

National Institute of Standards & Technology

# Gaithersburg Campus Master Plan

May 2018





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# Gaithersburg Campus Master Plan

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Existing Campus



November 2017 Google Earth/Google Maps

# Executive Summary

## CHAPTER 1

**T**HE National Institute of Standards and Technology (NIST) was founded in 1901 as the National Bureau of Standards. Today, NIST is a Federal agency within the U.S. Department of Commerce. NIST's mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology to support and enhance commerce and economic security.

The agency operates in two primary locations: a 579-acre headquarters campus in Gaithersburg, Maryland, and a 206-acre campus in Boulder, Colorado, with other facilities in Fort Collins, Colorado, and Kauai, Hawaii. NIST has a national presence through its research cooperative agreements, its Manufacturing Extension Partnership Centers and advanced Manufacturing USA Institutes. NIST employs nationwide approximately 3,350 scientists, engineers, technicians, and support and administrative personnel who are federal staff, and approximately 1,500 contracted staff. In addition, each year NIST hosts thousands of visitors, conference attendees, and

associates and facility users from academia, industry and other government agencies.

The National Institute of Standards and Technology (NIST) Gaithersburg campus is a beautiful setting, featuring a rolling terrain dotted with trees and wooded areas. There are 62 buildings and structures, totaling over 3.6 million gross square feet of space and housing approximately 4,000 personnel (both employees and associates). Approximately half of the permanent buildings are now more than 50 years old, although two significant facilities were built in the last 20 years: the Advanced Chemical Sciences Laboratory (ACSL) and the Advanced Measurement Laboratory Complex (AML). Additionally, NIST has constructed several smaller buildings and additions within the last 10 years for specialty research and support operations.

The last Master Plan for the site was prepared in 2009. That plan, approved by the National Capital Planning Commission (NCPC), documented NIST priorities and the planned construction projects over only a 5-year planning horizon. A



Exhibit 1: Existing Site Plan



Exhibit 2: Master Plan Concept



Programmatic Environmental Assessment was completed in parallel and resulted in a Finding of No Significant Impact (FONSI). In recent years, several planning studies have been completed, which include utilization studies, strategic plans, feasibility studies, historic assessments, and traffic studies. These recent studies, developments on the campus, and changes in the surrounding areas require that a comprehensive and coordinated framework for development be established, for the near term as well as the long term. The NIST Gaithersburg Campus Master Plan is envisioned to provide that framework.

The entire 579-acre Gaithersburg campus was recently (2016) determined eligible for listing in the National Register of Historic Places (NRHP) as an Historic District because of its significance to the history of science and, notably, its striking architectural design. Within the historic district, 24 contributing structures were identified along with the campus landscape. For both contributing and non-contributing elements, any proposed new construction as well as modifications to existing structures and landscapes must comply with the *Secretary of the Interior's Standards (SOI Standards) for the Treatment of Historic Structures*.

The development of the Master Plan was shaped in concert with NIST and a multi-disciplinary team of planners, architects, designers, engineers, and other professionals. Two NIST advisory groups participated in the evaluation and selection of the Master Plan approach: an executive Steering Committee and a Working Group with representatives from most NIST Organizational Units. Other NIST policy groups that participated in reviews included the NIST Leadership Board and the Security Advisory Board. In addition, the Master Plan was reviewed by local regulatory authorities such as the City of Gaithersburg, the National Capital Planning Commission and the Maryland Historic Trust. This collaboration was to ensure the following:

- The campus continues to support the NIST mission.
- Future development conforms with the scale, density, and character of the site and addresses the concerns and priorities of stakeholders and the surrounding community ;
- Future development integrates with open space, circulation, infrastructure and functional land uses, while accommodating programmatic requirements;
- NIST's future program requirements are satisfied, and the

sustainability and physical security goals of both NIST and the Department of Commerce are met while complementing those of the City and Region; and

- The plan respects the Historic District designation and achieves concurrence with local regulatory authorities.

## Master Plan Goals

The Department of Commerce (DoC) encourages its agencies have a physical master plan for their sites, reflecting both the anticipated special needs of the agency and the impact of its activities on the surrounding community. The master plans are used to both define needed physical facilities and to advance the agency's mission-related goals. This master plan for the NIST Gaithersburg campus was commissioned in response to institutional policy, to evaluate the space needs and facilities, to support the research functions and to develop a more efficient and flexible campus. But other factors also drove the request—the evolving mission of the labs, the greater demand for highly controllable research environments and specific facility needs.

Significant development has occurred on the NIST Gaithersburg campus over the past decade and new facility requirements are frequently identified to support ongoing and new research objectives. Although the NIST campus includes several buildings constructed within the past fifteen years, there are multiple aging facilities and temporary structures that need repair, modernization or replacement. The Master Plan is a supporting tool to meet the goals and priorities of NIST in support of the NIST research mission. The goals for the Master Plan include the following:

- A plan that creates a comprehensive and coordinated framework for future physical development of the Gaithersburg campus.
- A plan that develops appropriate facilities and infrastructure for the evolving and advancing scientific research, meeting both near and long-term needs.
- A plan that maintains the attractive campus environment.
- A plan that respects and embraces the designation of the campus as a historic district.
- A plan that supports and advances the sustainable design and environmental goals of NIST and the Department of Commerce.
- A plan for gradual change, complete at each step.

## Plan Highlights

The Master Plan provides for the modernization of aging, inefficient buildings and accommodates the anticipated growth in research programs over the next 20 years. Approximately 1.4 million gross square feet of new facilities will be added and 15 buildings will be renovated. Many of the proposed elements are needed today, and are not the result of program driven growth. The Master Plan offers a framework for accomplishing NIST's goals of meeting anticipated scientific program growth, enhancing the Gaithersburg campus, providing appropriate facilities, encouraging professional collaboration and advancing sustainable practices. The emphasis is on research buildings—upgrading existing laboratory buildings and infrastructure to support current and future research, and adding new facilities needed for planned programs.

The Master Plan concentrates new research buildings in the central campus core, where most of the existing laboratories buildings are located, including the seven original general purpose laboratories and the main administrative building. The building configurations follow a regular pattern, linked by an interior pedestrian concourse. The new building configurations

and locations build upon that historic pattern, and connect into the interior pedestrian concourses. New specialty laboratory buildings are placed outside the core, and the existing special purpose laboratories are planned for renovations and additions as part of the 20-year Plan. Other campus recommendations improve security, upgrade infrastructure and encourage collaboration. Highlights are as follows:

- **Upgraded Campus Utilities.** A new electrical switching station will be built for the safe and orderly replacement of aging switchgear, feeders and failing ductbanks. A piping supply loop for steam and chilled water will be extended to the south campus.
- **Advanced Research Facilities.** New precision laboratory buildings will be constructed to provide the flexibility, infrastructure and controlled environments needed to support advanced research and measurement science.
- **Renovated Special Purpose Laboratories.** Six specialty laboratory facilities, built in the 1960s as part of the original campus, are carefully renovated so that ongoing special programs can continue to operate.”



- **Secure Visitor Entry.** New circulation, facilities and equipment allows enhanced screening of visitors, in accordance with new security policies and procedures.
- **Gradual Growth.** Growth in laboratory, office and support needs will be gradual over the 20-year period, based on anticipated programs and in line with historic NIST growth patterns.
- **Modernized General Purpose Laboratories.** Complete renovation of the original General Purpose Laboratory Buildings (GPLs), built in 1966, will provide the improved environments necessary for advanced measurement science and research.
- **Specialty Research Buildings.** Specialty laboratory facilities are constructed as additions to existing buildings or new structures, in response to specific research programs.
- **Adaptive Reuse.** Several original General Purpose Laboratory Buildings are renovated for computer laboratory and office occupancy, in lieu of constructing new office buildings.
- **Connected Buildings.** New research buildings are within the campus core and linked into the interior pedestrian concourse, for flexible assignments and easy collaboration.
- **Enhanced Conference and Visitor Facilities.** The conference center is expanded, and the library and museum updated to support larger conferences, modern research methods, collaboration and campus security.
- **Historic Preservation.** The campus has been determined eligible for listing in the National Register of Historic Places as a historic district. The Master Plan has considered the campus' character defining features and recognizes that each future development and/or redevelopment action will be governed by the National Historic Preservation Act of 1966 (as Amended) and through NIST's conscientious application of the *Secretary of the Interior's Standards for the Treatment of Historic Properties*.
- **Consolidated Shipping and Receiving.** New Gate F facilities provide for secure commercial vehicle screening, consolidated transfer of materials and deliveries, while significantly reducing commercial vehicle traffic within the campus.
- **Pedestrian Circulation.** Pedestrian circulation is enhanced by adding sidewalks and creating a pleasant walkway from the core buildings to Building 301 and the future CCT transit stop. A new recreational path encircles the entire campus.
- **Coordinated Parking Strategy.** The Master Plan gradually reduces the parking per employee ratio over time as the staff grows. This assumes the completion of the state sponsored hiker-biker-trail as well as the Corridor Cities Transitway (CCT) along Quince Orchard Road. The new research buildings proposed for the third construction phase will be built on existing surface parking lots, which will then be replaced with an efficient parking structure.
- **Energy Conservation Emphasis.** Planned renovations to the original campus buildings will refurbish the uninsulated facades, and replace aging mechanical systems with modern energy-efficient/conserving systems. A new solar field will augment the several existing on-site solar arrays. The new warehouse and other non-lab buildings have net-zero energy use as a goal.
- **Natural and Sustainable Campus.** The Plan emphasizes natural and sustainable landscapes, introducing native and adapted vegetation for easy maintenance, a coordinated stormwater management strategy and the creation of additional landscaped seating and recreation areas.
- **Flexible, Incremental Growth and Change.** The Plan allows facilities to be added incrementally, as needed and financed when federal funding permits, each being linked to an established circulation and utility network.

## The Master Plan

Measurement science and research are the heart and business of NIST, and the Master Plan focuses on research facilities. NIST's mission, research methods and technology have evolved since the campus establishment in the 1960s, and this advanced research requires more sophisticated buildings. New and renovated facilities will strive for flexible, adaptable lab facilities, precise environmental control and efficient, comfortable working conditions for the research and support staff.

The central concept for the Master Plan reinforces the original campus plan, adapting the original buildings to modern needs and placing new buildings in locations and configurations that respect the linear pattern of the original labs. All new buildings in the campus core are planned as research buildings, to house laboratories, office space for researchers and support space. The seven original General Purpose Laboratory buildings are renovated for advanced research with state-of-the-art



**Exhibit 3: Master Plan Program Summary**

\*ASF =Assignable Square Feet

	EXISTING		5- to 10-YEAR PROJECTIONS		20-YEAR PROJECTIONS		20-YEAR OVERALL DIFFERENCE	
	People Number	Space ASF*	People Number	Space ASF	People Number	Space ASF	People Number	Space ASF
<b>PROJECTED GROWTH</b>								
People	4,007		4,525		5,106		1,099	
Office/Office Support		615,463		766,530		865,300		249,837
Laboratories/Support/Special		897,195		1,016,327		1,160,502		263,307
ADP		21,997		17,683		18,715		-3,282
Service and Support		313,044		313,644		313,644		600
Subtotal - Growth	4,007	1,825,702	4,525	2,096,501	5,106	2,339,446	1,099	513,744
<b>ADDITIONAL FACILITY NEEDS</b>								
Building Expansions/Screening				109,900		109,900		109,900
Buildings Removed				(16,145)		(16,145)		(16,145)
Subtotal—Facility Needs				93,755		93,755		93,755
Total Assignable Square Feet (ASF)		ASF 1,825,702		2,190,256		2,433,201		ASF 607,400
<b>Total Gross Square Feet (GSF)</b>		<b>GSF 3,641,215</b>				<b>est. GSF 5,050,000</b>		<b>est. GSF ± 1,400,000</b>
<b>RENOVATION</b>								
Building 101								345,818
General Purpose Laboratories								1,277,587
Other								460,560
<b>Total Gross Square Feet (GSF)</b>								<b>2,083,965</b>

infrastructure, for sophisticated computer-based programs, and for related offices and support. New research facilities are added and existing ones are expanded on the southern campus to support specialized programs. Aging administration and support buildings are upgraded for better utilization and energy efficiency. While meeting functional needs, the Master Plan recommends design strategies that enhance the work environment, encourage collaboration and sharing of resources.

The Master Plan evolved from evaluation of existing conditions, site and regional analyses, circulation studies, building evaluations and program needs—and the Master Plan includes more than building recommendations. Campus entrance gates are modified primarily in response to security considerations, providing more comprehensive screening of visitors and commercial vehicle deliveries. Campus pedestrian circulation is strengthened by extending the interior concourses, but also by completing the campus-wide sidewalk system and creating an informal recreational walking path. Campus environmental stewardship is enhanced with an expanded solar energy program, stormwater management and native plantings. All modifications recognize the historic nature of the campus buildings and landscape elements.

## Key Master Plan Components

### Building Modernization

At the core of the Master Plan is the provision of appropriate facilities to support NIST's advanced research and measurement science. Modernization of the original General Purpose Laboratory buildings (GPLs) is a priority. These seven buildings constitute over 45 % of the current campus research space, and their complete renovation is included. The buildings would be vacated and renovated to support three primary functions: 1) flexible laboratories with new infrastructure systems and equipment galley spaces; 2) advanced computer research facilities; and 3) offices. Small additions to three of the GPLs are included to provide offices and collaborative space for the laboratories.

The older Special Purpose Laboratory buildings also require renovation and infrastructure upgrades. Each of these buildings houses unique equipment and/or programs on campus and, therefore, cannot be vacated during renovation. Phased renovation will be the approach.

Building 101 is the main administrative building, and the center for conferences and other public events. Phased renovation

is proposed, replacing major infrastructure that has exceeded its useful life, and upgrading the building envelope for energy conservation. In addition, renovation of the two lower levels for better public use is planned, including a small addition to the north to augment the conference center and the library's collection storage.

### New Research Buildings and Additions

New research buildings are central to NIST's plan for growth, and lab and support space will be added to the central campus in multiple buildings over the Master Plan period, proximate to the GPLs and linking into the interior pedestrian concourse system. The new laboratories, more sophisticated than the modernized GPLs, will provide the flexibility, infrastructure and controlled environments needed to support advanced research and precision measurement science.

Specialty Research Buildings 235-NCNR and 207-Robotics have planned additions, and Building 245-Radiation Physics has a planned expansion under contract. The Standard Reference Material program requires a new facility to respond to 21st century demand for ultra-high purity materials. Three small facilities are planned to support upcoming projects: a wind/fire facility, a strong floor laboratory and a flexible high-bay laboratory addition to Building 206 that will also serve as swing space during renovation of the GPL buildings.

### Campus Gate Modifications

Security and safety requirements will be implemented at the campus gates. Gate A, the main entrance, will receive an expanded Visitors' Center and new security infrastructure to better screen visitors and their vehicles. Gate F will become the main commercial vehicle entrance for the campus. Because of this, new screening facilities will be added and a new building will be constructed for Shipping and Receiving, limiting most non-NIST commercial vehicle traffic on campus. An additional visitor screening center is also planned for Gate F.

### Buildings Removed

Two buildings are recommended for removal in the Master Plan, both of which were installed as temporary facilities. Building 411, called the Temporary Relocatable Facility, is a single story, pre-fabricated structure. Built over 20 years ago, the building is in poor condition, with the original mechanical, electrical and plumbing systems. It is currently used as office space, which the Master Plan will replace in the renovated GPLs and Building 101. Facilities Building 428 is the second building

**Exhibit 4: Master Plan Building Summary, 20-Year Program**

Building	New GSF	Renovation GSF*	Description
<b>Phase 1: Immediate Priorities</b>			<i>Site: Courtyard activation, Gates A &amp; F roadways, stormwater, landscaping, utility loop</i>
Building 245 Addition/Renovation	106,000	207,921	Research/3 construction phases
Research Building I	300,000		Research
GPLs—Modernization/Office Additions	86,000	1,277,587	Modernize for research, offices
High Bay Lab Addition to 206	16,000	8,165	Research
Gate A Visitor Ctr. & security mods	3,000	2,460	Building expansion/roadway modernizations
Gate F Visitor Center	4,400		Visitor screening/vehicle inspection
Gate F Shipping/Receiving/Inspection	17,000		Truck screening/transfer warehouse
Electrical Substaion	5,400		Infrastructure replacement
Demo buildings 411 and 428	(20,185)		When space available in GPLs, 301
Subtotal	517,615	1,496,133	
<b>Phase 2: Next Steps</b>			<i>Site: Courtyard landscaping</i>
Building 101 Expansion	50,000		Conference facilities/offices
Building 101 Renovation		345,818	Public spaces/offices/infrastructure
Subtotal	50,000	345,818	
<b>Phase 3 Program Expansion</b>			<i>Site: Pedestrian way, courtyards, roadway modification</i>
Research Buildings II, III, IV	480,000		Research
Parking Structure			720 cars/4 levels (as needed)
Chilled Water Plant Expansion	6,200		Addition to 302/New cooling tower
Subtotal	486,200		
<b>Independent Projects</b>			<i>Site: East-west pedestrian way, trails, stormwater management, meadows, reforestation</i>
Standard Reference Materials Building	54,000		Research
Strong Floor Building	15,000		Research
Fire/Wind Tunnel Building	15,000		Research
Building 207 Expansion-Robotics	17,000		Research
AML Addition	115,000		Research
NCNR Expansion	138,000		Research/Renovation tbd
Building 202 Renovation-Engineering Mechanics		78,575	Research
Building 230 Renovation-Fluid Mechanics		38,366	Research
Building 231 Renovation-Industrial		75,131	Research
Building 233 Renovation-Sound		42,881	Research
Building 237/238 Renovation-Non-magnetic		7,061	Research
Subtotal	354,000	242,014	
20-Year Totals	1,407,815	2,083,965	Gross Square Feet

\*Renovation GSF is total building – Renovation scope has not been determined for any building except GPLs, which will undergo complete modernization.

recommended for removal. It is a manufactured building constructed in 2010 of four portable office trailers. The Master Plan recommends that the building occupants be accommodated in the adjacent Building 301, where there will be space available after Shipping/Receiving moves to its new location at Gate F.

### **Landscape and Open Space**

The Gaithersburg campus has a beautiful pastoral quality, a benefit that the staff applauded in the employee survey. The Master Plan approach seeks to enhance and preserve the setting and landscape features, while improving the stormwater management, pedestrian connectivity and outdoor use. The plan establishes a hierarchy of outdoor spaces—meeting and social areas by the research buildings, outdoor dining opportunities, walking paths through both open and wooded landscape, and active recreation areas. Meadow will replace mowed lawns outside of the campus core, to reduce maintenance and contribute to stormwater management. Rainfall will also be managed with reforestation and the implementation of bioswales, and rain gardens integrated with parking and roadways. New pedestrian links will connect the core research buildings with the west campus and its future Corridor Cities Transitway transit stop, and with the main entry Gate A to the north. Original, modernist landscape elements will be preserved, to the greatest extent possible, including the central courtyards, the tree-lined formal entry drive, the lower ponds and the mature campus trees.

### **Utility Infrastructure**

The Steam and Chilled Water Generation Plant provides chilled water, steam and compressed air to most of NIST's campus buildings, distributed through underground piping system from the Plant via a loop main serving the north buildings and a single main serving the south buildings. Because of the loop arrangement, the north buildings have an inherently robust utility service, allowing for isolation of sections of the piping system without significantly interrupting service to large groups of buildings. The south buildings, on the other hand, are served by a single main which does not provide the same level of utility availability. A disruption or maintenance shutdown of the main piping can result in utility interruption to several of the special purpose labs. It is recommended that a redundant utility path be established for the south buildings creating a looped supply interconnecting the main on South Drive and existing main near Building 205.

The Master Plan projects will require enhancements to the chiller plant and electrical sub-station capacities to support

the mid-to-late Master Plan construction for the full twenty year build-out period. The existing chiller plant will be expanded to accommodate two 3,500-ton chillers prior to Phase 3 construction, including an additional piping main from the plant to the distribution system. Both the steam generation capacity and the compressed air are expected to be adequate to support the Master Plan, although there are detected losses in the compressed air distribution, likely because of leaks in deteriorated piping. As buildings are renovated and new research buildings constructed, NIST plans to switch towards supplying compressed air locally where needed.

A new electrical switching station is a priority, to replace the aging switchgear, primary feeders and failing ductbanks, some of which are collapsing, and partly glued up by old cable lubricant. This substation should be sized to accommodate an expanded primary electrical firm capacity, which will be exceeded during Phase 3.

While the individual piping systems are reported to be in generally good condition, they are more than 50 years old, like the original buildings, and approaching the end of their useful life. As a result, failures are occurring with increasing frequency. Phased replacement of many systems is expected to result after detailed evaluation and the development of a detailed plan.

### **Circulation and Parking**

The internal roadway system is original to the campus development, and remains essentially the same in the Master Plan. In fact, the roadway system and the corresponding parking lots are character defining features of the NIST historic district. Changes are concentrated at three of the four active campus entry gates. The main campus entrance, Gate A, will be modified to support more rigorous visitor screening. The entrance from West Diamond Avenue remains the same, but new roadways, parking and a roundabout are introduced near the Visitor Center. Gate F, on the southeast edge of campus, will be reconfigured for both commercial vehicle and visitor screening, with a new entrance from Muddy Branch Road to separate commercial vehicle traffic from passenger vehicles. At the west campus along Quince Orchard Road, Gate C is expected to shift location if the planned Corridor Cities Transitway moves forward.

New parking is planned only at the third phase of Master Plan implementation, gradually reducing the parking spots/ person as the NIST personnel grows over the first years. The third phase research building construction will eliminate two major

Exhibit 5: Master Plan



parking lots, which will be replaced by a parking structure. Parking spaces are planned to increase approximately 7%, while the personnel is projected to increase by 27%. Adding new parking only in this later phase allows for adjustment in the anticipated parking spots if ride-sharing services or autonomous vehicle use reduce the need.

### Sustainable Design Initiatives

Sustainable design and energy efficacy are core principles, both as responsible practice and meeting the requirements of the Department of Commerce and NIST. Augmenting strategies already in place, the Master Plan incorporates a broad range of strategies—water conservation, energy efficiency, adaptive reuse, stormwater management, landscape stewardship and renewable energy. Highlights include significantly improved energy efficiency with the Plan’s renovation of aging and obsolete laboratory buildings and a major upgrade of the envelope and systems of Building 101, the main administrative building. The goal for new non-lab buildings, such as the new shipping/receiving facility and the Gate F screening building, is net-zero energy consumption. Stormwater management strategies will emphasize natural features such as bioswales, rain gardens, and extensive reforestation. NIST plans to start construction of a 5 MW solar array in 2018. Additionally, solar collection is recommended on new non-lab buildings and the new parking structure, GPLs renovated for office occupancy, and over the surface parking lots.

### Master Plan Implementation

NIST’s priority is quality research space, including complete modernization of the aging General Purpose Laboratories. The Master Plan is a structured approach to construction and renovation that addresses that goal. Although the Master Plan has a twenty-year timeframe, the first phases are driven by the current need to modernize laboratories.

- Phase One—Immediate Priorities includes the addition/renovation of Building 245, which is underway. Much needed campus infrastructure upgrades and replacements are key priorities for this phase. The first planned new building is Research Building I. Upon its completion, the General Purpose Laboratory modernizations can begin. Gate A and Gate F modifications, together with the shipping/receiving facility, are considered priority projects, required to meet federal security policies.

- Phase Two—Next Step has the Building 101 addition and renovation as the primary project, improving the public access areas, office utilization and building system performance. The addition will provide much needed conference facilities, library modernization and security modifications to public-access areas. Its second floor office space will provide swing space for Building 101 infrastructure replacement and office modernization.
- Phase Three—Program Expansion adds new Research Buildings II, III, and IV, which will be constructed as growth and research projects dictate.
- Independent—The new Standard Reference Materials Facility, new specialty laboratories, and additions and renovations to existing Special Purpose Laboratories, are independent of other projects, and can be implemented in any desired order, as need and funding allow.

Master Plan implementation is dependent on many factors, such as funding, direction of scientific research, agency missions and priorities. The Master Plan should be considered as a living document, setting a framework that remains flexible and sensitive to the timing and composition of specific projects.

### Fast Facts

	2016	20-Year
Personnel	4,007	5,106
Buildings	62	72
Square Footage—GSF	3,641,215	5,050,000
Parking—Potential	3,704	3,979

# Background

## CHAPTER 2

### History of Campus Development

THE headquarters site of the National Institute of Standards and Technology (NIST) is located on a 579 acre campus in Gaithersburg, Maryland. The campus was developed in the 1960s to relocate the facilities from the District of Columbia. The original District buildings, constructed in the early part of the century, were antiquated, crowded and far short of the laboratory standards of the 1960's. The Gaithersburg site was selected because it met the desired criteria—a large site accommodating future buildings; a location near the District of Columbia, but not in the Baltimore-Washington corridor because of Cold War security concerns; isolation from population centers and their associated mechanical, electrical and atmospheric disturbance potential; and a location that would be convenient for personnel.

Initial construction on the Gaithersburg campus spanned the period from 1961 to 1969, during which 26 buildings were constructed in five phases. These buildings still provide approximately 73% of the overall campus assignable space, and approximately 70% of the laboratory space. The prominent architectural firm of Voorhees Walker Smith Smith and Haines was selected to complete the campus master plan and design following their well-received design for the Bell Research Laboratories corporate campus in Murray Hill, NJ. The architects and NIST leadership examined numerous design approaches for accommodating the various scientific research laboratories, before settling upon the concept of multiple buildings placed in a campus setting as the selected approach, favored for flexibility and control of environmental interference. The architecture team worked extensively with researchers and administrators in the design development. The user input influenced the overall program and the laboratory flexibility, features, lab windows (none) and infrastructure.

Groundbreaking was in June of 1961, bringing together senior executives from the Department of Commerce, General

Services Administration and National Bureau of Standards, for a ceremony on the future site of the Engineering Mechanics Building, now Building 202. The Engineering Mechanics Building and the Steam and Chilled Water Generation Plant (Building 302) were the first buildings to be constructed. The second group constructed included the Administration Building (Building 101), Radiation Physics Laboratory (Building 245), Supply & Plant Building (Building 301), Automotive Service Building (Building 303) and the Instrument Building (Building 304). This group was followed by the Center for Neutron Research (Building 235). The seven General Purpose Laboratories (Buildings 220-226) were built in the fourth construction phase. And the fifth and final phase of initial laboratory construction included the special purpose laboratories of Sound, Industrial, Hazards, Concrete Materials, Fluid Mechanics and Non-Magnetic (Buildings 233, 231, 236, 206, 230 and 237/238, respectively).

Following this major campus development, the next 20 years saw improvements and additions to existing buildings to support expanded missions or new assignments. A new Large Fire Facility (Building 205) was constructed in 1974 (expanded in 2010) for testing needs in fire research. During this period, a number of support buildings were constructed, including a major addition to the Steam and Chilled Water Generation Plant—Building 302. The first new research building in more than 20 years, the Advanced Chemical Sciences Laboratory (Building 227) was completed in 1999.

NIST's research and priorities continued to evolve into the twenty-first century, when new buildings and additions were constructed. The Advanced Measurement Laboratory (AML) was the major undertaking in recent years, an interconnected five-building complex of advanced laboratory space—Nano Fabrication Laboratory (Building 215), Center for Nanoscale Science and Technology (Building 216), Instrument West (Building 217), Metrology East (Building 218), and Metrology

West (Building 219). This complex supports sophisticated measurement science, in an environment of strictly controlled air quality, temperature, vibration and humidity. The new Visitor Center (Building 103) was completed in 2009. Other buildings added to the campus after 2010 are the Child Care Center (Building 320), Robotics Test Facility (Building 207), Standard Reference Materials Facility (Building 203), Emergency Services Facility (Building 318), and the Net-Zero Energy Residential Test Facility (Building 208), as well as expansions to Buildings 205, 235, 301, and 302.

Today, in addition to its diverse research programs, NIST provides services and standard reference materials to industry, academia, and government organizations. Research areas include:

Acoustics	Materials Science
Additive Manufacturing	Mathematics & Statistics
Biochemistry	Mechanical Engineering
Biology	Medical Physics
Biotechnology	Metallurgy
Chemistry/Chemical Engineering	Molecular Biology
Computer Science	Nanotechnology
Dimensional Metrology	Neutron Research
Engineering	Quantum Physics
Fire Research	Robotics
Forensic Science	Structural Engineering
	Wireless Communications

## Previous Master Plans and Studies

There was a campus planning effort in 2009 anticipating several new buildings, as well as targeted facility studies over the next few years. Following is a list of key recent studies with findings that are integrated into this Master Plan.

- *Campus Master Plan*, 2009; Mancini Duffy Architecture Design

The 2009 Gaithersburg campus master plan was limited in scope, with the primary goal of integrating NIST's priority laboratory and support needs into the campus fabric, circulation system and infrastructure framework. The plan that was developed incorporated current regulatory requirements, and was reviewed and approved by the National Capital Planning Commission. A Programmatic

Environmental Assessment was completed in parallel with the 2009 Master Plan and resulted in a Finding of No Significant Impact. The priority facilities of the master plan were several new buildings—Childcare Center (320), Robotics Test Facility (207), Emergency Services Facility (318) and the Net-Zero Residential Test Facility (208)— plus additions to several existing buildings, including Buildings 202,205,235, 301 and 302. The master plan did not project or develop a physical plan for long term facility needs.

- NIST *Space Utilization Study*, 2013; Metropolitan Architects and Planners, Inc.

The Utilization study documents all the space on the Gaithersburg campus and how it is used, to provide a data base for future planning. The study recorded various aspects of the space—the amount, the space types, its distribution, its utilization rate and how it is assigned—resulting in a detailed planning resource. In general, space is used well and utilization is efficient, with 86% of the laboratories well utilized and overall campus office space within the DoC utilization standards. However, many organizations are fragmented across campus, resulting from research mission and organizational changes. A significant number of laboratories are not used for their intended purpose because they have been converted to needed office and support space. Similarly, traditional laboratories are used for high density computer research, which does not require the piped infrastructure. In addition to documenting the space and building, the study addressed strategies to correct issues.

- NIST *Administrative Space Strategic Plan*, 2014; OKKS Studios

The planning study goal was to develop an approach and conceptual plan for the organization of administrative space in the four principal office facilities, Buildings 101, 301, 411 and 428. This was in response to organizational changes, vacant space created by new construction and security-related requirements for the public areas of 101. The analysis determined that approximately 295,000 assignable square of space is needed, of which 142-168,000 ASF is administrative space and the remainder conference center, library, shops and warehouse. Alternate approaches and test fits were explored, each aimed at accommodating organizational requirements, reducing space to meet the DoC standard utilization rate and building in flexibility for future changes. To accomplish this, the study recommended four strategies: 1) use more



Exhibit 6: History of Campus Planning and Development

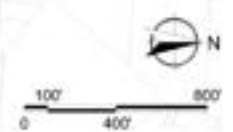


- 101 Administration
- 103 Visitor's Center
- 202 Engineering Mechanics
- 203 Standard Reference Material Fac.
- 205 Large Fire Facility
- 206 Concrete Materials
- 207 Robotics Test Facility
- 208 Net-Zero Energy Residential Test Fac.
- 215 Nanofabrication Facility
- 216 Instrument East
- 217 Instrument West
- 218 Metrology East
- 219 Metrology West
- 220 Metrology
- 221 Physics
- 222 Chemistry
- 223 Materials
- 224 Polymer
- 225 Technology
- 226 Building Research
- 227 Advanced Chemical Sciences Lab
- 230 Fluid Mechanics
- 231 Industrial
- 233 Sound
- 235 NIST Center for Neutron Research
- 236 Special Projects
- 237 Non-Magnetic
- 238 Non-Magnetic
- 245 Radiation Physics
- 301 Supply and Plant
- 302 Steam & Chilled Water Gen. Plant
- 303 Service
- 304 Shops
- 305 Switchgear / Cooling Tower
- 306 Electrical Substation
- 307 Materials Processing Stor.
- 309 Grounds Maintenance
- 310 Plant Storage Building

- 311 Grounds Storage Shed
- 312 Materials Processing
- 313 Site Effluent Neutralization
- 314 Backflow Preventer - East
- 315 Backflow Preventer - North
- 316 Electrical Service Building
- 317 Cooling Tower
- 318 Emergency Services Facility
- 319 Emerg. Services Storage Building
- 320 Child Care Center
- 321 NCMR Storage Facility
- 411 Temp. Relocatable Facility
- 418 NCMR Storage Building
- 420 OHPM Storage Building
- 421 Radiation Physics Storage
- 422 Concrete Materials Storage
- 423 Research House
- 424 NCMR Trailer 2
- 427 NCMR Trailer 1
- 428 Temp. Facilities Building

Legend: Year Commissioned

- 1960 - 1969
- 1970 - 1979
- 1980 - 1989
- 1990 - 1999
- 2000 - 2009
- 2010 -



shared offices in lieu of individual offices; 2) use more open workstations in lieu of offices; 3) standardize floor plans for B101 tower; and 4) use building-standard office furniture. A phasing strategy outlined step-by-step renovations over a 40 month schedule. Final recommendations for B101 Basement and 1st Floor were covered in a separate study.

- NIST *Research Facilities Strategic Plan*, 2014; Metropolitan Architects and Planners, Inc.

Existing Research Facilities	
Functionally compliant with current practices/needs	37%
In planning for modernization (Building 245)	8%
Need upgrades and modernization	55%

This study evaluated the existing laboratory space with the goal of developing a physical strategy to support and advance NIST research in the 21st Century. The study considered both the condition and capabilities of the laboratories, and the functional organization of the 27 laboratory buildings. The evaluations determined that the older laboratories do not perform at a level that supports current and planned research, with deficiencies in thermal and power stability, power quantity, piped services and general infrastructure degradation. Complete modernization was recommended for ten special purpose laboratories and seven general purpose laboratories, as well as new high bay and general purpose laboratories and office space. The implementation plan proposed a new “precision laboratory” facility and the gradual renovation of the special and general purpose laboratories over a multi-year program. In light of the recent historic district designation, recommendations from this study affecting the building façade should be re-evaluated.

- NIST *Building 101 Window and Induction Unit Study*, 2014; OKKS Studios

Building 101 retains many original finishes, systems and building envelope, which are beyond their service life. This study explored multiple strategies for modernization, and put forward six approaches for final consideration. Each would make improvements to the central mechanical plant, replace the terminal mechanical units, replace the windows and improve the insulation of the façade. The six approaches were described in detail and compared for cost, phasing, energy efficiency improvement and project complexity.

- NIST *Traffic and Gates Study for Gaithersburg Campus*, 2015; Gorove/Slade

The study assessed the transportation conditions at the Gaithersburg campus, both the regional/neighborhood vehicle and transit systems and the on-campus conditions. The analysis included traffic counts on and off-campus, review of traffic controls, roadway, pedestrian and bicycle networks in comparison to local and state standards, and a comprehensive assessment of gate operations. The Study recommended modifications prioritized by level of need and investment.

- *Historic Assessment*, National Institute of Standards and Technology, Gaithersburg, MD, 2015; R. Christopher Goodwin & Associates, Inc.

The comprehensive assessment of the historical development on the NIST Gaithersburg campus evaluated the significance and integrity (historical and architectural ) of the properties in light of the National Register Criteria for Evaluation. Original archival research and architectural investigations resulted in a survey of building and landscape resources within the historic context. See the Historic Assessment chapter, later in this report.

- NIST *Building 245 Feasibility Study Planning Alternative Development Options*, 2015; OKKS Studios

Building 245, the Radiation Physics Building, currently is being renovated as the initial phase of a multi-phased renovation project. This study explored several expansion and modernization options and the strategies for their implementation. Five options were developed and compared against criteria for risk, environmental control, program accommodation, disruption, radiation safety and best value. The preferred alternative proposed two building additions and a new mechanical penthouse to serve Wing A basement and sub-basement. This study formed the basis for the design documents of the current expansion.

- NIST *Cafeteria and Food Service Operations Evaluation and Recommendations*,

The two campus cafeterias—the primary one in Building 101 and satellite one in Building 301— need to be upgraded to address expanded demand, aging kitchen equipment and the customer dining experience. The analysis was

conducted with data review, surveys and user interaction utilizing interviews, focus groups and a campus-wide survey. Several options for each location were developed and compared for both function and business viability. The preferred option for Building 101 expands the kitchen server and sales area, and adds an interior dining loft for expanded seating. A separate coffee/snack bar would be added, which would have limited after-hours food service. For Building 301, the preferred option establishes a grab-n-go operation augmented by enhanced vending. An outdoor seating area would be added, as well as an entry that could be used by contractors and others without building-entry badges. Vending and scheduled food truck service were recommended for the remote laboratories.

- NIST *Building 101 Lower Levels Planning Study*, 2017; OKKS Studios

The two lower levels of Building 101, the main administrative building, house the primary public and staff community facilities for the campus. These include the cafeteria, conference center, research library, fitness center, health unit, badging and security offices. The study analyzed the space and future needs, in light of functional requirements, the changing role of technology, security considerations and NIST goals for integration and collaboration. The study explored a range of options and recommended an addition to Building 101 that would house new conference facilities on the first floor, library support in the basement, and office space on the second floor that would provide swing space during the 101 office tower renovations recommended in previous studies. A library renovation would create a more contemporary library facility focused on research, collaboration and technology, by moving some of the stacks to the new wing. The proposed renovations would consolidate areas that welcome public visitors and enhance research support, collaboration and conference capacity.

- NIST, *Gate A Visitor Screening Study*, 2017; Metropolitan Architects and Planners, Inc.

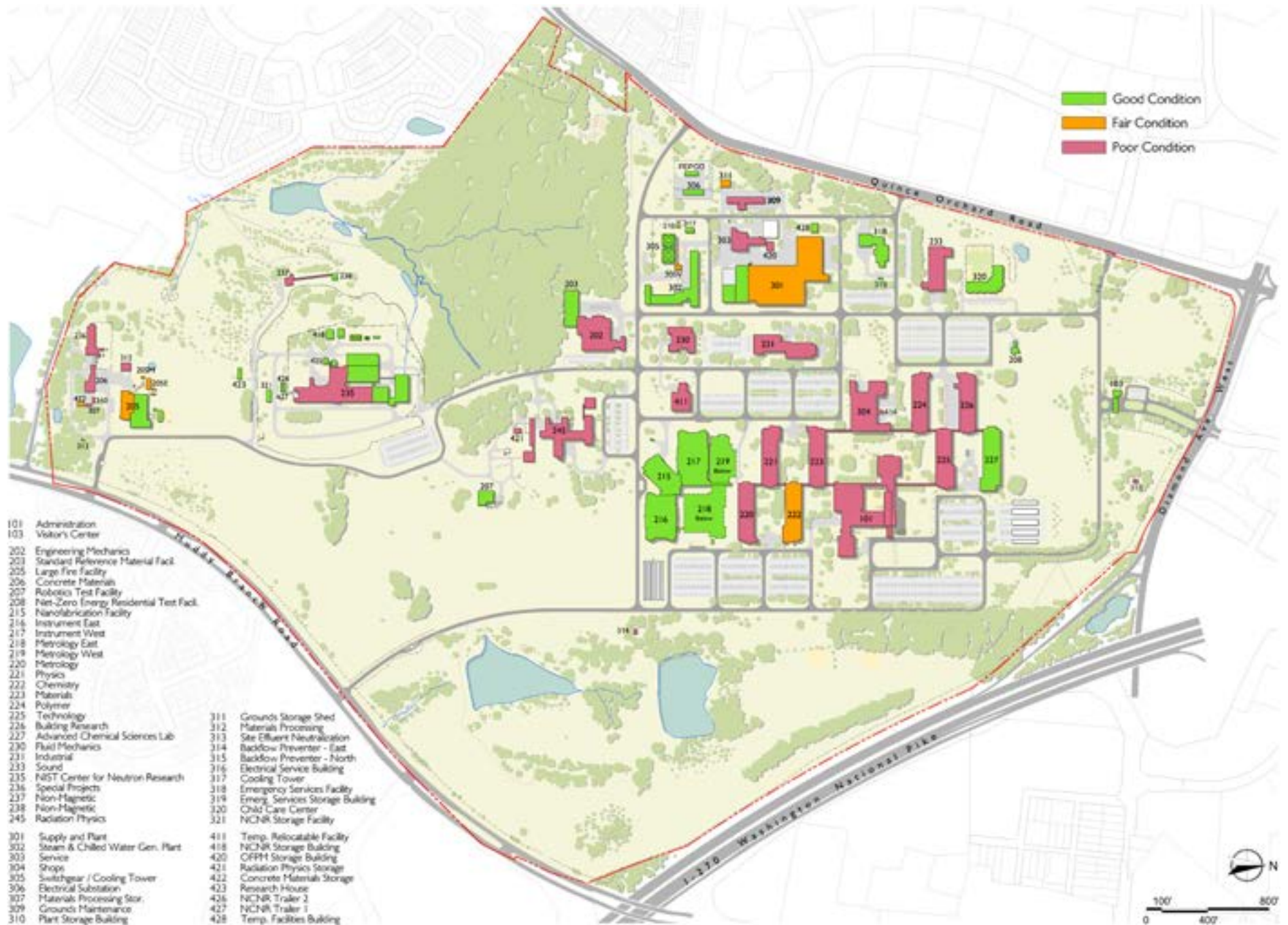
Gate A is the main campus entrance, used by staff and all visitors except major conferences participants, who are typically redirected to Gate F along Muddy Branch Road. Enhanced federal security requirements require modifications to the entrance facilities to allow increased screening

and better emergency capabilities. This study explored options to modify the Gate A facilities to support new security procedures and enable a more thorough screening of visitors. The recommended approach would establish a vehicle inspection canopy adjacent to an expanded existing Visitor Center building, housing x-ray and magnetometer equipment for screening visitors and their belongings. Vehicle screening systems would be added, including under-vehicle inspection, license plate recognition and barrier gate operators. A roundabout was recommended at the intersection of Bureau Drive and North Road Drive to ease merging from Gate A and the attendant congestion.

- NIST Facility Condition Assessment

NIST surveys each building on a regular cycle to determine its condition and repair needs. Recent assessments began with a 2011 baseline survey and the most recent update was 2015. Based upon the Facility Condition Assessment estimated cost of repairs, compared with the estimated replacement value, a Facility Condition Index (FCI) value is calculated for each building. The value is then classified into a rating of good, fair or poor. Currently, 27 of the buildings and structures on the NIST Gaithersburg campus have an FCI rating of 'Poor.' While NIST has a robust repair and maintenance program, the age of the buildings and obsolescence of their systems makes significant conditions improvements difficult to achieve.

Exhibit 7: Facility Condition Assessment



## Organizational Units on Campus

NIST was founded in 1901 as the National Bureau of Standards, and is a non-regulatory federal agency within the U.S. Department of Commerce. It promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.

The NIST Laboratories conduct world-class research, often in close collaboration with industry, to advance the nation's technology infrastructure and help U.S. companies continually improve products and services. About 80% of NIST's Laboratory Programs are located on the Gaithersburg Campus, which houses approximately 4,000 federal staff and associates organized into twenty Organizational Units (OUs).

The NIST organization is structured under the Office of the Director, and three Associate Directors. Five major Laboratories and two national user facilities (Centers) are within the Associate Director for Laboratory Programs and represent approximately two-thirds of the personnel on the Gaithersburg campus. The Associate Director for Innovation and Industry Services oversees three diverse extramural programs. The Associate Director for Management Resources oversees six administrative Chief Offices that provide operational support to the research mission.

### NIST Components at the Gaithersburg Campus

Organizational Units (OUs) are the functional groupings on campus and the building blocks for the Master Plan. Offices, laboratories and support spaces are assigned to OUs, and this Master Plan continues to use that designation. The OUs are not necessarily consolidated in location; however, specialized facilities and laboratory types may be grouped together for shared infrastructure. One goal of future development is to conveniently locate those specialized spaces that may be shared by several groups. See NIST Organizational Chart.

#### Director's Office

##### Director's Office—Organizational Unit 00

The NIST Director's Office provides leadership and direction to the entire NIST organization, in management, mission, organization and coordination with Congress, academia and the public.

## Associate Director: Management Resources

### Associate Director for Management Resources—Organizational Unit 13

The Associate Director for Management Resources is responsible for all NIST-wide institutional support and administrative offices and their functions, including: workforce management, information technology and services, safety and environmental management, facilities maintenance and construction, accounting and finance, acquisitions and grants management, budget formulation, strategic planning, and emergency response. OU 13 has four Staff Offices: Civil Rights and Diversity; Information Services Office; and Emergency Services and Fabrication Technology.

### Office of Acquisition and Agreements Management—Organizational Unit 14

The Office of Acquisition and Agreements Management is responsible for overseeing NIST's acquisition and financial assistance activities, including cooperative agreements, grants and interagency agreements. The OU provides business services that support NIST's scientific mission, as well as those of the Department of Commerce.

### Office of Safety, Health and Environment—Organizational Unit 15

The mission of the Office of Safety, Health and Environment is to reduce safety, health, and environmental risks at NIST by planning, developing and implementing NIST's safety, health and environmental programs and compliance. Disciplines include fire protection, environmental compliance, radiation safety and industrial hygiene.

### Office of Financial Resource Management—Organizational Unit 16

The Office of Financial Resource Management manages NIST's budget and directs the financial management activities related to the programs and operations of NIST, as well as client bureaus serviced by NIST. This includes the development of financial management policies and procedures, financial reporting, and financial internal controls, which comply with all applicable DoC, OMB, Treasury and FASB policies.

### Office of Human Resources Management—Organizational Unit 17

The focus of the Office of Resources Management is the people who work for NIST—the hiring and retention of the best talent, aligning programs with NIST's strategic plans, and supporting staff with training, tools and administrative services. OU 17 also develops, recommends and implements procedures in concert with Department of Commerce policies.

**Office of Information Systems Management—Organizational Unit 18**

The Office of Information Systems Management acquires and manages information technology resources for NIST scientific and business computing services. It has the responsibility for centralized IT functions including telecommunication, networking, web services, integrated information systems, knowledge systems, and other IT infrastructure support services. OISM provides customer services for software and hardware, and for integrating emerging technology to assist the research mission. OISM also provides security for the IT network, including oversight and training.

**Office of Facilities and Property Management—Organizational Unit 19**

The OFPM is responsible for facility activities and services, including space and real property management; facilities planning, building design, construction and renovation; building system operation, maintenance and repair; central plant operation and utility distribution services; grounds maintenance; janitorial services; oversight and support for NIST construction grants; and facilities support services including mail, reproduction, transportation, visual communications, logistics and personal property management.

**Associate Director: Innovation And Industry Services****Associate Director for Innovation and Industry Services—Organizational Unit 40**

Innovation and Industry Services oversees external partnership programs, including the Hollings Manufacturing Extension Partnership, the Baldrige Performance Excellence Program, the Office of Advanced Manufacturing and NIST technology transfer, economic analysis, and small business innovation research awards. They provide support to small and medium size manufacturing firms in adopting more advanced manufacturing technologies and practices.

**Exhibit 8: NIST Organization Chart****Baldrige Performance Excellence Program—Organizational Unit 45**

The Baldrige Program is a public-private partnership that educates organizations in ways to improve performance, offering an integrated management framework and assessment tools. The goal is to enhance competitiveness and performance, sharing best management practices and strategies. The Baldrige Program recognizes role models with a national award program.

**Hollings Manufacturing Extension Partnership Program—Organizational Unit 48**

The Hollings Manufacturing Extension Partnership is a public-private partnership dedicated to serving small and mid-sized U.S. manufacturers to help them create and retain jobs, and improve business results. It is a nationwide service network

providing a variety of services, from innovation strategies to process improvements to green manufacturing. MEP also works with partners at the state and federal levels on programs that put manufacturers in position to develop new customers, expand into new markets and create new products.

#### **Office of Advanced Manufacturing—Organizational Unit 49**

The Office of Advanced Manufacturing is responsible for NIST's outreach programs in advanced and innovative manufacturing, providing federal financial assistance under several programs and competitions addressing industrial research. The Office is also the headquarters for the interagency Advanced Manufacturing National Program Office, a collaboration of manufacturing-related organizations from federal agencies, industry and academia.

### **Associate Director: Laboratory Programs**

#### **Associate Director for Laboratory Programs—Organizational Unit 60**

The Associate Director for Laboratory Programs provides direction and operational guidance for the scientific and technical mission-focused NIST laboratory programs, and serves as principal deputy to the NIST Director.

#### **NIST Center for Neutron Research—Organizational Unit 61**

The NCNR is a national resource center for research focused on neutron measurement, using thermal and cold neutrons. The Center conducts a broad program of research using neutron techniques, and develops and applies new neutron measurement techniques. It is one of the two user facilities at NIST, providing support and instrumentation for qualified applicants from industry, university and other government agencies.

#### **Center for Nanoscale Science & Technology—Organizational Unit 62**

The Center is a unique national facility established to accelerate innovation in nanotechnology-based commerce. It operates a shared user resource for nanoscale fabrication and measurements, which supports researchers from industry, academia, NIST, and other government agencies with access to world-class nanoscale measurement and fabrication methods and technology. CNST disseminates new nanoscale measurement methods by incorporating them into facility operations, collaborating and partnering with others, and providing international leadership in nanotechnology.

#### **Material Measurement Laboratory (MML)—Organizational Unit 63**

MML serves as the national reference laboratory for measurements in the chemical, biological and material sciences. Activities range from fundamental and applied research, to the development and dissemination of certified reference materials and tools to assure quality of measurements. MML is also responsible for coordinating the NIST-wide Standard Reference Material and Standard Reference Data programs.

#### **Communications Technology Laboratory (CTL) —Organizational Unit 67**

The Communications Technology Laboratory, established in 2014, performs cutting edge research and development in advanced communication technology, targeting its understanding, testing and validation. CTL conducts leading research and development on the metrology and understanding of physical phenomena, and materials and systems relevant to advanced communications. Research areas include high-speed electronics, wireless systems metrology, antennas, advanced optics, network design and optimization, and public safety communication. The CTL is headquartered at the Boulder campus, with a unit in Gaithersburg.

#### **Physical Measurement Laboratory (PML) —Organizational Unit 68**

PML develops and disseminates the national standards in physical properties—length, mass, force and shock, acceleration, time and frequency, electricity, temperature, humidity, pressure and vacuum, liquid and gas flow, and electromagnetic, optical, microwave, acoustic, ultrasonic, and ionizing radiation. Its activities range from fundamental measurement research through provision of measurement services, standards, and data.

#### **Engineering Laboratory—Organizational Unit 73**

The Engineering Laboratory promotes innovation, industrial competitiveness and enhanced security by advancing measurement science, standards, and technology for engineered systems. Programs support research in a range of engineering disciplines: smart manufacturing and construction; sustainable and energy efficient materials and infrastructure; disaster-resilient buildings, infrastructure and communities; and cyber-physical systems.

#### **Information Technology Laboratory (ITL) —Organizational Unit 77**

ITL supports the NIST mission through research and development in information technology, mathematics, and statistics. ITL is addressing hard problems in IT Measurement Research

through development of protocols and operational standards that mitigate anticipated discrepancies in systems operation, and establishing assessment criteria and test data sets for validation of industrial products. ITL formulates metrics, tests, and tools for a wide range of subjects including information complexity and comprehension, high confidence software, space-time coordinated mobile and wireless computing, as well as, issues of information quality, integrity, and usability.

## Applicable Standards and References

The Master Plan was prepared in accordance with applicable Department of Commerce and other Federal statutes and requirements. In addition, the plan was guided by the City of Gaithersburg policies and the requirements of the National Capital Planning Commission, which will review and approve this Master Plan. Individual construction and renovation projects must follow relevant standards and references, including the following:

- National Environmental Policy Act (NEPA); US Environmental Protection Agency; January 1970
- National Historic Preservation Act of 1966, as amended; Department of the Interior, National Park Service
- US Clean Air Act; US Environmental Protection Agency, 1990
- US Clean Water Act; US Environmental Protection Agency; 1992; and NIST Stormwater Permit #COR042002
- US Energy Independence and Security Act of 2007 (EISA 2997) US Energy Policy Act of 2005 (EPAAct); 2005
- Executive Order 13693: Planning for Sustainability in the Next Decade; 2015; and associated CEQ instructions.
- US Executive Order 13514: Federal Leadership in Environmental, Energy, and Economic Performance; 2009
- US Department of Commerce Real Property Management Manual; August 2014
- US Department of Commerce Energy and Environment Management Manual, September 2012
- US Department of Commerce DAO 217-21, Space Allowance and Management Program
- US Department of Commerce, High Performance and Sustainable Buildings Handbook

- US Department of Commerce Implementation Handbook for the Strategic Sustainability Performance Plan; August 2013
- NIST Sustainable Design Manual; July 2014
- Comprehensive Plan for the National Capital, Federal Elements, NCPC; Draft October 2015
- Site Plans and Development Projects Submission Requirements; NCPC; October 1991 with subsequent amendments.
- Procedures for Intergovernmental Cooperation in Federal Planning in the National Capital Region; NCPC; September 1983 with subsequent amendments
- Environmental and Historic Preservation Policies and Procedures; NCPC; September 1979, with subsequent amendments

Some regulations and policies have had a greater influence on the development and review of the Master Plan. Here are further descriptions of key regulations:

**National Environmental Policy Act (NEPA).** The US Congress enacted the National Environmental Policy Act (NEPA) in 1970, primarily to promote the enhancement of the environment and to "...to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans." With a few exceptions, Federal agencies must comply with NEPA before they make final decisions about federal actions that could have environmental effects. Such Federal actions include, but are not limited to, federal construction projects; plans to manage and develop federally owned lands; and, federal approvals of non-federal activities such as grants, licenses, and permits. NIST has determined that the Master Plan requires the preparation of an Environmental Assessment (EA). The EA process has been followed, and the EA is a companion document to this Plan.

**National Historic Preservation Act of 1966, As Amended.** Federal agencies are required to consider the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment in accordance with the process mandated by Section 106. The Maryland State Historic Preservation Office has determined that the NIST Gaithersburg campus is eligible for listing on the National Register of Historic Places as a Historic District.



**The Secretary of the Interior's Standards for the Treatment of Historic Structures.** These standards and guidelines complement federal historic preservation laws to encourage consistent practices that guide planning, design and preservation work at the national, tribal, state, and local levels. In most cases, these standards are regulatory at the Gaithersburg campus because of the historic district designation.

**Interagency Security Committee Guidelines.** The Interagency Security Committee (ISC) was instituted in 1995 to address government-wide security for Federal facilities. One of the key documents of the Committee is *The Risk Management Process for Federal Facilities: An Interagency Security Committee Standard* (August 2013). This document defines the criteria and processes to determine the security level of a facility. The Master Plan follows NIST and DoC recommendations for physical security measures, including campus gate modification and visitor screening.

**Stormwater Management.** The National Pollutant Discharge Elimination System (NPDES) regulations under the Clean Water Act (CWA) require stormwater discharges from small municipal separate storm sewer systems (MS4s) for communities with populations less than 100,000 to obtain permit coverage. The State of Maryland has been authorized by the U.S. Environmental Protection Agency (EPA) to administer and to enforce the NPDES requirements. NIST maintains coverage under the Maryland Department of the Environment (MDE) NPDES General Permit No. MDR 055501 for Discharges from Small Municipal Separate Storm Sewer Systems. A Stormwater Pollution Prevention Plan (SWPPP) is in place that documents prevention measures in use at the facility to comply with the NPDES permit. Implementation of the Master Plan must follow the regulations.

**Forest Conservation.** NIST developed a Forest Conservation Plan in 1995 based on existing development and the then planned Advanced Technology Laboratory (ATL) and Advanced Chemical Sciences Laboratory (ACSL) projects (which have since been implemented). The Plan followed guidelines set by Maryland National Capital Parks and Planning Commission (MNCPPC) for overall forest preservation and afforestation. The Montgomery County guideline for the afforestation threshold for the NIST campus is 15% of the campus. The Conservation Plan identified three stands of trees on the campus and documented 120 large trees (24" dbh or greater) scattered throughout the campus outside of the stands.

The Forest Conservation Plan indicated that the NIST Campus is 578 acres of which 20 acres are in easements. The 15% target was estimated at 84 acres. The forested area as of 1995 was estimated at 55 acres indicating a shortfall of 29 acres. NIST has been increasing forested areas since then, including a tract established with the 2017 expansion of Building 245. The Master Plan extends reforestation efforts to meet the shortfall.

**National Capital Planning Commission.** The Commission is the federal government's planning agency for the National Capital Region and has the responsibility to adopt, approve/advise on plans and projects that impact the nation's capital and surrounding areas. One of the principal activities of NCPC, which has planners, architects, urban designers, and other professionals in its staff, is review and approval of Federal Plans and Projects. NCPC also coordinates the planning efforts of federal agencies that construct and renovate facilities within the National Capital Region. Because NIST is located outside of the District of Columbia, NCPC serves these functions in an advisory capacity.

## Master Planning Process

The Master Plan for the NIST Gaithersburg Campus was developed in three phases.

- Phase-I of the project started with reviewing previous studies, collecting information on campus facilities, site and regional context, which was summarized in a document of existing conditions. A functional programming exercise established 5-, 10, 15-, and 20-year campus requirements. Subsequently, several alternative planning concepts were developed and reviewed with NIST, then further refined before a final alternative was selected. Phase-I also included a NEPA scoping process, which anticipated the development of an Environmental Assessment.
- Phase-II developed the Draft Master Plan Document based on the selected alternative and development of the site infrastructure, circulation, architecture and landscape frameworks.
- In Phase-III, the Draft Master Plan Document was revised in two steps, preparing a Preliminary Final and ultimately the Final Master Plan document

In all three phases of the Master Plan development process,

MAP worked closely with NIST. Alternatives were reviewed with the NIST Leadership Board and the Security Advisory Board. In addition to NIST participation, the Master Plan was reviewed by local regulatory authorities, such as the City of Gaithersburg, the National Capital Planning Commission, and the Maryland Historic Trust.

### Campus User Feedback

An employee survey was conducted in the summer of 2016, with broad participation from the various Organizational Units and a 36% response from the Federal employees canvassed. The survey queried employees on their commuting patterns, campus issues, dislikes, likes and desires for future changes. A summary of the results is in the Appendix. Here are key findings:

- **Commuting.** Most employees drive to work alone in a personal automobile (84%). Less than 4% arrive by public transportation.
- **Issues.** The aging buildings and lack of environmental control in the laboratories was the most common complaint. Insufficient conference space was also noted.
- **Positives.** The beautiful campus, open green space and the building connectors were praised, and enhancements requested for the master plan.

### Master Plan Development

The Master Plan is the result of a comprehensive study of campus-wide physical and functional conditions and research program goals. A Contextual Analysis report preceded the Master Plan, which studied the current site, buildings, infrastructure and interaction with the local community. Following this, the team developed Alternative Concepts that explored different approaches to meet the goals and issues uncovered. Two NIST advisory groups participated in the evaluation and selection of the Master Plan approach, an executive Steering Committee and a Working Group with representatives from most Organizational Units. Other NIST policy groups that participated in reviews included the NIST Leadership Board and the Security Advisory Board. In addition, Alternative Concepts were reviewed by local regulatory authorities such as the City of Gaithersburg, the National Capital Planning Commission and the Maryland Historic Trust, and were released for NIST staff and public comments..

Three campus zones were evaluated separately: 1) central core, for laboratory and administrative growth; 2) gates A and F, for security considerations; and 3) southern campus, for specialty lab additions.

### Central Core Alternatives

The central core represents the campus area surrounding the original complex of General Purpose Laboratories (GPLs) and the main Administration Building. Six core concepts were developed, exploring different approaches to meeting the Master Plan goals and accommodating the future program for general purpose/precision measurement labs and administrative space. Each concept solved the same problems and accommodated the same functional elements, but in differing ways and different locations. The approaches were evaluated against facility, functional and implementation factors, including the following: accommodation of research, support and staff activities; flexibility; energy and maintenance efficiency; campus character and image; and potential implementation costs. The concepts each included the same existing infrastructure and program.

Of the concepts described below, **Alternative F** was selected by NIST as the Preferred Alternative concept for the Master Plan. The key reasons are the following:

- Development is concentrated in the center of campus, allowing easy connections into the interior pedestrian concourse that connects the core buildings. This proximity increases assignment flexibility and the ease with which specialized equipment and resources can be shared. Laboratory utility infrastructure is readily available.
- Most new construction is research-related, which supports NIST goals for laboratory configurations that are flexible and support advanced measurement science.
- Renovation of the GPLs includes office-type space in several GPLs, rather than laboratories. Renovation is less complex and more usable square footage is gained, resulting in less overall Master Plan construction.
- New research building construction recognizes the design approach and rhythm of the original campus laboratories.

The concepts considered were the following:

### A. Celebrating Courtyards

Alternative A configures new research buildings within the core to create courtyards that can be developed into neighborhood outdoor spaces. These new research buildings establish two courtyards adjacent to the GPLs, one centered around the Advanced Measurement Laboratory and the second around GPL Buildings 227 and 226. A new administrative office building is located to the west of Building 304. This would relate to Building 301, which houses other administrative office space, establishing an east-west administrative zone for added connectivity and flexibility. The alternative renovates the GPLs and adds three office/collaborative space additions recommended in the Research Facilities Strategic Plan.

**Exhibit 9: Alternative A Diagram**



**Exhibit 10: Alternative A Plan**



### B. Extending Connections

Alternative B recognizes the importance of NIST's internal concourse, and ties all new buildings into this pedestrian spine, extending it both north and south. This approach extends the pattern of the original campus plan by adding research buildings stepping to the north beyond Building 227. This brings buildings closer to the Gate A entrance, suggesting a pedestrian path from the gate to an employee entrance. Expansion for the Advanced Measurement Laboratory can link directly into the circulation system of Building 216. An office building for administration is located on an existing central parking lot, tying into the circulation spine near Building 223. Like Alternative A, the GPLs are renovated with several office additions.

**Exhibit 11: Alternative B Diagram**



**Exhibit 12: Alternative B Plan**



### C. Creating a New Precinct

Alternative C clusters new research and administration buildings in a new neighborhood, established to the south of South Drive. Both the research and administration facilities are in the new precinct, as well as shared amenities and services that can be shared with the specialized laboratory occupants in the southern campus. The development and size/shape of the new buildings is flexible; they could be connected to the NIST internal concourse. The GPLs are renovated, but no additions are built.

**Exhibit 13: Alternative C Diagram**



**Exhibit 14: Alternative C Plan**



### D. Capturing the Center

Alternative D concentrates buildings in the center of campus, emphasizing proximity and assignment flexibility. The location takes advantage of the existing central services. New research buildings are built to the south of Building 304, on the current parking lots, and connected into the pedestrian circulation spine near Building 223. A portion of roadway is removed for a pedestrian walkway to the administrative office building, west of Building 304 and near the other administrative offices in Building 301. This alternative renovates the GPLs and adds three office/collaborative space additions recommended in the Research Facilities Strategic Plan. Advanced Measurement Laboratory expansion is adjacent to the existing facility.

**Exhibit 15: Alternative D Diagram**



**Exhibit 16: Alternative D Plan**



## E. Functional Organization

Alternative E constructs lab-only and office-only buildings, linked to other facilities in the GPLs. This alternative is a program variation of Alternative D, in which the new research buildings contain only laboratories and their support, with the office space for researchers located in adjacent GPLs. Non-laboratory organizations now located in GPLs, would move to a new administration building. The approach maintains the cluster of new facilities in the campus center, and it builds more office space than laboratory space.

**Exhibit 17: Alternative E Diagram**



**Exhibit 18: Alternative E Plan**



## F. Emphasizing Research

Alternative F concentrates research buildings in the center of campus, and emphasizes office space rather than new laboratories in GPL renovations. Most new construction is for research, with its support and office areas. New research buildings are clustered in the center of campus, and like other alternatives, linked into the NIST pedestrian concourse. To accommodate needed laboratory space, a new research building is shown at the northern end of the concourse. The AML expansion would be adjacent to its related complex. Administrative office space is housed in renovated GPL buildings, which yield more usable square feet when renovated for this use.

**Exhibit 19: Alternative F diagram**



**Exhibit 20: Alternative F Plan**



## Gates A and F Alternatives

Gate A alternatives were developed in a separate study, parallel with the Master Plan—*Gate A Visitor Screening Study*, May 2017. The study evaluated different approaches to screening and circulation, each addressing security, safety and operational goals. The alternatives were reviewed with NIST and DoC security personnel, and the selected approach, endorsed by the Master Plan Steering Committee and the NIST Security Advisory Board, is shown in the Master Plan. Detailed analysis is available in the referenced Study.

Gate F alternatives were explored as part of this Master Plan. Each of four options uses the existing East Drive, incorporating an employee entrance and the facilities and equipment for the screening of commercial vehicles. A new building houses NIST's shipping, receiving and mail operations, moved from Building 301. Most commercial vehicles will proceed to this shipping/receiving center to off-load their cargo, and then leave the campus.

Gate F Concept 4 was the selected approach for the Master Plan, endorsed by the Steering Committee and the NIST Security Advisory Board. The dual entrance approach separates commercial vehicle traffic from passenger vehicles, minimizing conflicts and optimizing safety and security. It provides generous queuing and maneuvering room for commercial vehicles. The new Visitor Center provides maximum flexibility for accommodating future visitors and security requirements.

The alternative Gate F concepts were:

### 1. Minimal East Drive Alterations

For Option 1, all vehicles enter at East Drive. One new facility provides screening for conference attendees and their vehicles on one side, and screening for commercial vehicles on the other. The facility provides for credential screening for all conference attendees plus random selection for full vehicular and personal screening. Commercial vehicles receive full screening before they proceed to a NIST shipping and receiving center. All vehicles, including NIST employees and badge-holders, proceed to a security kiosk to double check their credentials before continuing into the campus. There are rejection lanes at both the initial screening facility and at the security kiosk.

**Exhibit 21: Option 1 Plan**



## 2. New Muddy Branch Entrance

Option 2 creates a new entrance and curb cut for commercial vehicles only, located at a separate Muddy Branch Road intersection to the south of the existing East Drive. This new entrance provides a dedicated commercial vehicle screening facility and more roadway for queueing. The commercial vehicle road leads to the shipping/receiving building, and then to East Drive to exit. Conference attendees and employees enter at the existing East Drive entrance where there is an ID screening facility for the visitors, and a security kiosk to check the credentials of screened visitors and employees.

## 3. East Drive Realignment

Option 3 is a variation on Option 1, with roadway configurations designed to increase the queuing space for both cars and commercial vehicles. The shipping/receiving building is farther removed from the entrance and screening. Like Option 1, the new screening building is designed to screen conference attendees on one side and commercial vehicles on the other, an arrangement that was determined to not meet the functional requirements.

## 4. Screening All Visitors

Option 4 is a variation that adds screening capability to Option 2. Today, and in the Master Plan, visitors typically are screened at Gate A, and only large conferences use Gate F for their conference attendees. This Option explored the implications of screening all conference attendees at Gate F, as they would be at Gate A. Visitors enter Gate F at East Drive and proceed to a full screening facility, with a covered pavilion for vehicle screening and an adjacent building with x-ray machines and magnetometers for individual screening. Adjacent is a parking lot for visitors who prefer to leave their car and walk onto campus. Commercial vehicle access and screening is the same as Option 2.

## Specialty Laboratory Additions

The Master Plan includes laboratory additions to the NCNR complex 235 and the Robotics Building 207, as well as several small new specialty laboratories. Alternative locations were not explored because these are functionally specific and related to existing buildings.

**Exhibit 22: Option 2 Plan**



**Exhibit 23: Option 3 Plan**



**Exhibit 24: Option 4 Plan**







# Master Plan



# Master Plan Program

## CHAPTER 3

**T**HE space program is a planning tool that identifies the square footage and types of space needed under the Master Plan. It defines new buildings, expansions and other space changes that are needed to address NIST's research requirements. The NIST Master Plan program was projected for a twenty-year period. The short-term space projections are the most accurate; nevertheless, the Master Plan looks ahead in order to create a physical framework that will accommodate gradual growth over time.

The Gaithersburg campus has 62 permanent and temporary buildings, 25 of them remaining from the initial 1960's construction. The total built space on campus is approximately 3,641,000 gross square feet, ranging in use from laboratories to offices to warehouses. Twenty-seven laboratory buildings account for 78 % of the overall campus space, including related offices and support. As of September 2016, the population of campus was 4,007 people, including federal employees, affiliates and contractors.

**Exhibit 25: Existing Personnel and Occupied Space: September 2016**

Personnel	4,007
Space, Assignable Square Feet (ASF)	
Office / Office Support Space	615,463
Laboratories / Special / ADP	875,198
ADP/Computer Space	21,997
Service & Support	313,044
<b>Total, Assignable Square Feet</b>	<b>1,825,702</b>
<b>Total, Gross Square Feet (GSF)</b>	<b>3,641,255</b>

The space needs of current and future NIST employees are constantly shifting, modulating with the rise and fall of research projects, changes in staff assignments, and shifts in agency priorities and budget realities. For the Master Plan, space requirements

were projected based on NIST's historic growth patterns, current usage, programmatic requirements and research goals developed for the Plan, realizing that the program components and square footages are a framework for the Master Plan and will be reviewed with each construction project. Space needs were projected for a twenty-year period, with 5-10 years being the most realistic projections.

The space program for the NIST Gaithersburg campus was developed with NIST participation, and analysis of the current space use and data base information. The process to understand their requirements and estimate the space necessary to accomplish their functional goals was based on the following:

- Review of DoC and NIST guidelines and policies for labs and office space.
- NIST recent planning studies, which analyzed specific facility space, physical condition and functional need (see list in Background section and as summarized in Chapter 2).
- Consultation with each Organizational Unit (OU) to estimate growth/change based on planned research projects, programs and support needs.
- Review and projection of staff growth based on historic patterns. This was compared with the projections of the OUs and found to be almost identical.
- Meetings with the Master Plan Steering Committee and Working Group about facility priorities, future direction and goals
- Employee survey of amenities and campus-wide needs
- Analysis of campus buildings, their functional issues and locations.
- Consideration of overall campus goals and integration of the various users—staff, affiliates, visitors.

Personnel growth on Campus is projected to increase by approximately one quarter overall during the planning period.

New space will be needed to accommodate this growth, but construction will be based more on the renovation of aging and inadequate facilities than on space needed for additional personnel.

## Space Needs for Growth

The square footages on the accompanying table are shown in terms of both assignable and gross square feet. Assignable square footage is the area that is usable and assigned to specific personnel groups, such as offices and labs. For administrative space, assignable space includes the office areas and the secondary circulation within the suites. Gross square footage covers the entire building, including the bathrooms, corridors, exterior walls, mechanical spaces, etc. The ratio of assignable-to-gross varies for different kinds of space; for example, modern lab spaces have a very high assignable-to-gross ratio because the mechanical and equipment galley space is part of the “gross”. For the Master Plan, gross square footage is the building block, because it represents the entire building or addition that must be included in the plan.

The space program projections are based on assumptions and the priorities of NIST. These projections are not definite requirements or funded projects, but provide the planners a basis to develop a framework for the Master Plan. The following chart projects the additional space that is required to accommodate projected staff increases, and anticipated growth or change in laboratory/support needs, and changes in service and support requirements. In addition to this space program

based on growth and anticipated projects, the Master Plan proposes new facilities to replace outdated facilities or special needs. See Facility Need section that follows.

The Master Plan space program is based on the anticipated staff growth and planned research initiatives. New square footage is included for the following:

*Personnel Space.* Office and office support space is allocated based on Department of Commerce policy of assigning 170 assignable square feet per-person. This allocation covers offices, workstations and related offices areas such as conference rooms, copy centers, breakrooms, filing, internal circulation, etc. This standard has been applied for the Master Plan program. Today, office space is below that standard, especially in the Laboratory programs, and approximately 25% of the projected new office space is planned to fill that gap.

*Laboratories and Lab Support.* Lab space allocations are based on the existing lab utilization, planned research programs, historic trends and reviews from laboratory directors. Specifically, planned research projects make up the projected staff increases, anticipated growth or change in laboratory/support needs, and changes in service and support requirements, which add approximately 30% to the current lab stock over the 20-year period. All of the Laboratory programs are projecting significant growth. For instance, the Information Technology Laboratory (ITL) and the Communications Technology Laboratory (CTL) both anticipate growth in personnel and computer-based laboratories. The two national user facilities, NIST Center for Neutron Research

**Exhibit 26: Space Needs for Growth**

	EXISTING		5- to 10-YEAR PROJECTIONS		20-YEAR PROJECTIONS		20-YEAR OVERALL DIFFERENCE	
	People Number	Space ASF*	People Number	Space ASF	People Number	Space ASF	People Number	Space ASF
PROJECTED GROWTH								
People	4,007		4,525		5,106		1,099	
Office/ Office Support		615,463		766,530		865,300		249,837
Laboratories/Special/ ADP		897,195		1,016,327		1,160,502		263,307
Service and Support		313,044		313,644		313,644		600
<b>Totals</b>	<b>4,007</b>	<b>1,825,702</b>	<b>4,525</b>	<b>2,096,501</b>	<b>5,106</b>	<b>2,339,446</b>	<b>1,099</b>	<b>513,744</b>
							+ 27%	+ 28%

\*ASF=Assignable Square Feet

## Exhibit 27: Projected Growth Distribution By Type

	EXISTING		5- to 10-YEAR PROJECTIONS		20-YEAR PROJECTIONS		20-YEAR OVERALL DIFFERENCE	
	People Number	Space ASF*	People Number	Space ASF	People Number	Space ASF	People Number	Space ASF
<b>Summary by Type of Space</b>								
Office/Office Support	4,007	615,463	4,525	766,530	5,106	865,300	1,099	249,837
Laboratories/Special/ADP		897,195		1,462,795		1,672,760		263,307
Other - Service & Other Support		313,044		313,644		313,644		600
Total	4,007	1,825,702	4,525	2,096,501	5,106	2,339,446	1,099	513,744
<b>People and Offices</b>								
Laboratory OUs	2,616	394,643	2,857	485,690	3,244	551,480	628	156,837
Admin/Management Resource OUs	1,391	220,820	1,668	280,840	1,862	313,820	471	93,000
Total	4,007	615,463	4,525	766,530	5,106	865,300	1,099	249,837
<b>Summary by Discipline—Office + Laboratory + Other</b>								
Laboratory OUs	2,616	1,252,616	2,857	1,462,795	3,244	1,672,760	628	420,144
Admin/Management Resource OUs	1,391	573,086	1,668	633,706	1,862	666,686	471	93,600
Total	4,007	1,825,702	4,525	2,096,501	5,106	2,339,446	1,099	513,744
<b>Type of Space by Discipline</b>								
Laboratory OUs								
Office/Office Support	2,616	394,643	2,857	485,690	3,244	551,480	628	156,837
Laboratories/Support/Special		857,973		977,105		1,121,280		263,307
Total	2,616	1,252,616	2,857	1,462,795	3,244	1,672,760	628	420,144
Admin./Management Resource/non-lab OUs								
Office/Office Support	1,391	220,820	1,668	280,840	1,862	313,820	471	93,000
Laboratories		39,222		39,222		39,222		0
Other—Service & Other Support		313,044		313,644		313,644		600
Total	1,391	573,086	1,668	633,706	1,862	666,686	471	93,600

\*ASF=Assignable Square Feet

**Exhibit 28: Master Plan Building Summary, 20-Year Program**

	Master Plan Proposed Buildings	Assignable Square Feet	Gross Square Feet	Comments
<b>EXISTING BUILDINGS</b>				
<b>4,007 Existing Staff</b>	Building 101	204,682	345,818	Several renovation projects; public access facilities, 1st floor & basement; upgrades for infrastructure/energy efficiency; office utilization improvement
	General Purpose Laboratory Buildings	722,683	1,509,499	7 of 8 buildings modernized—approx. 1,277,000 GSF Some functions move to New Research Buildings
	Special Purpose Laboratory Buildings	632,905	1,328,634	6 laboratory buildings to be renovated
	Admin., Support & Service Buildings	265,432	457,304	minimal changes
	<b>Subtotal: Existing</b>	<b>1,825,702</b>	<b>3,641,255</b>	
	Assignable Space lost with GPL Renovation	(37,000)	–	Because of increased space required for infrastructure
	Space lost with demo of B411 and B428	(16,145)	(20,185)	Accommodate B411 staff in renovated GPLs and B428 staff in B301
	Subtotal: Master Plan Existing	1,772,557	3,621,070	
<b>NEW SPACE: NEW PROGRAMS and GROWTH</b>			<i>Estimated GSF</i>	
<b>1,099 Staff Growth</b>	New Research Buildings/Additions to GPLs	228,463	866,000*	*GSF includes Research, Offices and B411 replacement
	Administration Office Space	93,600	*included above	Space accommodated within modernized GPLs
	Standard Reference Material Building	26,750	54,000	
	Advanced Measurement Lab Addition	44,162	115,000	Addition to Building 216
	NCNR Addition	92,169	138,000	Addition to Building 235
	Robotics Building Addition	8,600	17,000	Addition to Building 207
	New Wind Tunnel	10,000	15,000	
	New Strong Floor Laboratory	10,000	15,000	
	Chiller Plant Addition	0	6,200	Increased capacity for development
	<b>Subtotal: Program for Growth</b>	<b>513,744</b>	<b>1,226,200</b>	
	Space Added to replace GPL Renovation loss	37,000	*included above	
Subtotal: New Buildings—Growth	550,744	1,226,200		
<b>NEW BUILDINGS: CURRENT and OTHER NEEDS</b>			<i>Estimated GSF</i>	
	Building 245 Laboratory Addition	41,200	106,000	Phase 1 under construction
	Building 101 Addition	30,000	50,000	
	Gate A Visitor Center Expansion	2,000	3,000	Plus 2500 GSF of modernization in Building 103
	Gate F Screening/Shipping/Receiving	13,200	17,000	Commercial vehicles
	Gate F Visitor Screening	2,900	4,400	
	Building 411 Replacement	13,000	*included above	Accommodate in renovated GPLs
	High Bay Laboratory Addition to Building 206	7,600	16,000	Space also allows renovation of Building 226
	Electrical Switching Station	0	5,400	Infrastructure replacement
	Subtotal: New Buildings—Other	109,900	201,800	Staff included in existing
<b>CAMPUS TOTALS</b>				
<b>5,106 Staff</b>	Total 20-Year Master Plan Buildings	2,433,201	5,050,000	Plus parking structure GSF rounded

(NCNR) and the Center for Nanoscale Science and Technology (CNST), also project continued growing demand for their services and facilities.

See Appendix A for the space program distribution by organization and building.

## Facility Needs

The Master Plan Program identifies other building and facility needs. In addition to space for anticipated growth, space is needed to meet current initiatives and replace obsolete facilities.

Much of the advanced research taking place on the Gaithersburg campus is based on precise performance and measurements, which demand very controlled environments—rigorous temperature and humidity control, vibration stability, air cleanliness and quality electric power. The Advanced Measurement Laboratory complex and other recent buildings meet these exacting levels of control. However, in the older laboratory buildings such as the General Purpose Laboratories, these conditions are difficult to achieve.

Approximately two-thirds of the laboratory facilities (17 of 27 buildings) are part of the original campus development in the 1960s. These older facilities, though designed and constructed to best practices at the time, do not provide the performance expected of laboratory spaces for current research. Some architectural deficiencies notwithstanding, the researchers' dissatisfaction stems largely from lack of thermal stability, inadequate quality and quantity of power, deficiencies in piped services to laboratories, and the general degradation in infrastructure equipment and distribution. For a range of precision experiments, power and thermal fluctuations have often required set-ups within labs to be re-initiated, resulting in days or weeks of lost time and productivity.

These facility needs, more than anticipated growth, are at the core of the Master Plan's immediate approach. Seven original General Purpose Laboratories are slated for complete modernization, as one of the first steps of Master Plan implementation. Each building will be vacated for complete renovation. In addition, older specialty lab facilities will be renovated and modernized. However, unlike the GPLs, these renovations will be phased because the labs are purpose built providing specialized services and cannot be vacated. For example, Building 245 is currently beginning a phased renovation and expansion project, while its laboratory and service functions continue to operate.

In addition, administrative and support organizational units require new or renovated facilities. A study of public functions in Building 101 resulted in recommendations for a small addition to provide needed conference space, support the updating of the library, and provide office swing space to enable renovations of the Building 101 office tower. Building 411, a deteriorating modular structure from 1989 provides administrative office space but must be replaced in the coming years. Both Gate A and Gate F will be modified to meet security requirements: Gate A requires added space for expanded visitor screening; and Gate F requires visitor screening, as well as new facilities for screening commercial vehicles delivering to the campus. The shipping and receiving functions, now located in Building 301, will be relocated to a new building at Gate F, to limit campus access for non-governmental commercial vehicles.

**Exhibit 29: Facility Needs Summary**

Facility	New Construction		Renovations	
	Assignable SF	Estimated GSF	Assignable SF	GSF
Building 245 Radiation Physics	41,200	106,000	96,892	207,921
Building 101 Administration	30,000	50,000	204,682*	345,818
Gate A Visitor Center	2,000	3,000	1,341	2,460
Gate F Commercial vehicle Shipping/Receiving	13,200	17,000		
Gate F Visitor Screening	2,900	4,400		
Building 411 Replacement	13,000	**		
High Bay Laboratory Addition	7,600	16,000		
GPL Renovations	included with Growth Table		641,566	1,277,587
Building 202 Engineering Mechanics			52,572	78,575
Building 230 Fluid Mechanics			25,168	38,366
Building 231 Industrial			42,877	75,131
Building 233 Sound			22,537	42,881
Building 237/238 Non-Magnetic			4,463	7,061
<b>Totals</b>	<b>109,900</b>	<b>196,400</b>	<b>1,092,098</b>	<b>2,075,800</b>

\*B101 Renovation has 2 projects: Public access facilities; and Renovation for offices, support, and infrastructure.

\*\*Accommodated in renovated GPLs.





# Master Plan Concept

## CHAPTER 4

THE Master Plan development began with NIST's goals for the campus, and took shape based on projected space needs, recent studies and the detailed evaluation of the existing site conditions, infrastructure and buildings. Alternative concept plans were explored and evaluated by the design team in concert with NIST's executive Steering Committee and a Working Group comprised of representatives from most Organizational Units (OUs). Staff and public comments regarding the alternative concepts were also taken into consideration. The selected concept became the basis for the Master Plan.

### Considerations of the Master Plan

The master plan looks to the future, anticipating growth and change to NIST's mission and requirements. But it also looks at today, and the campus issues that need improvement to achieve an efficient and pleasant workplace.

- *Laboratory Environmental Control.* Much of the advanced research taking place on the Gaithersburg campus is based on precise performance and measurements, which demand very controlled environments—rigorous temperature and humidity control, vibration stability, air

cleanliness and quality electric power. These conditions are difficult to achieve in the older laboratory buildings.

- *Aging Buildings and Infrastructure.* Twenty-five buildings remain from the initial campus construction. Although well-maintained, these buildings and their engineering systems date from the 1960's and are well past their service life. Environmental control is compromised, repairs frequent and parts often unavailable.
- *Office Utilization.* Overall campus office utilization is within the Department of Commerce goal of 170 assignable square feet/person. However, there are disparities throughout the campus. Some groups or OUs are well below and some are above the utilization goal. In many cases, these utilization rates are impacted by building configurations and traditional office layouts.
- *Public Facilities.* Conferences and professional visits bring many people to the campus and Building 101 facilities, at a time when security requirements are more of a concern. A completed study proposes improvements to food service on campus, and a separate study has made recommendations for changes to the conference center, library and visitor-use services.
- *Historic District Context.* The State Historic Preservation Office determined that the entire NIST campus is eligible

Concept: View from West Diamond Avenue at Quince Orchard Road



for listing on the National Register of Historic Places as a historic district. All improvements should comply with the *Secretary of the Interior's Standards for the Treatment of Historic Preservation* to the degree possible.

- **Stormwater Management.** Regulations require NIST to control stormwater run-off. Future planning must reduce runoff from existing impervious surfaces and offset any addition, using structural or bio-retention approaches. To-date, NIST has introduced a variety of bio-retention strategies, comparing their effectiveness for campus conditions.
- **Transit linkages.** The State of Maryland is planning a rapid bus route, the Corridor Cities Transitway (CCT) that would connect to both the Shady Grove Metro Station and the Metropolitan Grove MARC station as Phase 1, and would continue north along I-270 as Phase 2. A dedicated bus lane would be built on the west side of campus along Quince Orchard Road with a NIST station, impinging the west property line and requiring the relocation of Gate C. Implementation timing has not been determined.
- **Campus Circulation.** Generally, congestion on the campus roads is not an issue. However, the entrance gates around the campus perimeter do experience frequent congestion at peak times, with limited queuing and turnaround space. Visitors who are dropped off at the Gate A Visitor's Center have very long walks to most points on campus.
- **Security.** Most commercial vehicles currently enter at Gate C, but with lack of queuing space and inspection facilities, the vehicles are brought into campus to Building 301 for inspection, an inappropriate location. None of the gates have adequate turnaround lanes, and rejected commercial vehicles must be escorted to another gate to exit. In addition, there are no facilities to screen visitors' or staff vehicles.
- **Pedestrian Connections.** Pedestrian sidewalks are discontinuous across campus, and inconsistent in materials and crossings. There are few paths to provide access to the natural and landscaped areas of the campus, for the enjoyment of staff.
- **Landscape.** The master plan offers the opportunity to unify the landscape and enhance the focal points within the core. Introduction of native and sustainable plantings would reduce required maintenance.
- **Parking.** Parking capacity and distribution must be a

balanced approach, considering campus functions, employee commuting patterns, conference surge, public transportation opportunities, and community and environmental considerations.

## Master Plan Concept

The Master Plan centers around the goal of improved research facilities—modernizing outdated laboratories and creating new ones that support advanced measurement science. It builds upon the structure and layout of the original 1960's campus, and retains the original buildings in the campus core. Objectives are to enhance the working environment, encourage interactions, and maintain the sense of place and pride in the institution.

Creating an integrated campus research core is at the heart of the Master Plan concept. The central campus has eight buildings designated the General Purpose Laboratories, seven of which are original to the 1960's campus construction. Together with the more recent Advanced Measurement Laboratory complex, they house over 55% of the laboratory facilities on campus. These central buildings are linked together by an interior pedestrian concourse, which also links the Administration Building 101 and Shops Building 304 that supports the labs. The Master Plan builds upon that system, connecting new research buildings into the concourse. This proximity and connection encourages collaboration, as well as supports flexibility in lab assignments and sharing of resources.

## Visual Character and Historic District

The Gaithersburg campus is visually cohesive, characterized by low scale brick buildings in a beautiful suburban landscape. The Administration Building 101 is the central focus, with an eleven-story tower and public spaces arranged in a pinwheel at the first floor. The original buildings were designed in the International Style, and have simple geometric forms, unadorned facades and flat roofs. The research buildings are typically buff-colored brick and the support buildings are red brick. The General Purpose Laboratory buildings in the campus center are aligned in a regular pattern, separated by landscaped courtyards. The long facades face north and south, with a vertical emphasis characterized by alternating wall and window openings. A continuous metal fascia caps these buildings.

Exhibit 30: Master Plan Concept



The other campus laboratories and support buildings have similar characteristics, but are configured to suit their specific research or purpose.

The Maryland State Historic Preservation Officer and the Keeper of the National Register have determined that the campus is eligible for listing on the National Register of Historic Places as a historic district, for both its historic and architectural significance. The Master Plan has embraced the historic designation and proposed buildings architecturally compatible in scale, massing, and design approach with the original campus buildings. New construction and work to existing buildings should comply with the Secretary of the Interior's *Standards for the Treatment of Historic Preservation*, to the degree possible. See the Guidelines section for characteristic features.

## Master Plan Building Elements

Measurement science and research are the heart and business of NIST. Its mission, research methods and technology have evolved since the campus establishment in the 1960's, and

General Purpose Laboratory:  
Building 225



this advanced research requires more sophisticated buildings. Renovations, additions and new facilities will strive for flexible, adaptable lab facilities, precise environmental control, and efficient, comfortable working conditions for the researchers. The Master Plan puts these objectives at its center.

Many of the Master Plan elements respond to current needs, rather than projected growth over the 20-year planning horizon. Aging buildings and inadequate infrastructure demand laboratory building renovations to support current and future research. Evolving security policies require modification to campus entry points for visitors, conference attendees and campus deliveries. Energy efficiency and sustainable design goals cannot be met without building and service upgrades.

### General Purpose Laboratory Renovations

NIST's priority is the modernization of the seven original General Purpose Laboratory (GPL) buildings, which house a variety of research facilities and are used by all the Laboratory Organizations. Occupants of each building, in turn, will be relocated to swing space or new permanent locations, to allow complete building renovations. Renovations will be phased over time, and the final configuration will house state-of-the-art measurement and technical laboratory facilities, computer laboratories, office space and general support. Three generalized uses will be accommodated:

- Contemporary Research Laboratory Modernization—Adaptable laboratories, research support and office areas for the Material Measurement Laboratory, Physical Measurement Laboratory, and Engineering Laboratory.
- Computer Research Modernization—Computer laboratories, support and office areas for the Information Technology Laboratory, and Communications Technology Laboratory.
- Office and Support Modernization—Flexible office areas and support for non-lab OUs now in GPL space, staff relocated from Building 411, anticipated office need and the relocated Central Computing Facility.

GPL Building 227, the Advanced Chemical Sciences Laboratory, was completed in 1999. It is in excellent condition, and is not scheduled for renovation during the Master Plan period.

Distribution of these three space types among the GPLs will be determined as part of a later renovation staging plan, but

the Master Plan has several recommendations. Four existing GPLs should be renovated for laboratory research in whole or in part—Buildings 220, 221, 225 and 226. These buildings have basements suitable for specialized research (220, 221, 225) or existing high-bay space (226). The total square footage in these four buildings is greater than the master plan GPL research lab and office need, so the remainder should be renovated for general office space (approximately 2 floors). ITL and CTL lab and office space should be in adjacent buildings for collaboration and sharing of resources. One building is dedicated to the Central Computing Facility, related support space, and Office of Information Systems Management offices.

#### **GPL—Contemporary Research Laboratory Modernization**

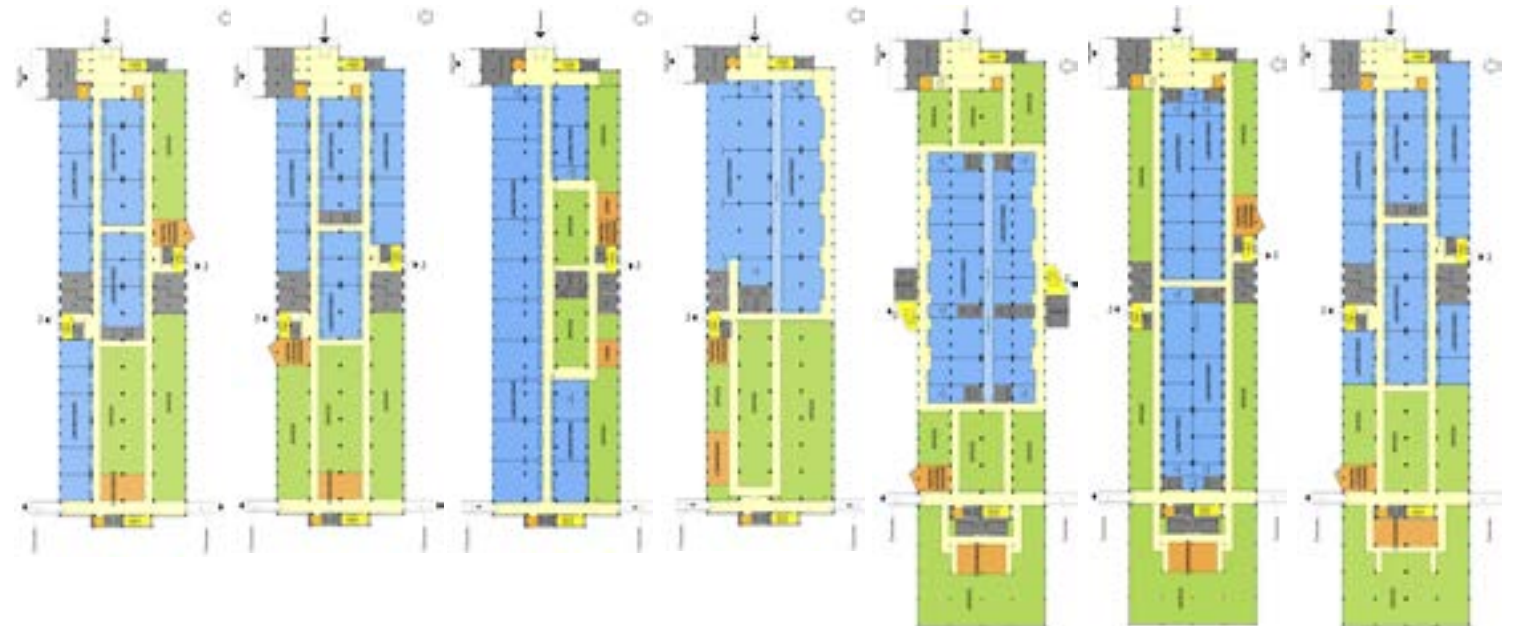
Detailed assessment of the GPLs was conducted in the 2014 *Research Facilities Strategic Plan*, finding that the infrastructure systems have long outlived their useful life and are very energy inefficient. Maintenance is handicapped, as components for legacy equipment are difficult to obtain, requiring frequent service downtime. Lacking spare capacity, the mechanical and electrical systems are unable to service special requirements of individual labs, including acceptable temperature control required for advanced instrumentation, quality air filtration,

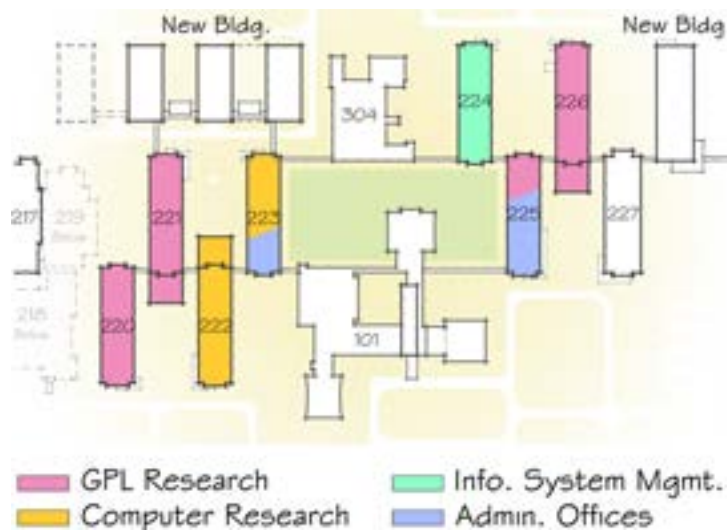
and back-up power generation or central uninterrupted power supply systems. The buildings are not provided with the now mandatory fire sprinkler systems. The absence of many piped laboratory services hamper research, and the aged piping systems are prone to leaks. The building skin in these older facilities is uninsulated and does not comply with energy efficiency requirements. The GPLs are also deficient in dedicated office space which is often rigidly organized into individual offices.

Collectively, these deficiencies are significant and cannot be ameliorated by piece-meal renovation upgrades. Modernization (gut-renovation) of these facilities will allow for improved performance and enhance user satisfaction. These significant renovations will require that the entire facility be made compliant with current codes, including energy efficiency and sustainability mandates. A full-scale modernization of these facilities is essential.

The laboratory modernization approach will be based on contemporary design practices and requirements for advanced measurement science. In addition to complete infrastructure replacement, the characteristics include improved flexibility, core and shaft redesign, increased collaboration areas, and open, daylit office and support spaces. Infrastructure systems

**Exhibit 31: Examples of Possible GPL Laboratory Renovation Layouts**



**Exhibit 32: GPL Renovations: Potential Assignments**

are to be designed with flexibility and spare capacity, to both address specific laboratory needs and allow lab conversion over the building's life. Service galleys are planned to connect the labs, which will provide better control of central services and isolate noisy or vibrating equipment.

The final floor plate concept and system design will be developed during the design process. Each of these research buildings will support modular laboratory design, system support and office space for the researchers. Because of the infrastructure improvements, the amount of assignable space will be reduced in these buildings. The *Research Facilities Strategic Plan* explored several possible layouts, examples of which are shown on the previous page. There are no planned changes to the façade's appearance, although new windows and insulation will be installed. The GPLs renovated for laboratories will require an additional penthouse and stacks for infrastructure to upgrade the labs and meet the current energy code. The penthouse will be set back from the building edge to minimize its appearance from the ground.

The Master Plan proposes an office block addition to three of the GPLs, located adjacent to the internal pedestrian concourse connecting the lab buildings. These blocks will provide needed research office and collaboration space and keep more of the GPL available for labs. The locations on the concourse allows for shared use and flexible assignments.

### GPL—Computer Research Modernization

Not all research requires the sophisticated infrastructure of piped services, precise temperature, humidity and mechanical control. Two Laboratory OUs—Information Technology Laboratory (ITL) and Communications Technology Laboratory (CTL)—conduct their research using computer technology. Laboratories for ITL and CTL require increased, reliable power, and thermal control for lab servers/equipment that generate heat. Computer laboratory power will be backed with UPS systems that allow an orderly shutdown in case of outage.

General Purpose Laboratory renovations will house both ITL and CTL in office space and computer labs. These renovations will yield more assignable square footage than those for the wet, precision or specialty labs because they do not require the equipment galleys and system support. Together the two Laboratories will require approximately 159,000 assignable square feet (existing plus growth) within the 20-year timeline, well over one GPL of space.

### GPL—Offices and Support Modernization

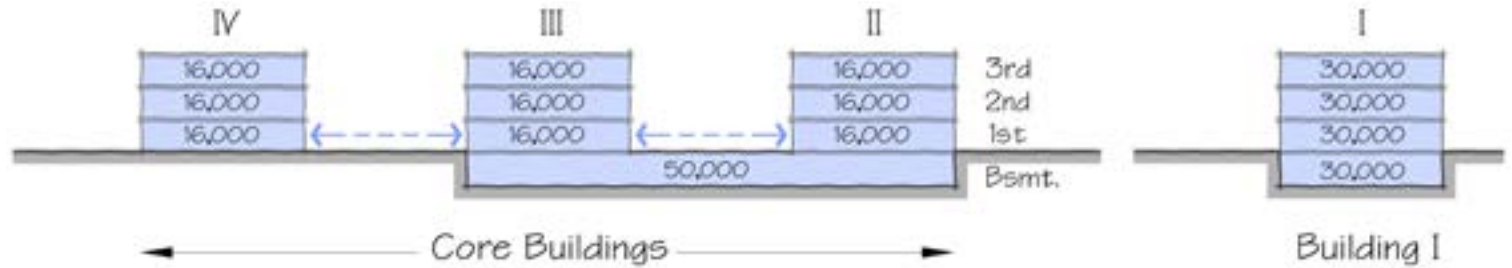
Additional general office space will be needed over the Master Plan period, both for the replacement of the aging, modular Building 411 and anticipated gradual growth of administration and management resource staff that will parallel laboratory growth. In addition, several Organizational Units (OUs) currently have space within the GPLs and can be accommodated there after renovation. These include the Associate Director of Laboratory Programs, Innovations and Industry Programs and the Office of Safety, Health and Environment.

The NIST Central Computing Facility (CCF) and related staff also will be in renovated GPL space. The CCF is part of the Office of Information Systems Management (OISM), and is now located on the lower level of Building 225, with satellite facilities in Buildings 101 and 215. The OISM staff and facilities are projected to grow significantly over the next 20 years, and are planned occupants of renovated GPL space.

Renovation of GPL floors into office space will create a working environment of open workstation areas, enclosed offices, collaboration and meeting rooms, and general support. Layouts and assignments will follow the Department of Commerce programs for space allowances, space management and sustainable design. These guidelines and approach will apply to all the office spaces in the GPL renovations.

**Exhibit 33: New Advanced GPLs: Potential Distribution of Space**

Numbers represent assignable square footage



**New Advanced General Purpose Research Buildings**

New research buildings will accommodate future program growth, provide more advanced laboratories for existing programs and create additional research space that will allow the renovation of the existing GPLs. The new laboratories will be flexible, modular, facilities that can be adapted to many NIST research teams and projects, with the infrastructure and controlled environments necessary for advanced measurement science.

The Master Plan proposes linear buildings that recognize the visual features and organizational pattern of the original campus general purpose research buildings. The building interiors and final configurations will reflect advanced laboratory needs, with infrastructure and equipment galley space, lab modules tailored to research mission, and flexible office concepts and collaboration spaces.

The Master Plan proposes several buildings to meet the anticipated growth, phased in as needed over the next 20-years. Each building is planned to be three stories above grade, as are the existing GPLs. Basement levels are especially valuable for certain research programs, and these are anticipated in the new buildings.

**Research Building I**

The first new research building is proposed to be north of Building 226, continuing the pattern of laboratory buildings and tying into the internal circulation concourse. This is proposed as the first phase of the Master Plan. It will not only provide advanced laboratories, but also the space required to vacate at least one existing GPL and begin the renovation process for these aging labs. It is anticipated that research programs housed within the GPLs requiring more sophisticated and controlled environments would be candidates for this building. Based on its location near the main campus gate, an employee entrance with shared collaboration facilities is proposed, connecting to the gate with a pedestrian walkway. The footprint shown is similar to Building 227, although approximately 10 feet wider to allow for more flexible and collaborative office space. The final layout will be determined during building design, based on mission and research requirements. Basement research space is suggested, valued for its stability and isolation. The design will need to consider the nearby Net-Zero Energy Residential Test Facility to the west and potential shading of the rooftop solar array.



**Exhibit 34: New Research Buildings Proposed Space Distribution**

	Assignable Square Ft.	Est. Gross Square Ft.
<b>Building I</b>	120,000	300,000
<b>Building II</b>	48,000	120,000
<b>Building III</b>	48,000	120,000
<b>Underground Connector</b>	50,000	120,000
<b>Building IV</b>	48,000	120,000
<b>GPL Additions</b>	54,000	86,000
<b>Total</b>	368,000	866,000

Program numbers are rounded.

### Research Buildings II, III, IV

The subsequent new Research Buildings will be in the campus core, just to the west of Buildings 221 and 223, and also connected into the internal circulation. Three buildings are proposed, with the Buildings II and III linked by underground laboratory space.

These buildings share the orientation of the existing GPLS, plus the established rhythm of buildings separated by courtyard space. The three buildings are linked to each other, and to the existing pedestrian concourse. Shared facilities, such as meeting rooms and collaboration spaces are suggested along the links.



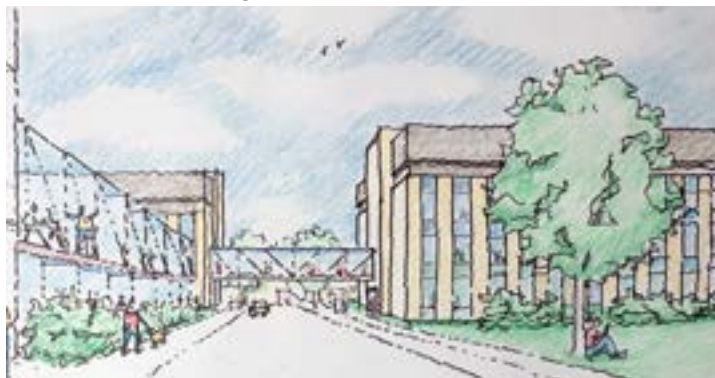
### New Specialty Laboratories and Additions

#### Radiation Physics Laboratory Addition: Building 245

Building 245 is in the initial stage of a phased facility modernization, beginning construction in 2017 on the first of multiple phases. Two additions of laboratory space will be followed by mechanical penthouse construction, all allowing the modernization of the existing lab areas. This multi-year project is expected to be complete in 2027.



#### Concept: Research Building Connections



### Standard Reference Material Facility

NIST certifies and supplies accurate reference materials to industry, academia and government organizations to facilitate commerce and advance research. These materials are used to verify measurements, calibrate instruments and validate quality assurance programs. Building 203 houses this function, and is adequate for the metal, cements, engineering material and organic materials, but is at capacity for refrigerated and frozen storage. Changing research needs require the preparation of ultra-high purity material, which exceeds the capacity of Building 203 and is an incompatible use with the functions there. The new reference material facility will be highly technical, with refrigerated and frozen storage, tissue bank, cell repository, laboratories, clean room and sample preparation facilities. The planned location is opposite Buildings 202 and 203, sharing a loading access drive with the specialty lab Fluid Mechanics Building 230.



### Wind/Fire Tunnel

The Engineering Laboratory requires a specialized wind tunnel for experiments associated with wind and fire incidents. The separate building will be in the southern campus and equipped with the following infrastructure, a high-bay space with material handling crane(s), piped utilities, process exhaust and special electrical power. The Laboratory has several planned programs that require this facility, including these four examples: research on computational wind engineering methods modeling wind loads on buildings; studies of wind-driven infiltration in buildings; experiments on ignition and fire spread under wind condition; and research on the effect of wind on drones.



### Strong Floor Laboratory

The Engineering Laboratory requires a facility for structural research using full scale models of beams-columns, shear walls and other elements. This specialized laboratory will be in the southern



Concept: SRM Facility (left) and garage (right)



campus, constructed with a strong floor, strong wall, hydraulic power systems and other equipment for gravity and lateral load testing. Several planned research projects will examine seismic behavior of steel connections, behavior of slender reinforced concrete shear wall, and performance of aging concrete structures.

#### High-Bay Laboratory Facility

A flexible high-bay laboratory addition to Building 206 is proposed along with the renovation of Building 206. The new space will augment the campus high-bay facilities and provide for the relocation of existing high-bay laboratories now located in Building 226, allowing for its renovation. Completion of the Building 226 modernization would, in turn, accommodate the anticipated growth in research requiring high-bay laboratory space.

#### Robotics Laboratory Addition: Building 207

Robotics research by the Engineering Laboratory takes place in Building 207 and in several ad hoc locations including a remote site scheduled for release. The proposed B207 addition will consolidate these activities, accommodate planned programs and create a multi-use space for large-scale manufacturing robotics research. The existing robot arm and gantry will be relocated from Building 304. The addition requires a non-conductive/shielded high-bay space with



cranes for material handling, vibration isolation and enhanced infrastructure services.

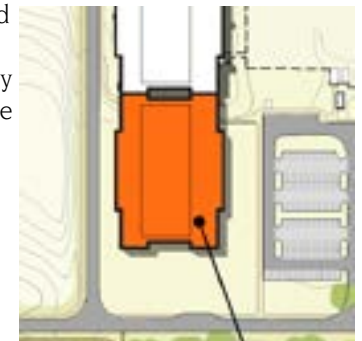
#### NCNR Addition: Building 235

The NCNR facility provides neutron measurement capabilities to the research community, available to outside researchers as well as those at NIST. The proposed addition will augment the facility's guide hall, allowing the installation of additional equipment and better maneuvering room. Laboratories and office space would be constructed adjacent to the guide hall. The addition would be a high-bay structure located to the west of the facility and linked to the existing guide hall.



#### Advanced Measurement Laboratory

Completed in 2004, the Advanced Measurement Laboratory (AML) is one of the most technologically advanced research facilities in the world, offering highly controlled environmental conditions for precision measurement science and nanotechnology. The complex of five research buildings has NanoFab laboratory space, clean rooms and reconfigurable laboratory modules, used by outside researchers and collaborators, as well as NIST scientists. The planned building addition reflects growing nanoscale and fabrication needs in the nano-biomedical research community, and anticipated need for NIST participation and user support. Flexible laboratory space, user facilities and office space for added staff are planned. The proposed addition is proposed as a direct expansion of Building 216, for access and sharing of equipment and support facilities. Its construction would necessitate the relocation or replacement of a solar panel array.



#### Specialty Laboratory Renovations

Six special purpose laboratory buildings, constructed as part of the original campus in the 1960's, require modernization for continued usefulness. All have been designated in poor physical

condition in the latest building condition survey. These labs have a common need for core infrastructure and energy efficiency related upgrades. In general, they require upgrades or replacement of their mechanical, electrical and plumbing systems; improvements to their envelopes to stop infiltration and improve thermal performance; architectural upgrades to interiors; and ADA compliance for entries and exits, circulation pathways, and access to conveniences and utilities. In addition, each building in this group has specific needs dictated by its technical measurement and research requirements, structure and occupancy considerations.

Each building requires a specific modernization and phasing plan because of specialized equipment and services that are not practical to recreate in swing space. Modernizations will take place in phases, permitting the core programs to continue

**Laboratory in Building 216**



to function. The specialty laboratories slated for modernization are the following:

- Building 202, Engineering Mechanics Building
- Building 230, Fluid Mechanics Building
- Building 231, Industrial Building
- Building 233, Sound Building
- Buildings 237 and 238, Non-Magnetic Buildings

### **Building 101 Renovations and Addition**

Three considerations drive the need to renovate and expand Building 101, NIST's main administrative building.



- **Physical Condition.** Like other original campus structures, Building 101 is in poor physical condition. In fact, through NIST Facility Condition Assessments, the condition of Building 101 has been documented to be among the worst on the Gaithersburg campus. Although well maintained, the infrastructure—mechanical, electrical and plumbing systems—and the building envelope are past their useful lives. Energy efficiency and maintenance costs will be significantly improved with renovation and upgrades.
- **Shared and Public-use Facilities.** Additional conference facilities are needed to support the research community and the large conferences hosted by NIST. Also, security policy requires that the conference center, together with other facilities used by the public, be co-located within one zone on the First Floor.
- **Office Utilization.** The 10 floors of office space must be modernized to replace traditional private offices with a more modern, collaborative workplace. This will meet both Department of Commerce space policy, and additional need for administrative workstations.

The Master Plan proposes an addition to Building 101 of approximately 50,000 square feet, adjacent and connected to the main lobby. The ground floor will accommodate an auditorium and three conference rooms, which are spaces needed to augment the conference center. The lower level will house storage and stack space for the library and museum, allowing the creation of

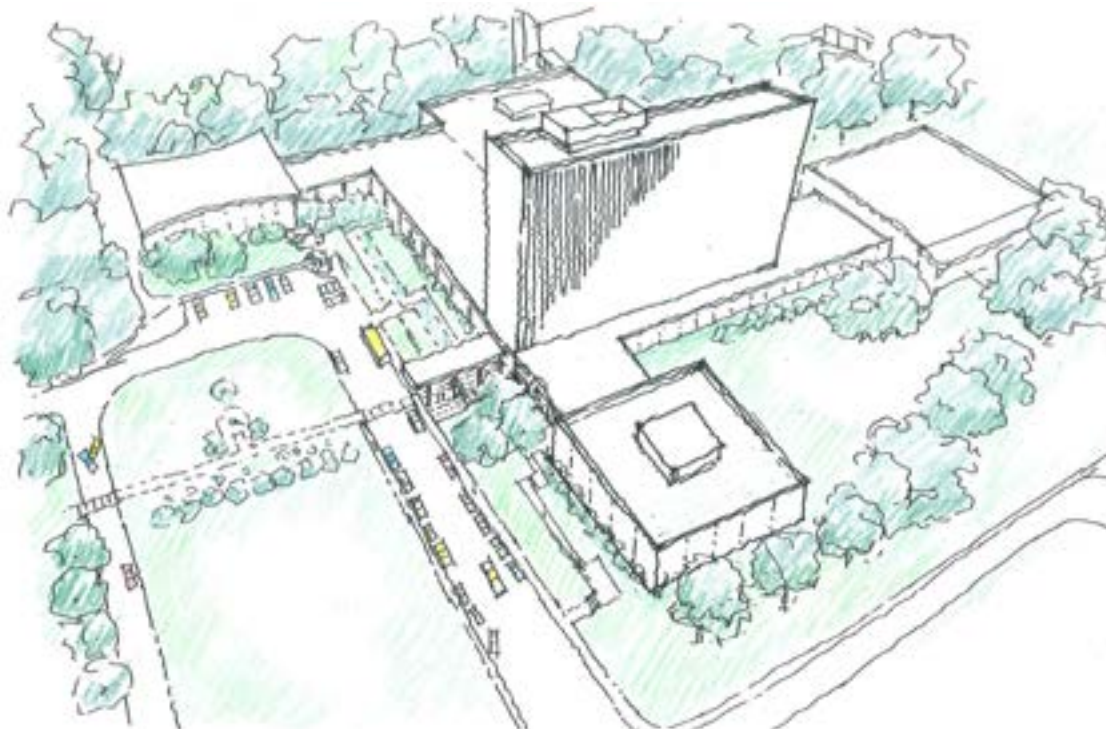
a modern library with media resources, collaboration and reading areas, special collections and NIST-priority meeting rooms. A second floor will house office space, to operate as swing space as the renovations take place in the rest of the building and later for growth.

Several recent studies support these proposals, and contain detailed recommendations and back-up analysis. They are: *NIST Building 101 Lower Levels Planning Study*, 2017; *NIST Cafeteria and Food Service Operations Evaluation and Recommendations*, 2015; *NIST Building 101 Window and Induction Unit Study*, 2014; *NIST Administrative Space Strategic Plan*, 2014.

Architecturally, this addition will be modest in size, and in keeping with historic considerations. Its footprint is imagined as completing the pinwheel of public spaces that rotate around the tower at the first floor—now, auditorium, cafeteria, library. It's height will be similar to the other pinwheel elements and the neighboring GPLs.

### Administration Office Space

Concept: Building 101 and Addition



Administrative office needs and growth will be accommodated in existing buildings, phased in as renovations open up space for new uses. The renovation of the Building 101 office areas will improve the utilization, and absorb some of the anticipated need as renovations progress. The GPL renovations will dedicate space in one or more GPLs to office use and accommodate the Central Computing Center and related staff in another.

Building 428, which is a modular building west of Building 301, was constructed by combining four portable office trailers. It has a capacity of sixteen people in workstations and offices. At the time of the master plan survey, nine staff members from OFPM were housed there. This facility should be phased out, and its occupants moved into adjacent Building 301. The planned relocation of the shipping/receiving function will allow renovation for this move.

### Gate A Visitor Screening Facilities

Gate A is the main entrance to the campus, used by staff and all visitors except attendees at major conferences. Existing Gate A security facilities consist of two structures: a guard booth with canopy, through which all vehicles and pedestrians pass to enter the campus; and a Visitor Center building where security personnel check identification and issue visitor badges. For entry today, NIST



staff and others with permanent badges drive or walk to the canopy and show their badges to the security personnel. Visitors park in an adjacent lot, and enter the Visitor Center building to obtain their temporary badges. Then, they return to their cars, proceed to the canopy and show the temporary badges to the personnel there.

Enhanced security requirements require modifications to the entrance facilities to allow increased screening and better emergency capabilities. These modifications encompass changes to the entry canopy, expansion of the Visitor Center, reconfigured circulation and installation of screening and security technology. See the Circulation Framework section for more detail. Key features of the plan are the following:

- NIST entrance. Bureau Drive will remain the NIST entrance from West Diamond. Other circulation improvements will

ease traffic on the two entrance lanes, and alleviate the stacking that occurs at morning rush.

- Visitor screening. A new vehicle inspection canopy will be built adjacent to an expanded Visitor Center for the simultaneous screening of visitors and inspection of their vehicles. A loop road will branch off Bureau Drive, directing visitors to the inspection station, and allowing space for 30 vehicles to queue. A parking lot will be provided for individuals who prefer to walk onto campus without vehicle screening or vehicles awaiting passengers. The

Concept: Gate A



Gate A



expanded Visitors' Center will support ID checks as well as screening of individuals and belongings with magnetometers and X-Ray machines. Visitors who fail inspection would be directed off campus.

- Employee entry. ID checks for employees and others with permanent security badges will occur at the existing canopy, opening up two lanes. There will be security systems upgrades and limited staff vehicle inspections.
- Roadway modifications. A roundabout is planned at North Drive, where staff and visitors merge into campus cross traffic. An exit turn lane is provided for staff or visitors who are rejected at the main canopy. Screening technology will be deployed in the entrance roadway system, including license plate readers, CCTV and Under-Vehicle Inspection Systems (UVIS).
- Bus entry. Shuttle buses bring employees and visitors from the Metro and MARC trains to campus. Employee IDs are checked, and visitors must disembark for formal screening in the Visitors' Center A bus pull-off is planned, for the shuttle and other buses that drop off and then leave the campus.
- Drop-off. A drop-off lane will be provided for staff or visitors arriving by shared automobile.



## Gate F Delivery and Screening Facilities

Commercial vehicle deliveries now enter the campus at Gate C along Quince Orchard Road. That gate has no room for commercial vehicle screening or queuing, so they must proceed to campus Building 301 for physical inspection. These conditions do not meet current security requirements

and present a safety risk for NIST in a zone of major campus infrastructure. A related future development is the proposed construction of the Corridor Cities Transitway, a bus rapid transit line that will extend along Quince Orchard Road and require the moving of Gate C to accommodate the bus lane and a new NIST Station transit stop.

The Master Plan moves the commercial vehicle entrance to Gate F, where screening can take place before commercial vehicles enter the campus. The new location and procedure will control campus commercial vehicle access by moving the shipping/receiving facilities to the gate. After inspection, commercial delivery vehicles will unload their goods, which will be transported to campus buildings by NIST vehicles. Commercial vehicles with specialized equipment or construction materials will be allowed to enter the campus after screening.

Commercial vehicles will enter the campus from a new entrance on Muddy Branch Road, at Palmspring Drive.



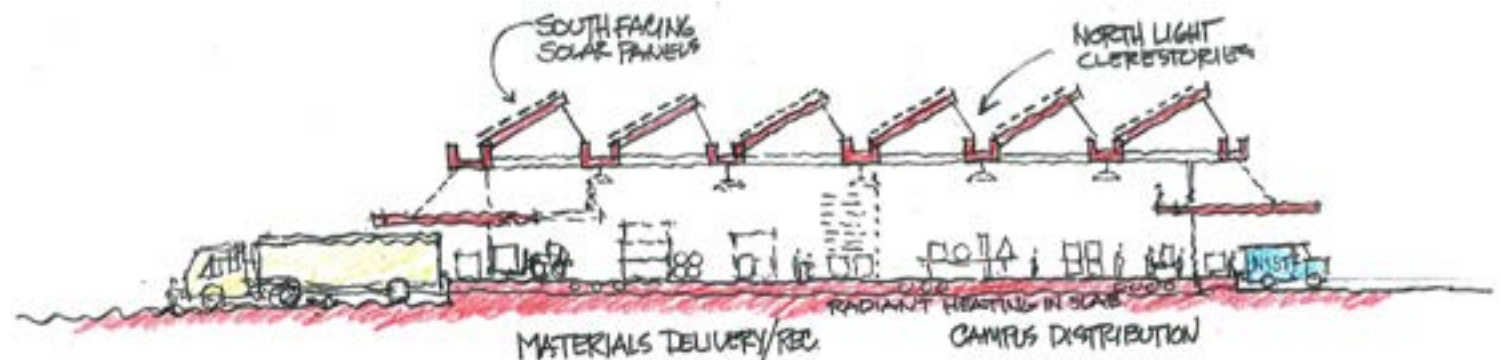
Commercial vehicle inspection will take place after entry, but before a commercial vehicle approaches the shipping/receiving building. A commercial vehicle that fails inspection will be directed to

leave the campus by East Drive, an intersection controlled by traffic signal.

Today, conference attendees for large conferences use Gate F instead of the main entrance at Gate A. With the Master Plan, the conference attendees now will be screened, as they would be at Gate A. Vehicles will enter at East Drive, and proceed to the screening facility, with a building for the screening of visitors and their belongings with magnetometers and X-Ray machines and an adjacent canopy for simultaneous vehicle inspection. Rejected vehicles will exit the campus at East Drive. A parking lot will be provided for individuals who prefer to walk onto campus without vehicle screening or vehicles awaiting passengers. Screened visitors would proceed to a security kiosk for final check before entering the campus.

NIST employees and badge-holders will enter at East Drive as they do today, proceeding to the security kiosk for ID confirmation. There will be a reject lane for those with incorrect IDs and for visitors who have mistakenly bypassed the screening center.

### Concept: Net Zero Shipping/Receiving Facility



**Exhibit 35: Existing Campus**



Exhibit 36: Master Plan



DECEMBER 31 2017

NIST MD PROPOSED





# Landscape Framework

## CHAPTER 5

**T**HE approach to the landscape and site at NIST's Gaithersburg campus seeks to provide modest, achievable solutions that respond to the campus's ecological, social, and programmatic needs. This plan addresses the restoration and continuation of the historic landscape and hardscape of the campus. Five strategies are comprised in the landscape recommendations and they are as follows:

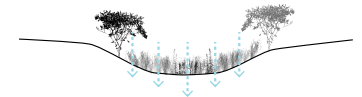
- 1. Storm Water Management.** As the campus expands and modernizes, it will need to meet current storm water management requirements. There are many simple interventions within the landscape that can slow run-off. In this plan those include removing curbs and creating bio-swales, retrofitting parking lots to include small rain gardens, possible building green roof systems, and reforestation.
- 2. Reforestation.** Expanding the canopy cover will create a noise and visibility buffer from highway 270, slow wind speeds, and aid in the absorption of storm water run off.
- 3. Historic Preservation.** NIST developed and relocated from the District of Columbia to its current Gaithersburg campus in the 1960s. Its campus reflects many aspects of suburban research campuses that were prominent in the US from the 1950s-1970s. Many of these elements on site need restoration, protection, or enhancement.
- 4. Connectivity.** This landscape plan seeks to address the site circulation needs—from creating a stronger pedestrian pathway network to incorporating other modes of transportation and recreation into the existing fabric.
- 5. Site Activation.** Establishing a hierarchy of social outdoor spaces will help modernize the campus and respond to the needs of staff and employees in the 21st century who value access to the outdoors.

## Landscape Stormwater Management

Campus stormwater management strategies are discussed in Chapter 6: Stormwater Management. Several landscape techniques will help absorb surface runoff and meet the stormwater permit requirements for existing development.

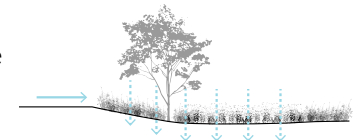
### Bioswales

Bioswales absorb low storm water flows or carry runoff from heavy rains to storm sewer inlets or directly to surface waters. Bioswales improve water quality by infiltrating storm water runoff. Native species with deep roots are the best selection for the best infiltration and less maintenance. The thicker and heavier the grasses, the better the swale can filter out contaminants.



### Rain Gardens

Rain gardens function much like bioswales, but instead of directing flows, they absorb run off from adjacent impervious paving and hold water during heavy storm events.



### Meadows

As an alternative to lawns, meadows and prairies increase runoff infiltration and biodiversity, and create a more dynamic aesthetic. Meadows and prairies can be seeded and plugged, but because of the deer browse on site, a no mow approach to the existing expansive lawn is recommended.

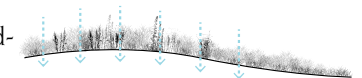


Exhibit 37: Landscape Plan



LEGEND

- Pond
- Proposed buildings
- Forest canopy cover
- Increased tree clusters
- Mowed lawn
- Meadow
- Activated core
- Multi-use trail
- Pedestrian network

## Landscape Preservation

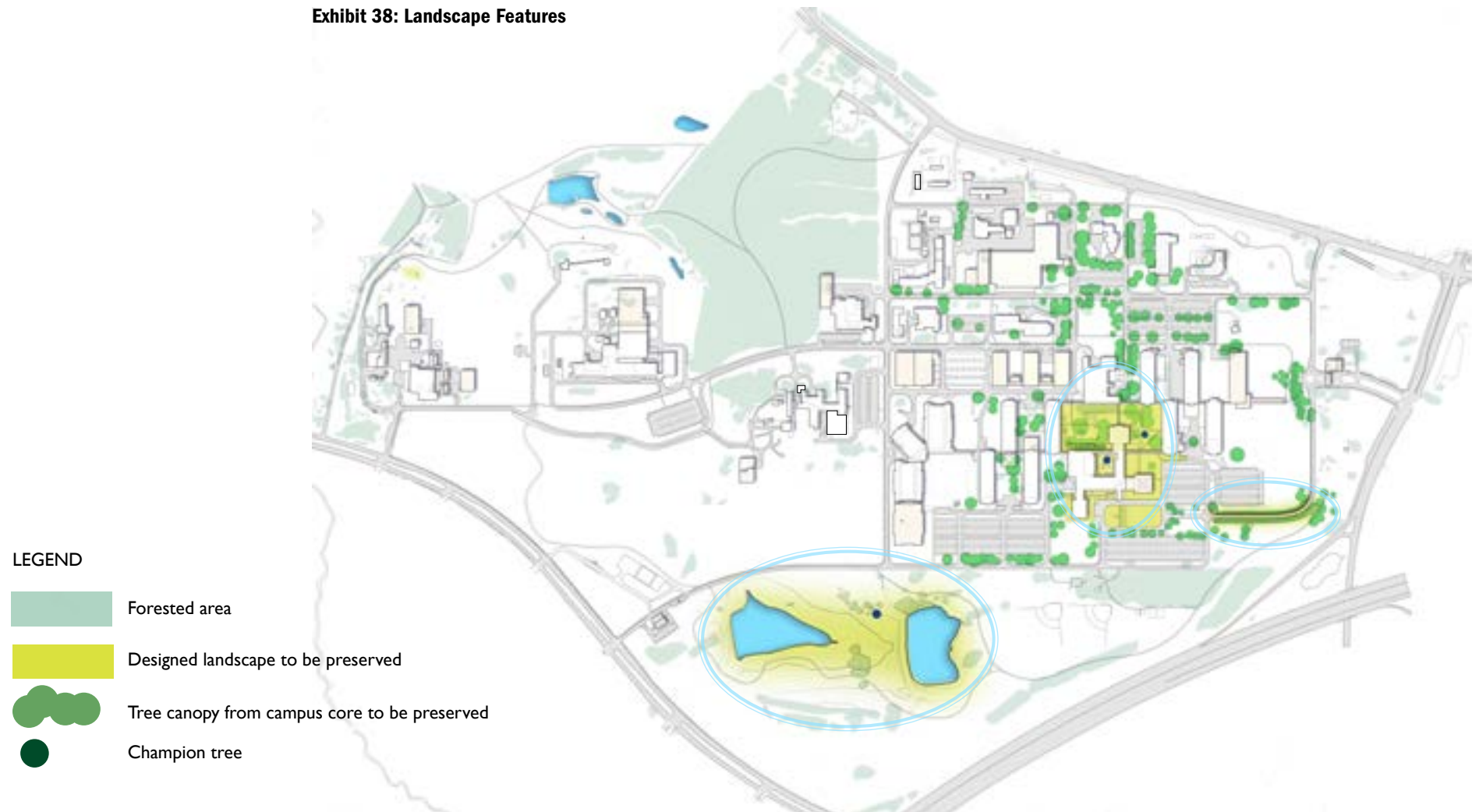
### Restore & Maintain Historic Features

The NIST Gaithersburg campus follows a grand tradition of Modernist Research Labs of the 1950s-1970s. Some examples of this style of campus facility include the General Motors Technical Center in Warren, MI, and Bell Labs Holmdel Complex in Holmdel, NJ. These campuses were defined by a series of place-making strategies including modular building design, modern architectural palette, suburban setting, and abundant manicured landscape. As research and technology

campuses retreated to suburban environments, they created systems of highly organized and mechanical buildings surrounded by rolling, pastoral landscapes.

The NIST Gaithersburg campus landscape embodies many of these elements. The periphery of campus is organically planted with loose clusters of trees emerging from rolling hills of grass. Within the immediate core of campus, more linearly planted mature trees frame the modular building system and pockets of ornamental plants accent prominent entries of buildings. The prominent hardscape on site is asphalt from the abundant, suburban parking lots, but the remaining hardscape on site requires maintenance and preservation.

**Exhibit 38: Landscape Features**



**Landscape Preservation:** Four aspects of the historic landscape and hardscape have been selected for a preserve in place strategy. These aspects are the lower ponds, the formal entry drive, the central courtyards, and the mature campus trees.

### 1. Lower Pond Edges

The edges at the lower ponds are soft and natural edges with year-round aesthetic appeal. A variety of water-tolerant grasses establish an organic frame for two man-made ponds, helping them appear to be more naturally occurring. Additionally, these bodies of grasses host a diverse ecosystem that can help maintain the vitality of the pond environments. These edge plantings are integral to the historic nature of the campus's pastoral landscape and need to remain in place as well as continue into the surrounding area. While this plan does call for allowing the turf grass in this region of the site to grow naturally, a mowed path surrounding the ponds should be maintained so they can continue to be enjoyed.



### 2. Entry Drive

When the original NIST campus (then NBS) was relocated from the District of Columbia to Gaithersburg, one of the prominent campus elements came to the new location: the original gates. These gates still serve as the ceremonial entrance to the NIST headquarters, main administration building and primary visitor destination, Building 101. Critical to this ceremonial approach are the allée of trees lining the drive leading to the gates. These trees are now mature, and their encompassing size create a grand and elegant approach for visitors. The allée also creates the effect of hiding the approaching campus buildings, creating a stately reveal of Building 101 and the auditorium. Lastly, this allée is part of a larger framework of linearly organized trees throughout campus, and it remains vital to the integrity of that intention to leave these trees in place.



Original gates from NBS headquarters in the District of Columbia

### 3. Central Courtyards

This area includes all the formal and ornamental spaces around the prominent Administration Building 101 and its public spaces: the library, cafeteria, and auditorium.



Building 101 Entry

- Library plaza:** Extending from the grand library porch is a large plaza space with large pavers. The large granite pavers are original to the campus design and reflect the modernist styling of the surrounding buildings. Many of the large granite pavers are cracked, broken, chipped, or stained. As this outdoor hardscape space is integral to the design intent of the library, this surfacing should be repaired where possible and replaced with replicas where necessary. Additionally, the area currently filled with gravel should be planted with ground cover to enhance the ornamental quality of the space. Lastly, the large, monolithic benches placed at the edge of the paving are underutilized and out of place. A more desirable alternative would be to remove the benches and replace them with lightweight, movable furniture to match that of the library porch. To connect this plaza to the lower courtyard around Building 101, some design interventions will adapt this space. All materials, forms, and furnishings will reflect the existing midcentury design language. See the Activation section for more information on the plan.



- Interior courtyard:** The interior courtyard adjacent to the cafeteria is well utilized, comfortable and vibrant, and is a prime example of modernist plaza spaces. Its long, low horizons and simple, orthogonal lines are the hallmark of modernist design ideas. Large, ornamental, willowing trees soften the space and provide a distinct character. The champion weeping beech is a focal point and remarkable gathering space, as many staff members eat underneath the drooping canopy. As this courtyard is highly utilized and in good condition, it should continue to be preserved in place.

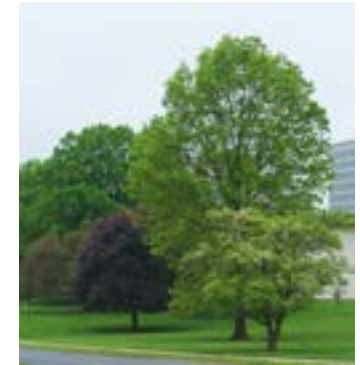


- Plaza by the Auditorium:** This quiet and understated space serves as the primary southern entrance to Building 101. Its granite pavers reflect the adjacent modernist auditorium façade. Currently, the approach to this landing is a large concrete path leading to a small plaza of patterned pavers. It is recommended that the concrete be replaced by granite pavers to create a more unified and formal gathering area.



#### 4. Mature Trees Framing Campus

Throughout the historic core of campus, large mature trees accent buildings and frame parking lots. Some appear to be planted linearly, and others in clusters. These trees provide many attributes: they shade parking lots and open areas, they delineate walkways and entry points, and they buffer direct visual impact of the campus's large parking lots. Many of the original trees have reached full maturity with some nearing the end of their life span. It will become vital to implement a replacement strategy for these mature trees for when they require removal. There are three strategies for this solution: in-fill planting, root sprout replacement, and planting into stumps



#### Champion Trees

There are three trees on campus that have been included in the 2017-2018 Maryland register of State Champion Trees. These trees are the largest of their species in the state of Maryland. The trees included are the weeping beech in the Building 101 courtyard, the Newton apple tree located between the Library and Building 225, and the Ohio buckeye tree located in the State Tree arboretum. Regular maintenance such as pruning, pest and disease inspection, and soil management are critical to these mature trees' health.

#### Exhibit 39: NIST's Champion Trees

	Species Name	Common Name	Location	Height	Circumference
1	<i>Malus pumila</i> "Flower of Kent"	Apple "Flower of Kent" (Newton Apple Tree)	In front of NIST Library	25'	8'-2"
2	<i>Fagus sylvatica</i> "Pendula"	Weeping Beech	Building 101 courtyard	38'	12'-1"
3	<i>Aesculus glabra</i>	Ohio Buckeye	NIST State Tree Arboretum, east of East Drive	56'	8'-3"

2017-2018 Maryland Register of State Tree Champions

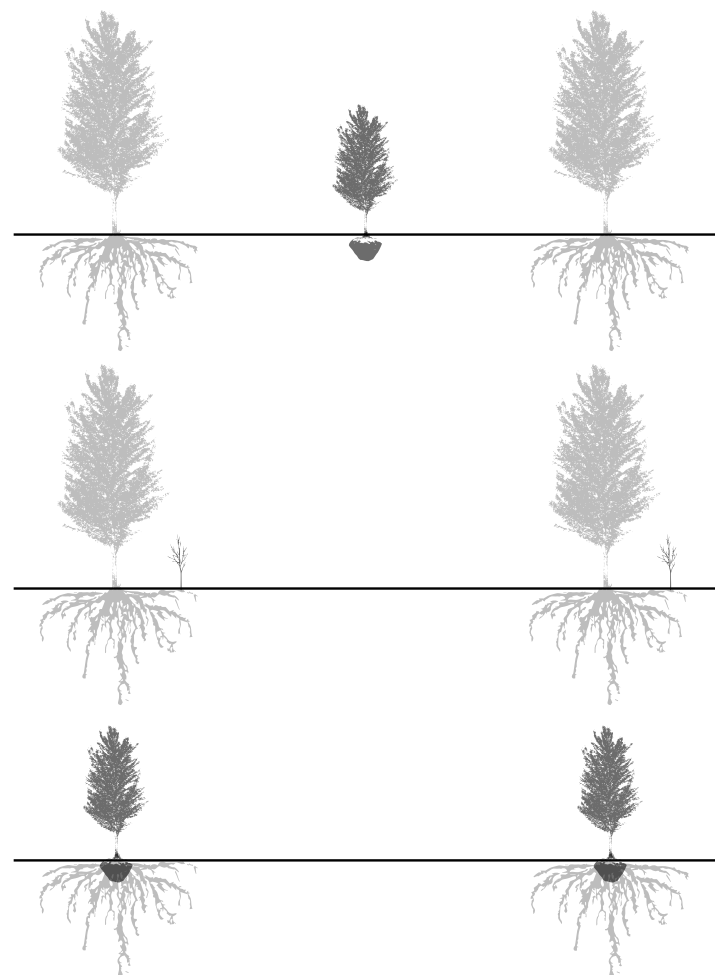
## Preserve and Restore Trees

NIST relocated from the District of Columbia to its current Gaithersburg campus in the 1960s. Its campus reflects many aspects of pastoral research campuses that were prominent in the U.S. from the 1950s–1970s. In order to preserve and restore the original design intent for the campus tree patterns, the following strategies are recommended.

**1. In fill Plantings:** This process uses adaptive management strategies to place young trees in between rows of, or next to larger mature trees. Because of the expansive nature of the mature trees' root systems, the new trees will remain small, while they seek root space to establish. However, once the mature trees die, decay, and are removed, the new trees can quickly establish and grow.

**2. Root Sprout Replacement:** By using root sprout to replace mature trees, the new tree retains the genetic authenticity of the original specimen and requires minimal soil and environmental damage. Be certain not to use the root sprout of a grafted tree as the genetic material is different and not verifiable. The process begins with selecting a vigorous root sprout that is well anchored into the soil and the surrounding root system. After the tree dies, allow the stump and root system to decompose naturally. The sprout will require mulch, protection, and watering until well established.

**3. Plant into Decayed Stump:** By using this strategy, the historic design intent remains intact. By using the limits of the existing stump, the limits of soil disturbance are significantly less than the standard planting practice. For this procedure, select the smallest root ball size available and plant directly into the previous stump once the stump has decayed and the decay has been removed from the stump. Then elevate the root ball a few inches above the boundaries of the decay and back fill with soil.



Existing Maryland Champion Weeping European Beech Tree in dining courtyard and other trees bordering parking lots that reinforce linear patterns of site circulation.

## Connectivity

Currently, campus circulation primarily connects drivers to their respective buildings. While most of campus is accessible by car, the Master Plan seeks to open access to pedestrians and cyclists by expanding the network of pathways, sidewalks, and trails. This plan creates a hierarchy of pedestrian connections, by emphasizing the most important and utilized routes.

The interior concourses will remain the primary north-south pedestrian route within the campus core buildings. The three

new research lab buildings, located to the west of the GPLs, will connect into the concourse system and into the courtyards around Building 101. Elevated corridor connections will link the new buildings to GPL Buildings 221 and 223 and to each other, extending the internal pedestrian connections.

The next layer in the circulation hierarchy is the reinforcement of exterior pedestrian connections. Sidewalks are realigned or created where they don't exist, especially along the parking lots. These connections offer pedestrians more safety and separation from vehicular traffic and also wayfinding reassurance.

**Exhibit 40: Campus Connectivity Plan**



Within the core of campus, sidewalks have been extended or created, where currently they abruptly stop, to reinforce the gridded campus form and enhance connectivity. Each street will have sidewalks on at least one side to allow pedestrians a safe place to travel. Pathways have also been added to connect Gate A to Building 101 to the west side of campus.

To enhance availability of outdoor recreation, a multi-use trail runs throughout the periphery of campus. It connects the major points of interests outside of the core of campus to each other. Runners, walkers, or cyclists can access this trail at many different points within the core of campus and it will take them to site features such as the ponds, the recreation and sports fields, western forest, and historic stone test wall. The trail will be low maintenance and not paved, except where it uses existing sidewalks. Several materials are suggested--woodchip path, natural surface, mown path, gravel--depending on the campus location. Some portions of the trail exists today and are frequently used.

Lastly, bicycle access throughout the site will create an easier way to navigate campus, provide more alternative options of transportation to campus, and create an additional outlet of recreation. There are bike racks outside of some lab and office buildings, but more bike racks will be needed with additional development and renovation. The trail that runs the perimeter of campus will be open to cyclists as well.

## Activation

Activation is determined based on a synthesis of proposed development, desired circulation patterns, and increased programming around prominent buildings (library, cafeteria, and Building 101). This plan is designed to respect the historic landscape by mimicking the modernist and orthogonal design language and selective placement to avoid interfering with the typical pastoral landscape.

### Pedestrian Promenade

The pedestrian promenade serves to create a prominent east-west axis that connects Building 101 and its features with the proposed CCT stop and the campus boundary. To emphasize this path, the walkways will be widened to 20 feet and use granite pavers to match those found around Building 101. Bordering the walkway is a low site wall with an alternating pattern of planter boxes and pedestrian height lights. Adjacent to the new

Research Buildings, II, III, and IV, the Research Drive becomes a pedestrian-only zone (allowing vehicular access as needed). The alternating planter and site wall pattern becomes modified to allow for more fluid circulation.

A cohesive axial connection is dependent upon access through the concourse between Buildings 304 and 223, where there is an existing door. Once through the concourse, the path connects to the new Cafeteria patio spaces, and terminates with a granite paved walk to the Auditorium plaza. Like the pedestrian only portion, the segment of the axis within the Building 101 courtyard will also be able to support occasional vehicles.

## New Programmed Spaces

### Building 301 Patio

A new entrance into the Building 301 cafeteria is planned to accommodate visitors and contractors without a security badge. As part of that concept, there will be a patio outside the cafeteria for dining and gathering. The patio will connect the new cafeteria entrance, the existing door on Building 301, the new pedestrian promenade, and the existing curved sidewalk in front of Building 301. By avoiding interference with the existing trees, the patio will offer a variance of sun and shade. It will provide a few tables, chairs, and benches.

### Research Building Patios

To encourage and facilitate outdoor meeting, two patio spaces are located in between the rear of Research Buildings II, III, and IV. They offer moveable and fixed dining furniture, and built shade structures to provide a closed-off space for meetings.

### Library Plaza

In combination with restoration, the plaza in front of the Library will be rejuvenated to foster more activation in front of one of NIST's most iconic buildings. In addition to the efforts described in Landscape Preservation, a path of non-white granite will run through the plaza where the current northern boundary is. This will emphasize the connection to the Building 101 entrance and the paths leading further into the Library courtyard. On the northern edge of the plaza, the portion that is currently unpaved, adjacent to the Newton Apple tree, will be replaced with granite to match the typical white pavers in this area. This space will become a gathering space with moveable furniture. Granite will be removed and replaced with ground cover planting to symmetrically frame the Library façade.



### New Cafeteria Patios

In design at the time of this document is a cafeteria renovation with new egress stairs and exterior dining space. A deck will be added at the first floor adjacent to the cafeteria with stairs leading down to a terrace below. At ground level, the terrace will be furnished with tables and chairs, creating opportunity for custom dining arrangements and outdoor meeting spaces. The patio connects to the east-west pedestrian axis and to the pathway network that leads to the Library Plaza. A micro-biore-entention area is added.

### Temporary Programmed Spaces

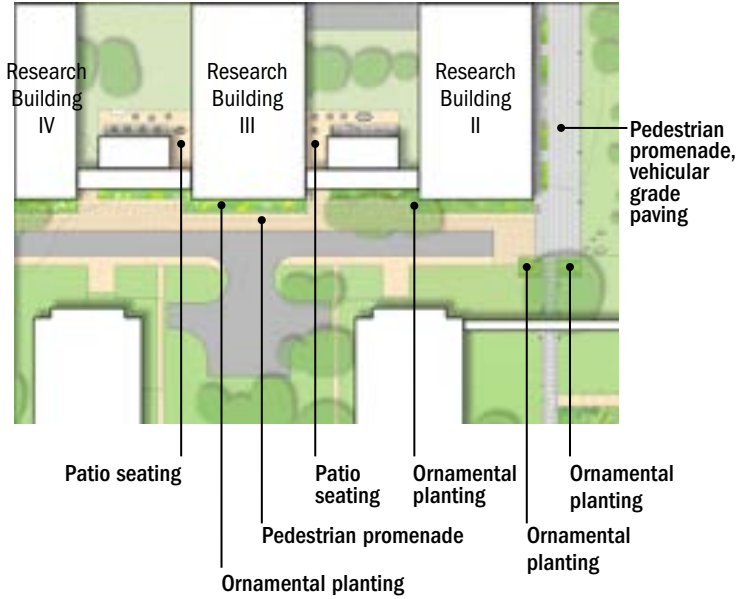
The modular form of the NIST campus creates inactive and dormant spaces between the General Purpose Laboratories. The approach to activate these spaces will be temporary and flexible. These rear courtyard spaces can host moveable furniture, and can fluctuate location based on need and use. The moveable furniture can include tables, chairs, charging stations, umbrellas, and benches. Ultimately, once preferred locations are determined through use, these spaces can be formalized and built.

**Exhibit 41: Campus Activation**

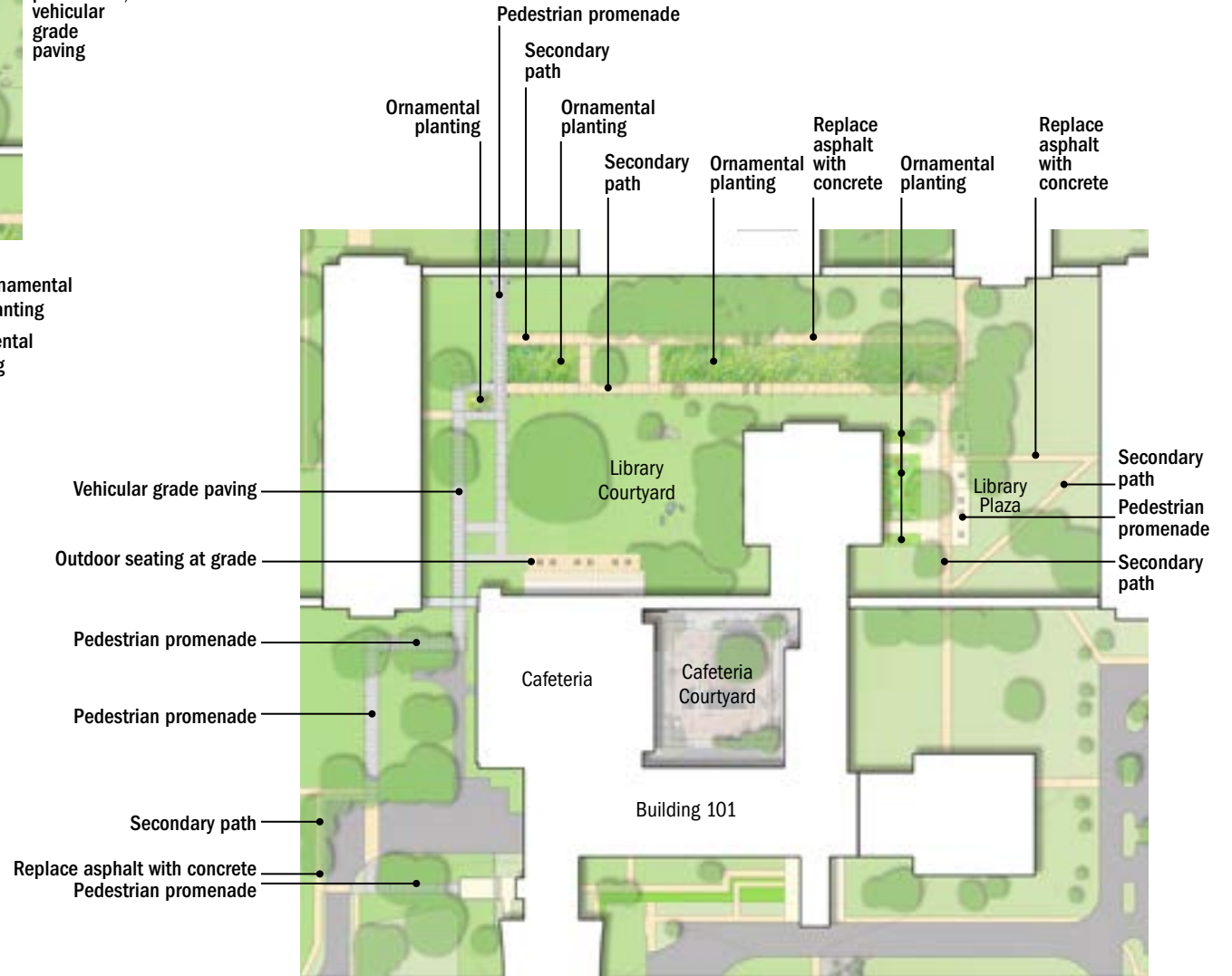


# Sample Programmed Social Spaces

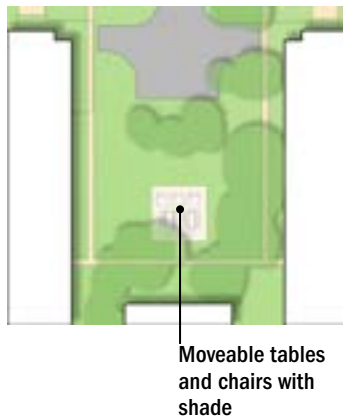
**Exhibit 42: New Research Buildings II, III, IV**



**Exhibit 44: Building 101 Courtyard**

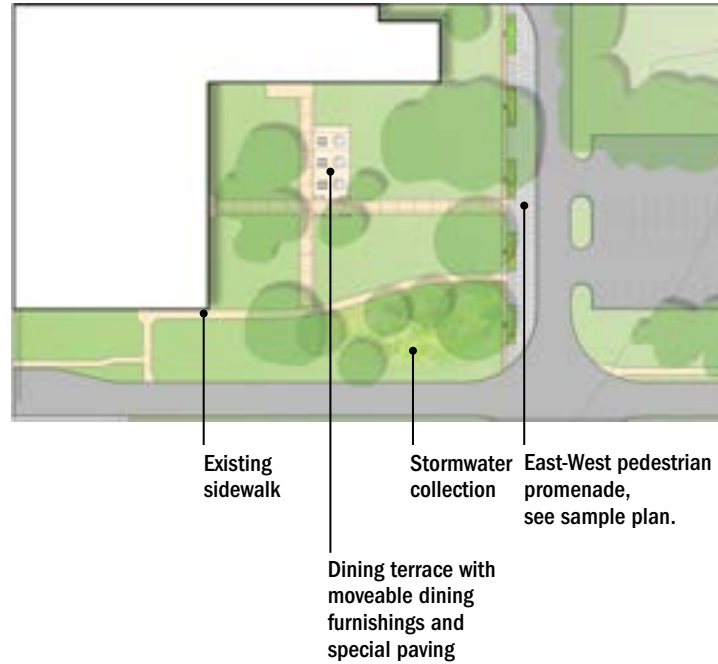


**Exhibit 43: Temporary Courtyard Activation**

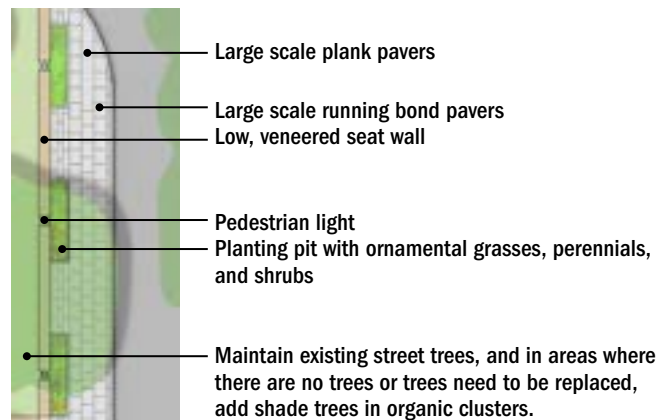


**Sample Programmed Social Spaces, continued**

**Exhibit 45: Building 301 Cafeteria**



**Exhibit 46: Sample East-West Pedestrian Promenade Plan**





# Stormwater Management

## CHAPTER 6

**W**HEN stormwater falls on an undeveloped site, it can be absorbed into the ground. This process naturally filters the stormwater and reduces the volume of water that is experienced downstream. When an area is developed with new buildings, pavement, and other impervious surfaces, this natural process is inhibited, and additional pollutants and volumes of water are experienced downstream. The objective of Stormwater Management (SWM) on a developing site is to maintain its pre-developed runoff rates and water quality by removing pollutants and temporarily storing volumes of water on site.

For State and Federal Projects in Maryland, this process is regulated by the *Maryland Stormwater Management and Erosion & Sediment Control Guidelines for State and Federal Projects*, February 2015 (the Guidelines) published by the Maryland Department of Environment (MDE).

The existing NIST campus stormwater management system consists of an extensive storm drain collection system and established stormwater management features that assist in natural water infiltration. The stormwater management features include ponds, bio-retention areas, rain gardens and bioswales—many associated with building projects. These existing SWM facilities are shown in Chapter 13: Campus Site Analysis.

The Master Plan proposes additional stormwater management approaches that address two situations:

- Master Plan development that will increase impermeable surfaces and require additional stormwater management; and
- A new Maryland Stormwater Permit that require NIST to treat 20% of the runoff from existing impervious surfaces, regardless of the anticipated growth or its timing.

### Stormwater Management for Master Plan Development

The future growth identified in this Master Plan will add approximately 20 acres of impervious surface to the campus, which will be added incrementally as individual projects are implemented. Site conditions for the projects vary by location—some are on undeveloped site areas, some on existing parking lots. During each project's design, stormwater management approaches will be considered that compensate for any increased impervious surface. Environmental site design strategies will be chosen based on the building location and specific surrounding site conditions.

Buildings on existing pervious areas are classified by MDE as "New Development." New construction on an existing impervious surface is considered "Redevelopment" by MDE, with no net increase in impervious surface. If certain developments identified in the Master Plan are classified as "Redevelopment" (such as Research Buildings II, III, and IV on existing parking lots) the SWM requirements can be reduced. Additionally, if redevelopment is proposed elsewhere on the campus (not currently identified in the Master Plan), additional SWM requirements will apply for those areas.

### Stormwater Management for Existing Conditions

NIST Gaithersburg currently holds a municipal separate storm sewer system (MS4) permit under Maryland's National Pollutant Discharge Elimination System (NPDES). In the renewal of this permit, the facility is required to treat 20% of existing (untreated) impervious surfaces that were installed prior to 2006. This requirement is in addition to the stormwater treatment for Master Plan development. This results in the treatment of an additional 17 acres of existing impervious surface.

Like new construction, this quality requirement can be satisfied through the use of various MDE-approved stormwater management strategies, including reforestation, bioswales, rain gardens, planter boxes, meadows and other structural methods. NIST plans to meet a significant portion of the requirement through their reforestation program. Forestation of an additional 34 acres is planned, which would provide treatment for approximately 13 of the needed 17 acres. Bioswales, raingardens, planters and other methods will be proposed to treat the remaining existing impervious surfaces.

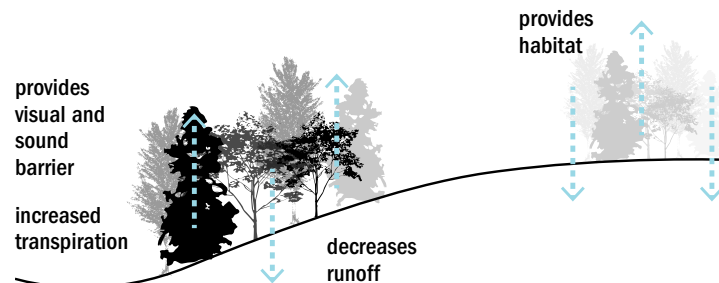
## Environmental Site Design Strategies

Stormwater management practices seek to control the quality and quantity of runoff with on-site measures, and reduce the amount of water flowing into municipal stormwater sewers. For both new development and existing impervious surfaces, NIST will evaluate opportunities to incorporate environmental site design (ESD) strategies that emphasize natural processes.

The stormwater management approach will be unique to each project, responding to its location and immediate surroundings. For example, Gate F development will be located in open land, but the central-campus development sites are very constricted. A thorough analysis of SWM need, available land, neighboring buildings, slope and soil conditions will determine the most appropriate approach. Maintenance staff at NIST is limited, and the campus-wide deer population is aggressive to young trees and many plants, so designers will seek to avoid high maintenance landscape approaches. NIST will include low-maintenance ESD methods such as reforestation, grass swales, rainwater harvesting, permeable paving, drywells, and green roofs (on non-lab buildings) and will ensure that SWM approaches are consistent with the MDE stormwater management guidelines.

Below are potential ESD strategies to be considered. All will require maintenance, such as watering and deer protection, until adequately established. The Master Plan recommends that NIST include a required maintenance period in future construction and landscape contracts.

## Reforestation



U.S. Coast Guard Headquarters



Alexandria Central Library



The NIST Gaithersburg campus currently has two prominent forested areas; one flanking the eastern border with Interstate 270, and a large portion of the southwest section of the site. Additionally, there are clusters of informally planted trees throughout the site, particularly in the southern half of campus. Extending the tree canopy will provide many assets, including noise and sight barriers, increased biodiversity, earth stabilization, aesthetic appeal and the mitigation of vast expanses of existing mowed grass. There are three components of this strategy: reforestation, increased tree clusters, and traditional stormwater management.

Reforestation is the replacement of tree cover through both seedlings and adaptive management to recreate a densely forested area. In this plan, reforestation will continue the existing efforts on the eastern side of the campus and extend the western forest to the south. The addition of a dense forest on the east side of the campus will create a barrier for the campus from the noise and visual impact of the adjacent Interstate 270. It will also create an enhanced visual setting for the two pastoral ponds.

The second strategy for increased canopy growth, is the planting of separated clusters of trees. This strategy provides all the same benefits of dense reforestation, but in smaller, focused clusters building off of existing planting patterns. This planting

strategy will occur mostly surrounding the NCNR, Large Fire, and Special Projects buildings. More tree clusters can be planted to help stabilize the slope of the earth infill adjacent to Building 205 and reinforce its planting pattern.

Reforestation on a Pervious Urban setting is defined as the survival rate of 100 trees per acre or greater; at least 50% of trees have two inch diameter or greater (4.5 ft. above ground) caliper. This is the equivalent of 0.38 acres treated for stormwater.

The Master Plan proposes the addition of 34 acres of forested area, yielding a stormwater credit of approximately 13 acres ( $0.38 \times 34 = 12.92$ ). When implemented, these 13 acres can be deducted from the 17 acres needed for existing conditions, identified above. (Reference Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated, MDE.) Remaining acres of treatment may be satisfied using one of the other ESD methods.

**Exhibit 47: Reforestation Plan**

### Appropriate species for Reforestation

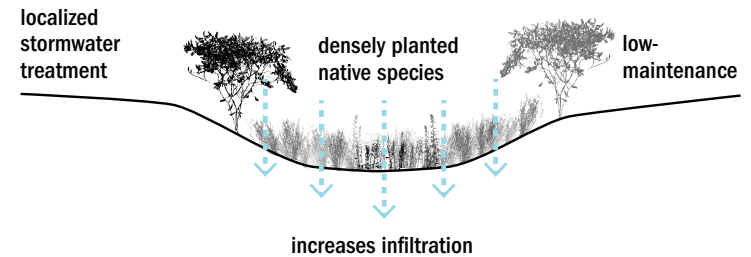
Tulip Poplar, *Liriodendron tulipifera*  
 White Oak, *Quercus alba*  
 Southern Red Oak, *Quercus falcata*  
 Northern Red Oak, *Quercus rubra*  
 Black Oak, *Quercus velutina*  
 Sassafras, *Sassafras albidum*  
 Sweet Gum, *Liquidambar styraciflua*  
 Beech, *Fagus grandiflora*  
 Pignut Hickory, *Carya florida*  
 Black Cherry, *Prunus serotina*  
 Sycamore, *Platanus occidentalis*  
 River Birch, *Betula nigra*  
 Red Maple, *Acer rubrum*  
 Dogwood, *Cornus florida*  
 Shadbush, *Amelanchier arborea*



## Bioswales

Bioswales capture low storm water flows or carry runoff from heavy rains to storm sewer inlets or directly to surface waters. Bioswales improve water quality by infiltrating storm water runoff. Native species, with their deep roots, are preferred to maximize infiltration rates and reduce maintenance. The thicker and heavier the grasses, the better the swale can filter out contaminants. Additionally, sub-grade drains and amended soils may be needed to facilitate infiltration. Slopes should not be greater than 3:1, and the soil infiltration rate should be greater than 0.5 inches per hour.

The preferred locations for these swales are along the roads in the southern portion of campus, along the streets on the periphery of campus core, and in some parking lots. Where curbs do not exist, water will sheet flow into the swales. Where swales are indicated next to roads that have curbs, those curbs may be removed. In parking lots, the curbs will be cut to direct flow into the swale. Due to limited maintenance capacity, these swales would remain grass, but not mown. This approach has been successfully implemented along the new roadway to the Robotics Building, and could be implemented as campus roads and parking lots are repaved.



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Andropogon/HOK

James Madison University



Rhodeside & Harwell

### Exhibit 48: Sample Deer Resistant Plants for Stormwater Management



*Chasmanthium latifolium*  
River Oats



*Geranium maculatum*  
Wild Geranium



*Coreopsis verticillata*  
Threadleaf Coreopsis



*Helianthus angustifolia*  
Swamo Sunflower



*Liatris spicata*  
Blazing Star



*Monarda fistulosa*  
Wild Bergamot



*Viburnum dentatum*  
Arrowwood



*Asclepias tuberosa*  
Butterfly Weed



*Baptisia australis*  
False Blue Indigo



*Helenium autumnale*  
Sneezeweed



*Osmundastrum cinnamomeum*  
Cinnamon Fern



*Panicum virgatum*  
Switchgrass



*Schizachyrium scoparium*  
Little Bluestem



*Cornus amomum*  
Silky Dogwood



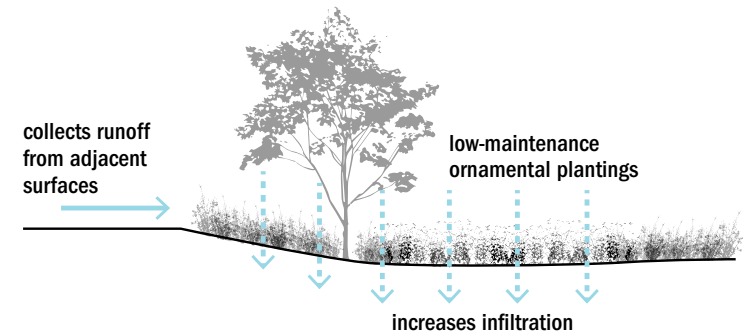
## Rain Gardens

Rain gardens function much like bioswales, but instead of directing flows, they absorb run-off from adjacent impervious paving and hold water during heavy storm events. They are best planted with native, water tolerant species that help stabilize the slope, infiltrate surface waters, provide more efficient water distribution, and require less maintenance. To avoid interrupting the historic landscape and to minimize maintenance requirements, rain gardens have been suggested in several locations. These locations will help capture runoff and create attractive landscape features. The species selected for these areas should be native or adaptive to the region, tolerate intense periods of rainfall, and be resistant to the aggressive deer population.

Exhibit 49: Rain Garden Diagram



- BASE: 24"-36" Depth**
  - Woody stem shrubs
  - Groundcovers
- SLOPE: 12"-24" Depth**
  - Woody stem shrubs
  - Grasses
  - Herbaceous perennials
- BUFFER: 0"-12" Depth**
  - Grasses
  - Turf
- SURROUND: 0" Depth**
  - Turf



Alexandria Central Library



Rhodeside & Harwell

At NIST Campus



Rhodeside & Harwell

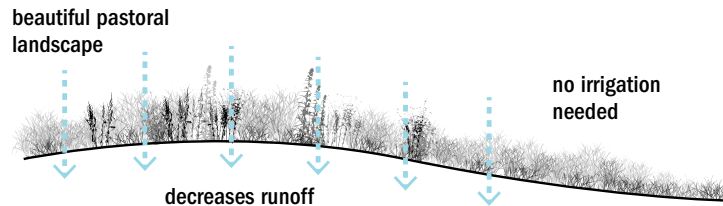
## Planter Boxes

Planter boxes are walled rain gardens that can support pollutant removal and capture runoff for infiltration. They can be raised boxes or depressed landscape features that receive runoff from adjacent impervious surfaces through wall cuts and/or drain systems. Plant varieties should include native, water-tolerant, deer resistant, herbaceous perennials and grasses. Intended for urban settings, planter boxes are proposed along the new pedestrian promenade. Planter boxes in this location will support infiltration, as well as enliven and define the pedestrian walkway.

## Meadows

While not specifically listed as a SWM technique, the conversion of grassland to meadow reduces the runoff experienced, lowering the amount of SWM required and reducing the frequency of maintenance.

Currently, over 60% of the 579 acre campus is mowed regularly. The process of mowing the entirety of the site can take up to seven days and requires constant maintenance. As an alternative to lawns, introducing meadows and prairies increases sheet flow infiltration and biodiversity, and creates a more dynamic aesthetic. Meadows and prairies can be seeded and plugged, but due to the deer browse on site, a no-mow approach to the existing expansive lawn is highly recommended. This approach reduces the quantity of mown grass, and limits lawns to the historic core of the campus and the immediate surroundings of the buildings in the southern portion. Grass on the rest of the site will be allowed to grow naturally, with one or two mowings a year. Over time, additional seeds and plugs can be planted in the mix to create more diversity. By allowing the grass to grow naturally, this will significantly alleviate maintenance requirements and recall the landscape environment typical of mid-century research campuses. Additionally, taller, thicker grass can help slow the rate of storm water runoff. The edges of paths, sidewalks, roads, and fences can be mowed for better defining pedestrian safe areas, creating a cleaner aesthetic, and meeting security requirements.



U.S. Coast Guard Headquarters



National Aquarium In Baltimore



## Permeable Paving

Permeable paving allows stormwater to infiltrate to a stone base layer and aquifer below, either through the material or through cracks between paving elements. It is most suitable for walkways, drives and parking lots with light and medium traffic. Permeable paving is increasing in popularity, with more options and quality products including porous concrete, porous asphalt and a range of pavers. Permeable paving requires maintenance to remove any debris or material that could block the porous materials. There is limited new paving proposed in the Master Plan, but the approach could be used in replacement projects.

## Dry Wells

Dry wells are underground structural facilities that collect roof top stormwater or surface runoff, and hold it until it can percolate slowly into the ground. Typically, this is accomplished with a buried concrete or plastic tank with an inlet for water and side perforations to allow the water to infiltrate the surrounding soil. Commercial drywells usually include provision for pretreatment to remove possible contaminants and reduce the risk of clogging. At NIST, drywells may be appropriate for tighter building sites.

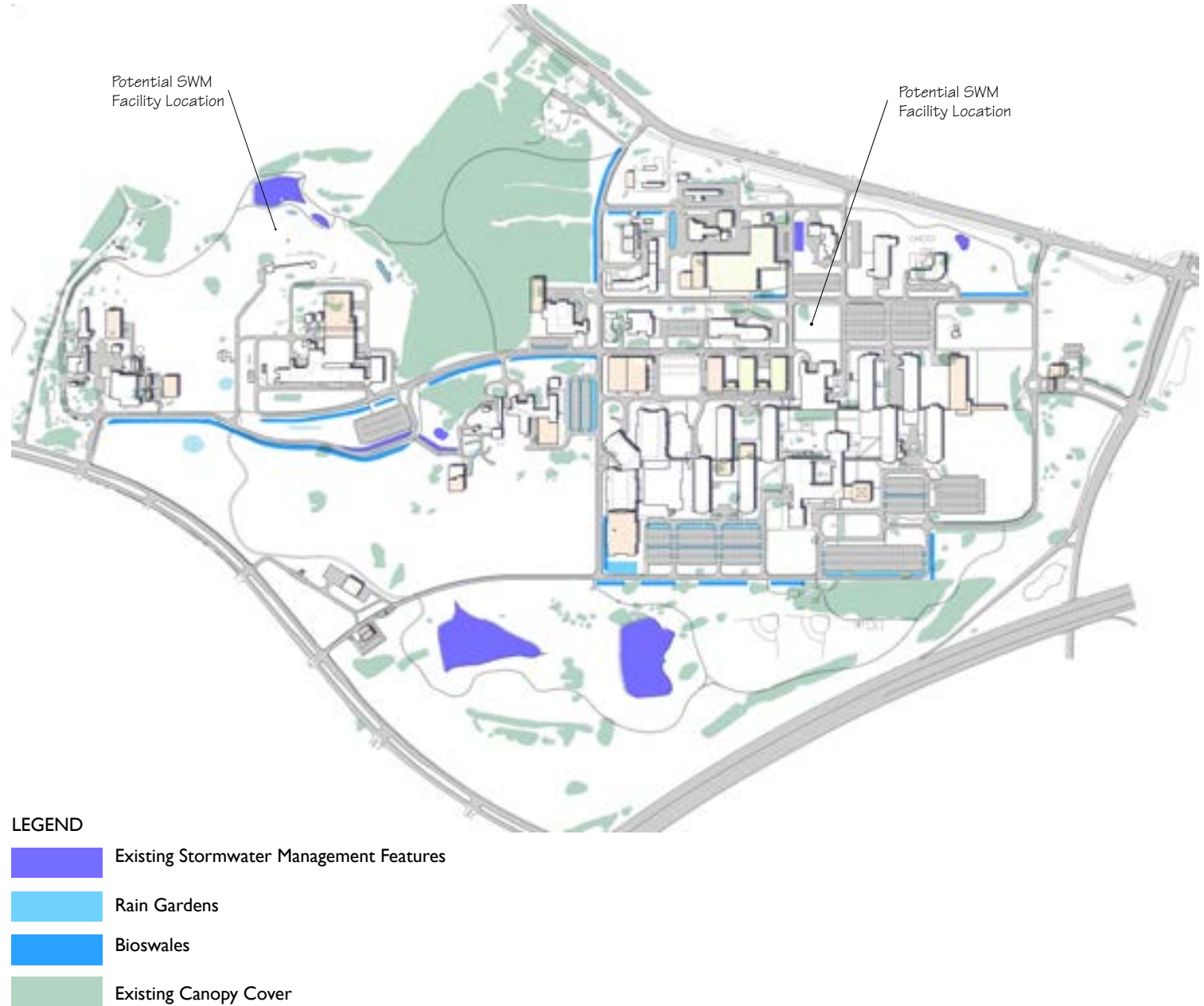
## Building-Based Strategies

Stormwater management features can be incorporated in the design and construction of the buildings. For new projects, rainwater could be collected and reused for cooling tower make-up, toilet flushing, irrigation, car washing or other non-potable uses. The Building 245 addition project is planning this for its roof. Green roofs could be installed on non-lab buildings, including the GPLs that will be renovated for office-type occupancy. Vegetated roofs can provide significant stormwater retention and detention, among other benefits.

Exhibit 50: Meadows



### Exhibit 51: Campus-wide Stormwater Management Features



## Compensatory Stormwater Management

Stormwater management strategies will be specific to each individual project. When a new building development is proposed, SWM is considered, designed into the project, and located on-site adjacent to the new development. NIST will exhaust ESD measures before other approaches are implemented. However, it may be difficult to satisfy the SWM needs on specific projects with ESD alone.

Maryland Department of Environment permits the use of Compensatory Stormwater Management, in which stormwater is managed in an area different from the development location. This is typically done through the use of a Water Quality Bank (WQB). A WQB must be approved and established with MDE by NIST prior to the WQB's implementation. Once established, NIST would be able to add credit to the WQB through the use of various SWM strategies. For example, if existing impervious surface is removed, SWM credit can be added to the WQB. If new impervious surface is added and space limitations or other impediments prevent the use of ESD measure to fully satisfy SWM requirements, then SWM credit can be deducted from the WQB without providing additional (physical) SWM facilities on site. Similarly, if a SWM facility is installed, the credit can be added to the WQB and later deducted if future developments are unable to fully incorporate ESD measures. (See Section 5.5 and 5.6 of the MDE *Guidelines* for additional information.)

Excerpt from the Guidelines<sup>1</sup>

### 5.5 Compensatory Stormwater Management

*MDE may allow compensatory stormwater management for a specific project or portion of a project. Compensatory management means the stormwater from an area different from the area being developed is being managed. The level, type, and location of management provided by compensatory management shall meet the requirements of Section 4.0 of the Guidelines. Additionally, compensatory stormwater management must meet the specific requirements detailed in the Procedures for one of the following categories:*

*A. Compensatory stormwater management shall be provided as part of the project's stormwater management plan; or*

- B. Compensatory stormwater management (i.e., the Water Quality Bank) shall be implemented in accordance with a previously approved Memorandum of Agreement (MOA) between MDE and the State or federal applicant; or*
- C. The compensatory stormwater management shall be consistent with any applicable watershed management plan approved by the local stormwater management authority and acceptable to MDE.*

The Master Plan has designated two potential locations for a consolidated SWM facility, available if NIST establishes a Water Quality Bank system. The design and construction of a consolidated SWM facility in the first development phase would allow NIST to acquire credits that could be debited for later development on the campus. This approach could be permitted by MDE through the use of Compensatory SWM and a Water Quality Bank. NIST would implement this program through a Memorandum of Agreement with MDE and approval by the City of Gaithersburg.

Each building development project would maximize ESD to control its runoff quantity and quality, in accordance with MDE requirements. If available measures do not satisfy MDE requirements, the use of compensatory stormwater management would allow NIST to deduct credits from the Water Quality Bank as needed to meet further requirements.

<sup>1</sup> Maryland Stormwater Management and Erosion & Sediment Control Guidelines for State and Federal Projects; February 2015



# Circulation Framework

## CHAPTER 7

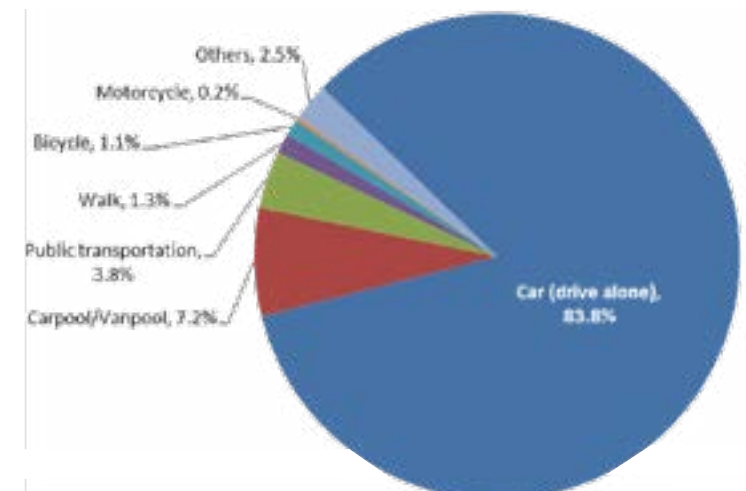
**T**HE Master Plan proposes both circulation and parking changes in conjunction with new construction and new security policies. The existing campus internal road network remains essentially the same, but there are modifications at three of the campus entrances. The following is a summary of the key circulation and parking changes in the Master Plan:

- The main campus entrance, Gate A, would be modified to support more rigorous visitor screening. Entrance from West Diamond Avenue remains the same, but new roadways, parking and a roundabout are introduced at the Visitor Center building.
- Gate F would be reconfigured for both commercial vehicle and visitor screening, with a new entrance from Muddy Branch Road to separate commercial vehicle traffic from passenger vehicles.
- The Planned Corridor Cities Transitway (CCT) would modify the campus entrances at Quince Orchard Road, moving Gate C south to align with the intersection of Quince Orchard Blvd. and incorporate a NIST CCT station.
- New research building construction would eliminate two major parking lots, which would be replaced by a parking structure.
- Pedestrian circulation would be improved by establishing an east-west pedestrian way, connecting discontinuous sidewalks, adding a walkway from the Visitors' Center, and creating a recreational trail.
- NIST plans to enhance their Transportation Demand Management policies to further encourage use of public transportation and bicycles, and reduce the use of single-occupancy vehicles.
- Bicycle connectivity within the campus is currently difficult to navigate, resulting in recommended changes to connect the exterior network with facilities within the campus, including proposed trails and additional infrastructure.

## Campus Access

A NIST employee survey was conducted in July and August 2016. This survey of only Federal employees elicited 1,042 responses, comprising 36 percent of the Federal staff, which was 25 percent of the full NIST employee population. The survey asked transportation-related questions, including mode to work, carpool participation, and knowledge of the Corridor Cities Transitway (CCT), a planned Bus Rapid Transit (BRT) line with a stop along the west gate at NIST. As seen in the chart below, 91 percent (760 of 835 respondents) responded that they commute to NIST by auto, including 7 percent who carpool. Distance to work is within 10 miles for 394 (47 percent) employees, with an additional 253 employees (30 percent) living 10-25 miles away.

**Exhibit 52: Modal split based on Survey Responses**



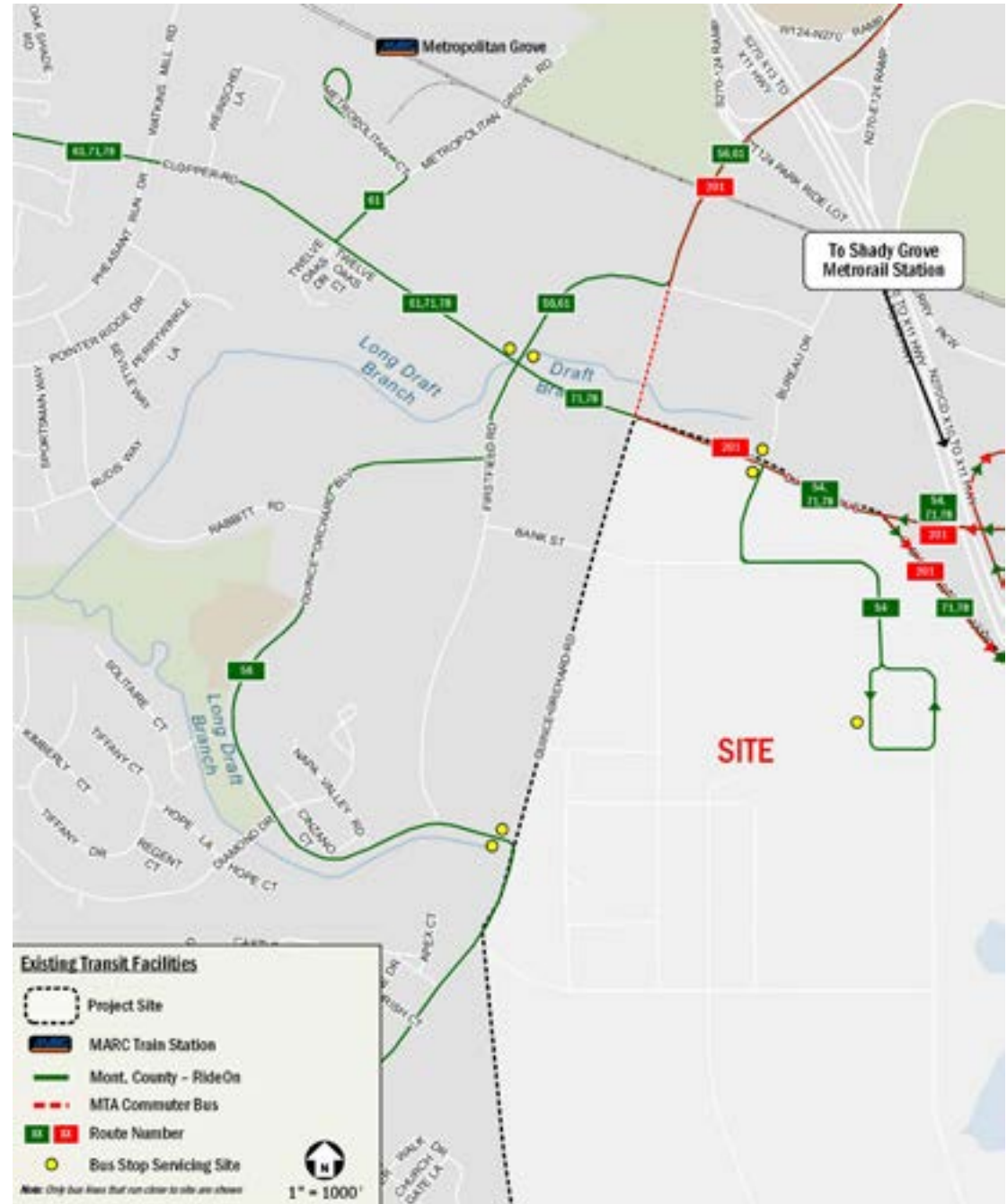
## Vehicular Access

Located in suburban Montgomery County, the campus is well-connected to regional roadways such as Clopper Road (MD-117), Quince Orchard Road (MD-124), Great Seneca Highway (MD-119), and Interstate 270, which connects to the Capital Beltway (I-495) that surrounds Washington, D.C. and its inner suburbs. All of these roadways bring vehicular traffic within one-half mile of the NIST campus. I-270, in particular is a major regional gateway connecting Gaithersburg to Frederick and I-70 to the north and I-370, Inter-County Connector, and the Capital Beltway to the south. High Occupancy Vehicle (HOV) restrictions are in place along I-270, with the southbound lanes restricted from 6-9 AM on weekday mornings. The northbound lanes are HOV-restrictive from 3:30-6:30 PM on weekday afternoons. Approaching on I-270 from the south, one exits at Clopper Road (exit 10, called West Diamond), and approaching from the north, one exits at Quince Orchard Road (exit 11). Both these exits are less than a mile from the NIST campus. As discussed in a later exhibit, Residential Zip Code Map for NIST Employees, an abundance of commuters near I-270 do not live near stations along the Frederick Branch of the MARC line, indicating that the opening of the CCT would likely not affect employees in these communities.

## Multi-Modal Transportation

The site is served directly by RideOn from Montgomery County and Maryland Transit Authority commuter bus. The site is serviced directly by RideOn and MTA Commuter Bus with multiple bus stops located adjacent to the site. These bus lines connect the site to many areas of the region, including the Shady Grove Metrorail station, Metropolitan Grove and Gaithersburg MARC stations, and BWI Airport. The project site is also served by shuttles for official visitors and employees to and from the Shady Grove Metrorail station as well as the Metropolitan Grove and Gaithersburg MARC stations. The existing transit facilities surrounding the site are shown in the accompanying exhibit.

Exhibit 53: Existing Transit Facilities





## RideOn

The site vicinity is currently served by the 56, 61, 71, and 78 RideOn bus routes with stops along West Diamond Avenue, Firstfield Road/Quince/Orchard Blvd. and Quince Orchard Road. These four RideOn routes service the site with 40 buses during the morning peak hour and 42 during the afternoon peak hour. Additionally, Building 101 on the NIST campus is served directly by the 54 route, which runs from Lakeforest Mall to the Rockville Metrorail Station. It services the campus with one bus in each direction during the morning and afternoon peak hours. As a security precaution, only NIST employees are allowed to alight at Building 101, and NIST security boards at Gate A to check the credentials of any passengers wishing to alight on-campus at Building 101. Outside of the peak hours, the route's nearest stop to the campus is just east of I-270 at West Diamond Avenue and Muddy Branch Road. The aforementioned NIST employee survey revealed out of the 82 respondents to choose public transportation, 13 (16 percent) utilized RideOn services.

## MTA Commuter Bus

The 201 route, serviced by MTA Commuter Bus, provides commuter service with points west and north, including the Shady Grove Metrorail station, Dorsey MARC station, and BWI Airport. The route services the site near the north gate, at the intersection of West Diamond Avenue and Bureau Drive. Hourly service is provided during weekdays, with travel times to BWI Airport MARC station of approximately 80 minutes. No respondents to the NIST commuter survey noted using this as a commuter option, although the route may receive some usage from NIST commuters given the proximity of its stop near campus.

## MARC

The closest MARC station to the NIST campus is the Metropolitan Grove station, which is located approximately one mile from the site on Metropolitan Grove Court, and the Gaithersburg Station, which is located approximately 1.5 miles from the site on South Summit Avenue. The Metropolitan Grove and Gaithersburg MARC stations are served by the Brunswick Line, which travels south from Martinsburg, West Virginia, through Washington County, Fredrick County, and Montgomery County and terminates at Union Station near the District core. Trains run approximately every 14 to 43 minutes

during the morning and afternoon peak hours. Of the 82 survey respondents who answered their choice of public transportation, 9 (11 percent) reported using MARC. To encourage use, NIST operates a shuttle that transports employees and registered visitors to and from the Metropolitan Grove and Gaithersburg MARC stations. The Metropolitan Grove shuttle operates on weekdays from 6:45 AM to 8:25 AM, with 5-25 minute headways during morning peak hour. The Gaithersburg shuttle operates on weekdays from 3:40 PM to 5:35 PM, with 25-45 minute headways during afternoon peak hour. The travel time on the shuttle is approximately 7-8 minutes from either station to NIST.

## Metrorail

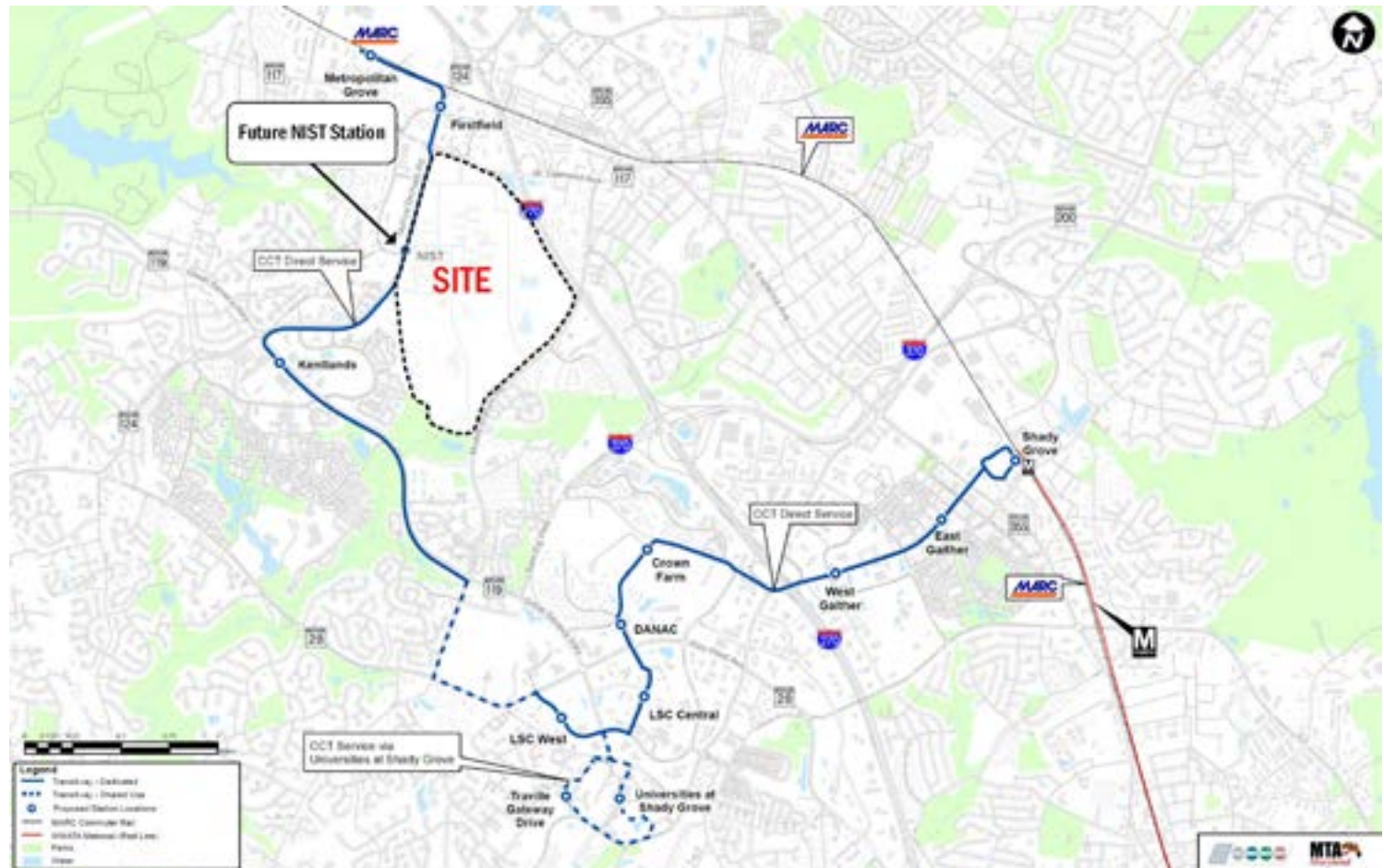
The nearest WMATA Metrorail station is Shady Grove, located approximately four miles southeast of the NIST campus. The station is the terminus for Red Line trains, which travel into southern Montgomery County and the District Core before returning to Montgomery County via Silver Spring, terminating at Glenmont. The Red line provides connections to all additional Metrorail lines, allowing access to much of the D.C. Metropolitan Area. Connections are available to the aforementioned 61, 71, and 78 RideOn routes, along with the 201 MTA Commuter route. Of the 82 employees who responded to the NIST survey question about public transportation choice, 60 answered Metro as their transit of choice (73 percent). To encourage use, NIST operates a shuttle, which transports employees and registered visitors to and from the Shady Grove Metrorail station. The shuttle operates on weekdays from 6:45 AM to 6:10 PM, with 30 minute headways. The travel time on the shuttle is approximately 15 minutes from Shady Grove to NIST.

## Corridor Cities Transitway

The Corridor Cities Transitway (CCT) is a planned 15-mile Bus Rapid Transit (BRT) line in Montgomery County. The CCT is expected ultimately to connect the COMSAT facility in Clarksburg, Maryland with the Shady Grove Metrorail station. Phase 1 of the project will link Shady Grove to the Metropolitan Grove MARC station, including a stop at the NIST Campus (along Quince Orchard Road) as well as the Universities at Shady Grove and residential areas such as King Farm (East Gaither), Crown Farm, and the Kentlands. Current plans call for the alignment to travel along Quince Orchard Road, with the NIST stop at the intersection of Quince Orchard

Road and Quince Orchard Boulevard, just west of the campus by Gate C. The route is shown on the following Exhibit. The planned headways for the CCT during its design year of 2035 is every 3.5 minutes during the morning and afternoon peak hours, with 6 minutes during weekday midday and 10 minutes during early morning, late nights, and all day on weekends. One-way travel between Shady Grove and Metropolitan Grove is expected to be 38 minutes. Although planned since 2000, funding for the CCT has been deferred to at least 2022, with actual completion unknown at this time. In the July and August 2016 NIST Employee survey, 773 out of 815 employees who responded (95 percent) stated that they did not expect to change

**Exhibit 54: Phase 1 Service for Future CCT Service**  
(Route as of Summer 2017)



their primary mode of commute to the NIST campus following the opening of the CCT.

## Exhibit 55: Existing Bicycle Facilities



## Regional Bicycle and Pedestrian Infrastructure

The NIST campus is accessible to nearby on-street bicycle facilities. Shared-use paths are present along Clopper Road/West Diamond Avenue, which provide east-west connectivity between the Metropolitan Grove MARC station and Gate A. At this time, there is no sidewalk on the east side of Quince Orchard Road along the campus. However, the State of Maryland has planned a new shared-use path for this location (see description below). A shared-use path to the south of the campus on Muddy Branch Road provides southern connectivity to the Great Seneca Highway, with bicycle access to areas northwest and southeast of the site. However within the campus, bicycle lanes are virtually non-existent. Bicyclists use a combination of on-campus roadways and sidewalks to navigate within the campus.

Pedestrian access to the campus uses sidewalks that connect Gates A, B and F with the neighboring streets, West Diamond Avenue, Quince Orchard Road and Muddy Branch Road, respectively. Within the campus, pedestrian facilities consist of asphalt and concrete sidewalks, which connect most of the campus facilities, but some areas lack pedestrian connectivity, or have disjointed walks flipping from one side of the street to the other.

Roadway standards that allow bicycles generally are in compliance with City of Gaithersburg and Montgomery County DOT (MCDOT) standards, including an allowance in minimum width standards, allowing for 11-12 foot lane widths for two-lane roadways.

Standards for pedestrian facilities are based on those of MCDOT and State Highway Administration (SHA). Based on these standards, some sidewalks and curb ramps would meet these criteria, but many locations would not. In particular, the asphalt sidewalks that are located throughout campus would not meet pavement material standards. Similarly, some curb ramps would not meet curb ramp standards. That being said, many of the concrete sidewalks throughout campus would meet MCDOT and SHA standards of width, pavement materials, and spacing from the street. NIST has undertaken a phased sidewalk improvement program where the existing asphalt sidewalks are being replaced, and new walks are being installed to complete needed connections.

### Future Bicycle Connectivity

Two community bicycle/pedestrian trails are proposed, which would provide additional access to and from the NIST campus:

- The Quince Orchard Road shared-use path would be an extension of the existing hiker/biker trail along the east side of Quince Orchard Road that currently terminates approximately one quarter mile south of Gate D to the West Diamond Avenue intersection. This trail would provide much needed pedestrian and bicycle connections and crossings adjacent to the campus on the east side of Quince Orchard Road that could be used by NIST staff to more safely access the campus, particularly at Gate C. Construction is planned for 2018.
- The Muddy Branch Trail is an initiative by the City of Gaithersburg that would provide a hiker/biker trail along the eastern edge of the NIST campus between the campus fence and the Interstate 270 right of way. The trail would provide a connection between West Diamond Avenue and Muddy Branch Road and would require some relocation of NIST fence lines.

Although 1% of respondents from the survey selected bicycle as their primary mode of travel to and from the campus, it is recommended that more bicycle racks, of the “U-shape” style be installed around the campus in order to encourage bicycle use.

### Gate A Visitor Entrance and Screening

Located off of West Diamond Avenue and providing close access to I-270, Gate A is the main entrance to the NIST campus. The gate is the only entrance that visitors must use when entering the campus, with other gates available for NIST staff, conference attendees, and commercial vehicle deliveries.

The security measures at Gate A consist of a guard booth with canopy, through which all vehicles, buses, and pedestrians pass to enter, and a Visitor Center building where identification is checked by security and visitor badges are issued. Visitors park in an adjacent lot and then enter the Visitor Center to obtain an identification badge before returning to their car and presenting their badges to security at the guard booth. All persons, including visitors and NIST staff must show their badges to security at the guard booth before proceeding into the campus.

As the number of NIST Campus employees and visitors increases over the next 20 years, the current security measures will need to adapt to meet growing demand, as well as required security procedures. In a separate study, a consultant team explored potential gate improvements. NIST, with the Department of Commerce Office of Security, selected a preferred option.

With the preferred option, the approach from West Diamond Avenue will remain the same, as vehicles continue to use the traffic signal to enter Bureau Drive and access the gate. The Visitor Center will undergo expansion to accommodate additional and enhanced screening while improving traffic flow during peak periods. On approach to the guard station and parking lot, license plate recognition (LPR) systems will be placed along Bureau Drive to facilitate identification checks. The existing parking lot for visitors to enter the Visitor Center will be relocated further west, allowing construction of a loop road that will direct visitors from Bureau Drive to the inspection station. To reduce the potential of vehicle backup on Bureau Drive into West Diamond Avenue, this loop has been designed to accommodate 30 vehicles in a queue. The expanded Visitor Center will include a new canopy to extend over the vehicle inspection lanes. Three lanes will be provided, with the outside two lanes intended for inspection and the center lane for bypass, allowing vehicles to be screened simultaneously as physical security officers are verifying the identification badges of all persons in each vehicle.

The relocated parking lot will contain 25 spaces, six more than the 19 at the present lot. This lot will remain outside of the security perimeter, allowing visitors the choice of parking their car, walking into the Visitor Center for credentials, and entering the secure area via shuttle or by foot. The 25 spaces proposed is considered sufficient as current parking demands do not appear to surpass 20 vehicles at any given time.

The existing guard booth will remain to check credentials for staff and visitors exiting the vehicle screening area. Two gates at the guard booth will be operational throughout the day, reducing queuing along southbound Bureau Drive and allowing for two 500 foot lanes (approximately 50 cars) for stacking, preventing spillback onto West Diamond Avenue. The islands at the gates will be widened with each lane narrowed to slow vehicles down and allow security personnel to perform thorough inspections safely.

Within the secure area, a roundabout is proposed at the

intersection of Bureau Drive and North Drive. Currently, the distance from the gate to the intersection is inadequate for a safe merging of vehicles and cross-traffic on North Drive does not stop. The roundabout is proposed to be either a one-lane or two-lane type, depending on additional analysis. A gate arm is also a possibility, allowing for better metering of vehicles entering the roundabout from the guard booth.

A bus pullout bay is proposed for the NIST Metro and MARC shuttles on southbound Bureau Drive between the visitor loop road entrance and guard booth. As this area may become congested during the morning peak hour, the buses can alternatively utilize the loop road and center bypass inspection lane to allow for pick-up and drop-off operations. Additionally, a shuttle stop is proposed within the secured area on North Drive, with services to be provided by either a reestablished on-campus route or the existing Metro and MARC shuttles to Building 101.

The advantages to the circulation upgrades include better mitigation against growing traffic projections for the NIST Campus. If the proposed operations remain unchanged and visitor

vehicles increase, the new parking lot can be expanded to the west, allowing additional capacity. Safety operations will also improve, with more efficient inspection tools to expedite and process the security screening. The inclusion of a bus bay may encourage more visitors and staff to utilize non-auto modes and reducing vehicle emissions. The installation of a roundabout, reducing potential conflicts between vehicles traveling at speed on North Drive and vehicles entering the NIST campus from the guard booth. The implementation will be made in phases, with the existing Visitor Center and guard booth to remain operational during the upgrades. All work will be performed within the NIST Campus, avoiding any modifications made on public roads, such as West Diamond Avenue.

Implementation will require regrading at the roundabout and modification of adjacent landscape and hardscape. A pedestrian connection to the planned Research Building I will be incorporated when Research Building I is constructed. Phased construction must be planned to minimize disruption to Gate A screening operations.

**Exhibit 56: Existing Gate A Conditions**



December 2017 Google Earth/Google Maps

**Exhibit 57: Recommended Gate A Improvements**



## Gate F Entrance and Screening

The Master Plan includes relocation of the primary commercial vehicle access to the campus from Gate C to Gate F. It also includes development of a screening facility for visitors at Gate F.

At present, Gate C does not have the infrastructure or space to appropriately screen commercial vehicles before they access the campus. Screening is conducted at Building 301. With the implementation of the CCT, and relocation of Gate C, there will be even less room for installing commercial vehicle screening infrastructure at the gate. Gate F is located at the southeast end of the NIST campus, accessible from the intersection of Muddy Branch Road and East Drive. Today it is used by staff, conference attendees and occasional deliveries. A security kiosk is present to check each vehicle's occupants for proper identification. Currently there is no true turnaround for vehicles which

have been denied entry into the campus. Although a bypass lane exists for turn-arounds, vehicles may need to make multi-point turns in order to turn around.

NIST selected the Gate F Master Plan approach from several concepts. Commercial vehicles and service vehicles will use a new driveway entrance west of the existing East Drive. The new driveway will be enter-only for commercial delivery vehicles, where screening and inspection will be conducted upon entering the campus. Beyond the screening and inspection facility, will be an exit/rejection lane back to East Drive and Muddy Branch Road and an entrance to a dedicated shipping/receiving building. This new building will enable transfer of deliveries to NIST vehicles within the secure area, which will then transport the materials to their campus destinations. Following the delivery of goods at the shipping/receiving center, commercial vehicles may exit the facility to Muddy Branch Road. Construction

**Exhibit 58: Existing Gate F Conditions**



December 2017 Google Earth/Google Maps

**Exhibit 59: Gate F Improvements**



and specialty vehicles will be able to proceed through the gate and onto the campus after inspection.

While the security kiosk will remain in this option, a visitor processing center similar to the one at Gate A will be built along the east side of East Drive prior to the kiosk. With this new Visitor Center, NIST will have improved capabilities for screening conference attendees as well as flexibility for admission and screening of other visitors. A parking lot will also be built to the east of the processing center. All screened vehicles will continue to the security kiosk for a final check, along with NIST staff vehicles.

The advantages of expanding the Gate F capabilities include a separate and secure entry for commercial vehicle deliveries, which will help reduce potential queuing along East Drive and reduce potential conflicts between commercial vehicles

and passenger vehicles. Additionally, with the construction of the shipping/receiving center, commercial vehicles can quickly transport their goods and then return to Muddy Branch Road without entering the campus. The addition of the Visitor Center allows a separate screening facility for all visitors at this gate, providing NIST with additional security capability and flexibility.

Changes will require review and permits from regulatory agencies to install an additional curb cut west of Gate F for the commercial vehicle delivery entrance. Roadwork would be needed in this otherwise undeveloped area and some grading will be required along East Drive. Although many commercial vehicles make regular deliveries, signage will be important, to direct them to the appropriate entry.

**Exhibit 60: Commercial vehicle Access to the NIST Campus Gate F**



## Parking

The NIST campus currently provides 3,704 total parking spaces. Of these, 229 spaces are reserved for service vehicles and 3,475 are open for employees<sup>1</sup> and visitors.

In addition to employee and NIST vehicle parking, there are other daily parking demands:

- *Conference Attendees.* In 2016 there were 77 conferences, with a total attendance of 7,577 people. The largest conference had 654 attendees. NIST intends to expand their conference center facilities as part of their research and education mission, which is expected to support more conferences.
- *Other Visitors.* Each day, researchers, business visitors and others come to campus. In a survey related to Gate A improvements, there were 254 visitors on a typical day in December 2016. Between 2012 and 2016, NIST had an average of 33,025 visits (based on visitor badges issued), that

<sup>1</sup> "Employee" refers to both NIST federal staff and non-federal staff who are stationed at NIST.

For large conferences, attendees also park on the grass by Building 101.



translates to about 250 visits a day (not including weekends and holidays).

- *Temporary/Drop-off.* Two buildings have temporary parking spots. The Child Care center has 12-15 spots for parents dropping off their children, and the Visitor Center has 19 temporary spots for visitors picking up credentials.
- *Internal Trips.* Several laboratory buildings have few or no assigned employees, particularly those in the southern campus zone. Parking is provided for employees working in other buildings who come to monitor research.

Current parking demands on the NIST campus on an average day, including service vehicles and visitors, are close to a parking ratio of two spaces for every three people (0.67 spaces per person or 2,672 spaces). Vehicular data was collected on an average weekday, April 27, 2016, which quantified the amount of people, vehicles, and parking spaces on the campus. As seen below, a total of 2,621 out of the 3,704 total available parking spaces were occupied (or a demand of 0.65 vehicles per employee) during the peak occupancy at 10AM. When reduced to exclude service vehicles, a total of 2,411 employee and visitor parking spaces were occupied (or a demand of 0.60 vehicles per employee).

### Exhibit 61: Comparison of Vehicle Parking on Conference Days

Day of Collection	Average Day (April 27, 2016)	Conference Day (April 14, 2016)
Total Vehicles	2,621	3,011
Employee/Visitor Vehicles	2,411	2,797
Total Spaces	3,704	3,704
Employee/Visitor Spaces	3,475	3,475

NIST hosts conferences throughout the year, bringing in official visitors in addition to employees and daily visitors. On these days, the parking lots on campus operate closer to capacity. Data was collected on a conference day, April 14, 2016, and compared with the April 27, 2016 data to observe the difference in parking. There were an additional 380 vehicles in the campus when compared to the data from April 27 (3,011 vehicles vs. 2,621). This amounts to a 0.75 vehicle per employee ratio and a 10% increase in parking demand on campus. When reduced to exclude service vehicles, a total of 2,797 employee and visitor parking spaces were occupied (or a demand of 0.70 vehicles per employee).

During these large conferences, parking on the grassy areas closer to the conference center is often observed.



## Future Parking Demand

The projected employee population for the Master Plan is 5,106 – which is a 27.4% increase over the 20 year horizon of the Master Plan. Over this period, NIST intends to achieve a 1:2 parking ratio for federal employees, in keeping with the National Capital Planning Commission (NCPCC) parking ratio guidelines. These guidelines suggest parking ratios between 1:1.5 to 1:2 for Federal facilities such as NIST that are located in suburban areas beyond 2,000 feet of Metrorail. The parking ratio, however, applies only to federal employees and not service vehicles, visitors, conference attendees, and non federal employees such as associates and guest researchers. Accounting for parking for non-Federal employees, visitors, conference attendees, and service vehicles, it is projected that the campus will require an additional 275 parking spaces.

The Plan assumes that visitors and conference attendees would increase at the same rate as employees. However, it is also assumed that there may be marginal improvements in their parking demands (0.90 space per visitor to 0.85 space per visitor). Per capita parking demand for non-Federal employees are also estimated to decrease to 0.60 spaces per employee.

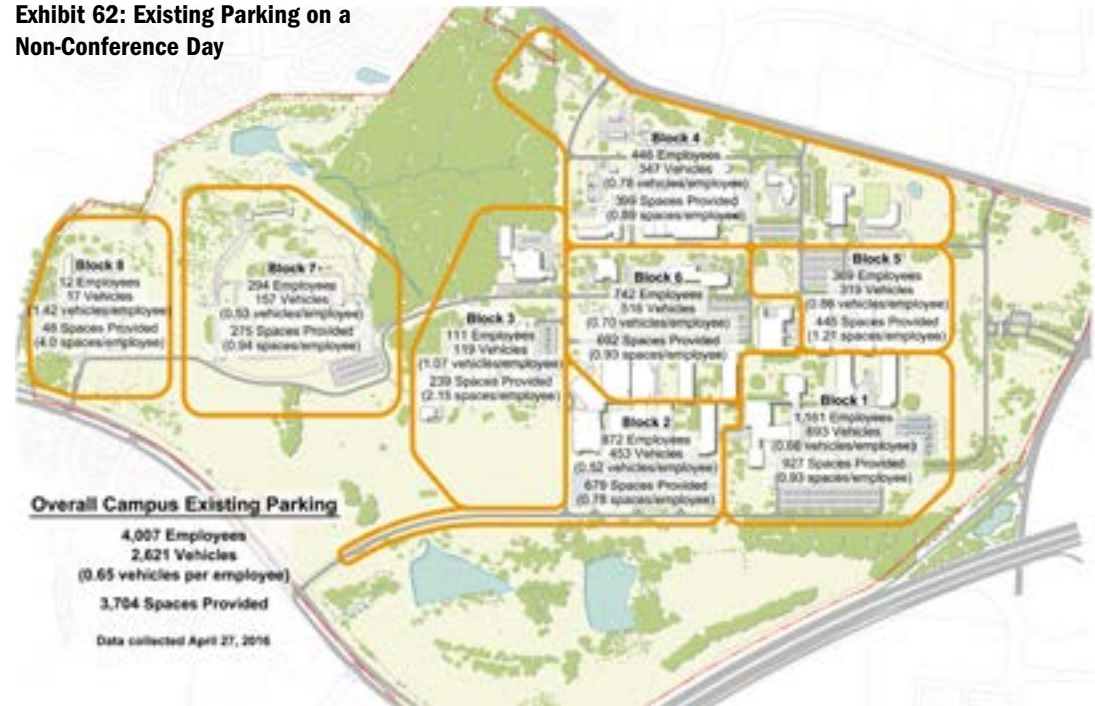
It is anticipated that densification of the campus core and improvement in pedestrian connections will significantly reduce in-campus trips and demand for incidental parking for employees traveling between the buildings. The parking projections did not include any such parking.

A detailed study was conducted to understand parking demand and strategies to reduce single occupancy vehicle use by federal employees and investigate the potential for reducing on campus parking.

NIST federal employees' home zip code data was examined to understand commuter patterns for the metropolitan area. Over 99% of NIST employees reside within 250 miles of the NIST Campus. Of these employees, the average commuting distance was found to be approximately 19 miles.

A Regional ZIP Code map highlights each ZIP code where employees reside, with darker shades indicating a higher number of employees. Overlaid with this data are the regional heavy rail lines, including the Brunswick MARC line and the six Metrorail lines. As can be seen from the figure, areas well served with public transit show few areas of high employee

**Exhibit 62: Existing Parking on a Non-Conference Day**



**Exhibit 63: Existing Parking on a Conference Day**



**Exhibit 64: Travel Times from Major Stations to NIST Campus**

Station	Via MARC to Metropolitan Grove & NIST Shuttle*	Via Washington Metro to Shady Grove & NIST Shuttle**	Via Future Corridor Cities Transitway	Via Auto (time during peak hour)***
Metropolitan Grove	7 minutes	–	5 minutes	5–10 minutes
Shady Grove	–	15 minutes	33 minutes	9–20 minutes
Union Station	46 minutes	57 minutes	44–75 minutes	40–60 minutes
Silver Spring	34 minutes	72 minutes	32–90 minutes	25–40 minutes
Rockville	12 minutes	19 minutes	10–37 minutes	15–30 minutes
Germantown	14 minutes	–	12 minutes	12–25 minutes
Tysons Corner	–	84 minutes	102 minutes	25–40 minutes
Gallery Place-Chinatown	–	56 minutes	74 minutes	35–50 minutes
Frederick	54 minutes	–	52 minutes	30–60 minutes
Harpers Ferry	56 minutes	–	54 minutes	50–85 minutes

\*Shuttle from Metropolitan Grove is approximately 7 minutes  
 \*\*Shuttle from Shady Grove is approximately 15 minutes  
 \*\*\*Driving time from Google Maps  
 Travel Times do not include dwell time for transfer to shuttle

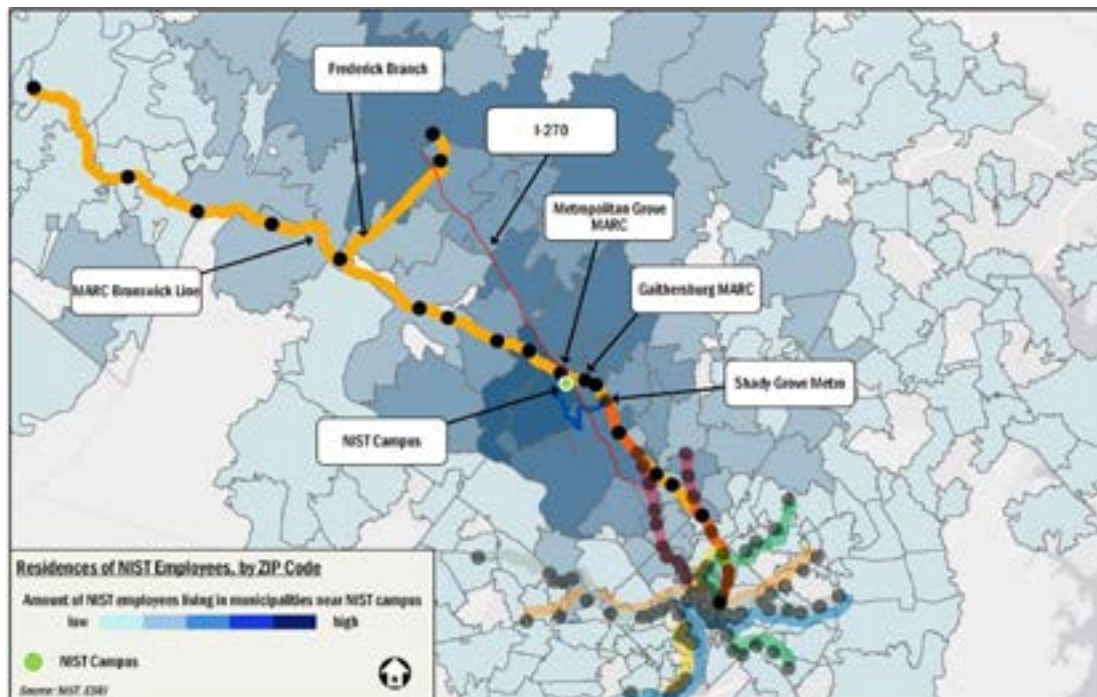
population, with the exception of areas along the Red Line and Brunswick Line in Montgomery County and Northwest, DC. Areas north and east of Frederick County contain communities where over 40 employees reside. Based on the distance from these municipalities to the Frederick Branch of the MARC Brunswick line, it is unlikely that these employees would be utilizing transit in the future if they aren't already doing so, because of the length of commute.

Census data was used to supplement the employee residence data to further refine employee commuting patterns. Utilizing the Census Transportation Planning Products Data (CTPP), of the 4,469 people who commuted to the site's Traffic Analysis Zone (TAZ), approximately 97 percent of people drove to the TAZ, compared with 2 percent by bus and 1 percent by rail. It should be noted that the TAZ and ZIP code percentages are optimistically conservative given the large amount of suburban ZIP codes. Although this may shift some with the introduction of the CCT, in reality, the number of employees with direct access to transit is likely much lower than currently reported.

Using the site's Traffic Analysis Zone (TAZ) and Census Tract, it was determined that approximately 85 to 90 percent of those within the site area commuted home by auto, with only 7 percent utilizing a form of transit (MARC, Metrorail, RideOn). If all vehicles recorded on April 27, 2016 were counted as driven by single-occupancy employees, then approximately 65 percent of all employees at NIST would use single-occupancy vehicles.

A table following presents a list of one-way travel times for selected destinations by public transit and auto to NIST. The time includes the shuttle from Shady Grove or Metropolitan Grove stations, but does not include wait time, which would increase travel times. Note that the CCT would likely decrease travel times compared to the NIST shuttle from Metropolitan Grove; however, the effect is opposite when traveling from Shady Grove. The first phase of the CCT anticipates travel times between Metropolitan Grove and Shady Grove of 38 minutes, and time to NIST approximately 33 minutes from Shady Grove and 5 minutes from Metropolitan Grove. It is unlikely that employees who live in these areas would utilize this new public transit option, compared to driving times or the NIST shuttle from Shady Grove.

**Exhibit 65: Residential Zip Code Map for NIST Employees**



**Exhibit 66: Campus Parking Projections**

	Current			Projected—20-Year Timeframe			Source/Remarks
	Personnel	Parking Spaces	Ratio	Personnel	Parking Needs	Ratio	
Total Parking Spaces		3,704			3,979		Existing: Parking Survey results
<b>SERVICE &amp; OTHER PARKING</b>							
Service Vehicle Parking		229			263		Existing: Parking Survey for current; Projected: Assume 15% increase over 20 years
Child Care Center		15			15		Assumed to remain unchanged
Gate A, Visitor Center		19			25		Assumed to increase 30% because of additional security requirements
Gate F, Visitor Center		–			35		Estimated as part of enhanced security and introduction of visitor screening
Average Day Visitors: @0.90 space/visitor at present; 0.85 in the future	254	229		324	275		Existing Visitor Counts: NIST Gate Study; Projected Counts: Prorated increase in visitors
Conference Attendees: @0.90 space/visitor at present; 0.85 in the future	600	540		765	650		Existing: Attendees for larger conferences; Projected: Prorated increase in attendees
Total Service & Other		1,032			1,263		
Parking Remaining for Employees		2,672			2,716		
Total Parking for Employees	4,007	2,672		5,106	2,716		Master Plan Program projects a 27.4% growth
Parking for non-Federal Employees*	1,280	854		1,631	979		Existing spaces: Prorated from total Projected: Assumed 0.6 spaces per employee
Parking Spaces for Federal Employees	2,727	1,819		3,475	1,737		Existing spaces: Prorated from total Projected: Assumed 0.5 spaces per employee
Parking Spaces per Federal Employee			0.67			0.50	Ratio of spaces per employee
<b>Parking Spaces added over 20 Years</b>					<b>275</b>		

\* Percentage of Non-Federal and Federal employees are assumed to remain unchanged

**Exhibit 67: Parking Provided in the Master Plan**

	Location	Spaces	Spaces Lost in MP
Block 1	Buildings 225, 227, 101 Lots	927	
Block 2	Buildings 220, 222, 216 Lots	679	94
Block 3	Buildings 202, 203, 207, 245 Lots	239	
Block 4	Buildings 301, 302, 309, 318, 233, 320 Lots	399	
Block 5	Buildings 224, 226 Lots	445	
Block 6	Buildings 217, 221, 223, 230, 231, 304, 411 Lots	692	443
Block 7	Buildings 235, 237 Lots	275	
Block 8	Building 205, 206, 236 Lots	48	
<b>Total Spaces</b>		<b>3,704</b>	537
Additional Spaces needed for growth			275
<b>Total Projected Need accounting for lost parking</b>			<b>812</b>
<b>Parking Provided in Master Plan</b>			
Garage: 4 Levels @ 180 each			720
Additional parking in lot north of 411 (3 rows @ 28 each)			84
<b>TOTAL PROVIDED</b>			<b>804</b>

**Master Plan Parking Approach**

The projected parking needs on the NIST campus over the 20-year Master Plan horizon is estimated to increase by 275 spaces, assuming a target ratio of 1:2 for federal employees. Analysis of the commuting patterns, campus location and availability of current and future public transportation did not project a significant demand decrease. A rigorous Transportation Demand Management program may, in the short run, have an effect in reducing parking demand and make headways in achieving the Master Plan targets.

On-campus parking will be provided in existing surface parking lots and a proposed parking structure associated with new research building construction. The Master Plan adds parking gradually, and will adjust the numbers as future demand requires. Phases one and two construction would add no parking spaces to the current inventory. Future research building construction in the campus core would be on existing parking lots south of Building 304. Parking would then be replaced in a

new parking structure adjacent to the new research buildings.

It is estimated that about 537 spaces would be removed to construct the new research buildings. Increase in campus population and other parking demand requires a net of 275 parking spaces. Overall, 812 parking spaces are required to make up for the loss in existing parking and additional parking demand. Current estimates call for a parking structure of 720 spaces on four levels, with an additional 84 spaces are to be provided in the surface parking lot located north of building 411. Electric vehicle charging stations will be included in the parking structure, in accordance with government regulations. The need and capacity of the parking structure will be re-evaluated when Research Buildings II, III and IV are designed.

Current Transportation Demand Management (TDM) elements as well as the implementation of recommended TDM elements will ensure that the campus maintains parking demands at or below those currently seen with future growth of the campus, regardless of the construction of the CCT.

There are several other factors that can potentially reduce future parking demand on the campus: Improvement in the public transportation infrastructure; innovations in autonomous vehicles; enhancement of bike infrastructure around the campus; and, demographic change in NIST's employee population resulting in a significant reduction of non-single-occupancy-vehicle users. Future updates to this Master Plan will need to reevaluate the parking demands as such changes occur.

**Transportation Demand Management**

Transportation Demand Management (TDM) is the application of policies and strategies to reduce travel demand or to redistribute demand to other times, spaces, or modes. TDM typically focuses on reducing the demand of single-occupancy, private vehicles during peak period travel times or on shifting single-occupancy vehicular demand to off-peak periods or other modes of transportation.

TDM strategies fall within four categories: improving transportation options, providing incentives, managing regional land use, and implementing traffic policies and programs. For NIST, improving transportation options might include transit improvements, non-motorized improvements (bicycle and pedestrian), rideshare programs, car sharing, and telework and

flextime options. These would benefit the campus with less pollution, better land use and reduction of impermeable surfaces, as well as broad benefits for the community at large.

NIST already implements elements of a TDM program to reduce single-occupancy vehicles on campus and encourage public transportation.

- **MARC/Metrorail Shuttles:** NIST operates shuttles from the campus to and from the Shady Grove Metrorail station and the Metropolitan Grove and Gaithersburg MARC stations. The shuttles operate roughly every 15-30 minutes with service in the morning and afternoon commuter peak hour. The travel time on each shuttle is 7 minutes to Metropolitan Grove and 15 minutes to Shady Grove. In the NIST employee survey, 199 out of 835 respondents (24 percent) stated they used the NIST shuttles to either station, with 19 percent reporting they used the shuttle to Shady Grove.
- **Telework:** NIST allows its employees the option of telecommuting, reducing the amount of single-occupant vehicles. In data provided to Gorove/Slade by NIST, out of 3,994 staff, 541 employees telework at least once a week, representing 14 percent of the workforce. Within that group, 24 employees teleworked three to five days a week, representing one percent of the workforce. Teleworking allows NIST employees to work from home or at a satellite work location, known as telecenters. However, the type of work by most NIST employees (research and lab activities) requires the employee to be present on campus and work atypical work hours.
- **Transit Subsidy:** NIST offers its employees enrollment in the Federal Workforce Transportation Subsidy program, where participants receive a monthly subsidy in the form of SmartBenefit voucher or value stored on a SmartTrip card. The program is available for employees who use rail, bus, or vanpool to commute. However, this subsidy is not available to Associates, the non-Federal employees that make up almost 30% of NIST staff.
- **Alternative work schedule:** NIST offers its employees alternative work schedules in addition to the traditional 8:30-5:00 working hours. With supervisory approval, employees can select a work schedule that includes working four 10-hour days or working eight 9-hour days and one 8-hour day, with one day off every two weeks. Like telework, research demands often dictate work schedules.

## Recommended TDM Elements

Developing a more robust TDM Plan for the NIST campus following the opening of CCT should expand on the current measures employed to make the campus accessible, multi-modal, and efficient. The following is a summary of recommendations that could improve multi-modal usage among NIST employees, thereby contributing to the reduction in parking demand on campus. Note that NIST is bound by Federal policies and practices that may limit management elements and incentives.

- Identify a TDM Coordinator for the campus and develop a multi-year plan.
- Provide a shuttle interior to the campus to facilitate employee and visitor movement throughout the campus without the use of personal vehicles. In the past, NIST did operate such a service but financial realities forced its elimination.
- Improve bicycle access opportunities. It would include additional secured bicycle parking/storage facilities with convenient shower and changing facilities. This approach must be coupled with improved bicycle trails in the community around the campus, such as the planned Quince Orchard Road Hiker/Biker Trail. NIST staff members have stated that they would ride to campus if there were convenient, safe access.
- Identify (and fund if necessary) locations for potential Capitol Bikeshare expansion both on campus and at the Visitor Center as the service expands further into Montgomery County past the current limits near Key West Avenue, within two miles of the NIST campus. Provide an on-campus bikeshare service for employees, if Federal policy permits.
- Require employees that drive to obtain/purchase parking permits to park on campus. These permits should designate a parking lot or area in which the vehicle is allowed to park.
- Provide reserved spaces for carpools and vanpools that are conveniently located near key campus buildings. Oversee a program to encourage carpools and vanpools. Dedicate spaces in the lots for car sharing services to use.
- Install a transportation information screen in the lobby of Building 101 and/or other employee-frequented locations to show real-time information regarding buses that serve the campus directly, interior campus shuttle, shuttles to MARC/Metrorail, and other multimodal transportation options that serve the campus.



# Utility Infrastructure

## CHAPTER 8

**T**HE Steam and Chilled Water Generation Plant, Building 302, provides chilled water, steam and compressed air to the general and special purpose laboratories, the Administration building and many of the support buildings. Service is distributed through a network of direct buried piping. Most of the major equipment and piping systems in the Plant are in good condition with several years of useful life. The steam and condensate distribution piping has been replaced. Other piping systems are reported to be in generally good condition, but they are more than 50 years old, like the original buildings, and approaching the end of their useful life. As a result, failures are occurring with increasing frequency. Phased replacement of many systems is expected to result after detailed evaluation and the development of a detailed plan. The Master Plan projects will require enhancements to the chiller plant capacity and electrical sub-station capacity to support the mid-to-late Master Plan construction.

### **Mechanical, Electrical and Piping Systems**

The implementation sequence for mechanical electrical and piping utilities generally will follow the phasing detailed in the Implementation Planning chapter. Based on the projected loads for each phase, the expanded chiller plant and the expanded electrical capacity projects will be required late in the Phase 2 or early in Phase 3, to support Phase 3 projects.

#### **Existing Utility Framework**

The Steam and Chilled Water Generation Plant provides chilled water, steam and compressed air to most of NIST's campus buildings, distributed through underground piping system from the Plant via a loop main serving the north buildings (north of South Drive) and a single main serving the south buildings

(south of South Drive). As noted in the existing conditions report, the chiller plant has a firm capacity of 21,000 tons (with N+1 redundancy), boiler plant has a firm capacity of 251,000 PPH (with Boiler 5 out of service and Boiler 6 removed as currently planned by the CHP project) when natural gas is available and 160,000 PPH when natural gas is curtailed. The compressed air system has a firm capacity of 2,100 scfm (with N+1 redundancy). Chilled water and steam piping systems are in generally good condition, and will be extended to most of the new and renovated buildings in the Master Plan. Because of the loop arrangement, the north buildings have an inherently robust utility service. The arrangement allows for isolation of sections of the piping system without significantly interrupting service to large groups of buildings. The south buildings on the other hand are served by a single main that does not provide the same level of utility availability. A disruption or maintenance shutdown of the main piping can result in utility interruption to several of the special purpose labs. Based on demand and capacity assessment, NIST personnel believe that the compressed air piping distribution system has significant line losses.

The campus is served by 13.8 kV power feeders originating from the switching station coupled with PEPCO sub-station via underground duct banks. As noted in the Campus Utility Infrastructure section, the maximum available capacity of the existing 2,000A switchgear is approximately 48 MVA (based on 80% of switchgear rating). NIST personnel have noted that many of the existing duct bank spare ducts may have failed and may not be usable for future feeder/cable installation.

Construction of a new electrical switching station is a Master Plan priority, for the orderly and safe replacement of the aging switchgear, feeders and failing ductbanks. The building should be sized for the capacity expansion in Phase 3 construction.

## Utility System Capacity and Distribution Analysis to Support Master Plan

A conceptual load analysis was performed to assess the capacity of the existing campus utility systems to support the Master Plan growth. Key findings and recommendations resulting from the analysis are as follows:

- Firm capacity of the existing chilled water system will be exceeded at the conclusion of Phase 2. It is recommended that the existing chiller plant be expanded to the north-west for the addition of two 3,500-ton chillers prior to Phase 3. During the same time an additional piping main should be installed from the plant to the distribution system to increase the chilled water flow capacity out of the plant (currently limited by the single 36-inch supply main).
- NIST is currently working with the State of Maryland MDE to retain Boiler 6 in place. If Boiler 6 is allowed to remain in place, N+1 redundancy can be maintained for either natural gas or oil firing while supporting full master plan growth. If Boiler 6 is removed, NIST should begin the permit and approval process for the installation of a new 80,000 PPH dual fuel boiler to replace Boiler 6 early in Phase 1 of master plan implementation. This will be necessary to meet Phase 1 steam demand of the Master Plan.
- Similar to the chilled water system, the primary electrical switchgear/sub-station will exceed its firm capacity during Phase 3. The switching station constructed in Phase 1 should be planned to allow the switchgear capacity to be augmented at or before Phase 3. Replacement of aging ductbank system should be part of Phase 1, because it is partially collapsed and partly glued up by old cable lubricant and needs to be replaced.
- The compressed air generation system capacity is anticipated to be adequate to support the Master Plan growth. However, because of detected losses in the piping distribution system, NIST plans to move towards supplying compressed air locally where needed as buildings are renovated and new research facilities constructed.
- A second chilled water and steam supply main should be installed to serve the south campus buildings. The piping should be routed along the east side of Building 245 complex and connected back to the existing main near Building 235 to create a loop and improved reliability.
- A new chilled water main should be installed in the

north-west portion of the campus to serve new Research Building I and create a loop for enhanced service reliability to the group of five northernmost GPLs.

## Relocations

The following utility relocation projects should be undertaken as part of the Master Plan implementation. Each of these relocation projects can be coordinated with the specific new building construction that warrants the relocation. In general, the relocation should be completed as an enabling project prior to beginning construction of the main building.

- Prior to beginning construction of the new laboratory buildings in the central quad, existing underground steam/condensate piping and the electrical ductbank should be relocated outside the footprint of the new buildings.
- Prior to beginning construction of the AML addition, the underground electrical ductbank should be relocated outside the footprint of the addition.

## New Research Building I

The new Research Building I north of Building 226 should be provided with steam and chilled water service from the Steam and Chilled Water Generation Plant and campus distribution system. Adequately sized main piping is located close to the proposed location of the new GPL. Normal electrical power and data communication services should be extended from the campus distribution system. Standby power should be provided via local dedicated diesel generators. Primary mechanical, electrical and plumbing equipment should be sized and arranged with redundancy such that if any major equipment fails or is out of service, the remaining equipment can support the laboratory demands without compromising function. Modular layout and distribution should account for long term flexibility allowing easy accommodation of changes in use within the same laboratory types. Laboratories should be zoned for energy and operational efficiency such that lighter duty labs that may use recirculating air systems are grouped together. Similarly, chemical and fume hood intensive laboratories requiring 100% outside air systems should be zoned together. Hybrid air/water cooling systems (such as chilled beams) should be considered for equipment and instrument intensive laboratories. Special attention should be provided in the electrical distribution system with regard to power quality. Piped utilities such as compressed air, vacuum, high



purity water distribution should generally follow the modular arrangement to maximize flexibility. Special laboratory gases may be provided by local sources such as generators or cylinders with local distribution.

### General Purpose Laboratory Modernizations

As part of the Master Plan, all GPLs except Building 227, will be fully renovated. Buildings 221, 222 and 226 will also include office additions at their respective ends. The primary utility services for the GPL modernization will continue to be from the campus Steam and Chilled Water Generation Plant and the main distribution system. Utility services are adequately sized to meet the anticipated loads after modernization.

All major equipment and distribution systems should be replaced as part of the GPL modernization. This will include chilled water system, steam system, hot water system, humidification system, process cooling system, supply and exhaust air systems, control system (BAS), normal and standby power systems, lighting system, fire alarm system, lightning protection system, information technology systems, security systems, domestic and laboratory water systems, laboratory pure water system, compressed air, gas and vacuum systems, waste and vent systems and fire suppression system.

Supply air system should be 100% outside air and 100% exhaust for lab spaces. Office area supply air can be either transferred into labs for space pressurization or returned to the air handling units. The amount of transfer and return air should be determined based on specific program requirements. Non-lab spaces and a portion of the lab spaces should use local cooling devices (chilled beams, fan coils, etc.) to reduce the primary air flow of systems to code minimums. All duct mains and air terminals should be located in the attic space or other established utility space for ease of maintenance. Individual distribution ducts should route from the attic/utility space to each temperature/lab control zone. Buildings or areas of buildings that are planned for computer labs or office occupancy should be served by return air HVAC systems.

Heat recovery systems and associated ductwork should be located in a new attic space above the existing attic space. High velocity vertical discharge exhaust fans should be located either on top of the new attic space or on one side of the new attic space away from outside air intakes. Heating hot water should be piped to perimeter heating devices on the floors

and to reheat coils in the attic space. Process chilled water and secondary cooling water should be distributed horizontally on each floor. Fan coil units should be used for high heat load spaces such as electrical rooms with transformers, IT/Data Rooms, freezer farms, or other areas where the heat loads exceed 15 watts per square foot.

The piping distribution serving the laboratories should be accomplished by centrally located risers distributing house waters and gases. The pipe rack should be routed down the corridors with branch piping serving individual labs. The individual lab branch piping should be routed over the door to the lab with isolation valves located in the corridor. Alternate distribution concepts such as mains in the attic/penthouse space with a combination of vertical and horizontal distribution may also be considered. Waste piping serving the labs should utilize shaft space in every column grid to minimize gravity drainage horizontal piping in the ceiling space and allow for higher ceilings with better access. Waste, vent, and water risers serving the toilet rooms should be routed in the toilet core.

New main service electrical equipment should be provided in the existing main electrical room for the building. The new main gear should be designed to supply power to each floor electrical room. The floor electrical rooms should include 277V lighting panels and low voltage lighting control panels of the public spaces. Also in the floor electrical rooms, there should be two 480V to 208/120V distribution transformers that will serve two 208/120V distribution panels ("A" and "B" distribution). The lab panels should be located on the lab wall facing the corridor. There should be one A-Panel and one B-Panel for every 2 lab modules. The A-panel will serve half of each of the two labs and the B-Panel will serve the other half of the two labs.

The group of General Purpose Labs also should be equipped with one or more generators to support life safety and standby loads in the complex. A central UPS should be planned to support laboratory loads that cannot tolerate outages. Distribution system for the life safety, standby and UPS power should also be located in the electrical room on each floor.

### Building 101 Addition and Renovation

Building 101 should continue to be served with steam and chilled water service from the Steam and Chilled Water Generation Plant and campus distribution system. The existing services are adequate to support the renovation and addition.

## Exhibit 68: Conceptual Estimate of Mechanical and Electrical Loads

Building	Area	Function	Cooling		Heating		Electrical Power		CUP	CUP Cooling Tons	CUP CHW GPM	Local Cooling		Electrical Power kVA	CUP Heating MBH
			sf/ton	Tons	Btuh/sf	MBH	VA/sf	kVA				Tons	kVA		
<b>Base Loads</b>															
101 Admin Building	345,818	Office	400	865	30	10375	3	1037	Y	865	1531	0	0	1037	10375
103 Visitor Center	2,460	Office	400	6	30	74	3	7	N	0	0	6	7	14	0
202 Engineering Mechanics	78,575	Lab	190	414	50	3929	5	393	Y	414	733	0	0	393	3929
203 Standard Reference Materials	24,915	Lab	190	131	50	1246	5	125	Y	131	232	0	0	125	1246
205 Large Fire Facility	48,746	Lab	190	257	50	2437	5	244	Y	257	455	0	0	244	2437
205E Emissions Control Electrical	260	Support	600	0	30	8	3	1	Y	0	0	0	0	1	8
205M Emissions Control Mechanical	322	Support	600	1	30	10	3	1	Y	1	2	0	0	1	10
206 Concrete Materials Building	8,165	Lab	190	43	50	408	5	41	N	0	0	43	52	93	0
207 Robotics Test Facility	9,898	Lab	190	52	50	495	5	49	N	0	0	52	62	111	0
208 Net Zero Energy Residential Test	7,374	Lab	190	39	50	369	5	37	N	0	0	39	47	84	0
215 Nano Fabrication Facility	109,376	Lab	190	576	50	5469	5	547	Y	576	1020	0	0	547	5469
216 Center for Nano-Scale Science and Tech	106,157	Lab	190	559	50	5308	5	531	Y	559	989	0	0	531	5308
217 Instrument West Bldg	129,358	Lab	190	681	50	6468	5	647	Y	681	1205	0	0	647	6468
218 Metrology East Building	106,739	Lab	190	562	50	5337	5	534	Y	562	995	0	0	534	5337
219 Metrology West Building	84,882	Lab	190	447	50	4244	5	424	Y	447	791	0	0	424	4244
220 Metrology Building	216,040	Lab	190	1137	50	10802	5	1080	Y	1137	2012	0	0	1080	10802
221 Physics Building	219,658	Lab	190	1156	50	10983	5	1098	Y	1156	2046	0	0	1098	10983
222 Chemistry Building	166,089	Lab	190	874	50	8304	5	830	Y	874	1547	0	0	830	8304
223 Materials Building	164,659	Lab	190	867	50	8233	5	823	Y	867	1535	0	0	823	8233
224 Polymer Building	164,008	Lab	190	863	50	8200	5	820	Y	863	1528	0	0	820	8200
225 Technology Building	204,333	Lab	190	1075	50	10217	5	1022	Y	1075	1903	0	0	1022	10217
226 Building Research Bldg	142,800	Lab	190	752	50	7140	5	714	Y	752	1331	0	0	714	7140
227 Advanced Chemical Sciences Lab	231,912	Lab	190	1221	50	11596	5	1160	Y	1221	2161	0	0	1160	11596
230 Fluid Mechanics Bldg	38,366	Lab	190	202	50	1918	5	192	Y	202	358	0	0	192	1918
231 Industrial Bldg	75,131	Lab	190	395	50	3757	5	376	Y	395	699	0	0	376	3757
233 Sound Bldg	42,881	Lab	190	226	50	2144	5	214	Y	226	400	0	0	214	2144
235 Center for Neutron Research	229,868	Lab	190	1210	50	11493	5	1149	Y	1210	2142	0	0	1149	11493
236 Special Projects Bldg	13,221	Lab	190	70	50	661	5	66	Y	70	124	0	0	66	661
237 Non-Magnetic Bldg	3,100	Lab	190	16	50	155	5	16	Y	16	28	0	0	16	155
238 Non-Magnetic Bldg	3,961	Lab	190	21	50	198	5	20	Y	21	37	0	0	20	198
245 Radiation Physics Bldg	207,921	Lab	190	1094	50	10396	5	1040	Y	1094	1936	0	0	1040	10396
301 Supply and Plant Bldg	163,765	Office	400	409	30	4913	3	491	Y	409	724	0	0	491	4913
302 Steam and Chilled Water Plant (incl CHP)	60,053	Utility	600	100	25	1501	300	18016	Y	100	177	0	0	18016	1501
303 Service Building	14,572	Office	400	36	30	437	3	44	Y	36	64	0	0	44	437
304 Shops Building	75,589	Office	400	189	30	2268	3	227	Y	189	335	0	0	227	2268
305 Cooling Tower Building	16,162	Utility	600	27	25	404	2	32	N	0	0	27	32	64	0
306 Electrical Substation	4,532	Utility	600	8	25	113	2	9	N	0	0	8	10	19	0
307 Material Processing Storage	374	Storage	600	1	25	9	2	1	N	0	0	1	1	2	0
309 Grounds Maintenance	11,701	Office	400	29	30	351	3	35	N	0	0	29	35	70	0
310 Plant Storage Building	505	Storage	600	1	25	13	2	1	N	0	0	1	1	2	0
311 Grounds Storage Shed	2,511	Storage	600	4	25	63	2	5	N	0	0	4	5	10	0
312 Material Processing Bldg	3,877	Storage	600	6	25	97	2	8	Y	6	11	0	0	8	97
313 Site Effluent Neutralization	245	Utility	600	0	25	6	2	0	N	0	0	0	0	0	0
314 Backflow Preventor East	663	Utility	600	1	25	17	2	1	N	0	0	1	1	2	0
315 Backflow Preventor North	663	Utility	600	1	25	17	2	1	N	0	0	1	1	2	0
316 Electrical Service Bldg	487	Utility	600	1	25	12	2	1	N	0	0	1	1	2	0
317 Cooling Tower West	3,441	Utility	600	6	25	86	2	7	N	0	0	6	7	14	0
318 Emergency Services Facility	22,123	Office	400	55	30	664	3	66	Y	55	97	0	0	66	664
319 Emergency Services Storage	312	Storage	600	1	25	8	2	1	N	0	0	1	1	2	0

Exhibit 68: Conceptual Estimate of Mechanical and Electrical Loads, *continued*

Building	Area GSF	Function	Cooling		Heating		Electrical Power		CUP Y/N	CUP Cooling Tons	CUP CHW GPM	Local Cooling		Electrical Power kVA	CUP Heating MBH
			sf/ton	Tons	Btuh/sf	MBH	VA/sf	kVA				Tons	kVA		
320 Childcare Center	23,687	Office	400	59	30	711	3	71	Y	59	104	0	0	71	711
321 Liquid Helium Recovery Facility	1,900	Utility	600	3	25	48	2	4	N	0	0	3	4	8	0
411 Temporary Relocatable Facility	17,362	Office	400	43	30	521	3	52	N	0	0	43	52	104	0
414 Janitorial Storage Building	803	Storage	600	1	25	20	2	2	N	0	0	1	1	3	0
418 NCNR Storage Building	3,000	Storage	600	5	25	75	2	6	N	0	0	5	6	12	0
420 OFPM Storage Building	2,615	Storage	600	4	25	65	2	5	N	0	0	4	5	10	0
421 Radiation Physics Storage	1,499	Storage	600	2	25	37	2	3	N	0	0	2	2	5	0
422 Concrete Materials Storage	1,200	Storage	600	2	25	30	2	2	N	0	0	2	2	4	0
423 Research House	2,261	Lab	190	12	50	113	5	11	N	0	0	12	14	25	0
425 NCNR Storage Building II	303	Storage	600	1	25	8	2	1	N	0	0	1	1	2	0
426 NCNR Trailer 2	663	Office	400	2	30	20	3	2	N	0	0	2	2	4	0
427 NCNR Trailer 1	663	Office	400	2	30	20	3	2	N	0	0	2	2	4	0
428 Facilities Building	2,823	Office	400	7	30	85	3	8	N	0	0	7	8	16	0
Connecting Corridors	13,908	Support	600	23	30	417	3	42	Y	23	41	0	0	42	417
<b>Existing Campus Total</b>	<b>3641255</b>									<b>16549</b>	<b>29293</b>	<b>304</b>	<b>362</b>	<b>34757</b>	<b>162036</b>
<b>Master Plan Phase 1</b>															
Building 245 Addition/Renovation	106000	Lab	190	558	50	5300	5	530	Y	558	988	0	0	530	5300
New GPL (Research Building I)	300000	Lab	190	1579	50	15000	5	1500	Y	1579	2795	0	0	1500	15000
Security/Visitor Center	3000	Office	400	8	30	90	3	9	N	0	0	8	10	19	0
Truck Inspection	17000	Support	600	28	30	510	3	51	N	0	0	28	34	85	0
Visitor Vehicle Inspection	4400	Support	600	7	30	132	3	13	N	0	0	7	8	21	0
New High Bay Lab Building	16000	Lab	190	84	50	800	5	80	Y	84	149	0	0	80	800
Renovate GPL's	0	Lab	190	0	50	0	5	0	Y	0	0	0	0	0	0
GPL Office Additions	86000	Office	400	215	30	2580	3	258	Y	215	381	0	0	258	2580
Demo Building 411/428	-20185	Office	400	-50	30	-606	3	-61	N	0	0	-50	-60	-121	0
New Electrical Switching Station															
South Utility Loop															
302 Steam and Chilled Water Plant															2314
<b>Total</b>	<b>4153470</b>									<b>18985</b>	<b>33606</b>			<b>39443</b>	<b>185716</b>
<b>Master Plan Phase 2</b>															
101 Conf Center Addition	50000	Office	400	125	30	1500	3	150	Y	125	221	0	0	150	1500
302 Steam and Chilled Water Plant															119
<b>Total</b>	<b>4203470</b>									<b>19110</b>	<b>33827</b>			<b>39712</b>	<b>187216</b>
<b>Master Plan Phase 3</b>															
New Research Buildings II, III, IV	480000	Lab	190	2526	50	24000	5	2400	Y	2526	4471	0	0	2400	24000
302 Steam and Chilled Water Plant															2400
<b>Total</b>	<b>4683470</b>									<b>21636</b>	<b>38298</b>			<b>44512</b>	<b>211216</b>
<b>Independent Projects Beyond Phase 3</b>															
NCNR Expansion	138000	Lab	190	726	50	6900	5	690	Y	726	1285	0	0	690	6900
Strong Facility	15000	Lab	190	79	50	750	5	75	Y	79	140	0	0	75	750
Wind/Fire	15000	Lab	190	79	50	750	5	75	Y	79	140	0	0	75	750
207 Addition	17000	Lab	190	89	50	850	5	85	Y	89	158	0	0	85	850
AML Addition	115000	Lab	190	605	50	5750	5	575	Y	605	1071	0	0	575	5750
SRM	54000	Lab	190	284	50	2700	5	270	Y	284	503	0	0	270	2700
302 Steam and Chilled Water Plant															1769
<b>Total</b>	<b>5037470</b>									<b>23498</b>	<b>41595</b>			<b>48051</b>	<b>228916</b>

The addition should be provided with dedicated mechanical systems (supply and return air systems). New central infrastructure such as chilled water, heating water, domestic water, normal and standby power equipment should be sized to serve the entire building and implemented as part of the addition. This will allow the renovation of office floors in the existing building with source utilities extended from the new equipment installed in the addition. Renovation should include replacement of equipment and distribution system for chilled water system, steam system, hot water system, humidification system, supply, return and exhaust air systems, control system (BAS), normal and standby power systems, lighting system, fire alarm system, lightning protection system, information technology systems, security systems, domestic water systems, waste and vent systems and fire suppression system.

### **Research Buildings II, III and IV**

Prior to beginning construction of the new laboratory and support buildings in the central campus core, the existing underground electrical duct bank and steam/condensate piping should be re-routed outside the footprint of the buildings. Campus steam, chilled water and compressed air service should then be extended from the relocated main distribution piping. Normal electrical power and data communication services should be extended from the relocated campus distribution system. Standby power should be provided via local dedicated diesel generators. Building mechanical, electrical and plumbing equipment and distribution systems should be organized similar to that described above for the new Research Building I to support the specific laboratory program.

### **Gate F: Commercial Vehicle Inspection, Shipping/Receiving Facility, and Visitor Center**

These buildings are planned to meet or exceed LEED Gold certification with net-zero energy consumption through conservation strategies, on-site photovoltaics and/or other renewable energy systems, and a maximum energy use index of 25 kBtu/sf-yr. The building should be provided with dedicated heating and cooling systems independent of the campus systems. Normal electrical power and data communication services should be extended from the campus distribution systems.

### **Advanced Measurement Laboratory Addition**

Prior to beginning construction of the AML addition, the existing underground electrical ductbank should be re-routed outside the footprint of the building. Campus steam, chilled water and compressed air service should be extended from the main distribution piping located along South Drive. The addition should be designed to meet similar high performance criteria established for the original building. Laboratories and clean rooms should be designed for tight temperature and humidity control and cleanliness and pressurization. Power supply distributed to the laboratories should meet quality standards established for the AML complex. Primary equipment should be designed with appropriate spare capacities and redundancies to ensure reliable operation of the labs. Similar to the existing AML, the addition should be designed with full interstitial floors above each laboratory floor for distribution of utilities. This arrangement provides the required flexibility and minimizes maintenance activities on the laboratory floor.

### **Special Purpose Buildings: SRM, Fire/Wind, Strong Floor, NCNR)**

Each of these buildings should be designed, constructed and commissioned to meet the specific programmatic and technical criteria established for each building. Thermal, compressed air, power and communication utilities should be extended from the campus distribution network. Emergency/standby power and special gases should be provided via local generators and tank/distribution systems.

### **Special Purpose Laboratories Renovations**

Each of these laboratories houses specialized programs and/or equipment, and work will be done in phases. Primary utilities such as power, communications, steam and chilled water services should be maintained. Secondary building systems and equipment including transformers, switchgear, water heaters, pumps, pressure reducing station, heat exchangers, air handling units, exhaust fans and all distribution systems should be replaced in a phased manner. Replacement systems and equipment should meet requirements of current program, codes and standards.

**Exhibit 69: Future Domestic Water Loads**

Building	Total Building Area (NASF)	Lab Area (NASF)	Admin Area (NASF)	Peak Domestic Water Demand (GPM)
Existing Load	1,811,947	853,321	972,381	1,177.1
Lab with Office Growth (No. 1)	120,000	60,000	60,000	56.3
Lab with Office Growth (No. 3)	72,000	36,000	36,000	33.8
Lab with Office Growth (No. 4)	72,000	36,000	36,000	33.8
Lab with Office Growth (No. 5)	48,000	24,000	24,000	22.5
AML Expansion	44,000	25,000	19,000	19.7
GPL Addition (No. 1)	19,000	—	19,000	11.9
GPL Addition (No. 2)	19,000	—	19,000	11.9
GPL Addition (No. 3)	19,000	—	19,000	11.9
Conference/Office Expansion	30,000	—	30,000	18.8
Standard Reference Material	20,000	13,330	6,670	8.3
Building 245 Expansion	41,200	33,000	8,200	15.4
Building 207 Expansion	8,600	8,600	—	2.7
NCNR Expansion	92,000	73,000	19,000	34.7
Wind/Fire	10,000	8,000	2,000	3.8
Strong Facility	10,000	8,000	2,000	3.8
High Bay	7,600	5,000	2,600	3.2
Additional demand for cooling	—	—	—	104.4
Total Future Load (Main Campus)	632,400	329,930	302,470	396.9
Total Flow (Main Campus)	2,444,347	1,183,251	1,274,851	1,574.0
Gate F Visitor Screening	2,920	—	2,920	1.8
Gate F Shipping/Receiving	13,120	—	13,120	8.2

## Notes:

- Peak usage based upon the following usage factors:
  - Admin/General      0.0003 GPM/NASF
  - Laboratory          0.0006 GPM/NASF
  - Peak Demand = (Admin. NASF) X 0.0003 + (Lab NASF) X 0.0006
- Because of proximity, Gate F buildings would not be connected to main campus domestic water system.

**Domestic Water**

The NIST Gaithersburg campus is supplied domestic water by Washington Suburban Sanitary Commission (WSSC) through two metered connections at the north and east sides of campus. NIST operates an extensive distribution system, consisting of approximately 44,000 linear feet (lf) of ductile iron piping and 56 fire hydrants. The majority of it was originally installed in the 1960's.

**Master Plan Domestic Water System**

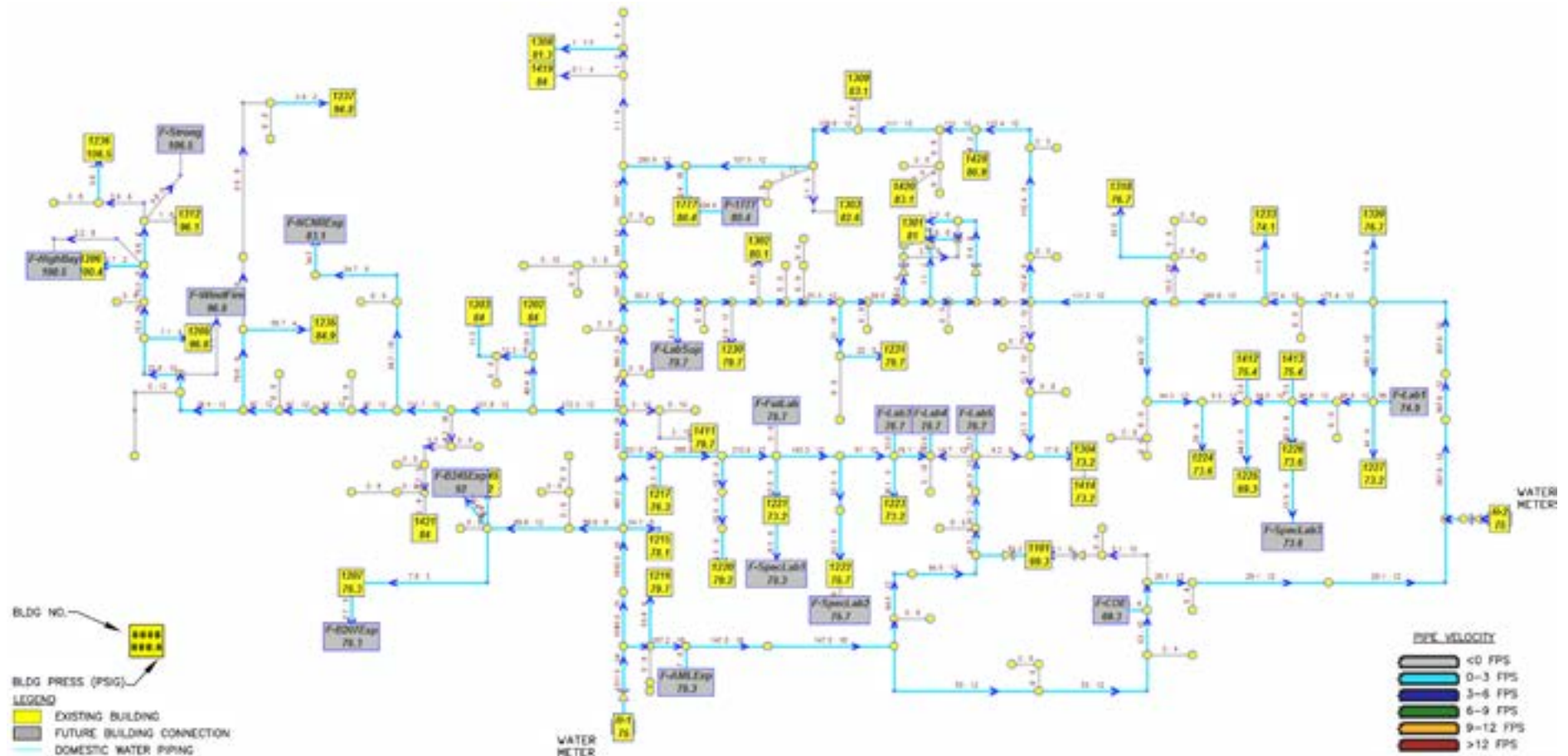
With the addition of new facilities on the NIST campus, the domestic water system will have increased water demand. Future demands were developed based upon unitary loads for lab and office space percentages. A summary of the peak domestic water demand for each of the planned future facilities is presented in the accompanying table. A site plan of the potential future building connections is presented on the next page. Because of its location, the Gate F facilities should be connected via a separate new meter, perhaps somewhere in proximity to Muddy Branch Road.

The existing domestic water model from the earlier campus analysis (see Campus Utility Infrastructure section) was amended to include the future loads of the current plan. A schematic of the future domestic water modeling is presented in exhibit Future Domestic Water Hydraulic Schematic. Based upon the existing looped distribution, there is enough piping capacity within the mains so that they do not experience high velocities greater than 12 feet per second (fps) or pressure drop issues during normal operation as well as during a system fire flow.

**Sanitary System**

The NIST Gaithersburg utilizes the services of the Washington Suburban Sanitary Commission (WSSC) for the discharge of their sanitary sewer system. NIST owns and maintains an extensive collection system, consisting of approximately 26,300 linear feet of sewer pipe, the majority of which was originally installed in the 1960s. The existing sanitary sewer system generally is in good condition and is sized adequately for the future campus master plan additions and renovations. NIST maintenance personnel indicated that few repairs have been made on the sewer system and that, in general, the pipes were in good condition. The condition of the sanitary manholes is rated good campus wide.

## Exhibit 70: Future Domestic Water Hydraulic Schematic



Utility drawings are not included in the Master Plan document based on NIST security policy.

### Master Plan Sanitary Sewer System

The additional load on the sanitary sewer system can be analyzed using the increased domestic water load at each proposed building (domestic water consumption approximately equals sanitary sewer discharge). The desired percentage of actual flow versus full capacity per the WSSC design manual is 50% for pipes fifteen inches and smaller and 75% for larger pipes. A complete hydraulic analysis of the existing and proposed sanitary sewer system was not performed as part of this study. Existing direct-buried sanitary sewer piping may need to be relocated out of proposed construction as shown in the accompanying drawing.

### Stormwater System

NIST owns and maintains an extensive storm drain collection system, the majority of which was installed in the 1960's. The NIST storm drain system is collected on the campus through an extensive sewer system of pipes, manholes, and inlets. The major outfalls from the storm drain system flow to a series of storm water management ponds recently constructed by NIST in conformance with State of Maryland Department of the Environment (MDE) Storm Water Management Regulations. The storm drain system consists of a series of manholes and pipe segments with several outlet structures leading to several storm water management structures.

The campus has installed a number of stormwater management structures in recent years, often in concert with specific building projects. These include bioretention and micro-bioretention areas, underground detention, rain gardens and swales. These structures and strategies for the Master Plan are discussed in Chapter 6 Stormwater Management.

## Information Technology

### Voice

The voice switch located in the basement of Building 101 is the original analog Siemens system installed when the campus was first built. It is backed up by a generator.

In 2010, OISM began the process of updating network closets with UPS, increased cooling and more rack space to facilitate the future transition of the phone system to VOIP. There are currently ninety IT closets around campus, powered by UPS, not generator, so they go off-line 90 minutes into a power outage. For planned electrical outages, Security deploys portable generators to power their closets. The Physical Security system needs to be 100 percent available, no outages.

Cellular coverage on campus is spotty and carrier-dependent. Coverage has been provided in the public spaces of Building 101 but not all carriers are supported (Sprint is not supported). The metal walls that are typical in many of the buildings cause a lot of problems with cellular signal strength. A DAS (Distributed Access System) for cellular retransmission was previously investigated for the campus but it was found that the cost would be excessive.

NIST will complete the process begun in 2010 to update the network closets and transition the phone system to VOIP.

### Data

The central data center for the campus is in a 10,000 square foot space in the basement of Building 225. Most laboratories have dedicated servers within their spaces, and every General Purpose Laboratory has a Main Distribution Frame. There are multiple service connections to the outside world, including links to other DoC campuses. NIST Gaithersburg makes use of hosted cloud services by Amazon and e-mail through Microsoft 365 Cloud Services. There is no campus-wide or

building-wide WiFi service, although there is broad coverage in Building 101 public spaces. Other installations are centered around conference rooms and cost-reimbursed by the organizational units. See Chapter 17 for a detailed description of the existing data systems.

NIST is currently working on a program to refresh the information technology system every five years. NIST has 1 GBS connections to every desktop. The next step will be 10 GBS in the cores, then to each building and finally to each desktop. There are currently no plans that would require expanding the data center.

Thirty years ago, NIST developed the backbone for the network by putting routers in each building and pulling fiber between buildings. Most of the installed fiber is first-generation with an estimated life of 30 years and is nearing the end of its useful life (The fiber between Buildings 245 and 205 is new, and from 205 and 236 is new). The Office of Information Systems Management (OSIM) is investigating options for improved campus networking.

1. Continue as today with new and additional Cat 6 cable in the buildings and single-mode fiber between buildings.
2. Change to Passive Optical Network (PON) with much more fiber and much less copper cable. (Fios is based on this model.) This would bring fiber to the workstation outlet. This system uses centralized equipment and would be able to eliminate the network closets in buildings. No power, equipment or cooling would be needed. PON has been used by carriers for some time but it is now being tested in the enterprise.
3. Also, the installation of a campus central UPS backed by one or more generators is under considerations.

Cost comparison for running Cat 6a copper cable versus single-mode fiber optic cable:

Cat 6a copper cable:	\$8/LF
Single-mode fiber optic cable:	\$0.11/LF

The Master Plan suggests that NIST replace the aging campus copper and fiber ring network with a fiber optic star network and convert inside plant cables from copper to fiber-to-the-desk. A speed of 10GBPS is the upper limit on copper cable to the desktop. Faster speeds require single-mode fiber to the desktop with a fiber-copper converter on the desk.

PON fiber cannot support power over Ethernet (POE) to power wireless access points, phones, etc. The PON ports can generate the necessary 120V or 48VDC POE power. There would need to be some UPS in closets for traditional switches for power users and PON ports for regular users. PON ports for regular users would connect to one strand of fiber. Power users require multiple strands per user. PONS is a star network with splitters for up to 128 branches. The physical networks would remain NIST-provided services. Ideally, each building should have two separate fiber optic entrances.

The goal for the wireless network is to convert the model from fee-for-service to a NIST-provided service. Because of the prevalence of metal and metal-coated walls, at least 1400 wireless access points will be required provide campus-wide WiFi.

Cyber locks which communicate over WiFi are becoming more common on campus. Building 245 used to have no WiFi datapoints but they are adding a large quantity of secure doors. Ultimately, at least 10,000 cyber locks are expected, campus-wide.

Over time, more cell phones can route calls over a WiFi connection. OISM would need to obtain the necessary funding to complete campus-wide coverage support WiFi calling and eliminate the need for a distributed antenna system.

## Building Design Strategies

Performance, energy efficiency and user comfort are important goals in the design and construction/renovation of the campus buildings. New buildings and full renovations offer the most opportunity for maximizing these goals. The new Shipping/Receiving Facility and Gate F Visitor Center should be designed, constructed and commissioned to meet or exceed the following performance criteria:

- Certified LEED Gold or higher
- Net Zero energy consumption through a combination of energy reduction technologies and the use of on-site photovoltaic systems
- A maximum Energy Use Index of 25 kBtu/sf-yr

The new Laboratory Buildings and major additions should be designed, constructed and commissioned to meet or exceed the following performance criteria:

- Certified LEED Gold or higher

Major renovations of General Purpose Laboratory Buildings should be designed, constructed and commissioned to meet or exceed the following performance criteria:

- Certified LEED Silver or higher

Following are some design strategies and concepts to help achieve these performance goals, although not exhaustive; supplemental strategies may be required to achieve the aforementioned criteria. Moreover, opportunities should be explored to improve upon these systems to reduce further the resource consumption and environmental impact during construction and operation.

A high-performance building is comprised of highly efficient systems, all of which are designed to work together as an integrated whole. Any given system will be designed to work synergistically with the other building systems. The whole truly does operate as something greater than the sum.

Each building type suggests its own strategies. For example, natural ventilation would not be an appropriate system for laboratories with critical temperature control requirements. Certain strategies may not be applicable to the technical areas of special purpose buildings such as NCNR expansion or AML expansion. Each project implementation team should assess strategies that enhance the overall building performance without compromising the core functions of the building.

## Strategies and Technologies

The design strategies and related technologies utilized will evolve with the optimization and refinement of the project program, architecture and budget. The descriptions below are intended to both provide high performance design ideas and to identify potential strategies and technologies that may be appropriate. NIST's buildings will be constructed/renovated over 20 years, and new and emerging technologies should be evaluated for each project.

Building design should develop the performance strategies supported with detailed analysis, documentation and



ultimately proven out through field commissioning at the end of construction. The approach should be multi-tiered that

- 1) reduces demand,
- 2) increases efficiency, and
- 3) provides a clean renewable energy supply.

The building design should employ both passive and active systems.

### Natural Ventilation

While the climatic conditions of Gaithersburg is not ideally suited for natural and passive ventilation for much of the year, non-critical functional areas such as warehouse facilities may be considered for natural ventilation when ambient conditions permit. The design should consider integrating both passive and natural ventilation into these areas. In addition, ceiling fans should be provided along with nighttime flushing and additional thermal mass as required to maintain occupant comfort. The use of outside air filters for the passive ventilation strategy should be reviewed with NIST during the design development. Active mechanical cooling should be limited to spaces and times dictated by functional and technical requirements.

### Improved Envelope

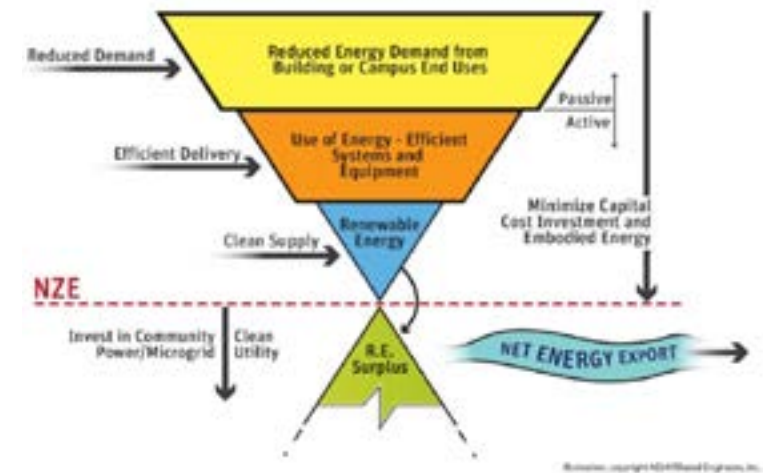
Building envelope design is not only a matter of aesthetics and basic enclosure, but also an opportunity to address various climatic and operational impacts on building energy and comfort performance. It is the intersection for aesthetics, solar radiation (heat gain and daylight), heat transfer, moisture transfer, visual connection, and natural air movement—to be addressed in an integrated manner.

For NIST, the approach to envelope design and upgrade must also consider the historic district context, the compatibility of materials, proportions and glazing, and the requirements of the Secretary of the Interior's *Standards*.

A simple adjustment of either window to wall ratio or the solar heat gain coefficient can lead to significant cooling load increases. In turn, this requires an increase in cooling equipment capacity (and often size). The increase can also be a limiting factor in the types of cooling systems that can address the loads effectively.

Design can alter space cooling loads through varying the window-to-wall ratio and solar heat gain coefficient (SHGC). The

### Exhibit 71: Net Zero Strategy



amount of glazing area also plays a key role in allowing daylight into the space. Useful daylight is that which provides illumination to the tasks occurring in the space without creating glare discomfort. Thus, a balance must be determined between window area and the visible light transmittance. This balance must also consider the impact on solar gains to the space, which result in cooling loads. Often this balance between glare, useful daylight, and heat gain is only partially resolved, resulting in the use of internal shade devices. Another possible solution to explore is the use of electrochromic glazing. This technology uses a small electrical charge to change the glass from a “transparent” state to a “tinted” state along a continuum with operational steps between the two points. The advantage is that both the visible light transmittance and solar heat gain coefficient area dramatically lowered when in the tinted state, reducing glare potential and cooling load, yet there is still a visual connection to the outdoor environment, unlike with internal shade devices. The system can be controlled using solar time or solar radiation, and connection to the space thermostat can inform modulation of the dimming to offset any comfort heating demand.

The application of electrochromic or similar thermochromic glazing is most likely not cost effective or necessary in all building areas, but various target areas could be considered. In addition to these types of dynamic glazing, active external shading devices can provide similar benefit with a different aesthetic expression. In evaluating such envelope strategies,

it should be recognized that the building skin is an integral part of the building HVAC system and it is possible to reduce mechanical HVAC capital costs with such strategies.

### Lighting Load Reduction

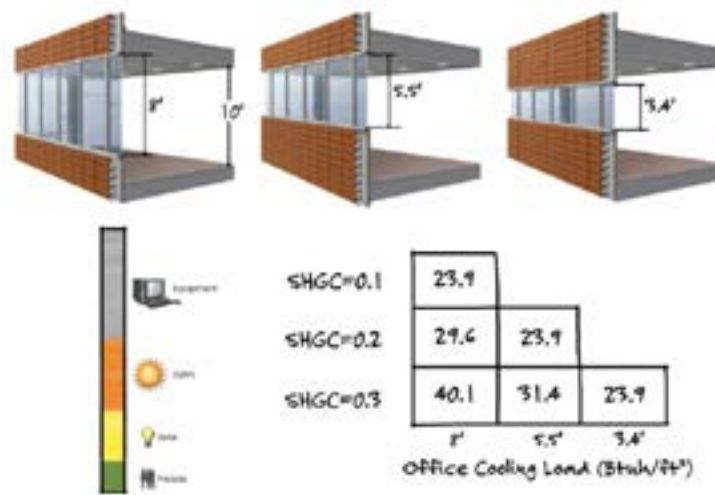
New buildings and renovations present opportunities to create outstanding and memorable buildings with reduced energy consumption. Lighting load reduction begins with the effective utilization of natural light, especially in office and support areas. Design studies should maximize the potential for using natural light for most daytime general illumination, augmented by task lighting tailored to the activities. Natural lighting strategies must control glare, which is dangerous in shop areas and which can prompt office workers to close the shades/blinds, negating the environmental and energy benefits. NIST Gaithersburg typically has not incorporated natural light into existing research laboratories, but this strategy should be considered case-by-case for future labs.

Lighting systems should provide appropriate task oriented light levels, with minimum energy consumption, while creating beautiful spaces. To successfully meet the energy goals, the lighting systems must be designed to incorporate highly efficient technologies, while reducing glare or veiling reflections, e.g. dimmable LED light sources. The intensity of light should be accurately tailored to the task requirements of the users, with little or no excess capacity. Key components should be developed to form a comprehensive strategy that unites various spaces within the building to create a consistent light character and quality of light. The solutions to be developed should integrate light within the form and structure of the space to clearly communicate function and relate to the larger architecture of the building. Comprehensive control systems should be employed to maximize the benefits of day light, turn off lights when spaces are un-occupied, and reduce lighting after hours. These should be selected to maximize simplicity within spaces while still providing the highest level of controllability.

### Plug Load Reduction

Purchasing more efficient equipment is the most direct way to reduce plug loads in office areas. Equipment with energy saving features may or not have a higher associated first cost. When older, less efficient equipment is being moved into a new building from other facilities, effort should be taken to replace or upgrade those inefficient devices. Intelligently controlling equipment can also lead to reduced energy use. Some equipment can be controlled via occupant-sensing

**Exhibit 72: Window-Wall Ratios and Solar Heat Gain**



**Exhibit 73: Electrochromic Glazing**



technologies. Examples include computer monitors with occupant sensors, banks of equipment linked to room occupant sensors, etc. Where possible, shared occupant sensors linked to multiple pieces of equipment can help to reduce first costs.

### Air-side Energy Savings

The use of appropriate air distribution and control strategy can be an efficient means to provide cooling. The requisite amounts of outside air supplied to office and support spaces is based on the number of people in each space. To lower the conditioning and fan energy associated with supply of outside air, occupancy sensors and carbon dioxide monitoring should be used to determine the quantities required (CO<sub>2</sub> serves as a proxy for occupancy). Decoupled cooling and ventilation systems such as chilled beams should be considered for spaces with high sensible loads.

Laboratory buildings with high concentration of internal equipment loads tend to be ideal candidates for decoupled systems such as chilled beams. This allows a dramatic reduction to the ventilation air that normally results in high heating, cooling and humidification energy. Further, decoupling ventilation from cooling allows for significant reduction in installed design capacities such as boilers and chillers. Specifically, for renovation of existing buildings such as the GPL's with limited floor to floor height, chilled beam solution will allow for creating modern laboratory environment with functional ceiling heights, acoustics and temperature control.

### Water-side Energy Savings

As noted with air-side savings, the distribution of cooling energy via water rather than air is typically much more efficient. Zone level cooling also creates energy efficiency opportunities because of elevated chilled water temperatures. This warmer chilled water can be provided via the return leg of the campus chilled water system, via water-side economizing with a fluid cooler device, or via chillers in the building operating at higher efficiency because of decreased lift.

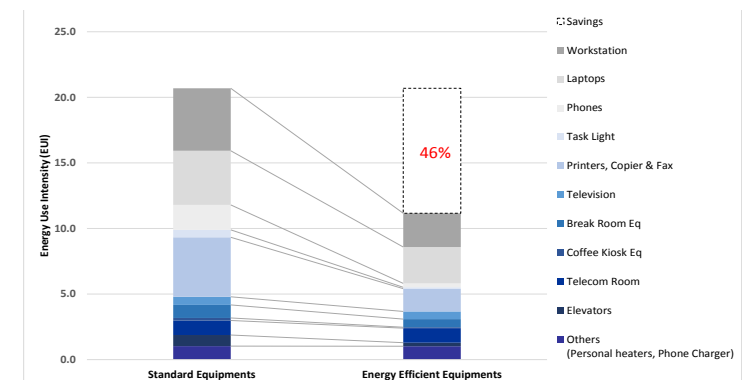
### Geo-thermal System

Ground source heat pump may be considered for space cooling and heating in stand-alone buildings that are remote from the campus thermal utility grid. The Shipping/Receiving Facility and the Gate F Visitor Center are likely candidates for such a system. Deep well geo-thermal system can provide required cooling and heating capacity for the anticipated loads in these buildings while supporting the net zero energy goals of these buildings.

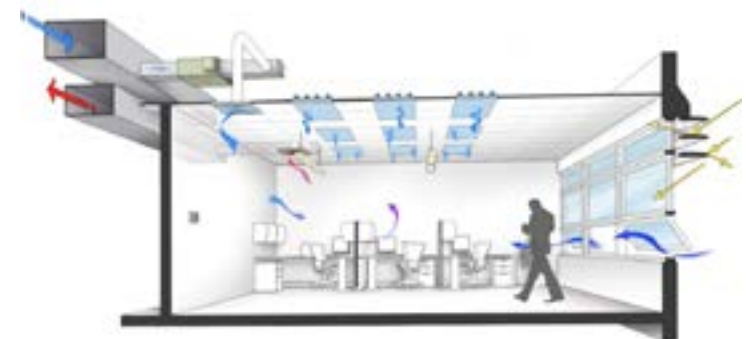
**Exhibit 74: Office Lighting Strategy**



**Exhibit 75: Plug Load Reduction**



**Exhibit 76: Office Space Energy Strategy**



### **Solar Energy Systems**

NIST has a strong history of supporting solar technologies, especially photovoltaic energy systems. The Gaithersburg campus currently has a three solar PV arrays that are integrated with the campus power system. In addition, NIST is planning a 5 MW solar PV field on 15 acres in the southern portion of campus. New building design should consider inclusion of the renewable energy PV systems both on top of the building structure and over the canopy shielding the parking areas. The quantity, orientation and efficiency of the PV cells should be as required to achieve the net zero energy criteria. The maximum roof coverage should conform to the fire marshal mandates and local ordinances.

### **Combined Heat and Power**

Combined Heat and Power (CHP) is an economically attractive strategy when balanced between simultaneous power and thermal demands. On-site generation reduces transmission losses and improves overall system efficiencies. NIST has recently constructed a CHP addition to Building 302 (the central plant) under an Energy Savings Contract. The project provides for the installation of a nominal 8.0 MW gas turbine generator coupled with a heat recovery steam generator (HRSG). The HRSG will replace one of the 80,000 PPH boilers in the existing plant and integrate with the campus steam distribution system. The power generator at 4,160V will integrate with the campus 13,800V electrical system via step-up transformer.



# Sustainable Design Approach

THE Master Plan incorporates sustainable design and energy efficacy as core principles. The campus development approach incorporates environmentally responsible strategies into the plan and the building design guidelines. Certain principles are inherent in the Master Plan as it is implemented, and certain principles are enabled with the design of specific buildings following the Design Guidelines. The following are key sustainable design approaches:

- **NIST Requirements:** Meet the requirements of the NIST *Sustainable Design Manual*, July 31, 2014, and the DoC *Real Property Management Manual*, August 2014, rev. March 2017, and any subsequent editions. These Manuals reflect both NIST and DoC policies on sustainable design and the Federal Executive Orders and mandates on which they are based. Compliance with the *Guiding Principles in Federal Leadership in Sustainable Federal Buildings* and Associated Instructions, February 2016, is required.
- **Energy Efficiency:** Improve the energy efficiency of the campus facilities, meeting Department of Commerce goals of energy reduction. Implementation of the Master Plan will increase energy efficiency through the renovation of multiple buildings from the 1960's, with aging and inefficient mechanical systems and uninsulated building envelopes. The major proposed buildings would be connected to services from the central Steam and Chilled Water Generation Plant, which has been recently augmented with a Combined Heat and Power system. Locations for solar panel arrays are identified, both building-related and at-grade locations.

Energy efficient design strategies are recommended for the planned buildings, supported by the Design Guidelines. Recommended strategies for all the new and renovated buildings include: clustered building functions to allow the most efficient HVAC system design and distribution; daylighting; high performance building envelopes; natural

ventilation where appropriate, energy efficient equipment and systems. Energy conservation approaches should consider demand controls, process energy recovery, geothermal, fume hood controls, de-coupled cooling and ventilation, air-side and water-side economizers.

New buildings at Gate F, the visitor screening facility and the shipping and receiving warehouse, are proposed as a net-zero buildings, targeting reduced energy demand and efficient systems augmented by solar energy. The general approach first reduces the demand for energy through building design and organization, followed by the selection and commissioning of energy efficient systems, and then the provision of clean renewable energy.

- **Water efficiency:** Reduce water by installation of water conserving equipment and fixtures in projected new buildings and lab modernization. The NIST goal is a 20% reduction in potable water use over the baseline. NIST currently collects groundwater through the AML complex dewatering system, and redirects it to the campus cooling towers for reuse, saving approximately 26 million gallons per year. A similar system for redirecting groundwater is in planning for Building 245.
- **Stormwater Management:** Utilize strategies to ensure stormwater quality and quantity control, including landscape “best management strategies” such as swales and plantings that increase ground water recharge rather than runoff. To address new development as well as the treatment of 20% of existing impervious surfaces required by NIST’s MS4 permit, multiple landscape strategies are recommended. These include bioswales, rain gardens, meadows, reforestation, and disconnection of impervious surfaces.
- **Daylighting:** Organize the buildings to maximize the use of natural light for illumination and occupant comfort, specifically to the staff offices, support and corridors. The existing GPLs and planned research buildings have a good

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orientation for daylighting. Daylighting within the laboratories is not typical because of research requirements, but this should be discussed with each building project. The NIST Sustainable Design Manual sets a minimum goal of a 2% daylighting factor for 75% of regularly occupied areas.

- **Adaptive Reuse:** Utilize existing buildings that are in good condition, and renovate them for compatible uses. Seven General Purpose Laboratory buildings are planned to be renovated, some for labs and some for office space and computer research. The main administration building, Building 101, will undergo renovation for modernized conference, cafeteria and library functions, as well as phased renovation for energy efficient, modern office space. Building 411 is recommended for removal in the Master Plan because is not in good condition, not supportive to current needs and installed in 1989 as modular/temporary building.
- **Heat Gain and Wind Moderation:** Moderate the solar heat gain on the buildings through glazing selection and orientation, envelope and roof design and screening with vegetation. The prevailing wind primarily comes from the west. Although the research building courtyards are open to the wind, mature trees shelter the existing courtyards, and should be planted in the new.
- **Landscape Stewardship:** Minimize the disturbance of landscape features when new buildings and infrastructure are constructed. The Master Plan concentrates new research buildings on sites that have already held paved areas, with the exception of the first research building, at the north end of campus, and the GPL office additions. Planned additions to existing lab buildings are kept compact and are located on relatively flat terrain. The facilities and roadways at Gate F do not disturb forested land but will be built on open land, some of which was fill from other construction projects. The visitor screening facility must be carefully sited to stay away from a small wetland area.
- **Reforestation:** Augment the tree cover on the south and east sides of the campus to meet NIST's reforestation goals outlined in the 1995 Forest Conservation Plan, prepared by HDR Engineering, Inc. Montgomery County guidelines recommend forest cover over 15% of a site's acreage, which resulted in a need for an additional twenty-nine acres at the time of the study. NIST has been working toward that goal.
- **Appropriate Planting:** Add new trees within the campus core to moderate temperatures, shade the buildings,

enhance stormwater management and absorb pollutants. The landscape approach balances lawn and landscape preservation in the more historic central core with meadows of native or adapted species on the more open site areas for easy maintenance, reduction of fertilizer and pesticide use, and stormwater management. Currently over 60% of the site is mowed regularly. Minimize water-dependent landscapes and water intensive plantings that require irrigation.

- **Renewable Energy:** Consider renewable energy technology for both electricity and hot water. Solar technology is recommended for installation on the Gates A and F buildings and canopies, over new parking and potentially on new and renovated laboratory buildings as their rooftop infrastructure allows. Additionally, a fifteen-acre solar panel field is planned on the southern campus. The NIST Sustainable Design Manual sets a goal that 30% of hot water needs be met by solar technology. A feasibility and economic analysis should be conducted in light of this Master Plan and the Gaithersburg solar research findings.

## Current Sustainable Design Policies

The Master Plan promotes an integrated view of sustainability, incorporating Federal policies, guidelines and directives, and going beyond minimum standards toward creative environmental strategies.

The Master Plan integrates sustainability policies outlined by the Department of Commerce and NIST, referencing other Federal sustainability regulations. Included are: the NIST *Sustainable Design Manual* of July 31, 2014; the DoC *Real Property Management Manual*, August 2014, rev. March 2017, the DoC *Environmental Management System Operations and Implementation Manual* of October 2013, and the DoC *Implementation Handbook for the Strategic Sustainable Building Plan* of June 2013. Federal regulations include the Energy Policy Act of 2005 (EPA 2005), Energy Independence and Security Act of 2007 (EISA 2007), and EO 13693. These current regulations may change in the future, and each project would be designed to meet the sustainability regulations in place at that time.

The DoC *High Performance and Sustainable Building Handbook* and the NIST *Sustainable Design Manual* provide the framework for the Department's overall sustainability program, summarizing the Department's program for incorporating sustainable measures

Exhibit 77: Sustainable Design Plan



into its building assets. These and the supplementary documents reflect the requirements of Executive Order (EO) 13514, “Federal Leadership in Environmental, Energy and Economic Performance.” This EO has been revoked and superseded by Executive Order 13693, “Planning for Federal Sustainability in the Next Decade,” signed March 25, 2015.

Key provisions of EO 13693, Planning for Federal Sustainability in the Next Decade, include the following:

- *Guiding Principles.* The Guiding Principles for Sustainable Federal Buildings and Associated Instructions are environmental performance goals for Federal buildings developed to implement EO 13693. The current Principles were released in February 2016, and update those of December 2008. The Department of Energy has issued crosswalk documents to aid Agencies in their updates. The Guiding Principles contain specific requirements in the following areas:
  - I. Employ Integrated Design Principles
  - II. Optimize Energy Performance
  - III. Protect and Conserve Water
  - IV. Enhance Indoor Environmental Quality
  - V. Reduce Environmental Impact of Materials
  - VI. Assess and Consider Climate Change Risks
- *Energy and Water Conservation.* Each agency is required to meet energy reduction, clean energy and water use targets

over the next ten years. Among them is a target of 30% electric energy from renewable sources by FY25 and a requirement to reduce energy intensity by 25% by FY 25.

- *Zero-net Energy.* New federal buildings greater than 5000 GSF in size, for which planning is initiated in FY20 or later, shall be designed to achieve zero-net energy by FY30, with interim targets each 5 years. A zero-net energy building is defined as “a building that is designed, constructed and operated such that actual annual source energy consumption is balanced by on-site renewable energy<sup>1</sup>.”

## Rating Systems

NIST’s Sustainable Design Manual requires certification by a third-party for major construction or renovation projects, as well as meeting the Design Manual requirements and those of the *Guiding Principles* checklist. Certification by either LEED (Silver level) or Green Globes (two globes) is acceptable. LEED, developed by the United States Green Building Council, and Green Globes, developed by the Green Building Initiative, are both programs to assess building performance and meet broad sustainability goals. They differ in their assessment procedures and emphasis on specific areas of sustainability. Both programs are updated regularly, and current standards should be reviewed with each construction or renovation project.

<sup>1</sup> Executive Order 13693: Planning for Federal Sustainability in the Next Decade; March 25, 2015

### Exhibit 78: Impervious Cover

	Existing		Phase 1		Phase 2		Phase 3		Independent Phases	
	SF	Acres	SF	Acres	SF	Acres	SF	Acres	SF	Acres
<b>Impervious Areas</b>	<b>4,704,700</b>	<b>108</b>	<b>4,897,500</b>	<b>112</b>	<b>5,031,800</b>	<b>116</b>	<b>5,136,700</b>	<b>118</b>	<b>5,432,500</b>	<b>125</b>
Buildings	1,527,200	35	1,636,300	38	1,684,900	39	1,865,500	43	1,921,500	44
Parking/Loading Areas	1,891,900	43	1,913,700	44	1,923,000	44	1,822,200	42	1,825,100	42
Road/Side Walk	1,285,600	30	1,347,500	31	1,423,900	33	1,449,000	33	1,685,900	39
<b>Pervious Areas</b>	<b>20,535,300</b>	<b>471</b>	<b>20,342,500</b>	<b>467</b>	<b>20,208,200</b>	<b>464</b>	<b>20,103,300</b>	<b>462</b>	<b>19,807,500</b>	<b>455</b>
<b>Total Site Area</b>	<b>25,240,000</b>	<b>579</b>								



SITES is a sustainable landscape certification program that measures site design and development, considering measures for stormwater management, soils & vegetation, site material, recreation and construction practices. SITES is complementary to LEED, shares credits, and can parallel a LEED project or be applied separately. The Master Plan recommends that projects follow the principles of SITES.

The International Institute for Sustainable Laboratories, together with EPA and DOE, developed a toolkit called Labs21. This resource includes a rating system, benchmarking, and design guides intended to improve the energy efficiency and environmental performance of the nation's laboratories. This program bridges the gap in current implementation strategies (i.e., Green Globes, LEED) for sustainable design associated with laboratories. The master plan recommends that Labs21 be used in the design and performance evaluation of sustainable laboratory facilities.





# Implementation Planning

**T**HE Master Plan is a look into the future and a plan to build and renovate facilities in order to meet current and anticipated needs. Twenty years is the timeframe for this Master Plan, and the changes have been prioritized to recognize NIST's immediate need for laboratories with infrastructure that will support ongoing, advanced research. Additional priorities include security considerations, conference and public use spaces, and aging facilities.

As with any institution, NIST's program of renovation and construction are dependent on many factors—funding, research and agency-wide priorities. The Master Plan, therefore, becomes a living document, setting a framework that remains flexible and sensitive to the timing and composition of specific projects. The phasing of the plan is organized to meet the following implementation goals:

- The Master Plan is driven by current physical and functional needs, with growth integrated in the later years of the twenty-year timeframe.
- The Plan phases General Purpose Laboratory (GPL) building renovations as a multi-step process, designed to gradually improve infrastructure and research environments, while maintaining ongoing research programs.
- The Plan emphasizes an addition to Building 101 early in the phasing process for two primary reasons: to support the important conference and collaborative functions of the agency; and to provide some additional office space that will allow needed renovations to that building. Without this, there will be little early office relief for the occupants of aging Building 411 or for growth.
- The Plan allows great flexibility in the phasing of non-research facilities and Special Purpose Laboratories renovations, because their implementation is independent of the core, flexible research buildings. These new buildings and renovations should proceed when priorities and funding dictate.

- The Plan is able to accept variations in timing and project groupings.
- The Master Plan appears “complete” at the end of each phase or significant addition.

The purpose of the Master Plan is to guide future development; it does not represent the pre-approval of any individual facilities project or the specific needs of programs to be accommodated on the campus. The financing of such projects and programs must be addressed within the annual NIST budget process and review mechanisms. Furthermore, the Master Plan is not a commitment for the agency to build these facilities within a specific timeframe. Sometimes a twenty-year Master Plan becomes a thirty-year plan or a fifteen-year plan, yet the framework for this development remains valid.

## Phasing Priorities

Research facility improvements have been the primary goal of the Master Plan Steering Committee, an outlook supported by the ongoing renovation/expansion of Building 245 and the detailed study *NIST Research Facilities Strategic Plan*. The Master Plan anticipates that GPL renovations will be the core of implementation in the early years, enabled by the construction of one new research building. Implementing the recommended landscape improvement at the same time will improve the cohesion and visual image of the campus.

Other campus needs are independent packages, and can proceed when NIST mission requires them and funding is available. Security policy and priorities will determine when to implement the modifications to Gates A and F. Renovations to Special Purpose Laboratories and construction of a new Standard Reference Materials facility will depend largely on funding availability.

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## Exhibit 79: Phasing Summary

Phasing Packages	Major Components		Comments
<b>Phase 1: Immediate Priorities</b>			
<b>Building 245 Addition / Renovation</b>	Laboratory additions (3) construction Renovation of existing building		Ongoing phased construction
<b>Gate A Modification</b>	103 addition/renovation Canopy construction	Roadway/parking modifications Security equipment installation	Modifications in response to security policies
<b>Research Building 1</b>	Laboratory building construction Connection to campus concourse	Pedestrian path to Gate A Stormwater management facility	Completion will allow GPL modernizations to begin
<b>GPL Modernization</b>	Building modernization New office additions to 221, 222, 226 High-bay addition/206 renovation	Demolition of 411 Courtyard activation	Multi-step process, proceeding building-by-building
<b>Gate F Modification</b>	Visitor screening construction Shipping/receiving facility construction	New roadway, curb cut, parking Renovation in 301 for 428 occupants	Modifications in response to security policies
<b>Utility Upgrades</b>	Utility loop to the south campus New electrical switching station Detailed study of underground utilities	Electrical feeders, ductbank replacement	To provide redundancy/back-up Aging, failing electrical infrastructure
<b>Phase 2: Next-step Projects</b>			
<b>Building 101 Addition</b>	Building addition construction Renovation: public access areas Renovation: offices	Upgrades: building systems and facade	Office renovation will improve utilization, creating more office space for administration staff
<b>Phase 3: Program Expansion Projects</b>			
<b>Center Campus New Research Buildings II, III, IV</b>	Laboratory building construction Connection to campus concourse Parking structure construction	Roadway/parking modifications Courtyard landscape/social spaces	Added as needed. May overlap GPL renovations to enable early office occupancy of one GPL
<b>Steam and Chilled Water Plant and Electrical Switchgear Expansions</b>	Chilled water addition to 302 New cooling tower	New electrical switchgear	Coordinated with timing of new research building needs
<b>Independent Projects</b>			
<b>Site and Landscape Improvements</b>	East-West pedestrian walkway/planting Activation of courtyards Stormwater management features	Walking/multi-use trails Meadow replacement of lawns Reforestation	These should be implemented immediately, separately or in concert with construction projects
<b>Standard Reference Material Facility</b>	Laboratory building construction Access road/loading modifications	Relocation of assoc. staff from 222	This will proceed as mission priorities dictate.
<b>Specialty Laboratory—Additions/New</b>	Addition/renovation to 207, 235 Construction of Strong Floor, Wind/Fire Tunnel Access drive/parking modifications		Each will proceed as mission priorities dictate.
<b>Special Purpose Laboratory Renovations</b>	Upgrades to 202, 230, 231, 233, 237/238		Phased renovations, protecting ongoing research programs
	Laboratory building construction Tie in to 216	Solar panel removal/replacement Parking removal/roadway modification	This will proceed as mission priorities dictate.

## PHASE 1: IMMEDIATE PRIORITIES

Exhibit 80: Priority Phase Diagram



### Building 245 Expansion and Renovation

Building 245 is a multi-phase project, which began construction in 2017, for anticipated completion in 2027.

#### Components:

- Expansion and modernization of the B/C Wings, including utility upgrades and modification
- Addition to D Wing
- Mechanical penthouse to serve Wing A basement and sub-basement.
- New service drive and landscape modifications

#### Implementation Steps:

This project is underway, and the three phases have been defined and scheduled.

#### Disruption

- Building 245 is removed from other lab areas, and little campus disruption is anticipated
- Construction staging area has been defined and fenced.
- The construction and staging plan must protect the building occupants and the ongoing research within.

### Gate A Modifications

Gate A is the main entrance to the NIST campus, and used by all visitors except attendees at large conferences. Security policy requires greater screening of visitors and their vehicles. A separate study analyzed this and a phasing plan is proposed in the Gate A Visitor Screening Study.

#### Components

- Building 103 addition and renovation
- Vehicle screening bays and canopy
- Roadway and parking modifications, including a new roundabout
- Security equipment installations

#### Implementation Steps

1. Perimeter fence relocation
2. Road modifications to the Visitor access road, parking area and Bureau Drive, including the installation of the Under-vehicle Inspection System and license plate recognition
3. Expansion of the Visitor Center, Building 103, and renovation of the existing interior. Vehicle screening bays and canopy will also be constructed, along with related roadway modifications.
4. Construction of a roundabout, located as vehicles enter the campus after screening. The new circulation plan accommodates a shuttle bus stop and pedestrian crossing.
5. The planning of the roundabout, crossing and sidewalk must consider the planned pedestrian path to new Research Building I.

#### Disruption

- Screening operations must continue throughout the construction period. See the Gate A Visitor Screening Study for details.
- The installation of the roundabout will require temporary rerouting of traffic entering the campus.

## New Research Building One

The first phase of the Master Plan is planned construction of the first new research building, located to the north of GPL Building 226, and connected into the campus pedestrian concourse system. The completion and occupancy of this building will provide space to move research projects from one or more GPLs and begin their renovation.

### Components

- Laboratory building construction
- Connection to campus concourse
- Pedestrian path to Gate A
- Stormwater management facility

### Implementation Steps

1. Construction of Research Building 1, on a clear site.
2. Pedestrian connection. A link into the campus pedestrian concourse is planned, which will require renovation of the northwest corner of Building 227, to extend the corridor.
3. Loading dock. Access to the loading dock will be from the existing parking access to the west of the site.
4. Pedestrian path. A pedestrian path will be created that connects to Gate A, for easy staff access into the concourse system.
5. Occupancy. Upon completion, occupants of one or more GPLs would move into this building. At this time, the first move is anticipated to be from Building 224.
6. The stormwater management facility should be constructed as part of the first phase, which will accommodate the run-off from all the proposed new buildings and additions.

### Disruption

- Disruption of campus activities is expected to be limited to construction access and staging area.
- Design and final siting of the building must consider the Net-Zero Energy Residential Test Facility to avoid casting shadows on its solar panels.

## General Purpose Laboratory Modernizations

The seven original General Purpose Laboratories will be modernized in phases, moving the occupants and research projects to a completed building in turn. Modernizations will be implemented on empty buildings. The order of renovation, and who moves where, will be planned at project initiation. The goals are to move most labs only once, and to unite Laboratory programs and related research.

### Components

- Complete modernization of each GPL, meeting infrastructure standards for all lab buildings
- Additions to 3 GPLs. With modernization, office additions will be added to Buildings 221, 222 and 226, providing for increased lab space within the buildings and collaborative office settings.
- Landscape and activation of the existing courtyards between the GPLs.
- High-Bay addition and full renovation to Building 206.
- Building 411 demolition.

### Implementation Steps

1. A migration plan should precede the design and modernization of the buildings, to meet the goals of continuity and co-location. The assignable square footage planned for New Research Building I is larger than any of the GPLs, so consolidated program moves may speed up the renovation cycle.
2. Phase modernization and construction of office additions. This will proceed building-by-building as determined by the migration plan.
3. Construction of the High-Bay addition, before modernization of Building 226. This building, planned for the southern campus, will accommodate research using high-bay settings in Building 226, when it is slated for renovation. If these programs are discontinued or they are accommodated in a new research building, then the new High-Bay will not be required.
4. Upgrading the electrical capacity will be required, working with Pepco for increased capacity and service.
5. Demolition of Building 411. This modular office building will be demolished when office space for the 85 staff members is complete in the GPL renovation, or within Building 101 after modernization.

**Disruption**

- This phased renovation will have an extended construction period, and staging could disrupt central campus activities for years if not managed. Staging and construction parking areas must be established that consider security, access for equipment/supplies and the convenience and safety of NIST staff.
- Construction of the office additions and within the buildings must be planned to minimize disruption of research programs in adjacent buildings, considering vibration, noise, and air quality. Particular attention to vibration is required when working in Building 220 because of its proximity to underground Building 218.

**Gate F Modifications**

Gate F will remain an entrance for staff and conference attendees, and now will require all commercial delivery vehicles use this entrance. Screening of all deliveries, visitors and their vehicles will be performed in response to new security policies.

**Components**

- Visitor screening facility construction
- Shipping/receiving facility construction
- Commercial vehicle screening facility
- New roadways, curb cut, parking
- Renovation in Building 301 for Building 428 occupants

**Implementation Steps**

1. Obtain permits for the creation of a new curb cut along Muddy Branch Road.
2. Construct a new commercial vehicle screening facility and new shipping and receiving building to transfer cargo from non-governmental delivery vehicle to NIST vehicles. Add access roadways, loading areas, security screening systems, and security personnel kiosk. Upon completion, relocate the perimeter fence to open for operation.
3. Construction of a new building for the screening of visitors/conference attendees, with adjacent vehicle inspection bays and canopy. Add access roadways, parking and security screening systems. Upon completion, relocate the perimeter fence to open for operation.
4. Renovation within Building 301. Shipping and receiving is currently located in Building 301. Their vacated space will

allow renovation within the building to accommodate the personnel that now occupy Building 428, a trailer behind the building. Demolish or remove Building 428.

**Disruption**

- Screening operations for staff and conference attendees must continue throughout the construction period.
- Little disruption of campus activities is anticipated.
- Construction of the Visitor screening building must protect the small wetland located to the north of the planned site.

**Electrical Switching Station**

The campus has a central medium voltage (15kV) switching station (Building 306), served by a Pepco sub-station consisting of 69 kV incoming feeders, transformers and 15 kV outgoing feeders to the switching station. Multiple building feeders originate in the switching station and distribute to the buildings via underground ductbanks. Full implementation of the master plan will require upgrade to the existing switching station for additional capacity and feeders. Further, the existing ductbanks are partially collapsed and require upgrade/replacement.

**Components**

- New switchgear building sized for existing plus larger replacement gear for 20-year buildout.
- Replacement of existing building feeders and ductbanks, transferred over to the new gear.

**Implementation Steps**

- Construction of new building/switchgear sized for the full master plan build out capacity and adequate feeders/breakers.
- Assessment and replacement of existing ductbanks and feeders in the campus distribution system, thus changing over existing loads gradually to the new switchgear.
- Removal of existing switchgear after transferring all loads to the new gear.
- Both switchgear lineups should be maintained until all loads are transferred over.
- Coordination with Pepco to provide incoming service to both switchgear lineups.
- New buildings/additions under master plan will be served from the new gear.

**Disruption**

- To minimize electrical disruption, new switchgear should

be installed and commissioned prior to beginning transfer of loads.

- Replacement of ductbanks and feeders will require excavation and coordination with underground utilities and campus normal operations.

### Utility Infrastructure Upgrades and South Utility Loop

The campus buildings south of South Drive are served by a single primary utility pathway consisting of steam/condensate and chilled water service. Failure and/or disruption to this line will cause utility disruption to all south campus buildings. The Master Plan includes a secondary utility line be added from South Drive to south campus to create a loop and provide higher level of reliability.

#### Components

- New underground steam/condensate piping from South Drive to Building 235 location, east of Building 245 to create a loop.
- Evaluation of all utility lines and development of a plan for renewal.
- Similarly, new chilled water piping be installed to create a loop.

#### Implementation Steps

- Construction of new underground piping and connecting to existing mains.
- Phased renewal of utility distribution systems

#### Disruption

- To minimize utility disruption, connections to existing mains should be performed during off-season.
- Underground piping work will require excavation and coordination with underground utilities and campus normal operations.
- Routing east of Building 245 will require coordination with the proposed PV field.

## PHASE 2: NEXT-STEP PROJECTS

### Exhibit 81: Phase 2 Diagram



### Building 101 Addition and Renovations

The addition to Building 101 will provide much needed public use facilities, plus it will enable the modernization of traditional office space and the upgrading of aging systems.

#### Components

- Construction of Building 101 Addition
- Renovation of the Library, Cafeteria, other public-use functions
- Fire exit/stair addition
- West courtyard improvements
- Phase modernization of ten floors of office space
- Upgrades and replacements to the infrastructure systems, and energy efficiency improvements to the building envelope



### Implementation Steps

1. Construction of the Addition, on a clear site. Upon completion, many of the library stacks will be moved into the lower level to free-up space within the library for renovation.
2. Renovation of the 2 lower levels of the building for improved security and better public-use facilities. Included are the conference center, cafeteria, library and museum. A new fire exit stair addition is constructed to the west of the cafeteria wing. A new dining terrace and courtyard improvements are implemented in parallel with the cafeteria renovations and fire stair construction.
3. Staged modernization of the office floors and the building systems.

### Disruption

- Construction of the addition is expected to have limited disruption of campus activities, if appropriate staging areas and parking are established. The adjacent parking lot may be used.
- Subsequent interior renovations must be done in stages to control disruption to occupants, building circulation and services. The NIST Building 101 Window and Induction Unit Study proposed different approaches to phased mechanical system upgrades.
- It is important to protect the central courtyard to the west of Building 101, and the magnificent trees within and around it. Staging for the fire exit/stair cannot occur here.

## PHASE 3: PROGRAM EXPANSION PROJECTS

Exhibit 82: Phase 3 Diagram



### New Research Buildings II, III, and IV

New Research Buildings will be added to the campus core as needed to accommodate mission needs and growth. Three buildings are indicated, which may be built as individual projects or as one.

#### Components

- Construction of three modular Research Buildings, individually or together
- Bridge connection(s) to the existing campus circulation concourse
- Parking structure
- Roadway and parking modifications
- Courtyard landscaping and social spaces

**Implementation Steps**

1. Parking—construction of a parking structure on the site of the former Building 411. The planned site for other new research buildings is the existing central parking lots. The capacity of these lots will be replaced in a parking structure and include parking spots planned for staff growth. The size of the parking structure will be based on need, determined during the design process.
2. Construction of the first building/project
3. Pedestrian connection. A bridge link into the campus pedestrian concourse is planned, which will require renovation of the western side of Building 223, to connect. This future connection should be anticipated when Building 223 is renovated.
4. Construction of subsequent buildings/projects when required.
5. Landscape features and social spaces are recommended, which should be implemented with these projects.
6. Chiller capacity will need to be expanded by the end of this phase. Requirements should be re-evaluated at the beginning of the phase to ensure reliable service when needed.

**Disruption**

- Construction staging and parking can be located in the central area, opposite Building 219, if the parking structure is constructed first.
- Delivery access from Research Drive must be safely maintained for Buildings 219, 221 and 223.

## Steam and Chilled Water Plant Expansion Electrical Switchgear Expansion

Chilled water and electrical capacities need to be expanded at the beginning of this phase, to meet the needs of the added research buildings.

**Components:**

- Addition to the existing plant, Building 302
- New cooling tower installation adjacent to existing B317
- Replacement of chilled water supply/return piping to accommodate increased flow
- Replacement of chilled water supply/return piping from building to distribution system (near intersection of South

and Center Drives).

- Modification of Steam Drive to accommodate the building expansion and service access.
- Expansion of the electrical capacity and switchgear.

**Implementation Steps:**

1. Construction of the Building 302 addition, new equipment and cooling tower installation.
2. Replacement of chilled water supply/return piping from building to distribution system (near intersection of South and Venter Drives).
3. Tie-in the Building 302 and the existing system
4. Modification of Steam Drive to provide access and turn-arounds
5. Coordinate with PEPCO to increase electrical capacity, and augment electrical switchgear. Accommodate this in new Switching Station of Phase 1.

**Disruption**

- Little disruption of campus activities is anticipated. There may be minor pedestrian disruption with the pipe replacement project.
- With the modification of Steam Drive, the service areas west of Building 301 will exit only to Service Drive.
- Tie-in to Building 302 and central services will need to be seamless.

## INDEPENDENT PROJECTS

### Exhibit 83: Independent Phases



### New Standard Reference Material Facility

A new standard reference material facility will be constructed for the preparation and storage of ultra-high purity materials, with laboratories, refrigerated and frozen storage.

#### Components:

- Construction of the SRM Building
- Modification of the service drive to adjacent Building 230 to serve both buildings.

#### Implementation Steps:

1. Construction of the new building.
2. Construction of loading dock access by modifying the Building 230 access drive.

#### Disruption

- The selected site is not large and a staging area will need to be identified. Possible locations include the parking lot adjacent to Building 231 or the open area by Building 411 (anticipating later construction of the parking structure).
- Renovation of adjacent Building 230 is planned. Any exterior changes could be coordinated with the SRM construction.

### Special Purpose Laboratory Additions and Renovations, and New Specialty Laboratory Buildings

Specialty Laboratory renovations, addition and new construction are individual projects that will proceed independent of other campus changes.

#### Components: Individual Projects

- New Wind/Fire Tunnel Facility
- New Strong Floor Laboratory
- Addition: Robotics Test Facility, Building 207
- Addition: NCNR Laboratory, Building 235
- Renovation: Engineering Mechanics Building, Building 202
- Renovation: Fluid Mechanics Building, Building 230
- Renovation: Industrial Building, Building 231
- Renovation: Sound Building, Building 233
- Renovation: Non-Magnetic Buildings, Buildings 237 and 238

#### Implementation Steps

1. Each project will require some modification of access drives, loading zones and adjacent landscaping.
2. The renovation projects will take place in functioning buildings, and will require a phasing plan that minimizes disruption to ongoing research, and protects the staff and equipment.

#### Disruption

- Each project is outside the dense campus core, and is not expected to disrupt daily activities. Staging areas and construction parking must be established for each project.

### Advanced Measurement Laboratory Building

The addition will expand the capabilities for precision measurement research and user facilities, and is intended to be an extension of the existing complex.

**Components**

- Laboratory building construction.
- Tie in to Building 216.
- Solar panel removal/replacement.
- Parking removal/roadway modification.

**Implementation Steps**

1. Solar Panels. The proposed location of the new laboratory building is on the site of existing solar panels. These must be moved or replaced in a new location.
2. Modification of the parking lot to east of Building 218, reducing the parking spaces and changing the access.
3. Construction of the new laboratory building.
4. Renovation of the eastern end of Building 216 to allow the tie in of the new facility.

**Disruption**

- Little disruption of campus activities is anticipated.
- Particular attention to vibration control is required to minimize research disturbance in adjacent Building 216 and nearby Building 218.

**Site and Landscape Improvements**

These individual projects can be implemented immediately, gradually or with the phased construction projects.

- East-west Pedestrian Walkway. The project includes sidewalk modification, landscaping, lighting and benches from the central campus to the proposed CCT transit station. This should tie into the Building 301 dining terrace and landscaping.
- Courtyard Activation. The project adds seating areas to the courtyards between GPLs. This can be done immediately; if not, this should be done with the GPL renovations.
- Stormwater Management Features. Bio-swales and rain gardens are proposed to improve existing stormwater management.
- Walk and Multi-Use Trails. The proposed walking trails can be implemented gradually, in segments.
- Meadow Replacement. Meadow replacement will begin by limiting grass mowing.
- Reforestation. This is a continuation of NIST's tree-planting program.

# Design Guidelines

## CHAPTER 11

**T**HE Master Plan, as a physical framework for development, was formed around core design and organizational principles that address the goals for a future NIST Gaithersburg Campus. The Master Plan Steering Committee and administration selected a physical Master Plan concept that preserved the campus character, met their functional goals and added flexibility for growth and change. The design guidelines focus on the key characteristics that would maintain those opportunities.

Creating a lasting, functional campus requires a consistent design focus with a set of flexible rules. The illustrative plan indicates the preferred Master Plan growth, but recognizes that there needs to be flexibility in its implementation. The design guidelines are the tools that anchor the design planning principles for a cohesive whole. The master plan design guidelines address three objectives:

- Ensure preservation of the character defining features of the historic district, and compliance of construction and renovation projects with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*.
- Identify the key architectural, landscape, and urban design features of the campus, and provide guidance so that future improvements preserve them.
- Establish sustainable methods for infrastructure improvements.

NIST is proud of its historic campus and endeavors to be a responsible steward. Preservation efforts do not freeze the campus in time, or compromise its effectiveness. Growth and development will need to support NIST's organizational goals without the loss of historical and architectural integrity.

These guidelines are specific to the Gaithersburg campus, and are intended to supplement any Department of Commerce standards and polices. They provide direction

that preserves Master Plan decisions, yet flexibility to allow latitude in responding to future programs. Diagrams and sketches in these sections illustrate underlying principles rather than actual designs.

These design guidelines cover several different design elements:

- Campus Organization—zones for facility types.
- Architecture—volume, scale, mass, height, color palette, orientation and connections, as well as materials that conform to current building character.
- Urban Design—view sheds, siting, setbacks, building rhythm and spacing.
- Landscape—stormwater management, reforestation, planting, paving and preservation of character-defining landscape features.
- Circulation—roadways, parking and bicycle support, pathways and paving materials.

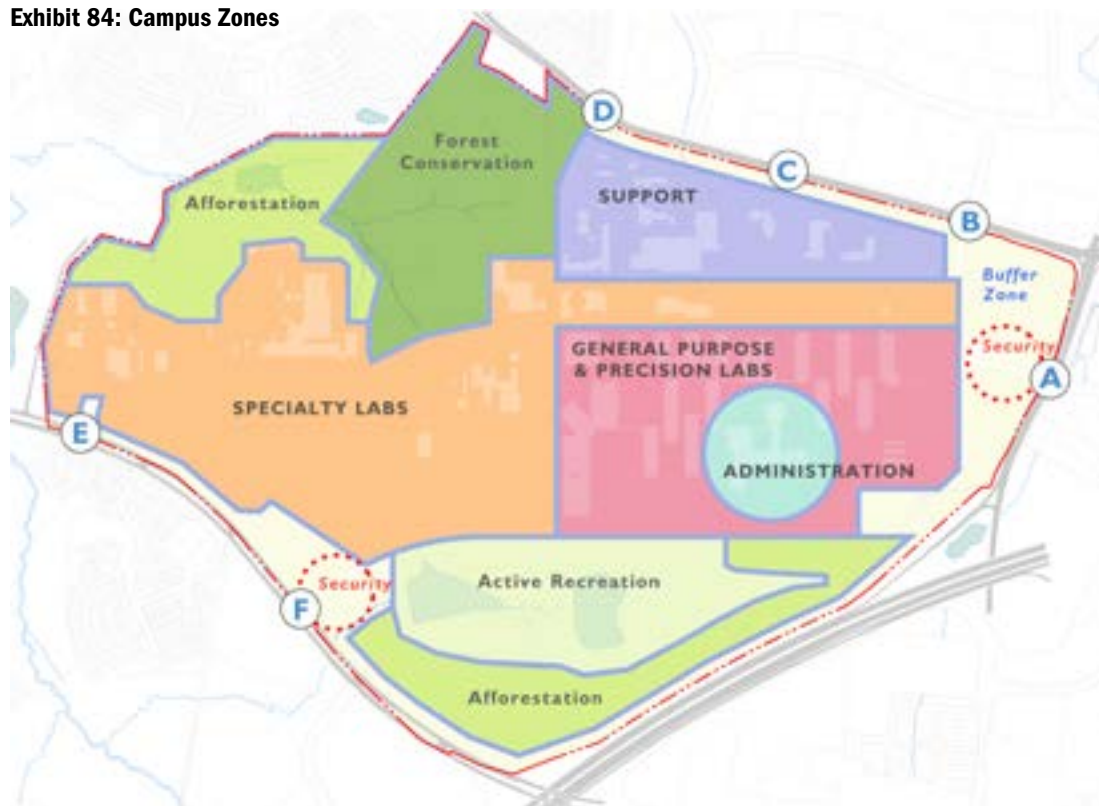
## Campus Zones

The existing land use zones give order and clarity to the campus, and the Master Plan recommends that future development preserve them. The buildings within the zones are also quite distinct. The entire campus is eligible for listing on the National Register of Historic Places, and the Section 106 process applies to all buildings. For these guidelines, an overlay is designated for the area with the highest concentration of resources contributing to historic district eligibility. This overlay is designated as the **Campus Core**, and some of the Guidelines apply primarily to that area.

The campus has eight distinct land use zones based on the functions that each accommodates.

- a. General Purpose and Precision Lab Zone: General Purpose Laboratory (GPL) buildings (Buildings 220 through 227) and the precision labs (Buildings 216-219) constitutes the majority of the campus center. The GPLs are among the earliest buildings on the campus and follow a distinctive pattern in terms of form, mass, configuration, and juxtaposition. GPLs are considered contributing resources to the historic character of the campus. Shops Building 304, which supports the GPLs, is within this zone.
- b. Administration Zone: As it has been since the inception of the campus, the 11-story Building 101 tower serves as the iconic heart of the campus. With executive and administrative offices, as well as major public spaces for staff and visitors, it is the primary visual landmark and destination on the Gaithersburg campus. Much needed new administrative space, as well as the space needed by the planned removal of temporary Building 411, is planned for areas adjacent to Building 101.

- c. Support Zone: The western campus area houses most of the support functions and infrastructure buildings. These include Supply and Plant Building (Building 301). Emergency Services Building (Building 318), Child Care Center (Building 320), and various maintenance, plant and equipment facilities. One existing laboratory—Sound Building (Building 233)—is within this zone. These buildings typically are low profile and single story.
- d. Specialty Lab Zone: The specialty lab zone sits outside the campus core, on the west and south. The buildings in this zone flank Center Drive south of South Drive, and also along the west side of Center Drive north of South Drive. As suggested by the name, these laboratories serve unique functions and vary widely in their shapes, sizes and profiles.
- e. Forest Conservation Zone: Located along the south west boundary and to a lesser extent on the north-east boundary of the campus, these are areas that have dense clusters of well-established, mature trees. The Forest Conservation Plan from 1995 established these areas as well as noted a need to add 29 additional acres of forests to meet a 15% afforestation target.
- f. Afforestation Zone: These are areas adjoining the Forest Conservation Zone that are best suitable for afforestation efforts to meet and exceed the 15% forested area target identified in the 1995 Forest Conservation Plan.
- g. Active Recreation Zone: NIST employees have expressed strong interest for planned active recreation areas in the campus. Most of the existing active recreation areas are located east of the campus core. The master plan recommends enhancement in active recreation opportunities within this area.
- h. Entrance Security and Perimeter Buffer Zone: The NIST Gaithersburg Campus has stringent requirements for entrance and perimeter security. This zone, located along the campus road frontages, is intended to accommodate the necessary buffer and entrance security infrastructure for the campus.

**Exhibit 84: Campus Zones**

## Architectural Design Guidelines

The architectural design guidelines define the form, bulk and location of the principal buildings, landscape features and planning considerations for future campus improvements that complement and reinforce the Master Plan principles.

### Historic District Context

The entire NIST campus has been determined eligible for listing in the National Register of Historic Places by the Keeper of the National Register and is a historic property as defined in 36 CFR 800. New construction and work to existing buildings should comply with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*, to the degree possible. Adoption of the Secretary's *Standards* for new construction, will assure architectural compatibility in scale, massing, size, and overall design with existing historic building stock and landscapes. In addition, application of the Secretary's *Standards* may streamline compliance with the requirements of Section 106 of the National Historic Preservation Act. Consistency with the *Standards* may result in a finding of no adverse affects under 36 CFR 800. The ten Secretary's *Standards* outline an approach to facilitate the continued use of historic properties and to new construction while retaining character-defining design features. The *Standards* are accompanied by guidelines for general and specific rehabilitation strategies.

### Contributing Resources

The GPLs and Building 101 are among the 24 contributing resources to the NIST Historic District. (See list ahead.) Character-defining elements of these buildings and/or landscape features should be retained and preserved. New construction should avoid the alteration or removal of the historic features, materials, and spatial relationships that characterize the property. The most common types of projects likely to be completed at NIST include new construction, rehabilitation, and the construction of additions. The Secretary of the Interior's *Standards for Rehabilitation* identifies approaches to each of these types of projects, which ensure the historical integrity of the NIST historic district.

#### A. New Construction

New construction projects should be compatible in size, scale, massing, design, and materials with the buildings in the historic district without duplicating the designs of those resources and creating a false sense of history. New

### Secretary of the Interior's Standards for Rehabilitation<sup>1</sup>

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.
10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

<sup>1</sup> *The Secretary of the Interior's Standards for the Treatment of Historic Properties*; US Department of the Interior, National Park Service, Technical Preservation Services, Washington DC; 2017.

construction should be clearly differentiated in design from the historic buildings and should not detract from the integrity of the historic district, as a whole.

#### B. Rehabilitation

Rehabilitation is the process of returning a historic building to a state of utility through repairs and/or alterations that are necessary to support contemporary use while preserving the building's character-defining features. Rehabilitation is undertaken applying the Secretary of the Interior's *Standards for Rehabilitation*, when possible, and is the preferred treatment for contributing elements of the NIST historic district.

#### C. Additions to existing historic buildings

Additions clearly should be differentiated in design from the historic building while being compatible in size, scale, mass, design, and materials with the historic building. New additions should not mimic or replicate historic designs. Additions generally should be sited to the rear of the principal building or adjoin a secondary elevation. All additions should be subordinate to the design hierarchy established by the historic property.

Original designed landscapes and landscape features are contributing elements to the historic district and should be retained where possible. Historic landscape materials, such as the Newton Tree, should be preserved using the least invasive approach possible. This method could be accomplished through temporary or permanent measures. Elements of the landscape, including the spatial organization, topography, vegetation, circulation, and water features should be protected and preserved.

Plans for modifications to non-contributing resources should emphasize compatibility with the character-defining qualities of adjacent contributing resources, if present; with contributing resources within the viewshed of the modification; and with the qualities that characterize the integrity of the historic district as a whole, including historic buildings, landscapes, and infrastructure. The establishment of a Design Review Board, comprised of members of OFPM's Planning, Historic Preservation, Life Safety, Grounds, and Design and Construction teams, is recommended to support consistency with the Secretary of the Interior's *Standards for Rehabilitation*, as well as consistency in application of the Master Plan design guidelines.

## View Sheds

Preserving and enhancing view sheds are important considerations for urban design, as they are an integral component of the campus character and experience. Campus views are dominated by the iconic Building 101 tower, the expansive grassy areas, and the mature trees.

Visitors and employees entering the campus through Gate A heading to Building 101 primarily see the trees at the south end of Bureau Drive and the grassy areas flanking them. Building 101 tower appears briefly as they are about to turn south from North Drive, forming the first significant view (View 1).

The allée of trees that greets the entrants after their south-bound turn leading to the gate and the gate posts are also unique parts of the first images of the campus (View 2).

The view from the east parking lot of Building 101 (View 3) is another significant view, as it is the largest parking lot on the campus and heavily used by visitors, employees and conference attendees. The approach to the Building 101 tower dominates the view from the parking area.

Building 101 also dominates the viewshed for visitors and employees approaching from Gates A, and F. The low profile of Building 216 helps maintaining this view. (View 4.)

If and when CCT becomes operational, the view from Research Drive looking at the core will become important for employees arriving through the relocated Gate C. This view is dominated by trees and the low-profile connector between Buildings 304 and 223 (View 5). The open space to the west of Building 304 maintains the view to Building 101 from the west campus, and should not become a building site.

The Master Plan ensures that these views remain unimpeded with the proposed improvements. The conference and office addition to Building 101 should be low-profile and should not visually interrupt the dominant presence of the tower. The landscape improvements along Research Drive will make minor changes to how the approach view is framed. The AML addition will be in keeping with low profile of Building 216. This will ensure that the tower remains as visible and as dominant in the approach view for entrants from Gate F.

There are other views within the campus core. The structured planting and mowed lawns between the laboratory buildings



**Exhibit 85: Prominent views**

Views show how Building 101, the tallest building on campus, is visible from many campus locations, helping to orient staff and visitors.



View when arriving from planned CCT

Visitor's first view of Building 101

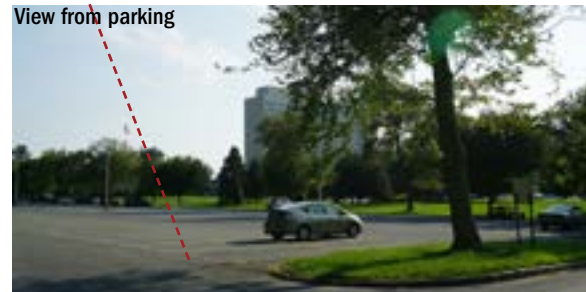


Scenic entry drive

View from Gate F



View from parking



are maintained in the Master Plan. Limiting the height of the conference addition to Building 101 also ensures that the office areas in the tower continue to have unobstructed natural views of the northern periphery of the campus.

Finally, the appearance of the connectors between the GPLs is a visual component of the suburban design of this campus. The connectors for the future research buildings should maintain this visual coherence with transparency.

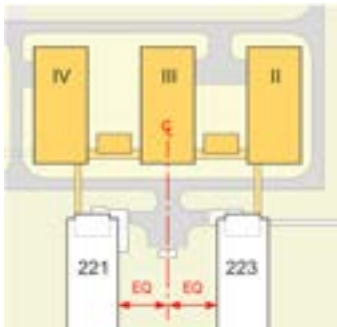
### Building Organization/Geometry

The integrated nature of the buildings and open spaces is intrinsic to the architectural character of the NIST Gaithersburg campus. Appropriate siting and orientation of buildings help enhance the character of a campus. The building orientations both define and differentiate the adjoining open spaces particularly in the historic core of the campus.

#### Building Orientation: Campus Core

Buildings in the core, both the GPLs and the office tower, are typically rectangular and elongated, with the longer dimension aligned east-west. The new buildings should conform to this orientation.

**Exhibit 86: Building Alignment**



All primary building entrances are located on the short sides of the GPLs—on the spines and/or facing the roads. The new research buildings should maintain this configuration. Entrances should be clearly marked or articulated and be visible from a distance.

Research Buildings II, III, IV should align with the existing Buildings 221 and 223 by centering the axis of the new building III on the courtyard between 221 and 223.

Building orientation should also consider service delivery and allow for loadings docks that are located away from user entrances. Deliveries to Buildings II, III and IV should be from Center Drive, because Research Drive is envisioned as a new pedestrian thoroughfare for much of its length. To the extent possible, entrances shall be configured such that they are free from snow drifts and accumulation.

The entrances shall also be directly connected to campus pedestrian networks and be proximate to bike racks/ bike locker areas.

#### Celebrate Daylight: All Buildings

Welcoming daylight into the buildings is a NIST and DoC goal, both for employee well-being and energy savings. The existing and planned research buildings in the campus core are

oriented with windows facing north-south—good for daylighting interior spaces with minimal glare. Guidelines for new construction, to be considered within the Secretary of the Interior's *Standards*:

- Generous windows are assumed for the personnel-oriented spaces such as offices and workrooms. High vertical window dimensions, paired with high ceilings are preferred, to maximize the daylight penetration.
- Windows should be appropriately shaded for their orientation to prevent glare. In general, enclosed offices and spaces should not be located along the windows; instead open work areas should face the windows.
- NIST has not introduced daylight into recent laboratory designs, because research protocols are often sensitive to light and temperature variables, and many researchers do not want windows in their labs. However, opportunities for daylight should be discussed in depth when planning specific facilities. If daylight is not desired, then spandrel glass may be used when the exterior appearance dictates a glazed surface treatment.
- Some research laboratories, like those for the Information Technology Laboratory, are computer oriented. Much like office space, these labs could benefit from natural light, but it is critical that glare, intensity and reflections be controlled.
- The new shipping and receiving building should be primarily daylighted, using clerestories, rooftop monitors, skylights, as appropriate.
- Windows, roof monitors and/or skylights should be used to illuminate circulation areas when practical.
- High performance glazing with high visual transmittance should be used.

#### Introduce Interior Spatial Variety: All Buildings

Most of the campus buildings house enclosed spaces with doors, whether laboratories, workshops, or conference rooms—making the corridors and lobbies the connecting, orienting and community spaces.

- Cohesion of design should not equate with sameness. Visual variety and orientation are important considerations when planning the new buildings, especially the research buildings.
- Collaboration opportunities should be created and made convenient, visible and inviting. Examples include: a nook

off a research hallway with a whiteboard; a kitchen area with a glass wall; a widened hallway with view window and seating. While flexibility is important, an intended collaboration space should not be configured like an office-in-waiting.

- The NIST Laboratories celebrate and share their work on the corridor walls in the research buildings. New buildings should provide for this display of projects and reference materials. Consideration should be given to the display of three-dimensional research artifacts.
- Daylight should be introduced into corridors whenever possible.

## Building Connectivity

**Exhibit 87: Building Connections**



### Maintain and Extend Interior Concourse: Campus Core

All buildings in the campus core are connected by a pedestrian concourse, running primarily north-south with intermittent east-west connections. The new research buildings should be located to enjoy and enhance this connectivity. Proposed Research Building I, north of Building 227, should continue the alternate juxtaposition of research buildings along the west spine of the core. Proposed Research Buildings II, III, IV on the west side of the core form a parallel but short north-south spine with the wings running east west, again conforming to the originally intended layout and configuration of the GPLs.

### Reinforce Interior—Exterior Connections: All Buildings

The connectivity within the buildings and to the outdoor pedestrian networks is vitally important for NIST, especially within the campus core. NIST desires a balance between strong connections and building security.

- Federal physical security policy limits the movement of unaccompanied visitors beyond the major public areas of the 1st floor of Building 101. Visitors can walk or drive to most of the buildings on the campus, although access is restricted and controlled. Certain functions are not to be accessible to guest researchers, and certain others are accessible to only authorized NIST personnel. This requires planning for selective permeability in the newly proposed buildings and building connectors.
- The proposed buildings should not simply define or enclose an open space but should also actively engage them. It is important to have ground floor levels of buildings to open up to active outdoor spaces where appropriate. The building interiors around those access points should complement the outdoor spaces. When weather conditions prevent use of the outdoor spaces, complementary indoor spaces should be designed to foster informal interaction.

### Building Massing

The NIST campus, especially the campus core, has a distinct architectural expression in terms of scale, height, setbacks, spacing and fenestration. New buildings, while first designed to match their function, must also respect the campus-wide historic district and the *Secretary of the Interior's Standards for the Treatment of Historic Structures*. Compatibility in scale, mass, proportion, color and materials should be an objective.

### Building Massing: Campus Core

Building massing and articulation should be compatible with the massing and patterns of articulation found in historic building stock. New designs should not duplicate historical patterns, but relate appropriately to the design principles expressed in the existing buildings through compatible scale, design, materials, color and character. (See *Secretary of the Interior's Standard* number 9.)

- Research buildings should follow the established pattern of buildings separated by landscaped courtyards. The lawns, planting, and the orthogonal pedestrian connections are intrinsic to the fabric of the core.



Typical Ground Level Connector

- The buildings should be rectangular in plan, of simple geometric form with regularly articulated or modulated facades, capped by flat roofs that do not extend beyond the wall plane. Some buildings may have set-back penthouses.
- New buildings should respect the height of the existing fabric. The Master Plan shows advanced GPL research buildings with three occupied stories plus mechanical penthouse, which is the configuration of the existing GPLs. The AML building should follow the height and massing of the adjacent Building 216.
- The three office additions to GPLs should be clearly differentiated from adjacent buildings and compatible with the district and GPLs. They should match the width of the GPLs and connect directly to the existing floors.
- Mechanical equipment should be set back from the primary and other highly-visible elevations so it is inconspicuous when viewed from surrounding streets. New roof-top mechanical equipment should be installed so that it is minimally visible.
- The Building 101 addition footprint completes the pin-wheel of public spaces that rotate around the tower at the first floor—now, auditorium, cafeteria, and library. It is expected to be two or three stories above-grade, keeping its height generally below the windows of the office tower.

#### Exhibit 88: Heights and Set-backs, Isometric View looking Southwest



1. Heights of the renovated and new GPL/Precision Laboratory blocks should remain comparable to current GPLs.
2. Heights for the mechanical penthouses and stair blocks for renovated and new GPL/Precision Laboratories should remain comparable to current GPLs.
3. The spacing between adjacent GPL/Precision Laboratory buildings should generally be maintained.
4. The renovated and new GPL/Precision Laboratory buildings should generally maintain the minimum setbacks from the road and maintain the current alignment and rhythm.
5. The height of the Conference Facility addition to Building 101 should be comparable to the Library Block and existing Conference block.
6. The minimum setback from the road for the Conference Facility addition to Building 101 should be comparable to the minimum setbacks for existing Conference block.

## GPL Facade



- New pedestrian concourse connections should not be more than two stories above the ground level, depending on purpose. The proposed east-west connectors linking buildings 221 and 223 with new Buildings II and IV are planned at an upper level to facilitate pedestrian and vehicle movement along Research Drive.
- The parking areas, a character-defining feature of the historic landscape, also contribute to the orthogonal grid of the campus core, and as originally designed, they feature a steady setback from both the roads and the buildings. This articulation should be retained, as well as the strictly rectilinear (as opposed to angular) arrangement of parking spaces.
- The consistent building set-backs from roads and parking lots should be respected.

### Building Facades

The visual cohesion of the campus comes not only from repetitive forms, but also from the facades, materials and colors used. New buildings should be compatible with, but not duplicate the building facades, materials and color palette utilized in the historic building stock. Rather, the new construction should be clearly distinguishable from historic fabric and compatibly relate to the historic design.

The original campus buildings are brick, following a pattern of buff-colored brick for research buildings, and red brick for support buildings. These materials and colors contribute to the cohesive and calm look of the campus. New buildings should respect these color designations.

#### Building Facades: Campus Core

The original research buildings in the core are similar in materials, colors and façade characteristics. Some of these characteristics are shared by original buildings outside of the campus core, although those outside the core have more variety in design, materials and scale to suit their specific function. Common campus core features are the following:

- The facades are vertically oriented, with alternating bands of window and brick wall. Windows are set directly above each other separated by metal panels, forming a continuous ground to fascia line. This characteristic also appears in original campus buildings outside of the Campus Core, such as Buildings 245 and 301.

- A continuous metal fascia caps the laboratory buildings, dark in color and contrasting with the buff-colored brick. Penthouses are integrated or set behind this fascia.
- The facades are flat and unadorned. The entrances are typically on the short ends of the rectangular research buildings, covered with horizontal canopies. Other openings, such as the Building 101 entrance and laboratory loading docks, share this horizontal overhang detail.
- Building trim is stainless steel or aluminum.
- Windows are mounted on, rather than set into, the masonry openings, extending slightly beyond the brick face.
- Distinctive rooflines accent Building 101, including a folded-plate walkway to Building 225, a scalloped roof on the cafeteria and a swooping roofline over the auditorium. The Master Plan recommends that the new walkway from Gate A reflect this characteristic with a folded-plate covering.
- The proposed parking structure is within the campus core, and its facade must be sensitive to the core's visual features and materials. Adequate setbacks from South Drive, Research Drive and West Drive with a landscape screening of trees may be appropriate.

The Master Plan recommends that NIST create a Design Review Board to review and approve major capital improvements to buildings and grounds. This board would establish a predictable process for assuring that projects are consistent with the Master Plan, Secretary of the Interior's Standards for the Treatment of Historic Preservation, NIST standards and mission goals. The composition of the Board should include representatives from all related OFPM organizations.

## Exhibit 89: New Campus Core Landscaping



## Landscape & Site Guidelines

Landscape features, both plantings and hardscape, contribute to the historic campus visual and functional cohesion. As a contributing element to the historic district, the landscape articulates the campus spatial organization, with a pattern of courtyards alternating with buildings in the campus center. Beyond the campus core, the treatment is a less formal, attractive suburban setting.

- Landscape projects and buildings should be implemented together; each project includes the proximate planning, social spaces and pedestrian circulation.
- Reinforce the east-west pedestrian pathway from Building 101 to the proposed CCT station, with sidewalks, trees and seating. Transform the segment of Research Drive between Building 304 and new Research Building II to a pedestrian way, changing the paving and limiting traffic.
- Maintain the pattern of buildings with courtyards in the campus core.
- Create social areas in the courtyards and around buildings. Begin with temporary furnishing, to more permanent settings if successful.

### Landscape Design Language: Features, Materials, Furnishings

The NIST campus landscape design language considers three different but related zones of development and landscape features: the formal historic core; new development areas; and the greater campus.

#### Historic Core

The historic core is the formal center of the campus, encompassing the main courtyard with surrounding space—cafeteria, library, auditorium, administration building, and future conference center. These spaces welcome visitors to the campus, and host events and social amenities for staff. This area is more public, activated, and characterized by more ornamental materials and furnishing. The existing surfaces should be restored and maintained, and new surfaces should reflect those materials. Significant paths should use granite pavers to match either the Library plaza, the Building 101 entrance, or the Auditorium plaza. The dimensions should match the proportions of existing pavers. The asphalt sidewalks that currently run through the Library courtyard should be replaced with more formal,

edged concrete paths. Site walls in this area should use marble coping, with either granite or tinted concrete veneer. Handrails should be brushed steel to match existing conditions. New furnishing in this area should match the aluminum and steel furnishing in the newer parts of campus. Lighter profile furnishing will be less cumbersome on the landscape, and will highlight the modernist design features of these prominent buildings.

### **New Development Areas**

Newer buildings on campus, like the AML Labs and the NCNR additions, display a materials palette that reinterprets the greater campus materials to become more streamlined and modern. These spaces use brushed concrete, silver steel and aluminum furnishings, glass with the tan brick. New development that is planned—around Research Buildings II, III, and IV, the pedestrian promenade, renovation at Building 245, and the new campus entrance—should reflect these newer materials. Furnishings should be contemporary aluminum and steel, and walkways should be edged, brushed concrete.

### **Greater Campus**

Throughout the majority of NIST's campus, there are custom furnishings and simple site materials. In those areas not subject to extensive development, this palette should be maintained. Drive aisles and parking should remain asphalt, and sidewalks should remain concrete. Litter bins should match existing exposed aggregate receptacles. Furnishings should be selectively added where outdoor seating is desired.

### **General**

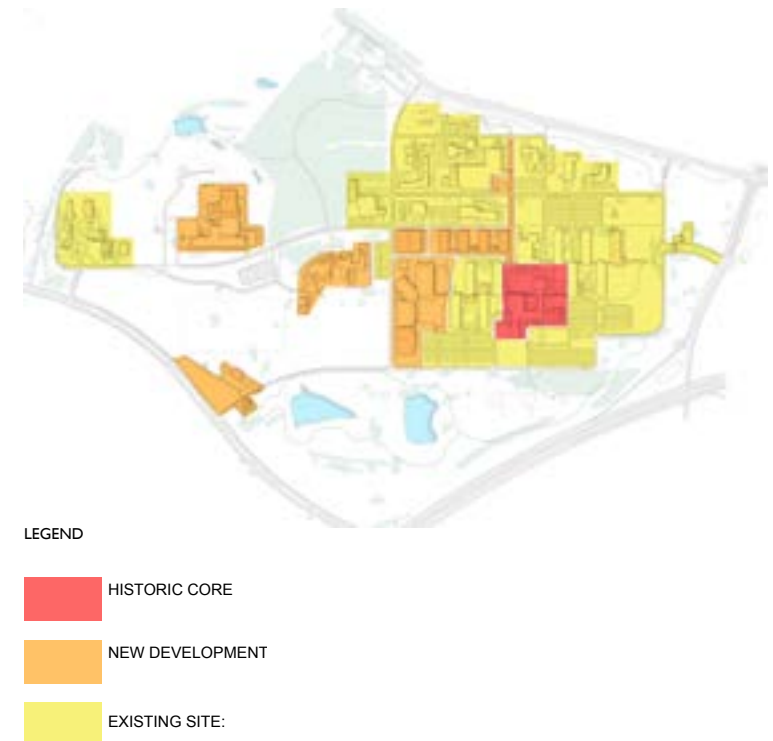
Materials not appropriate for the landscape in any zone are wood, plastic, red brick elements, and brightly colored materials or furnishings. A comprehensive signage program should be initiated to better identify buildings, improve wayfinding and update the campus graphic image. Outdoor displays and/or markers should be considered along the trails and near research buildings.

### **Campus Lighting**

Original to the Gaithersburg campus are custom light poles with angled arms, which are placed along streets throughout campus. These light poles should continue to be used along streets to maintain consistency. Within the pedestrian scale, there are illuminated bollards lining sidewalks. Around the Library courtyard, the bollards are textured concrete. Building 101 and bollard style should blend with the other materials in their zones. In the Historic Core zone of campus, the concrete

bollards should be used; in the New Development zone of campus, aluminum bollards should be used to match the materials in these spaces.

**Exhibit 90: Design Language Zones**



## Historic Core Landscape Design Features

The design features shown to the right serve as a visual vocabulary and inspiration for future, formal, outdoor spaces that reference campus landscape design tradition.

### 1. Orthogonal Elements

Reinforcing the Modern architectural design of the late 1950s and the 1960s, the prominent landscape architectural elements are all orthogonal with minimal ornamentation. The designed landscape and hardscape reflect this design pattern. Shapes are rectangular, and lines are long and solid, vertical and horizontal. Most of the landscape stands in stark contrast to this, as trees and ornamental planting are loose and organic. Only street and parking lot trees are planted linearly to reinforce the orthogonal campus core structure. Future designed spaces should reflect the design intent and avoid curvilinear forms and overly ornate details.



The built, orthogonal elements contrast the loose, organic forms of the willowing spruce trees



Orthogonal detailing of a column, pavers, stairs, and handrail

### 2. Repetitive Patterns

Across the building facades and throughout the site, elements are repeated to create patterns and banding. These patterns typically follow an A-B-A-B scheme, using either two alternating materials, colors, dimensions or heights. Outdoor programmed spaces should include this pattern making within structures, walls, and paving patterns.



This covered walkway has an alternating pattern of high and low points in its canopy



There is an alternating pattern between the columns and the barrier wall



Alternating paving pattern



### 3. Layering Of Levels

Within the courtyard and major building entry plazas, there is a stacking of spaces to accommodate the change in topography, and to allow people to comfortably make this transition. These terraced spaces are defined by low walls and short, deep stairs. New courtyards and plazas should incorporate elements at varying heights including: low walls, large stairs, and terraced spaces over grade changes. Areas outside of the campus core, or within the core, but not part of a formal courtyard or plaza should follow the topography and maintain a simple aesthetic.



The internal courtyard at the cafeteria is informed by a series of long, low layers at varying heights



The formal entrance to Building 101.

### 4. Massive Scale

The built elements throughout the buildings and hardscape are large and monumental. Building facades, columns, windows, pavers, and site furnishings are significantly taller, wider, and larger than the human scale. This makes the buildings and outdoor spaces feel significant and commanding. Future core campus hardscape should continue the use of monumental scale. Where possible, pavers, wall veneers, and furnishings should be selected to match the existing materials and scale.



Large pavers with oversized platform benches



Building 101 Auditorium

**Exhibit 91: Appropriate Site Materials**

Material	Color/Finish	Surface	Location
Concrete	Broom finish	Paving Site/Retaining walls	Campus wide
	Exposed aggregate	Furnishing—litter bins	Campus core
	Tinted—grey	Vehicular grade paving	Pedestrian zone near research buildings Pedestrian promenade in the library courtyard
Asphalt	Dark grey	Paving	Campus wide: Roadways Parking areas
Granite	Grey	Paving Stair treads	Library plaza Pedestrian promenade Cafeteria patio Building 101 courtyard Auditorium plaza
	White	Paving	Library plaza Pedestrian promenade
Marble	White	Wall coping Column coping	Building 101 entrance Auditorium Library
Brick	Buff	Exterior walls	Research buildings
	Red	Exterior walls	Service and support buildings
Aluminum	Brushed	Furnishing	New development
	Galvanized	Furnishing	Campus wide
Steel	Brushed	Handrails	Campus wide
	Stainless	Furnishing	New development
Gravel	—	Access drives	Southern campus
River rock	Rounded, smooth	Stormwater features	New development

**Existing Campus Materials and Furnishings**

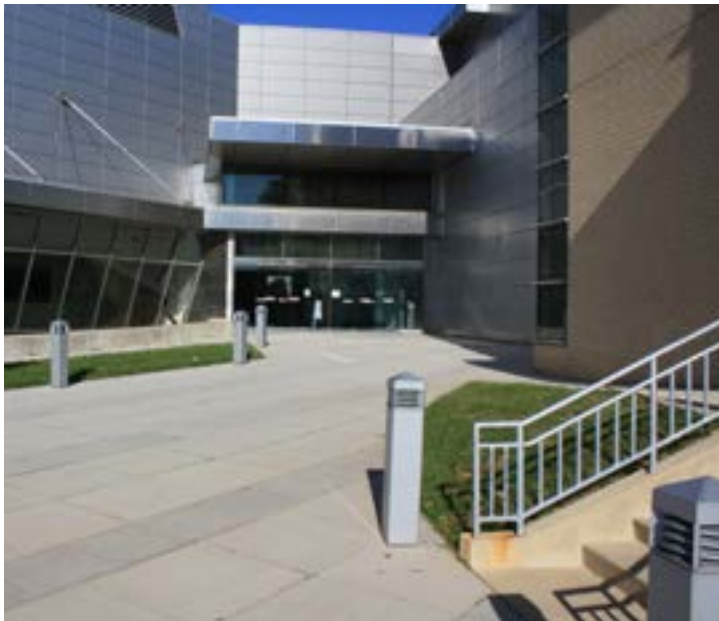
Dining table—Building 101 courtyard



Decorative paving—Building 101 entrance



Large white granite pavers—Historic Core



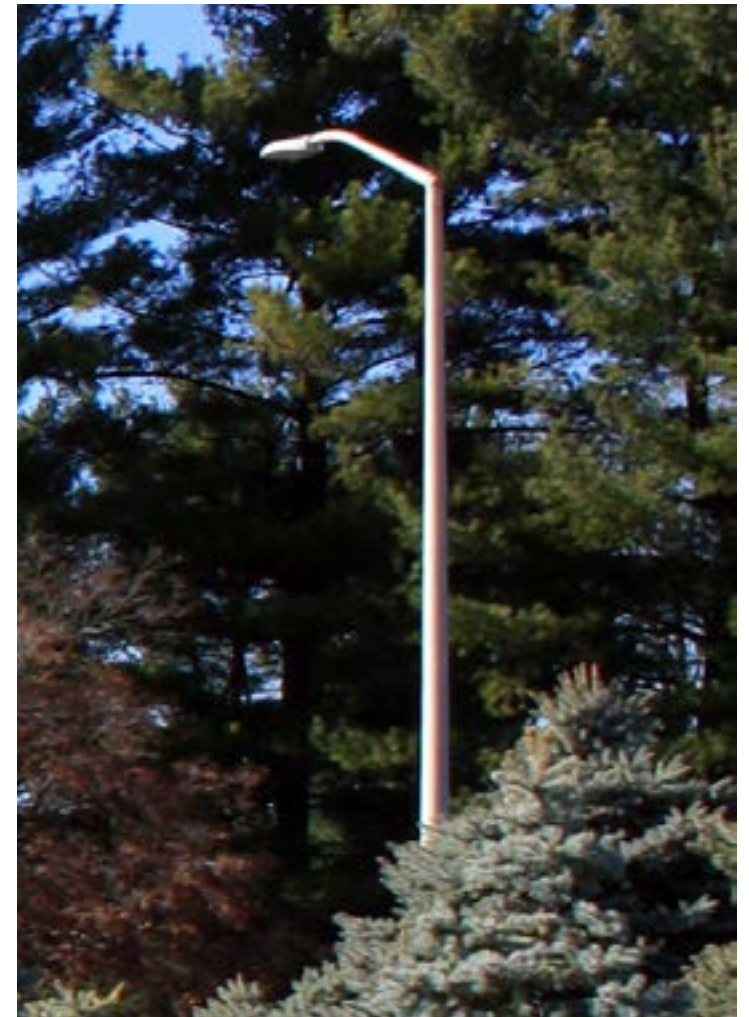
Typical materials—new development



Concrete bollard



Typical bollards



Custom light pole



Granite veneer, marble coping, steel handrail—Historic Core



Casual table



Litter bins



Typical building sign



Bicycle lockers

## Circulation Guidelines

The campus Master Plan proposes changes to the circulation system to better connect the campus for pedestrians and bicyclists. The campus is well-suited for vehicular circulation with multiple roadways connecting drivers to their buildings. Pedestrian and bicycle improvements should coincide with the construction of new laboratory buildings and the proposed parking structure in the center of the campus. Gates A and F must include pedestrian facilities (sidewalks, curb ramps, crosswalks) that are in compliance with local standards. As with other design initiatives, circulation changes must consider the Secretary of the Interior's *Standards*.

In a 2015 transportation assessment and recommendations study of the NIST campus, the pedestrian facilities were reviewed and noted that some areas did not fall within appropriate standards, based on MCDOT and SHA requirements and supported by the American Association of State Highway and Transportation Officials (AASHTO) recommendations and the City of Gaithersburg.

- Roadway cross-sections: roadways within the campus provide 24 to 25 feet of paved surface width (including gutters where used). These widths are in compliance with the City of Gaithersburg and MCDOT standards, as roadway widths, which should have a desired width of 26 feet (two 13 foot lanes) may utilize 11 and 12-foot lanes.
- Sidewalk standards: SHA technical standards state that concrete shall be used in the construction of sidewalks. While NIST is not required to meet SHA standards for sidewalks, the asphalt sidewalks within the campus would not meet this standard. Additionally, some of the campus' curb ramps do not meet ADA-compliance by MCDOT and SHA standards. It is recommended that all asphalt sidewalks continue to be replaced over time with concrete, and for sub-standard curb ramps to be replaced with compliant types.
- Bicycle racks and shelters: Covered bicycle parking near key entrances is recommended to encourage ridership. Simple, manufactured shelters are planned. Several potential locations are shown on the Campus Connectivity Plan in Chapter 5. New and replacement bicycle racks should be MCDOT-recommended "U-shape" racks rather than the typical grid style racks existing on campus.

- Bicycle routes: Bicycle signage is almost nonexistent within the campus, with cyclists using a combination of sidewalks and roadways to maneuver around. It is recommended that shared lane markings (sharrows) be installed on the pavement of North Drive, West Drive, East Drive, South Drive, Center Drive, and Research Drive. By designating these roadways as bicycle routes with appropriate MUTCD-approved signage, drivers will be more aware of cyclists and reduce potential conflicts.
- Controlled bicycle exits are recommended at Gates D (along Quince Orchard Road) and F (along Muddy Branch Road), extended to Gate E if initial installation is effective. Exits should allow employees to securely enter and exit the campus using their key cards.

## Parking

On-campus parking will be provided in existing surface parking lots and a proposed parking structure to replace two existing lots that will be lost with new research building construction. The new parking structure is anticipated to be the primary parking for the new and existing buildings, located less than a 5-minute walk from the parking structure.

Accessible parking for people with disabilities should be located as close to the campus buildings as possible. On-street parking should be prohibited along all roadways.

The following practices can be applied to the existing and proposed parking facilities in order to better the daily experience for each driver:

- A high percentage of deciduous tree cover should be utilized to shade vehicles and reduce the heat island effect of large paved areas.
- Light colored paving and permeable paving should be used whenever practical.
- Parking structure design should follow current MCDOT standards for off-street parking, including arrangement, markings, size of space, circulation, driveways, and walkways.
- Parking lot and garage design should follow current federal ADA standards on accessible design, including minimum number of parking spaces.
- Parking structure design should seek to reduce energy consumption and enhance the user experience by introducing

natural light through light wells and openings, and by utilizing natural ventilation.

- Electric vehicle charging stations are should be included in the garage, in accordance with government regulations. Six percent of NIST survey respondents stated their preference for including charging stations for personal electric vehicles, a number that is expected to grow.
  - Solar panels should be considered over the upper level of the parking structure and over existing surface parking.
  - Parking lot design should optimize the layout for snow removal, considering plowing patterns and locations for removed snow.
- Walkways must drain properly, to minimize icing.
  - Best management practices for localized stormwater management should be incorporated.
  - Pedestrian circulation should have dedicated walkways through the parking lots and parking structure.
  - Existing parking lots feature right angle parking that reinforces the orthogonal characteristics of the original landscape design. Any new parking and circulation routes should be so designed.
  - Temporary parking lots should be identified early in the planning for each construction project.





# Campus Analysis





# Regional Context Analysis

## CHAPTER 12

THE National Institute of Standards and Technology (NIST) is headquartered in a 578 acre campus located in the City of Gaithersburg in Montgomery County, Maryland. The regional context of the campus is an important component in the development of the master plan. This chapter examines the regional setting of the Institute including:

- Overview of the Region
- Demographic and Socioeconomic Environment: population, major employers, and education and cultural institutions;
- Business and Institutional Environment
- The Regulatory Environment: governing jurisdictions, comprehensive plans, zoning and other regulations;
- Transportation infrastructure; and,
- The Natural Environment: climate, topography, vegetation, watercourse, flood plains and wetlands, recreational opportunities.

### Overview of the Region

The NIST Campus is located within the center of the City of Gaithersburg, in the Interstate 270 corridor. The City, which is the fourth largest incorporated city in Maryland, is located in the geographical center of Montgomery County. The City of Gaithersburg was settled in the the mid-18<sup>th</sup> century as a small agricultural settlement. In the 1970s, there was a construction boom, and Gaithersburg slowly transformed from an agricultural settlement to a suburb of Washington D.C. which is to the southeast of the City.

The NIST campus as well as the City of Gaithersburg are part of the National Capital Region (NCR). The Region, as established by the National Capital Planning Act of 1952, includes

the District of Columbia; Montgomery and Prince Georges Counties in Maryland; Arlington, Fairfax, Loudoun and Prince William Counties in Virginia; as well as all existing and future cities within the boundaries of the included counties of Maryland and Virginia.

The National Capital Region is subject to growth pressures because of its regional and national significance. Accordingly, the pressure on the Maryland and Virginia suburban areas close to Washington, DC, like Montgomery County and Gaithersburg, always persists. The presence of the Federal Government agencies and organizations that provide services to the Federal Government together form a robust engine of economic growth in the NCR. From 1970 to 1990, the population of the Washington region increased by 35.5 percent, while the amount of land used for urbanized purposes (houses, shopping centers, office buildings, parking lots, etc.) increased by 95.7 percent.

Since 2010, however, federal employment has fallen almost 6 % and procurement outlays are down 13.6 % in the region primarily because of sequestration, and the forced budget cuts. The federal segment of the economy started shrinking from its 2010 high of nearly 40% and is now projected to fall under 30 percent in 2020. Other regional economic competitiveness is also perceived to be threatened<sup>1</sup>.

Despite the downturn, the region benefits from many strong assets: a highly-educated workforce, world-class educational and research institutions, large companies, great neighborhoods, and rich cultural, natural, and recreational amenities that attract employers and talent.

<sup>1</sup> Source: 2016 *State of The Region: Economic Competitiveness Report* published by the Metropolitan Washington Council of Governments

## Exhibit 92: The National Capital Region



## Demographic and Socio Economic Environment

The demographic and socioeconomic analysis is based primarily on the American Community Survey 5 year estimates, an ongoing statistical survey by the U.S. Census Bureau. It regularly gathers information previously contained only in the long form of the decennial census. Comparative statistics for the nation, the Northeast Region, the State of Maryland and the City of Gaithersburg have been analyzed and presented. This analysis provides insight into the immediate surrounds of the NIST campus and how it is different from the State, the region and the nation.

### Population

The campus is located within the Baltimore-Washington Metropolitan Area (a Combined Statistical Area (CSA) by the US Census designation). With about 9.5 million residents across eight

Metropolitan Statistical Areas (MSAs), the CSA was the fourth largest in the nation according to 2013 estimates. The CSA's population has been growing consistently over the recent years, registering a 4.3% increase from 2010 to 2013.

Montgomery County, with over 1 million residents, is the most populous county in the state of Maryland and is home to 17% of the state population. The City of Gaithersburg is the fourth largest city in Maryland and is home to 1% of the state population and 6% of the County population.

The gender ratio of males to females is 1:1.023 for the City compared to 1:1.037 for the County and 1:1.017 for the nation. The State, the County and the City all have a smaller percentage of the population that is 65 years or older compared to the region and the nation. The relative percentage of males in the 24 years and under group for the County and the City is higher compared to females unlike the larger geographies.

### Exhibit 93: Summary of Population

	United States	Northeast Region	Maryland	Montgomery County, Maryland	Gaithersburg, Maryland
POPULATION	314,107,084	55,805,991	5,887,776	1,005,087	63,491
24 years & under	33%	32%	32%	31%	32%
25 years to 64 years	53%	54%	55%	56%	57%
65 years & over	14%	15%	13%	13%	10%
Male	154,515,159	27,148,094	2,851,238	483,505	30,996
24 years & under	35%	33%	34%	33%	34%
25 years to 64 years	53%	54%	54%	55%	57%
65 years & over	12%	13%	11%	11%	9%
Female	159,591,925	28,657,897	3,036,538	521,582	32,495
24 years & under	32%	30%	31%	30%	30%
25 years to 64 years	53%	53%	55%	56%	58%
65 years & over	15%	17%	14%	14%	12%

**Exhibit 94: The National Capital Region**



**Education**

The Region has several institutes of higher learning within 50 miles of the NIST Campus—the nearest ones being the Johns Hopkins University—Belward Research Campus, Universities at Shady Grove, Montgomery College, Uniformed Services University of the Health Sciences, American University, Georgetown University, and University of Maryland - College Park.

Montgomery County has the 17<sup>th</sup> largest school district in the nation with schools that consistently appear near the top in nationwide rankings. The school district caters to a diverse group of students from 157 countries speaking 138 languages. This also exemplifies the cosmopolitan nature of the region.

For the 18 to 24 year old population, Montgomery County has twice the percentage of college graduates compared to the national average while the

percentage for the City of Gaithersburg has 1.6 times the national average. The percentage of females who are college graduates in the City are twice that of the males.

For the 25 years and older population, the percentage of college graduates in the County are also twice that of the nation. More than half the population within the City of Gaithersburg are college graduates whereas for the nation, it is less than a third. For the City, 54% of males are college graduates compared to 49% of females. Also noteworthy is the percentage of the population that are school dropouts within this age group who did only finished 9th grade or less—7% in the City compared to 6% for the nation.

**Exhibit 95: Educational Attainment**

	United States	Northeast Region	Maryland	Montgomery County, Maryland	Gaithersburg, Maryland
<b>Among 18 to 24 year olds</b>					
Total	31,273,297	5,494,051	565,607	77,202	4,357
Less than High School Graduate	15%	13%	13%	14%	18%
High School Graduates/Equivalency	30%	28%	29%	24%	28%
Some College or Associate's degree	46%	46%	45%	42%	38%
Bachelor's Degree or higher	10%	14%	13%	20%	16%
<b>Among 25 year old and older</b>					
Total	209,056,129	38,182,166	3,973,193	689,671	43,074
Less than 9th Grade	6%	5%	4%	5%	7%
9th–12th Grade	8%	7%	7%	4%	5%
High School Graduates/Equivalency	28%	30%	26%	14%	15%
Some College, no degree	21%	17%	20%	15%	16%
Associate's degree	8%	8%	6%	5%	6%
Bachelor's Degree	18%	20%	20%	27%	27%
Graduate or professional degree	11%	14%	17%	31%	25%

## Housing

Montgomery County as well as the City of Gaithersburg has a housing stock with a much lower vacancy rate compared to the national average. The high cost of land in the greater DC metro area as well as the cost of living has a bearing on the housing stock. Overall, the immediate region has a stronger market for attached units and rental units. Only a fifth of the overall housing stock in the City is single family; for the County, it is less than half of all units; whereas nationwide, it is three-fifths. While the City has significantly higher percentage of rental units compared to the County as well as the national averages, rental vacancy rates are much lower compared to the state and the nation. Average household size is slightly higher in the City and the County, compared to the nation.

Housing cost in the immediate region is also quite high. Percentage of homes that are upwards of \$500,000 are almost 2.7 times the national average in Gaithersburg and four times in Montgomery County. The County also has 4 times the nationwide percentage of million dollar homes.

Rental costs are also high in this region. The percentage of rental units with rent upwards of \$1,500 is 16% nationwide whereas in Montgomery County and the City of Gaithersburg it is 57% and 50% respectively. Median rents are 1.6 times in the City and 1.75 times in Montgomery County.

In spite of a sound public transportation network in the region, there are fewer homes with no vehicles compared to the national average.

### Exhibit 96: Housing Comparison

	United States	Northeast Region	Maryland	Montgomery County, Maryland	Gaithersburg, Maryland
Total Housing Units	132,741,033	23,740,329	2,399,375	380,250	24,234
<b>TENURE</b>					
% of Occupied Housing Units	87.5%	88.6%	89.9%	95.4%	94.2%
% Owner Occupied	64.4%	62.3%	67.1%	66.6%	55.3%
% Renter Occupied	35.6%	37.7%	32.9%	33.4%	44.7%
Rental Vacancy Rate (%)	6.9%	5.3%	7.0%	3.9%	3.8%
<b>TYPE OF UNITS</b>					
% Detached Single Family Units	61.7%	51.6%	51.7%	48.3%	20.5%
<b>AGE OF HOUSING UNITS</b>					
25 years (1990+)	29.9%	16.6%	27.5%	25.1%	37.4%
25-45 years (1970-1989)	29.6%	22.0%	30.3%	37.7%	48.5%
Older than 45 years	40.5%	61.4%	42.2%	37.2%	14.2%
Avg. Household Size: Owner Occupied	2.70	2.70	2.75	2.87	2.83
Avg. Household Size: Renter Occupied	2.52	2.37	2.49	2.51	2.68
Owner Occupied units	74,787,460	13,114,597	1,445,880	241,626	12,618
Less than \$100,000	24.9%	15.4%	7.7%	2.6%	5.0%
\$200,000-\$499,000	64.9%	68.9%	74.9%	55.3%	67.7%
\$500,000-\$999,000	8.2%	12.7%	14.8%	33.8%	25.7%
\$1,000,000 or more	2.1%	3.0%	2.7%	8.3%	1.6%
Median Value of Owner Occupied Units	\$175,700	\$249,100	\$287,500	\$448,700	\$363,800
Median Rent	\$920	\$1,042	\$1,218	\$1,611	\$1,504
Households with no vehicles	9.1%	17.3%	9.4%	7.5%	7.5%

## Labor Force, Employment and Earnings

The percentage of 16 years and older population that is in the labor force is 74.2% in the City of Gaithersburg and 72.7% in Montgomery County. This is much higher than the national figures (64.3%). In spite of the presence of the Pentagon as well as multiple bases in the greater Washington DC area, the percentage of the labor force in Armed Forces is not significantly higher than the nationwide percentages.

Gaithersburg is in the Baltimore–Columbia–Towson Metropolitan Statistical Area, which has the fourth-highest median household income in the United States. The median household income for the City and the County are respectively 53% and 83% higher than the nation's. For the civilian employed population, nationally, the median income for men exceed the median income for women by 41%. In the state of Maryland and the City of Gaithersburg, difference is 35% and 36%.

### Exhibit 97: Labor Force and Employment

	United States	Northeast Region	Maryland	Montgomery County, Maryland	Gaithersburg, Maryland
POPULATION OF 16 YEARS AND OVER	246,191,954	44,849,079	4,645,779	781,128	48,045
Females	51.3%	52.0%	52.2%	52.7%	53.7%
Males	48.7%	48.0%	47.8%	47.3%	46.3%
% in labor force	64.3%	65.0%	69.2%	72.7%	74.2%
% in civilian labor force	99.3%	99.8%	99.1%	99.3%	99.6%
% of civilian labor force unemployed	9.7%	9.2%	8.2%	6.3%	6.3%
% in In Armed Forces	0.7%	0.2%	0.9%	0.7%	0.4%
% not in Labor Force	35.7%	35.0%	30.8%	27.3%	25.8%
NO. OF HOUSEHOLDS	115,226,802	21,000,807	2,138,806	357,579	22,474
No. of Families	76,595,548	13,705,777	1,432,382	244,586	15,002
% of married-couple families (of all families)	73.7%	73.0%	71.7%	78.0%	72.4%
Median Household Income	\$53,046	\$59,576	\$72,999	\$96,985	\$81,178
Median Family Income	\$64,585	\$74,030	\$88,092	\$116,846	\$101,275
MEDIAN EARNINGS					
Civilian employed population 16 years and over	\$33,829	\$38,392	\$43,923	\$52,036	\$44,510
Male	\$40,225	\$44,841	\$50,445	\$60,500	\$51,941
Female	\$28,476	\$32,215	\$38,722	\$44,729	\$38,180

## Business Environment<sup>2</sup>

- NIST is located about 15 miles from Washington, DC. It is the largest employer within the City of Gaithersburg, which is hub for high-tech companies. According to its Office of Economic Development, the City is home to more than 4,000 businesses.
- The region is recognized as a center of biotechnology with more than 350 bioscience companies and more than 75 of them being in the City of Gaithersburg area. According to the Milken Institute's 2012 State Technology and Science Index, Maryland led the nation in per Capita Research & Development Expenditures on Biomedical Sciences and Life Sciences.
- Information Technology is another strong sector in the region. Montgomery County is home to more than 1,200 firms and 90,000 employees engaged in a wide variety of Information Technology (IT) services. The Milken Institute's 2012 State Technology and Science Index, ranks Maryland second behind Massachusetts and ahead of California in the index's overall scoring.
- The Region's strengths in bioscience and infotech sectors can be attributed primarily to the presence of major Federal agencies and research facilities, proximity to world-class universities. In FY 2013, Federal government

**Exhibit 98: Largest Employers in the City of Gaithersburg<sup>2</sup>**

Company	Employees
National Institute of Standards & Technology (US Department of Commerce)	2,730
MedImmune, LLC Biologics	2,290
Asbury Methodist Village	820
Lockheed Martin	736
Sodexo, Inc.	570
Hughes Network Systems, LLC	450
Adventist HealthCare	400
Kaiser Permanente	350
OpenText GXS	346
Novavax	300

<sup>2</sup> Source: City of Gaithersburg, Office of Economic Development

contracts of more than \$2 billion were awarded to area companies. R&D and IT products/services accounted for four of the top five categories. There are almost 50 institutions of higher education

## Transportation Infrastructure

The NIST campus is within the geographical boundaries of the City of Gaithersburg which is located in Montgomery County, Maryland. Located off of I-270, the campus is bounded by MD Route 124 (Quince Orchard Road) to the west, MD Route 117 (West Diamond Avenue) to the north, I-270 and Muddy Branch Road to the east, and residential areas to the south.

The campus is served by six gates, four of which are routinely used, while the other two are intermittently used. The main gate (Gate A) is located off of MD Route 117 (West Diamond Avenue) at Bureau Drive. There are three gates on MD Route 124 (Quince Orchard Road)—Gates B, C, and D; and, two gates on Muddy Branch Road (Gates E and F).

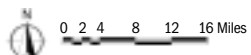
MD Route 117 (West Diamond Avenue) is a Maryland State Highway Administration (SHA) maintained roadway. It provides access to downtown Gaithersburg to the east and Germantown to the northwest. The roadway accommodates an average daily trip (ADT) volume of 46,120 vehicles adjacent to the campus.

MD Route 124 (Quince Orchard Road) on the west is also an SHA maintained roadway. It connects to Damascus on the north and suburban areas of Montgomery County to the south. The roadway accommodates an ADT volume of 27,211 vehicles adjacent to the campus.

Muddy Branch Road is a Montgomery County Department of Transportation maintained roadway. It provides access to Gaithersburg and MD Route 117 (West Diamond Avenue) to the north and suburban areas of Montgomery County to the south. The roadway accommodates an ADT volume of 16,800 vehicles adjacent to the campus.

Interstate highways provide more extensive access to other areas in the region. Interstate 270, which has an ADT volume of 179,151 vehicles near the campus, connects to the I-370 and the Capital Beltway (I-495) to the south. To the north, I-270 leads to Frederick, Maryland. Access to the south on Interstate 270 is through MD Route 117 (West Diamond Avenue) and to the north is through MD Route 124 (Quince Orchard Road).

Exhibit 99: Regional Map



## Transit Access

The campus has direct and indirect access to public transit which includes shuttle to the greater Washington Area Metro System and Maryland Transit Administrations Maryland Area Regional Commuter (MARC) Train Service stations, and Montgomery County's RideOn services.

The nearest metro station is Shady Grove—a terminal station on the Red Line, which serves Montgomery County and the District of Columbia via downtown Washington, DC. It is located within a 6-mile driving distance of the campus and can be accessed by Interstate 370.

The MARC Brunswick Line serves the Metropolitan Grove and Gaithersburg stations, located approximately one mile northwest and 1.5 miles northeast of the campus, respectively. The Brunswick Line provides commuter rail connections from Martinsburg, West Virginia and Frederick, Maryland through Gaithersburg to Union Station in downtown Washington, DC.

NIST operates a campus shuttle service from Building 101 to the Shady Grove Metrorail Station and the Metropolitan Grove and Gaithersburg MARC stations.

Montgomery County Transit's RideOn Route 54 provides direct access to the NIST Campus from Lake Forest Mall and from the Rockville METRO station, serving Building 101 in the core of the campus. RideOn routes 71 and 78 also have stops on MD Route 117 (West Diamond Avenue) at the Bureau Drive intersection.

The State of Maryland is planning a rapid bus route, called the Corridor Cities Transitway (CCT) that would connect the Shady Grove Metro Station and the Metropolitan Grove MARC Station. Both this route and a proposed shared use path would be located along Quince Orchard Road.

## Volumes and Levels of Service on Off-Campus Intersections/Roadways

The 2015 Transportation Assessment, Analysis, and Recommendations Report documented levels of service (LOS) for select off-campus intersections in the vicinity of the site. Many of these intersections operate beyond acceptable levels.

- West Diamond Avenue and Quince Orchard Road: The intersection operates at an overall LOS "E" during the AM

peak hours with the northbound and southbound approaches operating at LOS "F" and LOS "E", respectively. The primary reason for the poor LOS is due to the signal timings that prioritize through traffic along West Diamond Avenue. PM peak hour service is generally acceptable although the eastbound approach operates at LOS "E" primarily to allow for more turning maneuvers on the other approaches.

- West Diamond Avenue and Southbound I-270 Ramp: This intersection operates at acceptable levels during the AM and PM peak hours.
- West Diamond Avenue and Muddy Branch Road: This intersection operates at acceptable levels of service with the exception of some approaches. This is primarily due to the phasing of the traffic signal to accommodate the one-way southbound Chestnut Street approach.
- Great Seneca Highway and Quince Orchard Road: The intersection has an overall unacceptable level of service in the AM particularly because of the performance of the eastbound and southbound approaches. This is caused by the limited roadway capacity available in the eastbound lanes.
- Great Seneca Highway and Muddy Branch Road: The intersection operates at unacceptable levels during the AM peak hour with three out of the four approaches operating at LOS "E" or LOS "F". The reason is the limited roadway capacity available at the intersection for all approaches. The PM peak hour service is slightly better but the northbound and southbound Muddy Branch Road approaches still operate at LOS "E" and LOS "F".

## The Regulatory Environment

While Federal Agencies are generally exempt from local and state jurisdictional regulations, most follow a "good neighbor policy". Local governments are more often than not awarded opportunities to review and comment on plans and improvements occurring at Federal facilities. The following is an overview of the relevant regulatory agencies in the region.

## The City of Gaithersburg

The City of Gaithersburg is an incorporated city within Montgomery County and one of the largest cities in the state



Exhibit 100: Estimated Average Daily Traffic (ADT) Volumes



of Maryland. The City provides several services to its residents and businesses that include street lighting, snow removal, street maintenance and reconstruction, street sweeping, leaf collection, sidewalk repair, maintenance of street name signs and traffic control devices on City streets. Other services include maintenance and development of parkland, recreation programs, a stormwater program and storm drainage maintenance, supplemental crime prevention and enforcement, animal control, zoning, building, electrical, fire and rental housing inspections, and serves as an autonomous local planning authority.

The City of Gaithersburg's Planning Division provides services related to development review, zoning, historic preservation, and long range regional planning. The Division is also responsible for the updates to the City's Master Plan which "acts as a guide to public and private actions and decisions to ensure the development of public and private property in appropriate ways".

### Surrounding Land Uses and Zoning

The NIST property is assigned a "General Government" use on

the City's official housing and land use map. The parcel has a wide range of uses surrounding it. The campus has general commercial and office uses to the north across W Diamond Avenue. The northwest corner has residential apartments. Across Quince Orchard, to the west, there is a mix of uses that include general commercial establishments, commercial offices, research and development uses, and some residential townhomes. Along the south-western boundary of the property, there is a large parcel for utilities along with mixed residential uses, public and private parklands. Mixed residential uses that include townhomes, condominiums, apartments and senior housing are mixed with and also general commercial uses along the east and southeast boundaries.

The zoning designations of the nearby properties generally correlate to the current land uses. Although most municipalities typically include a public or institutional use designation within their zoning codes, the City of Gaithersburg, does not have such a zoning designation. The NIST parcel does not have an assigned zoning designation in the City's official zoning map.

The parcels to the north are zoned C-2 or General Commercial. The apartment community to the northwest is within a mixed use development (MXD). To the west, the parcels are zoned C-2 (General Commercial), E-1 (Urban Employment), some RP-T (Medium Density Residential). The E-1 Urban Employment Zone allows for a variety of uses including office buildings, public buildings, libraries, research/testing laboratories, some manufacturing/processing/assembly uses, wholesale businesses, retail sales, restaurants etc. The RP-T Medium Density Residential zone allows for single family attached and detached, two family, semi-detached, multiple family and multiple family condominium dwellings at a density not exceeding nine units per acre.

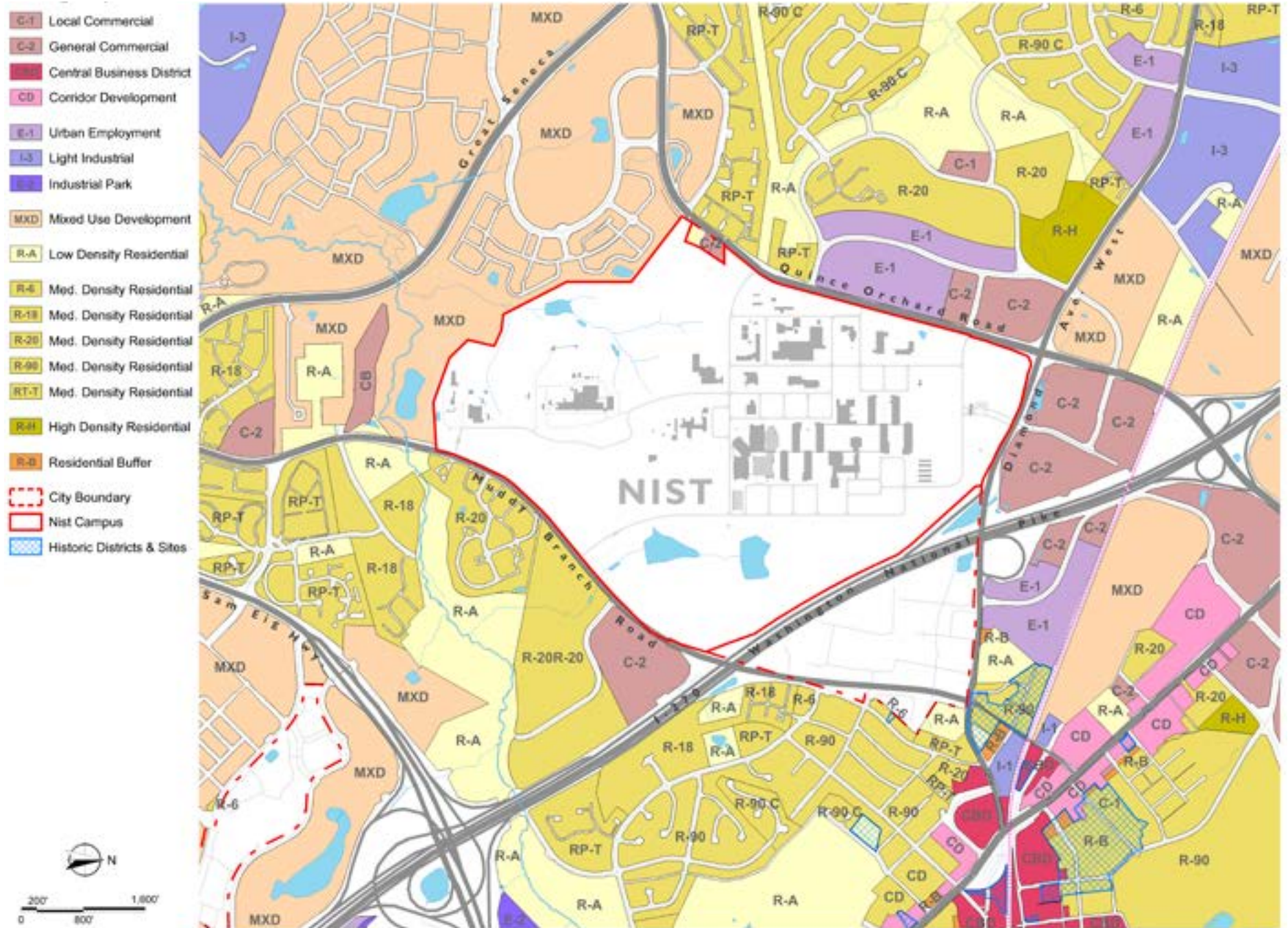
Along the southwest boundary of the campus, most properties are designated MXD (Mixed Use Development). This zone is for comprehensively planned multi-use projects that conform to the City's master plan recommendations. A variety of residential and commercial uses are generally permitted within this zone with the density standards contingent on the type of use.

The parcels to the southeast of the NIST campus are zoned R-20 Medium Density Residential Zones that allow all uses within the RP-T zone (see above) and also boarding houses, rooming houses, fraternity and sorority houses at a development density at or below 21.5 units per acre. There are also

Exhibit 101: Transit Circulation



Exhibit 102: Zoning



some areas southeast to the campus that are zoned C-2 General Commercial.

The NIST campus maintains a healthy buffer along its boundaries. In general, none of the current land uses of the zoning designations can be deemed incompatible with the NIST Campus.

### **Master Plan**

The State of Maryland requires and authorizes municipalities to adopt a comprehensive or “master” plan for land use, transportation, and sensitive areas, to guide and accomplish coordinated, adjusted, and harmonious development. The City completed its first Master Plan in 1997 which was subsequently updated in 2003 and 2009. The City’s Master Plan is reviewed and, if necessary, updated every six years.

### **National Capital Planning Commission (NCPC)**

Established in 1924 by Congress, NCPC is a US government agency charged to implement the McMillan Plan. Its mission was soon expanded to include the “comprehensive, systematic, and continuous development of the park, parkway, and playground systems of the National Capital and its environs.” It has a 12 member commission which includes three presidential appointees. Today, the National Capital Planning Commission is the central planning agency for the federal government in the National Capital Region and develops a comprehensive plan for the region to address Federal properties and Federal interests within the Capital Region.

The comprehensive plan sets a vision, creates planning policies and guidelines for the region in the areas of 1) urban design and plan review—to review federal development projects in the region, 2) comprehensive planning—to develop long term policies for the National Capital, 3) signature planning—to focus on special issues such as planning for future memorials and museums and 21st Century transportation challenges, and 4) Federal Capital Improvements Program—to review proposals from federal agencies and establish development priorities for the following six years. NCPC participates in several committees of the Metropolitan Washington Council of Governments (MWCOG) and is a nonvoting member of the independent Transportation Planning Board.

NCPC has a plan review authority in the 2,500 square mile National Capital Region spanning the District of Columbia and several cities and counties in Maryland and Virginia. NCPC has

approval authority for federal land and buildings that are within the District of Columbia whereas in Maryland and Virginia, NCPC’s recommendations are advisory in nature.

### **Montgomery County**

The NIST Campus lies within the boundaries of Montgomery County which is governed by a nine member county council that acts as a legislative branch. There is a Chief Administrative Officer who is appointed by the County Executive. The county seat is Rockville which is also the largest municipality in the county.

While the NIST campus is within the limits of the city of Gaithersburg, many of the adjoining communities are part of and governed by Montgomery County. The school system and many of the roads are within the purview of the County. Muddy Branch Road is a county road. (The other two roads adjoining the NIST Gaithersburg Campus, Quince Orchard Road—MD Route 124—to the west, West Diamond Avenue—MD Route 117—to the north, are state roads.)

### **Metropolitan Washington Council of Governments (MWCOG)**

MWCOG is an independent, non-profit association founded in 1957 and covers areas in Maryland, Virginia and in the District of Columbia. WMCOG is made up of 21 local governments (cities and counties), members of the Maryland and Virginia legislatures, and the United States House of Representatives and Senate. It is a regional organization where governments can develop comprehensive responses that affect the Capital region. Important issues that improve the livability and standard of living for the population in which WMCOG is interested in include: the environment, affordable housing, economic development, health and family concerns, human services, population growth, public safety, and transportation.

A Metropolitan Planning Organization called The National Capital Region Transportation Planning Board (TPB) became associated with MWCOG in 1966 and now serves under the umbrella of MWCOG. They work in conjunction with the Department of Transportation Planning at MWCOG and are charged to prepare plans which must be approved by the federal government in order for transportation funds to be provided. TPB provides a regional policy framework for transportation to guide investment and transportation construction.

## Physical and Natural Environment

### Geology and Physiography

The majority of Montgomery County and all of the City of Gaithersburg is part of the Upland Section of the Piedmont Plateau Province. This Province extends from the inner edge of the Coastal Plain westward to Catoctin Mountain, the eastern boundary of the Blue Ridge Province. It is composed of hard, crystalline igneous and metamorphic rocks. Bedrock in the eastern part of the Piedmont consists of schist, gneiss, gabbro, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin.

In several places these rocks have been intruded by granitic plutons and pegmatites. Deep drilling has revealed that similar metamorphic and igneous rocks underlie the sedimentary rocks of the Coastal Plain. Several domal uplifts of Precambrian gneiss mantled with quartzite, marble, and schist are present in Baltimore County and in parts of adjacent counties. Differential erosion of these contrasting rock types has produced a distinctive topography in this part of the Piedmont.<sup>1</sup>

This region contains a variety of mineral resources. Formerly, building stone, slate, and small deposits of nonmetallic minerals, base-metal sulfides, gold, chromite, and iron ore were mined. Currently, crushed stone is important for aggregate, cement, and lime. Small to moderate supplies of ground water are available throughout the region, but favorable geological conditions locally may provide larger amounts<sup>3</sup>.

Physiographically, the campus and the majority of the City of Gaithersburg is part of the Hampstead Upland District. The district has a mix of rolling and hilly uplands that are interrupted by steep walled gorges. It also has distinctive ridges, hills, barrens and valleys caused by differential weathering of adjacent, contrasting lithologies. The streams in this district characteristically have short segments of narrow steep sided valleys<sup>4</sup>.

### Local Ecology and Climate

There are over 1,500 miles of open streams within Montgomery County alone, providing vital habitat to aquatic and wildlife. Wetlands are present throughout the region and provide

essential functions including water quality protection, flood flow attenuation, nutrient removal, groundwater recharge, climate change mitigation, and wildlife habitat.

### Temperature

In warmer months, the average temperature is 73.1 degrees and the average temperature is 34.2 degrees during the colder months of the year. In the summer the average daily maximum temperature can reach into the low 100s during the day.

### Precipitation

Precipitation in the Washington Region remains fairly constant throughout the year with the wettest period being between the months of July through October. Average yearly precipitation in Montgomery County is approximately 43 inches. On average, Montgomery County enjoys 201 sunny days per year.

### Chesapeake Bay and Water Quality

Development of the Washington Region continues to greatly influence the water quality of the Chesapeake Bay, the largest estuary in the United States. The primary sources of degradation to the Bay continue to be erosion and runoff exacerbated by construction practices, the prevalence of impervious surfaces, untreated storm water runoff, as well as removal of vegetation. Improving the water quality of the Bay remains an important goal in local, regional and national governments. Policies are in place to help establish low-impact development practices aimed at reducing negative impacts of development on water quality such as providing buffers along wetlands and streams to remove nutrients and sediment before they enter the water system.

## Significance for the Master Plan

The regional context of the campus is an important component in the development of the master plan. The developments within the campus must take into account the surrounding contextual elements that impacts the campus and are in turn impacted by it.

<sup>3</sup> Source: Maryland Geological Survey: A Brief Description of the Geology of Maryland

<sup>4</sup> Source: Maryland Geological Survey: Physiographic Map of Maryland



# Campus Site Analysis

**T**HE NIST campus in Gaithersburg is approximately 579 acres in size, configured roughly in a diamond shape. It is a fenced campus, surrounded on three sides by major roadways with commercial and residential development opposite, and on the fourth side by a residential neighborhood and park. The main entrance gate is located on the north side along West Diamond Avenue, with three other active gates used by employees and for deliveries. The property is relatively flat, with some slightly rolling terrain. The central campus is characterized by both separated and connected buildings, some linked by enclosed concourses, surrounded

by lawn and parking lots. To the east and west, there is open space, a forested area, two ponds and scattered buildings.

The site presents opportunities and constraints that have influenced its development, and will shape any future growth or change. These influences fall into two categories: Natural Characteristics; and Development Characteristics. The natural characteristics are those inherent in the land itself in its current state, such as topography and water features. The development characteristics are regulatory, operational or physical in nature, such as zoning regulations and security requirements.

## CHAPTER 13



## Natural Characteristics

### Topography and Geology

The Gaithersburg campus is located in the Piedmont physiographic region of Maryland, which is made up of hard, crystalline igneous and metamorphic rocks. The underlying bedrock in the eastern part of the Piedmont consists of schist, gneiss, gabbro, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin.<sup>1</sup> The predominant soil type on the Gaithersburg campus is Glenelg silt loam, which covers the majority of the central campus, from North Drive to South Drive. Glenelg soils are deep and well-drained soils and generally conducive to development. There is a potential for erosion on steeper slopes. On the southern campus, Baile and Glenville soils are present in the lowland area along the stream north of Building 235. Baile is also a deep soil, but poorly drained. Glenville is also present along the eastern property line.

The Piedmont topography is characterized by rolling hills and low valleys with abundant streams, wetlands, and groundwater. There are over 1,500 miles of open streams within Montgomery County alone, providing vital habitat for aquatics and wildlife. Wetlands are present throughout the region and provide essential functions including water quality protection, flood flow attenuation, nutrient removal, groundwater recharge, climate change mitigation, and wildlife habitat.

The Gaithersburg campus is relatively flat in the northern section where most of the buildings are located, with an average elevation of 450 feet. Beyond South Drive, the terrain is more characteristic of the Piedmont region, with gentle rolling hills, an intermittent stream and small areas of wetland. Areas of steeper slopes are concentrated west and south of Building 235, extending into Muddy Branch Park.

Exhibit 103: Soils



<sup>1</sup> Maryland Geographical Survey, "A Brief Description of the Geology of Maryland," January 2001.

Exhibit 104: Existing Conditions Site Topography

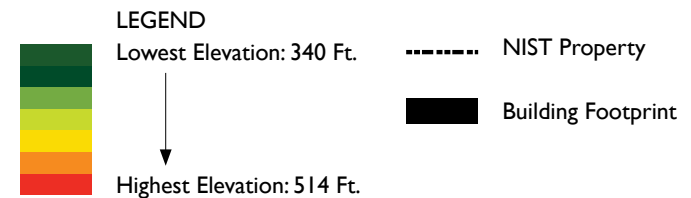
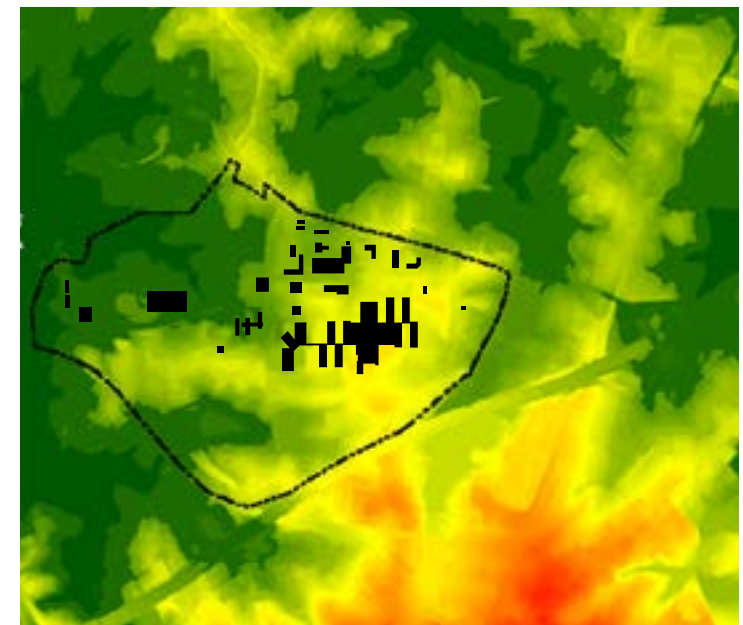
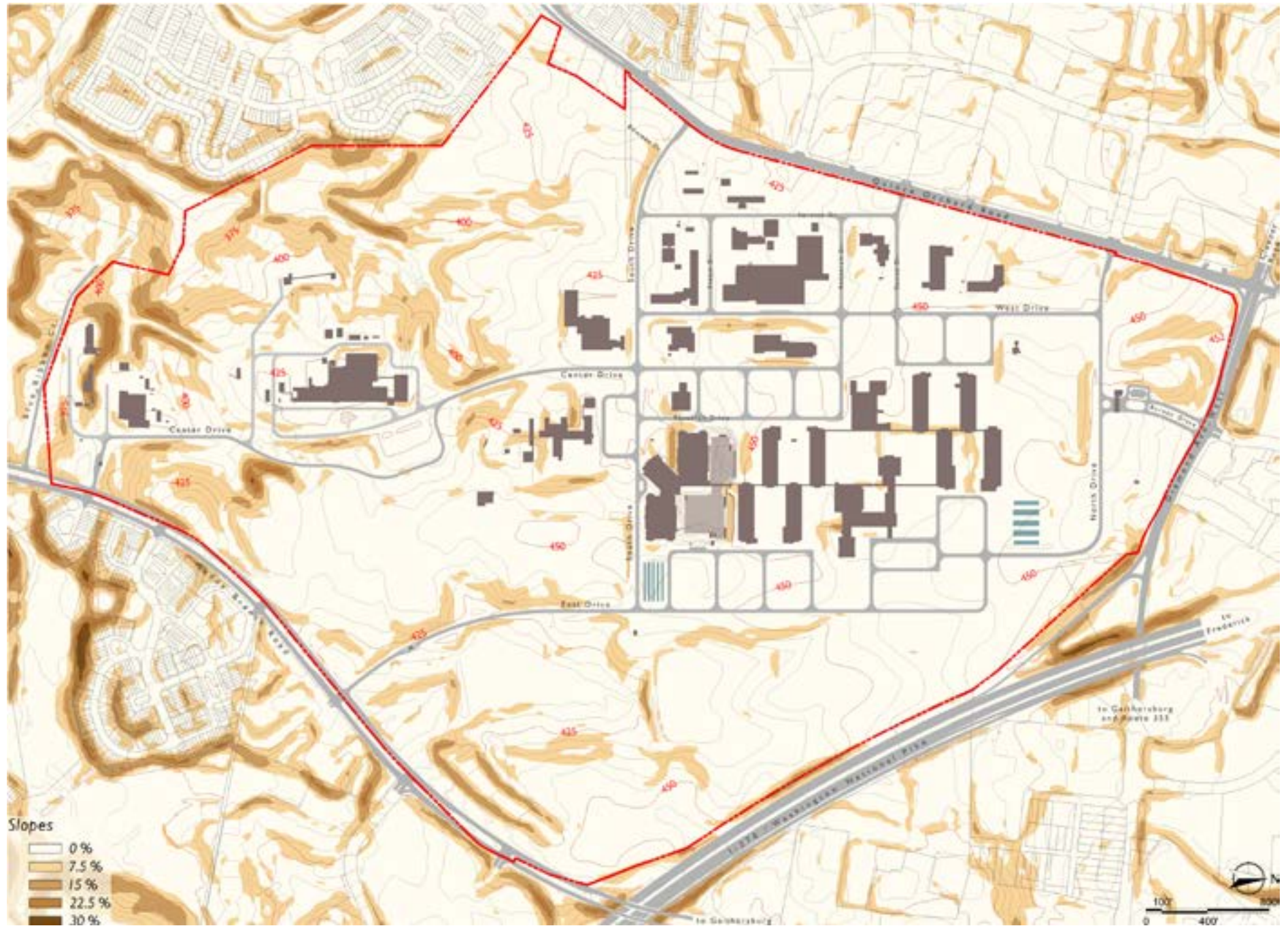




Exhibit 105: Slopes

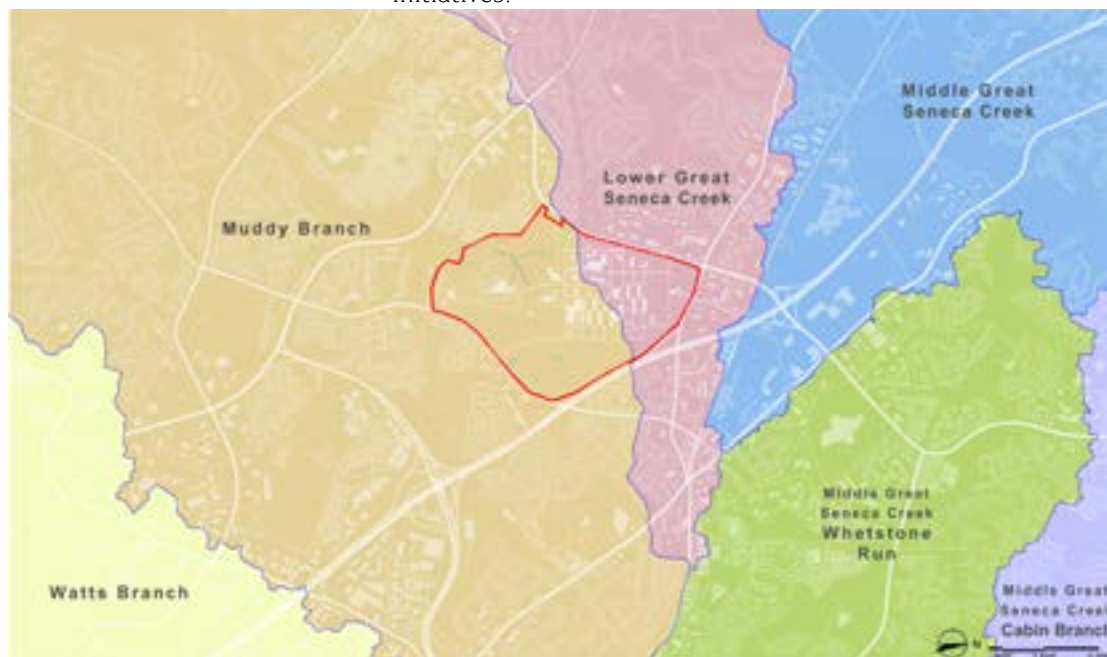


## Water Resources

### Watershed

NIST's Gaithersburg campus is within two watersheds, the Muddy Branch and the Lower Great Seneca Creek. These are two of the three watersheds within Gaithersburg, all of which discharge into the Potomac River and eventually the Chesapeake Bay. Protecting the River and the Chesapeake has become a regional effort for counties and municipalities in the region. The Environmental Protection Agency has established 2017 and 2025 goals for reduction of nitrogen, phosphate and sediment flowing into the Chesapeake Bay, intended to improve water quality, prevent erosion and disruption of natural ecosystems. The Potomac River has been cited by the EPA as a Category 5 impaired water with specific problem pollutants, and efforts must be made to reduce the pollutant load. The City of Gaithersburg is actively working to establish measures toward better stream and watershed conditions, with a Stormwater Management Program based on detailed studies of watershed conditions with recommended practices and the implementation of a stormwater program fee to fund projects and initiatives.<sup>2</sup> The *Muddy Branch Watershed Study* suggests coordination and partnering with NIST on their proposed initiatives.

Exhibit 106: Watersheds



<sup>2</sup> *Muddy Branch Watershed Study*, Prepared for the City of Gaithersburg, Maryland by URS Corporation, November 12, 2014.

The Muddy Branch watershed is a 3,191 acre area with overall impervious surfaces of 36.8%. On the NIST campus, this watershed roughly covers the southern half of the site. The Lower Great Seneca Creek watershed covers the remainder of the campus. Overall, it is 1,255 acre area with impervious surface totaling 44.7%.<sup>2</sup> Both watersheds are characterized by residential and commercial development, plus several parks. (These numbers exclude the NIST campus.) The NIST campus has impervious surfaces of approximately 19%, lower than the City averages.

### Surface Water and Wetlands

Stormwater retention ponds are the notable water bodies on campus. There are two connected man-made ponds on the east side of the site, which are 3.7 and 3.8 acres in size. Canada geese are attracted to these ponds. Several other stormwater management ponds are located at the southern side of the campus, the largest at 1.3 acres in size. A tributary stream of

Exhibit 107: Site Hydrology

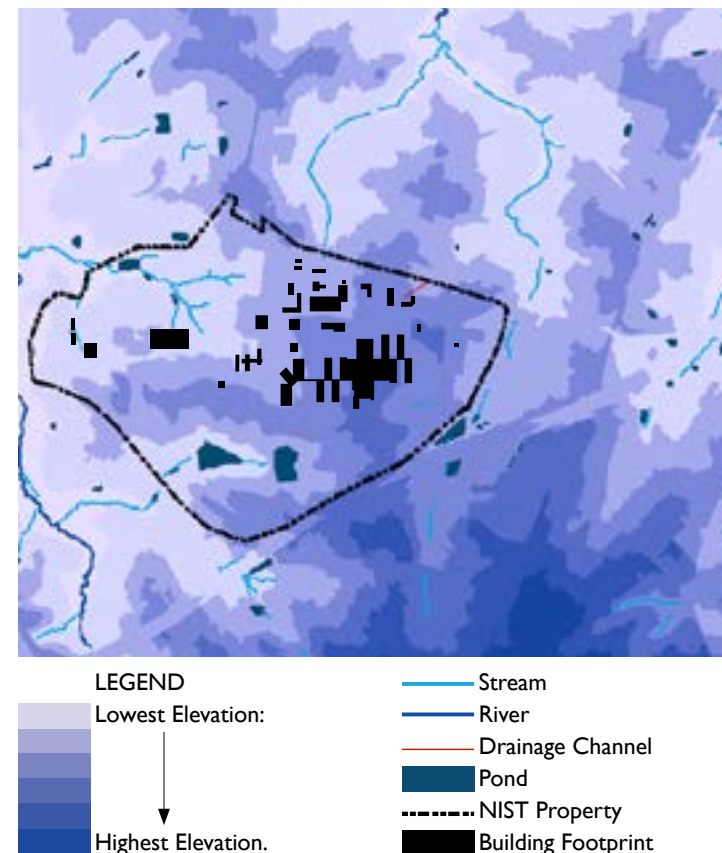
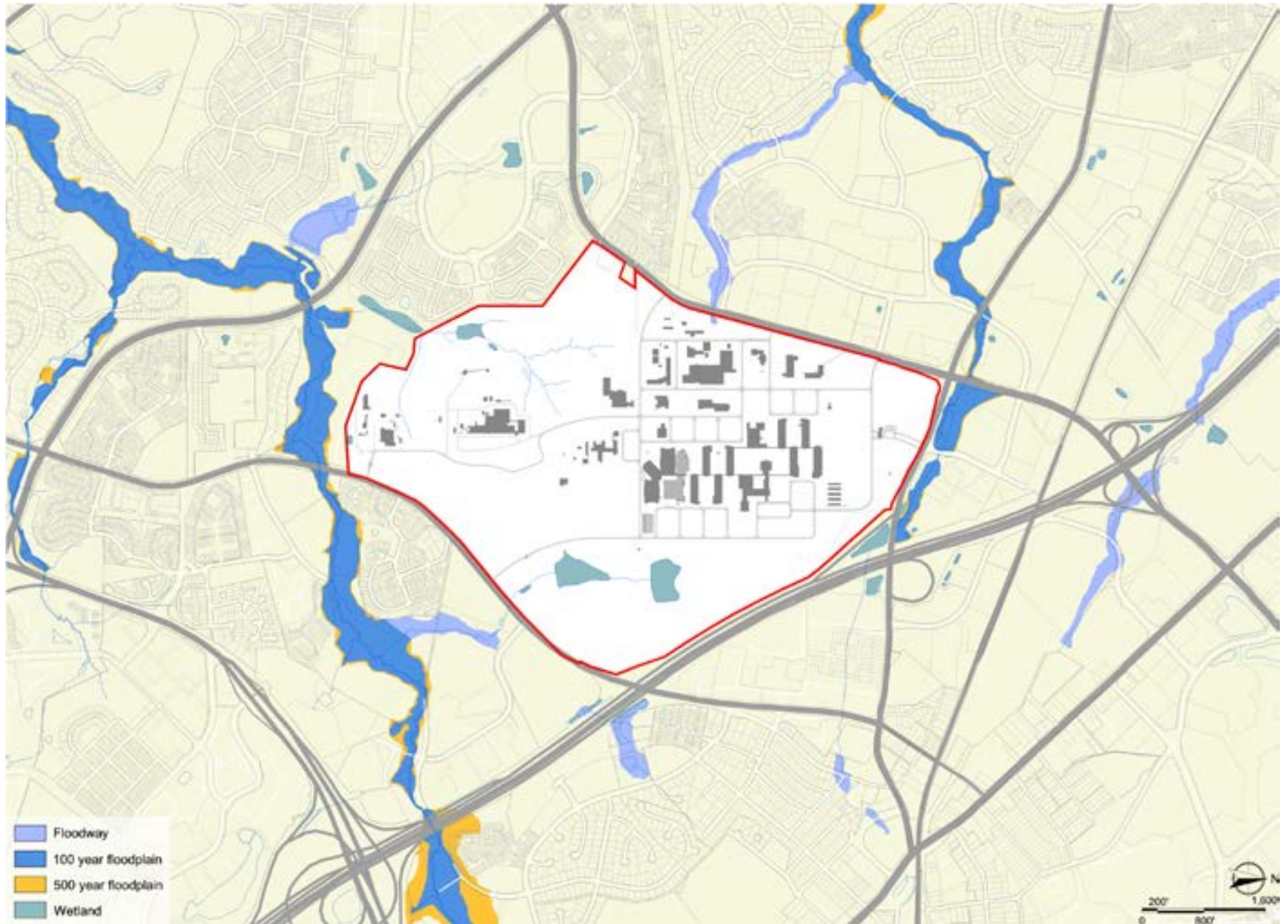


Exhibit 108: Hydrology



the Muddy Branch originates in the forested area of the campus and flows off the property, south into Elysium Lake.

There are several small wetland areas associated with these retention ponds, through which stormwater travels prior to flowing to campus outfalls. There is a small stream behind Building 309, which flows west into Long Draught Branch, then to Clopper Lake.

### **Flood Plain**

The Federal Emergency Management Agency (FEMA) is the official source for Flood Insurance Rate Maps, which identify areas subject to flooding for flood management planning and insurance underwriting. These maps are developed by studying data for river and stream flow, storm tides, hydrology, topography and rainfall. The current FEMA map for the campus shows a very small area in the 100-year floodplain, located on the western edge of the property behind Building 309.

### **Stormwater**

Stormwater is directed from all impervious surfaces (roads, roofs, parking lots) through seven drainage areas into the municipal system. There is an extensive underground storm drain system around the buildings and parking lots in the central campus and the larger specialty laboratories on the south end of campus. In the less developed areas, stormwater flows overland and/or through grass channels. Several stormwater management ponds receive stormwater and hold or slowly release water to the outfalls.

In addition to discharging stormwater from the site, NIST has established stormwater management features that assist in the natural infiltration of the water. Bio-retention areas, rain gardens and bio-swales have been installed in various locations, some associated with new building construction or expansion.

NIST Gaithersburg campus, with its Municipal Separate Storm Water System, holds a permit from the Maryland Department of the Environment, meant to protect runoff quality and prevent harmful pollutants from being discharged untreated into local waterbodies. This permit, called an MS4, meets the requirements of the National Pollutant Discharge Elimination System (NPDES), regulated under the Clean Water Act. The State of Maryland has been authorized by the US Environmental Protection Agency to administer the NPDES requirements. To support the MS4 permit, NIST has prepared a Stormwater Pollution Prevention Plan (SWPPP), which outlines

information, actions and training to meet the permit terms and protect water quality.

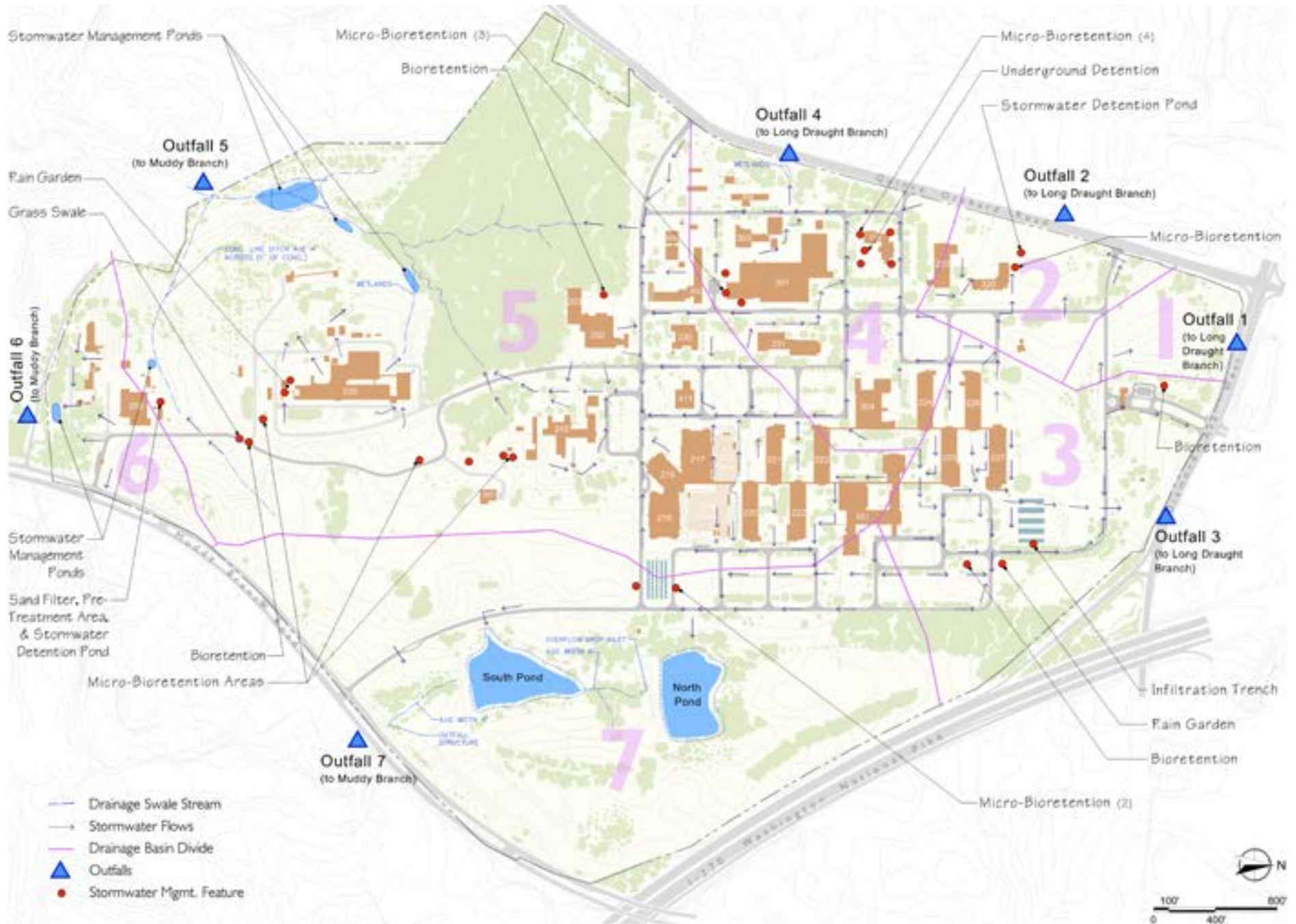
The purpose of the permit and the SWPPP is to eliminate or reduce pollutants that are carried by stormwater into the receiving streams. The SWPPP identifies actions and responsibilities for campus personnel, and included six minimum control measures (MCM) and the Best Management Practices (BMP) that support them. The six MCMs' include:

- Public Education and Outreach on Storm Water Impacts;
- Public Involvement/Participation;
- Illicit Discharge Detection and Elimination;
- Construction Site Storm Water Runoff Control;
- Post-construction Storm Water Management for New Development and Redevelopment; and
- Pollution Prevention and Good Housekeeping for Municipal Operations.

The MS4 permit and SWPPP are an important consideration for the master plan. The SWPPP includes best management practices to control runoff, spills and leaks in waste disposal, construction practices, and raw material storage. Any proposed development of one acre or more must follow specific requirements of the permit and be reviewed by the appropriate agencies. A key issue for the campus is controlling and offsetting the addition of impervious surfaces, recognizing the significant amount of paving that exists, most without trees or vegetation to control runoff.

NIST will be required to comply with the Chesapeake Bay Total Maximum Daily Load (amount of pollutants that the waterbody can receive), and with the Final Maryland Watershed Implementation Plan. By 2025, NIST will be required to have nutrient and sediment reductions equivalent to treatment of 20% of the pre-1985 impervious surfaces. Treatment can include traditional stormwater controls, as well as reducing pavement, forest planting, stream or wetland restoration, and improved operational practices.

Exhibit 109: Existing Storm Water Management



## Natural Ecosystems, Vegetation and Wildlife

Before the arrival of the settlers in 1634, the entire State of Maryland was covered by forests of oak, tulip-poplar, eastern hemlock, beech, loblolly pine, white pine and American chestnut. The Native Americans along the Chesapeake Bay and its tributaries were the first users of the forest, clearing and burning small areas for farming and berry production. The settlers found these forests to be a rich source of lumber and fuel, and soon started farming tobacco, wheat and corn clearing large sections of the forests. Forest clearing reached its peak in the mid-1800s. Over the next half a century, better farming techniques and a population shift to urban areas and to the western states allowed some of the cleared areas to revegetate. The abandoned agricultural, cut-over, or burned lands started being covered by grasses and brambles, and then shrubs and small trees, gradually developing into the forests of present day. While the original forests were primarily composed of hardwoods, today, conifers are more abundant than they once



were due to planting programs, natural succession, and scientific forest management. The main threats to the forests today are development, and environmental stresses, such as excess nutrients from wastewater, agricultural land, and developed land; sediment runoff from farms, construction sites, and other lands; and elevated levels of toxic chemicals.

The City of Gaithersburg, in the Environment and Sustainability section of its Master Plan (draft, September 2014), lays out a plan to support and increase the urban forest and tree canopy in the city. Plans are to increase the tree canopy to the State's recommended 40% by the year 2025. Measures include increasing diversity, supporting private efforts, controlling pests, and promoting cross-agency coordination.

The NIST campus retains two stands of forest, which amounted to approximately 56 acres at the time of the 1995 *Forest Conservation Plan* by HDR Engineering. The largest area, with approximately 52 acres, is located in the southwestern area of the property, west and south of Building 202. The forest areas are supplemented by tree cover across the campus, consisting of a wide variety of native and ornamental trees. The Forest Conservation Plan was prepared as part of the planning for construction of the AML and Advanced Chemical Science Laboratory. It committed NIST to preserving existing forest area and increasing the forest cover on campus by planting an additional 29 acres of new forest. The new forest areas were planned to be at the south end of the property between Building 235 and 202, west of Building 235, and around the two ponds on the east side of campus. NIST has continued to plant trees in accordance with this agreement, and with the expansion of Building 245, has an updated Memo of Understanding with the Maryland Department of Natural Resources to reforest an additional 2.2 acres near Building 245.

Exhibit 110: Existing Vegetation

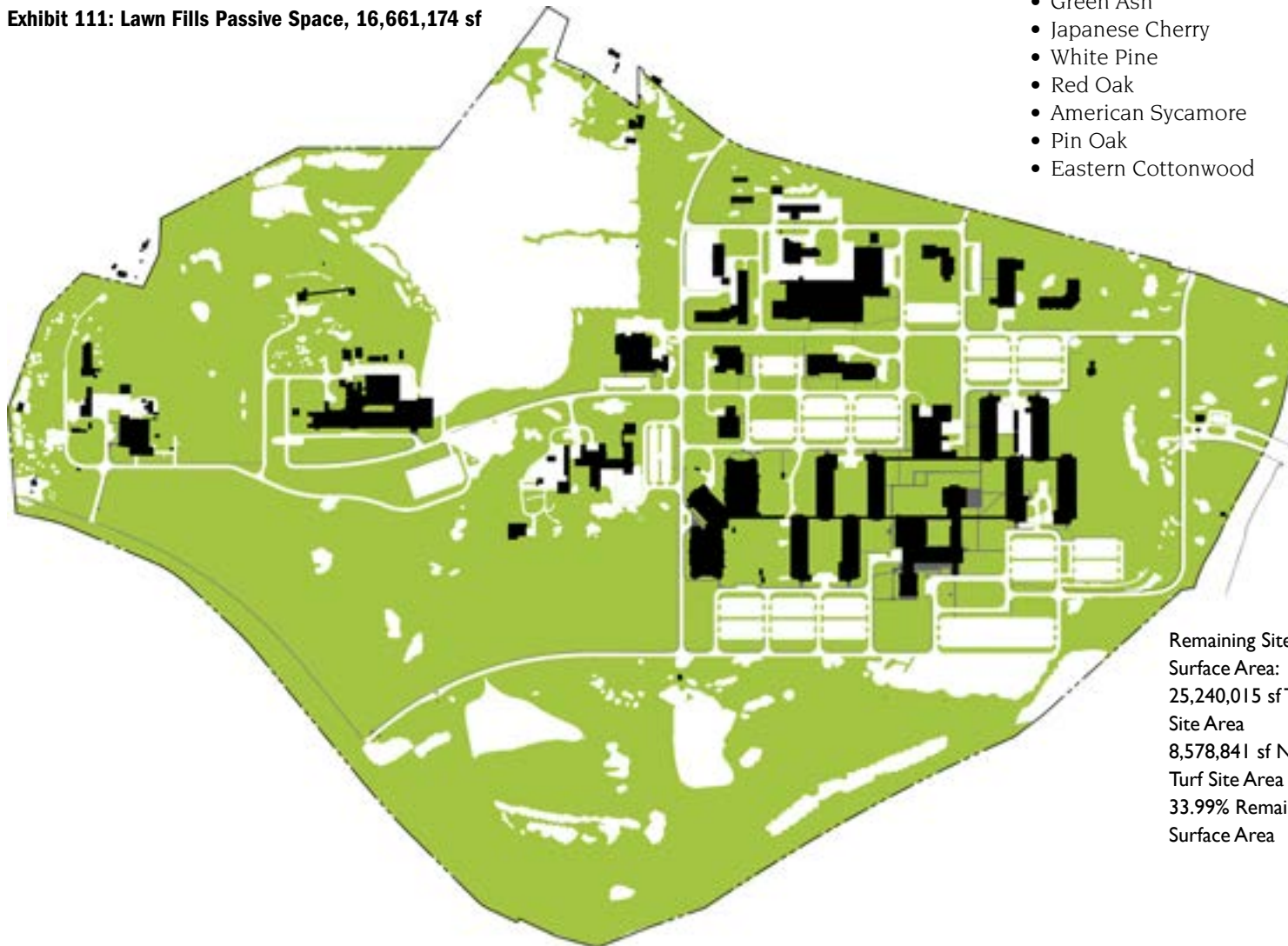


The majority of the existing campus is gently rolling terrain, with grass lawns, landscaping and open meadows. Recreation fields and picnic areas are interspersed. There are many large specimen trees with calipers of 24 inches or greater, some within the courtyards around the Administration Building. Frequently observed are oak, tulip poplar and maple, but there is a wide variety of tree species.

**Campus Tree Species:**

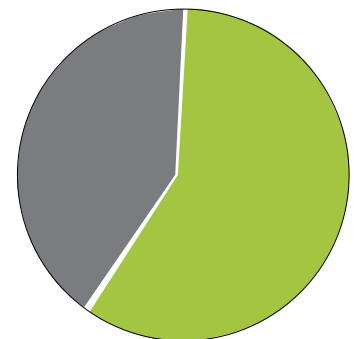
- Slash Pine
- White Spruce
- Atlantic White Cedar
- Loblolly Pine
- Bald Cypress
- Colorado Blue Spruce
- White Oak
- American Holly
- Scarlett Oak
- White Dogwood
- Green Ash
- Japanese Cherry
- White Pine
- Red Oak
- American Sycamore
- Pin Oak
- Eastern Cottonwood
- Sugar Maple
- Wye Oak
- Norway Pine
- Southern Magnolia
- White Dogwood
- Tulip Poplar
- Weeping Mulberry
- Ohio Buckeye
- American Redbud
- Douglas Fir
- Canadian Hemlock
- Flowering Cherry
- Willow Oak
- Pecan Tree
- Crimson King Maple
- Blue Atlas Cedar
- Cucumber Tree
- Plains Cottonwood

**Exhibit 111: Lawn Fills Passive Space, 16,661,174 sf**



Remaining Site Surface Area:  
 25,240,015 sf Total Site Area  
 8,578,841 sf Non-Turf Site Area  
 33.99% Remaining Surface Area

Manicured And Mowed Lawn  
 16,661,174 sf  
 Maintained Lawn Area  
 66.01% Remaining Surface Area

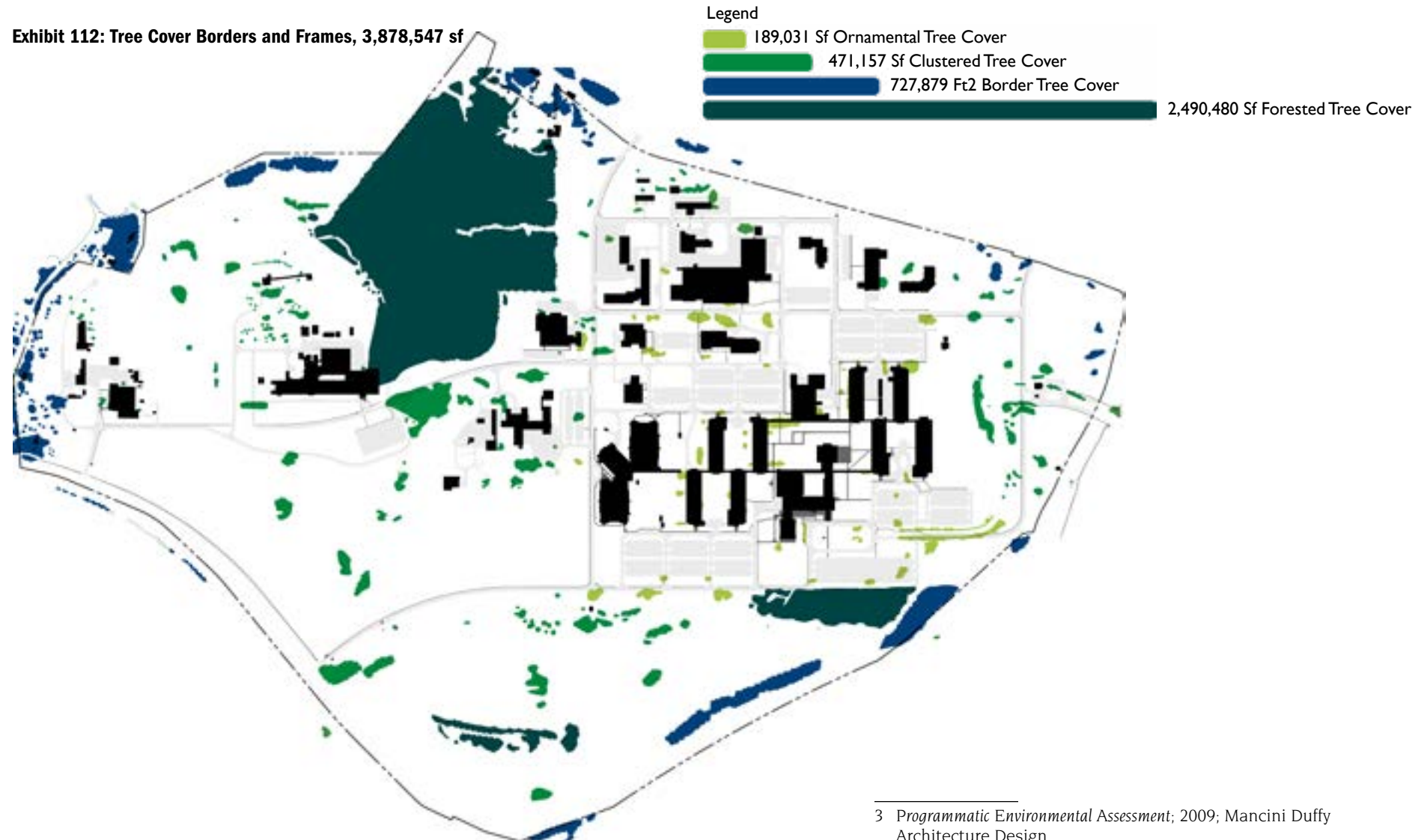




The trees, ponds and meadow areas create an inviting habitat for wildlife, including deer, birds, reptiles and other small animals. White tailed deer are a common sight on campus, and been noted since its establishment in the 1960s. Canada geese are attracted to the two eastern ponds. NIST has established programs to control both the deer population and

the geese. Letters from the Maryland Department of Natural Resources and the US Department of the Interior, Fish and Wildlife Service included in the PEA<sup>3</sup> stated that there are no known threatened or endangered wildlife species on the campus.

**Exhibit 112: Tree Cover Borders and Frames, 3,878,547 sf**



## Historic Landscape Design Features

### Exhibit 113: Historic Landscape Characteristics



#### Modular Design

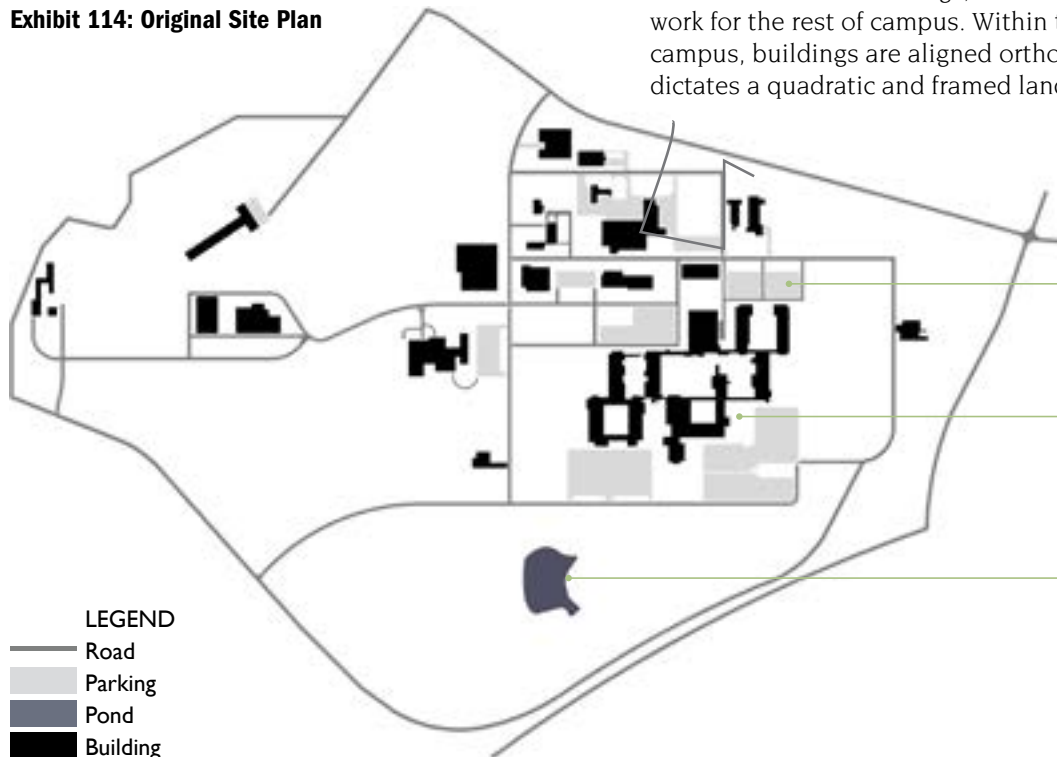
Following a modular building system, future additions or expansions could easily fit into existing site structure. In the NIST Gaithersburg campus, there is a central concourse running internally through 7 main lab spaces. Not only does this connect main labs and research buildings, but it creates a framework for the rest of campus. Within the center of campus, buildings are aligned orthogonally which dictates a quadratric and framed landscape.



#### Abundant Manicured Landscape

Outside of grid-like inner section of campus is a pastoral and lush setting. Original design concepts called for ample and dense planting- a variety of trees, shrubs, ground cover, and perennials- throughout the site to contrast with the stark architectural features. This landscape would help inform and embellish roadways, connections between buildings, and informal outdoor gathering spaces.

Exhibit 114: Original Site Plan



#### AMPLE PARKING

Providing plenty of parking space for employees and visitors subscribes to the suburban ideal for landscape design.

#### MODULAR BUILDING LAYOUT

Modernist buildings align along this central spine/corridor. When more buildings are added, it will be simple to add to this structure.

#### PASTORAL AND MANICURED LANDSCAPE

A pond in the southern corner of the site creates a focal point in the naturalistic aesthetic.

#### LEGEND

- Road
- Parking
- Pond
- Building



### **Modern Architectural Palette**

The Modern architectural features were chosen and implemented to promote functionalism. It was believed that simple, clean details would not distract employees, but would encourage focused, productive work. Built exterior site features would reflect this architectural style to create a cohesive campus.



### **Suburban Setting**

While the original NIST campus was located in downtown Washington, this campus was intended to be 10-20 miles outside of the city. With ample parking, rich green space, and easy access to major roads, it was intended to draw great appeal in contrast with the distractions and difficulties of the city.



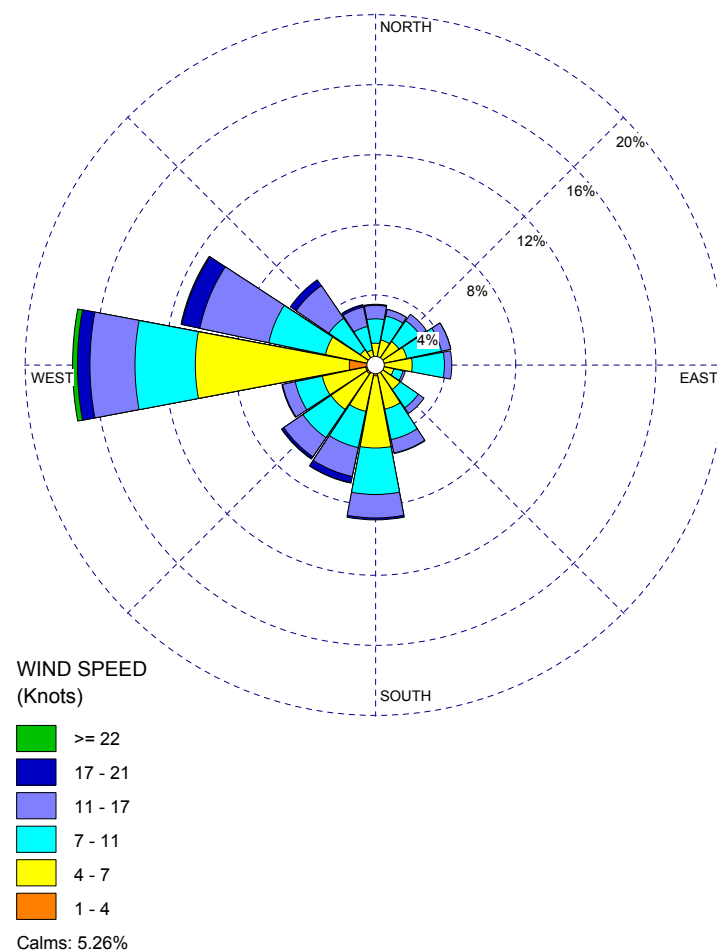
### **Campus Organization by Use**

Campus buildings were designed and laid out according to use: general labs, specialized labs, administrative, and support. They were aligned to foster communication and productive collaboration. The design intent was that similar and specific fields would be placed together to encourage collaboration within that field and that general labs and open gathering places would encourage dialogue between disciplines.

## Climate

Gaithersburg, located approximately 450 feet above sea level, has a primarily humid climate influenced by the Chesapeake Bay. The area has hot summers, fairly constant rainfall throughout the year and no dry season. Mean precipitation (1981-2010) has ranged from a monthly 2.72" to 3.83", with an annual mean of 40.3 inches. Temperatures are hot in the summers at a mean high of 85 degrees in July, and moderate temperatures in the winter at a mean low of 27 degrees in January.<sup>4</sup> Prevailing winds are predominately from the west.

**Exhibit 115: Wind Speed and Direction**



<sup>4</sup> Weather information for nearby Rockville, Maryland; Maryland State Climatology Office.

## Sustainable Design Opportunities

Successful integration of sustainable design strategies will require a comprehensive framework in the master plan, and a targeted approach for each project that results from it. The Department of Commerce, like other Federal agencies, strives to save energy, conserve resources and limit pollution. Following are standards and executive orders to be considered:

- NIST *Sustainable Design Manual*, July 2014
- US DoC "High Performance and Sustainability Handbook," February 2011
- US DoC "Implementation Handbook for the Strategic Sustainability Performance Plan," August 2013
- US DoC "Environmental Management Systems Operations and Implementation Manual," October 2013
- US Executive Order 13693: Planning for Federal Sustainability in the Next Decade; March 2016
- US Executive Order 13514: Federal Leadership in Environmental Energy and Economic Performance; 2009 (recently superseded by EO 13693)
- Memo of Understanding: Guiding Principles for Federal Leadership in High Performance and Sustainable Building; US Government 2006/2008
- US Executive Order 13423: Strengthening Federal Environmental, Energy and Transportation Management; 2007
- US Energy Independence and Security Act of 2007 (EISA 2997)
- US Energy Policy Act of 2005 (EPAct 2005)

NIST's Gaithersburg campus already embraces many of the principles of sustainable design in both operations and research, including solar collectors, stormwater management and whole-house energy research. Open space is a significant campus resource, consisting of lawn and landscaped areas, outdoor recreation, forest and ponds.

Solar power is being studied and utilized with the operation of three grid-connected monocrystalline silicon photovoltaic arrays installed on campus. Each array uses the same PV module, and performance is being studied in different configurations, orientations and tilts. Instrumentation at each array

Exhibit 116: Existing Campus Sustainable Features



records irradiance, temperature, wind, and electrical measurements, using research-grade sensors installed at each array and at the onsite weather station. A canopy array (243 kW) faces east-west over a parking lot. A surface array (271 kW) is mounted on tilted support, facing north-south, in an open area east of the AML. And a north-south facing roof array (73 kW) is located on a flat roof area of Building 101. Detailed information about this research is available in NIST *Technical Note 1896: High-Speed Monitoring of Multiple Grid-Connected Photovoltaic Array Configurations*, by Matthew T. Boyd.

Additional solar power collection is being planned, together with a Combined Heat and Power Generation facility (CHP). Construction and installation of the CHP facility is anticipated to provide greater efficiency and lower emissions by simultaneously producing heat and power. Currently, the Central Plant (Building 302) uses six dual-fuel steam boilers for heating, hot water production and other HVAC loads. Electricity is received from the local utility. The new CHP is anticipated to provide approximately 80% of the annual steam required for the campus, and generate approximately 41% of the annual electricity consumed. The new Combined Heat and Power plant will be built as a 4,000 square foot addition to Building 302. Also proposed is a separate 5 MW solar array, to be located in an open area east of Building 235.

An important environmental research initiative is the Net-Zero Residential Test Facility (Building 208), a four-bedroom, three-bath house similar in size and features to suburban homes in the metropolitan D.C. area. It was designed and built to demonstrate that a typical residence can produce as much energy from renewable energy resources as it consumes. After one year of operation, the house exceeded its goal and exported excess energy to the electric grid. Features include a geothermal heat pump system, solar panels (additional to the 3 described above), solar thermal hot water system, high performance building envelope, heat-recovery ventilation, energy efficient appliances and sophisticated system controls. The house is “occupied” by a sophisticated sensor and control system that mimics the everyday activities of a typical four person family.

Potential for wind power generation in the Gaithersburg area is low, based on information from the Department of Energy's National Renewable Energy Laboratory (NREL).

The campus has a Stormwater Pollution Prevention Plan in place, and manages its stormwater runoff with several retention ponds, bio-retention areas and rain gardens. Construction of all recent buildings has included new micro- bio-retention areas, and erosion and sedimentation plans are implemented during construction. Description of the stormwater management practices is included in Water Resources section.

The master plan will explore and address other opportunities for incorporating sustainable design strategies into campus development and future buildings.

- Recommend/incorporate the proposed Combined Heat and Power Generation plant.
- Enhance strategies for stormwater quantity and quality control as new buildings are planned, including reducing impervious surfaces and utilizing plantings where possible to increase ground water recharge rather than runoff.
- Enhance campus-wide energy performance by evaluating the small support buildings and potential consolidation and added efficiency.
- Expand the use of photovoltaics in the site planning, e.g. solar fields, parking cover, rooftop installation
- Facilitate and augment the already established bicycle and public transit use, and coordinate with Montgomery County transit and trail initiatives.
- Incorporate daylighting into building design for offices, support spaces and selected laboratories. Utilize strategies to reduce glare and solar heat gain on the building envelope through building orientation, design and screening with vegetation.
- Maintain and increase tree cover to moderate temperatures, shade the buildings and outdoor activity areas and absorb pollutants.

## Development Characteristics

### Campus Organization

The campus image and organization was established in the 1960s with the initial development of 26 buildings, and has changed little since that time. A Laboratory Planning Committee of NIST representatives worked closely with the original architecture team to develop concepts and specific requirements. Their collaboration was influential in the development, and continues to shape the campus today. The following were among the recommendations:

- Multiple buildings in a campus, rather than a consolidated structure
- Modular flexible general-purpose laboratories (GPL), and separate, special purpose laboratories
- Central location for administration and shared/public services
- Landscaped grounds, creating a contemplative environment
- Parking lots located to allow for additional buildings

The team organized the buildings in three zones, based on building function. For one of these, the general purpose laboratories and the Administration building are clustered together along the eastern side of the campus. Each GPL is oriented with an east-west long dimension, and they are situated in a linear progression and connected by an enclosed pedestrian concourse. It is a modular concept that allows for growth along the linear spine. The area is characterized by mowed lawn and trees between the laboratory buildings. Parking for these laboratories is located to both the east and west sides of the buildings and is accessed by the main drives—North Drive, West Drive, East Drive and Center Drive.

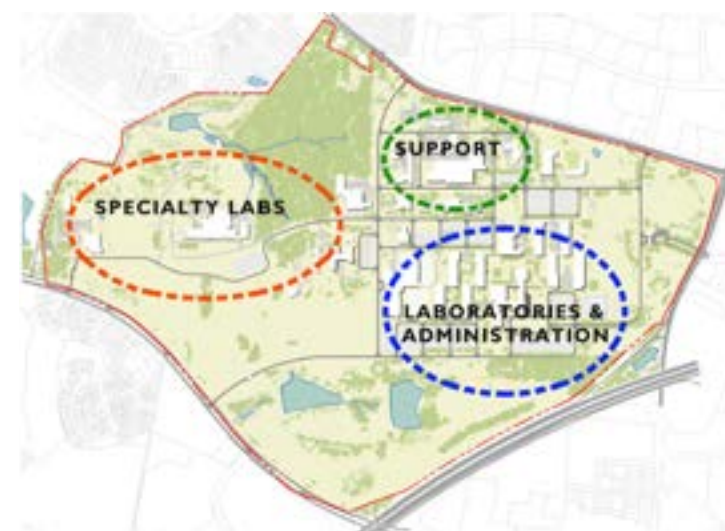
The campus support buildings such as the central plant, maintenance and supply are grouped on the western side of the campus. In general, these buildings are closer together, and there are fewer trees. West Drive serves as the primary access from the main campus entrance, but there also is nearby access from Gate C, at Quince Orchard Road. Vehicle yards and parking for these buildings are directly adjacent to each facility.

Special purpose laboratory buildings are sited individually, each with a specific layout and orientation appropriate for

the research conducted. Most are located in the southern half of the campus, past South Drive, a roadway that bisects the campus east-west. Service, parking and outdoor facilities are adjacent to each building. Those facilities that require isolation, such as the Large Fire Facility, are at the far south of the campus. Several of the smaller special purpose laboratories are outliers from this general organization and can be found north of South Drive.

This basic organization is generally maintained today. The newest laboratories—AML and Advanced Chemical Sciences—were built in line with the GPLs and connected by the pedestrian concourse. The Childcare Center is located on the western campus, with other support buildings and accessed from West Drive. The Standard Reference Materials Building (built 2012) is sited to the south of South Drive, among other specialized laboratories.

**Exhibit 117: Campus Organization**

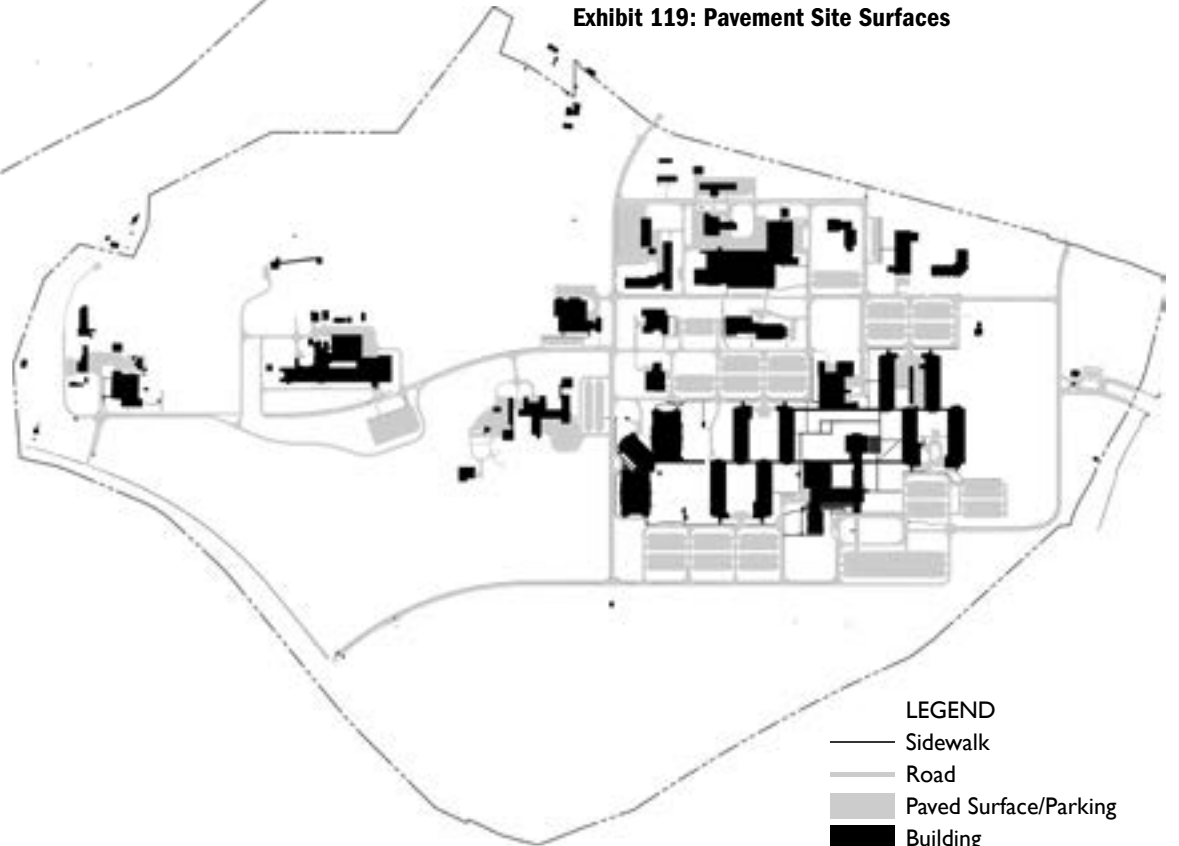


**Exhibit 118: Buildings Exhibit/  
Ground Site Framework**

62 Total Buildings  
3,635,267 gsf



**Exhibit 119: Pavement Site Surfaces**



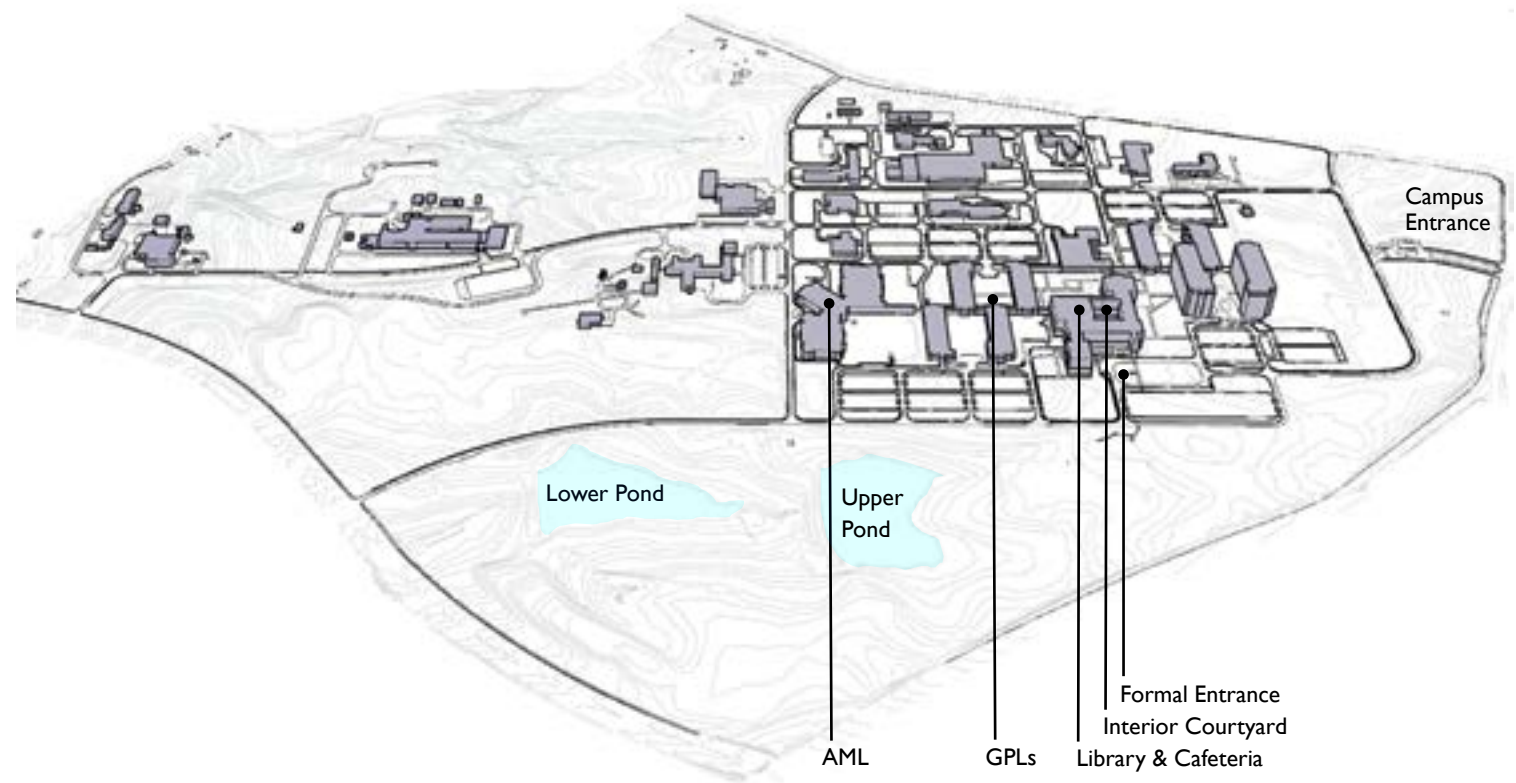
- LEGEND
- Sidewalk
  - Road
  - Paved Surface/Parking
  - Building



## Built and Open Space

Buildings and paved surfaces cover less than 20% of the overall site area, leaving the rest as lawn, landscaped area and natural vegetation. This aligns with the initial pastoral and natural design intent. Paved surfaces account for roughly 13% of the entire NIST campus. A significant proportion of the entire paved surface area is parking, which is predominantly clustered to the east of the GPLs and in the campus center. Sidewalks run alongside some the roads. Roads account for the majority of pavement at around two thirds of the total area. All of the pavement is internally focused to allow for a heavy landscape border around the site.

**Exhibit 120: Existing Conditions, Major Site Focal Features**



## Campus Circulation

The Gaithersburg campus is readily accessible from interstate roadways and local streets, with four active campus entry gates. The main entrance, Gate A, is used by all visitors and a significant proportion of NIST employees. From this entrance, a T-intersection divides the internal roadway (North Drive), with the West Drive leading to the support buildings, and the East Drive leading to many laboratories and their parking. West Drive is easily accessible from Gate C, and East Drive leads to Gate F—both these gates serve as employee entrances. The two roadways are connected in the middle of the campus by South Drive. Feeder roads serve central buildings and their parking. The special purpose laboratories in the south half of the campus have no direct connections to active gates, but are served by Center Drive, which originates in the middle of the campus at South Drive.

Pedestrian circulation is a dual system. One is an interior concourse system that connects the laboratories in the center of campus, and the other is an outside sidewalk system along the roadways. The interior system has over three-quarters of a mile of corridor, and connects the Administration Building, Shops Building and thirteen of the laboratory buildings. The concourse is convenient, but not a straightforward connector, with changes in orientation and levels. The campus sidewalks system is not continuous throughout campus and the traffic study has pointed out issues with curbs and crosswalks. Some feeder roads do not have sidewalks, causing pedestrians to walk in the street when using several of the parking lots. Walkways on campus are limited to sidewalks along the roads and a trail in the large forest conservation area.

Campus circulation considerations for the master plan include the following:

- **Security.** Commercial delivery vehicles entering at Gates A and C are not screened at the campus entrance, but are brought into the campus to Building 301 for screening. The commercial vehicles are escorted, but travel campus roads before screening.
- **Transit.** The State of Maryland is planning a rapid bus route called the Corridor Cities Transitway (CCT), which would connect the Shady Grove Metro Station and the Metropolitan Grove MARC station. A dedicated bus lane would be built on the west side of campus along Quince Orchard Road, and require that Gate C be relocated or

closed.

- **Parking.** A parking need evaluation will be added to this context report. The National Capital Planning Commission has requested that reducing parking and trips generated be a consideration.
- **Sidewalks.** Pedestrian walkways are discontinuous across campus, and not consistent in material, crossings and signage. The pedestrian connection from the main Gate A to the center of campus is not direct, requiring people to walk far to the east or west along the roadways. This is an annoyance for visitors who come by public transportation, because the shuttle bus drops them at the gate.
- **Wayfinding.** The interior concourse is a convenience for staff, but disorienting for newcomers because of the jogs and level changes, and the lack of visual or signage cues.
- **Trails.** The Gaithersburg campus has beautiful landscape features, but has no walkways for the enjoyment of staff. Trails and bicycle paths improvements along the perimeter of the campus are proposed by the City of Gaithersburg, which would encourage more pedestrian and bicycle commuters.
- **Disruption.** There is some concern about calming truck traffic near the AML along South Drive, to minimize any vibrations that might affect research.

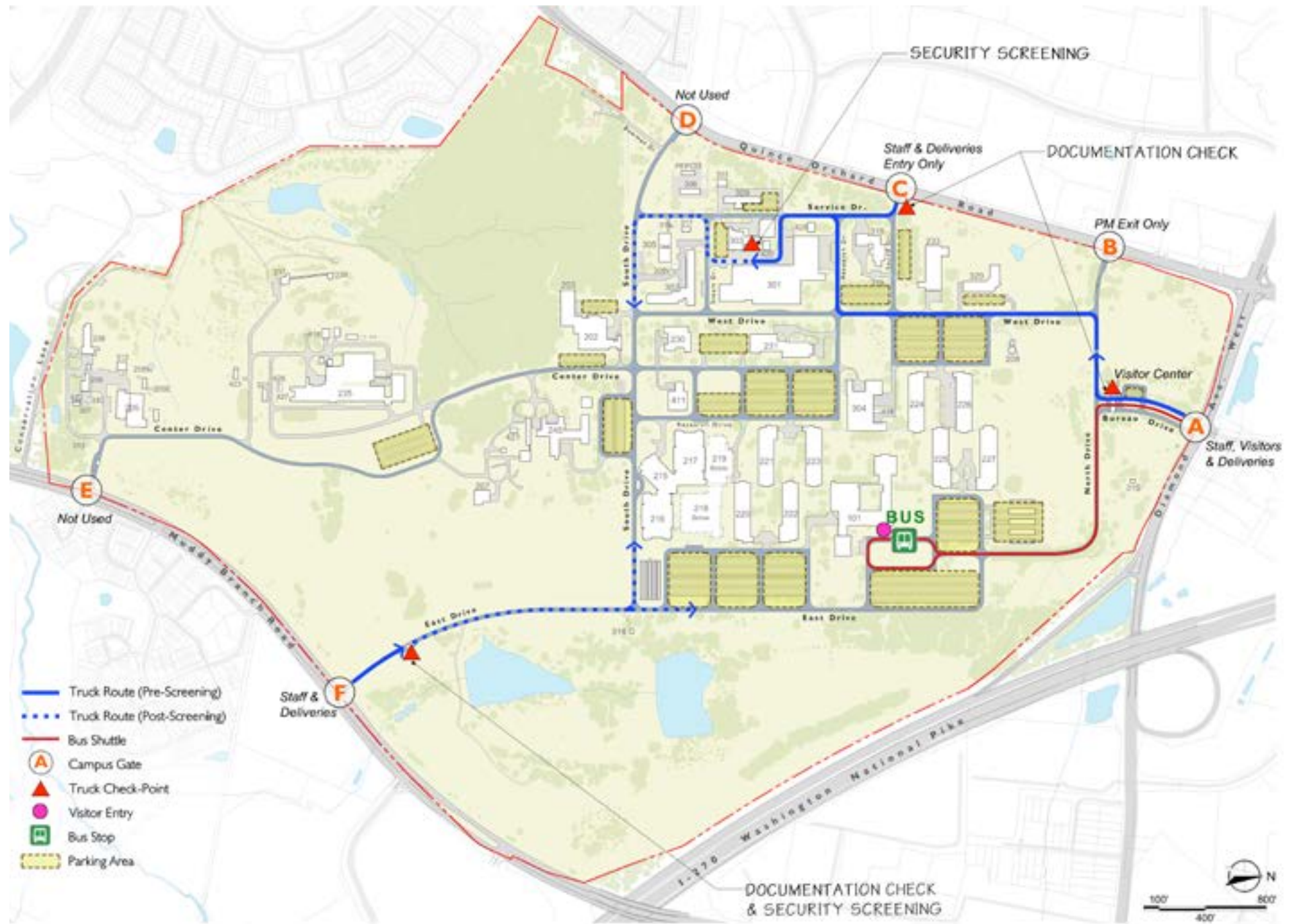
## Campus Security

Campus security is controlled at the entrance gates, and at each building entrance. The campus is surrounded by a fence, and there are six gates, four of which are active. Visitors must arrive at Gate A, where there is a visitor center building. Visitors must check in at the Visitor Center (Building 103), show identification and obtain a pass before proceeding to the gatehouse, where their pass and ID are checked. Employees and precleared contractors/visitors enter the campus at Gates A, C or F, where they must show their identification.

The Administration Building (101) has open access only on the main and basement levels, allowing non-employees to access the cafeteria, conference center, library and museum. Other floors and buildings, including the connecting pedestrian concourses, are entered using programmed key cards. The NCNR, Building 235, has an additional fence and vehicle access control.

All delivery vehicles are screened. Commercial delivery

Exhibit 121: Existing Campus Vehicular Circulation



vehicles are permitted to enter at Gates A, C and F, but all deliveries must be pre-scheduled. (Rejected commercial vehicles must be escorted through campus to an exit because the gate areas lack turn-around space.) Drivers have their identification examined before the vehicles' contents are screened. Those who enter at Gates A or C travel to the parking area by Building 301 for inspection. Those commercial vehicles that arrive at Gate F are redirected to Gate C. During data collection, the team observed that the majority of commercial vehicles entered through Gate C.



# Key Site Planning Issues

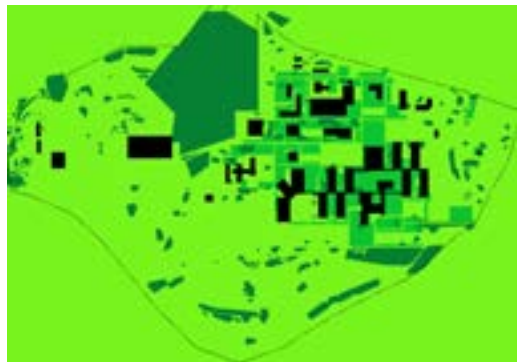
## Exhibit 122: Existing Conditions Analysis Matrix

### EXISTING CONDITIONS



#### SERIES A Enhance Site Circulation

1. Site Circulation



#### SERIES B Diversify Site Vegetation

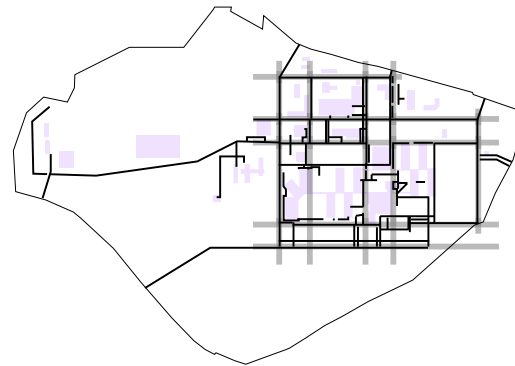
1. Zones Of Landscape Character



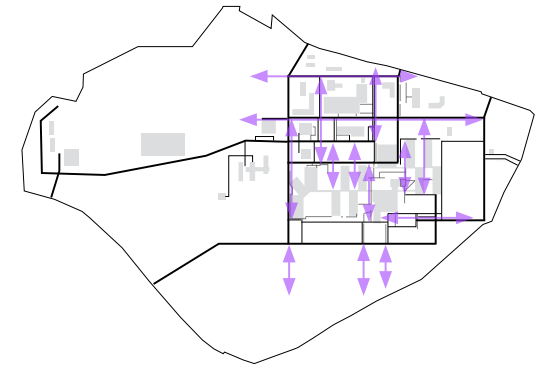
#### SERIES C Intensify Site Focal Points

1. Current Site Focal Points

### ANALYSIS



2. Gridded Campus Form



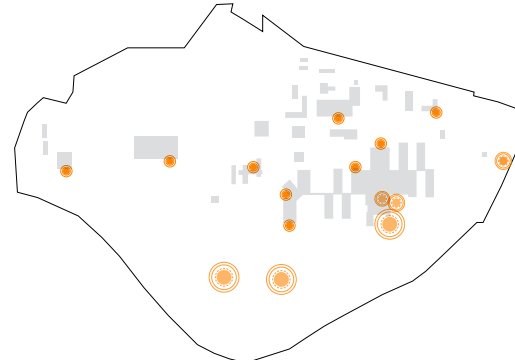
3. Fragmented Pedestrian Circulation



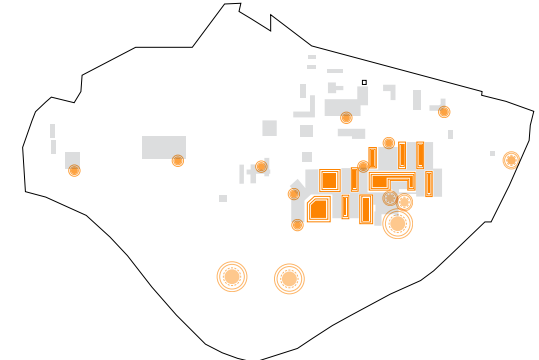
2. Composite Lawn Space



3. Currently Activated Green Space



2. Major Building Entrances



3. Focal Interior Courtyard Spaces

## Enhance Pedestrian Circulation

The campus form is characterized by its circulation pattern. A perimeter road runs around campus with feeder roads intersecting it and leading to buildings. Major roads frame the form of the campus labs and lead to and from site entrances. Significant parking lots are located close to the labs and buildings providing ample and convenient parking access for employees. Sidewalks run within and around the perimeter of campus. These sidewalks lead to building entrances and along some internal blocks, but break at various points on campus. This discontinuous form reflects the modular nature of the site design. Sidewalks and roads can be easily added or removed as the campus evolves.

Roads and sidewalks that run through campus are linear, aligning with the orthogonal shape and layout of the original buildings. This creates an implied gridded structure of road and walkways that enter at building entrances and at entrances to the concourse connectors. Buildings and parking lots are orthogonally aligned with the streets, helping to enforce a sense of gridded order.

Sidewalks along streets are inconsistent, and buildings are more strongly connected by the central internal concourse. These factors create fractures in the implied linear circulation. Sidewalks stop and pickup along horizontal roads through campus. Additionally, there is not clear pedestrian access to the two ponds and the naturalized areas outside of the main campus. There is also limited pedestrian access to the main visitor's entrance. Clear access between parking lots and building entrances is provided, but circulation between buildings and the spaces around them is less frequent.

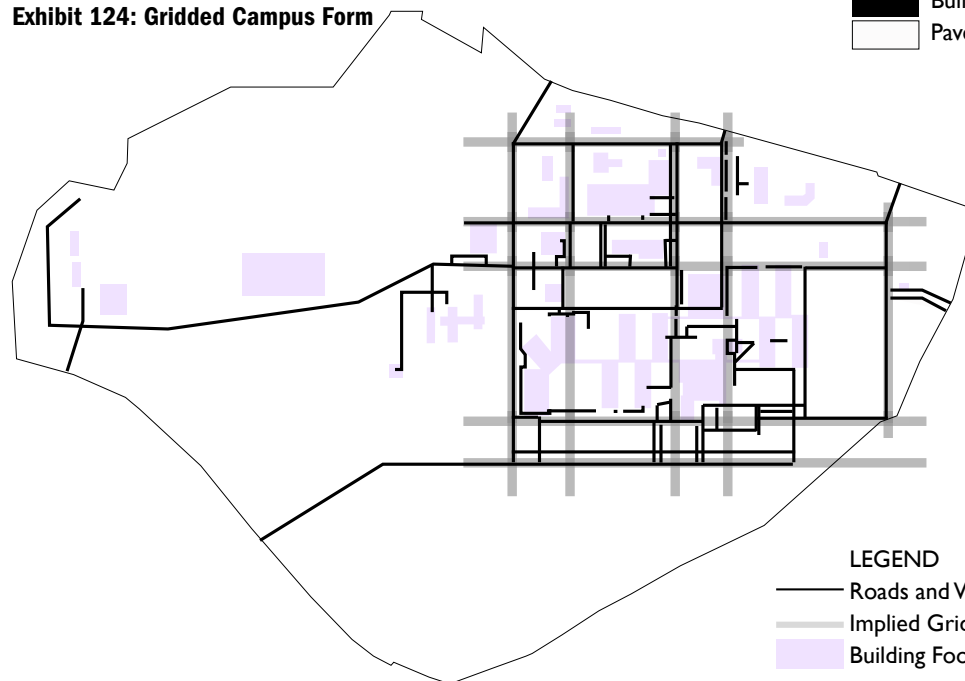
**Exhibit 123: Site Circulation**



**LEGEND**

- Building Footprint
- Paved Surface

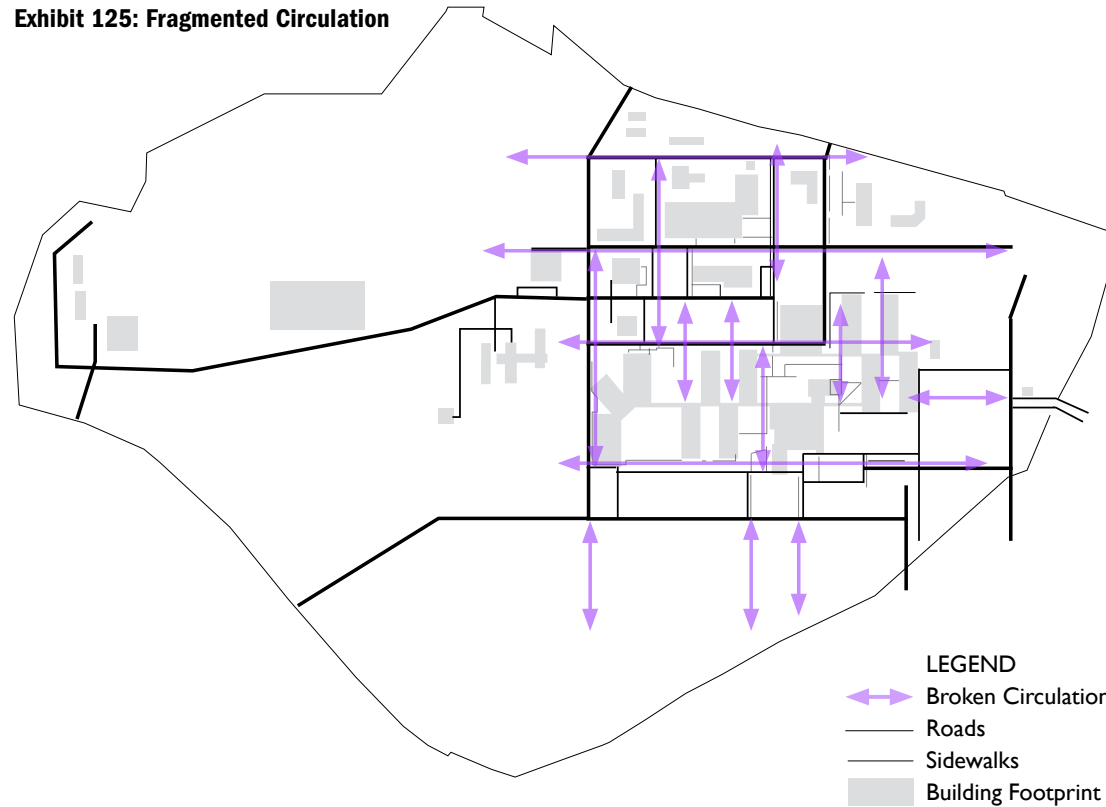
**Exhibit 124: Gridded Campus Form**



**LEGEND**

- Roads and Walkways
- Implied Grid Structure
- Building Footprint

**Exhibit 125: Fragmented Circulation**



There are many spaces on campus like this. Paved roadways and buildings frame open green space without explicit accessibility.



The main internal corridor with a connection to exterior circulation



Prominent circulation is internal along the central concourse that connects many lab buildings.



Sidewalks run alongside roads through campus. There is ample parking that connects to the streets and occasionally to the sidewalk system.

## Diversify Site Vegetation

There are three major, and separate, landscape zones: lawn, tree cover and forest, and maintained landscape. A rolling topography with maintained lawn defines most of the campus. The landscape surrounding the campus buildings generally consists of a mix of lawn and trees with some plants placed around building entrances. All lawn covered area is mowed and maintained. Forested areas do not contain under story planting because of deer damage. There is a variety of tree species to reflect the fifty states. This variety includes a mix of maple, ash, pine, cherry, evergreens, and species that grow hardily in this region like tulip poplars, magnolias, and dogwoods.

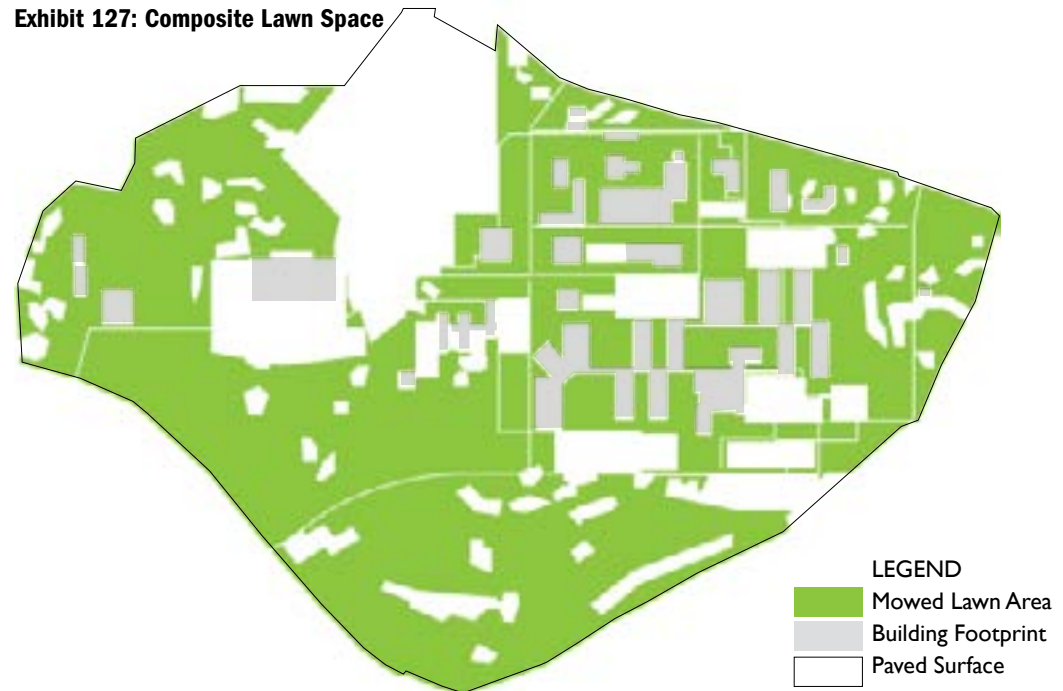
The campus would benefit from less maintenance and more variety. Over half of the total site area is mowed and maintained lawn. Lawn covers the filled topography and the landscape around new buildings. It also covers most of the area around existing and original lab buildings.

There are four prominent activated green spaces on campus: the internal courtyard behind the library, the plaza in front of the library, the Administration building, and the baseball fields and recreation area. These areas use a diversified planting and built site features to create outdoor gathering places.

**Exhibit 126: Zones of Landscape Character**



**Exhibit 127: Composite Lawn Space**





**Exhibit 128:  
Currently Activated Green Space**



A variety of shrubs at a building corner. This could be expanded throughout campus for more variety.



Bocce courts are next to the baseball fields. If cleaned and maintained, they could become a focal point



The formal entrance at the Administration Building uses ornamental planting to create a sense of place.



Two baseball fields lie south of campus for employee recreation. Access to these could be enhanced.



Lawn and tree cover are the prominent landscape characteristics on site.



The plaza in front of the library uses linear Modernist elements to cohere with architectural elements.

## Intensify Site Focal Points

The campus has six identifiable focal features: two ponds, the entrance at the Administration building, the courtyard in front of the library, the internal courtyard of the Administration building, and the main entrance at Gate A. These places are focal points because they are visually distinct and are site destinations. These places break the monotony of prominent campus features, and are identifiable places that can be used for wayfinding and to reference other places on campus.

The next most important focal elements are the courtyards and spaces created by the layout of the buildings. These spaces are intended to be spaces of informal gathering. They are the spaces that connect the otherwise isolated lab buildings. By creating desirable locations in these spaces, communication and collaboration can be more easily fostered.

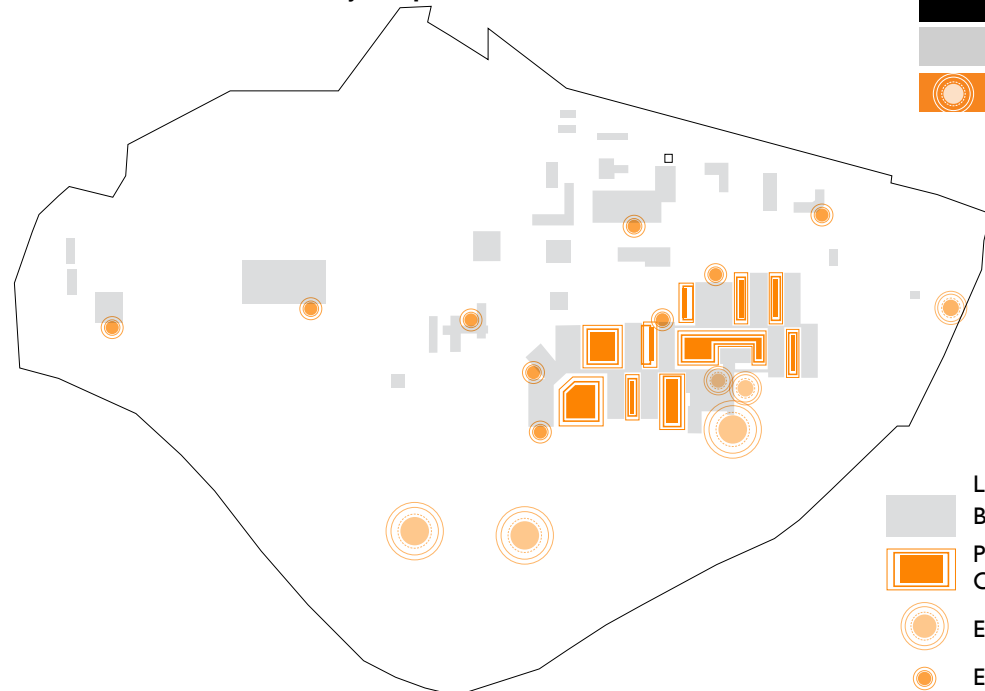
In the hierarchy of site focal features, the next most prominent places are major building entrances. Because of daily staff use, outdoor areas around the entrances are the most frequently visited outdoor spaces. Currently, they are minimally marked and understated with signage and occasional planting.

Because the landscape and site planning are noted features of the campus historic district, any proposed changes should be planned in full compliance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*.

**Exhibit 129: Current Site Focal Points**



**Exhibit 130: Focal Interior Courtyard Spaces**



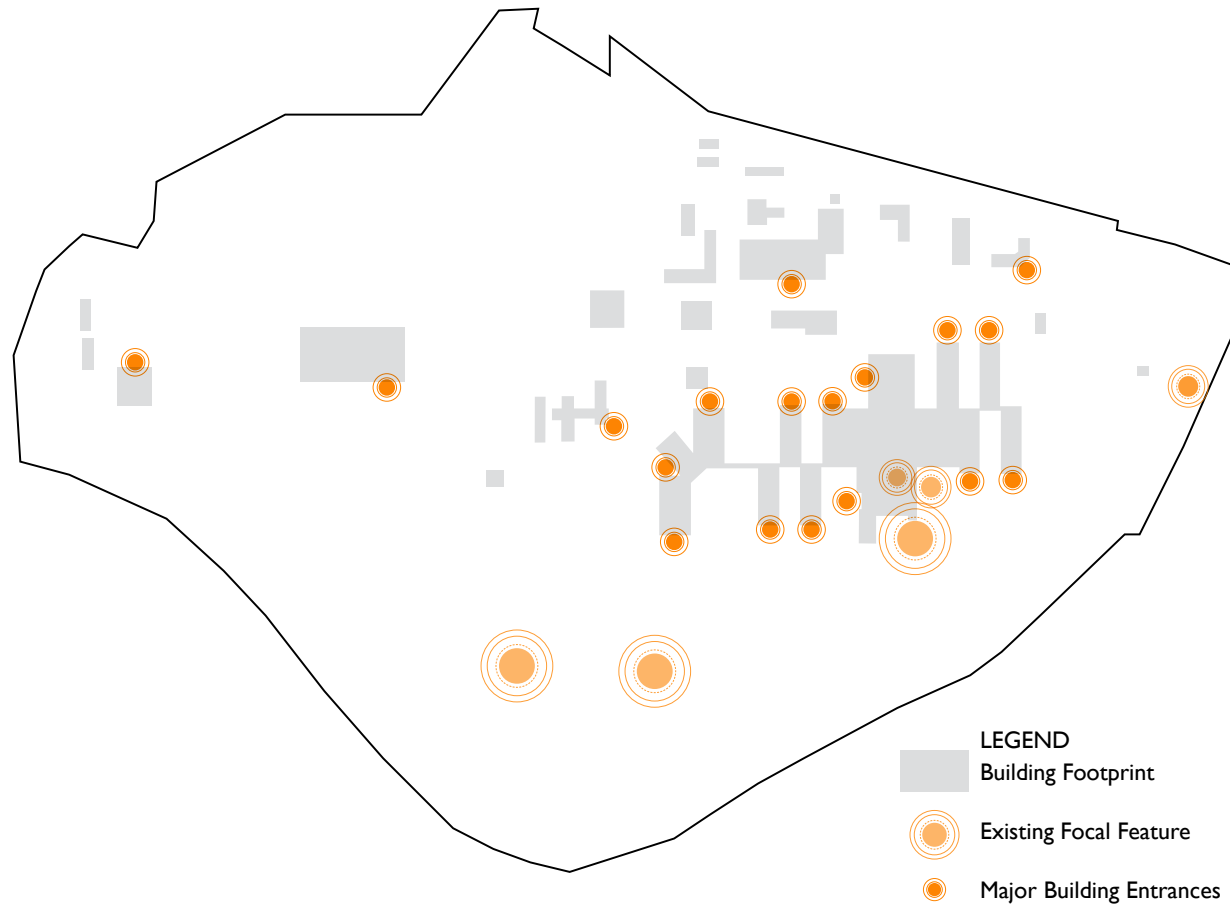
**LEGEND**

- Building Footprint
- Paved Surface
- Existing Focal Feature

**LEGEND**

- Building Footprint
- Prominent Interior Courtyard
- Existing Focal Feature
- Existing Focal Feature

**Exhibit 131: Major Building Entrances**



Side entry to Building 101. Stairs, plantings, benches, and bollards help establish a focal point.



The two ponds offer a focal point in the landscape with a variety of plants and wildlife



The formal entrance at the Administration Building is what designers originally intended to be welcoming site for visitors



The plaza in front of the library could be a campus focal point with ample seating



An entrance at the Technology Building. A lack of planting and site features downplay its significance.



The main building entrance at the Advanced Measurement Laboratory uses signage and bollards to mark the space



# Campus Built Environment

## CHAPTER 14

THE National Institute of Standards and Technology Gaithersburg Campus contains sixty-two permanent and temporary structures that support the research mission. These buildings represent a spectrum of uses, from general purpose laboratory buildings to special purpose research facilities to garages. Twenty-four buildings remain from the initial 1960s campus development including the first building—Engineering Mechanics, the prominent Administration Building and seven general purpose laboratories. Overall, these twenty-four buildings represent over 70% of the campus gross square footage. Recent construction of the five buildings of the Advanced Measurement Laboratory complex, plus the Robotics Test Facility, Advanced Chemical Sciences Laboratory and Net-Zero Energy Residential Test Facility, have added more than 800,000 gross square feet of sophisticated research facilities.

### Functional Observations

Campus buildings are well maintained, and repairs are made when necessary. Many needed renovations and modifications have been identified in the other recent studies listed in the Background section of this report.

The nature and activities of today's scientific research and support have outgrown many of the older facilities in which they now occur. Inefficiencies are not only in the physical building systems, but also in their layout and organization. For the master plan, the team reviewed each campus building for its condition and functional suitability, and coordinated the detailed findings of the other recent studies. Following is a summary of key observations and issues.

- *Laboratory Environmental Control.* Much of the advanced research taking place on the Gaithersburg campus is based on precise performance and measurements, which demand very controlled environments—rigorous

temperature and humidity control, vibration stability, air cleanliness and quality electric power. The Advanced Measurement Laboratory complex and several other recent buildings meet these exacting levels of control. However, in the older laboratory buildings such as the seven General Purpose Laboratories, these conditions are difficult to achieve. Researchers make due in the older buildings, but time is wasted and experiments sidelined.

- *Alternate Laboratory Uses:* For want of adequate office and support space for researchers near their experiments, a significant number of labs are used for non-laboratory functions. Building 222, once a laboratory building, was modernized for office use, eliminating over 100 lab modules. The GPLs also house senior laboratory management, which has resulted in some larger module laboratories being converted to conference facilities. A second underutilization of labs is their occupancy by information technology research programs, which do not require traditional lab services (gases, chemicals, sinks, fume hoods, venting, waste treatment, etc.). These IT programs could function well in office-type environments with proper power and cooling.
- *Fragmentation of Organizations.* NIST has gone through multiple re-organizations over the years. Functionally and administratively, these re-organizations have been a response to advances in research priorities and technologies, or administrative shifts. The impact has been the fragmentation of most Divisions and the related compromises in collaboration, sharing of resources and working efficiency.
- *Connectivity and Wayfinding:* Enclosed concourses connect the Administration Building, the GPLs and AMLs, which is both a convenience and a way to link organizations and researchers. These connectors essentially serve as interior streets. However, the sameness in design of both the laboratories and the linking concourses is disorienting and can be confusing.

- *Office Utilization:* Overall campus office utilization is approximately 163 asf/person, which is within the Department of Commerce goal of 170 asf/person. But there is disparity between the laboratory OU's limited office space and the more generous office space of the administrative OUs. Administrative office space in four buildings has been studied for strategies to reach the utilization goal through renovation, consolidation and reduction in the number of individual private offices.
- *Public Facilities:* Both increasing use and changing security requirements have put pressure on the aging public-use facilities in Building 101. The completed food service study proposes changes to the cafeteria, and a recently completed study of the Building 101 lower levels resulted in a plan for an addition to the north of the main lobby for expanded conference facilities on the first floor, library stacks on the basement level, and offices on the upper level. It also includes plans for renovating and updating select portions of the first floor and basement.
- *Historic Context:* The entire campus has been determined to be eligible for listing on the National register of Historic Places by the Keeper of the National Trust. New construction and work to existing buildings should comply with the *Secretary of the Interior's Standards for Treatment of Historic Properties*, to the degree possible.

## Physical Building Observations

Laboratory buildings account for 27 of the 62 buildings on the Gaithersburg campus, but approximately 78% of the overall gross square feet. The remaining buildings support NIST's research mission in a myriad of ways, including administration, emergency services, child care, maintenance and storage.

Laboratory facilities built from 1999 to 2014 have been constructed to meet scientific mission requirements, and serve their functions very well. Approximately two-thirds of the laboratory facilities (17 of 27) are part of the original campus development in the 1960s. These older facilities do not provide the performance expected for current research. Some architectural deficiencies notwithstanding, the researchers' dissatisfaction stems largely from lack of thermal stability, inadequate quality and quantity of power, deficiencies in piped services, and the general degradation in infrastructure equipment and distribution. For a range of precision experiments, power and thermal fluctuations

### Exhibit 132: Buildings on the Gaithersburg Campus

Building Type	Quantity	Square Footage
Administration/Offices*	4	529,768
Advanced Measurement Labs	5	536,512
Advanced Chemical Sciences Lab	1	231,912
General Purpose Labs	7	1,277,587
Special Purpose Labs	14	792,122
Support & Service Facilities	31	259,446
Connecting Corridors	–	13,908
<b>Total</b>	<b>62</b>	<b>3,641,255 gsf</b>

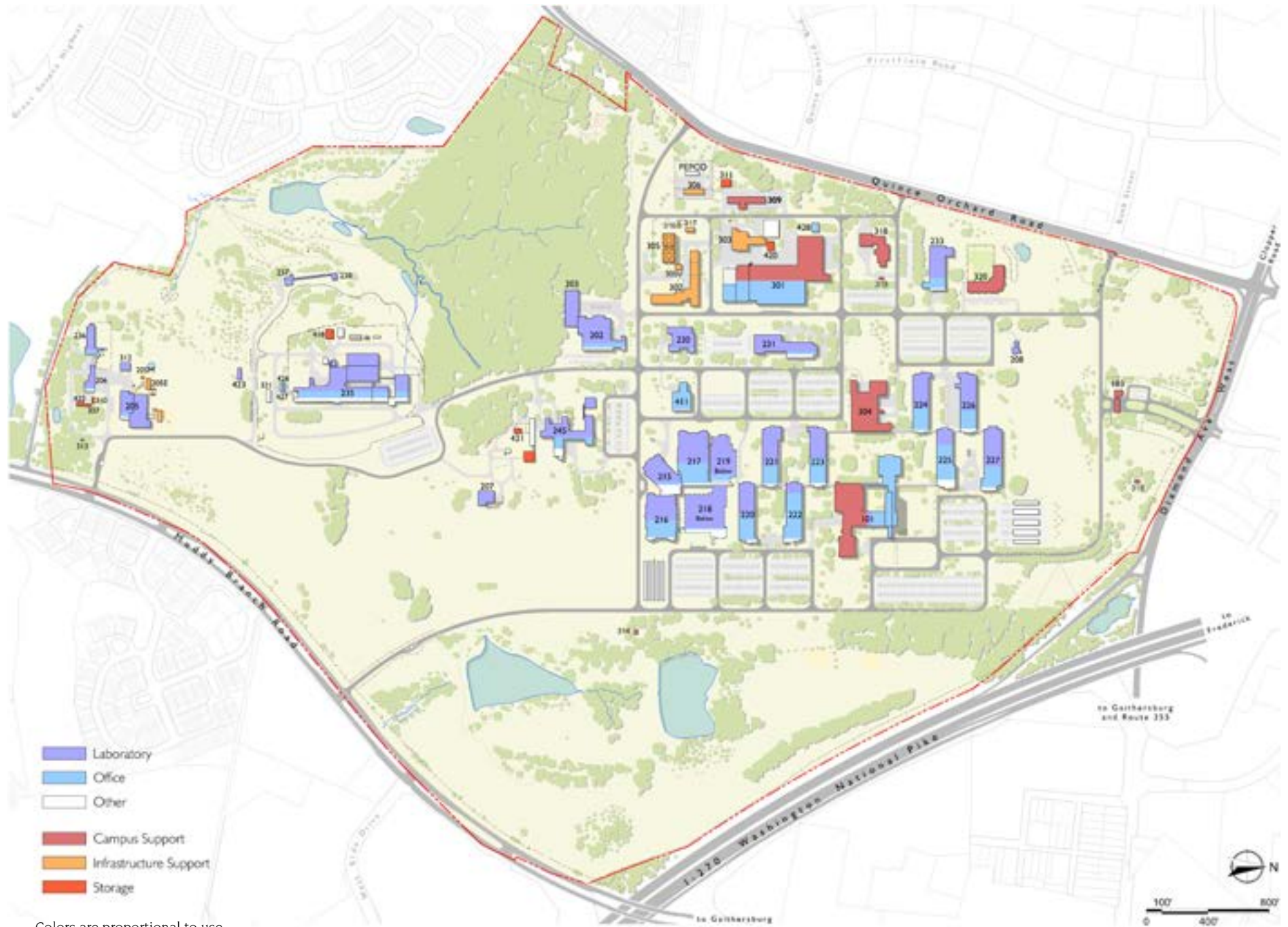
\*Includes Building 301, listed as 70% offices and 30% support

have often required set-ups within labs to be re-initiated, resulting in days or weeks of lost time and productivity.

An assessment of these older laboratories indicated that the infrastructure systems have long outlived their useful life and are very energy inefficient in their operation. Proactive maintenance has kept the buildings operational, but the task is increasingly handicapped as components for legacy equipment are difficult to obtain. The mechanical systems cannot provide the acceptable temperature control required for advanced instrumentation. Air quality concerns include low levels of filtration and potential entrainment of exhaust air. The electrical service is not supported with back-up power generation or with central uninterrupted power supply systems. The buildings are not provided with fire sprinkler systems, which are now mandatory. Lack of many piped laboratory services is not consistent with current design practice, and the aged piping systems are prone to leaks. The building skin in these older facilities is uninsulated and does not comply with energy efficiency requirements.

Like the older laboratory buildings, the original administrative and support buildings are reaching their 50th year, and many need upgrades or replacement of their engineering systems to prolong their useful lives, improve their efficiency and support the functions of today. The original Building 101 enclosure, especially the windows, are not insulated and do not meet federal energy conservation goals. The windows on the one-story buildings have been replaced with thermal windows.

Exhibit 133: Major Building Uses



## Facility Condition Assessments

NIST surveys each building on a regular cycle to determine its condition and repair needs. Recent assessments began with a 2011 baseline survey and the most recent update was 2015. Based upon the Facility Condition Assessment estimated cost of repairs, compared with the estimated replacement value, a Facility Condition Index (FCI) value is calculated for each building. The value is then classified into a rating of good, fair or poor. Currently, 27 of the buildings and structures on the NIST Gaithersburg campus have an FCI rating of “Poor.” While NIST has a robust repair and maintenance program, the age of the buildings and obsolescence of their systems makes significant conditions improvements difficult to achieve.

### Existing Research Facilities

A significant portion of the research facilities are in poor condition, based on the evaluation of the Research Facilities Strategic Plan. Of the existing 875,000 assignable square feet of research space, over 450,000 asf requires upgrades and modernization.

- Functionally compliant with current practices and needs 37%
- In design/construction for modernization (Building 245) 8%
- Needs upgrades and modernization 55%



Exhibit 134: Facility Condition Assessment



**Exhibit 135: Buildings Inventory**

	<b>Building Number And Name</b>	<b>Size (GSF)</b>	<b>Year Completed</b>	<b>Primary Occupants</b>
101	Administration Building	345,818	1965	Administration, Public Space
103	Visitor's Center	2,460	2009	OFPM
202	Engineering Mechanics	78,575	1963	MML, PML,EL
203	Standard Reference Materials Building	24,915	2012	MML
205	Large Fire Facility	48,746	1974	EL
205E	Emissions Control Electrical	260	2001	Unoccupied
205M	Emissions Control Mechanical	322	2001	Unoccupied
206	Concrete Materials Building	8,165	1968	EL
207	Robot Test Facility	9,898	2012	EL
208	Net-Zero Energy Residential Test Facility	7,374	2012	EL
215	Nanofabrication Facility	109,376	2004	CNST
216	Center Nano Science & Technology	106,157	2004	CNST
217	Instrument West Building	129,358	2004	MML, PML
218	Metrology East Building	106,739	2004	CNST, PML
219	Metrology West Building	84,882	2004	PML
220	Metrology Building	216,040	1966	PML. EL, ADLP, MML
221	Physics Building	219,658	1966	MML, PML
222	Chemistry Building	166,089	1966	PML, ITL, MML, ADLP, CTL, ADIIS
223	Materials Building	164,659	1966	MML, OSHE
224	Polymer Building	164,008	1966	MML, EL
225	Technology Building	204,333	1966	PML, ITL, OISM
226	Building Research Building	142,800	1966	EL
227	Advanced Chemical Sciences Laboratory	231,912	2001	MML
230	Fluid Mechanics Building	38,366	1969	PML
231	Industrial Building	75,131	1968	MML
233	Sound Building	42,881	1968	PML, EL
235	NIST Center For Neutron Research	229,868	1965	NCNR, PML, MML
236	Special Projects Building	13,221	1968	MML, EL
237	Non-Magnetic Building	3,100	1968	PML
238	Non-Magnetic Building	3,961	1968	PML
245	Radiation Physics Building	207,921	1964	PML
301	Supply and Plant Building	163,765	1964	OFPM, OAAM, HMEP
302	Steam And Chilled Water Generation Plant	60,053	1963	OFPM
303	Service Building	14,572	1964	OFPM
304	Shops Building	75,589	1964	EL, ADMR

**Exhibit 135: Buildings Inventory, continued**

Building Number And Name		Size (GSF)	Year Completed	Primary Occupants
305	Cooling Tower Building	16,162	1963	Unoccupied
306	Electrical Sub-Station	4,532	1963	Unoccupied
307	Materials Processing Storage	374	1972	Unoccupied
309	Grounds Maintenance Building	11,701	1975	OFPM
310	Plant Storage Building	505	1987	Unoccupied
311	Grounds Storage Shed	2,511	1975	Unoccupied
312	Materials Processing Building	3,877	1977	OSHE
313	Site Effluent Neutralization Building	245	1997	Unoccupied
314	Backflow Preventer Building - East	663	1998	Unoccupied
315	Backflow Preventer Building - North	663	1998	Unoccupied
316	Electrical Service Building	487	2011	Unoccupied
317	Cooling Tower West	3,441	2011	Unoccupied
318	Emergency Services Facility	22,123	2014	ADMR, OSY
319	Emergency Services Storage Building	312	2014	Unoccupied
320	Child Care Center	23,687	2012	Contractors
321	NCNR Storage	1,900	2017	Unoccupied
411	Temporary Relocatable Facility	17,362	1989	OISM, OAAM
414	Janitorial Storage Building	803	1994	Unoccupied
418	NCNR Storage Building	3,000	1995	Unoccupied
420	OFPM Storage Building	2,615	1996	Unoccupied
421	Radiation Physics Storage Building	1,499	1964	Unoccupied
422	Concrete Materials Storage Building	1,200	2004	Unoccupied
423	Research House	2,261	2004	EL
425	NCNR Storage Building II	303	2007	Unoccupied
426	NCNR Trailer 2	663	2008	Unoccupied
427	NCNR Trailer 1	663	2008	Unoccupied
428	Facilities Building	2,823	2010	OFPM
	Concourse	13,908		
	<b>Total Gross Square Feet</b>	<b>3,641,255</b>		

## LEGEND OF OCCUPANT NAMES

ADIIS Associate Director of Innovation &amp; Industry Services

ADLP Associate Director for Laboratory Programs

ADMR Associate Director for Management Resources

CNST Center for Nanoscale Science and Technology

CTL Communications Technology Laboratory

EL Engineering Laboratory

HMEP Hollings Manufacturing Extension Partnership

ITL Information Technology Laboratory

MML Material Measurement Laboratory

NCNR NIST Center for Neutron Research

OAAM Office of Acquisition and Agreements

OD Office of the Director

OFPM Office of Facilities and Property Management

OFRM Office of Financial Resource Management

OHRM Office of Human Resources Management

OISM Office of Information Systems Management

OSHE Office of Safety, Health and Environment

OSY Office of Security, Dept. of Commerce

PML Physical Measurement Laboratory

# The Buildings

## Building 101—Administration

The Administration Building serves as the image of NIST's Gaithersburg campus, and is the predominant building in size, function, and location. The 345,785 gross square feet, 15-story structure is the only high rise building on campus and the first building visible when entering from the main gate and Visitor's Center. The tower portion houses the NIST Director's Office, the Associate Directors' offices, and administrative components of other organizational units. The lower floors house NIST's central public spaces including the library, conference center, auditoriums, cafeteria, exhibits, and museum. Commissioned in 1965, the Administration Building is one of the earliest buildings on campus. It is centrally located and connects to the two pedestrian concourses that provide sheltered access to most of the laboratory buildings on campus.

Like many campus facilities, the core architecture and infrastructure of the building has generally remained unchanged from the original construction. Most of the major mechanical, electrical, and plumbing systems have exceeded their design life but are still operable and functional. The building



envelope, especially the windows, falls far short of the energy efficiency standards of today. The interior finishes of the public spaces such as the auditoriums, museum, and exhibits have been well maintained, and in some cases updated to accommodate the frequent use and changing nature of these spaces. Other public areas are largely untouched.

*Observations:* Building 101 serves the core administrative and special functions needs of the NIST campus very well. While the building is well maintained and major infrastructure appears to be operating normally, portions of the building clearly show its age and the facility is in need of significant modernization and HVAC replacement in the near future. In terms





of its space utilization, there are potential opportunities for improvement, including reconsideration of office suite layouts.

Four recent studies have made recommendations concerning Building 101:

- NIST *Administrative Space Strategic Plan* examined the office space configurations in this building and other administrative spaces, and recommended layout changes that meet OU goals, and improve overall utilization and flexibility.
- NIST *Building 101 Window and Induction Unit Study* evaluated the mechanical systems and building envelope and recommended system upgrades, window replacement and envelope insulation.
- NIST *Cafeteria and Food Service Operations Evaluation and Recommendations* studied the cafeteria in the Administration Building, making recommendations for renovations the

kitchen/servery areas, expansion of the seating and addition of a coffee bar.

- NIST *Building 101 Lower Levels Planning Study* analyzed the space and functional needs of the public and staff community facilities on the two lower levels of the building. The study recommended renovations, a library upgrade and a building addition to house conference facilities, library stacks and office space.

GSF: 345,818

Occupied: 1965

Occupants: Administration,  
Public Functions



## Building 103—Visitors' Center

Building 103 is a stand-alone facility located at the main entrance on Bureau Drive, at the north end of the campus and is the first facility to be encountered by NIST employees and the visitors. The visitor processing facility offers a welcoming aesthetic and provides for efficient inspection and ID check for all visitors entering the campus. Its dedicated parking lot is used by the visitors for short-duration parking.

The facility consists of two blocks. The visitors processing area is a chamfered rectangular block with an inviting entry vestibule and a processing area. The long transaction counter accommodates up to three staff persons. The main processing area has high ceiling and windows on three sides. The rear portion of the building houses a break-room, employee work-space, and building infrastructure.

The other block is an observation station located across two lanes of the Bureau Drive. The two blocks are united by a canopy spanning the road width for incoming traffic, and extending further to provide cover to the lanes in the opposite direction. The station has inclined glass panels on three sides and offers unobstructed view of all incoming and outgoing traffic.

Commissioned in 2009, this service facility replaced the now demolished Building 102. The Visitor Center building is a single level structure without basement space. Given the distance from the campus steam and chilled water network, the Visitor Center is equipped with its own HVAC service consisting primarily of a split air-handling unit and baseboard heating. Electrical service is provided from a pad-mounted transformer located outside the building. An electrical room and a telecom/data closet are located in the rear.

*Observations:* Building 103 is in good physical condition, and the spaces are well utilized for the desired functions. The priority maintenance item is roof replacement.

GSF: 2,460

Occupied: 2009

Occupants: DoC Office of Security



## Building 202—Engineering Mechanics

Building 202—Engineering Mechanics, completed in 1962, is the first laboratory building that was commissioned on the NIST Gaithersburg campus. This 78,577 square foot facility was designed specifically for research and experiments with large scale material testing and serves the same functions to this day. Besides use by NIST researchers, the facility is also used by other government agencies and the materials industry. While most of the structure is original, a single-level addition on the north has provided for three special purpose laboratories.

A large portion of Building 202 is constructed as high bay spaces for large scale materials measurements under various operating conditions. The Engineering Mechanics building is essentially an above-grade four level structure, with the exception of a service entry room and a small gravity chamber in the basement, constructed of steel and brick. It is one-of-a-kind facility with a 12,700 sf large test area at its core, which partially towers above the four levels of the adjacent rooms, and houses equipment for heavy weight impact testing of large scale materials. The building is structurally designed to handle the effects of high impact load testing.

Given the nature of experimentation in the facility, the building does not follow any uniform layout approach. The basically square shaped building has a partial ziggurat-like massing responding to the clear height needed for the equipment and experiments in the facility. The large high-bay space is surrounded on the east by two levels of office and infrastructure support spaces, on the south by high-bay laboratories, and on the north by three-to-four levels of stacked laboratories.

*Observations:* Building 202 continues to function for intended research needs. The building has benefitted from HVAC renovation and window replacement projects, but is in poor condition with needed replacement of the HVAC system and upgrades to the interior environment for improved efficiency and function.

GSF: 78,575

Occupied: 1963

Occupants: Material Measurement Laboratory, Physical Measurement Laboratory, Engineering Laboratory



## Building 203—Standard Reference Materials Building

Building 203—Standard Reference Materials Building is a warehouse building for temperate and cold storage of a variety of materials. These materials are packaged and sent to industry and academic customers as NIST Standard Reference Materials (SRMs). This NIST resource was completed in 2012 as part of a construction program funded by the American Reinvestment and Recovery Act. The facility is located directly adjacent and connected to the Engineering Mechanics Building 202.

Building 203 is two-stories in height and 24,914 gross square feet in size. The major spaces are storage rooms and large freezers, supported by a small office suite. The storage areas are served by a loading dock with a dock leveler and truck yard. This is a concrete block structure with a tan brick veneer façade, built on a slab-on-grade foundation. The roof consists

of a built-up system with gravel stop supported by metal truss joist and corrugated metal deck. There are nine metal personnel doors and one roll-up door. A natural gas fueled generator provides emergency power to designated panels and systems in the facility.

*Observations:* Building 203 is in good physical condition and well utilized.

GSF: 24,915

Occupied: 2012

Occupants: Material Measurement Laboratory





## Building 205—Large Fire Facility

Building 205—Large Fire Facility, completed in 1974 and recently expanded to 48,750 Gross square feet, is a special purpose laboratory designed for large scale tests and experiments of fire occurrences in buildings. The building facilitates precise characterization of real-scale fire behavior of combustibles, performance of structures on fire under various loading conditions, conducting of disaster and failure studies, and validation of predictive models at a suitable scale. Located a short distance from the building, separated from the building operations, are two special mechanical and electrical infrastructure and emissions control equipment facilities, designated Buildings 205 E and M.

The Large Fire Facility building is an above-grade two level structure. It is one-of-a-kind facility in that at its core is a large test area, a high-bay special space for fire tests on materials and assemblies. The test area includes multiple hood canopies for tests at small, medium or large scale, and also a wind tunnel with its own hood canopy for simulation of real-life conditions. This test laboratory has recently been expanded to over twice its original size and includes a post tensioned reinforced strong floor and strong wall for construction of large scale burn props. Adjoining the test area are calibration and test equipment spaces, offices and an observation overlook.

*Observations:* Besides its use by NIST, the facility also is used by other government agencies and the building industry for collaborative work with National Fire Research Laboratory. The structure and its infrastructure system are in good condition and continue to service effectively. A 90,000 cfm exhaust smoke scrubber, has been installed to comply with federal regulations.

205  
Large Fire Facility  
GSF: 48,746  
Occupied: 1974  
Occupants: Engineering Laboratory

205E  
Emissions Control Electrical  
GSF: 260  
Occupied: 2001  
Occupants: Office of Facilities and Property Management, unoccupied

205M  
Emissions Control Mechanical  
GSF: 322  
Occupied: 2001  
Occupants: Office of Facilities and Property Management, unoccupied



## Building 206—Concrete Materials Building

Building 206 –Concrete Materials Building was completed in 1968 as a special purpose facility. Constructed in the mode of a high-bay factory/processing plant structure, it is a specially designed facility for concrete materials mixing and testing. It has since been used for storage, sample preparation and aggregate processing of concrete materials for tests and experimentation in other facilities on the campus. The Engineering Laboratory, its current occupant, plans to re-purpose it for research on concrete pumping and building energy systems.

Building 206 is an at-grade concrete building, with two high-bay, column-free spaces designed for the preparation of samples and processing of aggregate materials. Major equipment includes gravity fed gravel bins, an overhead crane and testing equipment. The storage/work room is also constructed with no interior columns. Sample blends are packaged and shipped from this location. The building is structurally designed to handle heavy loads and movement of materials. There is only one office located here.

The structure and most components are original to the building; there has been no equipment, structural or architectural renovation of note except a roof replacement in 1994. The facility is in good condition, but upgrades to the mechanical, electrical and plumbing systems, including improved thermal control, would make the building function more efficiently.

*Observations:* The facility is not being used for the intended purposes, though it still stores materials and aggregates, and the high-bay labs are sporadically used for research programs. It is generally in poor physical condition, with a leaking roof and visible cracking along one façade.

GSF: 8,165  
Occupied: 1968  
Occupants: Engineering Laboratory



## Building 207—Robotics Test Facility

Building 207—The Robotics Test Facility, is a 25-foot tall, single-story, pre-engineered metal building constructed slab-on-grade. The 9,899 square foot building provides a 5000 sq. ft. high bay, enclosed isolation bays where robot sensing and endurance can be evaluated under controlled conditions such as cold, heat, and darkness, a meeting room, and extensive video and audio capture systems. The surrounding site area is also used for setting up prototype and standard test methods, such as for evaluating mobility in sand and gravel.

The Robotics Test Facility is a laboratory for testing and developing standard methods for measuring robot performance. The facility houses props and equipment for measuring how

well robots perform under a variety of tasks that mimic real-world challenges. Mobility, manipulation, sensing, endurance are some of the capabilities tested, for use in urban search and rescue, bomb disposal, manufacturing and other end-user requirements.

*Observations:* The building is in excellent condition and well utilized.

GSF: 9,898

Occupied: 2012

Occupants: Engineering Laboratory



### Building 208—Net-Zero Energy Residential Test Facility

Building 208—Net-Zero Energy Residential Test Facility, completed in 2012, is both a laboratory and a LEED Platinum rated house. The house was designed and built to demonstrate that a residence, typical in size and features of homes in the metropolitan D.C. area, can produce as much energy from renewable energy resources as it consumes on an annual basis.

The test facility is an all-electric four bedroom, three bath house, with a detached garage connected by a breezeway. Structure and layout are similar to a suburban home—two-story, wood frame construction, fiber cement siding, residential finishes. However, it was built to exacting standards of energy consumption, insulation and indoor air quality. Features include a geothermal heat pump system, solar panels, high performance building envelope, energy efficient appliances and sophisticated system controls. The house is “occupied” by

a sophisticated sensor and control system that mimics the everyday activities of a typical four person family. It was designed to be approximately 60 percent more energy efficient than a home meeting the requirements of the 2012 International Energy Conservation Code. After one year of operation, the house exceeded its goal, exporting excess energy to the electric grid.

*Observations:* The Net-Zero Energy Residential Test Facility is in excellent condition, and will continue to provide field data for residential energy-saving technologies, ventilation strategies and system controls.

GSF: 7,374

Occupied: 2012

Occupants: Engineering Laboratory



## Building 215—NanoFabrication Facility

Building 215—Nanofabrication Facility is one of NIST's prime user facilities. Located at south end of the array of interconnected laboratories on campus, it is part of the state-of-the-art Advanced Measurement Laboratory (AML) complex that was completed and commissioned in 2004. Consisting of five buildings, 215 through 219, the AML complex offers specialized laboratories with electromagnetic shielding, vibration isolation, and superior environmental control, allowing NIST to provide sophisticated measurements and standards.

With an area of 109,369 gross square feet, Building 215 is a Class 100/ISO 5 clean room facility primarily dedicated to laboratory and lab-support functions. The only non-laboratory related function is a 100 person lecture/conference space, shared by the NIST scientific community. The entire Clean Room environment and the conference area are on the first floor, supported by mechanical and electrical services on the second floor and the penthouse. The basement also includes a large space for storage and supply monitoring of toxic gases which are fed thru the air chase chambers to the laboratories above. A contact shop to support the laboratories in the AML

is also located in the basement. Like all the AML, Building 215 received steam, chilled water and compressed air from the Steam and Chilled Water Generation Plant.

The NanoFabrication Facility has special environmental control and laboratory gas services, supporting specialized research and processing of real-world products containing essential nanotechnology components. It operates as a user facility and provides NIST's collaborators with access to expensive nanofabrication tools and specialized expertise in a shared-cost environment.

*Observations:* The facility is in excellent condition and adequately serves the designed research functions. Portions of the building have been renovated, as necessary, to accommodate the latest in specialized equipment and research needs. The infrastructure has the designed potential to be upgraded to a Class 10/ISO 4 Clean Room environment when needed.

**GSF:** 109,376

**Occupied:** 2004

**Occupants:** Center for Nanoscale Science and Technology



**Building 216—Center for Nanoscale Science and Technology**

Building 216—Instrument East is one of NIST's newer laboratories and part of the state-of-the-art Advanced Measurement Laboratory (AML) complex that was completed and commissioned in 2004. Consisting of five buildings, 216 through 219, the AML complex offers specialized laboratories with electromagnetic shielding, vibration isolation, acoustic isolation, and superior environmental control.

Building 216 is a 106,177 gross square feet facility that offers laboratory and office space primarily serving the Center for Nanoscale Science and Technology and the Material Measurement Laboratory. This facility offers exacting thermal and humidity controls. The facility has high-ceiling laboratory area flanked by two levels of offices on the north and south perimeters. Wide circulation and service corridors run north-south on the front and rear of each laboratory. The service corridors are used to house each lab's specific service

equipment, particularly those that have high vibration or noise levels. The interior partitions offer high levels of flexibility and can be used at off-module locations to optimize equipment placement, and they use space very efficiently. The mechanical systems are located at the penthouse levels.

*Observations:* Building 216 is in excellent condition and supports its research functions very well. The laboratory modules are flexible and easily reconfigurable—a feature that has been extensively used to accommodate the latest in specialized equipment and research needs.

**GSF:** 106,157

**Occupied:** 2004

**Occupants:** Center for Nanoscale Science and Technology



## Building 217—Instrument West

Building 217—Instrument West was built in 2004 and is part of the state-of-the-art Advanced Measurement Laboratory (AML) complex. The five buildings in the AML complex, 216 through 219, offer specialized laboratories with electromagnetic shielding, vibration isolation, acoustic isolation, and superior environmental control.

Building 217 is a 129,393 gross square feet facility with laboratory and office space primarily serving the Material Measurement laboratory and the Physical Measurement Laboratory. Though similar in layout and features to Building 216, the Instrument West building is about 20% longer. The facility has high-ceiling laboratory area flanked by two levels of offices on the north and south perimeters. Wide circulation and service corridors run north-south on the front and rear of each laboratory. The service corridors are used to house each lab's specific service equipment, particularly those that have high vibration or noise levels. The interior partitions offer high

levels of flexibility and can be used at off-module locations to optimize equipment placement, and they use space very efficiently. The mechanical systems are located at the penthouse levels. Building 217 laboratories include Class 100, 1,000 and 10,000 clean rooms.

*Observations:* Building 217 is in excellent condition and supports its research functions very well. The laboratory modules are flexible and easily reconfigurable—a feature that has been extensively used to accommodate the latest in specialized equipment and research needs.

**GSF:** 129,358

**Occupied:** 2004

**Occupants:** Material Measurement Laboratory, Physical Measurement Laboratory



## Building 218—Metrology East Building

Building 218—Metrology East is one of the buildings of the Advanced Measurement Laboratory (AML) complex, completed and commissioned in 2004. This Dynamic Metrology Lab East Wing is an underground structure housing laboratory space, conference rooms and scientific testing rooms. Researchers and other users have their office space in other buildings within the AML.

Building 218 is a 106,739 gross square foot facility with laboratory space primarily serving the Physical Measurement Laboratory and the Center for Nanoscale Science and Technology. The below-grade structure was designed for a unique vibration-free stable environment for metrology experiments. To prevent jostling during the assembly of atomic structures and to shield ultrasensitive instruments from all but the slightest quiver, the specialized AML laboratory has the ultimate in vibration isolation. Located about 40 feet below ground level in a structurally isolated building its instruments sit atop specially designed, heavy mass isolation slabs supported on pneumatic “air springs.” An isolated, raised floor system spans over the pit containing each isolation slab so that researchers can run their experiments without affecting the isolation systems.

Building 218 has a small entry pavilion at-grade, and is connected below-grade to the other AML facilities. The high-ceiling laboratory area is flanked by core and support spaces on the south perimeter that include two conference rooms and two break rooms. Wide circulation and service corridors run north-south on the front and rear of each laboratory. Mechanical rooms are located in the basement and the laboratories are located in the sub-basement. The primary electrical distribution system for the entire AML is routed through Building 218.

*Observations:* Building 218 is in very good condition, supports its research functions very well and is a prime research asset. There are some totally isolated double-walled laboratories, but other modules are flexible and easily reconfigured.

**GSF:** 106,739

**Occupied:** 2004

**Occupants:** Center for Nanoscale Science and Technology, Physical Measurement Laboratory, Material Measurement Laboratory





## Building 219—Metrology West Building

Building 219—Metrology West is one of the five buildings of the Advanced Measurement Laboratory (AML) complex. It is an underground structure similar to the Metrology East Building 218 but approximately 20% smaller. Primarily a specialty lab building, there is limited office space, and researchers have their office space in other AML buildings.

Building 219 is an 84,880 gross square feet facility that offers laboratory space primarily serving the Physical Measurement laboratory. This below-grade building was designed for unique vibration-free stable environment for metrology experiments. To prevent jostling during the assembly of atomic structures and to shield ultrasensitive instruments from all but the slightest quiver, the laboratories have ultimate vibration isolation. The laboratories are located approximately 40 feet below ground level, structurally isolated, where instruments sit atop specially designed, heavy mass isolation slabs supported on pneumatic “air springs.” An isolated, raised floor system spans over the pit containing each isolation slab so that researchers can run their experiments without affecting the isolation systems.

Building 219 has a small entry pavilion at-grade, and is connected below-grade to the other AML facilities. Most laboratories have very precise environmental control and are constructed of a double wall system wherein the air is supplied and returned through the wall cavities. Significant space is dedicated to mechanical systems, which are on three sides of the laboratory perimeter. Additional mechanical systems are on the mezzanine level, accessed from the basement level.

*Observations:* Building 219 is in excellent condition and serves the designed research functions well. In addition to the vibration isolation capability of this structure, most of its laboratories are doubled walled for high-precision control of temperature and air-flow. This infrastructure is highly supportive of the advanced research that is performed in this facility.

GSF: 84,882  
 Occupied: 2004  
 Occupants: Physical Measurement Laboratory



## Building 220—Metrology

Building 220—Metrology is one of the original General Purpose Laboratories (GPL), completed and occupied in 1966. It is part of the grouping of laboratory buildings located along the connecting concourse of research buildings.

Building 220 is a 216,068 gross square foot building of offices and laboratories used primarily by Physical Measurement Laboratory and Engineering Laboratory. This modernist rectangular building has four occupiable floors—three above grade plus a basement. A typical floor is rectilinear in shape, with office space on the north and south perimeters and laboratory modules in the central spine. Some of the laboratory modules have been converted for the non-lab functions, mostly offices, conference rooms and office support. The basement level differs from other GPLs; there is an extended footprint on the

south provides long, linear laboratory space for dimensional metrology and calibration research.

The basic architecture of the building has remained unchanged from the original construction. Select infrastructure renovation projects have been carried out in recent years. These include rebuilding AHUs, upgrade to DDC controls, fume hood replacements, and light fixtures replacements for enhanced efficiency.

*Observations:* The building is well maintained but is showing its age. The space serves the research functions and provides proximate office space for research staff. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, fire detection system and fire stopping.). Other requirements noted are replacement of aging/outdated electrical and plumbing components, uninsulated windows, façade repairs and interior finish replacement.

GSF: 216,040

Occupied: 1966

Occupants: Physical Measurement Laboratory, Engineering Laboratory, Associate Director for Laboratory Programs, Material Measurement Laboratory



## Building 221—Physics

Building 221—Physics is one of the original 1966 General Purpose Laboratories (GPL), and one of the laboratory buildings located along the concourse circulation spine linking Building 101 and research buildings.

Building 221 is a 219,654 gross square feet building with laboratory and office space serving the Materials Measurement Laboratory and the Physical Measurement Laboratory. The building has four occupiable floors, three above grade and an expanded basement accommodating spectroscopy laboratories. It has a 39,600 gsf typical floor with office space on the north and south perimeters and back-to-back laboratory modules in the central spine separated from the offices by a shared corridor. Building 221 has limited ADP, storage and special function space.

This brick curtain wall building is generally unchanged from the original construction, including the major systems and the uninsulated windows. Recently, select infrastructure renovation projects have been carried out, including rebuilding AHUs, upgrade to DDC controls, fume hood replacements, and light fixtures replacements.

*Observations:* The building is well maintained, but showing its age. The space serves the research functions and provides proximate office space for research staff. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, fire detection system and fire stopping.). Other requirements noted are replacement of aging/outdated electrical and plumbing components, structural cracks, uninsulated windows, and interior finish replacement.

GSF: 219,658

Occupied: 1966

Occupants: Material Measurement Laboratory, Physical Measurement Laboratory



## Building 222—Chemistry

Building 222—Chemistry is one of the original General Purpose Laboratories (GPL), part of the grouping of laboratory buildings located along the concourse spine that connects many of the research buildings and the Administration Building.

Building 222 has 166,101 gross square feet of office and laboratory space, primarily serving the Information Technology Laboratory and the Physical Measurement Laboratory. The building has three above-grade occupiable floors. Except for the west half of the first floor, Building 222 is currently used as an office building, within the laboratory/office configurations. We observed 115 laboratory modules that were deployed for non-lab functions, mostly offices. The building houses laboratory staff, and also personnel from administrative organizations that benefit from its proximity to the Administration Building.

This is the only GPL that has been significantly renovated, with most of its infrastructure replaced and new interior finishes installed. Walls, floors, ceilings and windows have been

replaced, and a fire suppression system has been installed. Although some building systems are original, most mechanical equipment, electrical switchgear and plumbing systems have been replaced.

*Observations:* Building 222 is in good condition, and functions well for the occupants. However, the building has been adapted to house office-type function in spaces designed as laboratories. This neither makes the best use of lab-designed space nor provides flexible, efficient office space with open-plan layouts and improved penetration of natural light. Physically, improvements are still needed to the remaining original systems, with a priority recommendation to replace the original electrical bus ducts.

GSF: 166,089

Occupied: 1966

Occupants: Physical Measurement Laboratory, Information Technology Laboratory, Material Measurement Laboratory, Associate Director for Laboratory Programs, Communications Technology Laboratory, Assoc. Director of Innovation and Industry Services



## Building 223—Materials

Building 223—Materials is one of the seven original General Purpose Laboratories (GPL). It is located along the campus circulation spine connecting the GPLs and the Administration Building.

Building 223 is a 164,659 gross square feet building of laboratory and office space primarily serving the Materials Measurement Laboratory. It also houses some administrative and laboratory space for other NIST OUs. There are three occupiable floors, all above grade. The typical 39,600 gsf floor has office space on the north and south perimeters and back-to-back laboratory modules in the central spin, separated from the offices by a shared corridor. Like the other GPLs, some of the laboratory modules have been adapted to non-lab functions.

The building architecture has remained basically unchanged from the original construction, with renovations limited to those required to support laboratory and office space requirements. Select infrastructure renovation projects have been carried out over in recent years. These include rebuilding AHUs,

upgrade to DDC controls, new fume hoods and safety showers, and light fixtures replacements for enhanced efficiency.

*Observations:* The building is well maintained but is showing its age. The space serves the research functions and provides proximate office space for research staff. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, fire detection system and fire stopping.). Other requirements noted are replacement of aging/outdated electrical and plumbing components, uninsulated façade and windows and interior finish replacement.

GSF: 164,659

Occupied: 1966

Occupants: Material Measurement Laboratory, Office of Safety, Health and Environment



## Building 224—Polymers

Building 224—Polymer is an original General Purpose Laboratory (GPL), completed in 1966. It is located along the second concourse which connects a group of research buildings (GPLs and AML) with each other and to the Administration Building.

Building 224 is 164,028 gross square feet in size, with laboratory and office space serving the Materials Measurement Laboratory and the Engineering Laboratory. The building has three occupiable above-grade floors, each of approximately 39,600 gsf. Like the other GPLs, the floors are rectilinear in shape, with office space on the north and south perimeters and laboratory modules in the center. A few laboratory modules have been converted for the non-lab functions, mostly offices and conference rooms.

The building architecture is basically unchanged from the original construction, with renovations limited to those required to support laboratory and office space requirements. Select infrastructure renovation projects have been carried out in recent years. These include rebuilding AHUs, upgrade to DDC

controls, fume hood replacements, and light fixtures replacements for enhanced efficiency.

*Observations:* The building is well maintained but is showing its age. The space serves the research functions and provides proximate office space for research staff, but some of the laboratories are over-utilized, and others under-utilized. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, fire detection system and fire stopping.). Other requirements noted are replacement of aging/outdated electrical and plumbing components, uninsulated windows, façade repairs and interior finish replacement.

**GSF:** 164,008

**Occupied:** 1966

**Occupants:** Material Measurement Laboratory, Engineering Laboratory



## Building 225—Technology

Building 225—Technology is one of the original General Purpose Laboratories (GPL, completed and occupied in 1966. This modernist style rectangular building has four occupiable floors—three above grade and a basement. It is part of the grouping of laboratory buildings located along the concourse spine connecting research building and the Administration Building.

Building 225 has 204,332 gross square feet of laboratory and office space, primarily serving the Office of Information Systems Management (OISM), the Information Technology Laboratory (ITL), and the Physical Measurement Laboratory (PML). The building has been modified to accommodate the OISM's Central Computing Facility in the basement. Both ITL and OISM extensively use laboratory modules for office functions. The layout of the typical floor has office space on the north and south perimeters and laboratory modules in the central spine separated from the offices by a shared corridor.

The building and its infrastructure are basically unchanged since construction. A transformer and UPS system in the basement and an exterior back-up chiller on the north side were added

to serve the requirements of NIST Central Computing Facility. Select infrastructure renovation projects have rebuilt AHUs, upgraded DDC controls, replaced fume hoods and light fixtures.

*Observations:* The building is well maintained but showing its age. Using laboratories for offices functions a not good use of technical space, and ITL and OISM computer laboratory functions would be more appropriate in office-type environments with enhanced power and cooling. The basement location of the Central Computing Facility (CCF) is not ideal and uses significant lab space. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include roof replacement, and replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, fire detection system and fire stopping.).

**GSF:** 204,333

**Occupied:** 1966

**Occupants:** Physical Measurement Laboratory, Information Technology Laboratory, Office of Information Systems Management



## Building 226—Building Research

Building 226—Building Research is one of the seven original General Purpose Laboratories (GPL) that were occupied in 1966. It is located along the second concourse which connects some of the research buildings with each other and the Administration Building.

Building 226 is a 142,805 gross square feet building of laboratory and office space assigned to the Engineering Laboratory. This rectangular building has three above grade occupiable floors and a small laboratory and service area in the basement. This GPL was structurally adapted to specific building research needs with considerable high-bay laboratory space. Approximately 30% of the laboratory area is two floors high, and another 10% is 3 floors high. Given its unique high-bay configuration, the building has a single corridor and does not adhere to the 'race-track' plan of other GPLs, except for some areas on the third floor

Although the building configuration has been maintained, an energy conservation pilot project has been implemented. The

key features of the project included insulating exterior walls, installing double glazed replacement windows and using central conditioning to eliminating the induction coil units. Select infrastructure renovation projects in the building have also been carried out in recent years. These include rebuilding AHUs, upgrades to DDC controls, replacement of fume hood and light fixtures.

*Observations:* The building is well maintained but is showing its age. The space serves the research functions and provides proximate office space for research staff. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of roof, replacement of HVAC components and upgrades to the life safety system.

GSF: 142,800  
Occupied: 1966  
Occupants: Engineering Laboratory





## Building 227—Advanced Chemical Sciences Laboratory

Building 227—the Advanced Chemical Sciences Laboratory (ACSL) was complete in 1999, designed to provide measurement support for the chemical analysis needed for the nation's biotechnology, health care, pharmaceutical and environmental communities. The style and massing of building was based on the original General Purpose Laboratories, a concrete framed building with a flat slab construction with perimeter curtain wall system of metal panels, glass wall and face brick. The building is connected to the campus circulation spine.

Building 227 has 231,844 gross square feet of laboratory and office space dedicated to a single Organizational Unit, the Material Measurement Laboratory. The building has three full occupiable floors above grade, a fourth floor mechanical system, and a partial penthouse and basement floor that also house building services. The typical 45,400 gsf floor layout is similar to the GPLs, except that a service galley has been added between the back-to-back laboratories, accessible

from both sides. The building has state-of-the-art laboratory infrastructure providing required thermal environment, clean air, humidity control, reliable power supply and lab gases. The majority of the laboratory spaces are wet labs. In this facility almost all designed laboratory and support space is used for the intended purpose.

*Observations:* Building 227 is in very good condition, and well utilized. The building systems are original to the 1999 construction, in good condition and operating normally. The ACSL building is optimally utilized in its current configuration.

**GSF:** 231,912

**Occupied:** 2001

**Occupants:** Material Measurement Laboratory



## Building 230—Fluid Mechanics

Building 230—The Fluid Mechanics Laboratory is 47 years old and was built shortly after the original campus buildings. The building is located on the southwest part of campus off Research Drive. The Sensor Science Division of the PML is the prime user of the building and is responsible for advancing the measurement science, standards, and applications for sensing optical power, temperature, humidity, pressure, vacuum, flow, and related physical phenomena. This building is used for research and the development of standards relating to aerodynamics (the study of air and other gases in motion) and hydrodynamics (the study of liquids in motion).

Building 230 has 38,367 gsf of specialized laboratory and office space on three floors (basement, first and second). The first floor is largely dedicated to laboratories and the basement to facility and infrastructure support functions with limited laboratory space. High-bay space is prevalent throughout the facility, housing multiple wind tunnels and fluid-flow experiments. The dominant large wind tunnel is located on the west

end of the building. Only a small bay on the north side is used for offices on the first and second floors.

*Observations:* The building is well maintained but is showing its age. It continues to service current research functions and provide office space proximate to research. Select infrastructure renovation projects have been carried out, including rebuilding AHUs, window replacement and new fume hoods and safety showers. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the emergency lighting system.

**GSF:** 38,366

**Occupied:** 1969

**Occupants:** Physical Measurement Laboratory



## Building 231—Industrial

Building 231—the Industrial Building is 50 years old and was built shortly after the original campus buildings. The building is used for metallurgical studies, including the development of measurement and standards infrastructure for a range of applications such as sheet metal forming and machining standards applicable to the automotive industry, analysis of deformation of bullets to support research on soft-body-armor standards. Metrology research at this facility makes possible more accurate predictions of materials performance, manufacturability, and long-term reliability. A key feature is the Kolsky bar facility, used for high-rate mechanical testing at high temperatures under very controlled conditions.

Building 231 consists of a basement and two above-grade levels. The 75,121 gross square feet building contains laboratory and office space serving the Material Measurement Laboratory. This special purpose laboratory building has an unconventional massing and layout. It consists of two independent wings, one secure wing dedicated to proprietary testing and research

and a second wing housing the NIST Kolsky bar facility and the NIST Center for Automotive Light-Weighting.

*Observations:* The building is well maintained but aging. It continues to service its current research functions, but the systems are reported to operate with low reliability. Select infrastructure renovation projects have been carried out, including rebuilding AHUs, window replacement and new fume hoods and safety showers. The major building systems—mechanical, electrical and plumbing—are original to the building and past their rated life. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls), possible structural damage and upgrades to the emergency lighting system.

GSF: 75,131  
 Occupied: 1968  
 Occupants: Material Measurement Laboratory



## Building 233—Sound Laboratory

Building 233—the Sound Laboratory is 50 years old and was commissioned shortly after the original campus GPL and Administrative buildings. In addition to offering typical laboratory and office environments, two specially constructed research areas—one for acoustics studies and another for manufacturing process metrology—are appended to the building.

Building 233 is a 42,888 gross square feet building with one occupiable floor, used by the Physical Measurement Laboratory and the Engineering Laboratory. The layout is rectangular, similar to the GPLs. It has office space on the north and south perimeters and back-to-back laboratory modules in the center. Two specially constructed research areas—one for acoustics studies (anechoic chamber) and another for manufacturing process metrology—are added onto the lab/office block. One small laboratory space, designated as the Seismic Vault, is in a lower area (semi-basement) in the northwest corner of the building.

The basic architecture and infrastructure systems of the building have generally remained unchanged from the original construction. Most mechanical, electrical and plumbing systems are operating past their design life.

*Observations:* Building 223 clearly shows its age and NIST programs would benefit considerably from a whole building upgrade. The major building systems continue to function but not at levels required for a state-of-the-art facility.

The building electrical service was recently replaced, in conjunction with new construction in the proximity but major equipment remains original to the facility. Replacement of HVAC components (air handling units, distribution system and controls) is a priority upgrade/maintenance item.

GSF: 42,881

Occupied: 1968

Occupants: Physical Measurement Laboratory, Engineering Laboratory



## Building 235—NCNR

Building 235—the NCNR is focused on providing neutron measurement capabilities to the U.S. research community. The facility is a national center for research using thermal and cold neutrons for research and measurements in crystallography, reflectometry, small angle neutron scattering, and spectroscopy. NCNR offers its instruments for use by qualified applicants from industry, university, and other government agencies.

Building 235 is 229,849 gross square feet in size. It was first occupied in 1965, but has undergone several additions and renovations over its history. The architecture of this special purpose building has neither a regular layout, nor a typical floor. Among laboratory space, the high-bay special category dominates, including the guide hall footprint. Conventional office space is provided for staff and long-term guest researchers, while multiple small workstations are provided for short-term users. Supplemental site security includes a fenced enclosure, outer surround of security boulders and gated access.



Most recently an office wing and guide hall expansion were constructed, as well as infrastructure upgrades that included cooling tower replacement. The building has had infrastructure upgrades to the air handling units, new fume hoods and safety showers.

*Observations:* The building is rated as good condition overall, but many of the building's major systems are original to the building and need to be upgraded. Priority upgrade/maintenance items include the replacement of HVAC components in wings A, B and C.

**GSF:** 229,868

**Occupied:** 1965

**Occupants:** NCNR, Physical Measurement Laboratory, Material Measurement Laboratory

### Building 236—Special Projects Building

Building 236—the Special Projects Laboratory is nearing 50 years old and was commissioned shortly after the original campus GPL and Administrative buildings. It was designed for research of a hazardous nature, and is located at the far south of the campus.

Building 236 contains laboratory and office space, primarily on one level. The first floor footprint has office space on the south perimeter and laboratory modules on the north, sharing a 7' wide circulation corridor. An extension at the north-east end offers laboratory space which is partially below grade because of the terrain adjoining the facility. The laboratory space is constructed of solid-poured concrete walls, blast doors and pressure sensitive blow-out windows.

*Observations:* Building 236 currently is underutilized. A review of the building floor plan and construction suggest that it was custom designed for specific functions which seem to not have relevance in current operations. The laboratory spaces, designed for handling highly explosive material, are difficult to repurpose given their construction and configuration. It is in poor physical condition, although its mechanical system has been upgraded with a re-built AHU within existing casing and installation of DDC controls. Complete replacement of the HVAC system—heating and cooling, distribution and controls—is the priority recommendation for continued use as a lab and office building.

GSF: 13,221

Occupied: 1968

Occupants: Material Measurement Laboratory, Engineering Laboratory



## Buildings 237 and 238—Non-Magnetic Buildings

Buildings 237 and 238—the Non-Magnetic laboratory facilities are nearing 50 years old and were commissioned shortly after the original campus GPL and Administrative buildings. The sole user of the approximately 7,000 gross square feet pair of buildings is the Quantum Measurement Division of the Physical Measurement Laboratory.

These two buildings are adjacent structures, connected with a 275' long covered walkway. Building 238 is a uniquely constructed 3-level facility of wood construction, using no magnetic materials—substitute materials, such as copper nails, have been used. Building 237 is termed a 'sister' building and is a single level administrative and laboratory space to support the research and test functions in building 238. Building 238 has only laboratory facilities and no resident occupants. In Building 237, two-thirds of the assignable space in the former is used for laboratory functions and the remaining for housing six staff persons associated with the research in both facilities. Electrical and mechanical infrastructure to support both facilities is located in building 237 across the corridor from office and laboratory space. Building 237 has had new energy efficient windows installed, benefitting from an energy retrofit initiative covering select buildings on campus.

*Observations:* The basic architecture and infrastructure systems of the buildings have generally remained unchanged from the original construction. Given the unique construction of the latter, it is likely that there will be periods of under-utilization of the facility between projects. Most mechanical, electrical and plumbing systems are operating past their design life. Together, Buildings 237 and 238 are critical assets for specialized research and evaluation. Portions of the building do show their age and upgrade or renovation of the facilities, that includes MEP infrastructure, will be required in the near future.

### 237, Non-Magnetic Building

GSF: 3,100

Occupied: 1968

Occupants: Physical Measurement Laboratory

### 238, Non-Magnetic Building

GSF: 3,961

Occupied: 1968

Occupants: Physical Measurement Laboratory



## Building 245—Radiation Physics

Building 245—Radiation Physics, completed in 1962, was the first research facility built on campus, predating the completion of the GPL buildings. It was designed specifically for research on standards for radiation measurement, and continues to serve such functions to this date. Stakeholders for research conducted in this facility include several government agencies (DHS, NASA, DARPA, NOAA, ANSI, among others) and companies engaged in nuclear medical imaging.

Building 245 is 207,908 gross square feet in size, and houses radiation laboratories and office space assigned primarily to the Physical Measurement Laboratory. The building was designed to suit specialized research functions and does not follow a typical/general layout approach. The building consists of six wings, with most of the research space located below-grade in a basement and sub-basement. The three lower floors (sub-basement, basement and first floors) are physically spread out and each takes on a distinct 'organic' form in response to

specific equipment requirements. A three story wing on the north houses labs and the majority of office space.

*Observations:* Building 245 is in poor physical condition; most of the building systems and infrastructure are original and past their useful service life. The superstructure and basement walls have sustained serious damage from water intrusion. In addition to physical issues, advancements in research and technology over the decades have necessitated adaptive use of the laboratory spaces with some inherent limitations. The building is undergoing renovation and expansion to meet research demands and modernize the aging systems. The plan is for two building additions, and a new mechanical penthouse to serve the basement and sub-basement research laboratories.

GSF: 207,921

Occupied: 1964

Occupants: Physical Measurement Laboratory





## Building 301—Supply and Plant

Building 301—Supply and Plant is the hub for several campus-wide facility operations and logistics support services. Occupied in 1964, it is one of the oldest buildings on campus. There are offices, shops and warehouse storage space primarily for the Office of Facilities and Property Management. The building contains administrative and storage space for other NIST organizations, including the Hollings Manufacturing Extension Partnership Program, and Office of Acquisition and Agreements Management.

Building 301 is a single level, above-grade structure with a large footprint. Spaces include shipping/receiving for the entire campus, the central store room where lab and office supplies are available for purchase, as well as the specialty maintenance and construction shops. The shops are used to repair and fabricate components for maintenance of mechanical, electrical and plumbing infrastructure in campus buildings. In addition it has significant administrative space. A study of the small cafeteria, which serves occupants of this and neighboring buildings, recommends service changes as well as the addition of an un-badged entry for easier access.

*Observations:* The basic architecture and infrastructural systems of the building are original construction. Most of the major mechanical, electrical, and plumbing equipment have exceeded their design life but are still operable and functional. The building has had several interior renovation projects that include the cafeteria, offices and storage areas. Windows in the facility have also been replaced for improved energy efficiency. A recent project renovated interior spaces, and added a new high bay warehouse and receiving area to the south, expanding the footprint by approximately 30,000 gross square feet. The current facility assessment recommends priority replacement of the A and B wing HVAC components and the deteriorated dust collector of the carpentry shop. Renovation of the office areas has been recommended in the recent study, NIST Administrative Space Strategic Plan.

**GSF:** 163,765

**Occupied:** 1964

**Occupants:** Office of Facilities and Property Management, Office of Acquisition and Agreements Management, Hollings Manufacturing Extension Partnership



### Building 302—Steam & Chilled Water Generation Plant

Building 302—Steam and Chilled Water Generation Plant, together with the electric sub-station, was the first facility to be commissioned, before the first GPL and administration building came on line. It houses chillers and steam generators that provide heating and cooling for the entire campus. The Office of Facilities and Property Management is responsible for all campus infrastructure and is the sole occupant of this facility, operated by the Gaithersburg Facility Maintenance Division of OFPM.

Building 302 is a 55,253 gross square foot facility on two levels, plus a small mezzanine catwalk. The L-shaped building has two wings—one associated with steam generation equipment and the other housing an array of chillers. At the node of the two wings is the entry to the facility where offices and employee amenities are located. Proximate to the facility are the cooling towers that work in tandem with the chiller equipment in the

north block. The building has had several additions, one to accommodate 2 additional chillers in 1998, one to accommodate 2 additional boilers in 1998, and another chiller wing expansion in 2010. The building has benefitted from the window replacement program at NIST wherein high efficiency double pane low-e windows have now been installed.

*Observations:* Building 302 is well maintained and functions efficiently. The office and employee support spaces are adequately utilized. The recent facility assessment did not indicate any priority repairs, but recommended roof replacement and repair/replacement of some of the electrical service components in the next few years.

GSF: 60,053

Occupied: 1963

Occupants: Office of Facilities and Property Management



### Building 303—Service Building

Building 303—Service is also among the earliest campus buildings. Originally designed as a vehicle repair shop, it currently serves as a transport management and automotive repair facility. Until the completion of the Consolidated Emergency Services Building (318) in 2014, it served as the home to the NIST Fire and Emergency Services. Located among a cluster of service buildings on the west end of the campus, it has multiple points of convenient access to roads leading in all directions of the campus.

The Office of Facilities and Property Management is the sole occupant of this 14,573 gross square feet facility, operated by the Facilities Services Division. The building is single story, organized into two separate areas. The vehicle maintenance area includes a 5,700 sf high bay open space capable of servicing several standard vehicles and buses. This is supported by storage, office space for operations and support spaces for the employees. The former emergency service portion of the building has a two-vehicle garage bay with roll-up doors at both ends for through movement and office functions.

*Observations:* The building is in poor condition and showing its age. The basic architecture and infrastructure systems of the building have generally remained unchanged from the original construction. The major building systems—mechanical, electrical and plumbing—are operating past their rated life. The windows and exterior wall are uninsulated. Priority upgrade/maintenance items include the replacement of HVAC components (air handling units, distribution system and controls) and upgrades to the life safety system (emergency lighting, sprinkler system coverage). Other requirements noted are replacement of aging/outdated electrical and plumbing components, and interior finish replacement. Roof maintenance and repairs projects were implemented in 1992 and 2009.

GSF: 14,572

Occupied: 1964

Occupants: Office of Facilities and Property Management



## Building 304—Shops

Building 304—Shops is the operational hub of the Fabrication Technology Group, which provides a wide range of engineering, fabrication and technology services that create unique measurement instruments and scientific apparatus needed by NIST scientists and research staff. Part of the facility also houses research/lab space for the Engineering Laboratory. Occupied in 1964, it is one of the oldest buildings on campus. Building 304 is located centrally on the campus and is connected to the campus pedestrian concourse.

The 75,588 gross square feet Building 304 contains extensive shops, offices, laboratory, and storage space. The core of the facility is a 15,000 sf high-bay open plan instrument shop area that houses several pieces of state-of-the-art equipment for large scale fabrication. The high bay shops and shipping area are serviced by a monorail crane and control system. Each shop in the high bay area has large automatic double swing doors separating each area. There is also a large footprint of welding and glass blowing shops, specialty optics and glass shops, shipping,

receiving, and storage. An independent wing of this building was dedicated to the Credit Union, which recently vacated, and offices and support for the campus-wide Janitorial staff.

*Observations:* The building is well maintained, but is showing its age. Most of the major mechanical, electrical, and plumbing equipment have exceeded their design life but are still functional. There have been limited renovation projects over the years, although the windows have been replaced for improved energy efficiency. The recent facility assessment identified priority maintenance items including the replacement of the original HVAC system and replacement of the roof-mounted exhaust fans, which are operating below their rated flow rates.

GSF: 75,589

Occupied: 1964

Occupants: Engineering Laboratory, Associate Director for Management Resources



### Building 305—Cooling Tower Building

Building 305—Cooling Tower Building is a two-part structure; the larger component is a cooling tower, and the smaller component is an electrical equipment building. The cooling tower component is constructed of reinforced fiberglass and made up of eight cooling towers that serve the Steam and Chilled Water Plant (Building 302). Except for the foundations, the cooling tower structure was replaced and expanded in 2012. The electrical equipment building is a concrete block structure, which recently has been expanded by approximately 250 square feet, for a total of 16,162 gross square feet.

*Observations:* Building 305 is in good condition and operating efficiently.

GSF: 16,162  
 Occupied: 1963  
 Occupants: Office of Facilities and Property Management, unoccupied



### Building 306—Electrical Sub-Station

Building 306—Electrical Substation is the receiving facility for power from the local utility provider (Pepco), which is then distributed to campus buildings through underground electrical cables. There are two transformers located outside the building that feed the interior switchboards. The single story building is 4,532 gross square feet in size, with an open plan. It is a concrete block structure constructed on-grade, and houses the electrical switchgear systems and associated electrical equipment. Building 306 is unoccupied, and is the responsibility of the Office of Facilities and Property Management.

*Observations:* The building is in good condition, with no critical repairs identified. A new roof will be needed in the next few years.

GSF: 4,532  
 Occupied: 1963  
 Occupants: Office of Facilities and Property Management, unoccupied



### Building 307—Material Processing Building

Building 307—Materials Processing is one of three storage facilities located east of Building 206, accessed off of Center Drive. Built in 1972, it is a low height storage facility with three rooms for storage of packaged material, non-temperature sensitive spare parts, and some hazardous materials. Each of the three rooms is separate, with its own exterior door. Construction is CMU with exterior walls of face brick, slab on grade with a flat built-up roof system. The building is ventilated with wind-driven roof-top exhaust turbines and louvered doors, but is not otherwise conditioned. The 373 gross square foot facility is assigned the Office of Safety, Health and Environment. One of the three rooms is currently in use by Division 192 of OFPM.

*Observations:* Building 307 is in fair physical condition.

GSF: 374

Occupied: 1972

Occupants: Office of Safety, Health and Environment, unoccupied



### Building 309—Grounds Maintenance

Building 309—Grounds Maintenance, located west of Building 303 and 301, was constructed in 1975 to house the grounds maintenance personnel and equipment. The single story building is slab on grade construction and houses offices, shops, warehouse and support. The three shop areas are used for equipment repair and for housing mowers, snow removal equipment, tractors, trucks and miscellaneous outdoor equipment. Office areas are used for work control and dispatch functions, and include a 15 person training/lecture/meeting room. One of the bays is partially used as a staff lounge/locker area. The 11,702 gross square foot building is managed by the Office of Facilities and Property Management, and one 1,800 sf storage bay is used by the Material Measurement Division.

*Observations:* The building is in generally poor condition, and repair/replacement is recommended for the HVAC system some electrical and plumbing components and the roof. The original windows in the administrative spaces were replaced with double-pane energy efficient windows in 2011. The building appears to be heavily used.

GSF: 11,701

Occupied: 1975

Occupants: Office of Facilities and Property Management



### Building 310—Plant Storage Building

Building 310—Plant Storage is one of three storage facilities located east of Building 206. Built in 1987, it is a single story, open-air building for storage of non-temperature sensitive material, pipes and other parts, stored on pallet racks or shelving. The facility is assigned to OFPM. At 505 gross square feet in size, the building has one room and one entrance door, consisting of three chain-link, double swing gates. There are no HVAC or plumbing services.

*Observations:* Building 310 is in generally poor physical condition. Upcoming repairs include the replacement of corroded metal siding and roof replacement. The building appears to be well used.

GSF: 505  
 Occupied: 1987  
 Occupants: Office of Facilities and Property Management, unoccupied



### Building 311—Grounds Storage Shed

Building 311—Grounds Storage is a shed supporting the ground maintenance needs of the Office of Facilities and Property Management, including the storage of gravel and salt for road de-icing. Constructed in 1990, it is a single story building on a structural slab, segregated into three large bins to store the materials. Each of these bins has a roll-up door opening for vehicle access. Building 311 has a wood frame and truss structure with un-insulated painted sheet metal panels for the walls and roof. There are no HVAC or plumbing services, and the electrical power is fed from nearby Building 309.

*Observations:* The building is in fair-good condition and appears to be well-utilized for the function.

Grounds Storage Shed  
 GSF: 2,511  
 Occupied: 1975  
 Occupants: Office of Facilities and Property Management, unoccupied



### Building 312—Materials Processing Building

Building 312—Materials Processing, located on the western side of the campus, is a hazardous waste storage and 90-day holding facility. The facility was built in 1996 and is managed by the Office of Safety, Health and Environment. It is a 3,877 square foot, single story block structure, constructed slab-on-grade. The main space is a high bay storage room, flanked by metal mezzanine construction. Three separate chambers open into this space, for the storage of corrosives and reactive materials, organic and inorganic poisons and special medical waste, and flammable and combustible products. These chambers are individually vented. An office and restroom is adjacent. The building is fully sprinklered and contains flammables cabinets with integrated dry chemical suppression systems. Heating and cooling are provided by the Steam and Chilled Water Generation Plant.

*Observations:* The building is in poor physical condition, with priority maintenance needed to repair cracks in the foundation, walls and containment trench, believed to have been caused by the 2012 earthquake. Additional work will be needed in the next few years to replace the air handling unit, its controls and the compressed air piping. The building appears to be well used.

GSF: 3,877  
 Occupied: 1977  
 Occupants: Office of Safety, Health and Environment



### Building 313—Site Effluent Neutralization

Building 313—Site Effluent Neutralization is an unoccupied facility that houses equipment for effluent quality monitoring and neutralization. After effluent entering the building is monitored, it is neutralized and then discharged into the municipal waste water collection system via a lift station north of Building 313. Built in 1997, the facility is 245 gross square feet in size. It is a one story, single room structure, constructed of concrete block with brick veneer, on a slab-on-grade foundation. Heating is provided by wall-mounted space heaters installed in 2012, and ventilation is supplied by roof-mounted exhaust fans. Plumbing consists of two incoming PVC pipes with valves and fittings used to sample site effluent.

*Observations:* Building 313 is in good condition.

GSF: 245  
 Occupied: 1997  
 Occupants: Office of Facilities and Property Management, unoccupied





### Buildings 314 and 315—Backflow Preventer-East and North

Buildings 314 and 315—Backflow Preventer are two very similar unoccupied buildings, each 663 square feet in size. Each building houses two commercial backflow preventers with associated pressure regulators, valves and steel piping. This is where potable water from the local utility enters the campus. It is routed through the backflow preventers before it is distributed to campus buildings. The buildings are constructed of concrete block on a structural slab, with brick veneer facades. Heating is supplied by wall-mounted space heaters and a mechanical wall-mounted louver and exhaust fans system provide ventilation.

*Observations:* The two buildings are in fair condition. The roof systems on both will need replacement in a few years especially that of Building 315 which appeared to have water intrusion in an aerial roof survey.

314

Backflow Preventer-East

GSF: 663

Occupied: 1998

Occupants: Office of Facilities and Property Management, unoccupied

315

Backflow Preventer-North

GSF: 663

Occupied: 1998

Occupants: Office of Facilities and Property Management, unoccupied



### Building 316—Electrical Service Building

Building 316—Electrical Service Building was constructed in 2011 and contains high voltage electrical equipment. Additional high voltage equipment is installed on an adjacent concrete pad. The 487 gross square foot facility is a single story concrete block structure with a slab-on-grade foundation and brick veneer façade. The electrical services and distribution system consists of multiple switchgears and panelboards supplied by three, oil-filled transformers. There are no HVAC or plumbing services, but there is a sophisticated fire alarm system, with head end equipment, pull-stations at all exit doors, audio/visual strobes, visual strobes, smoke and heat detectors, conduit, wire and connections.

*Observations:* Building 316 is in very good condition, with no critical repair items noted in the recent facility survey.

Electrical Service Building

GSF: 487

Occupied: 2011

Occupants: Office of Facilities and Property Management, unoccupied



### Building 317—Cooling Tower West

Building 317—Cooling Tower West was constructed in 2011. It is 3,441 gross square foot facility that is comprised of two large cooling fans. The cooling tower serves the chiller systems in Building 302, Steam and Chilled Water Generation

*Observations:* The Cooling Tower West is a recently constructed facility and in excellent condition.

GSF: 3,441  
 Occupied: 2011  
 Occupants: Office of Facilities and Property Management, unoccupied



### Building 319—Emergency Services Storage

Building 319—Emergency Services Storage was constructed in 2014, together with the Emergency Services Facility. The building is 312 Gross Square feet in size and provides storage for the adjacent Building 318. The structure is concrete block with a brick veneer façade, on a slab-on-grade foundation. There are no heating, ventilation, cooling or plumbing services in the building.

*Observations:* Building 319 was recently constructed and is in excellent condition.

GSF: 312  
 Occupied: 2014  
 Occupants: Office of Facilities and Property Management, unoccupied



## Building 318—Emergency Services Facility

Building 318—Emergency Services Facility was completed in 2014, replacing the emergency facilities in Service Building 303. The building accommodates the emergency apparatus, NIST ambulance, equipment storage, office and training areas, and a dormitory/bunk facility.

*Observations:* The Emergency Services Building was recently constructed and is in good condition. Operationally, the building was well received and supports the emergency service functions.

### Emergency Services Facility

GSF: 22,123

Occupied: 2014

Occupants: Office of Facilities and Property Management



### Building 320—Child Care Center

Building 320—Child Care Center is classroom and support facility, serving children of NIST employees and associates. The Center has a capacity of 154 children, ranging in age from 6 weeks to kindergarten. The facility has 3 classrooms for infants/toddlers, two for two-year olds, 4 for preschool, 1 for kindergarten and 1 school-age classroom for the before/after school program. The kindergarten is a full-time, state-accredited kindergarten program, and the Center provides a summer program. In addition to the ten classrooms, there is a multi-purpose room, outdoor play spaces, administrative offices, food preparation and support areas.

Building 320 was completed in 2012, and is 23,686 gross square feet in size. It is a one-story building, constructed of concrete block with brick facing. There are large view windows into the classrooms and support areas, and direct access to the outside play areas. The CCC was designed based upon the GSA guidelines for child care centers.

*Observations:* The Center is in excellent condition, and very well received. It is operating at capacity and has a waiting list for enrollment.

GSF: 23,687

Occupied: 2012



### Building 411—Temporary Relocatable Facility

Building 411—the Temporary Relocatable Facility is over 20 years old although it was planned to be a temporary facility. It is a single story office building, assigned to the Office Information Systems Management and Acquisitions and Agreements Management.

Building 411 has a square footprint, with a small rectangular extension to the west. It is organized into suites of enclosed and open offices areas, supported by conference rooms and break rooms. The basic architecture and infrastructure systems of the building generally are unchanged from the original construction, except for interior reconfigurations that were required to support occupant needs. The building structure is a pre-fabricated steel frame wall and roof system, clad in wood siding and interlocking, insulated metal panels. There are few interior columns, easing interior reconfigurations.

*Observations:* The building is well maintained but showing its age. The facility serves its office function. The layout is flexible

but is not efficiently utilized. The building foot print is deep, limiting the penetration of daylight to many occupants. The major building systems—mechanical, electrical and plumbing—are original to the building, including rooftop package HVAC units. Repair/maintenance items noted include adding accessible rest room facilities and reconfiguring the HVAC distribution, which has been compromised by interior office reorganizations. Complete building renovation and space reorganization for better utilization have been recommended in the recent study, NIST *Administrative Space Strategic Plan*. Given the age of this temporary facility, consideration should be given to replacement with a permanent solution.

GSF: 17,362

Occupied: 1989

Occupants: Office of Information Systems Management, Office of Acquisitions and Agreements Management



### Building 414—Janitorial Storage Building

Building 414 is assigned to the Office of Facilities and Property Management and is used for storage of janitorial supplies. It is directly adjacent to the Shops Building 304 on its north façade and is accessible from the service dock area of the parent structure. The single-story 803 square foot, Janitorial Storage building was constructed in 1994. It is a window-less storage facility, constructed of precast concrete on a slab foundation. It has two uninsulated metal roll-up doors and one personnel door. The roll-up doors are at grade and require no dock. The HVAC is supplied by a single exterior wall-mounted package unit air handler and exhaust fan, and electrical power is fed from the adjacent Building 304.

*Observations:* Building 414 is in poor condition. The single HVAC package unit is out of service and needs to be replaced. The building is comprised of two separate structures, and differential settling has caused the bonding between them to separate.

#### Janitorial Storage Building

GSF: 803

Occupied: 1994

Occupants: Office of Facilities and Property Management, unoccupied



### Building 420—OFPM Storage

Building 420—OFPM Storage Building was originally built for a research program mock-up and now provides storage of construction and maintenance supplies for the Office of Facilities and Property Management. This 1996 building was relocated in 2010 to its current site at the rear of Service Building 303. It is a pre-engineered metal framed structure with a tilt-up corrugated building exterior. The interior is open, without partition or finishes, with a partial mezzanine remaining from its research use. It is thermally conditioned to provide a fully functional environment. Electrical service is fed from Building 301.

*Observations:* Building 420 is in fair condition.

#### OFPM Storage Building

GSF: 2,615

Occupied: 1996

Occupants: Office of Facilities and Property Management, unoccupied



### Building 421—Radiation Physics Storage

Building 421—Radiation Physics Storage is a 1,499 gross square foot, pre-engineered metal building used for storage of miscellaneous construction materials. Located south of the Radiation Physics Building 245, this facility is a windowless structure with an open plan. Constructed in 1984, the facility has steel framing and corrugated sheet metal siding, constructed on a slab-on-grade foundation. There is a hollow metal personnel door and two metal rollup doors. HVAC service consists of 4 electric heaters mounted high in the 4 corners. Electric service is fed from Building 245.

*Observations:* Building 421 is in generally poor condition. It appears to be well utilized.

#### Radiation Physics Storage

GSF: 1,499

Occupied: 1964

Occupants: Office of Facilities and Property Management, unoccupied



### Building 422—Concrete Material Storage

Building 422—Concrete Material Storage is located among a group of storage facilities in the southern section of the campus, near 205 and 206. Building 422 houses concrete aggregates, materials and chemicals related to Engineering Laboratory's concrete studies. This 1,200 gross square foot building was constructed in 2004. The building foundation is a concrete slab placed on grade, and the walls are precast concrete tilt-up panels with a granular pebble finish. The facility is a single room, served by four roll-up doors. The space is unconditioned but ventilated with a manually switched exhaust fan. Electric service is fed from nearby Building 206. Space is well utilized.

*Observations:* The building is in generally fair condition, and is well utilized.

GSF: 1,200

Occupied: 2004

Occupants: Engineering Laboratory, unoccupied



### Building 423—Research House

Building 423—Research House is a single story house that provides a laboratory environment for the study of indoor air quality in manufactured residential buildings. Research is conducted by the Indoor Air Quality and Ventilation Group of the Engineering Laboratory. This manufactured home is used for emission, air change and tracer studies, as well as and other experimentation related to indoor air quality. The lab does not include any furniture that would be in a typical house. Flexible tubes for air sampling are located in each room, which route back to the instrumentation located in the house. The house has 2,263 gross square feet of built area, comprised of a family-dining-kitchen space, three bed rooms and two baths, and including an attached garage and a small shed. Building 423 is of typical manufactured home construction, using a steel under-frame, wood floors, wood frame, pitched roof with shingles, and vinyl siding on the exterior.

*Observations:* The building is in very good physical condition, and adequately serves its intended research function.

GSF: 2,261  
 Occupied: 2004  
 Occupants: Engineering Laboratory, unoccupied



### Building 418—NCNR Storage Building

Building 418—NCNR Storage is assigned to the NCNR, located nearby in Building 235. This 3,000 square foot metal structure is used for storage of miscellaneous materials used in the NCNR facility. It is a single volume, high-bay building, with shelving on the perimeter and heavy materials, pallets, and miscellaneous containers interspersed throughout the space. It is serviced with a large roll-up door and accessed via two metal personnel doors. The structure is pre-engineered steel with steel panel walls and roof. HVAC is provided by a split direct expansion (DX) system with an air handling unit and an exterior pad-mounted condensing unit. Ventilation consists of manually operated roof dampers. Electrical service is fed from Building 235.

*Observations:* Building 418 is in excellent condition and appears to be well utilized.

NCNR Storage Building  
 GSF: 3,000  
 Occupied: 1995  
 Occupants: NCNR, unoccupied

### Building 425—NCNR Storage Building II

Located west of the NCNR and proximate to the cooling towers, this small space supports OU 19 logistics storage functions in the vicinity. The storage space is accessed via a personnel door and a roll-up door. The south part of the structure is a small electrical room accessed via another roll-up door. The facility is of CMU construction with brick veneer on the outside. The space is adequately used.

*Asset Description* The building is planned for demolition in 2011 and will be replaced with a new pump house building. The concrete block building was formerly used for chemical storage.

GSF: 303  
 Occupied: 2007  
 Occupants: NCNR, unoccupied



### Buildings 426 and 427—NCNR Trailers 1 and 2

Buildings 426 and 427—NCNR Trailers are two manufactured buildings for temporary office use, located near Building 235. The two single-width trailers are accessed from a shared ramp off a walkway south of the NCNR facility. Each trailer is 663 gross square feet in size, with an open office plan and a small electric equipment room. The structure is of steel underframe with wood floor and framing. The exterior walls are aluminum siding and exterior doors are insulated metal. Windows are aluminum framed single-pane sliders. The roof consists of rigid insulation topped with aluminum panels coated with elastomeric paint. The interior consists of one large space for open workstations and includes a small electric equipment room.

426

NCNR Trailer 2

GSF: 663

Occupied: 2008

Occupants: NCNR

427

NCNR Trailer 1

GSF: 663

Occupied: 2008

Occupants: NCNR

### Building 428—Facilities Building

Building 428—Facilities Building is a manufactured building for temporary office use, sited west of Building 301. It is located a short distance from the Supply and Plant Building 301 and near Service Drive and the Research Drive. The building was constructed by combining four portable office trailers, resulting in a rectangular footprint of 2,823 gross square feet. It provides temporary office space for approximately 16 people, using 4 offices, semi-enclosed workstations and a conference room. There are no rest room facilities in the building. The trailers have a steel underframe with wood floor and framing. The exterior walls are aluminum siding and exterior doors are insulated metal. A wooden ramp provides access.

*Observations:* The Facilities Building was placed in service in 2010 and most of its service equipment is original and in good working condition.

GSF: 2,823

Occupied: 2010

Occupants: Office of Facilities and Property Management



## Campus Connecting Corridors

Enclosed walkways connect 13 research buildings, the Shops Building and the Administration Building, providing sheltered links between these major facilities. The corridors connecting the seven General Purpose Laboratories and the Administration Building were part of the original 1960s construction, and the system was extended when the Advanced Measurement Laboratory complex and the Advanced Chemical Sciences Laboratory were constructed. The original corridors are constructed with single pane aluminum curtain wall systems, glazed on both sides, providing natural lighting and visibility through. Each concourse has one or two exterior glass doors on the first floor for badged entry and emergency exit. Ceiling-mounted vents at each end provide cooling and heating to the concourses. Total concourse space is 12,766 gross square feet.

*Observations:* The original connecting corridors are in poor physical condition, although they have been well maintained and repairs made when needed. The curtain wall seals have deteriorated, allowing noticeable air infiltration and water intrusion in many areas.

GSF: 13,908, various

Occupants: Office of Facilities and Property Management, unoccupied



# Historic Assessment

*Historic Assessment, National Institute of Standards and Technology, Gaithersburg, Maryland (Historic Assessment)* is a 2015 comprehensive study of the history and development of the NIST campus, prepared by R. Christopher Goodwin & Associates, Inc. A brief summary of the study is included here.

The study was undertaken to support NIST in its efforts to comply with Section 106 and Section 110 of the National Historic Preservation Act of 1966 (NHPA), as amended, through the identification and evaluation of historic properties. Section 106 of the NHPA requires Federal agencies to take into consideration the effects an undertaking may have on historic properties. A historic property is any resource, i.e., building, structure, object, site, or district, eligible for or included in the National Register of Historic Places (NRHP). The procedures for complying with Section 106 are codified in 36 CFR 800. Section 110 requires Federal agencies to identify, evaluate, and nominate historic properties to the NRHP, and directs Federal agencies to develop a preservation program.

The *Historic Assessment* was developed through an integrated program of archival research, site investigation, and data analysis applying the NRHP Criteria for Evaluation (36 CFR 60.4[a-d]) and an assessment of resource integrity. All work was completed in accordance with the guidelines set forth in the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (National Park Service 1983), and the Maryland Historical Trust (MHT)'s *Standards and Guidelines for Architectural and Historical Investigations in Maryland* (2000). All work was undertaken by project staff that meets, or exceeds, the Secretary of the Interior's professional qualifications in the disciplines of history and architectural history. The *Historic Assessment* document includes the following:

- Overview history and historic context of the NIST Gaithersburg campus, and its background and administrative history

- NIST Gaithersburg historic themes, time periods and people significant to its history
- Documentation of the architectural inventory on the campus, with descriptions and photos
- Evaluation of the significance and integrity of properties applying the NRHP Criteria for Evaluation, within the campus historic context

## National Register of Historic Places Criteria

Built resources are evaluated as historic properties applying the NRHP Criteria for Evaluation as found in 36 CFR 60.4(a–d). To be listed, or considered eligible for listing, in the NRHP, a historic property must meet at least one of the four following criteria:

- Criterion A: The resource is associated with events that have made a significant contribution to the broad pattern of history.
- Criterion B: The resource is associated with the lives of people significant in the past.
- Criterion C: The resource embodies distinctive characteristics of a type, period, or method of construction; represents the work of a master; possesses high artistic value; or represents a significant and distinguishable entity whose components may lack individual distinction.
- Criterion D: The resource has yielded, or may be likely to yield, information important in prehistory or history.

In addition, the NRHP has established Criteria Considerations. Ordinarily, cemeteries, birthplaces, or graves of historical figures; properties owned by religious institutions or used for religious purposes; structures that have been moved from their

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original locations; reconstructed historic buildings; properties primarily commemorative in nature; and properties that have achieved significance within the past 50 years shall not be considered eligible for the NRHP. However, such properties may be eligible if they are integral parts of districts that do meet the criteria, or if they fall within specifically defined categories.

In addition to significance, a property must also retain integrity in order to merit consideration for inclusion in the NRHP. Integrity includes those qualities a property must retain in order to convey its significance. The NRHP program defines seven aspects of integrity: location, design, setting, materials, workmanship, feeling, and association (U.S. Department of Interior 1997:44). Not all seven aspects are required for eligibility, but the property must retain the integrity necessary to convey its significance.

All buildings at NIST Gaithersburg were evaluated individually and collectively for significance applying the NRHP Criteria



NIST 1964

for Evaluation. Resource integrity also was assessed individually and collectively applying the seven aspects of integrity. Additional relevant guidance regarding resources from the recent past and scientific facilities are discussed in the full *Historic Assessment* document.

## Summary of Findings

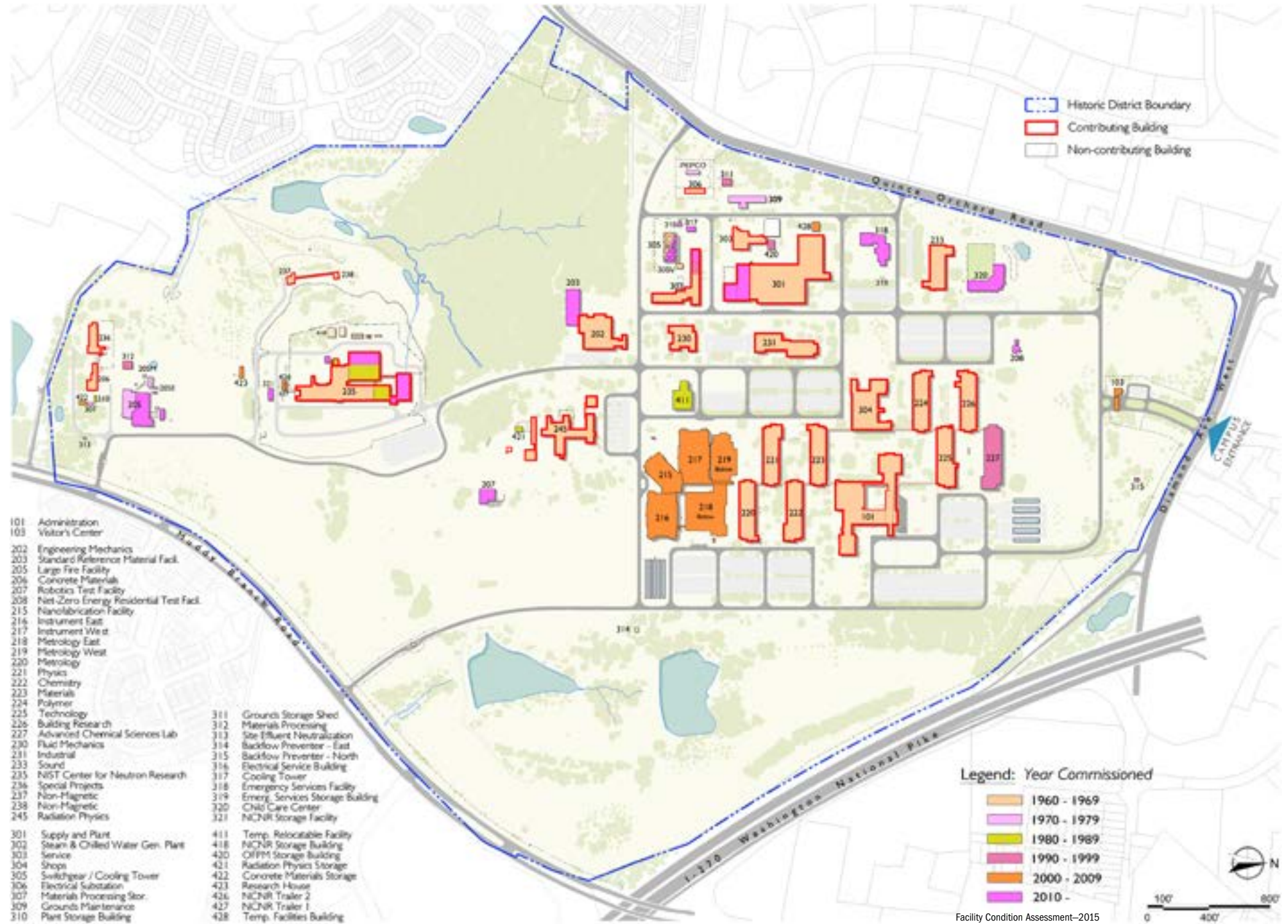
Buildings completed in the initial campus development have begun to reach 50 years of age. The major buildings of this period established a campus architectural identity, designed in the International Style with character-defining features of curtain-wall construction, ample use of glass, clean monolithic forms and minimal ornamentation. The suburban setting, formal landscape, ample parking, large-scale monumental buildings and general and specialized laboratories are hallmarks of postwar research campus design.

The Administration Building 101 is the central campus focus, and the destination for public, professional and social events. It is an example of the International Style applied to a principal building in a campus setting. Together with Building 101, eight other buildings, which include the GPLs, and their surroundings form a cohesive architectural precinct within the campus.

The *Historic Assessment* recommended this central campus precinct eligible as a historic district, significant under Criterion A for its association with events that made important contributions to the broad patterns of history under the Science and Technology and Postwar Research Campus Design themes, and under Criterion C as a recognizable entity that embodies the characteristic of Post War Research Campus design. Ten buildings completed between 1965 and 1966 are included in this district. The identified district as originally proposed, included nine contributing buildings and one non-contributing building, one contributing site (the campus landscape plan), and one contributing object (the flag pole). The Administration Building (101) was recommended individually eligible for inclusion in the NRHP as a representative example of the International Style (Criterion C).

The MHT, during its review of the *Historic Assessment*, concluded that the entire Gaithersburg campus was eligible for inclusion in the NRHP. In accordance with 36 CFR 63.2, NIST sought a formal determination of eligibility by the Keeper of the National Register. Upon its review of the documentation

Exhibit 136: Historic District



Facility Condition Assessment—2015

submitted to the MHT, the Keeper formally determined the entire district NRHP eligible. NIST consulted with the MHT regarding the identification of contributing and non-contributing resources to the campus-wide NRHP-eligible historic district. As a result, a list of the contributory and non-contributory resources within the NIST campus historic district was developed and accepted by NIST and the MHT. See adjacent list. The identification of contributing and non-contributing resources will help assist NIST fulfill its cultural resources management responsibilities, Section 106 compliance requirements, and master-planning initiatives.

## Significance for the Master Plan

Section 106 of the National Historic Preservation Act of 1966, as amended, requires NIST, as a Federal agency, to take into consideration the effects undertakings may have on historic properties and to afford the Advisory Council on Historic Preservation (ACHP) the opportunity to comment (36 CFR 800.1). Undertakings are defined as any project, activity, or program funded in whole or in part by a Federal agency, as well as the issuance of any licenses, permits, or approvals. The Section 106 process, as implemented in accordance with 36 CFR 800 Protection of Historic Properties, comprises four major steps: establish the undertaking, identify historic properties within the area of potential effect, assess adverse effects, and resolve adverse effects. NIST consults with the ACHP and the State Historic Preservation Officer (SHPO) in this process. In Maryland, the Maryland Historical Trust (MHT) functions as the SHPO. Local governments and members of the public also are consulting parties to Section 106.

The NIST historic district boundaries encompass the entire Gaithersburg campus. These boundaries were determined by the MHT and confirmed by the Keeper of the National Register of Historic Places. The broad definition of a Federal undertaking under 36 CFR 800 Protection of Historic Properties and the volume of routine property maintenance and management activities at the NIST campus that might be subject to the Section 106 process, support consideration of alternative approaches to addressing routine and repetitive projects aside from action-by-action review. The Master Plan recommends that a Programmatic Agreement (PA) be negotiated with the MHT and ACHP to address the category of undertaking. The objectives of such an agreement would be streamlining the Section

106 process by identifying standards for categories of routine projects and by developing standardized review procedures for new construction and rehabilitation projects that are larger in scope. NIST's Federal Preservation Officer would be responsible for the implementation of such a PA.

To achieve the complementary goals of the Master Plan and appropriate stewardship of the historic campus applying best preservation practices, it is highly recommended that NIST establish an internal Design Review Board, which should meet regularly to review proposed projects for consistency with the Secretary's *Standards for Rehabilitation* and with the Master Plan Design Guidelines and principles. The Design Review Board would support execution of NIST cultural resources management responsibilities. In addition, the Master Plan development will include an environmental assessment to meet the requirements of the National Environmental Policy Act (NEPA). The NEPA process will involve review of effects on cultural resources management responsibilities.

### Exhibit 137: Contributing Resources in the NIST Historic District

Building Number & Name		Building Number & Name, cont.	
101	Administration Building	238	Non-magnetic Laboratory
202	Engineering Mechanics	245	Radiation Physics
206	Concrete Materials	301	Supply and Plant
220	Metrology	302	Steam and Chilled Water Generation Plant
221	Physics	303	Service
222	Chemistry	304	Shops
223	Materials	306A	PEPCO
224	Polymer	306B	PEPCO
225	Technology	Campus Landscape Plan associated with the GPLs and Building 101, including vehicular and pedestrian circulation networks and parking lots	
226	Building Research		
230	Fluid Mechanics		
231	Industrial		
233	Sound		
235	NCNR	Flag pole	
236	Hazards		
237	Non-magnetic Laboratory		

Source: Addendum to Maryland Historical Trust Maryland Inventory of Historic Properties Form, Inventory No. M: 20-47, February 12, 2016

# Circulation and Transportation Analysis

## CHAPTER 16

A traffic study was conducted in 2015 that assessed the transportation conditions at the Gaithersburg campus, both the regional/neighborhood vehicle and transit systems and the on-campus conditions. The analysis included traffic counts on and off-campus, review of traffic controls, roadway, pedestrian and bicycle networks in comparison to local and state standards, and a comprehensive assessment of gate operations. The Study recommended modifications prioritized by level of need and investment. The circulation and traffic recommendations are summarized from this study. See the document *NIST Traffic and Gate Study for Gaithersburg Campus, 2015*, by Gorove/Slade for more information.

Subsequent to the traffic study, a parking analysis was initiated for this Master Plan. A campus parking inventory and occupancy summary is included at the end of this chapter, with further analysis to be added as the Master Plan approaches are developed.

### Campus Circulation

The NIST Gaithersburg Campus is bounded by MD Route 124 (Quince Orchard Road) to the west, MD Route 117 (West Diamond Avenue) to the north, Interstate 270 and Muddy Branch Road to the east, and residential neighborhoods to the south.

Access to the site is provided via six gates. The main entrance to the campus is through Gate A, from MD Route 117 (West Diamond Road) at Bureau Drive. This entrance also has the Visitor Screening Center. There are three gates from MD Route 124 (Quince Orchard Road)—Gates B, C, and D—and, two gates from Muddy Branch Road—Gates E and F. Of the six gates serving the NIST campus, only four are operational on a regular basis.

- Gate A: This gate serves as the primary entrance to the NIST campus and the only one that is operational 24x7. A gate house serves the campus entrance to carry out inspections. A Visitor Center located near the entrance processes NIST visitors' identification and vehicle registration before entering the campus. Visitor processing times during peak hours typically range from five to ten minutes. A 19-space parking lot serves the Visitor's Center. All persons entering the campus must show identification to the guards at the gate house. While most vehicles pass through this check in two to five seconds, sometimes checks can take up to two minutes.
- Gate B: This gate is an outbound-only gate operational in the afternoon and it remains closed during the morning hours. The signalized intersection at the North Drive and Quince Orchard Road provides a convenient exit for outbound NIST vehicles.
- Gate C: Operated as an inbound-only gate, it serves both employees and commercial vehicle delivery traffic. Employees are subject to an identification check similar to Gate A taking approximately two to five seconds for each vehicle. Commercial vehicle delivery traffic, after an initial documentation check for the driver (which was observed to take up to one minute), is escorted to a location near Building 301 for further inspection. Pedestrians were also noted to use this gate.
- Gates D & E: These gates are not regularly used and remain closed to most traffic.
- Gate F: Although this gate primarily serves employee traffic entering and exiting the site, it also serves as an alternate entrance for commercial vehicle delivery traffic and provides a separate commercial vehicle screening area. When

Exhibit 138: NIST Campus Map





large events are held on the campus, some visitor traffic is routed through Gate F.

A network of streets organized in a grid pattern, running north-south and east-west connects the campus facilities. North Drive and South Drive are the primary east-west connectors while East Drive, Center Drive, West Drive and Service Drive are the main north-south connectors.

### On Campus Traffic Volumes and Levels of Service

The 2015 *Transportation Assessment and Recommendations Report* documented turning movement traffic counts at five (5) major on-campus intersections, four (4) operating campus gates, and six (6) major off-campus intersections in the vicinity of the site.

On-campus intersections studied generally had acceptable levels of service (LOS). Some delay (although still within acceptable limits) was noted for vehicles turning left from Bureau Drive onto North Drive just inside Gate A. This could be attributed to through traffic along North Drive that requires southbound Bureau Drive traffic to wait. Some delay (again, within acceptable limits) was also noted on the eastbound and westbound Sound Drive approaches to West Drive. These delays were caused by through traffic along West Drive requiring eastbound and westbound Sound Drive traffic to stop and wait.

Levels of service at the gate intersections during the morning and afternoon peak hours were also generally acceptable with some exceptions.

- Gate A—Bureau Drive intersection with West Diamond Avenue: During the AM peak hour, this intersection operates at an overall LOS “D” for the northbound approaches and at LOS “E” (with delays of over 70 seconds) for southbound approaches. This is primarily due to the signal timings that prioritize through traffic along West Diamond Avenue. Eastbound traffic turning right sometimes backs up onto West Diamond Avenue during the morning rush. The westbound left turn from West Diamond Avenue onto Bureau Drive also operates at an LOS “E”, with the left turn lane frequently fully occupied during the morning peak hour and extending into the main lanes of traffic at times. This causes some vehicles at peak times to wait through more than one signal cycle to complete the left turn.
- During the PM peak hour, the level of service for the

intersection drops to an “F” with overall delays of 136 seconds or more. The worsening of the situation during the PM peak hour is due to the heavier outbound traffic volumes on the northbound, southbound and westbound approaches.

- Gate B: North Drive intersection with Quince Orchard Road: While overall operations are within acceptable levels, there are some delays on the westbound North Drive approach during the afternoon peak and westbound Bank Drive approach during both peak hours.
- Gate C: Sound Drive intersection with Quince Orchard Road: This is the only intersection serving a NIST gate that is not signalized. That causes some delays for the eastbound office park driveway opposite the NIST campus. While capacity analysis indicates that the intersection operates within acceptable limits, some queuing was observed east of the gate house primarily because of commercial vehicle inspections. This lack of queuing space frequently causes cars to back up onto Quince Orchard Road.
- Gate F: East Drive intersection with Muddy Branch Road: Delays were noted on the westbound apartment complex driveway approach (associated with the outbound residential trips during the morning) and the eastbound East Drive approach (associated with exiting NIST traffic).

### Campus Modal Split

Department of Commerce, NIST’s parent agency, conducts an employee survey periodically to collect modal split data for its facilities. The findings of a recent survey indicated that for the NIST Gaithersburg campus, majority of the employees utilize personal vehicles for their commutes to work. The table below summarizes the modal split.

**Exhibit 139: Employee Commuters**

Single Occupant Vehicles (SOV)	79%
Carpool/Vanpool	8%
Commuter Rail	1%
Metro Rail	2%
Bus	3%
Walk	1%
Bicycle	3%
Telework	3%

Exhibit 140: On-Campus Capacity Analysis Results

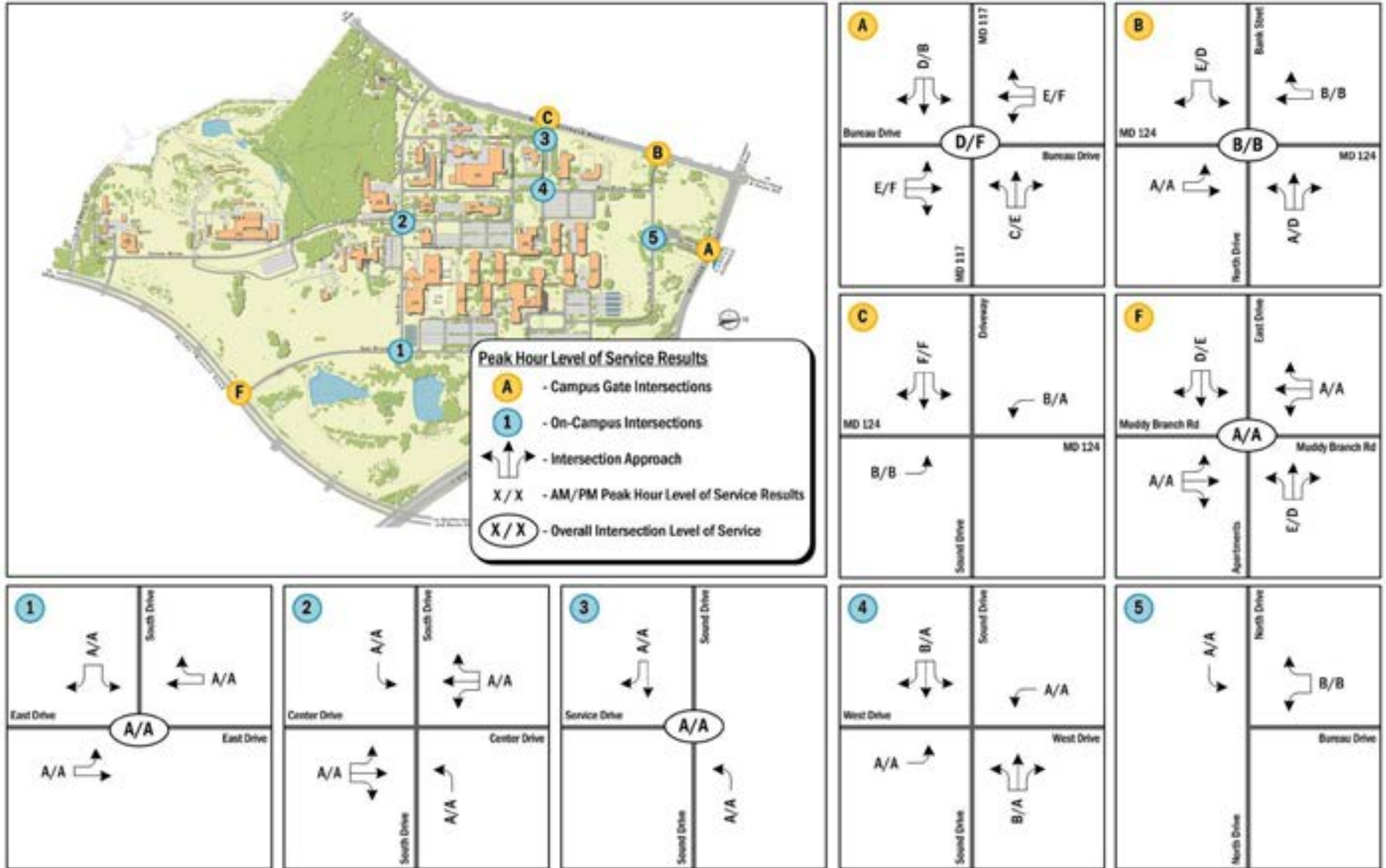


Exhibit 141: Estimated Average Daily Traffic (ADT) Volumes



## Pedestrian and Bicycle Infrastructure

The campus has a combination of asphalt and concrete sidewalks and crosswalks which allows pedestrian circulation throughout the campus. However, some areas like Research Drive and Center Drive in the central part of the campus, lack pedestrian connectivity. It was noted that local standards require concrete sidewalks, thereby rendering the asphalt sections of sidewalks out of compliance. In addition, while many curb ramps were noted to meet local standards, there were also many curb ramps that did not meet standards or were missing in locations that should be served. Connectivity with sidewalk networks on off-campus roadways are available at Gates A and F only with access to West Diamond Avenue and Muddy Branch Road.

Bicycle facilities are not as ubiquitous on campus as pedestrian facilities. Although some bicycle racks are provided on-campus, they are not found consistently throughout the campus. Bicycle lanes and signage are virtually non-existent. Bicyclists use a combination of on-campus roadways and sidewalks to navigate within the campus.

Public shared-use bicycle and pedestrian trails exist along West Diamond Avenue and Muddy Branch Road outside the campus.

## Community Coordination

Several planned community transportation and trail initiatives may have an impact on the NIST campus:

- Corridor Cities Transit Way (CCT) is a planned initiative of the Maryland Transit Administration. CCT is a rapid bus route that would use dedicated bus lanes to connect the Shady Grove Metro Station and the Metropolitan Grove MARC train station, with a possible later route extension. The CCT would be constructed at Quince Orchard Road (Route 124), on the east side of the campus with a NIST station. CCT would require relocation or closing of NIST's Gate Cf.
- The Quince Orchard Road Hiker/Biker Trail is planned to be extended along Quince Orchard Road, providing much needed pedestrian and bicycle connections and crossings adjacent to the campus. This trail currently ends approximately one quarter mile south of Gate D.
- The Muddy Branch Trail is an initiative of the City of Gaithersburg to create a trail that would extend along

campus along the eastern edge, connecting West Diamond Avenue and Muddy Branch Road.

- And the Gaithersburg Master Plan identifies plans for several other pedestrian and bicycle paths/lanes in the surrounding neighborhood.

## 2015 Traffic Study Recommendations

The traffic study reviewed the campus transportation infrastructure for appropriate design and compliance with local and state transportation standards. Specifically, standards used were those of the City of Gaithersburg, Montgomery County Department of Transportation and the Maryland State Highway Administration. These requirements are based on industry standards as set by the American Association of State Highway and Transportation Officials (AASHTO) in their *Policy on Geometric Design of Highways and Streets*. Roadway widths, curbs, signage, controls, sidewalks were reviewed, and the majority of conditions are in compliance. Improvements are noted in the recommendations below. The most serious recommendations are functional, suggesting roadway modifications around Gate A for safety and congestion, and at Gate C for commercial vehicle screening.

The 2015 traffic study categorized recommendations by prioritized needs and by cost and effort to implement. Low Investment recommendations are those that could be implemented at low cost, effort or time. Medium Investment recommendations are those that would need some time planning, budgeting and implementing. High Investment recommendations are those that would need significant time and budget. Following are the categorized recommendations from the Gorove/Slade study.

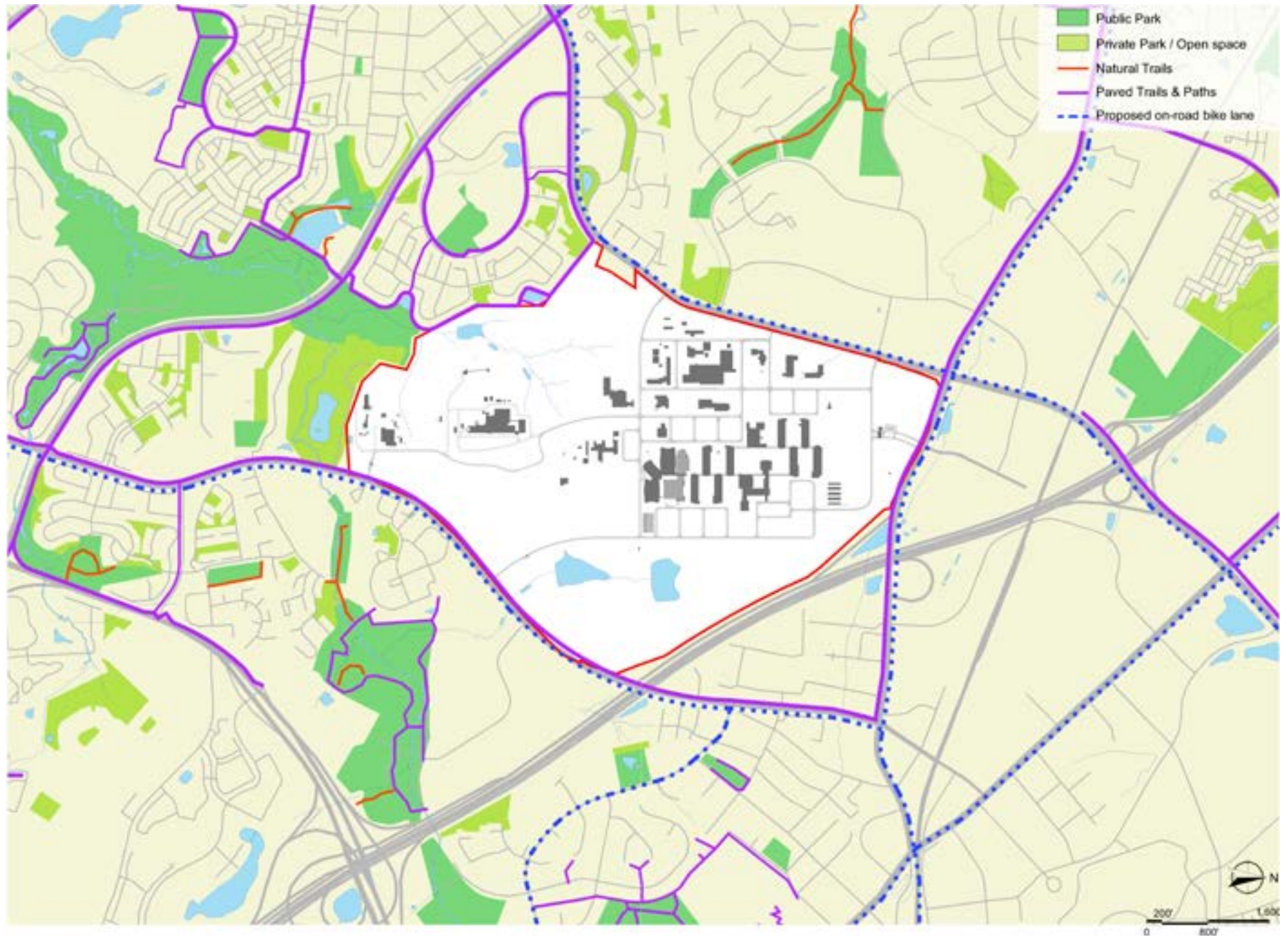
## Exhibit 142: Traffic Study Recommendations

LOW INVESTMENT RECOMMENDATIONS	
High Priority	Convert North Drive/Bureau Drive Intersection to All-Way Stop Condition
	Remove Directional Arrows Exiting Visitor's Center to Northbound Bureau Drive Lanes
	Designate and Sign Transit Bus Stop Adjacent to the Building 101 Porte Cochere
	Designate and Sign Charter Bus Pick-up/Drop-off Area Adjacent to Buildings 225 & 227. Designate Charter Bus Staging Area in Nearby Parking Lot.
	Designate and Sign Charter Bus Pick-up/Drop-off Area Adjacent to Buildings 225 & 227. Designate Charter Bus Staging Area in Nearby Parking Lot.
	Replace Yield Signs at Parking Lot Exits to Campus Roadways with Stop Signs
Medium Priority	Replace MUTCD R1-9a Sign from Research Drive
	Replace Directional Arrows at Gates B and C
	Install One Way Signage on Service Drive at Sound Drive
	Replace One Way Sign near Building 101 Porte Cochere with MUTCD Compliant Signage
	Install One Way Signage at Building 320 Entrance from West Drive
	Convert West Drive/Sound Drive Intersection to All-Way Stop Condition
	Convert West Drive/Research Drive Intersection to All-Way Stop Condition
Convert South Drive/Center Drive Intersection to All-Way Stop Condition	
High Priority	Replace Yield Sign at Bowman Drive/South Drive Intersection with Stop Sign (if Gate D Activates)
MEDIUM INVESTMENT RECOMMENDATIONS	
High Priority	Replace Non-Standard Crosswalks with 45 Degree Angled Crosswalk Striping
	Install Commercial vehicle Lane at Existing Gate C to Relieve Queuing and/or Restrict Commercial vehicle Entry to Outside of Peak AM Commuter Time (8-9:30am)
Medium Priority	Replace Pedestrian Signage with MUTCD W11-2 and/or R1-6 Signage
	Replace Bicycle Racks with Standard "U" Racks
	Designate Bicycle Routes with Signage and Pavement Markings
	Construct New Sidewalk Along South Side of Research Drive to Complete Segment to Service Drive
	Construct New Sidewalk Between Visitor's Center and Building 227
	Construct New Sidewalk Between Building 318 and Parking Lot East of Building
	Construct New Sidewalk Along West Side of Center Drive from Research Drive to South Drive
	Construct New Sidewalk Along North Side of South Drive from Center Drive to Building 215
	Construct New Sidewalk Along South and West Sides of East Drive from North Drive to Picnic Area Near Building 101
	Replace Non-Standard and Missing Curb Ramps with MCDOT and SHA Standard Curb Ramps
HIGH INVESTMENT RECOMMENDATIONS	
High Priority	Widen Southbound Bureau Drive Approach to Gate A between the Visitor's Center Parking Lot Driveways from One Lane to Two Lanes
	Replace Asphalt Sidewalks with SHA Standard Concrete Sidewalks
Medium Priority	Convert North Drive/Bureau Drive Intersection to Roundabout in Future
	Reconstruct Gate C as Recommended by CCT Plan & This Document
Low Priority	Relocate North Drive and Construct Separate Visitor's Entrance at Gate A
	Construct Commercial vehicle Screening Facility and Relocate All Commercial vehicle Screening to Gate F

Exhibit 143: Pedestrian/Bicycle Facilities



Exhibit 144: Trails



## Campus Parking Inventory and Occupancy Summary

Parking occupancy and inventory data was collected on the Gaithersburg campus on Tuesday, April 7, 2016 from 8:00 AM to 5:00 PM to determine the utilization of the parking areas throughout the NIST campus. Data was collected when local schools were in session and represents an average day on the NIST campus, when no significant events were scheduled.

### Inventory Summary

An inventory of the parking spaces available on campus revealed that there are a total of 3,723 parking spaces on campus. The 3,723 parking spaces are designated as follows:

- Unrestricted – 3,362 parking spaces
- Handicapped – 92 parking spaces
- Motorcycle – 21 parking spaces
- Government – 56 parking spaces
- Reserved – 135 parking spaces
- Emergency – 7 parking spaces
- Short-Term – 11 parking spaces
- Visitor – 39 parking spaces

Of note, the 135 reserved parking spaces encompass a variety of reservations from those for specific employees or leadership, carpool/vanpools, CFC vehicles, and other designations. The vast majority of spaces on-campus are not designated for any particular use.

Nine (9) parking areas make up 3,170 of these parking spaces with the remaining 553 parking spaces divided between approximately 60 smaller parking areas throughout the campus that each accommodate anywhere from two (2) to 53 vehicles. The nine larger parking areas accommodate anywhere from 113 vehicles (serving Buildings 230 and 231) to 636 vehicles (serving Buildings 216, 220, and 222). Eight (8) of these nine (9) larger parking areas are located within the central core of the campus with the ninth area located in the southern portion of the campus serving Building 235.

### Occupancy Summary

As noted above, parking occupancy data was collected hourly on a day when local schools were in session and no significant events were scheduled on the NIST campus. This data was

used to determine the utilization of the on-campus parking areas and was noted for usage of the various restrictions that are signed in the on-campus parking areas.

As noted in the Hourly Occupancy Summary table, the peak parking occupancy was noted at 10:00 AM, when 3,011 of the 3,723 on-campus parking spaces (or 81 percent) were occupied. While the occupancy of the unrestricted spaces mirrored that of the campus as a whole, there were several subtle differences in the occupancy of the various restricted spaces throughout the campus as summarized below:

- Only one motorcycle was parked on-campus during the peak period. Throughout the day, demand for the 21 motorcycle parking spaces never exceeded three (3) motorcycles.
- Emergency vehicle spaces were utilized at a rate between 71 and 114 percent of the allocated spaces during the morning hours, but tapered to just over 50 percent during the afternoon.
- Demand for short-term parking spaces far outpaced the supply, peaking at 200 percent of the available spaces during 9:00 AM hour and remaining over 100 percent of the available spaces throughout the day. Much of this unmet demand was noted in the small lot that occupies the space between the western portions of Buildings 221 and 223.
- Demand for Visitor, Handicapped, and Government spaces were adequately met throughout the day.
- Other reserved spaces (such as those for specific employees or leadership, carpool/vanpools, CFC vehicles, and other designations) were generally highly utilized throughout the day with usages above 85 percent for most of the day.



**Peak Occupancy**

During the 10:00 AM peak hour, the nine (9) larger parking areas accommodated 3,281 of the 3,723 vehicles on campus. In particular, the parking areas serving Buildings 101, 225, 227, 301, and 318 were at or exceeding capacity during the peak hour. A summary of the occupancy of these parking areas is as follows:

**Buildings 225/227 Lot**

- 442 parking spaces
- 434 vehicles (98 percent occupancy)

**Building 101 Main Lot**

- 437 parking spaces
- 459 vehicles (105 percent occupancy)

**Buildings 224/226 Lot**

- 443 parking spaces
- 321 vehicles (72 percent occupancy)

**Buildings 301/318 Lot**

- 134 parking spaces
- 128 vehicles (96 percent occupancy)

**Buildings 221/223/304/411 Lot**

- 664 parking spaces
- 478 vehicles (72 percent occupancy)

**Buildings 230/231 Lot**

- 113 parking spaces
- 74 vehicles (65 percent occupancy)

**Buildings 216/220/222 Lot**

- 679 parking spaces
- 528 vehicles (78 percent occupancy)

**Building 245 Lot**

- 136 parking spaces
- 87 vehicles (64 percent occupancy)

**Building 235 Lot**

- 233 parking spaces
- 164 vehicles (70 percent occupancy)

**Exhibit 145: Hourly Occupancy Summary**

Time	Total			Unrestricted			Handicapped			Motorcycle			Government			Reserved			Emergency			Short-Term			Visitor			Load'g
	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Spaces	Pct.	Veh.	Veh.
8:00 AM	3,723	48%	1,786	3,362	48%	1,609	92	41%	38	21	5%	1	56	25%	14	135	76%	103	7	14%	1	11	118%	13	39	18%	7	2
9:00 AM	3,723	69%	2,567	3,362	70%	2,341	92	61%	56	21	5%	1	56	21%	12	135	85%	115	7	86%	6	11	200%	22	39	36%	14	3
10:00 AM	3,723	81%	3,011	3,362	82%	2,750	92	66%	61	21	5%	1	56	41%	23	135	94%	127	7	71%	5	11	173%	19	39	64%	25	5
11:00 AM	3,723	80%	2,973	3,362	81%	2,715	92	62%	57	21	14%	3	56	29%	16	135	96%	130	7	114%	8	11	155%	17	39	69%	27	6
12:00 PM	3,723	73%	2,733	3,362	75%	2,506	92	55%	51	21	5%	1	56	21%	12	135	84%	114	7	57%	4	11	127%	14	39	79%	31	2
1:00 PM	3,723	74%	2,771	3,362	76%	2,545	92	53%	49	21	5%	1	56	25%	14	135	90%	122	7	57%	4	11	118%	13	39	59%	23	3
2:00 PM	3,723	75%	2,802	3,362	76%	2,569	92	61%	56	21	5%	1	56	27%	15	135	86%	116	7	57%	4	11	127%	14	39	69%	27	1
3:00 PM	3,723	71%	2,659	3,362	72%	2,435	92	51%	47	21	5%	1	56	29%	16	135	85%	115	7	57%	4	11	136%	15	39	67%	26	1
4:00 PM	3,723	58%	2,147	3,362	58%	1,965	92	41%	38	21	5%	1	56	25%	14	135	68%	92	7	43%	3	11	118%	13	39	54%	21	2
5:00 PM	3,723	39%	1,434	3,362	39%	1,309	92	13%	12	21	5%	1	56	23%	13	135	47%	64	7	57%	4	11	109%	12	39	49%	19	-



# Campus Utility Infrastructure

## CHAPTER 17

THE Steam and Chilled Water Generation Plant, Building 302, provides chilled water, steam and compressed air to the general and special purpose laboratories, the Administration building and many of the support buildings. Service is distributed through a network of direct buried piping. Most of the major equipment and piping systems in the Steam and Chilled Water Generation Plant are in good condition with several years of useful life. The steam/condensate distribution piping has undergone complete replacement. Both the domestic water system and sanitary system are in good condition, and adequately sized for future campus additions and renovations. While the individual piping systems are reported to be in generally good condition, it is also recognized that, like the original buildings, the piping systems are more than fifty years old and approaching the end of their useful life. Failures have been documented with increasing frequency throughout the campus. Phased replacements of many of the systems are anticipated after a more detailed evaluation and replacement plan is developed.

### Steam and Chilled Water Generation Plant

The Steam and Chilled Water Generation Plant, Building 302 houses chilled water, steam and compressed air generation and distribution equipment. The existing steam generating system consists of six boilers with a total installed capacity of 336,000 PPH. This includes four 44,000 PPH boilers and two 80,000 PPH boilers. All boilers are dual fuel (natural gas and ultra-low sulfur diesel) fired, water-tube boilers with stack economizers. The system also includes related auxiliaries such as condensate return equipment, deaerator/feed-water equipment and fuel distribution. The chilled water generating system consists of seven chillers with a total capacity of 23,500 tons. This includes five 3,500 ton chillers and two 3,000 ton chillers. All chillers are electric driven, water-cooled centrifugal

chillers. The system also includes associated cooling towers, primary and secondary chilled water pumps and condenser water pumps. Compressed air generating system consists of four air compressors and related auxiliaries.

Service to buildings consists of a network of underground chilled water, steam and condensate piping distribution system via direct buried piping. The following information regarding underground utilities is extracted from the Asset Overview Report furnished by NIST. Chilled water supply and return piping was originally installed in the 1960s and consists of asphalt coated carbon steel piping. Underground valves are located in valve boxes. Few pipe sections have been replaced since the original construction with the exception of the new section between Building 202 and 235 and a new section north of Building 231. Steam distribution system delivers high pressure steam to the buildings and condensate distribution system returns steam condensate to the plant. The system consists of 41 manholes and all manholes have been re-built within the last seven years. In addition, the piping distribution system has undergone full replacement and is currently in the final phase. Campus Chilled Water and Steam/Condensate distribution plans are included here.

Most of the major equipment and piping systems in the Steam and Chilled Water Generation Plant are in good condition with several years of remaining useful life with good maintenance and upkeep. There are several projects that are currently underway:

- A Combined Heat and Power (CHP) system addition has recently been constructed. It includes the addition of an 8.0 MW gas turbine generator package, one heat recovery steam generator (HRSG), a new gas compressor and related auxiliaries. The existing Boiler 6 (80,000 PPH output) was removed. The CHP system is designed such that the turbine exhaust is capable of producing 35,000 PPH of

150 psig steam through the HRSG. With the addition of gas-fired duct burners, an additional 45,000 PPH of steam can be produced resulting in a total output of 80,000 PPH. The CHP turbine is natural gas fired and the natural gas fuel supply to NIST campus is subject to curtailment. Therefore, removal of Boiler 6 results in reduction of available steam capacity during times when the plant is subject to gas curtailment.

- The existing 3,000 ton chillers are replaced with 3,500 ton chillers.
- The primary chilled water pumps are provided with variable frequency drives.
- The existing free-cooling heat exchanger system are modified to operate in parallel of series operation thus allowing longer periods of free cooling.
- The existing air compressors are to be replaced with four new rotary screw compressors.

Natural gas service to the plant is provided at 50 to 55 psig from the campus service line. Supply pressure to the plant distribution system is at 20 psig. Fuel oil system serving the Steam and Chilled Water Generation Plant consists of eight 30,000 gallon underground storage tanks.

Plant control and monitoring system is based on MicroMod Automation and Control System. Steam generating system is controlled and monitored by MicroMod including boiler control, and plant master control. Chillers are controlled by Johnson Controls Optiview for chillers and monitored by MocoMod. Pumping systems are controlled and monitored by MicroMod. Compressed air system is monitored by MicroMod.

## Chilled Water System

As indicated above, chilled water is generated in the Steam and Chilled Water Generation Plant and distributed to all major buildings via an underground direct buried piping system. Chillers 1 through 4 are 3,500 ton, R-134, York, single compressor chillers installed in 1998. Chillers 5 and 6 are 3,000 ton, R-22, York single compressor chillers installed in 1993. Chiller 7 is a 3,500 ton, R-134, York dual compressor chiller installed in 2010. Chillers 5 and 6 are scheduled to be replaced with 3,500 ton, R-134, York, dual compressor chillers in 2017. After replacement, all chillers will be 3,500 tons and will utilize R-134 refrigerant.

The plant capacity will increase to 24,500 tons with a firm capacity of 21,000 tons.

Chiller 7 is coupled with a dedicated cooling tower to provide free cooling in winter via a plate and frame heat exchanger. Under the ongoing plant improvement project, an additional free cooling heat exchanger will be added. Also, chillers 5 and 6 will supplement free cooling in winter. Further, the piping system will be reconfigured to provide parallel and series free cooling thus increasing the duration of free cooling operation. The main cooling tower was completed in 2010. Towers 1, 2, 3 and 4 are capable of 3,500 tons each and towers 5, 6, 7 and 8 are capable of 2,250 tons each. All condenser water pumps have been upgraded to 10,500 gpm each.

Primary chilled water pumps are in a common manifold with flow control valves at the evaporator. As part of the on-going project, VFD's are being installed for the primary chilled water pumps to reduce decoupler flow. Similar to primary chilled water pumps, condenser water pumps are also in a common manifold with flow control valves at each condenser.

Chilled water supply and return piping was originally installed in the 1960s and consists of direct buried, asphalt coated, carbon steel piping. Pipe segments 8" and smaller are typically insulated. Larger piping segments are uninsulated. Underground chilled water valves are direct buried with valve boxes for access. Few pipe sections have been replaced since the original construction including the new section between Building 202 and 235 and a new section north of Building 231 (creating a loop between east and west mains). Chilled water piping is generally in good condition with no major issues reported.

With the installed capacity of 24,500 total tons (seven 3,500 ton chillers after chillers 5 and 6 are replaced as planned), the available reliable capacity of the plant is 21,000 tons based on N+1 equipment redundancy. The plant maintains detailed logs of equipment operation and total consumption data. However, recorded historical data on peak loads are not readily available. Based on discussion with plant operating personnel, peak plant campus load is 17,000 tons. This indicates an available additional capacity of 4,000 tons for future load additions because of master plan development. The capacity of the piping system to deliver the capacity to new load additions will be determined based on the zones of development, projected load density and the capacity of distribution system in the vicinity of new development.

## Steam and Condensate System

High pressure is generated in the Steam and Chilled Water Generation Plant and distributed to all major buildings via an underground direct buried piping distribution system. As indicated above, the plant houses six boilers consisting of four 44,000 PPH boilers and two 80,000 PPH boilers. Under the on-going project, one of the 80,000 PPH boilers will be removed. The HRSG from the CHP system will provide the equivalent 80,000 PPH capacity. Based on data provided by the plant operating personnel, the actual steam output of the existing boilers is less than the rated nameplate output. Boilers 1 through 4 have a total output of 171,000 PPH with gas firing and 160,000 PPH with oil firing. Boiler 5 has an output of 80,000 PPH with gas firing and 75,000 PPH with oil firing. As previously noted, the CHP is fired only with gas. Firm capacity of the plant with the largest boiler (Boiler 5) out of service is 251,000 PPH when natural gas is available and 160,000 PPH when natural gas is curtailed. NIST is currently working with the State of Maryland MDE to retain Boiler 6 so that reliable steam capacity will be available with either fuel source.

Condensate returned from the campus is collected in a surge tank and transferred to the deaerator via two transfer pumps. Boiler feed water system consists of two deaerators with a capacity of 190,000 PPH each. The system includes three feed water pumps each capable of approximately 105,000 PPH. The feed water pumps are scheduled to be replaced in the near future.

Steam distribution system delivers high pressure steam at 150 psig to the buildings and condensate distribution system returns steam condensate to the plant. The system also consists of several manholes. All underground distribution piping and piping within manholes have been replaced between 2008 and 2013. Few building legs were not replaced. New piping consists of direct buried conduit system with insulated carbon steel carrier piping and carbon steel outer casing with HDPE coating. Selected segments of steam piping were increased from the original size. While the piping is generally good condition, certain manholes have water accumulation and steaming problems. Manholes typically do not have sump pumps.

With the installed capacity of 336,000 PPH, the available reliable capacity of the plant is 256,000 PPH based on N+1 equipment redundancy. The plant maintains detailed logs of equipment operation and total consumption data. However,

recorded historical data on peak loads are not readily available. Based on discussion with plant operating personnel, peak plant campus load is 160,000 PPH. This indicates an available additional capacity of 96,000 PPH for future load additions due to master plan development. However, there are detected losses in the compressed air distribution system. The capacity of the piping system to deliver the capacity to new load additions will be determined based on the zones of development, projected load density and the capacity of distribution system in the vicinity of new development.

## Compressed Air System

Compressed air is generated in the Steam and Chilled Water Generation Plant and distributed to all major buildings via an underground piping system. Generally, compressed air piping is routed parallel and adjacent to the chilled water distribution piping. Direct buried carbon steel piping is utilized for compressed air distribution. The existing compressed air generation equipment is being replaced with two 200 HP variable speed compressors and two 100 HP constant speed compressors with a total capacity of 3,100 cfm.

With the installed capacity of 3,100 cfm, the available reliable capacity of the plant is approximately 2,100 cfm based on N+1 equipment redundancy. Based on discussion with plant operating personnel, peak plant load to meet campus demand is 1,700 cfm with an average baseline demand of 1,300 cfm. This indicates an available additional capacity of 400 cfm for future load additions for master plan development. However, there are detected losses in the compressed air distribution system. The capacity of the piping system to deliver the capacity to new load additions will be determined based on the zones of development, projected load density and the capacity of distribution system in the vicinity of new development.

## Primary Electrical System

Building 306 houses the electrical service to the campus. The electric needs of the campus facilities are served by a four bus solidly-grounded 15 kV substation. The substation is fed from three 69 kV PEPCO utility feeders which serve other customers in addition to NIST. The feeders connect to three PEPCO-owned 69 kV to 15 kV step down transformers.

The Main-Tie-Main-Tie-Main-Tie-Main switchgear has eight circuit breaker cubicles on the A bus (two spares), eight circuit breaker cubicles on the B bus (two spares), seven circuit breaker cubicles on the C bus (two spares) and seven circuit breaker cubicles on the D bus (two spares). The busses are connected in a ring configuration, with tie breakers A-B, B-C, C-D and D-A.

Spot network systems, such as the system utilized at NIST, are designed to provide highly reliable low voltage service to a building. In this system, a fault or failure of any one transformer or one campus/utility feeder will not result in any interruption of service. Only a fault or failure of two transformers or two campus/utility feeders will result in a loss of service to part of the building being served. This is a very robust and reliable normal power distribution system that also provides flexibility for future growth.

The majority of buildings on the campus are served by three 15 kV feeders terminating at separate 480/277 volt and 208/120 volt substations within the individual buildings with the remaining buildings either served with two 15 kV feeders or served via low voltage from a nearby building.

The campus buildings that house the general purpose laboratories are all fed from the 15 kV campus distribution system in the following configuration.

- Campus Feeder Nos. FA-2, FB-2 and FD-2 serve Meteorology Building 220, Chemistry Building 222 and Technology Building 225 as well as other campus buildings. Feeder FB-2 is known to be faulted and is out of service but the NIST high voltage electricians have not been able to locate the fault.
- Campus Feeder Nos. FB-3, FC-3 and FD-3 serve Polymer Building 224, Building Research Building 226, Physics Building 221 and Materials Building 223 as well as other campus buildings. Feeder FB-2 has been reported as faulted but the campus high voltage electricians have not been able to locate the fault as of the current date.

The campus buildings that house the advanced measurement laboratories are all fed from the 15 kV campus distribution system in the following configuration. Campus Feeder Nos. FA-7, FB-7 and FC-7 serve Nanofabrication Facility 215, Meteorology East Building 218, Meteorology West Building 219, Instrument East Building 216 and Instrument West Building 217.

Seven feeders are dedicated to medium-voltage chillers in the Central Plant, Building 302.

The campus distribution to all campus facilities consists of an underground concrete ductbank system with radial feeders connected in a spot network configuration. The feeders which make up a triplet serving a group of buildings are run through the same ductbank, limiting the redundancy available. There are no isolation switches in the system, further reducing the maintenance options available to NIST.

When the campus was built, there were spare ducts in the ductbanks. However, at this point several ducts have collapsed and others have become unusable because the cable pulling lubricant used to pull abandoned cables into the duct has turned to glue over the ensuing decades, making it impossible to remove the cables and reuse the ducts.

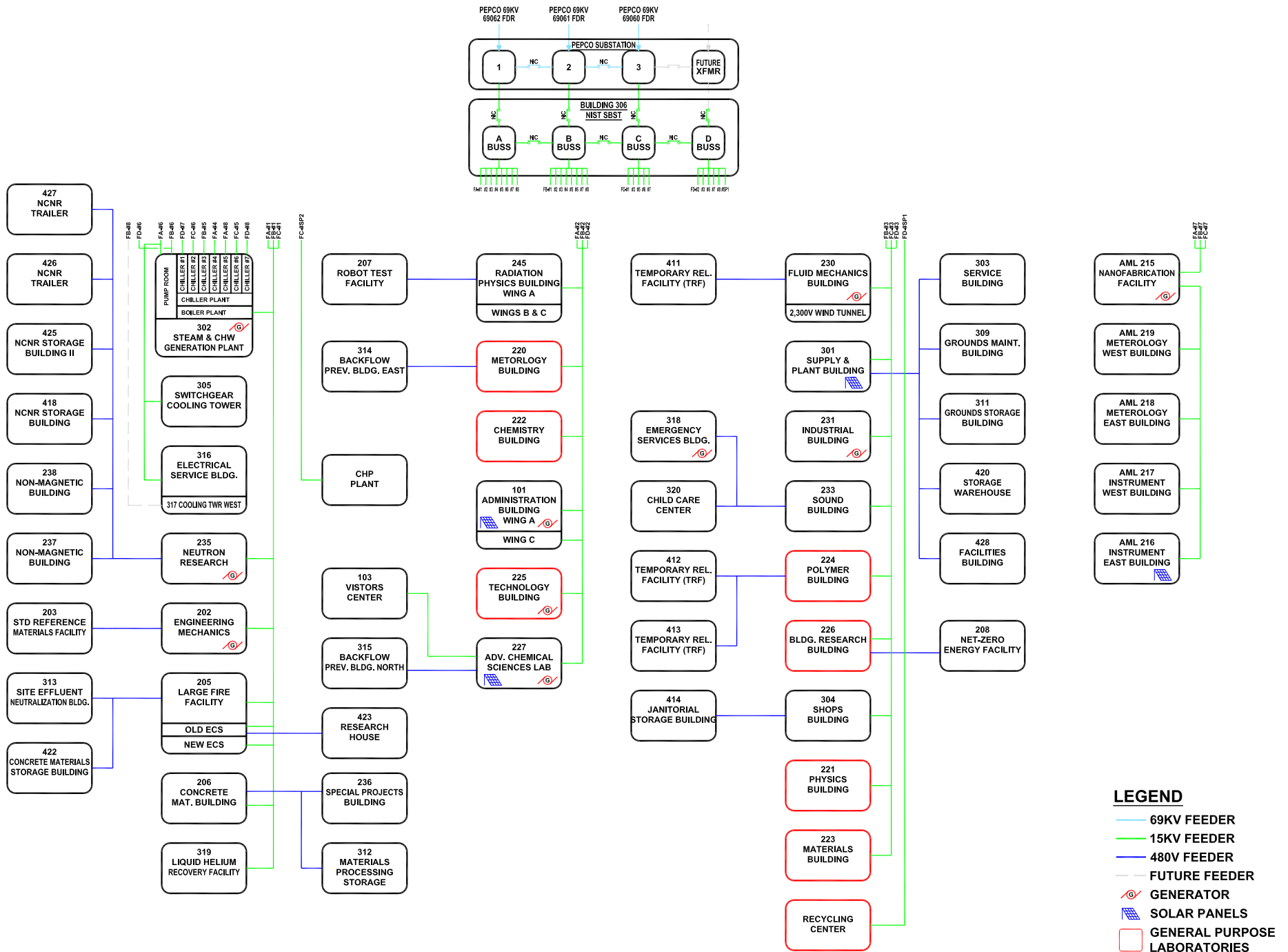
When the campus was built, all of the distribution feeders were installed as paper-insulated, lead covered (PILC) medium voltage cable with splices at each building. There is no way to separate a building from the feeder or to isolate a faulted length of cable. The current industry standard is EPR insulation and load break disconnects at each building and at various points along the radial feed. NIST is beginning to upgrade their distribution system at building taps as buildings are renovated but there is no current plan to replace the aging existing PILC cable.

Three PEPCO 69kV-13.8kV transformers have the available reliable capacity based on N+1 equipment redundancy. The plant maintains detailed logs of total consumption data. However, recorded historical data on peak loads is somewhat limited. Available metering data does not cover every building or every feeder into the buildings where metering is available (loads on the feeders dedicated to the Steam and Chilled Water Generation Plant, Building 302, were not made available). Based on the metering data available, the peak plant campus load is about 47 MVA. The capacity of the medium voltage feeder system to deliver the capacity to new load additions will be determined based on the zones of development, projected load density and the capacity of distribution system in the vicinity of new development.

Existing peak metering data is summarized in the Existing Electric Building Load Summary exhibit.



Exhibit 147: Electrical Single-Line Diagram





## Domestic Water

### System Description

The NIST Gaithersburg campus is supplied domestic water by Washington Suburban Sanitary Commission (WSSC) through two metered connections at the north and east sides of campus. NIST operates an extensive distribution system, consisting of approximately 44,000 linear feet (lf) of ductile iron piping and 56 fire hydrants in which a majority of it was originally installed in the 1960s. The existing system was evaluated for adequate capacity to meet existing loads and fire flow demands. A site plan of the existing domestic water distribution system is included here.

### Load Requirements

A summary of the peak domestic water demand for each building is presented in the table Existing Domestic Water Load. A peak domestic water demand of approximately 1,180 GPM includes both the 880 GPM for the facility loads and the 300 GPM required for Steam and Chilled Water Generation Plant usage.

The NIST water bills for 2010 through 2014 were used to develop a general comparison of the estimated campus load versus the water demand derived from metered data. The total site consumption for each month was divided into water supply to the Steam and Chilled Water Generation Plant and water to the site. An average flow rate to the site was calculated for each month. Based upon the average rate the peak flow demand was estimated. A summary of the development of the peak water load is presented in Domestic Water Usage Table. The maximum annual peak (2010) site demand (without the Steam and Chilled Water Generation Plant) is 817 GPM which is within 7% of the calculated loads.

### Site Distribution

The domestic water distribution system consists of a looped piping network with two WSSC feeds into the system. One feed is located at the east portion of the loop and the other is connected at the north end of the loop. The computerized hydraulic model was utilized to simulate the distribution system under normal operating conditions. The results of the hydraulic model are presented in accompanying hydraulic diagram. Based upon the hydraulic model, there are no high velocities within the system and the maximum distribution loss is 1.5 feet.

The computer model output was compared to fire hydrant test data. Hydrant tests conducted in 2009 were obtained from NIST fire protection services and indicate the static pressure under normal conditions as well as the open hydrant flow for each hydrant. The pipe roughness factor was adjusted within the model to correspond to the fire flow test results. The hydraulic model was calibrated based an average roughness factor of  $C = 115$ . It was found that the roughness was lower ( $C=90$ ) in the pipe segments south of Building No. 202. This could be correlated to this segment of piping having higher internal tuberculation, which is common for municipal water systems of this age.

Based upon the existing looped distribution, the site has the capability to increase the load to the system dramatically (higher than two or three times the total load) before piping capacity in the mains start to experience high velocities greater than 12 feet per second (fps) or pressure drop issues during normal operation as well as during a system fire flow.

## Sanitary Sewer

### System Description

The NIST Gaithersburg utilizes the services of the Washington Suburban Sanitary Commission (WSSC) for the discharge of their sanitary sewer system. NIST owns and maintains an extensive collection system, consisting of approximately 26,300 linear feet sewer pipe in which a majority of it was originally installed in the 1960s. A site plan of the existing sanitary sewer for the NIST campus is included here.

The site plan includes manhole locations and building connections. A total of 119 manholes have been identified in the system. Of these 119 manholes, 12 were laboratory waste manholes. The type of manhole installed at NIST is either brick or precast concrete. The manholes were field surveyed to obtain information on the physical condition of each structure. Also, each manhole was measured and assigned a type as indicated the accompanying drawing.

### Hydraulic Analysis

Daily flows from all buildings on campus were developed based upon the domestic water load in a previous study of the system by RMF. The maximum daily sanitary flow from each

## Exhibit 148: Existing Domestic Water Load Summary

Year Occupied	Building Number	Building Name	Space Utilization					Total Assign. Area (NASF)	Total Gross Area (GsSF)	Peak Dom. Wtr Demand (GpPM)
			Admin. Area (NASF)	Std Lab Area (NASF)	High Bay Lab Area (NASF)	Cl/Spl Lab Area (NASF)	Auxiliary Space Area (NASF)			
Jan 1965	101	Administration	100,052	1,344	1,019	—	81,788	184,203	358,313	58.3
Jan 1963	202	Eng Mechanics	9,307	4,460	33,300	4,056	221	51,344	78,578	29.1
Aug 2012	203	Standard Reference Materials Building	Assumed That Two-Thirds of Building Area Is Lab Space					21,722	24,914	11.3
Jan 1974	205	Fire Research	1,115	1,104	8,445	1,150	141	11,955	17,652	7.1
Jan 1968	206	Concreting Matls	1,195	—	5,270	—	—	6,465	8,166	3.7
Aug 2012	207	Robot Test Facility	Assumed That Two-Thirds of Building Area Is Lab Space					9,497	9,899	4.9
Jan 2004	215	Nanofabrication Facility	Assumed That Two-Thirds of Building Area Is Lab Space					103,780	109,369	54.1
Jan 2004	216	Center Nano Science & Technology	Assumed That Two-Thirds of Building Area Is Lab Space					102,612	106,177	53.4
Jan 2004	217	Instrument West Building	Assumed That Two-Thirds of Building Area Is Lab Space					125,289	129,373	65.3
Jan 1966	220	Metrology	44,094	53,239	—	12,968	963	111,264	215,460	55.5
Jan 1966	221	Physics	37,020	63,981	—	11,776	787	113,564	219,654	59.2
Jan 1966	222	Chemistry	29,596	48,060	—	1,584	347	79,587	166,101	40.4
Jan 1966	223	Materials Test	33,531	42,604	528	528	1,063	78,254	164,659	38.1
Jan 1966	224	Polymer	29,879	45,037	—	1,229	2,394	78,539	164,028	39.0
Jan 1966	225	Technology	53,076	34,171	—	2,294	15,298	104,839	204,332	44.2
Jan 1966	226	Building Research	24,498	20,051	18,587	2,774	171	66,081	142,804	33.6
Mar 2001	227	ACSL	—	54,503	—	—	27,367	81,870	200,090	41.0
Jan 1969	230	Fluid Mechanics	2,964	1,755	16,546	764	—	22,029	38,367	12.8
Jan 1968	231	Industrial	7,435	5,652	21,956	3,889	—	38,932	75,120	22.0
Jan 1968	233	Sound	5,794	465	5,528	9,532	—	21,319	42,889	11.5
Jan 1965	235	Reactor	24,133	12,538	62,528	5,513	915	105,627	160,463	69.7
Jan 1968	236	Hazards	1,008	984	—	4,585	—	6,577	13,217	3.8
Jan 1968	237	Nonmagnetic Lab	—	1,467	—	—	—	1,467	3,099	0.9
Jan 1964	245	Radiation Physics	35,692	9,881	35,221	11,459	396	92,649	207,907	46.6
Jan 1964	301	Supply & Plant	74,801	—	—	—	3,855	78,656	135,519	24.6
Jan 1963	302	Generation Plant	1,913	—	—	—	—	1,913	46,288	0.6
Jan 1964	303	Service	2,955	—	—	—	477	3,432	14,573	1.1
Jan 1964	304	Shops	15,288	1,574	16,210	1,806	2,734	37,612	75,588	17.9
Jan 1969	308	Bowman House	751	—	—	—	277	1,028	6,083	1.0
Jan 1975	309	Grounds	7,837	—	—	—	—	7,837	11,702	2.4
Jan 1997	312	Matls Processing	216	—	—	—	—	216	3,877	1.0

Continues ahead

Exhibit 148: Existing Domestic Water Load Summary, *continued*

Year Occupied	Building Number	Building Name	Space Utilization					Total Assign. Area (NASF)	Total Gross Area (GsSF)	Peak Dom. Wtr Demand (GpPM)
			Admin. Area (NASF)	Std Lab Area (NASF)	High Bay Lab Area (NASF)	Cl/Spl Lab Area (NASF)	Auxiliary Space Area (NASF)			
Feb 2014	318	Emergency Services Facility	Assumed That Two-Thirds of Building Area Is Lab Space					20,219	22,127	10.5
May 2012	320	Child Care Center	Assumed That Two-Thirds of Building Area Is Lab Space					22,890	23,686	7.2
n.a.	410	Townhouse	1,740	—	—	—	—	1,740	2,119	0.5
Sep 1989	411	Temp Reloc. Fac.	7,882	—	—	—	1,691	9,573	17,358	3.0
Jun 1996	412	Temp Reloc. Fac.	1,930	—	—	—	—	1,930	2,800	0.6
Jun 1996	413	Temp Reloc. Fac.	1,930	—	—	—	—	1,930	2,800	0.6
Jun 1994	414	Janitorial Stor.	—	—	—	—	—	—	803	—
Aug 1994	419	Temp Building	109	—	—	—	122	231	1,640	0.1
Nov 1996	420	Atl Lab Mockup	—	—	—	—	—	—	2,615	—
Apr 1964	421	Rad. Phys. Stor.	527	—	—	—	—	527	1,499	0.2
Oct 2010	428	Facilities Building	Assumed That Two-Thirds of Building Area Is Lab Space					2,747	2,823	1.4
	<b>Total</b>		<b>558,268</b>	<b>402,870</b>	<b>225,138</b>	<b>75,907</b>	<b>141,007</b>	<b>1,809,200</b>	<b>3,231,708</b>	<b>878.1</b>

## LEGEND:

Building has been connected to domestic water system since 2000.

## NOTES:

- Space utilization based upon NIST Facilities Master Plan.
- Domestic water load based upon space utilization.
- NSF: Net Assigned Square Footage
- GSF: Gross Square Footage
- Peak Usage Based Upon Similar Research Campus Operation And The Following Usage Factors:  
Admin/General 0.0003 GPM/NASF 0.2 GPD/NASF (WSSC) X 2.25 Demand Factor / 1,440 Min. Per Day

existing buildings was considered equal to the amount of flow distributed to each of the building from the water supply systems. This provides a conservative analysis for the pipe capacity.

The sanitary system was hydraulically analyzed for existing conditions using peak daily flows. The desired percentage of actual flow versus full capacity per the WSSC design manual is 50% for pipes fifteen inches and smaller and 75% for larger pipes.

The pipes in the network are all flowing less than 50% of full capacity with the maximum percentage of full flow of approximately 42% in pipe segments 3 of the pipe segments which are 18-inch pipes, the design guidelines allow 75% of full flow in 18" pipes. The sub-network pipes are generally flowing from 0% to 30% of full capacity. Overall, the existing system has the capacity to handle approximately twice its existing load.

## Conclusions

The previous analysis of the sanitary sewer system for NIST included a complete hydraulic analysis and inspection of the visible portions of the system. A review of the physical condition of the pipes was not included however interviews with maintenance personnel indicated few repairs had been made on the sewer system and that in general the pipes were in good condition. In addition, overall, the condition of the sanitary manholes is rated good campus wide. Weighing the various factors associated with the existing sanitary sewer system indicates that the system is in good condition and is sized adequately for the future campus master plan additions and renovations.

## Storm Water

### System Description

NIST owns and maintains an extensive storm drain collection system, in which a majority was originally installed in the 1960s. The NIST storm drain system is collected on the campus through an extensive sewer system of pipes, manholes, and inlets. The major outfalls from the storm drain system flow to a series of storm water management ponds recently constructed by NIST in conformance with State of Maryland Department of the Environment (MDE) Storm Water Management Regulations. The existing system was evaluated during a recent study by RMF to determine adequate capacity to meet existing and future campus loads and

**Exhibit 149: Domestic Water Usage Based Upon Meter Data (2010–2014)**

Month	Site Consumption (10 <sup>3</sup> Gal)	Central Utilities Plant			Net Water To Site (10 <sup>3</sup> Gal)	Average Day (Gpd)	Average Rate (Gpm)	Peak Demand (Gpm)
		Cooling Generated (Ton-Hours)	Clg. Twr. Make-Up (10 <sup>3</sup> Gal)	Steam Make-Up (10 <sup>3</sup> Gal)				
January 2010	11,010	1,223,900	2,693	1,380	6,937	210,225	146	292
February 2010	11,167	1,220,000	2,684	1,380	7,103	202,943	141	282
March 2010	12,805	1,454,400	3,200	1,040	8,565	389,333	270	541
April 2010	12,723	1,641,500	3,611	830	8,282	276,057	192	383
May 2010	14,241	1,893,100	4,165	280	9,796	316,006	219	439
June 2010	21,368	2,835,200	6,237	140	14,991	405,150	281	563
July 2010	24,783	3,445,700	7,581	140	17,062	588,361	409	817
August 2010	22,368	3,103,500	6,828	140	15,400	550,011	382	764
September 2010	21,300	2,448,300	5,386	240	15,674	474,962	330	660
October 2010	19,596	1,804,400	3,970	350	15,276	449,304	312	624
November 2010	12,606	1,242,300	2,733	1,040	8,833	315,462	219	438
December 2010	11,802	1,319,200	2,902	1,210	7,690	265,164	184	368
January 2011	11,242	1,223,900	2,693	1,380	7,169	231,272	161	321
February 2011	17,195	1,220,000	2,684	1,380	13,131	397,909	276	553
March 2011	14,615	1,454,400	3,200	1,040	10,375	384,271	267	534
April 2011	11,146	1,641,500	3,611	830	6,705	248,322	172	345
May 2011	10,535	1,893,100	4,165	280	6,090	196,457	136	273
June 2011	15,507	2,835,200	6,237	140	9,130	344,512	239	478
July 2011	18,858	3,445,700	7,581	140	11,137	384,050	267	533
August 2011	21,277	3,103,500	6,828	140	14,309	476,977	331	662
September 2011	15,133	2,448,300	5,386	240	9,507	297,086	206	413
October 2011	11,610	1,804,400	3,970	350	7,290	235,172	163	327
November 2011	15,307	1,242,300	2,733	1,040	11,534	339,234	236	471
December 2011	10,580	1,319,200	2,902	1,210	6,468	248,760	173	346
January 2012	9,334	1,223,900	2,693	1,380	5,261	175,381	122	244
February 2012	12,019	1,220,000	2,684	1,380	7,955	265,167	184	368
March 2012	10,201	1,454,400	3,200	1,040	5,961	229,282	159	318
April 2012	10,118	1,641,500	3,611	830	5,677	291,113	202	404
May 2012	14,490	1,893,100	4,165	280	10,045	358,756	249	498
June 2012	16,204	2,835,200	6,237	140	9,827	333,104	231	463
July 2012	19,357	3,445,700	7,581	140	11,636	439,112	305	610
August 2012	23,295	3,103,500	6,828	140	16,327	480,215	333	667

**Exhibit 149: Domestic Water Usage Based Upon Meter Data (2010–2014), continued**

Month	Site Consumption (10 <sup>3</sup> Gal)	Central Utilities Plant			Net Water To Site (10 <sup>3</sup> Gal)	Average Day (Gpd)	Average Rate (Gpm)	Peak Demand (Gpm)
		Cooling Generated (Ton-Hours)	Cig. Twr. Make-Up (10 <sup>3</sup> Gal)	Steam Make-Up (10 <sup>3</sup> Gal)				
October 2012	12,631	1,804,400	3,970	350	8,312	277,055	192	385
November 2012	14,536	1,242,300	2,733	1,040	10,763	316,545	220	440
December 2012	10,521	1,319,200	2,902	1,210	6,409	246,494	171	342
January 2013	10,638	1,223,900	2,693	1,380	6,565	177,444	123	246
February 2013	11,612	1,220,000	2,684	1,380	7,548	264,842	184	368
March 2013	11,334	1,454,400	3,200	1,040	7,095	248,940	173	346
April 2013	11,587	1,641,500	3,611	830	7,146	213,304	148	296
May 2013	13,196	1,893,100	4,165	280	8,751	312,542	217	434
June 2013	16,121	2,835,200	6,237	140	9,744	341,879	237	475
July 2013	23,752	3,445,700	7,581	140	16,031	485,802	337	675
August 2013	14,806	3,103,500	6,828	140	7,838	261,277	181	363
September 2013	23,581	2,448,300	5,386	240	17,955	512,993	356	712
October 2013	15,267	1,804,400	3,970	350	10,947	364,903	253	507
November 2013	15,776	1,242,300	2,733	1,040	12,003	387,181	269	538
December 2013	13,172	1,319,200	2,902	1,210	9,059	348,436	242	484
January 2014	12,807	1,223,900	2,693	1,380	8,734	264,679	184	368
February 2014	18,137	1,220,000	2,684	1,380	14,073	426,466	296	592
March 2014	10,607	1,454,400	3,200	1,040	6,367	265,290	184	368
April 2014	10,628	1,641,500	3,611	830	6,187	206,223	143	286
May 2014	15,176	1,893,100	4,165	280	10,731	346,167	240	481
June 2014	16,234	2,835,200	6,237	140	9,857	328,552	228	456
July 2014	18,264	3,445,700	7,581	140	10,543	340,112	236	472
August 2014	22,284	3,103,500	6,828	140	15,316	494,074	343	686
September 2014	19,939	2,448,300	5,386	240	14,313	477,091	331	663
October 2014	12,299	1,804,400	3,970	350	7,979	265,977	185	369
November 2014	11,889	1,242,300	2,733	1,040	8,116	279,861	194	389
December 2014	12,863	1,319,200	2,902	1,210	8,751	282,283	196	392

## Notes:

1. Average daily usage calculated by dividing the net water to site by the number of days per month.
2. Peak demand is based upon a demand factor of 2.0 (Average x 2).
3. Central utilities plant information based upon data from site utility system replacement master plan

for the physical condition of the manholes, inlets, and pipes to meet the future needs of the campus. The site plan includes man-hole locations and building connections. The storm drain system consists of series of manholes and pipe segments with several outlet structures leading to several storm water management structures. There are 103 manholes, 131 catch basins, 245 inlets, 5 trench drains, and approximately 56,500 linear feet of pipe with the pipe sizes ranging from 3 inch to 60 inch. The type of manhole installed at NIST is either brick or precast concrete.

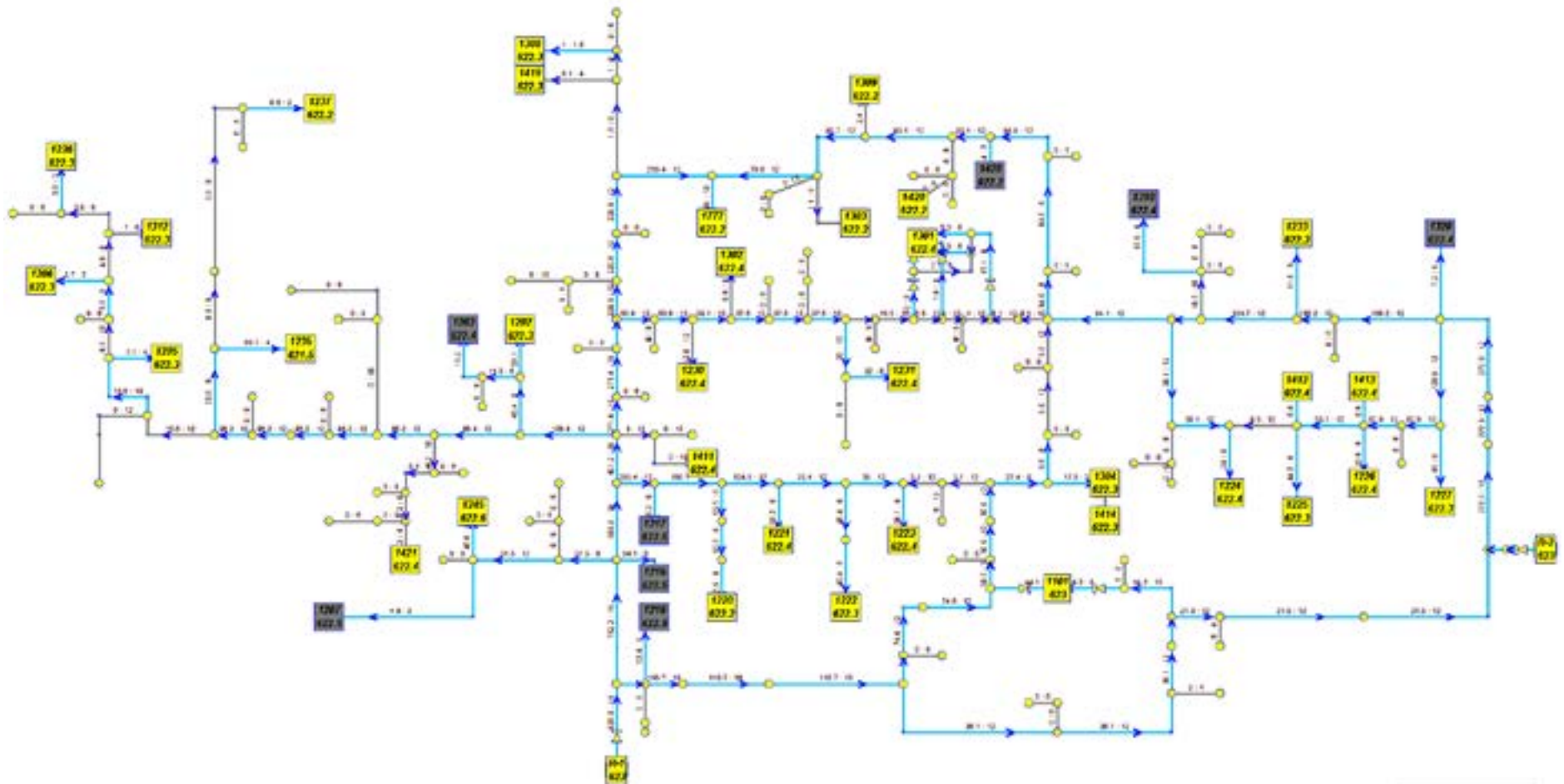
### Hydraulic Analysis and Conclusions

Storm Drain systems are impacted by new construction, when surfaces which permitted rainfall to infiltrate into the ground, such as lawns and woods, are changed to impervious areas, such as roofs and pavement areas. The total flows generated from the additional buildings can be adequately served by the existing storm drain systems. In addition regulations for Montgomery County which the facility is currently required to meet, require that there is no net increase in runoff from new construction. As new facilities are added, additional storm water management structures will be required to meet this criterion.

### GPS Monuments

The NIST Gaithersburg campus is host to over 60 Global Positioning System (GPS) monuments, marking longitude, latitude and height. Their locations must be reviewed during project planning, so individual monuments can be protected or moved, as necessary. A plan of current locations is included in the Appendix.

## Exhibit 150: Domestic Water Hydraulic Model



## Legend

- EXISTING BUILDING
- EXISTING BUILDING (BUILT SINCE LAST MAJOR STUDY IN 2000)
- EXISTING DOMESTIC WATER PIPING

Node	Junc	Dm	Type	Pipe Velocity	Time Case 0
<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>	<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>	<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>	<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>	<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>	<span style="display: inline-block; width: 15px; height: 10px; background-color: yellow; border: 1px solid black;"></span>
				<= 1	<= 0
				> 1	<= 3
					<= 6
					<= 9
					<= 12
					> 12

## Information Technology

### Voice

The voice switch located in the basement of Building 101 is the original analog Siemens system installed when the campus was first built. It is backed by a generator. In 2010, OISM began the process of updating network closets with UPS, increased cooling and more rack space to facilitate the future transition of the phone system to VOIP. There are currently ninety network closets around campus, powered by UPS, not generators, so they go off-line 90 minutes into a power outage. For planned outages, Security deploys portable generators to power their closets. The voice switch currently is backed up by a generator. There is consideration of installing a campus central UPS, backed by one or more generators. The physical security system needs to be 100 percent available, no outages.

Cellular coverage on campus is spotty and carrier-dependent. Coverage is provided in the public spaces of Building 101, but not all carriers are supported. (Sprint is not supported.) The metal walls that are typical in many of the buildings cause a lot of problems with cellular signal strength. A Distributed Access System (DAS) for cellular retransmission was investigated previously, but the cost was found to be excessive.

### Data

The central data center for the campus is located in a 10,000 square foot space in the basement of Building 225. Most laboratories have dedicated servers within their spaces. Every General Purpose Laboratory has a Main Distribution Frame. There are multiple service connections to the outside world

There are multiple service connections to the outside world:

- A 100 MBS Department of Commerce connection through Verizon
- Two 1GBS fiber connections routed over two different routes, from two different vendors provide access to the Gaithersburg campus internet service provider.
- Two 1GBS fiber connections are routed to a commercial data center in Virginia to provide direct access to Amazon AWS services and the DOE Energy Sciences Network.
- Two 1 GBS connections via NOAA N-Wave to NIST Boulder
- Three 1 GBS connections configured as hot/standby for

network time standards, one at Gaithersburg, one at Boulder and one at Ft. Collins.

- Two T1 lines that NIST is hoping to eliminate in the long term.
- NIST wants to obtain more fiber connections to NOAA Silver Spring or MAX GigaPOP
- Two “dark fiber” services. Fiber runs direct from Point A to Point B, interrupted by dedicated repeaters where required. No switches, spliced cable.
  - The main data center is located in Building 225 and the dark fiber goes off campus at Clopper Rd.
  - The redundant data center is located in AML and the dark fiber goes off campus on Quince Orchard Rd.
- Wave Division Multiplexing uses multiple “colors” to send multiple signals on one fiber.
- Fiber has no bandwidth limitations; the active electronics are the limiting factor.

### Distribution:

- The fire alarm network is an optical ring
- The Ethernet network is a star network.
- The current IT network consists of a logical star riding on a physical ring.
- Boulder is advocating for the installation of a physical star network.
- The Security network consists to fiber to each building and then copper backbone within the building.
- The physical networks are NIST overhead installations.

The OSIM networks at Gaithersburg are nearing the end of their useful life. NIST is currently working on a program to refresh the information technology system every five years. NIST currently has 1 GBS connection to every desktop. The next step will be 10 GBS in the cores, then to each building and finally to each desktop.

There are currently no plans that would require expanding the data center, unless the laboratories want to co-locate their servers with the central servers. There is currently a Government mandate to reduce the number of computer rooms.

NIST Gaithersburg currently makes use of hosted cloud services by Amazon and e-mail through Microsoft 365 Cloud Services. The domain controller and active directory are hosted locally.

WiFi is becoming a more popular choice for indoor networks, offering higher speeds and more mobility. Single-mode fiber continues to be the popular choice for outside plant.

There is no campus-wide or building-wide WiFi service. Service that exists is typically centered around conference rooms and is installed on a cost-reimbursed basis, paid for by the working units who request them. Building 101 public spaces and the Library do have broad coverage. The metal walls that move here are typical in many of the buildings cause many problems with WiFi signal strength. In order to achieve adequate coverage throughout the building, it is necessary to install 2–3 times the number of WiFi access points as would be required for typical masonry or gyp. board construction.

There are 600 Wireless Access Points (WAPs) installed around campus. Currently, WAPs are Power Over Ethernet (POE) over copper cable. A WAP is limited to approximately 25 devices because of bandwidth limitations. In addition, the WAPs bandwidth is shared with Bluetooth, cell phones, cordless phones and othe devices, further limiting the number of devices and data rates.

Thirty years ago, NIST developed the backbone for the network by putting routers in each building and pulling fiber between buildings. All of that fiber is obsolete or unserviceable and has been abandoned in place in the ductbanks.

Networking, Physical Security, Building Automation and Fire Alarm all share the same physical plant. Fire alarm is the only system riding on multi-mode fiber, the rest are hosted on first-generation single-mode fiber. Copper cables are a combination of 2nd and 3rd generation cable. Cable is run in ductbank, with the exception of the cable to Gate F which is direct-buried. There are plans to extend this cable to the new truck entrance off Muddy Branch Road. The fire alarm has dedicated cable; the other systems have dedicated strands in shared cable.

Typically, manholes are located in triplets; one for power, one for telephone and one for signal. Not all locations have all three manholes.

Approximately 20 years ago the campus fire alarm system needed to be upgraded, which required pulling new fiber optic cable. IT networking was added to the scope of that project and more campus fiber was pulled into the ductbanks. The fire alarm system uses a ring technology with nodes and fiber connecting to each building (Class A Ring). The IT network

uses a star technology that shortcuts some of the runs but still uses the ring.

Fire Alarm, IT Network, Security, and DDT (bldg. control system) all use the same fiber backbone. It consists of:

- 24 strand multi-mode fiber – dedicated to Fire Alarm
- 36 strand multi-mode fiber – shared by IT, Security, and DDT
- 60 72 strand single-mode fiber – shared by IT, Security, and DDT

Fiber enters into the basement of each building. Each group extends it up to a main closet for their work.

Enterprise Network for the Campus – OISM has systematically wired all the buildings. Most buildings have CAT 5 and CAT 6 wire up to 1 GB.

The installed fiber is first-generation, with an estimated life of 30 years, and is nearing that point. The fire alarm system has recently experienced some problems and NIST has asked OISM to test the fiber.

A significant problem for the fiber distribution system is that the manholes fill with water which causes water to run through the conduit. The resulting freeze/thaw cycles are degrading the fiber over time.

Some of the conduits in the ductbank system are filling up. Each conduit has four innerducts. NIST is currently using Maxell nylon sleeves.

The fiber between Buildings 245 and 205 is new, and from 205 and 236 is new.

As buildings are modernized, a Passive Optical Network (PON) may be an option, where the office connections will move from copper to fiber. This system uses centralized equipment and would be able to eliminate the network closets in buildings. No power, equipment or cooling would be needed. PON has been used by carriers for some time but it is now being tested in the enterprise. PON fiber is not capable of delivering Power Over Ethernet (POE) to devices such as Wireless Access Points (WAPs), VOIP phones, etc. A PON port can create the 120VAC or 48VDC power required.





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