



# Fermilab

2018 campus master plan



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# Planning Context

## Director's statement

The Fermilab Campus Master Plan presents a vision for how to centralize, consolidate and modernize the facilities of a laboratory hosting a world-leading, accelerator-based neutrino program. The plan's implementation will position Fermilab as one of the top research destinations of choice for present and future generations of particle physicists.

Fermilab will be a place where researchers and staff easily connect, work collaboratively and exchange ideas in their quest to lead, inspire and enable scientists from all over the world. Just as we look to our strategic laboratory plan to direct the laboratory's scientific program, we look to the Campus Master Plan for providing a place to make the scientific program possible.

*~ Nigel Lockyer, Fermilab director*

## Foreword

What are we made of? How did the universe begin? What secrets do the smallest, most elemental particles of matter hold, and how can they help us understand the intricacies of space and time? Since 1967, Fermilab has worked to answer these and other fundamental questions to enhance our understanding of everything we see around us.

However, much has changed in the world of basic science research since 1967. The system of national laboratories, made up of the places where answers are researched, is undergoing a transition. The postwar laboratory model, expressed in scattered, dark and narrow bunker-like places, is giving way to open and transparent international centers for generating and sharing knowledge.

Responding to these changes, the Fermilab Campus Master Plan presents a transformative plan to create an open, inviting and collaborative international

research community for 21st-century science. Charting a path for the transition, it establishes the framework and the key elements of the Fermilab campus, reflecting a vision for future development. It synthesizes the collective goals and aspirations for the laboratory, giving them form and organization, and defines a realistic plan for implementation.

The plan is organized in three parts. Part I, Planning Context, introduces the laboratory and provides baseline planning information campus history and geography, along with strategic goals and guiding principles to guide and inform future plans. Part II, Emerging Priorities, presents campus-wide initiatives to organize and design the campus for future development. Part III, Development Plan, describes development projects culminating in an international research community, with the scientific tools and supporting infrastructure to enable the next generation of world-leading research.



## The Laboratory

Fermilab, the only U.S. national laboratory dedicated totally to particle physics, was founded in 1967. The 1,700 employees and 2,000 scientific users advance humankind's understanding of matter, energy, space and time by carrying out a world-leading program of discovery. The backbone that supports this mission is Fermilab's core capabilities in accelerator science and technology; advanced computer science, visualization and data; particle physics; and large-scale user facilities.

The laboratory is managed by the Fermi Research Alliance LLC, an organization made up of the University of Chicago and a consortium of 87 other universities. All laboratory buildings are owned by the U.S. Department of Energy.

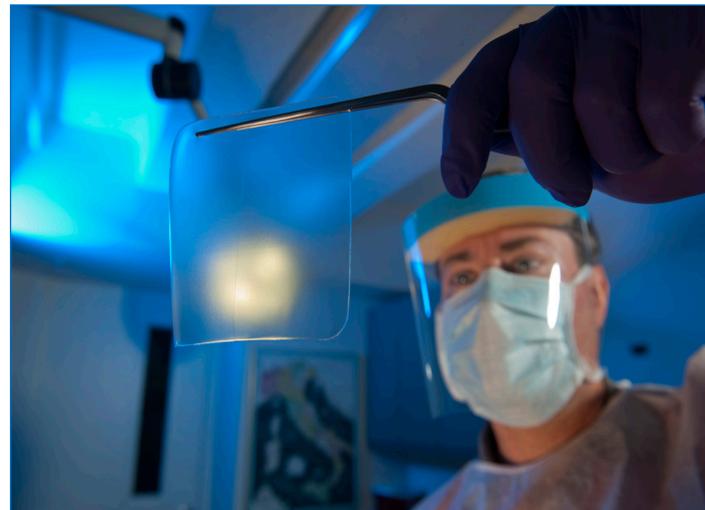
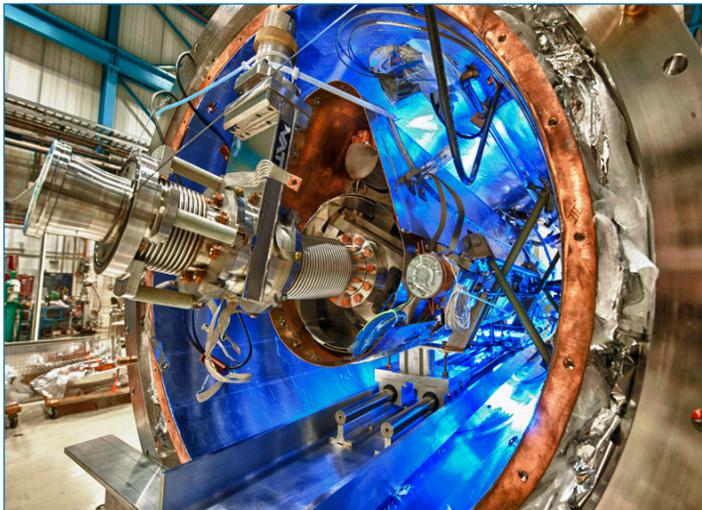
Fermilab is home to one of the largest accelerator facilities in the world, including a powerful accelerator complex, test accelerators and infrastructure for the development of accelerator technologies. The laboratory's accelerator complex produces the world's most powerful high-energy beam of neutrinos, mysterious subatomic particles studied by scientists around the globe. It also provides intense beams that allow scientists to study ultrarare processes in nature. Its staff and users build, operate and lead experiments to investigate dark matter, dark energy and ultrahigh-energy cosmic rays. Additionally, Fermilab is a U.S. hub for research at the Large Hadron Collider and for R&D for the next generation of particle accelerators and detectors for use in science and society.



## Distinct Character

Fermilab is a multifaceted place with a distinct character and culture, creating a fertile environment complementing and enhancing its research mission. Delineating what people like most about Fermilab, the following narratives and photos describe the character and culture that create a place more than the sum of the parts.

**Science and Technology:** At the forefront of particle physics for five decades, Fermilab builds world-leading accelerators and detectors to conduct some of the most advanced particle physics experiments possible, then collects and analyzes the data from those experiments with some of the most powerful computers in the world. The laboratory's accelerator complex produces the world's most powerful high-energy beam of neutrinos, mysterious subatomic particles studied by scientists around the globe. It also provides intense beams that allow scientists to study ultrarare processes in nature. Its staff and users build, operate and lead experiments to investigate dark matter, dark energy and ultrahigh-energy cosmic rays.



**International Community and Worldwide Reach:** The people of Fermilab form an international community of scientists, engineers and support staff. Intellectual curiosity is energized by sharing a zeal for discovery and by working collaboratively and cooperatively on common goals. Fermilab is a U.S. hub for research at the Large Hadron Collider and for R&D for the next generation of particle accelerators and detectors for use in science and society. As an international center for particle physics research, Fermilab's scientists work with thousands of physicists around the world to conduct experiments probing the nature of matter, energy, space and time.

**People and Diversity:** As an organization, Fermilab is committed to attracting, developing and retaining diverse talent and cultivating an inclusive work environment that supports scientific, technological and operational excellence. Laboratory efforts to cultivate a diverse and inclusive labwide workforce include recruitment strategies, pipeline education programs, community outreach and collaboration efforts. Initiatives and programs aim to increase the recruitment and retention of underrepresented racial minorities, other people of color, women, veterans and individuals with disabilities in the lab's education, employment and outreach platforms



**Safety:** As the United States premier particle physics laboratory, Fermilab is committed to supporting its research and operations by protecting the health and safety of our staff, the community and the environment.

To meet this objective and fully support the laboratory's scientific mission, scientists, technicians and visitors work closely with environment, safety, health and quality professionals and subject matter experts from a variety of disciplines to plan, build and achieve successful experiments. Through this spirit of collaboration we have been able to create a truly integrated, world-class health and safety program that ensures excellence and continuous improvement now and into the future.



**STEM and Education:** Fermilab is committed to developing a science, technology, engineering and mathematics, or STEM, workforce and stimulating science literacy. Laboratory programs serve students at all levels, from prekindergarten to graduate school.

The Fermilab Education Office supports programming for educators, families, young people and the public. Our programs provide avenues for technical staff to engage these audiences with Fermilab's science and technology. Themes include scientific discovery, practical applications, and scientific and engineering practices. Because the next-generation STEM workforce is in school today, educator programs must strengthen teaching and learning in science, technology, engineering and mathematics. Our programs are a catalyst for change and a resource to schools and districts nationwide.



**Sustainability and Environment:** The laboratory is committed to using natural resources sustainably, striving for energy efficiency, using renewable energy sources and designing buildings to minimize waste. This commitment includes integrating sustainable design into its buildings and practices.

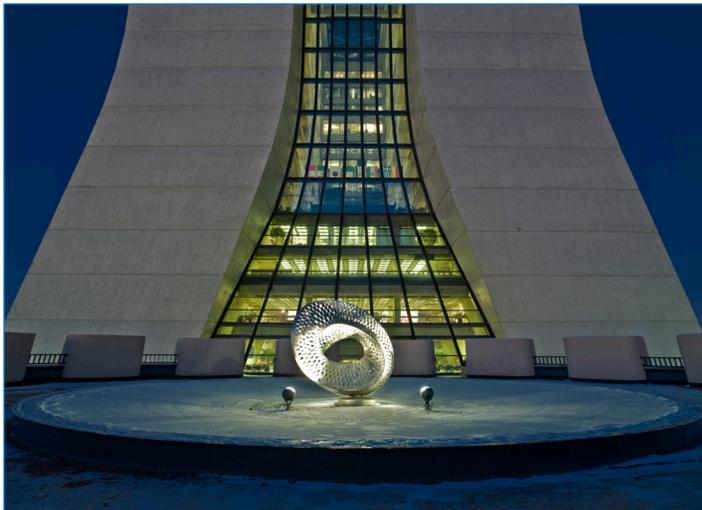
Sustainable design comprises numerous interrelated approaches. The varied approaches combine to form a complete systematic path to sustainability. Planning efforts aim beyond just building design, encompassing all aspects of building and siting and development and operations. The laboratory implements renewable-energy methods where possible; works to improve the energy efficiency of existing buildings; recycles waste and uses products that are durable, less toxic and easily recycled; restores and conserves our land and its diverse species.



**By the Numbers:** The Fermilab Campus occupies 6,800 acres of former farmland 42 miles west of Chicago in Batavia, Illinois. Purchased by the state of Illinois and turned over to the Atomic Energy Commission (a precursor to the Department of Energy), the site includes hundreds of buildings totaling about 2.4 million gross square feet of space. The laboratory includes 122 acres of parking lots. Utilities on the site include two primary electrical substations, 241 secondary electrical substations, 27 miles of underground industrial cooling water, and 14 miles of underground sanitary piping. Also on site are the Central Utility Building. All totaled, hundreds of miles of utility infrastructure, including roads, electrical, natural gas, industrial cooling water, potable water and sanitary systems spread across the 6,800 acres.



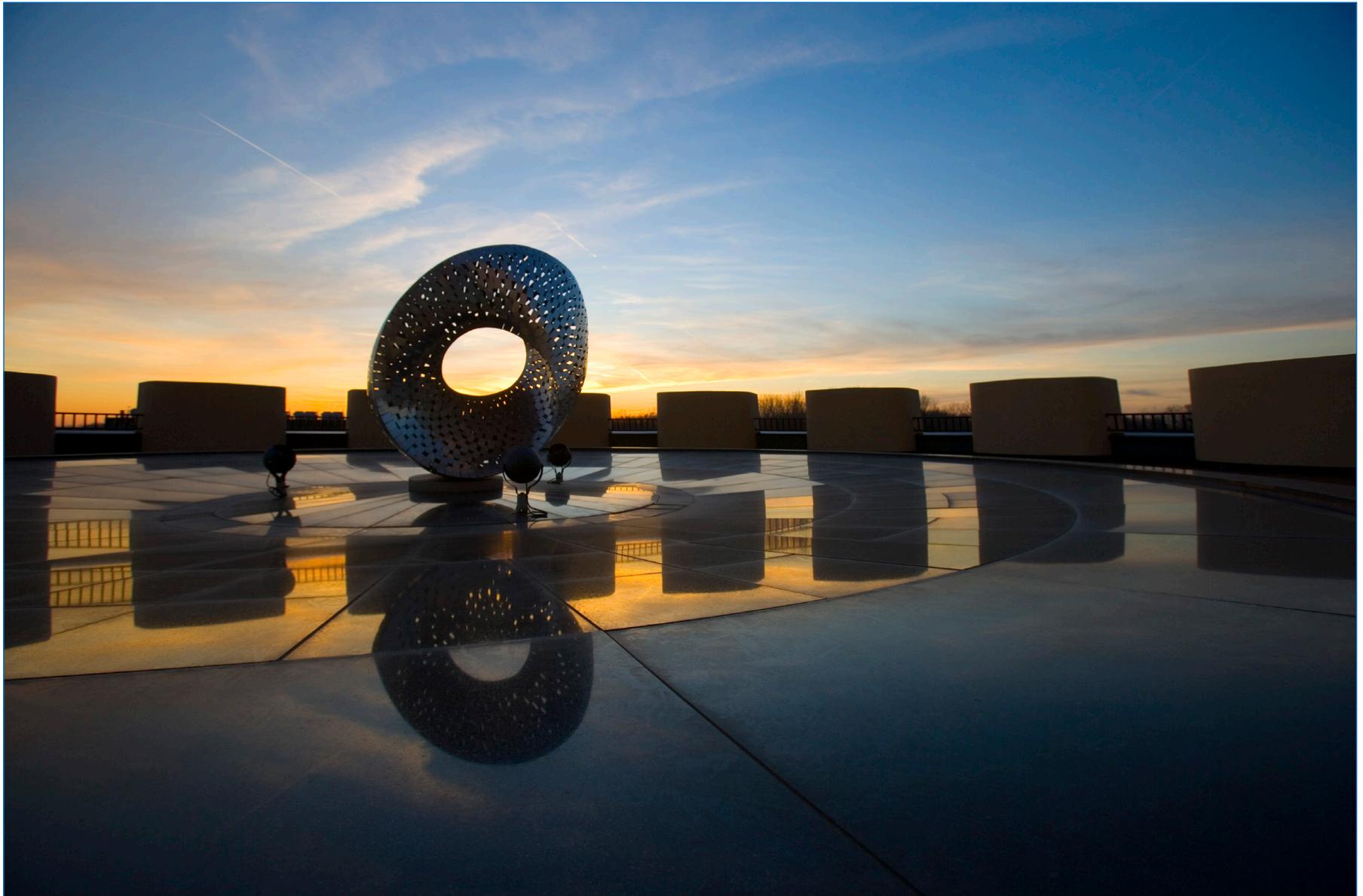
**Buildings and Sculpture:** Founder Robert R. Wilson hoped to create “a Utopian place where scientists could gather from around the world.” He strove to create a campus blending its natural environment with architectural grandeur and cultural splendor. Dr. Wilson helped design the centerpiece of the site, the stately 16-story Robert Rathbun Wilson Hall, inspired by a Gothic cathedral in Beauvais, France. The building serves as a central meeting place, housing the laboratory’s cafeteria and the campus’s largest concentration of offices. Adjoining Wilson Hall to the south is the 830-seat Norman F. Ramsey Auditorium, which hosts numerous talks and cultural events. Wilson also influenced the unique design and character of several other founding-era buildings and structures on campus and created several of the site’s iconic sculptures.



**Natural Setting:** Fermilab’s built environment is complemented by a biologically diverse natural environment. The campus includes over 2,500 acres of natural areas, containing rich and diverse ecosystems such as tallgrass prairie, oak woodland, sedge meadow and floodplain forest. These habitats are important for rare plants and many kinds of wildlife, including upwards of 300 species of birds, numerous uncommon butterflies, dragonflies and other insects, thriving populations of amphibians and reptiles, and mammals such as coyote and mink. The laboratory is committed to the beauty and ecological integrity of these places.

Visitors to the site enjoy hiking, fishing, bird watching, bicycling, cross-country skiing and photography. In 1989, Fermilab was designated a National Environmental Research Park, one of seven in the United States.





# Campus Geography

## 1. Fermilab Location Map

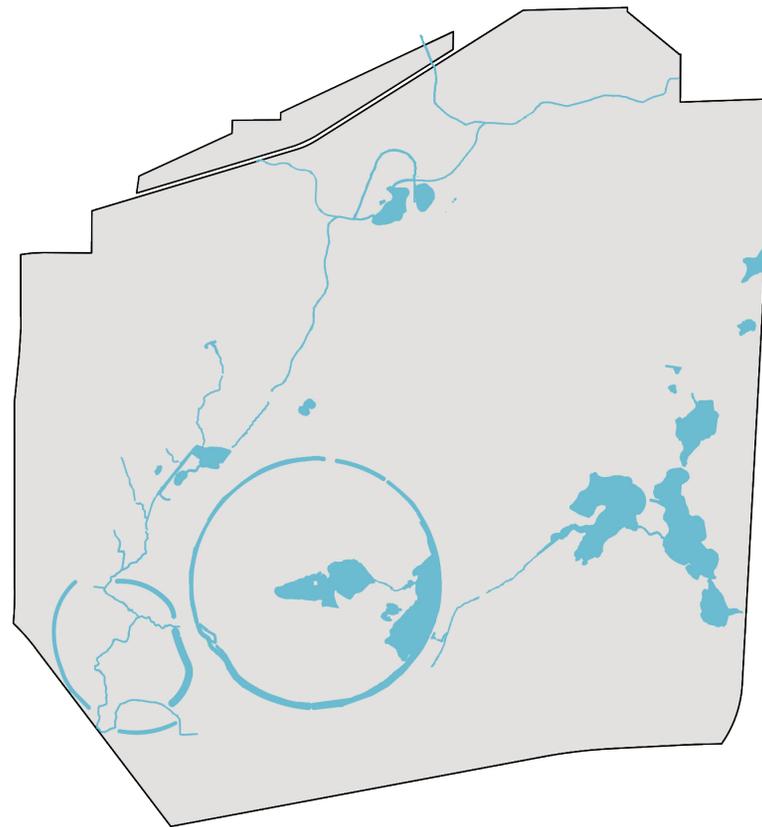
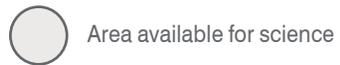
Fermilab is in Batavia, Illinois, 42 miles west of Chicago, Illinois. It is surrounded by the communities of Batavia, North Aurora, West Chicago and Warrenville. The main entrance is from Kirk Road on the west side of the site. Kirk Road is easily accessed from Interstate 88 to the south. A secondary entrance used by many staff is on the east side of the site through Warrenville. The service entrance is at the northwest corner of the site also accessed from Kirk Road.





## 2. A Science Campus

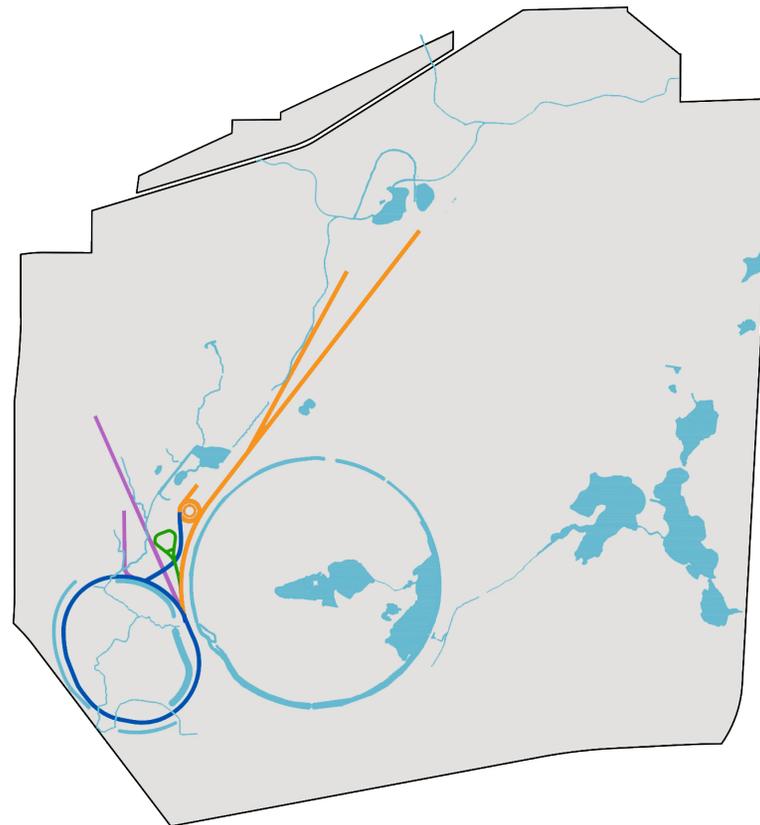
Fermilab's 6,800-acre site encompasses current and planned large-scale physics research activities and installations. The maps on the following pages illustrate both how the site is used currently, as well as near term plans and long-term potential.



### 3. Current Beamlines

This map illustrates existing underground active experiment beamlines and experiment installations.

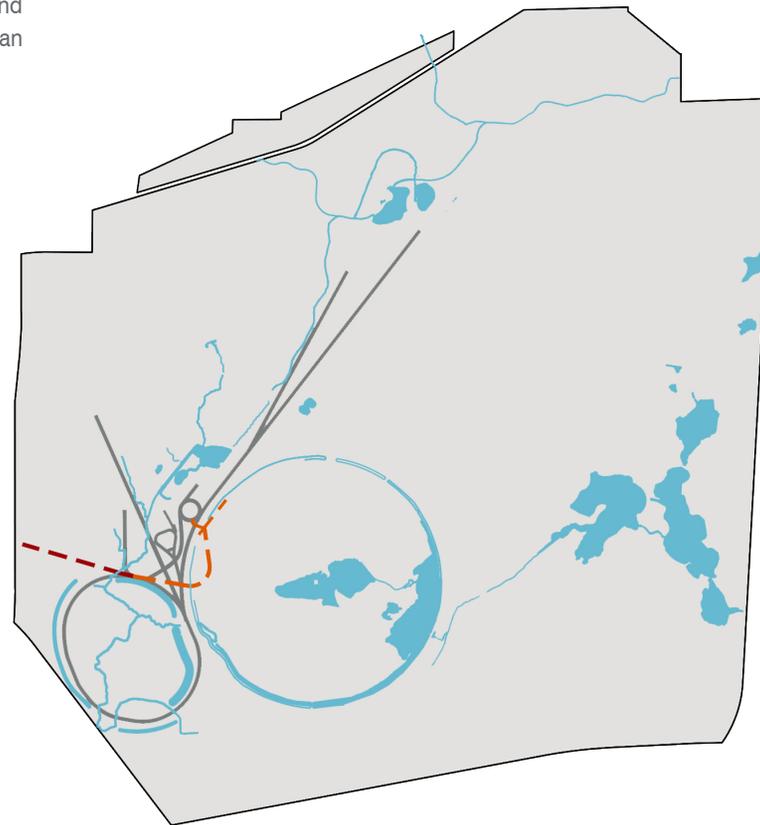
- Linac and Booster
- Neutrino and Booster Neutrino
- Muon / Anti-proton
- Main Injector



## 4. Future Beamlines - Near Term

This map illustrates underground beamlines and installations currently in planning. These are anticipated for construction and active experiment operations in the Fermilab Campus Master Plan execution 20-year timeline.

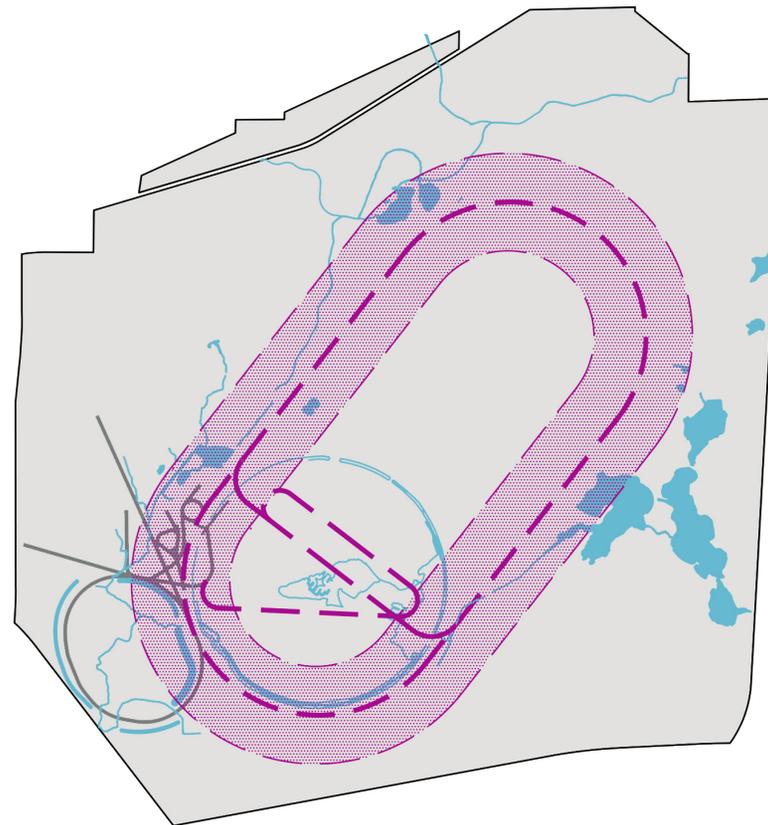
-  Continued from previous era
-  PIP-II and PIP-III
-  Long-Baseline Neutrino Facility



## 5. Long-Term Options

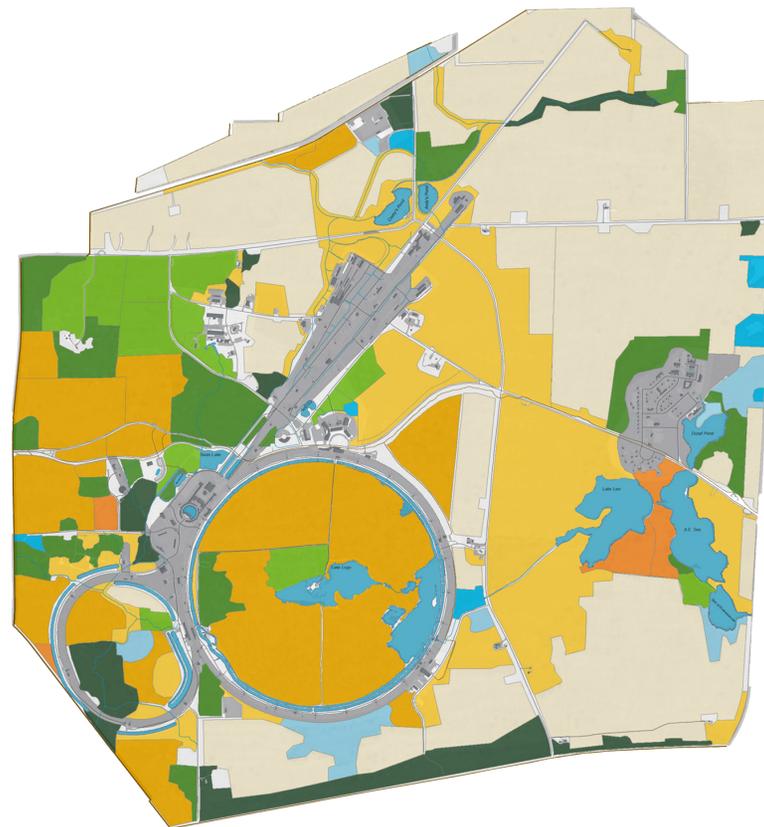
As noted in earlier maps, the entire site is dedicated and suitable for new and sometimes unforeseen science research infrastructure. Illustrated below is one possible manifestation of the sites potential, a muon collider, imagined beyond the 20-year Fermilab Campus master plan horizon.

- Continued From previous era
- Muon Collider



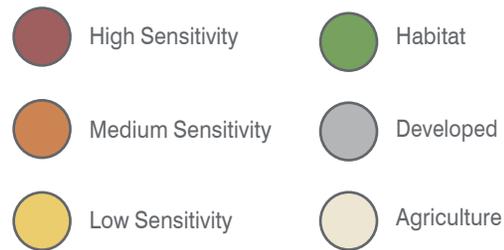
## 6. Habitat Communities

The laboratory site is home to many types of habitat communities providing STEM education, environmental conservation and sustainability opportunities. As science installations expand, reasonable efforts are always employed to maintain these valuable resources while harmonizing with the science mission.



## 7. Ecologically Sensitive Areas

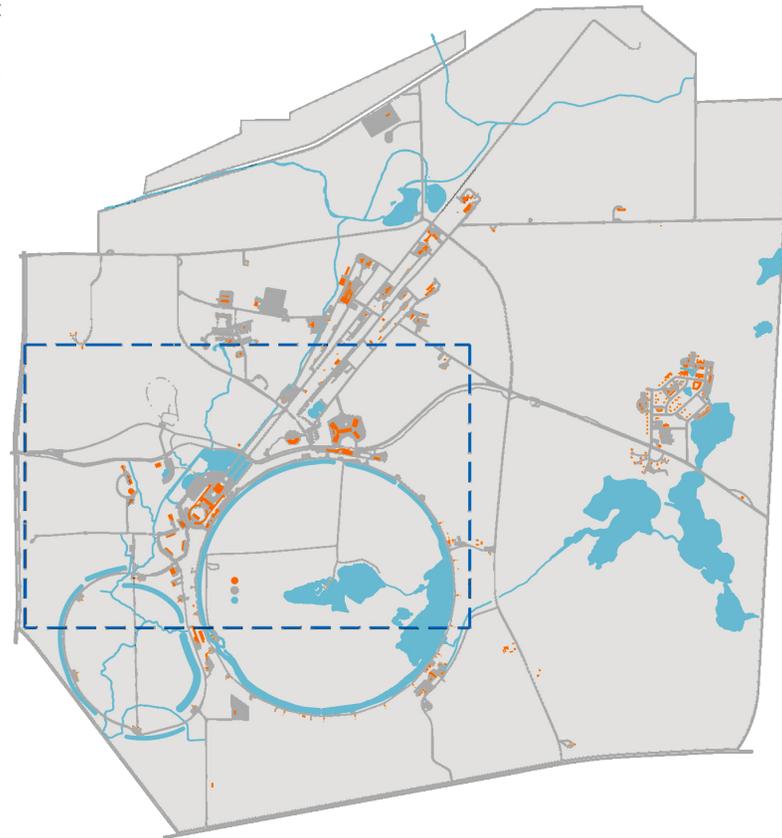
The purpose of this map is to make Fermilab staff (senior management, project planners, engineers, environmental reviewers, operations staff and the grounds crew) aware of areas that have special sensitivity and to avoid unnecessary impacts to them. It was created by superimposing multiple sources of biological data (representing thousands of samples across many years) on a map of the site and using established criteria to determine areas of high, medium or low sensitivity. All habitat areas are important and carry intrinsic weight, but this work highlights areas worthy of deeper consideration and protection.



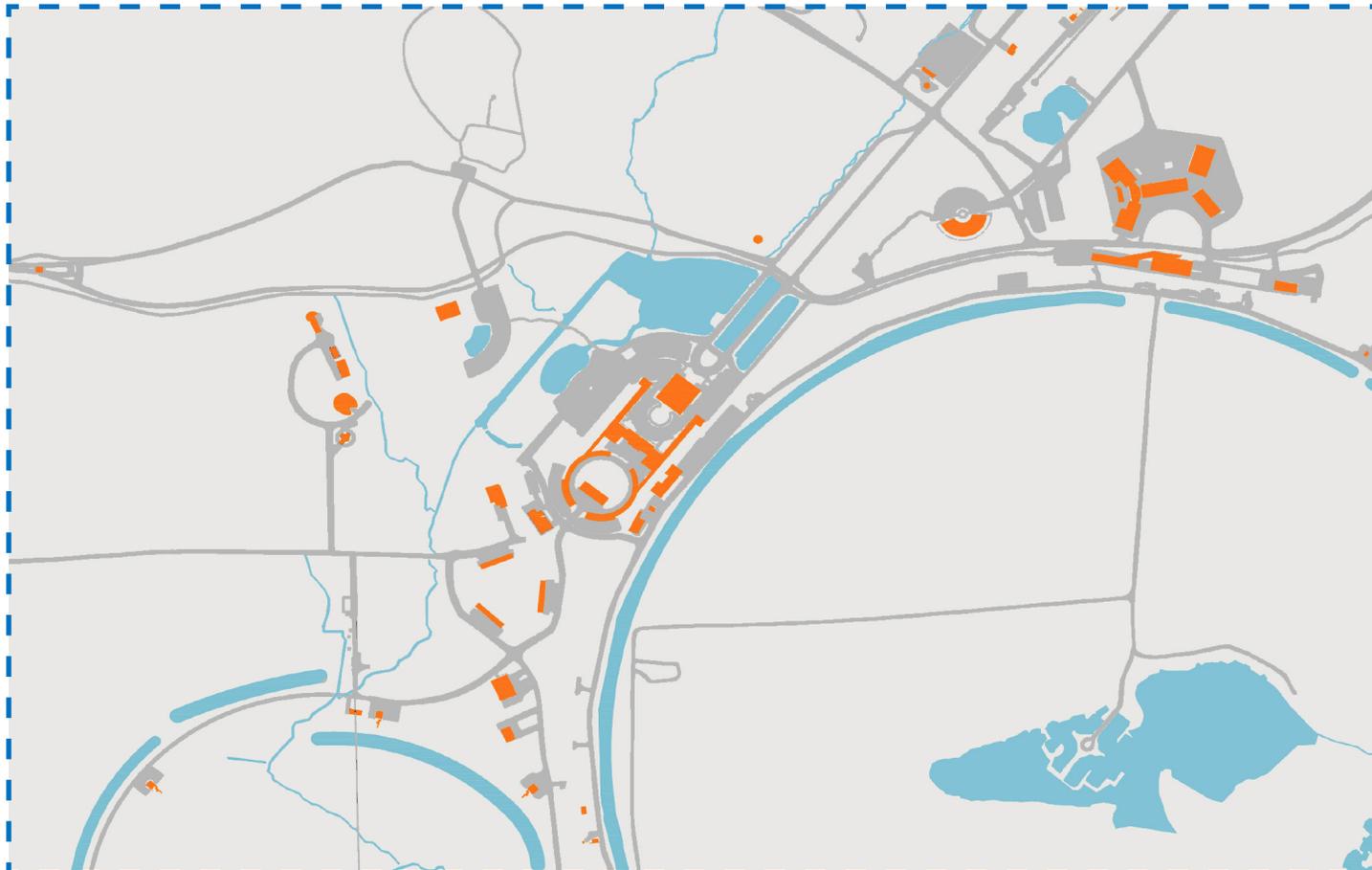
## 8. Surface Developments

Site development has typically “followed the science” throughout Fermilab’s 50 years. Earlier technologies tended to require that computer rooms and people be near the experiments. However, advances in technology, communication and computing have opened the way for remote operation and monitoring of facilities. This trend is helping to drive more condensed and centralized developments, creating a more connected community of researchers.

-  Buildings
-  Paved Area
-  Water
-  Area of Enlarged Central Area Plan  
*(facing page)*



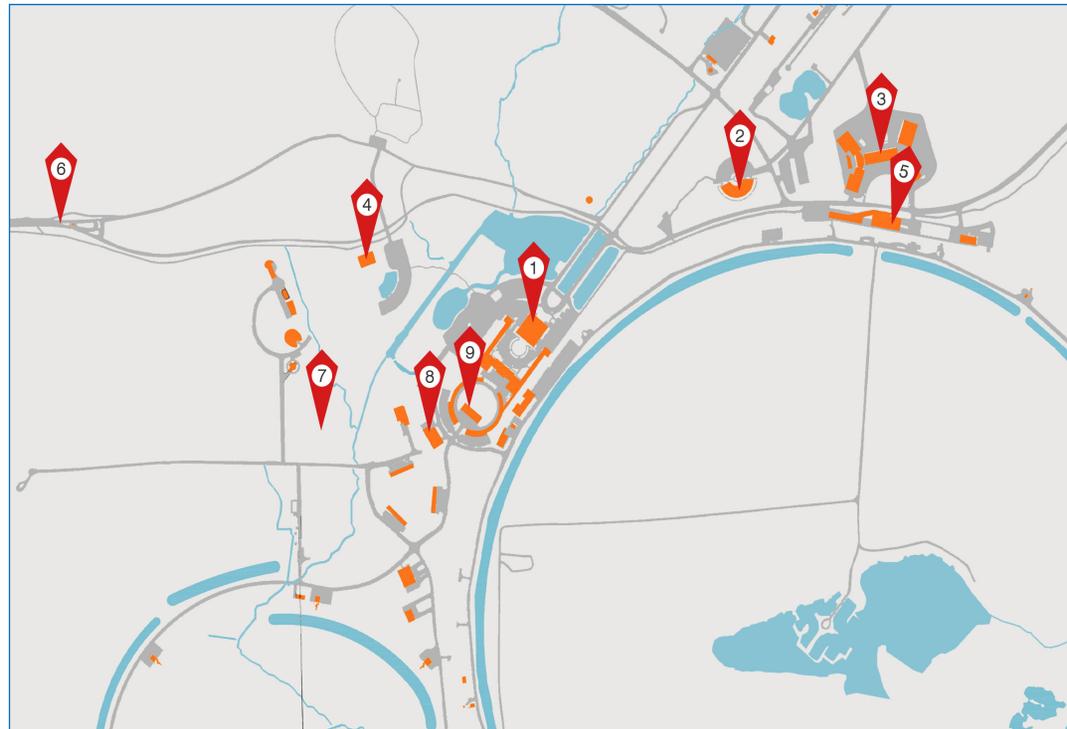
## Central Area Enlargement



## 9. Existing Central Campus

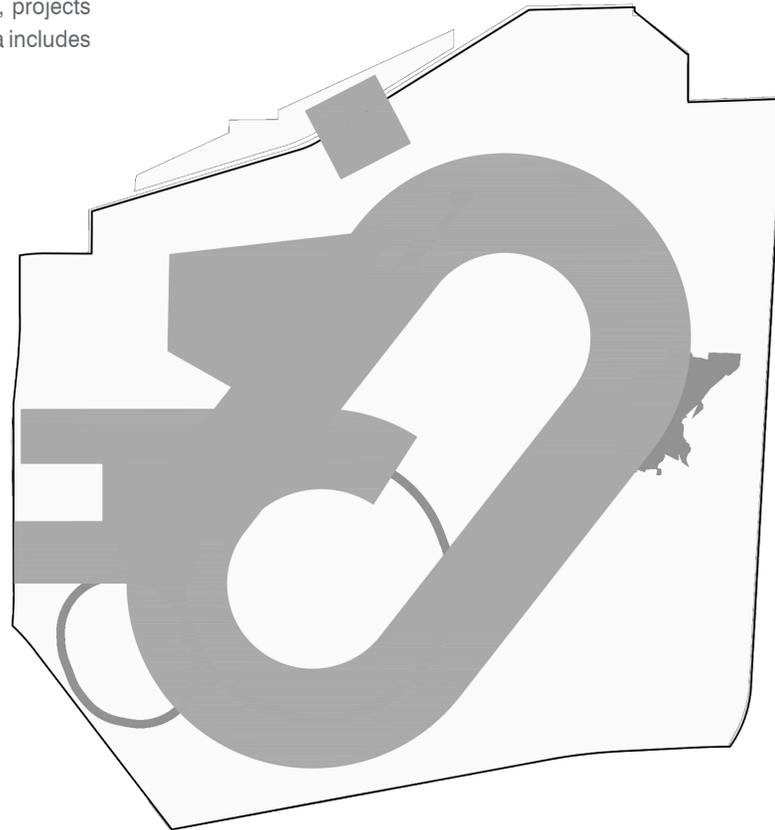
This diagram illustrates the major facilities and focal points of the central region of the campus. Part three of this Fermilab Campus Master Plan repeats this illustration, identifying major planned new facilities and significant improvements and upgrades to existing facilities.

1. Wilson Hall
2. Feynman Computing Center
3. Industrial Buildings
4. Lederman Science Center
5. Illinois Accelerator Research Center (IARC)
6. Pine Street (Main) Entrance
7. Neutrino Campus
8. Muon Campus
9. Central Utility Building (CUB)



## 10. Potential Development Area (2050)

This map illustrates the potential scope of site development by the year 2050. The shaded area encompasses existing development, projects currently in planning and potential long-term options. The area includes both surface and below-ground facilities.

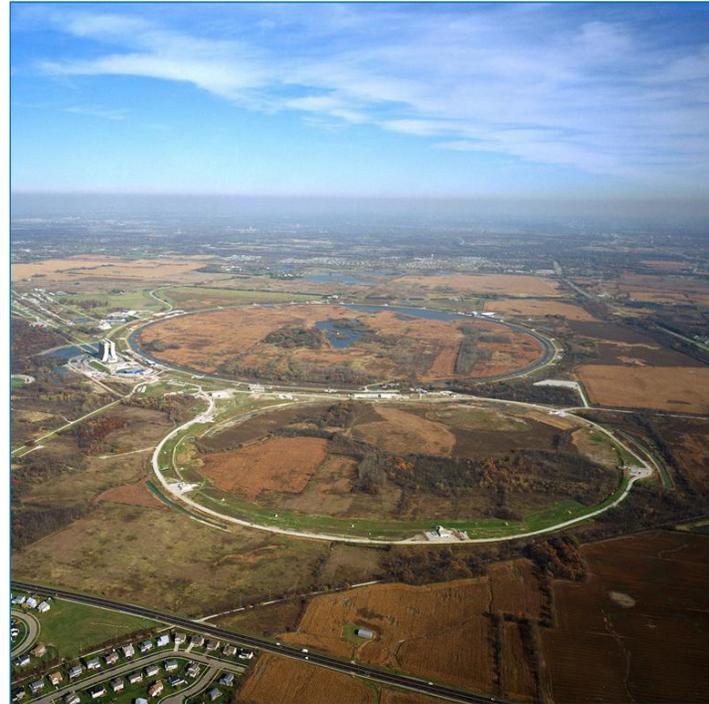


## Campus History

Campus development has been 105 years in the making. Prior to the laboratory's beginning in 1967, the labs 6,800 acres were used for agriculture. The oldest structure currently on the site dates from 1912. In 1967 the 6,800 acres were purchased by the state of Illinois. The land was later transferred to what is now the Department of Energy for the creation of Fermilab. The area was largely farmland, with the exception of the small town of Weston, Illinois. The town, now known within Fermilab as the Village, became the headquarters for the administration and construction of the newly formed laboratory.

Existing single-family homes in the Village were repurposed in place or relocated and grouped to serve as offices, laboratories and residences. Premanufactured barn-like structures were erected in the Village to temporarily house machine shops and development facilities. Additionally, many of the barns and farmhouses scattered around the site were also repurposed in place or relocated. The laboratory's current roadway system, rooted in the agricultural and Weston eras, were modified and expanded as needed to support lab development.

The following paragraphs describe the various eras that make up Fermilab's 105-year development history. They provide useful background and data to inform the campus planning process, along with a visual time line.



# 60%

of buildings' square footage is over 40 years old,  
a total of 1,400,000 square feet.

# 222

of Fermilab's 364 buildings are over 40 years old.

# 35%

of Fermilab's current buildings were already on  
site at its founding.

To provide a framework to help understand, organize and assess the many buildings and structures on the campus, the planning team placed them within the context of their time of construction. Each era possesses rather distinct history and character. The eras and descriptions follow.

**The Farm (1912-1962):** In 1967 Fermilab came into possession of its 6,800-acre property. The land, developed from 1912 through 1962, was used for farming. The 55 farmhouses and barns presented an opportunity for the startup laboratory. They were repurposed for laboratory use, primarily as staff housing and storage. These structures, now 50 years older, have been in continuous use since.

**The Suburb (1963-1968):** Throughout the 1950s and 1960s Chicago-land suburban development rapidly expanded westward. 1963 saw the creation of the tiny town of Weston, Illinois, a residential subdivision within the bounds of what became Fermilab. The 100 or so new homes were repurposed for laboratory use. Individually, and relocated into clusters, they became housing, laboratories, offices, the Users Center and the children's daycare. In continuous use since, many house prime candidates for consolidation and relocation into modern facilities.

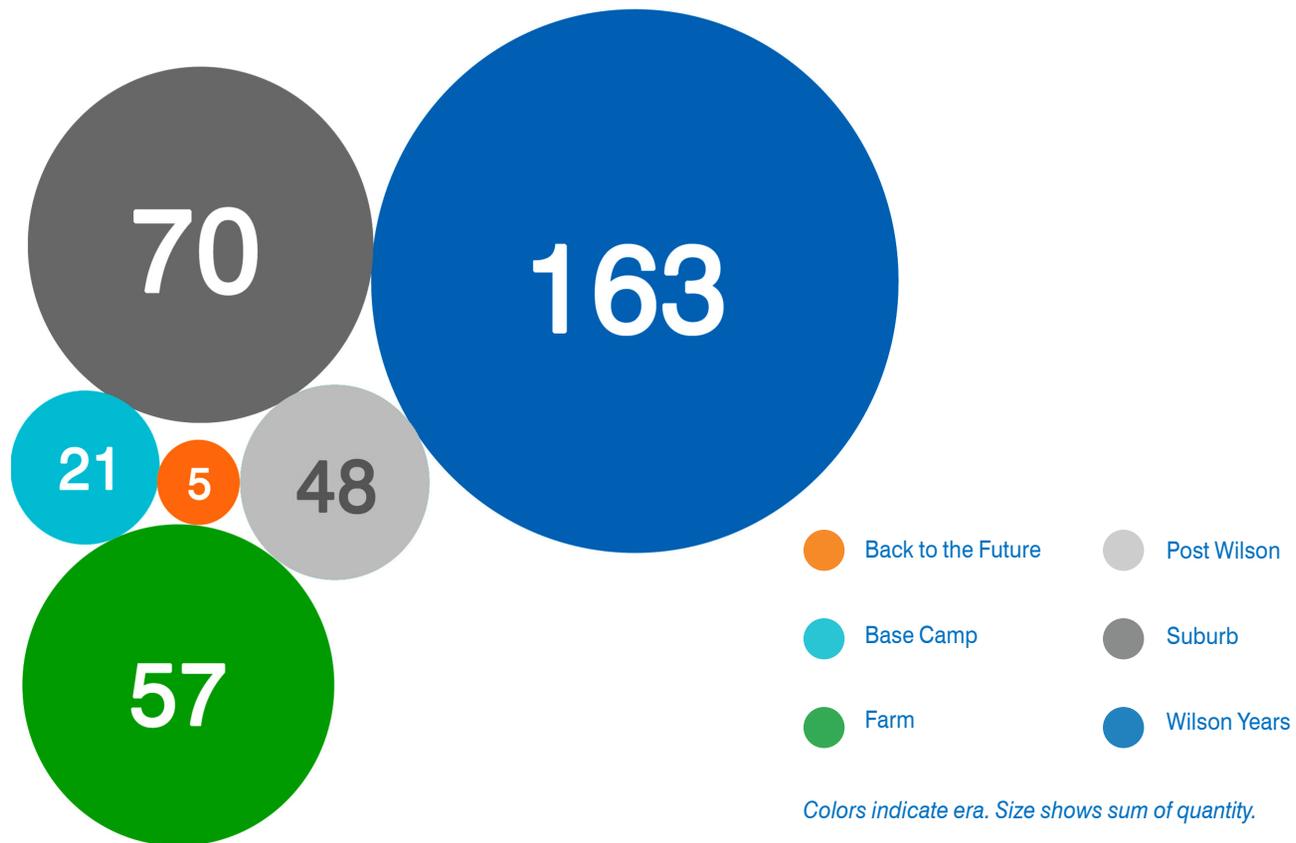
**Base Camp (1969-1970):** Like a frontier outpost, the base camp structures were intended as temporary buildings to house, direct and execute the activities necessary to build the permanent laboratory facilities. Augmenting the repurposed and reconfigured farm and suburb structures, base camp structures are premanufactured metal barn-like buildings housing machine shops and laboratories. While intended for short term use, these antiquated and inadequate buildings continue in use, awaiting modern replacement facilities.

**Wilson Years (1971-1993):** The Wilson Years encompass 67% of the lab's total above-grade square footage. Designed and constructed as the permanent laboratory, this era includes Fermilab's iconic structures: Wilson Hall, Feynman Computing Center, NML, Meson Lab and the Industrial Center Buildings. Also built in this area are the original colorful, playful service and support buildings, with their bright colors and painted circles, as well as the sculptures, and pi poles. Guided by the creativity and enthusiasm of Robert Wilson and the resident artist Angela Gonzales, the Wilson Years epitomize his founding vision for the campus. Collectively, they contribute greatly to what has become the "unique character of Fermilab."

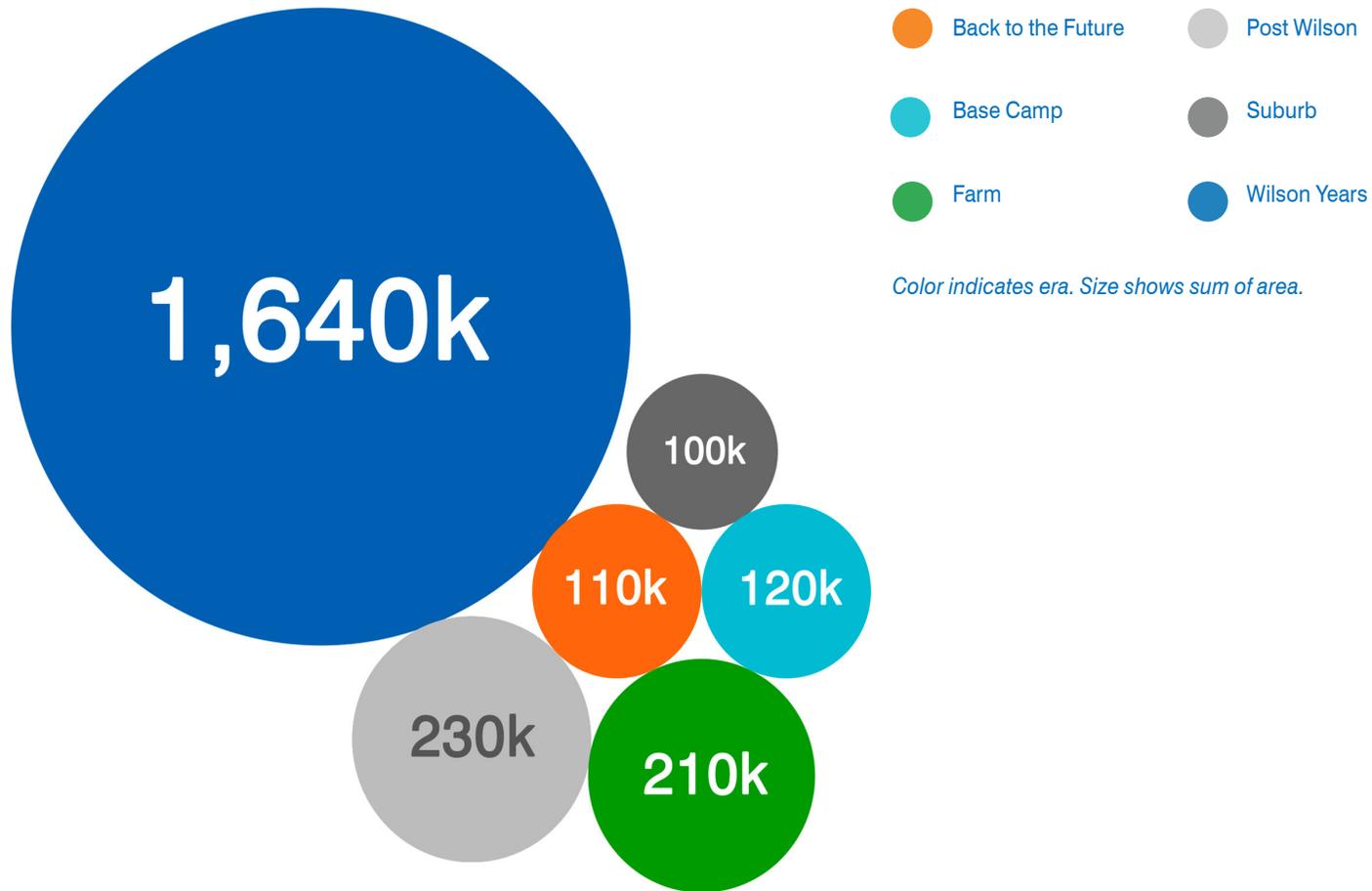
**Post-Wilson (1994 -2008):** The Post-Wilson era derived from the Wilson Years, but in significant ways is very distinct. The colorful and energetic buildings of that founding era were evidencing deficiencies in durability, maintainability and flexibility. Thus, the dozens of new buildings designed and constructed post-1994 for the Main Injector project prioritized practicality over the aesthetic ambitions of earlier times. As purely utilitarian structures they eschewed the colorful motifs and details of the Wilson Years, opting instead for uniform neutral siding. Each building looked just like the others. This Main Injector design approach became the de facto pattern for all building designs well into the 21st century. As time has progressed they have met their practical objectives well. However, many at Fermilab desire to recapture the founding spirit and energy evident in buildings of the Wilson Years.

**Back to the Future (2008-2014):** Back to the future, while whimsical, captures this somewhat ambiguous era. Recent development, while thoughtful and creative, was carried out without a consistent, modern campuswide approach to siting and design. One reason for the campus plan is to address this void and provide direction for the future. Later chapters of the FCMP and appendix delineate initiatives and design guidance to alleviate ambiguity and provide direction for future development.

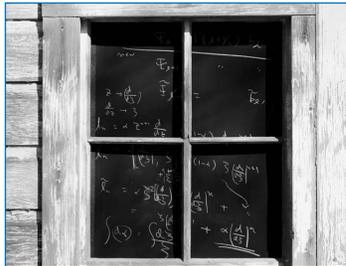
**Building quantity by era:** Fermilab contains 364 buildings. The diagram below illustrates the number from each development era.



**Building area by era:** Fermilab contains 2,490,000 SF of buildings. The diagram below illustrates the square feet built in each development era.



# 1900



The 57 farm buildings comprise 210,000 sf of floor area, 9% of Fermilab's total square footage and 16% of the numerical total of buildings on site.

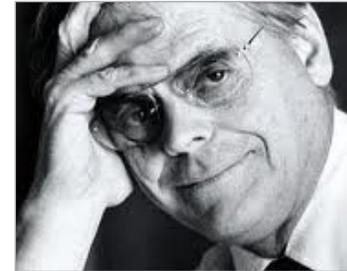
## The Farm (1912-1962)

## The Suburb (1963-1966)

The 70 facilities of this era comprise 100,000 sf of floor area, 4% of Fermilab's total square footage and 9% of the numerical total of buildings on site.



The Founder Robert Wilson



The 21 Base Camp era facilities comprise 120,000 sf of floor area, 5% of Fermilab's total square footage and 6% of the numerical total of buildings on site.

## Base Camp (1969-1970)

## Wilson Years (1971-1993)

- The 163 Wilson Years buildings comprise 1,640,000 sf of floor area, 67% of Fermilab's total square footage and 45% of the numerical total of buildings on site.



## Back to the Future (2008-2014)

- The five Back to the Future era buildings comprise 110,000 sf of floor area, 5% of Fermilab's total square footage and 1% of the numerical total of buildings on site.



- The 48 Post-Wilson era buildings comprise 230,000 sf of floor area, 10% of Fermilab's total square footage and 13% of the numerical total of buildings on site.

## Post-Wilson (1994-2008)



# Present

## Guiding Principles

A plan is a set of actions conceived to achieve some desired outcome. To create a master plan, the desired outcome must be clearly understood.

Twenty-first-century science needs a 21st-century laboratory. What does that mean? How will it look and feel? How is it organized? What does it imply about the current state of the laboratory? Where does the lab fall short? What is missing?

To provide answers, the Fermilab master planning team developed the *Guiding Principles* for the Campus Plan. These seven principles provide the underpinning ideals for the plan. They bring the values, needs and qualities envisioned for a 21st-century laboratory.

**Support Cutting-Edge Research:** The laboratory strategic plan describes how to use the laboratory's existing world-class accelerators and infrastructure and build new capabilities to support groundbreaking particle physics and accelerator science research. Campus planning and development projects will be driven by the priorities delineated in this strategic plan.

**Enhance the Campus Experience:** Fermilab's campus shall contain a diversity of inviting, accessible and safe places for the enjoyment and interaction of staff and visitors. Improvements will be made to pedestrian walkways and bicycle paths to increase safety, improve functionality and enhance opportunities for cultural and social engagement.

**Reinforce Community:** Central to the scientific mission is the desire to foster a sense of community. The Campus Plan shall enhance the community building aspects of the laboratory by designing buildings and open spaces that bring together researchers and staff. This should result in the creation of vibrant centers of laboratory life, fostering the free exchange of ideas and enabling teamwork and collaboration.





**Ensure Integrative Planning and Design:** The planning and design of the campus shall integrate disciplines, connect communities, and coordinate scientific and supporting development with mobility, wayfinding, landscape and infrastructure initiatives.



**Promote Stewardship:** Fermilab shall respect and manage the physical environment of its campus facilities and lands for the health and well-being of the laboratory, its staff, users, neighbors and visitors, and the ecosystems supported by the laboratory. Facilities should be designed and built in accordance with applicable guidelines for state-of-the-art sustainable design and energy conservation.



**Ensure the Campus is Welcoming to Visitors:** Fermilab has a long and important legacy as a place for science education and community outreach. An enriching experience for visitors is an important element of Fermilab's mission. The Campus Plan should provide a welcoming entrance and clear designation of visitor areas. The planning and design of the campus should consider the visitors, education and outreach in all aspects. Displays should promote the unique qualities of the site and explain what it has to offer in terms of science and nature.



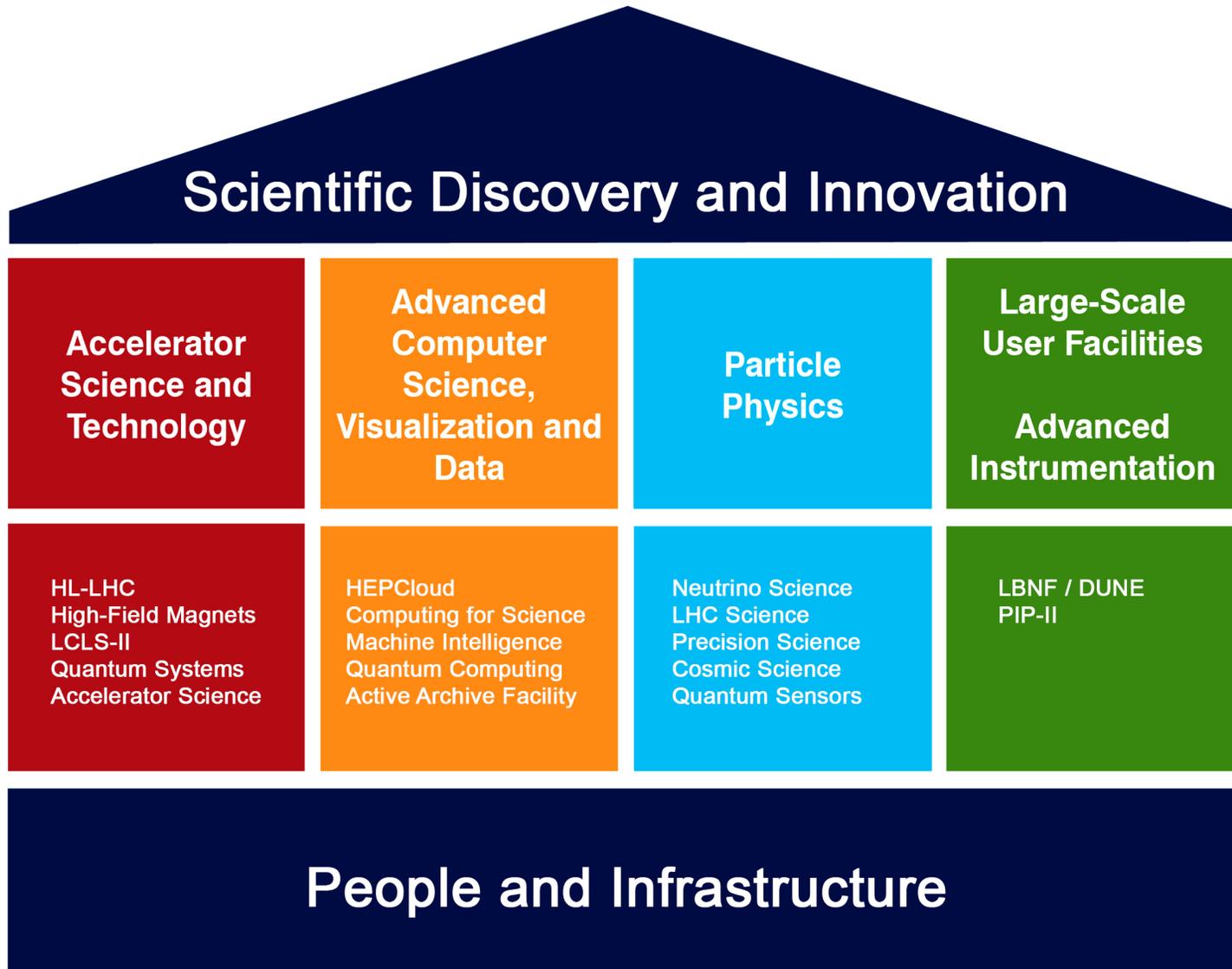
**Uphold the Unique Character of Fermilab:** The laboratory has a tradition of architectural innovation and excellence defined by the founder's vision of "a Utopian place where physicists from around the globe could work in functional surroundings reflective of the magnificence of their discoveries and theories." This is evident in the design of many of its founding-era buildings and structures, representing architectural innovations for their time. The Campus Plan should perpetuate the founding vision while acknowledging what has changed in terms of science, values and performance since the founding of the laboratory.

## Strategic Plan

Developing a plan for the future of Fermilab's campus and facilities is driven by the laboratory's Strategic Plan, which is built around Fermilab's four core capabilities: 1) Accelerator Science and Technology 2) Advanced Computer Science, Visualization and Data 3) Particle Physics and (4) Large-Scale User Facilities. These are defined by criteria established by the U.S. Department of Energy Office of Science (DOE/SC) and are leveraged to support the DOE/SC Scientific Discovery and Innovation mission.

Fermilab's major science and technology initiatives stem from the core capabilities and are aligned with the Particle Physics Project Prioritization Panel (P5) plan, DOE and the science community. High-intensity particle beams are used to answer compelling questions in neutrino science and reveal new physics phenomena through high-precision tests of the Standard Model of particle physics. High-energy particle beams are used to discover new particles and probe the architecture of the fundamental forces of nature. Underground experiments as well as telescopes are used to uncover the natures of dark matter and dark energy and probe the cosmic microwave background. Fermilab's strategy for supporting its core capabilities is called "Building for Science" and focuses on mission-based priorities related to people and infrastructure. Infrastructure is the focus of the Fermilab Campus Master Plan.

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## Current Perspectives

The planning team embarked on a critique of the current campus to understand how it measured up to the *Guiding Principles*. This critique was approached from two directions. The first was internal. We engaged Fermilab staff and management on the campus's needs and its direction for the future. The second involved gaining outside perspectives. Fermilab management engaged the services of John Ronan Architects, a noted Chicago design firm. Mr. Ronan provided observations based on his expertise of state-of-the-art campus and building design. Outside critique and working sessions were also conducted with the university architect from the University of Chicago. The resulting Current Perspectives represents the outcome of these studies.

**Fermilab employees and visitors appreciate the spirit in which the campus was originally designed and would like it upheld.**

The laboratory should continue to recognize and enhance the founder's Utopian vision, on which Fermilab was based and which informed its early design.

**Some of the founding spirit seems to have been lost in the utilitarian and backward-looking design of the post-founding-era buildings and utilities.**

Site development and building design during the post-founding era has been implemented around economy-oriented limitations and replications of the original buildings. This process has resulted in a site including many rather nondescript, utilitarian structures.

**Many of the founding-era buildings are not conducive to the workplace expectations of current and future generations of researchers.**

Many of the early buildings do not prioritize quality of life or contribute to a sense of place. Many of the buildings housing scientists and staff members feel as if they were designed from the outside in, prioritizing image or representation over improving experience and quality of life. They do not have usable outdoor spaces or clear and welcoming entrances.

**The campus is not pedestrian-friendly.**

Like many offices and industrial campuses developed in the postwar period, the Fermilab campus was designed and meant to be experienced by automobile. Minimal accommodations exist for pedestrian travel. This conflicts with the sense of community Fermilab seeks to create among its scientists and staff members.

**Some of the existing buildings tend to dominate, as well as distract from, the laboratory's natural landscape.**

The natural landscape is a significant identifying characteristic of the Fermilab campus, making it unique among laboratories. The design of current buildings is not responsive to or well integrated with the landscape.

**Many of Fermilab's aging and inadequate facilities will need to be updated or replaced to accommodate the laboratory's scientific program plan.**

Fermilab requires high-quality industrial, high-bay, offices and technical spaces to accommodate the laboratory's scientific program.

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**The campus has a haphazard feel due to the scattered nature of the structures, roadways and utilities about the site.** The organizational principle guiding the siting of buildings is unclear and results in a rather random and dissonant overall character.

**The visitor experience needs improvement.** Visitors on campus need to have a more welcoming and informative experience. The campus has weak entry points that are easily missed and do not convey a sense of arrival. The overall entry sequence is not a welcoming experience. Public areas of the campus are not distinguished from private areas, and it is not clear which campus areas and buildings are open to the public and which are off limits. Additionally, it is difficult for an outsider to understand what happens at Fermilab, and it is currently possible to pass through the site unaware that any scientific research is taking place.

**Fermilab needs to facilitate a more international and collaborative environment.** From its founding in the village of Weston, Illinois (now the Village), Fermilab has developed in a geographically dispersed manner. This barrier to collaboration extends to our scientist guests, who often come from abroad for both short- and long-term visits. During their stay at the laboratory, they should feel that they are an active part of the laboratory's research environment, a goal that is currently hampered by their wide physical separation from the scientific centers of the laboratory.

**The laboratory should use space efficiently.** The laboratory should strive toward alignment with comparable research institutions, generational and industry reference points and national laboratory trends. Additionally, buildings tend to be categorized by organization and divisions, thereby not taking advantage of the possibilities and benefits of shared space.

**The main entrance needs improvement.** The main entrance at Pine Street, aside from the sculpture "Broken Symmetry" by Robert Wilson, is unimpressive and disorienting to the uninitiated. One is not sure whether he can enter, and there is minimal indication as to what Fermilab is.

**The vehicular circulation and wayfinding is inadequate and unclear.** The transportation and circulation system also present several challenges. The roadway layout was initially based on pre-existing rural roads. New roads were then added to access the experiments. Additionally, raised-earth berms shielding the Main Ring and linear accelerators, along with new and planned berms, interrupt roads and require alternative circuitous routes to get around campus. Building identification and wayfinding signage throughout the site is minimal, inconsistent and inadequate.

## Twenty-Year Vision

The Campus Plan is based on a long-term vision of what the Fermilab Campus can become and how it might look, feel and function 20 years from now.

**State of the art:** Buildings will be state-of-the-art places representing and furthering the advancement of Fermilab's ongoing research.

**Welcoming and international:** Campus improvements will continue to transform Fermilab into an ever more welcoming and international community of researchers.

**Open and green:** Consolidation of buildings will help preserve Fermilab's rich and diverse natural areas and make available other areas for future large-scale physics machines.

**Consolidated and integrated:** Currently diffuse facilities will be condensed into the central campus. Creativity and innovation will flourish as researchers and staff mingle in this distinct and vibrant place of research and collaboration.

**Connected and engaged:** The campus will be connected by various modes of transportation: walking, biking and, possibly, a campus shuttle.

**Built on the legacy:** the campus will embody Wilson's optimism of a "A Utopian place where physicists from all parts of the country, and from all countries, would be doing their creative thing in an ambience of well-functioning and yet beautiful instruments, structures and surroundings that would reflect the magnificence of their discoveries and theories...", and his "fantasy of a Utopian laboratory clearly required a setting of environmental beauty, of architectural grandeur, of cultural splendor..."

**Innovative and significant buildings and structures:** New structures will embrace Wilson's aim: "I had better pay close attention to the architecture of the project, for I was determined that it be significant yet affordable. If we produced a dowdy site with shabby buildings, then the technical people we wanted to work with us would not come and the statesmen, who might judge us in part by appearances, would not in the long run give us the funds that we would need for our physics." In a fresh and innovative ways, it will attract the next generation of international researchers.

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# Emerging Priorities

Part II of the Fermilab Campus Master Plan builds on the history, vision, and *Guiding Principles* set forth in Part I. Presenting an integrated, holistic approach, this *Emerging Priorities* chapter delineates initiatives to evaluate, organize, plan and design the campus to realize the FCMP 20 year vision. Responding to the aspirations embodied in the *Guiding Principles*, these initiatives provide a framework for campus development. When fully implemented, the result will be a campus supporting cutting-edge research, fostering international collaboration and community, and harmoniously integrating new developments with the natural setting. The campus will be transformed into an open, inviting and collaborative research community for 21st-century science.

“The Campus Plan looks at what type of experience we want to offer Fermilab’s current users, users of the future, as well as our own scientists and staff, and our community neighbors. Campus improvements and new facilities will be undertaken with a view toward qualitatively reinforcing what makes Fermilab a unique and special place.”

~ *Tim Meyer, Fermilab Chief Operating Officer*

## Create Planning Regions

The Current Perspectives noted the haphazard feel of the campus resulting from the scattered nature of the structures, roadways and utilities about the site. Creating planning regions aims to address this issue, providing context, logic and framework for future campus design and development. While the entire site is open for science (reference FCMP Part I, Campus Geography), four planning regions are identified herein and are illustrated on the map on the facing page. Each has a distinct focus, character and requirements. Creation of these regions provides guidance for future planning and design guidelines.

**Core Campus:** The core campus comprises the most public, most accessible and most populated areas of Fermilab. Including the arrival area of the campus as well as Wilson Hall, Ramsey Auditorium, FCC, the Lederman Science Education Center, IARC and the Technical District, this region is also the location for the future IERC and a possible Global Accelerator Center. The Core Campus should be characterized by a refined, qualitative approach to its architecture and site planning. Over time, this region will be the focus of improvements in landscaping, pedestrianization, transit, signage, and wayfinding initiatives to transform and unify this vibrant core of the campus.

**Test:** As the oldest operating science region, the Test Region includes the Fermilab Test Beam Facility, Labs A through G, the landmark Robert Wilson-designed NML building and the recently built Cryomodule Test Facility. The long-term vision for the region is one redevelopment and renewal, removing some obsolete facilities while revitalizing others for new usage.

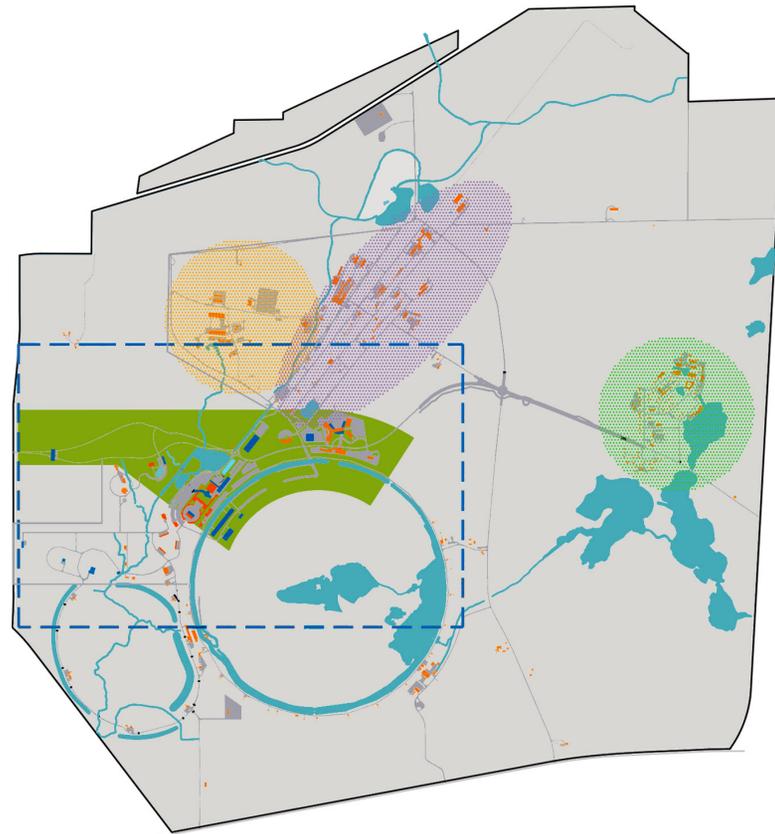
**Village:** The Village is where the laboratory began. Many of the buildings in the Village are currently obsolete shops, labs and small offices. Due to their poor conditions and distance from Wilson Hall, these present prime candidates for consolidation and centralization projects. As staff and functions are moved out, antiquated buildings can be removed and areas returned to nature, enhancing the Village as a place focused on housing and recreation.

**Services:** The Services Region is home to many support groups such as shipping and receiving, vehicle refueling, operations and maintenance, and the Fire Department. Long-term plans for the area may include the construction of a new consolidated warehouse. Consideration should also be given to the creation of a consolidated facilities management building and a consolidated fire station and security facility.

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## Planning Regions Key Map

- Core Campus
- Services
- Test
- Village



## Consolidate and Centralize

Condensing the development footprint of the laboratory will enable the envisioned collaborative international research community, y bringing staff from remote locations into the core of the campus. As noted in the Campus History (Part I), many parts of the campus were not purpose-built but rather developments of opportunity. As such, they are not ideal for their usage and are in poor locations. Other regions are remote because they were originally built near experiments due to technological limitations. Guided by the planning region concept, this initiative to consolidate and centralize moves people and functions from distant, antiquated, scattered and obsolete facilities to modern consolidated facilities within the core campus. Ultimately, up to 500 staff members currently dispersed across the site can be moved to optimally located, modern state-of-the-art facilities.

The diagram to the right illustrates the general nature of these movements. It identifies the regional clusters of outdated facilities. It then indicates the movement to campus core destinations. The resulting condensed footprint will enable the envisioned consolidated and integrated, connected and engaged workplaces. Pedestrian-friendly outdoor connections, as well as climate-controlled links between buildings, will create a collaborative community where researchers work nearby, easily meeting together to exchange ideas. Following are additional notes on three color-coded circled regions on the map on the facing page.

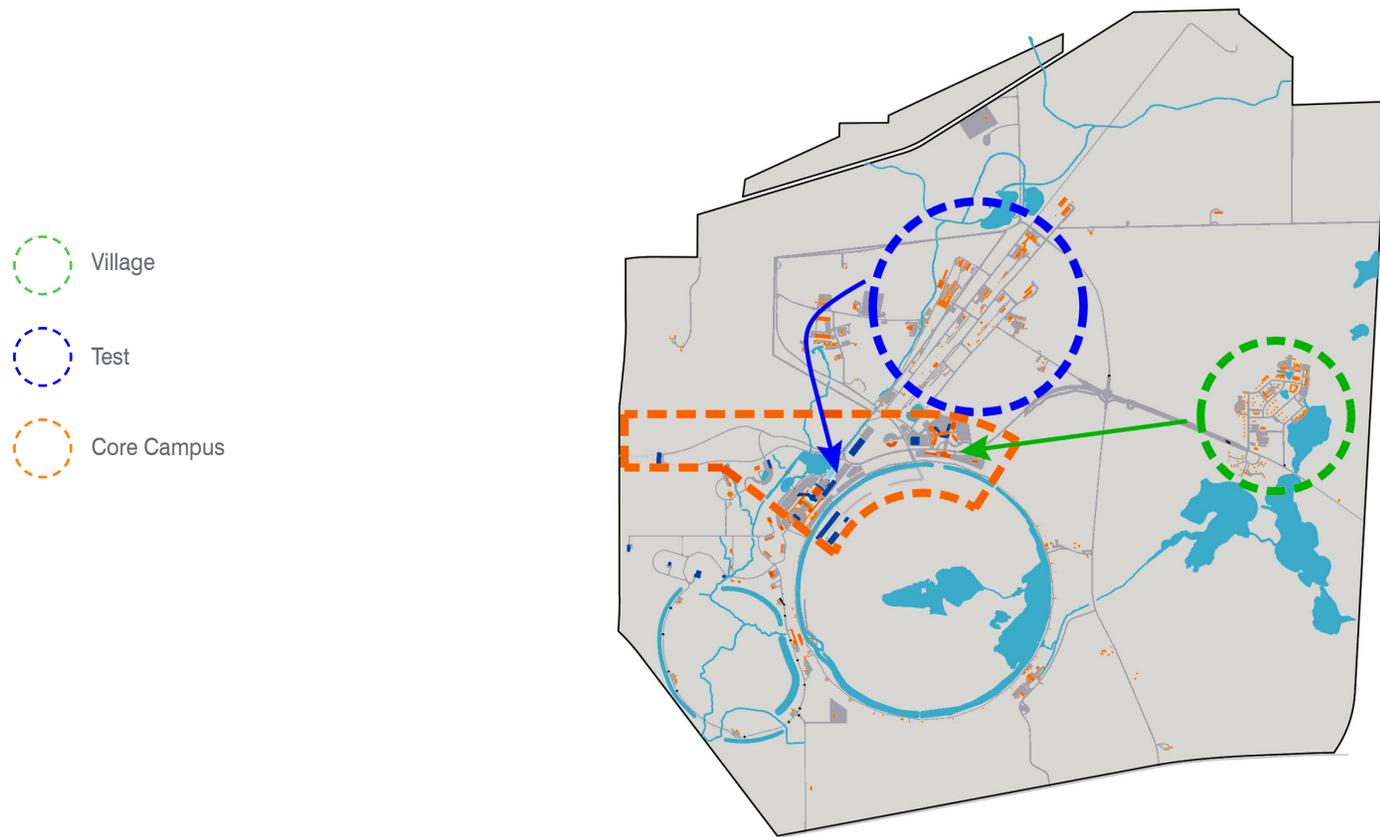
**Green:** The green circle targets the Village. While maintaining its housing and recreational facilities and functions, future developments will allow the Village to shed unrelated functions into more optimized locations. Over time, dozens of obsolete shops, labs and offices will be relocated to modern, consolidated and optimal facilities in the Core Campus.

**Blue:** The blue circle primarily targets the test area. While many well-functioning and effective facilities exist here, many others are obsolete and deteriorating. Over time, new modern, centralized and consolidated replacement facilities will be constructed in the Core Campus. As staff and functions relocate, these movements will make way for the removal or adaptive reuse of the current antiquated structures in the test area.

**Orange:** The orange boundary delineates the newly defined Core Campus region. As the focus of new development, the region is the destination for consolidation and centralization into new state-of-the-art facilities. Staff from all over the site will increasingly be located here, becoming the envisioned place where researchers and staff easily connect, work collaboratively and exchange ideas.

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## Consolidation and Centralization Key Map



## Strategically Assess Buildings and Infrastructure

A fully integrated, holistic approach to long-term planning must consider the state and appropriateness of the buildings and structures on site. Additionally, planning must assess the capacity and condition of the utility systems that provide the campus buildings, experiments and accelerators with electricity, heating, cooling and water. Improvement and expansion of these systems to meet the present and future needs of the laboratory, while delivering enhanced functionality, reliability and efficiency, must be at the core of the assessment process. In that spirit, this campus plan initiative aims to strategically assess and align the campus buildings and utility systems, considering the future direction and development plans for the laboratory.

**Campus Buildings:** The Campus History (Part II) noted that 127 (35%) of Fermilab's current buildings were on site by 1963. Predating the laboratory's founding by many years, these structures, totaling 13% of Fermilab's total square footage, are rooted in the farm and suburban periods. A second grouping of buildings, 95 structures (26% of Fermilab's total) date from its 1967 founding through 1979. In total, 222 buildings, totaling about 60% of the laboratories square footage, is more than 40 years old. As an aging facility, the future of the campus is as much about erasure as it is about addition.

To that end, this campus plan initiative aims to strategically assess and align the campus buildings to the future vision. Location, condition, quality, design, flexibility, safety and risk are among the criteria for evaluation. The Appendix at the end of this FCMP provides background information, assessment criteria and a broad roadmap for this process. Then, hand in hand with new developments in FCMP Part III, informed modernization of the laboratory can take place. At the end of 20 year planning horizon, dozens and perhaps hundreds of obsolete buildings could be renovated, repurposed or removed from the site.

**Campus Utilities:** The 20 year plan for the campus delineates significant movements of population and activities to new locations around the campus. It envisions major new experiment facilities and beamlines. These changes, along with the effects of time, require ongoing improvement to the sitewide utility systems. The Appendix of this FCMP document provides an overview of the systems and proposes further study and development of a free-standing campus utilities plan. The plan should assess the condition, capacity, location and suitability of all systems as Fermilab prepares for the future.

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## Establish Design Guidelines

Fermilab has a legacy of distinctive buildings and structures, each taking their place in the unique history and development of the campus. The founder's "Utopian" vision upon which Fermilab was based, and from which its early design inspiration proceeded, stands. However, much has changed since the founding era. Like many places of its time, the original design of the campus and buildings was meant to be accessed and experienced by automobile and are not pedestrian-friendly. Additionally, much has changed in terms of science, values and performance since the founding period.

The *Guiding Principles* envision a state-of-the-art laboratory with a sense of community, fostering the free exchange of ideas central to the laboratory's scientific mission. The founding-era design approach presents a conflict with the sense of community which Fermilab seeks to create amongst its scientists and staff and presents a challenge to sustainability goals. The Campus History chapter (Part I) described how the design of many of the recent buildings evidences an unsolved transition from the Wilson Era design approach to the present time. Many newer projects emphasize looking backwards, resulting in poorly and inappropriate emulations of the Wilson Era.

Dozens of new buildings are planned for the next 20 years. As the FCMP unfolds in the coming decades, it is vital to set forth design approaches consistent with the goals embodied in the *Guiding Principles*. The design of buildings and open spaces should support these goals by creating modern facilities that encourage interaction, bringing staff, users and visitors together, and create vibrant centers of laboratory life. While continued care and stewardship of the campus requires an appreciation for the existing buildings and open spaces defining Fermilab, new buildings and future renovations must create the best campus environment possible. Design teams should recognize Fermilab's legacy, carrying the vision forward in innovative ways.

In that spirit, the Appendix of this FCMP highlights the need for design guidelines. Informed by the *Guiding Principles*, these will guide the creation of modern, state-of-the-art facilities. New buildings and structures will be designed to be fresh, inviting, dynamic and forward-looking. They will also be designed with a view toward flexibility and efficiency, enabling them to meet the needs of current and future generations of staff and users.

## Strengthen Campus Landscapes

**Conserve Natural Resources:** The Campus Plan envisions smart growth and development to conserve open space. The land and its ecological integrity is one of the most important assets at Fermilab. It is an important component of the laboratory's STEM education initiatives and programs. Also, it is an important aspect of our regional stewardship, positively benefiting and serving the surrounding communities.

The Fermilab campus is spread across four watersheds and boasts over 2,500 acres of natural areas such as tallgrass prairie, oak savanna, open water marsh, sedge meadow and floodplain forest. There are also many acres of agricultural lands and old-field grasslands. Responsible management of the physical site is an important consideration for realizing the campus of the future. Indeed, the abundant open space on the site allows for construction of the large machines needed to carry out cutting-edge particle physics research.

DOE and Fermilab recognize the significance of conserving and restoring biological diversity. Both are members of the Chicago Wilderness partnership and are committed to supporting their Biodiversity Recovery Plan for the region. The Fermilab Ecological Land Management (ELM) Committee is charged with providing sound, ecologically informed recommendations during lab planning through formal review mechanisms. The ELM Committee is composed of consulting professionals and internal experts, and together, they author a plan for enhancing the natural resources of the Fermilab site through an ecosystem management approach. This includes monitoring plant and animal communities as indicators of environmental health and assessing presence and viability of keystone and rare species. Ultimately, these contribute to restoration and expansion of core habitat, wildlife corridors and connecting remnant ecosystems across the 6,800-acre site and with adjacent public areas. These efforts require that Fermilab remain open to experimenting with new and different land management techniques as a part of how it does business effectively.

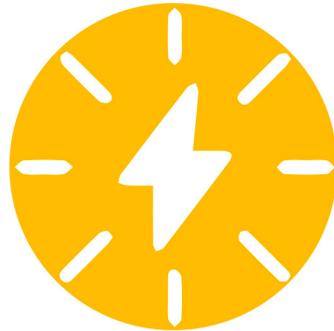
The ecological science behind managing open land continues to guide approaches to land stewardship and resource conservation. The ELM Committee also reference the Illinois Wildlife Action Plan and relevant Executive Orders concerning environmental protection. The committee works closely with the Roads and Grounds Department to integrate the ecosystem management approach into their broader responsibility of managing the site. Individual members of the ELM Committee also serve on the Campus Facility and Planning Board and Fermilab's ESH&Q Committee, chaired by the laboratory director.

**Create New Landscapes:** Landscapes beautify the Fermilab Campus, helping establish the identity of different areas, and balance development with green space and outdoor amenities. Currently, many of Fermilab's existing buildings and utility installations tend to dominate and distract from the laboratory's natural setting. Proposed landscape initiatives at select portions of the Core Campus will screen and moderate the intrusiveness of the built environment, bridging the gap between natural settings. A "connective tissue" will be created, helping shape and define the character of Fermilab for the coming generations.

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## Prioritize and Integrate Sustainability



**Energy:** Fully implement both active and passive building design strategies in all future projects. Retrofit current facilities where possible. Optimize building orientation in response to seasonal solar exposure and location. Adhere to Site Sustainability Plans goal to work toward renewable and alternative energy, providing 25% of all energy used by FY2025. Adhere to Site Sustainability Plan calling for the inclusion of net-zero design strategies by FY2020.



**Ventilation:** Natural ventilation is a key component of the passive design systems. It contributes to a healthy indoor environment and energy savings. Use cross-ventilation to cool interior spaces and to circulate air through the spaces. Use controlled ventilation during the day and night. Consider stack ventilation to cool interior spaces. Advanced ventilation and mechanical systems increase air flow and reduce exposure to air-borne microbial agents.



**Environment:** Conserve and maintain Fermilab's more than 2,000 acres of restored ecosystems per Fermilab's Ecological Land Management Plan. Preserve native plant communities and soil as much as possible. Preserve the strategy of natural landscaping and ecosystem management that requires minimal watering or mowing. Minimize erosion-causing construction practices. Connect occupants to the external environment in a meaningful and educational way.



**Health and Well-Being:** Central and attractive open staircases encourage occupants to take the stairs rather than the elevator. Bike racks, bike paths and showers encourage workers to bike to work. Natural daylighting and proper ventilation increase productivity. Double - and triple-pane insulating glass help maintain comfortable interior temperatures during the winter. Provide views to outside from as many workspaces as possible, as they have a restorative effect on workers.



**Water:** Fermilab collects rainwater to provide adequate industrial cooling water. Water is then recycled many times before evaporating into the atmosphere. This minimizes Fermilab's demand for water from external sources. At Fermilab, no potable water is used for landscape or agricultural purposes. Surface-water management is a high priority. As the land drainage systems depend on topography, a surface water management program is in place to guide long-term surface water management.



**Waste Management:** A sitewide recycling program consistently diverts well over 50% of municipal waste and construction and demolition waste from landfills. A public bus transportation system, on-site electric vehicles and encouraging carpooling would decrease pollution. Use local materials when possible to decrease the transportation load, and support the local economy. Use recycled or recyclable building materials when possible. Choose materials that provide a healthy working environment.



**Climate Change Adaptation:** Fermilab will seek to incorporate climate change resilience into campus planning and facility operations. The potential impacts of climate change will be proportional to extreme weather-related variations currently experienced in this region of the country. The implementation of forward-thinking, progressive design with an eye towards climate variability will help mitigate the potential variability risks to laboratory mission and function.



**Transportation:** A coordinated and integrated transportation system can promote health and reduce emissions. This integrated approach begins with making improvements for pedestrians and cyclists and then considering the creation of a multipassenger shuttle system between the major central districts and regions within the campus. Increasingly centralized campus developments will reduce on-site vehicular use by minimizing the need to travel around the site encouraging more pedestrian and bike use.

## Improve Mobility and Wayfinding

How Fermilab's campus functions and the experience it provides depend in large part on how people move about and how well-connected the lab's various parts are to one another. Given its location, size and land-use diversity, Fermilab must accommodate multiple modes of travel. This section addresses aspects of the laboratory's movement systems, focusing on strategies to make the campus more pedestrian and bicycle friendly and less automobile-dependent. Additionally, it addresses the need for informational and directional signage in order to make the campus more navigable and understandable.

**Approach and Arrival:** The initial experience of the first-time visitor is via the Pine Street entrance. The experience is unimpressive and possibly disorienting. Jersey barriers, flashing lights, an unoccupied guardhouse, the visual clutter of piping and mechanical equipment west of the MINOS building, the lack of signage, and a confusing intersection as one approaches Wilson Hall are components of the visitor's impression upon arrival.

**Visitor Experience:** As mentioned previously, a compact core campus with new visitor-friendly buildings can greatly enhance the visitor experience. Improved signage will welcome, inform and direct visitors guiding their visit and help them understand what happens at Fermilab. The Campus Plan also proposes informative sign kiosks at key points around the site. Examples include the bison field, the prairie, the butterfly trail and the site entrance.

**Signage and Wayfinding:** The Fermilab Campus Master Plan *Guiding Principles* aim to ensure an enhanced campus experience that is welcoming and informative to both local and international visitors. The campus plan initiatives envision integrative design, improvements in campus landscapes, and improvements in mobility and wayfinding. A complete integrated signage system approach and design should be developed and incrementally realized as the campus plan implementation proceeds.

**Parking:** Parking will continue to be a necessary and significant presence on the site. However, large uninterrupted fields of asphalt should be avoided by using landscape initiatives to integrate entire developments with their natural surroundings. Whenever possible, parking should be reduced, consolidated, screened and/or tucked under buildings to minimize its visual impact. Paving areas should be reduced to a minimum throughout the site. Where vehicles are welcome, the needs of pedestrians and transit users should be a paramount concern, ensuring the development of a truly pedestrian-oriented campus.

**Cycling:** Improvements for cycling the campus should include the creation of designated bike lanes along Pine Street and Discovery Road, along with improved signage and segregation for primary bike routes through campus. Major new buildings should include indoor bike storage spaces, along with shower and changing rooms. All occupied buildings should have adequate bike rack space. Consideration should be given to a bike sharing program with stations at major populations areas within the campus.

**Vehicles and Traffic:** Given limited mass transit options to reach Fermilab, cars will continue to have a large presence on the campus. However, as consolidation and centralization progress, the number of vehicles traveling around and across the campus can be reduced. Walking, cycling and transit use can become realistic options for day-to-day business.

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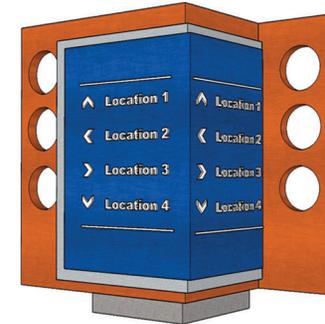
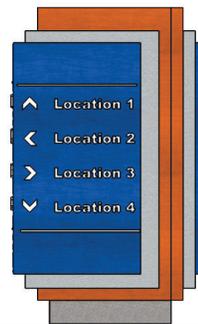
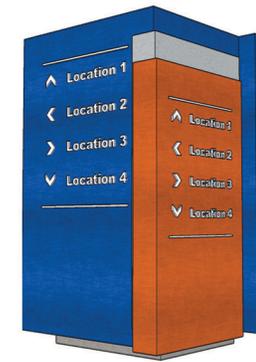
**Regional Signage**



**Building Signage**



**Wayfinding Signage**



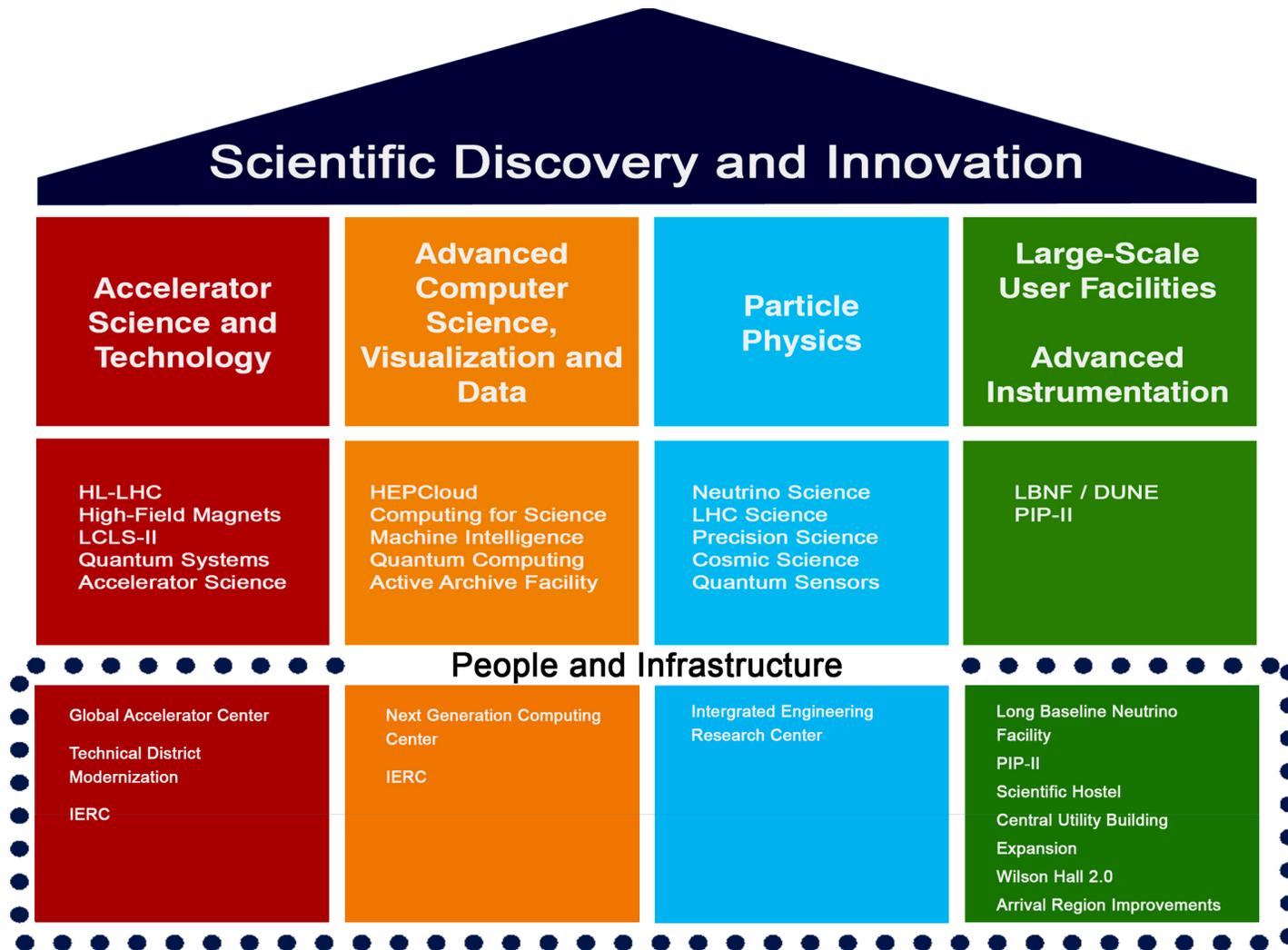
# Development Plan

Over the next 20 years, the projects set forth in the Development Plan will transform the laboratory. Informed by the *Guiding Principles*, the vision for the campus, and the laboratory Strategic Plan, they present a balanced portfolio of facilities and upgrades.

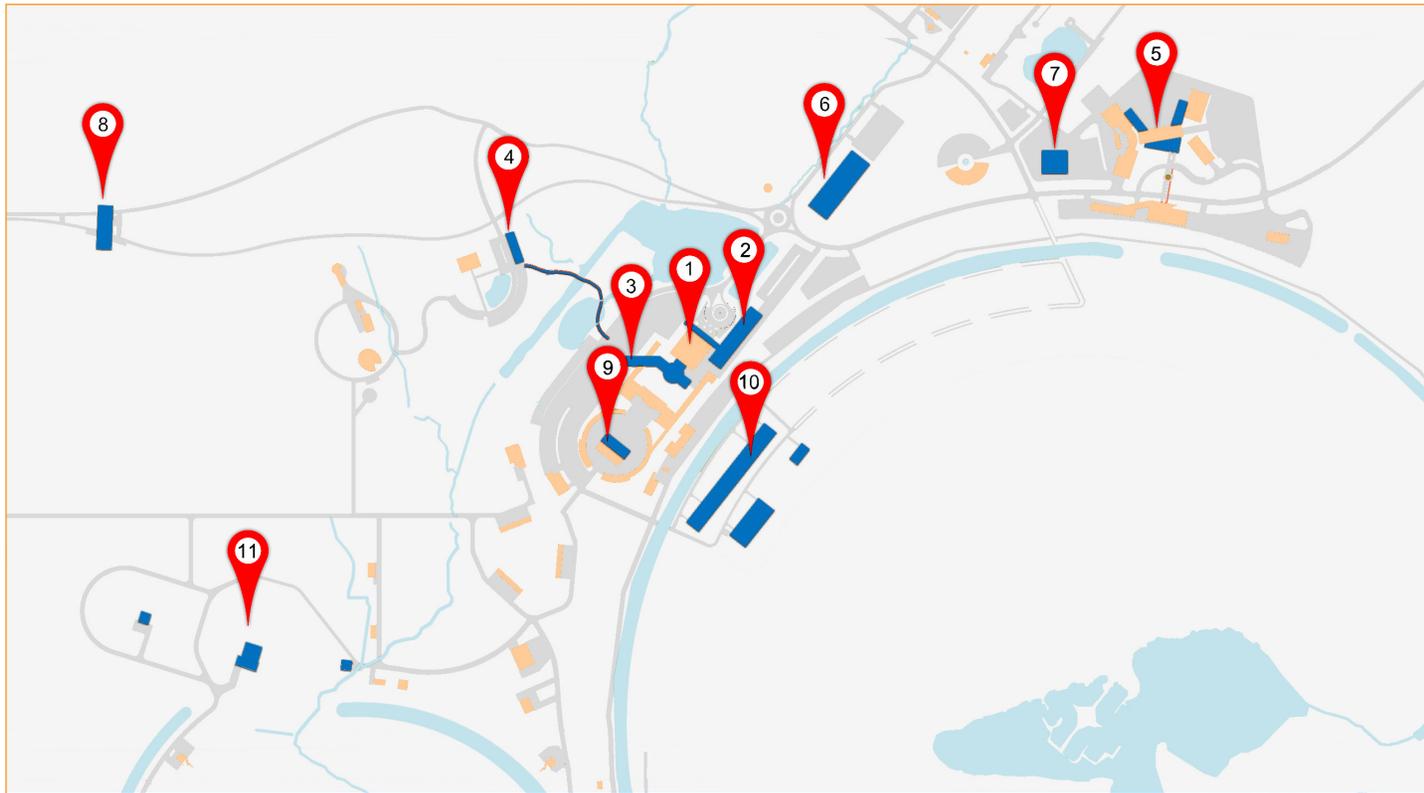
The following two pages provide a big picture overview of the projects via two diagrams. The first, a drawing from the Strategic Plan presented in Part I, notes the development projects in support of the laboratory's core capabilities. The second is a location key map locating the proposed development projects. Individual project descriptions follow, completing Part III.

Completion of strategic development projects will culminate in a modern, state-of-the-art laboratory, positioned as the centerpiece of a global science program.

# Strategic Plan



## Development Projects Key Map



### Legend

- |   |  |                                       |
|---|--|---------------------------------------|
| 1. Wilson Hall 2.0                        | 5. Technical District Modernization                  | 9. Central Utility Building Expansion |
| 2. Integrated Engineering Research Center | 6. Next Generation Computing Center (Possible site)  | 10. PIP-II                            |
| 3. Global Accelerator Center              | 7. Next Generation Computing Center (Alternate site) | 11. Long Baseline Neutrino Facility   |
| 4. Scientific Hostel                      | 8. Arrival Region Improvements                       |                                       |

## Wilson Hall 2.0

<i>Core Capability:</i>	<i>Large-scale user facilities</i>
<i>Scope:</i>	<i>Portfolio of individual projects supporting ongoing renovation of existing 16-story office building</i>
<i>Area:</i>	<i>420,000 square feet</i>
<i>Year Built:</i>	<i>1972</i>
<i>Usage:</i>	<i>Research, administration and collaboration</i>
<i>Capacity:</i>	<i>750 staff currently</i>

Significant technological, cultural and sociological changes have occurred since Wilson Hall's construction in 1972. Workplace design is more important than ever before. A fundamental shift has occurred in the way people work. Younger generations and recent graduates expect multiple possible types of workspaces, including ones that are more casual and open than just the office or the cubicle.

For these reasons, Wilson Hall 2.0 reimagines the iconic hub of Fermilab life and culture. As Fermilab moves into its next generation of workers, creating the open, inviting and collaborative international research community envisioned at Fermilab necessitates the renovation and reorganization of Wilson Hall. Workspaces will be transformed into places designed to foster collaboration, attract and retain the next generation of scientific researchers, promote well-being, and use space efficiently.

Wilson Hall 2.0 is not one large project but rather an umbrella encompassing several, recently completed, ongoing, or evolving and planned revitalization efforts over the next decade. Completing these projects will ultimately renovate the entire building. In that context, the following pages illustrate recent improvements to the atrium, highlights of the current Wilson Hall Renovations GPP project, and other planned improvements. When completed, the portfolio of projects will transform Wilson Hall into vital and relevant hub for the next era of science.

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## Recently Completed



*An area for visitors to feel welcome while viewing Fermilab video presentations has been recently unveiled. Located behind the video wall are two fully renovated public restrooms.*

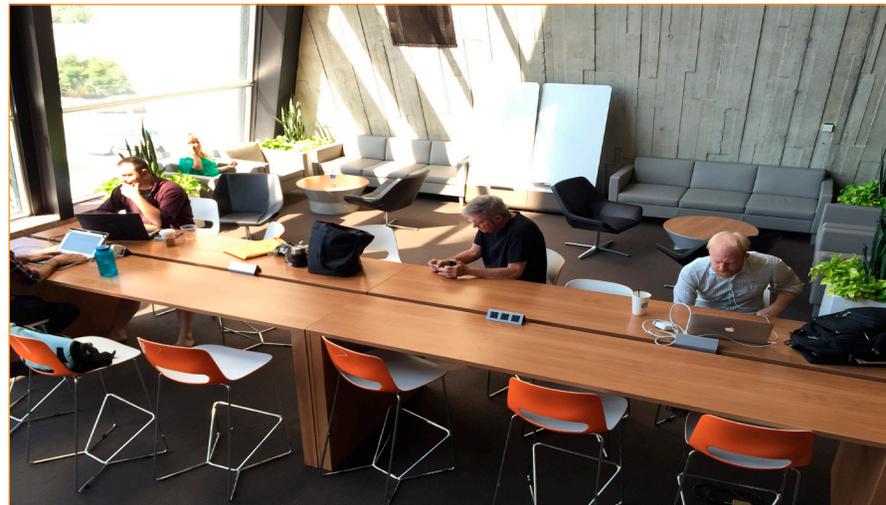


*Formerly heavy and off-putting concrete walls were removed to create an open and transparent entrance for a new director's office (beyond). Seating groups and planters have been placed around the atrium, creating a warm and hospitable environment.*

*The newly installed reception desk, staffed during business hours, directs business visitors to their destinations while informing the casual curious visitor about what to see and do during their visit.*



*The southeast and southwest corners of the atrium have been reimagined and renovated as “work café” areas. These function as informal collaboration and meeting spaces as well as alternative individual work areas offering a break from typical office space.*



## Current Projects

**13th Floor Renovation Project:** Wilson Hall has not had significant renovation since its original construction in the 1970s. The 13th-floor renovation is the first of many projects that will reimagine and modernize Wilson Hall for the next era. When completed in the summer of 2018, it will reveal a fresh, state-of-the-art, flexible and adaptable headquarters for the LBNF staff. Embodying the vision for the future, it establishes the prototype for future planned renovations of Wilson Hall. The diagram below illustrates the concept model floor plan. This concept informed the 13th-floor project and will serve as guidance for future ongoing floor-by-floor renovations.



**Ground Floor Renovation – Step 1:** Currently, much of the square footage on the ground floor is devoted to machine shops and other utilitarian uses. However, due to its convenient access, these areas present excellent potential as prime locations for broadly used employee and staff functions. In that spirit, machine shops will be relocated to suitable locations outside of Wilson Hall and the spaces re-imagined. The phase one renovation project creates two major new functional spaces. The first is an office suite and studio for the Creative Services Group. The second is a new Global Services Center. This center, located immediately adjacent to the well-traveled west entrance, will provide a welcoming and useful portal for the many international users arriving annually. The target completion date for these two projects is mid-2018.

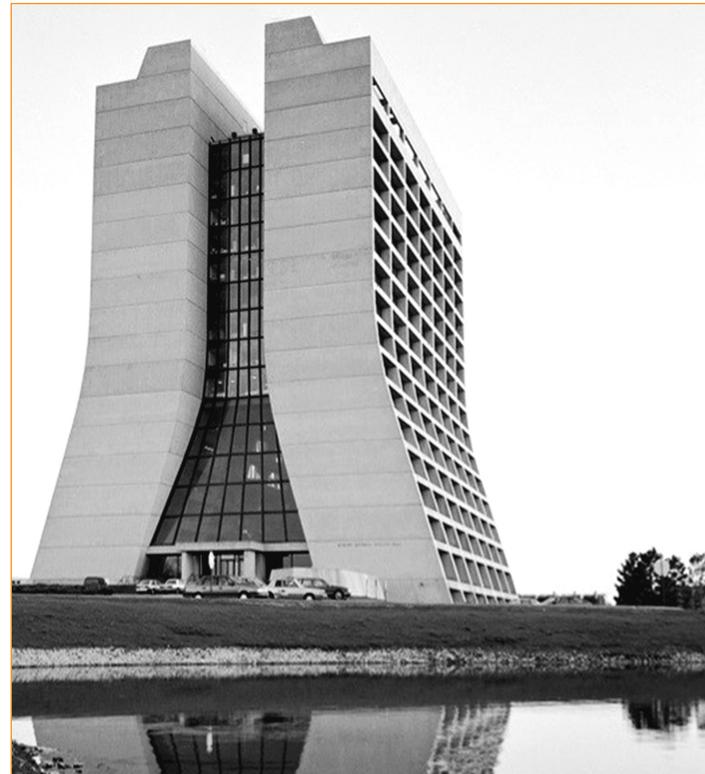
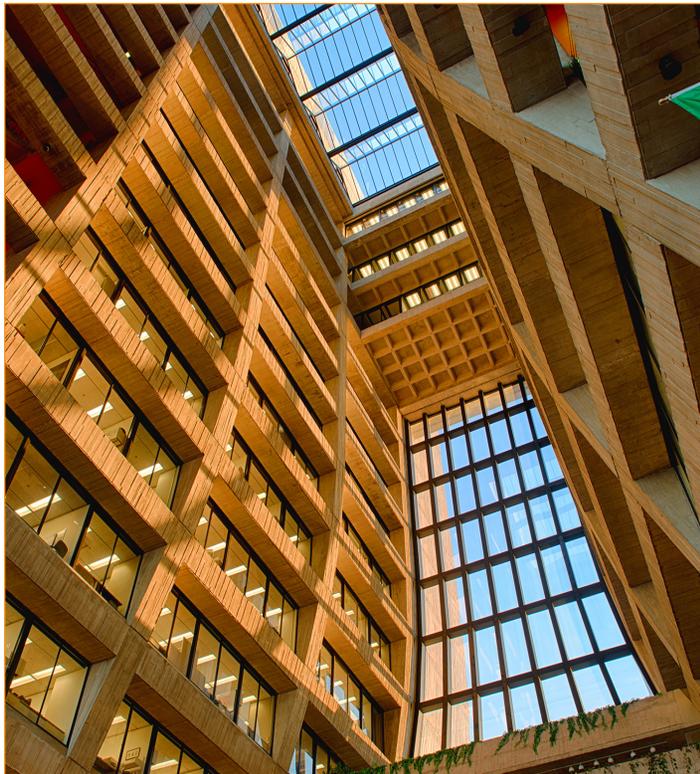


## Future Projects

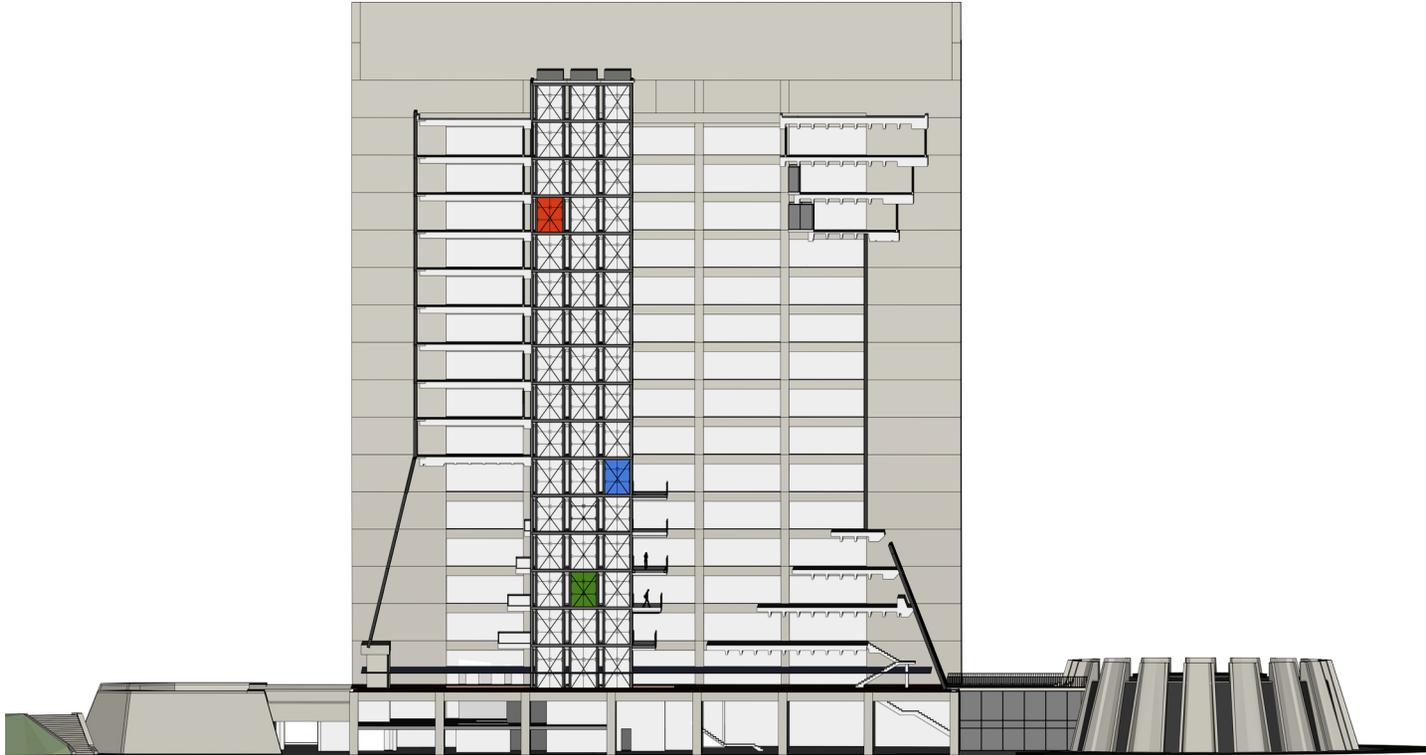
**Ground Floor Renovation-Step 2:** Continuing the reimagining of the ground floor, a new wellness center centrally located for convenient usage by Fermilab staff is proposed. Replacing inconveniently located and inadequate founding era fitness center in the Village, the project will also include a modernized medical office and a new public corridor easily accessing the auditorium from the Wilson Hall main ground-floor entrance. New public toilet rooms for the auditorium and general usage are also included in the phase 2 scope.



**Building Shell and HVAC:** Wilson Hall's nearly 50 year old building shell and infrastructure are in need of renovation. Improvements should include the full replacement of all windows with new, energy-efficient windows and glass curtain walls. Also needed are comprehensive exterior concrete repairs. Together, these improvements will create an energy-efficient and maintainable shell while keeping the historic facade and architectural expression intact. The HVAC and plumbing systems are in need of major system replacements. Wilson Hall's core HVAC, plumbing and piping equipment and controls should be completely replaced with modern, state-of-the-art systems, allowing for greater control and efficiency. Combined, these projects will improve occupant comfort, reduce energy consumption and improve functional reliability, setting the stage for the next 50 years.



**Elevator and Life Safety Upgrade:** Designed and constructed between 1969 and 1972, Wilson Hall was conceived around that era's emerging trend of designing a building around a large, full-height atrium. In the intervening years, continuous improvement to life safety issues in atriums have evolved. Wilson Hall would benefit from implementing these life safety improvements. Additionally, from the beginning, Wilson Hall has had no freight elevator and insufficient passenger elevators to meet the daily demand. This will become increasingly problematic considering renovations over the next decade. As illustrated, the project will install six new high-speed glass elevators, located in center of the atrium. Extending from the ground floor to the 15th floor of Wilson Hall, they will remedy a longstanding problem. The existing elevator shafts will be retrofitted with much needed freight elevators. Life safety improvements will include enclosure of the open atrium stairs and the installation of a smoke evacuation system for the atrium.





## Integrated Engineering Research Center

<i>Core Capability:</i>	<i>Particle Physics</i>
<i>Location:</i>	<i>Adjacent to Wilson Hall</i>
<i>Size:</i>	<i>93,500 square feet, four stories</i>
<i>Status:</i>	<i>Conceptual design</i>
<i>Usage:</i>	<i>Laboratory, office, technical and collaboration Space for 200 staff and users</i>
<i>Replace:</i>	<i>Obsolete facilities scattered throughout the site</i>

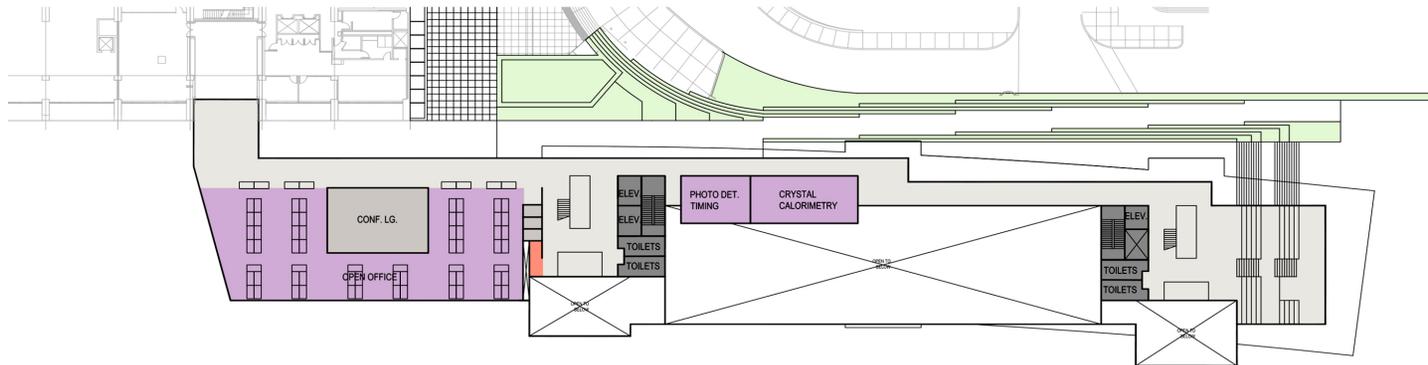
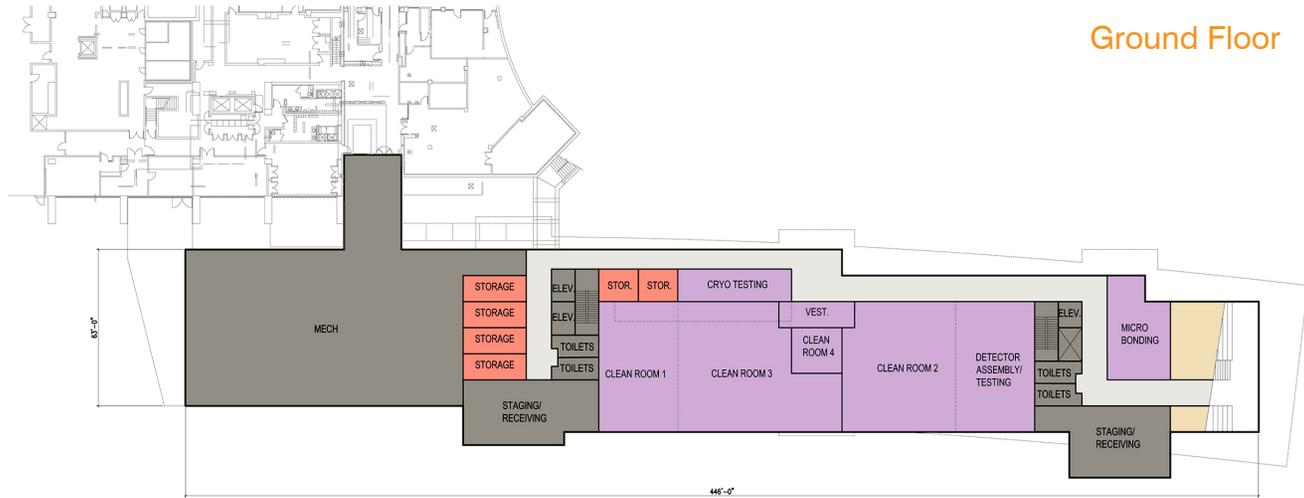
Bringing people together is a vital feature of a collaborative international research community. The Integrated Engineering Research Center (IERC) creates a 93,000-square-foot facility promoting interdisciplinary collaboration and greater efficiency in designing, developing, building, commissioning and operating particle physics accelerator and detector facilities and equipment.

Replacing outdated laboratory space and obsolete facilities, the IERC will revitalize and streamline research in particle physics for the benefit of the particle physics community and the DOE Office of Science. The IERC will consolidate engineering and technical teams in a collaborative environment, bringing together engineering disciplines from Fermilab's Accelerator Division, Particle Physics Division and Scientific Computing Division. The result will be interdisciplinary collaboration built on existing laboratory capabilities and expertise, currently dispersed across the Fermilab site.

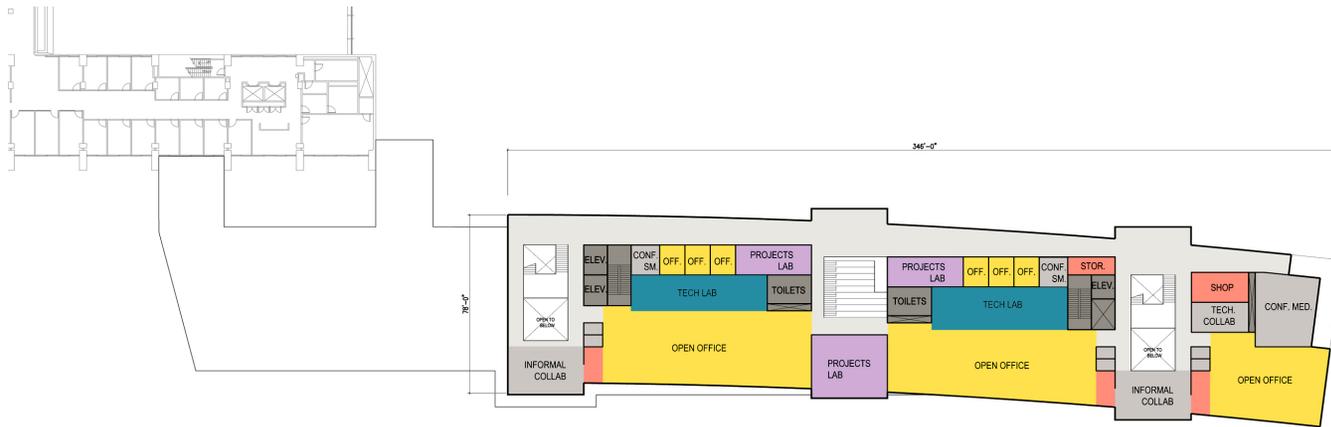
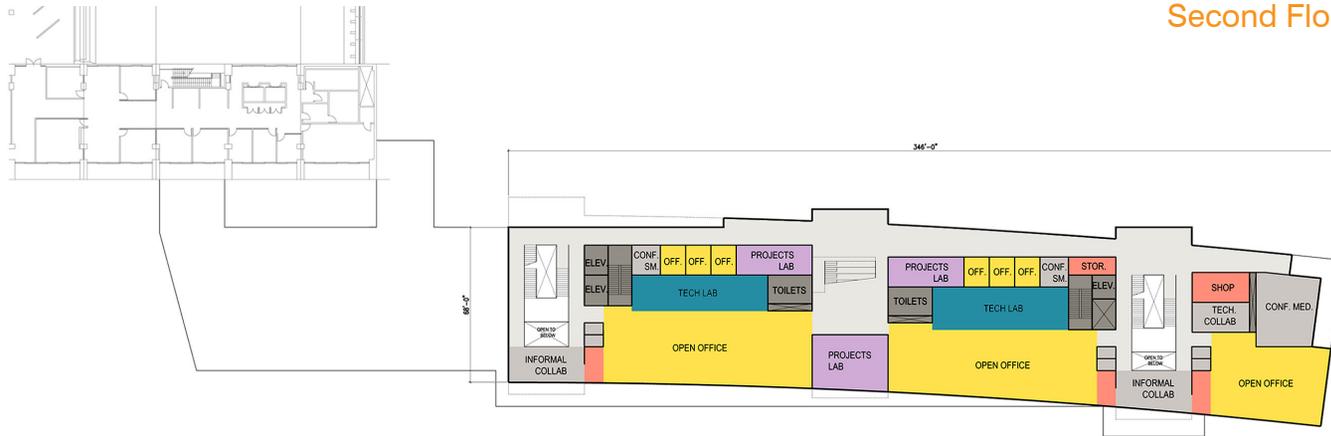
The IERC is a four-level structure with direct indoor connections to Wilson Hall at the ground level and atrium level, integrating staff directly in the vibrant center of Fermilab. The ground floor contains flexible high-bay space for state-of-the-art cleanrooms. The concourse level flows from the Wilson Hall atrium, connecting all the IERC via its two vertical collaboration zones. The concourse also accesses the Wilson Hall entrance plaza, invigorating and connecting the exterior spaces. The two upper floors contain flexible and reconfigurable space for engineers and staff.

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## Second Floor



## Third Floor

## Global Accelerator Center

<i>Core Capability:</i>	<i>Accelerator science and technology</i>
<i>Location:</i>	<i>Directly south and attached to Wilson Hall, walking distance to PIP-II and LBNF science facilities</i>
<i>Size:</i>	<i>95,000 square feet, four stories</i>
<i>Status:</i>	<i>Conceptual design</i>
<i>Usage:</i>	<i>Laboratory, office, technical and collaboration Space for 300 staff and users</i>
<i>Notable:</i>	<i>Connection to WH includes expansion of WH dining, accommodating staff relocated to center of campus and replaces obsolete facilities across the site. It will be designed as Fermilab's first net-zero energy-efficient building.</i>

Fermilab has transitioned from operations focused on high-energy colliding beams at the Tevatron to providing high-intensity proton beams for neutrinos and precision physics measurements using muons. Additionally, Fermilab leads national and international teams of accelerator scientists to develop transformational accelerator technologies for use across the site. This transition, combined with the condition and age of Fermilab accelerator facilities, creates the need to consolidate core research functions and modernize key support buildings.

In that spirit, the Development Plan proposes construction of the Global Accelerator Center. This modern facility will provide modernized working conditions for many laboratory staff, creating a unified culture with a strong sense of community both for the laboratory and national and international user community. It will house laboratory accelerator scientists and visiting and collaborating nationals, as well as international accelerator scientists.

The Global Accelerator Center will replace current, 40 year-old, outdated and inefficient buildings and portable trailers currently spread across the laboratory. It will enable integration of the accelerator science, operations, and technology community and allow these scientists to better support the science missions at the laboratory. In addition, the project will renovate for adaptive reuse two 1970s era buildings (the Cross Gallery and Transfer Gallery). The project will result in interdisciplinary collaboration built on existing laboratory capabilities and expertise, currently dispersed across the Fermilab site.



## Scientific Hostel

<i>Core Capability:</i>	<i>Large-scale user facilities</i>
<i>Location:</i>	<i>Walking distance west of Wilson Hall</i>
<i>Size:</i>	<i>100 “microhotel” guest rooms, four stories</i>
<i>Status:</i>	<i>Conceptual design</i>
<i>Usage:</i>	<i>Hostel, augmenting existing long-term housing on site</i>

The phrase “eat-sleep-work to drive discovery” has become a Fermilab motto, capturing the atmosphere critical to implementing its role in the Particle Physics Project Prioritization Panel (P5) Strategic Plan, “Building for Discovery.” Convenient temporary lodging is important to realizing laboratory goals and the creation of an open, inviting and collaborative international research community.

To that end, the Development Plan proposes the construction of a 100-room hostel as part of the laboratory complex. Drawing from the Master Plan vision, the *Guiding Principles* and the motto, the Scientific Hostel will be located near Wilson Hall, placing it in the dynamic center of activity. Designed for short-term visitors, one night through two weeks, the facility fills a niche not currently accommodated in Fermilab's Village housing. Planned operation via a private enterprise hospitality organization will also make the rooms available to general community surrounding Fermilab.

Providing modern, attractive, efficient rooms’ it employs the emerging “millennial” design approach to lodging. This approach creates very compact guest rooms (1/2 to 2/3 the size of standard rooms). While economical to construct, the smaller rooms also encourage guests to use spaces outside of the room for work while staying at Fermilab. As Wilson Hall is only a quarter-mile walk through a pleasant wooded area, it encourages collaboration with colleagues within community gathering spaces the atrium.

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*The room designs use space efficiently while providing state-of-the-art technology to keep visitors connected and engaged during their working visits. This approach emphasizes stewardship of natural and financial resources as well as energy consumption.*



## Technical District Modernization

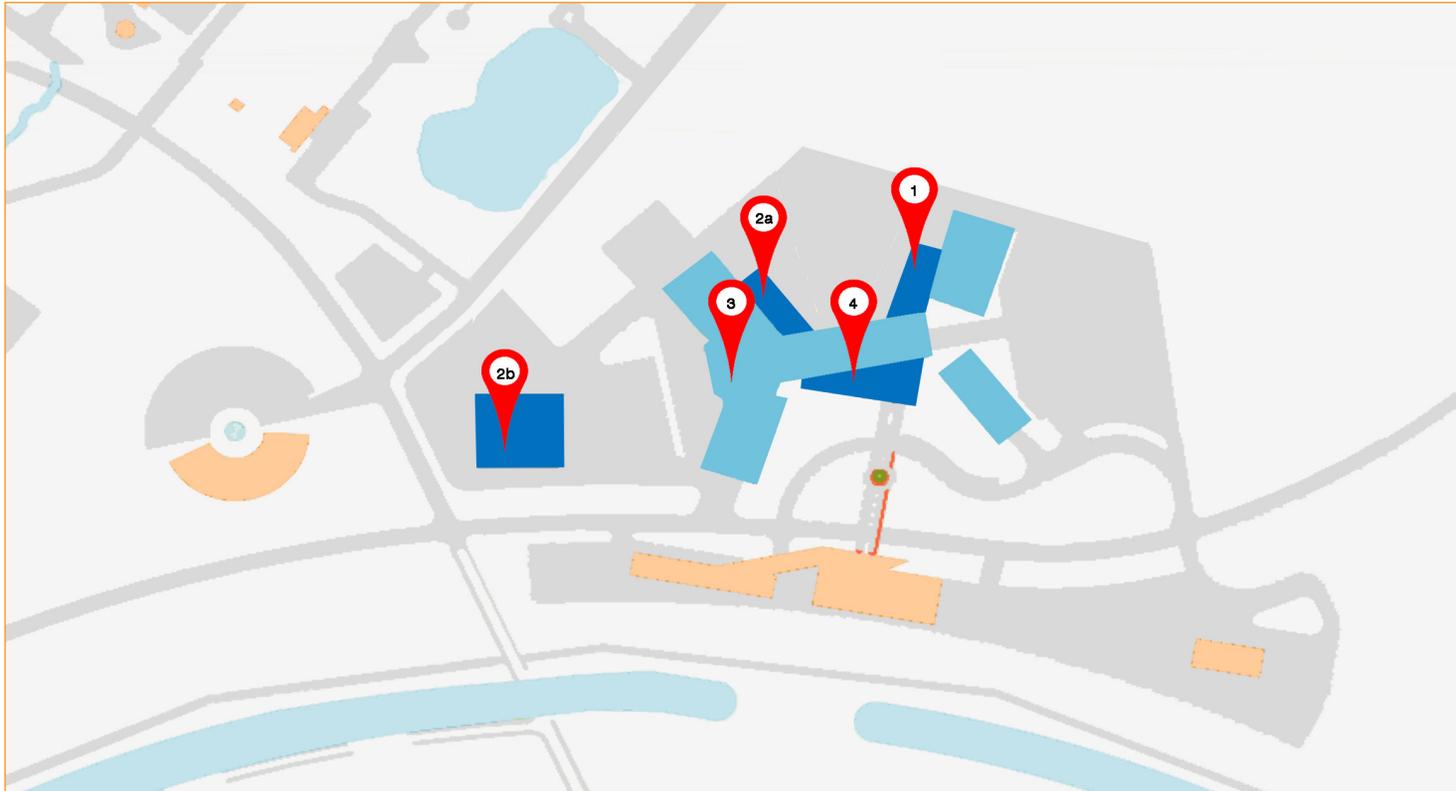
<i>Core Capability:</i>	<i>Accelerator science and technology</i>
<i>Scope:</i>	<i>Portfolio of four projects in support of ongoing modernization of the Technical District</i>
<i>Usage:</i>	<i>Component processing assembly, office and technical</i>
<i>Status:</i>	<i>One project funded and in current development</i>

For nearly 40 years the Technical District complex of industrial buildings has been home to the vital mission of design, development, fabrication, procurement and testing of accelerator components. Here Technical Division personnel not only build the components of the accelerators and detectors of today and the near future, but also think far in advance to prepare for the next generation of high-energy physics machines.

The Technical District is a complex of six major facilities along with several ancillary buildings and structures. As Fermilab embarks on its next major scientific initiatives, the complex is in need a makeover. In that spirit, the Development Plan proposes projects to modernize the complex. When completed, these projects will provide a renovated and reinvigorated Technical District, exemplifying the Master Plan Guiding Principles and setting the stage for its next 40 years and beyond.

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## Modernization Projects Key Map

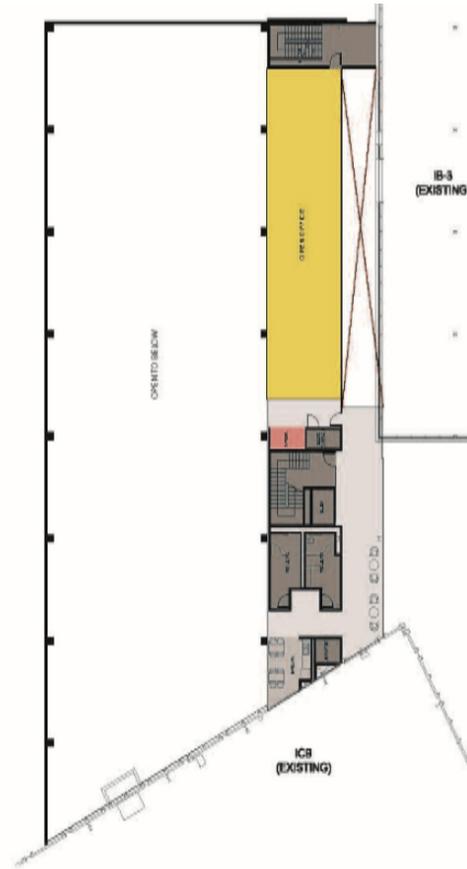
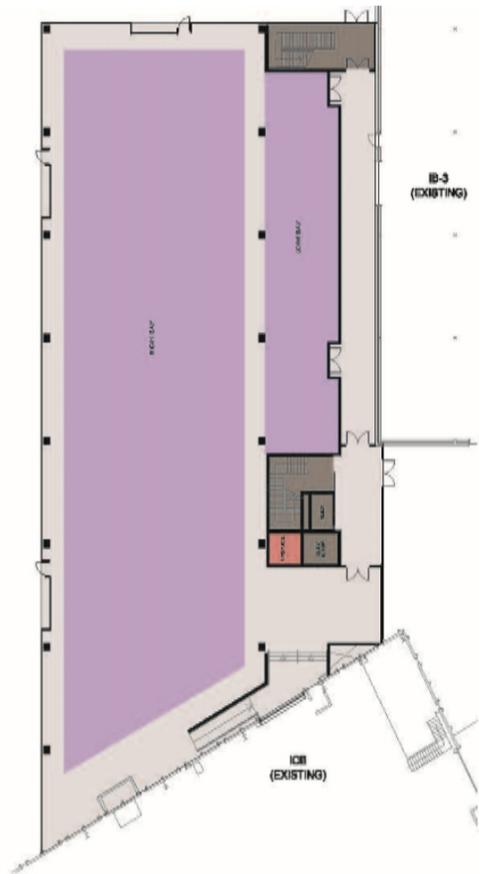


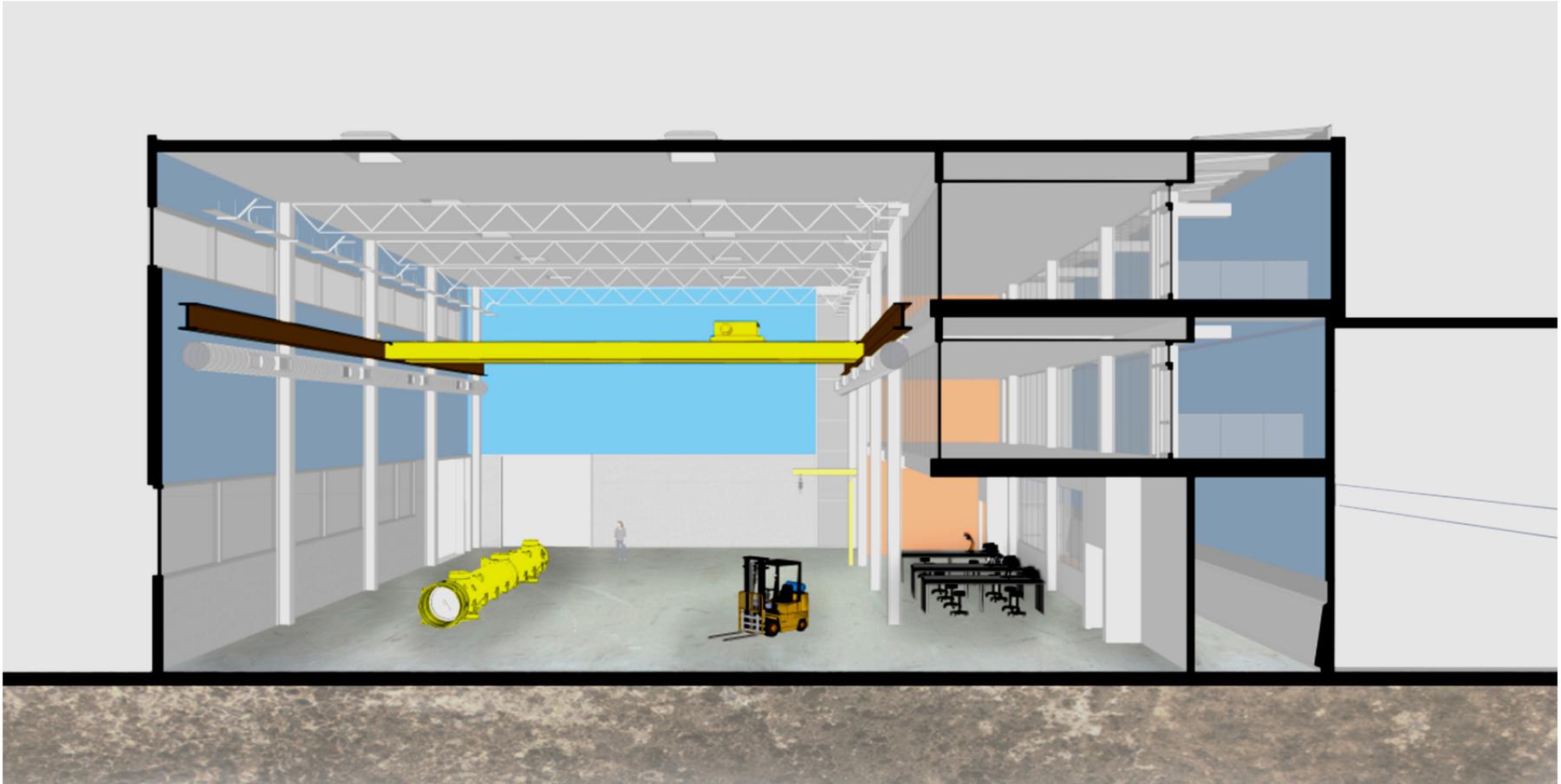
### Legend

1. ICB-A
2. Consolidated Machining Center (2a/2b alternate)
3. Industrial Buildings Revitalization
4. Industrial Center Gateway

## Current Projects

**ICB-Addition:** Fermilab's ongoing ambitious science program is pressing the industrial facilities toward a particularly intense period of component processing and assembly. Responding to the evergrowing demand placed on the current infrastructure, the Department of Energy has approved the construction of the ICB-A project, providing additional high bay and supporting office space to meet this demand.



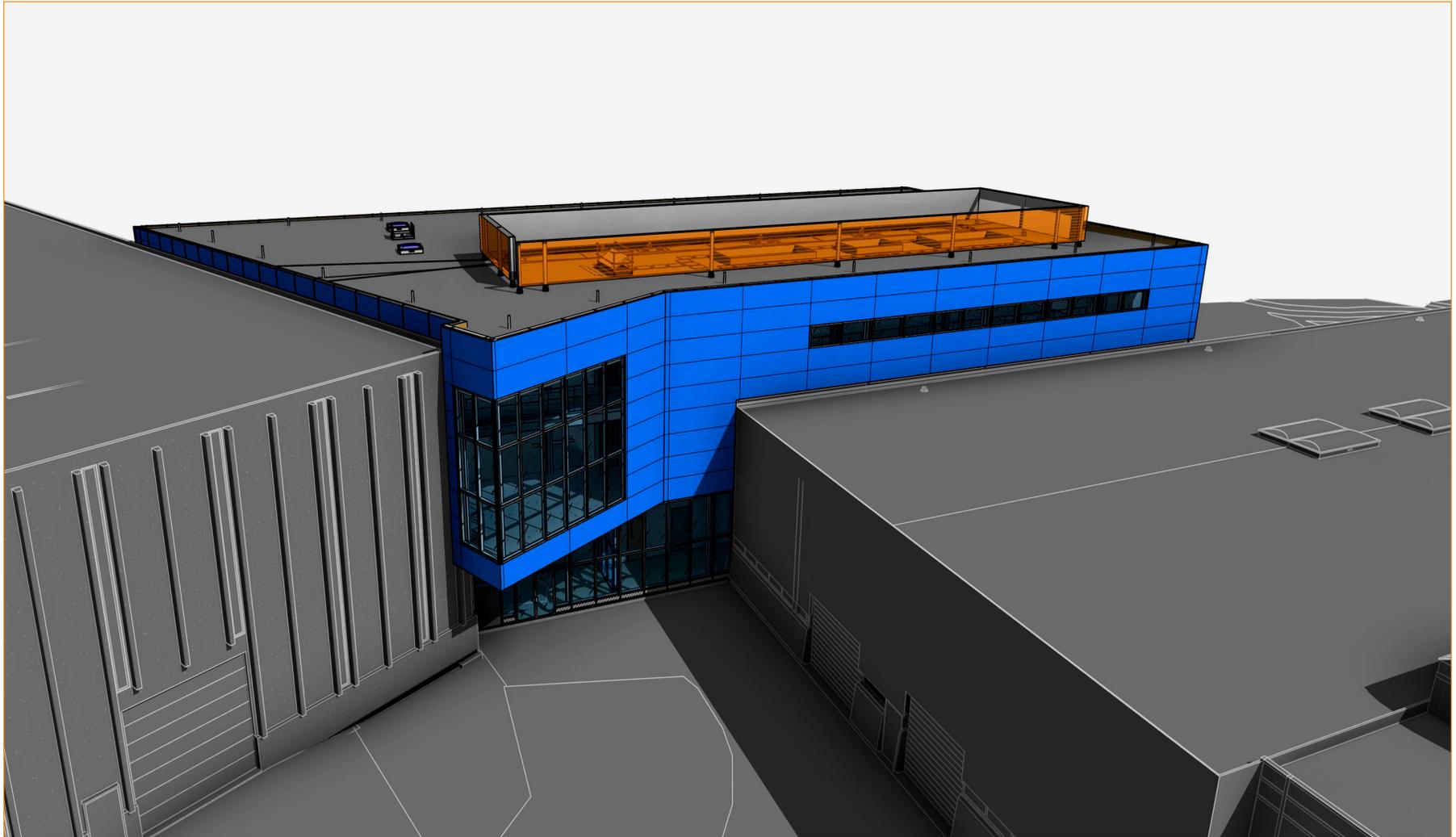


*The project will build a new high-bay addition to the Industrial Center Building (ICB). The proposed addition will include 15,000 gross square feet at grade comprising 10,500 square-feet of high-bay space with 40-ton crane coverage and 2,400 square feet of low-bay space. When completed in 2019, the ICB addition will provide critical high-bay space for component processing and assembly, well positioning the complex for the future.*









## Future Projects

**Consolidated Machining Center (CMC):** In the spirit of consolidation and centralization, this proposed facility will replace 12 scattered, remote and obsolete buildings dating from the suburb and basecamp eras, enabling their demolition. Two possible locations are under consideration. One is the site currently occupied by the decommissioned Central Helium Liquefier. The other is as a mirror image to the current ICB-A project. In either case, the CMC's location will be convenient for both the Technical Division and the laboratory at large. The new CMC will also incorporate the functions and equipment currently located in the ground floor of Wilson Hall, freeing this space for the construction of the employee wellness center, part of WH 2.0.



**Industrial Buildings Revitalization:** Beyond IARC and IBC, the other four major buildings in the Technical District are IB-1, IB-2, IB-3 and IB-4. The exteriors of these buildings, all constructed early in the Wilson Years, are suffering significant deterioration of their metal siding and window systems. The revitalization project will design and install new energy-efficient siding and windows on all four buildings, preparing them for the next era. In addition to providing significant energy and maintenance savings, the overall aesthetics of the region will be improved, enhancing the campus experience and aiding efforts to attract and retain the next generation.



**Industrial Center Gateway (ICG):** The ICG is proposed as staff offices for the Technical Division HQ and support staff. Replacing current dark, narrow, bunker like office space, this 15,000-square foot building will provide modern, day-lit office space for about 40 division management and staff along with conferencing, collaboration and other common spaces. The location directly to the south of, and attached to, the pre-cast concrete industrial center (ICB) will provide a fresh and inviting “face” and clear entrance to the Technical Division. Providing transparency for visitors and a more functional organization of offices for management, engineers and scientists, it will also connect with other buildings, including the soon to be completed ICB addition. Exterior work will include reimagined roadways, pedestrian ways and courtyard to the south, visually unifying the new construction with the recently completed IARC facility.



## Next Generation Computing Center

<i>Core Capability:</i>	<i>Advanced computer science, visualization and data</i>
<i>Location:</i>	<i>Near Feynman Computing Center</i>
<i>Size:</i>	<i>80,000 square feet, three stories, plus berm space</i>
<i>Status:</i>	<i>Conceptual design</i>
<i>Usage:</i>	<i>Computing systems and archival data storage</i>

Computational science is an important strategic theme at the laboratory. Fermilab's core capability in advanced computer science, visualization and data is at the heart of understanding and interpreting the scientific mission. Major computational science initiatives on the horizon include the HEP Cloud, an active archival facility, and a scientific workflow system.

Supporting these initiatives requires ongoing improvements in computational science infrastructure and facilities to keep pace with fast developing technology and scientific demands. The Development Plan proposes the construction of the Next Generation Computing Center (NGCC). Located in the Computing District near the iconic Feynman Computing Center (FCC), this facility will provide additional functionality complementing the FCC and setting the stage for the next generation.

Two major elements are included in the conceptual program for the new NGCC. The first is "big data" storage. This storage-driven component will provide large disk storage, tape storage and networking space. This space is planned to be located underground, protected from weather disasters, as it will house "treasure data" from experiments.

The second element is the construction of space to provide additional computing systems and equipment. Two system augmentations are envisioned; one system for business needs and a separate more open system for the scientific community and other general-purpose needs. The project design process will investigate the use of open-air, state-of-the-art, and green cooling systems. When completed, the NGCC will provide much needed facilities and capacity for the next generation of computational science at Fermilab.

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## Arrival Region Improvements

<i>Core Capability:</i>	<i>Large-scale user facilities</i>
<i>Scope:</i>	<i>Portfolio of six projects to improve campus arrival and major circulation areas, functionally and aesthetically</i>
<i>Status:</i>	<i>Conceptual design</i>

As noted in earlier in the FCMP, the visitor experience to the campus needs improvement. The main entrance is confusing and disorienting, and vehicular circulation and wayfinding is inadequate and at times unclear. Part II of the FCMP details several initiatives to address these issues. Building on those initiatives, the planning team developed a group of projects under the umbrella of the Arrival Region Improvements. These improvements will reimagine and transform the entire entrance experience from the Kirk and Pine intersection to Wilson Hall. The projects are multifaceted, bringing together integrative design improvements in campus landscapes, facilities, mobility and wayfinding,

The current entry experience misses the mark of creating the welcoming and informative visitor experience envisioned by the FCMP. As one of the first planned improvements, a new 24-hour, manned entrance gateway and gatehouse are proposed to address this first-impression issue. Presenting a fresh and inviting portal to the campus, it will replace the current outdated gate, confusing road configuration and off-putting concrete barriers. Central to the project is the new guardhouse replacing two existing obsolete structures. The most ambitious version of this plan will include a new state-of-the-art security office and visitor center.

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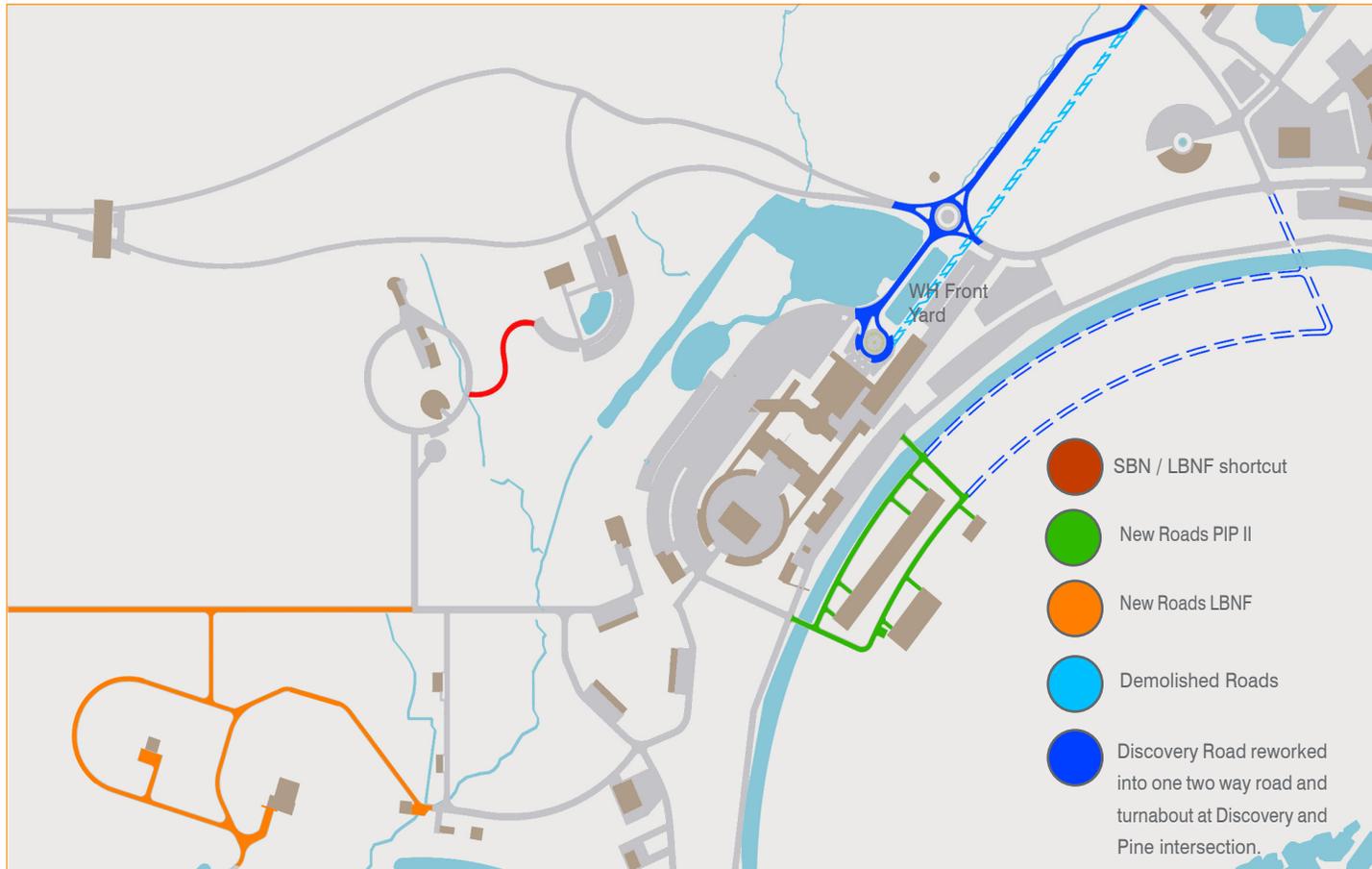
**Wilson Hall “front yard”:** This project reimagines the “front yard” of Wilson Hall (noted on map on facing page): the roads, parking and landscaping defining the reflecting pond. Major emphases of the design are removal of parking from the area, the elimination of the easternmost of the two access roads, integration of the new IERC, pedestrian and bike paths, and vehicle-free access to the pond from IERC to the reflecting pond.



**Landscaping Improvements:** Landscaping and other screening approaches are proposed to hide undesirable views of equipment and the like within the Arrival Region. The diagrams above show before and after renderings illustrating two of the most pressing areas for visual improvements via landscape interventions. Other landscape improvements are integrated within each of the other individual projects.

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**New roadways and pathways:** This project envisions the construction of new connecting roads to better access the SBN area and ultimately provide access to LBNF. Also, considered are upgrades to the pathway from the Lederman Center and Scientific Hostel to Wilson Hall, including lighting and pedestrian amenities.



## Central Utility Building Expansion

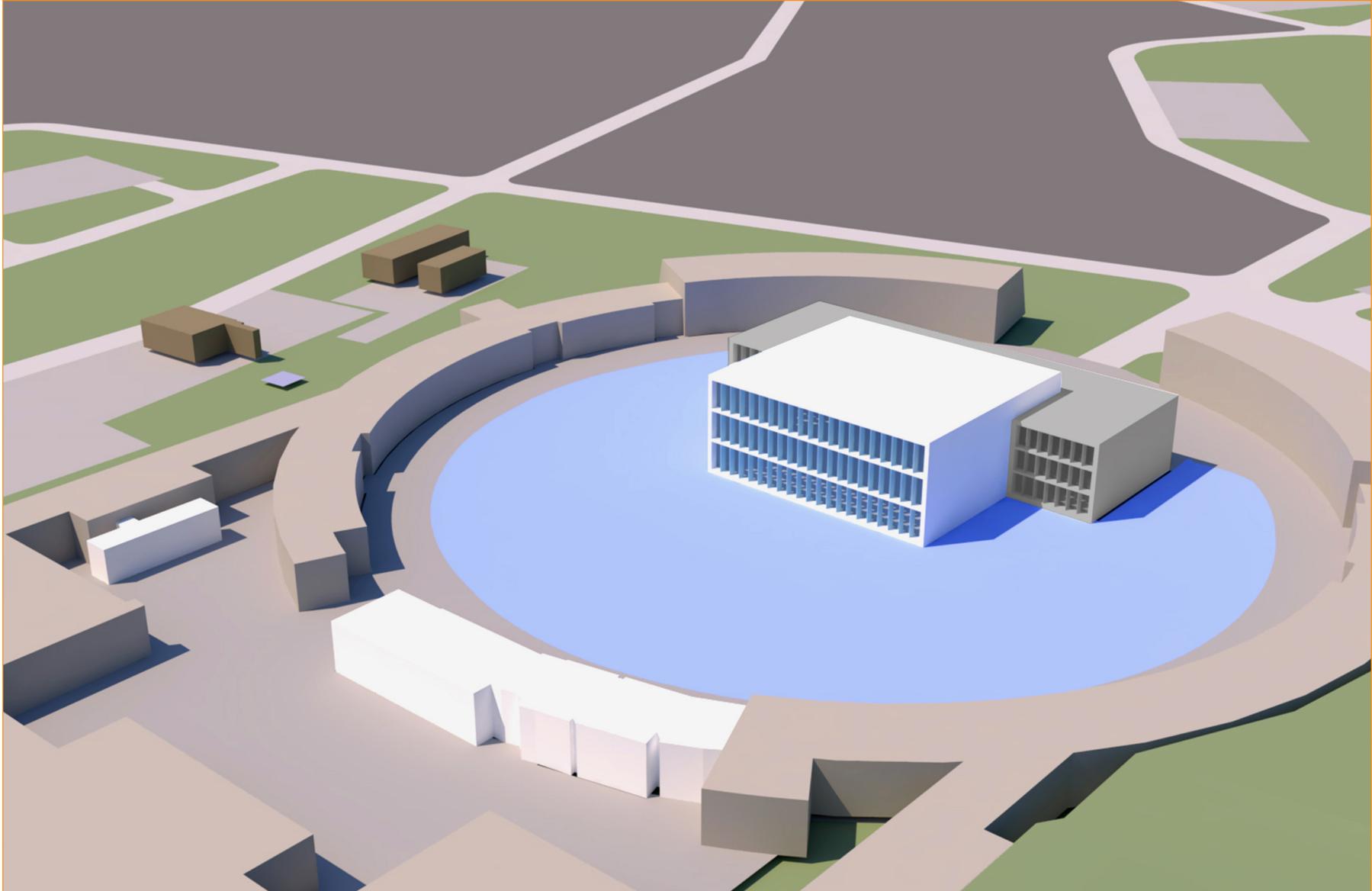
<b>Core Capability:</b>	<i>Large-scale user facilities</i>
<b>Scope:</b>	<i>12,000-square-foot central utility building resulting in a 28,000-square-foot facility</i>
<b>Status:</b>	<i>Conceptual design</i>

The utility plant at Fermilab's Central Utility Building (CUB) has a proven, decades-long track record of efficiently providing heating and cooling water for both conventional and programmatic uses. The conventional side provides water for heating and cooling Wilson Hall, as well as the footprint area buildings south of Wilson Hall. The programmatic side of the plant provides treated water to experimental areas and facilities beyond the footprint.

As described elsewhere in the Development Plan, several projects in the vicinity are in the planning stages. This convergence of next-era developments presents an important opportunity for synergy of projects. Expanding the CUB will enable Fermilab to build on its efficiency while increasing its capacity to serve these new projects. One project that could use an expanded and upgrade CUB is the Integrated Engineering Research Center. Another is the Global Accelerator Center, proposed just south of Wilson Hall and very near the CUB. Finally, on the programmatic side, the Superconducting Linac Complex hosting the PIP-II and ultimately PIP-III accelerators is planned just to the east of the CUB and will benefit from process water.

The expansion is necessary and beneficial on two fronts. The first is assuring its continued efficient operation to meet current loads, by providing much needed space for maintenance access, equipment replacement and redundancy, and functional separation needs. Secondly, it will facilitate the provision of heating and cooling water to potential nearby developments noted previously. In summary, the enlarged facility will serve the needs for the next 20 years in a safe, maintainable, efficient and accessible manner.

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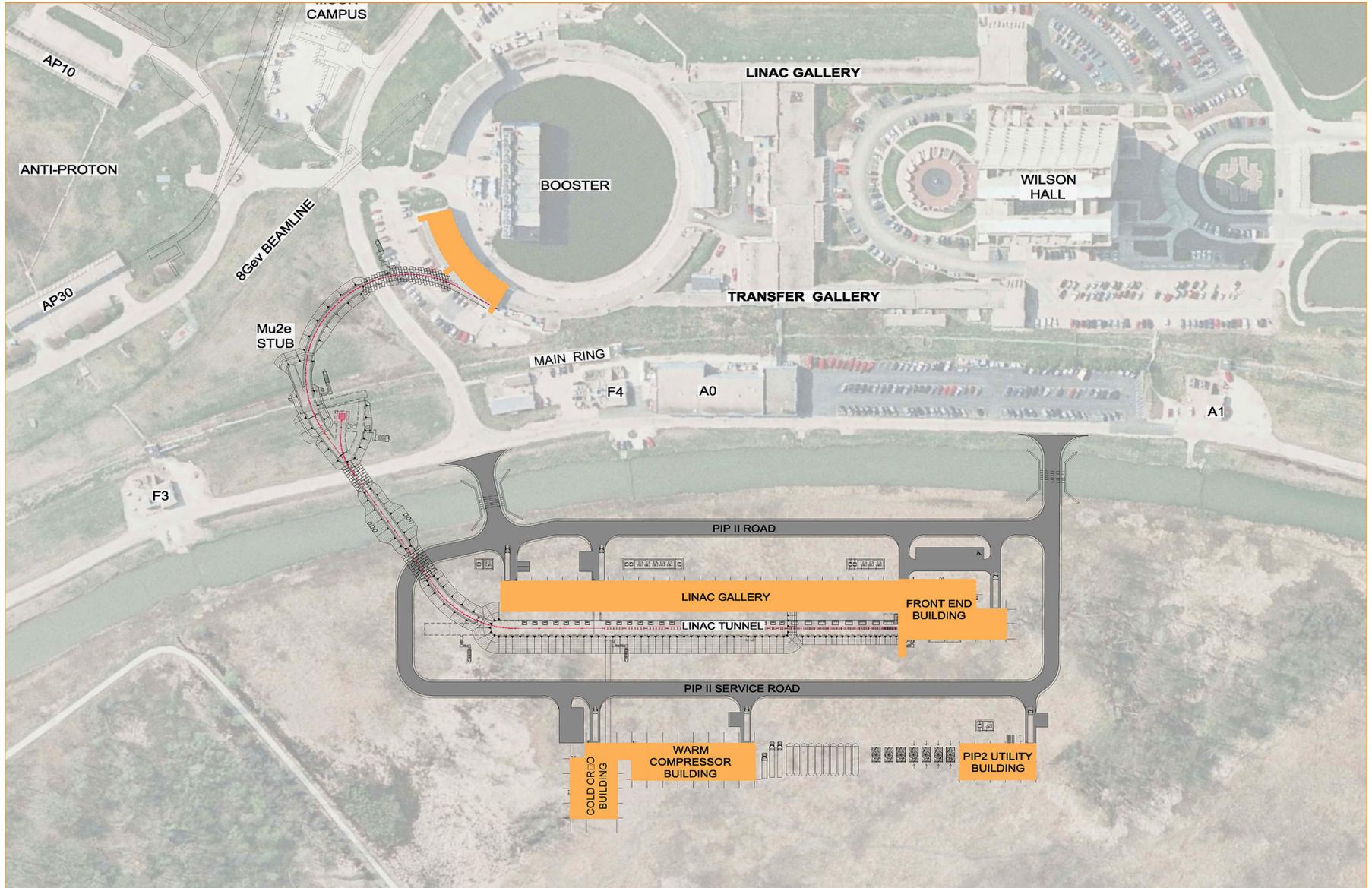


## PIP II

<i>Core Capability:</i>	<i>Accelerator science and technology</i>
<i>Scope:</i>	<i>Complex of above- and below-ground structures and beamline</i>
<i>Usage:</i>	<i>Research, host international experiments</i>
<i>Status:</i>	<i>Currently in CD-1 design</i>

The existing Linac and Booster have served Fermilab for decades. To improve and expand accelerator science and technology for the next era of science, the PIP-II project is in development. As part of a comprehensive, long-term, PIP II, Superconducting Linac Complex is at the core providing a powerful new accelerator. As a set of improvements to the existing accelerator complex, the Super Conducting Linac Complex will provide high-power proton beams in support of the Fermilab particle physics research program. PIP-II comprises the construction of a new 800-MeV superconducting linear accelerator injecting protons into the existing accelerator complex. Upon the completion of PIP-II, the existing 400-MeV linear accelerator will be retired from service. The immediate goal of PIP-II is to provide more than 1 megawatt of proton beam power onto the LBNF/DUNE neutrino production target (the PIP-II experiment facility). The secondary goal is to provide a platform for long-term development of the Super conducting Linac complex, supporting higher beam power to LBNF/DUNE and a broader research program based on high-power proton beams.

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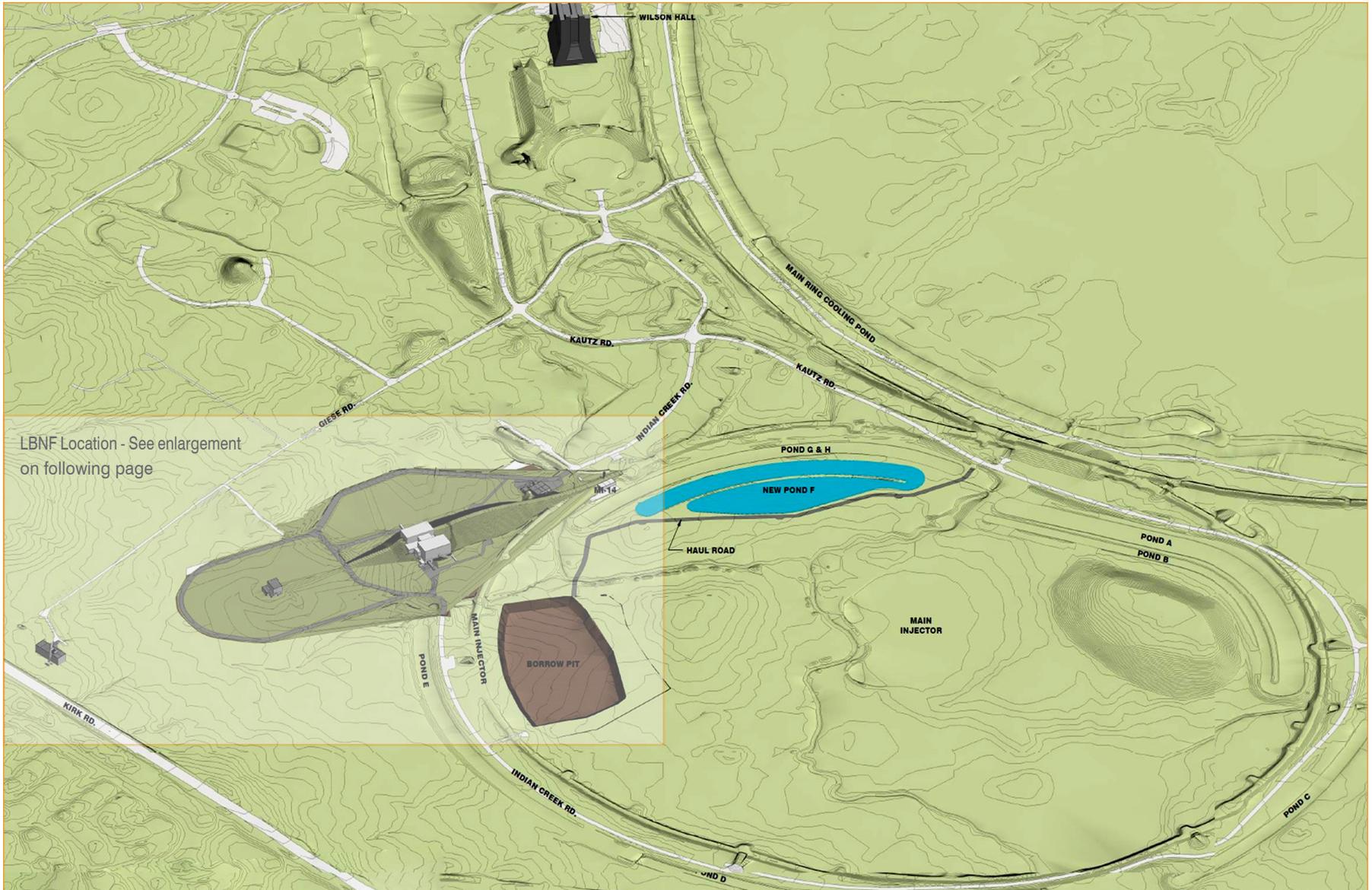


## Long Baseline Neutrino Facility

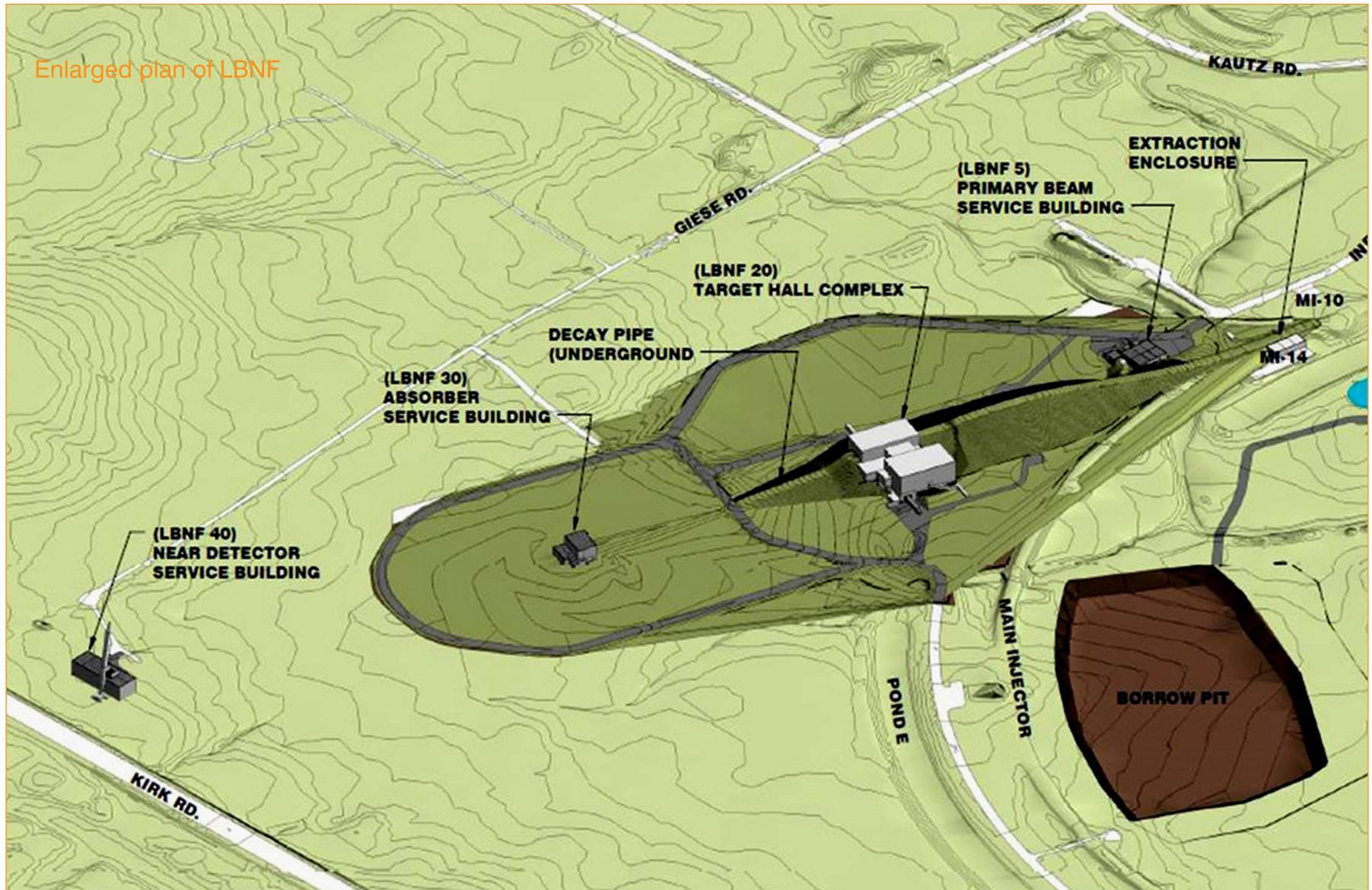
<i>Core Capability:</i>	<i>Large-scale user facilities</i>
<i>Scope:</i>	<i>Complex of above- and below-ground structures and beamline</i>
<i>Usage:</i>	<i>Research, host international experiments</i>
<i>Status:</i>	<i>Currently in CD-1 design</i>

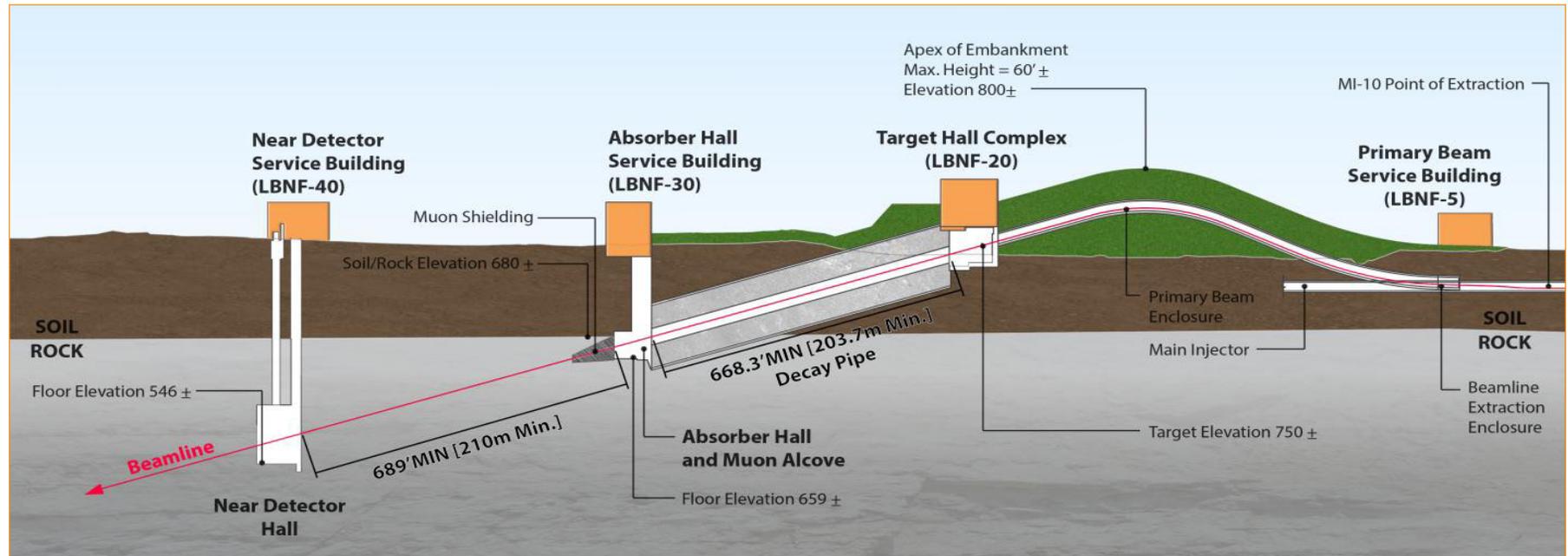
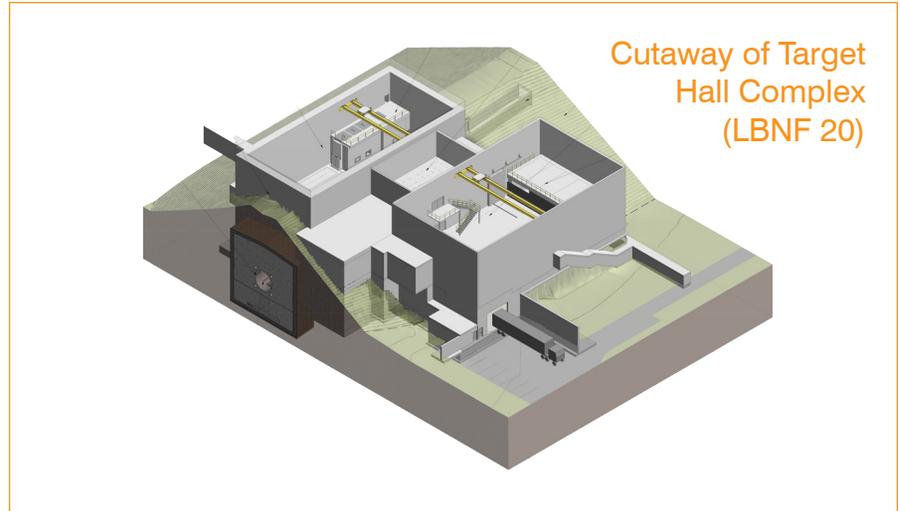
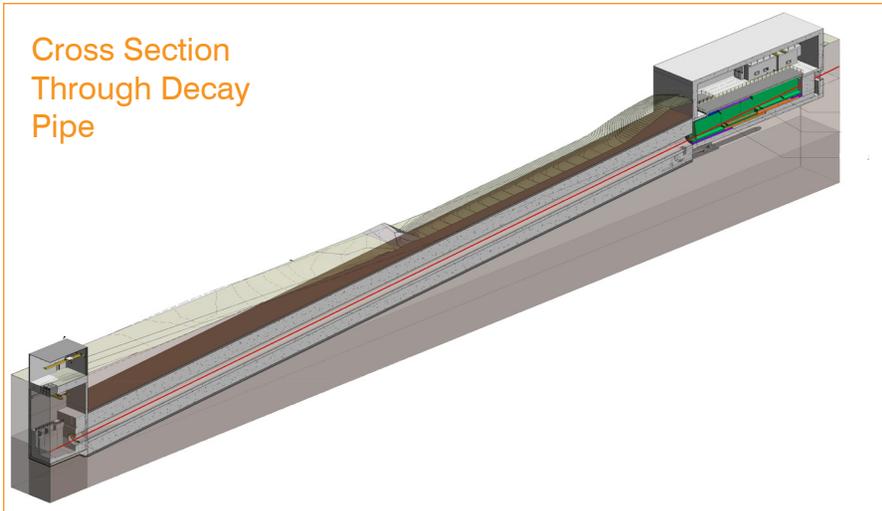
The Long-Baseline Neutrino Facility is an international mega-science project for hosting the Deep Underground Neutrino Experiment in the United States. Its location in the Neutrino Campus provides easy proximity to Core Campus facilities housing the international community of researchers and engineers supporting the science program. The resulting powerful particle accelerator complex will produce the world's most intense high-energy neutrino and antineutrino beams and send them 800 miles straight through the earth to the partner DUNE detectors in South Dakota. The complex, currently in the planning stages, will include the construction of several surface buildings, an earth berm and extensive underground construction. The scope of development will include additional roadways and access from the Core Campus as well as site configurations to accommodate the new facilities.

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Enlarged plan of LBNF





Cross Section of Project





# Appendix

The appendix expands on three significant topics introduced Part II of the FCMP. Each topic grows out of an emerging priority initiative contained therein. Each requires ambitious planning efforts to inform and complement laboratory planning processes. Together, these complex, interrelated and interdependent issues are vital components to developing and implementing a complete and consistent 20 year laboratory plan. The three are:

- Strategically assess campus buildings
- Strategically assess campus utilities
- Establish design guidelines

The appendix is a means to kick start an organizational process to guide further study. Ultimately, by the year 2020, the laboratory hopes to publish each topic as a freestanding institutional companion document to the Fermilab Campus Master Plan.

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# 1.0 Strategically Assess Campus Buildings

## 1.1 Introduction

Fermilab currently has 364 individual buildings totaling 2.49 million square feet constructed over a period of 115 years. One-hundred twenty-seven of these building 35% were already on site at the 1967 founding of the laboratory. At that time they were repurposed for laboratory use. From 1969-1970, 21 temporary buildings were constructed on the site for laboratory usage. During the Wilson Years, 163 new buildings were constructed on the site. As of this writing, 1.4 million square feet of building area, making up 60% of Fermilab's total, are over 40 years old.

**Relationship to the Fermilab Campus Master Plan** - As Fermilab celebrated its 50th anniversary in 2017, the laboratory is clearly embracing its next era of science. Important global particle physics research initiatives are under way, and others are well along in their planning and development. In response to these circumstances, the Fermilab Campus Master Plan (FCMP) was developed to guide the transition of laboratory facilities to support the next era. The FCMP is a "twenty-year transformational plan creating a state of the art, open inviting and collaborative international research community for 21st century science.

The FCMP presents several initiatives to realize that transition. One vital initiative, and the subject of this part of the appendix, is the assessment and strategic alignment of the buildings on the campus with the 20 year vision.

**Ready for the future?** Accomplishing this transformation requires that a substantial number of legacy buildings be strategically assessed to determine their suitability and readiness for the next era of science. As described in Part I of the FCMP, construction of the campus buildings has been 115 years in the making. Development both surged and declined at various periods, leading to a phenomenon referred to as block obsolescence, a condition resulting from large numbers of buildings reaching their usable end simultaneously.

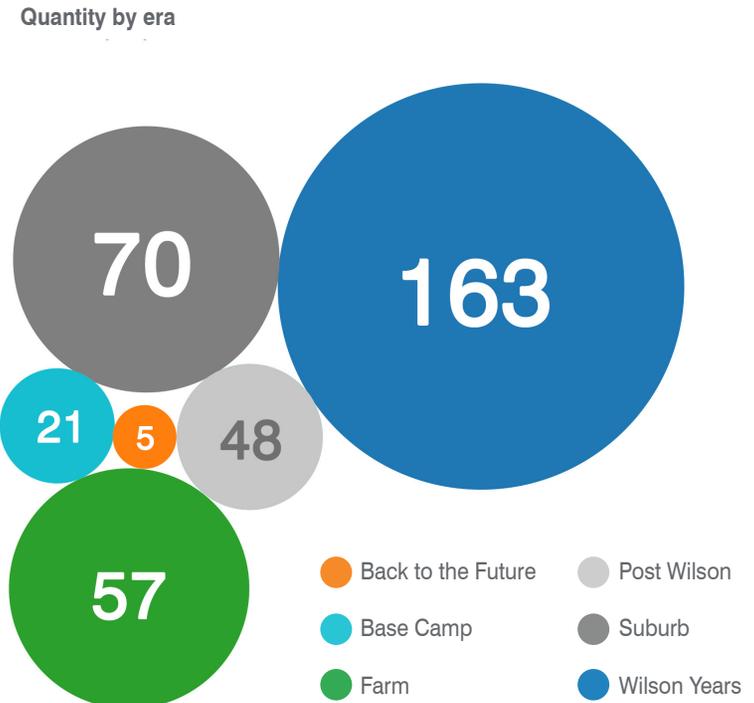
**Repurpose, replace, retire, renovate?** Questions about these aging facilities need to be answered. To frame and kick off an effort to find those answers, the campus planning team created this appendix for the FCMP. Providing bulk building data, as well as a first pass at assessment criteria, it creates a foundation for a soon-to-be convened team to build upon.

The teams work will ultimately result in a formalized long-term planning document. The document is imagined as a one-stop, core, institutional resource documenting the plan and a companion document to the FCMP.

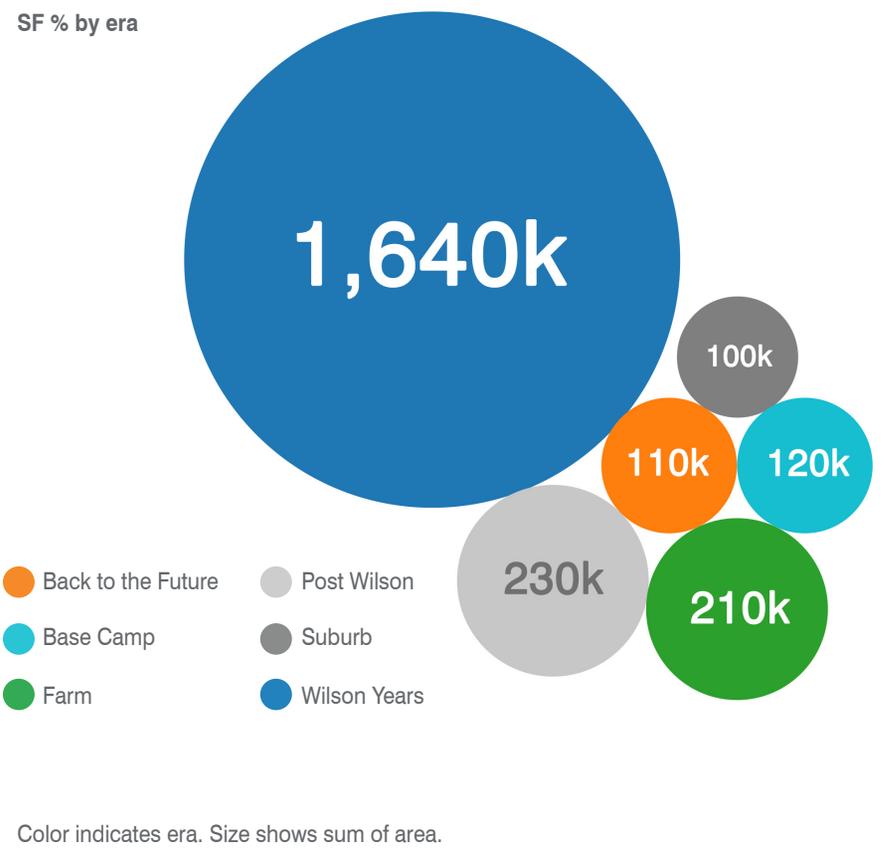
The pages that follow describe the above referenced building data and assessment criteria. Part 4 at the end of this appendix illustrates the proposed timeline for development and publication of the Strategic Facility Assessment Plan.

## 1.2 Building Data

Composition by era constructed	Quantity	
	Total / Era	%
Farm (1912 - 1962)	57	16%
Suburb (1963)	70	19%
Base Camp (1969 - 1970)	21	6%
Wilson Years (1971 - 1993)	163	45%
Post Wilson (1994 - 2008)	48	13%
Back to the Future (2009 - Now)	5	1%
<b>Totals</b>	<b>364</b>	

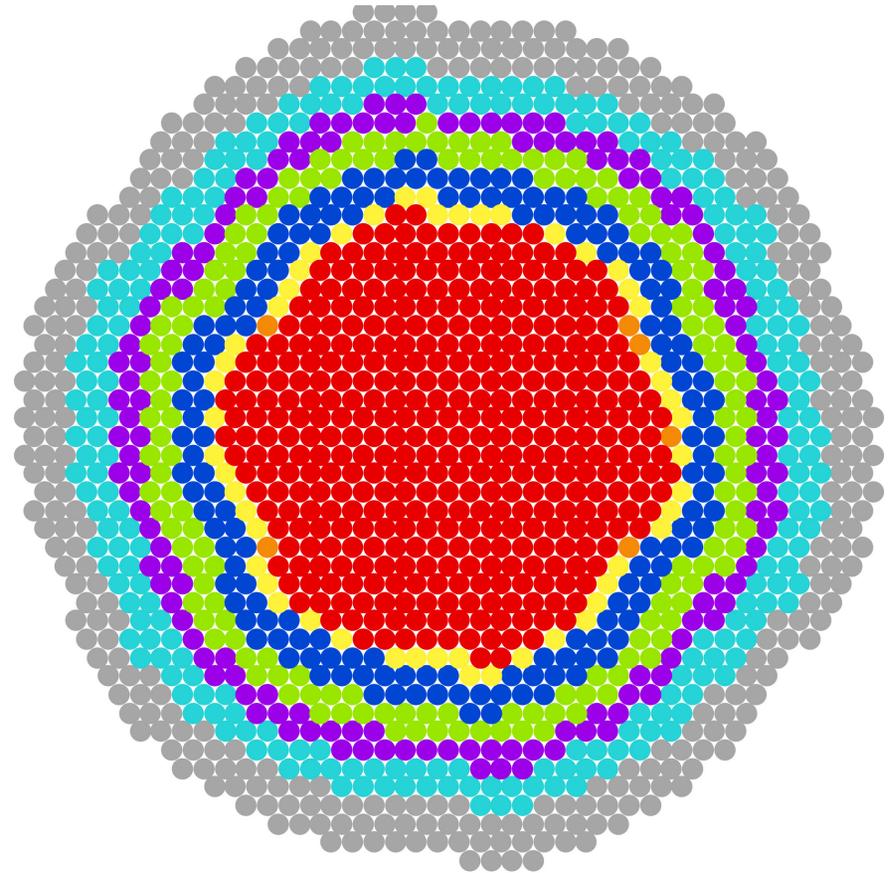


Composition by era constructed	Area	
	SF	%
Farm (1912 - 1962)	210K	9%
Suburb (1963)	100K	4%
Base Camp (1969 - 1970)	120K	5%
Wilson Years (1971 - 1993)	1,640K	67%
Post Wilson (1994 - 2008)	230K	10%
Back to the Future (2009 - Now)	110K	5%
<b>Totals</b>	<b>2,410K</b>	



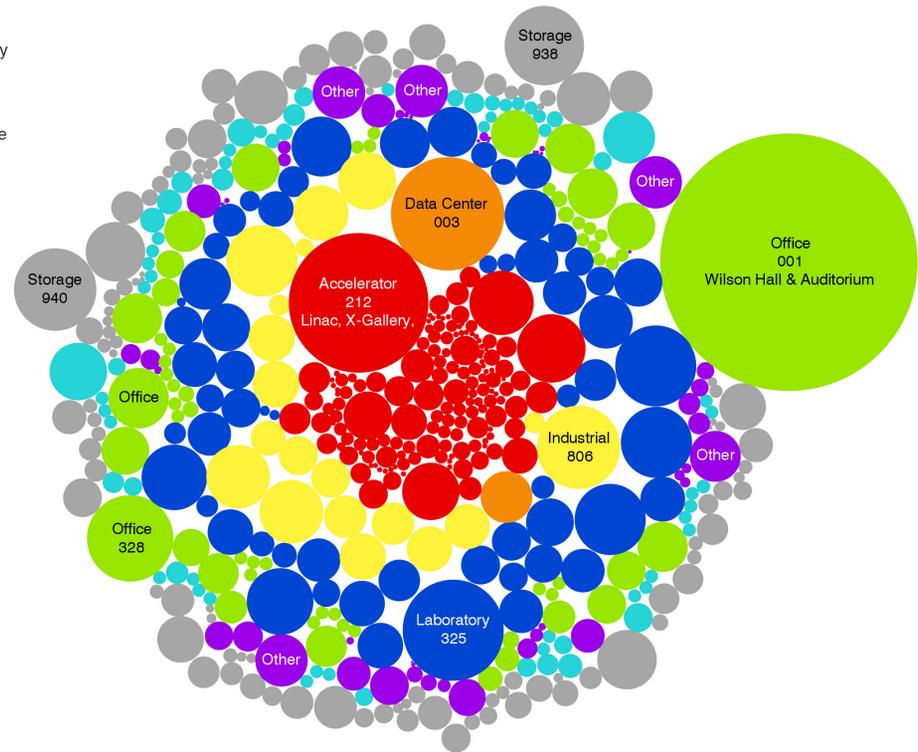
Composition by function	Number	% of total
Offices	34	27%
Data Centers	2	4%
Residences	64	6%
Storage	80	15%
Industrial	13	9%
Physics Labs	37	20%
Accelerator	95	15%
Other	39	5%
<b>Totals</b>	<b>364</b>	<b>100%</b>

- Accelerator
- Data Center
- Industrial
- Laboratory
- Office
- Other
- Residence
- Storage



Composition by usage	Total area (SF)	% of total
Offices	640,000	27%
Data Centers	100,000	4%
Residences	140,000	6%
Storage	350,000	15%
Industrial	220,000	9%
Physics Labs	470,000	20%
Accelerator	360,000	15%
Other	120,000	5%
<b>Totals</b>	<b>2,410,000</b>	<b>100%</b>

- General Usage
- Accelerator
- Data Center
- Industrial
- Laboratory
- Office
- Other
- Residence
- Storage



## 1.3 Assessment Criteria

The FCMP *Guiding Principles* and Emerging Priorities cut across several interrelated facility issues. Responding to these issues, the planning team created the following starter list of questions to aid in evaluating existing facilities.

Science Need	Is it currently used for ongoing science? If not, is it reasonably adaptable for other usage? Is it part of experiments or beamlines that have ended or are scheduled to end?
Location	Does its location support the vision of consolidation and centralization into a core campus and the associated goals of pedestrianizing, reduction of vehicle usage, and collaboration through proximity? Does it reinforce community? Is it optimally located for current functions relative to the lab at large?
Condition	Does its condition enhance or detract from the campus experience? Is it inviting and informative to international and local visitors? Is it consistent with the envisioned state-of-the-art laboratory? Is it past its realistic useful life?
Quality, Design, Character and Identity	Does it contribute to quality of life and sense of place? Is it desirable place to work? Will it aid in attracting and retaining future researchers and staff? Is it, or can it be, renovated to become a state-of-the-art facility? Is it optimally design and suited to current usage? Is it purpose-built or was it originally designed and built for a different function? Does it contribute to or detract from character identity of Fermilab? Is it historically significant? Does it enhance or detract from the natural setting?
Flexibility and Life Cycle Value	Is it of a quality, scale and durability conducive to continued use or long-term adaptive reuse? Can it support cutting-edge research? Can it use space efficiently?
Stewardship	Does it pose any environmental or safety hazards or risk? Is it safe for long-term habitation? Does it facilitate efficient use resources? Does it use energy efficiently? Does it require excessive maintenance efforts and cost? Is it, life cycle efficient and justifiable?
Long-Term Validity and relevance	Is it a facility Fermilab wants to be using 20 years from now?



## 2.0 Strategically Assess Campus Utilities

## 2.1 Introduction

A fully integrated, holistic approach to planning necessitates looking beyond buildings, site layout, roads and landscaping. Planning must consider the utility systems that provide the campus buildings, experiments and accelerators with electricity, heating, cooling and water. Fermilab has an extensive network of utility infrastructure throughout its 6,800-acre site. Significant portions date to the early years of the laboratory. As the future unfolds, new buildings and experimental facilities will require effective and reliable site infrastructure to support the future facilities vital to achieve Fermilab's mission.

As Fermilab celebrated its 50th anniversary in 2017, it had clearly embarked on its next era of science. Important global particle physics research initiatives are under way, and others are well along in their planning and development. To insure cohesive planning and guide future developments, the Fermilab Campus Master Plan (FCMP) has been developed to guide the transition of laboratory facilities to support the next era. The FCMP is a "20 year transformational plan creating a state of the art, open inviting and collaborative international research community for 21st-century science".

The FCMP presents several initiatives to realize that transition. One vital initiative, and the subject of this part of the appendix, is the strategic assessment of the campus utility infrastructure to determine systems' suitability and readiness for the next era of science. Many questions about these aging facilities need to be answered. To frame and kick-off an effort to find those answers, the campus planning team created this appendix the FCMP.

This appendix provides an overview of the utility systems currently on site. They are domestic water, industrial cooling water, sanitary sewer, natural gas, electrical power, telecommunication and computing. The site has one central utility plant, the CUB, that provides both hot and chilled water to Wilson Hall and associated buildings in the campus's central region.

Using the information herein, an infrastructure evaluation team will be assembled. The teamwork will ultimately result in a formalized long-term planning document. The document will be a one-stop, core, institutional resource used as a companion document to the FCMP. Part 4 at the end of this appendix illustrates the proposed time line for development and publication of the Strategic Utility Assessment Plan.

2

Primary electrical  
substations

27

Miles of underground industrial  
cooling water piping

14

Miles of underground  
sanitary piping

241

Secondary substations

## 2.2 Utility Systems Overview

**Electrical System Overview:** The Fermilab electrical system is owned and operated by the laboratory. Its primary source is provided by two 345,000-volt transmission lines feeding two electrical substations that contain four 40-MVA power transformers each and distribute power at 13,800 volts. The substations contain buildings housed in metal enclosed switchgear with vacuum circuit breakers for feeder protection. The feeders distribute throughout the main campus through underground concrete-encased ductbank type.

The laboratory Village area is a separate electrical system served by a single distribution feeder at 12,470 volts. The distribution feeder is provided by the local investor-owned electrical utility, ComEd. The distribution in the Village is primarily overhead construction and owned and operated by the laboratory. A backup tie from the main campus electrical system is available.

**Distribution:** Power is distributed throughout the laboratory medium voltage feeders, primarily at 13,800 V on the main laboratory campus and 12,470 V in the Village area. Two on site electrical substations are used as primary distribution: Kautz Road Substation (KRS) and Master Substation (MSS).

Kautz Road Substation was built in 1998 as part of the Main Injector facility. The station is designed to provide power to two separate types of users: pulsed power and conventional power. This is accomplished with six separate 13,800 volts busses-four for pulsed and two for conventional power. The pulsed-power busses have space for up to 28 vacuum circuit breakers that feed the Main Injector power supplies along with the harmonic filters to reduce any adverse effects of the connected pulsed power supplies on the electrical system. These feeder breakers are dedicated to the power supplies and are an integral part of the operations of the Main Injector to isolate power sources via LOTO for maintenance. The conventional power busses have space for up to 12 vacuum circuit breakers that feed conventional facilities such as buildings and miscellaneous industrial loads.

The Master Substation was built in 1969 as part of the original laboratory construction and was fully renovated in 2017 with state-of-the-art equipment and a new enclosure building. The station is designed to provide power to two separate types of users: pulsed power and conventional power. This is accomplished with five separate 13,800 Volts busses-two for pulsed and three for conventional power. The pulsed power busses have space for up to 14 vacuum circuit breakers. While pulsed-power is no longer connected to Master Substation, the separate pulsed-power busses are used to isolate and feed the sensitive programmatic facilities in the original footprint area. The conventional-power busses have space for up to 32 vacuum circuit breakers that feed conventional facilities such as buildings and miscellaneous industrial loads in the original footprint area.

**Feeders:** The feeders that provide power across the site originate at the substation vacuum circuit breakers. They exit the substations and route around the site in underground conduit ductbanks. The feeder system is designed as an open-loop sectionalized system. The feeders use air switches and available connections with each other for redundancy, allowing sections to be isolated for maintenance without requiring full feeder outages. Several feeders are dedicated to a backfeed system between Master Substation and Kautz Road Substation. This backfeed system allows the two substations to provide limited redundancy to each other to maintain power

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distribution during maintenance periods. Feeder technology has changed in the 50 years of the laboratory, and all of the original cables have been replaced. A small number of older cables exist that are not in use, but the feeder may be used in the future. The cables are anticipated to be replaced at that time. Current cable technology enables an expected useful life of 40 years.

**Unit Substations:** Fermilab is made up of complexes of large industrial-type electrical loads. With this type of load, the electrical system generally uses 480-volt, three-phase services to the buildings with a typical transformer size of, 1500 KVA. Because many of the buildings are built in cluster areas, the unit substation configuration with large circuit breakers to feed multiple services was installed at the inception of the laboratory in 1969 and into the 1970s. These unit substations were constructed with sections for high-voltage switchgear, transformer and low-voltage switchgear. The technology of low voltage switchgear has changed over time, and the usefulness of this multipart configuration has become obsolete. As site improvements have allowed, the unit substations have been replaced with modern pad-mounted transformers.

**Switching Equipment:** As described above, the feeders are sectionalized using 15-kilovolt-rated switches. The original equipment installed for this purpose used a dielectric oil tank technology that enclosed the mechanical components of the switch. Over time, this technology has proven to be obsolete and has been slowly replaced by an air-insulated switch technology. The replacement of the oil switches is nearly complete, with four remaining switches to be replaced.



**Industrial Cooling Water:** The industrial cooling water system at Fermilab has a dual purpose. It is used to supply water to the various fire protection sprinkler systems located in buildings across the site. It is used in many of the experimental areas as a source for conventional-magnet cooling. The distribution system for ICW extends from the main pumping station at Casey's Pond to the support area, Wilson Hall and footprint area, and most of the experimental areas located on the Fermilab site.

The main storage reservoir for the ICW system is Casey's Pond, which is in the northern portion of the Fermilab site. Two sources provide water to the reservoir. A sitewide network of lakes and ditches is used to collect runoff water, as well as heat exchanger and sump discharge water, and return it to the main reservoir at Casey's Pond. Water is also collected in the Main Ring Lake, located within the main accelerator ring, and Lake Law, located in the southeast portion of the site. The water from these lakes is then transferred to the main reservoir by means of a pumping station located at the Main Ring Lake. It is important to note that the whole of the 6,800-acre Fermilab site provides runoff to this network of ditches and lakes, and thus even open areas of the site contribute to the experimental effort of the laboratory. Another source, under certain circumstances, may be used to supply water

to the main reservoir. A contract with the state of Illinois allows Fermilab, when water levels are sufficient, to pump water from the nearby Fox River to supplement and maintain water levels at Casey's Pond.

The present total capacity of the on-site ICW supply system is 185.7M million gallons based on existing lake and ditch sizes and average rainfall. Building 855, the pumping station at Casey's Pond, contains three 5,000-gpm variable-speed primary pumps and four 1,000-gpm single-speed secondary pumps that supply water to the sitewide distribution system. The average pumping output of the Casey's Pond pumping station is primarily dependent on the water temperature of the reservoir supply. This temperature varies with the time of year and the amount of experimental equipment requiring cooling. In the winter months, with minimum cooling demand from equipment, the output may be as low as 4,000 gpm. In the summer months, with a maximum cooling demand, the output could exceed 11,000 gpm. There are three other supplemental pumping stations: C-4 on the Main Ring, Swan Lake and CMTF pump stations.



**Domestic water:** Water for the entire site is sourced from the City of Warrenville. Two separate 8-inch-diameter taps connect to the Warrenville system along the east boundary of the site. Two separate sources allow redundancy in the system in case of a failure in one of the feeds. The consumption rate for the entire laboratory ranges from 0 to 90 gpm depending on the time of day. The pressure of the system is 35 psi.

There are about 20 miles of DWS pipe on site. Much piping, especially in the Village, is ductile iron and about 50 years old. Piping that has been installed more recently is HDPE material. Separate from the city of Warrenville distribution lines, there are four shallow water wells that serve individual buildings at Sites 29, 52, 56 and 58. These facilities are used for residential purposes, storage and care for the bison barn.



**Sanitary Sewer:** Two underground sewage collection systems are at the laboratory. One serves the main site, and the other serves the Village. The main site collection system has six lift stations; the Village system has one. No sewage is treated on site. Sewage from the main site is treated on a fee basis by the city of Batavia. Sewage from the Village is handled by the city of Warrenville under a similar arrangement.

There are approximately 16 miles of sanitary piping across the site. The collection system that serves the main-site facilities is in generally good working condition. For the Village system, there has been an increase in the infiltration rate in recent years primarily due to the age of the system. A portion of this system has been repaired. Investigation continues to identify and remedy the remainder of this problem.



**Natural Gas:** There are approximately 20 miles of natural-gas piping across the site. Gas is delivered to Fermilab by the Northern Illinois Gas Company from two separate source points. The primary gas supply is an 8 inch line that is metered at the Wilson Road boundary. Two branch lines then extend south. One serves the Village while the other terminates at the Central Utility Building. A second 4 inch back-up feed supplies gas through a meter station at the west boundary of the site, adjacent to Giese Road.

Through a system of sectioning valves, gas supply can be maintained to the site in the event of an interruption of service from the 8-inch primary supply. The sitewide pressure is regulated to maintain 90 psi and is considered high pressure. There are no identifiable problems with the gas distribution system.



**Central Utility Building:** The Fermilab Central Utility Building (CUB) was constructed in the early 1970s and has been remodeled numerous times to support the lab's mission. Housing the comfort chilled water system, the process chilled water system, the Linac chilled water system and the hot water heating system, its 16,000 square feet contain equipment that produces process chilled water, comfort chilled water, Linac chilled water, 95-degree low-conductivity water (LCW) for muon delivery ring and for Booster, deionized (DI) water, condenser water for chillers, condenser water for 95 LCW heat exchangers, and tower water system to reject condenser water heat to ambient air.

The comfort chilled-water systems' primary function is to provide comfort cooling to Wilson Hall, Ramsey Auditorium, Cross Gallery, Transfer Gallery, Cross Gallery, Booster towers and other area buildings. The system consists of chillers CH-1 and CH-5 (each with a 4,160-volt, 800-ton capacity and 1,800-gpm evaporator), primary pumps CP1, 2/3 (each with 40-horsepower, 1,800-gpm flow) and a secondary loop that contains secondary pumps CP-4/5 with variable speed drives (each with 40-horsepower variable-speed drive and 3,600-gpm flow) and a heat exchanger, HX-2 of nominal 800-ton capacity with pumps, 30 horsepower each CP12/13. The primary loop has various operating modes. Two chillers and two pumps operate during peak summer months. HX-2 provides cooling during the winter months. The secondary loop's normal operating mode is one pump. HX-2 provides cooling from the process chilled-water system to the comfort system and will normally carry the light winter loads. HX-2 may be used in an emergency to transfer heat in either direction between the comfort and process systems.

The process chilled-water system provides cooling water for process loads at remote locations. It consists of a primary system with chillers CH-2 (800 Tons), CH-4 (800 Tons), free cooling HX-1 (1,800 tons) and primary pumps CP-10/11 with variable speed drive controls (6,720, 300 horsepower each). The primary system flows water through a bridge capable of feeding (1) the process secondary chilled water system, (2) the Linac secondary low-conductivity water chilled-water system through a heat exchanger HX-3, LP-13/14 and (3) the comfort chilled-water system through heat exchanger HX-2, CP-12/13. The process secondary chilled water system temperature, flow and pressure are dictated by process requirements.

The Linac chilled-water system provides low-conductivity water (for cooling) to the Linac loop. Chiller CH-3 and primary pump CP-9 operate in the primary loop. Secondary pumps LP-4/5, an emergency operation heat exchanger HX-3 tied to the process chilled water primary bridge and HX pumps LP-13/14 operate in the secondary loop. The secondary loop serves Linac Chilled-water (HX-7) and 55 LCW loads.

The heating hot water system provides comfort conditioning for the various footprint area buildings. Two boilers in CUB operate individually. Three 25 horsepower boiler pumps, two running and one standby unit-pump water through system and back to the boilers. There are over a dozen heating zones that have airhandlers, terminal units and radiation. The zones predominantly have three-way valves for control, and many have dedicated zone pumps.

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3.0

# Establish Design Guidelines

## 3.1 Introduction

The Fermilab Campus Master Plan (FCMP) presents goals and aspirations to guide the transition of laboratory facilities to support the next era of science and discovery. The plan sets forth guiding principles and planning initiatives, providing the framework for the process. One of these initiatives, Establish Design Guidelines, is the subject of this appendix.

As described in the FCMP, Fermilab has a legacy of distinctive buildings and structures created out of the founder's vision for the laboratory. The result is a place with a character and identity unique among the world's research laboratories. Upholding that unique identity while responding to the vastly different sociological and technological landscape of the current and future eras is the aim of creating design guidelines.

To frame and kick off this effort, the campus planning team created this appendix to the FCMP. The content herein provides design history and general design guidelines. A design guidelines development team composed of subject matter experts, will be charged to create formalized, long-term, detailed design guidelines. The outcome of their work will be a freestanding *Fermilab Design Guidelines* document. It will be an institutional document serving as a companion publication to the FCMP. Part 4 at the end of this appendix illustrates the proposed timeline for development and publication of the *Fermilab Design Guidelines*.



## 3.2 Design History

*“A Utopian place where physicists from all parts of the country, and from all countries, would be doing their creative thing in an ambience of well-functioning and yet beautiful instruments, structures and surroundings that would reflect the magnificence of their discoveries and theories.”*

This quote from laboratory founder Robert R. Wilson embodies his vision for Fermilab. He imagined scientists from around the world gathering in a place of natural beauty, amid architectural grandeur and cultural splendor.

The interplay of art, science and technology formed the basis for the design approach to the laboratory. Sculptural forms became a prominent feature. Landmark buildings were distinguished simple sculptural shapes, materials, colors and textures. Playful, colorful geometry, squares and circles, became emblematic of the laboratory and were painted on buildings throughout the campus.

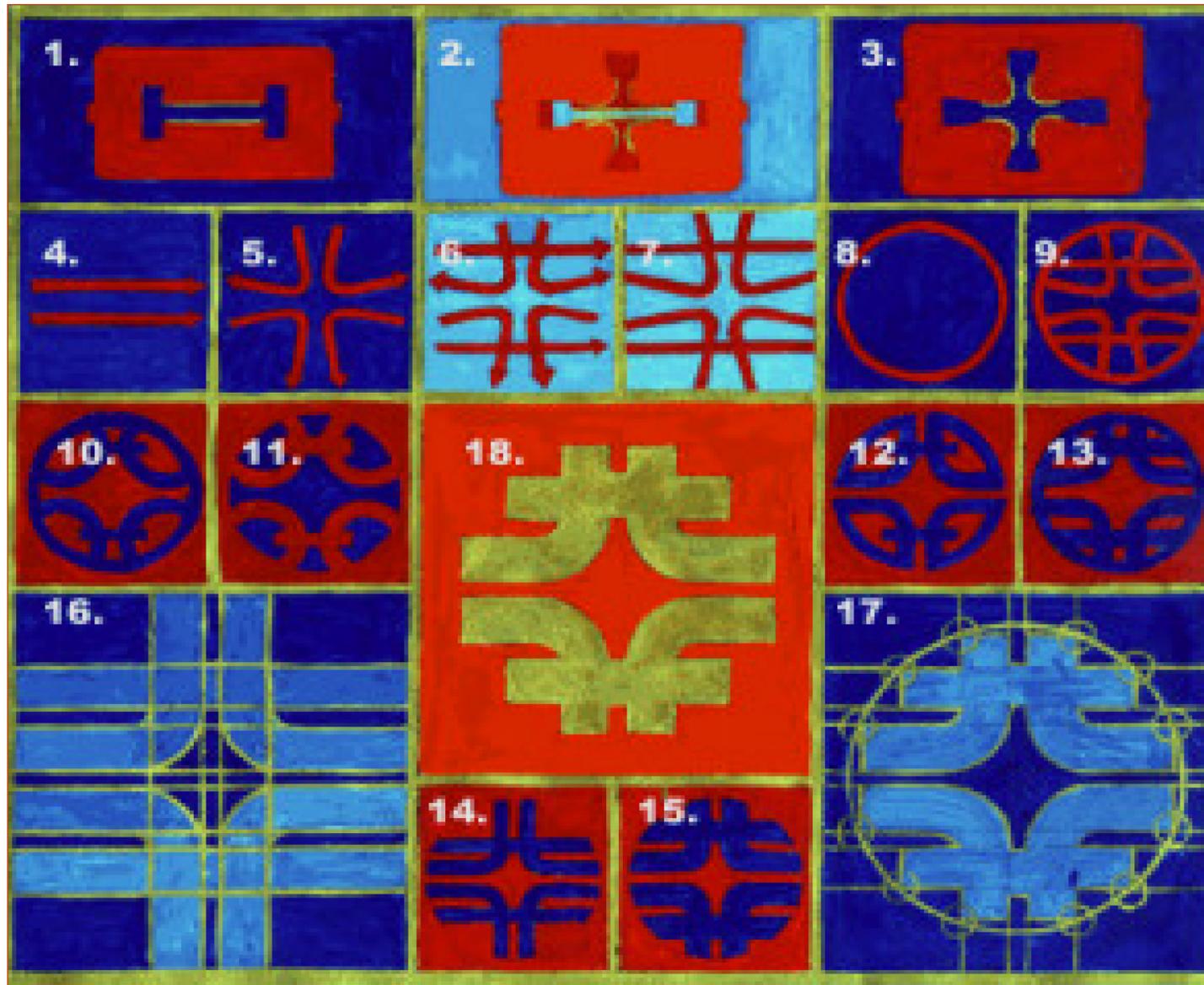


Robert Wilson helped design the centerpiece of the site, the stately 16-story Robert Rathbun Wilson Hall, inspired by a Gothic cathedral in Beauvais, France. The building serves as a central meeting place, housing the laboratory’s cafeteria and the campus’s largest concentration of offices. Adjoining Wilson Hall to the south is the 830-seat Norman F. Ramsey Auditorium, which hosts numerous talks and cultural events.

Wilson also influenced the unique design and character of several other founding-era buildings and structures on campus and created several of the site’s iconic sculptures.

Assisting Wilson at the founding was artist and designer, Angela Gonzales. She was a major influence in forming the laboratory’s distinct character. Her work created the color palette and bold geometric approach to architecture and graphic design, exemplified by the images below and on the facing page.





Beginning with the canvas of farmland, farmhouses, barns and the small town of Weston, a physics laboratory was imagined that would embody Dr. Wilson's vision while deriving inspiration from the existing context.

**Colors, Forms and Textures:** Robert Wilson drew inspiration from the surrounding farmland and farm equipment, the local flora and fauna, the sky, the horizon and surrounding fields, and the materials and textures of the existing buildings and barns. These inspirations would form the color and texture palette for the laboratory. The laboratory buildings would take on these colors and textures and be scattered throughout the site-like colorful toy blocks scattered about, forming the "Physics Playground."

*"I have always felt science, technology and art are importantly connected; indeed, science and technology seem to many scholars to have grown out of art.*

*"I had better pay close attention to the architecture of the project, for I was determined that it be significant yet affordable. If we produced a dowdy site with shabby buildings, then the technical people we wanted to work with us would not come and the statesmen, who might judge us in part by appearances, would not in the long run give us the funds that we would need for our physics | My fantasy of a Utopian laboratory clearly required a setting of environmental beauty, of architectural grandeur, of cultural splendor..."*

*Robert R. Wilson, founder*





## 3.3 General Design Guidelines

**The design of buildings and open spaces should encourage interaction, creating the settings to bring staff, users and visitors together, becoming vibrant centers of laboratory life.**

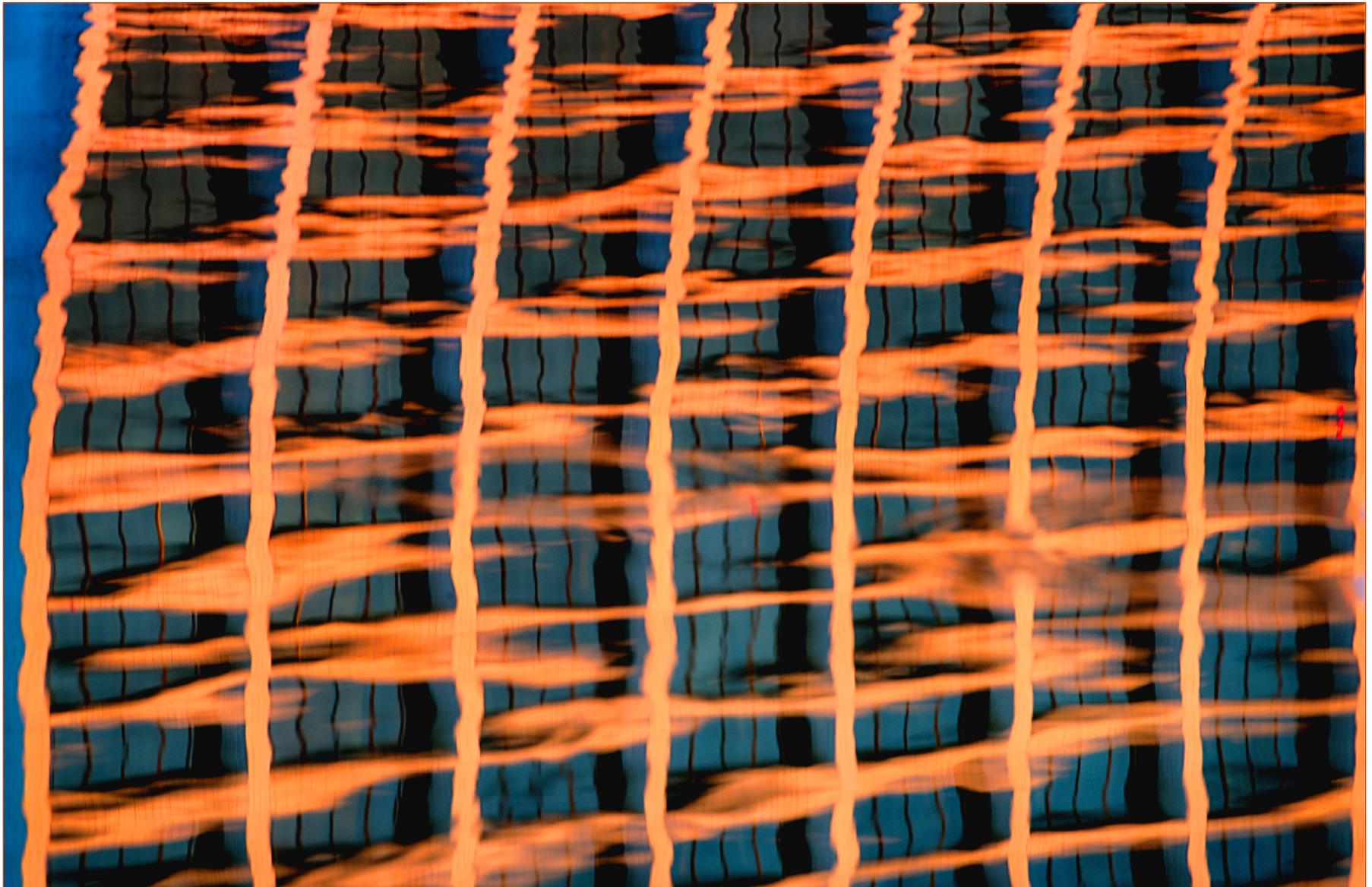
**Entrances and Ground Floors:** Buildings should be welcoming, strengthen existing gathering spaces and provide new opportunities for social interaction. Entrances should be evident in the daytime and at night. The ground floor of buildings should emphasize transparency. Service and utility areas should be located so as not to negatively affect pedestrian paths, important streets or building entrances.

**Public Spaces:** Public spaces should be generous, promote interaction and be visible to those using the buildings or walking past them. Outdoor and indoor public spaces should be designed to allow for informal gatherings and social interactions during both daytime and evening hours. Lighting and security of public spaces are critical for their success. Rooftops and terraces should be considered participatory spaces for the campus community, accommodating social spaces, conferencing and unique offices. Buildings should provide universal access so they are not encumbered unnecessarily by level changes, ramps and stairs.

**Long-term flexibility and life cycle value:** Buildings on campus should have the inherent capacity and flexibility to outlive the original program. Appropriate attention to the design of floor plates, floor-to-floor heights and structural systems will enable a high degree of flexibility for unanticipated future uses. Over time, campus buildings should anticipate a variety of programs and uses, responding to new needs and unanticipated demands. New projects should be designed with a commitment to flexibility, quality and durability to provide long-term usefulness. Building design should also anticipate future changes in technology and scientific methods in the planning and design of buildings and research spaces. They should incorporate building systems and support infrastructure, facilitating easy adaptation for new programs and future demands. When making building system decisions, consider initial capital investments as they affect long-term operational costs in the full life cycle of the project.

**Uphold the unique character of Fermilab:** The Fermilab campus is rooted in the tradition of architectural innovations and excellence representing the architectural innovations of the time in which they were built. A strong component of the campus includes architecture significant for and symptomatic of its time. Design of new and renovated facilities should acknowledge this legacy while pursuing design excellence appropriate and symptomatic of the current era, continuing the tradition of design excellence. The collection of landmark buildings within the community can be captured into a community of architectural styles resulting in a dynamic relationship between the past and the future. Buildings contributing to the legacy of the campus should be retained and revitalized when feasible. Open spaces and significant landscapes should be identified and respected as critical components of the campus experience.

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4.0

Next Steps

# 4.1 Planing Documents Development Timeline

Activity	2018												2019				2020			
	2018				2019				2020				2021							
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
<b>Strategic Facility Assessment</b>	[Grey bar]																			
Issue Appendix I Form project team	[Green]																			
Assess I stakeholder mtgs I document			[Green]				[Green]				[Green]									
CFPB interface	[Green]		[Green]				[Green]				[Green]									
Plan review and comment I Publish												[Green]								
<b>Strategic Utility Assessment</b>	[Grey bar]																			
Issue Appendix I Form project team	[Green]																			
Assess I stakeholder mtgs I document			[Green]				[Green]				[Green]									
CFPB interface	[Green]		[Green]				[Green]				[Green]									
Plan review and comment I Publish												[Green]								
<b>Design Guidelines</b>	[Grey bar]																			
Issue Appendix	[Green]																			
CFPB interface	[Green]																			
<b>Develop office types and standards</b>	[Grey bar]																			
Form project team		[Green]																		
Content I stakeholder mtgs I document			[Green]																	
Subplan review and comment I Publish					[Green]															
<b>Develop exterior / shell design guidelines</b>	[Grey bar]																			
Form project team		[Green]																		
Content I stakeholder mtgs I document				[Green]				[Green]												
Subplan review and comment I Publish										[Green]										
<b>Develop landscaping and site design guidelines</b>	[Grey bar]																			
Form project team		[Green]																		
Content I stakeholder mtgs I document					[Green]				[Green]											
Subplan review and comment I Publish												[Green]								

## 4.2 Planning Documents Relationship Grid

