APL's New Campus Master Plan

Brian E. Cornell

ABSTRACT

The Johns Hopkins University Applied Physics Laboratory (APL) has had a long history of campus land planning, beginning with its purchase of a 290-acre property in Laurel, Maryland in 1952. With the APL campus currently encompassing nearly 500 acres including owned and leased properties, the Laboratory faces several challenges in planning for future development. First it is hitting ceilings on available land on which to build. The continued tightening of government regulations, including environmental and zoning requirements, limits APL's property development potential to approximately 250 acres. Second is the increasing complexity of the facilities APL requires today. Facilities often need to be uniquely tailored to meet specific sponsor or program needs, limiting their ability to be repurposed later. Third is the continued land planning efforts necessary to address the ever-evolving workplace requirements and needs of APL staff. Beyond simply indicating where staff are to work, development plans must fully consider how staff need to work. In response to these challenges, the Laboratory undertook a new master planning effort for its campus. The subsequent new Campus Master Plan, developed during the Campus Development Process, is grounded in the Laboratory's core values and addresses the evolving aspects of technology, sponsor needs, environmental and regulatory requirements, and workplace culture and effectiveness.

BACKGROUND

In 1952 the Laboratory purchased a 290-acre property in Laurel, Maryland, approximately 16 miles from where it was then located in downtown Silver Spring, Maryland. Surrounded by agricultural land, Building 1 opened in 1954. In 1963 the Laboratory purchased an additional 75-acre parcel adjacent to the original, resulting in the large and singular property extending north from Johns Hopkins Road to and slightly beyond APL's Gate 4.

Between 1954 and 1980 the campus grew into a collection of various sized buildings. In the early 1960s, Buildings 2, 3, 4, and 5 as well as the Gibson Library were constructed in line parallel to Johns Hopkins Road. In 1963 a large parabolic antenna, measuring 60 feet in diameter, was constructed on the campus's highest point north of Building 1. Buildings 6, 7, 8, and 9 were added in the 1960s and 1970s. Building 1 continued to provide services, including a cafeteria and small amenity services, for APL staff members working at the Laboratory. Cafeteria services were also available in Building 5 until its space was repurposed in 2000. Subsequent

development occurred north of the early facilities. This pattern continues today.

As the Laboratory's population grew during the 1980s and 1990s, office, laboratory, and technical spaces were added to the campus. Continued evolution of sponsor and program requirements as well as advancements in building technologies resulted in new larger buildings that are more accommodating than those constructed in the 1950s and 1960s. The newer building technologies allowed for a more effective use of available campus land while providing collaboration opportunities to the growing APL staff population.

Building 23 was added in 1983 and was soon followed by Buildings 13, 24, and 25. Each incorporated current workplace environment trends, including staff offices wrapping the perimeter of the floor plate while laboratory, fabrication, technical, and support spaces were located in the center. The Kossiakoff Center was also added in 1983, with its new auditorium and classrooms greatly increasing space for collaboration. In the late 1990s, Buildings 26 and 36 and a series of modular buildings, intended as short-term solutions, were added. Several of the modular facilities have been demolished as larger office and laboratory or technical buildings have been added to the facility portfolio.

The Laboratory has continued to add facilities in response to increased sponsor and program needs. Since 2000, low-density buildings and outdated infrastructure have been razed in advance of the construction of new office, laboratory, and technical facilities, including Buildings 17 and 21. Building 20, the Laboratory's District Utility Plant, was constructed in 2004. It was during this time that the Laboratory began leasing several buildings in Montpelier Office Park, including MP1 through MP7. Buildings 12 and 15 and the van pad were added in 2007, and Building 30 was constructed in 2012. Laboratory support facilities including Buildings 29, 31, 32, and 35 followed. Building 32A opened in 2020 following the opening of Building 32 in 2017. Buildings 14 and 201 are scheduled to open in 2021 and MP8 in 2022.

Through the ongoing development, the Laboratory has maintained a generous setback from the surrounding public roadways. Originally intended to provide a grand tree-lined welcome to APL staff and visitors, APL Drive and the front lawn also provide a necessary physical security perimeter. The front lawn is reminiscent of the approach to a farm, hearkening back to the rural land uses commonplace in Howard County when the Laboratory arrived in the 1950s. Now a recognizable element of the Laboratory, the entry drive and front lawn have not significantly changed over the past 70 years, with the exception of the 2002 addition of ornamental fencing and gating along the campus perimeter. Figure 1 provides an aerial photo from above Johns Hopkins Road looking north.

The south-to-north development pattern was interrupted in 2006 with the purchase and subsequent redevelopment of the MeadWestvaco property on the south side of Johns Hopkins Road. Once the purchase of

Figure 1. An aerial photo from above Johns Hopkins Road looking north. Building 1 and the front lawn are in the foreground. The Central Green, in the middle of the image, is to the north of the Laboratory's legacy buildings, those built prior to 1970. Recent facilities, including Buildings 17, 21, and 24, built just prior to the beginning of the 21st century, are above the Central Green. Buildings 23 and 30 are located near the top of the image. Parking has been added to the campus incrementally to support the continued expansion.

Figure 2. An aerial photo looking north toward Building 200. A portion of the open space in the foreground is now occupied by Building 201, currently under construction. Building 1 is visible in the break in the tree line to the left of Building 200. MP6, located in the Montpelier Office Park, is visible to the right of Building 200.

this 35-acre parcel was complete, the existing facilities were razed and Building 200 was constructed in their place. Figure 2 provides an aerial photo of Building 200 south of Johns Hopkins Road taken before construction of Building 201. In 2015 APL purchased two additional parcels, totaling just over 54 acres. Formerly owned by the Price family, both sites are currently used for agricultural purposes. Figure 3 provides an aerial photo of the Price family properties.

The Laboratory has taken advantage of available office space in the Montpelier Office Park, designed and built by private developers, to the east. APL began leasing several facilities in this development in 2001. While the Laboratory still leases facilities on approximately 20 acres, it now owns several other facilities situated on just over 12 additional acres. Figure 4 provides an aerial photo of the Laboratory-owned facilities including MP2, MP3, MP4, and MP5. MP7, a facility APL began leasing in 2017, is visible in the lower right corner.

The Laboratory has continued to add leased properties in support of its expansion. This includes facilities within or immediately adjacent to sponsor and program locations in northern Virginia, southern Maryland, California, Florida, North Carolina, and Utah, as well as space in the Rivers Park Office Park located along Guilford Road in Columbia, Maryland.

Just as the Laboratory has continued to grow, so has the surrounding community. During the second half of the last century, Howard County, Maryland, began its transition from a rural agricultural county between Baltimore, Maryland, to the north and Washington, DC, to the south to a suburban bedroom residential community serving both metropolitan areas. The increased development pressures both cities placed on Howard County have resulted in additional residential, commercial, and institutional lifestyle opportunities and a steady increase in Howard County's residential population. The establishment of Columbia as a residential community by the Rouse Development Corporation, now the Rouse Company, in 1967 offered new living opportunities not only for APL staff but also for residents of both cities. As Columbia has matured, additional development has occurred at its edges. This development continues today, most recently exemplified by the development of the Maple Lawn mixed-use community located to the south of the Laboratory.

As the communities surrounding the Laboratory grew, so did the Baltimore and Washington, DC, metropolitan region. The addition of both public and private sector jobs continues to bring new residents to the area. This growth has increased demands on infrastructure and services provided by state and local governments. Over the past decade, growth in the areas immediately around the Laboratory, specifically new residential and business developments to the north and south, has strained public roadways and services. It is impossible to ignore the impact this development has on the continued expansion of the Laboratory and the additional requirements the government can legally impose on the Laboratory's future campus expansion efforts.

Figure 3. An aerial photo of the Price family properties acquired by the Laboratory in 2015. Accessible from Johns Hopkins Road and Price Manor Way, both properties provide long-term development opportunities. Building 200 is visible at the top of the image toward the middle, and MP6 in the Montpelier Office Park is in the top right corner. Maple Lawn, a mixed-use development made up of residential, office, and retail spaces typical of new developments occurring around the Laboratory, is in the top left corner.

Figure 4. An aerial photo of a portion of the Montpelier Office Park. MP2 is in the center, with MP4 and MP5 immediately behind it. MP3 is in the upper right corner. All four facilities are owned by the Laboratory. MP7, a facility leased by the Laboratory, is visible in the lower right corner.

WHAT IS A CAMPUS MASTER PLAN?

A campus master plan directs the physical manifestation, or built environment, of an organization's culture and values. Its vision provides the framework for future development of the organization's land, influenced by the organization's desires and requirements. It is the critical tool for framing short- and long-term development discussions. Without such a plan, critical development decisions, including but not limited to new facility locations and infrastructure enhancements, could be made without understanding the organization's culture and values or considering the overall development vision.

The sphere in which the Laboratory operates, providing critical contributions to critical challenges, places great importance on APL's overall development vision. The Laboratory does not exist in an environment allowing it to follow a static development plan that simply locates assets across the property. Rather, APL requires a decision-making tool providing a flexible and adaptable framework to support future and as-yet-unknown sponsor and program needs. This approach allows the Laboratory to navigate successfully the shifting landscape of sponsor and program priorities and financial environment. The Campus Development Process provides the decision-making tool. Constructed in advance of the new Campus Master Plan, this process begins by understanding what is important to the Laboratory and then provides the guidance to physically create an environment that says, "This is APL."

THE CAMPUS DEVELOPMENT PROCESS

The Campus Development Process has been developed ahead of the Campus Master Plan. This process guided discussions and decision-making for the new Campus Master Plan. The Campus Development Process and subsequent master plan replace the earlier static campus development plans with a flexible and adaptable tool to frame campus growth.

Previous iterations of the campus development plan, published every 8–10 years, included a plan indicating the next building location as well as the necessary supporting infrastructure, roadways, and parking. Prior plans were supported by substantial information including circulation, infrastructure, security, zoning, and natural constraints. The revision process commenced once the campus development plan had aged 5 years. It was not atypical for this timeline to be shortened in response to accelerated development needs.

As the output of the Campus Development Process, the new Campus Master Plan incorporates much of this same information but focuses on how the Laboratory's core values and culture drive and innovate the development of its campus and how they are physically expressed in its built environment. To support the development of the new Campus Master Plan, the Campus Development Process includes four key components:

1. APL Development Principles
2. Campus Development Concept
3. Campus Land Management
4. Campus Land Use

It is important to understand the symbiotic relationships among components. Each component informs the one that follows. If components 2, 3, or 4 are modified, the preceding components must be reexamined and might also need to be modified. This methodology ensures a deliberate, transparent, and flexible structure to address changing needs. It accommodates continual evaluation and verification of requirements during campus development discussion and decision-making efforts.

Collectively, all four components make up the Campus Development Process. The first two components, the APL Development Principles and the Campus Development Concept, constitute the new Campus Master Plan. Together they integrate the Laboratory's core values, workplace, and culture into the delivery of facilities and other assets across the campus.

APL Development Principles

The first component of the Campus Development Process, the APL Development Principles are derived from the Laboratory's core values and staff input. They provide the foundation for the built response expressing the Laboratory's understanding of who it is, what it is doing, and where it wants to go in the future. As the key element for sustainable campus development, the principles formulate the overall development vision for the campus. The principles only need to be modified if the Laboratory's core values and cultural desires change.

The APL Development Principles center on the Laboratory's five core values:

1. Unquestionable integrity
2. Trusted service to the nation
3. World-class expertise
4. Game-changing impact
5. A highly collaborative, fulfilling (even fun!) environment

These values have been distilled from the Laboratory's past and present cultural norms to inform and guide its future endeavors. Integrated into the new Campus Master Plan, along with input from APL staff, the APL Development Principles create a campus development framework reflective of the Laboratory's culture and values. The resultant physical workplace environment is a direct expression of these core values.

Campus Development Concept

The second component, the Campus Development Concept, is the application of the APL Development Principles to the existing campus with an understanding of Laboratory workplace needs. This comprehension includes where APL staff work, how they relate to their workplace environment, and how both collectively constitute the workplace experience. The understanding of other factors, including office, fabrication, laboratory, technical, and support use typologies, are also needed. Knowledge of work processes and the role of key existing facilities is required. The Campus Development Concept is expressed as a diagram indicating development opportunities. It locates key elements on the campus in response to APL initiatives and in support of organizational values, goals, and objectives. Applied to exterior and interior spaces, the Campus Development Concept only needs to be modified if the APL Development Principles are revised.

Campus Land Management

The third component, Campus Land Management, is the continual allocation management of development regulations placed on Laboratory properties by the government to ensure that the greatest value is extracted from campus lands. This component also ensures that development decisions, including the placement of facilities and other assets on the campus, do not prohibit future development opportunities.

Campus Land Management also includes the continual definition and comprehensive maintenance of development sites through the active management of land buffers, easements, open-space requirements, setbacks, zoning, and other constraints. This effort updates and refines the edges and boundaries of development sites across the campus, which is especially critical when the Laboratory acquires new property since doing so presents new development opportunities across the entire property portfolio. The Campus Land Management component needs to be evaluated and possibly modified if the Campus Development Concept is revised. Independent of organizational changes, the Campus Land Management allocations can also be revised in response to new land development regulations set in place by federal, state, and local government entities.

Campus Land Use

The fourth component, Campus Land Use, is the most active portion of the Campus Development Process and the most visible to APL staff. It includes the selection of a development site indicated in the Campus Development Concept in response to internal Laboratory requirements resulting from external, sponsor, and program stimuli. The Campus Land Use component is integrated with the 10-Year Annual Capital and Long Range Development Plans. Concurrence between Campus Land Use efforts and both financial plans ensures that pending development aligns with Laboratory finances.

To achieve this objective, the Campus Land Use component determines and synthesizes the next facility's program space needs with Laboratory occupants, programs and locations. Understanding these requirements allows site and infrastructure needs to be determined and correctly incorporated into the development program. The combined development program can then be financially appreciated and revised if and when needed in conjunction with the 10-Year Capital and Long Range Development Plans. This component is evaluated and modified if the Campus Land Management approach is revised.

Previous APL campus land planning efforts were limited to the Campus Land Use component of the Campus Development Process. Plans had an 8- to 10-year shelf life and only looked ahead to the next new building. Once that building was completed, the campus land plan was revised and looked toward the next new building. As a result, each planning iteration limited the overall vision and development potential of the campus. By expanding the efforts to incorporate all four components into a defined and cohesive process, the new Campus Master Plan aligns the Laboratory's core values, culture, and staff needs with future campus development efforts to appropriately respond to sponsor and program requirements that have grown greater in complexity. The Campus Development Process is not a linear exercise but a looping discussion, continually evaluating current decisions against the first two components. As a tool it provides the framework for a comprehensive and holistic strategic campus development approach. Figure 5 shows the Campus Development Process and its components, the relationships among components, the continual evaluation of components, and the location of the new Campus Master Plan within the process construct.

THE NEW CAMPUS MASTER PLAN: THE APL DEVELOPMENT PRINCIPLES AND CAMPUS DEVELOPMENT CONCEPT

Establishment of the Campus Development Process and its APL Development Principles and Campus Development Concept is a deliberate departure from previous campus land planning efforts. While they utilize information from previous efforts, the APL Development Principles and Campus Development Concept are not a site plan indicating future buildings, but are tools providing an adaptable and flexible development framework to support future and as-yet-unknown sponsor and program requirements.

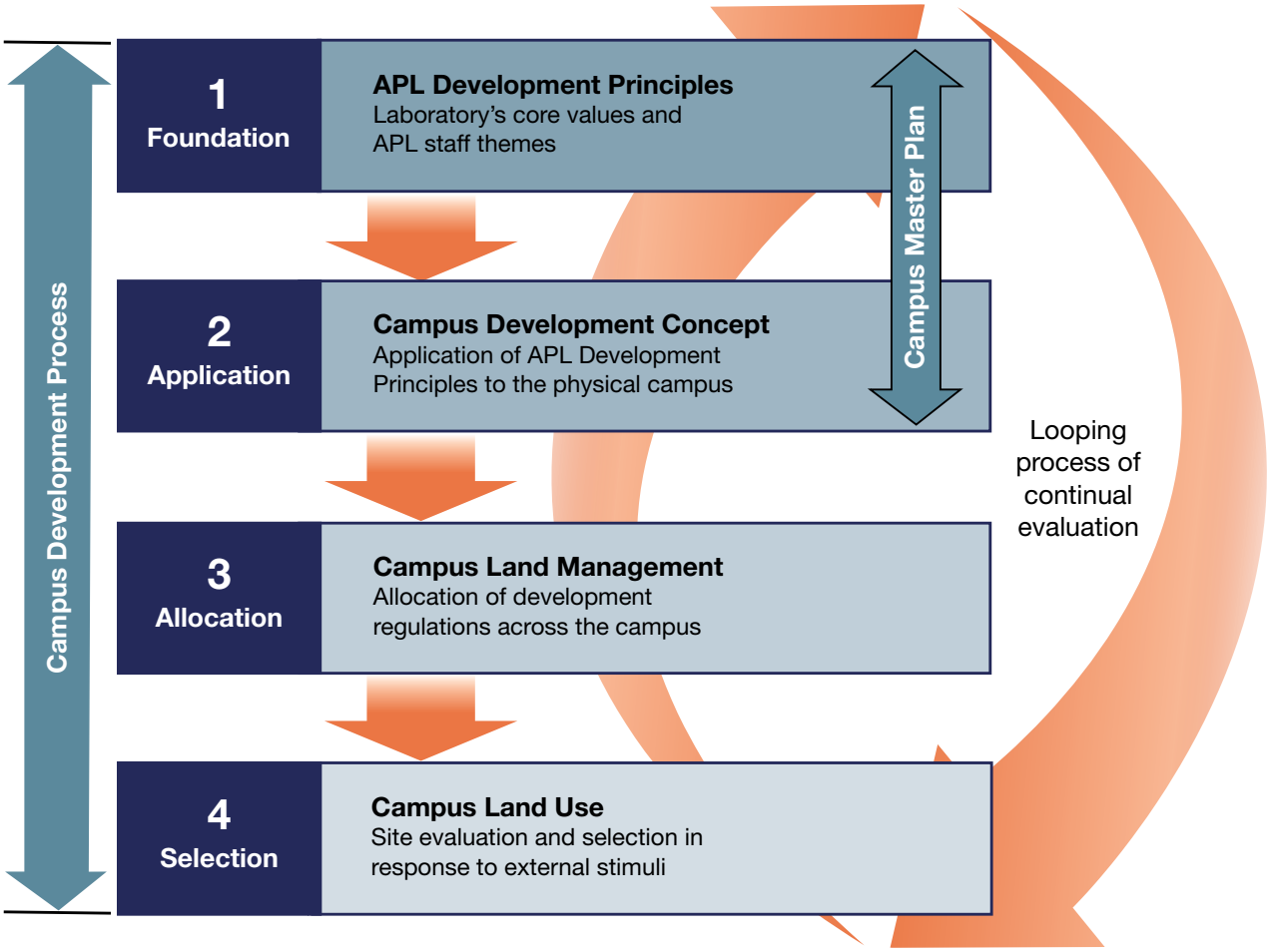

Figure 5. The four components of the Campus Development Process. The first two components, the APL Development Principles and the Campus Development Concept, make up the new Campus Master Plan. As the foundation and application elements of the process, they integrate the Laboratory's core values and culture with delivery of facilities and supporting assets. Campus Land Management is the continual allocation and management of requirements for and restrictions on land uses across all Laboratory properties. Campus Land Use is the selection of development sites in response to requirements from external, sponsor, and program stimuli.

Objectives

The four objectives for the APL Development Principles and Campus Development Concept are to provide a development plan that:

1. Reflects and is consistent with the Laboratory's core values and culture
2. Accelerates to a 30- to 40-year vision
3. Accommodates both large and small facility requests by providing an integrated, flexible, and adaptable framework
4. Anticipates a campus capacity of 10,000 staff

The first step in achieving these objectives was to ask how the Laboratory's core values and culture drive and innovate the development of its campus and ultimately how they are physically expressed in the Laboratory's built environment. The APL Development Principles answer this question by providing the tool and framework necessary to deliver the campus development vision. Applied to the existing campus, the Campus Development Concept provides the diagram indicating future Campus development opportunities, positioning elements in support of APL initiatives and organizational goals and objectives.

Input

The APL Development Principles combine the Laboratory's core values with APL's workplace culture. To fully represent the diversity of the Laboratory's workplace culture, input from APL staff members has been synthesized with content from industry thought leaders and precedent investigations.

Internal Input

Engagement with APL staff members included informal meetings and discussions as well as formal design charettes and scheduled activities. Staff members

contributed insights into what is most important to them in their workplace, emphasizing what is required to achieve success in their workplace environment. Staff members also described their vision for the Laboratory's lifestyle and culture and provided input on how these factors evolve over time. These engagements, which furthered understanding of current and desired workplace environments, channeled into four topics:

1. Clarifying internal and external brands
2. Embracing the Laboratory's past while moving forward
3. Developing an inclusionary culture
4. Framing an agile and nonprescriptive response

Concurrent to these discussions, the Future APL Design Exercise provided an additional avenue for staff members to influence campus development. A multiday Laboratory-wide event spread over several weeks, the exercise asked staff members to design a new campus, including desired work and amenity elements, within the current campus property limits. The designs provided insight into what is important to the staff professionally and personally.

Nine themes emerged:

1. Opportunity to be creative
2. Sense of connectedness
3. Proximity
4. Integration of technology
5. Integration of nature
6. Inspirational architecture
7. Sense of well-being
8. Life–work balance
9. An environment that is more like home

The themes create an inflection point, the characteristic of a defining innovation, typically achieved abnormally through inclusionary and collaborative efforts. In addition to these themes, staff members noted a desire for a heightened sense of workplace community and enhanced opportunities for collaborative engagement with colleagues to support innovation. Suggestions for interior workplace enhancements included additional conference areas and amenity spaces such as cafeterias, gyms, and exterior courtyards and gathering areas. Suggested exterior enhancements included additional open and green spaces, intra-campus mobility, and defined pedestrian walkways and vehicular roadways throughout the campus.

External Input

Discussions with industry thought leaders as well as facility tours and site visits to similar organizations provided benchmarking opportunities. Precedent investigations of existing campus planning approaches also provided insightful revelations from other organizations. The input from industry thought leaders in workplace and interior environments coalesced into the internal Laboratory discussions. The ideologies of Proximity, Privacy and Permission, now best practices in the design of workplace environments and how employees interface with shared and assigned workplaces, have been amalgamated into internal discussions along with the following 12 industry Workplace Design Principles:

1. Support colocation
2. Let people try new environments
3. Design for the most common workflows
4. Reduce barriers to connection
5. Play is serious work
6. The environment must support fluid idea generation
7. Create lots of third spaces for pausing and meeting
8. A building is a reflection of its people
9. Every community needs a town square
10. Bring the Laboratory vision to life in "wow" moments
11. Imbue spaces with unique identities
12. Give people opportunities to showcase live work

Precedents

Examination of other organizations' campus development solutions provide precedents for analysis. While locally and nationally known academic campuses provide some insight, the most compelling and spatially related campus precedent to the Laboratory is the Facebook campus in Menlo Park, California.

Situated on the eastern shore of the San Francisco peninsula between San Mateo and San Jose, California, the Facebook campus was built by private developers between 1993 and 1995. Facebook has continued developing the campus, originally occupied by Sun Microsystems and later Oracle, adding new facilities that emulate the company's culture, ideals, and values. Located on 57 acres, the initial campus includes over one million square feet of office and technical space spread across multiple buildings surrounding a central interior pedestrian environment. Surface parking lots surround the facilities. An additional 22-acre site located to the south and west of the initial campus is home to two large employee-occupied facilities. A regional roadway separates the locations from one another.

The similarities between the campuses of Facebook and APL are striking. Both exhibit bifurcated locations, or areas requiring connection, separated by public roadways; both have central interior pedestrian

environments; and both campuses have expansive surface parking surrounding their facilities. The campuses differ in their physical expression of their distinct cultures in the workplace environment. Facebook has been actively repositioning its facilities to convey its people-oriented, collaborative, and engaging culture. APL is only just beginning to express its culture in its campus. While Facebook has blatantly expressed its values physically, APL's expression is much more modest and composed, indicative of its culture.

The intent of this investigation was not to see how to make APL's workplace environment more like Facebook's. Rather it was to comprehend Facebook's aptitude in understanding its culture, program requirements, and employee needs and its subsequent delivery of a physically engaging workplace environment contributing to increased collaboration and idea sharing across the organization. This process provides a workplace of continual engagement, continually building upon itself, ultimately strengthening the organization.

This input has shaped the Laboratory's campus development discussion and provided invaluable insight into the creation of a tool to frame future campus development discussions. Blending APL's core values with this input created the APL Development Principles and their following component, the Campus Development Concept. The Campus Development Concept establishes a set of decision points that include continual input from APL staff.

Exterior and Interior Applications

To provide a cohesive workplace environment for APL staff, the APL Development Principles must apply to both exterior campus areas and interior facility spaces. Recognizing that APL is an organization composed of individuals who make up teams that make up the Laboratory, it is vital to understand how APL staff members relate to their workplace environment and how they collectively constitute the workplace experience.

APL staff members engage their workplace via personal and physical interactions. Personal interactions include human interfaces: colleagues, project teams, sponsors, etc. Physical interactions include the work space environment: office, fabrication, laboratory, technical, and support spaces, and parking, etc.

Categorizing the elements of workplace interactions create the "me," "team," and "we" experiential work space designations. Me spaces include the personal office and technical spaces that empower the APL staff member. Team spaces include project and collaboration areas that reinforce community connections and provide collaboration opportunities. We spaces make up the unique public spaces across the Laboratory that celebrate the APL vision. An APL staff member will engage multiple work space designations daily. Each designation applies to exterior and interior spaces and accommodates a scalable response. The campus's built response needs to address how staff move through and engage each of these spaces and the interactions that occur within each.

The APL Development Principles

As discussed, the APL Development Principles are built on the Laboratory's core values. They were established with APL staff input that was authenticated by industry thought leaders and corroborated with precedent investigations. The APL Development Principles is the first of four components of the Campus Development Process. Collectively all four components of this process provide a looping discussion, continually evaluating current decisions against the first two components of the Campus Development Process.

The organizational underpinning for the Campus Development Concept, the APL Development Principles are agility, connectivity, and identity. Agility allows the Laboratory to be flexible and adaptable in its development in response to APL staff needs and sponsor and program requirements. Connectivity promotes conscious and subconscious collaboration among APL staff members by ensuring intentional proximity. Identity is what makes the Laboratory a community and what makes it and its culture unique.

As the tool framing development discussions, the development principles provide a roadmap, but not the map itself, for future dialogue and decision-making. Implementation of the APL Development Principles provides the Laboratory with the framework and methodology for sustainable campus development. The principles are the basis of the design of the physical workplace environment, allowing APL's culture to shape the physical environment in the manner desired by APL staff and in a way that is indicative of the Laboratory's values. Figure 6 illustrates the APL Development Principles creation process.

Relationships

Application of the principles on the existing campus and the current built facilities to create the Campus Development Concept requires an understanding of the work processes and methodologies used by APL staff. A graphical representation of the Laboratory's work environment reveals multiple relationships among spaces, and these relationships define probable models for work space collaboration. Each relationship diagram has been evaluated against the APL Development Principles. The four diagrams include linear, axial, nodal, and satellite relationships.

A linear relationship implies a singular development track, with the next step occurring only after the previous one has been completed. In axial relationships, thought and idea development are fed into a centralized

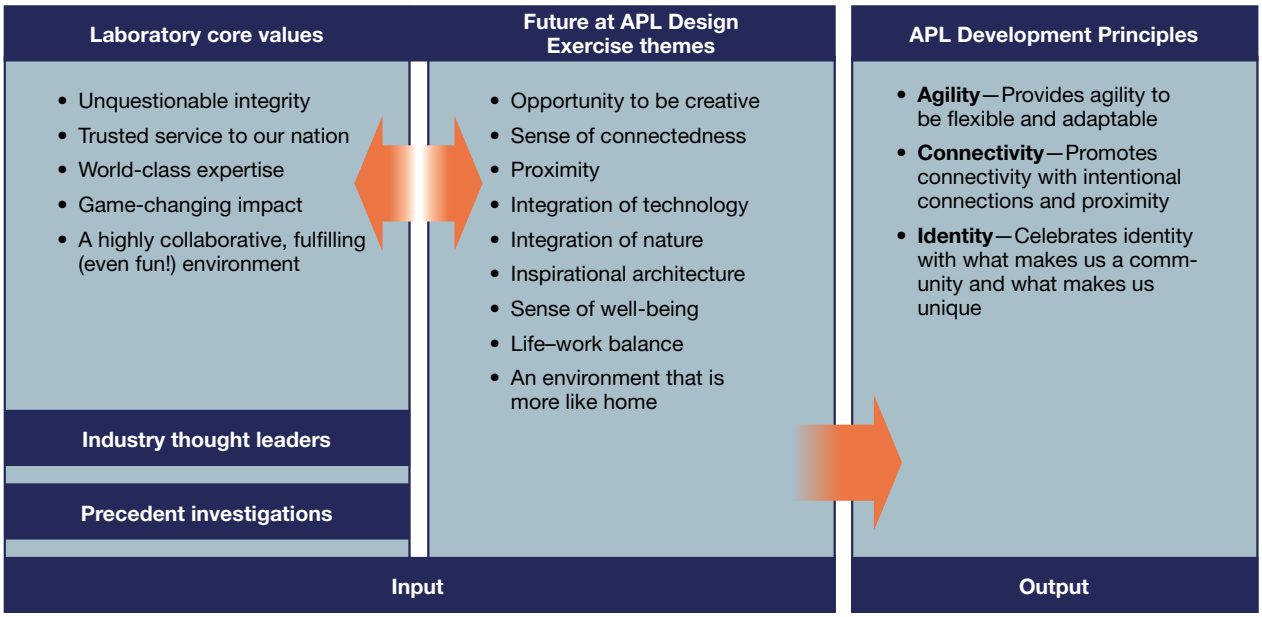

Figure 6. The APL Development Principles creation process. The principles were created from the assemblage of the Laboratory's core values, APL staff inputs including the Future at APL Design Exercise themes, authentications with industry thought leaders, and precedent investigations. As the tool framing development discussions, the principles provide a roadmap, but not the map itself, for future dialogue and decision-making.

assembly. Nodal relationships include a centralized repository and hub for idea sharing. With satellite relationships, work occurs in separate places. While all four diagrams express workplace environments, only two, axial and nodal, express the Laboratory's workplace and workflow environments while adhering to the APL Development Principles.

Evaluation of the axial and nodal relationship diagrams reveals that the Laboratory's workplace environment and workflow processes combine both relationships. The axial relationship allows for the free flow of ideas from an unlimited number of sources along a central spine, allowing each source to act as an informant to others. A scalable concept, this relationship diagram works at the Laboratory level. The nodal relationship is similar, but its interaction is more intimate, with input collected from individuals and project teams. Synthesized information from the nodal relationship's individual and project team repositories can be fed into the axial's central spine, or the Laboratory, offering the opportunity for idea sharing across the organization. Figure 7 illustrates the four relationship diagrams evaluated against the APL Development Principles and the collective axial and nodal diagram expressing the Laboratory's workplace and workflow processes of idea sharing and problem solving.

When the axial and nodal relationship diagrams are applied to the existing APL campus, four neighborhoods emerge. The nodal relationship diagram applies to the center of each neighborhood. The neighborhoods' connections are illustrated by the axial relationship diagram. Collectively they express the Laboratory's workplace and workflow processes of idea sharing and problem solving.

Neighborhoods

A neighborhood is typically thought of as an exterior space made up of elements with similar characteristics or occupants with similar backgrounds and interests. However, a neighborhood can also be an interior area where work and collaboration occur to help an organization achieve its own business objectives as well as those of its partners. Multiple neighborhoods within a given area typically have unique characteristics and identities. Adjacent neighborhoods may provide unique amenities to encourage cross-neighborhood interaction. Neighborhood edges are often blurry and intentionally undefined.

Neighborhoods emphasize intersections, with edges that can be quickly reached from their centers. Exterior neighborhood centers are typically open or green spaces. Interior neighborhood centers are congregation areas, including cafeterias, classrooms, and conference facilities. On a conscious level, neighborhoods orient participants and provide a sense of place amid the unique characteristics of central spaces. On a subconscious level, neighborhoods provide sensory feelings of organization and belonging.

The axial and nodal relationship diagramming effort reveals four neighborhoods making up the Laboratory's campus: the central, east, north, and south neighborhoods. This realization reframes the relationships among areas of the campus, recognizing the campus as an integrated community rather than made up of disparate

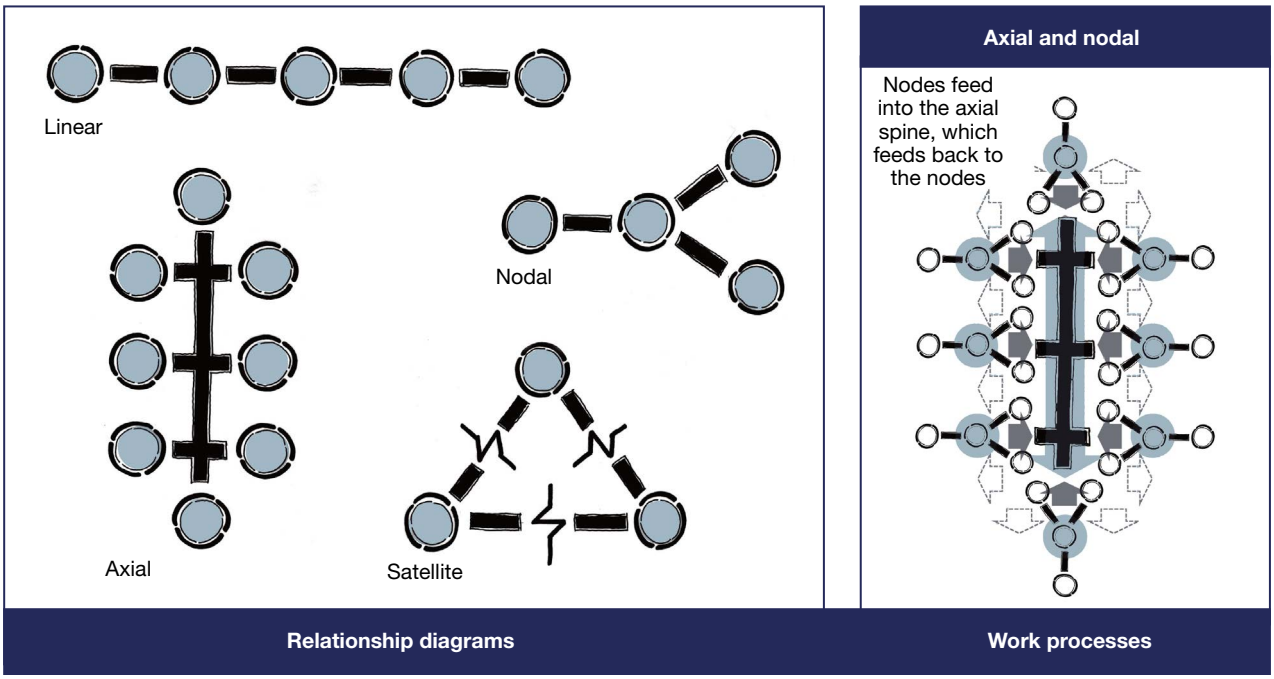

Figure 7. The four relationship diagrams illustrate axial, linear, nodal, and satellite relationships. While all four diagrams express workplace environments, only two, axial and nodal, express the Laboratory's workplace and workflow environments while adhering to the APL Development Principles.

locations. Figure 8 illustrates the application of the axial and nodal relationship diagrams revealing the campus neighborhood structure.

Current APL staff population concentrations support the neighborhood concept. Along the Laboratory's historical south-to-north development spine, high-density areas are collocated with areas of workplaces and amenities. Definable edges between neighborhoods vary in response to permeation opportunities. The most defined Laboratory neighborhood includes the facilities surrounding the Central Green.

Containing the Central Green, the central neighborhood provides APL staff members with work spaces, including office, fabrication, laboratory, technical, and support areas, and amenity spaces, including cafeterias, classrooms, conference facilities, gymnasiums, and exterior green spaces. The combined work and rejuvenation spaces provide opportunities for APL staff members to congregate for work and to recharge. Gathering areas, both planned and impromptu, within the central neighborhood encourage APL staff members to engage with one another, promoting idea sharing and fostering collaboration. This workplace environment provides the most desirable balance of work and amenity opportunities.

Two additional neighborhoods are densely populated by APL staff members: the south neighborhood, including Building 200, and the east neighborhood, including the Laboratory-owned and -leased facilities in the Montpelier Office Park.

Building 200 provides several amenities, including destination conference and cafeteria facilities, and its south neighborhood will soon be enhanced with the opening of Building 201. The influx of APL staff will increase planned and impromptu collaboration opportunities and bring additional amenities. A new open space, the South Green, will be located between the facilities. Further expansion into the Price family properties, the parcels east of Buildings 200 and 201, is being considered, but development costs and connection considerations present challenges that currently make development in other neighborhoods more beneficial to the Laboratory.

The Laboratory continues to purchase and lease facilities in the Montpelier Office Park in the east neighborhood. The office park was originally designed to accommodate individual tenants, with little or no planned interaction between building occupants. This presents unique challenges to APL as staff members increasingly need to collaborate and connect and have requested more mobility options and outdoor spaces. Recent attempts to overcome the physical barriers to collaboration through creative technological and physical solutions have proven successful. Further enhancements to the east neighborhood are planned, including additional pedestrian walkways, outdoor spaces, and a pedestrian connection between the central and east neighborhoods through the forested area. Figure 9 illustrates the elements of the existing central, east, north, and south neighborhoods along the Laboratory's

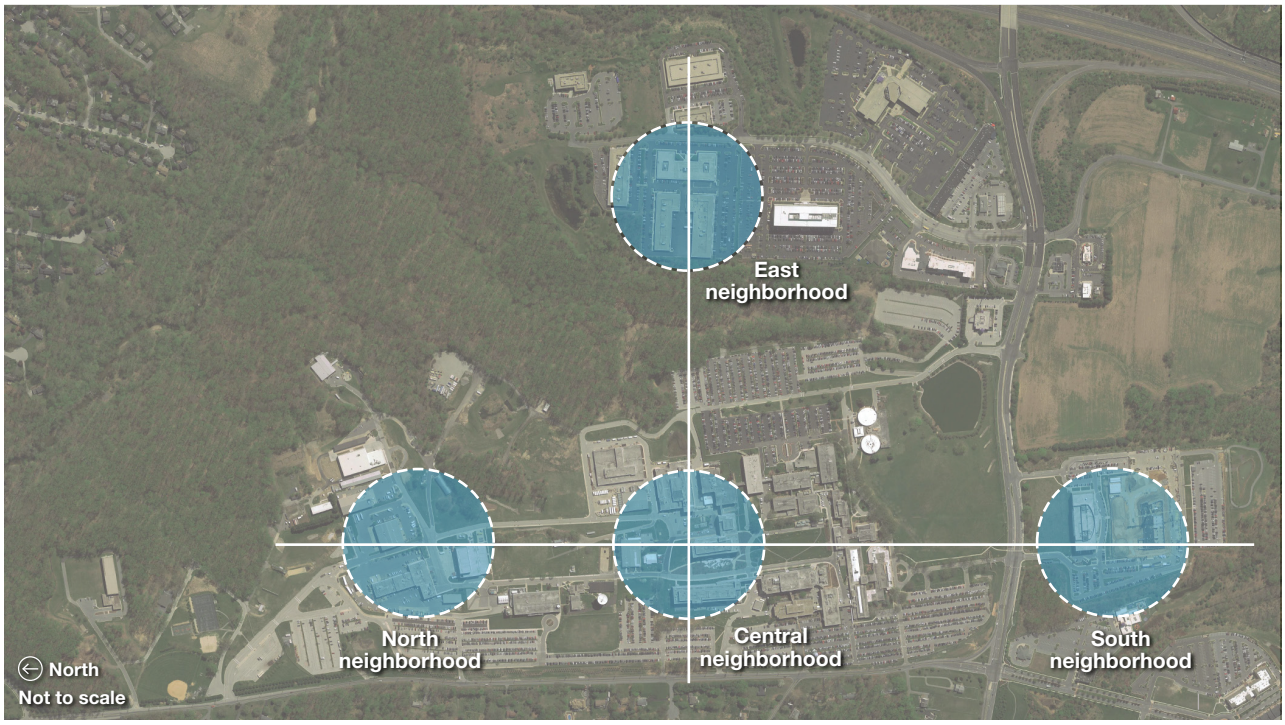

Figure 8. APL's campus neighborhoods. Application of the axial and nodal relationship diagrams reveals the four neighborhoods of the Laboratory's campus. This realization reframes the relationship between each area of the campus, recognizing the campus as an integrated community.

historical development spine and the current and potential placement of key building and program elements.

Validation of Development Principles and Concepts: Development of the North Neighborhood

The fourth neighborhood includes the area occupied by Buildings 23, 29, 30, 31, 32, 32A, 35, 42, and 48. Building 25 and the firehouse are located at the edge of this neighborhood. Designated the north neighborhood, this area has the greatest development potential on the campus. Because the neighborhood currently lacks a center, it provides limited opportunities for APL staff to collaborate, and the shortage of amenities limits idea sharing beyond building walls. The total population of APL staff working in this neighborhood is not large enough to take full advantage of the available infrastructure, leaving utilities and parking facilities underutilized.

The north neighborhood's existing conditions provide an opportunity for the Laboratory to validate its development principles, substantiating their usage as the basis for the Campus Development Concept. Once the concept is authenticated, it can then be applied to the entire campus.

Laboratory Staffing

Staffing levels are a key element in institutional development and campus planning. Reflecting data from multiple years and typically based on anticipated public and private funding, staffing levels determine work space requirements. However, APL's staffing levels are determined by sponsor and program needs. Requirements influence decisions about whether to develop a standalone facility or a combination of work spaces including office, laboratory, fabrication, technical, support, and other spaces. Once the composition of the work space types is understood and corroborated with required staffing levels in support of sponsor programs, the facility size and necessary supporting elements, including infrastructure and parking, can be calculated.

Understanding the Laboratory's anticipated growth trends is critical to the development of the north neighborhood. Over the past several years the Laboratory has grown its staff by an average of 5% annually. This increase, approximately 2% more than anticipated, comes as a result of APL's continued successes. The Laboratory's population is currently approximately 7,600 full- and part-time staff members distributed across all four neighborhoods. Temporary on-call staff and summer interns account for approximately 600 additional staff. Nearly 80% of these 8,200 staff members are assigned to work spaces in the central neighborhood. This percentage is expected to adjust downward with the opening of several new facilities in other neighborhoods.

The Laboratory currently has approximately 3.1 million gross square feet of built facilities. The current building expansion portfolio includes the opening of MP8 in the east neighborhood, Building 14 in the north

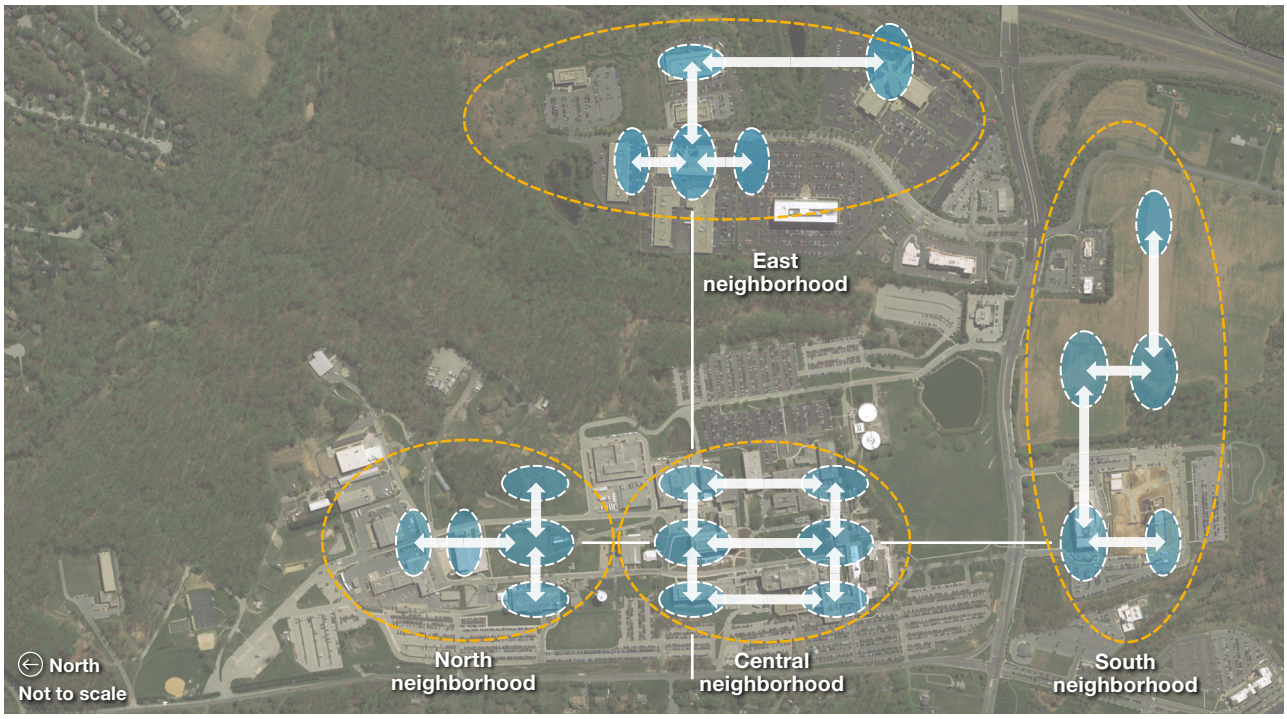

Figure 9. Elements of APL's neighborhoods. The central and south neighborhoods are high-density areas offering workplace and amenity opportunities to varying degrees. Increased connectivity to and within the east neighborhood enhances APL staff collaboration.

neighborhood, and Building 201 in the south neighborhood. All three facilities are anticipated to open in 2021 or 2022. Once these facilities open, the Laboratory will have more than 3.7 million gross square feet of built facilities. There are plans for an additional 750,000 gross square feet of facilities, which would bring APL to approximately 4.5 million gross square feet of interior space, a 50% increase in built facilities within a single decade.

The continual balancing of APL's population with available work space requires an overall vision. The enduring framework, the APL Development Principles and the Campus Development Concept, provides the holistic guidance necessary for future campus development. As the first two components of the Campus Development Process, they allow the Laboratory to accommodate the minute work space details of sponsor and program requests without the continual need to reexamine the campus development portfolio.

Conditions Analysis

Review of the north neighborhood reveals multiple circulation routes, internal and external to the campus, providing mobility opportunities for pedestrians and vehicles. Because the existing facilities are close to one another, people can easily move within the neighborhood on foot. The proximity of the north neighborhood to APL parking areas poses few accessibility concerns, and the north and central neighborhoods and beyond are accessible by a short walk or shuttle ride. Areas within the north neighborhood provide unique topography for multiple development sites, facility connections, and open space.

The need for a neighborhood center is the genesis for the north neighborhood development program. The neighborhood center will act as the focal point for existing and future facilities potentially incorporating office, fabrication, laboratory, technical, and support areas with amenities. This development will allow the staff to take full advantage of the unused infrastructure at this end of campus.

Application of the APL Development Principles

Applying the APL Development Principles of agility, connectivity, and identity to frame the north neighborhood development discussion integrates this neighborhood with the broader campus and ensures delivery of the preferred workplace environment to APL staff while advancing the Laboratory's image and character.

Agility

Development of the north neighborhood begins with the principle of agility and the relocation of the West Service Road from the east of Buildings 13, 21, and 23 to their west. The repositioning of the perimeter security fence will accommodate the relocated roadway and adjusted APL staff entry gates. This bold, game-changing shift in this area of the campus removes the

service roadway from the internal area of the north neighborhood, allowing greater flexibility for future development opportunities.

The area vacated by the service road will be transformed into a pedestrian and staff-oriented zone or outdoor mall, providing a safe and walkable connection between the north and central neighborhoods. Relocation of vehicular traffic to the neighborhood's perimeters reduces pedestrian and vehicular circulation conflicts while encouraging APL staff connection between facilities in this area of the campus. While service vehicles will still be allowed in this area, they will be the exception, not the norm.

The relocation of the service roadway strategically positions the north neighborhood for further development. Future opportunities regarding existing facility additions, previously unavailable, are now possible. Buildings facing the new pedestrian zone now have expansion opportunities including interior work space and amenity areas, enhanced connectivity within their interiors, and added exterior green spaces.

Connectivity

The principle of connectivity and the need for a neighborhood center provides the development's location. Positioned at the center of the north neighborhood, this development will provide links to Buildings 14, 23, 29, 30, 31, 33, and 35 as well as multiple future development sites within the neighborhood. The connection between these facilities and neighborhood spaces promote planned and impromptu staff interactions. Programmed to potentially include office, technical, integration, and amenity spaces, including classrooms, conference facilities, a cafeteria, and a gymnasium, this development and its accompanying program are projected to bring an additional 1,000 to 1,200 staff members to the north neighborhood. This increase, combined with the openings of Buildings 14 and 33 as well as the addition to Building 32A, will increase the population of the north neighborhood from just over 400 today to approximately 1,800. While some staff members arriving to the north neighborhood will be new to the Laboratory, others will be current staff members relocated from other areas of the campus. To meet the increased population, accommodate visitors, and help alleviate the parking challenges in other areas of campus, parking capacity and alternative staff commuting options will be added. Infrastructure enhancements, including expansion of existing utilities, are also planned. This development, including reallocation of space vacated by staff members moving to it, looks to achieve development equilibrium across the campus.

Exterior open space in the north neighborhood is a deliberate inclusion that enhances the workplace environment. Spatially, open space hierarchically arranges facilities, providing orientation and wayfinding. It also allows the neighborhood to establish its own identity and character. Facilities central to the neighborhood, those that make up its core, take on the additional importance of defining a unique experience. Replicating this environment through the neighborhood and subsequently across the campus creates a rhythm that encourages daily use of exterior space, facilitating planned and impromptu APL staff engagement opportunities through experiential movement.

Identity

The third APL Development Principle, identity, is the product of the previous two. Agility promotes a development program that anticipates future growth opportunities. Connectivity, the principle with the greatest impact on the staff, establishes development and program priorities framing hierarchical relationships and exemplifying the Laboratory's core values, workplace environment, and culture. Identity is the amalgamation of agility and connectivity. Expressed in the built campus environment as focal points, including interior and exterior destination and collaboration spaces, the embodiment of this principle says, "This is APL, this is how APL works, and this is what is important to APL." In response to the principles, the combined development program is designated as Building 28. Figure 10 illustrates the results of the application of the APL Development Principles, framing the development for the north neighborhood and designating the location of Building 28 and its accompanying development program.

Continued North Neighborhood Application

The APL Development Principles frame future campus growth opportunities in the north neighborhood beyond Building 28. Two development sites located between Buildings 17 and 28 provide the prospect for enhanced connectivity between the central and north neighborhoods. The relocation of APL staff and functions from Building 25 and the firehouse to other facilities position the area north of Building 17 for redevelopment. Additional development opportunities exist east of Building 28. All of these sites enable an agile response to future development in support of future sponsor and program requirements. Within the north neighborhood, each development site provides connectivity allowing APL staff members to move throughout the campus.

The new North Green is located south of Building 28. A direct response to the APL Development Principles, it promotes APL staff connectivity and neighborhood identity by providing planned and impromptu collaboration opportunities for APL staff. Facilities looking onto the North Green further neighborhood, campus, and Laboratory identity. Each building's unique embellishments,

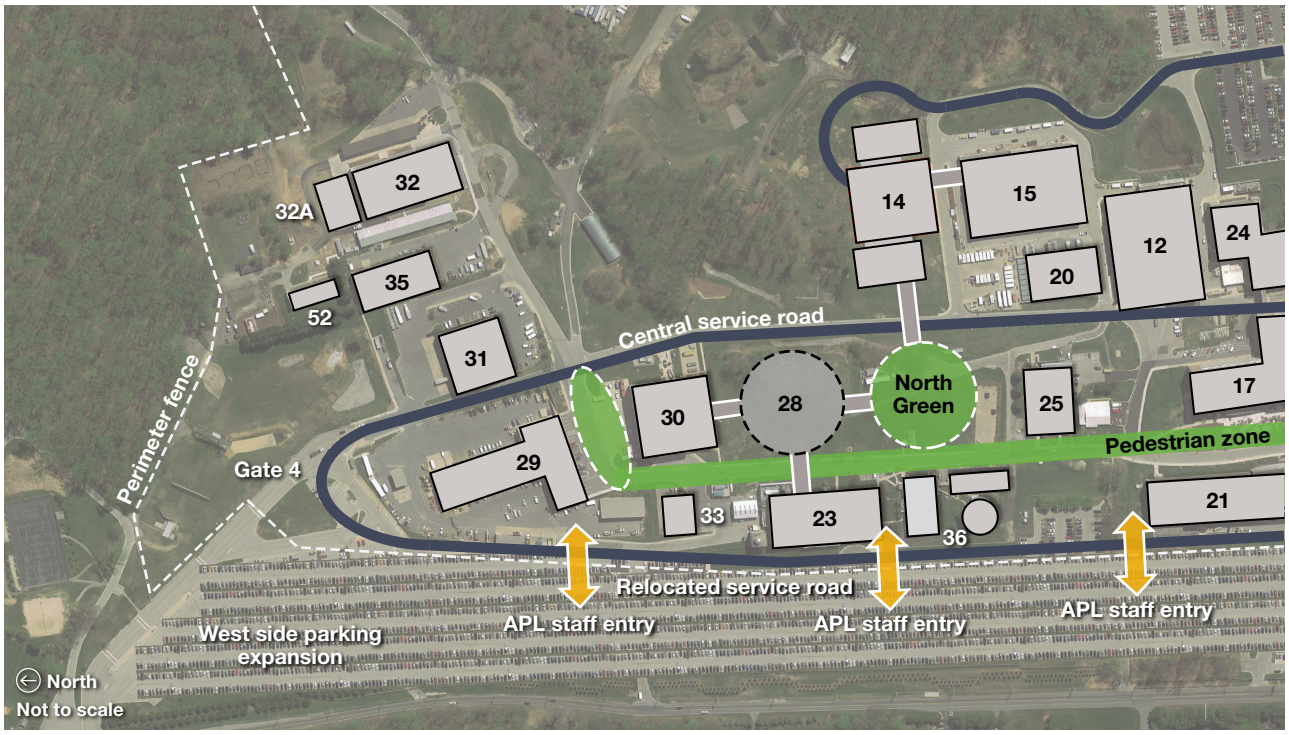

Figure 10. Application of the APL Development Principles of agility, connectivity, and identity frame the north neighborhood development discussion. Application of these principles integrates this neighborhood with the broader campus while ensuring delivery of the staff's preferred workplace environment. Beginning with the principle of agility, the West Service Road and perimeter security fence were relocated, creating a pedestrian and staff-oriented zone. The principle of connectivity yielded the location of the development which will potentially include office, technical, integration, and amenity spaces and provides connections to existing facilities. The third principle, identity, is evident in the resulting neighborhood environment and character expressing the Laboratory's core values and staff desires. The combined development program is designated as Building 28.

such as entry and building facade details, are recognizable. This orients APL staff and visitors and reduces dependence on facility numbering and campus maps, instead emphasizing the character and experience of the built environment.

The North Green may later become a landscaped roof terrace over a new underground facility. Taking advantage of the topography between Buildings 14, 17, and 28 allows this new building to be stepped or terraced into the existing hillside, appearing as a flush on-grade open space when viewed from Building 23 but architecturally expressing itself as a multi-story facility emerging from the hillside when viewed from Building 14. A connection between the east facade of this facility and the west facade of Building 14 enables greater APL staff connectivity and mobility between buildings.

Relocation of the Central Service Road from the west side of Buildings 12 and 14 and the van pad provides uninterrupted connection between Buildings 7, 8, 12, 14, and 15 and Buildings 31, 32 and 35. Once north of Building 52, the relocated Central Service Road connects to the relocated West Service Road north of Gate 4. The area vacated by the Central Service Road provides the opportunity for a second pedestrian zone between Buildings 24 and 31.

In addition to minimizing pedestrian and vehicular conflicts within the campus interior by relocating vehicular traffic to the perimeter and creating a pedestrian-focused interior space, the repositioning of both service roads yielded the opportunity for intra-connected development sites within the interior of the north neighborhood. Multiple sites along the eastern edge of the neighborhood are now viable considerations for future development, as are sites along its western edge.

Connections between buildings are available with the addition of Building 28. Continuing with the precedent in the south neighborhood, facilities in the north neighborhood have planned connections with a series of conditioned pedestrian bridges and underground corridors. A future connection is planned between Buildings D and 17, linking the central and north neighborhoods. Exterior connections are also provided and encouraged for use by APL staff between each of the facilities. Together these connections further collaboration and adjacencies.

Careful consideration continues to be given to building footprints, heights, and locations in the north neighborhood to minimize their impact on the 60-foot parabolic antenna. In addition to operational changes to the 60-foot parabolic antenna, impact mitigations include stepping back the facades of new buildings and the

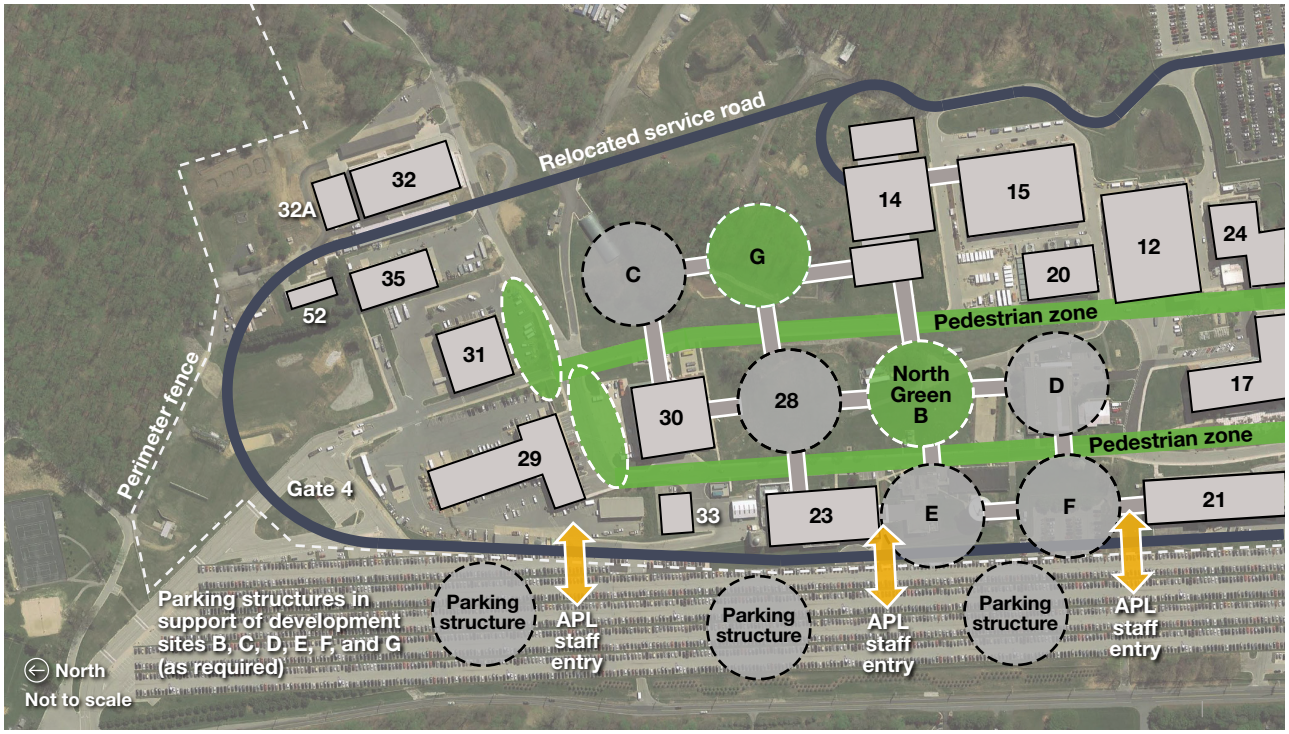

Figure 11. Future development opportunities available in the north neighborhood. Two development sites are located south of Building 28, including the North Green. Additional opportunities exist east and west of Building 28. A second pedestrian and APL staff zone is created with the relocation of the Central Service Road. Parking, circulation and supporting infrastructure will be provided to support the additional development.

careful positioning of building roof-mounted mechanical systems. Figure 11 illustrates the north neighborhood's development opportunities beyond Building 28. Figure 12 illustrates the development details in a section for this area of the north neighborhood, including anticipated connections between Buildings 30, 28, B, and D and heights of Buildings B and D. Figure 13 illustrates the development details in a section, including connections between Buildings 23, B, and 14 as well as Building B's anticipated uses and provision of the North Green.

APL staff shuttles, logistical activities, and maintenance service needs for each facility are accommodated with the relocated West and Central Service Roads. While there will be some maintenance service vehicle traffic within the newly established pedestrian zones, it will be the exception. Staff members can continue to use the multiple intra-campus mobility options. Staff members will enter the western side of the north neighborhood through new and relocated personnel gates. Additional entrances will be available on the east side of Buildings 14 and 24, as Building 28 is nearly equidistant from the central neighborhood's east parking area and the north neighborhood's west parking area. This proximity provides agility for the Laboratory to accommodate future parking demands in support of APL staff, visitor, and event requirements.

The parking area to the west of the north neighborhood along Sanner Road will be repositioned to accommodate additional APL staff and visitors. While parking is currently being added west of the north neighborhood, future expansion will include the renovation of existing surface lots and driveways, the addition of parking structures, or a combination of both. The quantity and type of parking facilities will be determined after analysis of financial considerations and impacts on local and regional roadway traffic volumes and their required mitigation. Impact mitigations include widening Sanner Road between Johns Hopkins Road and the Cedar Lane interchange with Maryland Route 32. This may also include the addition of dedicated turn lanes and signalized intersections between Sanner Road and the parking areas on the west side of campus. One or both mitigations may be required to expand the parking facilities on the west side in support of continued campus development needs. Additional improvements may also be required along Johns Hopkins Road at the entrances to the central, east, and south neighborhoods. Any improvements to public roadways will be in direct response to local and regional transportation requirements in support of Laboratory development approval requests.

To address this concern, campus access and parking solutions are being analyzed and developed at the campus level as part of the Campus Land Management component of the Campus Development Process. Current

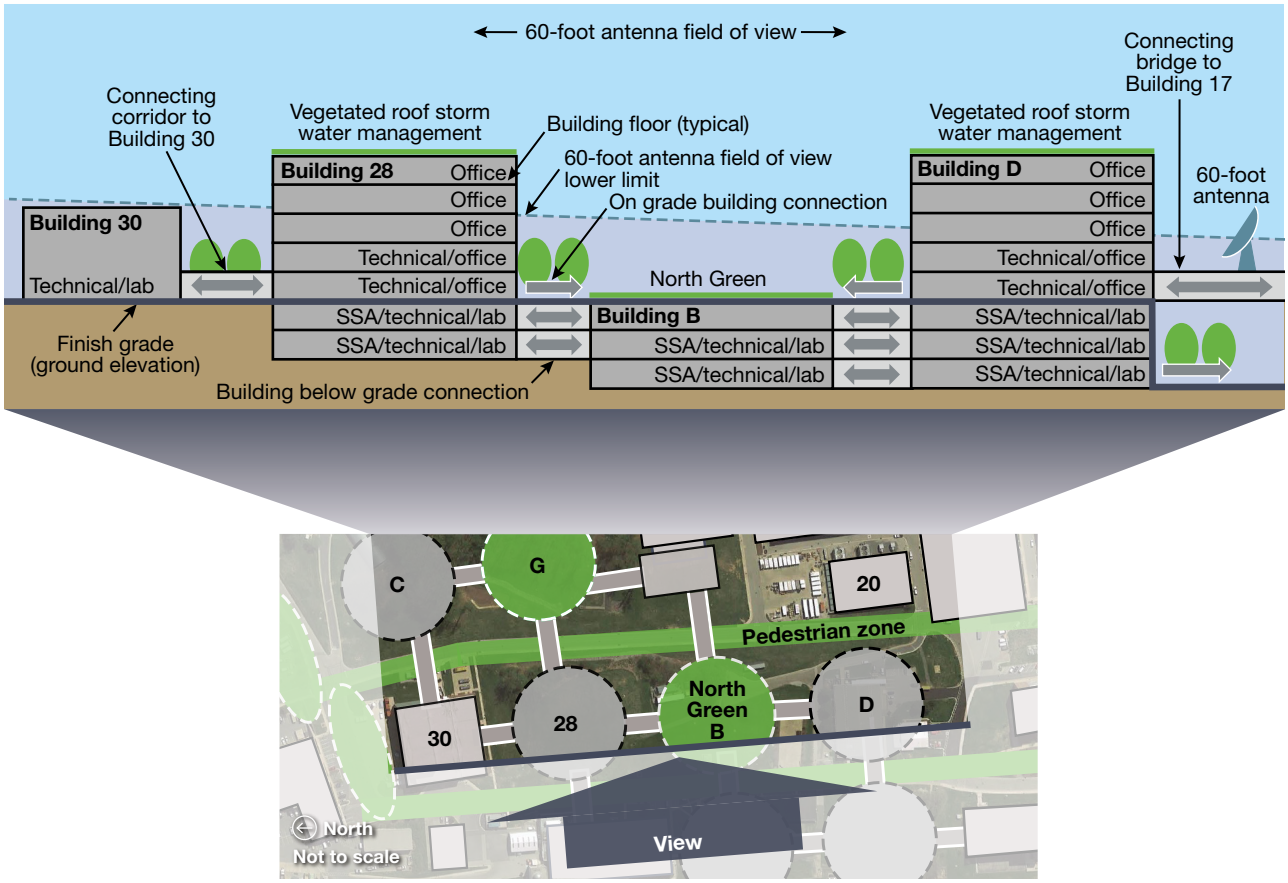

Figure 12. A section illustrating future development opportunities for the north neighborhood. Anticipated building heights and staff workplace uses are indicated by floor. Staff connections between proposed buildings include the use of enclosed elevated bridges, underground corridors and conditioned hallways. Connection between Buildings D and 17 provide an interior circulation route between the central and north neighborhoods. Building B, visible in the middle of the diagram, is an underground building. This facility's vegetated roof provides the North Green, a large green space for staff. Additional vegetated roofs are provided on Buildings 28 and D. Designed to accommodate government storm water regulations, the vegetated roofs reduce the need for land consuming open storm water ponds while providing roof mounted antenna and building mechanical equipment opportunities. The indicated 60-foot parabolic antenna's field of view provides the reminder of the importance of understanding the impacts new development has on existing facilities and programs and the need to find a balance to support both.

studies are underway that will integrate these solutions with Building 28. Study recommendations developed during the Campus Land Use component of the process will optimize the number of spaces available to APL staff and visitors while minimizing the Laboratory's expense of adding spaces. This includes examination of all campus driveways and entrances from the surrounding public roadways. Existing driveways between the west parking areas along Sanner Road will need to be reconfigured or eliminated to funnel campus traffic to fewer signalized intersections with dedicated turn lanes to enter and exit the property. Positioning of the signalized intersections will comply with state and county transportation regulations, including the minimum distance between intersections and colocation with neighboring roadways. Vehicle waiting queues at signalized intersections will be incorporated into the existing parking areas, impacting the overall space count.

This analysis and subsequent Campus Land Use solution is influenced by factors beyond just the development of the Laboratory. Modifications to existing roadways are also connected to local and regional development activities on nearby properties. Combined, all of these development activities add burden on the existing infrastructure. To continue to build facilities on the campus, the Laboratory may need to invest beyond the limits of its property, such as on public roadway and supportive infrastructure improvements. The expense associated with this external development will need to be balanced against the Laboratory's ability to deliver the facilities necessary to support sponsor and program requirements and may potentially shift development to other areas of the campus.

Campus Application

Application of the APL Development Principles across the campus produces the Campus Development

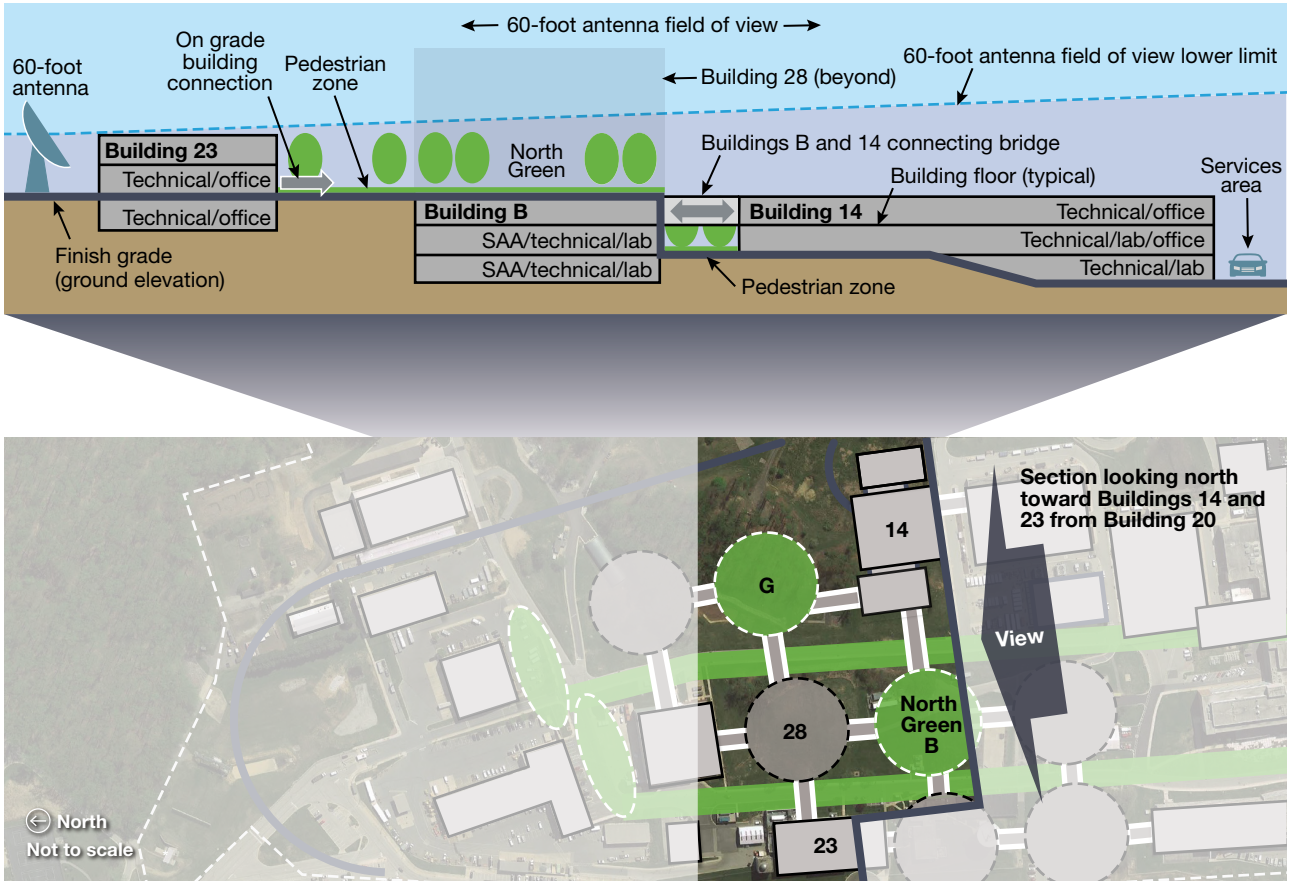

Figure 13. A section illustrating the development of the north neighborhood. Building B, visible in the middle of the diagram, provides an exterior connection to Building 23. An enclosed elevated bridge provides connection between Buildings B and 14. Interior connection between Buildings B and 23 is available via Building 28. All of the facilities in the north neighborhood are externally connected with two pedestrian zones and green spaces connecting the central and north neighborhoods. Both zones are possible with the relocation of the existing service roads to the neighborhood perimeter. This approach provides an agile and adaptable environment for future development decisions. The indicated 60-foot parabolic antenna's field of view provides the reminder of an awareness to balance new development with existing facilities.

Concept. Together the principles and development concept provide the new Campus Master Plan for the Laboratory. As the development framework, the Campus Development Concept diagrams sites across the property, indicating development opportunities in each neighborhood in response to the APL Development Principles. As the organizational construct sensitive to the Laboratory's current built environment, this tool will be used to make collaborative and strategic development decisions.

A scalable tool, the Campus Development Concept provides development direction for each campus neighborhood. Continued development infill efforts, including the replacement of older facilities, are being planned in the central and north neighborhoods. Further facility infill and replacement activities for the east neighborhood and development of the south neighborhood are under consideration. Expanded pedestrian and motorized mobility routes that connect all neighborhoods across the campus will be enhanced in support of continued development efforts.

Enhanced interior and exterior pedestrian routes and vehicular traffic, including routes for APL staff shuttles, logistical deliveries, and maintenance service, are accommodated with the internal road network. As staff mobility needs increase, options allowing greater capacity and shorter durations between destinations will be provided. Figure 14 illustrates the Campus Development Concept, demonstrating the growth opportunities for the campus when following the APL Development Principles.

CONCLUSION

The APL Development Principles—agility, connectivity, and identity—are applied to the campus using the conjoined axial and nodal relationship diagrams. Once the principles are overlaid, the east, central, north, and south neighborhoods materialize. Application of the principles at the neighborhood level yields opportunities for facility locations and collaboration. The principles also frame the relationship between facilities and their

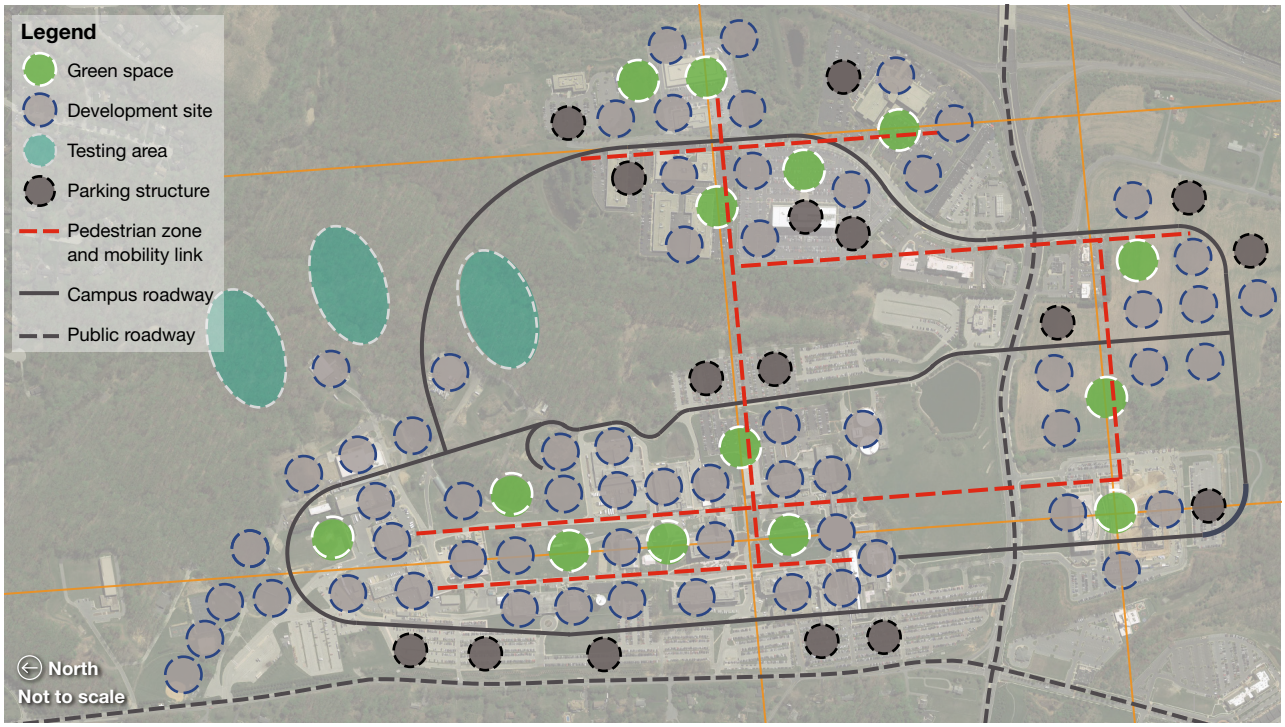

Figure 14. The Campus Development Concept. Application of the APL Development Principles—agility, connectivity, and identity—overlaid on the existing campus using the conjoined axial and nodal relationship diagrams produce the Campus Development Concept, the new Campus Master Plan for the Laboratory.

surrounding environments. Application of the principles to a facility's interior provides direction to balance office, fabrication, laboratory, technical, and support work spaces with collaborative and feature areas.

The continued application of the APL Development Principles, defined above, across the campus produces the Campus Development Concept. Providing the new Campus Master Plan for the Laboratory, the Campus Development Concept depicts development sites across the campus.

The tool to make informed and collaborative development decisions, the new Campus Master Plan, including the APL Development Principles and the Campus Development Concept, answers the question: "How do the Laboratory's core values and culture drive and innovate the development of its campus, and how are they physically expressed in the Laboratory's built environment?" Grounded in the Laboratory's core values, culture, and workplace lifestyle, the new Campus Master Plan was established by listening to APL staff members to understand current and desired workplace environments. Authenticated with industry thought leaders, and corroborated with precedent investigations, the new Campus Master Plan provides the foundation and application components of the Campus Development Process to direct the Laboratory's built expression of who it is, what it is doing, and where it wants to go in the future.

Brian E. Cornell, Business, Construction, and Facilities Department, Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland

Brian E. Cornell is the supervisor of the Campus Development Section at APL. He holds a BS in landscape architecture from Pennsylvania State University (Penn State). A collaborative landscape architect, master planner, and urban designer with professional licenses in multiple US states and Canadian provinces, Brian brings over 25 years of global public and private experience in master planning, landscape design, and implementation. At APL he is responsible for the development and implementation of the Campus Master Plan. Brian's previous work includes institutional, mixed-used, residential, and health care developments in the United States, Africa, China, Korea, and the Middle East, including multiple Leadership in Energy and Environmental Design (LEED)-awarded projects, renovation of landscapes listed on the National Register of Historic Places, and the design and implementation of resilient and economically and socially responsible exterior spaces. Brian is a contextual thinker focused on delivering a work space environment that expresses the Laboratory's culture and values, and he regularly collaborates with staff members in support of these efforts. His email address is brian.cornell@jhuapl.edu.