, daycare facilities, hospitals), nearest residents, and landmarks (including highways, transportation facilities, rivers, and other bodies of water) within 5 miles (8 km) of the Licensed Area. The lists provided Table 2-4 are representative and may not be all inclusive as the 5-mile (8-km) region covers a large urban area where conditions frequently change. Table 2-5 provides a list of schools within 5 miles (8 km) of the Licensed Area.

The siting of the reactor is based on several key considerations:

- Selecting a location that is supported by ample existing high-quality site data for licensing and design.
- Facilitating both immediate and future testing capabilities, which strongly favors proximity to the existing Abbott Power Plant site.
- Enhancing U. of I.'s testing, research, and training initiatives, as well as production demonstration capabilities.

### *2.2.2 Site Layout*

Figure 2-2 shows the planned layout of major structures for the reactor research facility. It is assumed that 1.01 acres (0.41 hectares) will be permanently disturbed for operations of the facility. The following structures within the Licensed Area are shown in Figure 2-2:

- Reactor facility
- Molten salt storage tanks
- Steam supply building
- Utility tunnel

The reactor facility will contain the Citadel building (which will house the reactor), the main control room, and other reactor support structures and systems.

Construction support areas will serve as an uncontrolled non-nuclear areas either within or outside of the Site Boundary which will be utilized as a construction laydown and storage areas. These areas are non-natural disturbed areas such as paved parking lots. These areas can be used to stage equipment modules and large size equipment before they are needed onsite. They will act as a close-by transition area between the material delivery and construction. The project does not anticipate utilizing any other areas that will result in temporary land disturbances.

#### 2.2.3 Chemical, Diesel Fuel, and Hazardous and Radioactive Material Receipt, Holding, Storage Areas

Various types of hazardous material will be used during operation of the research reactor facility. Radioactive materials will be stored in the reactor building and the nuclear support building. Hazardous materials will be stored in the nuclear support building and steam supply building. Diesel fuel will be stored in an onsite above-ground diesel fuel tank.

#### 2.2.4 Utilities

Electrical power for the research reactor facility will be supplied by an off-site medium-voltage source from the local utility. At the facility's point of connection, this supply will be transformed to three-phase 480 VAC, 60 Hz, which serves as the facility's normal-power distribution system supporting operation of the reactor systems and associated infrastructure. The normal electrical power system does not perform any safety-related functions and is not credited for mitigating any postulated events.

Demineralized water used in the reactor facility itself is contained in closed-loop systems and is replenished manually in case of leaks. Demineralized water needed for the steam supply building will be produced on-site through the treatment of municipal water. The water treatment process will include pre-filtration, carbon filtration, softening, reverse osmosis, and a deionizing system. Potable water will be supplied through the U. of I. campus water distribution system, which is serviced by the Illinois American Water Corporation (Reference 7-5). Wastewater generated by the facility will be managed through the campus sanitary sewer system, which is tributary to the Urbana & Champaign Sanitary District (UCSD). Facility water and sewer pipelines will connect to existing utility pipelines via current utility rights-of-way.

U. of I. operates both a sanitary sewer system and a separate stormwater sewer system. As part of U. of I.'s development requirements, stormwater discharge from new projects must be limited to predevelopment levels (Reference 7-5). The facility's stormwater systems will be designed to comply with permit requirements under the National Pollutant Discharge Elimination System (NPDES). Additionally, a Stormwater Pollution Prevention Plan will be prepared and implemented during the construction phase of the project.

The university's sanitary sewer system serves most campus buildings; however, due to the proximity of Champaign and Urbana, new buildings may also connect to municipal sanitary sewer systems. These systems are tributary to the UCSD, which operates wastewater treatment plants for the region. Connection permits are required for new buildings or additions to existing buildings (Reference 7-5).

#### 2.2.5 Monitoring Stations

The need for and general description of monitoring stations for various media are described below:

- Air Monitoring and Meteorological Monitoring
  - See ER Section 3.2.4.1 for a discussion on air quality and meteorological monitoring.

- Groundwater Monitoring
  - Groundwater sampling stations (monitoring wells) will be located downgradient of the Reactor building to monitor groundwater radiological contamination. Groundwater flow typically follows surface topography, which generally slopes downward to the northeast toward Boneyard Creek (Reference 7-5).
- Surface Water Monitoring
  - There are no surface water bodies near the project site. However, if necessary, stormwater runoff sampling stations would be installed to collect surface water samples as required by the facility NPDES permit.
- Ecological Monitoring
  - See ER Section 4.5 for a discussion of ecological monitoring.
- Radiological Monitoring
  - Radiation monitoring will primarily be accomplished using continuous air monitors and passive dosimeters such as thermoluminescent dosimeters. Radiation monitoring stations will be located:
    - At an offsite location with a sufficient distance to provide a control station which monitors background dose;
    - At areas expected to have regular occupancy, such as the nuclear support building; and
    - At points along the Licensed Area boundary; considerations in selecting these monitoring locations include the direction to the nearest permanent resident or livestock, the shortest distance between the reactor facility and the Licensed Area boundary, and data collected on local prevailing winds (See ER Section 3.2.4.1).

**Table 2-3 Nearby Facilities and Projects**

| Facility/Project Name | Summary of Facility/ Project | Location (from Reactor Building) | Status | Potentially Affected Resource(s) | Notes |
|---|---|---|---|---|---|
| **Federal Facilities** | | | | | |
| Chanute Air Force Base (decommissioned) | Redevelopment of former Air Force base | 16 miles N | On-going development | None | None |
| **Industrial Facilities** | | | | | |
| Abbott Power Plant | Hybrid natural gas and coal power plant | 0.05 mile W | Operational | Water; air quality, human health | Evaluated in PSAR Section 2.2 |
| U. of I. Nuclear Physics Laboratory | Experimental nuclear physics research facility | 0.16 mile SSW | Operational | Human health | None |
| U. of I. Facilities and Services Physical Plant Services Building | Wastewater Treatment Plant | 0.33 mile SSW | Operational | None | None |
| Fuel Oil Storage Tanks | Two 1,000,000-gallon above ground storage tanks; feeds Abbott Power Plant | 0.6-mile SSW | Operational | Water; air quality, human health | Evaluated in PSAR Section 2.2 |
| Silgan Closures America | Food and beverage closures production facility | 3.77 miles NW | Operational | None | None |
| Advanced Filtration Systems | Fluid filter production facility | 3.67 miles NW | Operational | None | None |
| Clifford Jacobs Forging | Steel forging production facility | 2.74 miles NNE | Operational | Air quality | None |
| Guardian West | Manufacturer and supplier of components for the automotive industry | 3.04 miles ENE | Operational | Air quality | None |
| APL Engineered Materials, Inc. | High-purity performance chemical manufacturing facility | 3.07 miles NE | Operational | None | Evaluated in PSAR Section 2.2 |

**Table 2-3 Nearby Facilities and Projects (Continued)**

| Facility/Project Name | Summary of Facility/ Project | Location (from Reactor Building) | Status | Potentially Affected Resource(s) | Notes |
|---|---|---|---|---|---|
| Urbana & Champaign Sanitary District Southwest Treatment Plant | Wastewater Treatment Plant | 4.95 miles WSW | Operational | Human health | Evaluated in PSAR Section 2.2 |
| Champaign Water Treatment | Wastewater Treatment Plant | 2.84 miles NW | Operational | Human health | Evaluated in PSAR Section 2.2 |
| Urbana & Champaign Sanitary District Northeast Plant | Wastewater Treatment Plant | 2.57 miles ENE | Operational | Human health | Evaluated in PSAR Section 2.2 |
| Herff Jones | Manufacturer of school graduation products | 1.40 miles N | Operational | None | None |
| Kraft-Heinz Champaign | Food manufacturing facility | 2.06 miles NW | Operational | None | None |
| Menasha Packaging Inc. | Packaging manufacturing facility | 2.08 miles NW | Operational | None | None |
| Wirco Incorporated Foundry Division | Forged parts manufacturing facility | 2.06 miles WNW | Operational | Air quality | None |
| Plastipak Packaging Inc. | Packaging manufacturing facility | 3.24 miles WNW | Operational | None | None |
| Clinton Nuclear Power Station | Single-unit 3,473 $MW_t$ General Electric Type 6 boiling water reactor | Approximately 32 miles W | Operating; license will expire in April 2047 | None | The Clinton Nuclear Power Station is considered too far away to have measurable impacts at U. of I. |

**Table 2-3 Nearby Facilities and Projects (Continued)**

| Facility/Project Name | Summary of Facility/ Project | Location (from Reactor Building) | Status | Potentially Affected Resource(s) | Notes |
|---|---|---|---|---|---|
| **Transportation Facilities** | | | | | |
| U.S. Highway 45 | United States Highway Route 45 | 0.1 mile W | Operational | Transportation, human health, air quality | Evaluated in PSAR Section 2.2 |
| U.S. Highway 150 | United States Highway Route 150 | 1.1 miles NE | Operational | | None |
| Illinois Highway 10 | Illinois Highway Route 10 | 0.6 mile N | Operational | | None |
| Illinois Highway 130 | Illinois Highway Route 130 | 3.2 miles ENE | Operational | | None |
| Interstate Highway 57 | United States Interstate Route 57 | 3.4 miles W | Operational | | None |
| Interstate Highway 72 | United States Interstate Route 72 | 2.3 miles WNW | Operational | | None |
| Interstate Highway 74 | United States Interstate Route 74 | 2.1 miles N | Operational | | None |
| Canadian National Railway (north-south) | Canadian National north-south railroad | 0.1 miles W | Operational | | Evaluated in PSAR Section 2.2; |
| Canadian National Railway (west-east) | Canadian National west-east railroad | 1.8 miles NW | Operational | | No company has track rights. |
| Norfolk Southern Railway (east-west) | Norfolk Southern east-west railroad | 1.2 miles N | Operational | | No company has track rights. |
| Willard Airport | Commercial airport | 4.6 miles SW | Operational | | Evaluated in PSAR Section 2.2 |
| Frasca Field | Regional airport | 3.5 miles NE | Operational | | Evaluated in PSAR Section 2.2 |
| Amtrak Station | Train station | 0.8 miles N | Operational | | None |

**Table 2-3 Nearby Facilities and Projects (Continued)**

| Facility/Project Name | Summary of Facility/ Project | Location (from Reactor Building) | Status | Potentially Affected Resource(s) | Notes |
|---|---|---|---|---|---|
| **Residential Facilities** | | | | | |
| Alpha Gamma Rho House | University student housing | 0.1 mile E | Occupied | Human health | None |
| Delta Chi House | University student housing | 0.1 mile E | Occupied | | None |
| Wassaja Hall Residential Hall | University student housing | 0.15 mile ESE | Occupied | | None |
| 75 Armory Apartments | Off-campus apartments | 0.1 mile ENE | Occupied | | None |
| 52 E. Armory Apartments | Off-campus apartments | 0.09 mile NE | Occupied | | None |
| Others beyond 0.15 miles | Off-campus apartments | Beyond 0.15 mile | Occupied | | None |

**Table 2-4 Sensitive Populations, Nearest Resident, and Landmarks within 5 Miles of the Site**

| Facility Type | Location of Interest (lists are representative and are not all-inclusive) | Distance from Licensed Area Boundary (miles) |
|---|---|---|
| Residential | Nearest Full-Time Resident (1014 S. Oak St.) | 0.07 |
| | Nearest Part-time Resident (58 E Gregory Dr.) | 0.1 |
| Park | Nearest Park, Campus Basketball Courts, E Gregory Dr. | 0.04 |
| | McCollumn Park | 0.1 |
| | Washington Park | 0.3 |
| | Hessel Park | 0.3 |
| | Scott Park | 0.5 |
| | West Side Park | 0.9 |
| | Meadowbrook Park | 2.2 |
| | Weaver Park | 3.2 |
| | Helms Park | 0.8 |
| | Mattis Park | 0.9 |
| | Hazel Park | 2.0 |
| | Larson Park | 2.3 |
| | Noel Park | 1.6 |
| Medical | Bella Medical Center | 0.9 |
| | U. of I. McKinley Health Center | 1.1 |
| | OSF Heart of Mary Medical Center | 1.2 |
| | Carle Foundation Hospital | 1.6 |
| | Mills Breast Cancer Research Institute | 1.7 |
| | Caryle Christie Clinic | 4.3 |
| | Provena Covenant Medical | 1.8 |
| Daycare | Devonshire KinderCare | 0.8 |
| | La Petite Academy of Champaign | 1.2 |
| | Little Hearts & Hands Early Learning | 2.9 |
| | Little Legends Learning Center | 3.8 |
| | Kid's N Play Learning Center Daycare | 2.6 |
| | Nancy's Daycare | 3.9 |
| | Happi-Time Day Care | 0.3 |
| | Teddy Bear Daycare | 0.2 |
| Community Center | U. of I. Disability Resources & Educational Services | 0.06 |
| | U. of I. Activities and Recreation Center (ARC) | 0.3 |
| | Helen Stevic Senior Center | 0.6 |

**Table 2-4 Sensitive Populations, Nearest Resident, and Landmarks within 5 Miles of the Site (Continued)**

| Facility Type | Location of Interest (lists are representative and are not all-inclusive) | Distance from Licensed Area Boundary (miles) |
|---|---|---|
| Animal Research or Production | U. of I. Imported Swine Research Laboratory | 1.0 |
| | U. of I. Dairy Cattle Research Unit | 1.5 |
| | U. of I. Poultry Research Farm | 3.5 |
| Rivers/Creeks | Boneyard Creek | 0.5 |
| | Embarras River | 1.8 |
| | Phinney Branch | 2.1 |
| Railroads | Canadian National Railway (north-south) | 0.1 |
| | Norfolk Southern Railway | 1.2 |
| | Canadian National Railway (west-east) | 1.8 |
| Highways | US Hwy 45 | 0.1 |
| | US Hwy 150 | 2.0 |
| | Illinois Hwy 130 | 3.3 |
| | Illinois Hwy 10 | 0.7 |
| | Interstate 72 | 2.2 |
| | Interstate 74 | 3.6 |
| | Interstate 57 | 3.3 |

**Table 2-5 Educational Facilities within 5 Miles of the Site**

| Location of Interest | Distance from Licensed Area Boundary (miles) |
|---|---|
| Site is located on the U. of I. Campus | 0.0 |
| Edison Middle School | 0.5 |
| South Side Elementary School | 0.80 |
| Champaign Central High School | 1.07 |
| Westview Elementary School | 1.40 |
| Early Childhood Center | 1.41 |
| Novak Academy | 1.42 |
| Bottenfield Elementary School | 1.67 |
| Carrie Busey Elementary School | 3.17 |
| Centennial High School | 2.17 |
| Doctor Howard Elementary School | 1.51 |
| Franklin Middle School | 1.66 |
| Garden Hills Elementary Academy | 2.93 |
| International Prep Academy | 1.74 |
| Jefferson Middle School | 2.15 |
| Kenwood Elementary School | 2.72 |
| Robeson Elementary School | 2.61 |
| South Side Elementary School | 0.80 |
| Stratton Elementary School | 1.42 |
| Washington Elementary School | 1.54 |
| Dr. Preston L. Williams Jr. Elementary School | 3.31 |
| Leal Elementary School | 1.66 |
| Dr. Martin Luther King Jr. Elementary School | 1.46 |
| Thomas Paine Elementary School | 3.05 |
| Urbana Early Childhood Center | 3.42 |
| Urbana High School | 1.81 |
| Urbana Middle School | 1.91 |
| Yankee Ridge Multilingual School | 2.48 |

**Figure 2-1 U. of I. Research Reactor Site Location**

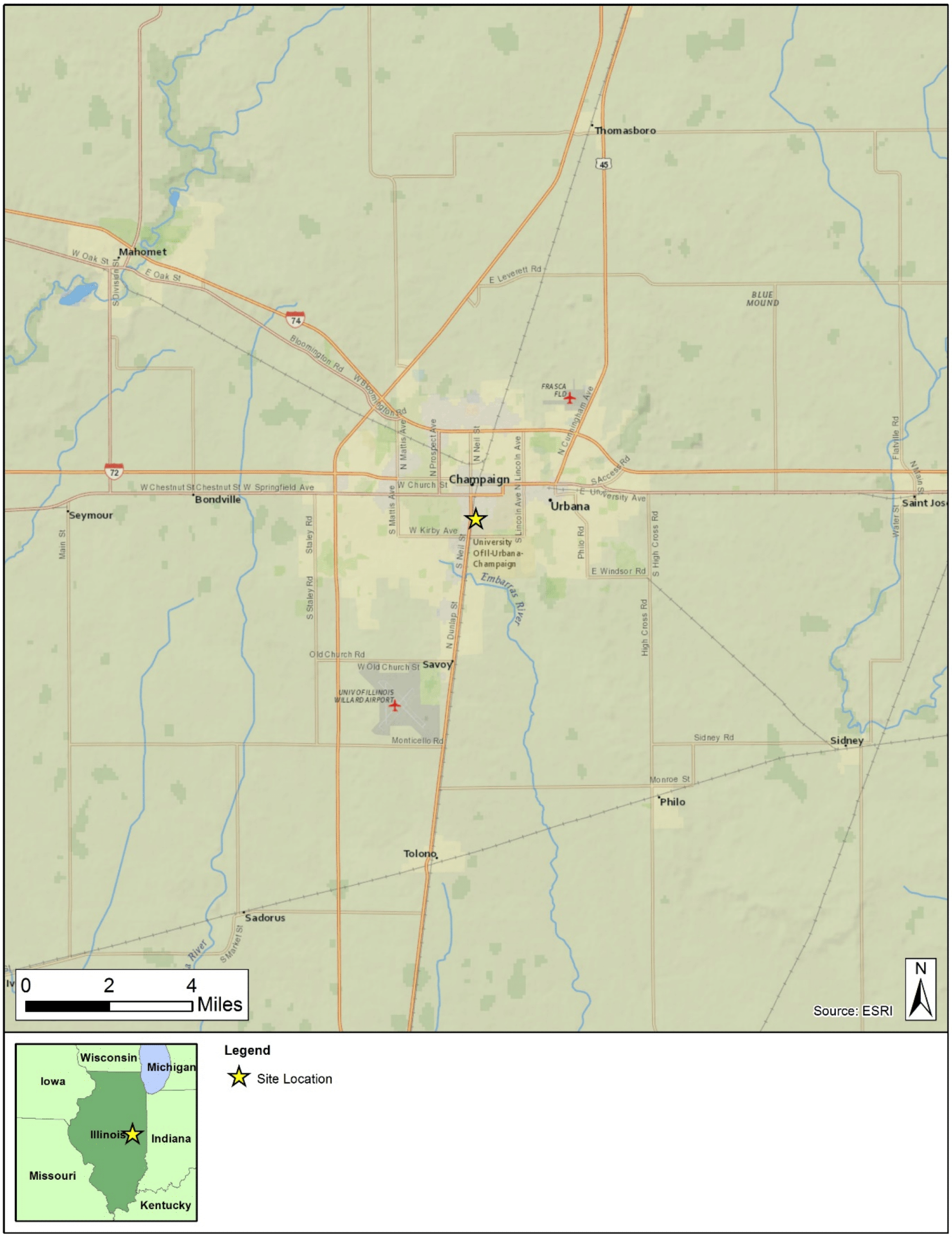
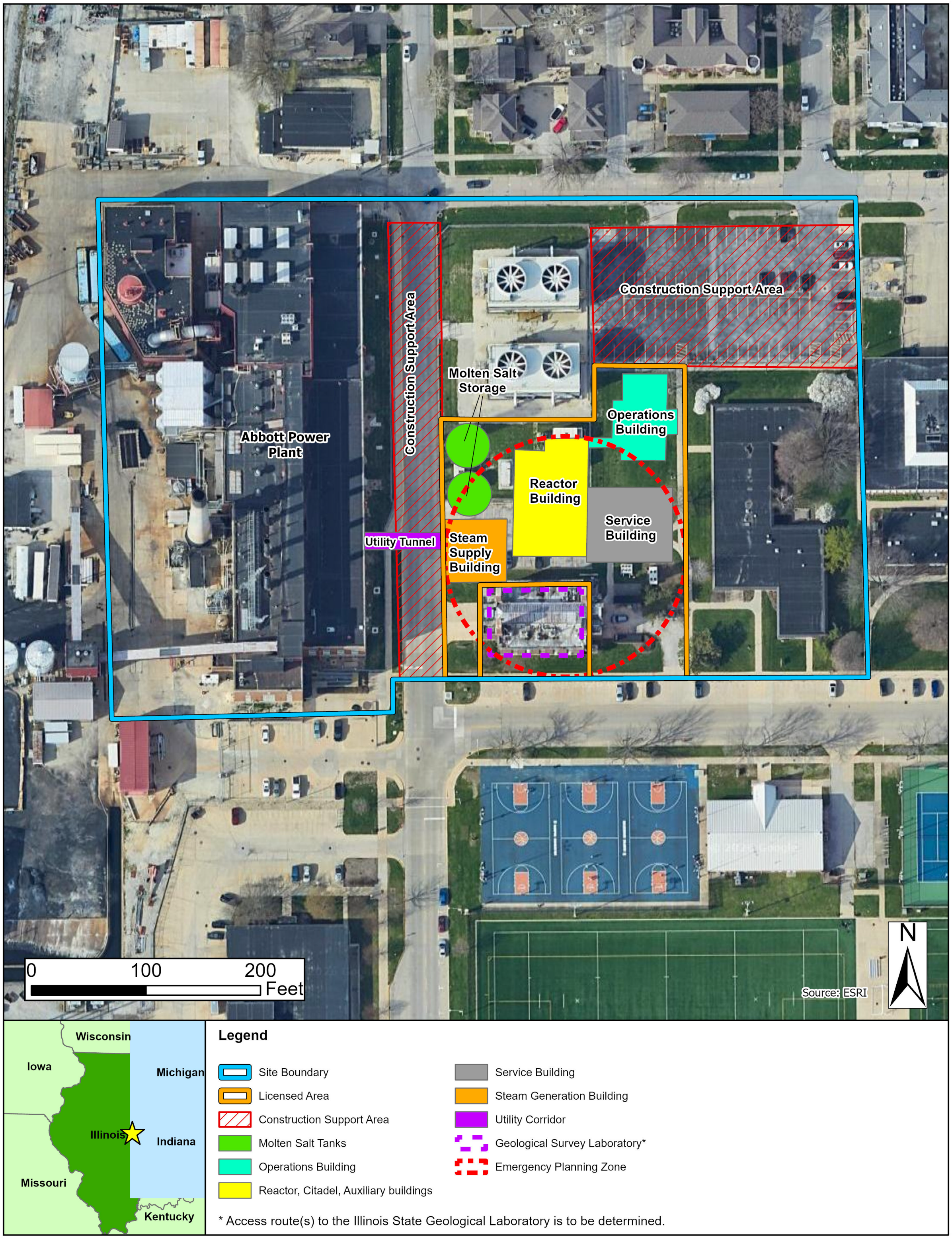


**Figure 2-2 Expected U. of I. Research Reactor Site Layout**



## 2.3 NON-POWER REACTOR

The proposed facility will house a single high-temperature gas-cooled research reactor developed by Nano Nuclear Energy, featuring a reactor core configuration made up of 150 fuel blocks containing encapsulated TRI-structural ISOtropic (TRISO) fuel pellets, graphite moderator, and helium gas coolant.

The research reactor will be operated as a Class 104(c) "production or utilization facility" as described in 10 CFR 50.21(c), at maximum thermal power of 45 megawatts thermal. U. of I. plans to utilize the reactor for research, education, and demonstration of power production and integration with the legacy electricity and steam production system (Reference 7-5).

Heat is generated in the reactor core and is removed by the helium primary coolant, which is transported out of the core via the Heat Transport System (HTS). The HTS consists of a single, closed-cycle primary loop containing the hot gas duct, intermediate heat exchanger (IHX), and helium circulator. Both the reactor core and HTS are housed entirely within the primary coolant pressure boundary formed by the Vessel System. The hot gas duct connects the reactor core outlet to the IHX inlet. Heat is transferred from the primary coolant to the molten salt secondary coolant in the IHX. The molten salt secondary coolant, contained in the Thermal Energy Storage System, carries the heat to the steam supply building. Figure 2-3 shows the basic flow diagram for the reactor system.

The research facility and Abbott Power Plant are functionally separated by the Thermal Energy Storage System and steam supply building. The Thermal Energy Storage System accepts and stores heat generated by the reactor in molten salt; the hot salt is then used in the steam supply building to generate steam. The steam will be piped to the Abbott Power Plant via underground utility corridors. The ER describes the research facility from the reactor through the steam supply to provide appropriate context for the assessment. However, the Abbott Power Plant is excluded from the site's licensing basis. The Thermal Energy Storage System and steam supply building effectively isolate the reactor from any of the actions or events that may occur in the Abbott Power plant, so that its power stability and reactivity are not affected.

The design life for the reactor vessel and its internal structures is targeted at 50 years, comprising 40 years of operational plant life followed by an additional 10 years dedicated to decommissioning support. The active core is made up of fueled graphite blocks and control rod blocks, surrounded by an outer reflector region composed of unfueled graphite blocks. The graphite moderator is a nuclear-grade graphite. Design considerations include machined right hexagonal prisms for the active core and reflectors, as well as machined non-hexagonal prisms for the reflectors. The fueled blocks incorporate channels for loading fuel pellets, burnable absorbers, and the control rod blocks incorporate channels for inserting control rods.

The Vessel System, which includes the reactor vessel, IHX vessel, circulator vessel, and cross-connection vessel, forms the primary coolant pressure boundary and provides structural support to the reactor core and the HTS. The design, fabrication, and quality assurance of the Vessel System follows the requirements of the ASME Boiler and Pressure Vessel (Section III). Constructed from low-alloy steel materials, specifically SA-508 Grade 3 Class 1 and SA-533 Grade B Class 1, the reactor vessel will be fabricated and tested in accordance with the rigorous standards of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, specifically Section III, Division 5, Subsection HB.

The reactor core uses annular ceramic fuel pellets containing TRISO particles. These annular fuel pellets are stacked in columns and inserted into the fueled graphite blocks in the reactor core. The TRISO particles are comprised of a uranium oxycarbide fuel kernel, porous carbon buffer layer, and three outer coating layers of carbon and ceramic based materials that prevent the release of radioactive fission products. Figure 2-4 shows a schematic of the fuel design. The enrichment of the uranium fuel will be less than 9.9 weight percent, with a core total heavy metal mass of less than one ton.

**Figure 2-3 U. of I. Research Reactor Process Flow Diagram**

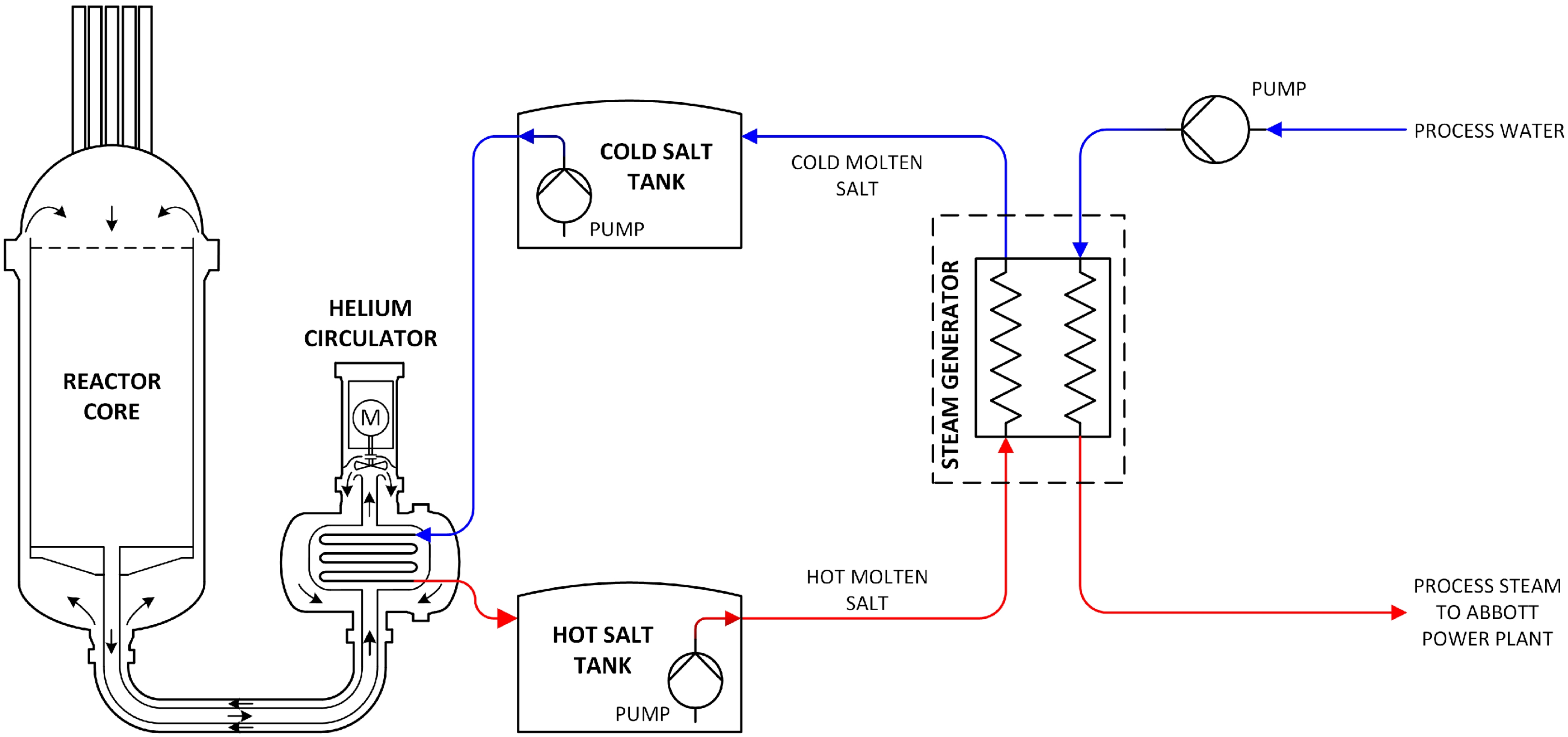
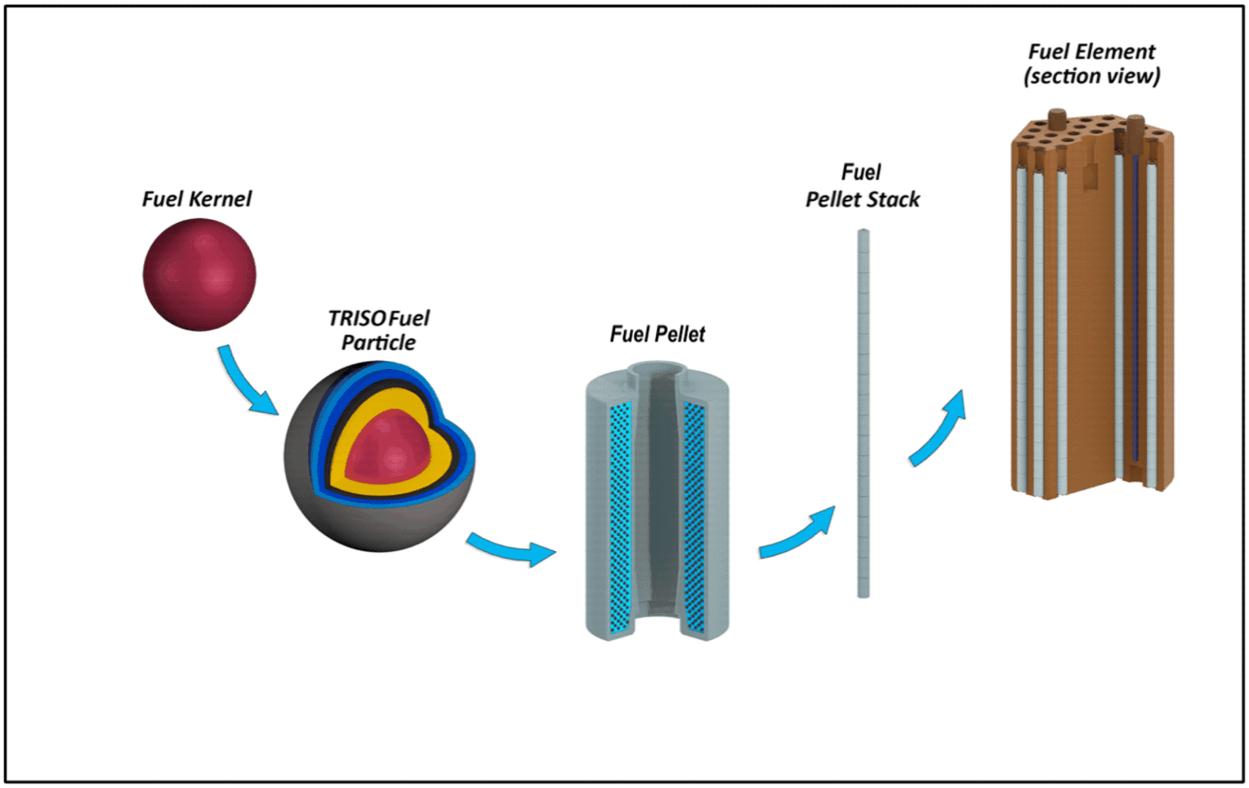


**Figure 2-4 Fuel Design**




## 2.4 WATER CONSUMPTION AND TREATMENT

### *2.4.1 Water Sources and Consumption*

Structures, facilities, and improvements requiring a water supply will be connected to the public-water system. Neither surface water nor groundwater underlying the property are planned to be utilized.

Potable and service water for the facility will be obtained from the campus water system. All water is delivered to the campus water system by the local water public utility, Illinois American Water Corporation. The components of the campus water system vary greatly in age, and some piping may be quite dated. However, water outages are held to a minimum, and the system is considered reliable (Reference 7-5).

Figure 2-5 shows a water balance diagram for the facility. Water uses for the facility will include:

- Fire protection systems
- Potable water, bathrooms
- Nuclear facility systems

The fire protection system for the research reactor facility has not been designed. However, based on National Fire Protection Agency rule-of-thumb estimates, required water flow rate for firefighting could exceed 10,000 gallons (38,000 liters) per minute.

Service water required for the potable water (site usage, wash bays, and bathrooms) is estimated to be approximately 500 gallons (1,892 liters) per day. Approximately 15,760 gallons (59,658 liters) per day are needed to feed the demineralizer plant which support steam production. Sanitary wastewater will be discharged to the sewer at the same rate of approximately 500 gallons (1,892 liters) per day. The boiler blowdown from the Abbott Plant will contribute about 11,820 gallons (44,700 liters) per day. The boiler blowdown is not a new source of discharge to the sewer system as the Abbott Power Plant currently discharges boiler blowdown to the sewer. Operation of the research reactor facility will not add to the boiler blowdown volume.

The research reactor facility nuclear systems do not require a constant water source. The only system with notable water demand is the Reactor Cavity Cooling System (RCCS). However, the RCCS only requires filling prior to operation and does not require routine refilling during operations. The RCCS does not require additional onsite water storage.

Stormwater runoff will flow into existing stormwater collection points located in the area surrounding the project site. Due to the size of the site, a stormwater retention basin is not needed.

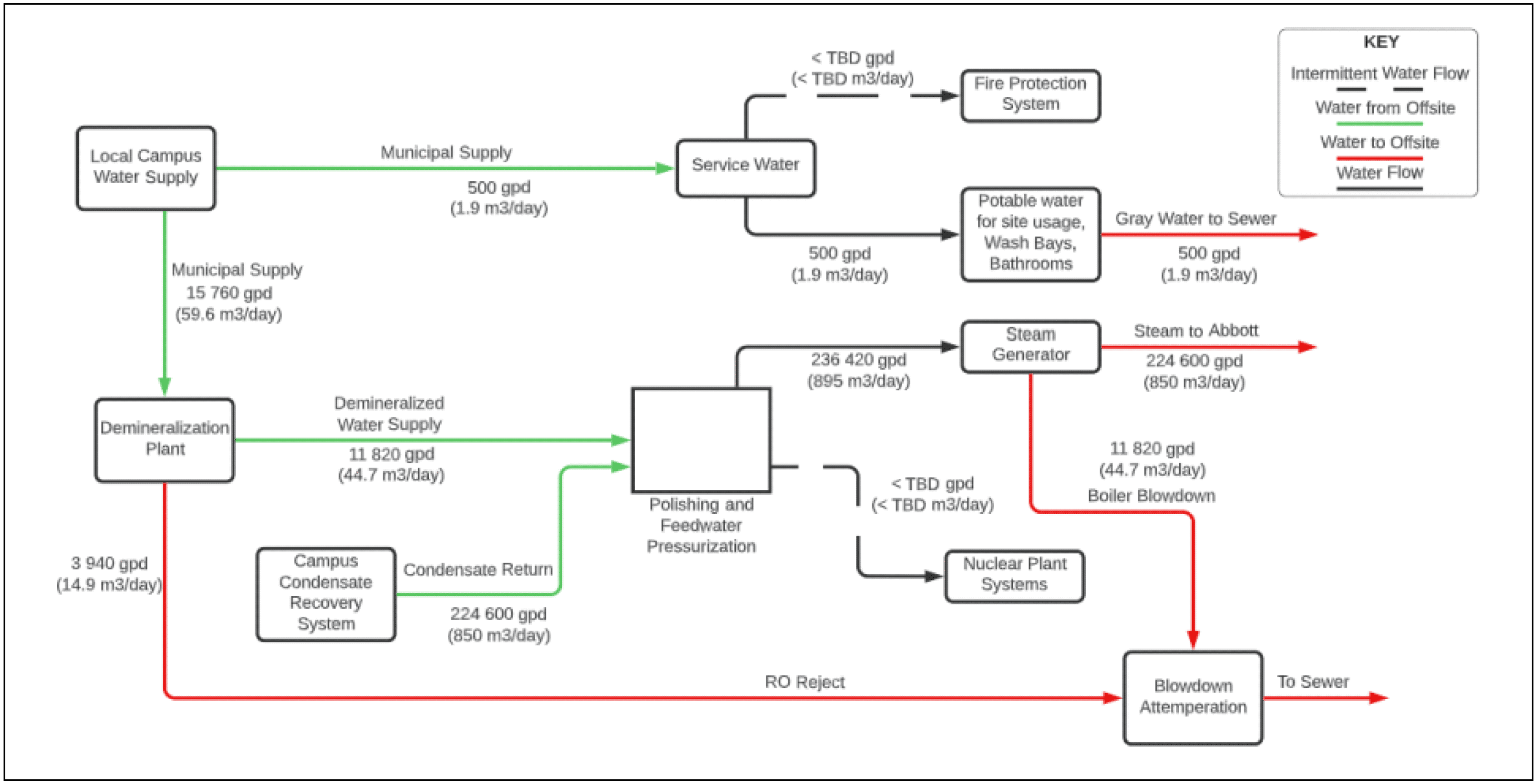
### *2.4.2 Water Treatment System*

Demineralized water will be supplied via the on-site treatment of municipal water. Demineralized water storage will be provided in a storage tank local to the reactor site. Condensate return from the U. of I. campus condensate network will supply boiler feedwater to the steam supply building. Condensate makeup and boiler feedwater makeup will be supplied from the on-site demineralized water storage tank. Water treatment will typically consist of pre-filtration, carbon filtration, softener, reverse osmosis system, and a deionizing system.

Municipal water obtained from the local campus water supply will be used for the chilled water system, which is typically treated prior to addition to the chilled water system and doused periodically. The dousing will be determined by testing. The types of chemicals added to the water will be:

- Biocides – added to inhibit microbial growth in the water to avoid fouling.
- Corrosion inhibitors – added to inhibit corrosion of piping and components through which the cooling water flows. Often corrosion is inhibited by halogen-based biocides.
- Scale inhibitors – added to reduce scale formation, particularly within heat exchangers. The specific inhibitor(s) is selected based on the chemistry of the makeup water for the chilled water system.

**Figure 2-5 Research Reactor Water Balance Diagram**



## 2.5 COOLING AND HEAT DISSIPATION SYSTEMS

### *2.5.1 Raw Cooling Water System*

No raw cooling water usage is planned for the facility.

### *2.5.2 Heat Transport System*

The purpose of the HTS (Figure 2-6) is to transfer heat generated in the reactor core to the Thermal Energy Storage System for use in the steam supply building. The HTS establishes the primary coolant flow path as follows:

- Hot primary coolant exits the reactor core through the outlet plenum, flows into the hot gas duct and through to the IHX, where heat is transferred to the secondary coolant.
- Cold primary coolant exiting the IHX enters the helium circulator through its impeller region.
- Upon exiting the helium circulator, the cold primary coolant flows through the space between the IHX and the IHX vessel, and into the annular space between the hot gas duct and the cross-connection vessel.
- Upon reaching the reactor vessel region, the cold primary coolant flows up through the annulus between the core barrel and the reactor pressure vessel.
- Finally, the primary coolant reaches the top of the core region and flows back down through the core region where it heats up as it goes down.

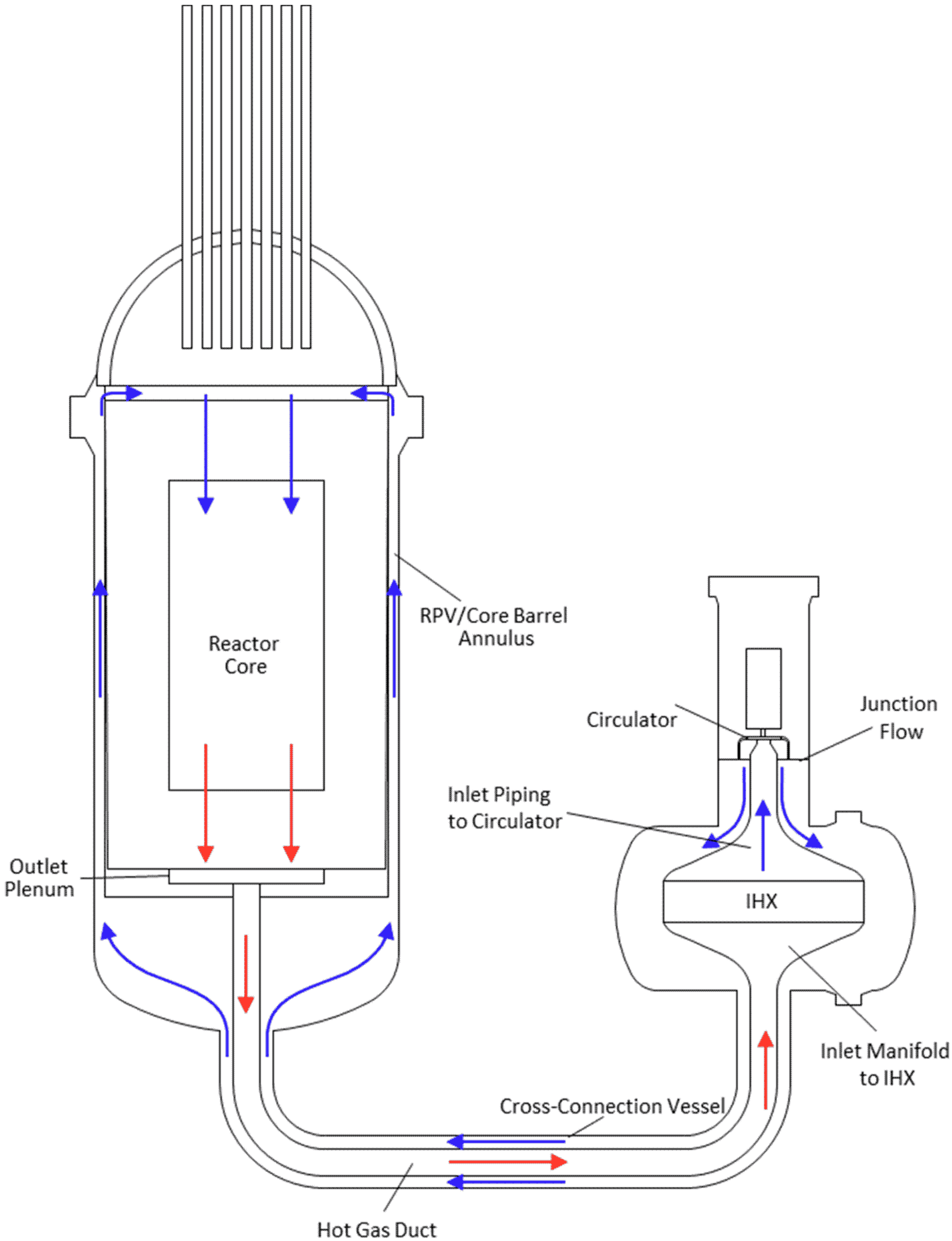
Heat is transferred from the helium to the molten salt in the IHX, which is a printed-circuit heat exchanger. The printed-circuit heat exchanger forms an inherent pressure boundary and is placed inside its own pressure vessel (IHX Pressure Vessel) to comply with ASME Boiler and Pressure Vessel Section III.

The pressure differential required to establish helium flow in the HTS is developed by the helium circulator, a vertically oriented electric motor-driven circulator. It is driven by a variable speed drive that accommodates different operating conditions based on pressure and mass flow rate.

### *2.5.3 Reactor Cavity Cooling System*

The RCCS is a passive heat removal system that provides long-term decay heat removal from the reactor vessel following a normal reactor shutdown, anticipated operational occurrences, and postulated events. In high-temperature gas-cooled reactors, the RCCS is a key component of the facility’s inherent safety strategy.

**Figure 2-6 HTS and Primary Loop Flow Path Illustration**



## 2.6 WASTE SYSTEMS

Waste generated at the facility during the phases of construction, operation, and decommissioning will include radioactive, nonradioactive, and hazardous waste. Waste management systems will provide mechanisms for the collection and disposition of waste in accordance with applicable state and federal environmental regulations. The disposal of the separated waste will occur in permitted nonradioactive, nonhazardous, and hazardous waste disposal facilities and licensed radioactive disposal facilities. The precedent for university research reactors is that the U.S. Department of Energy (DOE) maintains ownership of the nuclear fuel throughout the full lifecycle and takes responsibility for its disposal. The U. of I. is currently pursuing this approach and is actively engaged with the DOE University Fuel Services Program. Therefore, spent fuel will be handled and shipped utilizing U.S. DOE requirements as they are the ultimate owner and disposal pathway for the spent fuel.

### *2.6.1 Radioactive Liquid, Solid, and Gaseous Waste Systems*

Radioactive waste generation will occur during the operations phase and decommissioning phase. The following subsections describe the waste systems implemented during the operations phase of the facility. These systems are designed to limit discharges of radioactive materials in accordance with 10 CFR 20. The methods employed for the controlled release of those contaminants is dependent primarily upon the state of the radioactive material (i.e., liquid, solid, or gaseous).

#### *2.6.1.1 Liquid Radioactive Waste Handling System*

Liquid radioactive waste systems will collect, store, monitor, process, and dispose of potentially radioactive liquid waste produced from normal reactor operations and maintenance. Major sources of liquid radioactive waste include water used for hand washes inside the radiologically controlled area, liquids used in decontamination of equipment or components, ingress water or spilled liquids in the radiologically controlled area. Liquid radioactive waste will be processed by a combination of on-site storage to allow decay to occur, and treatment to remove radionuclide content. The system will dispose of the treated liquid by internal recycling for additional treatment or discharge to the environment. Liquid effluent will be controlled and sampled prior to discharge through the sanitary line.

#### *2.6.1.2 Solid Radioactive Waste Systems*

Solid radioactive waste systems provide for the collection, processing, packaging, and storage of wet and dry solid radioactive waste produced from normal reactor operations and maintenance. Because there will be no solid waste disposal at the site, all low-level radioactive waste (LLRW) and intermediate level radioactive waste will be shipped offsite periodically during operations as packaged solid waste. Any waste that could be radioactive will be characterized to ensure proper handling and disposal. Solid Waste will be categorized as follows:

- Non-active solids
- Solids to decay in storage
- Solids (small items) that can be decontaminated
- Compressible active solids
- Active Solids to package

The LLRW volumes per year vary dependent upon the amount of maintenance done and if refueling took place in the year. Anticipated solid waste major constituents include personal protective equipment, swabs, smears, counters, particulate filters, high-efficiency particulate air (HEPA) filters, and solidified liquid waste. The reactor facility will have a storage capacity of approximately 26 $yd^3$ (20 $m^3$) for solid and liquid radioactive waste. Therefore, no more than three shipments of LLRW would be expected in any given year. Table 2-6 provides estimated volumes of LLRW as "less than" values based on values previously analyzed in the "Environmental Survey of Transportation of Radioactive Material to and from Nuclear Power Reactors" (Reference 7-6).

#### *2.6.1.3 Helium Purification System*

The Helium Purification System (HPS) removes chemical and radioactive impurities, including tritium, from the primary coolant.

The HPS continuously redirects a small quantity of primary coolant from the HTS to buffer storage, where the system purifies the helium by utilizing high-temperature absorbers, oxidizers, dryers, filters and low-temperature absorbers to control chemical impurities and radionuclides before returning compressed helium back to the HTS. The HPS includes a regeneration module that removes and processes the adsorbed impurities from saturated beds to restore their capacity.

Liquid, gas, and solid radioactive wastes are generated by the HPS during primary coolant cleanup. Liquids from the purification and regeneration coolers are collected in a vessel that is sealed and moved to a waste area for storage. Gases are adsorbed on the low temperature adsorber and transferred to radioactive gas waste storage vessels in the waste area. Solid waste in the form of waste filter and carbon cartridges is removed and transported in waste casks to the waste storage area. The waste vessels and casks are handled, packaged and disposed of as discussed in Section 2.6.1.2.

#### *2.6.1.4 Gaseous Radioactive Waste System*

Helium that may leak from the pressure boundary is anticipated to be released to the atmosphere during normal operations. Upset conditions that do not result in a helium release from the pressure boundary will not have any impact on public dose. The circulating helium activity is continuously monitored. If helium activity exceeds a pre-defined limit, actions, such as reactor shutdown, will be taken to prevent release of radioactivity. The pre-defined limits will be sufficient to ensure that any release to the atmosphere will maintain radiation exposure levels outside the controlled area to be as low as is reasonably achievable and does not exceed 10 CFR Part 20 limitations.

The HVAC system is also engineered to accommodate and filter helium leaking from the pressure boundary during normal operations and some Anticipated Operational Occurrences. For depressurization events, or events in which non-safety related systems cannot be credited, (e.g., Maximum Hypothetical Accident), the HVAC systems are bypassed, and the helium releases are vented directly to atmosphere.

### ***2.6.2 Nonradioactive and Nonhazardous Waste Systems***

The research reactor facility will generate general types and quantities of nonradioactive and nonhazardous solid waste. No specific systems are planned other than waste management plans and policies that will control nonradioactive and nonhazardous solid waste. Solid waste management and control measures for the facility will include waste reduction, recycling, and waste minimization practices that will be employed during all project phases (construction, operation, and decommissioning). Such waste will be managed in accordance with applicable federal and state regulations.

The facility is expected to produce various waste streams classified as hazardous under the Resource Conservation and Recovery Act. These wastes may include, but are not limited to, paint-related materials and spent solvents used for cleaning and degreasing. Additionally, the facility may generate universal waste, such as used batteries and fluorescent light bulbs. It is anticipated that the facility will qualify as a Small Quantity Generator of hazardous waste with the volume of waste generated considered negligible. Materials such as scrap metal, universal waste, used oil, and antifreeze will be collected, stored, and either recycled or recovered at an offsite permitted recycling or recovery facility, as appropriate.

### ***2.6.3 Direct Radiation Sources Stored Onsite or Near the Facility***

#### *2.6.3.1 Direct Radiation Sources Stored Onsite*

Areas that contain direct sources of radiation will be located inside the reactor building. Sources of radiation will include those associated with the reactor core systems, the HPS, neutron startup sources, temporary spent fuel storage, and LLRW storage and shipping.

#### *2.6.3.2 Direct Radiation Sources Stored Near the Facility*

Clinton Nuclear Power Station is located approximately 32 miles (51.5 km) west of the project site. It is the nearest commercial nuclear power reactor to U. of I. However, because of its distance from U. of I., radioactive sources at or radioactive emissions from the Clinton Nuclear Power Station will not have an effect on personnel at the U. of I. research reactor facility.

The U. of I. Nuclear Physics Laboratory (NPL) is located approximately 600 feet (183 meters) south-southwest of the project site. There are no radioactive sources, accelerators, or cyclotrons currently located at the U. of I. NPL and there are no plans for new accelerators or cyclotrons at this time. The NPL introduces and removes radioactive sources as needed for detector testing. The sources used are low activity and do not trigger updates in work or safety procedures. The purpose of the NPL is instrumentation development for experiments to be carried out at user facilities elsewhere. No major sources of radiation are currently present at the NPL and none are planned during the operating life of the research reactor.

### ***2.6.4 Pollution Prevention and Waste Minimization***

Pollution prevention and waste minimization planning provides the framework for promoting environmental stewardship and educating employees in the environmental aspects of activities occurring in the workplace, the community, and homes. The facility will have a program for pollution prevention and waste minimization that is expected to include the following:

- Waste minimization and recycling for the various phases of the facility construction and operation;
- Employee training and education on general environmental activities and hazards regarding the facility, operations, and the pollution prevention program, as well as waste minimization requirements, goals, and accomplishments;
- Employee training and education on specific environmental requirements and issues;

- Responsibilities for pollution prevention and waste minimization; and
- Consideration of pollution prevention and waste minimization in day-to-day activities and engineering.

**Table 2-6 Estimated Type and Quantity of Radioactive Wastes**

| Description | Matrix | 10 CFR 61.55 Waste Class | Contents | Volume | No. of Shipments | Destination |
|---|---|---|---|---|---|---|
| LLRW | Solid | A | PPE, filters, etc. | < 15,440 $ft^3$/yr [a] | < 46/yr [b] | Energy*Solutions* or Waste Control Specialists |
| LLRW | Solid | B and C | Reactor hardware | | | Waste Control Specialists |
| Spent nuclear fuel | Solid | - | TRISO ceramic nuclear fuel | 150 fuel blocks per refueling < 120 $ft^3$ [c] | 40 in 40 years of operation (~1/yr)[d] | DOE Facility [e] |

[a] Based on 2,100 55-gallon drums per year (Reference 7-6).

[b] The total LLRW waste shipments will be bounded by 46 annual shipments, the number of shipments from an 880 megawatt electrical reference reactor (Reference 7-6, Reference 7-7); actual estimate is ≤ 3 shipments.

[c] Spent fuel will have a volume of not greater than 120 $ft^3$; this quantity is assumed to fit into not more than 3 standard DOE spent fuel canisters (Reference 7-8).

[d] Refueling will occur approximately every 3 years over the 40-year operating life of the reactor (14 total); 3 spent fuel shipments per refueling (40 total)

[e] Returned to DOE according to fuel leasing and takeback arrangements under the DOE's University Fuel Services Program; shipments to either Savannah River Site or Idaho National Laboratory.

## 2.7 STORAGE, TREATMENT, AND TRANSPORTATION OF RADIOACTIVE AND NONRADIOACTIVE MATERIALS

### *2.7.1 New and Irradiated Fuel*

The research reactor will use annular fuel pellets consisting of TRISO fuel particles embedded in a ceramic matrix. The fuel design is described in PSAR Section 4.2. New fuel will be shipped to the research reactor facility in U.S. Department of Transportation certified shipping containers.

The reactor is designed for a once-through fuel cycle. Refueling is required approximately every 3 years when operating at full power. The fuel handling equipment and used fuel interim storage space will enable for fuel removal and new fuel loading. The PSAR provides further details including the design bases for the refueling approach.

The Final Safety Analysis Report will provide procedures and administrative controls for fuel handling including initial fuel loading, removal, onsite storage, transportation, and disposal. In accordance with U. of I.'s fuel leasing and takeback arrangement with the DOE under the Research Reactor Infrastructure Program, it is anticipated that DOE will take custody of the spent fuel from the U. of I. facility. This pathway is not dependent on construction and permitting of a regional interim spent fuel storage site or a geological repository.

### *2.7.2 Low-Level Radioactive Waste*

Operation and decommissioning activities will generate solid LLRW. LLRW will be stored in industrial packages approved for transportation. Common waste containers include B-12 and B-25 steel boxes, and 55-gallon (208 liter) steel drums. LLRW will be transported by truck to disposal sites west of Andrews, Texas (Waste Control Specialists) or near Clive, Utah (Energy*Solutions)*. The Waste Control Specialists disposal site accepts Class A, B, and C waste and is approximately 1,100 miles (1,770 km) from the U. of I. campus. The Energy*Solutions* disposal site accepts only Class A waste and is approximately 1,470 miles (2,365 km) from the U. of I. campus. Estimated quantities of radioactive waste are provided in Table 2-6.

The LLRW volumes per year depend upon the amount of maintenance done and if refueling took place in the year. Therefore, the total number of LLRW shipments will be low and will be bounded by the 46 annual shipments of LLRW provided for an 880 megawatt electrical (MWe) reference reactor described in NRC guidance (Reference 7-6).

### *2.7.3 Nonradioactive Materials*

Reactor operations will generate small volumes of nonradioactive waste for disposal and recycling. These will be stored in on-site receptacles and picked up and managed by the U. of I. Facilities and Services Waste Management department. The Facilities and Services Waste Management department provides campus-wide recycling and waste hauling, with an aim to continuously reduce the total volume of waste being sent to a landfill. The 2020 Illinois Climate Action Plan set a vision of Zero Waste for campus, and the State Waste Reduction Plan provides a five-year plan for continuing to reduce total landfill waste.

# CHAPTER 3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

## 3.1 LAND USE AND VISUAL RESOURCES

This subsection outlines the land use characteristics of the proposed University of Illinois Urbana-Champaign (U. of I.) research reactor at the Urbana-Champaign campus and its surrounding region. The analysis of land use is based on data from the National Land Cover Database (Reference 7-9). For evaluations and rating visual resources, the U.S. Department of the Interior Bureau of Land Management Visual Resource Management Plan (Reference 7-10) is utilized.

### *3.1.1 Land Use*

#### *3.1.1.1 Project Site*

The research reactor Licensed Area covers 1.01 acres (0.41 hectares) and is situated on the western edge of the U. of I. campus, near the intersection of South Oak Street and East Gregory Drive in Champaign, Illinois and it lies within the broader Site Boundary (Reference 7-9). Currently, the Licensed Area includes a parking lot and unpaved areas adjacent to the Geological Survey Laboratory (GSL) located at 1116 South Oak Street and the U. of I. Personnel Services building at 52 East Gregory Street. The Site Boundary includes the GSL building, the Personnel Services building, the Abbott Power Plant, a segment of South Oak Street, and adjacent parking lots. The Personnel Services building is currently occupied by U. of I. administrative personnel and the GSL building is presently utilized by the Illinois State Geological Survey of the Prairie Research Institute. Directly across East Gregory Drive to the south, there are basketball and tennis courts, as well as the U. of I. Campus Bike Center (Reference 7-11).

The project site is located within the city and county of Champaign, Illinois, and is less than 1 mile from downtown Champaign in the east-central region of the state. It is currently zoned as “Multifamily 3 - High Density Multifamily Residential/Limited Business (MF3),” a designation that accommodates a mix of high-density multifamily housing, college housing, offices, and mixed-use developments typically found near universities and colleges (Reference 7-12). Surrounding the site are other parcels zoned as MF3, and nearby features include a railroad, McCollum Park, and U.S. Highway 45, which serves as a crucial corridor connecting the U. of I. campus to neighboring communities (Reference 7-11). The permitted uses within the MF3 District are outlined in Section 37-50.2 of the zoning code, including:

1. Assisted/independent living
2. Bed and breakfast; Club or lodge
3. College or university
4. Community living facilities (Category I and II)
5. Community center
6. Community garden
7. Attached dwellings (common lot line)
8. Multifamily, single family, and two-family dwellings
9. Government facilities

10. University group housing
11. Recovery homes
12. Religious institutions
13. Residential care facilities
14. K-12 schools.

As the research reactor will be owned by the U. of I., it qualifies as a permitted use within the MF3 (high density multifamily residential and limited business) zoning district. The proposed footprint for the reactor facility building, as depicted in Figure 2-2, encompasses approximately 21,250 square feet (1,974 square meters).

The land cover inside the Licensed Area is classified as "developed," with 83.6 percent categorized as medium intensity and 16.4 percent as high intensity, as illustrated in Figure 3-1 (Reference 7-9). Medium intensity is characterized by impervious surfaces covering 50 to 79 percent of the total area, while high intensity is defined by impervious land coverage of 80 to 100 percent (Reference 7-13). Figure 3-1 indicates that the GSL parking lot is generally classified as "high intensity."

#### *3.1.1.2 Region*

The region surrounding the research reactor site is defined as the area within a 5-mile (8-kilometer [km]) radius from the site's center point. Major land uses and land cover within this region are detailed in Table 3-1 and illustrated in Figure 3-2. The predominant land use is cultivated crops, which comprise 41.5 percent of the area and are primarily located outside the city limits. Within the city limits, developed lands represent the primary land use and are categorized into low-intensity (23.7 percent), medium-intensity (18.4 percent), high-intensity (6.7 percent), and developed open space (6.5 percent). Other land uses in the region include hay/pasture, mixed forest, deciduous forest, water bodies, and both herbaceous and woody wetlands (Reference 7-9). Although the project site itself does not engage in crop production, the surrounding region is known for producing corn, soybeans, alfalfa, and various types of hay (Reference 7-14). Figure 3-3 offers a visual representation of land cover and crop production in the region, as reported by the U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS).

##### *3.1.1.2.1 University Campus*

The U. of I. campus occupies 6,370 acres (2,577 hectares) of land, which spans the City of Urbana, the City of Champaign, the Village of Savoy, and unincorporated areas of Champaign County. The campus comprises approximately 750 owned and leased buildings, totaling 23 million gross square feet (21.3 million gross square meters). While predominantly urban, the campus also includes a significant agricultural area known as "South Farms," located in its southern section. This farmland serves as a living laboratory for the College of Agricultural, Consumer, and Environmental Sciences (Reference 7-5).

The campus is characterized by flat terrain, with gentle slopes near basins and drainage corridors. Champaign County is similarly recognized for its flat, expansive agricultural landscape, with elevations ranging from approximately 620 to 860 feet (189 to 262 meter) above mean sea level across its 998 square miles (2,584 square kilometers) (Reference 7-15). The reactor site and its surrounding region are part of the Illinois/Indiana Prairie ecoregion, which was shaped by glaciation over 12,500 years ago. This area features flat to rolling plains, fertile soils, and a long growing season. Historically dominated by tall-grass prairies, the region has largely been converted to agricultural land, with corn and soybeans as the primary crops. In the South Farms area, livestock such as cattle, sheep, poultry, and hogs are raised, contributing to the region's agricultural economy. However, agricultural activities have adversely affected stream chemistry, turbidity, and habitat quality (Reference 7-16).

*3.1.1.2.2 Future Land Use and Zoning*

In 2021, the City of Champaign updated its comprehensive plan, which was originally adopted in 2011. The revised document, titled the "Champaign Tomorrow 2021 Plan," integrates land use and transportation considerations, serving as a framework for future growth and property utilization. It categorizes future land use into three main areas: parks, trails and open space; neighborhoods; and centers. According to the Future Land Use Map, the proposed project site falls within the "University or College Campus" category, which includes areas affiliated with the University of Illinois and Parkland College. These areas typically feature classrooms, offices, dining facilities, libraries, recreation centers, and sports complexes (Reference 7-17).

Adjacent land use transitions into residential areas designated as "University Neighborhood" on the Future Land Use Map. This category includes parcels located east of the Canadian National Railroad right-of-way and south of University Avenue. The residential areas primarily consist of multi-family apartment buildings, dormitories, and group homes, such as fraternity and sorority houses. Residents enjoy close proximity to Campustown, Downtown, Midtown, and U. of I. facilities, all supported by frequent transit services and a street grid that facilitates walking and biking (Reference 7-17).

*3.1.1.2.3 Parks and Recreation*

Champaign County features a variety of parks and recreation areas managed by agencies and nonprofits. Key organizations include the Champaign County Forest Preserve District, Champaign Park District, Urbana Park District, Mahomet Parks and Recreation Department, and the Rantoul Park District/Recreation Department. These agencies collectively manage numerous parks and preserves:

- Champaign Park District: Manages 64 parks spanning 610 acres (246 hectares).
- Urbana Park District: Operates 24 parks covering 580 acres (234 hectares).
- Mahomet Parks and Recreation Department: Maintains 11 parks across 131 acres (53 hectares).
- Rantoul Park District: Oversees 21 parks totaling 184 acres (74 hectares).
- Champaign County Forest Preserve District: Operates six forest preserves throughout Champaign County (Reference 7-17).

*3.1.1.2.4 Transportation*

Champaign and Urbana, the two largest cities in Champaign County, are strategically positioned 130 miles south of Chicago, 120 miles (193 kilometer) west of Indianapolis, Indiana, and 165 miles (265 kilometer) north-northeast of St. Louis, Missouri (Reference 7-15). The nearest major metropolitan area is Decatur, Illinois, located approximately 43 miles (69 kilometer) southwest of the proposed project site, with a population of 70,522 as of 2020 (Reference 7-18).

Champaign County serves as a statewide transportation hub, characterized by a network of roadways that includes county and township roads, as well as federal and state highways such as Interstate Highways 57, 72, and 74, and U.S. Highways 45, 136, and 150. Additionally, extensive railroads facilitate both passenger travel and freight services, as discussed in Section 3.7. Commercial and private passenger air services are available at Willard Airport, situated south of Savoy, along with several smaller airports throughout the county (Reference 7-15).

#### *3.1.1.2.5 Industrial Operations*

Notably there are no chemical plants, refineries, mining or quarrying operations, or military facilities within five-mile radius of the proposed reactor site.

### ***3.1.2 Visual Resources***

The proposed site is positioned at the edge of a well-established university campus, surrounded by a highly developed environment. The area that will experience the effects of construction features a mix of extensive road networks, existing industrial zones with paved lots, multifamily residential buildings, and various campus facilities.

- Looking directly west, the viewshed is dominated by the Abbott Power Plant and its related facilities. Beyond the Abbott Power Plant are a railroad, a small pocket park, and a major transportation corridor (U.S. Highway 45), that links the campus with neighboring communities, beyond which lie mixed commercial and residential uses.
- The view to the north includes two large cooling towers and multifamily residential structures across East Armory Avenue.
- The view to the east is the single-level U. of I. Personnel Services building.
- To the south, the scenery shifts to feature outdoor recreational areas (basketball courts and intramural fields), an outdoor stadium, industrial uses (including Oak Street Chiller Plant and the Physical Plant Services building), as well as campus buildings and commercial establishments.

The aesthetic and scenic quality of the site has been evaluated using the Bureau of Land Management Visual Resource Management System (Reference 7-10). In this framework, aesthetics refer to the sensory experience derived from an environment—its sights, sounds, smells, tastes, and tactile qualities—while scenic quality pertains to the visual value of the landscape, assessed based on factors such as landform, vegetation, water features, color, adjacent scenery, uniqueness, and human alterations. Scenic quality is rated on a scale from "A" (highest) to "C" (lowest). A desktop analysis determined that the project site has an overall scenic quality rating of "C." This rating reflects the site's flat and uniform landform, limited natural vegetation and diversity, absence of water features, and muted color palette. However, the scenic quality is modestly enhanced by adjacent outdoor recreational fields and a nearby pocket park.

The Sensitivity Level, which measures public concern for preserving scenic quality, is categorized as High, Medium, or Low. This level is determined by factors such as the types and number of users, public interest, nearby land uses, and specific management objectives (Reference 7-10). While the proposed project will increase land-use intensity, its visual impact is expected to be minimal. The facility will occupy a small footprint, with a significant portion constructed underground, thereby reducing its visibility. The project will be located on developed land and will integrate seamlessly with the existing Abbott Power Plant. Both the project and the power plant fall under the "University or College Campus" designation on the Future Land Use Map, ensuring strong contextual compatibility (Reference 7-17). Additionally, the presence of adjacent taller industrial buildings and the incorporation of the existing GSL building will help buffer the facility's viewshed from neighboring properties. With the research reactor installed within an underground concrete structure, the visible impact on surrounding areas will be further minimized. As a result, the overall sensitivity rating for the site is considered low (Reference 7-19).

The proposed project also aligns with established energy efficiency goals and represents a significant step toward achieving the Champaign community's vision for sustainable development. The Illinois Climate Action Plan (iCAP) outlines the campus' strategy to achieve carbon neutrality—or net-zero greenhouse gas (GHG) emissions—by 2050, or sooner. The updated 2020 iCAP identifies 56 SMART (specific, measurable, achievable, relevant, and time-based) objectives across eight thematic areas: Energy, Transportation, Land & Water, Zero Waste, Education, Engagement, Resilience, and Implementation.

**Table 3-1 Summary of 2020 Land Use/Land Cover within the Project Site and Region**

| NLCD [2016] Land Cover Class | Project Site | | | Region | | |
|---|---|---|---|---|---|---|
| | acres | hectares | Percent | acres | hectares | Percent |
| Water | **0.00** | 0.00 | 0.0% | 131.3 | 53.1 | 0.3% |
| Developed, Open Space | 0.00 | 0.00 | 0.0% | 3257.0 | 1318.1 | 6.5% |
| Developed, Low Intensity | 0.00 | 0.00 | 0.0% | 11914.4 | 4821.6 | 23.7% |
| Developed, Medium Intensity | 0.83 | 0.33 | 83.6% | 9237.3 | 3738.2 | 18.4% |
| Developed, High Intensity | 0.16 | 0.07 | 16.4% | 3389.7 | 1371.8 | 6.7% |
| Barren Land (Rock/Sand/Clay) | 0.00 | 0.00 | 0.0% | 44.3 | 17.9 | 0.1% |
| Deciduous Forest | 0.00 | 0.00 | 0.0% | 233.7 | 94.6 | 0.5% |
| Evergreen Forest | 0.00 | 0.00 | 0.0% | 2.8 | 1.1 | 0.0% |
| Mixed Forest | 0.00 | 0.00 | 0.0% | 291.5 | 118.0 | 0.6% |
| Shrub/Scrub | 0.00 | 0.00 | 0.0% | 26.6 | 10.8 | 0.1% |
| Herbaceous | 0.00 | 0.00 | 0.0% | 801.0 | 324.2 | 1.6% |
| Hay / Pasture | 0.00 | 0.00 | 0.0% | 20890.2 | 8454.0 | 41.6% |
| Cultivated Crops | 0.00 | 0.00 | 0.0% | 39.9 | 16.2 | 0.1% |
| Woody Wetlands | 0.00 | 0.00 | 0.0% | 4.8 | 1.9 | 0.0% |
| Emergent Herbaceous Wetlands | 0.00 | 0.00 | 0.0% | 131.3 | 53.1 | 0.3% |
| **Total** | **0.99** | **0.40** | **100.00%** | **50,264.6** | **20,341.4** | **100.0%** |

Source: Reference 7-9

**Figure 3-1 Licensed Area Land Cover**

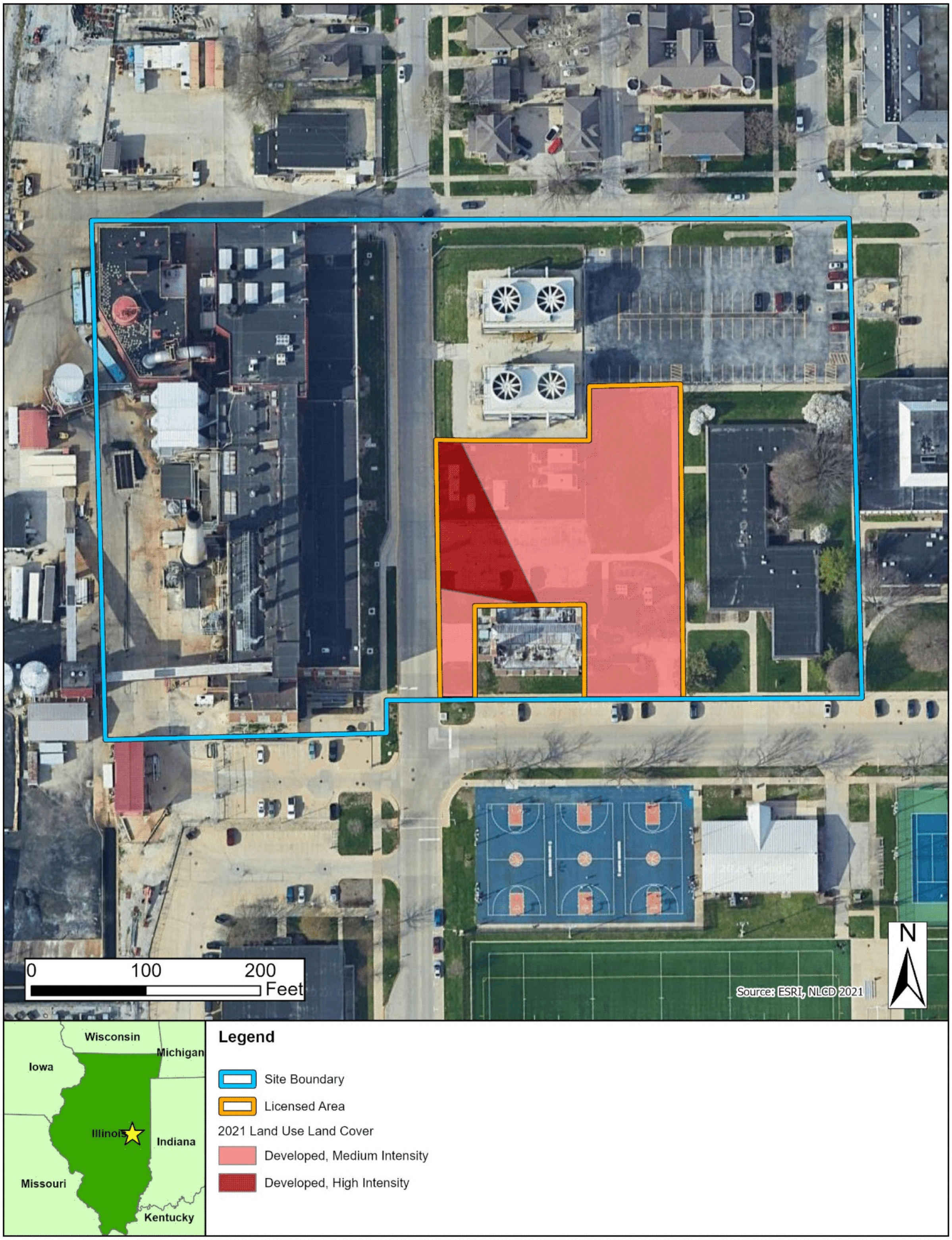


**Figure 3-2 Major Land Uses in the 5-Mile Region**

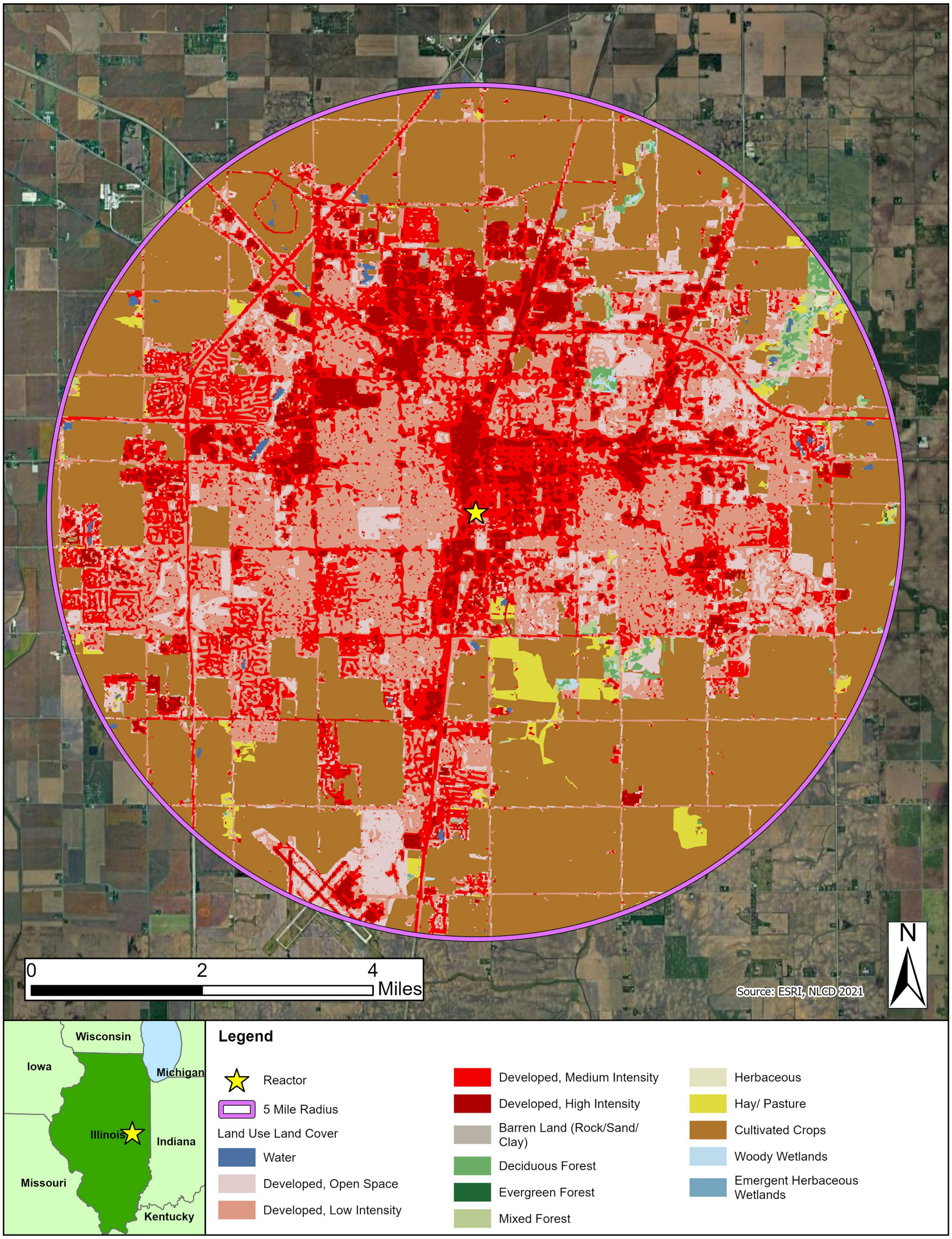
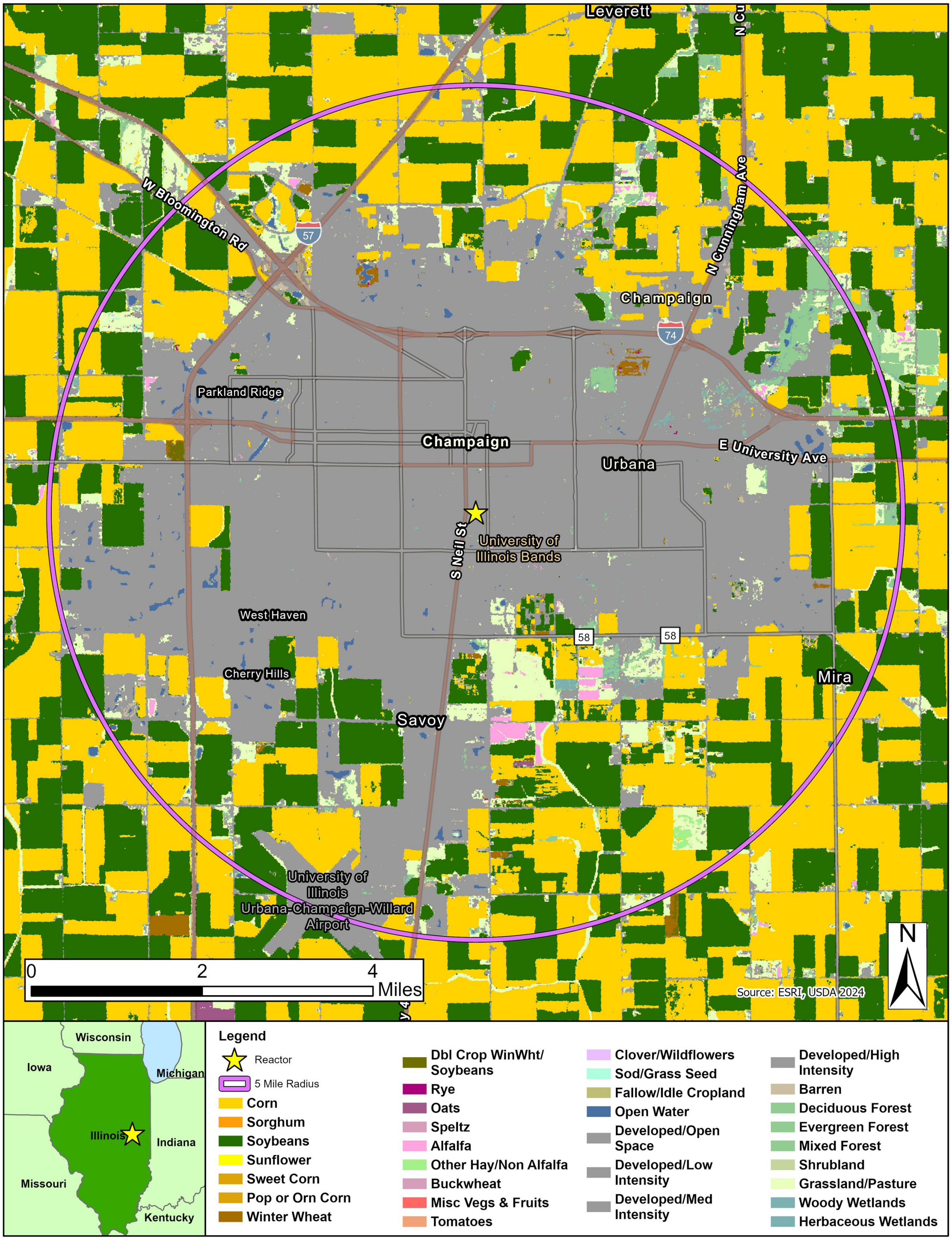


**Figure 3-3 2020 Cropland Within 5 Miles of the Site**



## 3.2 AIR QUALITY AND NOISE

### *3.2.1 Regional Climatology*

Climate represents the long-term, statistical expression of atmospheric conditions – typically averaged over several decades – whereas weather describes short-term (minutes to months) variations. To characterize the prevailing climate at a specific location, multiple information sources were utilized:

- Synoptic weather maps that capture broad, instantaneous atmospheric patterns
- Climatic atlas products summarizing long-term regional trends
- Instrumental records from National Weather Service (NWS) and other monitoring stations
- Published climatic normal (e.g., 30-year datasets) compiled by the National Oceanic and Atmospheric Administration (NOAA) and the Illinois State Climatologist

The objective is to place the U. of I. research reactor within the broader climatic context of east-central Illinois and the surrounding Midwest. The assessment begins with large-scale regional patterns, then progressively narrows to local monitoring stations, which are the most representative of on-site conditions. This tiered approach yields a defensible description of site climate within the U.S. Midwest/Upper Mississippi River Valley setting.

The Licensed Area occupies 1.01 acres (0.41 hectares) on the western edge of the U. of I. campus in Champaign County, approximately:

- 80 miles (130 km) southeast of Peoria, Illinois
- 120 miles (190 km) west of Indianapolis, Indiana
- 130 miles (210 km) south of Chicago, Illinois

Its location, relative to the region, is illustrated in Figure 3-4. Its location, relative to the U. of I. campus, is illustrated in Figure 3-5.

**Macro-Scale Climate Controls**

Illinois sits midway between the Rocky Mountain Continental Divide and the Atlantic seaboard. The climate is typically continental with cold winters, warm summers, and frequent short fluctuations in temperature, humidity, cloudiness, and wind direction (Reference 7-20). The state's continental climate is shaped primarily by:

- Latitude – Governs solar radiation receipts, with pronounced seasonal contrasts.
- Synoptic weather systems – Frequent passage of polar and tropical air masses, guided by the polar jet stream (especially active from autumn through spring), produces rapid shifts in temperature, humidity, wind, and cloud cover. High-pressure systems bring calm, clear conditions that are regularly interrupted by low-pressure systems delivering clouds, gusty winds, and precipitation.

Topographically, east-central Illinois is predominantly flat, providing little orographic influence on local weather.

**Urban-Rural Contrast**

Urbanization modulates the microclimate. Surfaces such as buildings, pavement, and other impervious features create urban heat-island effects – exemplified by Chicago, IL, which records average night-time temperatures roughly 2 degrees Fahrenheit (°F) warmer than adjacent rural zones. Urban areas can also amplify warm-season convective precipitation and subtly alter humidity, cloud-cover, and near-surface wind patterns (Reference 7-20).

**Local Climate Characteristics (Urbana-Champaign)**

Based on the 1991-2020 National Climatic Data Center (NCDC) (Reference 7-21) climatic normals for Willard Airport (the closest long-term station), key parameters include:

- Temperature
  - January: mean daily maximum temperature is 33.5°F (0.8 degrees Celsius [°C]), mean daily minimum temperature is 17.9°F (-7.8 °C)
  - July: mean daily maximum temperature is 85.2°F (29.6 °C), mean daily minimum temperature is 65.2°F (18.4 °C)
- Precipitation averages: 41 inches (104 centimeters [cm]) annually.
  - Wettest period: May to July (13.8 inches/ 35 cm)
  - Driest period: December to February (6.9 inches / 17.5 cm)
- Snowfall Average: 20.8 inches (52.8 cm) per season, generally November-March
- Relative humidity: Annual mean ~ 77% (2012-2022 Willard Airport Local Climatological Data) (Reference 7-22).

Drought is an inherent aspect of Illinois's hydroclimate. Since 1965, three notable extreme drought episodes – 1988-1989, 2012 and 2025 – have affected the state (Reference 7-23, Reference 7-24).

Additional information on severe convective storms, winter storms, and other extreme events relevant to design considerations is provided in Section 3.2.3.

### *3.2.2 Regional Air Quality*

Champaign County is currently in attainment for all criteria pollutants, including ozone, particulate matter, carbon monoxide, nitrogen oxides (NOx), sulfur dioxide, and lead (Reference 7-25). Geographic areas that have previously experienced non-attainment but are now in compliance with the National Ambient Air Quality Standards are designated as "maintenance areas." However, no parts of Champaign County have a history of non-attainment, nor are they classified as maintenance areas. Furthermore, none of the counties surrounding Champaign County are designated as non-attainment areas. The nearest non-attainment and maintenance areas are in counties located adjacent to Chicago and Peoria, Illinois, and St. Louis, Missouri (Reference 7-25).

The Prevention of Significant Deterioration program is a federal permitting initiative that applies to sources classified as major sources or major modifications to existing sources, as defined in 40 Code of Federal Regulations (CFR) 52.21, and located in attainment areas. For the purposes of this air quality analysis, a threshold of 250 tons per year of any criteria pollutant, as specified in 40 CFR 52.21, will be used to assess the significance of air quality impacts associated with operations.

The primary objective of the Prevention of Significant Deterioration program is to prevent the degradation of air quality in areas where air quality is currently good. The program establishes mandatory Class I areas, which are designated for their pristine air quality and important visibility values. Class I areas include national parks larger than 6,000 acres (2,428 hectares) and national wilderness areas exceeding 5,000 acres (2,023 hectares). All other areas are classified as Class II and receive less stringent protections (Reference 7-26, Reference 7-27).

The nearest Federal Class I areas are Mammoth Cave National Park in Kentucky, located approximately 230 miles (370 kilometers) southeast of the site, and the Mingo Wilderness Area in Missouri, situated about 240 miles southwest (386 kilometers), as illustrated in Figure 3-6. Table 3-2 lists all the nearest Class I areas. These distances, which exceed 186.4 miles (300 km) from the project site, suggest that the effects of project emissions on Air Quality Related Values, such as visibility and acidic deposition, may be exempted from consideration. According to the "FLAG 2010" guidance (Reference 7-28), effects need not be evaluated if the combined project emissions are less than the "10D" threshold. Specifically, if the planned short-term allowable emissions for the project of sulfur dioxide, NOx, sulfuric acid, and particulate matter, expressed in tons per year, are less than 3,700 tons per year (which is ten times the distance in kilometers to the nearest Class I area), then visibility and acidic deposition effects are assumed to be minor and do not require further evaluation (Reference 7-28).

### *3.2.3 Severe Weather*

Severe weather phenomena necessitate careful consideration in the design of safety-related structures, systems, and components, and it is essential to evaluate the effects of such weather on plant safety. The statistics on severe weather phenomena presented in the following sections are derived from historical data. Most of the data is sourced from the NCDC Storm Events Database, which covers a 75-year period from 1950 to 2025; however, longer data periods are utilized for certain phenomena to better capture the occurrence of rare events.

#### *3.2.3.1 Extreme Wind*

Windstorms, while relatively infrequent, can occur several times a year, typically in association with thunderstorms. Moderate to strong winds often accompany migrating cyclones and air mass fronts. These strong winds are generally linked to lines of thunderstorms that develop along or ahead of cold fronts and are more likely to occur in late winter and spring than at any other time of the year. Brief, intense gusts of wind can result from downdrafts and outflow from individual thunderstorms, although such occurrences are usually confined to large, intense thunderstorms that develop during the spring and summer. Estimated extreme wind speeds are based on climatological data from Willard Airport (Reference 7-22).

Hourly averaged (scalar) wind speeds at the 32 feet (10-meter) level are recorded every 10 seconds and averaged over the hour, as reported by the Illinois Climate Network (2025). Data from the Illinois Prairie Research Institute Water and Atmospheric Resources Monitoring Program are available for the period from 1989 to 2024. The maximum hourly averaged wind speed for the 35 years analyzed (1989-2024) was 58.9 miles per hour (mph) (Reference 7-29). Table 3-3 presents the average daily wind speeds and maximum wind speeds for 2020 - 2024. The highest wind gust recorded by the NCDC Local Data Collection was 76 mph between 2015 and 2025 (Reference 7-22).

Tropical storm and hurricane winds primarily pose a concern for coastal locations, as illustrated by the wind speed contours in Regulatory Guide 1.221 and NUREG/CR-7005. Due to the rapid dissipation of hurricane winds as they move inland from their oceanic energy sources, such winds are not a concern for the project site, which is located more than 600 miles (965 kilometers) from the Atlantic Ocean and the Gulf of Mexico. The wind speed contours in Regulatory Guide 1.221 and NUREG/CR-7005 terminate well before reaching the site, with a maximum wind speed contour of 130 mph (209 kmh). A review of the NCDC Storm Events Database from January 1, 1950, to June 30, 2025, indicates that there have been no weather events attributed to hurricanes or tropical storms in this area (Reference 7-30).

#### *3.2.3.2 Tornadoes and Waterspouts*

Illinois ranks high in the frequency of tornado occurrences. The peak tornado season in the state typically spans from April to June, with an average of 54 tornadoes reported annually based on data from 1991 to 2020. Notably, a record 142 tornadoes were documented in 2024 (Reference 7-31).

During the 75-year period from 1950 to 2025, Champaign County reported 81 tornadoes, with 27 of these occurring within 10 miles of the project site (Table 3-4). The intensities of these tornadoes ranged from F0/EF0 to F3/EF3 (Reference 7-32). According to the tornado strike probability data presented in NUREG/CR-4461, there were 384 tornado events recorded from 1950 through August 2003 within a 2-degree box that includes Champaign County, resulting in an average of seven tornado events per year within this area. The tornado strike probability area, as outlined in NUREG/CR-4461, is illustrated in Figure 3-7. Additionally, the Tornado Risk Assessment provided by NOAA indicates that there were 478 tornado events from 1950 to 2019 within an 80-km radius of the Champaign zip code, yielding an annual average of seven tornado strikes in this region.

#### *3.2.3.3 Water Equivalent Precipitation Extremes*

Historical precipitation data for the site were obtained from several NWS sites (Reference 7-33, Reference 7-34, Reference 7-35, Reference 7-36, Reference 7-37) and the Illinois State Climatologist (Reference 7-31), summarized in Table 3-5. The similarity in maximum recorded 24-hour and monthly totals among these stations, along with their distribution around the site, suggests that these statistics are reasonably representative of the precipitation extremes expected at the site.

Droughts were relatively common in the early 20th century but have become much rarer since 1965. Since that time, extreme drought conditions have occurred only twice, in 1988-1989 and 2012. These recent droughts were shorter and less intense than many of those experienced in the early 20th century (Reference 7-23). The maximum estimated annual precipitation ranges from 24 to 42 inches (60 to 106 cm), with the maximum 24-hour rainfall recorded at less than 10 inches (25 cm) and the maximum monthly rainfall at approximately 20 inches (50 cm) (see Table 3-5). The average annual snowfall in the vicinity of the site is between 20 and 24 inches (50 and 60 cm), with normal and extreme snowfall events discussed in Section 3.2.3.4.

### 3.2.3.4 Hail, Snowstorms, and Ice Storms

In Champaign County, severe hail (defined as 3/4 inch in diameter or larger) has been reported 134 times from 1950 to 2025 (Reference 7-38), averaging less than two severe hail events per year. Statewide, annual average hail days range from 3.3 days in the southwest to less than 1.8 days in the northeast (Reference 7-20).

The maximum reported snow depth in the Urbana-Champaign area during the 30-year record was 19 inches (48 cm) in February 1982 (Reference 7-39). Snowfall records from stations around the site (Table 3-5) indicate a maximum 24-hour snowfall of 18.6 inches (47 cm) recorded in Chicago in January 1999 and 13 inches (33 cm) in Lincoln in February 1914 (Reference 7-33, Reference 7-37).

Frost penetration depth is crucial for protecting water lines and other buried structures from freeze damage. In Champaign County, frost depth typically reaches around 20 inches (50 cm), with extreme depths recorded at approximately 30 inches (Reference 7-40; Reference 7-41).

Estimates of regional ice (glaze) probabilities have been provided by Tattelman and Gringorten (Reference 7-42). For Region II, which includes Illinois, storms producing ice thicknesses of 1 inch (2.5 cm) or greater occurred 15 times over a 50-year period, while storms with ice thicknesses of 2 inches (5 cm) or greater occurred 3 times in the same timeframe. Historical data from 1900 to 1960 indicate 102 severe winter storms that produced 6 or more inches of snow within 48 hours or glaze covering 5,000 square miles or more of the state (Reference 7-23).

According to the American Society of Civil Engineers (ASCE) Standard No. 7-22 (Reference 7-43), the 500-year mean recurrence interval for uniform ice thickness resulting from freezing rain in Champaign County is estimated at 2.0 inches (5 cm), with a concurrent 3-second wind gust of 40 mph (64 kph). For glaze ice, the probabilities for ice thicknesses of 0.25 inches (0.63 cm) and 0.5 (1.27 cm) inches are approximately 0.343 and 0.28, respectively, in any given year (Reference 7-42). While glaze ice thicknesses of less than 0.5 inches typically result in minimal structural damage, such storms can create travel hazards in affected areas and may damage above-ground utility wires when combined with strong winds.

### 3.2.3.5 Thunderstorms and Lightning

Thunderstorms contribute to 50-60 percent of annual precipitation in Illinois and are quite common, with an annual average of 60 storms in the far northeast and up to 80 storms in the southwest. Nearly half of all thunderstorm days occur during the June to August period. The annual average number of cloud-to-ground lightning strikes per square mile ranges from 5 strikes in the northeast to more than 11 strikes in the southwest (Reference 7-20).

A nationwide study utilizing cloud-to-ground lightning flash data from the U.S. National Lightning Detection Network examined the temporal and spatial distributions of lightning from 1992 to 2018. Based on this data, the project site can expect between 34 and 65 days with thunderstorms annually, averaging 4 to 8 cloud-to-ground lightning flashes per square kilometer each year (Reference 7-44).

### 3.2.3.6 Snowpack and Probable Maximum Precipitation

Snowpack, as used in this section, is defined as a layer of snow and/or ice on the ground surface, and is usually reported daily, in inches, by the NWS at all first-order weather stations. Historical snowpack and snowfall were developed by reviewing data from first-order NWS stations and the cooperative network.

From Figure 7.2-1 of ASCE No. 7-22 (Reference 7-43), the 50-year mean recurrence interval snowpack for Champaign County is 29 pounds per square foot (psf).

The maximum reported snow depth for Urbana-Champaign was used to estimate the weight of the maximum historic snowpack at the site. The greatest snow depth reported since 1903 was 19 inches (48.3 cm) in February 1982 (Reference 7-20). Interim Staff Guidance (ISG) on Assessment of Normal and Extreme Winter Precipitation Loads on the Roofs of Seismic Category I Structures (ISG-007) (Reference 7-45), provides an algorithm (below) for converting historical maximum snowpack depth to a ground snow load.

$$L = 0.279D^{1.36} \qquad \text{Equation 3-1}$$

where, D is the snowpack depth in inches and L is the resulting snow load in psf.

Using the 19-inch (48.3-cm) snow depth for Urbana-Champaign gives a snow load of 15.3 psf for the maximum historical snowpack.

The 100-year return period snowfall event is given in data provided by the NCDC. Based on these data, the 48-hour 100-year return snowfall event for Urbana-Champaign is 15 inches (38.1 cm) during a January 1999 snowstorm (Reference 7-20) and 29 inches (73.7 cm) for Chicago during a January 1979 snowstorm (Reference 7-34). The equation below from ISG-7 was used to determine the snow load due to the 48-hour 100-year return period snowfall event and the historical maximum snowfall event.

$$L = 0.15 \times S \times 5.2 \qquad \text{Equation 3-2}$$

where L is the snow load in psf and S is the snowfall depth in inches.

Using the maximum 100-year return snowfall event of 15 inches results in a snow load of 11.7 psf. Using a 23-inch (58.4-cm) historical maximum snowfall event for a 48-hour period results in a snow load of 17.9 psf. The governing design snow load is taken as the maximum of the ASCE No. 7-22 value and the site-specific value (Reference 7-43).

The Normal Winter Precipitation Event, defined as the maximum ground-level weight (psf) of the (1) 100-year snowpack (snow cover), (2) historical snowpack (snow cover), (3) 100-year return 2-day snowfall event, or (4) historical maximum 2-day snowfall event, is determined to be 17.9 psf. The Extreme Frozen Winter Precipitation Event, defined as the maximum of the (1) 100-year return 2-day snowfall event or (2) historical maximum 2-day snowfall event, is also determined to be 17.9 psf.

From Hydro-Meteorological Report HMR-53, NUREG/CR-1486, the 48-hour Probable Maximum Winter Precipitation (January through March) for a 10 square-mile (25.8 square kilometer) area is estimated to be 23.5 inches (59.7 cm) by logarithmic interpolation. The March probable maximum precipitation was utilized because the historically deepest snowpack occurred in March 1993. The 48-hour probable maximum precipitation is equivalent to the Extreme Liquid Winter Precipitation Event.

*3.2.3.7 Extreme Temperatures*

Temperature data for Urbana-Champaign (Reference 7-22, Reference 7-46 is presented in Table 3-6. Normal daily maximum temperatures ranged from about 32 °F (0 °C) in mid-winter to about 85°F (29.4 °C) in mid-summer. The normal daily minimum temperatures ranged from about 16°F (-8.8 °C) in mid-winter to about 64°F (17.7 °C) in mid-summer. The record high temperature recorded was 109°F (42.7 °C) (July 1954) and the record low of -24°F (-31.1 °C) was recorded four times (February 1899, February 1905, January 1994, and January 1999) (Reference 7-20).

*3.2.3.8 Restrictive Dispersion Conditions*

Dispersion conditions are influenced by several factors, including plume density, atmospheric stability, wind speed, the presence of buildings, and the distance to the observer or receptor. The releases from the research reactor will be either neutrally or positively buoyant, although nearby buildings can significantly impact dispersion. Buildings create turbulence and eddies in the airflow, which can increase the width of the plume and enhance the entrainment of air into the plume, resulting in greater dispersion. Consequently, buildings typically enhance dispersion closer to the source, leading to lower ground-level concentrations at greater distances. However, they can also bring elevated plumes closer to the ground near the source and inhibit dispersion, depending on the release height of the plume and the direction of the prevailing winds. For example, a ground-level release situated between two buildings may experience minimal dispersion, resulting in increased plume concentration (Reference 7-47).

The speed of prevailing winds, in conjunction with atmospheric stability, plays a critical role in the dispersion characteristics of a plume. Higher wind speeds generally facilitate more effective dispersion than lower wind speeds, while stable atmospheric conditions tend to limit both lateral and vertical spreading of the plume, resulting in reduced dispersion compared to unstable conditions. The most constraining scenario for ground-level releases occurs under low wind speeds and stable atmospheric conditions. Conversely, for elevated releases associated with the proposed project, the most constraining scenario is likely to involve moderate wind speeds combined with neutral atmospheric conditions.

Figure 3-8 illustrates calculations of the dosage of a radioactive substance over distance, produced by the U.S. Nuclear Regulatory Commission (NRC) for several scenarios (Reference 7-48, Reference 7-49). Two combinations of wind speed and atmospheric stability were analyzed: (1) a wind speed of 3.28 feet (1.0 meter) per second in a moderately stable atmosphere and (2) a wind speed of 14.76 feet (4.5 meters) per second in a neutral atmosphere. The analysis considered both ground-level releases and buoyant plume releases from a source 65.6 feet (20 meters) tall, assuming a person standing in an open field along the plume centerline downwind of the source. The results indicate that restricted dispersion, combined with limited plume height—whether from a ground-level or buoyant elevated plume—results in peak ground-level concentrations. Under low wind speeds and moderately stable conditions, concentrations remain relatively significant over a considerable distance, extending up to 1,400 meters from the source for both ground-level and elevated plume releases. In contrast, under moderate winds and a neutral atmosphere, ground-level concentrations of the plume decrease with distance, becoming moderately reduced beyond 3,937 feet (1,200 meters) from the source for both types of releases.

### *3.2.4 Local Meteorology*

#### *3.2.4.1 Topography*

The topography of an area can influence the local climate. Illinois is generally flat, lying wholly within the Central Plains, with gentle sloping hills and shallow river valleys. The site is in central Illinois, which is mostly flat prairies and till plains. The till plains were carved and leveled by glaciers, allowing a similar climate to prevail over the entire area. The climate is typically continental with frequent short fluctuations in temperature, humidity, cloudiness, and wind direction.

The site is located at an elevation of approximately 765 feet (233 meters) above mean sea level. Figure 3-9 through Figure 3-12 show the elevation profiles within 50 miles of the site in each of eight compass directions (at 45-degree intervals).

#### *3.2.4.2 Local Data Sources*

Meteorological data are collected at different levels above the ground, to 196 feet (60 meters) at some towers, assessing the vertical structure of the atmosphere, particularly with respect to wind shear and stability. Stable boundary layers and significant wind shear zones can significantly affect the movement of a plume after a facility release. Data are collected at the 32- or 49-feet (10- or 15-meter) level at most towers. Temperature, relative humidity, and precipitation are measured at some sites at 6.5 feet (2 meters), but wind speed and wind direction typically are not. Tower height will vary depending on the surrounding topography and data to be collected.

There are 44 meteorological towers in the proximity of the site monitoring various data. The State Climate Office operates the NOAA cooperative weather observation station for Urbana-Champaign (CHAMPAIGN 3S) located approximately 1.5 miles (2.4 kilometers) south of the site. This tower is also known as the Illinois Climate Network Champaign meteorological station (U. of I. Met Station). Local climatological data were also obtained from Willard Airport located about 5 miles (8 kilometer) southwest of the site.

#### *3.2.4.3 Plans to Access Local Meteorological Data During License Period*

U. of I. is relying upon existing measurements to fulfill its requirement for pre-operational site-specific meteorological monitoring. The three stations that will be used in the development of the meteorology and modeling: the U. of I. Meteorological Station will serve as a proxy for on-site wind data; the Willard Airport meteorological station will be used for development of the surface meteorology; and the Lincoln-Logan County Airport (approximately 300 miles (482 kilometer) to the west) meteorological station will provide upper air meteorology. The locations of these towers are provided in Figure 3-13.

*3.2.4.4 Comparison of Local and Regional Wind Roses*

Tower data from Willard Airport are presented as wind roses in Figure 3-14 through Figure 3-17. Data presented includes 1996 to December 2025 and calendar years 2024, 2023, and 2022, respectively. For comparison, a wind rose for Chicago Midway Airport, based on 39 years of data (1996 through 2025), is presented in Figure 3-18.

Wind speeds at Willard Airport were generally light with an average wind speed of 10.8 mph (17.4 kph) over the 73-year period. Wind speed and direction have remained consistent (Reference 7-50).

Mountains of the western United States and the High Plains have greater wind speeds. In general, trees and hilly terrain slow down the winds. The site is in an urban area of nearly flat terrain. The urban setting will influence the air flow patterns around the site.

*3.2.4.5 Atmospheric Stability*

The NRC's preferred method for computing atmospheric stability is based on the temperature difference between two measurement levels, e.g., between the upper and lower measurement levels. However, alternative methods for determining atmospheric stability, e.g., based upon sigma-theta, sigma-phi, or wind and cloud cover (Turner stability class) are allowed by Regulatory Guide (RG) 1.23, Rev. 1.

Nearby representative meteorology measuring one of the two parameters (delta T, the difference in ambient temperature at two regulated heights or sigma-phi, a measure of the standard deviation of elevation angle (phi) of the vertical wind direction) for determining atmospheric stability classes are not available for the preferred (temperature difference) metric. An alternative means to obtain stability classes using available nearby meteorological data is allowed by RG 1.23, Rev. 1 using Turner stability classes derived from regional cloud cover. Cloud cover data are available from the nearby Willard Airport automated surface observing system.

***3.2.5 Programs or Policies to Reduce Greenhouse Gas Emissions***

U. of I. is committed to minimizing its carbon footprint and promoting initiatives to reduce emissions of greenhouse gases. In 2008, the campus signed the American College and University President's Climate Commitment, formally committing to become carbon neutral as soon as possible, and no later than 2050.

The iCAP (Reference 7-19) outlines a comprehensive approach to campus sustainability with an acute focus on GHGs. Goals of this plan targeting GHGs include:

- Using at least 140,000 megawatt hours per year of clean power (about 30 percent of the annual power demand) by Fiscal Year (FY) 2025.
- Divesting the endowment and all University of Illinois System funds from fossil fuels, reinvesting U. of I. financial resources in sustainable and socially responsible funds and making all investments more transparent.
- Decarbonizing the campus thermal energy systems, specifically Abbott Power Plant, and increasing U. of I. energy procurement from renewable sources.
- Establishing written replacement plans for at least 80 percent of campus fleets by FY 2024.

- Establishing an Electric Vehicle Task Force to identify key goals for supporting the use of electric vehicles on and off campus by FY 2022.
- Reducing driving on campus and report the percentage of staff trips made using single-occupancy vehicles from 60 percent to 50 percent by FY 2025 and 45 percent by FY 2030.
- Developing a Commuter Program (bus, bike, and hike) for faculty and staff. Register 100 people by FY 2024 and 500 people by FY 2030.

### *3.2.6 Noise*

Noise is defined as an unwanted or unwelcome sound, typically resulting from human activities, that intrudes upon the natural acoustic environment of a locale. It disrupts normal activities and diminishes the quality of the surrounding environment. Sound pressure levels are quantified in decibels (dB). To create a standardized measurement that reflects human perception of loudness and annoyance, the decibel measurement is weighted to emphasize frequencies that are most audible to the human ear. This is referred to as the A-weighted sound level, or dBA.

The dBA scale is based on sound intensity and is adjusted for frequency because the human ear does not perceive all frequencies equally. As the dBA level increases, the risk of hearing damage also increases. Common noise levels measured in dBA for various activities and events illustrate this concept (Reference 7-51, Reference 7-52, Reference 7-53). For most individuals to notice an increase in noise, the change must be at least 3 dBA. A change of 5 dBA is typically readily noticeable.

- 0 dBA – the softest sound a person can hear with normal hearing
- 10 dBA – normal breathing
- 20 dBA – average whispering at 5 feet (1.5 m), rustling leaves
- 30 dBA – quiet rural area
- 50 dBA – quiet suburb, moderate rainfall,
- 60 dBA – normal conversation
- 80 dBA – garbage disposal, freight train at 50 feet (15 m)
- 90 dBA – subway, passing motorcycle at 25 feet (7.6 m)
- 110 dBA – auto horn at 3.1 feet (1 m),
- 120 dBA – thunder, chain saw
- 140 dBA – Near jet engine

The sound pressure level measured in dBA reflects noise levels at a specific moment in time; however, since most noises are not constant, alternative methods for describing noise over extended periods have been developed. One such method involves characterizing fluctuating sound over a specific time period as if it were a steady, unchanging sound. This is achieved through a descriptor known as the equivalent sound level ($L_{eq}$). $L_{eq}$ represents the constant sound level that conveys the same sound energy as the actual time-varying sound over a given situation and time period, such as one hour (denoted as $L_{eq}(1)$) or 24 hours (denoted as $L_{eq}(24)$).

The Day-Night Sound Level ($L_{dn}$) is another important metric, representing the 24-hour average noise level with a 10 dB penalty applied to noise levels occurring between 10 PM and 7 AM. This penalty accounts for increased sensitivity to noise during nighttime hours (Reference 7-51).

The project site is situated near the center of Champaign, with the nearest noise receptors within a 5-mile (8-km) radius including the U. of I. campus, which is immediately adjacent, as well as several schools, parks, churches, and country clubs. The closest residential areas consist of campus housing located less than 0.25 miles (0.40 kilometers) east of the proposed site. Additionally, a railroad station is located approximately 0.75 miles (1.2 kilometers) to the north, and Willard Airport is situated about five miles to the south, both of which contribute to the overall noise environment.

#### *3.2.6.1 Baseline Noise Study*

This section presents the methods and results of baseline noise monitoring collected at one monitoring site around the project site from September 26 to September 27, 2022 (Reference 7-54). These results will be used in the assessment of potential noise effects to the community around the project site from the proposed project in the future.

##### *3.2.6.1.1 Selection of Noise Receptor*

One receptor location within the project site was selected for ambient noise monitoring for establishing baseline ambient noise conditions. This receptor location was within the unpaved grass area between the GSL parking lot and the U. of I. Personnel Services building.

##### *3.2.6.1.2 Noise Monitoring*

The baseline noise monitoring program was conducted between September 26 to September 27, 2022. At the receptor location the noise monitoring was conducted over approximately 24 hours measuring both daytime and nighttime ambient noise conditions around the project site (Reference 7-54).

##### *3.2.6.1.3 Existing Noise Levels*

The measured ambient noise levels at the site show relatively constant noise exposure levels within both daytime and nighttime hours during a typical weekday. These measured levels are considered representative of an ambient noise environment common to a neighborhood area immediately around a power plant and its cooling fans where the project is located. The $L_{dn}$ was calculated as 69.47 dBA. The $L_{dn}$ refers to a 24-hour average noise level with a 10 dB penalty applied to the noise levels during the hours between 10 PM and 7 AM, due to increased sensitivity to noise levels during these hours. The fluctuation in noise over a specific time period, the $L_{eq}$, over one-hour monitoring periods ranged from 62.7 to 63.8 dBA (Reference 7-54).

**Table 3-2 Nearest Federal Class I Areas to the Site**

| Class I Area/Federal Land Manager | Approximate Distance from Project Site (km) | Approximate distance from Project Site (miles) | Direction from Project Site |
|---|---|---|---|
| Mammoth Cave National Park - Kentucky | 370 | 230 | Southeast |
| Mingo Wilderness Area - Missouri | 390 | 240 | Southwest |
| Hercules-Glades Wilderness Area - Missouri | 560 | 348 | Southwest |
| Great Smoky Mountains National Park - Tennessee | 650 | 404 | Southeast |

**Table 3-3 Average (Scalar) Wind Speed, Meteorological Tower**

| Period of Record | 2020 | | 2021 | | 2022 | | 2023 | | 2024 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Average Wind Speed (mph) | Max Wind Speed (mph) | Average Wind Speed (mph) | Average Wind Speed (mph) | Average Wind Speed (mph) | Max Wind Speed (mph) | Average Wind Speed (mph) | Max Wind Speed (mph) | Average Wind Speed (mph) | Max Wind Speed (mph) |
| January | 4.9 | 35.9 | 4.9 | 25.8 | 5.6 | 27.8 | 5.3 | 28.9 | 5.6 | 31.5 |
| February | 5.5 | 28.3 | 6.1 | 34.2 | 5.6 | 32.5 | 5.6 | 34.1 | 5.0 | 31.7 |
| March | 5.4 | 34.5 | 5.6 | 38.8 | 5.8 | 32.4 | 6.3 | 49.8 | 6.1 | 30.3 |
| April | 5.1 | 32.6 | 5.0 | 26.0 | 5.9 | 32.2 | 4.9 | 34.4 | 5.5 | 34.2 |
| May | 3.7 | 31.3 | 3.5 | 26.8 | 3.7 | 23.3 | 3.1 | 27.1 | 2.9 | 22.5 |
| June | 2.9 | 28.0 | 2.6 | 26.9 | 2.6 | 18.7 | 3.1 | 54.9 | 3.0 | 33.2 |
| July | 2.2 | 27.4 | 2.5 | 19.9 | 2.5 | 20.7 | 2.4 | 23.5 | 2.4 | 29.3 |
| August | 2.3 | 31.3 | 2.1 | 29.5 | 2.4 | 24.8 | 2.6 | 28.9 | 2.4 | 44.3 |
| September | 2.8 | 25.6 | 2.7 | 24.3 | 2.4 | 33.0 | 2.0 | 19.9 | 2.8 | 30.9 |
| October | 3.3 | 21.4 | 2.7 | 20.7 | 3.2 | 24.1 | 2.8 | 25.3 | 2.4 | 24.2 |
| November | 4.9 | 40.8 | 3.7 | 27.5 | 5.1 | 29.3 | 3.9 | 25.1 | 4.6 | 33.5 |
| December | 4.8 | 34.0 | 5.0 | 36.1 | 5.6 | 34.7 | 4.2 | 24.9 | 5.2 | 27.3 |
| Overall | 4.0 | 40.8 | 3.9 | 38.8 | 4.2 | 34.7 | 3.8 | 54.9 | 4.0 | 44.3 |

Source: Reference 7-29; Section 3.2.3.1

**Table 3-4 Tornadoes within 10 Miles of the Site**

| Date | Counties Affected | Magnitude (WS range) | Length (miles) | Width (yards) | Closest Distance to the Site (miles) |
|---|---|---|---|---|---|
| 05/13/2025 | Champaign | EFU (Unknown) | 0.05 | 10 | 2.45 |
| 03/14/2025 | Champaign | EF1 (86-110 mph) | 13.72 | 450 | 7.51 |
| 02/27/2023 | Champaign | EFU (Unknown) | 1.53 | 25 | 4.34 |
| 02/27/2023 | Champaign | EF0 (65-85 mph) | 1.14 | 30 | 5.92 |
| 05/26/2019 | Champaign | EF1 (86-110 mph) | 1.01 | 250 | 6.18 |
| 05/26/2019 | Champaign | EF1 (86-110 mph) | 0.85 | 250 | 0.32 |
| 05/26/2019 | Champaign | EF1 (86-110 mph) | 0.9 | 250 | 0.34 |
| 06/07/2015 | Piatt and Champaign | EF0 (65-85 mph) | 1.18 | 25 | 10.9 |
| 11/17/2013 | Champaign | EF3 (136-165 mph) | 14.67 | 880 | 10.5 |
| 05/25/2011 | Champaign | EF0 (65-85 mph) | 0.2 | 15 | 8.7 |
| 04/02/2006 | Champaign | EF0 (65-85 mph) | 0.1 | 30 | 1.0 |
| 05/31/2006 | Champaign | EF0 (65-85 mph) | 1.2 | 50 | 7.6 |
| 05/31/2006 | Champaign | EF0 (65-85 mph) | 0.4 | 50 | 8.0 |
| 04/20/2004 | Champaign | EF0 (65-85 mph) | 0.1 | 50 | 8.5 |
| 06/10/2004 | Champaign | EF0 (65-85 mph) | 0.7 | 10 | 8.0 |
| 06/10/2004 | Champaign | EF0 (65-85 mph) | 0.5 | 10 | 8.5 |
| 07/09/2003 | Champaign | EF0 (65-85 mph) | 0.1 | 10 | 1.0 |
| 08/18/2001 | Champaign | EF0 (65-85 mph) | 0.1 | 5 | 8.5 |
| 10/24/2001 | Champaign | EF1 (86-110 mph) | 1.0 | 100 | 1.0 |
| 06/04/1999 | Champaign | EF0 (65-85 mph) | 0.1 | 20 | 1.0 |
| 05/02/1998 | Champaign | EF0 (65-85 mph) | 0.1 | 10 | 8.0 |
| 06/29/1998 | Champaign | EF0 (65-85 mph) | 0.6 | 20 | 8.0 |
| 04/19/1996 | Champaign | EF3 (136-165 mph) | 4.0 | 220 | 3.0 |
| 05/28/1996 | Champaign | EF0 (65-85 mph) | 0.3 | 40 | 1.0 |
| 06/17/1992 | Champaign | EF0 (65-85 mph) | 0.1 | 10 | 1.0 |
| 05/09/1990 | Champaign | EF1 (86-110 mph) | 0.5 | 50 | 1.0 |
| 06/20/1990 | Champaign | EF2 (111-135 mph) | 5 | 100 | 1.0 |

Sources: Reference 7-32; Section 3.2.3.2

**Table 3-5 Regional Precipitation Extremes**

| Station | Period of Record (years) | Normal Annual Rainfall (inches) | Max 24-hour Rainfall (inches) | Max Monthly Rainfall (inches) | Normal Annual Snowfall (inches) | Max 24-hour Snowfall (inches) | Max Monthly Snowfall (inches) |
|---|---|---|---|---|---|---|---|
| Chicago NWS Station | 136 [a] | - | 9.35 (Aug 1987) | 17.10 (Aug 1987) | - | 18.6 (Jan 1999) | 29.0 (Feb 2011) |
| | 25 [b] | 37.90 | - | - | 37.8 | - | - |
| Lincoln, IL | 120 [c] | - | 5.22 (May 1914) | | - | 13.0 (Feb 1914) | 24.0 (Feb 1914) |
| | 25 [d] | 38.88 | - | 20.3 (Feb 2022) | 17.6 | - | - |
| Urbana-Champaign | 107 [e] | 41.38 | - | - | 23.2 | 15.0 (Jan 1999) | - |
| | 25 [f] | 40.49 | - | 13.82 (Jul 1992) | 19.6 | - | 20.4 (Dec 2010) |

[a] Source: Reference 7-33, records began in 1886

[b] Source: Reference 7-34, 2000 - 2025

[c] Source: Reference 7-35, records began in 1905

[d] Source: Reference 7-36, 2000 - 2025

[e] Source: Reference 7-20

[f] Source: Reference 7-37, 2000 - 2025

**Table 3-6 Air Temperatures for Urbana-Champaign, Illinois**

| Time Period | Normal Daily High | Normal Dry Bulb | Normal Daily Low | Extreme Daily Maximum | Extreme Daily Minimum |
|---|---|---|---|---|---|
| | Temperatures in Degrees F | | | | |
| January | 33.7 | 26.7 | 17.8 | 70 | -25 |
| February | 38.5 | 28.3 | 21.4 | 76 | -25 |
| March | 50.8 | 39.7 | 30.8 | 86 | -9 |
| April | 64.0 | 52.1 | 40.7 | 91 | 14 |
| May | 74.8 | 64.7 | 52.2 | 97 | 26 |
| June | 83 | 72.7 | 61.5 | 103 | 37 |
| July | 84.7 | 74.3 | 64.4 | 109 | 41 |
| August | 83.3 | 73.4 | 62.2 | 102 | 39 |
| September | 78.9 | 69.7 | 54.6 | 101 | 29 |
| October | 66.2 | 56.4 | 42.0 | 93 | 13 |
| November | 50.9 | 40.5 | 32.0 | 81 | -5 |
| December | 38.6 | 33.7 | 23.4 | 71 | -20 |
| Annual | 62.4 | 52.7 | 42.1 | -- | -- |
| Period of Record (years) | 30 [a] (1991-2020) | 10 [b] (2015-2025) | 30 [a] (1991-2020) | 120 [a] (1902-2025) | 120 [a] (1902-2025) |

[a] Reference 7-46

[b] Reference 7-22

**Figure 3-4 Regional Setting**

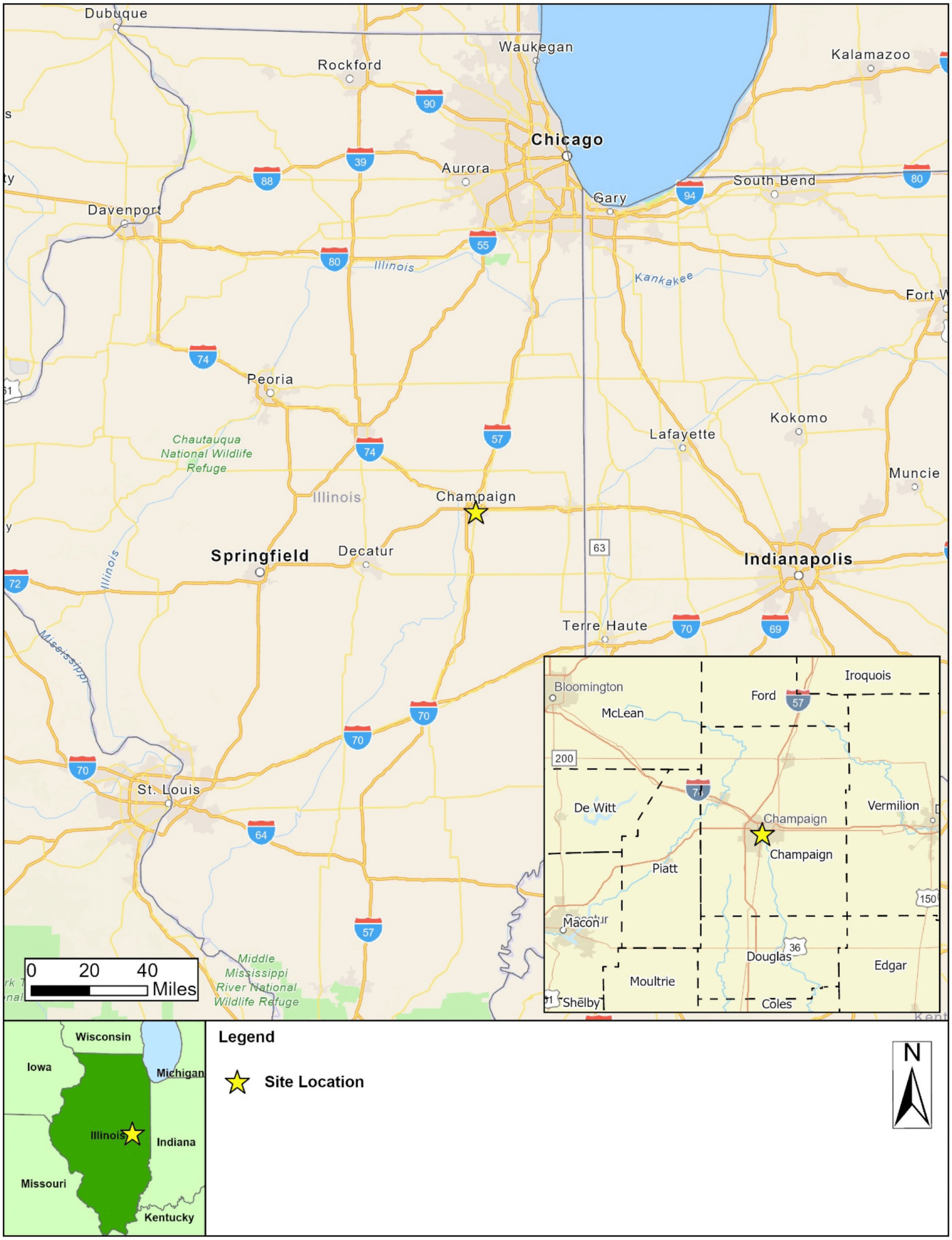


**Figure 3-5 U. of I. Campus Boundary**

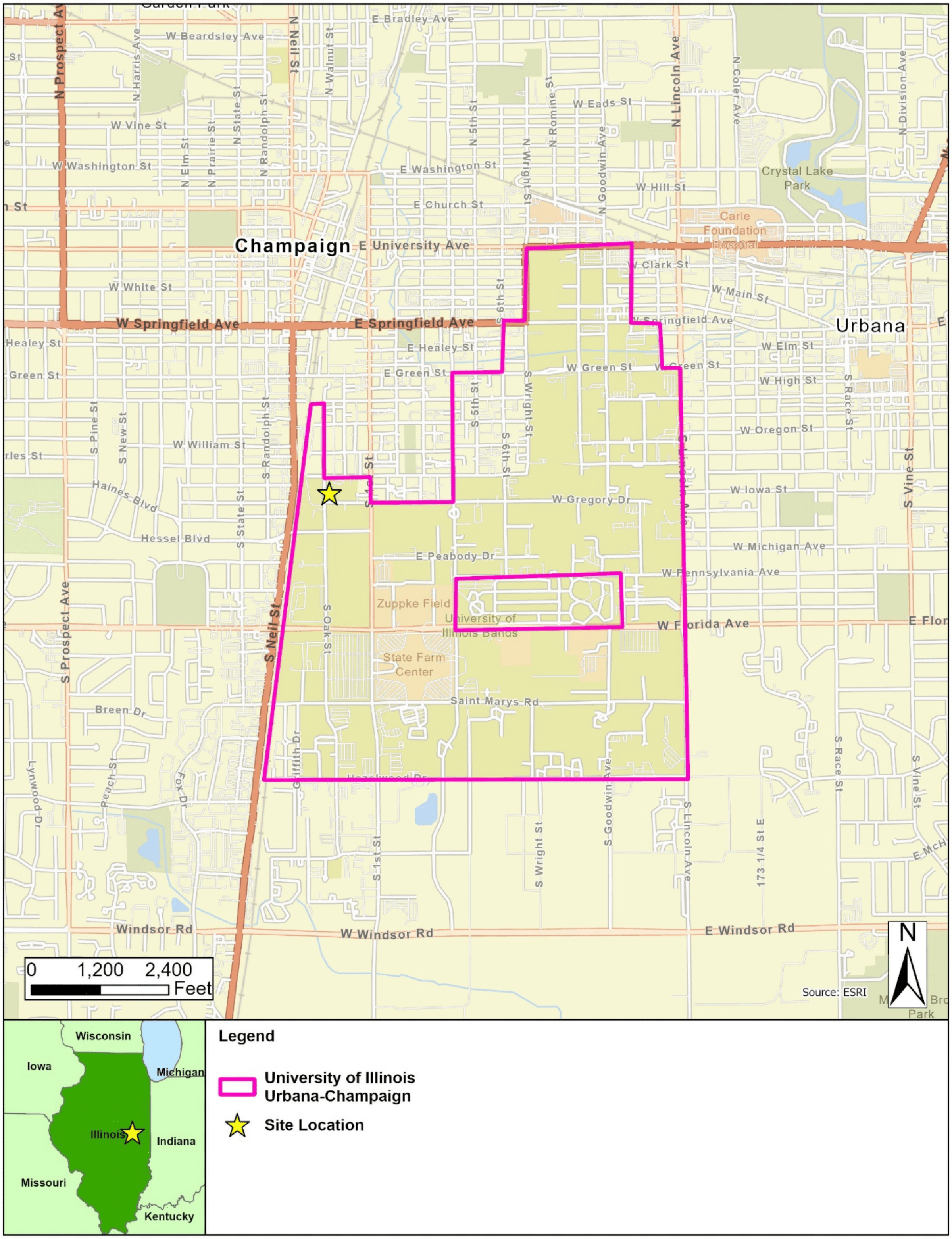


**Figure 3-6 Federal Class I Areas Nearest the Site**

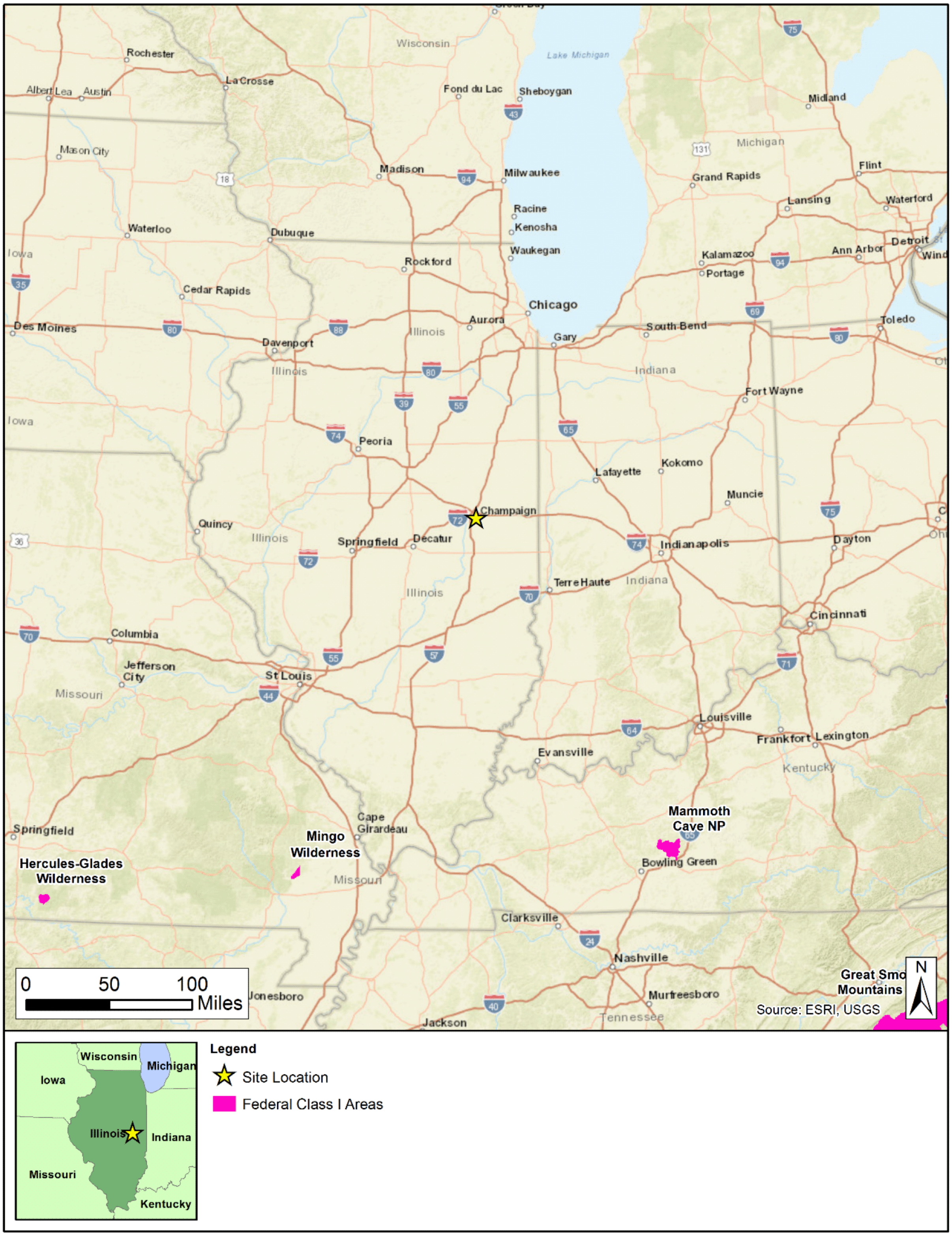


**Figure 3-7 Tornado Probability – 2° Box**

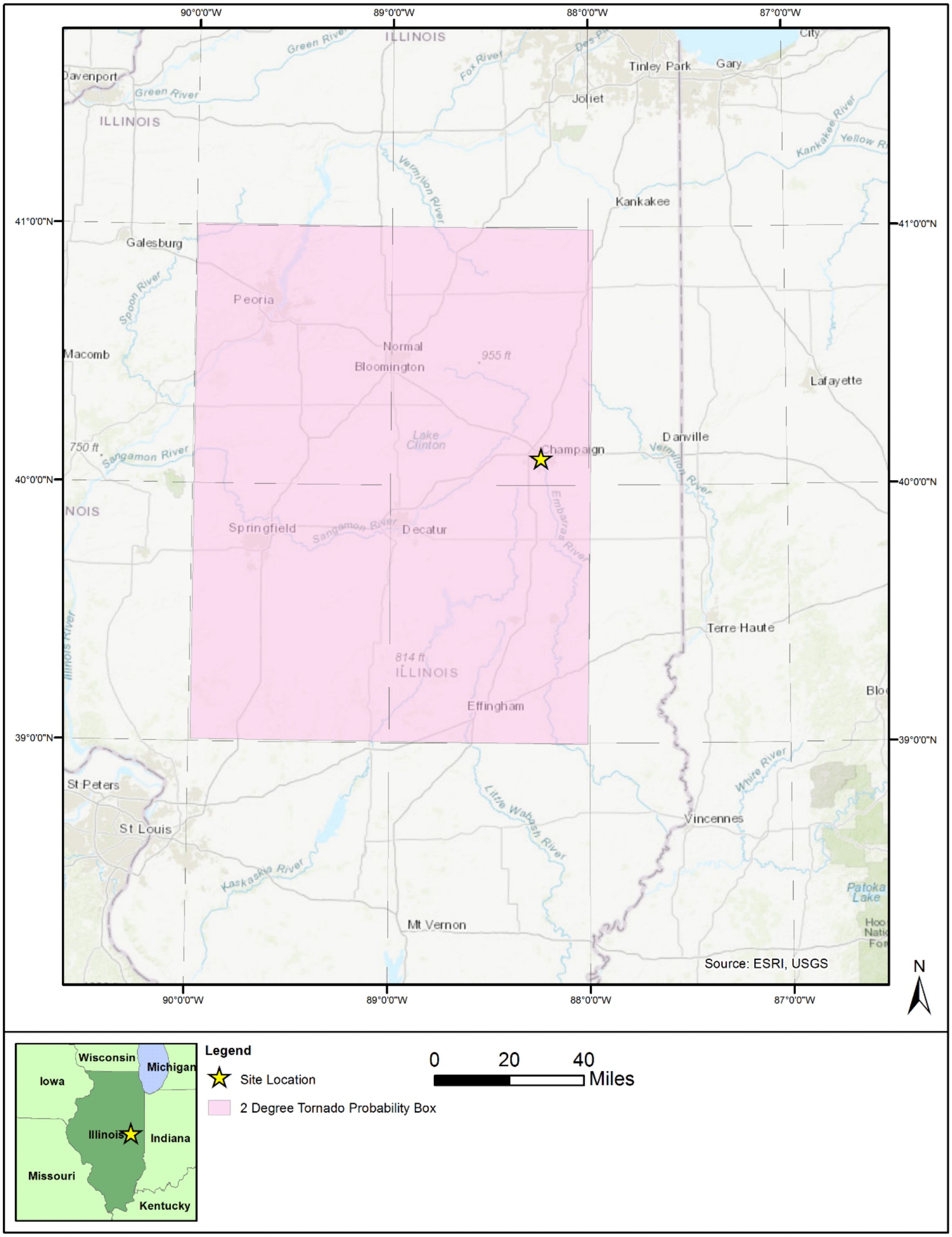
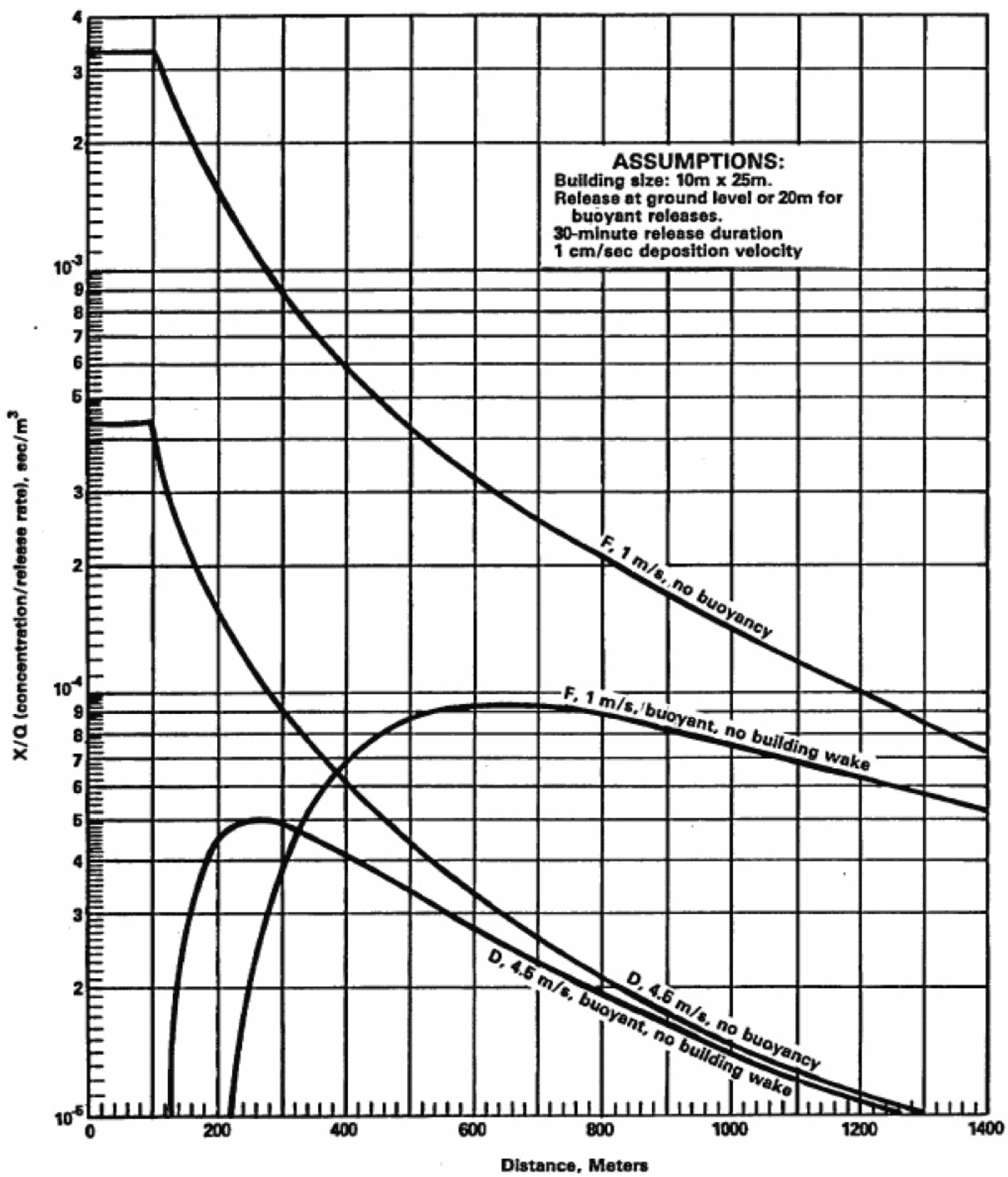
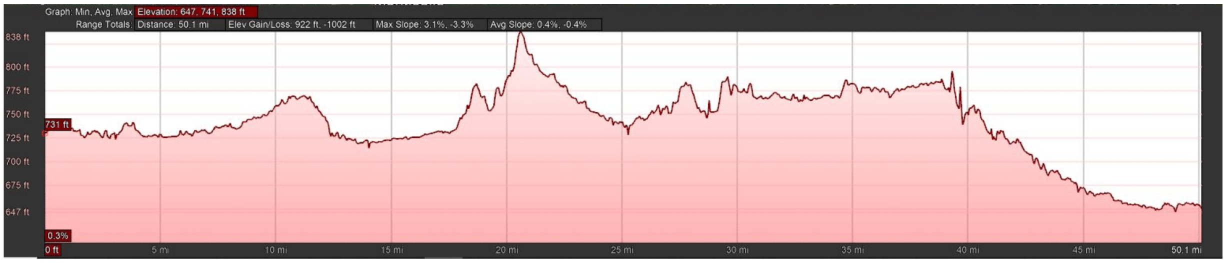


**Figure 3-8 Atmospheric Dispersion Versus Distance**

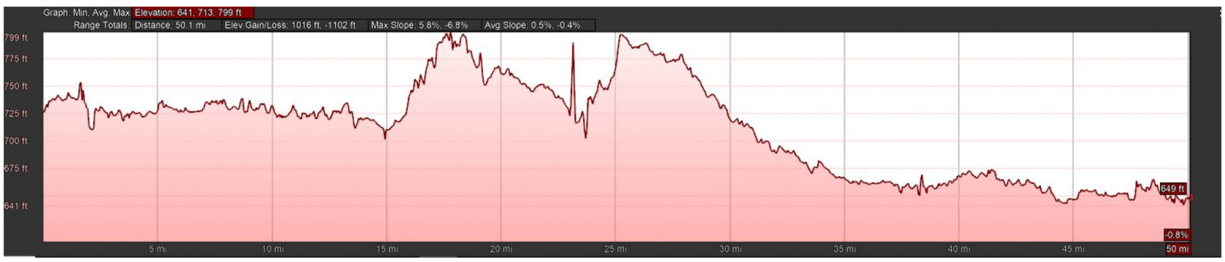



Source: Reference 7-48

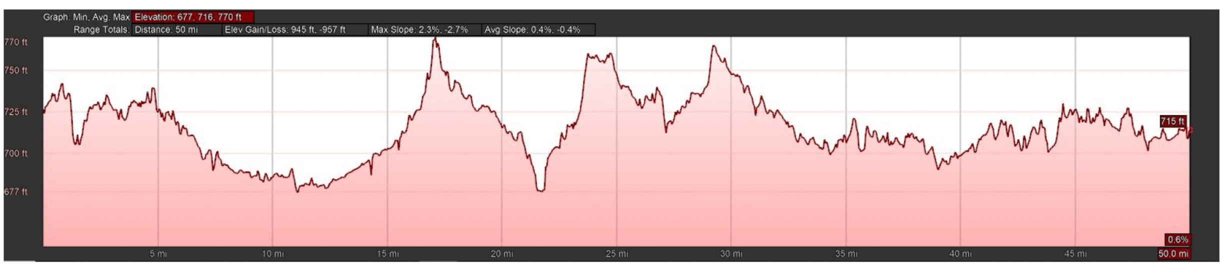
**Figure 3-9 Terrain Elevations Within 50 Miles North, North-Northeast, Northeast, and East-Northeast of the Site**



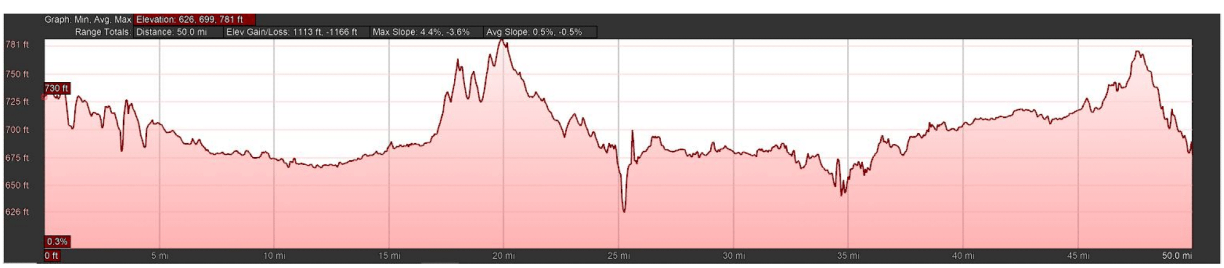

North




North – Northeast

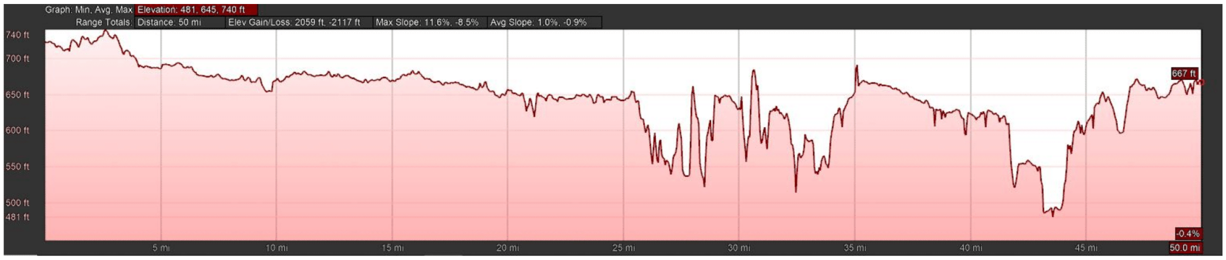



Northeast

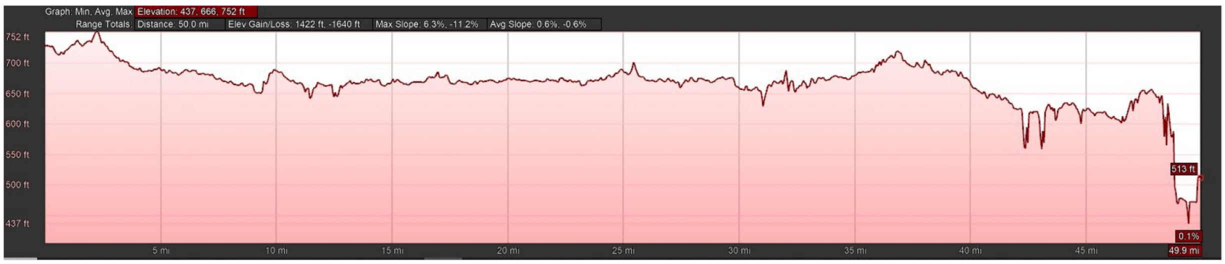



East – Northeast

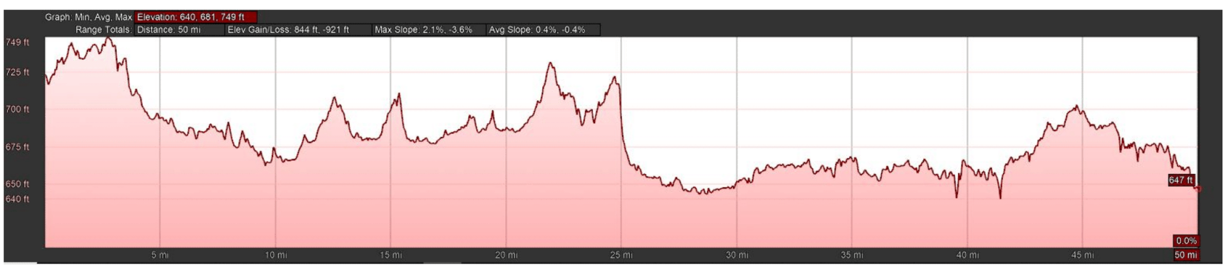
**Figure 3-10 Terrain Elevations within 50 Miles East, East-Southeast, Southeast, and South-Southeast of the Site**




East



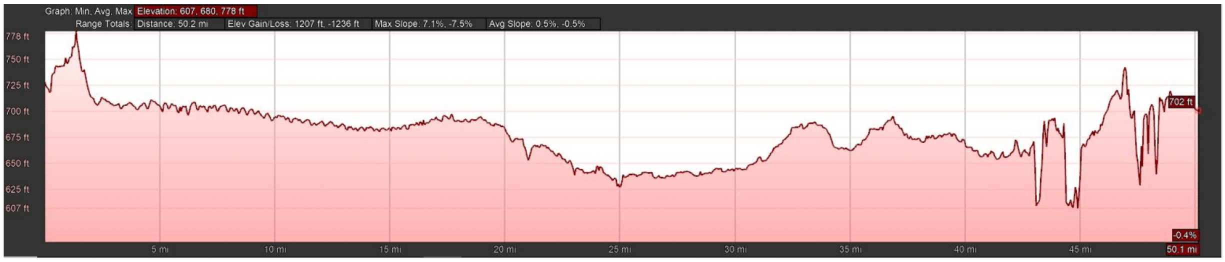

East-Southeast



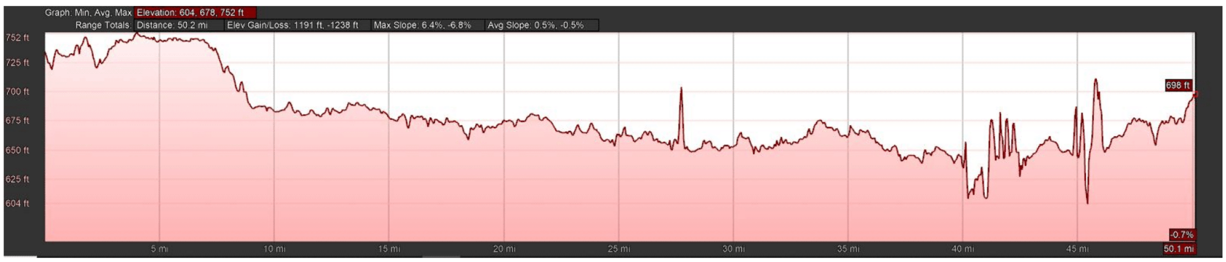

Southeast


South – Southeast

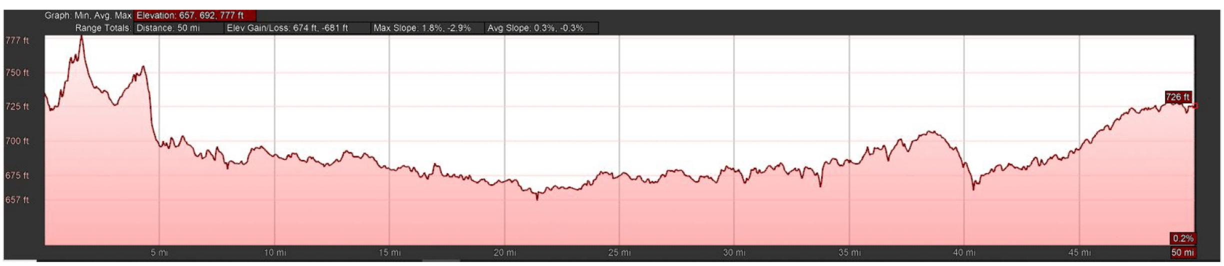
**Figure 3-11 Terrain Elevations Within 50 Miles South, South-Southwest, Southwest, and West-Southwest of the Site**



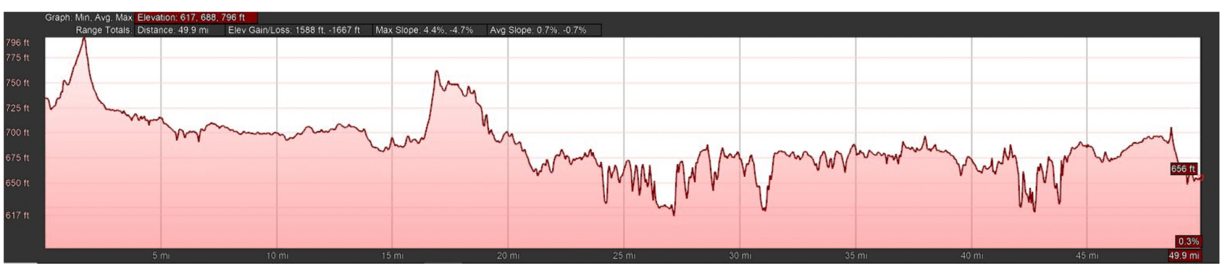

South




South – Southwest



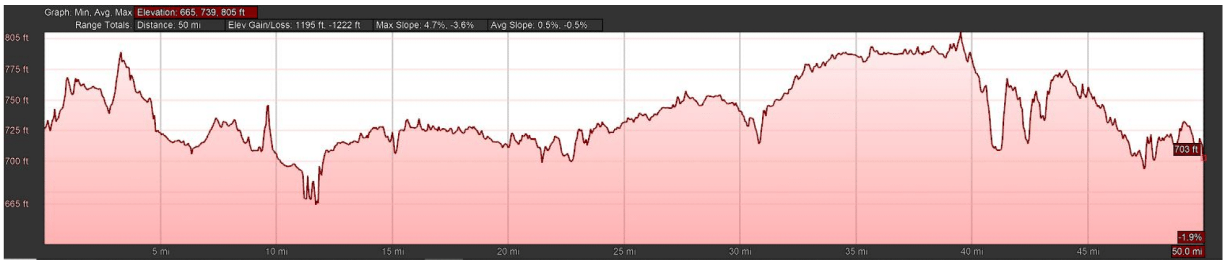

Southwest



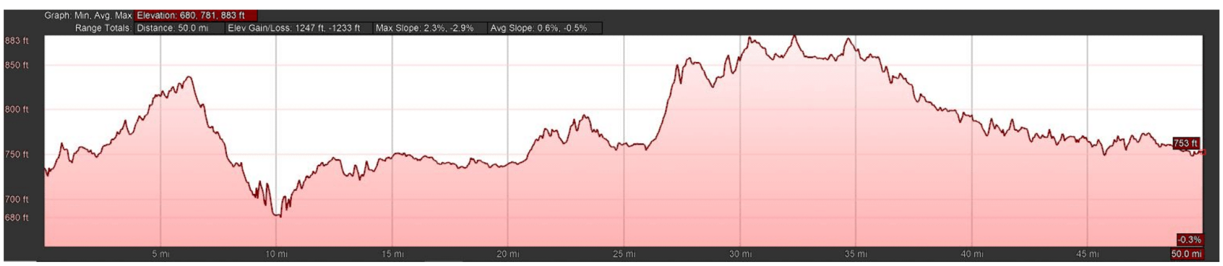

West – Southwest

**Figure 3-12 Terrain Elevations Within 50 Miles West, West-Northwest, Northwest, and North-Northwest of the Site**

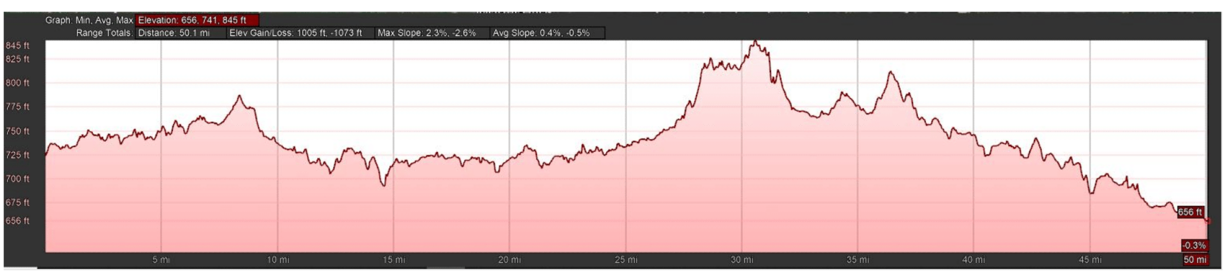

West




West – Northwest




Northwest




North - Northwest

**Figure 3-13 Meteorological Towers in the Vicinity of the Site**

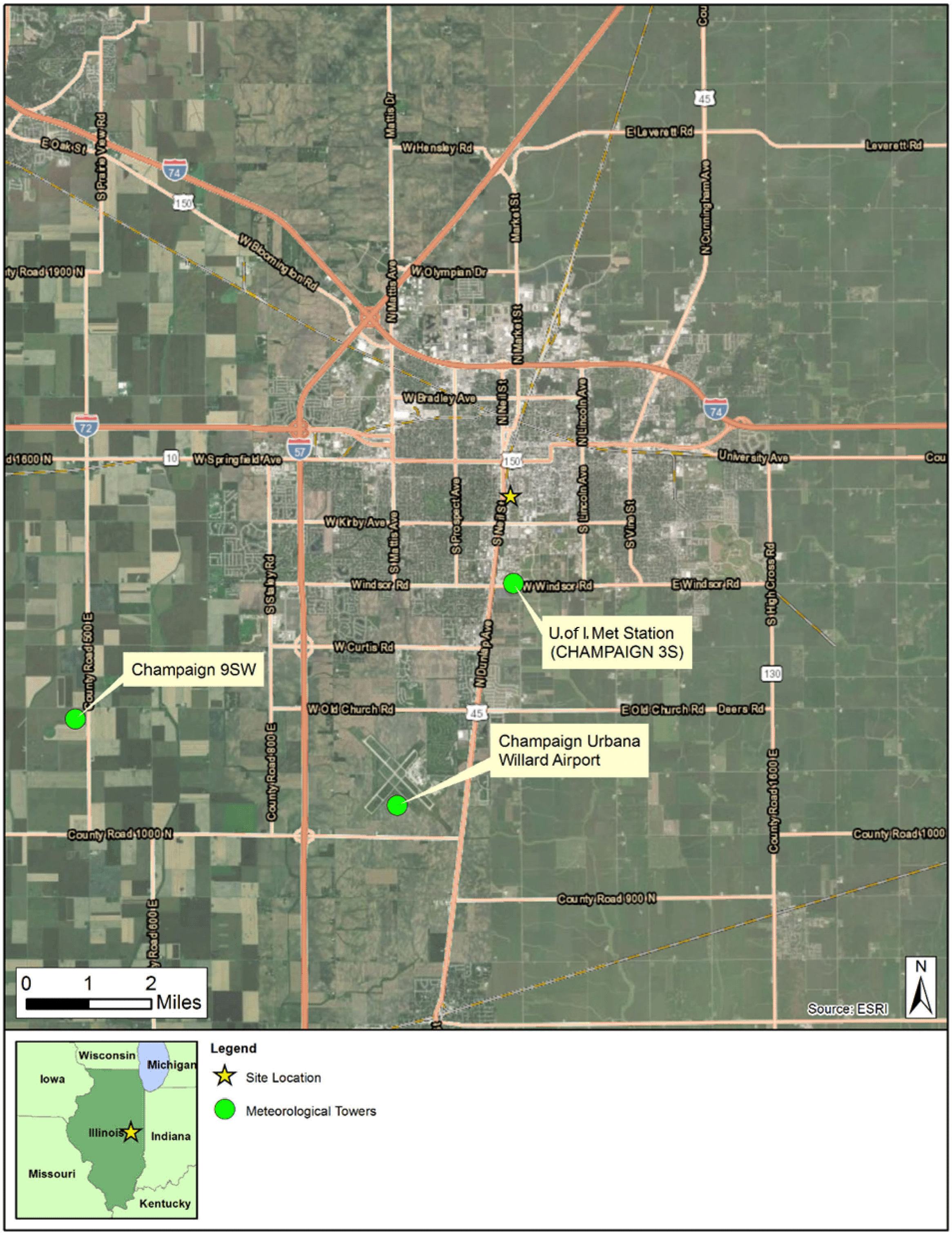
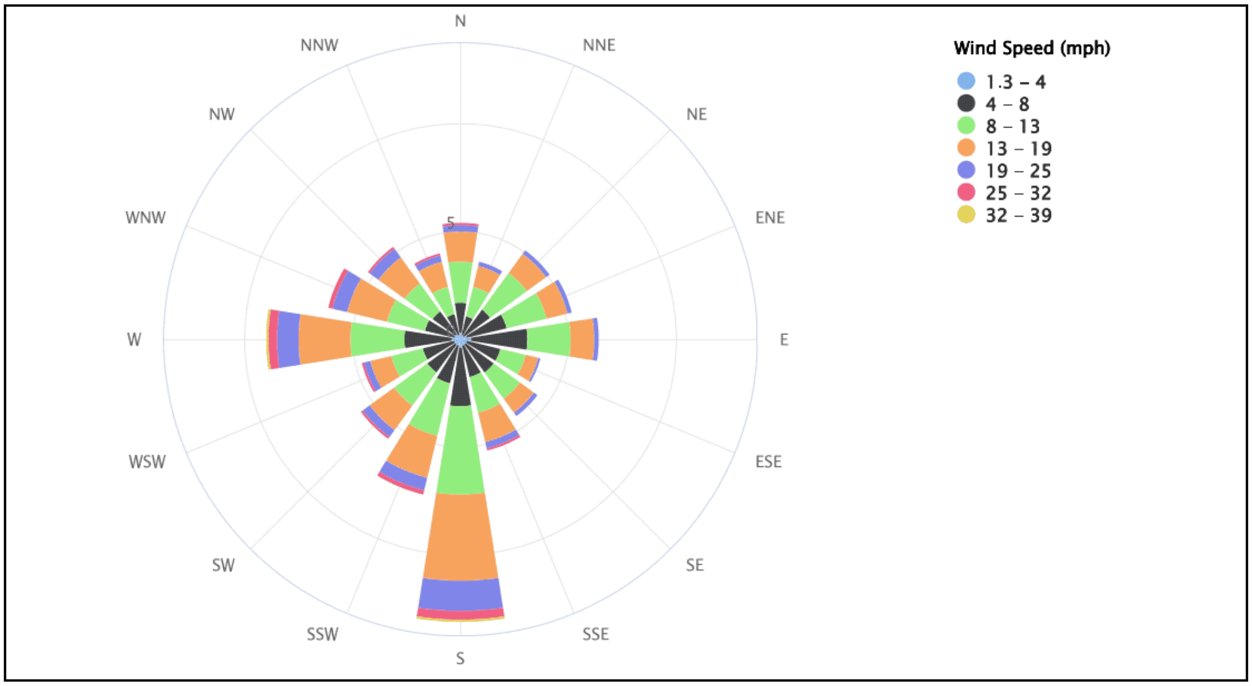
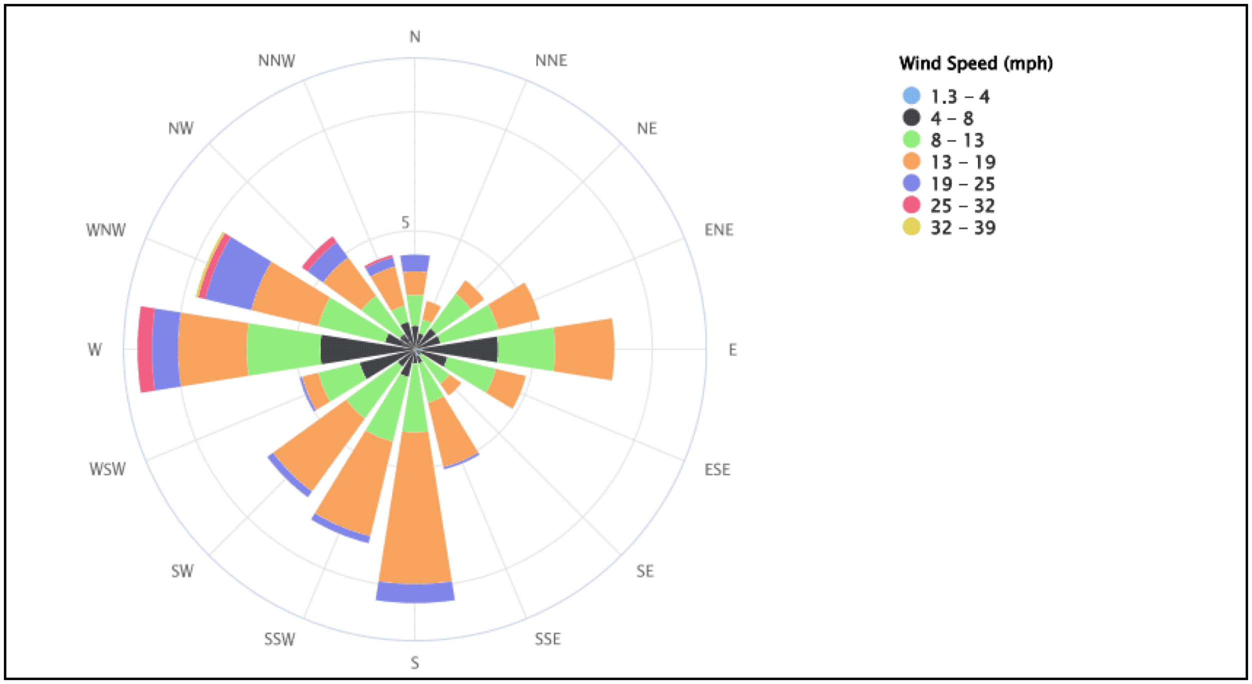


**Figure 3-14 Willard Airport Wind Rose July 1, 1996 through December 2025**



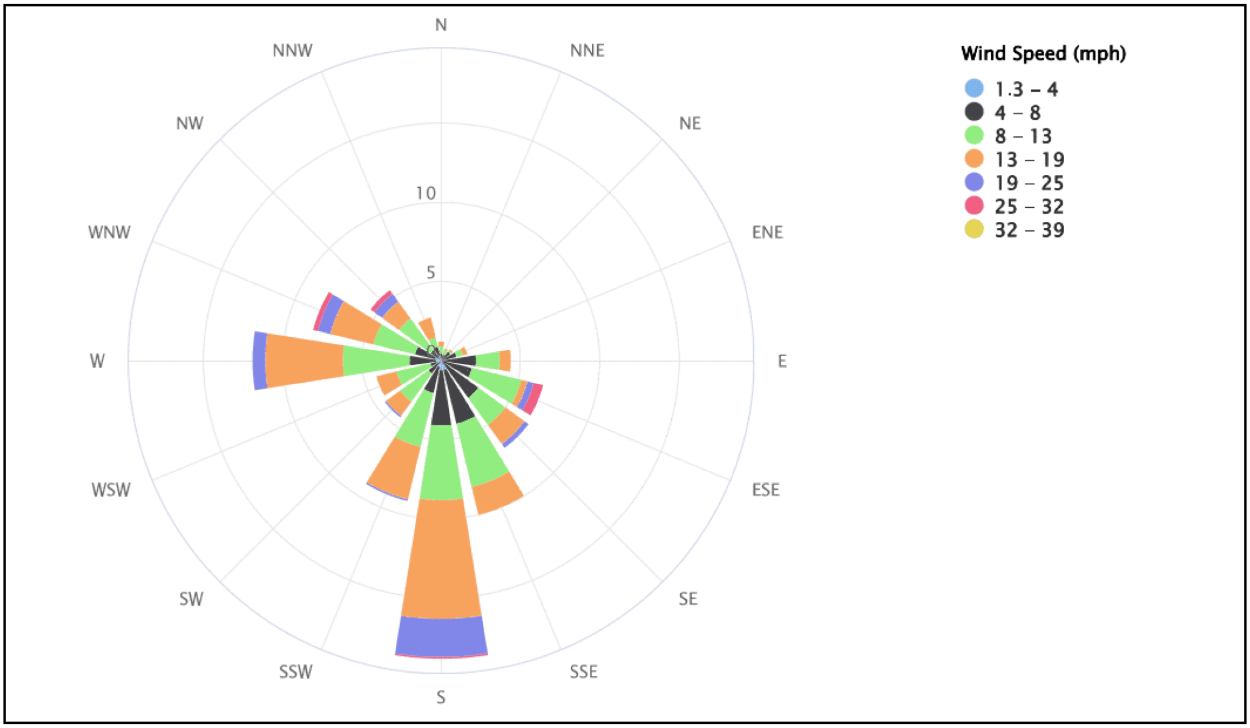

Source: Reference 7-50

**Figure 3-15 Willard Airport Wind Rose 2024**



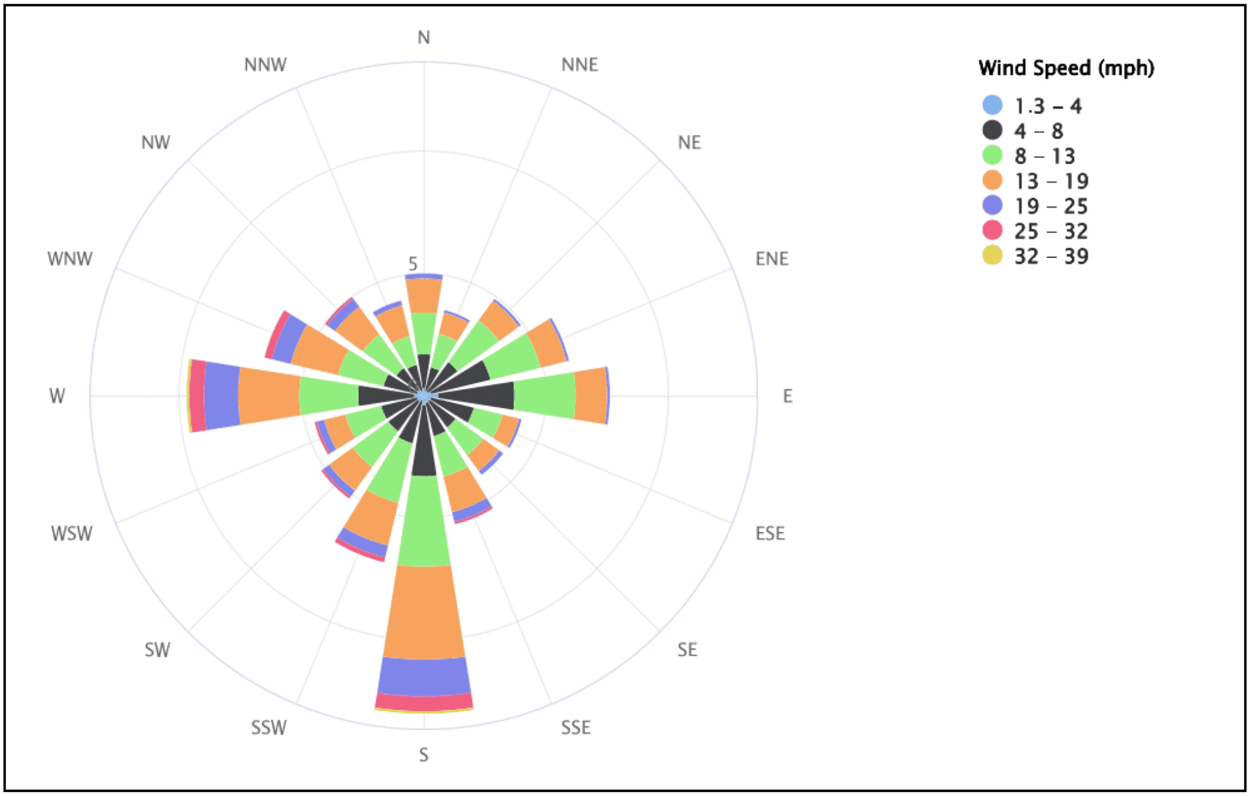

Source: Reference 7-50

**Figure 3-16 Willard Airport Wind Rose 2023**



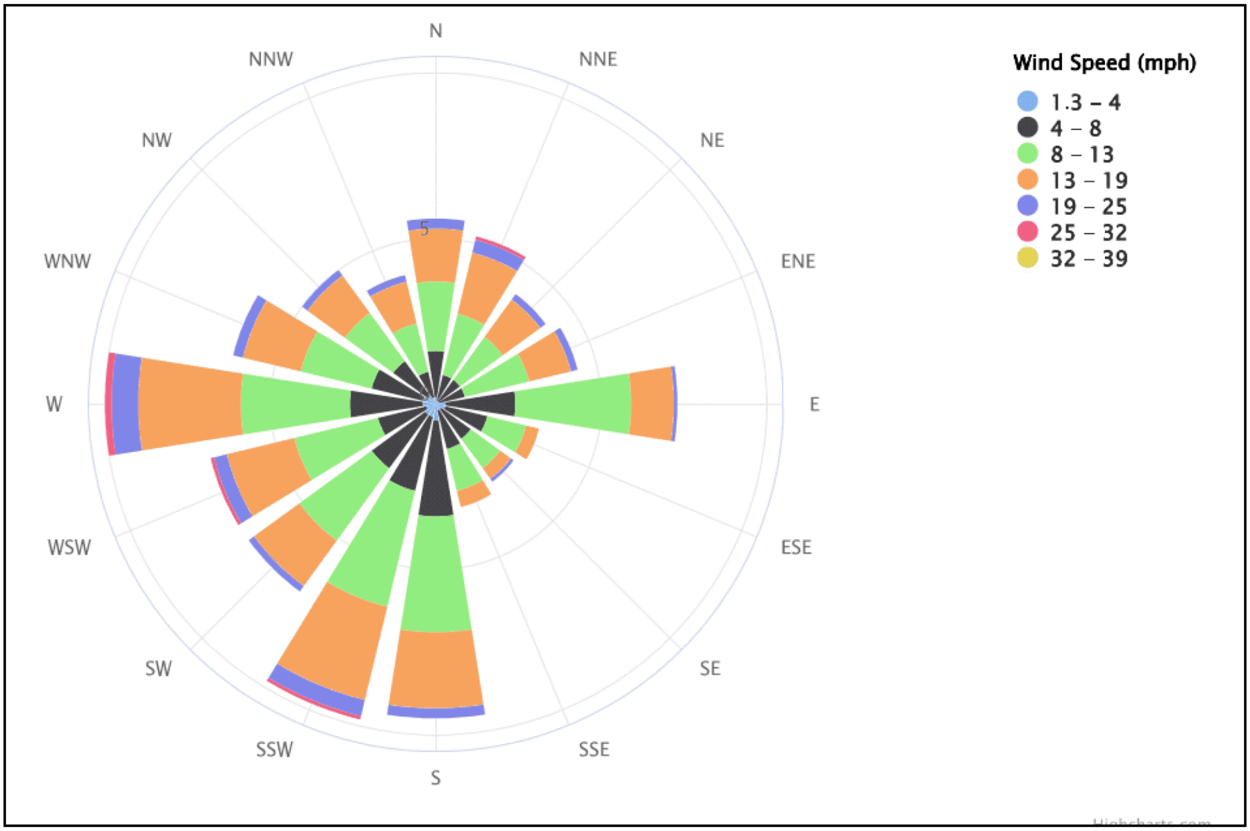

Source: Reference 7-50

**Figure 3-17 Willard Airport Wind Rose 2022**




Source: Reference 7-50

**Figure 3-18 Chicago Midway Airport Wind Rose January 1, 1996 through December 2025**




Source: Reference 7-50

## 3.3 GEOLOGICAL ENVIRONMENT

This section provides a description of the geology, soils, and seismology of the site and region.

### *3.3.1 Summary of Previous Offsite and Recent Onsite Geotechnical Investigations*

The bedrock geology of the U. of I. campus was characterized in 2018 through the drilling of a 385-foot (117 meter) borehole as part of a U. of I. initiative to construct a geothermal monitoring well approximately 0.8 miles (1.3 kilometer) northeast of the proposed project site (Reference 7-55).

In 2002, Midwest Engineering Services, Inc. conducted a subsurface exploration of the adjacent Abbott Power Plant site. The objectives, scope, methods, and findings of this investigation are documented in the Geotechnical Engineering Report dated February 27, 2002. The report provides detailed information on the soils encountered at the site, with boring depths reaching a maximum of 76.5 feet (23.3 meters) below ground surface (bgs), as well as data on groundwater depth and geological conditions at the neighboring Abbott site (Reference 7-56). The report also concluded that the risk associated with liquefaction of near-surface soils during a seismic event in the area of the project site is low (Reference 7-56).

A geotechnical investigation specific to the research reactor site was conducted in October and November 2025. The findings from this investigation are discussed in Section 2.5 of the Preliminary Safety Analysis Report (PSAR).

### *3.3.2 Geology*

The project site is located on the U. of I. campus near the center of Champaign County. The site lies within the Central Lowlands physiographic province of the United States (Reference 7-57) in an area where thick sections of sedimentary rock overlie crystalline rock of Precambrian age (Reference 7-58). The Central Lowlands province is located near the center of the North American craton. The North American craton is a relatively stable portion of the North American continental plate that has been largely unaffected by collisions with other plates or tectonic activity.

#### *3.3.2.1 Bedrock Geology*

Bedrock at the U. of I. campus is located beneath more than 250 feet (76 meters) of glacial deposits and is primarily composed of rocks from the Pennsylvanian Period. Figure 3-19 (Reference 7-59) illustrates the geological cross-section, indicating the depth to the Pennsylvanian bedrock across the campus. In central and southern Illinois, the aggregate thickness of the Pennsylvanian (sedimentary) bedrock exceeds 1,000 feet (304 meters), representing the upper strata of depositional sequences within the Illinois Basin, a midcontinent Paleozoic-age depositional and structural basin (Reference 7-60). The Pennsylvanian strata are categorized into six formations that contain a similar mix of rock types, including mudstone, shale, and sandstone (Reference 7-61).

In 2018, a 385-foot (117 meters) borehole was drilled as part of a U. of I. initiative to construct a geothermal monitoring well. A continuous core sample was collected from this borehole, and where sample recovery was inadequate, geological materials were interpreted based on borehole data

(Figure 3-20). The analysis of the borehole data indicates that the upper bedrock consists of microgranular limestone and mudstone, exhibiting soft sediment brecciation and signs of erosion on the bedrock surface (Reference 7-55).

#### *3.3.2.2 Glacial Geology*

Champaign County is situated within a glaciated landscape known as the Bloomington Ridged Plain, which was formed during the Wisconsin Glacial Episode that concluded approximately 23,000 years ago in the Urbana area (Reference 7-55, Reference 7-59). During this period, lobes of glacial ice likely advanced into Illinois across six or more glaciations (Reference 7-58). In the vicinity of the U. of I. campus, the tills deposited during the most recent Wisconsin Glacial Episode include the Batestown Member of the Lemont Formation, the Piatt Member of the Tiskilwa Formation, and the undivided unit of the Tiskilwa Formation. These tills are overlain by glacial outwash or glacial lake sediments (Reference 7-55). Additionally, the glacial deposits are covered by postglacial windblown silt and fine sand, known as loess. The tills were primarily deposited by the southwest flow of glaciers across central Illinois (Reference 7-59).

In regions where water flowed across the landscape due to melting glaciers, glacial outwash composed of sand and gravel from the Pearl Formation was deposited (Reference 7-55). The glacial and nonglacial deposits that lie beneath the Illinois Episode sediments are the oldest in the region and cover a dissected preglacial bedrock surface (Reference 7-59). Alluvial and colluvial deposits from the Canteen Member of the Banner Formation accumulated in valley bottoms prior to the initial glacial advance, while subsequent glacial advances from the pre-Illinois Episode are characterized by sequences of till, silt, and clay (Reference 7-55).

### ***3.3.3 Soils***

A geotechnical investigation was completed for the project site in October and November 2025 and included five seismic cone penetration tests and 15 geotechnical borings (Reference 7-62). The borings were advanced using sonic drilling methods, with Standard Penetration Tests (SPTs) performed at regular intervals to characterize soil density, consistency and to support the engineering evaluation of subsurface conditions. Laboratory testing was performed on selected soil samples; however, at the time of preparation of this chapter, portions of the laboratory program remain in progress. The seismic cone penetration test soundings were advanced to a maximum depth of approximately 70 feet (21 meters) bgs, and the boring depths ranged from about 10 feet (3.0 meters) bgs to 125 feet (38.1 meters) bgs.

A geophysical survey was also performed during this period and included two electrical resistivity tests, approximately 500 linear feet (152 meters) of Multichannel Analysis of Surface Waves, Vs30 measurements at five locations, and two P–S suspension logs (Reference 7-62).

Subsurface conditions at the site consist of a thin surface layer of topsoil and asphalt underlain by uncontrolled fill, glacial outwash soils, and glacial till. Topsoil (approximately 4 to 8 inches [10 to 20 cm]) and asphalt (approximately 4 to 6 inches [10 to 15 cm]) were encountered at the boring locations; however, these thicknesses may vary across the site (Reference 7-62).

Uncontrolled fill was present beneath the pavement at all borings and ranged from approximately 1 to 10 feet thick (0.3 to 3 meters), with SPT N-values of 1 to 9 blows per foot (bpf), indicating very loose to loose conditions (Reference 7-62).

Glacial outwash soils underline the fill across most of the site and extend to depths of up to approximately 45 feet (13.7 meters) bgs. These deposits consist of interbedded sandy and cohesive soils, including clayey and silty sands (SC, SM, SW-SM, SP-SM) and clayey/silty soils (CL, CH, CL-ML, ML). SPT N-values range from WOH to 25 bpf, indicating very loose to medium dense sands and soft to medium stiff cohesive soils. CPTu corrected tip resistances generally range from 50 to 250 tonnes per square foot, and shear-wave velocities range from approximately 500 to 1,500 feet (152 to 457 meters) per second based on Vs30 testing and 800 to 1,200 feet (244 to 366 meters) per second from P-S suspension logging (Reference 7-62).

Glacial till was encountered only in deeper borings advanced beyond approximately 65 feet bgs and extends to the maximum exploration depth of 125 feet (38.1 meters). The till consists of very dense sandy soils and very stiff to hard cohesive soils, with SPT N-values ranging from 32 bpf to refusal in sands and 13 to 84 bpf in cohesive soils. CPTu soundings generally terminated between 55 and 75 feet (16.7 and 22.9 meters) bgs at a very dense to very stiff till layer. Shear-wave velocity measurements indicate relatively consistent stiffness across the site, with values ranging from approximately 1,000 to 1,800 feet (305 to 549 meters) per second (Reference 7-62).

Groundwater was encountered at depths ranging from approximately 11 to 16 feet (3.4 to 4.9 meters) bgs, as observed in soil borings and temporary monitoring wells (Reference 7-62).

The soils at the site are classified by the USDA Soil Conservation Service Soil Survey of Champaign County, Illinois, as Flanagan silt loam with a slope of 0 to 2 percent (Figure 3-21). These soils are characterized as somewhat poorly draining, typically exhibiting low runoff characteristics, and are generally well-suited for agricultural and crop production (Reference 7-63).

#### *3.3.3.1 Prime Farmland Soils*

The Natural Resources Conservation Service (NRCS), in collaboration with various federal, state, and local government organizations, has identified and inventoried land suitable for the production of the nation's food supply. Prime farmland, as defined by the USDA, represents a category of important farmland that possesses the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops. The soil types at the project site, identified as Flanagan silt loam with less than 2 percent slopes, are classified as prime farmland by the USDA Natural Resources Conservation Service (Reference 7-63).

#### *3.3.3.2 Soil Erodibility*

Highly erodible land refers to cropland, hayland, or pasture that is susceptible to excessive erosion (Reference 7-63). The erodibility of soil units is influenced by factors such as soil type, rainfall and runoff amounts, wind speed, and the length and steepness of slopes. The Flanagan silt loam (0 to 2 percent slope) soils present at the project site are classified as non-highly erodible lands, and no highly erodible areas were identified on the project site or in the surrounding vicinity (Reference 7-63).

#### 3.3.3.3 Shrink-Swell Potential

Based on the geotechnical and geophysical investigations carried out in October and November 2025, and the available laboratory data, the potential for shrink and swell is considered low. The cohesive soils encountered are highly over consolidated due to glacial deposition and are not highly plastic, which further indicates a low potential for swell and shrink behavior (Reference 7-62).

### 3.3.4 Seismology

The New Madrid Seismic Zone, located approximately 240 miles (386 km) southwest of the U. of I. campus, is capable of generating significant earthquakes. The northernmost section of this seismic zone extends to Cairo in southern Illinois (Reference 7-58). According to the 2014 Seismic Hazard Map for Illinois, the Peak Ground Acceleration for Champaign County is estimated to range from 0.06 g to 0.1g, based on a probability of exceedance of 2 percent over 50 years (Reference 7-64, Figure 3-22). The potential effects of seismic hazards on the reactor facility is thoroughly assessed in PSAR Section 2.5.

No known faults have been identified within a 5-mile (8-km) radius of the proposed project site. The Wabash Valley liquefaction feature is situated approximately 30 miles (48.3 km) south of the site, extending across a broad area from St. Louis, Missouri, to Indianapolis, Indiana (Reference 7-64).

Earthquakes with Richter magnitudes exceeding 5.0 can be felt over large areas and may cause minor shaking and damage to structures. However, no earthquakes with magnitudes greater than 5.0 have been recorded within 50 miles (80 km) of the project site. Two smaller earthquakes, with magnitudes of 2.7 and 2.4, were recorded with epicenters approximately 22 and 15 miles (35 and 24 km) south of the project site, respectively. The 2.7 magnitude earthquake occurred on February 16, 1978, while the 2.4 magnitude earthquake was recorded on November 6, 2020. Additionally, a third smaller earthquake, also with a magnitude of 2.4, occurred approximately 45 miles (72 km) east of the site on November 25, 1974. The largest regional earthquake in the past 100 years, with a magnitude of 3.3, occurred near Mattoon, Illinois, approximately 60 miles (96.5 km) south of the site on May 13, 2025. Figure 3-23 illustrates the locations and intensity of historical earthquakes in the region since 1900 (Reference 7-65).

Liquefaction typically occurs in loose, saturated sands and silts subjected to strong seismic shaking. Based on October 2025 geotechnical borings and CPTu data, loose sandy soils susceptible to liquefaction were not encountered in the near-surface stratigraphy at the project site. Accordingly, the potential for liquefaction during a design-basis seismic event is low (Reference 7-62). This assessment is further supported by the 2026 geotechnical and geophysical exploration results, which indicate a very low liquefaction susceptibility across the explored subsurface materials (Reference 7-62).

### 3.3.5 Other Hazards

#### 3.3.5.1 Tsunamis

The site, located in central Illinois, is inland and not subject to threats from tsunamis.

*3.3.5.2 Volcanism*

The site, located in central Illinois, is distant from active volcanism and not subject to threats from volcanic action.

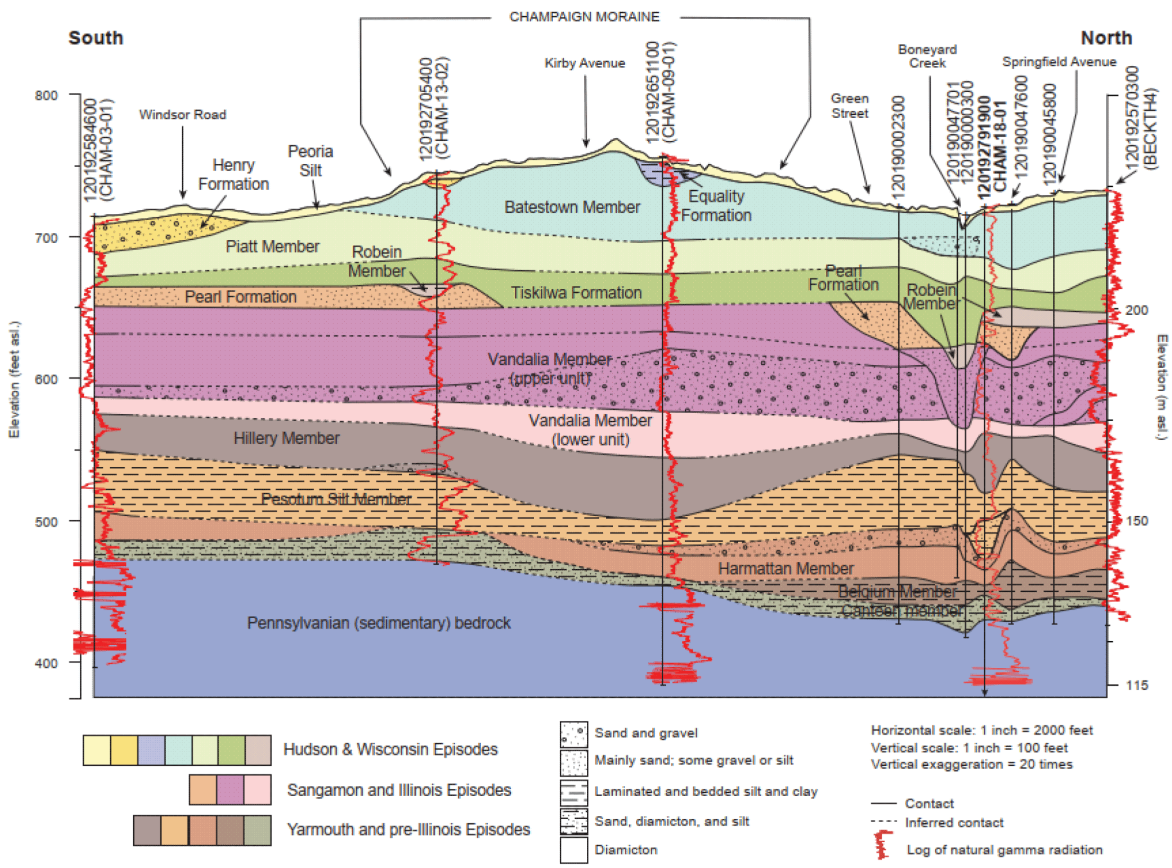
*3.3.5.3 Landslides*

The topography of the U. of I. campus is relatively level and not prone to catastrophic landslide activity. The U.S. Geological Survey (USGS) landslide overview map rates the site as low to moderately susceptible with low incidence of landslides, or less than 1.5 percent of the area involved in landslides (Reference 7-66).

*3.3.5.4 Karst and Subsidence*

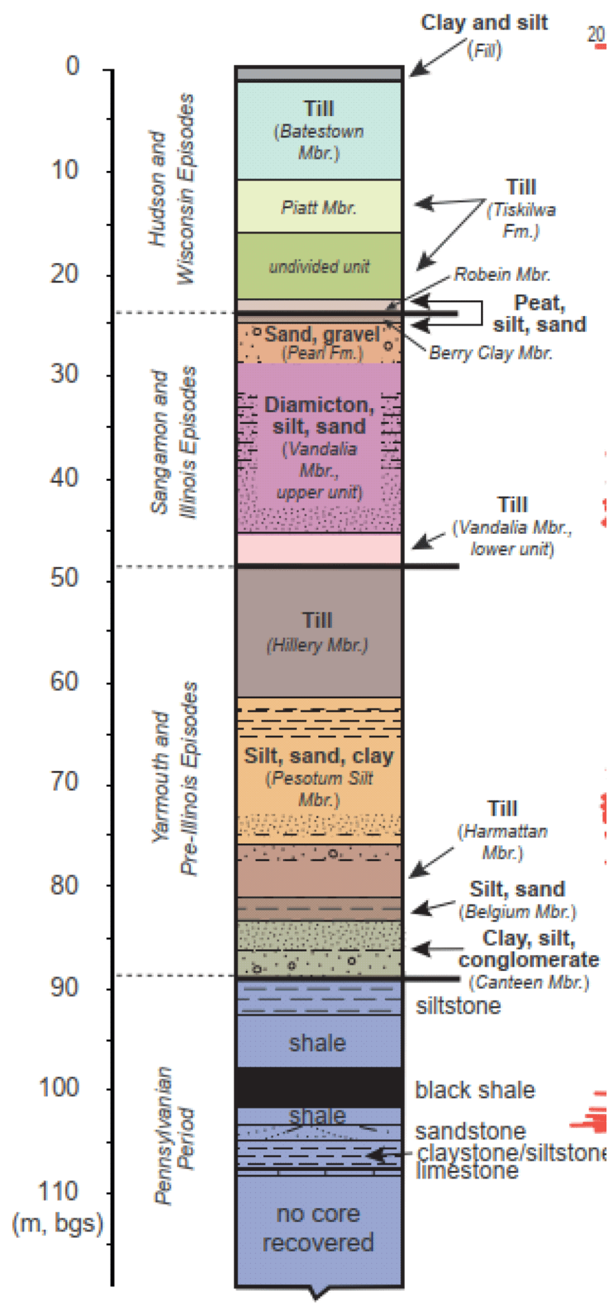
Soils across the region are composed of glacial till, sands, and gravel, with thicknesses on the order of hundreds of feet above bedrock. The conditions that increase the likelihood of sinkhole development generally include dissolvable rock layers (i.e., limestone) below shallow soil. In Illinois, this type of soil condition occurs in an area limited to the Sinkhole Plain, a region in the southwestern portion of the state along the banks of the Mississippi River. As such, development of sinkholes is not anticipated at the project site (Reference 7-67). The recent geotechnical investigation did not indicate any signs of subsidence.

**Figure 3-19 Geologic Cross Section along South to North Transect of U. of I. Campus**



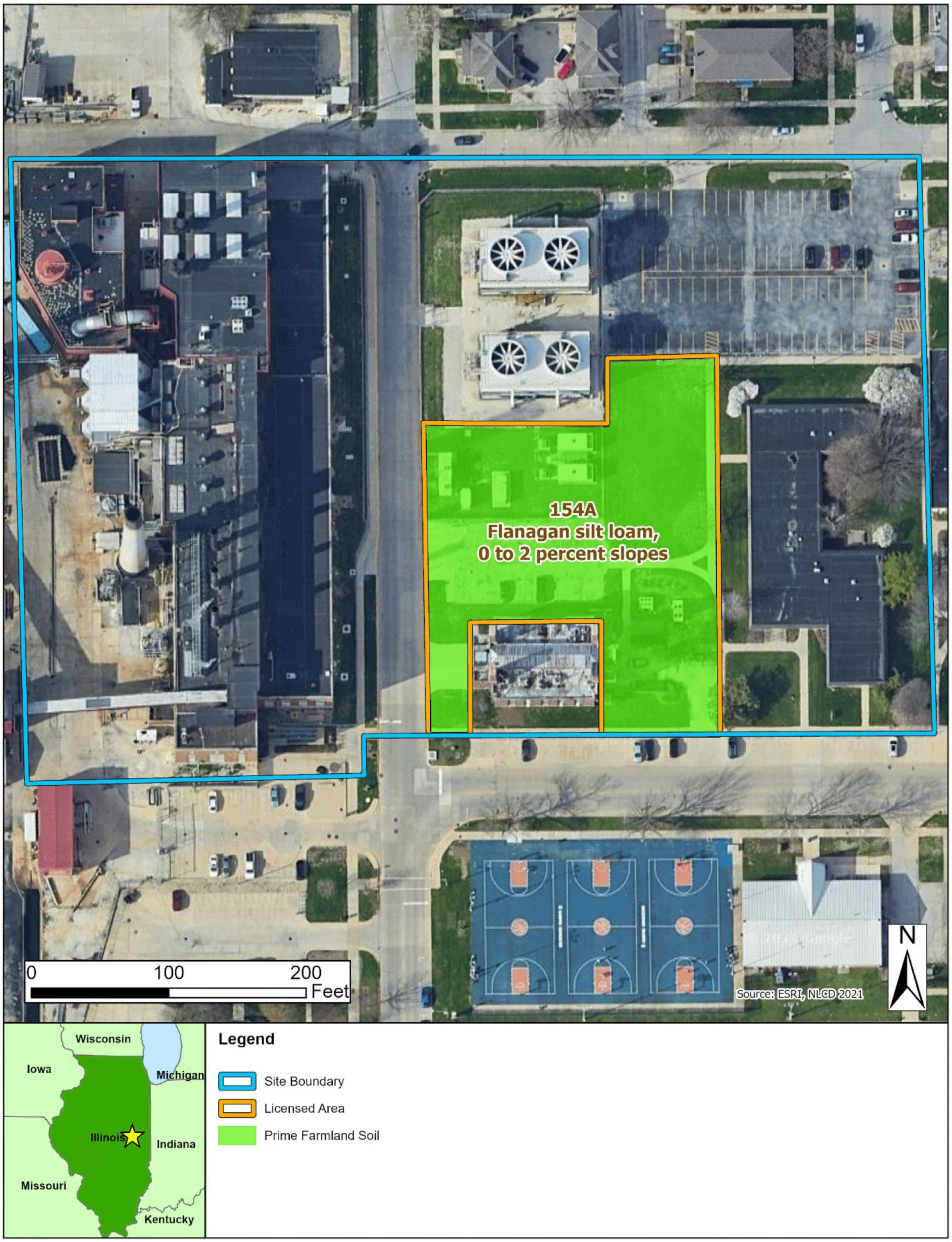

Source: Reference 7-55

**Figure 3-20 Boring Data, Including Material Classification, of Core Sample Taken South of Talbot Laboratory, U. of I.**




Source: Reference 7-55

**Figure 3-21 NRCS Soil Survey Soil Type Designation at the U. of I. Research Reactor Site**




Source: Reference 7-63

**Figure 3-22 Seismic Hazard Map of Illinois**

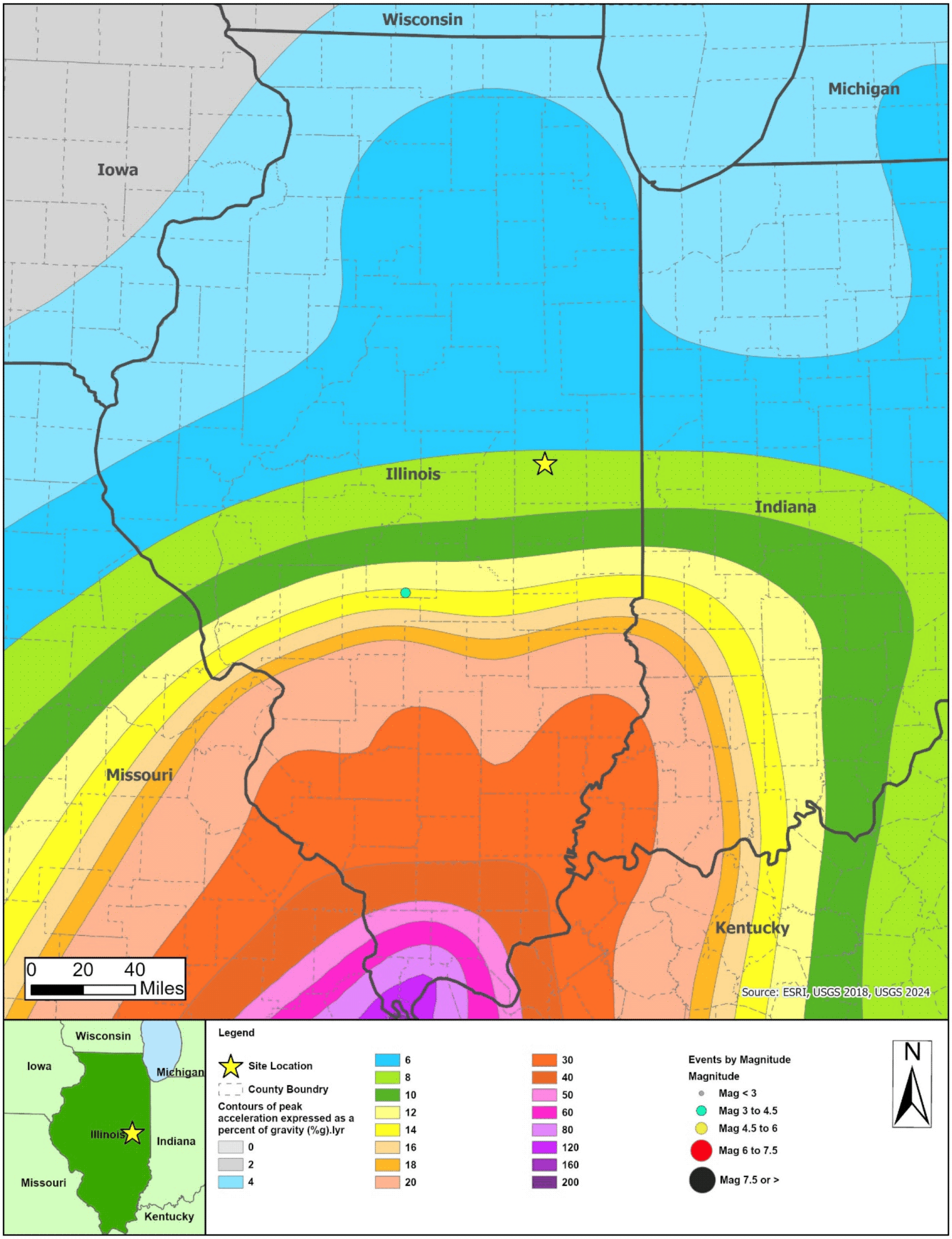
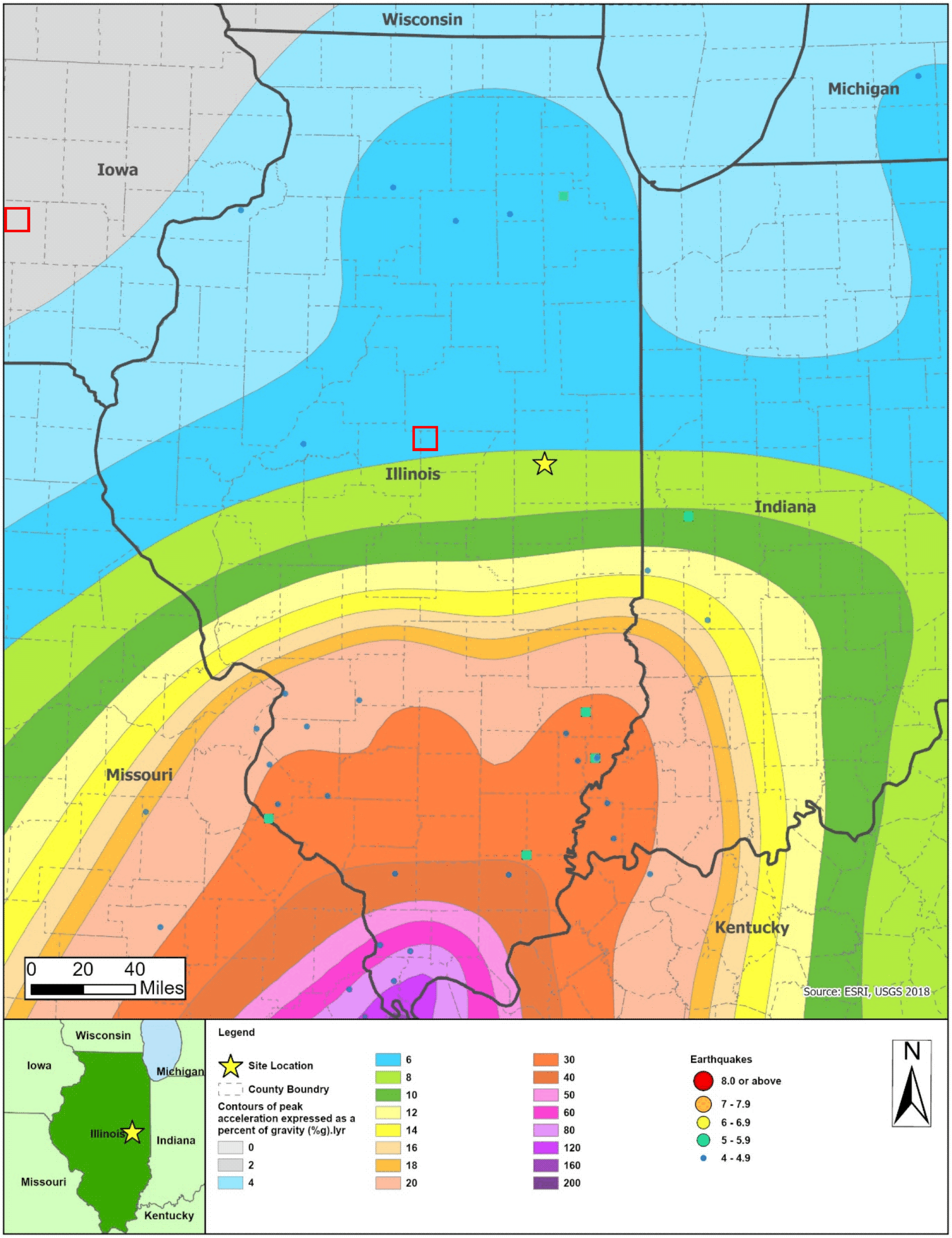


**Figure 3-23 Historical Earthquakes in Region**



## 3.4 WATER RESOURCES

### *3.4.1 Hydrology*

#### *3.4.1.1 Surface Water*

There is no onsite surface water, nor are there any affected surface water bodies near the project site. The project area is located less than 0.5 miles (0.8 km) from the crest that forms the divide between the Mississippi and Ohio River watersheds, resulting in no run-on from upgradient areas. Surface water drainage and watersheds are depicted in Figure 3-24. The project area drains into a stormwater sewer that flows to Boneyard Creek, a three-mile waterway traversing the campus and draining from Urbana and Champaign, ultimately leading to the Saline Branch Drainage Ditch. These waterways are not natural streams; they were originally marshy areas engineered to manage stormwater runoff from Champaign and Urbana.

##### *3.4.1.1.1 Watershed Description*

The City of Champaign straddles the divide between the Mississippi River and Ohio River watersheds. The eastern portion of the city includes sub-watersheds that are part of the larger Embarras River, Little Vermilion River, and Vermilion River watersheds, which flow south and east into the Wabash River and subsequently into the Ohio River. Conversely, the western part of the city encompasses sub-watersheds associated with the Kaskaskia River watershed, which flows south and east toward the Mississippi River.

The project area is situated within the Crystal Lake-Saline Branch sub-watershed, part of the larger Vermilion River watershed. The Crystal Lake-Saline Branch sub-watershed (Hydrologic Unit Code 51201090202) covers 23,365 acres (9,455 hectares), primarily located on the north side of Champaign, draining into the Saline Branch Drainage Ditch. The project site, which encompasses about one acre, is located on the south side of the sub-watershed, near the drainage divide. Stormwater from the project area enters a stormwater drain on Oak Street and flows through stormwater sewers to discharge into Boneyard Creek approximately 0.5 miles (0.8 km) to the northeast. Boneyard Creek then flows about two miles (3.2 km) northeast to the Saline Branch Drainage Ditch. From the Saline Branch Drainage Ditch, runoff continues an additional 10.4 (16.7 km) miles to the east to the Salt Fork of the Vermilion River. In its natural state, the Salt Fork drained a vast upland marsh between Urbana and Rantoul, but has since been extended into these marshes by drainage ditches, including Boneyard Creek and Saline Branch. Including its drainage ditches, the Salt Fork is approximately 38 miles (61 km) long and has a drainage area of about 500 square miles (1,294 square kilometers) (Reference 7-68, Reference 7-69). The distance from the Salt Fork discharge location to the Vermilion River is approximately 42.9 miles, and from the Vermilion River to the Wabash River is about 28.7 miles (46.2 km).

The U.S. Environmental Protection Agency (EPA) Index of Watershed Indicators is a database compiled from information gathered between 1990 and 1999, aimed at highlighting watershed health across the United States. The Index of Watershed Indicators assesses watershed health based on current water quality levels and vulnerability to further degradation. Four watersheds in Champaign County—the Embarras, Kaskaskia, Middle Wabash-Little Vermilion, and Vermilion—are rated as conforming to EPA water quality standards, indicating relatively less serious water quality issues. All five watersheds in Champaign County were rated as having low vulnerability to further degradation, with recommended actions to prevent additional deterioration deemed appropriate but less urgent than those needed in more vulnerable watersheds (Reference 7-68).

Boneyard Creek, located 0.5 miles (0.8 km) northeast of the site, is a highly engineered and channelized waterway that flows east to west through the city of Champaign and the north side of U. of I., often flowing underground through culverts. Poor water quality and flooding issues prompted the City and U. of I. to develop a redevelopment plan for Boneyard Creek, which includes the restoration of the Second Street Detention Basin, an increase in stormwater holding capacity, and enhancements to the ecological function of the creek. The redesigned detention basin provides 100-year flood protection for areas downstream (Reference 7-70).

*3.4.1.1.2 Climate*

The climate of the Champaign-Urbana area is characterized by four distinct seasons. According to the summary of monthly normals (1991-2020) prepared by the NOAA, monthly normal temperatures range from a maximum daily average of 85.2°F (29.6 °C) in July to a minimum daily average of 17.9°F (-7.8 °C) in January (Reference 7-21).

The normal annual precipitation in Champaign County is approximately 40.92 inches (103.9 cm). Monthly precipitation varies, with a maximum daily average of 4.78 inches (12.1 cm) in May and a minimum daily average of 2.18 inches (5.5 cm) in February. The normal annual snowfall is 20.8 inches (52.8 cm) (Reference 7-21). A summary of monthly and annual precipitation, temperature, and snowfall data is provided in Table 3-7. Streamflow data for Boneyard Creek have been collected by the USGS since 1948 at a gauge located downstream from Wright Street on the U. of I. campus. However, precipitation data during this period are spatially and temporally insufficient due to the presence of only one recording rain gauge, which is located southwest of the watershed boundary. Furthermore, the Boneyard Creek watershed has undergone numerous hydrologic alterations throughout its history, lacking the stationary conditions necessary for valid comparisons using the flood-frequency approach (Reference 7-71).

*3.4.1.1.3 Soil and Land Cover*

The Salt Fork Vermilion River Watershed encompasses approximately 381 square miles (986 square kilometers) in Champaign and Vermilion Counties, with over 80 percent of the drainage area utilized for row-crop agriculture (Reference 7-72). Approximately 8 percent of the watershed is classified as rural grasslands, while 7 percent is classified as urban (Reference 7-73). Glacial moraines form the boundaries of the drainage area, resulting in predominantly flat land with fertile soils due to the glacial legacy. Agricultural productivity in the region is closely tied to drainage, with drainage ditches and subsurface field tile drains installed over the past century to manage the naturally wet soils. Approximately 44 drainage districts serve the area (Reference 7-74).

The native soils are primarily clay and loam, which are characteristic of the region. The northern portion of the campus consists mainly of poorly draining soils with a high groundwater table. The dominant hydrologic soil group in the watershed and the Champaign-Urbana area is Group B, which includes the Catlin-Flanagan-Drummer soil series. These dark soils possess high available water-holding capacity and moderate permeability, with Drummer soils being more prevalent in the area, resulting in slow runoff (Reference 7-5).

The depth to the water table within the project area is approximately 2.45 feet (0.75 meters) (Reference 7-73). The relatively low runoff potential is reflected in the absence of well-defined intermittent stream channels near the site. Section 3.3 provides a detailed description of the geology and soils for the project site and surrounding areas.

*3.4.1.1.4 Streamflow*

There are no streamflow monitoring data available from the project area, nor are there any permanent streams on or near the site. The closest monitoring site on Boneyard Creek is maintained by the USGS Illinois Water Science Center (identifier USGS-IL) and is located approximately 0.9 miles (1.4 km) east-northeast and upstream of the project site (Reference 7-75). The identifier for this stream site is USGS-03337000, which has a drainage area of 4.46 square miles (11.5 square kilometers) (Reference 7-76). According to the available median daily statistics for this stream site, the average daily streamflow between 1948 and 2025 was 4.8 cubic feet per second (cfs) (0.13 cubic meters per second [$m^3/s$]), with the lowest recorded value being 0.52 cfs (0.014 $m^3/s$) in 1990 and the highest being 70 cfs (1.98 $m^3/s$) in 1950 (Reference 7-75).

*3.4.1.1.5 Dams and Reservoirs*

No dams or reservoirs are located near the project site.

*3.4.1.1.6 Estuaries and Oceans*

No estuaries or oceans are located near the project site.

*3.4.1.1.7 Applicable Regulations and Permits*

A list of applicable regulations regarding safe drinking water is described below:

- Site development stormwater regulatory criteria applicable to the project site are established by the Municipal Code of Champaign, Illinois, Chapter 29.5, Article IV (Drainage System Designs), Section 29.5-4.04 (Stormwater Detention) (Reference 7-77).
- The EPA enforces the requirements of the Safe Water Drinking Act to ensure that the supply of public drinking water and its sources are protected and ensures that public drinking water systems comply with health-based federal standards for contaminants, which includes performing regular monitoring and reporting (Reference 7-78).
- The Clean Water Act and associated federal regulations (Title 40 CFR 123.25(a)(9), 122.26(a), 122.26(b)(14)(x) and 122.26(b)(15)) require nearly all construction site operators engaged in clearing, grading, and excavating activities that disturb one acre or more, including smaller sites in a larger common plan of development or sale, to obtain coverage under a National Pollutant Discharge Elimination System permit for their stormwater discharges (Reference 7-79). The Licensed Area boundary is estimated to occupy approximately 1.01 acres; therefore, construction site operators may not be required to prepare a Stormwater Pollution Prevention Plan.

The local stormwater regulations require that the drainage system for a development shall be designed to control the peak rate of discharge from the property for the 100-year, 24-hour event to levels which will not cause an increase in flooding or channel instability downstream when considered in aggregate with other developed properties and downstream drainage capacities. The peak 100-year discharge shall not be greater than 0.18 cfs (0.005 $m^3/s$), per acre of property drained. These release rates may be modified by provisions of a detailed study, if one exists, for the watershed in which a proposed development is to be located (Reference 7-77).

The project site is not located within a FEMA 100-year floodplain. However, Champaign County ordinance Chapter 29.5 (Reference 7-80) provides for regulation of floodplain development within regional floodplains, defined as floodplains that are mapped by local, non-FEMA studies. No regional floodplain mapping at the site is known.

#### *3.4.1.2 Groundwater*

Depth to the shallow groundwater at the project site is 10 to 15 feet (3.0 to 4.6 meters) bgs and groundwater resources around the project site are limited. Except along the Embarras River, the geology over much of the Salt Fork Vermilion River watershed, which includes the U. of I. campus, is largely unfavorable for the development of community groundwater systems. For many communities, the historical development of groundwater supply systems has been problematic, often resorting to using a large number of shallow wells or a long pipeline to a distant aquifer. Because shallow groundwater also does not provide a reliable source of baseflow for many of the streams in the region, most larger communities in the watershed have needed to develop reservoir storage to provide a reliable primary source of supply during drought periods (Reference 7-81).

The following list of applicable regulations regarding groundwater is described below (Reference 7-78):

- Ground Water Rule — EPA issued the Ground Water Rule to improve drinking water quality and provide protection from disease-causing microorganisms. Water systems that have groundwater sources may be susceptible to contamination, which, in many cases, can contain disease causing pathogens. The Ground Water Rule applies to public water systems that use groundwater as a source of drinking water.
- The Illinois EPA must report to the EPA on the quality of groundwater resources and other municipal sources of water [Section 305(b)] and provide a list of those waters where their designated uses are deemed “impaired” [Section 303(d)].

Groundwater withdrawals in Illinois came under the rule of reasonable use by the Water Use Act of 1983. The Act defined reasonable use as “the use of water to meet natural wants and a fair share for artificial wants.” The definition specifically states that it does not include water used wastefully or maliciously. The Act established a process through which potential water conflicts could be reviewed before damage occurred (Reference 7-82).

In addition to the protections afforded by Section 12 (a) and (d) of the Illinois Groundwater Protection Act, the Mahomet Aquifer and all groundwater in Illinois is protected by the Illinois Groundwater Protection Act (415 ILC 55/et. seq.). Among its provisions establishing various mechanisms for ensuring the protection of groundwater, Section 8 of the Groundwater Protection Act mandates that the Agency “propose regulations establishing comprehensive water quality standards which are specifically for the protection of groundwater” and that the Board promulgate those standards into Illinois’ environmental regulations (Reference 7-83).

*3.4.1.2.1 Surficial Aquifer System*

U. of I. is located over a tributary of the Mahomet Bedrock Valley, one that was deeply incised into bedrock of the Pennsylvanian Period, which is filled primarily with silty to clayey glacial sediment. Unlike the Mahomet Bedrock Valley, this tributary is not filled with thick deposits of sand and gravel correlated to the Mahomet Sand Member (the stratigraphic unit containing the Mahomet aquifer). Instead, the production wells constructed historically were screened in water-bearing deposits of sand and gravel in the Vandalia Member (correlated to the Upper Glasford aquifer) and the Harmattan Member (Banner Formation) (Reference 7-55). The water table in the project site, as well as the remainder of Champaign County, normally lies approximately 2.4 to 6 feet (0.7 to 1.8 meters) below ground level. Seasonal fluctuations in the water table range from 5 to 8 feet (1.5 to 2.4 meters) (Reference 7-73, Reference 7-84).

The Mahomet Aquifer, which supplies clean drinking water to Champaign-Urbana residents, is one of the largest sand/gravel aquifers in the state, at around 3,700 square miles. The aquifer supplies over 500,000 people across 14 counties and is directly fed by the Sangamon River. As a Sole Source Aquifer, it supplies at least 50 percent of the drinking water to the surrounding areas. As such, there are no reasonably available alternative drinking water sources should the aquifer become contaminated (Reference 7-15).

A number of studies have examined the physical nature of the Mahomet aquifer, delineating the basic shape, size, and stratigraphy of the deposits within the bedrock valley, as well as the geology and hydrogeology of the aquifer. When using the 500 feet (152 meters) bedrock elevation contour to define its boundaries, the Mahomet bedrock valley in Illinois is over 124 miles (199 km) long and ranges from 8 miles (12.8 km) wide at the Illinois/Indiana border to 20 miles (32.2 km) at its widest point. The hydraulic gradient for most of the Mahomet aquifer is approximately 1 foot per mile, except near the cone of depression that has recently developed near Champaign-Urbana. In the northeastern portion of the Mahomet aquifer, hydraulic head data indicate that groundwater gradients are reversed. Groundwater may originate from surrounding uplands, travel down into the bedrock valley, and recharge the Mahomet aquifer (Reference 7-85). The Mahomet Aquifer is mainly utilized for municipal withdrawals and has a 600 million gallons per day (mgd) available water supply. The average withdrawals from the Mahomet Aquifer was approximately 200 mgd in 2016. Current use is still less than the available water supply, but from 1990-2010 water demand has increased by 35 percent and users of the Aquifer has increased 40 percent (Reference 7-15).

The deposits responsible for producing the aquifers clean waters are typically found 500 feet (152 meters) below the surface. These deposits average close to 100 feet (30.5 meters) thick and may be as much as 200 feet (61 meters) in some places. It is only in areas near the Illinois River that the aquifer reaches the surface. While many of the recharge areas have been mapped using groundwater flow models, knowledge of these recharge areas is not complete (Reference 7-86).

*3.4.1.2.2 Bedrock Groundwater*

The bedrock in Champaign County may contain water-yielding formations but because groundwater supplies are usually available from unconsolidated material, water wells rarely penetrate the bedrock (Reference 7-87). Pennsylvanian bedrock, encountered below the drift in most parts of the area, generally is not a reliable source of groundwater. Locally, however, domestic and farm supplies are obtained from creviced limestone, permeable sandstone, or cracked shale and coal in the upper part of the Pennsylvanian bedrock (Reference 7-87).

Within Champaign County, the bedrock aquifers are not utilized as a water resource because of the availability of groundwater from the major sand and gravel aquifers. The quality of groundwater from bedrock aquifers is considered inferior to that of the major sand and gravel aquifers because of the larger levels of arsenic present. Deeper wells are required to access groundwater from the bedrock aquifers (Reference 7-15).

### *3.4.2 Water Use*

Because of projected population and economic growth, Illinois may require 20 to 50 percent more water in the coming decades. Since 2006, the Illinois Department of Natural Resources (IDNR) has funded the Illinois State Water Survey to lead regional water supply planning activities (Reference 7-88). The project site is located in the Salt Fork Vermilion River watershed, which is part of the Wabash River Basin. Except along the river, the geology in much of the Salt Fork Vermilion River Region is largely unfavorable for developing groundwater systems that can supply water to more than a few households. As a result, communities often rely on numerous shallow wells or long pipelines to transport water from distant aquifers. Additionally, shallow groundwater does not provide a reliable source of baseflow for many streams in the region, necessitating that most larger communities develop reservoir storage to ensure a dependable primary water supply during drought periods (Reference 7-89).

#### *3.4.2.1 Regional Water Use*

Approximately 50 percent of Illinois' population relies on groundwater from wells for drinking water. Nearly all rural residents (98 percent) obtain their drinking water from wells, and about 75 percent of Illinois' community water systems utilize groundwater. According to the USGS, Champaign County, where the project site is located, derived approximately 15 mgd from groundwater sources for public non-irrigation supply in 2020 and no surface water sources (Reference 7-90).

The Illinois EPA has established a groundwater protection program aimed at restoring, protecting, and enhancing the state's groundwater as a vital public resource. This program derives much of its authority from the Illinois Groundwater Protection Act, which emphasizes a prevention-oriented approach. The Illinois Groundwater Protection Act is a comprehensive law that relies on a partnership between state and local entities and was the first approved in Region 5 by the EPA under the Federal Safe Drinking Water Act. While the Illinois Groundwater Protection Act focuses on protecting groundwater as a natural and public resource, it also includes special provisions targeting drinking water wells. Illinois' groundwater policy establishes a framework for managing groundwater as a critical resource, focusing on its uses and implementing statewide protection measures for potable water wells (Reference 7-91).

The USGS typically reports water use information every five years by county. In 2020, the total water use in Champaign County was approximately 15 mgd, all sourced from groundwater (Reference 7-90).

U. of I. purchases drinking water from Illinois American Water (IAW), specifically from the Champaign District. Water is delivered to the campus through five metered locations. Currently, 21 wells supply water for treatment at two lime softening plants: the Mattis Avenue Plant, located in Champaign, and the Bradley Avenue Plant, situated west of Champaign. These wells, primarily located in the Mahomet Aquifer, range in depth from 208 to 366 feet (63.4 to 111.5 meters) and are protected from surface contamination by geological barriers within the aquifers.

The Illinois State Water Survey began monitoring water levels in the Mahomet Aquifer just west of Champaign in 1953 to help resolve a dispute between a petrochemical company in Tuscola and the water utility serving Champaign and Urbana. In the 1990s, increased interest in understanding groundwater flow led to state funding for the Aquifer Assessment Program. This monitoring network was significantly expanded between 2007 and 2009 with funding from IAW (Reference 7-92).

In 2017, the Mahomet Aquifer Task Force was established to identify gaps in existing aquifer protection regulations and efforts. The Task Force assessed threats and potential threats to the water quality of the Mahomet Aquifer, with a particular focus on underground natural gas storage. This focus was prompted by a natural gas leak identified in December 2016 from a Peoples Gas Light and Coke Company underground storage facility located in northern Champaign County, within the designated sole-source aquifer boundary for the Mahomet Aquifer (Reference 7-83).

The Illinois Department of Agriculture (IDA) serves as the lead state agency for regulating pesticide use in Illinois. Similar to many states, Illinois is voluntarily implementing the EPA-recommended provisions of pesticide management plans to protect groundwater. In June 2000, under the leadership of the IDA, the Pesticide Subcommittee of the Interagency Coordinating Committee on Groundwater approved the Illinois Generic Management Plan for Pesticides in Groundwater. In addition to sampling the monitoring well network for pesticides, the IDA has sampled these wells for nitrates biennially since 2006. The results of these sampling events indicate that several IDA wells have recorded detections exceeding the groundwater quality standard for nitrate of 10 milligrams per liter, with some wells having five or more detections above this standard (Reference 7-93).

All industrial and domestic wastewater generated on the U. of I. main campus is directed to the UCSD for treatment before being discharged into a waterway. U. of I. facilities that discharge wastewater to UCSD must comply with the District's Ordinance 678 requirements. In certain circumstances, a Special Discharge request may be necessary prior to discharging (Reference 7-94). UCSD operates two treatment plants in the area: a northeast plant and a southwest plant. The northeast plant has a rated design average flow of 17.3 mgd and services the U. of I. campus and surrounding areas. This plant receives the majority of the industrial flow, including that from a large industrial food manufacturer. All solids processing occurs at the northeast plant, with thickened waste activated solids from the southwest plant and the food manufacturer being transported to northeast plant. The solids processing includes gravity belt thickening, anaerobic digestion, dewatering via centrifuges, and land application to farmers' fields. The northeast plant also receives other trucked wastes, including those from restaurant grease traps, septic tanks, portable toilets, and leachate from a municipal landfill, with pretreatment (Reference 7-95).

Table 3-8 presents water withdrawal data for the Mahomet Aquifer in 2005 and projected withdrawals for 2050. In 2005, the primary water use was for thermoelectric generation at 1,315 mgd, followed by irrigation and agriculture at 338 mgd. Public water supply accounted for 127 mgd, while industrial use was approximately 64 mgd. Projections for 2050 indicate similar trends, with thermoelectric use at 1,275 mgd, irrigation and agriculture at 512 mgd, public supply at 176 mgd, and industry at 137 mgd (Reference 7-86).

Table 3-9 details projected water withdrawals for the 14-county area within the Mahomet Aquifer. Dewitt and Sangamon counties are projected to have the largest total water withdrawals at 813 mgd and 374 mgd, respectively. Only five of the 15 counties are expected to withdraw water for power generation, including Dewitt County at 810 mgd, Sangamon County at 331 mgd, Mason County at 105 mgd, Tazewell County at

26 mgd, and Vermilion County at less than 3 mgd. Champaign, Sangamon, Macon, Tazewell, and McLean counties are projected to withdraw the most water for public supply, with estimates of 33 mgd, 31.74 mgd, 31.33 mgd, 25 mgd, and 24 mgd, respectively (Reference 7-86).

Overall water usage statistics are summarized in Table 3-10, covering the period from 1990 to 2020. In 2020, total water withdrawals for non-irrigation public supply in Champaign County were estimated at 15 mgd. Notably, the USGS is not report any water withdrawals for thermoelectric (steam-cycle) generation in Champaign County 200 (Reference 7-90). However, the Abbott Power Plant was not included in these values likely because it is not directly served from groundwater wells. Champaign County has no large thermoelectric power plants.

#### *3.4.2.2 Facility Water Use*

As discussed in Section 2.4.1, the facility will obtain water for cooling, sanitary needs, fire protection, and other purposes from municipal water suppliers through the campus water distribution system. The estimated total daily water requirement from municipal sources for the site is 16,260 gallons per day (gpd). There is no expectation of directly using surface water through an intake or groundwater through production wells. A facility water balance diagram illustrating water sources and discharges is provided in Figure 2-5.

Of the 16,260 gpd supplied by the campus water system, 500 gpd will be allocated for service water to the reactor plant, while 15,760 gpd will be directed to the demineralization plant for the production of demineralized water. The demineralization system will typically consist of pre-filtration, carbon filtration, a softener, a reverse osmosis system, and a deionizing system. The demineralized water will be stored in a tank located at the project site. The design details and capacity of this storage tank are currently under evaluation as part of the integration study. The Bradley Avenue Water Treatment Plant provides 20 million gpd.

The reactor facility is expected to discharge approximately 500 gpd into the campus sewer system while the Abbott Plant currently contributes and will continue to contribute more than 224,000 gpd into the campus sewer system, which is managed by the UCSD.

The water demand for the fire protection system has yet to be determined. It is anticipated that internal consumption will be relatively small; however, this quantity will be influenced by the fire risk assessment, fire system design, and the finalization of internal reactor facility system top-up requirements.

### ***3.4.3 Water Quality***

#### *3.4.3.1 Surface Water*

There are no affected surface water bodies near the project site and there are no sources of surface water on the site. The only hydrologic feature near the project site (0.5 miles [0.8 km] in distance) is the Boneyard Creek. Running through the Champaign-Urbana area, the Boneyard Creek feeds into the Saline Branch drainage ditch just north of downtown Urbana. Channelized in the early 20th century for flood control and running through many acres of private property, the Boneyard Creek has been polluted over the years from runoff and dumping, with little jurisdiction to undergo large-scale restoration or maintenance. Currently, the creek is considered an "impaired water" by the Illinois Environmental Protection Agency (IEPA; Reference 7-15).

#### *3.4.3.2 Groundwater*

No site-specific groundwater quality monitoring has been conducted for the project site. However, groundwater quality in the vicinity of the site has been the focus of multiple ongoing monitoring programs, as detailed in the latest water quality report (Reference 7-96).

The IEPA completed a source water assessment for the Champaign County system, indicating that the wells supplying water to Champaign County are not geologically sensitive. To evaluate the susceptibility of IAW, Champaign District, to groundwater contamination, a Well Site Survey Report from February 1991 and a source inventory conducted in 1999 by the Illinois Rural Water Association, in cooperation with the IEPA, were reviewed. These documents identified potential sources of groundwater contamination that could pose a risk to the groundwater extracted by the IAW, Champaign District's community water supply wells (Reference 7-96).

The IEPA determined that the IAW, Champaign District's wells are not susceptible to contamination from inorganic chemicals, volatile organic chemicals, or synthetic organic chemicals. U. of I. is required to test the water in its distribution system for coliform, lead, copper, trihalomethanes, and haloacetic acids. In 2024, no violations related to monitoring, reporting, treatment techniques, maximum residual disinfectant levels, or maximum contaminant levels were recorded (Reference 7-96).

Additionally, there are no identified domestic, municipal, industrial, mining, recreational, navigation, or hydroelectric power uses of any bodies of water or aquifers in close proximity that could affect or be adversely affected by the proposed facilities.

**Table 3-7 Summary of Monthly and Annual Temperature, Precipitation, and Snowfall Data for Champaign-Urbana, Illinois**

| Month | Average High (°F) | Average Low (°F) | Average Precipitation (Inches) | Average Snowfall (Inches) |
|---|---|---|---|---|
| January | 33.5 | 17.9 | 2.31 | 6.50 |
| February | 38.4 | 21.2 | 2.18 | 5.80 |
| March | 50.4 | 31.2 | 2.77 | 2.50 |
| April | 63.1 | 41.6 | 3.94 | 0.30 |
| May | 73.8 | 52.7 | 4.78 | 0.00 |
| June | 82.7 | 62.1 | 4.58 | 0.00 |
| July | 85.2 | 65.2 | 4.49 | 0.00 |
| August | 84.0 | 63.6 | 3.54 | 0.00 |
| September | 78.8 | 55.6 | 3.37 | 0.00 |
| October | 65.8 | 43.9 | 3.35 | 0.00 |
| November | 50.7 | 32.2 | 3.21 | 0.90 |
| December | 38.5 | 23.6 | 2.40 | 4.80 |
| Annual | 62.1 | 42.6 | 40.92 | 20.8 |

Source: Reference 7-21

**Table 3-8 Summary of Water Withdrawals in East-Central Illinois**

| Use Type | 2005 (mgd) | 2050 (mgd) |
|---|---|---|
| Public Supply | 127 | 176 |
| Industry | 64 | 137 |
| Irrigation and Agriculture | 339 | 513 |
| Thermoelectric | 1,315 | 1,275 |

Source: Reference 7-86

**Table 3-9 Projected 2050 Withdrawals for Illinois Counties, by Demand Sector**

| County | Public water supply (mgd) | Thermoelectric (mgd) | Industry (mgd) | Irrigation and Agriculture (mgd) | Total (mgd) |
|---|---|---|---|---|---|
| Cass | 2.32 | - | 3.16 | 15.84 | **21.76** |
| Champaign | 33.62 | -[a] | 9.74 | 6.15 | **52.07** |
| Dewitt | 1.83 | 810.44 | 0.03 | 0.94 | **813.64** |
| Ford | 2.25 | - | 6.54 | 0.92 | **9.96** |
| Iroquois | 3.3 | - | 1.48 | 3.25 | **8.99** |

**Table 3-9 Projected 2050 Withdrawals for Illinois Counties, by Demand Sector (Continued)**

| County | Public water supply (mgd) | Thermoelectric (mgd) | Industry (mgd) | Irrigation and Agriculture (mgd) | Total (mgd) |
|---|---|---|---|---|---|
| Logan | 3.99 | - | 2.82 | 2.08 | **9.59** |
| Macon | 31.33 | - | 26.59 | 0.41 | **58.54** |
| Mason | 0.95 | 105 | 7.48 | 108.26 | **222.24** |
| McLean | 24.07 | - | 2.07 | 2.15 | **29.85** |
| Menard | 1.04 | - | 0 | 3.09 | **4.16** |
| Piatt | 1.42 | - | 1.56 | 0.48 | **3.94** |
| Sangamon | 31.74 | 331.46 | 7.93 | 1.64 | **374.31** |
| Tazewell | 25.39 | 25.88 | 62.05 | 39.14 | **152.59** |
| Vermilion | 10.52 | 2.76 | 6.04 | 0.72 | **20.71** |
| Woodford | 3.08 | - | 0.02 | 1.39 | **6.06** |
| **Total** | **176.88** | **1,275.54** | **137.51** | **186.46** | **1,788.40** |

a – Excludes Abbott Power Plant which gets its water from the public utility and not directly from the aquifer

Values are in millions of gallons per day.

Source: Baseline scenario in Reference 7-85

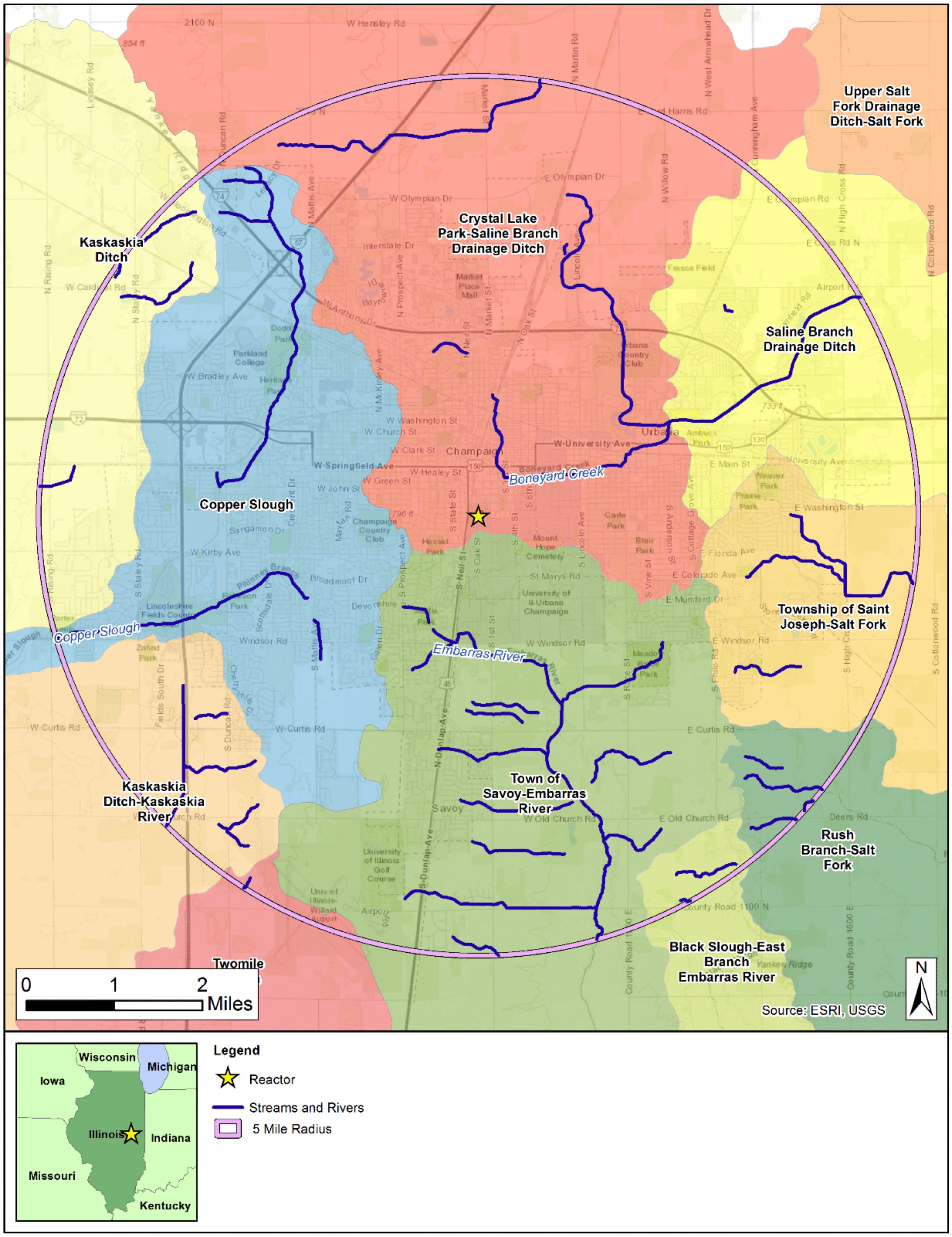
**Table 3-10 Groundwater Withdrawals for Champaign County, Illinois**

| Groundwater Use (mgd) | 2000 | 2005 | 2010 | 2015 | 2020 |
|---|---|---|---|---|---|
| Public Supply | 13.41 | 15.18 | 15.19 | 14.46 | 14.96 |
| Thermoelectric (excludes Abbot Power Plant) | 0 | 0 | 0 | 0 | 0 |
| Irrigation | 12.81 | 9.77 | 16.68 | 10.82 | 13.12 |

Considers all 12-digit hydraulic unit codes (HUC12s) that are at least 98% within the county bounds

Source: Reference 7-90

**Figure 3-24 Streams and Rivers within a 5-Mile-Radius of the Site**



## 3.5 ECOLOGICAL RESOURCES

This section provides a description and characterization of the terrestrial ecosystems potentially affected by the proposed construction and operation of the research reactor within the project site.

### *3.5.1 Offsite Areas*

Champaign County is a part of the Illinois/Indiana Prairies level IV ecoregion, which is the largest ecoregion found in Illinois. The natural vegetation associated with this ecoregion is a mosaic of bluestem prairie and oak-hickory forest. The flat and rolling plains of this ecoregion are characterized by dark, very fertile soils that developed under tall-grass prairie. Marshes and wet prairies naturally occurred in poorly drained areas, and forests grew on concentric moraines and floodplains. The surrounding land includes urban areas as well as areas used for agriculture and forestry (Reference 7-16).

### *3.5.2 Site and Near-Site Areas*

The proposed project site encompasses mainly an open space, including a small parking lot, adjacent to roads and existing structures. Because of its history, the project site generally provides poor-quality habitat for ecological receptors and is likely to be used principally by common species that are adapted to human disturbance. The proposed project site sits east of the Abbott Power Plant, which supplies 70 to 75 percent of the energy demand for the U. of I. campus. To the south of the project site is the Geological Survey Laboratory. Vegetation within the surrounding areas near the project site includes a mixture of mowed grasses with a few shrubs and trees (especially around buildings), small areas of mixed tree/shrub/grass associations, or mixed evergreen-deciduous vegetation. Few of the shrubs and trees in the landscaping are native species.

There are no streams draining the site and no potentially affected waterbodies in surrounding areas.

### *3.5.3 History*

U. of I. was founded in 1867 as one of the original 37 land-grant institutions following approval of the Morrill Land-Grant Colleges Act in 1862. The campus began as a single academic building situated on 10 acres of land between the central Illinois towns of Urbana and Champaign, with an additional 565 acres of agricultural land holdings located approximately 1 mile south of the Main campus. The early curriculum was narrowly focused on agriculture and engineering programs (Reference 7-5).

The Abbott Power Plant is the most significant structure located adjacent to the project site. Originally constructed in 1940, this cogeneration facility simultaneously produces both steam and electricity for campus. Of the seven boilers at Abbott, two are dual fuel, utilizing natural gas or fuel oil; three are coal boilers; and two are heat recovery steam generators. (Reference 7-97).

### *3.5.4 Places and Entities of Special Interest*

There are currently no areas of special interest with long-term environmental protection that are on or near the project site. Areas of special interest are defined by the USDA and may be designated for scenic, geological, botanical, zoological, paleontological, archaeological/historic, or recreational values, or combinations of these values. The designation recognizes certain areas and allows land uses to interpret, maintain and enhance those special features (Reference 7-98).

### *3.5.5 Terrestrial Communities*

The project site is located on the U. of I. campus, which encompasses 6,370 acres (2,577 hectares) of U. of I. buildings, research park buildings, non-university buildings, open spaces, campus landscape, recreational areas, and agricultural landscape (Reference 7-5).

The project site is a part of the Illinois/Indiana Prairies level IV ecoregion, which is the largest ecoregion in Illinois. The natural vegetation associated with this ecoregion is a mosaic of bluestem prairie and oak-hickory forest (Reference 7-16).

The terrestrial ecological communities currently existing on and adjacent to the project site reflect the effects of the area's history. The natural communities of the area have been modified by development and industrial use over many decades, which was followed by demolition and revegetation. The effects to plant communities have in turn affected the habitats available to animal communities. Many areas surrounding the project site have been similarly effected by historical development, and the species present on the project site are expected to be similar to species found to occur in those areas.

#### *3.5.5.1 Plant Community*

The Licensed Area covers 1.01 acres (0.41 hectares) in a highly developed area. The limited vegetation on the site consists of herbs, shrubs, and trees. As a result of historical development and industrial use, vegetation on the project site is predominantly an herbaceous community of grasses and forbs covering the areas between structures, parking lots, streets, and walkways. These areas are mainly dominated by planted grasses, which are maintained as lawns by regular mowing. Woody vegetation includes two deciduous trees within the Licensed Area, an additional deciduous tree immediately adjacent to the southeastern corner, and small areas of planted shrubs. The trees consist of three maples – sugar maple (*Acer saccharum*), black maple (*Acer nigrum*), and red maple (*Acer rubrum*) – that serve as moderate-size shade trees. The shrubs consist of ornamental species planted and maintained as hedges or screens.

#### *3.5.5.2 Animal Community*

The animal community on the project site is very limited in numbers and diversity because of the minimal size of the site, the low-quality habitat provided by the vegetation present, and the extensive development surrounding the site. Mammals that may utilize the site are small and include the fox squirrel (*Sciurus niger*), eastern gray squirrel (*Sciurus carolinensis*), eastern cottontail rabbit (*Sylvilagus floridanus*), plains pocket gopher (*Geomys bursarius*), least shrew (*Cryptotis parva*), and eastern mole (*Scalopus aquaticus*) (Reference 7-99). Birds that may be present on the site during various seasons include species that are typical of urban and suburban areas, such as the American robin (*Turdus migratorius*), common cardinal (*cardinalis cardinalis*), tufted titmouse (*Baeolophus bicolor*), and Canada goose (*Branta canadensis*) (Reference 7-100). Among the few reptiles and amphibians that may occur on the site are the brown snake (*Storeria dekayi*) and American toad (*Anaxyrus americanus*) (Reference 7-101).

### *3.5.6 Invasive Species*

The urban and historical development of and around the project site has allowed the establishment of non-native, invasive species, particularly in the areas where native communities have been disturbed. Executive Order 13112 defines an invasive species as any species that is non-native to an ecosystem and that when introduced causes or is predicted to cause harm to the ecology, economy and/or human health. Invasive species have the potential to reduce biodiversity by displacing and outcompeting natural floral and faunal populations, reducing effective management practices, degrading wildlife habitats, and permanently altering the environment (Reference 7-102). Prevention is one of the most effective and cost-efficient means of managing invasive plants. Regulations are one tool used to help prevention efforts. While several laws and administrative rules exist that regulate invasive plants in Illinois, the Illinois Exotic Weed Act (525 ILCS 10) is the primary means of regulating the movement of invasive plant species that threaten terrestrial natural ecosystems in Illinois (Reference 7-103).

Invasive, non-native, mammals that have the potential to occur on the site include the brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*) (Reference 7-104).

According to IDNR, non-native and invasive birds that can be found in Illinois include the European starling (*Sturnus vulgaris*), house finch (*Haemorhous mexicanus*), house sparrow (*Passer domesticus*), and rock pigeon (*Columba livia*) (Reference 7-105). These species have the potential to occur on the project site. While typically these species are not problematic, they may build nests in unwanted areas, such as vents, and compete with native birds.

### *3.5.7 Protected Species*

Rare species may be protected under the federal Endangered Species Act and by regulations of the State of Illinois. Such species are assigned a legally protected status of endangered or threatened, or they may be classified in other categories based on their rarity or the degree of concern for their vulnerability. Federal-listed species identified by the U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) system as potentially occurring in the vicinity of the project site are included in Table 3-11. No designated critical habitats were identified in the project vicinity (Reference 7-105). The table also includes species from the IDNR database that have a state or federal listing status and recorded occurrences in Champaign County.

Table 3-11 includes a brief description of the habitat preferred by each species. Based on comparison of the habitat requirements and the habitats present on and adjacent to the project site, the table provides an estimate of the potential for each species to occur in the area that may be affected by the construction and operation of the U. of I. research reactor. Approximately 22 species are considered to have a low potential to occur in the action area because habitats on or adjacent to the project site are only marginally supportive. Five species may have a moderate potential to occur based on more suitable habitat. Of these 27 species, 6 are federal and state listed as endangered or threatened. These species are discussed below.

### 3.5.7.1 Federal Listed Species

According to the IPaC report for the area of the project site, the federal listed species with a potential to occur in the vicinity based on their ranges include two bats (Indiana bat and northern long-eared bat), and one flowering plant (eastern prairie white-fringed orchid). One insect that is a candidate for listing (the monarch butterfly) also has the potential to occur in the area. These species are discussed below.

#### 3.5.7.1.1 Bats

Indiana bat (*Myotis sodalis*)

The Indiana bat has a federal listing status of endangered and is listed as endangered in Illinois. The destruction of cave habitats has decreased available wintering sites, and the loss of foraging areas over aquatic habitats is also a problem. Numbers of the Indiana bat are stable or decreasing throughout portions of its range largely because of disease (white-nose syndrome) and loss of habitat (Reference 7-106).

In summer, the Indiana bat may be found in the southern one-third of Illinois. Females seek dead trees with loose bark or live trees with shaggy bark in which to rest and raise their young. They tend to forage around water, over floodplain trees and in and around wooded areas. Males forage among trees. About 90 percent of the entire population of these bats hibernate in a few caves in Missouri, Kentucky, and southern Indiana. The Indiana bat is an insectivore, eating mostly moths, caddisflies, leafhoppers, planthoppers, and beetle larvae. Mating occurs in fall, winter, or spring. Females mating in fall and winter store sperm in the uterus until spring, when it is used to fertilize the eggs. Females leave the wintering site in April. Young are born in June or July (Reference 7-107).

Champaign County is not part of the reported Indiana bat habitat (Reference 7-108). Additionally, the project site does not provide suitable foraging habitat, and the few trees on the site do not have the characteristics of suitable roost trees. Therefore, the Indiana bat is not be expected to be present on the site during either the warm, non-hibernating season or winter (Reference 7-106).

Northern Long-eared Bat (*Myotis septentrionalis*)

The northern long-eared bat was listed as threatened in 2015 primarily because of the threat posed by white-nose syndrome, a fungal disease that has resulted in substantial mortality, particularly in the northeastern United States. Although declines in populations of this species have been observed in the southeast region, the declines have not been as dramatic as those in the northeast. The northern long-eared bat hibernates in caves during winter and migrates to roost on the landscape during summer, where they roost singly or in colonies beneath exfoliating bark or in crevices of dead or live trees (Reference 7-109). Although studies of their habitat use during summer are few or ongoing, available data suggest that summer habitat use by the northern long-eared bat is probably similar to that of the Indiana bat. The project site does not include caves for use as hibernacula.

Northern long-eared bats have smaller summer home ranges than gray bats and forage within 1.5 miles of roost trees. The project site does not provide suitable foraging habitat, and the few trees on the site do not have the characteristics of suitable roost trees. Therefore, the northern long-eared bat is not be expected to be present on the site during either the warm, non-hibernating season or winter (Reference 7-109).

*3.5.7.1.2 Insects*

Monarch butterfly (*Danaus plexippus*)

The monarch butterfly is a candidate species and not yet listed or proposed for listing. Adult monarch butterflies are large and conspicuous, with bright orange wings surrounded by a black border and covered with black veins. The black border has a double row of white spots, present on the upper side of the wings.

During the breeding season, monarchs lay their eggs on their obligate host plant, milkweed (primarily *Asclepias spp.*). Larvae emerge after 2 to 5 days. Larvae develop through five larval instars (intervals between molts) over a period of 9 to 18 days, feeding on milkweed and sequestering toxic chemicals (cardenolides) as a defense against predators. The larva then pupates into a chrysalis before emerging 6 to 14 days later as an adult butterfly. There are multiple generations of monarchs produced during the breeding season, with most adult butterflies living approximately 2 to 5 weeks; overwintering adults enter reproductive diapause (suspended reproduction) and live 6 to 9 months.

In many regions where monarchs are present, monarchs breed year-round. Individual monarchs in temperate climates, such as eastern and western North America, undergo long-distance migration, and live for an extended period. In the fall in both eastern and western North America, monarchs begin migrating to their respective overwintering sites. This migration can take monarchs distances of over 3,000 km and last for over two months. In early spring (February-March), surviving monarchs break diapause and mate at the overwintering sites before dispersing (Reference 7-110).

The common milkweed is often found in old fields, pastures, degraded prairie, and along roadsides (Reference 7-111). This plant is not present on the project site. Because monarch butterflies need milkweed to lay their eggs and flowers for nectar, it is unlikely that they are present on the project site.

*3.5.7.1.3 Flowering Plants*

Eastern prairie fringed orchid (*Platanthera leucophaea*)

The eastern prairie fringed orchid has a federal listing status of threatened and occurs in a wide variety of habitats, from mesic prairie to wetlands such as sedge meadows, marsh edges, even bogs. It requires full sun for optimum growth and flowering and a grassy habitat with little or no woody encroachment. This orchid is a perennial herb that grows from an underground tuber. Flowering begins from late June to early July and lasts for 7 to 10 days. Blossoms often rise just above the height of the surrounding grasses and sedges. The early decline of this species was the result of loss of habitat, mainly conversion of natural habitats to cropland and pasture. The current decline is mainly a result of habitat loss from the drainage and development of wetlands. Other reasons for the current decline include succession to woody vegetation, competition from non-native species and over-collection (Reference 7-112).

The project site does not provide suitable habitat for the eastern prairie fringed orchid.

### *3.5.7.2 State Listed Species*

Of the 25 species with a state status and recorded occurrences in Champaign County, (Table 3-11), four also have a federal listing status and are discussed above, and 21 (19 animals and two plants) have only a state status. Based on the types and quality of the habitats at the project site, these 21 species are considered to have essentially no likelihood of occurrence on or near the site. Information about each species' state status and habitat preferences are provided in Table 3-11.

#### *3.5.7.2.1 Migratory Birds*

In addition to the rare species federally protected under the Endangered Species Act, birds are also federally protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA). Protected migratory birds include those identified above (federal and state listed species and species with other state status) as well as essentially all other native birds that inhabit the vicinity of the project site.

The IPaC Trust Resources Report for the project site contains a list of migratory birds of conservation concern (BCC) that potentially could occur in the area. BCCs are species of particular concern to USFWS either because they are on the USFWS BCC list or warrant special attention at the project location. The 13 BCC species identified for the project vicinity based on their ranges, and the seasons in which they may occur there, are the following (Reference 7-113):

- American golden-plover (*Pluvialis dominica*) – breeds elsewhere
- Black-billed cuckoo (*Coccyzus erythropthalmus*) – breeding (summer-fall)
- Bobolink (*Dolichonyx oryzivorus*) – breeding (spring-summer)
- Cerulean warbler (*Dendroica cerulea*) – breeding (spring-summer)
- Eastern whip-poor-will (*Antrostomus vociferus*) – breeding (spring-summer)
- Henslow's sparrow (*Ammodramus henslowii*) – breeding (spring-summer)
- Kentucky warbler (*Oporornis formosus*) – breeding (spring-summer)
- Lesser yellowlegs (*Tringa flavipes*) – breeds elsewhere
- Prothonotary warbler (*Protonotaria citrea*) – breeding (spring-summer)
- Red-headed woodpecker (*Melanerpes erythrocephalus*) – breeding (spring-fall)
- Rusty blackbird (*Euphagus carolinus*) – breeds elsewhere
- Short-billed dowitcher (*Limnodromus griseus*) – breeds elsewhere
- Wood thrush (*Hylocichla mustelina*) – breeding (spring-summer)

Seven of these 13 BCC species primarily occur in forest habitats, two species primarily occur in damp meadows, three species prefer marsh/mudflat areas, and one species occurs in the region only during migration between arctic and subarctic tundra breeding areas and South America.

The project site does not provide suitable habitat for any of these BCC species.

*3.5.7.2.2 Bald Eagle*

In addition to protection under the MBTA, eagles are also protected under the BGEPA of 1940, as amended (16 USC Part 668). The BGEPA provides protections to bald and golden eagles in addition to those provided by the MBTA. This act prohibits anyone, without a permit issued by the USFWS, from taking bald and golden eagles, including their parts, nests, or eggs. The Act defines “take” as to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb. To “disturb” means to agitate or bother an eagle to a degree that causes or is likely to cause, based on the best scientific information available: 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior. The National Bald Eagle Management Guidelines (Reference 7-114) provide recommendations to minimize disturbance to bald eagles in accordance with the BGEPA, such as buffers around nests. Although there is a possibility that bald eagles may nest or forage year-round in the region where suitable habitat is available, the project site does not provide suitable habitat, and the bald eagle would not occur on or adjacent to the project site.

**Table 3-11 Species with Federal or State Listing Status and Recorded Occurrences in Champaign County, Illinois**

| Common Name [a, b] Scientific Name | Habitat [c] | Potential to Occur [d] | Federal Status | State Status | State Rank |
|---|---|---|---|---|---|
| **Mammals** | | | | | |
| Indiana bat *Myotis sodalis* | Caves and mines during winter; large trees with exfoliating bark near riparian areas in summer. | None | E | E | S2 |
| Northern long-eared bat *Myotis septentrionalis* | A forest bat whose summer roosts may include caves, mines, live trees and snags; hibernates in caves and mines, often using small cracks and fissures. | None | T | T | S1 |
| Franklin's ground squirrel *Poliocitellus franklinii* | Tallgrass and mid-grass prairies, as well as riparian areas (marsh edges), forest-field edges, fields, hedgerows, and unmowed strips along railroad rights-of-way and roadsides. | None | - | T | S1 |
| **Birds** | | | | | |
| Upland sandpiper *Bartramia longicauda* | Large areas of short grass interspersed or adjacent taller grasses for nesting and brood cover. | None | - | E | S2 |
| Northern harrier *Circus hudsonius* | Open habitats ranging from Arctic tundra to prairie grasslands to fields and marshes. | None | - | E | S2 |
| Least bittern *Ixobrychus exilis* | Habitats vary throughout North America, but nesting usually occurs among dense, tall growths of emergent vegetation, interspersed with some woody vegetation and open, fresh water. | None | - | T | S3 |
| Loggerhead shrike *Lanius ludovicianus* | Open country with scattered trees and shrubs, savanna, and, occasionally, open woodland; often perches on poles, wires or fenceposts (Tropical to Temperate zones). Suitable hunting perches are an important part of the habitat. | None | - | E | S1 |
| Yellow-crowned night-heron *Nyctanassa violacea* | Marshes, swamps, lakes, lagoons, and mangroves; chiefly coastal. Prefers mangroves and gallery forest for roosting. Nests in trees in wooded situations near water, occasionally in arid scrub on islands; sometimes on ground. | None | - | E | S1 |

**Table 3-11 Species with Federal or State Listing Status and Recorded Occurrences in Champaign County, Illinois (Continued)**

| Common Name [a, b] Scientific Name | Habitat [c] | Potential to Occur [d] | Federal Status | State Status | State Rank |
|---|---|---|---|---|---|
| **Reptiles** | | | | | |
| Blanding's turtle *Emydoidea blandingii* | Marshes, ponds, swamps, lake shallows, backwater sloughs, shallow slow-moving rivers, protected coves and inlets of large lakes, oxbows, and pools adjacent to rivers; waters with soft bottom and aquatic vegetation. | None | - | E | S2 |
| **Amphibians** | | | | | |
| Mudpuppy *Necturus maculosus* | Lives in permanent waters including rivers, perennial streams, ponds, inland lakes, Great Lakes bays and shallows, reservoirs, canals, and ditches. Prefers medium to large rivers and lakes, and aquatic habitats with abundant shelter or cover. | None | - | T | S1 |
| **Fish** | | | | | |
| Eastern sand darter *Ammocrypta pellucida* | Small creeks to large rivers and lake shores. | None | - | T | S3 |
| Bluebreast darter *Etheostoma camurum* | Creeks and small to medium rivers with moderate gradient with substrate of coarse gravel, rubble, or boulders. | None | - | E | S3 |
| Bigeye chub *Hybopsis amblops* | Small to moderate size, clear-water tributaries with sand, gravel, or rocky bottom. | None | - | T | S3 |
| Pallid shiner *Hybopsis amnis* | Habitat includes medium to large rivers; quiet waters over sandy-silty bottoms; often at ends of sand and gravel bars. | None | - | E | S3 |
| **Mollusks** | | | | | |
| Purple wartyback *Cyclonaias tuberculata* | Gravel/mud bottom in medium-sized to small streams or in the main channel of large rivers. | None | - | T | S2 |
| Northern riffleshell *Epioblasma rangiana* | Preferred habitat appears to require swiftly moving water. The high oxygen concentrations in swift streams may be necessary for survival. It is a species of riffle areas of smaller streams. | None | E | E | S1 |
| Spike *Eurynia dilatata* | Medium streams to large rivers but can occasionally be found in tailwaters of dams and in lakes. | None | - | E | S3 |

**Table 3-11 Species with Federal or State Listing Status and Recorded Occurrences in Champaign County, Illinois (Continued)**

| Common Name [a, b] Scientific Name | Habitat [c] | Potential to Occur [d] | Federal Status | State Status | State Rank |
|---|---|---|---|---|---|
| Wavy-rayed lampmussel *Lampsilis fasciola* | Small- to medium-sized streams and rivers of various sizes at depths of up to 1 m. | None | - | E | S1 |
| Monkeyface *Quadrula metanevra* | Found in medium to large rivers in gravel or mixed sand and gravel. | None | - | T | S2 |
| Salamander mussel *Simpsonaias ambigua* | Although occasionally found elsewhere, the preferred habitat is in sand or silt under large, flat stones in areas of swift current in medium to large rivers and lakes. | None | - | E | S1 |
| Rainbow *Villosa iris* | Within gravel and sand in moderate to strong current. Most abundant in small- to medium-sized rivers but can also be found in lakes. | None | - | E | S1 |
| **Crustacean** | | | | | |
| Bigclaw crayfish *Faxonius placidus* | Found principally in shallow, rocky, upstream pools of streams. | None | - | E | S1 |
| **Insects** | | | | | |
| Rusty patched bumble bee *Bombus affinis* | Typically found close to or within woodlands, urban parks, and gardens with flowers providing nectar and pollen. | None | E | E | S1 |
| Monarch butterfly *Danaus plexippus* | In general, breeding areas are virtually all patches of milkweed in North America and some other regions. The critical conservation feature for North American populations is the overwintering habitats, which are certain high altitude Mexican conifer forests or coastal California conifer or Eucalyptus groves. | None | C | C | S5 |
| **Flowering Plants** | | | | | |
| Yellowwood *Cladrastis lutea* | Typically occurs in rich, well-drained limestone soils in river valleys, slopes, and ridges along streams, and is the only species of Cladrastis that is native to North America. | None | - | E | S1 |
| Sangamon phlox *Phlox pilosa ssp. sangamonensis* | Known to inhabit forest openings, blufftops, prairies, and railroad rights-of-way. | None | - | E | S1 |

**Table 3-11 Species with Federal or State Listing Status and Recorded Occurrences in Champaign County, Illinois (Continued)**

| **Common Name [a, b]** **Scientific Name** | **Habitat [c]** | **Potential to Occur [d]** | **Federal Status** | **State Status** | **State Rank** |
|---|---|---|---|---|---|
| Eastern prairie fringed orchid *Platanthera leucophaea* | Mesic to wet prairies and wet sedge meadows. Peripheral habitat includes sedge-sphagnum bog mats around neutral pH kettle lakes, and fallow agricultural fields. Wet ditches and railroad rights-of-way also serve as refugia. | None | T | E | S1 |

Federal and State Listing Status Abbreviations (legal listing status under federal and state regulations):

E = Endangered

T = Threatened

C = Candidate for listing

\- = No federal status

State Rank Abbreviations (non-legal rank indicating rarity and vulnerability at the state level):

S1 = Extremely rare and critically imperiled

S2 = Very rare and imperiled

S3 = Vulnerable

S4 = Apparently secure, but with cause for long-term concern

S5 = Secure

Sources:

[a] Reference 7-108

[b] Reference 7-109

[c] Habitat description: Reference 7-115

[d] Potential to occur was estimated based on habitat requirements versus habitats observed on or in the vicinity of the project site.

## 3.6 HISTORIC AND CULTURAL RESOURCES

Defined by the U.S. National Park Service, cultural resources are evidence of past human activity. Cultural resources contain links to our past and provide an understanding of the prehistory and early history of the area. These resources include sites, structures, buildings, or areas. Cultural resources are classified in this report as historic places listed under the National Register of Historic Places (NRHP), archaeological areas designated by the Illinois State Historic Preservation Office (ISHPO), and cemeteries. Site investigations are often necessary to determine locations, and certain regulations protecting these sites require consideration of the effects to such locations, preserving the past to inform the future. The U. of I. is required to comply with the Illinois State Agency Historic Resources Preservation Act (20 ILCS 3420, as amended, 17 IAC 4180). This requires that the Campus Historic Preservation Officer review all undertakings by the U. of I. and consult with ISHPO to determine if the undertaking will have any adverse effects on any historic properties. All new facilities are reviewed and submitted to ISHPO for their concurrence that there will not be any adverse effects on any historic properties. Because this project may involve federal funds, it will also need to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.

### *3.6.1 Cultural Setting*

This section examines the current cultural background and the known historic and cultural resources at the proposed site in Champaign, Illinois, as well as in the surrounding city of Urbana. It discusses information sourced from the NRHP, archaeological site inventories, burial site inventories, and the Illinois State Museum. The history of Central Illinois and Champaign County can be traced back through five distinct periods: the Paleo-Indian, Archaic, Woodland, Mississippian, and Historic periods.

The Paleo-Indian Period began approximately 12,000 years ago when Paleo-Indians migrated into North America. As the glaciers in Southern and Central Illinois melted, these early inhabitants traveled throughout the region. As hunters and gatherers, they utilized materials such as stone, bone, and wood to create specialized weapons and tools, including spearheads and knives, tailored for specific tasks (Reference 7-116, Reference 7-117).

During the Archaic Period, around 10,000 years ago, a warming climate led to the growth of new plant species, which in turn influenced the terrestrial animal populations in the region. The reliance on hunting and gathering diminished as more permanent settlements were established. While existing tools and weapons remained in use, new, more efficient tools were introduced to meet evolving demands (Reference 7-116, Reference 7-117).

By approximately 3,000 years ago, the Woodland Period saw the introduction of pottery, pipe-making, plant cultivation, mound building, and trade throughout the area. The advent of the bow and arrow, along with crop cultivation, significantly effected agricultural practices and societal structures. Additionally, these items were often placed in burial mounds as a sign of respect for the deceased (Reference 7-116, Reference 7-117).

The Mississippian Period, which began around 1,000 years ago, is characterized by the emergence of large, permanent settlements across Illinois. A prominent example of a Mississippian settlement is Cahokia, located in present-day St. Louis. The cultivation of crops supported the prosperity of these settlements, leading to a shift in focus from mere survival to the exchange of ideas, techniques, art, and specialized skills. This flourishing culture produced sculptures, figures, bowls, and pipes that reflected their beliefs (Reference 7-116, Reference 7-117).

The Historic Period marks a decline in Native American habitation in the area, which began around 700 years ago. As European colonization progressed, many regions of what would later become Illinois were found to be uninhabited. Settlements with remaining Native American populations gradually diminished as Europeans established their presence. In 1833, French colonizers founded what would eventually become Champaign County. The rise of large-scale farms and cash crops led to increased agricultural investment in the region. Permanent settlements in Champaign County expanded over time, paving the way for urban development. The establishment of the Illinois Central Railroad in 1855 marked the beginning of commercialization in Champaign, connecting the county to various parts of the United States and transforming it into a commercial and trade hub. The U. of I. was established as a public land-grant university in 1867. In the 20th century, Champaign County and Illinois experienced significant growth in manufacturing, which became a vital contributor to the county's economy, focusing on food products, chemicals, fabricated metals, computer and electronic products, and rubber products (Reference 7-116, Reference 7-117, Reference 7-118, Reference 7-119).

### *3.6.2 Previous Investigations*

A historic properties assessment was conducted to determine if known historic properties would be potentially impacted by construction of the U. of I. research. The background records review was completed at the ISHPO in Springfield, Illinois; NRHP-listed properties were identified using the online NRHP database (Reference 7-120).

#### *3.6.2.1 Archaeological Resources*

The ISHPO identifies areas with a high probability of containing archaeological sites, artifacts, or structures related to early human settlement or prehistory. This designation is based on soil characteristics, as well as geological member and formation data, to assess potential locations throughout the state. In Champaign County, areas within 300 yards (274 meters) of the bluff line crest (valley wall) of all streams and rivers meet these criteria. Consequently, the regions surrounding all streams and rivers in the county are considered potentially archaeologically significant, necessitating site investigations to determine whether regulatory protections apply.

Public data regarding confirmed archaeological sites often remains classified to safeguard archaeological integrity. Generally, most archaeological sites in the county consist of low-density scatters of stone tools left by mobile hunting and gathering groups, typically found as surface scatters in plowed fields. Sites of particular archaeological significance date back to the period before intensive Euro-American settlement in the county, which began around the mid-1800s. Notable examples include artifacts from early French explorers in Illinois during the 17th century and materials associated with the Kickapoo Indians, who arrived in the late 1700s. While materials from prehistoric farming groups have been discovered along rivers and streams, such findings are uncommon in Champaign County.

The Sangamon and Embarras Rivers have provided much of the archaeological information for the area, with sites dating back as far as 10,000 years to the Paleo-Indian Period documented. According to the Illinois Historic Preservation Agency (IHPA), there are 57 known archaeological sites across Illinois.

However, there are no known archaeological sites in Champaign County, nor are there any eligible or listed archaeological sites awaiting inclusion in the NRHP registry for historic sites. No archaeological resources were identified at the project site, and no additional fieldwork was recommended (Reference 7-120).

*3.6.2.2 Historic Resources*

The NRHP tracks buildings and sites of historical significance across the County. The designation considers the age, significance, and integrity of the site, as described by the U.S. National Park Service (Reference 7-120, Reference 7-121):

- Location: Location is the place where the historic property was constructed or the place where the historic event occurred;
- Design: Design is the combination of elements that create the form, plan, space, structure, and style of a property;
- Setting: Setting is the physical environment of a historic property;
- Materials: Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property;
- Workmanship: Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history or prehistory;
- Association: Association is the direct link between an important historic event or person and a historic property; and,
- Feeling: Feeling is a property's expression of the aesthetic or historic sense of a particular period of time.

The buildings and sites located within the project area were evaluated based on the above criteria and the results are summarized in Section 3.6.3.

*3.6.2.3 Cemeteries*

Champaign County is home to a total of 75 cemeteries, spread out in relative uniformity across the area. None of these cemeteries are listed on the NRHP, but planners need to be aware of state regulations concerning impacts to these sites. The Illinois Human Skeletal Remains Protection Act prohibits disturbances to grave sites from any project without a permit from the IHPA. This law also pertains to grave markers within unregistered cemeteries over 100 years old on both private and public land. Avoidance procedures must be considered before any work is conducted that may impact a cemetery. Although there are no records of any cemeteries within or adjacent to the project site, it is still possible for an unanticipated discovery of a burial due to the anticipated deep excavations at the site. If avoidance is impossible, an application for grave and remains removal must be submitted to the IHPA describing the alternatives considered and the reasons the burial site cannot be avoided (Reference 7-122, Reference 7-123, Reference 7-124, Reference 7-125, Reference 7-126).

### 3.6.3 Results of Cultural Resource Investigation

A Phase I literature review and aboveground cultural resources survey were conducted around project site (Reference 7-120). The research on historic resource investigations focused on aboveground cultural resources located within a 500-foot (152 meter) radius around the project, which is a standard area for literature review searches. The archival resources considered for this review included properties and historic districts listed on the NRHP, the Illinois Historic Preservation Online Services (HARGIS), prior Cultural Resource Management-related survey reports, staff from U. of I., the University of Illinois State Museum, and the City of Champaign's Planning and Development Department's Champaign Interactive Historic Map.

On June 21, 2022, AECOM conducted a field reconnaissance at the project site. This survey was instrumental in refining the Area of Potential Effects (APE) for both site options. The APE was defined based on an examination of the urban landscape and the locations of buildings on the U. of I. campus, reflecting the character of the built environment. The field examination of the potential site options led to the identification of 11 historic resources within the combined Project APE. Of these, one resource, the GSL, is identified as eligible for listing in the NRHP, while the remaining 10 aboveground historic-age resources are recommended as not eligible for NRHP listing.

The research indicates that many of the identified properties reflect the establishment of U. of I. and the settlement of the area prior to the establishment of the U. of I. campus. One historic-age resource was identified during the literature review within the 500-foot (152 meter) radius of the project sites: HARGIS #113969, located at 52 East Armory, Champaign, which is noted to be north of the project sites and outside the APE. The NRHP evaluation for this resource is recorded as undetermined. Additionally, there are no cemeteries, NRHP-listed individual historic resources, NRHP-listed historic districts, or previous cultural historic reports within the APE, as indicated in the HARGIS system (Reference 7-127).

No historic sites or evidence of cultural resources were identified within the survey area, and no further aboveground investigations are recommended (Reference 7-120). The report will be submitted to the Campus Historic Preservation Officer for review with ISHPO.

### 3.6.4 Native American and State Agency Consultation

The Prairie Band Potawatomi Nation was federally recognized in 2024 in DeKalb County, Illinois (Reference 7-128). Consequently, no tribal consultations are required.

## 3.7 SOCIOECONOMICS

This section characterizes the current socioeconomic conditions within the region of influence (ROI) surrounding the site and provides a basis for assessing potential socioeconomic effects because of construction and operation. The socioeconomic characterization addresses demographics (resident and transient population growth rates, race and ethnicity), community characteristics (the economy, housing availability, public services, local transportation), and tax payment information.

Socioeconomic characterization is presented on a spatial and temporal (demography) basis. The nature and extent of socioeconomic characterization is consistent with the Draft Interim Staff Guidance Augmenting NUREG-1537, Part 1, Section 12.12.3.7.

### 3.7.1 Demography

#### 3.7.1.1 Resident Population

##### 3.7.1.1.1 Resident Population of Communities in Region of Influence

The ROI is identified as Champaign County, which encompasses the twin cities of Champaign and Urbana and the village of Savoy, as illustrated in Figure 3-25. The ROI is defined by the areas where the research reactor construction and operations workers and their families are most likely to reside, and spend their wages, salary, and benefits on goods and services, which effect the socioeconomic environment in the region.

Table 3-12 provides the historic resident population for the ROI (Champaign County) and the municipalities located within. Between 2000 and 2020, population increased 14.6 percent in Champaign County. During the same period, the cities of Champaign and Urbana and Savoy Village grew 30.1 percent, 5.9 percent and 105.6 percent respectively (Reference 7-129, Reference 7-130, Reference 7-131)

The closest metropolitan areas include Decatur, Illinois (43.2 miles southwest of the site; population: 70,522; located in Macon County) and Bloomington, Illinois (47.7 miles northwest of the site; population: 78,680; located in McLean County) (Reference 7-131).

##### 3.7.1.1.2 Region of Influence Resident Population Growth Projection

Table 3-12 provides projected population in Champaign County through 2030 as predicted by the Illinois Department of Public Health. Population is expected to increase 2.9 percent from 207,577 in 2020 to 213,700 in 2030 (Reference 7-132). However, the 2024 Champaign County population of 212,374 reported by the U.S. Census Bureau (USCB; Reference 7-133) is very close to the 2030 projected population; USCB's 2020 population is reported as 206,455.

##### 3.7.1.1.3 Transient Population within 5 miles (8 km)

Transient populations are temporary or seasonal populations residing in the area, such as in lodging accommodations, dormitories or classrooms on a college campus. The U. of I. campus and Parkland College lie within 5 miles (8 km) of the site. In the decennial 2020 census, college students who live in college/university student housing were counted at the student housing rather than at their parents' or guardians' home (Reference 7-134). According to the 2020 decennial census, 13,255 students lived in college or university student housing in the county (Reference 7-135).

##### 3.7.1.1.4 Race and Ethnicity of the Resident Population in the Region of Influence

Race and ethnicity data were gathered using 2020 decennial USCB data. As shown in Table 3-13, the aggregate minority population in Champaign County (the identified ROI) was 39.1 percent. Minority populations in the municipalities contained within the ROI were more numerous than in the county. The cities of Champaign and Urbana had minority populations of 48.6 percent and 50.8 percent, respectively. The Village of Savoy had 34.8 percent minority population. The largest minority groups within the ROI included African American (6.4 percent) and Asian (21.4 percent) groups, reflecting a large number of international students from mainland China (Reference 7-136). As shown in Table 3-14, during the same time, the nation and the state had minority population of 42.2 percent and 41.7 percent, respectively. The largest minority groups in the nation and state included African American (12.1 percent and 13.9 percent, respectively) and Hispanic/Latino (18.7 percent and 18.2 percent, respectively). The nation and state has relatively small percentages of Asian group (5.9 percent and 5.8 percent respectively) (Reference 7-131).

### *3.7.2 Community Characteristics*

Community Characteristics refer to socioeconomic attributes of the local economy, local housing statistics, public services, infrastructure including major transportation, facilities, and tax payment information. The data presented reflect the community characteristics within the ROI.

#### *3.7.2.1 Economy*

The economy of the ROI is evaluated by examining per capita and household income, division of the labor force, unemployment rates, and poverty rates. Data were provided by the USCB and the Bureau of Economic Analysis.

##### *3.7.2.1.1 Income (Population and Household)*

As provided in Table 3-15, per capita income in Champaign County was $31,254 in 2020, less than the nation ($35,384) and the state ($37,306). Median household income in Champaign County is $53,936, less than the nation ($64,994) and the state ($68,428) (Reference 7-137).

##### *3.7.2.1.2 Labor Force and Unemployment*

Table 3-16 provides unemployment rates and the number of individuals in the labor force. The unemployment rate in the ROI was 4.8 percent in 2020, less than the nation (5.4 percent) and the state (6.0 percent). In 2020, there were 107,998 people in the labor force in Champaign County (Reference 7-137).

Table 3-17 provides the total number of people employed as well as the types of employment. Within the ROI in 2020, government jobs, which include jobs at the state universities, comprised the dominant industry category (29.5 percent) as compared to the nation (12.6 percent) and the state (11.3 percent) (Reference 7-138).

##### *3.7.2.1.3 Poverty Rates*

The analysis for low-income populations in the ROI followed the Council on Environmental Quality guidance for identifying low-income populations. Information was derived from the 2016-2020 American Community Survey 5-Year Estimates because these data were not available in the 2020 decennial census as of this writing. Table 3-18 provides the results of the low-income population analysis within the ROI. In 2020, the percentage of individuals with income less than the poverty level was 19.1 percent in Champaign County, which was more than the nation (12.8 percent) and the state (12.0 percent). Poverty rates in the twin cities of Champaign and Urbana, municipalities within Champaign County were greater, at 23.9 percent and 29.1 percent (Reference 7-139).

Reflecting the large population of single students living on campus within the ROI, the percentage of families with income less than the poverty level was 6.9 percent in Champaign County, less than the nation (8.9 percent) and the state (8.2 percent). Poverty rates in the twin cities of Champaign and Urbana, were greater than the county at 7.6 percent and 6.6 percent respectively (Reference 7-139, Reference 7-140).

#### *3.7.2.2 Housing*

As provided in Table 3-19, the total number of housing units in Champaign County in 2020 was 93,679 of which 83,059 were occupied units and 10,620 were vacant units. The rental vacancy rate for the ROI was 10.8 percent, which was greater than the nation (5.8 percent) and the state (5.9 percent). The median home value was $166,600 in Champaign County, which was less than the nation ($229,800) and the state ($202,100) (Reference 7-141).

### ***3.7.3 Transportation***

#### *3.7.3.1 Roads and Highways*

As shown in Figure 3-26, there are three major interstates surrounding the U. of I. campus that include:

- I-57
- I-72
- I-74

I-72 and I-74 primarily run east and west just north Champaign, Illinois. I-57 runs north and south and connects I-74 and I-72 on the west side. In relation to the site, I-72 is located 2.3 miles to the west northwest, I-74 is located 2.1 miles to the north, and I-57 is located 3.4 miles to the west.

Nearby major highways include U.S. Highway 45, U.S. Highway 150, Illinois Highway 10, and Illinois Highway 130. U.S. Highway 45 is located 0.1 miles (0.16 km) west of the site and generally extends from north to south whereas U.S. Highway 150 is oriented east to west and is located 1.1 (1.8 km) miles northeast of the site. Illinois Highway 10 is located 0.6 miles (0.97 km) northwest of the site, just south of I-72, and is orientated east to west. Illinois Highway 130 is located 3.2 miles (5.1 km) east of the site, is orientated north to south, and intersects U.S. Highway 150. U.S. Highway 45, U.S. Highway 150, and Illinois Highway 10 all pass-through Champaign, Illinois near the campus whereas Illinois Highway 130 is located far east of Champaign, Illinois outside of the campus.

U.S. Highway 45 is the closest U.S. highway located just west of the site and northeast of Hessel Park. Illinois Highway 10 is located near the Prairie Gardens just west of the Champaign Illinois Secretary of State Facility. U.S. Highway 150 is near the Carle Foundation Hospital south of Crystal Lake Park. Illinois Highway 130 is near the Walmart Supercenter and is just on the edge of the city to the east.

From the site, I-74 is accessible via South Neil Street to North Neil Street. I-72 and I-57 can be accessible using West Church Street and West University Avenue.

Traffic volumes, obtained from the Illinois Department of Transportation, are for 2024 and are listed below (Reference 7-142). Figure 3-27 provides a visual representation of traffic volumes near the project site.

- I-57 – 25,800 vehicles per day, west of the site
- I-74 – 48,900 vehicles per day, north of the site
- I-72 – 10,450 vehicles per day, northwest of the site
- U.S. Highway 45 – 19,600 vehicles per day, west of the site
- U.S. Highway 150 – 12,000 vehicles per day, north of the site
- Illinois Highway 10 – 12,100 vehicles per day, northwest of the site
- Illinois Highway 130 – 7,750 vehicles per day, east of the site

To estimate future traffic volumes, level-of-service (LOS), and Volume-to-Capacity ratio (v/c) on the street system around the project site, several sources of information were reviewed. For traffic volumes, the U. of I. Master Plan and historical traffic count data from the Illinois Department of Transportation were used. The master plan does not directly consider traffic volumes but does set an Illinois Climate Action Plan of zero net growth. This focuses on such items as building use and square footage, connectivity, the campus core and landscaping. By providing a more livable and walkable campus, vehicle trips are not expected to significantly increase in the future. U. of I. anticipates being within 1.5 percent of the Net Zero Growth target over the next 10 years. The Illinois Department of Transportation provides maps of annual average daily traffic (AADT) volumes on roadways throughout the state. The traffic growth rate was estimated by using the exponential growth formula and available AADT volumes for the years 2016, 2021 and 2024. These are shown on Table 3-20. Planning level thresholds for determining roadway LOS are shown on Table 3-21 (Reference 7-5, Reference 7-128, Reference 7-143).

Traffic volumes have decreased on Gregory Drive and First Street during the past 5 years while Locust Street has remained unchanged. This seems to indicate that the campus planning for Zero Net Growth is having a positive effect. However, the effects of the pandemic cannot be ignored, and traffic volumes and growth patterns may increase. For this reason, a conservative traffic volume growth rate per year was assumed to be at least 1.5 percent for all corridors except Armory Avenue which is assumed to be 2.5 percent to estimate future traffic volumes for the build year of 2027. Existing and future AADT, LOS and Volume-to-Capacity ratios are shown in Table 3-22 and Table 3-23 respectively.

#### *3.7.3.2 Transit*

Public transportation is provided by Champaign-Urbana Mass Transit District (MTD) and works well with the campus providing U. of I. iCard holders free access to the community wide Mass Transit District service. According to statistics, around 10 percent of employees use the Mass Transit District as their primary mode of transportation and around 30 percent of students use it as their primary mode of transportation. There were approximately 60,848 students including 38,572 undergraduate students and 22,276 graduate and professional students attending U. of I. for the year 2024-2025. The total number of instructors was about 2,708 plus around 2,852 graduate assistants. There are four primary campus routes connecting the campus with the downtown areas of Champaign and Urbana. Most campus locations are within a 3-minute walk to a bus line. The one issue students are concerned about is that they feel it is extremely difficult to walk from the North Campus to the other parts of campus within 10 minutes between their classes. A stronger connecter is needed to better unite the entire U. of I. campus (Reference 7-5, Reference 7-144) .

*3.7.3.3 Rail*

The nearest railroad to the site is the Canadian National Railway, which is approximately 0.1 miles (0.16 kilometer) west of the site and is oriented north-to-south direction. This railway is primarily a freight railway. There are also two other railways located near the site. The Canadian National Railway Way that is oriented west-to-east, is located approximately 1.8 miles (2.9 kilometer) northwest of the site. The final railway is the Norfolk Southern Railway located 1.2 miles (1.9 kilometer) north of the site and is oriented east-to-west. The Norfolk Southern Railway is also a Class 1 freight railroad. The Illinois Terminal is located 0.8 miles from the project site and it serves Amtrak passenger rail utilizing the Canadian National Railway tracks (Reference 7-145).

*3.7.3.4 Air*

There are two general aviation airports near the site. Willard Airport is located approximately 4 miles (6.4 km) southwest of the site. The airport has three runways with the lengths of 8,102 feet (2,469 meters), 6,501 feet (1982 meters), and 3,817 feet (1,136 meters) long. The airport has more than 45,000 operations per year (landings and take-offs); the largest aircraft is the Embraer ERJ175 regional passenger jet. The second airport, Frasca Field, is located approximately 3.5 miles (5.6 km) northeast of the site and is much smaller than Willard Airport. Frasca Field has two runways with lengths of 4,001 feet (1,220 meters) long and 3,654 feet (1114 meters) long. The airport has approximately 15,000 operations per year (landings and take-offs) (Reference 7-146). Frasca Field services single-engine and light twin-engine propeller airplanes.

### *3.7.4 Tax Payment Information*

In 2023, state-imposed taxes, including income, sales, motor fuel, public utility, riverboat, hospital assessment, and miscellaneous other taxes increased by $865 million, or 4.4 percent, from fiscal year 2022, and remained the largest overall revenue for fiscal year 2023, comprising 46.7 percent of total governmental fund revenues. Federal government revenues comprised 38.3 percent of total governmental fund revenues (Reference 7-147). Illinois has a flat 4.95 percent individual income tax rate. Illinois also has a 9.50 percent corporate income tax rate. Illinois has a 6.25 percent state sales tax rate, a 4.75 percent max local sales tax rate, and an average combined state and local sales tax rate of 8.81 percent (Reference 7-148).

A county-wide sales tax rate of 1.25 percent is applicable to localities in Champaign County, in addition to the 6.25 percent Illinois sales tax, so the minimum sales tax rate in Champaign County is 7.5 percent (not including any city or special district taxes). The total sales tax rate in any given location can be broken down into state, county, city, and special district rates. In the cities of Champaign and Urbana, the sales tax rate is 9 percent (Reference 7-149).

Property taxes in Illinois support city governments, county governments and school districts, along with a vast number of other local services and projects. Champaign County collects, on average, 2 percent of a property's assessed fair market value as property tax. Property taxes are managed on a county level by the local tax assessor's office. The exact property tax rate paid is set by the tax assessor on a property-by-property basis (Reference 7-150).

The U. of I. Urbana-Champaign is part of the U. of I. system, an instrumentality of the State of Illinois. As such it is exempt from federal income tax under Section 115 and Section 501(c)(3) of the Internal Revenue Code. U. of I. is also exempt from state and local income tax, property tax and other taxes (Reference 7-151).

### *3.7.5 Public Services*

The City of Champaign is served by IAW with water sourced from the Mahomet Aquifer. The Mahomet Aquifer encompasses 15 counties and provides drinking water to over 850,000 people. The aquifer supplies over 100 mgd for public water use, industrial use, and irrigation (Reference 7-152). The average withdrawals from the Mahomet Aquifer was approximately 200 mgd in 2016 (Reference 7-15).

The UCSD serves the village of Savoy, the U. of I., and the surrounding adjacent developed areas. UCSD operates two wastewater treatment plants; the Northeast plant in Urbana and the Southwest plant in Champaign. UCSD operates sanitary interceptor sewers and 27 pumping stations that transport wastewater to the treatment plants. Champaign, Urbana, Savoy and the U. of I. operate their respective collector sewers to which homes and businesses are connected (Reference 7-152) .

#### *3.7.5.1 Local Public Schools*

As shown in Table 3-24, the ROI is served by Champaign Unit #4 District and Urbana School District #116.

Champaign Unit # 4 District has 19 schools and serves approximately 10,616 students. The student body is diverse, and come from 77 different countries, speaking more than 80 different languages (Reference 7-153, Reference 7-154). Urbana School District #116 serves approximately 4,089 students with 9 schools (Reference 7-155, Reference 7-156).

The closest school to the Project Site is Edison Middle School, 306 W. Green Street, Champaign, 61820, located less than 0.6 miles northwest of the proposed project site. It is part of the Champaign Unit #4 District.

#### *3.7.5.2 Public Recreational Facilities*

There are no national or state parks in Champaign County. However, various agencies manage park and recreation areas within the region and surrounding areas as follows (Reference 7-15):

- The Champaign Park District operates 64 different parks over 610 acres (247 hectares).
- The Urbana Park District operates 24 parks distributed over 580 acres (234 hectares).
- The Mahomet Parks and Recreation Department operates 11 parks over 131 acres (53 hectares).
- The Rantoul Park District/Recreation Department there are 21 parks over 184 acres (74 hectares).
- The Champaign County Forest Preserve District operates six forest preserves in Champaign County, as well as the Kickapoo Rail Trail.
- U. of I. facilities include indoor and outdoor recreation facilities and fields, agricultural landscape and open space (Reference 7-5).

**Table 3-12 Historic and Projected Population and Growth Rates of ROI County and Municipalities**

| Location | 2000 | 2010 | 2020 | Projected 2030 | Percent Change 2000 - 2010 | Percent Change 2010 - 2020 | Percent Change 2000 - 2020 | Percent Change 2020 - 2030 |
|---|---|---|---|---|---|---|---|---|
| Champaign City | 67,873 | 81,055 | 88,302 | N/A | 19.4 | 8.9 | 30.1 | N/A |
| Urbana City | 36,196 | 41,250 | 38,336 | N/A | 14.0 | -7.1 | 5.9 | N/A |
| Savoy Village | 4,307 | 7,280 | 8,857 | N/A | 69.0 | 21.7 | 105.6 | N/A |
| Champaign County | 179,669 | 201,081 | 205,865 | 213,700 | 11.9 | 2.4 | 14.6 | 3.8 |

Source: Reference 7-129, Reference 7-130, Reference 7-131, Reference 7-132

**Table 3-13 Demographic (Race and Ethnicity) Characteristics of ROI County and Municipalities in 2020**

| Racial/Ethnic | Champaign City, IL | | Urbana City, IL | | Savoy Village, IL | | Champaign County, IL | |
|---|---|---|---|---|---|---|---|---|
| | Population | Percent | Population | Percent | Population | Percent | Population | Percent |
| Total Population | 88,302 | - | 38,336 | - | 8,857 | - | 205,865 | - |
| White | 45,409 | 51.4 | 18,848 | 49.2 | 5,774 | 65.2 | 125,280 | 60.9 |
| Aggregate Minority | 42,893 | 48.6 | 19,488 | 50.8 | 3,083 | 34.8 | 80,585 | 39.1 |
| Black or African American | 15,625 | 17.7 | 7,112 | 18.6 | 603 | 6.8 | 28,215 | 13.7 |
| American Indian and Alaska Native | 99 | 0.1 | 54 | 0.1 | 11 | 0.1 | 279 | 0.1 |
| Asian | 14,705 | 16.7 | 6,985 | 18.2 | 1,627 | 18.4 | 24,420 | 11.9 |
| Native Hawaiian and Other Pacific Islander | 27 | 0.0 | 13 | 0.0 | 1 | 0.0 | 60 | 0.0 |
| Other Race | 431 | 0.5 | 172 | 0.4 | 38 | 0.4 | 897 | 0.4 |
| Two or More Races | 4,289 | 4.9 | 1,884 | 4.9 | 424 | 4.8 | 10,048 | 4.9 |
| Hispanic or Latino | 7,717 | 8.7 | 3,268 | 8.5 | 379 | 4.3 | 16,666 | 8.1 |

Source: Reference 7-131

**Table 3-14 Demographic (Race and Ethnicity) Characteristics of State of Illinois and United States in 2020**

| Racial/Ethnic | Illinois | | United States | |
|---|---|---|---|---|
| | Population | Percent | Population | Percent |
| Total Population | 12,812,508 | - | 331,449,281 | - |
| White | 7,472,751 | 58.3 | 191,697,647 | 57.8 |
| Aggregate Minority | 5,339,757 | 41.7 | 139,751,634 | 42.2 |
| Black or African American | 1,775,612 | 13.9 | 39,940,338 | 12.1 |
| American Indian and Alaska Native | 16,561 | 0.1 | 2,251,699 | 0.7 |
| Asian | 747,280 | 5.8 | 19,618,719 | 5.9 |
| Native Hawaiian and Other Pacific Islander | 2,959 | 0.0 | 622,018 | 0.2 |
| Other Race | 45,080 | 0.4 | 1,689,833 | 0.5 |
| Two or More Races | 414,855 | 3.2 | 13,548,983 | 4.1 |
| Hispanic or Latino | 2,337,410 | 18.2 | 62,080,044 | 18.7 |

Source: Reference 7-141

**Table 3-15 Median Household and Per Capita Income Levels in ROI County**

| | Champaign County | Illinois | United States |
|---|---|---|---|
| Median Household Income (dollars) | 53,936 | 68,428 | 64,994 |
| Per Capita Income (dollars) | 31,254 | 37,306 | 35,384 |

Source: Reference 7-137

**Table 3-16 Civilian Labor Force and Unemployment Rates**

| | Champaign County | Illinois | United States |
|---|---|---|---|
| Civilian Labor Force | 107,998 | 6,631,897 | 164,759,496 |
| Unemployment Rate (percent) | 4.8 | 6.0 | 5.4 |

Source: Reference 7-137

**Table 3-17 Employment by Industry**

| | Champaign County, IL | | Illinois | | United States | |
|---|---|---|---|---|---|---|
| | **Total** | **Percent** | **Total** | **Percent** | **Total** | **Percent** |
| Total employment (number of jobs) | 125,909 | - | 7,388,506 | | 190,776,800 | - |
| Farm employment | 1,240 | 1.0 | 71,639 | 1.0 | 2,591,000 | 1.4 |
| Construction | 4,695 | 3.7 | 326,192 | 4.4 | 10,850,300 | 5.7 |
| Manufacturing | 6,686 | 5.3 | 573,839 | 7.8 | 12,807,500 | 6.7 |
| Retail trade | 10,214 | 8.1 | 652,568 | 8.8 | 17,949,200 | 9.4 |
| Health care and social assistance | 15,914 | 12.6 | 861,786 | 11.7 | 22,455,500 | 11.8 |
| Accommodation and food services | 8,435 | 6.7 | 429,381 | 5.8 | 12,169,000 | 6.4 |
| Other services (except government and government enterprises) | 5,696 | 4.5 | 419,059 | 5.7 | 10,510,900 | 5.5 |
| Government and government enterprises (include state universities) | 37,086 | 29.5 | 837,599 | 11.3 | 24,129,000 | 12.6 |

Source: Reference 7-138

**Table 3-18 Percent of Individuals and Families Living Below the Census Poverty Threshold in ROI County and Municipalities**

| | Champaign City, IL | Urbana City, IL | Savoy Village, IL | Champaign County, Illinois | Illinois | United States |
|---|---|---|---|---|---|---|
| Percentage of Individuals whose 12-momth Income was below Poverty Level | 23.9 | 29.1 | 12.8 | 19.1 | 12.0 | 12.8 |
| Percentage of Families whose 12-month Income was below Poverty Level | 7.6 | 6.6 | 5.9 | 6.9 | 8.2 | 8.9 |

Source: Reference 7-139

**Table 3-19 Housing**

| | Champaign County, IL | Illinois | United States |
|---|---|---|---|
| Total housing units | 93,679 | 5,373,385 | 138,432,751 |
| Occupied housing units | 83,059 | 4,884,061 | 122,354,219 |
| Vacant housing units | 10,620 | 489,324 | 16,078,532 |
| Homeowner vacancy rate (Percent) | 2.2 | 1.6 | 1.4 |
| Rental vacancy rate (Percent) | 10.8 | 5.9 | 5.8 |

Source: Reference 7-141

**Table 3-20 2016, 2021 and 2024 AADT**

| # | Road Name | 2016 AADT | 2021 AADT | 2024 AADT | 8-year growth rate (Percent/year) | Assumed growth rate (Percent/year) |
|---|---|---|---|---|---|---|
| 1 | Armory Avenue (north) | 950 | 1,150 | 1,150 | 2.4 | 2.5 |
| 2 | Gregory Drive (south) | 1,800 | 1,250 | 1,250 | -4.5 | 1.5 |
| 3 | First Street (east) | 8,700 | 7,150 | 7,150 | -2.4 | 1.5 |
| 4 | Oak Street (west) | No data | No data | No data | No data | No data |
| 5 | Locust Street (north) | 550 | 550 | 550 | 0 | 1.5 |

AADT – Annual Average Daily Traffic

Source: Reference 7-142

**Table 3-21 Planning LOS Traffic Volume Thresholds**

| Roadway Type | LOS C | LOS D | LOS E |
|---|---|---|---|
| 2 Lane Undivided (35 MPH or less) | 7,300 | 14,800 | 15,600 |

LOS – Level-of-Service

MPH – Miles per Hour

Source: Reference 7-157

**Table 3-22 Existing 2024 Study Area Planning Level-of-Service and Volume-to-Capacity Ratios**

| # | Road Name and Posted Speed Limit | Roadway Type | 2024 AADT | LOS | Volume/Capacity Ratio |
|---|---|---|---|---|---|
| 1 | Armory Avenue (north) – 25 MPH | 2-Lane Undivided | 1,150 | C | 0.064 |
| 2 | Gregory Drive (south) – 25 MPH | 2-Lane Undivided | 1,250 | C | 0.069 |
| 3 | First Street (east) – 30 MPH | 2-Lane Undivided | 7,150 | C | 0.397 |
| 4 | Oak Street (west) – 25 MPH | 2-Lane Undivided | No data | - | No data |
| 5 | Locust Street (north) – 25 MPH | 2-Lane Undivided | 550 | C | 0.031 |

Source: Reference 7-142

AADT – Annual Average Daily Traffic

LOS – Level-of-Service

MPH – Miles per Hours

**Table 3-23 Projected 2028 Study Area Planning Level-of-Service and Volume-to-Capacity Ratios**

| # | Road Name | Roadway Type | 2028 AADT | LOS | Volume/Capacity Ratio |
|---|---|---|---|---|---|
| 1 | Armory Avenue (north) – 25 MPH | 2-Lane Undivided | 1,269 | C | 0.084 |
| 2 | Gregory Drive (south) – 25 MPH | 2-Lane Undivided | 1,327 | C | 0.077 |
| 3 | First Street (east) – 30 MPH | 2-Lane Undivided | 7,589 | D | 0.441 |
| 4 | Oak Street (west) – 25 MPH | 2-Lane Undivided | No data | | No data |
| 5 | Locust Street (north) – 25 MPH | 2-Lane Undivided | 584 | C | 0.034 |

Source: Reference 7-142

AADT – Annual Average Daily Traffic

LOS – Level-of-Service

MPH – Miles per Hours

**Table 3-24 Schools. Public Schools in the Region**

| Location | Total Number of Schools | School | Number of Schools | Number of Students in 2025 | Total Number of Students in 2025 | Expenditure per Student per Year [a] |
|---|---|---|---|---|---|---|
| Champaign Unit District 4 | 19 | Elementary | 12 | 4,800 | 10,616 | $20,323 |
| | | Middle | 4 | 2,706 | | |
| | | High | 2 | 3,059 | | |
| | | Specialized | 1 | 51 | | |
| Urbana School District #116 Schools | 9 | Elementary | 5 | 1,555 | 4,092 | $28,180 |
| | | Middle | 2 | 1,359 | | |
| | | High | 1 | 1,111 | | |
| | | Specialized | 1 | 67 | | |

Source: Reference 7-140, Reference 7-155

[a] Site level per pupil expenditures

**Figure 3-25 Population Centers near U. of I. Research Reactor Project Site**

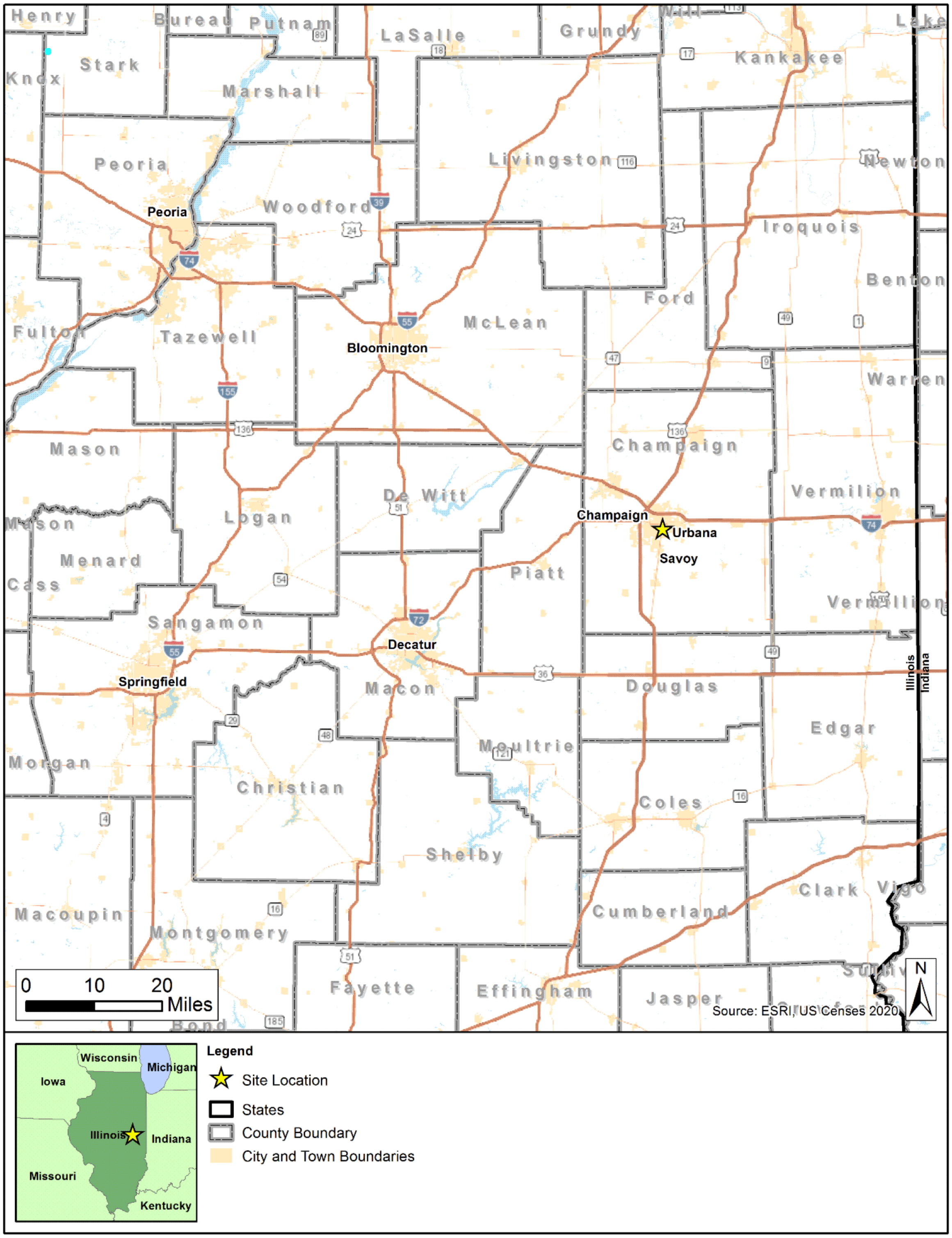


**Figure 3-26 Road, Highway, Railroad, and Airport Systems in the Area**

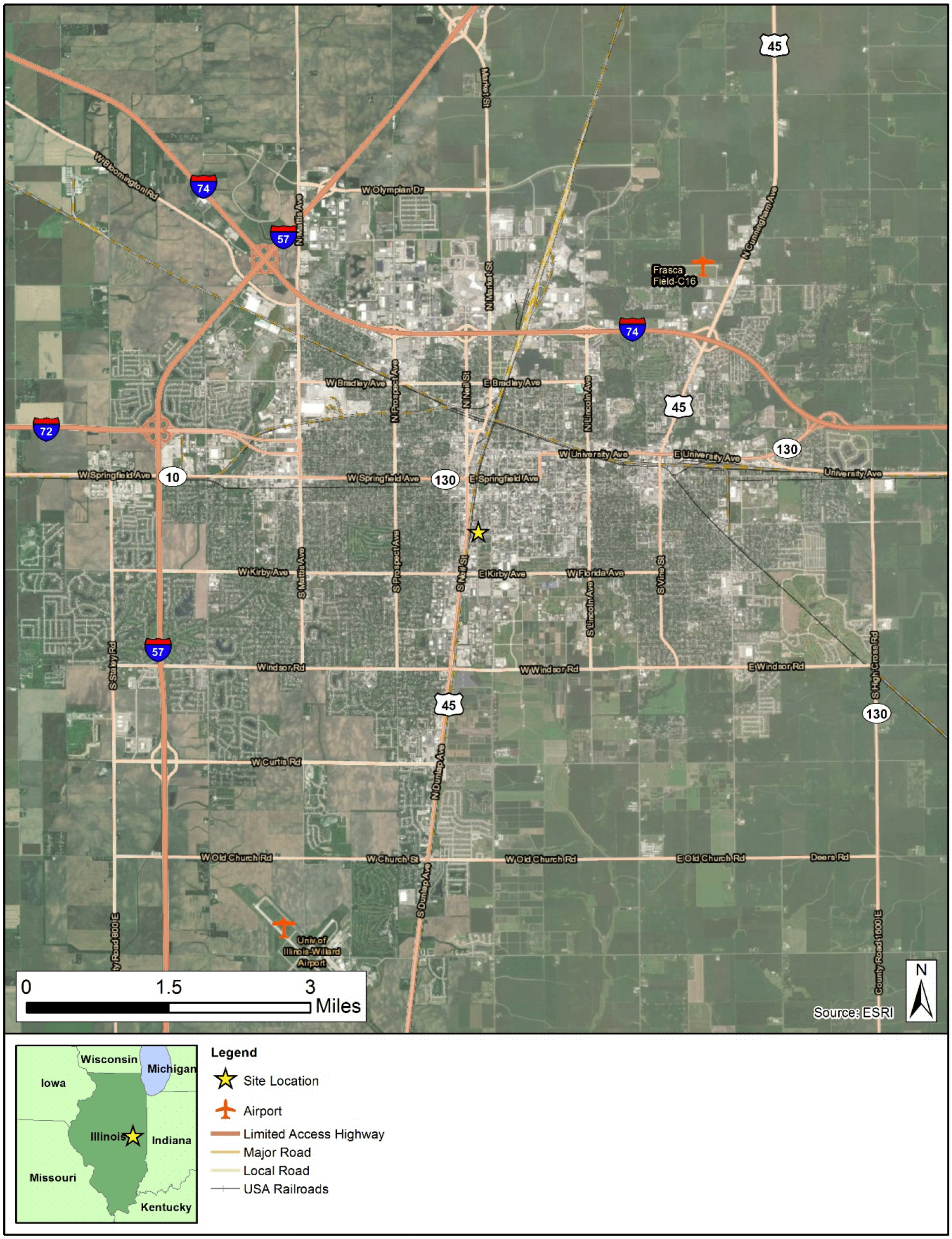
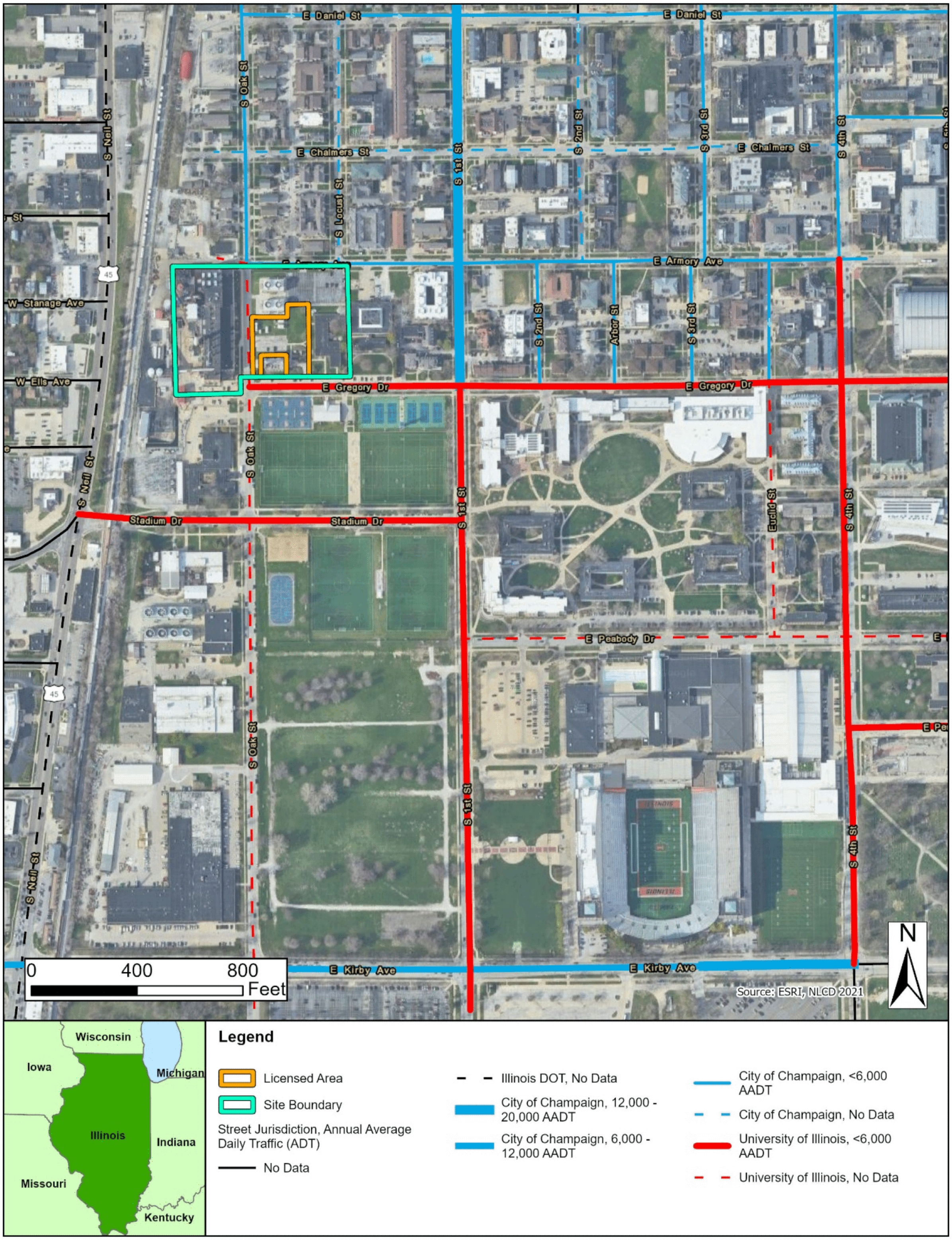


**Figure 3-27 Traffic Volumes near the Site**



## 3.8 HUMAN HEALTH

Existing public and occupational health issues are discussed in this section.

### *3.8.1 Potentially Sensitive Surrounding Receptors*

Figure 3-28 shows distances to the nearest potential full-time resident (off-campus), nearest part-time resident (on-campus), and nearest sensitive receptors within a 1-mile radius from the Licensed Area boundary. Potentially sensitive surrounding receptors include:

- Nearest full-time resident
- Nearest part-time resident
- Other sensitive receptor locations:
  - Parks
  - Medical
  - Educational
  - Daycare
  - Community Center
  - Animal Research or Production

Locations of potentially sensitive surrounding receptors within a 5-mile (8-km) radius and their respective distances to the proposed Licensed Area boundary are summarized in Table 3-25. The two closest parks located off the U. of I. C campus, McCollum Park and Washington Park, are 0.1 mile and 0.3 mile (0.16 km and 0.48 km), respectively, from the Licensed Area. The nearest educational facility other than U. of I. campus facilities is Edison Middle School less than 0.6 miles (0.96 km) northwest of the project site and the nearest medical facility is Bella Medical Center about 0.9 miles (1.45 km) from the Licensed Area boundary.

### *3.8.2 Background Radiation Exposure*

As detailed below, there is no background radiation from natural or man-made sources in the vicinity of the proposed project site that will result in abnormal radiation hazards to the public. According to the NRC, people generally receive a total annual dose of about 620 millirem (mrem) (6.2 millisieverts [mSv]). Of this total, natural sources of radiation account for about 50 percent, while man-made sources account for the remaining 50 percent.

Sources of radiation exposure in the United States include (Reference 7-158):

- The radioactive gases radon and thoron
- Cosmic (space)
- Terrestrial (Soil)
- Internal (in your body)
- Medical Procedures
- Nuclear Medicine

- Consumer Products
- Industrial and Occupational

### *3.8.2.1 Natural Sources*

Natural background radiation comes from the following three sources:

**Cosmic Radiation**

The average annual dose or exposure from cosmic radiation is 33 mrem (0.33 mSv) or 11 percent of a person's yearly exposure resulting from all natural sources of radiation. This yearly amount of radiation is similar to the amount of radiation from three chest x-rays (Reference 7-159). Cosmic radiation consists of high-energy charged particles, x-rays, and gamma rays produced by the stars, including our own sun. Charged particles react with the earth's atmosphere to produce secondary radiation which reaches the earth. Some particles make it to the ground, while others interact with the atmosphere to create different types of radiation. Radiation doses resulting from cosmic radiation will vary with altitude. Higher altitudes mean greater exposure to cosmic radiation. The higher the altitude, the larger the dose. The altitude of the proposed research reactor site is approximately 764 feet above mean sea level where the dose from cosmic radiation would be about 26 mrem (0.26 mSv) per year; the average dose in Illinois is reported as 27.4 mrem (0.274 mSv) per year (Reference 7-159).

**Terrestrial Radiation**

The Earth itself is a source of terrestrial radiation. Radioactive materials (including uranium, thorium, and radium) exist naturally in soil and rock. Essentially all air contain radon, which is responsible for most of the dose that Americans receive each year from natural background sources. In addition, water contains small amounts of dissolved uranium and thorium, and all organic matter (both plant and animal) contains radioactive carbon and potassium. Some of these materials are ingested with food and water, while others (such as radon) are inhaled. The dose from terrestrial source varies in different parts of the world, but locations with larger soil concentrations of uranium and thorium generally have larger doses (Reference 7-158). The average annual dose from terrestrial radiation in Illinois as provided by the EPA is 26.6 mrem (0.266 mSv) (Reference 7-159).

**Internal Radiation**

All people have internal radiation, mainly from radioactive potassium-40 and carbon-14 inside their bodies from birth and, therefore, are sources of exposure to others. The variation in dose from one person to another is not as great as that associated with cosmic and terrestrial sources (Reference 7-158).

### *3.8.2.2 Man-Made Sources*

Although all living things are exposed to natural background radiation, exposure to man-made sources differs for the following:

- Members of the Public
  - Medical Sources
  - Consumer Products
- Occupationally Exposed Individuals (Workers)

**Medical Sources**

Medical sources are by far, the most significant man-made source (Reference 7-158). Radiation is used in a variety of medical examinations and treatments. Medical procedures like X-rays and computed tomography scans provide the majority of man-made radiation exposure to the public.

- Diagnostic x-rays
- Nuclear medicine procedures

**Consumer Products**

Typical consumer products available to the general public that contain small amounts of radioactive materials include for example ionization chamber smoke detectors for use in private homes. These contain small amounts of americium-241. Other examples are high-intensity lamps that are used as xenon car lighting and high-wattage lighting used outdoors, such as in sports stadium, which may contain small amounts of thorium-232, krypton-85, or tritium. The list below indicates examples of consumer products that expose the public to radiation:

- Building and road-construction materials
- Combustible fuels, including gas and coal
- X-ray security systems
- Televisions
- Fluorescent lamp starters
- Smoke detectors (americium)
- Luminous watches (tritium)
- Lantern mantles (thorium)
- Tobacco (polonium-210)
- Ophthalmic glass used in eyeglasses
- Some ceramics

Approximately 2 percent of a person's yearly exposure to sources of radiation comes from consumer products (Reference 7-158).

**Nuclear Fuel Cycle**

The nuclear fuel cycle, from uranium mining and milling operations to fuel fabrication facilities, are strictly regulated to control occupational and public exposures to limits below those established in 10 CFR 20. Public exposures are primarily form regulated emissions and chance minimal exposures during transportation of raw materials, processed materials, and waste.

#### *3.8.2.3 Nuclear Reactor Facilities*

The contribution of man-made radiation from nuclear reactor facilities in the vicinity of the proposed project is minimal. Typically, nuclear electricity generation releases only negligible amounts of radioactive materials into the environment. On average, the annual dose from all practices within the nuclear fuel cycle is a tiny fraction of that from natural radiation, measuring less than 1 mrem (0.01 mSv) per year (Reference 7-160). The radiation dose to the maximumly exposed individual from an operating nuclear power plant is also generally less than 1 mrem (0.01 mSv) per year (Reference 7-160). Consequently, the contribution of nuclear energy to environmental radiation is small compared to the exposures individuals receive from various other sources.

The nearest nuclear power plant, Constellation Energy's Clinton Power Station (CPS), is located approximately 44 miles away. This single-unit reactor has the capacity to produce up to 1,080 megawatts (MW) of electricity. While the public dose impacts from normal operations at CPS are minimal, the distance between CPS and the proposed project site ensures that it has no measurable effect on the site.

From the perspective of collective dose commitment, under normal conditions and excluding contributions from very long-lived radionuclides, the public global exposure resulting from a year of nuclear electricity production is equivalent to slightly less than one additional hour of exposure to natural background radiation in that year. When long-lived radionuclides, primarily carbon-14, are included, the committed dose is roughly equivalent to an additional 37 hours of natural irradiation (Reference 7-160).

Furthermore, the proposed project site is situated near three major interstates- I-72, I-74, and I-57-all within a 5-mile (8-km) radius. Radioactive materials and waste may be transported along these highways, which means that populations located on or adjacent to these routes may receive small doses of radiation from the transportation of radioactive materials.

### ***3.8.3 Radioactive and Nonradioactive Liquid, Gaseous, and Solid Waste Management Effluent Control Systems***

Radioactive waste management strictly governed by NRC and the International Commission on Radiological Protection regulations involves two fundamental approaches: the radioactive materials can be either released to the environment or they must be disposed at licensed radioactive waste disposal sites. Releases of radioactivity to the environment generally occur as liquid or gaseous effluents from nuclear facilities. The amount of radioactivity which can be released is based on allowable exposures to population groups and is controlled by NRC regulations and guidelines, usually based on recommendations of the International Commission on Radiological Protection.

There are very few instances where radioactive effluents from nuclear facilities can be released without some form of control or treatment to remove excessive radioactivity. Radioactive waste management involves the use of normal industrial operations and techniques adapted to cope with the barriers needed to protect the workers and operations from excessive radiation and contact with the radionuclides.

There are no radioactive materials currently stored on the site or within other facilities located near (within approximately 1,000 feet [304 meters]) the proposed project site; therefore, there are no radioactive effluent control systems on or near the site.

### *3.8.4 Radioactive and Nonradioactive Effluents Released to the Environment*

There are currently no radioactive materials stored on the site; therefore, there are no radioactive effluents released to the environment from the site. A discussion of radioactive releases from the nearest operating nuclear reactor is presented in Section 3.8.8.

Table 3-26 provides a list representative of the types of hazardous materials stored within five miles of the proposed reactor site. As the area within 5 miles from the proposed reactor facility includes the U. of I. campus, there are a substantial number of research laboratories/facilities. Additionally, the majority of Urbana and Champaign, IL, is highly developed. Therefore, the list presented in Table 3-26 is only representative and not comprehensive. However, it is assumed that any of these materials could be released to the environment within the vicinity of the proposed reactor site.

### *3.8.5 Radioactive and Nonradioactive Hazardous Material Stored Onsite or within the Vicinity*

No radioactive materials or hazardous materials are currently stored at the proposed project site. Approximately 0.2 miles south-southeast of the site is the U. of I. Nuclear Physics Laboratory. At this time, U. of I. has no intentions to store radioactive materials or install radiation generating devices or equipment at the facility. Therefore, no contributions from artificial sources of radiation are expected from this laboratory.

The most significant facility close to the project site is the Abbott Power Plant. It is a hybrid natural gas and coal facility that serves the U. of I. owned and operated electrical and steam distribution system. Abbott supplies 70 to 75 percent of the energy demand and supplies 100 percent of the steam requirement for the U. of I. campus. Its primary fuel is natural gas but is not limited to just one fuel source as it is capable of using three different kinds of fuel – natural gas, coal, and fuel oil but currently uses mostly natural gas. The plant uses efficient, environmentally responsible combined heat and power technology that allows it to produce both steam and electricity from the amount of fuel used by conventional power plant just to produce electricity. Abbott today generates 84 MW electric generating equipment capacity, with 77 MW peak load. Additionally, it has the capacity of 1,025,000 pounds per hour (lb/hr) (464,932 kilogram per hour [kg/hr]) steam production equipment capacity, with peak demand at approximately 550,000 lb/hr (249.475 kg/hr). No radioactive materials are stored or used at Abbott and a listing of its nonradioactive material being stored or used is given in Table 3-26. Consequently, no significant contributions of radiation are expected from this power plant.

Nonradioactive hazardous materials may be present at two major industrial facilities near the project site: Duce Construction and Urbana Recycled. Duce Construction Company provides concrete pumping and material conveying services to the Champaign, IL and surrounding areas. Other services include concrete work, directional drilling, site utilities installation, excavation, soil work, grading, demolition, and custom earth retention systems. Urbana Recycled, part of Vulcan Materials Company, is a supplier and distributor of construction materials. It offers construction aggregates, including gravel, sand and crushed stone, for use in building bridges, parking lots, roads, airport runways, houses, apartments, schools, commercial buildings and more.

### *3.8.6 Current Onsite or Nearby Sources and Levels of Exposure to Members of the Public and Workers from Radioactive Materials*

There are no existing radioactive materials currently stored on-site; therefore, there is no exposure to the public. As listed in Table 3-25, there are medical facilities within the 5-mile (8-km) radius and many of these facilities provide x-ray services to patients. Given that the annual background radiation of 620 mrem (6.2 mSv) includes exposure from medical sources, it is anticipated that these medical facilities are not additional contributors of exposure to the public.

There may be some radiation dose received from the transportation of radioactive material along I-72, I-74 and I-57 that should be considered. All three interstates are within five miles of the Licensed Area boundary. Railroads are located near the proposed project site to the north and northwest, so transportation of radioactive materials along these railroads may contribute to additional doses.

### *3.8.7 Historical Exposures to Radioactive Materials to Both Workers and Members of the Public*

There are no recordable incidents involving radioactive material in the vicinity of the proposed reactor site. U. of I. successfully and safely operated a nuclear research reactor on campus for 38 years from 1960-1998, and its fuel was safely stored on-site until 2004. The reactor facility systems and structures were removed, and the license was terminated in 2013, and site is now in Greenfield status (Reference 7-161). No incidents were reported during operation and the decommissioning phase.

### *3.8.8 Description of Nearby Nuclear Power Facilities' Effluent Monitoring Programs*

Constellation Energy's CPS submits an annual radiological environmental operating report to the NRC. The most recent report covers the period January 1, 2023, through December 31, 2024, and in assessing all the data gathered for this report and comparing these results with preoperational data, it was concluded that the operation of CPS had no adverse radiological effects on the environment (Reference 7-162).

There were zero radioactive liquid releases from CPS during 2024 (Reference 7-162). Releases of gaseous radioactive materials were accurately measured in plant effluents. There were no gaseous effluent releases that approached the limits specified in the CPS Offsite Dose Calculation Manual. The largest calculated off-site dose received by a member of the public in 2023 resulting from the release of gaseous effluents from CPS was 0.242 mrem (0.00242 mSv) (Reference 7-162).

Surface, drinking, and well water samples were analyzed for concentrations of tritium and gamma-emitting nuclides. Drinking water samples were also analyzed for concentrations of gross beta and iodine-131. No fission or activation products were detected. No tritium or gross beta activity was detected, and the required lower limit of detection was met (Reference 7-162).

Air particulate samples were analyzed for concentrations of gross beta and gamma-emitting nuclides. No fission or activation products were detected (Reference 7-162).

Iodine-131 analyses were performed on weekly air samples. All results were less than the lower limit of detection for iodine-131 (Reference 7-162).

High sensitivity iodone-131 analyses and gamma analyses were performed on cows' milk samples. All results were below the required lower limit of detections for iodine-131. Concentrations of naturally-occurring potasium-40 were consistent with those detected in previous years. No fission or activation products were found (Reference 7-162).

Food product samples were analyzed for concentrations of gamma-emitting nuclides. No fission or activation products were detected (Reference 7-162).

Environmental gamma radiation measurements were performed quarterly using Dosimeters of Legal Record. Levels detected were consistent with those observed in previous years (Reference 7-162.)

### *3.8.9 Relevant Occupational Injury Rates and Occupational Fatal Injury Rates*

Occupational injury and fatal injury rates applicable to the construction, operation, and decommission of the research reactor facility are discussed in this section.

Recent U.S. Bureau of Labor Statistics data, which lists the national incidence rates of nonfatal occupational injuries and illnesses by industry, were consulted to estimate relevant occupational injury rates for the project. The incidence rate is defined as the number of injuries and illnesses per 100 full-time workers. For this estimate the incidence rate of the total number of recordable cases in 2020 was used. In educational services, the total number of recordable cases for employees working in colleges, universities, and professional schools has been reported to be 1.4 per 100 full-time workers. Applicable to the project, during the construction and decommissioning phases, the total number of recordable cases for construction workers in the construction industry is 2.3 per 100 full-time workers (Reference 7-163). It is surmised that during the operation phase of the research reactor, employees will work in environments representing multiple industries, therefore, the total number of recordable cases for all industries, 2.7 per 100 full-time workers (Reference 7-163), is used to estimate the occupational injury rate for employees.

Comparable Bureau of Labor Statistics data exists for national occupational fatal injury rates. The Bureau of Labor Statistics defines fatal injury rates as the number of fatal occupational injuries per 100,000 full-time equivalent workers. There were 5,286 fatal work injuries recorded in the U.S. in 2023 (Reference 7-164). The fatal work injury rate was 3.52 fatalities per 100,000 full-time equivalent workers. For the construction industry, falls remain the most frequent type of fatal event with 1,075 fatal injuries, accounting for 20.34 percent of all work-related fatalities. For services in education, there were 45 fatal work injuries recorded, which accounts for 0.85 percent of all work-related fatalities, and considerably fewer when compared to fatalities in the construction industry (Reference 7-164).

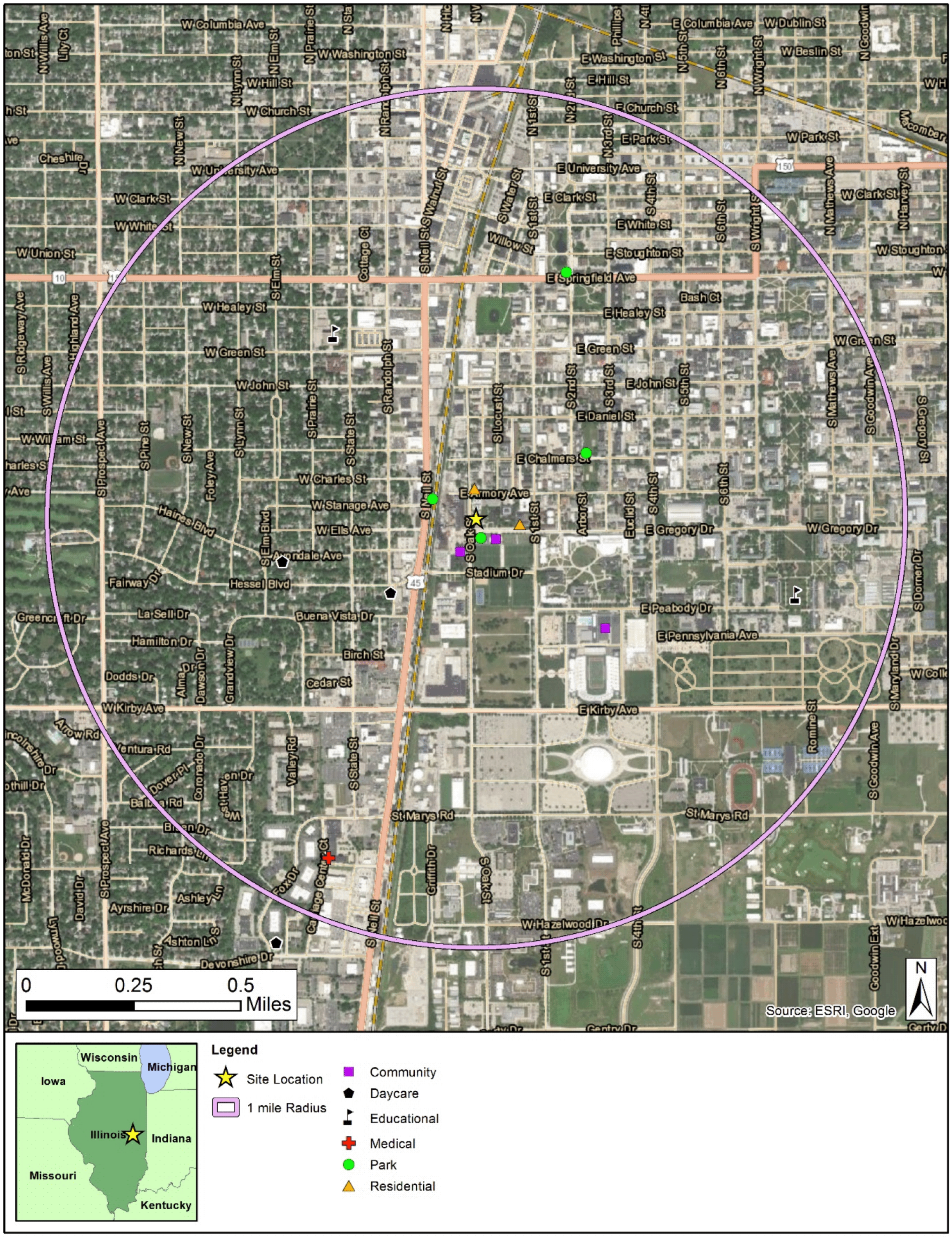
**Table 3-25 Distance to Nearest Sensitive Receptors**

| Facility Type | Location of Interest | Distance to Site Licensed Area (mi) |
|---|---|---|
| Residential | Nearest Full-time Resident (1014 S. Oak St.) | 0.07 |
| | Nearest Part-time Resident (58 E Gregory Dr.) | 0.1 |
| Park | Nearest Park, Campus Basketball Courts, E Gregory Dr. | 0.04 |
| | McCollum Park | 0.1 |
| Medical | Bella Medical Center | 0.9 |
| | U. of I, McKinley Health Center | 1.1 |
| Educational | University of Illinois Urbana-Champaign | 0.0 |
| | Edison Middle School | 0.5 |
| Daycare | Teddy Bear Daycare | 0.2 |
| | Happi-Time Daycare | 0.3 |
| Elder Care / Retirement Home | Eden Supportive Living | 1.1 |
| | Clark Lindsey Assisted Living | 2.2 |
| Community Center | Campus Bike Center/student recreational areas | 0.02 |
| | U. of I, Disability Resources & Educational Services (DRES) | 0.06 |
| | U. of I, Activities and Recreation Center (ARC) | 0.3 |
| Animal Research or Production | U. of I, Imported Swine Research Laboratory | 1.0 |
| | U. of I, Dairy Cattle Research Unit | 1.5 |

**Table 3-26 Representative Chemicals Used/Stored within 5 Miles of the U. of I. Research Reactor Project Site**

| Facility | Chemical Used/Stored |
|---|---|
| Abbot Power Plant | Diesel fuel |
| | Gasoline |
| | Used Oil |
| Multiple U. of I. Facilities | Diesel fuel |
| | Gasoline |
| | Pesticides/Insecticides |
| | Herbicides |
| | Laboratory chemicals |
| Bacon & Van Buskirk Glass Co Inc. | Benzene |
| National Coatings Supplies | Barium |
| | Chromium |
| | Lead |
| | Methyl Ethyl Ketone |
| Twin City Pontiac Co (now called Sierra Buick GMC Champaign) | Xylene |
| | Acetone |
| | Ethyl Acetate |
| | Ethyl Benzene |
| | Ethyl Ether |
| | Methyl Isobutyl Ketone |
| | N-Butyl Alcohol |
| | Cyclohexanone |
| | Methanol |
| | Toluene |
| | Carbon Disulfide |
| | Isobutanol |
| | Pyridine |
| | 2-ethoxyethanol |
| | 2-nitropropane |

**Figure 3-28 Distance to Nearest Full-time Resident and Other Sensitive Receptors (within 1 mile)**



# CHAPTER 4 IMPACTS OF PROPOSED CONSTRUCTION, OPERATIONS, AND DECOMMISSIONING

This chapter provides an analysis of the impacts of construction, operation, and decommissioning of the facility. Overall impact rankings are given to each environmental resource evaluated. Unless otherwise defined, criteria followed the guidance given in the U.S. Nuclear Regulatory Commission (NRC) Impact Rankings in 10 Code of Federal Regulations (CFR) 51 Subpart A, Appendix B, Table B-1, Footnote 3 as follows:

- SMALL – Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE – Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE – Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

## 4.1 LAND USE AND VISUAL RESOURCES

This section assesses the impacts of construction, operation, and decommissioning on land use and visual resources for the project site and region. As described in Section 3.1, the land use for the site and region is analyzed using the National Land Cover Database 2021. Impacts include effects from activities associated with construction and operation, including excavation, placement of fill material, temporary staging and construction laydown, construction of permanent features, and potential operational disturbances. The current land use is consistent with the land use as observed in 2025. No temporary land disturbances are anticipated for the construction, operation, or decommissioning.

### *4.1.1 Land Use*

This section discusses the land use impacts from construction and operation of the facility. The NRC staff has determined in Draft NUREG-2249, *Generic Environmental Impact Statement for Advanced Nuclear Reactors*, that for a site meeting specific criteria defined in Section 3.1.1 of Draft NUREG-2249, including small sites less than 50 acres with a permanent foot print of disturbance on 30 acres or less, the land use impacts can generically be determined to be SMALL. However, the site is less than 0.5 miles from the nearest full-time and part-time residents and other sensitive areas resulting in a MODERATE impact.

#### *4.1.1.1 Site and Region*

As described in Section 3.1.1.1, the research reactor Licensed Area encompasses 1.01 acres (0.41 hectares) and is located on the western edge of the University of Illinois Urbana-Champaign (U. of I) campus. The Licensed Area is located within the Site Boundary as described in Section 3.1.1.1.

The potentially impacted region surrounding the Licensed Area is defined as the area within a 5-mile (8-km) radius of the site's center point. The entire region is located within Champaign County.

The construction of the research reactor will not substantially interfere with nearby land uses or alter regional land use characteristics and trends. While there are two mechanical draft cooling towers present on adjacent property, no cooling towers are required for the research reactor. Additionally, there are no power transmission rights-of-way needed for overhead power lines. The land use impacts to the site and near offsite areas will be consistent with routine U. of I. capital projects. The site has been historically part of the U. of I. campus and the new research reactor facility will continue to serve the university. As such, the U. of I. research reactor facility will not noticeably alter land use patterns in the surrounding landscape and thus, the impacts will be SMALL.

#### *4.1.1.2 Special Land Uses and Sensitive Areas*

In Draft NUREG-2249, the NRC staff assumes that for a SMALL land use impact, that sites would not be situated closer than 0.5 mile (0.8 km) to residential areas or 1 mile (0.62 km) to sensitive land uses such as federal, state, or local parks, wildlife refuges, conservation lands, etc. As discussed in Section 3.2.2, there are no Federal Class I lands (e.g., National Parks) within the site's region or on the project site. However, other sensitive lands do lie within 1 mile (1.6 km) of the site with the site approximately 275 feet (83 meters) north of U. of I. recreational facilities (outside basketball courts and intramural fields) and 600 feet (182 meters) east of McCollum Park. Additionally, the center of the site is located approximately 260 feet (79 meters) south of the nearest resident at 36 East Armory Avenue.

In Draft NUREG-2249, the staff also assumes that for a SMALL special land use impact, the site development would avoid impacts to not more than 0.5 acres (0.40 hectares) of wetlands and other waters of the United States (U.S.), and avoid any encroachment into floodplains, shoreline, or riparian lands that may be within the site boundaries. As described in Section 3.1.1.2 and Table 3-1, there are no wetlands, floodplains, or other waters of the U.S. near the project site.

Therefore, while the project will not have an impact on wetlands, floodplains, or other waterways, the project is located near sensitive areas as discussed above. Therefore, the impacts to sensitive areas from construction and operation of the research reactor will be MODERATE as they may be sufficient to alter noticeably, but not to destabilize important attributes of some of the nearby sensitive resources.

#### *4.1.1.3 Agricultural Resources and Facilities*

In Draft NUREG-2249, the NRC staff assumes that for a SMALL land use impact, there is no prime or unique farmland, or other farmland of statewide or local importance within the footprint of disturbance. While Table 3-1 and Figure 3-2 in Chapter 3 show a significant amount of land dedicated to pasture or cultivated crops (41.7%) within the 5-mile (8-km) region, there are no agricultural resources for facilities on or adjacent to the project site. Therefore, direct and indirect impacts to agricultural resources and facilities from construction and operations will be unlikely to occur and will be SMALL.

#### *4.1.1.4 Historic Structures*

A field reconnaissance at the project area was conducted in June 2022. This survey was instrumental in defining the Area of Potential Effects (APE) for the site as in accordance with 30 CFR Part 800. An *Undertaking* (or project as defined by 30 CFR Part 800) may directly or indirectly cause alterations in the character or use of historic properties, if such properties exist. The delineation of the APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the Undertaking. The APE was defined based on an examination of the urban landscape and the locations of buildings on the U. of I. campus, reflecting the character of the built environment. The field examination led to the identification of 11 historic resources within the project APE (Reference 7-120). Of these 11 historic resources, only the GSL is eligible for listing in the National Register of Historic Places (NRHP).

NRHP eligibility determinations were dependent upon the application of the recovered data set to the following criteria as defined by 36 CFR Part 60. The GSL was built in the Industrial Commercial style with Art Deco influence. The building has retained its integrity of location, setting, design, materials, workmanship, feeling. The resource does appear to be the work of a master or convey distinctive characteristics of a type, period, or method of construction and is identified as eligible for the NRHP under Criterion C. Criterion C is defined as a resource that embodies the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction (Reference 7-120).

There are currently no listed historical structures within the project site and therefore, there will be no impact to historic structures. Should the GSL be listed as a historic property the research reactor construction will not adversely impact the attributes of the GSL building and the impacts will be considered SMALL to historic structures.

##### *4.1.1.5 Impacts from Decommissioning*

The research reactor is expected to begin operational activities in approximately 2030. The operating life of the facility is expected to be 40 years. As a result, decommissioning activities would be expected to commence in approximately 2070. Decommissioning activities, however, are similar to construction activities and involve heavy equipment to dismantle buildings and remove roadway and parking facilities. Resultant land uses following decommissioning are undetermined but may consist of reutilizing the space for other university functions. As such, direct and indirect impacts from decommissioning are anticipated to be similar to the impacts associated with construction and will be SMALL.

### *4.1.2 Visual Resources*

The proposed site is on the edge of a developed university campus. The visual setting of the area that will be affected by the construction of the facility is highly developed with roads, an existing adjacent industrial facility, paved parking lots, multifamily residential buildings, and campus related structures. Photos taken within or adjacent to the proposed research reactor site are provided in Figure 4-1 through Figure 4-8. The construction of the facility will alter the onsite condition and will partially obstruct views of the existing landscape. However, the visual setting of the project site is that of a parking lot and is located adjacent to the Abbott Power Plant and GSL, with a generally flat and uniform landform with low vegetation.

As mentioned previously, the area immediately surrounding the facility consists of a paved parking lot and impervious surfaces. It is not likely the facility will significantly alter the visual setting. Therefore, impacts from construction and operations to visual resources will be unlikely.

**Figure 4-1 View of The Southwest Corner of The Site with Abbott Power Plant in The Background**

**Figure 4-2 View of The Northwest Corner of GSL From The Western Side of The Site**

**Figure 4-3 View of The North Side of GSL From The Site**

**Figure 4-4 View of The East Side of The GSL With Basketball Courts Across Gregory Street in The Background**

**Figure 4-5 View to The Southeast From The Site**

Note: GSL mechanical equipment in the foreground and Personnel in background (left)

**Figure 4-6 North View of Abbott Cooling Towers From The Site**

**Figure 4-7 GSL Mechanical Equipment Located East of The GSL**

**Figure 4-8 GSL Storage Area Located East of The GSL**

## 4.2 AIR QUALITY AND NOISE

### *4.2.1 Air Quality*

This section provides a description and characterization of air quality and noise levels potentially affected by the proposed construction, operations, and decommissioning of the research reactor within the project site. There are no aquatic ecosystems on or adjacent to the project site.

The NRC staff has determined in Draft NUREG-2249, *Generic Environmental impact Statement for Advanced Nuclear Reactors*, that for a site meeting specific criteria defined in Sections 3.3 (Air Quality) and 3.9.1 (Noise), Draft NUREG-2249 would result in a SMALL finding impact. These assumptions are included in the following sections which evaluate the potential impacts and demonstrate compliance of the research reactor project with the Draft NUREG-2249 criteria.

#### *4.2.1.1 Impacts from Construction*

Construction activities result in localized increases in emissions of some air pollutants. Earthmoving, excavation, clearing, pile driving, erection, batch plant operation, and construction-related traffic generate fugitive dust and fine particulate matter that potentially impact both onsite workers and offsite residents of the surrounding community. Vehicles and engine-driven equipment (e.g., generators and compressors) generate combustion product emissions such as carbon monoxide, NOx and, to a lesser extent, sulfur dioxide. Painting, coating, and similar operations also generate emissions from the use of volatile organic compounds. People living near or working at or near construction sites may be subject to the physical impacts of construction activities. Activities associated with the use of construction equipment may result in varying amounts of dust, air emissions, noise, and vibration. The magnitude and area of extent of the impacts from these emissions depends in part on atmospheric conditions at the time of the activity. The magnitude of these potential impacts is typically related to the specific construction activities that occur at a given site, the nature and effectiveness of implemented environmental controls, and the proximity of the site to populated areas. Contractors, vendors, and subcontractors are required to adhere to appropriate federal and state occupational health and safety regulations. These regulations set limits to protect workers from adverse conditions, including air emissions.

Construction equipment usage and generated traffic volumes are expected to be relatively minor during construction of the U. of I. research reactor facility compared to other regional traffic-generated emissions, so potential air quality impacts from construction will be limited. Implementation of controls and limits at the source of emissions on the construction site will result in reduction of offsite impacts. For example, a dust control program will reduce dust due to construction activities and minimize dust reaching site boundaries.

Transportation and other offsite activities will result in emissions from vehicle usage. Offsite transportation activities generally occur on improved surfaces, limiting fugitive dust emissions.

Based on the Draft NUREG-2249 assumptions, the impacts from air quality will be SMALL because:

- The site is less than 100 acres (40.5 hectares);
- Both the temporary and permanent footprint of disturbance is less than 20 acres (8 hectares) of vegetated land;

- No new rights-of-way for transmission lines, pipelines, or access roads are to be constructed;
- The site is located within an EPA attainment area and criteria pollutants emitted from vehicles and standby power equipment during operations are less than Clean Air Act de minimis levels (see Section 3.2.2);
- The site is not located within 1 mile of a mandatory Class I Federal area (See Section 3.2.2);
- The Level of Service determination for affected roadways does not change;
- Best management practices (BMPs) will be implemented to mitigate fugitive dust;
- Construction activities will be in compliance with air permits under state and federal laws; and
- Greenhouse gases (GHGs) emitted by equipment and vehicles will not exceed the 2,534,000 metric tonnes of carbon dioxide equivalent ($CO_2e$) during the 97-year GHG life-cycle period.

GHG emissions for equipment use, workforce footprint emissions, shipments of fuels and waste material, and the plant life-cycle fuel footprint are estimated in Draft NUREG-2249 based on emission estimates for a 1,000 megawatt electrical ($MW_e$) reactor. The 45 megawatt thermal ($MW_{th}$) design of the research reactor is significantly smaller than the design basis for the reference reactor and will therefore have much lower GHG emissions.

In summary, air emission impacts from construction will be controlled at the source where practicable; maintained within established regulatory limits designed to minimize impacts; and generally localized on the site. However, Draft NUREG-2249 also assumes that for impacts to be SMALL, there would be no existing residential areas within 0.5 miles (0.8 km) of the site. Because there are residents within 0.5 miles (0.8 km) of the research reactor site, the impacts from construction at the site to air quality will be MODERATE.

#### *4.2.1.2 Impacts from Operation*

Operation of the research reactor facility will emit non-radioactive gaseous and particulate emissions into the atmosphere from auxiliary non-reactor sources and quantities emitted will remain well below the applicable regulatory emission limits. For evaluating the operation of the research reactor facility, it is assumed that emissions will not be greater than those estimated by Kairos Power for their Hermes non-power reactor at the East Tennessee Technology Park in Oak Ridge, Tennessee. As described in the Kairos Power's Hermes Non-Power Reactor Environmental Report (Reference 7-165), the primary sources of emissions for the Hermes Non-Power Reactor are from auxiliary systems and are expected to be auxiliary boilers and standby diesel generators. These effluents commonly include particulates, sulfur oxides, carbon monoxide, hydrocarbons, and NOx.

The research reactor facility will employ up to two standby diesel generators and engine-driven emergency equipment but is not expected to have auxiliary boilers. The diesel generators and engine-driven emergency equipment will be used as needed, intermittently and for brief duration.

Given the similarities in scale of the 45 $MW_{th}$ research reactor to Kairos Power's 35 $MW_{th}$ Hermes reactor being constructed in Oak Ridge, Tennessee, the operational emissions established in the Kairos ER (Reference 7-165) are considered comparable for the U. of I. research reactor application and the impacts during operation will also be comparable. Kairos determined that operation of the Hermes reactor would have a SMALL impact on air quality and likewise, operation of the U. of I. research reactor will also have a SMALL impact on air quality.

#### *4.2.1.3 Impacts from Decommissioning*

Following the completion of operations and shutdown of the site, the first disposition activity is to deactivate the facilities. Deactivation minimizes risks by protecting workers, the public, and the environment. Decommissioning includes decontamination and dismantling facilities to the ultimate end state of demolition. During decommissioning, hazardous and radioactive materials and contamination are removed or fixed in place to ensure protection of workers, public health and safety, and the environment. Demolition is construction in reverse and includes the recycling of demolition materials to the extent practical and the disposal of non-recyclable materials. During the decommissioning phase, activities, equipment usage and their associated emissions are expected to be similar, but less than that of the construction phase as decommissioning activities are less extensive than construction. Therefore, impacts during the decommissioning phase will be SMALL.

### *4.2.2 Noise*

As provided in Draft NUREG-2249, the assumptions for construction and operations resulting in a finding of SMALL impacts to noise levels include ensuring noise does not exceed 65 A-weighted decibel (dBA) at the Licensed Area boundary, unless relevant state or local noise abatement law or ordinance sets a different threshold:

- The noise level would be no more than, unless a relevant state or local noise abatement law or ordinance sets a different threshold, which would then be the presumptive threshold for personal protective equipment (PPE) purposes.
- If an applicant cannot meet the 65 dBA threshold through mitigation, then the applicant must obtain a variance or exception with the relevant state or local regulator.
- The project would implement BMPs, including modeling, foliage planting, construction of noise buffers, and the timing of construction and/or operation activities.

#### *4.2.2.1 Impacts of Construction*

Construction will have temporary adverse effects on noise and vibration during the likely 2-year construction duration of the project. Construction activities will cause temporary increases and fluctuations in ambient noise levels around the site depending on the number and type of equipment in use at any given time.

As described in Section 3.2.6, the Day-Night Sound Level ($L_{dn}$) at the project site was calculated as 69.47 dBA. Therefore, the predicted noise impacts from construction equipment will likely not be perceptible in the nearest sensitive receptors. However, when pile driving activities and/or multiple heavy equipment operate simultaneously, a readily perceptible noise increase will likely be perceived by the nearest sensitive receptors. In addition, BMPs will be utilized to mitigate noise levels. Given the temporary nature of construction activities and implementation of BMPs to mitigate noise levels, the impact of noise from onsite construction will be SMALL.

Traffic associated with the construction workforce traveling to and from the site also generates noise. The increase in noise relative to ambient background conditions will be most noticeable during the shift changes in the morning and late afternoon. Given the short duration of such potential traffic noise increase, potential noise impacts to the community are intermittent and limited primarily to shift changes, deliveries, and waste removals (e.g., excavated soil). The impact from noise from construction-related traffic will be SMALL.

#### *4.2.2.2 Impacts of Operation*

Operation of the facility will involve equipment that will emit noise levels typical of industrial activities. The continuously operated equipment will include heat exchanger fans and exhaust fans in addition to intermittently or infrequently used equipment, such as compressors and standby generators. However, most equipment will be indoors within enclosures resulting in minimal outdoor noise emissions. These enclosures mainly include:

- Reactor building
- Auxiliary Systems building
- Service building

Outdoor equipment and routine maintenance activities involving trucks will be perceptible in the immediate vicinity of the facility, particularly during nighttime hours when ambient noise levels are lower. However, the project site is located near the Abbott Power Plant and operational noise is unlikely to be perceptible. Therefore, operational impacts relative to the noise environment will be SMALL.

#### *4.2.2.3 Impacts of Decommissioning*

Decommissioning is the removal of a nuclear facility from service and reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. During the decommissioning phase, activities, equipment usage, and the noise associated with typical decommissioning operations are expected to be similar or less than that of the construction phase. Therefore, impacts during the decommissioning phase will be SMALL.

## 4.3 GEOLOGICAL ENVIRONMENT

Potential impacts to geologic and soil resources during the construction, operation, and decommissioning of the proposed facility include regional-scale hazards and local hazards. The regional-scale hazards include earthquakes, volcanic activity, landslides, subsidence, and erosional processes. Local hazards are associated with site-specific properties of the soil and bedrock and include soil disturbance due to excavation, exposure of contaminated soil, blasting of bedrock (if required for construction), the volume of material excavated or used during construction, impacts to rare or unique geologic resources, and impacts to economic rock, mineral, or energy resources.

### *4.3.1 Impacts of Regional-Scale Hazards*

Based on the information presented in Section 3.3, the probability of regional-scale impacts due to geologic factors will be low. The seismology (Section 3.3.3) of the region demonstrates that the site is located in a relatively active seismic zone of low to moderate intensity. As discussed in Section 3.3.3, the Seismic Hazard over a 50-year period only has a 10 percent probability of peak ground acceleration exceeding 30 percent of the acceleration due to gravity.

The geologic environmental features that are associated with landslides, subsidence, and erosional processes are discussed in Section 3.2.3, Section 3.3.4 and Section 3.3.5. The potential for landslides and subsidence in Champaign County is low. As discussed in Section 3.3.5.3, the topography of the site is relatively level and not prone to catastrophic landslide activity. The information from the geotechnical investigation presented in Section 3.3.2 did not report any evidence of recent or active subsidence at the site. Consequently, impacts relative to the geologic environment will be SMALL.

### *4.3.2 Other Impacts on Soils and Geology*

The cumulative impacts on the geologic environment primarily relate to land disturbance, the potential for soil erosion and loss, and the projected consumption of geologic resources. The description of the affected geologic environment is provided in Section 3.3. The geographic area of analysis for evaluation of cumulative impacts on soil resources includes the 5-mile (8- km) vicinity surrounding the proposed site. For geologic resources, the extent of the geologic area of analysis has been expanded to all of Champaign County to encompass potential commercial sources of rock and mineral resources to support construction activities at the proposed site and vicinity. Because the aspects of land disturbance and conversion are addressed in Section 3.3, the cumulative impact analysis focused on soil loss, including the loss of prime farmland soils and other important farmland soils, and the consumption of geologic resources. These losses are minimal because the research reactor facility is to be constructed on the U. of I. campus in a previously disturbed area.

The incremental impacts from construction, operations, and decommissioning of the proposed research reactor on the geologic environment, including geologic and soil resources, will be SMALL.

## 4.4 WATER RESOURCES

This section provides an analysis of the impacts of construction, operation, and decommissioning of the project site and its effects on water resources near or adjacent to the project site.

### *4.4.1 Hydrology*

Currently, there are no affected surface water bodies near the research reactor project site nor on the site. Additionally, the project site does not receive run-on from any upgradient areas. The project site is bound by the Upper Sangamon and Wabash Basin watersheds. No direct impacts to these watersheds are expected as all construction activities will occur on land. No intake or discharge facilities are expected to be constructed or renovated as a part of this project.

Stormwater from the project area enters a stormwater drain on Oak Street and passes through stormwater sewers to discharge in Boneyard Creek approximately 0.5 miles (0.8 km) to the northeast. During construction, installation of a stormwater management system will be required and will follow applicable BMPs. Federal, state, and local regulations and permit procedures will be applicable to construction, operation, and decommissioning of the project site.

During operations, an Industrial Storm Water Discharge Permit for discharge of operational stormwater flows will be required. In compliance with this permit, stormwater runoff will be retained in a stormwater pond to be later discharged to Boneyard Creek via an existing oil/water separator, as appropriate and discharge structure.

As previously mentioned, the project site is located near two watersheds. However, no decommissioning will occur within these watersheds. Therefore, there will be no direct impact. During decommissioning activities, a Stormwater Pollution Prevention Plan (SWPPP), similar to that required for construction, and including a sediment and erosion control plan, will be required and will mitigate the potential indirect impacts associated with the release of sediment or other runoff constituents to offsite areas. Accordingly, indirect impacts of decommissioning of the facility on nearby watersheds will be unlikely and impacts to local hydrology will be SMALL.

### *4.4.2 Water Use*

As discussed in Section 2.4.1, water used by the facility will be obtained from the university or municipal water suppliers via the campus water distribution system. The only water consumption of note is water consumed through basic utilities such as sprinkler systems, toilets, sinks, cleaning and personnel decontamination showers (approximately 500 gpd). Water is also used to fill the RCCS; however, the RCCS does not require refilling during operations. The RCCS does not require additional onsite water storage. Water consumption at the Abbott power Plant is not considered as water used by the research reactor facility. This water will be consumed with or without the construction and operation of the facility. Water in this region is plentiful relative to the present population. This facility has little to no noticeable impact on local water supplies as the Bradley Avenue Treatment Plant one of the two major treatment plants supplying the area provides 20 million gpd.

Additional contributions to the local sewer system will only be approximately 500 gpd. With an average flow design capacity of 17.3 million gpd at the Northeast Treatment Plant, the additional discharges will not be noticeable at the treatment plant.

Because of the overall capacity within municipal public works, potential indirect effects of the demand from the facility will be SMALL.

### *4.4.3 Water Quality*

In this section, potential groundwater quality impacts of site construction and operation are discussed. As discussed in Section 4.4.1, a construction SWPPP, which will require the implementation of erosion and sediment control measures, will be developed and followed throughout construction and decommissioning activities.

In addition to sediment resulting from soil erosion, hazardous materials used onsite during construction, including fuels, paints, and lubricants, could be released to surrounding watersheds. As discussed in Section 4.4.2, dewatered groundwater will be properly managed. Thus, impacts to water quality will be SMALL.

### *4.4.4 Monitoring*

Because of the absence of direct impacts to groundwater, the low potential for indirect impacts, and the use of management measures and controls to prevent releases to groundwater, no non-radiological groundwater monitoring activities are planned for the site.

## 4.5 ECOLOGICAL RESOURCES

This section provides a description and characterization of the terrestrial ecosystems potentially affected by the proposed construction, operations, and decommissioning of the research reactor within the project site. There are no aquatic ecosystems on or adjacent to the project site.

Federally listed endangered species are identified in Section 3.5.7. No designated critical habitat has been identified onsite. No Federal or state-listed threatened, endangered or special concern plant species have been observed on or in the immediate vicinity of the site. Potential impacts from construction, operations, and decommissioning on protected species potentially occurring on the site or in near offsite areas are SMALL.

The NRC staff has determined in Draft NUREG-2249, *Generic Environmental Impact Statement for Advanced Nuclear Reactors*, that for a site meeting specific criteria defined in Section 3.5.1, the environmental impact assessment will result in a SMALL finding. These assumptions are included in the following sections which evaluate the potential impacts and demonstrate compliance of the U. of I. research reactor project with the Draft NUREG-2249 criteria.

### *4.5.1 Impacts from Construction*

Activities such as construction-related traffic, the use of raw materials, transportation of materials from source to the building site, the environmental footprint of the construction site, as well as waste removal and disposal, could generate impacts to ecological resources during the construction phase of the project. However, impacts to ecological resources associated with construction of the research reactor will be limited to the lands within the project area, which primarily consists of a small landscaped open space containing two mature trees and a small parking lot. The site is also adjacent to roads and existing structures.

Given the developed nature of the site and surrounding area, beyond the removal of the two mature trees and landscaping, land clearing will not be necessary. The project is not located near streams or wetlands. Therefore, there will be no impact to existing ecosystems in those areas. Additionally, the project site is generally considered a poor-quality habitat for ecological receptors and is likely only used by common species that are already adapted to the area (e.g., mice, squirrels, birds). Therefore, impacts to ecological resources from construction will be SMALL.

In accordance with the Draft NUREG-2249 assumptions, construction impacts will be SMALL because:

- The site is less than 100 acres (40.5 hectares);
- Both the temporary and permanent footprint of disturbance is less than 20 acres (8 hectares) of vegetated lands;
- Temporarily disturbed lands will be revegetated using regionally indigenous vegetation once the lands are no longer needed to support building activities;
- No new offsite rights-of-way for transmission lines, pipelines, or access roads are to be constructed;
- The footprint of disturbance (permanent and temporary) will contain no ecologically sensitive features such as floodplains, shorelines, riparian vegetation, late-successional vegetation, land specifically designated for conservation, or habitat known to be potentially suitable for one or more federal or state threatened or endangered species;
- Total wetland impacts from use of the site will be no more than 0.5 acres (0.2 hectares);
- BMPs will be used for erosion, sediment control, and stormwater management;
- There will be no decreases in the level of service designation for affected roadways; and
- Noise generation will not exceed 85 dBA 50 feet (15 M) from the source.

### *4.5.2 Impacts from Operations*

Places and entities of special interest, as described in Section 3.5.4, include a description of habitats of special interest, other sensitive or susceptible areas, and important ecological systems in the region of influence (ROI) of the project site, of which, there are none. Located within the U. of I. campus, activity at the project site and its immediate surroundings have affected nearby animal habitats and other ecological communities. Therefore, impacts from operations of the research reactor facility will not be unlike the impacts of the operation of other campus facilities, and the impacts to surrounding ecosystems and places/entities of special interest due to operation of the research reactor will be SMALL.

Additionally, the assumptions presented in Draft NUREG-2249 also apply to operations supporting a conclusion that impacts to ecological resources from operation will be SMALL.

### *4.5.3 Impacts from Decommissioning*

Following the end of operation, the research reactor facility will be decommissioned. Decommissioning activities will be similar to construction activities and involve heavy equipment to dismantle buildings and remove roadway and parking facilities. As such, impacts from decommissioning will be similar to the impacts associated with construction and will be considered SMALL.

In addition, decommissioning will include license termination activities such as radiological characterization, limited soil or material remediation if required, and final status surveys conducted to demonstrate compliance with applicable release criteria. These activities will be short-term and localized, and potential impacts to ecological resources will be bounded by the more conservative human-health–based evaluation criteria.

## 4.6 HISTORIC AND CULTURAL RESOURCES

### *4.6.1 Impacts from Construction and Operation*

As described in Section 3.6.3 and Section 4.1.1.4, a field reconnaissance at the project area was conducted in June 2022. A total of 11 historic buildings were identified within the combined project APE (AECOM 2022). Only the GSL was identified as eligible for listing in the NRHP (AECOM 2022). No direct impacts will be expected to occur to the GSL in association with either construction or operational activities of the site. Therefore, potential impacts to historic and archaeological resources will be SMALL if the GSL is listed as a historical structure.

Due to the absence of historic cemeteries and prehistoric mounds within the boundaries of the site, and the previous disturbance of the site and nearby areas, the potential for the presence of human burials or human remains will be SMALL. To minimize impacts, an Archaeological Monitoring and Discovery Plan will be developed to specify procedures for addressing and handling the unexpected discovery of human remains or archaeological material during construction. A field reconnaissance at the project area was conducted in June 2022. In accordance with the Archaeological Monitoring and Discovery Plan, if human remains are discovered, the construction personnel will contact a representative of U. of I. The representative will contact the appropriate local law enforcement and the Campus Historic Preservation Officer and Illinois State Historic Preservation Office (ISHPO) and communicate that human remains have been discovered. If the human remains are determined to be archaeological in nature, the Campus Historic Preservation Officer, in conjunction with the ISHPO and U. of I., will determine further actions.

Operational activities will not result in any changes to surrounding buildings, therefore the potential impacts to historic and archeological resources will be SMALL.

### *4.6.2 Impacts from Decommissioning*

Following the cessation of operation, the facility will be decommissioned. Decommissioning activities will be similar to construction activities and involve heavy equipment to dismantle buildings and remove pavement areas. As such, impacts from decommissioning will be similar to the impacts associated with construction and will be SMALL.

## 4.7 SOCIOECONOMICS

This section describes potential impacts to the socioeconomic environment, including transportation system impacts associated with the construction, operation and decommissioning of the facility. The evaluation of potential socioeconomics impacts addresses potential changes in the regional population, economy, housing availability, and public services. The evaluation of transportation system impacts addresses routes and modes that are involved with transporting materials, workers, and equipment to the site.

### *4.7.1 Socioeconomics Impacts*

This section evaluates impacts to the population, housing, public services (e.g., water supply), public education, and tax revenues in the ROI, that result from constructing, operating, and decommissioning the research facility. The ROI is defined by the areas where the research reactor construction and operations workers and their families are most likely to reside, and spend their wages, salary, and benefits on goods and services, which impact the socioeconomic environment in the region as illustrated in Figure 3-25. Potential impacts of constructing the facility are attributable to the size of the construction workforce, the expenditures needed to support the construction program, and the tax payments made to political jurisdictions. Because direct impacts are those that occur onsite, the only direct impacts are associated with the presence of the workforce at the site. All other socioeconomic impacts are indirect, as they occur offsite. The analysis presented in this section is based on the bounding parameters for the projected workforces for construction, operation, and decommissioning.

Construction activities associated with the research reactor include subgrade installation of the reactor and construction of aboveground structures. Typical heavy construction activities associated with a large structural building are not expected. Consequently, the construction/installation labor force will not be more than 170 onsite workers. During operation, the facility is estimated to require an average of nine to eleven workers per weekday for staffing with a minimum of two reactor operators required for nonstandard work hours and weekends. Required staffing include licensed operators, health physics staff, administration, management, engineering, and instrumentation and mechanical support. As many as twelve additional researchers, instructors, and/or students may also be present daily. Peak operational staffing is estimated to require approximately 31 workers. Decommissioning could start soon after shutdown at the end of the operational period in approximately 2070 or it could be delayed after placing the facility in a safe storage "SAFSTOR" condition. If decommissioning started soon after shutdown, it is expected that the decommissioning period will be approximately ten years. The decommissioning labor workforce will be expected to be similar to, or less than, the construction workforce of 40 to 50 onsite workers given the longer anticipated decommissioning period. The analysis presented in this section is based on these parameters for the projected workforces for construction, operation, and decommissioning.

#### *4.7.1.1 Population Impacts*

Section 3.7.1.1 and Table 3-12 provide a summary of residential population sourced from the 2020 census. In 2020 the population of Champaign County was 205,865 and population was expected to increase 3.8 percent to 213,700 in 2030 (see Table 3-12). The analysis of population impacts considers the population growth potential due to the workforce requirements for construction, operational and decommissioning phases.

The number of workers anticipated for construction and operations is very small compared to the ROI population. Thus, the estimated ROI labor force in the construction trades is demonstrated to be abundant relative to construction workforce requirements, which greatly reduces the potential for large numbers of trade workers to relocate in the ROI. It is possible that some workforce commutes or temporarily relocates to the site from non-ROI counties, but these numbers are not significant or do not cause a perceptible increase in the ROI population. Therefore, the impact of construction, operation, and decommissioning of the facility on population will be SMALL.

#### *4.7.1.2 Housing Impacts*

Section 3.7.2.2 and Table 3-18 provide a summary of housing utilization sourced from the 2020 census. This data is used to evaluate the number of housing units that may be available to accommodate housing demands resulting from construction, operations and decommissioning.

In 2020, there were 10,620 vacant housing units in Champaign County (see Table 3-18). The amount of housing availability within the ROI is greater than the total estimated demand for housing due to construction of the facility, which is negligible because the peak requirements for construction and decommissioning are likely available in the ROI labor force. Thus, workers may not need to relocate to the ROI to support construction phase peak needs, operational workforce needs or decommissioning. However, should construction require some workers temporarily relocation, there will likely be an adequate supply of vacant housing to accommodate the requirements of new workers or families who may choose to relocate to the site for temporary or permanent housing.

The potential impacts on housing will be SMALL due to the likely number of available vacant housing units in the ROI and the limited demand relative to the ROI population related to the construction, operations and decommissioning workforce.

#### *4.7.1.3 Public Services Impacts*

Construction of the facility requires potable water to support the needs of the construction workforce. During construction and operations, either the U. of I. or municipal systems will supply water to the site, including potable water uses, fire protection uses, and typical construction uses (e.g., dust suppression and concrete mixing). As discussed in Section 3.7.5, Illinois American Water serves 15 counties and provides drinking water to over 850,000 people. The regional aquifer supplies over 100 mgd for public water use, industrial use, and irrigation.

Water use during construction, operation, and decommissioning will not be significant or cause a perceptible increase to local water supply systems. Therefore, impacts to the municipal water supplier will be SMALL.

#### *4.7.1.4 Public Education Impacts*

Schools and student populations are discussed in Section 3.7.5.1. Population increase due to construction workforce, operational workforce, and decommissioning workforce requirements is not expected. The estimated ROI labor force in the construction trades is demonstrated to be abundant relative to construction and operations workforce requirements, which greatly reduces the potential for large numbers of trade workers to relocate in the ROI. It is possible that some workforce may commute or temporarily relocate to the site from non-ROI counties, but these numbers are not significant or cause a perceptible increase in the area’s population or result in any perceptible change in school enrollment. Therefore, the level of impact to the local public education system will be SMALL.

#### *4.7.1.5 Tax Revenue Related Impacts*

Tax revenues associated with the construction, operation, and decommissioning of the facility include payroll taxes on wages and salaries of the construction and operations work forces, sales and use taxes on purchases and the construction, operations and decommissioning workforces, and property taxes on owned real property and improvements. Increased tax collections are a benefit to the state, county, and municipal-level jurisdictions as well as school districts.

#### *4.7.1.6 Personal and Corporate Income Taxes*

Workforce payroll taxes (federal and state) are generated by construction, operations and decommissioning activities and purchases as well as taxes generated by workforce expenditures. State tax payments are distributed throughout the ROI and extend beyond the ROI, based on the expectation that some construction, operations and decommissioning employees will reside outside of the ROI. The relocation of workers to the ROI and surrounding counties, including some expected to relocate to Illinois from other states, results in an increase in payroll taxes paid to Illinois.

#### *4.7.1.7 Sales Taxes*

Workers commuting to the site from within and outside of the ROI contribute sales tax revenues to the State of Illinois and to Champaign County and any other counties where they live. Most sales tax revenues from the ROI are collected by the state, as the Champaign County sales tax rate is very low. But the ROI does experience an increase in the amount of sales taxes collected, reflecting the concentration of relocated workers. Sales tax revenues also result from direct purchases for materials, equipment and services supporting the construction project, long term operations, and decommissioning. The distribution of these tax revenues is determined by the business locations of the material and service providers and likely reflects a broad area including the ROI and beyond to multiple states. The amount of sales taxes collected over a potential 40-year licensed operating period that are attributable to the research facility is significant but is relatively minor when compared to the total amount of taxes collected in the ROI.

#### *4.7.1.8 Property Taxes*

The research facility will be in Champaign County. As such, property taxes are paid to Champaign County. These jurisdictions all provide public services that benefit the business and employees.

#### *4.7.1.9 Summary of Tax Impacts*

Overall tax revenues generated by construction, operation and decommissioning of the facility will be significant in absolute dollars across the lifetime of the facility. However, the overall tax revenues are relatively small in comparison to the established tax base of Champaign County. The maximum increase in property tax revenues after expiration of the tax increment financing agreement is expected to be substantially less than 10 percent of the total tax revenue at the city and county levels. Therefore, total tax revenues from the U. of I. research reactor facility will result in a SMALL positive impact at the community level.

#### *4.7.1.10 Other Socioeconomics Related Impacts*

Socioeconomics-related impacts in addition to those specifically described above include the potential for supportive business expansion and associated land use changes in Champaign County as a result of the investments from U. of I. Land use changes due to housing needs are not expected due to the large number of existing vacant housing units. Potential land use changes include those to provide for expansion of existing small businesses or locations for new small businesses that might support the facility and facility employees. If realized, such business expansions and/or new business developments are likely to occur in the ROI in locations where conditions are appropriate for business development. Any such land use changes are subject to local zoning regulations and associated impacts on socioeconomic conditions will be SMALL.

##### *4.7.1.11 Mitigation Measures to Minimize Socioeconomic Impacts*

As described in the sections above, the socioeconomic impacts on the ROI resulting from construction, operation, and decommissioning of the facility will be SMALL and no mitigation measures are required to minimize socioeconomic impacts.

### *4.7.2 Transportation*

Section 3.7 describes the transportation infrastructure at the site in detail. The area around the site is served by a transportation network of federal and state highways; three freight rail lines; and two general aviation airports (Willard Airport and Frasca Field). Figure 3-26 illustrates the road, highway, railroad, and airport systems in the area. The effects on the local transportation infrastructure as a result of construction and operations are measured against the existing traffic conditions and the future no-build traffic conditions. Goods and services to support the facility will reach the site using existing roadway and rail networks.

The construction, operation, or decommissioning of the facility does not alter existing transportation routes for conveying materials or personnel to the site. Therefore, the impacts to transportation routes will be SMALL.

The construction, operation, or decommissioning of the facility does not alter existing traffic patterns to and from the site because of the limited increase in number of workers; therefore, the impacts to traffic patterns are SMALL.

### *4.7.3 Public Recreational Facilities*

Traffic, visual impairments, and other negative impacts to surrounding recreational facilities will be minimal because the research reactor is located within the U. of I. campus, which mitigates sounds and will limit construction, operation, and decommissioning impacts to these recreational facility locations and the overall impacts will be SMALL.

## 4.8 HUMAN HEALTH

The subsections below evaluate potential health impacts – both nonradiological and radiological – on the public and on the research facility workers during the construction, operation, and decommissioning of the research reactor facility. All waste-related activities (generation, handling, storage, treatment, protection, and disposal) must comply with federal regulations administered by the NRC and other state and federal regulators. Key federal statutes include the Clean Air Act, Clean Water Act, Atomic Energy Act of 1954, as Amended, and Resource Conservation and Recovery Act (RCRA).

In Illinois, the project also requires construction and operation permits from the Illinois Environmental Protection Agency (IEPA) pursuant to the federal Clean Air Act and Clean Water Act. Moreover, the Illinois Health and Hazardous Substances Registry Act, chapter (410 Illinois Compiled Statutes 525) establishes a coordinated statewide program to safeguard public health, safety, and welfare through comprehensive hazardous-substance management.

### *4.8.1 Nonradiological Impacts*

Nonradiological hazards at the research facility stem from physical hazards, electrical hazards, and chemical exposure hazards from routine emissions, liquid discharges, solid wastes, and the potential for accidental spills or releases. All nonradioactive wastes produced from construction, operation, and eventual decommissioning activities will be collected, handled, and disposed of in full compliance with applicable federal, state, and local regulations, as well as all relevant permit conditions.

#### *4.8.1.1 Nonradioactive Chemical Sources*

During construction, nonradioactive chemical sources expected onsite will include fuels, oils, solvents, and other materials necessary for site preparation. During operation, small quantities of nonradioactive chemicals will be stored onsite, such as lubricating oil for rotating equipment and cleaning supplies used for maintenance activities. As described in Section 2.1, approximately 3,170 gallons (12,000 liters) of diesel fuel is required for melting the salt needed to fill the Thermal Energy Storage and 11,880 gallons (44,971 liters) of diesel fuel for all deliveries during construction. Diesel fuel is assumed to be the bounding fuel type for construction activities. The bounding inventory of major chemicals (i.e., those in excess of 1,000 pounds (454 kg) used during operations at the research reactor facility is provided in Table 4-1. During decommissioning, the types of nonradioactive chemicals present onsite will resemble those used in the construction phase.

#### *4.8.1.2 Nonradioactive Liquid, Gaseous, and Solid Waste Management and Control Systems*

##### *4.8.1.2.1 Nonradioactive Liquid Wastes*

Insignificant volumes of nonradioactive liquid wastes will be generated during construction, operation, and decommissioning. The primary source of liquid wastes will be sanitary waste. Any wastewater generated by the research facility will be managed through the campus sanitary sewer system, which is tributary to the local sanitary district (Urbana and Champaign Sanitary District). Additionally, U. of I. operates both a sanitary sewer system and a separate stormwater sewer system. Other sources may include stormwater; oil from pumps; solvents for maintenance; and heating, ventilation, and air conditioning (HVAC) water replacement. Oil containment collection devices will be strategically placed around equipment and routed through the proper channels for disposal. It is anticipated that some lab-scale chemical use will occur, however any liquid waste produced because of these activities will be treated to ensure they meet the requirements of the wastewater treatment facility before being discharged to the municipal sewer system. Any chemical waste liquid will be bottled and disposed of in accordance with a U. of I. chemical hygiene plan. Larger volumes of liquid hazardous waste will be pumped into a mobile hazardous liquid waste tanker (truck) that will transport the waste to an appropriate offsite facility for processing and disposal. The bounding inventory of nonradioactive liquid discharge rates at the research reactor facility are provided in Table 4-2.

##### *4.8.1.2.2 Nonradioactive Gaseous Wastes*

As described in Section 4.2.1, during construction and decommissioning of the research reactor facility there will be limited gaseous effluents. Activities associated with construction and decommissioning along with the respective workforce traveling to and from the project site can result in varying air emissions, however gaseous waste during these two phases will be insignificant.

During operations, the research reactor facility will generate gaseous effluents resulting from process operations and the ventilation of operating areas. Lab-scale exhaust such as from fume hoods, instrument exhaust, and any other laboratory exhaust will be ventilated to the roof through high-efficiency particulate air (HEPA) and carbon filtration.

The research reactor facility will generate gaseous effluents resulting from process operations and the ventilation of operating areas. The dominant nonradioactive gaseous effluent stream from the facility is air from the HVAC system.

##### *4.8.1.2.3 Nonradioactive Solid Wastes*

Dedicated areas will be assigned for collection and storage of nonradioactive solid waste. Solid waste management and control measures for the facility will include waste reduction, recycling, and waste minimization practices that will be employed during all project phases. Solid waste generated from either construction, operations, and decommissioning will ultimately be shipped offsite to a permitted or licensed facility for further processing and disposal.

#### *4.8.1.3 Nonradioactive Effluents Released*

Air emissions of nonradioactive gaseous criteria pollutants and other hazardous air pollutants will be emitted during construction, operation, and decommissioning of the research reactor facility. Implementation of controls and BMPs at the source of emissions during construction will result in reduction of impacts offsite. During decommissioning, associated emissions are expected to be similar. During operations, the major contributor of nonradioactive effluents released are GHGs associated with the commute of the workforce and deliveries to the site. No liquid effluents will be released to any surface water bodies or retention ponds.

Kairos Power's Hermes reactor project is anticipated to generate up to 8,190 metric tons of CO2 equivalent (CO2e) annually during its construction phase (Reference 7-165). Once operational, the Hermes reactor could produce up to 1,460 metric tons of CO2e per year (Reference 7-165). Given that the emissions from the Hermes project are significantly below the 25,000 metric tons per year (tpy) threshold set by the EPA's Greenhouse Gas Reporting Program, the project is not subject to GHG regulations. When comparing the Hermes project to the construction and operation of the U. of I. research reactor facility, it can be inferred that, due to the similar scale of both projects, the U. of I. research reactor facility is also expected to remain well below the 25,000 metric tpy threshold. Consequently, the U. of I. reactor facility will not be subject to GHG regulations.

#### 4.8.1.4 Chemical Exposure to the Public

##### 4.8.1.4.1 Air Emissions

In the state of Illinois, air pollution sources are considered minor sources if their potential to emit air pollution is less than the threshold for a major source annual emission threshold (Reference 7-166). Air emissions from the research reactor facility are estimated to be well below 100 metric tpy for all applicable criteria pollutants (sulfur dioxide, NOx, particulate matter with a diameter of 10 micrometers, particulate matter with a diameter of 2.5 micrometers, carbon monoxide, volatile organic compounds, lead) during the site preparation and construction period and decommissioning phases of the project. Chemical exposures through air emissions will be even lower during operations. As the estimated offsite emissions will be insignificant from all phases of the project, direct and indirect human health impacts beyond the Licensed Area boundary during construction, operations, and decommissioning will be SMALL.

Table 4-3 provides additional information on the discharge rates of nonradioactive chemical effluents.

##### 4.8.1.4.2 Liquid Effluents

As described in Section 4.8.1.3, construction, operation, and decommissioning of the facility will not release nonradioactive chemicals to the environment as liquid effluents will be controlled and releases are monitored. Effluents will be collected and treated through internal recycling for additional treatment or discharge to the environment. Effluent discharged through the sanitary sewer line will be controlled and measured. Therefore, the direct and indirect human health impacts from liquid effluents during construction, operation, and decommissioning will be SMALL.

#### 4.8.1.5 Physical Occupational Hazards

Physical occupational hazards exist during all phases of the project with more hazards present during the construction and decommissioning phases. Modularization will be maximized offsite and the integration of the already assembled standard transportable modules will minimize labor and labor intensity at the site. Because occupational hazards occur onsite and during construction, operation, and decommissioning, they are considered direct impacts. Potential impacts from physical hazards during offsite assembly of components and parts are considered indirect impacts.

Table 4-4 lists the general types of occupational physical hazards (physical, electrical, and chemical) that may be present at the facility during the phases of the project. Occupational physical hazards will be reduced or eliminated through implementation of safety practices, training, and physical control measures. Operations will adhere to the regulations and standards established by the U.S. Occupational Safety and Health Administration and the National Institute of Occupational Safety and Health regulations. Therefore, the impacts from occupational hazards will be SMALL.

#### 4.8.1.6 Chemical Exposure to the Workforce

As planned, the research reactor facility will not store or use highly hazardous chemicals in quantities above the Threshold Quantities in Appendix A to 29 CFR 1910.119 during construction. The chemicals used at reactor facilities are generally divided into two main categories: primary process chemicals and secondary process chemicals. Primary process chemicals are chemicals that will be used regularly for the general operations of the facility. There are not primary process chemicals that will be used at the U. of I. research reactor facility. Secondary process chemicals are typically chemicals that are expected to be used on the facility on an infrequent basis in small quantities for activities such as commissioning or maintenance. Because potential chemical exposure to the workforce during operations will occur onsite, they are considered direct impacts. Potential exposures to chemicals during offsite manufacturing are considered indirect impacts. The research reactor facility practices will ensure compliance with use and storage requirements and limit exposures. Therefore, impacts from chemical occupational hazards will be SMALL.

##### *4.8.1.7 Environmental Monitoring Programs*

State regulations prescribe non-radiological monitoring requirements and may include those associated with emergency management, environmental health, drinking water, water and sewage, pollution discharge, air pollution, and hazardous waste management. The facility will generate gaseous effluent resulting from operations and the ventilation of operating areas. Specific monitoring requirements in support of required air permits will be determined through the permitting process.

##### *4.8.1.8 Mitigation Measures*

Mitigative measures such as administrative procedures and protective measures that are more restrictive than regulations and requirements will be used to ensure protection of human health and the environment. The facility is committed to best management practices during construction, operation, and decommissioning to minimize pollutant releases to onsite and offsite areas, to ensure delivery of all wastewaters to the collection system, and to control air emission as appropriate. Normal operating liquid effluents discharge will be below the allowable release limits. Required permits will be obtained for applicable effluents and emissions. Furthermore, waste reduction practices, including recycling and waste minimization, will be employed.

#### *4.8.2 Radiological Impacts*

This section describes the public and the occupational health impacts from the management of radioactive materials at the research facility. During the construction phase, radioactive material present onsite will be for construction-related activities (e.g., compaction testing and radiography). These radioactive materials will be in the form of sealed sources and will be covered by a contractor's radioactive materials license. The impacts from the use of these radioactive materials on both occupational health and public health will be SMALL when the devices containing the radioactive materials are operated according to standard operating procedures and their respective license conditions. The radiological impacts addressed in the following subsections will result from reactor-related sources during the operation and decommissioning phases of the facility.

##### *4.8.2.1 Baseline Radiation Levels*

Background radiation levels and radiation levels in the vicinity of the site are discussed in Section 3.8. There are no radioactive materials or hazardous materials currently stored at the research reactor site. Approximately 0.2 miles (0.32 km) south-southeast of the research reactor site is the U. of I. Nuclear

Physics Laboratory. There are no radioactive materials stored at the Nuclear Physics Laboratory and there are no intentions to store radioactive materials or install radiation generating devices or equipment. As a result, no contributions from artificial sources of radiation will be expected from this laboratory.

The most significant facility close to the research reactor site is the Abbott Power Plant. It is a hybrid natural gas and coal facility that serves the U. of I. owned and operated electrical and steam distribution system. No radioactive materials are stored or used at Abbott Power Plant. Consequently, no significant contributions of radiation will be expected from this power plant.

Historically, the U. of I. successfully and safely operated a nuclear research reactor on campus for 38 years from 1960 to 1998, and its fuel was safely stored onsite until 2004. The reactor facility systems and structures were removed, the license was terminated in 2013, and the site is now in greenfield status (Reference 7-167). The nearest operating nuclear power plant, the Clinton Power Station, is approximately 44 miles away.

Within a 5-mile radius of the project site there are medical facilities that provide x-ray and other nuclear medicine services to patients. Given that the annual average background radiation of about 620 millirem (mrem) )6.2 millisieverts) in the U.S. as described by the NRC includes exposure from medical sources, it is anticipated that these medical facilities are not significant contributors of radiation exposure to the public in the vicinity of the site.

As there are no radiation sources in the vicinity of the research reactor site that will result in abnormal radiation level, the average baseline radiation for the site is assumed to be equivalent to the national average of about 310 mrem (3.1 millisieverts) described by the NRC for natural sources which includes cosmic and terrestrial radiation and radon.

#### *4.8.2.2 Layout and Location of Radioactive Material*

Figure 2-1 depicts the physical layout of the site indicating site features, structures, and designated areas. The reactor is expected to undergo refueling approximately every 3 years when operating at full power during its projected approximate 40-year operational life. Provisions are made in the design of the research reactor fuel elements to segregate various types of waste in order to reduce the impact of the spent nuclear fuel. This may include additional processing of the fuel elements at an offsite facility prior to permanent disposal. However, the spent nuclear fuel from the research reactor will be returned to the U.S. Department of Energy (DOE) in accordance with U. of I.'s fuel leasing and takeback arrangement with the DOE.

#### *4.8.2.3 Gaseous Sources of Radiation*

During operations the anticipated sources of gaseous radioactive waste may be:

- Helium leakage of gaseous waste/effluent,
- Helium leakage from the primary circuit and helium services into Citadel building air volumes,
- Evaporation of water in the citadel building (e.g., sumps, condensates) into Citadel building air volumes,
- Citadel building air volume releases through pressure zoning and controlled/monitored HVAC release, and

- General evaporation of potentially contaminated water in the radiologically controlled area.

Noble gases in the primary coolant will be filtered and collected in the Helium Purification System. Collected waste in filters will be discharged to solid radioactive waste for further processing. It is anticipated that annual gaseous releases will be below the bounding normal operating annual gaseous release limits. Tritium in the primary coolant is filtered by and collected in the Helium Purification System. Tritiated concentrate from this system will be packaged and discharged to solid radioactive waste for further processing and disposal to an offsite facility. It is expected that this packaged tritiated concentrate sent to the solid radioactive waste stream will be less than 35.3 cubic feet per year (0.01 cubic meters per year [$m^3$/yr]).

All releases will result in a total dose to the public that will be below the annual public dose limits established in 10 CFR 20.1301. As part of evidencing compliance with those limits consideration will be given to 10 CFR 20, Appendix B, Table 2 and the guidance provided in Regulatory Guide 4.20. Overall, the impacts on human health from gaseous sources of radiation will be SMALL. Additional details on doses from gaseous releases are provided in Section 4.8.2.6.

#### *4.8.2.4 Liquid Sources of Radiation*

During operations the anticipated sources of liquid radioactive waste may be:

- Water used for routine hand washes by personnel inside of the radiologically controlled area,
- Water used for the decontamination shower by operators/maintenance personnel,
- Liquids used in the decontamination of equipment or components,
- Any ingress water (such as ground water) or spilled liquids in the radiologically controlled areas,
- Water used for cleaning and mopping of the reactor building, and
- Active condensate from the HVAC.

Provisions for controlled and monitored releases of the liquid generated will be done by the Liquid Radioactive Waste Handling System. The Liquid Radioactive Waste Handling System deals with all the liquid waste that is potentially radioactive. The system will dispose of the treated liquid by internal recycling for additional treatment or discharge to the environment. Liquid effluent will be controlled and sampled prior to discharge through the sanitary line. Figure 4-9 summarizes the holdup, monitoring, and release logic of the liquid holdup and monitoring process. Table 4-5 indicates the daily volumetric flow rate of normal operating liquid effluents being discharged to sewage and is expected to be below the allowable release limits in 10 CFR 20, Appendix B, Table 2.

Any liquids that cannot be discharged into the sewage system will be recycled internally to undergo additional treatment and additional decay in storage. In the case where recycled liquid is above the allowable release limits, it is isolated and certified contractors will remove the waste from site for processing.

In the case of major equipment failures that will lead to large quantities of potentially radioactive liquid waste being generated, the facility will contain the liquid and certified contractors will remove the waste from site for processing.

Thus, there will be minimal routine liquid radioactive releases from the facility, and all releases will be within regulatory limits. Therefore, the impacts from liquid sources of radiation on human health will be SMALL.

#### *4.8.2.5 Solid Sources of Radiation*

During operations the anticipated sources of solid radioactive waste may be:

- The decontamination system,
- Radiologically Controlled Area, and
- Helium Purification System.

The Solid Radioactive Waste Handling System deals with all the solid waste that is potentially radioactive that is generated during normal operations of the plant. Any waste that has the possibility to be radioactive will be characterized to ensure it is dealt with appropriately. Solid waste will be characterized and sorted into the following categories:

- Nonradioactive solids
- Solids to decay in storage
- Solids to be decontaminated (only small items)
- Incinerable solids
- Compressible active solids
- Active solids to package

To reduce the volume of radioactive waste, items can either be decontaminated, left to decay in storage within the facility, or compressed. All radioactive waste will be packaged appropriately before it is shipped to an offsite facility for processing. All low and intermediate-level radioactive waste will be shipped as packaged solid waste.

The anticipated major constituents of radioactive solid waste are listed below:

- Operator PPE
- Swabs, smears, and counters
- Particulate filters
- HEPA filters
- Solidified liquid waste

The volume of solid low-level radioactive waste (LLRW) volumes depend upon the amount of maintenance done and if refueling took place in the year.

In summary, sources of radiation inside the facility will be from waste staging, decay-in-storage, and shipping areas. The areas identified to have stationary sources of radiation will be designed with appropriate shielding to control external dose to the public such that the total dose is maintained below the annual public dose limits provided in 10 CFR 20.1301.

The research reactor is expected to undergo refueling approximately every 3 years during the approximate 40-year operation life of the reactor. Temporary shielding and administrative and other engineering controls will be in place during refueling events to also meet the annual public dose limits in 10 CFR 20.1301 at the Licensed Area boundary. The spent fuel will be managed in accordance with U. of I.'s fuel leasing and takeback arrangement with the DOE, and spent nuclear fuel will be returned to the DOE. While detailed shielding designs and spent fuel handling procedure are not finalized at this time, the direct dose to the public at the Licensed Area boundary will be held within regulatory limits and the dose will substantially decrease with increasing distance from the Licensed Area boundary. Therefore, the public dose impacts from direct exposure sources will be SMALL.

#### *4.8.2.6 Annual Dose to Maximally Exposed Member of the Public*

Small quantities of radioactive gases may be discharged to the environment during normal operation of the U. of I. research reactor. The impact of these releases on individuals of the general population in the vicinity of the site is evaluated by considering the most important pathways from the release to the receptors of interest. The major pathways are those that could yield the highest radiological doses for a given receptor. The relative importance of a pathway is based on the type and amount of radioactivity released, the environmental transport mechanism, and the consumption or usage factors at the receptor.

The exposure pathways considered, and the analytical methods used to estimate doses to the maximally exposed individual (MEI) and to the general population surrounding the U. of I. research reactor site are based on RG 1.109 and RG 1.111. The MEI is defined as a member of the public located to receive the maximum possible calculated dose. For this analysis, given the proximity of the research reactor facility to the general public, the location with the highest calculated X/Q value located along the Licensed Area was chosen as a conservative receptor for the purposes of the MEI calculation.

The NRC-endorsed GASPAR II computer code, described in NUREG-4653 (NUREG/CR-4653, 1987) and implemented in NRCDose3 version 1.1.5, was used to calculate the radiation doses to offsite receptors from the proposed U. of I. research reactor. This program implements the radiological exposure models described in RG 1.109 to estimate the doses resulting from radioactive releases in gaseous effluents. Radiological exposure from potential liquid effluent discharge will be below the limits in 10 CFR 20, Appendix B, Table 2. The dose associated with this release will be bounded by the gaseous effluent dose.

The following exposure pathways are considered in GASPAR II:

- External exposure to an airborne plume
- External exposure to contaminated ground
- Internal exposure from inhalation of airborne activity
- Internal exposure from ingestion of contaminated vegetables, milk, and meat

Population doses from the U. of I. research reactor normal operations emissions are calculated for the year 2070. The total projected population was calculated using the methodology presented in PSAR Section 2.1.3. Based on the design inputs and assumptions shown in Table 4-6, the GASPAR II computer program was used to calculate doses to the MEI from gaseous radioactive effluents at the nearest site boundary. Projected annual doses to the MEI from gaseous radioactive effluents from the research reactor facility are shown in Table 4-7. The results of this analysis demonstrate compliance with the 0.1 rem (1 mSv) limit of 10 CFR 20.1301. Estimated annual collective doses to the projected 2070 population within 50 miles (80 km) of the U. of I. research reactor facility are shown in Table 4-8.

##### *4.8.2.7 Annual Dose to Maximally Exposed Worker*

Occupational radiation exposures to workers from all sources at the facility will not result in a dose greater than the occupational dose limits provided in 10 CFR Part 20 limits, Subpart C. Therefore, the dose impacts from direct exposure sources to site workers will be SMALL.

Occupational and public exposures due to operations at the site will be controlled by limiting exposure times, maximizing distances to sources, and/or utilizing shielding when appropriate. This exposure minimization goal is met through both engineered and administrative controls. The following subsections discuss each individually.

###### *4.8.2.7.1 Engineered Controls*

The facility will utilize the following engineered controls to minimize radiation exposure to the public and workers:

- Radiation source identification and controls
- Shielding around radiation sources
- Ventilation control
- Access control to radiation areas
- Remote operation
- Physically separated systems that prevent cross-contamination

###### *4.8.2.7.2 Administrative Controls*

To minimize radiation exposure to the public and workers, the facility will utilize administrative controls, which consist of written procedures, policies, and employee training in the following subject areas:

- Radiation safety
- Dose monitoring
- Contamination controls
- Radioactive waste minimization
- Responsibilities for radiological environmental stewardship
- Employee recognition for efforts to improve radiological conditions

### *4.8.3 Radiological Monitoring*

Radiological monitoring is a critical component of the operational framework at the research facility, encompassing both effluent monitoring and environmental monitoring as stipulated by 10 CFR Part 20, Subpart F. Effluent monitoring involves a systematic approach that includes continuous measurements of specific effluent streams, periodic assessments of radioactive particles captured on filters, and the analysis of samples from effluent releases conducted in batches.

In conjunction with effluent monitoring, environmental monitoring is integrated into the research facility's Radiation Protection Program and Technical Specifications. This program includes baseline condition evaluations, which are established through the collection of soil samples and the execution of gamma radiation surveys in the vicinity of the project site.

The detection of releases to the environment will be achieved through multiple methodologies, including the monitoring of contamination, effluent assessments, environmental surveys, and the evaluation of airborne radioactivity within the research facility. These monitoring procedures will be vital for safeguarding both the environment and public health from potential radioactive releases, while also facilitating a thorough understanding of the radiological impact associated with the research facility's operations

Implementation of monitoring strategies will be designed to ensure that any impacts on public health remain minimal. The information gained from these monitoring efforts will also play a crucial role in controlling radiological effects and ensure they remain SMALL. Therefore, impacts to public health from implementing monitoring described above are SMALL.

**Table 4-1 Summary of Major Chemical Inventory and Quantity**

| Chemical | Approximate Bounding Inventory | Hazard Class | Storage Location |
|---|---|---|---|
| Diesel Fuel | 11,880 gallons | Class 3 – Flammable Liquids | Within Licensed Area |
| Molten Salt (60% $NaNO_3$, 40% $KNO_3$) | 900,000 kilograms | Class 9 - Solids | Within Licensed Area |

**Table 4-2 Nonradioactive Liquid Chemicals**

| Nonradioactive Discharge Rates | Bounding Parameters |
|---|---|
| Oil for pumps | 10 liters/year |
| Solvents for maintenance | 80 liters/year |
| HVAC water replacement | 7 cubic meters/year |

**Table 4-3 Nonradioactive Gaseous Chemical Effluents**

| Nonradioactive Discharge Rates | Bounding Parameter |
|---|---|
| Discharge rates for any applicable chemicals | 160 kilograms/year of NOx |

**Table 4-4 Potential Occupational Hazards**

| Construction and Decommissioning | | |
|---|---|---|
| **Physical** | **Electrical** | **Chemical** |
| Heavy construction equipment<br>Working from heights<br>Excavation and trenching<br>Heavy Lifts<br>Demolition<br>Slips and falls<br>Hot work | Power connects/disconnects<br>Generators<br>General wiring<br>Power tools<br>Underground wiring | Oils and fuels<br>Decontamination fluids<br>Cleaners<br>Paints/solvents<br>Natural Gas |
| **Operations** | | |
| **Physical** | **Electrical** | **Chemical** |
| Ergonomics<br>Slips and falls<br>Lifting<br>Loading and unloading<br>Cranes and hoists<br>Elevated work surfaces<br>Stairs | General electrical<br>Wiring<br>Electronics | Molten salt<br>Oils and fuels<br>Cleaners |

**Table 4-5 Normal Operating Liquid Effluents Discharge to Sewage**

| Stream | Volumetric Flow Rate ($m^3$/day) |
|---|---|
| Total municipal input supply | < 61.9 |
| Gray water discharge | < 1.9 |
| Sewer discharge | < 60 |
| Portion of sewer discharge | < 1 |

< = less than

**Table 4-6 Gaseous Effluent Dose Calculation Parameters**

| Parameter | Value | Basis/Comments |
|---|---|---|
| Atmospheric Dispersion and Deposition Factors | X/Q (site boundary) = 3E-03<br>D/Q (site boundary) = 1.18E+06 | Site atmospheric dispersion factors (X/Q values) and ground deposition factors (D/Q values) are presented in PSAR Section 2.3.5. The maximum X/Q and D/Q values at the Site Boundary were used for MEI calculations. Values calculated up to 31 miles (50 km) away from the Site and at regular direction intervals were used to determine total population dose. |
| Fraction of Year Leafy Vegetables Grown | 1 | Most conservative value |
| Fraction of Year Milk Cows on Pasture | 1 | Most conservative value |
| Fraction of Maximum Individual's Vegetable Intake from own Garden | 0.76 | Default value from RG 1.109, Table E-15 |
| Fraction of Milk-Cow Feed from Pasture | 1 | Most conservative value |
| Average Absolute Humidity for Growing Season | 8 g/m$^3$ | Default value in GASPAR II |
| Average Temperature over Growing Season | N/A | Not used if absolute humidity is specified |
| Fraction of Year Goats at Pasture | 1 | Most conservative value |
| Fraction of Goat Feed from Pasture | 1 | Most conservative value |
| Fraction of Year Beef Cattle at Pasture | 1 | Most conservative value |
| Fraction of Beef Cattle Feed from Pasture | 1 | Most conservative value |
| Population Within 50 miles (80 km) | Total Projected 2070 Population = 2,479,298 | Population within 50 miles of the U. of I. research reactor facility as of 2024 is 716,560. This value was multiplied by a factor of 3.46 according to the population projection analysis in PSAR Section 2.1. |

**Table 4-6 Gaseous Effluent Dose Calculation Parameters (Continued)**

| Parameter | Value | Basis/Comments |
|---|---|---|
| Milk Production within 50 miles (80 km) | 1.48E08 L/yr | Values obtained from USDA survey results (USDA Quick Stats) for the state of Illinois. Meat and milk production were adjusted using the fraction of Illinois population within 50 miles of the U. of I. research reactor site (0.056). Vegetable production was adjusted using the fraction of harvested land within 50 miles (0.20). All production volumes were then scaled by projected population increase from 2020 to 2070 (3.46x increase). |
| Meat Production within 50 miles (80 km) | 6.02E08 kg/yr | |
| Vegetable Production within 50 miles (80 km) | 2.35E08 kg/yr | |
| Radionuclide Release Rates / Source Term | Table 4.8-5 | PSAR Section 2.3-1 |

Notes:

$g/m^3$ – gram per cubic meter

L/yr – liters per year

kg/yr – kilograms per year

**Table 4-7 Gaseous Radioactive Effluent Doses for the Maximally Exposed Individual**

| Pathway | Dose (mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Body | GI-Tract | Bone | Liver | Kidney | Thyroid | Lung | Skin |
| External | | | | | | | | |
| • Plume | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 4.430 |
| • Ground[(a)] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| • Total | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 2.770 | 4.430 |
| Inhalation | | | | | | | | |
| • Adult | 0.005 | 0.005 | 0.007 | 0.005 | 0.005 | 0.005 | 0.005 | 0.004 |
| • Teen | 0.006 | 0.006 | 0.009 | 0.006 | 0.006 | 0.006 | 0.006 | 0.004 |
| • Child | 0.006 | 0.006 | 0.013 | 0.006 | 0.006 | 0.006 | 0.006 | 0.004 |
| • Infant | 0.004 | 0.004 | 0.010 | 0.004 | 0.004 | 0.004 | 0.004 | 0.002 |
| Vegetables | | | | | | | | |
| • Adult | 0.107 | 0.107 | 0.328 | 0.107 | 0.107 | 0.107 | 0.107 | 0.107 |
| • Teen | 0.154 | 0.154 | 0.532 | 0.154 | 0.154 | 0.154 | 0.154 | 0.154 |
| • Child | 0.330 | 0.330 | 1.280 | 0.330 | 0.330 | 0.330 | 0.330 | 0.330 |
| Meat | | | | | | | | |
| • Adult | 0.030 | 0.030 | 0.122 | 0.030 | 0.030 | 0.030 | 0.030 | 0.030 |
| • Teen | 0.024 | 0.024 | 0.103 | 0.024 | 0.024 | 0.024 | 0.024 | 0.024 |
| • Child | 0.043 | 0.043 | 0.193 | 0.043 | 0.043 | 0.043 | 0.043 | 0.043 |
| Cow Milk | | | | | | | | |
| • Adult | 0.041 | 0.041 | 0.133 | 0.041 | 0.041 | 0.041 | 0.041 | 0.041 |
| • Teen | 0.067 | 0.067 | 0.245 | 0.067 | 0.067 | 0.067 | 0.067 | 0.067 |
| • Child | 0.150 | 0.150 | 0.602 | 0.150 | 0.150 | 0.150 | 0.150 | 0.150 |
| • Infant | 0.296 | 0.296 | 1.180 | 0.296 | 0.296 | 0.296 | 0.296 | 0.296 |

**Table 4-7 Gaseous Radioactive Effluent Doses for the Maximally Exposed Individual (Continued)**

| Pathway | Dose (mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Body | GI-Tract | Bone | Liver | Kidney | Thyroid | Lung | Skin |
| Goat Milk | | | | | | | | |
| • Adult | 0.055 | 0.055 | 0.133 | 0.055 | 0.055 | 0.055 | 0.055 | 0.055 |
| • Teen | 0.086 | 0.086 | 0.245 | 0.086 | 0.086 | 0.086 | 0.086 | 0.086 |
| • Child | 0.180 | 0.180 | 0.602 | 0.180 | 0.180 | 0.180 | 0.180 | 0.180 |
| • Infant | 0.342 | 0.342 | 1.180 | 0.342 | 0.342 | 0.342 | 0.342 | 0.342 |
| MEI | | | | | | | | |
| • Adult | 3.0 | 3.0 | 3.5 | 3.0 | 3.0 | 3.0 | 3.0 | 4.7 |
| • Teen | 3.1 | 3.1 | 3.9 | 3.1 | 3.1 | 3.1 | 3.1 | 4.8 |
| • Child | 3.5 | 3.5 | 5.5 | 3.5 | 3.5 | 3.5 | 3.5 | 5.1 |
| • Infant | 3.4 | 3.4 | 5.1 | 3.4 | 3.4 | 3.4 | 3.4 | 5.1 |
| Maximum Group | 3.5 (Child) | 3.5 (Child) | 5.5 (Child) | 3.5 (Child) | 3.5 (Child) | 3.5 (Child) | 3.5 (Child) | 5.0 (Child/Infant) |

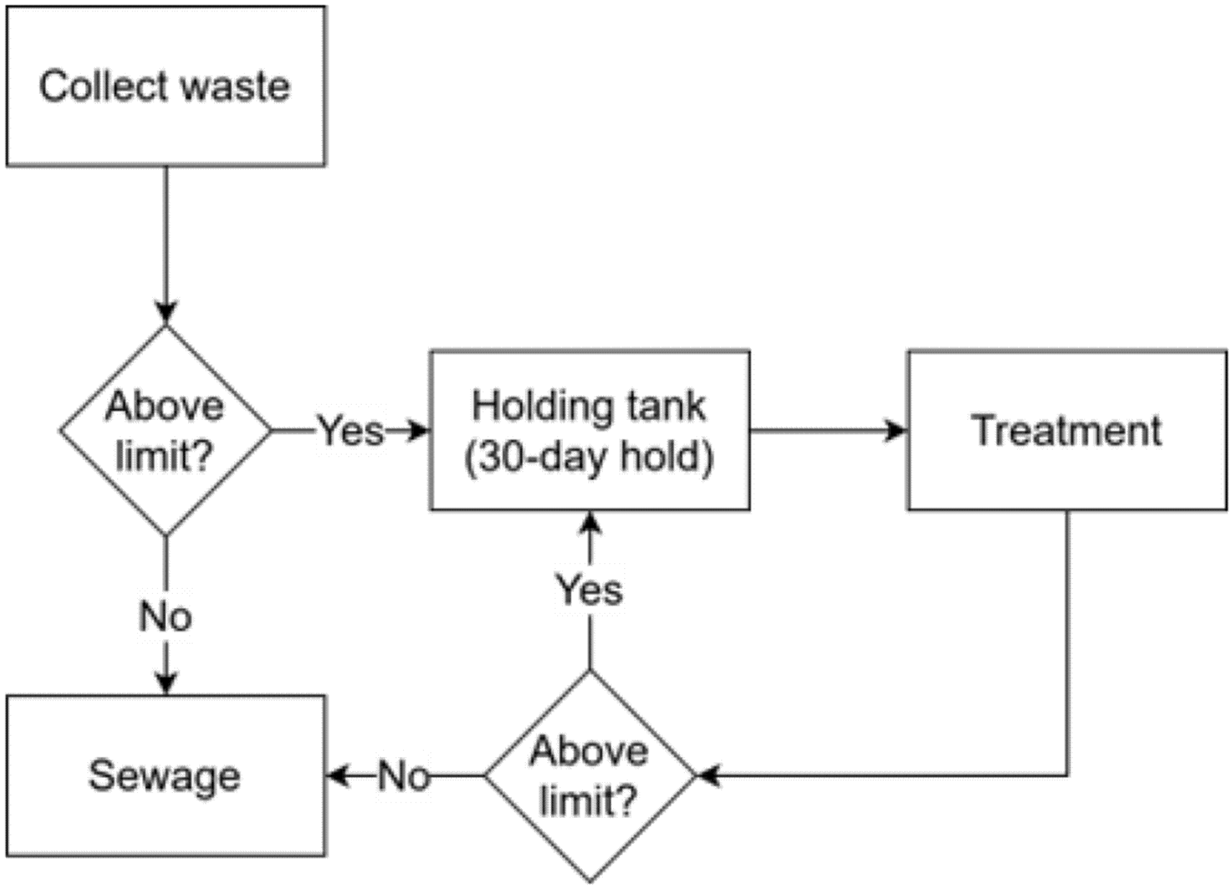
Notes: The Maximally Exposed Individual (MEI) is assumed to be a member of the population that resides at the nearest point on the site boundary to the U. of I. reactor facility (30 meters). This choice was made to produce conservative dose results.

[a] The radionuclides included in this analysis are not predicted by GASPAR II to introduce a significant radiation dose through the ground deposition pathway.

**Table 4-8 Collective Doses to the 2070 Population within 50 Miles of the U. of I. Research Reactor Facility from Gaseous Effluents**

| Radionuclide | Dose (person-mrem/yr) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Total Body | GI-Tract | Bone | Liver | Kidney | Thyroid | Lung | Skin |
| Total | 1.32E-02 | 1.32E-02 | 1.98E-02 | 1.32E-02 | 1.32E-02 | 1.32E-02 | 1.32E-02 | 2.15E-02 |

**Figure 4-9 Liquid Holdup and Monitoring Process**



## 4.9 WASTE MANAGEMENT

### *4.9.1 Sources and Types of Waste Created*

The following sections discuss nonradioactive, nonhazardous, hazardous, and radioactive wastes associated with the research reactor facility during construction, operation, and decommissioning.

The NRC staff has determined in Draft NUREG-2249, *Generic Environmental impact Statement for Advanced Nuclear Reactors*, that for a site meeting specific criteria defined in Section 3.10.1 of the Draft NUREG-2249, the environmental impact assessment will result in a SMALL finding. These assumptions include meeting applicable regulatory requirements and bounding criteria for waste generation. The following sections demonstrate compliance of the U. of I. research reactor facility with the Draft NUREG-2249 criteria.

#### *4.9.1.1 Construction*

During the construction phase, the majority of waste generated will be construction and demolition (C&D) waste. Local solid waste haulers will be contracted to dispose of C&D waste in permitted local landfills. This waste will include material produced directly or indirectly from C&D activities, including, but not limited to, scrap lumber, bricks, glass, non-asbestos insulation, roofing materials, building siding, scrap metal, nails, wood, electrical wiring, rebar, concrete, excavated dirt, rubble, trees and tree stumps. The construction will follow all applicable regulations, permitting requirements, and BMPs.

Soils excavated for the purpose of construction will be temporarily stockpiled onsite and managed to limit water and wind erosion as well as impacts from runoff or direct loaded into trucks. Sanitary waste will be picked up on a routine schedule and transported to a local sanitary waste landfill. Only small amounts of hazardous waste will be generated during construction. These could include waste oils, degreasers, etc. No radioactive waste will be generated during construction. As the facility is a small industrial facility, the impacts of waste management from construction activities will be SMALL.

During the construction phase, the radioactive material onsite will be for construction related activities, such as compaction testing and radiography. These radioactive sources will be in the form of sealed sources and will be covered by a contractor’s radioactive materials license. The impacts from the use of these radioactive materials on both occupational health and public health will be SMALL when the devices containing the radioactive materials are operated according to standard operating procedures.

#### *4.9.1.2 Operation*

Facility operations will generate municipal solid waste commonly known as “trash” or “garbage” which will consist of food, plastic, paper, and other general waste. General office and industrial supplies waste will also be generated at the facility. Solid waste generated in conjunction with operation of the facility will be collected and stored temporarily onsite, managed in accordance with applicable state and federal environmental regulations, and recycled or disposed of in approved and licensed disposal facilities according to existing U. of I. practices.

There is expected to be no significant sources of hazardous waste during facility operations. Hazardous waste generated at U. of I. is managed in accordance with facility-specific written waste management plans that conform to state and federal regulations regarding the storage and disposal of hazardous waste and U. of I. policies. Hazardous waste generation will not exceed the threshold for small quantity generators as defined by RCRA.

Radioactive waste that will be generated by the operation of the facility, include but are not limited to:

- non-active solids,
- filters and absorbers, and
- routine waste from maintenance activities.

Systems designed to support the safe and efficient management of radioactive waste, including meeting all regulatory and permitting requirements, are described in Section 2.6. The anticipated quantities of radioactive waste are also discussed in Section 2.6. Waste systems will be operated in accordance with written procedures such that the final waste form will be acceptable for transportation in U.S. Department of Transportation (DOT) and/or NRC-certified shipping containers. There will be no onsite disposal of radioactive waste during operations. Quantities of LLRW generated will be less than the quantities at existing nuclear power plants.

Reprocessing is currently unlikely in the U.S., and an open fuel cycle is anticipated. Management of used nuclear fuel is addressed in 10 CFR 51.23 and the associated NUREG-2157, "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel". NUREG-2157 concluded that the impact for at-reactor storage will be small for short-term, long-term, and indefinite storage. NUREG-2157 did not address non-light water reactors (LWRs). To provide additional guidance for non-LWR license applications, the DOE prepared "Non-LWR Reactor Fuel Environmental Data" (Reference 7-168). The environmental impacts for continued storage of LWR fuel described in NUREG-2157 are considered to bound any impacts of the research reactor fuel storage until return to DOE.

Based on the quantities of waste, systems designed to manage radioactive waste streams, and waste management, impacts from all types of waste generated during operations, including impacts on the capacity of waste management facilities, will be SMALL. Impacts from waste transportation are discussed in Section 4.10.

#### *4.9.1.3 Decommissioning*

Prior to decommissioning the facility, U. of I. will provide the NRC with a license termination plan (LTP) as described in NUREG-1757, "Consolidated Decommissioning Guidance," Volumes 1 through 4. The LTP is defined in NUREG-1757 as a "detailed description of the activities a reactor licensee intends to use to assess the radiological status of its facility, to remove radioactivity attributable to licensed operations at its facility to levels that permit release of the site in accordance with NRC's regulations and termination of the license, and to demonstrate that the facility meets NRC's requirements for release. An LTP consists of several interrelated components including: (1) a site characterization; (2) identification of remaining dismantlement activities; (3) plans for site remediation; (4) detailed plans for the final radiation survey; (5) a description of the end use of the facility, if restricted; (6) an updated site-specific estimate of remaining decommissioning costs; and (7) a supplement to the environmental report, pursuant to 10 CFR 51.33, describing any new information or significant environmental change associated with the licensee's proposed termination activities (see 10 CFR 50.82)."

There will be no onsite disposal of waste during decommissioning of the facility. Aspects of decommissioning, including waste management, will be described in the LTP which will be submitted to the NRC for review and acceptance.

The environmental impacts from the decommissioning of nuclear power plants, including the impacts from wastes generated during decommissioning, have been analyzed by the NRC as described in NUREG-0586, "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," Supplement 1, Volume 1. For each impact area affected by waste management, the NRC concluded that the impacts from waste management operations will not result in an impact that will be greater than SMALL, including the commitments of land required for disposal of LLRW. Given that the research reactor facility will be much smaller than the reactor facilities analyzed in NUREG-0586, the impacts from waste management during decommissioning will be bound by the conclusion made by the NRC and will also be SMALL. While Supplement 1 of NUREG-0586 applies only to power reactors, the original NUREG-0586, dated August 1988, does not exclude research reactors and the conclusions provided in the 1998 version NUREG-0586 for research reactors are consistent with the conclusions provided in Supplement 1 of NUREG-0586.

## 4.10 TRANSPORTATION

Transportation of nonradioactive, radioactive, and special nuclear materials will be required during construction, operation, and decommissioning of the facility. These materials will include construction materials, construction and demolition waste, new nuclear fuel, spent nuclear fuel, helium gas, nitrate salts, diesel fuel, radioactive waste, and routine nonradioactive waste. The following subsections describe the environmental consequences of transportation of these materials within the context of the requirements of Section 12.12.4.10, Transportation, of the Draft Interim Staff Guidance (ISG) for NUREG-1537, Part 1. The guidance states that the following should be presented in the ER:

- Transportation mode (i.e., truck, plane, rail, or barge) and projected destinations of radioactive waste and nonradioactive waste
- Estimated transportation distance from the originating site to the projected destinations of radioactive waste and nonradioactive waste
- Treatment and packaging for radioactive and nonradioactive waste
- Calculated radiological dose to members of the public and workers from incident-free transportation scenarios

The NRC has generically evaluated the environmental impacts of the transportation of fuel and radioactive waste in Table S-4 of 10 CFR 51.52 for LWR fuel that meet certain entry conditions specified in 10 CFR 51.52(a). Section 51.52 discusses LWRs but does not provide direction on evaluating transportation of nuclear fuel and waste to and from non-LWRs in an ER. However, the applicant and the NRC must still evaluate transportation. As such, to provide additional guidance to non-LWR license applications, the NRC, through Pacific Northwest National Laboratory (PNNL), prepared Environmental Impacts from Transportation of Fuel and Wastes to and from Non-LWRs (Reference 7-168).

While considering the information requested for non-power reactors in Section 12.12.4.10 of the Draft ISG for NUREG-1537 and the additional guidance provided in PNNL-29365 for non-LWR license applications, transportation impacts are assessed in the following sections broken down by the phase of the reactor's life:

- Construction Phase
  - Nonradioactive material and waste shipments
- Operation Phase
  - New unirradiated nuclear fuel shipments
  - Irradiated (spent) fuel
  - Nonradioactive material and waste shipments
  - LLRW shipments
- Decommissioning
  - Nonradioactive material and waste shipments
  - Irradiated (spent) fuel
  - LLRW shipments

### *4.10.1 Impacts from Construction*

Construction materials are expected to be transported to the facility primarily via truck; however, rail lines are accessible in very close proximity to the site. Materials consumed during the construction phase are provided in Chapter 2, Table 2-1 and the types of construction equipment to be utilized during this phase are listed in Chapter 2, Table 2-2. The impacts from the increased traffic from the construction phase of the project on other resources such as air quality, noise, etc. are described in other sections of this ER, however the direct and indirect impacts from the construction-related traffic will be SMALL.

### *4.10.2 Impacts from Operation*

During the operation period, which includes pre-startup and startup activities, the research reactor facility will receive a one-time shipment of nitrate salt and routine shipments of new nuclear fuel, helium gas, and diesel fuel. As mentioned in Chapter 2, Section 2.1, no routine shipments of nitrate salt will be required during operations, and no onsite storage is required for interim waste salt storage since no waste nitrate salt is generated. Transportation during operations will be estimated at one delivery per week or a monthly average of four truck deliveries.

During refueling, which is approximately every 3 years when operating at full power, new nuclear fuel will be transported to the research facility. Additionally, the helium inventory will be replaced during refueling. Helium gas will be needed to replenish the system's inventory. There is sufficient helium storage capacity within the operations building. Similarly, there will be sufficient onsite storage capacity for spent nuclear fuel. Spent fuel transportation will be discussed in Section 4.10.2.3.

Operations result in the accumulation of radioactive and nonradioactive waste. The research facility anticipates some long-term storage of radioactive and nonradioactive materials, however it will be treated and temporarily stored as a part of operation processes within the facility until shipped off site for disposal at a monthly rate of one offsite waste shipment.

The following sections describe the impacts from transportation of materials to and from the facility during operations. Collectively, these impacts will be SMALL.

#### *4.10.2.1 Nuclear Fuel and Supply Chain*

The research reactor is designed for refueling cycle approximately every 3 years when operating at full power. To facilitate this process, a comprehensive fuel handling and storage program will be developed for the site. This will allow for initial nuclear fuel removal and new nuclear fuel loading to ensure seamless operational continuity.

High-Assay Low-Enriched Uranium (HALEU) plays a critical role in the operation of small modular reactors and microreactors (Reference 7-169). HALEU is defined as nuclear fuel enriched to levels from 10 to less than 20 percent in the uranium-235 (U-235) isotope. However, Low-Enriched Uranium Plus (LEU+), which refers to nuclear fuel enriched to levels less than 10 percent U-235, will be utilized in the reserach reactor.

For the research reactor, it is assumed that prior to startup, new nuclear fuel will be shipped by truck from either one of the following locations: Richland, Washington (Framatome) or Lynchburg, Virginia (BWXT). The PSAR provides additional details on the refueling approach, including the design bases and operational considerations.

#### *4.10.2.2 Transportation of Unirradiated Fuel*

Nuclear fuel will be transported to the U. of I. research reactor facility in NRC-certified fuel shipping containers based on the research reactor's refueling cycle. Approximately 150 containers of new nuclear fuel (one fuel block per container) will be shipped approximately every three years. Assuming a minimum of 25 shipping containers per truck, approximately six trucks will be needed to transport a fresh supply of nuclear fuel when refueling.

Unirradiated nuclear fuel is transported using exclusive-use vehicles and fuel packages. The conveyances carrying these packages must adhere to the radiation level restrictions specified in 49 CFR 173.441. For exclusive use shipments, the dose on contact with the package will not exceed 1 rem per hour (rem/hr) (10 milliSieverts per hour [mSv/hr]) for a closed transport vehicle, 0.2 rem/hr (2 mSv/hr) at any point on the outer surface of the vehicle, and 0.01 rem/hr (0.1 mSv/hr) at 6.5 feet (2 meters) from the outer surface of the vehicle provided the conditions in 49 CFR 173.441(b)(1) are satisfied. An evaluation in the Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants (WASH-1238) (Reference 7-6) indicated that the external dose rate for traditional unirradiated nuclear fuel shipments containing between 0.5 and 2.0 curies of uranium in fuel casks will average about 4.0E-04 rem/hr (4.0E-03 mSv/hr) at about 3.28 feet (1 meter) from the surface of the package and 5.0E-05 rem/hr (5.0E-04 mSv/hr) at about 9.84 feet (3 meters), well below the regulatory limits (Reference 7-6).

Based on the assumptions made regarding specific shipping modes and routes for transporting TRISO nuclear fuel, case-specific RADTRAN analyses are not performed for transportation of new fuel. Transportation dose modeling of traditional LWR nuclear fuel using RADTRAN has shown that the impacts from incident-free transportation and transportation accidents are classified as SMALL (Reference 7-170, Reference 7-171, Reference 7-172). The U.S. Department of Defense, acting through the Strategic Capabilities Office, has analyzed the transportation of high-activity low-enriched uranium TRISO fuels in VP-110 packages from Lynchburg, Virginia to Idaho using RADTRAN. This analysis determined that the radiological risk measured as the risk of latent cancer fatality is less than 1 in 10,000 (Reference 7-173). Consequently, the impacts from the transportation of TRISO new fuel to the U of I. research reactor facility are also considered SMALL.

#### *4.10.2.3 Transportation of Spent Fuel*

In accordance with U. of I. fuel leasing and takeback arrangements with the DOE under the University Fuel Services Program, the DOE will assume custody of spent nuclear fuel from the research reactor likely at either the Savannah River Site in South Carolina or the Idaho National Laboratory (Reference 7-174). For evaluation of the impacts from transportation of spent fuel, transportation to the Idaho National Laboratory is assumed as the bounding condition.

During normal full-power operations, refueling will occur approximately every 3 years. Spent nuclear fuel shipments from the U. of I. research reactor facility will be transported as follows:

- By truck over commercial highways.
- To a facility not more than 1,500 miles (2,414 kilometer) away, which is the approximate distance from Champaign, Illinois to Idaho Falls, Idaho.
- In a transportation cask that is certified by the NRC and the DOT for transportation of spent nuclear fuel.
- Radiation doses to members of the public and workers from incident-free transportation are bound by the DOT conveyance dose rate limits evaluated in Section 4.10.2.5.
- Not more than 1 spent nuclear fuel shipment by truck in a single year.

#### *4.10.2.4 Transportation of Radioactive Waste*

Routine LLRW will be transported offsite for disposal via truck. As provided in Table 2-6, radioactive waste volumes will be bound by the estimates in WASH-1238 (Reference 7-6), 15,440 $ft^3$/yr of solid LLRW. LLRW will include a combination of Class A low-level dry active waste (PPE, filters, etc.,) and Class B and C (nuclear removal systems) solid LLRW. These volumes will result in no more than 46 truck shipments per year. While some dry active waste may be compacted in waste drums, U. of I. will not treat any other LLRW onsite prior to transportation.

Class B waste will be shipped approximately 1,200 miles (1,931 kilometer) to Waste Control Specialists' LLRW disposal site located west of Andrews, Texas. Class A waste will be shipped to Waste Control Specialists or approximately 1,600 miles (2,574 kilometer) to EnergySolutions' LLRW disposal site located near Clive, Utah.

Prior to shipment, radioactive materials will be packaged in accordance with the regulations set forth by DOT and NRC. LLRW generated from routine operations, will be solidified and prepared for transport in compliance with the relevant regulatory frameworks.

The packaging of LLRW will conform to the requirements outlined in 49 CFR 173, Subpart I, which pertains to Class 7 (Radioactive) materials, as well as 10 CFR Part 71, which governs the packaging and transportation of radioactive material. Class A waste will be likely transported as Low Specific Activity (LSA) waste and will be packaged in Industrial Package Type IP-1. This may include robust containers such as 55-gallon drums or B-12/B-25 waste boxes. For the transportation of higher-activity Class B waste, Type A and Type B packages will be utilized. These packages have been rigorously tested to ensure they can withstand both normal transport conditions and hypothetical accident scenarios without compromising the integrity of their contents.

In accordance with 49 CFR 173.427(a)(1), the external radiation dose rate on a package of LSA waste must not exceed 1 rem/hr (10 mSv/hr) at a distance of 10 feet (3 meters) from the unshielded material within the package. Furthermore, the dose on contact with the package must not exceed 0.2 rem/hr (2 mSv/hr), unless the conveyance is designated for exclusive use, in which case the dose on contact may reach up to 1 rem/hr (10 mSv/hr), provided that the conditions specified in 49 CFR 173.441(b)(1) are met.

The LLRW generated at the facility will meet the conditions of 10 CFR 51.52(a)(4), and it is anticipated that the number of trucks transporting radioactive waste will be fewer than one per day. This rate also accounts for the shipment of spent nuclear fuel and is already discussed in Section 4.10.2.2. Given these considerations, the environmental impacts associated with the transportation of LLRW, both under routine conditions and in the event of potential accidents, are not expected to exceed the impacts delineated in Table S-4 of 10 CFR 51.52. Since the LLRW shipped will be in solid form and packaged according to DOT regulations, and because the frequency of radioactive waste shipments, along with the volumes and activities of the waste, remains within the bounds established in WASH-1238, the anticipated impacts from the transportation of LLRW are deemed to be SMALL.

#### *4.10.2.5 Transportation of Nonradioactive Materials and Hazardous Waste*

General office supplies and industrial supplies supporting the maintenance and day-to-day operations of the research facility will be transported to the site. Office waste is generated at the site and transported from the site to a local sanitary waste facility without being treated or packaged. These activities will be typical for a general commercial facility within the Urbana-Champaign, Illinois area. The associated incident-free transportation activities do not have an adverse impact on the environment, workers, or the members of the public. There will be no significant shipments of hazardous waste from the facility. As such, the transportation of nonradioactive materials, nonradioactive waste, and hazardous waste associated with the operation of the facility will be SMALL.

#### *4.10.2.6 Incident-Free Radiological Doses*

The ISG for NUREG-1537 requires that applicants assess the radiological impacts associated with incident-free transportation of radioactive materials. This assessment focuses on the radiological doses received by two primary groups: members of the public and workers involved in the transportation process, including transportation and handling personnel. Notably, the ISG does not request an analysis of radiological impacts resulting from transportation accidents.

The NRC has previously determined during its evaluations of early site permit and construction and operation permit for nuclear power facilities, that the radiological impacts from transportation accidents involving radioactive waste will be SMALL (Reference 7-170, Reference 7-171, Reference 7-172).

During incident-free transportation, radiological doses arise from exposure to the external radiation field surrounding the transportation vehicle. The population dose is influenced by several factors, including the number of individuals exposed, their proximity to transportation vehicle, the duration of their exposure, and the intensity of the radiation field surrounding the containers. Importantly, the specific radionuclide composition of the transported material does not affect the dose calculation. For long-distance transportation routes, average population densities tend to be similar, making the distance traveled the primary factor in determining the radiological dose from transportation.

This ER evaluated the dose impacts from incident free transportation for the following 3 transportation scenarios which are bounding for the research reactor project.

- New nuclear fuel shipped from
  - Richland, Washington to Champaign, Illinois
- LLRW shipped from
  - Champaign, Illinois to Andrews, Texas
  - Champaign, Illinois to Clive, Utah
- Spent nuclear fuel shipped from Champaign, Illinois to Idaho Falls, Idaho

The assessment of dose impacts from incident-free transportation of radioactive materials is based on the external dose rate of the conveyance and the distance of the shipment. The U. of I. shipments are modeled using NRC-RADTRAN GUI Version 1.1.0 Build 2 at the DOT dose rate limits for exclusive use shipments provided in 49 CFR 173.411(b)(3). Radiological impacts were evaluated for two crew members (truck drivers) and the general population that may encounter the transport vehicle along the route. The crew members receive dose during transportation as well as during stops for refueling and inspections. The general population includes individuals residing within 0.5 miles on the U. of I. side of the truck route (off-link), those sharing the road (on-link), and individuals present at inspection and refueling stops. Table 4-9 provides the input parameters used for the NRC-RADTRAN analyses. Vehicle density data was variable based on each route with information provided by Saricks and Tompkins, 1999.

Potential traffic interruptions could lead to a member of the public being exposed to a loaded radioactive material shipment for some period of time. To include the potential of traffic congestion, the WebTRAGIS routes account for travel through suburban and urban zones, leading to a lower average speed and higher traffic density. Additionally, the analysis will also consider an individual stuck in traffic, a member of the public sharing the route and encountering a potential traffic interruption.

The radioactive material shipments were assigned the maximum external dose rate of 10 millirem per hour (mrem/hr) (0.1 mSv/hr) at 6.5 feet (2 meters) from the outer lateral surfaces of the vehicle surface of the exclusive use vehicle [49 CFR 173.441(b)(3)]. The NRC-RADTRAN model equated this limit to a dose rate of 13 mrem/hr (0.13 mSv/hr) at 3.3 ft (1 meter). For new nuclear fuel, U. of I. assumed the dose rate to be 0.1 mrem/hr (0.001 mSv/hr) at 3.3 ft (1 meter) (Reference 7-175).

Table 4-10 provides the single shipment dose impact from these shipments. Route distances in Table 4-10 are approximated from the closest routes provided by the Web-Based Transportation Analysis Geographic Information System (WebTRAGIS). The person-rem dose rates for the shipments are presented in Table 4-10.

The incident-free risk associated with spent nuclear fuel shipments will similarly be bound by the same dose rate limit. It is anticipated that incident-free transportation of spent fuel to any future offsite storage site will be comparable to shipments planned for Idaho Falls, Idaho.

To calculate the collective dose, a unit risk factor for a single shipment (a per-shipment risk factor) between a given origin and destination was developed to estimate the impact of transporting one shipment of radioactive material over the shipment distances in various population density zones. Dose is a function of the distance and exposure time for both the driver and the exposed public.

Table 4-10 presents the per-shipment risk factors for the transport of new nuclear fuel, LLRW, and spent nuclear fuel. Radiological risks are expressed in terms of doses and Latent Cancer Fatalities (LCFs) per shipment for each route. The exposed population encompasses the off-link public (individuals living along the route) and the worker crew. LCF risk factors were calculated by multiplying the incident dose risks by a health risk conversion factor of 0.0006 LCF per rem or person-rem of exposure (Reference 7-176).

Table 4-11 present the per shipment dose for the transport of radioactive materials to the on-link public (pedestrians and vehicle occupants along the route), and the public presence at rest, fuel, and inspection stops. The maximally exposed individual is the individual/resident that will be exposed to all shipments passing along the route, located near the Licensed Area.

The total dose to transportation crews involved in transporting radioactive material to and from the facility during operations is estimated at 1.15 person-rem per year (11.5 person-mSv per year) (sum of crew doses in Table 4-10; assuming one of each route per year). For the general public, the dose due to the transportation of radioactive material to and from the facility during operations is estimated at 2.49 person-rem per year (24.9 person-mSv per year) (sum of populations doses in Table 4-10 and all dose Table 4-11 excluding the Maximally Exposed Individual; assuming one of each route per year). However, spent fuel shipments will occur only every three years. With a population of approximately 205,000 individuals in Champaign County and a natural background radiation dose of 0.31 rem per year (3.1 mSv per year) from natural sources, the population dose from natural background radiation is approximately 63,550 person-rem per year (635.5 person-Sv per year). In comparison to the background dose in the vicinity of the facility, the radiation exposure from incident-free transportation is considered SMALL.

#### *4.10.3 Impacts from Decommissioning*

At the conclusion of the reactor's licensed operational life, the research facility will initiate decommissioning and transportation of all spent fuel, equipment, material, and waste. Therefore, the transportation of spent fuel analyzed in Section 4.10.2 will be similar to transportation of spent nuclear fuel. During the decommissioning phase, all radioactive equipment and materials will be transported off site for disposal. The truck traffic associated with decommissioning will be small given the size of the research facility and is assumed to be approximately equivalent to the traffic defined in the construction phase. As such, the overall impact from the transportation of decommissioning waste will be SMALL.

**Table 4-9 NRC-RADTRAN Input Parameters**

| Input Parameter | NRC RADTRAN Input Value | References |
|---|---|---|
| 55-gallon Drum Packaging Height (ft) | 1.93 | Reference 7-177 |
| 55-gallon Drum Packaging Diameter (ft) | 2.90 | Reference 7-177 |
| Shipping Container Package Length (ft) | 40 | Reference 7-178 |
| Shipping Container Package Width (ft) | 8 | Reference 7-178 |
| Shipping Container Package Height (ft) | 8.6 | Reference 7-178 |
| Spent Fuel Canister Package Diameter (ft) | 2 | Reference 7-179 |
| Spent Fuel Canister Package Length (ft) | 15 | |
| Crew Distance to Package (ft) | 11.48 | Reference 7-180 |
| Dose Rate at 1 meter from New/Unirradiated fuel Package (mrem/hr) | 0.1 | - |
| Dose Rate at 1 meter from LLRW Package (mrem/hr) | 13 | - |
| Dose Rate at 1 meter from Spent Nuclear fuel Package (mrem/hr) | 13 | - |
| Number of Truck Crew | 2 | Reference 7-181 |
| Number of People in Adjacent Vehicles | 2 | Reference 7-181 |
| Shielding Factor | 1 | - |
| People at Stops (Break/Gas) | 25 | Reference 7-181 |
| Stop Distance, meters (ft) [Break/Gas] | 65.6 | Reference 7-181 |
| People at Stops (Inspection / Resident / Person in Traffic Obstruction) | 1 | Reference 7-173 |
| Stop Distance, meters (ft) [Inspection] | 9.8 | Reference 7-173 |
| Stop Distance, meters (ft) [Resident] | 98.4 | Reference 7-173 |
| Stop Distance, meters (ft) [Person in Traffic Obstruction] | 3.3 | Reference 7-173 |
| Stop Time, hr/stop (Break / Inspections / Person in Traffic) | 0.5 | Reference 7-173 |
| Stop Time, hr/stop (Gas) | 2 | Reference 7-173 |
| Stop Time, hr/stop (Resident) | 0.25 | - |

**Table 4-10 Crew and Nearby Resident Dose and Risk Factors per Shipment of Radioactive Materials**

| Origin | Material | Destination | Incident-free Radiation Dose Impacts per Shipment | | | | |
|---|---|---|---|---|---|---|---|
| | | | Approx. Distance (miles) | Crew Dose (person-rem) | Crew Risk (LCF) | Population Dose (person-rem) | Population Risk (LCF) |
| Richland, WA | Unirradiated (new) nuclear fuel | Champaign, Illinois | 1,896 | 6.22E-03 | 3.73E-06 | 3.96E-04 | 2.38E-07 |
| Champaign, Illinois | LLRW | Clive, Utah | 1,080 | 5.62E-01 | 3.37E-04 | 2.22E-02 | 1.33E-05 |
| Champaign, Illinois | LLRW | Andrews, Texas | 1,396 | 3.95E-01 | 2.37E-04 | 2.97E-02 | 1.78E-05 |
| Champaign, Illinois | Spent nuclear fuel | Idaho Falls, Idaho | 1,510 | 1.90E-01 | 1.14E-04 | 8.14E-03 | 4.88E-06 |

**Table 4-11 On-Link and En Route Dose per Shipment of Radioactive Materials**

| Origin | Material | Destination | Incident-free Radiation Dose Impacts per Shipment | | | | |
|---|---|---|---|---|---|---|---|
| | | | On-Link Dose (person-rem) | Rest Stop Dose (person-rem) | Gas Stop Dose (person-rem) | Inspection Stop Dose (rem) | Maximally Exposed Individual Dose (rem) |
| Richland, WA | Unirradiated (new) nuclear fuel | Champaign, Illinois | 1.75E-02 | 2.53E-03 | 2.33E-03 | 7.37E-04 | 2.11E-06 |
| Champaign, Illinois | LLRW | Clive, Utah | 5.45E-01 | 2.27E-01 | 2.02E-01 | 5.47E-02 | 2.74E-04 |
| Champaign, Illinois | LLRW | Andrews, Texas | 5.32E-01 | 1.52E-01 | 2.02E-01 | 5.47E-02 | 2.74E-04 |
| Champaign, Illinois | Spent nuclear fuel | Idaho Falls, Idaho | 2.25E-01 | 9.84E-02 | 7.87E-02 | 4.27E-02 | 1.07E-04 |

## 4.11 POSTULATED EVENTS

This section describes the postulated events that are within the design basis of the facility and a maximum hypothetical accident (MHA) that bounds the radiological consequences of the postulated events. A preliminary list of postulated initiating events and related assumptions for the U. of I. research reactor licensing basis are provided in this section.

### *4.11.1 Event Categories*

Credible event sequences have been identified and grouped using the accident categories provided in NUREG-1537. Given that the NUREG-1537 accident categories were created for light water reactor technologies, the list below provides NUREG-1537 accident categories and the corresponding event sequence category for the research reactor.

| **NUREG-1537 Accident Categories:** | **Research Reactor Event Sequence Categories:** |
|---|---|
| • MHA | • MHA |
| • Insertion of Excess Reactivity | • Insertion of Excess Reactivity |
| • Loss of Coolant | • Depressurized loss of forced cooling (D-LOFC) with air ingress |
| • Loss of Coolant Flow | • Pressurized loss of forced cooling (P-LOFC) |
| • Mishandling or Malfunction of Fuel | • Mishandling or Malfunction of Fuel |
| • Experiment Malfunction | • N/A (no in-core experiments) |
| • Loss of Normal Electrical Power | • Loss of Normal Electrical Power |
| • External Events | • Internal and External Hazards |
| • Mishandling or Malfunction of Equipment | • Mishandling or Malfunction of Equipment |

Acceptance criteria for figures of merit for these events represent design limits that ensure the MHA is bounding. Figures of merit are key quantitative metrics used to judge the severity of an accident scenario and whether safety requirements are being met. The MHA dose consequences are evaluated in PSAR Chapter 13.

### *4.11.2 Event Descriptions*

#### *4.11.2.1 Maximum Hypothetical Accident*

The MHA is a bounding event with conservative radionuclide transport assumptions that challenge the important radioactive retention features of the functional containment. The MHA is generally a high-temperature event where hypothesized conditions result in a release of radionuclides. The material at risk for release in the MHA includes radionuclides contained in the fuel and radioactive material distributed within the reactor coolant systems.

As described in PSAR Section 13.1, very conservative assumptions drive radionuclide movement and bound the system response to other postulated events. The MHA analysis provided in the PSAR suggests the dose of a maximally exposed person staying at the site boundary full time for 30 days will be below the 10 CFR 50.34(a)(1)(i) dose criteria of 1 rem (10 mSv). Thus, the impact of the MHA will be SMALL. The estimated dose resulting from the MHA is further described in PSAR Section 13.2.

#### *4.11.2.2 Insertion of Excess Reactivity*

The Insertion of Excess Reactivity events encompass several critical scenarios. First, there is the molten salt maximum flow (overcooling event), where the molten salt flow experiences an abrupt transition from normal parameters to a state characterized by minimum inlet temperature and maximum flow rate simultaneously. Additionally, a spurious withdrawal of a single control rod can occur, where a control rod of maximum worth is withdrawn from its current position at the limiting withdrawal speed.

#### *4.11.2.3 Loss of Coolant Events*

Design descriptions have been assessed to determine whether the breach of a piping system can result in anticipated operational occurrences or accident conditions. Generally, piping systems that contain reactor coolant and/or radioactive material, or breaches that could give rise to an internal hazard are retained for further analysis. Specific pipe break locations are identified for retained piping systems. For helium pressure boundary and molten salt system breaches, all breach locations are retained. For other systems, breach locations can be qualitatively screened out depending on sources of radioactivity and hazard consequences or effect on the reactor facility.

The impact of air ingress into the primary coolant loop must be evaluated for D-LOFC event sequences. Initiating event could include an un-isolated small breach in helium pressure boundary, a small Intermediate Heat Exchanger (IHX) leak, or a breach in largest connecting pipe to pressure boundary. A small IHX leak occurs when pressurized helium leaks into the salt side.

P-LOFC events could result from blockage of a helium coolant channel, blockage in helium flow in a single fuel element, loss of direct reactor cooling (loss of primary helium flow), molten salt flow stoppage, loss of secondary heat sink, or total loss of forced flow (i.e., total loss of primary and secondary flow).

#### *4.11.2.4 Mishandling of Fuel*

During refueling a mishandling of fuel event could occur during movement of irradiated fuel, resulting in inadvertently dropping a fuel element back onto the reactor core.

#### *4.11.2.5 Internal Hazards*

Generic internal hazards that have been evaluated include: internal fires, internal explosions, internal missiles and pipe breaches, internal flooding, heavy load drop, electromagnetic interference, and release of hazardous substances inside the reactor facility.

#### *4.11.2.6 External Hazard Events*

##### *4.11.2.6.1 Earthquakes*

PSAR Section 2.5 covers the geological conditions and risks to the research reactor. The overall conclusions for earthquakes are that significant earthquakes are not a natural phenomenon known to occur in the vicinity of the chosen site. No significant earthquakes have originated in Champaign County in recorded history. Most measurable earthquakes in Illinois occur in the southern part of the state or in adjacent seismic zones. Overall, the site is in a low-seismicity area, and earthquakes greater than about magnitude 3-4 are unlikely based on the available records, locally. The seismic hazard is controlled primarily by distant regional sources, chiefly the New Madrid and Wabash Valley zones, which can produce infrequent, low-to-moderate ground shaking at the site, which are essentially below the levels associated with damage, so the seismic effects expected at the site are low and are not likely to result in significant transient disturbances affecting the safety of the facility.

##### *4.11.2.6.2 Tornadoes*

Illinois is ranked high in terms of the number of tornados that occur throughout the state. Peak tornado frequency in Illinois is between April and June. The state averages 54 tornadoes per year based on 1991-2020 data. Notably, a record 142 tornadoes were documented in 2024 (Reference 7-31).

During the 75-year period of 1950-2025, 81 tornadoes were reported in Champaign County, of which 27 tornadoes were reported within 10 miles (16 km) of the project site with intensities ranging from F0/EF0 to F3/EF3 (Reference 7-32).

Based on the tornado strike probability presented in NUREG/CR-4461, *Tornado Climatology of the Contiguous United States*, the number of tornado events from 1950 through August 2003 within a 2-degree box surrounding the site is 384. This gives an annual average of seven tornado events striking somewhere within the 2-degree box. Based on the Tornado Risk Assessment provided by the National Oceanic and Atmospheric Administration, the number of tornado events from 1950 through 2019 within a 50-mile (80-km) radius (approximately the same area as the 2-degree box used in NUREG/CR-4461) of the Champaign zip code is 478. The annual average for tornado strikes for this area is also seven.

Regulatory Guide 1.76*, Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants*, lists the design-basis tornado parameters and the design-basis tornado-generated missile parameters required for a nuclear reactor in Illinois, which is located in Tornado Intensity Region I. Table 2.3-3 of the PSAR lists the maximum wind speed, translational speed, maximum rotational speed, radius of maximum rotational speed, pressure drop, and rate of pressure drop of a tornado that a Region I nuclear plant is required to withstand. Table 2.3-4 of the PSAR lists the maximum horizontal wind speeds that will turn a solid steel sphere 1 inch in diameter, an automobile weighing approximately 4,000 pounds (1,814 kilograms), and a schedule 40 pipe approximately 6.625 inches (16.8275 cm) in diameter and 15 feet (4.57 meters) long into tornado-generated missiles.

*4.11.2.6.3 Floods*

PSAR Section 2.4 covers the hydrology and flood risks to the research reactor site. The overall conclusion is that collectively, through Federal Emergency Management Agency (FEMA) mapping, historical hydrologic data, and relative topographic relief demonstrate that the research reactor is positioned above the flood elevations associated with both the 1 percent and 0.2 percent annual-chance events. Consequently, flooding from Boneyard Creek, the nearest surface water body, is not anticipated to pose a significant hazard to the proposed installation.

*4.11.2.6.4 Volcanism*

The chosen site is geologically stable and volcanic activity is not a credible threat to the reactor facility.

*4.11.2.6.5 Missile Impact*

Credible missile impact can result from objects transported by high winds or from tools or other equipment falling onto the reactor from above. While detailed structural analysis has not been completed yet on the research reactor building, the subgrade reactor design and heavy shielding above the reactor is anticipated to be more than sufficient to withstand any credible impact that might occur.

*4.11.2.6.6 Nearby Hazards*

PSAR Section 2.2 covers the risks associated with nearby hazards to the research reactor. Including airway and aircraft crash hazards, explosive hazards from nearby facilities and transportation routes including rail and truck, toxic analysis from chemical hazards, and flammability vapor clouds. PSAR Section 2.2 covers the hazards and lists the specific scenarios that exceed the risks criteria that require consideration in the design of the facility.

## 4.12 ENVIRONMENTAL JUSTICE

This section describes the potential impacts to environmental justice communities from construction, operation and decommissioning of the facility.

### *4.12.1 Minority and Low-Income Populations*

According to the Council on Environmental Quality (CEQ), adverse health effects evaluated within the context of environmental justice impacts may include bodily impairment, infirmity, illness, or death. Environmental effects may include ecological, cultural, human health, economic, or social impacts. Disproportionately high and adverse environmental effects occur when the risk or rate of exposure to an environmental hazard or an impact or risk of an impact on the natural or physical environment for a minority or low-income population is high and appreciably exceeds the impact level for the general population or for another appropriate comparison group (Reference 7-182).

In accordance with Section 19.4.12 of the ISG for NUREG-1537, and consistent with the NRC's Policy Statement (69 Federal Register 52040), affected populations are defined as minority and low-income populations who reside within a 5-mile (8-km) radius of the proposed facility site. As discussed in Section 3.7, no minority or low-income populations were identified within a 5-mile (8-km) radius.

Furthermore, Section 4.8 evaluated the impacts of the proposed project on human health and the environment. It was determined that activities associated with the construction, operations and decommissioning of the proposed project will be SMALL to the general population.

Therefore, there will be no disproportionate effects to environmental justice communities in association with the research reactor project, and human health and environmental impacts on minority and low-income populations will be SMALL.

### 4.13 CUMULATIVE EFFECTS

This section contains a summary of potential cumulative environmental impacts associated with construction, operation, and decommissioning activities for the site in combination with other past, present, and reasonably foreseeable actions or projects in the area. The term *cumulative impact,* which was previously defined in the regulations of the CEQ implementing National Environmental Protection Act (NEPA), has been repealed. However, in the revised 2020 NEPA regulations, the definition of *effects* or *impacts* (40 CFR 1508.1(g)) includes evaluation of collective actions, and is defined as follows:

> "Effects or impacts means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives."

For the purposes of this evaluation, reasonably foreseeable actions are projects that are clearly indicated in an available long-term master plan or comparable document and/or have received funding and/or have applied for a permit associated with construction or operation. Per NUREG-1537, this section includes "related and non-related federal and non-Federal actions that could contribute to cumulative impacts, such as:

- Information about current or planned local economic development programs or projects (e.g., commercial, industrial, and/or residential); and
- Information about current or planned infrastructure improvements (e.g., transportation, electric and water utility)."

A summary of past, present, and reasonably foreseeable projects that could have a cumulative effect within the geographic area of interest are limited to those associated with the U. of I. The campus is highly developed, with its core infrastructure strategically designed to support academic, administrative, residential, and recreational facilities. The area surrounding the campus is largely residential, thereby limiting the off-campus industrial development. In accordance with the U. of I. Master Plan (Reference 7-5), U. of I. projects include renovation and expansion of research facilities, reinforcing the campus access and connectivity, and renovation and expansion of student-centered facilities.

The resources assessed include land use and visual resources; air quality and noise; geologic environment; water resources (hydrology, water use, water quality); ecological resources (terrestrial and aquatic communities); historic and cultural resources; socioeconomics; human health; waste management; and environmental justice. According to CEQ's Considering Cumulative Effects Under NEPA, the establishment of an appropriate geographic area of analysis is an important step in performing the cumulative effects analysis. The analysis of cumulative environmental impacts is resource specific. The geographic area of analysis of the considered past, present, and reasonably foreseeable actions from the site are the same as those used for each resource discussed above and are based on the environmental effects that may occur to each of the affected resources under consideration. An appropriate context of analysis was selected for each of the resources described below.

### *4.13.1 Land Use and Visual Resources*

The description of the affected environment in Section 3.1 serves as a baseline for the land use and visual resources cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on land use and visual resources is the same as that used in Section 4.1 and includes 1.01 acres (0.41 hectares) within the Licensed Area boundary and the 5-mile (8-km) region surrounding the site. Recent past, present, and reasonably foreseeable future actions within the geographic extent of analysis that can be assessed to determine cumulative effects on land use and visual resources. Relevant actions that are considered in this cumulative effects analysis are limited to proposed and/or in progress developments which could alter current land use status and the visual character of the area.

#### *4.13.1.1 Land Use Resources*

The Licensed Area consists of a 1.01-acre (0.41 hectare) area located on the U. of I. campus in Champaign County. As discussed in Section 4.1.1, impacts to land use as a result of the construction, operation, and decommissioning of the research reactor will be MODERATE, solely due to the proximity of the project to the nearest full-time and part-time residents (0.5 miles or less).

Other U. of I. construction projects could also occur within 0.5 miles of the nearest full-time and part-time residents or other sensitive areas therefore causing MODERATE impacts to land use. While the size of the research reactor construction project is relatively small given their place in such a highly developed area, cumulative impacts from the research reactor project and other U. of I. construction projects would likely not impact the same nearby receptors. Regardless, the incremental contribution to cumulative impacts from the proposed project could be MODERATE.

#### *4.13.1.2 Visual Resources*

Similar to land use, impacts to visual resources will occur due to the proposed or in-progress construction projects noted above. The majority of these projects will not be visible from the site. However, this site is (and was) already highly developed with respect to visual resources; therefore, cumulative impacts will be minor.

If proposed campus improvements were to be constructed at the same time as the U. of I. research reactor, visual impacts could occur due to multiple construction sites in the same vicinity with very large equipment. These impacts will be temporary, however, and will cease once construction is complete. Overall, due to the already developed appearance of the vicinity, cumulative impacts to visual resources will be SMALL and the incremental contribution to cumulative impacts from proposed project will also be SMALL.

### *4.13.2 Air Quality and Noise*

#### *4.13.2.1 Air Quality*

The description of the affected environment in Section 3.2 serves as a baseline for the air quality cumulative impact assessment. As described in Section 4.2.1.1, air emission impacts from construction will be MODERATE. While emissions will be controlled at the source where practicable and maintained within established regulatory limits designed to minimize impacts, the research reactor project site will be less than 0.5 miles (0.8 km) from the nearest resident. Other U. of I. construction projects could also be within 0.5 miles (0.8 km) of the same receptor and cumulative impacts from the proposed project and other projects will also be MODERATE. As discussed in Section 4.2.1.2, operation of the research reactor facility will also have a SMALL impact on air quality.

Although the global cumulative impacts from GHGs continue to rise and could be considered LARGE, given the relatively low emissions from the research reactor facility construction and operation, in comparison to total global emissions, the incremental contribution of the research reactor project to global cumulative impacts will be SMALL.

#### *4.13.2.2 Noise*

The description of the affected environment in Section 3.2.6 serves as a baseline for the noise cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects from noise emissions includes the 1.01 acres (0.41 hectare) within the Licensed Area boundary and the 1-mile (1.6 km) area surrounding the site. Noise impacts resulting from construction and operation of the facility are discussed in Section 4.2.1.1 and Section 4.2.2.2 and are SMALL.

Recent past, present, and reasonably foreseeable future actions within the geographic extent of analysis that can be assessed to determine cumulative effects on noise. Relevant "other actions" that are considered in this cumulative effects analysis are limited to facilities and projects within one mile of the site.

During the construction periods for the site and the potential and in-progress facilities above, additional impacts to noise are expected in the immediate area around each site, if construction happens at the same time. Noise levels from construction equipment are expected to attenuate rapidly with distance. Noise levels are also impacted by increases in traffic volume during both construction and operation; however, they are not expected to be significantly higher than current traffic levels. External noise emission from the facility and other potential and in-progress facilities operation are primarily limited by the walls and other physical barriers of the facilities themselves.

Therefore, cumulative impacts to noise in the region are SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### *4.13.3 Geologic Environment*

The description of the affected environment in Section 3.3 serves as a baseline for the geologic environment cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on geologic resources is the same as that used in Section 4.3 and includes the 1.01 acres

(0.41 hectare) within the Licensed Area boundary and the 5-mile (8 km) region surrounding the site. As discussed in Section 4.3, construction and operation impacts from the site on the geologic environment are SMALL.

Other potential projects in the vicinity of the site will result in impacts to the same geologic resources as those affected by the facility. However, there are no sensitive geologic resources in the region surrounding the site. Additionally, as noted in Section 3.3, the probability of regional-scale impacts due to geologic factors will be low. Impacts from those projects identified within five miles are expected to be localized and minor. As discussed in Section 4.3.2, impacts to soils from the facility will be SMALL as minimal amounts of grading and excavation will occur. Additionally, fill material will be stockpiled and used on-site. Due to the sizes of the acreages of the proposed and in-progress facilities within five miles, it is likely that these same measures will occur at these other facilities for cost reduction purposes. Therefore, cumulative impacts to geological resources will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### *4.13.4 Water Resources*

The description of the affected environment in Section 3.4 serves as a baseline for the water resources cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on water resources is the same as that used in Section 4.4 and includes the 1.01 acres (0.41 hectare) within the Licensed Area boundary and the 5-mile region surrounding the site. As discussed in Section 4.4.1, construction impacts to water resources are SMALL. Impacts from operation of the facility are discussed in Section 4.4.2 and will be SMALL.

Potential cumulative impacts are discussed in the sections below.

#### *4.13.4.1 Hydrology*

There are no surface water resources located on the site; therefore, there are no direct impacts as a result of alteration of streams or water bodies. BMPs will also be used in accordance with IDEP and federal rules to prevent sediment runoff and subsequent siltation in receiving streams during construction. During operations, potential impacts associated with hydrology are also related to stormwater management.

All construction projects will be regulated by IDEP as part of the National Pollutant Discharge Elimination System (NPDES) permit program which will reduce potential impacts to surface water due to stormwater runoff in general. Due to the minimal impacts to hydrology presented by each potential project in the vicinity of the site, cumulative hydrologic impacts will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.4.2 Water Use*

As discussed in Section 4.4.2, impacts to surface water and groundwater use due to the site during construction, operation, and decommissioning will be SMALL.

The proposed and in-progress projects and facilities which could contribute to cumulative impacts to water use will also have relatively small impacts to water and wastewater systems during construction and operation. Due to these relatively small and the present operating capacities of the water systems, cumulative impacts from water use will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.4.3 Water Quality*

As stated in Section 3.4.3.1, there are no affected surface water bodies near the project site and there are no sources of surface water on the site. Additionally, water use is expected to come from municipal or U. of I. water services and not from groundwater, resulting in a SMALL impact to water quality. Some future projects may include construction nearer to Boneyard Creek which could have an impact on water quality. Therefore, due to the lack of groundwater use, the multiple municipal water systems, and NPDES regulations, cumulative impacts to water quality will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### *4.13.5 Ecological Resources*

The description of the affected environment in Section 3.5 serves as a baseline for the ecological resources cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on ecological resources is the same as that used in Section 4.5 and includes the 1.01 acre (0.41 hectare) within the Licensed Area boundary and the 5-mile (8-km) region surrounding the site. As discussed in Section 4.5.1, impacts from construction on terrestrial and aquatic ecosystems, including protected species, are SMALL. Section 4.5.2 demonstrates that the potential impacts from operation of the facility on terrestrial and aquatic ecosystems, including protected species, will be SMALL.

Relevant other actions that should be considered in this cumulative effects analysis with respect to terrestrial ecological resources were not identified, as the operational, proposed, or in-progress projects are located on similar habitats to the facility (previously developed with industrial structures, heavily disturbed, or artificially vegetated herbaceous habitats). The smaller projects in the vicinity are also on already developed or disturbed land. Therefore, cumulative impacts to terrestrial ecological resources will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

Additionally, because of the implementation of BMPs onsite during construction at the various proposed and in-progress facilities, cumulative impacts to aquatic resources will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### *4.13.6 Historical and Cultural Resources*

The description of the affected environment in Section 3.6 serves as a baseline for the historical and cultural resources cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on historical and cultural resources is the same as that used in Section 4.1 and Section 4.6 and includes the 1.01 acres (0.41 hectare) within the Licensed Area boundary and the 5-mile (8-km) region surrounding the site. As discussed in Section 4.6.1, impacts from construction and operation of the facility will be SMALL.

Relevant other actions to considered in this cumulative effects analysis were not identified, as the U. of I. Master Plan (Reference 7-5) reinforces the campus framework with maintaining the historical integrity of the campus.

Additionally, no historic properties will be impacted by the site, therefore, no additional cumulative impacts to historic and cultural resources will occur. Consequently, potential cumulative impacts of the site will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### *4.13.7 Socioeconomic Environment*

The description of the affected environment in Section 3.7 serves as a baseline for the socioeconomic cumulative impact assessment. The geographic area of analysis for evaluation of cumulative effects on socioeconomic resources is the same as that used in Section 4.7 and includes the 1.01 acres (0.41 hectare) within the Licensed Area boundary and Champaign County. As discussed in Section 4.7.1, impacts from construction and operation of the facility have a SMALL impact on socioeconomic conditions. Impacts to transportation in the ROI associated with the development of the site are discussed in Section 4.7.2 and will be SMALL.

Relevant actions are considered in this cumulative effects analysis.

#### *4.13.7.1 Population*

As described in Section 4.7.1.1, impacts to population due to the construction and operation of the facility will be SMALL. Potential cumulative impacts to population could occur if the multiple proposed and planned construction project will occur at the same time. This could cause a sudden influx of construction workers. Additionally, the multiple business and industrial parks could sell more parcels and cause a need for additional construction workers. During operations of the multiple proposed facilities and potential new facilities at the business and industrial parks, additional persons may move into the area due to an abundance of well-paying jobs. However, this situation is unlikely, and due to the minor impacts to population from the construction and operation of the facility, cumulative impacts will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.2 Housing*

The current housing available in the ROI is discussed in Section 3.7.2.2, and the impacts are discussed in Section 4.7.1.2, and are considered SMALL. Potential cumulative impacts to housing could occur if the multiple proposed construction projects are in-progress at the same time, causing a high housing demand. Additionally, if the multiple projects cause an abundance of well-paying jobs during operations, an influx of persons could occur, raising housing demand. Neither of these situations is likely to occur, and present, proposed, and future housing developments will be able to construct housing for additional population in the ROI. Additionally, there is ample workforce available in the ROI and jobs will likely go to people already living in the ROI prior to any influx. Therefore, due to the ample housing available, the multiple residential developments in progress and planned, and lack of a significant influx of workers to the area, cumulative impacts to housing will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.3 Public Services*

Public services currently in the ROI are discussed in Section 3.7.5 and include public water supplies and wastewater treatment systems. Impacts to public services are discussed in Section 4.7.1.3 and are estimated to be SMALL due to the construction and operation of the facility. As discussed in Section 4.13.4, cumulative impacts to water resources (including both water use and wastewater generation) are expected to be SMALL. As a large influx of population is not likely, and due to the current situation where water availability is far larger than water use, cumulative impacts to public services will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.4 Public Education*

Public education is described in Section 3.7.5.1 and includes local schools. Section 4.7.1.4 discusses impacts to public education in the ROI and estimates that the impacts due to the construction and operation of the facility will be SMALL. One proposed project in the ROI concerns the consolidation of five public high schools in Roane County. This will cause impacts to public education in Roane County only, and will constitute a beneficial impact, modernizing buildings and obtaining new technology for the students. The other proposed and planned projects within the ROI will not significantly impact public education due to a lack of immigration of families to the area. Therefore, due to a lack of significant influx to the area due to the facility and the other planned facilities, the amount of spaces for school children in the public education system, cumulative impacts to public education will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.5 Tax Base*

Section 3.7.4 describes the tax payment situation in the ROI, including sales tax and property tax. As discussed in Section 4.7.1.5, tax revenue impacts due to the construction and operation of the facility will be SMALL and beneficial. The other proposed and planned projects will also result in tax revenue impacts likely also be beneficial. Due to the similarities in taxes associated with all of the facilities being completed on-campus changes due to the other projects will likely be similar. As discussed in Section 4.7.1.9, the overall tax revenue from the site is positive, and relatively small in comparison to the established tax bases. Therefore, in combination with the other projects, cumulative effects to the tax bases will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.6 Transportation*

As described in Section 4.7.2, no modifications to the local traffic infrastructure are necessary as a result of construction-related traffic at the site and no mitigation measures will be required. If other concurrent projects were to cause impacts, it is expected that these projects will have mitigation measures to reduce them. Therefore, cumulative effects to transportation infrastructure and traffic patterns will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.7 Public Recreational Facilities*

Public Recreational Facilities within the ROI are described in Section 3.7.5.2. As stated in Section 4.7.3, impacts due to the construction and operation of the facility are expected to be SMALL. The majority of other proposed projects in the ROI will be similar to the facility with respect to traffic and visual impairments, as they are also located within the campus. Noise and indirect impacts to traffic patterns are possible at all proposed and in-progress project sites, therefore, cumulative impacts to public recreational facilities will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.7.8 Summary of Socioeconomic Cumulative Impacts*

In summary, cumulative impacts from other actions on aspects of socioeconomics, including water/wastewater systems, population growth, local tax base, the labor force, transportation, public education, and recreational facilities will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

### ***4.13.8 Human Health***

The geographic area of analysis for evaluation of cumulative effects on human health is the same as that used in Section 4.8 and includes the 1.01 acres (0.41 hectare) within the Licensed Area and the 5-mile (8-km) region surrounding the site. As discussed in Section 4.8.1 and Section 4.8.2, impacts from operation of the facility will have a SMALL impact on human health.

Recent past, present, and reasonably foreseeable future actions within the geographic extent of analysis are assessed to determine cumulative effects on human health.

#### *4.13.8.1 Nonradiological Impacts*

Construction of any facility includes potential hazards to workers typical of any construction site. Normal construction safety practices will be employed to promote worker safety and reduce the likelihood of worker injury during construction. Therefore, because controls are in place to limit injuries and illnesses and occupational impacts rarely reach beyond the construction site, cumulative occupational hazards from construction will be SMALL.

Potential nonradiological public health hazards pertaining to the construction and operation of facilities the 5-mile region surrounding the site are associated with routine emissions and discharges as well as accidental spills/releases.

To minimize potential exposure to the public, control systems are in place to limit emissions in accordance with federal, state, and local requirements. These controls include conveyance of wastewater to appropriate approved wastewater treatment facilities, discharges to Waters of the United States in accordance with NPDES permits, implementation of Spill Prevention Control and Countermeasure Plans, and air emission controls. The incremental contribution to cumulative impacts to human health from the proposed project will be SMALL.

*4.13.8.2 Radiological Impacts*

As described in Section 4.8.2, the radiological impacts from construction and operation of the research reactor will be SMALL.

None of the past, present, and future projects and actions involve operations that will have radiological impacts with no contribution to the cumulative impacts.

### *4.13.9 Waste Management*

All regional construction, operation, and decommissioning projects will have an impact on cumulative waste management and the region of influence is dependent on the type of waste and the available disposal locations. Due to its relatively small size and operating staff, the contribution of the research reactor project on the local (multi-county) nonradioactive and nonhazardous C&D waste and general sanitary waste (i.e., "garbage") management resources and disposal capacity will be SMALL and the percentage of the contributed when considering other current and proposed projects will also be SMALL. With respect to hazardous waste, construction, operation, and decommissioning of the research reactor will have a negligible effect on the cumulative impact on regional (multi-state) hazardous waste management and disposal resources from regional projects. For radioactive waste generated during operation and decommission, such disposals are only available at a few existing facilities that are located well outside the local region. Given the volumes of LLRW received at these facilities from industries such as the nuclear power industry (94 operating commercial reactors in 2025), medical industry, research and development, the operation and future decommissioning of a single non-power reactor will not contribute significantly to LLRW management and disposal resources. Therefore, the cumulative impact of the proposed project on all waste management resources will be SMALL.

### *4.13.10 Transportation*

Section 4.10 describes the radiological impacts of incident-free transportation assuming all shipments of radioactive materials and waste to and from the U. of I. research reactor facility are by truck. Shipments include irradiated (spent) fuel, unirradiated fuel, and radioactive waste. Probable transportation routes were bound by shipping radioactive waste more than 1,600 miles (2,574 km) to Texas or Utah and shipping spent fuel approximately 1,500 miles (2,414 km) to Idaho Falls, Idaho. An estimated six shipments of new fuel to the facility and spent fuel shipments will occur every three years. Approximately three shipments of LLRW will occur each year to Texas or Utah. After final reactor shutdown, the final fuel shipments will occur following an interim cool-down period. As shown in Section 4.10, impacts from incident-free transportation associated with the transport of fuel and waste for the proposed project will be SMALL.

This cumulative analysis considers radiological impacts from incident-free transportation associated with the transportation of fuel and waste for the proposed project along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts within the geographic area of interest. The geographic area of interest for radiological impacts of transportation is nationwide. Like the shipments associated with the research reactor site, the impacts from each individual shipment will be minimal and, when combined with the impacts associated with the site, the total impact will also be minimal. While the region will have a significant number of radioactive material and radioactive waste shipments when compared to other regions of the country, the dose impact from each shipment is very small when compared to natural background radiation. Therefore, the cumulative radiological impacts of incident-free transportation of unirradiated fuel, along with irradiated fuel and radioactive waste will be SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.11 Environmental Justice*

The geographic area of analysis for evaluation of cumulative effects on environmental justice includes the 1.01 acre within the Licensed Area boundary and the 5-mile region surrounding the site. No environmental justice communities have been identified within area analyzed; therefore, disproportionate impacts on low-income or minority populations from other actions are not expected. Disturbance to nearby residents related to temporary and minor traffic, air quality and noise impacts during construction, operations and decommissioning will affect the general population and are not expected to disproportionately other populations.

No present or on-going actions were identified that are relevant to this analysis. Thus, the cumulative impacts on environmental justice are SMALL and the incremental contribution to cumulative impacts from the proposed project will also be SMALL.

#### *4.13.12 Conclusion*

Table 4-12 summarizes the cumulative impacts in all resource areas. In conclusion, there are no significant cumulative adverse environmental impacts from the construction and operation of the site when considered together with other past, present, and reasonably foreseeable future projects in the area.

**Table 4-12 Cumulative Impacts on Environmental Resources, Including the Impacts of the Proposed Project**

| Resource Category | Level of Cumulative Impacts |
|---|---|
| **Land Use and Visual Resources** | |
| Land Use | MODERATE |
| Visual Resources | SMALL |
| **Air Quality and Noise** | |
| Air Quality | MODERATE |
| Noise | SMALL |
| **Geologic Environment** | SMALL |
| **Water Resources** | |
| Hydrology | SMALL |
| Water Use | SMALL |
| Water Quality | SMALL |
| **Ecological Resources** | |
| Terrestrial Ecosystems | SMALL |
| Aquatic Ecosystems | SMALL |
| **Historic and Cultural Resources** | SMALL |
| **Socioeconomics** | SMALL |
| **Human Health** | |
| Nonradiological Health | SMALL |
| Radiological Health | SMALL |
| **Transportation** | SMALL |
| **Environmental Justice** | SMALL |

# CHAPTER 5 ALTERNATIVES

The proposed federal action involves issuing a Construction Permit (CP) for the University of Illinois (U. of I.) research reactor facility, which will house a KRONOS™ Micro Modular Reactor (MMR) developed by Nano Nuclear Energy Inc. The primary purpose of this research reactor facility is to provide educational opportunities on and public awareness of advanced nuclear reactor technologies and to demonstrate commercial readiness of the critical technologies, design features, and safety functions of this High Temperature Gas-cooled Reactor (HTGR). Additionally, the U. of I. research reactor aims to provide data that will validate safety analysis tools and computational methodologies essential for future design and licensing efforts.

U. of I. has identified three main missions for the research reactor facility: education, research, and at-scale demonstration (Reference 7-183). A key objective of this initiative is to explore how advanced nuclear reactors can be integrated with existing power generation and distribution systems. By placing the reactor on campus, U. of I. intends to leverage the diverse expertise and innovative spirit found across various scientific and technological disciplines within the university.

This initiative is structured around two core missions, education and research, alongside a cross-cutting mission of practical demonstration. These elements are vital to realizing the vision of a Class 104(c) facility as defined in the Atomic Energy Act of 1954, as amended. Through this integrated approach, the U. of I. research reactor facility is positioned to significantly advance nuclear technology and its application in modern energy systems.

The decision to locate the research reactor at the Urbana-Champaign campus is well-founded based on several key factors: power-source integration, nuclear engineering capabilities, site environment, research synergy, and public engagement aligned with safety requirements. The U. of I. system comprises three distinct campuses - Urbana-Champaign, Chicago, and Springfield. Among these, Urbana-Champaign uniquely stands out for its robust research, engineering, and agriculture programs, and its longstanding history in nuclear engineering. The campus previously hosted a TRIGA reactor for nearly four decades, providing institutional knowledge and experience that are critical for successful planning and operation of a new research reactor.

A primary focus of the research reactor project is its integration with the Abbott Power Plant, to study the advantages and challenges of combining microreactor processes with existing power generation and distribution technologies. The Urbana-Champaign campus uniquely provides a university-owned generation facility that supports controlled, non-exporting operations appropriate for the research nature of this project. By contrast, the Springfield campus relies on the local utility grid - City Water, Light and Power (CWLP) - which complicates the ability to conduct experiments that require isolation from public grid influences. The Chicago campus, equipped with Combined Heat and Power (CHP) plants, is primarily designed to serve building loads for critical facilities (hospital and medical facilities) and general campus energy needs rather than facilitate research-oriented integration.

Urbana-Champaign is home to the University's flagship Nuclear, Plasma, and Radiological Engineering (NPRE) program with deep faculty expertise and dedicated laboratories. The Springfield and Chicago campuses do not host a nuclear engineering department or equivalent capabilities, which significantly diminishes their capacity to support the reactor's research and educational mission. While relocating the nuclear engineering faculty and students to either the Chicago or Springfield campuses is technically possible, a comprehensive cost analysis was not performed; however, such a move would likely involve significant expenses. These include costs associated with establishing specialized infrastructure to support nuclear research, relocating faculty and students, and addressing potential disruptions to ongoing research and academic programs. Although the Springfield campus may offer lower living and operational costs in general and the Chicago campus may be more central geographically and therefore easily accessible, these factors do not offset the mission-critical benefits of co-locating the reactor with NPRE and the Abbott Power Plant.

The existing infrastructure at Urbana-Champaign can be leveraged to support the research reactor without incurring substantial capital expenditures. This existing framework enables seamless integration with existing infrastructure academic programs, research activities, and reactor monitoring, ensuring that faculty, staff, and students can engage with the facility continuously. The proximity of the reactor to the Abbott Power Plant further enhances this synergy, allowing for collaborative research that would not be feasible at alternative campus locations. Access would be carefully managed to meet safety and security standards, building on the campus's established safety culture and experience with radiological work.

Compared to the Chicago and Springfield campuses, the Urbana-Champaign campus provides a more controlled environment for public engagement that aligns with the reactor's safety, security and educational objectives. The campus is large enough to attract visitors and policymakers, yet it maintains a defined security perimeter that facilitates safe and meaningful interactions with the community. Public engagement opportunities can be carefully curated to ensure compliance with safety protocols while fostering outreach initiatives that benefit both the university and the surrounding community.

The Urbana-Champaign campus presents the preferred case for hosting the research reactor. Its unique integration with the Abbott Power Plant, established nuclear engineering capabilities, existing infrastructure, and strategic advantages for public engagement collectively position it as the optimal choice for advancing nuclear energy research and fulfilling the project's mission effectively and efficiently. In contrast, the Springfield campus offers limited integration potential, lacks a nuclear engineering program, and would require significant investment in new infrastructure. The Chicago campus, while centrally located, faces urban constraints that complicate research operations and public engagement. Therefore, the Urbana-Champaign campus stands out as the ideal location for this initiative.

## 5.1 NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the U.S. Nuclear Regulatory Commission (NRC) would not issue the CP for the U. of I. research reactor facility. As a result, the facility would neither be constructed nor operated. In accordance with the guidance outlined in the Final Interim Staff Guidance (ISG) augmenting NUREG-1537, Chapter 19, the environmental consequences of the No-Action Alternative are assumed to maintain the status quo.

If the U. of I. research reactor is not constructed and operated, the adverse environmental impacts discussed in Chapter 4 would be avoided. However, as detailed in Chapter 4, the anticipated adverse effects associated with the construction and operation of the research reactor are generally classified as SMALL. The only potential for MODERATE adverse impacts pertains to land use and air quality during the construction phase, primarily due to the proximity of the nearest residence. MODERATE impacts are defined as those that could noticeably alter, but not destabilize, important attributes of a resource. Consequently, the benefit of avoiding these impacts is not considered significant.

As emphasized in Section 1.1, the construction and operation of the research reactor represent a critical opportunity to demonstrate key HTGR technologies, design features, and safety functions at a scale comparable to a commercial power reactor. Additionally, the research facility would generate validation data to support the development of safety analysis tools and computational methodologies essential for the design and licensing of HTGR commercial power reactors.

Under the No-Action Alternative, the U. of I. would rely on computer-based simulations to model the operation of a microreactor for educational purposes, such as training the next generation of nuclear engineers and reactor operators. While simulations are valuable for theoretical learning, this approach would fail to achieve two key objectives of the project (Reference 7-184):

- Demonstrating Microreactor Feasibility in Urban Areas: Proving that a microreactor can be sited with public support, constructed, and safely operated within a relatively populated urban area, such as a university campus. Simulations cannot replicate the real-world challenges of licensing, construction, and public engagement necessary to build confidence in microreactor technology.
- Integrating Microreactors with Existing Non-Nuclear Facilities: Establishing that a microreactor can be co-located with an existing non-nuclear facility, thereby offering additional community benefits beyond research and education, such as energy production and utilization. Virtual models cannot replicate the engineering interfaces, operational synergies, and regulatory approvals required for physical integration. The co-location of nuclear and non-nuclear infrastructure is a critical aspect of many advanced reactor technologies that have been studied extensively but have yet to be demonstrated in the United States.

Under the No-Action Alternative, the programmatic benefits associated with the construction and operation of the research reactor would not be realized. These benefits include generating empirical data, training a hands-on workforce, and advancing the deployment of innovative nuclear technologies. Such outcomes are essential for addressing critical challenges like decarbonization, enhancing energy reliability, and integrating advanced reactor systems into existing infrastructure.

By proceeding with the research reactor at Urbana-Champaign, U. of I. ensures these programmatic benefits are achieved while positioning itself as a leader in nuclear research and demonstrating the feasibility of microreactor technologies in real-world applications. This initiative not only supports U. of I. educational and research mission but also reinforces the United States strategic leadership in advancing next-generation nuclear technologies to address global energy and environmental challenges.

## 5.2 REASONABLE ALTERNATIVES

This section outlines the development of the proposed primary site and examines potential alternatives to the proposed project, in accordance with Section 19.5 of the Final ISG augmenting NUREG-1537. Following the provided guidance, this section includes the following components:

- A comprehensive description of the process used to develop, identify, and evaluate reasonable alternatives.
- An overview of the reasonable alternatives that were considered.
- An identification of the alternatives that were dismissed from further evaluation.
- An assessment of whether the alternatives could mitigate or reduce adverse effects.

The ISG indicates that reasonable alternatives may include, but are not limited to, alternative sites, alternative siting within a proposed site, modifications of existing facilities, alternative technologies, and/or alternative transportation methods. Since the proposed project involves the demonstration of new technology, alternative technologies are not considered relevant, and modifying an existing facility to accommodate the proposed research reactor is not a feasible option.

Regarding alternative transportation methods, the specific location of the proposed site within the U. of I. campus limits transportation options primarily to vehicle transport using the existing road network. Although alternative routes, vehicle types, carpooling arrangements for workers, and other transportation-related features could be considered as mitigation measures, they do not require a comprehensive analysis as alternatives. Additionally, the proposed project has been strategically located near the Abbott Power Plant to minimize potential impacts. Among the evaluated sites, the primary site is situated to the east of the Abbott Power Plant, identified as the preferred location for its optimal integration and reduced impact. The alternative site, located to the north of the Abbott Power Plant, was assessed but deemed less suitable which is described in Section 5.2.2. Therefore, there are no other viable locations within the vicinity that would effectively reduce or avoid adverse effects as effectively as the preferred site.

Since none of these potential alternative types are feasible or would mitigate adverse effects, this section focuses solely on identifying and analyzing potential alternative locations. This approach aligns with the ISG guidance, which stipulates that if new construction is proposed, at least one alternative location should be included. Furthermore, the level of analysis for the alternative site(s) in this section corresponds to the context, degree, and intensity of the potential impacts, as articulated in the ISG documents.

### *5.2.1 Alternative Sites*

U. of I. is submitting a CP Application for a non-power research reactor to be located on its campus in Champaign, Illinois. A key part of developing the CP Application involves selecting a site that provides an appropriate geographic setting for the facility, as well as identifying potential alternative locations that could meet U. of I.'s objectives and significantly reduce environmental impacts. This section describes the bases, assumptions, and processes used to identify candidate sites for detailed analysis, along with the selection of the proposed site and potential alternatives.

The objective of the siting process is to identify a location that aligns with U. of I.'s project goals, meets the site suitability requirements set by the NRC, and complies with the NRC's implementation guidance for National Environmental Policy Act (NEPA) analysis requirements for non-power reactors, particularly regarding the consideration of alternative sites. The U. of I. research reactor will facilitate essential educational and research activities, including the study of how advanced nuclear reactors can be integrated with existing power generation infrastructure. As a public, non-profit, land-grant university, U. of I. is dedicated to advancing technologies that benefit the common good through research and education. To support this mission, U. of I. will adopt a research-based approach to operating the reactor and integrating it with the existing Abbott Power Plant.

The process used by U. of I. to identify and evaluate alternative research reactor sites began with the consideration of three key documents: the Electric Power Research Institute (EPRI) Siting Guide (Reference 7-185), ANSI/ANS-15.7 (Reference 7-186), and a Feasibility Study (Reference 7-187). It is important to note that the EPRI Siting Guide does not specifically apply to research reactors, while ANSI/ANS-15.7 provides very high-level guidance focused more on associated boundaries than onsite evaluation (ANSI/ANS-15.7 was withdrawn shortly after it was reaffirmed in 1986 but still provides valuable guidance). In the absence of specific guidance for identifying and evaluating alternative non-power reactor sites, U. of I. has utilized the process outlined in the EPRI Siting Guide. This process involves defining the region of interest (ROI), identifying candidate areas, pinpointing potential sites within those areas, evaluating and scoring candidate sites, and determining which candidate site(s) will be included in the analysis of alternatives.

Three categorical factors were particularly important to U. of I. during the site evaluation process, as summarized in Table 5-1. To support its role as a demonstration and research platform, the objectives for site selection include:

- Ensuring easy access for U. of I. Nuclear Engineering faculty, staff, students, and the public to fulfill teaching, research, and outreach missions.
- Selecting a site that is, or can be, supported by sufficient high-quality site data for licensing and design.
- Choosing a site that can be integrated into an existing power generation and distribution network for electricity and steam, demonstrating the feasibility of integration with current technologies.

### *5.2.2 Identification of Reasonable Alternatives*

The screening criteria and project requirements established in previous evaluations identified the State of Illinois as the appropriate location for a research reactor to be owned and operated by the U. of I. system. As a state-funded institution, it is logical to locate the reactor on one of U. of I.'s three campuses. Among these, the Urbana-Champaign campus was selected as the most suitable choice due to its alignment with project goals and its status as the home of the NPRE program.

The ROI was defined with a central focus on the Abbott Power Plant, which supports the primary objective of the project: demonstrating the integration of a nuclear facility with a non-nuclear facility. Within a 5-mile radius of the Abbott Power Plant, four candidate sites were identified: the Primary Site, North Site, South Site, and South Farm Site. Table 5-2 provides descriptions of these sites, while Figure 5-1 illustrates their locations relative to the Abbott Power Plant.

The Primary Site is located within 0.1 mile (0.16 km) of the Abbott Power Plant, allowing for efficient steam delivery. It is approximately 1.2 miles (1.9 km) from the Bardeen Quadrangle and 0.7 miles (1.12 km) from Boneyard Creek. The area is relatively open, as shown in Figure 5-2, and will require site preparation that includes demolishing a university parking lot and relocating utilities, backup power generators, and some vegetation. No buildings need to be decommissioned, making this site readily available for the project.

The North Site, shown in Figure 5-3, is located within 0.1 mile (0.16 km) north of the Abbott Power Plant and 1.2 miles (1.9 km) from the Bardeen Quadrangle. **The site** raises safety concerns due to its proximity to an active railway and adjacent private homes. Portions of the site are developed, necessitating the demolition of existing buildings. Site preparation would involve removing a parking lot and relocating utilities, and the availability of this site for the research reactor facility is uncertain due to competing interests from the Abbott Power Plant.

The **South Site** is located within 0.1 mile (0.16 km) south of the Abbott Power Plant and 1.3 miles (2.1 km) from the Bardeen Quadrangle. It also faces safety concerns related to the nearby railway. As shown in Figure 5-4, the site includes a parking lot adjacent to the Abbott Power Plant's Coal Crushing building. The parking lot is also adjacent to and used by the U. of I.'s Disability Resources and Educational Services building. Site development would be like the Primary Site.

The **South Farm Site** is about 2.1 miles (3.3 km) from the Abbott Power Plant, located approximately 1,400 feet (426 meters) east of South 1st Street on the south side of East Windsor Road and an unnamed gravel road. Due to its distance from the power plant, it does not meet the project goal of being situated in a populated urban area. A new 2-mile (3.2 km) pipeline would be necessary for steam delivery. The site is approximately 2.6 miles (4.2 km) from the Bardeen Quadrangle and lacks public transportation access. It is characterized as an undeveloped pasture as shown in Figure 5-5 and would require significant infrastructure and utility installations. The Embarras River is located 900 to 950 feet (274 to 289 meters) south of East Windsor Road.

Each site presents unique characteristics and challenges, as summarized in Table 5-3. The Primary Site offers proximity to the Abbott Power Plant and minimal preparation needs. While the North Site and South Site are also very close to the Abbott Power Plant, development at these sites would involve demolishing existing structures and addressing potential safety concerns from the adjacent railway. The South Farm Site is distant from the Abbott Power Plant and presents logistical and environmental issues due to its current undeveloped state. Collectively, these descriptions highlight the Primary Site as the most favorable option for the project.

## 5.3 COST-EFFECTIVENESS OF THE ALTERNATIVES

The objectives of the siting process are to identify a location that aligns with the U. of I. financial and mission objectives for the project, satisfies the site suitability requirements recommended in the EPRI Siting Guide (2022), and complies with the NRC implementation guidance for NEPA analysis requirements for research reactors, particularly regarding the consideration of alternative sites. The evaluation of potential sites for the research reactor and the rationale for selecting the primary site are detailed in *Preliminary Evaluation of Alternative Sites for the U. of I. Micro-Modular Reactor* (Reference 7-184). The categorical factors of importance are outlined in Table 5-1, with proximity to the Abbott Power Plant identified as the dominant requirement to meet the project's objectives.

The challenges associated with the North and South Sites, as highlighted in Table 5-3, include their proximity to the railway which may require protective barriers or hardened structures to be built at additional cost. Similarly, the South Farm site would incur additional costs due to the need to install a long steam pipeline. Based on the categorical factors of importance, including cost considerations, the Primary Site, located east of the Abbott Power Plant, emerges as the most cost-effective option for the project.

## 5.4 COMPARISON OF THE POTENTIAL ENVIRONMENTAL IMPACTS

All candidate sites, including the Primary Site and the alternative sites, are located within the 5-mile ROI. Therefore, the environmental impacts from the following factors are expected to be similar across all sites:

- Geology/Seismology
- Air and Groundwater Radionuclide Pathways
- Meteorological and Extreme Weather
- Air Quality
- Socioeconomic Impacts

The environmental impact associated with reactor construction, operations, and decommissioning activities is expected to be similar for the Primary, North, and South Sites. However, the Primary Site offers several advantages, including a greater distance from the railway and minimal land-use change, as the area is generally unused. Additionally, pre-existing geotechnical and seismic data indicate favorable ground conditions for the Primary Site, supporting its suitability for the project.

In contrast, the South Farm Site has the highest ecological and infrastructure footprint. It faces challenges due to the need for a lengthy steam pipeline and its proximity to the Embarras River represents an external hazard concerns, such as increased flood risks. Furthermore, the site's closeness to agricultural areas introduces potential pathways for radionuclide ingestion through food, as emphasized by EPRI guidance recommending sites with minimal agricultural activity.

**Table 5-1 Categorical Factors of Importance**

| Proximity | Environment | Site Preparation |
|---|---|---|
| Distance between each proposed site and the Abbott Power Plant | Potential for food ingestion pathway (adjacent crops and pasture operations) | Financial |
| Distance between each proposed site and the Bardeen Quadrangle | Availability of information for the Environmental Review | Mission |
| Distance between each proposed site and the nearest full-time resident | Constructions, Operations, and Decommissioning | Availability of information for the Environmental Review |
| Distance between each proposed site and surface-water bodies | | Constructions, Operations, and Decommissioning |
| Distance between each proposed site and railroads, city streets and county roads | | |

**Table 5-2 Primary Site and Alternative Sites Descriptions**

| Site Name | Location | Distance from Abbott Power Plant (mile) |
|---|---|---|
| Primary Site (A) | East of the Abbott Power Plant | 0.1 |
| North Site (B) | North of the Abbott Power Plant | 0.1 |
| South Site (C) | South of the Abbott Power Plant, Disability Resources and Education Services building | 0.1 |
| South Farm Site (D) | South corner of East Windsor Road and an unnamed campus gravel road | 2.1 |

**Table 5-3 Key Features and Challenges**

| Site Name | Key Features | Challenges |
|---|---|---|
| Primary Site (A) | Adjacent to Abbott Power Plant; open area; minimal preparation required | Parking lot demolition; utility and backup power generator relocation |
| North Site (B) | Adjacent to Abbott Power; partially developed | Utilization of existing Abbott Power Plant laydown areas; railway safety concerns; adjacent to residential properties |
| South Site (C) | Adjacent to Abbott Power Plant; includes existing infrastructure | Utilization of Disability Resources and Educational Services building and Abbott Power Plant parking lots; railway safety concerns; complex utility adjustments |
| South Farm Site (D) | Remote; undeveloped pasture; adjacent to Embarras River | High pipeline cost; efficiency losses; environmental risks; diminished alignment with the research reactor mission |

**Figure 5-1 Primary and Alternative Sites**

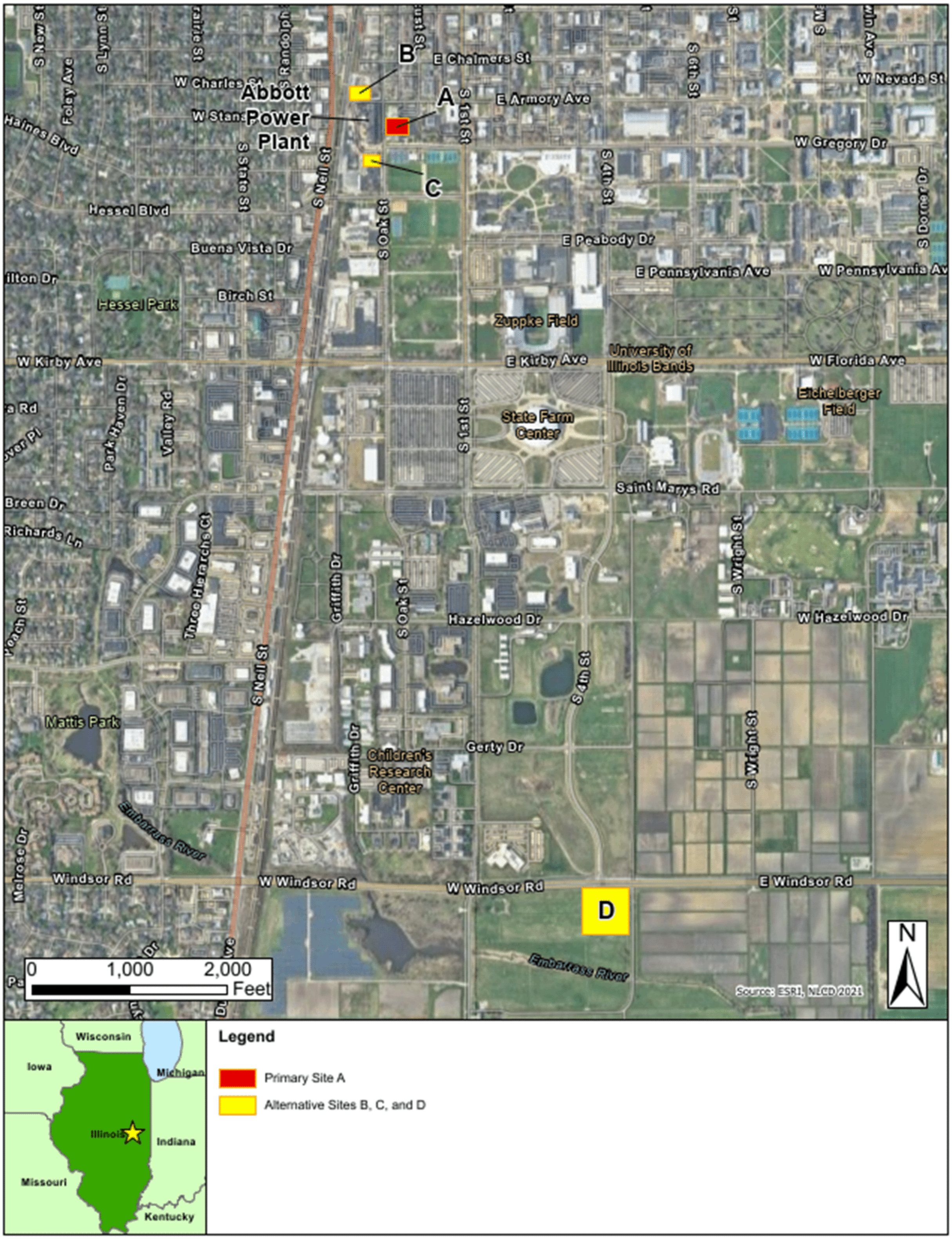


**Figure 5-2 Primary Site**

**Figure 5-3 North Site**

**Figure 5-4 South Site**


**Figure 5-5 South Farm Site**

# CHAPTER 6 CONCLUSIONS

## 6.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

This section summarizes unavoidable adverse environmental impacts of construction and operation of the University of Illinois (U. of. I.) research reactor.

### *6.1.1 Unavoidable Adverse Environmental Impacts of Construction*

Construction activities will lead to temporary “short-term” use of environmental resources. The term “short-term” refers to the duration of these construction activities. Since the construction of the U. of I. research reactor will involve construction of buildings and installing components and equipment occupying only approximately 1 acre of the U. of. I. campus, the environmental impacts are minimal. Most impacts discussed in Chapter 4 are classified as SMALL, meaning they are either undetectable or insignificant compared to the availability of the affected resources. Additionally, no construction-related activities will result in disproportionately high and adverse environmental or health effects on minority or low-income populations.

However, it is important to note that the site is located less than 0.5 mile (0.8 km) from the nearest full-time and part-time residents, as well as other sensitive areas. Due to this proximity impacts on land use and air quality, as identified in Draft NUREG-2249, would be MODERATE. MODERATE impacts are sufficient to noticeably alter important attributes of the resources, but they do not destabilize them.

The unavoidable adverse impacts from the construction of the U. of I. research reactor facility include:

- Impacts to land areas currently used for employee parking and transportation, including the closure of South Oak Street.
- Varying, minor amounts of dust, air emissions, noise, and vibration associated with the use of construction equipment and travel of the construction workforce to and from the project site.
- Minor unavoidable water use impacts; abundant water is available in both the county and university municipal systems.
- Minor impacts on social services and traffic patterns due to the potential influx of a small temporary construction workforce.
- Minor impacts to the capacity of waste disposal facilities managing construction waste.

### *6.1.2 Unavoidable Adverse Environmental Impacts of Operations*

Impacts due to the operation of the U. of I. research reactor facility are discussed in detail in Chapter 4. Operations-related impacts are SMALL because they either are not detectable or are minor compared to the availability or status of the affected resource. Operation of the U. of I. research reactor has no negative effect on land use, ecological resources, or historic and cultural resources. No operations or decommissioning-related activities result in disproportionately high and adverse environmental or health effects on minority or low-income populations.

Unavoidable adverse impacts from operation of the U. of I. research reactor facility include:

- Increased noise and potential increases in air emissions from the facility and increased vehicle traffic from the U. of I. research reactor facility workforce.
- Minor impacts to water supply and sanitary treatment systems; university and municipal water suppliers have ample capacity to provide the balance of water required for the facility.
- Potential small impacts to social services because of the anticipated small increase in the U. of I. research reactor facility operations staff. There may be a small, positive, socioeconomic impact from increased local expenditures by the operations staff and from visiting faculty members using the facility.
- Potential impacts to the general public and operations workforce from radiation sources and airborne radioactive effluents; however. Additionally, there are potential impacts because of exposure to physical, electrical, and chemical hazards at the facility.
- Potential impacts to the capacity of waste disposal facilities managing low-level radioactive waste.

## 6.2 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

This Environmental Review focuses on the analyses and resulting conclusions associated with the environmental impacts from activities during the construction, operation, and decommissioning U. of I. research reactor. For the purposes of this section, these activities are classified as short-term uses. The long-term implications are considered to begin once the proposed facility decommissioning is completed at the site. This section also evaluates how these short-term uses may limit options for any future long-term use of the site.

Section 6.1.1 summarizes the potential unavoidable adverse environmental impacts of construction. Some small adverse environmental impacts can remain after all practical measures to avoid or mitigate them are taken; however, none of these impacts represent long-term effects that preclude any options for future use of the site.

Similarly, Section 6.1.2 summarizes the unavoidable adverse environmental impacts of facility operations. Some small adverse environmental impacts can remain after all practical measures to avoid or mitigate them are taken; however, none of these impacts represent long-term effects that preclude any options for future use of the site.

During operation, exposure to and management of radioactive and hazardous materials and waste are unavoidable; however, adherence to exposure and dose limits established by regulatory agencies and implementation of a robust health and safety program for the facility can limit impacts to workers and the general public to well below regulatory limits. Exposure to radioactive materials during transportation is also unavoidable; however, the dose impacts to the exposed populations are only a small fraction of background dose.

Operation of the facility has a comparable impact on all populations in the region around the site. No disproportionate impacts are expected to either minority or low-income populations as such populations are not identified within the region around the site. Therefore, there are no long-term negative effects to environmental justice that preclude any options for future use of the site.

In summary, the impacts resulting from the facility construction, operation, and decommissioning result in both adverse and beneficial short-term impacts. The principal short-term adverse impacts are mostly SMALL with MODERATE residual impacts to land use and air quality due to the facility's proximity to residential and sensitive populations. As defined in Chapter 4, MODERATE impacts are potentially noticeable, but do not destabilize the environmental resource. However, there are no significant long-term impacts to the environment. The principal short-term benefits are the creation of additional jobs, additional tax revenues, and knowledge gains from the research conducted at the U. of I. research reactor. The principal long-term benefits are the knowledge and skills acquired by a new generation of scientists and engineers and operators from work at the U. of I. research reactor and advancements in understanding high-temperature gas-cooled micro reactor technology. The short-term impacts and benefits and long-term benefits do not affect long-term productive use of the site.

## 6.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

This section describes the anticipated irreversible and irretrievable commitments of environmental resources used in the construction, operation, and decommissioning of the facility. The term "irreversible commitments of resources" describes environmental resources that are potentially changed by the new facility construction or operation and that cannot be restored at some later time to the resource's state prior to construction or operation. Irretrievable commitments of resources are materials used for the proposed facility in such a way that they cannot, by practical means, be recycled or restored for other uses.

Irreversible environmental resource commitments resulting from the new facility include:

- Short-term degradation of air and water resources, and
- Commitment of land for disposal of wastes, including hazardous and low-level radioactive waste.

The proposed facility requires water from local municipalities and the U. of I. for construction, potable water, fire protection, and facility heating and cooling. U. of I. provides water supply for both public drinking and fire protection through treatment of surface water. Because there is sufficient capacity within the U. of I. and municipal water supply systems, there will be no indirect effects associated with the demand from the facility. There will be no direct impacts to water quality or hydrology from the facility; therefore, there are no irreversible impacts.

Construction and decommissioning activities create dust and other emissions, such as vehicle exhaust. During operations, emissions are a product of vehicle exhaust, ventilation system exhaust, and radioactive effluents, resulting in very low levels of gaseous pollutants and particulates released from the facility into the air. Emissions during operations will follow applicable federal and state regulations, minimizing their impact on public health and the environment. Therefore, no irreversible impacts on air quality are anticipated.

Irretrievable commitments of resources during new plant construction will be like that of any small-scale facility construction project on the U. of I. campus. These materials are irretrievable unless they are recycled at decommissioning. Use of construction materials in the quantities associated with the facility will have a SMALL impact with respect to the commitment of such resources.

During operation, the main resource that is irretrievably committed is nuclear fuel. Based on today's fuel cycle and supply chain in the United States, spent nuclear fuel is not recycled. Materials used in the construction of the reactor, spent fuel canisters, and other waste containers containing metals and concrete activated as result of reactor operations also are irretrievable and will be disposed of as radioactive waste.

While the given quantity of material consumed during facility construction, operation, and decommissioning at the site is irretrievable, the impact on material availability will be SMALL as the quantity of required materials is relatively small. Furthermore, the reasonably stable supply and common nature of materials required for U. of I. research reactor facility construction and operation suggests that these materials will continue to be available for the foreseeable future in response to demand.

# CHAPTER 7 REFERENCES

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